



Cape Cod Bridges Program

Bourne, Massachusetts

Draft Environmental Impact Report

SUBMITTED TO:
Secretary of Energy and Environmental Affairs
Executive Office of Energy and Environmental Affairs (EEA)
Massachusetts Environmental Policy Act (MEPA) Office
100 Cambridge Street, Suite 900
Boston, MA 02114

PROPONENT:
The Massachusetts Department of Transportation
Highway Division
10 Park Plaza
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Submitted August 2025

massDOT
Massachusetts Department of Transportation

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September 2, 2025

Secretary Rebecca Tepper
Executive Office of Energy and Environmental Affairs
Massachusetts Environmental Policy Act (MEPA) Office
Attn: Tori Kim, MEPA Director
100 Cambridge Suite, Suite 900
Boston, MA 02114

Re: Bourne – Cape Cod Bridges Program (EEA# 16695)
(MassDOT Project Number: 608020)

Dear Secretary Tepper and Director Kim:

The Massachusetts Department of Transportation is pleased to submit for your review the enclosed Draft Environmental Impact Report for the Cape Cod Bridges Project, which proposes to replace the Sagamore and Bourne highway bridges spanning the Cape Cod Canal; reconfigure the highway approach networks north and south of the canal to align with the replacement highway bridges; and provide improved pedestrian and bicycle accommodations along the replacement bridges and local roadway network. The purpose of the Cape Cod Bridges Project is to improve cross-canal mobility and accessibility between Cape Cod and mainland Massachusetts for all road users and to address the increasing maintenance needs and functional obsolescence of the aging Sagamore and Bourne Bridges, which are both currently owned, operated, and maintained by the U.S. Army Corps of Engineers as part of the Cape Cod Canal Federal Navigation Project.

While the original intent was to submit a single, joint environmental document addressing both state (MEPA) and federal (National Environmental Policy Act) requirements, MassDOT has opted to file the DEIR first, followed by the Draft Environmental Impact Statement under NEPA. This phased approach will provide the public with ample opportunity to review and comment on each document individually, ensuring a thorough and transparent environmental review process. Notice of Availability of the federal DEIS is anticipated to be published in the Federal Register in late summer/early fall 2025.

Please publish the notice of availability of the DEIR for public review in the September 10th edition of the Environmental Monitor. We request that the comment period be extended by two-weeks, to provide additional time to review and comment on the document. Based on this proposed schedule, we understand that comments will be due by October 24, 2025, and a certificate would be issued on October 31, 2025.

MassDOT has scheduled a Public Open House for **Thursday, September 25, 2025,** from **3:00 PM to 7:00 PM**, to be held at the **Bourne Veteran's Memorial Community Center** located at 239 Main Street Buzzards Bay, MA 02532. MassDOT officials and project design team members will present to share details about the Cape Cod Bridges Project as described in the DEIR and respond to questions related to both the project and the environmental review process.[1]

[1]For accommodation or language assistance, please contact MassDOT's Chief Diversity and Civil Rights Officer by phone (857-368-8580), TTD/TTY at (857) 266-0603, fax (857) 368-0602 or by email (MassDOT.CivilRights@dot.state.ma.us). Requests should be made as soon as possible prior to the

This DEIR has been distributed electronically as per the requirements of MEPA as further specified in the Secretary's Certificate on the Environmental Notification Form (ENF) issued July 7, 2023. Requests for translation of the Executive Summary and/or hard copies of the DEIR should be directed to Mark Kolonoski at 617-532-2351 or via e-mail at mkolonoski@hntb.com.

Sincerely,

Luisa Paiewonsky

Luisa Paiewonsky
Executive Director
Megaprojects Delivery Office

meeting, and for more difficult to arrange services including sign-language, CART or language translation or interpretation, requests should be made at least ten business days before the meeting.

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Appendices and Attachments

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Appendix 7, Secretary's Certificate and MEPA Review Comments

Acronyms and Abbreviations

Acronym/Abbreviation	Definition
AAB	Architectural Access Board
AADT	Average Annual Daily Traffic
AASHTO	American Association of State Highway and Transportation Officials
AAWDT	average annual weekday traffic
ACEC	Area of Critical Environmental Concern
ACHP	Advisory Council on Historic Preservation
ACM	asbestos-containing materials
ACS	American Community Survey
ADA	Americans with Disabilities Act
ADT	Average Daily Traffic
ANRAD	Abbreviated Notice of Resource Area Delineation
APE	Areas of Potential Effects
ARPA	Archaeological Resources Protection Act
ASL	American Sign Language
ASTM	American Society for Testing and Materials
AUL	Activity Use Limitation
BA	Biological Assessment
BFE	Base Flood Elevation
BG	Block Group
BGEPA	Bald and Gold Eagle Protection Act
BLSF	Bordering Land Subject to Flooding
BMP	best management practices
BN	Bourne North (quadrant)
BO	Biological Opinion
BRA	Bourne Recreation Authority
BS	Bourne South (quadrant)
BUAR	Board of Underwater Archaeological Resources
BVW	Bordering Vegetated Wetlands

Acronym/Abbreviation	Definition
CAA	Clean Air Act
CADD	computer aided design and drafting
CAF	capacity adjustment factors
CART	Communication, Access, Realtime Translation
CB	Coastal Bank
CBO	community-based organizations
CCAA	Candidate Conservation Agreement with Assurances for the Monarch Butterfly
CCC TIP	Cape Cod Canal Area Transportation Improvement Program
CCCTS	Cape Cod Canal Transportation Study
CCETP	Cape Cod Emergency Traffic Plan
CCRTA	Cape Cod Regional Transit Authority
CDWM	Construction and Demolition Waste Management Plan
CEQ	Council on Environmental Quality
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
CF	cubic feet
CFR	Code of Federal Regulations
CGP	Construction General Permit
CH4	methane
CHS	Coastal Hazard System
CMF	crash modification factors
CMP	Conservation Management Plan
CMR	Code of Massachusetts Regulations
CO	carbon monoxide
CO2	carbon dioxide
CP4	Construction Period Erosion, Sedimentation and Pollution Prevention Plan
CSO	combined sewer overflow
CT	census tract (use with specific census tract number; otherwise, spell out lowercase)
CTPS	Central Transportation Planning Staff
CWA	Clean Water Act

Acronym/Abbreviation	Definition
CY	Calendar Year
D-B	Design-Build
D-B-B	Design-Bid-Build
dBA	A-weighted decibel(s)
DCR	Massachusetts Department of Conservation and Recreation
DEIR	Draft Environmental Impact Report
DGA	Designated Geographic Area
DHCD	Massachusetts Department of Housing and Community Development
DPA	Designated Port Area
DPH	Massachusetts Department of Public Health
DPM	diesel particulate matter
EA	Environmental Assessment
EB	eastbound
EC	Engineering Circular
EFH	Essential Fish Habitat
EH	Estimated Habitat
EHASP	Environmental
EIR	Environmental Impact Report
EJ	Environmental Justice
ENF	Environmental Notification Form
EO	Executive Order
EOD	Equity Outreach Dashboard
EOS	Enhancement of Survival
EPA	U.S. Environmental Protection Agency
EPD	Environmental Product Declaration
ERDC	Engineer Research and Development Center
ESA	Endangered Species Act (Note: Spell out Environmental Site Assessment)
FAA	Federal Aviation Administration
FCM	fracture critical members

Acronym/Abbreviation	Definition
FEIR	Final Environmental Impact Report
FEIS	Final Environmental Impact Statement
FEMA	Federal Emergency Management Agency
FFY	Federal Fiscal Year
FHWA	Federal Highway Administration
FIRM	Federal Insurance Rate Map
FIS	Flood Insurance Study
FNP	Federal Navigation Project
FONSI	Finding of No Significant Impact
FRA	Federal Railroad Administration
FTA	Federal Transit Administration
FWCA	Fish and Wildlife Coordination Act
GARFO	Greater Atlantic Regional Fisheries Office
GATRA	Greater Attleboro-Taunton Regional Transit Authority
GHG	greenhouse gas
GIZ	Growth Incentive Zone
GPR	ground-penetrating radar
HCM	Highway Capacity Manual
HCS	Highway Capacity Software
HEC	Hydraulic Engineering Circular
IAGWSP	Impact Area Groundwater Study Program
IC	Intersection Control
ICE	Intersection Control Evaluation
IHSDM	Interactive Highway Safety Design Manual
ILSF	Isolated Land Subject to Flooding
IPaC	Information for Planning and Consultation
IPCC	Intergovernmental Panel on Climate Change
IWPA	Interim Wellhead Protection Area
JBCC	Joint Base Cape Cod

Acronym/Abbreviation	Definition
JD	Jurisdictional Determination
LBP	lead-based paint
LCP	Local Comprehensive Plan
LCSCF	Land Subject to Coastal Storm Flowage
LEP	Limited English Proficiency
Leq	equivalent sound level
LID	Low Impact Development
LiDAR	Light Detection and Ranging
LOS	Level of Service
LSCSF	Land Subject to Coastal Storm Flowage
LST	Land surface temperatures
LSTA	Land Subject to Tidal Action
LTH	Loudest Traffic Hour
LUO	Land Under Ocean
LUW	Land Under Water Bodies and Waterways
LWCF	U.S. Land and Water Conservation Fund Act
MA CZM	Massachusetts Office of Coastal Zone Management
MA EEA	Massachusetts Executive Office of Energy and Environmental Affairs
MA WPA	Massachusetts Wetlands Protection Act
MA CZMP	Massachusetts Coastal Zone Management Program
MACRIS	Massachusetts Cultural Resources Information System
MassDEP	Massachusetts Department of Environmental Protection
MassDOT	Massachusetts Department of Transportation
MassWildlife	Massachusetts Division of Fisheries and Wildlife
MBTA	Massachusetts Bay Transportation Authority
MBTA	Migratory Bird Treaty Act
MCP	Massachusetts Contingency Plan
MCCP	Massachusetts Climate Change Projections
MC-FRM	Massachusetts Coast Flood Risk Model

Acronym/Abbreviation	Definition
MCP	Massachusetts Contingency Plan
MEPA	Massachusetts Environmental Policy Act
MESA	Massachusetts Endangered Species Act
MGL	Massachusetts General Law
MHC	Massachusetts Historic Commission
MHHW	Mean Higher High Water
MHHI	median household income
MHW	Mean High Water
MLLW	Mean Lower Low Water
MLW	Mean Low Water
MMPA	Marine Mammal Protection Act
MMR	Massachusetts Military Reservation
MOA	Memorandum of Agreement
MOE	Measure of Effectiveness
MOU	Memorandum of Understanding
mph	miles per hour
MRE	Major Rehabilitation Evaluation
MRER	Major Rehabilitation Evaluation Report
MS4	municipal separate storm sewer system
MSAT	mobile source air toxics
MTL	mean tide level
MVMT	million vehicle miles traveled
N20	nitrogen dioxide
NAAQS	National Ambient Air Quality Standards
NAC	Noise Abatement Criteria
NACCS	North Atlantic Coast Comprehensive Study
NACTO	National Association of City Transportation Officials
NAICS	North American Industry Classification System
NAVD88	North American Vertical Datum of 1988

Acronym/Abbreviation	Definition
NB	northbound
NCHRP	National Cooperative Highway Research Program
NEPA	National Environmental Policy Act
NHESP	Natural Heritage and Endangered Species Program
NHL	National Historic Landmark
NHPA	National Historic Preservation Act
NMFS	National Marine Fisheries Service
NO2	nitrogen dioxide
NOAA	National Oceanic and Atmospheric Administration
NOI	Notice of Intent
NOx	nitrogen oxides
NP&EDC	Nantucket Planning and Economic Development Commission
NPDES	National Pollution Discharge Elimination System
NRHP	National Register of Historic Places
NTP	Notice to Proceed
O3	ozone
O-D	origin-destination
OHM	oil and hazardous material
ORAD	Order of Resource Area Delineation
OSHA	Occupational Safety and Health Administration
OTP	Office of Transportation Planning
OWJ	Officials with Jurisdiction
PAH	polycyclic aromatic hydrocarbons
Pb	lead
pc/mi/ln	per mile per lane
PCB	polychlorinated biphenyl
PDDG	Project Development and Design Guide
PH	Priority Habitat
PIMA	Public Involvement Management Application

Acronym/Abbreviation	Definition
PIP	Public Involvement Plan
PM10	respirable particulate matter of diameter less than 10 microns
PM2.5	fine particulate matter of diameter less than 2.5 microns
ppb	parts per billion
ppm	parts per million
ppv	parts per
Program	Cape Cod Bridges Program
Program	Cape Cod Bridges Program (use for all technical reports and DEIS/DEIR chapters)
PROTECT	Promoting Resilient Operations for Transformative, Efficient, and Cost-Saving Transportation
PROWAG	Public Right-of-Way Guidelines
PVP	potential vernal pools
RCNM	Roadway Construction Noise Model
RCRA	U.S. Resource Conservation and Recovery Act
REC	Recognized Environmental Condition
RHA	Rivers and Harbors Act
RMAT	Resilient Massachusetts Action Team
ROD	Record of Decision
ROW	right-of-way
RPP	Regional Policy Plan
RSA	Road Safety Audits
RSLR	relative sea level rise
RTE	rare, threatened, and endangered species
RTP	Regional Transportation Plan
SAF	Safety Adjustment Factors
SAV	Submerged Aquatic Vegetation
SB	southbound
SCM	storm control measure
SCS	Soil Conservation Service
Section 4(f)	Section 4(f) of the U.S. Department of Transportation Act of 1966

Acronym/Abbreviation	Definition
SF	square feet
SHLO	state highway layout
SHMCAP	Massachusetts State Hazard Mitigation and Climate Adaptation Plan
SHPO	State Historic Preservation Officer
SLR	sea level rise
SMS	Stormwater Management Standards
SN	Sagamore North (quadrant)
SO2	sulfur dioxide
SOI	Secretary of Interior
SPUI	Single-Point Urban Interchange
SRHP	State Register of Historic Places
SRPEDD	Southeastern Regional Planning & Economic Development Commission
SS	Sagamore South (quadrant)
SSA	sole source aquifer
SUP	shared-use path
SWOT	Strengths, Weaknesses, Opportunities, and Threats
SWPPP	Stormwater Pollution Prevention Plan
TAZ	Transportation Analysis Zone
TBD	To Be Determined
THPO	Tribal Historic Preservation Officer
TIAS	Traffic Impact and Access Study
TIP	Transportation Improvement Program
TMDL	Total Maximum Daily Load
TMP	Traffic Management Plan
TNM	Traffic Noise Model
TOY	time of year
TRB	Transportation Research Board
TRI	Toxics Release Inventory
TSCA	U.S. Toxic Substances Control Act

Acronym/Abbreviation	Definition
TSS	Total Suspended Solids
UMDI	University of Massachusetts Amherst Donahue Institute
Uniform Act	Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970
USACE	U.S. Army Corps of Engineers
USC	United States Code
USCG	U.S. Coast Guard
USDOT	U.S. Department of Transportation
USFWS	U.S. Fish and Wildlife Service
UST	underground storage tank
VAST	Vulnerability Assessment Tool
VHT	vehicle hours traveled
VMT	vehicle miles traveled
VOC	volatile organic compounds
VPI	Virtual Public Involvement
WB	westbound
WCSC	Waterborne Commerce Statistics Center
WOTUS	Waters of the United States
WQS	Water Quality Standards
µg/m^3	microgram per cubic meter

Acronym/Abbreviation	Definition
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ES.1 Introduction

This executive summary provides an overview of the Draft Environmental Impact Report (DEIR) for the Cape Cod Bridges Program (Program). The purpose of the DEIR is to analyze and disclose the anticipated social, economic, and environmental impacts of the Program under the Massachusetts Environmental Policy Act (MEPA). The executive summary is not intended to be a substitute for the DEIR. Please refer to the DEIR and its appendices for additional information.

ES.2 What is the Cape Cod Bridges Program?

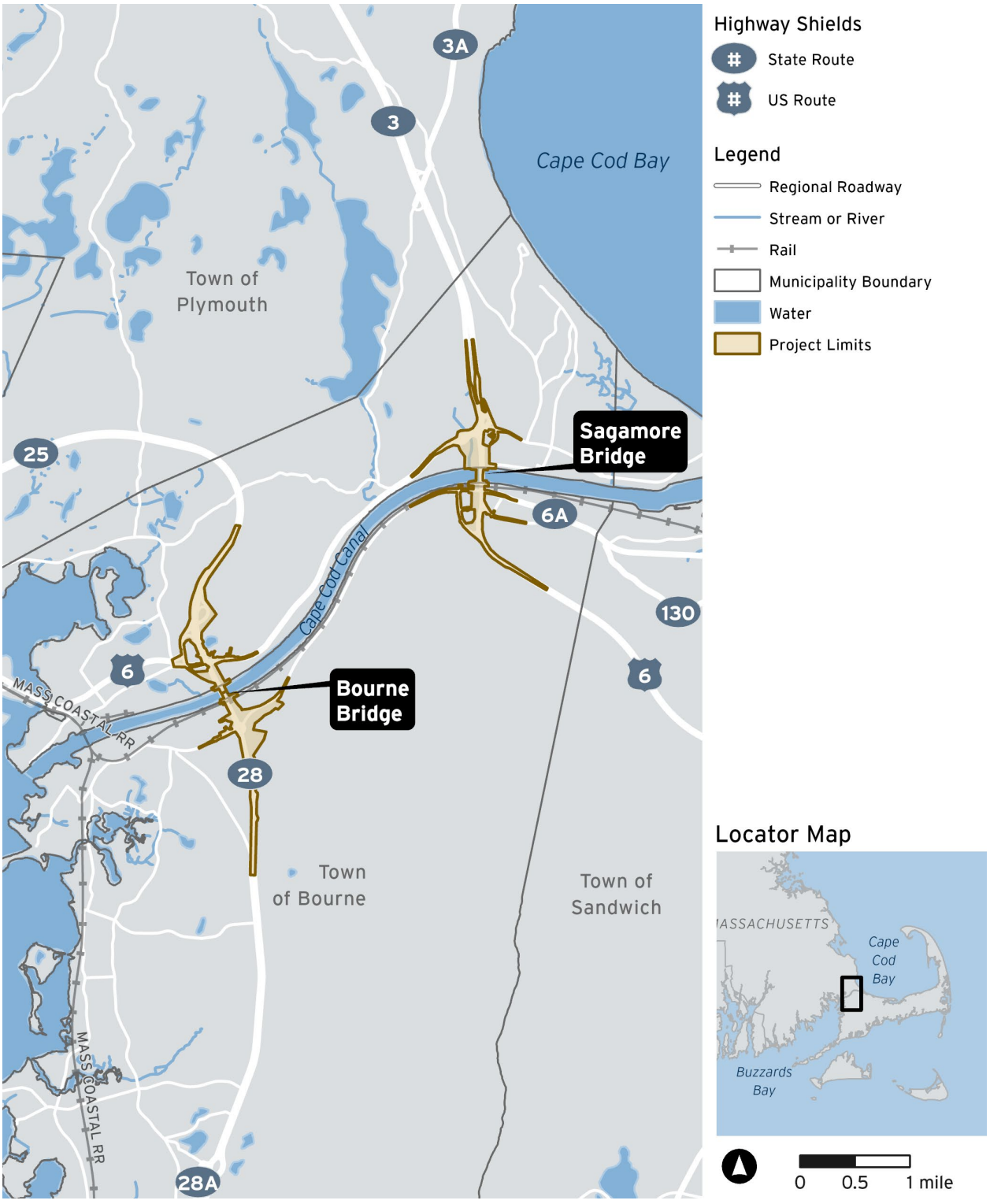
The Program, proposed by the Massachusetts Department of Transportation (MassDOT) and the Federal Highway Administration (FHWA), in partnership with the U.S. Army Corps of Engineers (USACE), would replace Sagamore and Bourne Bridges in the town of Bourne, Barnstable County, Massachusetts. Sagamore Bridge carries U.S. Route 6 across Cape Cod Canal, the Massachusetts Coastal Railroad, and Sandwich Road. Bourne Bridge, which is approximately 3.5 miles west of Sagamore Bridge, carries State Route 28 across Cape Cod Canal, Sandwich Road, and the Massachusetts Coastal Railroad.

Sagamore and Bourne Bridges are federally owned, operated, and maintained by the USACE as part of the Cape Cod Canal Federal Navigation Project. Cape Cod Canal separates Cape Cod from mainland Massachusetts, with Sagamore and Bourne Bridges being the only ways for car travel on and off Cape Cod. As the only roadway connections between Cape Cod and the mainland, the bridges are critical assets for the economy of the Cape Cod region and serve as essential routes for daily commuting, truck freight distribution, tourism, and hurricane evacuation off Cape Cod and the Islands (including Martha's Vineyard, Nantucket, and Elizabeth Islands). Both bridges, built between 1933 and 1935, are in deteriorated condition and functionally obsolete as they do not meet current design standards.

Sagamore and Bourne Bridges are the only roadway connections between the mainland and the Cape Cod peninsula, serving 230,000 year-round residents of Barnstable County and millions of annual visitors to the Cape Cod region.

The Program proposes replacing the deteriorating and functionally obsolete Sagamore and Bourne Bridges with new bridges built to modern design standards; constructing separated pedestrian and bicycle accommodations along the replacement bridges with connections to the local roadway network; and reconfiguring the highway approach networks north and south of Cape Cod Canal to align with the replacement bridges. The Program would be delivered in two phases, with the Sagamore Bridge Replacement Project as Phase 1 and the Bourne Bridge Replacement Project as Phase 2. **Figure** ES-1 depicts the approximate Project Limits at Sagamore and Bourne Bridges.

Figure ES-1. Bridge Locations and Project Limits



Source: Massachusetts Department of Transportation, 2024

ES.3 What is the status of the Massachusetts Environmental Policy Act and National Environmental Policy Act reviews for the Program?

The Program is subject to regulatory review under MEPA due to the requirement for state agency actions and exceedance of review thresholds outlined in Section 11.03 of the MEPA regulations. MassDOT is the Lead State Agency for review under MEPA.

On April 28, 2023, MassDOT submitted an Environmental Notification Form (ENF) for the Program to the MEPA Office. The ENF was published in the Environmental Monitor on May 10, 2023, which started the public comment period. On July 7, 2023, the Secretary of Massachusetts Executive Office of Energy and Environmental Affairs (MA EEA) issued a Certificate on the ENF (MA EEA #: 16695), which required the submission of a mandatory Environmental Impact Report (EIR) and included a scope of additional analysis for a DEIR.

The Program is also subject to regulatory review under the National Environmental Policy Act (NEPA) due to the allocation of federal funding for the Sagamore Bridge Replacement Project. The FHWA is the Lead Federal Agency for review under NEPA. NEPA requires federal agencies to consider the environmental impacts of their proposed actions (such as funding or permitting) on the human and natural environment, document these analyses, and make the information available to the public for review and comment before implementing those actions.

In August 2023, the FHWA determined that the Program is likely to have a significant impact on the environment, thereby requiring the preparation of an Environmental Impact Statement (EIS). As the recipient of federal funds for the Program, MassDOT is the Project Sponsor and Joint Lead Agency with shared responsibility for review under NEPA. The FHWA, in coordination with MassDOT, issued a Notice of Intent to prepare an EIS for the Program in the Federal Register on February 29, 2024. MassDOT anticipates publication of the Draft EIS in the Federal Register in late summer/early fall.

ES.4 How have the public and agencies been involved?

The FHWA and MassDOT implemented an extensive public and agency outreach program during the ongoing MEPA, NEPA, and design development processes for the Program. MassDOT uses multiple communication tools and resources to inform the public about the Program and to gather feedback, including (but not limited to) a Program website, a stakeholder database managed through the Public Involvement Management Application, and social media. The website has been visited over 75,000 times by approximately 50,000 different users. The database includes over 5,600 stakeholders.

To keep the public informed of design development, MassDOT held 11 public information meetings between June 2021 and May 2025. MassDOT presented Program updates, highlighted key milestones, and offered the public the opportunity to provide input and feedback on various aspects of the Program, including the preliminary purpose and need, draft measures of effectiveness criteria, and analysis of bridge types, deck configurations, mainline alignment locations, as well as highway interchange approach options under consideration for the replacement bridges.

MassDOT initiated the MEPA public comment period for the Program through publication of the ENF in the Environmental Monitor on May 10, 2023. The ENF requested public and agency comments regarding the Program's purpose and need, Program alternatives, and environmental impacts. Prior to the issuance of the Certificate on the ENF on July 7, 2023, MassDOT hosted two in-person Open House events in Bourne. The Open House events were held on May 13 and May 17, 2024, where MassDOT provided an opportunity for the public to review and discuss the design plans developed to date and provide oral and comments. MassDOT presented its recommended Build Alternative, including the preferred interchange approach options at each replacement bridge crossing, during an in-person Open House event in the town of Bourne on November 18, 2024.

Throughout Program development, MassDOT has ensured that all meetings, Open House events, and Program materials are accessible to Environmental Justice populations. These accommodations include, but are not limited to, the following:

- Providing Spanish and Portuguese translations of comment forms, flyers, public notices, and newspaper advertisements. Additional translation services are available upon request.
- Providing Spanish, Portuguese, and American Sign Language interpreters at public events. Additional interpretation services are available upon request.
- Hosting in-person and virtual events, during daytime and evening hours to maximize attendance.
- Posting recordings of public meetings online.

ES.5 What is the format of the Draft Environmental Impact Report?

The Draft EIR for the Program is organized into nine chapters:

- **Chapter 1, Introduction**, provides background information and context for the Program including the history of Cape Cod Canal and its bridge crossings, past planning studies and decisions that were foundational to Program development and the DEIR and descriptions of the existing Sagamore and Bourne Bridges and their supporting roadway network.
- **Chapter 2, Purpose and Need**, explains why the Program is being undertaken and what problems or unsatisfactory conditions it intends to address or improve.
- **Chapter 3, Proposed Action and Alternatives**, describes the alternatives that are retained for detailed study in the DEIR, including identification of a preferred alternative. This chapter also

identifies other alternatives that were considered but dismissed from further evaluation, including reasons for dismissal.

- **Chapter 4, Existing Conditions, Program Impacts, and Mitigation**, describes elements of the natural, social and economic environments that may be impacted by the alternatives, the anticipated impact of the alternatives on these environments, and measures to avoid, minimize, and mitigate adverse impacts, where applicable.
- **Chapter 5, Construction Approach**, discusses construction-period activities, including sequencing, traffic management, land based and in-water work, and site maintenance and restoration.
- **Chapter 6, Agency Coordination and Public Involvement**, summarizes agency coordination and public involvement activities conducted by FHWA and MassDOT leading up to and during the NEPA review process.
- **Chapter 7, Responses to Comments**, provides direct responses to comment letters received during the MEPA review process.
- **Chapter 8, Mitigation and Draft Section 61 Findings**, summarizes the measures taken for the Program to comply with applicable state, federal, and local environmental standards and to ensure that all feasible measures to avoid or minimize environmental harm have been taken for approval under MEPA.
- **Chapter 9, DEIR Distribution List**, identifies the agencies, organizations and individuals who were sent a copy of the DEIR for review and comment.

ES.6 What is the purpose and need for the Program?

The purpose of the Program is to improve cross-canal mobility and accessibility between Cape Cod and mainland Massachusetts for all road users and to address the increasing maintenance needs and functional obsolescence of the aging Sagamore and Bourne Bridges.

The following "needs" summarize the transportation problems or unsatisfactory conditions that the Program is intended to address or improve.

Need to address the deteriorating condition and escalating maintenance demands of the bridges.

Sagamore and Bourne Bridges, both serving traffic since 1935, have deteriorated over time and are now beyond their functional service lives. Both bridges require frequent and costly maintenance by the USACE due to their age, heavy traffic demands, and setting within the corrosive saltwater environment of Cape Cod Canal. Routine maintenance activities require lane closures, which typically restrict traffic to one lane in each direction, for extended periods of time. These lane closures result in heavy backups for travelers waiting to cross the bridges, with traffic queues extending for several miles along the highway approaches and local roadways.

Need to address substandard roadway design of the bridges and their immediate approaches.

The 1930s era Sagamore and Bourne Bridges do not meet current MassDOT bridge and highway design standards for key characteristics, such as travel lane widths, median barrier separation, shoulder widths, and roadway grades. The 10-foot-wide travel lanes on the bridges are narrower than the standard 12-foot lane width typically used on highways. The bridges lack physical separation between opposing traffic lanes and shoulders to provide emergency vehicle access and refuge for vehicle breakdowns or crashes. The roadway grades along the approaches to the bridges, up to 6% in some sections, are steeper than the 4% to 5% maximum grade typical for limited access highways.

Need to improve traffic operations.

Sagamore and Bourne Bridges were designed to handle considerably less traffic volumes than those served by the bridges today. High traffic volumes and substandard features of the bridges (narrow travel lanes, lack of shoulders and steep grades) result in poor traffic operations, congestion, and high crash rates. According to traffic analyses for the base year 2019 Condition, the bridges and their highway approaches operate at unacceptable levels (traffic volumes are at or exceed the capacity of the roadway) in the morning and afternoon peak travel periods during the fall weekday off-peak tourist season. With projected growth in traffic volumes in future years, operating conditions are expected to worsen over time.

Need to improve accommodations for pedestrians and bicyclists.

Sagamore and Bourne Bridges provide a single raised sidewalk with grades of up to 6%, which do not comply with current Americans with Disabilities Act accessibility standards. As there are no dedicated accommodations for bicycle travel on the bridges, cyclists typically walk their bicycles along the sidewalks across the bridges. The lack of shoulder or physical separation between the roadway and sidewalks along the bridges poses safety risks for non-motorized bridge users. Gaps exist in the current sidewalk and bicycle network surrounding the bridges.

ES.7 What alternatives were considered for the Program?

MassDOT conducted an independent conceptual screening of 12 alternatives that were considered by the USACE as part of the Cape Cod Canal Highway Bridges Major Rehabilitation Evaluation Report (MRER)/Environmental Assessment (EA). The 12 alternatives were evaluated based on their ability to meet the Program purpose and need. MassDOT also considered other factors, including environmental impacts, engineering, and cost as part of the alternatives screening process.

Based on the screening of the USACE MRER/EA alternatives, MassDOT determined that replacement of both existing highway bridges with new bridges (each with four through travel lanes and two auxiliary

lanes), updated to comply with modern highway design standards, is the only Build Alternative identified for further consideration. This determination is consistent with the USACE MRER/EA alternatives evaluation.

Incorporating the USACE's preferred alternative, MassDOT conducted engineering assessments on the following design parameters to develop the Build Alternative for detailed study in the DEIR:

- Bridge highway cross-section and shared-use path
- Bridge vertical and horizonal navigation clearances
- Bridge main span length and pier location
- Bridge deck configuration
- Bridge and mainline alignment location
- Bridge type
- Highway interchange approach options

MassDOT's assessments at the schematic, conceptual (5%), and preliminary (10% through 15%) design levels focused on the Program's purpose and need, as well as other factors, including environmental impacts, public safety, and cost.

ES.8 What alternatives are evaluated in detail in the Draft Environmental Impact Report?

The DEIR presents a comprehensive secondary evaluation of the 10 highway interchange approach alternatives that were presented in the ENF and identifies a "Preferred Alternative," which includes the selected bridge design parameters and highway interchange approach options, for each crossing. The DEIR also evaluates the impacts of the Preferred Alternative within resource-specific study areas, which establish the geographic extent for each analysis. Although the No Build Alternative would not meet the Program purpose and need, it was retained as a baseline against which the impacts and benefits of the Build Alternative can be compared.

No Build Alternative

The No Build Alternative would leave the existing Sagamore and Bourne Bridges in their current alignment and roadway configuration of four 10-foot-wide travel lanes (two in each direction), with one 6-foot-wide sidewalk and a 2-foot-wide safety curb. The USACE would continue operation and maintenance of each bridge and would make any repairs needed to maintain safety (fix-as-fails). There would not be any major rehabilitation or replacement of major bridge components, nor any roadway improvements that are proposed for the Build Alternative. The No Build Alternative would include recently completed and proposed transportation improvement projects identified in the Federal Fiscal Year 2025–2029 Transportation Improvement Program for the Cape Cod Metropolitan Planning Organization.

Build Alternative

Table ES-1 summarizes the Build Alternative based on preferred bridge design parameters and highway interchange approach options. The Build Alternative—incorporating the preferred bridge design options and the preferred highway interchange approach options—is identified as the preferred alternative, as it would fully meet the Program's needs. **Exhibit ES-1** and **Exhibit ES-2** present representative renderings of the proposed twin tied-arch bridges.

Table ES-1. Cape Cod Bridges Program Build Alternative

Program Element/ Program Design Parameter	Description of Program
Highway Bridges	Replacement of Both Highway Bridges with New Bridges with Four Through-Traffic Lanes and Two Auxiliary Lanes (In-Kind Bridge Replacement) (updated to comply with federal and state highway and design safety standards).
Highway Bridge Cross-Section and Shared-Use Path	Each replacement highway bridge would provide four 12-foot-wide through travel lanes (two in each direction), two 12-foot-wide entrance/exit (auxiliary) lanes, a 4-foot-wide left shoulder, and a 10-foot-wide right shoulder. Right and left barriers would be offset an additional 2 feet beyond the limits of the shoulders. Each crossing location would include one bidirectional pedestrian and bicycle shared-use path, separated from vehicular traffic by the shoulder and barrier. The usable width of the shared-use path would be 14 feet wide on the bridge main spans, 20 feet wide on the interchange approaches, and 12 feet wide on the connecting roadways.
Bridge Vertical and Horizontal Clearances	The replacement bridges would maintain the existing vertical clearance of 135 feet above mean high water and account for 3 feet of fluctuations in relative sea level, for a total vertical clearance of 138 feet above mean high water. The replacement bridges would provide a minimum of 500 feet of horizontal channel width consistent with the existing authorized navigational channel width.
Main Span Length and Bridge Pier Location	The replacement bridges would have a main span length of approximately 700 feet, which would locate the bridge piers at the waterline adjacent to the service road (shoreline piers) into the riprap slope but above the low tide line.
Bridge Deck Configuration	Each bridge (Sagamore and Bourne) would have two separate decks (twin structures).

Program Element/ Program Design Parameter	Description of Program
Mainline Alignment	The mainline alignment locations at both bridges would be offline inboard. Both spans of the replacement highway bridges would be outside the footprint of the existing bridge, approximately 10 feet apart and parallel to each other, and on the side of Cape Cod Canal between the existing bridges. The replacement main spans at the Sagamore crossing would be west of existing Sagamore Bridge toward Buzzards Bay. The replacement main spans at the Bourne crossing would be east of existing Bourne Bridge toward Cape Cod Bay.
Bridge Type	The replacement bridges would be twin tied-arch bridges, with delta frames supporting an approximate 600-foot arch and 700-foot mainline span.
Interchange Approach Network	Interchange approach improvements at each bridge would be as follows: • Sagamore Bridge Crossing: Direct connection to State Road in the Sagamore North quadrant and westbound on-ramp under U.S. Route 6 with Cranberry Highway Extension and Sandwich Road Connector in the Sagamore South quadrant • Bourne Bridge Crossing: Directional Interchange in the Bourne North quadrant and of the Diamond Interchange in the Bourne South quadrant

Exhibit ES-1. Proposed Replacement Bridge: Cape Cod Canal Viewpoint



Source: Massachusetts Department of Transportation, 2024

Exhibit ES-2. Proposed Replacement Bridge: Driver Viewpoint



Source: Massachusetts Department of Transportation, 2024

ES.9 What is the construction plan for the Build Alternative?

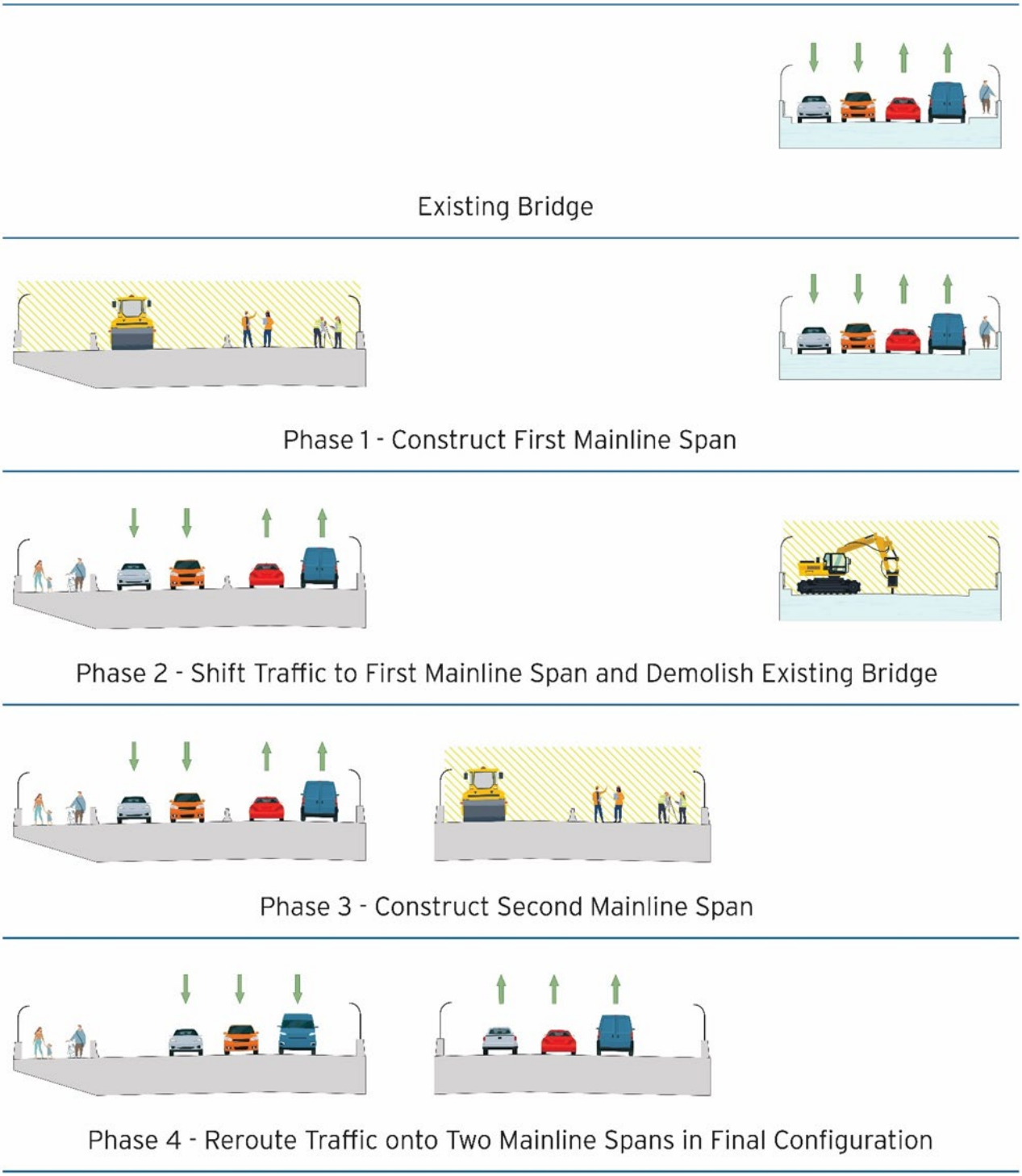
MassDOT proposes to use a "best value" design-build procurement method for the construction of the Program to accelerate project delivery, better control costs and schedule, promote innovation, and reduce overall risk. A design-build process is a construction delivery system that combines design and construction services within a single contract and can "fast-track" the overall construction process.

Figure ES-2 presents a simplified schematic of the Program's bridge construction sequencing approach, illustrating four key phases that apply to both bridges. The replacement bridges would be constructed offline (outside of the existing footprint) and a maximum of 250 feet inboard of the existing highway bridges. Sagamore Bridge would be replaced first followed by Bourne Bridge. At each site, the inboard main span (inboard bridge) would be constructed first. At the Sagamore Bridge site, this would be the western-most bridge, which would ultimately carry traffic onto Cape Cod. For the Bourne Bridge site, this would be the easternmost bridge, which would ultimately carry traffic off Cape Cod. After construction of the first new span, all traffic would be shifted onto it so the existing bridge can be demolished, and the second main span (bridge) can be constructed.

The Program's construction sequencing approach is a critical element of the design of the highway bridges, interchanges, and surrounding local roadway network. The construction sequencing goals for the Program include the following:

- Remove traffic from the existing bridge as quickly as possible.
- Maintain existing roadway and ramp connections through construction duration.
- Avoid the need for construction detours.
- Reduce or minimize traffic shifts.
- Maintain pedestrian and bicycle connectivity.

Figure ES-2. Proposed Bridge Construction Sequencing Approach



Source: Massachusetts Department of Transportation, 2024

ES.10 What are the potential impacts of the Build Alternative, and how will they be mitigated?

Table ES-2 summarizes the potential long-term impacts of the Build Alternative relative to subject matters evaluated in the DEIR, compared to the No Build Alternative. **Table ES-3** summarizes the impacts of temporary construction-related activities for the Build Alternative. Measures to mitigate the potential for adverse impacts of the Build Alternative are included in both tables, as needed.

Table ES-2. Summary of Potential Operational Impacts and Mitigation

DEIR Section	No Build Alternative	Build Alternative	Mitigation
Transportation, Traffic, and Safety (Section 4.2)	• Increased vehicle hours traveled and delays under the 2050 No Build Condition compared to the 2019 Base Year Condition during the Fall Weekday afternoon peak hour	• Reduced vehicle hours traveled, delays, and congestion under the 2050 Build Condition compared to the 2019 Base Year and 2050 No Build Conditions during the Fall Weekday afternoon peak hour	**Benefit** – No mitigation required
	• Continued decline in safety conditions, due to increased traffic volumes, delays, and congestion, and continuation of substandard bridge and approach roadway features	• Reduction in predicted crashes on the bridges by up to 48%, based on evaluation of safety performance metrics and crash modification factors associated with proposed improvements	**Benefit** – No mitigation required
	• No changes to railroad facilities or operations.	• Displacement and relocation of Bourne Station along the Cape Main Line Corridor, due to the construction and operation of Bourne Bridge	No long-term mitigation required; refer to **Table ES-3** for construction period mitigation.

DEIR Section	No Build Alternative	Build Alternative	Mitigation
	Longer response times for law enforcement and emergency response vehicles due to increased congestion and inadequate roadway conditions	• Improved public safety and security through reduced delays and improved travel-time reliability for emergency vehicle service and operations • Provision of additional service redundancy in case of an emergency evacuation or a compromising event impacting a single bridge structure	**Benefit** – No mitigation required
Pedestrian and Bicycle Facilities (Section 4.3)	Continuation of ongoing safety and mobility problems due to poor conditions on the bridges and lack of connectivity between bridges and the surrounding road network, including the Canal Service Roads	Improved pedestrian and bicycle facilities within the Project Limits on the new bridges with connections to new shared-use paths and pedestrian/bicycle accommodations adjacent to the local roadways	**Benefit** – No mitigation required
Maritime Transportation, Traffic, and Safety (Section 4.4)	Reduced capacity to accommodate largest vessels using canal over time; no improvement in navigation safety; potential adverse impact to navigation due to channel closures required by bridge maintenance activities	Improved navigability and navigational safety due to effective increase in horizontal clearance; no impact to maximum vessel class types and sizes currently using the canal	**Benefit** – No mitigation required

DEIR Section	No Build Alternative	Build Alternative	Mitigation
Socioeconomics (Section 4.5)	Anticipated adverse impacts to worker productivity, local business employment, tourism, and freight costs due to worsening traffic congestion and future traffic delays associated with continued maintenance of the bridges	Increased economic output, value added, jobs, and labor income due to travel-time savings and improved mobility and accessibility	**Benefit** – No mitigation required
Land Use, Zoning, and Community Cohesion (Section 4.6)	No changes to land use or development patterns; no advancement of local and regional land use policies and plans related to conservation land, open spaces, and green corridors	Approximately 306 acres of land alteration, including: • Approximately 51-acre increase in impervious area for new roadways and shared-use path areas to allow for temporary roadways, permanent roadways, and shared-use path installation • Approximately 132 acres of tree clearing	• Development of stormwater management system that uses low-impact green infrastructure, such as rain gardens and infiltration basins, and improves the treatment and quality of stormwater runoff • Implementation of landscaping plan for over 200 acres, consisting of landscape restoration and reforestation; street tree, buffer, and roundabout planting; and lawn reseeding

DEIR Section	No Build Alternative	Build Alternative	Mitigation
	Worsening traffic congestion and the lack of pedestrian and bicycle connectivity within the Study Areas would result in reduced community connectivity, and diminished access to recreational opportunities, leisure activities, cultural events, and historical sites, hindering community cohesion in the town of Bourne	• The new alignment and the areas needed for construction staging, and the demolition of the existing bridges and interchange improvements would result in unavoidable temporary and permanent property effects • Improved access, mobility, and connectivity within the Study Areas would strengthen community cohesion and provide quality of life benefits for surrounding neighborhoods	Provision of a buffer area to separate residential areas from the transportation land uses
Community Facilities (Section 4.7)	Projected traffic growth within the Study Areas would increase congestion and continue to hamper mobility and accessibility to community facilities and services	Improved traffic operations and multimodal accommodations to access community facilities	**Benefit** – No mitigation required
Property Acquisition, Displacement, and Relocation (Section 4.8)	No changes to current conditions	• Full acquisition of 29 parcels • Partial acquisition of 34 parcels • Easements on an additional 114 parcels	Implementation of property acquisition activities, including relocations, in accordance with the Uniform Relocation Assistance and Real Property Acquisition Policies Act, 1971, and Massachusetts General Laws, primarily Chapter 79.

DEIR Section	No Build Alternative	Build Alternative	Mitigation
Environmental Justice (Section 4.9)	No changes to current conditions	No increase to the risk of climate change or exacerbation of existing environmental or public health burdens experienced by Environmental Justice populations	**Benefit** – No mitigation required
Wetlands and Floodplains (Section 4.10)	No changes to current conditions	Permanent impacts to the following: • State-regulated Bank (285 linear feet) • Land Under Water (1,065 square feet [sf]) • Bordering Land Subject to Flooding (2,960 sf) • Bordering Vegetated Wetlands (federally regulated Vegetated Wetlands) (2,040 sf) • Land Under Ocean (25,107 sf)	Compensatory mitigation to replace the loss of floodplain, wetland and aquatic resource functions per federal and state regulatory requirements
Water Quality and Stormwater (Section 4.11)	No changes to current conditions; stormwater runoff would remain largely untreated	Increase of approximately 51 acres of new impervious surface area compared to existing conditions	Design and implementation of stormwater control measures, including infiltration basins and bioretention areas/ rain gardens, to comply with the Massachusetts Stormwater Management Standards

DEIR Section	No Build Alternative	Build Alternative	Mitigation
Threatened, Endangered, and Protected Species and Habitats (Section 4.12)	Continued baseline conditions, with USACE coordinating protections with federal agencies during bridge and canal maintenance activities	• Loss of suitable summer habitat for northern long-eared bats and tricolored bats due to tree removal • Direct or indirect and temporary or permanent stressors to aquatic resources, including underwater noise, entrapment, changes in water quality/turbidity, benthic disturbance, reduction in fish passage, habitat alteration and/or conversion, and vessel interaction • Loss of existing submerged aquatic vegetation at Bourne Bridge site	• Incorporation of multiple mitigation measures and best management practices, including time-of-year restrictions, to minimize effects to terrestrial- and aquatic-based resources • Mitigation of submerged aquatic vegetation • Ongoing coordination with MA Natural Heritage and Endangered Species Program, including obtaining a Conservation Management Permit as needed
Coastal Zone Consistency and Chapter 91 Waterways Review (Section 4.13)	Routine bridge maintenance activities and future dredging operations conducted by USACE would be implemented per permit requirements to protect coastal resources	Consistent with the applicable policies of the Massachusetts Coastal Zone Management Program addressing coastal hazards, growth management, habitat, protected areas, public access, and water quality	Implementation of resource-specific mitigation measures to minimize and compensate for unavoidable adverse impacts to coastal resources

DEIR Section	No Build Alternative	Build Alternative	Mitigation
Air Quality and Greenhouse Gas Emissions (Section 4.14)	Increased localized carbon monoxide (CO) and regional criteria pollutant emissions due to worsening congestion and delays under 2050 traffic volumes	Reduced localized CO and regional criteria pollutant emissions due to improved traffic operations and reduced delays	**Benefit** – No mitigation required
Noise and Vibration (Section 4.15)	A total of 59 noise sensitive properties to have traffic noise levels that approach or exceed FHWA noise abatement criteria	A total of 58 noise sensitive properties to have traffic noise levels that approach or exceed FHWA noise abatement criteria	• Noise abatement measures for impacted properties not found to be feasible and reasonable
Visual Resources (Section 4.16)	• No changes to the visual quality of the bridges • Changes to travelers' viewshed on local and regional roadway networks due to proposed developments	• Loss of Sagamore and Bourne Bridges, the most prominent cultural visual resources • Adverse changes to the visual quality of the Sagamore Bridge and Bourne Bridge Areas of Visual Impact at two locations	• Incorporation of context-sensitive design elements, compatible bridge design, recreational amenities, landscaping, and aesthetic treatment of bridge abutment and retaining walls
Cultural Resources (Section 4.17)	No changes to the appearance of the bridges or to other architectural historic properties due to the USACE's bridge maintenance and repair program	• Adverse effects due to removal of National Register-eligible Sagamore Bridge and Bourne Bridge • No adverse effects to the Cape Cod Canal Historic District or historic architectural properties within the viewshed area of potential effect	Execution of Section 106 Programmatic Agreement identifying stipulations to mitigate for adverse effects

DEIR Section	No Build Alternative	Build Alternative	Mitigation
Public Parks, Recreational Facilities, and Open Space (Section 4.18)	• Temporary effects to USACE-leased and -owned recreational areas under or immediately adjacent to bridges due to the USACE's bridge maintenance and repair program • No effects to other parks, recreational facilities or open space	Temporary and/or permanent impacts to public park and recreation areas owned by the USACE, the Town of Bourne, and the Bourne Recreation Authority	Implementation of measures to minimize harm and mitigate effects to affected parks and recreation areas, developed in coordination parcel owners
Solid and Hazardous Waste Material Management (Section 4.19)	Removal of lead-containing paint from both bridges during routine maintenance activities	Reduced likelihood of exposure to or potential contamination from hazardous waste materials through removal of existing bridges and off-site disposal of contaminated soils	Adherence to applicable laws and regulations governing the removal handling, storage, and transport of hazardous waste materials for any future bridge and roadway maintenance activities
Utilities and Services (Section 4.20)	No long-term effects	Relocation of telecommunications, electrical, water main, sewer systems	Coordination of utility relocation requirements with utility owners

DEIR Section	No Build Alternative	Build Alternative	Mitigation
Public Health (Section 4.21)	• Potential adverse health-related effects due to worsening traffic congestion and delays. • No support of healthy modes of transportation due to lack of accommodations and network connectivity for pedestrians and bicyclists	Beneficial health-related effects due to improved traffic operations, access for emergency vehicles, pedestrian and bicycle network connectivity and air quality	**Benefit** – No mitigation required
Climate Change Adaptation and Resiliency (Section 4.22)	• Vulnerability to progressive bridge collapse due to lack of redundancy in steel truss design • Continued vulnerability of the bridges to winter weather and extreme wind	• Increased structural redundancy due to replacement network tied-arch bridge types • Potential for icing on bridge cables and members in winter weather • Improved resistance against wind-induced vibrations and deformation due to replacement network tied-arch bridge types • Potential for pier scour with sea level rise and storm surge	• Implementation of deicing measures for bridge cables in accordance with best management practices • Build Alternative for Sagamore Bridge designed to remain stable during the maximum scour design and check events. Mitigation measures will be re-assessed for Bourne Bridge pending scour analyses

Table ES-3. Summary of Temporary Construction Effects and Mitigation

DEIR Section	Build Alternative	Mitigation
Transportation, Traffic, and Safety (Section 4.2)	Increased congestion and delays anticipated due to additional construction vehicle trips, work zone interactions, and reduced speeds	• Implementation of construction sequencing to minimize impacts to the traveling public • Preparation and implementation of a Traffic Management Plan addressing truck routes, traffic control and safety measures, and communication protocols with stakeholders
	Service disruptions to freight and seasonal passenger train operations along Cape Main Line Corridor	Preparation and implementation of a Rail Operations Coordination Plan addressing temporary service disruptions, and communication protocols with rail operators and the public
Pedestrian and Bicycle Facilities (Section 4.3)	Temporary closure of Canal Service Roads within construction zone.	Placement of appropriate signage in advance of closure to guide users along available detour routes.
Maritime Transportation, Traffic, and Safety (Section 4.4)	• Potential encroachment into the navigation channel by work vessels • Six short-term closures (3 to 5 days) of the navigation channel for float-in of the new bridge arches and float-out of the existing bridge arches	Advanced notification of canal closures to mariners, provided in coordination with the U.S. Coast Guard via local maritime publications, social media, local media, and other similar platforms
Wetlands and Floodplains (Section 4.10)	Potential erosion and sedimentation of wetlands and waterbodies due to ground disturbing and demolition activities	Preparation, implementation, and monitoring of a storm water pollution prevention plan to prevent erosion and sedimentation effects to wetlands, waterbodies, or other sensitive environmental resources
Water Quality and Stormwater (Section 4.11)	Potential sedimentation of waterbodies due to soil disturbance and runoff, impacting water quality and aquatic habitats	Preparation, implementation, and monitoring of a storm water pollution prevention plan to identify and prevent potential sources of pollution from stormwater runoff

DEIR Section	Build Alternative	Mitigation
Threatened, Endangered, and Protected Species and Habitats (Section 4.12)	• Potential acoustic and turbidity effects to marine species • Loss of submerged aquatic vegetation at Bourne Bridge site	• Confinement of in-water work to approved in-water work windows • Implementation of protocols and best management practices to protect marine species • Development and implementation of a submerged aquatic vegetation mitigation and monitoring plan in coordination with U.S. Army Corps of Engineers
Air Quality and Greenhouse Gas Emissions (Section 4.14)	• Temporary increase in airborne dust from ground disturbing activities • Temporary increase in air pollutant emissions from operation of construction-related equipment • Potential generation of airborne lead dust and fumes during bridge demolition	• Use of best management practices, including less polluting equipment, dust control measures, clean fuel in diesel engines, and limitation of heavy-duty vehicle idling to five minutes or less • Implementation of a lead abatement plan to guide proper removal of bridge components coated with lead-based paint • Monitoring for contractor compliance
Noise and Vibration (Section 4.15)	Intermittent increases in noise levels due to operation of construction equipment, demolition activities and pile driving	• Preparation and implementation of a noise control plan to establish procedures for predicting construction noise levels before performing construction activities, including identification of noise reduction measures required to meet the noise level limitations and minimize nuisance noise conditions • Implementation of best management practices, including noise monitoring to document compliance with recommended construction noise limits and implementation of a public outreach program
	Potential for ground-borne vibration effects to nearby sensitive receptors from pile driving activities	MassDOT's Contract Specifications to include provisions for pre-construction surveys, vibration monitoring, adherence to vibration limit thresholds, and equipment restrictions, as necessary

DEIR Section	Build Alternative	Mitigation
Visual Resources (Section 4.16)	Visual impacts due to staging areas, construction lighting, vegetation clearing	• Control of fugitive light from portable sources, including direction away from residential areas • Use of plant protection fencing to minimize effects to visual natural resources • Reseeding of disturbed areas and planting with native vegetation to provide long-term stabilization
Cultural Resources (Section 4.17)	Disturbance of areas with low archaeological sensitivity	• Continued monitoring of the need for additional archaeological investigations • Inclusion of Special Provision in construction contract for discovery of unanticipated archaeological remains
Solid and Hazardous Waste Material Management (Section 4.18)	Generation of approximately 179,000 tons of demolition and excavation waste	• Requirement for segregation and management of demolition waste within Massachusetts Department of Transportation's (MassDOT) Contract Specifications, including: • Adherence to federal and state regulations governing the removal, handling, storage and transport of hazardous materials • Pre-demolition hazardous building materials surveys and preparation of hazardous waste and safety plans in compliance with applicable regulatory requirements and MassDOT Contract Specifications • Monitoring of contractor compliance
Utilities and Services (Section 4.20)	Short-term service disruptions due to utility relocations	Advanced coordination with utility companies, town departments, and property owners to minimize service disruptions and avoid delays
Public Health (Section 4.21)	Potential effects related to demolition and ground-disturbing activities	Adherence to best management practices and compliance with applicable laws and regulations

ES.11 What authorizations, permits, and approvals will be required?

Table ES-4 lists the federal authorizations, and state permits and approvals required prior to implementation of the Program.

Table ES-4. Required Federal and State Authorizations, Permits, and Approvals

Authorization, Permit, or Approval	Issuing Agency
Issuance of Record of Decision or Combined Final EIS/Record of Decision under the National Environmental Policy Act (NEPA)	Federal Highway Administration – Lead Federal Agency
Finding under Section 4(f) of the U.S. Department of Transportation Act	Federal Highway Administration
Consultation under Section 106 of the National Historic Preservation Act	Massachusetts State Historic Preservation Officer
Consultation under Section 7 of the Endangered Species Act	U.S. Fish and Wildlife Service, National Marine Fisheries Services
Consultation under the Fish and Wildlife Coordination Act	U.S. Fish and Wildlife Service, National Marine Fisheries Services
Consultation under the Magnuson-Stevens Fishery Conservation and Management Act	National Marine Fisheries Services
Federal Consistency Review under the Coastal Zone Management Act	Massachusetts Office of Coastal Zone Management
Issuance of Section 408 permission under Section 14 of the Rivers and Harbors Act of 1899	U.S. Army Corps of Engineers
Issuance of Bridge Permits under the General Bridge Act of 1946	U.S. Coast Guard
Issuance of permits under Section 404 of the Clean Water Act and Section 10 of the Rivers and Harbors Act	U.S. Army Corps of Engineers
Approval of Notice of Proposed Construction or Alteration under Title 14 of the Code of Federal Regulations Part 77, Safe, Efficient Use, and Preservation of the Navigable Airspace	Federal Aviation Administration

Authorization, Permit, or Approval	Issuing Agency
Issuance of National Pollutant Discharge Elimination System – Construction General Permit under Section 402 of the Clean Water Act	U.S. Environmental Protection Agency
Issuance of Secretary Certificate on the Final Environmental Impact Report under the Massachusetts Environmental Policy Act	Massachusetts Executive Office of Energy and Environmental Affairs
Issuance of an Order of Conditions under the Massachusetts Wetlands Protection Act	Bourne Conservation Commission
Issuance of Water Quality Certification under the Massachusetts 401 Water Quality Certification Regulations	Massachusetts Department of Environmental Protection
Determination of Applicability under the Massachusetts Chapter 91 Waterways Regulations	Massachusetts Department of Environmental Protection
Issuance of a Conservation and Management Permit under the Massachusetts Endangered Species Act	Massachusetts Division of Fisheries and Wildlife – Natural Heritage and Endangered Species Program

ES.12 What are the next steps in the Environmental Impact Report process?

Public comments are being solicited on this DEIR, which is available for public review at the Cape Cod Bridges Program website (http://www.mass.gov/cape-bridges), on the Massachusetts Office of Energy and Environmental Affairs' Environmental Monitor, and at viewing locations listed on the Program website. Responses to comments received on the DEIR will be provided in the subsequent FEIR submittal.

MassDOT has requested an extended comment period. Comments on the DEIR may be submitted to the MEPA Office through October 24, 2025, via the following methods:

MA EEA Public Comment Portal	https://eeaonline.eea.state.ma.us/EEA/PublicComment/Landing/
E-mail	Nicholas Moreno, Analyst nicholas.moreno@mass.gov mepa@mass.gov

Electronic comments are preferred; however, written comments may be mailed to the MEPA Office at this address:

Secretary of Energy and Environmental Affairs
Executive Office of Energy and Environmental Affairs (EEA)
Attn: MEPA Office
[Analyst Name], EEA No. _____
100 Cambridge Street, Suite 900
Boston, MA 02114

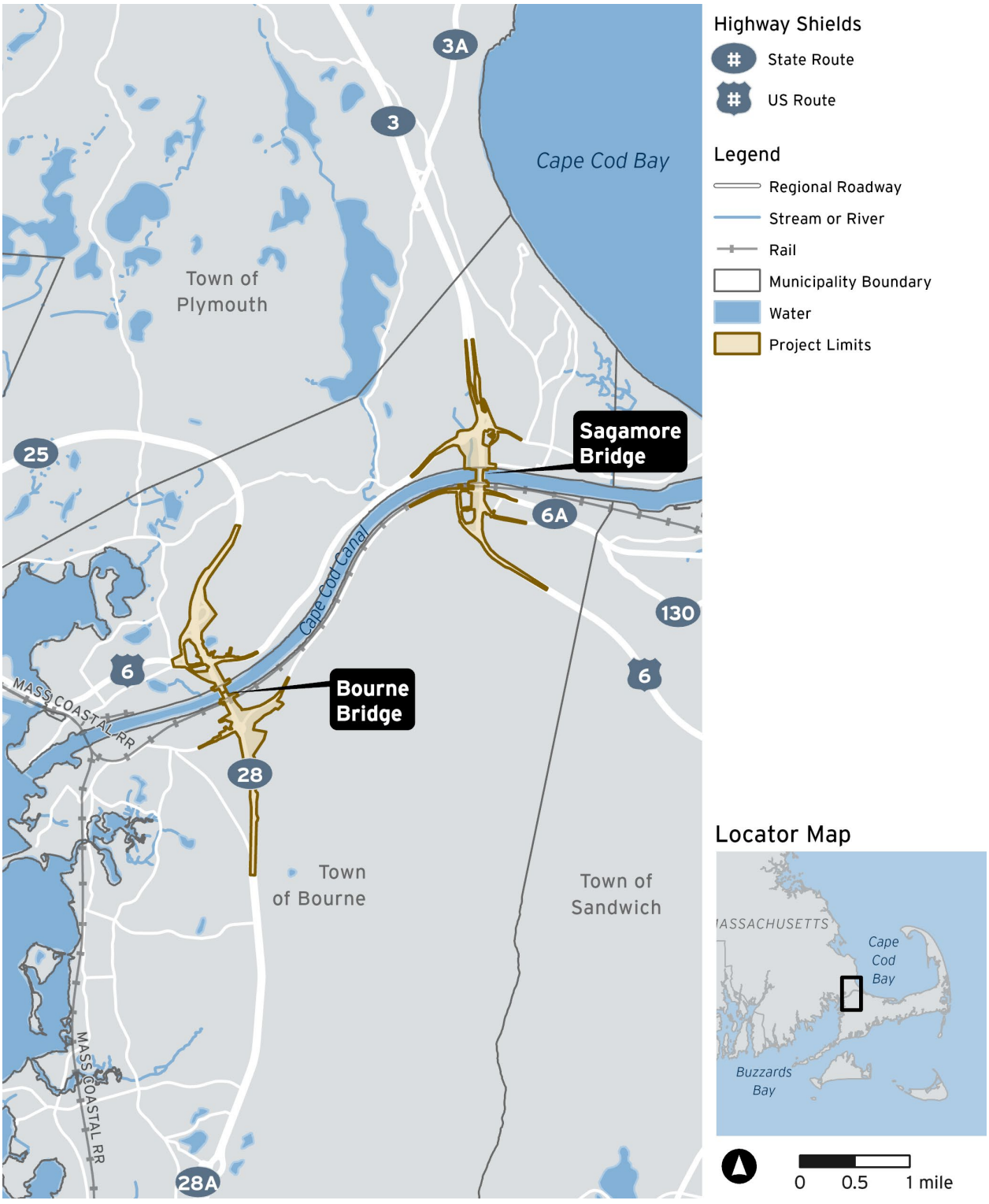
1 Introduction

The Massachusetts Department of Transportation – Highway Division (MassDOT) and the Federal Highway Administration – Massachusetts Division (FHWA), in partnership with the New England District of the U.S. Army Corps of Engineers (USACE), are proposing the Cape Cod Bridges Program (Program) to replace the Sagamore and Bourne Bridges crossing Cape Cod Canal in the town of Bourne, Barnstable County, Massachusetts. These bridges—which provide the only roadway connections between Cape Cod and the mainland—are currently owned, operated, and maintained by the USACE as part of the Cape Cod Canal Federal Navigation Project. Built simultaneously between 1933 and 1935, both bridges are in deteriorating condition and functionally obsolete as they do not meet current design standards for criteria such as lane width, shoulder width, and vertical profile grade.[1] Refer to **Section 2.3, Need for the Program**, for details describing the identified transportation-related problems the Program is intended to address or improve. The Program proposes replacing Sagamore and Bourne Bridges with new bridges built to modern highway design standards and reconfiguring the highway approach networks north and south of Cape Cod Canal to align with the replacement bridges. The Program is planned to be delivered in two phases, with the Sagamore Bridge Replacement Project as Phase 1 and the Bourne Bridge Replacement Project as Phase 2. **Figure 1-1** depicts the location of Sagamore and Bourne Bridges and the proposed Project Limits at each crossing. Refer to **Section 3.5.2, Construction Schedule and Estimated Construction Costs**, for information on the anticipated construction schedule and costs.

MassDOT prepared this Draft Environmental Impact Report (DEIR) in compliance with the Massachusetts Environmental Policy Act (MEPA) and other relevant state environmental laws and regulations. The analysis in this DEIR describes the anticipated beneficial and adverse social, economic, and environmental impacts that may result from the construction and long-term (operational) phases of the Program. Where potential adverse impacts are identified, proposed measures to mitigate those impacts are described. A Preferred Alternative (including the preferred highway interchange pairings for the replacement bridges) is identified in **Section 1.5** and described in detail in **Chapter 3, Proposed Action and Alternatives**. The DEIR also addresses the public comments received on the Environmental Notification Form (ENF) from May 10, 2023, through June 27, 2023, during the MEPA public comment period. Refer to **Chapter 7, Response to Comments**, for direct responses to comment letters received during the ENF public comment period.

[1] The vertical profile grade is the percent of elevation change along the centerline of the roadway.

Figure 1-1. Project Limits at Sagamore and Bourne Bridges



Source: Massachusetts Department of Transportation, 2024

The Program is also subject to regulatory review under the National Environmental Policy Act (NEPA) due to the allocation of federal funding for the Sagamore Bridge Replacement Project. FHWA is the Lead Federal Agency for review under NEPA. In August 2023, FHWA determined that the Program is likely to have a significant impact on the environment, thereby requiring the preparation of an Environmental Impact Statement (EIS). As the recipient of federal funds for the Program, MassDOT is the Project Sponsor and Joint Lead Agency with shared responsibility for review under NEPA, and the Lead State Agency for review under MEPA. MassDOT anticipates publishing the Draft EIS in the Federal Register in September 2025.

The following sections provide background information and context for the Program including the history of Cape Cod Canal and its bridge crossings, past planning studies and decisions that were foundational to development of the Program and this DEIR and descriptions of the existing Sagamore and Bourne Bridges and their supporting roadway network.

1.1 History of Cape Cod Canal and Bourne and Sagamore Bridges

Cape Cod Canal is a 17.4-mile human-made waterway in southeastern Massachusetts that connects Cape Cod Bay to the northeast with Buzzards Bay to the southwest (refer to **Figure 1-1**). The canal was constructed to provide marine shipping traffic with a more direct and safer route from northern New England ports to other areas on the U.S. eastern seaboard.

Construction of the canal began in June 1909, and it was opened to marine traffic in July 1914 as a privately operated toll waterway. The originally constructed canal had a maximum width of approximately 100 feet and a depth of 25 feet. Because the canal physically divided Cape Cod from mainland Massachusetts, construction of two vehicular bridges and one railroad bridge were required to reconnect Cape Cod to the rest of Massachusetts.

In 1910, Buzzards Bay Railroad Bridge became the first bridge to be constructed across the canal. The original Bourne and Sagamore Bridges were later constructed across the canal in 1911 and 1913, respectively. These original highway bridges were electrically operated double-bascule drawbridges with only 41 feet of vertical clearance in the closed position. Although they provided 140 feet of vertical clearance when open, the length of time they took to open posed navigational hazards because ships were forced to wait in the canal and contend with its strong currents before navigating through the bridges.

The USACE continues to maintain both highway bridges as a part of the federally authorized Cape Cod Canal Federal Navigation Project.

The federal government purchased Cape Cod Canal outright for $11.4 million in 1927 and directed the USACE to operate and improve the canal under the authority of the Rivers and Harbors Act of 1927.[2] The USACE was authorized to construct three new bridges over the canal, allowing improved navigation for taller vessels and removal of the original Buzzards Bay Railroad Bridge and the Bourne

[2] Public Law 70-560, January 21, 1927

and Sagamore drawbridges under the National Industrial Recovery Act of 1933.[3] The Public Works Administration began constructing two high-level, fixed-span highway bridges and a new vertical lift railroad bridge over Cape Cod Canal in 1933, which opened to traffic in June 1935. The USACE was authorized to operate and maintain the bridges as part of the Cape Cod Canal Federal Navigation Project (FNP) under the Rivers and Harbor Act of 1935.[4] Also under the authority of the Rivers and Harbors Act of 1935, Cape Cod Canal was deepened to 32 feet at mean low water and widened to approximately 480 feet, with all work completed by 1940. The USACE continues to maintain both highway bridges as part of the federally authorized Cape Cod Canal FNP.

1.2 Past Studies and Decisions

The Program builds upon and references prior foundational studies that evaluated alternatives for addressing the deteriorating performance of the aging Sagamore and Bourne Bridges and the multimodal transportation deficiencies of the surrounding approach roadway networks.[5] **Section 1.2.1** and **Section 1.2.2** provide an overview of these studies and their findings. Based on interagency collaboration during the development of these studies, the USACE and MassDOT signed a Memorandum of Understanding (MOU) regarding Sagamore and Bourne Bridges, as discussed in **Section 1.2.3**.

1.2.1 MassDOT Office of Transportation Planning Cape Cod Canal Transportation Study

MassDOT Office of Transportation Planning, in collaboration with the FHWA, performed a multiyear conceptual planning study beginning in 2015, known as the Cape Cod Canal Transportation Study (CCCTS), to identify existing and future multimodal transportation needs around Cape Cod Canal. The study area for the CCCTS included land up to four miles on either side of the canal, as well as farther points to include major highway interchanges in the towns of Bourne and Sandwich, Massachusetts. MassDOT coordinated closely with the Study Working Group, including the USACE and a broad range of stakeholders, to guide the planning process for identifying transportation improvements within the study area.

The CCCTS developed and evaluated a broad range of roadway and intersection improvement alternatives within the study area, as well as two public-private partnership[6] alternatives that included the following:

- Providing a direct highway connection from State Route 25 to State Route 3 (north of Cape Cod Canal)
- Providing a roadway connection from State Route 25 to U.S. Route 6 (Scenic Highway), including an interchange at U.S. Route 6 and a third highway bridge across the canal

[3] Public Law 73-67, June 16, 1933
[4] Public Law 74-409, August 30, 1935
[5] In accordance with 23 United States Code (USC) 139(f)(4)(E)(ii) and 40 Code of Federal Regulations (CFR) 1501.12
[6] Public-private partnerships are contractual agreements between public agencies and private-sector partners that allow for greater private-sector participation in the design, construction, financing, and maintenance of infrastructure assets.

The two public-private partnership alternatives were dismissed from further consideration in the CCCTS based on potential impacts to residential neighborhoods, wetland and drinking water resources, and sensitive tribal areas. MassDOT also determined that the study's goals and objectives could be met through improvements to existing infrastructure.

The final CCCTS report[7] provided recommendations for improving multimodal connectivity and mobility across Cape Cod Canal, including the following:

- Improvements to pedestrian and bicycle accommodations and connections proximate to and from local roadways over Cape Cod Canal via Sagamore and Bourne Bridges
- Implementation of major transportation system improvements at roadway approaches to Sagamore and Bourne Bridges, including adjacent interchanges and intersections

1.2.2 USACE Major Rehabilitation Evaluation of Sagamore and Bourne Bridges

The USACE performed a multi-year Major Rehabilitation Evaluation (MRE) of Sagamore and Bourne Bridges beginning in 2016 to evaluate the current condition of the aging bridges and feasible alternatives for the future. The MRE evaluated the economic and environmental impacts of major rehabilitation of both bridges and various bridge replacement alternatives versus continuing to repair the bridges as needed. The MRE considered a preliminary range of alternatives for new canal crossings, including new bridges, tunnels, causeways, low-level versus high-level bridges, and closure of the canal to navigation with restoration to the pre-canal road system.

The MRE resulted in publication of a Major Rehabilitation Evaluation Report (MRER) by the USACE in March 2020, which served as the basis of decision-making to determine the most cost-effective, safe, and practicable alternative for providing vehicular access between Cape Cod and the mainland.[8] The USACE also prepared an Environmental Assessment (EA) in compliance with NEPA to examine the potential impacts of the alternatives considered within the MRER and to allow for public involvement in the environmental review process. The FHWA and MassDOT participated as Cooperating Agencies in the USACE's development of the MRER/EA.

From an initial assessment of 12 alternatives, including the No Action Alternative (Base Condition), the USACE advanced three alternatives for further analysis in the MRER/EA:

- No Action, consisting of continued standard maintenance replacing elements as identified through regular inspection

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[7] Cape Cod Canal Transportation Study. October. https://www.mass.gov/lists/cape-cod-canal-study-documents#cape-cod-canal-transportation-study:-final-report

[8] Major Rehabilitation Evaluation Report and Environmental Assessment (MRER/EA), Cape Cod Canal Highway Bridges, Bourne, Massachusetts. March 2020. https://www.nae.usace.army.mil/Portals/74/docs/Topics/Cape%20Cod%20Canal%20Bridges/Reports/FinalMRERDocument.pdf

- Major Rehabilitation of Both Bridges
- Replacement of Both Highway Bridges with New Bridges, consisting of four through-traffic lanes and two auxiliary lanes

The USACE MRER/EA identified the preferred alternative as replacement of both highway bridges with new bridges, consisting of four through-traffic lanes and two auxiliary lanes and updated to comply with current design standards, to be constructed adjacent to the existing bridges. Based on the findings of the MRER/EA, on April 3, 2020, the USACE officially announced its decision to replace the current Sagamore and Bourne Bridges with two new bridges built to modern-day standards. In its decision, the USACE noted that this solution would provide the federal government with the best long-term investment for safe and reliable access to Cape Cod for the traveling public over the next 50 plus years. The USACE indicated that the MRER/EA represented Phase 1 of the bridge replacement project, and that Phase 2 of the bridge replacement project would consist of the design and construction phases.

The USACE MRER/EA identified the preferred alternative as replacement of both highway bridges, to be constructed adjacent to the existing bridges.

The USACE determined that the replacement of both highway bridges with new bridges would not have a significant adverse impact on the environment. On March 29, 2022, the USACE formally issued a Finding of No Significant Impact for the MRER/EA and the proposed action to replace Sagamore and Bourne Bridges in accordance with NEPA.

1.2.3 Memorandum of Understanding Between the USACE and MassDOT Regarding Bourne and Sagamore Bridges

Development of the October 2019 CCCTS and the March 2022 MRER led to partnerships between MassDOT and USACE to replace Sagamore and Bourne Bridges, as well as reconfigure the surrounding approach roadway networks to accommodate the new bridges through the Program.

The USACE and MassDOT have executed an MOU regarding Sagamore Bridge and Bourne Bridge and their approach highway infrastructure. Initially developed in June 2018, the MOU was updated in July 2020 and again in March 2024.[9] According to the terms of the MOU, the USACE and MassDOT are engaged in a collaborative approach to developing a fully functional, cost-efficient, resilient, and safe transportation corridor across Cape Cod Canal. The USACE will continue to be responsible for ownership, operation, and maintenance of the two existing bridges until their demolition by MassDOT, while partnering with MassDOT on the funding, design, and construction of the replacement bridges. MassDOT will lead the delivery of the Program, including preparing documentation for NEPA review, applying for and securing permitting, completing required design, and overseeing and managing all

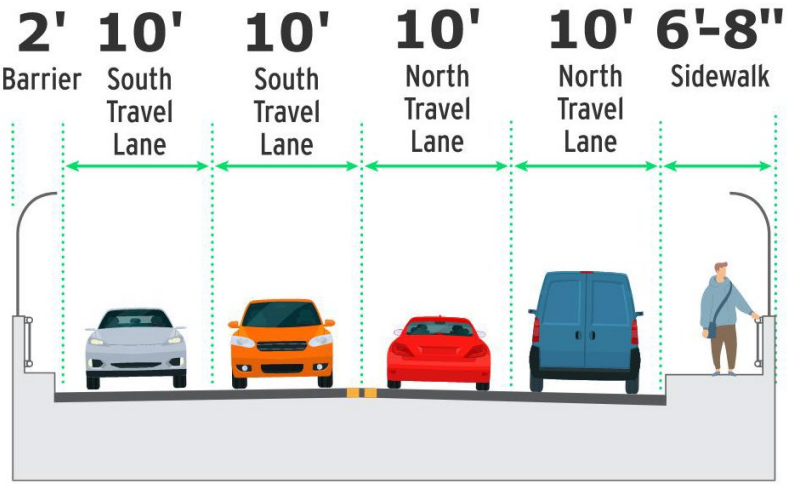
[9] The three Memoranda of Understanding between the U.S. Army Corps of Engineers (USACE) and Massachusetts Department of Transportation (MassDOT) regarding Sagamore and Bourne Bridges are dated June 28, 2018, July 7, 2020, and March 21, 2024.

construction of the new bridges. MassDOT will then own, operate, and maintain the completed bridges and approaches as part of the system of state highways.

1.3 Overview of Existing Sagamore and Bourne Highway Bridges

Sagamore Bridge is 1,408 feet long with three spans, carrying U.S. Route 6 across Cape Cod Canal, the Massachusetts Coastal Railroad, and Sandwich Road. Bourne Bridge is 2,384 feet long with seven spans, carrying State Route 28 across Cape Cod Canal, the Massachusetts Coastal Railroad, and Sandwich Road. U.S. Route 6 and State Route 28 are functionally classified as Urban Principal Arterials on the National Highway System. The posted speed on the bridges is 40 miles per hour. Each bridge is 48 feet, 8 inches wide, including four 10-foot-wide vehicular travel lanes (two lanes in each direction) with a single raised 6-foot- and 8-inch-wide sidewalk, and a 2-foot-wide safety curb along the side opposite the sidewalk. **Figure 1-2** provides a representative roadway cross-section configuration of the existing bridges. Refer to **Appendix 1, Existing Conditions Plans**, for plan views that depict the existing bridges and interchange approaches.

Figure 1-2. Representative Roadway Cross-Section of the Existing Sagamore and Bourne Bridges



Source: Massachusetts Department of Transportation, 2024

The steel truss bridges are nearly identical. Each bridge has a mainline center span length of 616 feet over Cape Cod Canal supported by two concrete piers within each side of the navigational channel, and a vertical clearance of 135 feet above mean high water. The bridge center spans crossing Cape Cod Canal are through arch truss suspended spans with cables suspending the roadway deck from the arch. The side spans to the north and south of the center span are deck trusses. The bridge approaches consist of a 150-foot-long reinforced concrete abutment at each end. **Exhibit 1-1** and **Exhibit 1-2** present aerial views of the existing bridges.

Sagamore and Bourne Bridges are vital components of the local, regional, and state transportation network because they provide the only roadway connections between mainland Massachusetts and the Cape Cod peninsula in Barnstable County, which comprises 15 towns with a year-round population of approximately 230,000 residents.[10] These bridges also serve as the gateway to Cape Cod for millions of annual visitors to the region during the height of the popular summer tourist season between Memorial Day and Labor Day. According to MassDOT Automatic Traffic Recorder counts obtained in

[10] 2020 U.S. Census

2019, the average daily traffic on Sagamore and Bourne Bridges during the fall season from September to October was over 108,000 vehicles, including both directions of travel. The 2019 average daily traffic on the bridges during the summer season from July to August was over 137,000 vehicles, including both directions of travel.

Exhibit 1-1. Aerial View of Sagamore Bridge (looking north)



Source: Massachusetts Department of Transportation, 2024

Exhibit 1-2. Aerial View of Bourne Bridge (looking west)



Source: Massachusetts Department of Transportation, 2024

In addition, both bridges support a daily average of 6,600 truck crossings and 122 school bus crossings.[11] As the only roadway access points to and from Cape Cod, and by extension to the islands of Martha's Vineyard and Nantucket via Cape Cod–based ferry services, Sagamore and Bourne Bridges are vital lifelines for daily commuting, freight distribution, commerce, tourism, and evacuations off Cape Cod in case of emergency. Both bridges—particularly Bourne Bridge—are key arteries for transportation of military personnel and supplies to major national defense facilities at Joint Base Cape Cod in the upper western portion of Cape Cod.

1.4 Supporting Roadway Network

The highways that provide access to and from Sagamore and Bourne Bridges include State Route 3, U.S. Route 6, State Route 25, State Route 28, as well as Scenic Highway and Sandwich Road, the two highways that run parallel to Cape Cod Canal and connect the two bridges. MassDOT owns and maintains these highways as part of the Massachusetts State Highway System. State Route 3, U.S. Route 6, State Route 25, State Route 28, and Scenic Highway are also part of the National Highway System.

Vehicular connections between the bridges and the connecting highways are made at Sagamore Interchange, U.S. Route 6 Exit 55 Interchange, State Route 25/Scenic Highway/State Route 28 Interchange, Belmont Circle, and Bourne Rotary.

1.4.1 Regional Highways

The regional highway approaches to Sagamore Bridge include State Route 3 on the north side of Cape Cod Canal and U.S Route 6 on the south side of the canal. State Route 3 provides the main highway connection from Boston and other points north to Cape Cod. State Route 3 generally provides two 12-foot-wide travel lanes in each direction. At the southbound approach to Sagamore Bridge, State Route 3 narrows to a single lane just north of Sagamore Flyover. The single lane from State Route 3 is joined by an additional lane from the entrance ramp from Scenic Highway, to form two lanes that are carried on Sagamore Bridge via U.S. Route 6. South of Sagamore Bridge, U.S. Route 6 runs the length of Cape Cod to Provincetown at the far northeastern end of Cape Cod. U.S. Route 6 provides two travel lanes in each direction within the Project Limits at the Sagamore Bridge crossing.

The regional highway approaches to Bourne Bridge include State Route 25 on the north side of Cape Cod Canal and State Route 28 on the south side of the canal. State Route 25 connects to Interstate 495 (I-495) and to Interstate 195 (I-195), which provide access to Cape Cod from points west and south. State Route 25 generally provides three 12-foot-wide travel lanes in each direction. After Exit 10 on the eastbound approach to Bourne Bridge, State Route 25 narrows to two lanes that are carried over Bourne Bridge via State Route 28. South of Bourne Bridge, State Route 28 (also known as MacArthur Boulevard) is a four-lane highway that provides connections to Falmouth in the southwestern corner of

[11] Cape Cod Commission. 2024. Cape Cod Comprehensive Economic Development Strategy, 2024-2029. June. https://capecodcommission.org/resource-library/file?url=/dept/commission/team/Website_Resources/economicdevelopment/CEDS/2024/2024%20Cape%20Cod%20CEDS.pdf

Cape Cod. From Falmouth, State Route 28 runs near the southern coast of Cape Cod, where it turns north in Chatham to join U.S. Route 6 in the town of Orleans. **Figure 1-3** illustrates the regional highway network within Cape Cod.

1.4.2 Cape Cod Canal-Side Highways

Figure 1-4 illustrates Scenic Highway on the north side of Cape Cod Canal and Sandwich Road (State Route 6A) on the south side of Cape Cod Canal. These highways enable vehicular connections between Sagamore and Bourne Bridges.

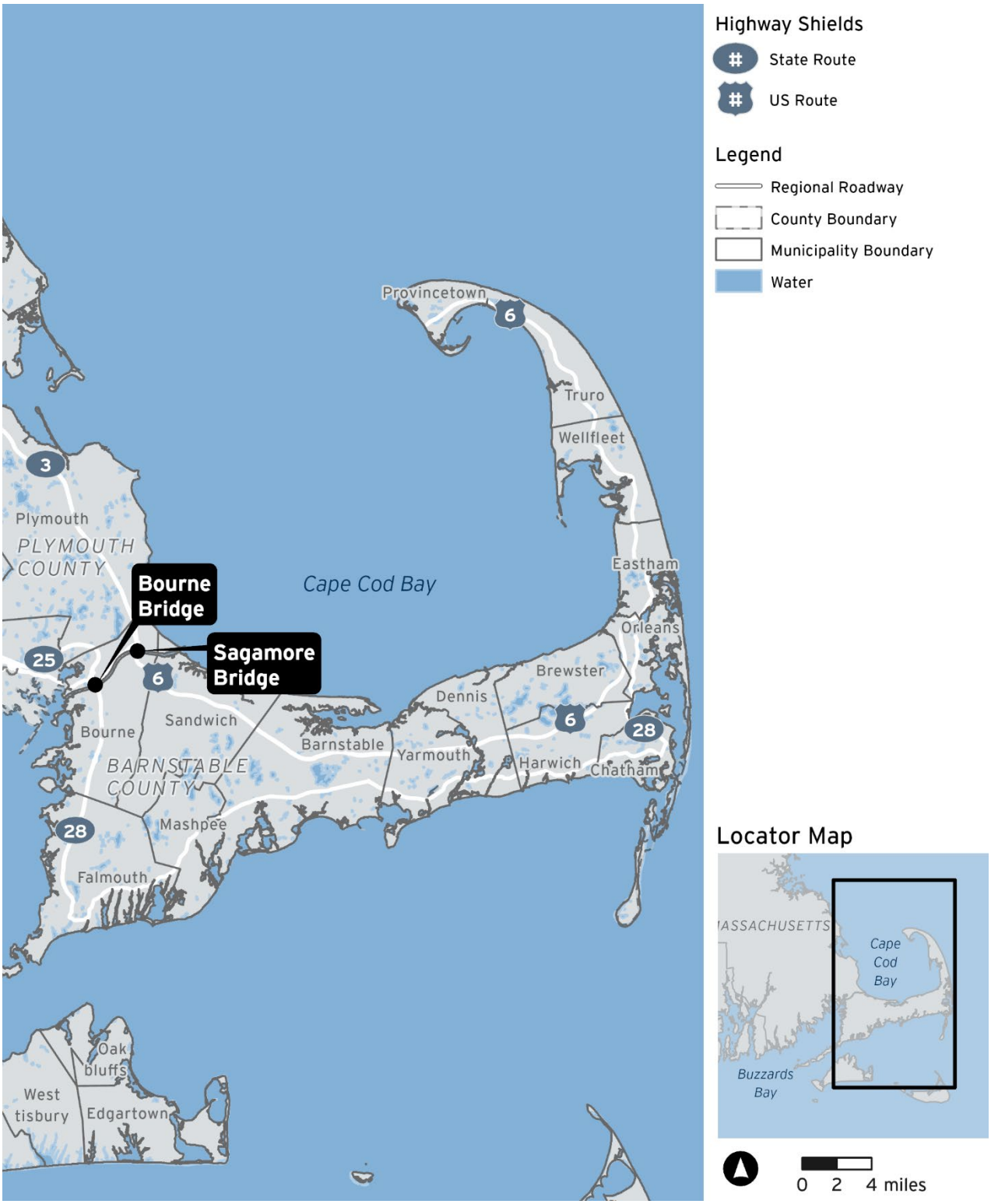
1.4.2.1 Scenic Highway (U.S. Route 6)

Scenic Highway extends east-west for approximately 3.5 miles, parallel to the north side of Cape Cod Canal, from State Route 3 at Sagamore Interchange west to Belmont Circle (**Figure 1-4**). Scenic Highway generally provides two travel lanes in each direction.

1.4.2.2 Sandwich Road (State Route 6A)

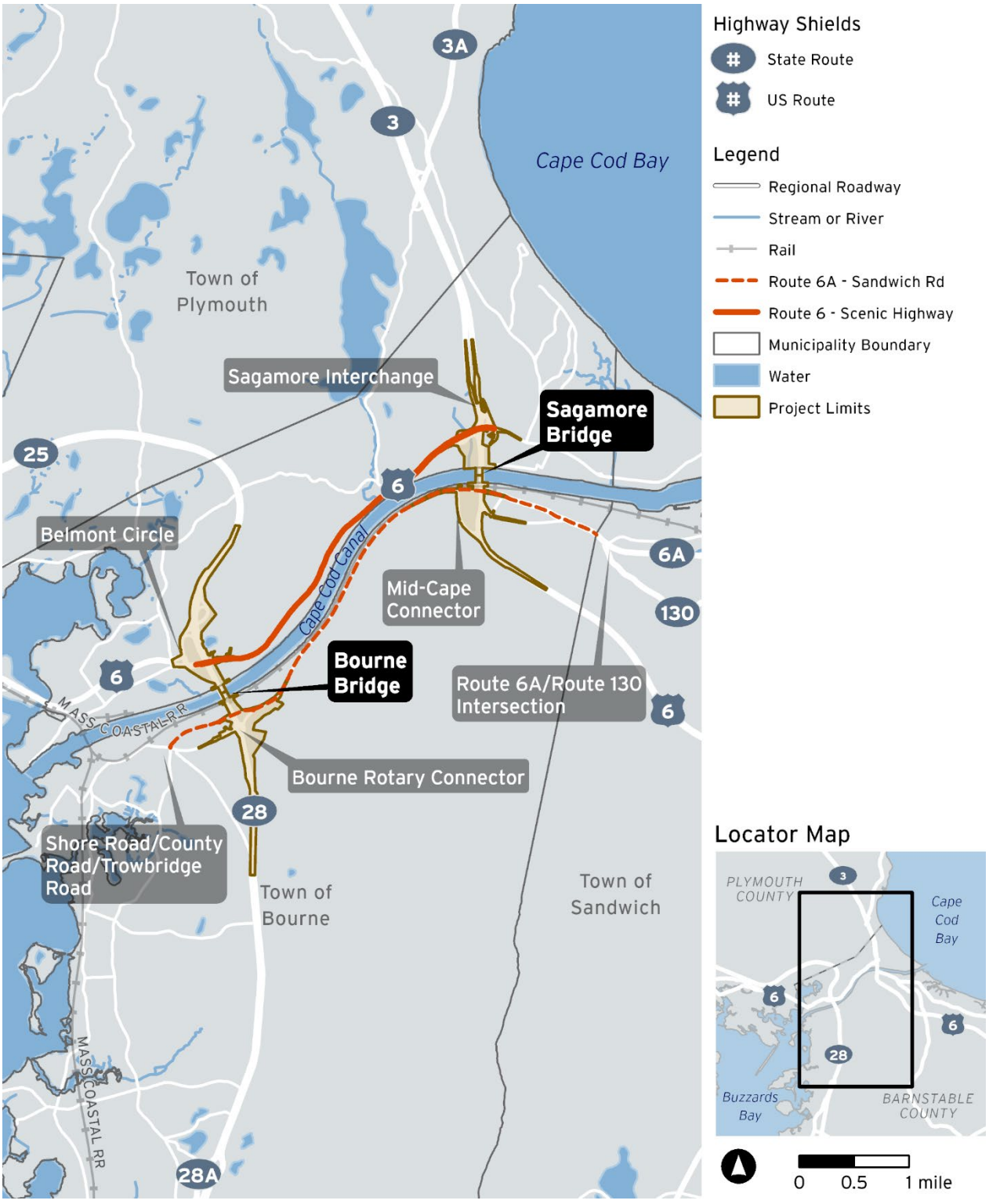
Sandwich Road extends east-west for approximately 4.7 miles, parallel to the south side of Cape Cod Canal from the State Route 6A/State Route 130 intersection to a four-way intersection at Shore Road/County Road/Trowbridge Road in Bourne (**Figure 1-4**). Sandwich Road provides one travel lane in each direction within the Project Limits at each bridge crossing. Sandwich Road is classified as a local road between its intersection at Shore Road/County Road/Trowbridge Road and Bourne Rotary Connector. Sandwich Road is part of the National Highway System between the Bourne Rotary Connector and Mid-Cape Connector.

Figure 1-3. Cape Cod Regional Highway Network



Source: Massachusetts Department of Transportation, 2024

Figure 1-4. Scenic Highway and Sandwich Road



Source: Massachusetts Department of Transportation, 2024

1.4.3 Interchanges and Rotaries

The interchanges and rotaries within the Cape Cod Canal area network that enable vehicular connections between the bridges and the connecting highways include Sagamore Interchange, U.S. Route 6 Exit 55 Interchange, Belmont Circle, and Bourne Rotary.

1.4.3.1 Sagamore Interchange and U.S. Route 6 Exit 55 Interchange

Sagamore Interchange (**Figure 1-5**) is north of Sagamore Bridge. The interchange includes a series of ramps for connections to State Route 3, Scenic Highway (U.S. Route 6), and Meetinghouse Lane. U.S. Route 6 Exit 55 Interchange (**Figure 1-6**) is south of Sagamore Bridge. It provides access from U.S. Route 6 eastbound to Sandwich Road via Mid-Cape Connector and from U.S. Route 6 westbound to Cranberry Highway.

1.4.3.2 State Route 25/Scenic Highway/State Route 28 Interchange and Belmont Circle

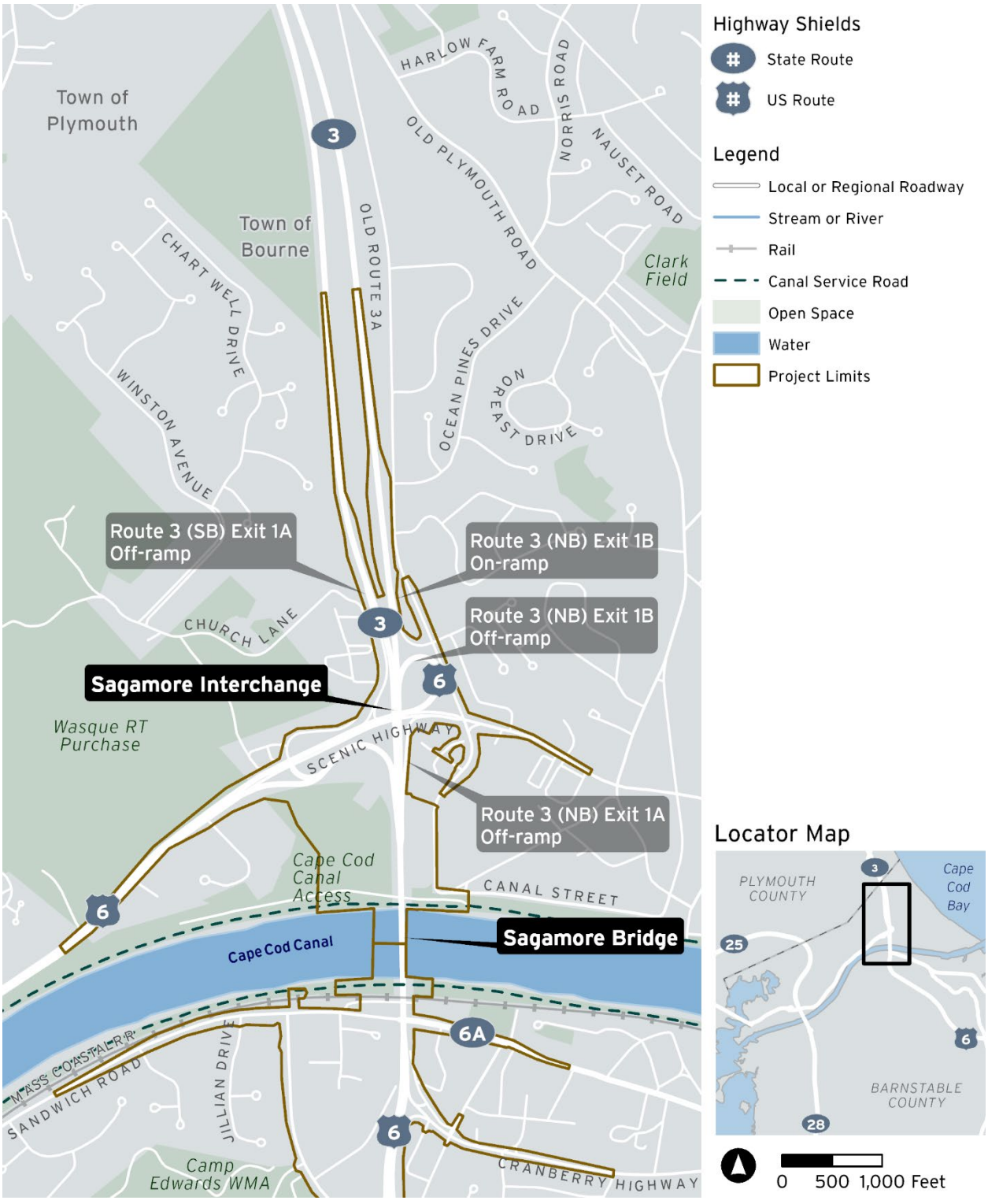
The State Route 25/Scenic Highway/State Route 28 interchange is north of Bourne Bridge. The interchange includes a series of ramps for connections to Scenic Highway (U.S. Route 6), Main Street, and State Route 28 via Belmont Circle. **Figure 1-7** depicts the locations of the State Route 25/Scenic Highway/State Route 28 interchange and Belmont Circle.

Belmont Circle is a three-lane rotary immediately west of the State Route 25 approach to Bourne Bridge on the north side of Cape Cod Canal. The rotary connects various roadways including Scenic Highway (U.S. Route 6), Main Street, State Route 28 (Buzzards Bay Bypass), Head of the Bay Road, and ramps to State Route 25. A State Route 25 eastbound access ramp accommodates access between Belmont Circle and Bourne Bridge. **Exhibit 1-3** provides an aerial view of Belmont Circle.

1.4.3.3 Bourne Rotary

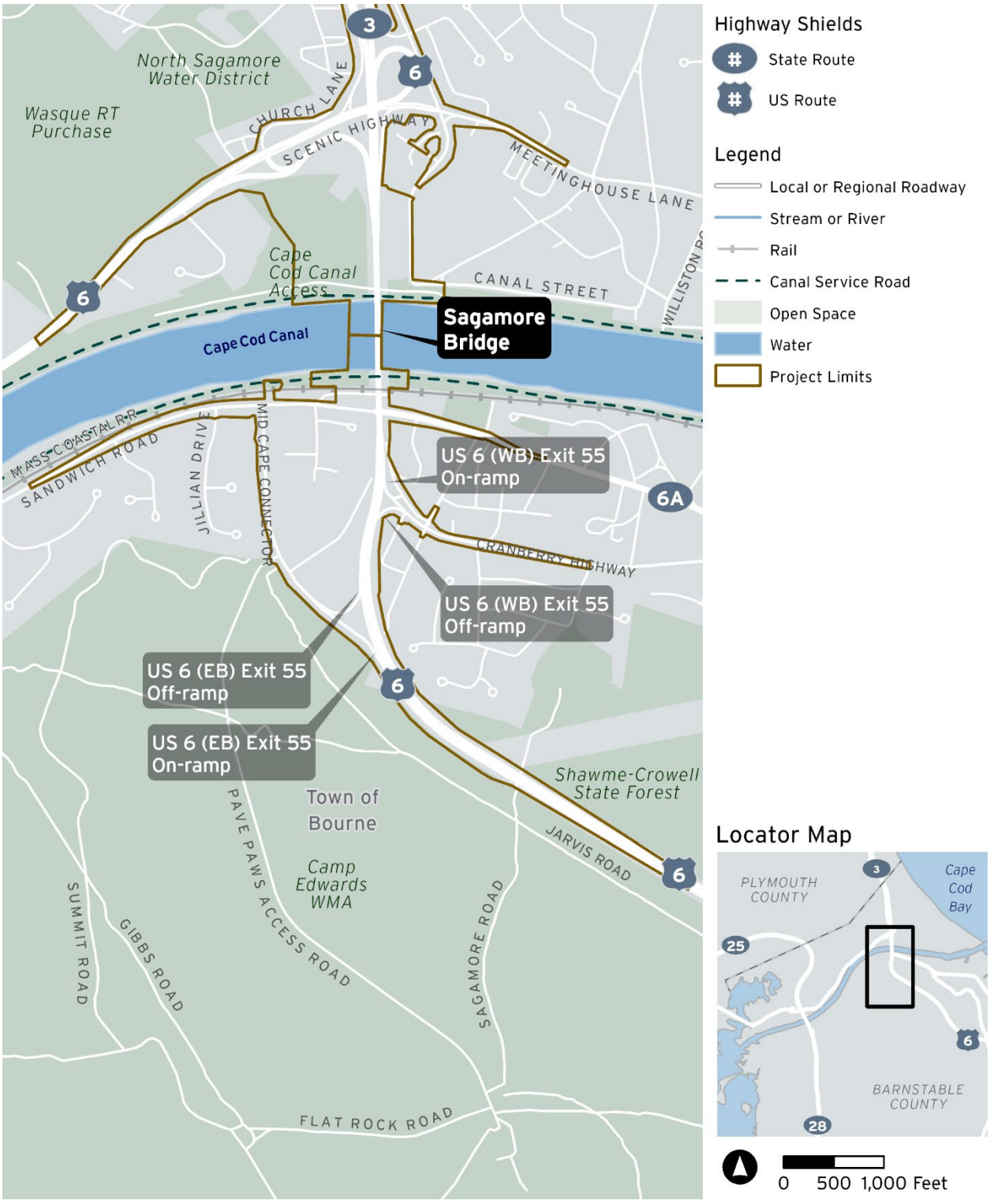
As illustrated in **Figure 1-8**, Bourne Rotary is immediately south of Bourne Bridge with four approaches, including State Route 28 (on both the north and south sides of Bourne Rotary), Trowbridge Road, and Bourne Rotary Connector. Sandwich Road provides a roadway connection north of the rotary between Trowbridge Road (via Veterans Way) and Bourne Rotary Connector. Bourne Rotary provides two lanes, in addition to a channelized right-turn lane from State Route 28/MacArthur Boulevard northbound to Sandwich Road eastbound and a right-turn lane from State Route 28 southbound to Trowbridge Road. All traffic crossing Bourne Bridge must pass through Bourne Rotary. **Exhibit 1-4** provides an aerial view of Bourne Rotary.

Figure 1-5. Sagamore Interchange



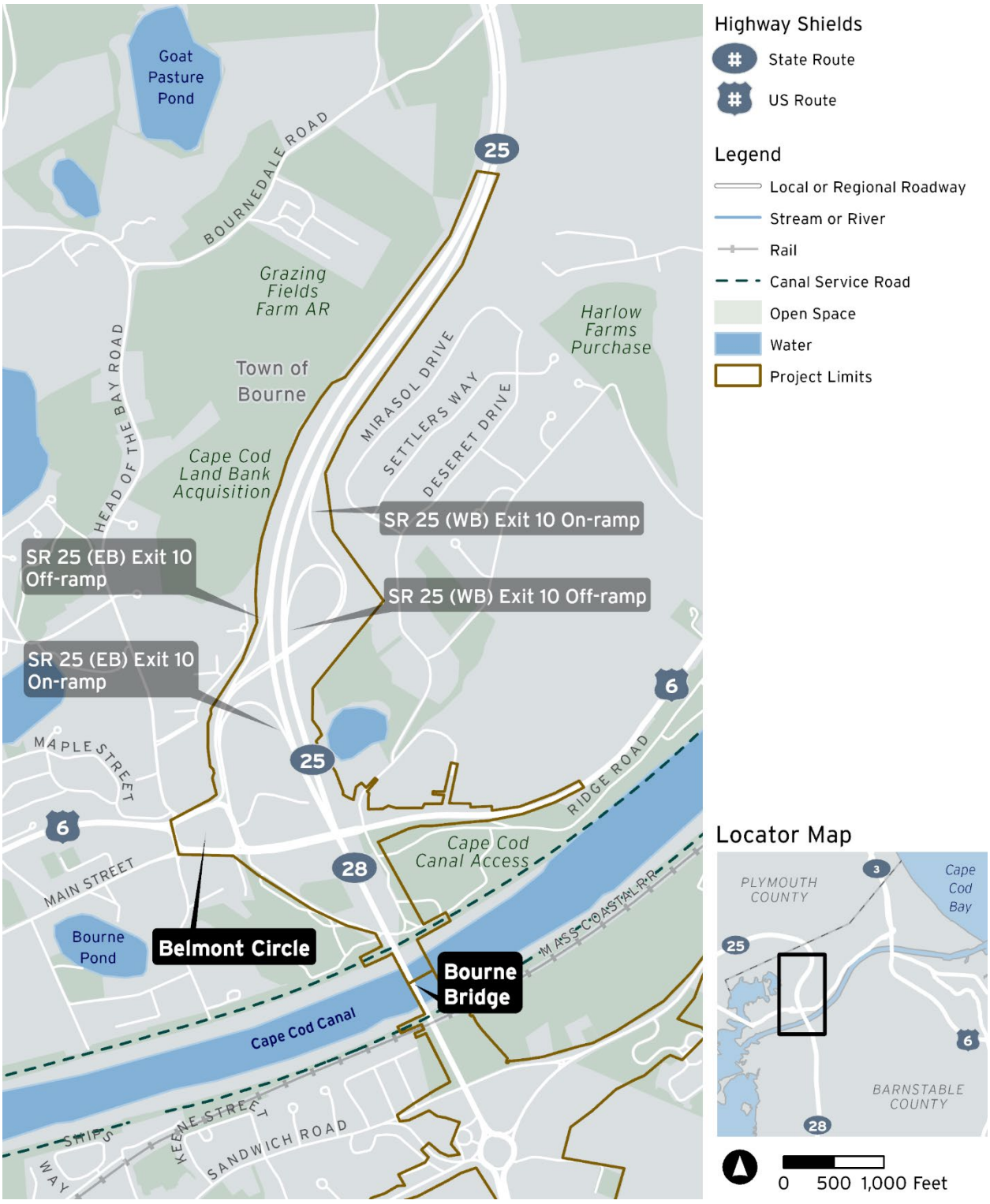
Source: Massachusetts Department of Transportation, 2024

Figure 1-6. U.S. Route 6 Exit 55 Interchange



Source: Massachusetts Department of Transportation, 2024

Figure 1-7. State Route 25/Scenic Highway Interchange and Belmont Circle



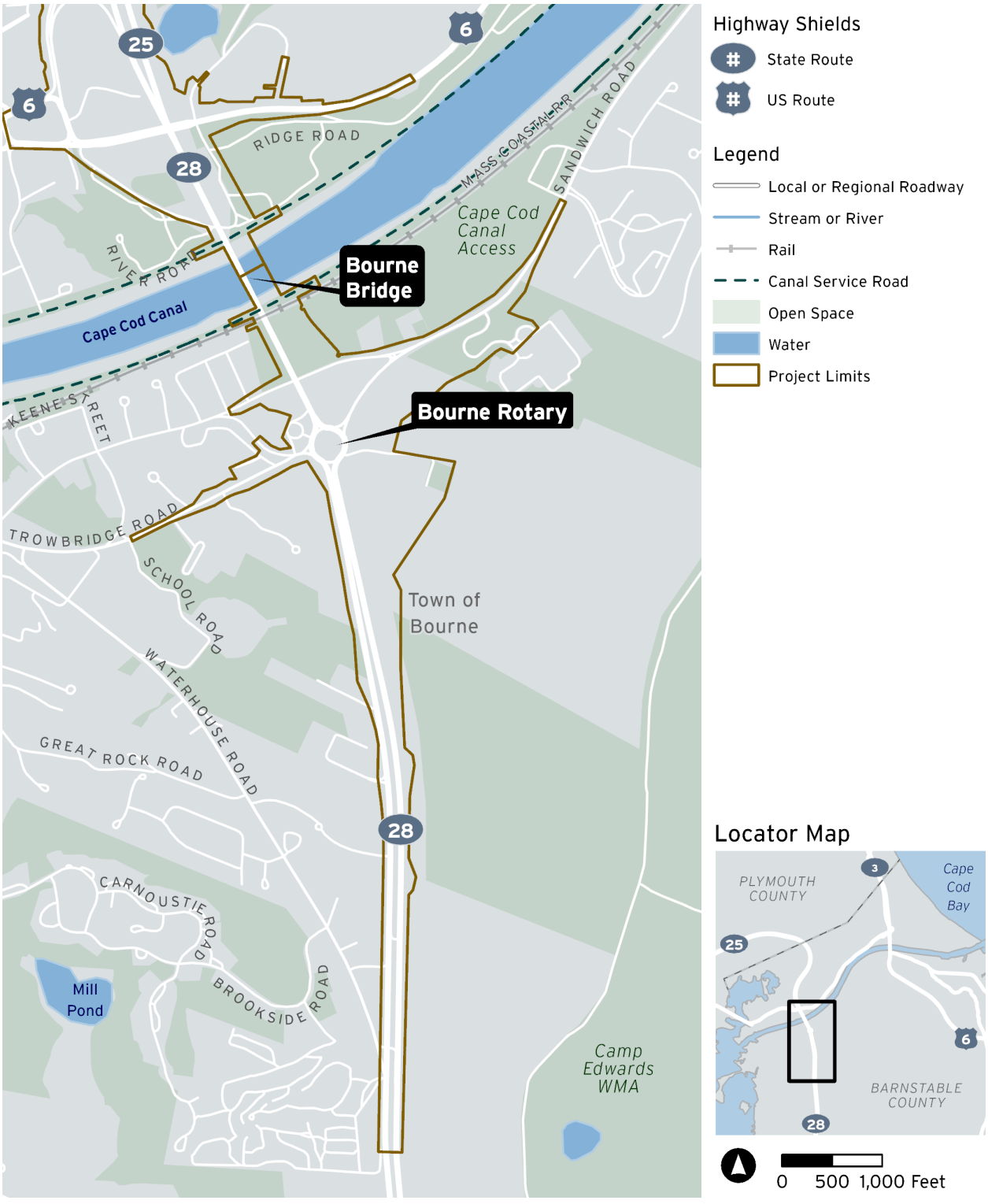
Source: Massachusetts Department of Transportation, 2024

Exhibit 1-3. Aerial View of Belmont Circle (looking east)



Source: Massachusetts Department of Transportation, 2024

Figure 1-8. Bourne Rotary



Source: Massachusetts Department of Transportation, 2024

Exhibit 1-4. Bourne Rotary (looking north)



Source: Massachusetts Department of Transportation, 2024

1.5 Proposed Program Overview

The Program proposes replacement of the Sagamore and Bourne Bridges over Cape Cod Canal. The existing bridges would be replaced with parallel, twin tied-arch bridge structures, approximately 10 feet apart, resulting in two bridges at each crossing and four bridges total. The replacement bridge mainline alignment location at both crossings would be offline (outside of the footprint of the existing bridge) and inboard of the existing highway bridges on the side of the canal between the existing Sagamore and Bourne Bridges. Each main span would provide two through-traffic lanes, one auxiliary lane, and shoulders and barriers in compliance with current MassDOT and FHWA standards. Each crossing would also provide one bidirectional pedestrian and bicycle shared-use path, separated from vehicular traffic by a shoulder and barrier. Additionally, the highway interchange approach networks would be reconfigured to align with the replacement bridges on both sides of Cape Cod Canal. A detailed description of the proposed Program is provided in **Chapter 3, Proposed Action and Alternatives**.

1.6 MEPA History

MassDOT submitted an ENF for the Program to the MEPA Office on April 28, 2023. The ENF was published in the Environmental Monitor on May 10, 2023, which initiated a 30-day public comment period, which was subsequently extended to 45-days. On July 7, 2023, the Secretary of Executive Office of Energy and Environmental Affairs (EEA) issued a Certificate on the ENF (EEA #: 16695) which required the submission of a mandatory Environmental Impact Report (EIR) and included a scope of additional analysis for this DEIR.

1.6.1 Summary of Changes Since Filing the Environmental Notification Form

The ENF presented the screening methodologies to arrive at preferred options for the main span length, bridge pier location, bridge deck configuration, bridge type, and highway bridge mainline alignment over Cape Cod Canal. The ENF also broadly identified and evaluated the impacts of the 10 high-level conceptual interchange approach alternatives to the replacement bridges within two distinct study areas: the Sagamore Bridge and Bourne Bridge Study Areas. The ENF did not identify a "Preferred Alternative."

The DEIR presents the details of a secondary, 15% design-level evaluation of the 10 interchange approach alternatives that were presented in the ENF and identifies a "Preferred Alternative," which includes the selected bridge design parameters and highway interchange approach options, for each crossing. The DEIR also evaluates the impacts of the Preferred Alternative within resource-specific study areas, which establish the geographic extent for each analysis. **Chapter 4** of the DEIR provides an updated analysis of potential impacts of the Preferred Alternative relative to the natural, social, and built environments due to design progression since the ENF.

The DEIR has been developed to comply with recent federal directives relative to Environmental Justice, climate change adaptation, and resiliency, including Executive Order 14173 and the U.S. Department of Justice, February 5, 2025, memorandum "Rescinding Environmental Justice Memoranda" and Executive Order 14154 and the Council on Environmental Quality, February 19, 2025, memorandum "Implementation of the National Environmental Policy Act".

1.7 Required Permits and Approvals

The federal authorizations and state approvals and permits applicable to the Build Alternative are identified in **Table 1-1** and **Table 1-2**, respectively. MassDOT will be responsible for applying for and obtaining federal and state permits required to implement the Build Alternative. The status of all authorizations, permits, and approvals, including the applicable issuing agencies, is also provided.

Table 1-1. Federal Authorizations

Regulation	Regulatory Summary	Issuing Agency	Required Authorization	Status
National Environmental Policy Act (NEPA) (42 United States Code [USC] 4321 et seq)	NEPA requires federal agencies to assess the environmental and related social and economic effects of proposed major federal actions prior to making decisions. Federal agencies must prepare an Environmental Impact Statement (EIS) if a proposed major federal action is determined to significantly affect the quality of the natural and human environment.	Federal Highway Administration (FHWA) - NEPA Lead Agency	Issuance of Record of Decision (ROD) or Combined Final EIS/ROD pursuant to 23 USC 139	Scheduled for completion by February 2026
Section 4(f), U.S. Department of Transportation (USDOT) Act (49 USC 303)	Section 4(f) prohibits USDOT agencies from using land from significant publicly owned parks, recreation areas, wildlife and waterfowl refuges, or public and private historical sites unless there is no prudent or feasible alternative to that use and the action includes all possible planning to minimize harm, or the impact is *de minimis*.	FHWA	Section 4(f) Evaluation and Finding for use of Section 4(f) land	Scheduled for completion by February 2026
Section 106 of the National Historic Preservation Act (NHPA) [54 USC 306108]	Section 106 of the NHPA requires federal agencies to consider the effects of their undertakings on historic properties, which are defined as districts, archaeological sites, and individual buildings, structures, or objects that are listed or are eligible for listing in the National Register of Historic Places.	Massachusetts State Historic Preservation Officer	Consultation	Consultation ongoing; scheduled for completion by October 2025

Regulation	Regulatory Summary	Issuing Agency	Required Authorization	Status
Section 7 of the Endangered Species Act (ESA) [16 USC 1531 et seq]	Section 7 of the ESA requires federal agencies to ensure their actions are not likely to jeopardize the continued existence of any endangered or threatened species or result in the destruction or adverse modification of designated critical habitats.	• U.S. Fish and Wildlife Service (USFWS) • National Oceanic and Atmospheric Administration (NOAA) Fisheries	Consultation	NOAA Fisheries and USFWS consultation complete; refer to **Appendix 4.12, Attachments 1 and 2**
Fish and Wildlife Coordination Act (FWCA) [16 USC 2901-2911]	The FWCA requires federal agencies to consult with USFWS, NOAA Fisheries, and the appropriate state wildlife agency before undertaking or permitting any activities that modify or control waters in the United States.	• USFWS • NOAA Fisheries	Consultation	Consultation complete; refer to **Appendix 4.12, Attachments 1 and 3**
Magnuson-Stevens Fishery Conservation and Management Act (MSA) [16 USC 1801 et seq]	Section 305(b)(2) of the MSA requires federal agencies to consult with NOAA Fisheries when activities they authorize, fund, or undertake, or propose to authorize, fund, or undertake, may adversely affect Essential Fish Habitat.	NOAA Fisheries	Consultation	Consultation complete; refer to **Appendix 4.12, Attachment 3**
Coastal Zone Management Act (CZMA) [16 USC 1451 et seq]	The CZMA contains a "federal consistency provision" that requires federal agency activities that have reasonably foreseeable effects on state coastal zones be consistent, to the maximum extent practicable, with the enforceable policies of a coastal state's federally approved coastal management program.	Massachusetts Office of Coastal Zone Management	Federal consistency review	Scheduled for completion by March 2026

Regulation	Regulatory Summary	Issuing Agency	Required Authorization	Status
Section 14 of the Rivers and Harbors Act of 1899 (33 USC 408) [Section 408]	Section 14 of the Rivers and Harbors Act of 1899 provides that the Secretary of the Army may, upon the recommendation of the Chief of Engineers, grant permission to other entities for the permanent or temporary alteration or use of any U.S. Army Corps of Engineers (USACE) Civil Works project. This requires a determination by the Secretary that the requested alteration will not be injurious to the public interest and will not impair the usefulness of the USACE project.	USACE	Section 408 permission	Scheduled for completion by April 2026
General Bridge Act of 1946 (33 USC 525)	The General Bridge Act of 1946 requires the approval of the U.S. Coast Guard for the construction, maintenance, and operation of bridges and approaches over navigable Waters of the United States (WOTUS).	U.S. Coast Guard (USCG)	Approval of USCG Bridge Permit for construction and operation of replacement bridges	Scheduled for completion by May 2026
Section 404 of the Clean Water Act (CWA) (33 USC 1344)	Section 404 of the CWA authorizes the USACE to issue permits for the discharge of dredged or fill material into all WOTUS, including wetlands.	USACE	Approval of Section 10/404 General Permit	Scheduled for completion by April 2026
Section 10 of the Rivers and Harbors Act (33 USC 403)	Section 10 of the Rivers and Harbors Act requires a permit from the USACE for any work in, over, or under navigable WOTUS.			

Regulation	Regulatory Summary	Issuing Agency	Required Authorization	Status
Title 14 of the Code of Federal Regulations (14 CFR) Part 77, Safe, Efficient Use, and Preservation of the Navigable Airspace; 49 USC 44718	14 CFR Part 77 was adopted to establish notice standards for proposed construction or alteration that may result in an obstruction or interference with air navigation facilities and equipment or navigable airspace.	Federal Aviation Administration (FAA)	Approval of Notice of Proposed Construction or Alteration	Scheduled for completion before the start of construction
Section 402 of the CWA [33 USC 1342]	Section 402 of the CWA requires that all construction sites on an acre or greater of land, as well as municipal, industrial, and commercial facilities discharging wastewater or stormwater directly from a point source (a pipe, ditch, or channel) into a surface water of the United States (a lake, river, and/or ocean) must obtain permission under the National Pollutant Discharge Elimination System (NPDES) permit.	EPA	NPDES Construction General Permit	Scheduled for completion before the start of construction

Table 1-2. State Environmental Review and Permitting Schedule

Regulation	Regulatory Summary	Issuing Agency	Permit/Approval	Status
Massachusetts Environmental Policy Act (MEPA) (301 Code of Massachusetts Regulations [CMR] 11.00)	MEPA establishes review thresholds that identify categories of projects, or aspects thereof, of a nature, size, or location that are likely, directly or indirectly, to cause damage to the environment. A review threshold that is met or exceeded specifies whether MEPA review shall consist of an Environmental Notification Form (ENF) and a mandatory Environmental Impact Report (EIR) or of an ENF and other MEPA review if the Secretary so requires.	Massachusetts Executive Office of Energy and Environmental Affairs (MA EEA)	MA EEA Secretary Certificate on Final EIR	Scheduled for completion by January 2026
Article 97 of the Amendments to the Massachusetts Constitution (Article 97) and the Public Lands Preservation Act (PLPA) [Ch. 274 of the Acts of 2022, codified at M.G.L. c. 3, § 5A]	Article 97 and the PLPA prohibits the change in use or disposal of public lands protected under Article 97 without legislative approval and a publicly disclosed alternatives analysis. It requires replacement land of equal or greater value, or monetary compensation at 110% of appraised value to be used within three years for land acquisition. Waivers may be granted under limited conditions by the Secretary of Energy and Environmental Affairs.	MA EEA	Article 97 Land Disposition - requiring 2/3 roll call vote of both houses of the Legislature	Pending
Massachusetts Wetlands Protection Act (MA WPA) [310 CMR 10.00]	The MA WPA prohibits any filling, excavation, or other alteration of the land surface, water levels, or vegetation in wetlands, floodplains, riverfront areas, or other wetland resource areas, regardless of ownership, without a permit from the local Conservation Commission.	Bourne Conservation Commission (BCC)	Order of Conditions	Scheduled for completion by February 2026

Regulation	Regulatory Summary	Issuing Agency	Permit/Approval	Status
401 Water Quality Certification (401 WQC) Regulations (314 CMR 9.00)	The 401 WQC Regulations require that any applicant seeking a federal permit or license for an activity that could result in a discharge of fill or dredge material into Waters of the United States must obtain a state water quality certification, ensuring the proposed activity complies with state water quality standards before the federal permit can be issued.	Massachusetts Department of Environmental Protection (MassDEP)	• Major Fill/ Excavation Project Certification • Major Dredge Project Certification	Scheduled for completion by February 2026
Chapter 91 Waterways Regulations (310 CMR 9.00)	The Chapter 91 Waterways Regulations require a Chapter 91 waterways license or permit for any activity located in, under, or over flowed tidelands, filled tidelands, Great Ponds, and certain non-tidal rivers and streams located throughout the Commonwealth of Massachusetts.	MassDEP	Determination of Chapter 91 Applicability	Pending
Massachusetts Endangered Species Act (MESA) Regulations (321 CMR 10.00)	MESA protects rare species and their habitats by prohibiting the "take" (i.e., harming, harassing, killing, or disrupting) of any plant or animal species listed as Endangered, Threatened, or Special Concern by the Massachusetts Division of Fisheries and Wildlife. Projects resulting in a "take" of state-listed species must either be revised to avoid such impacts or require a Conservation and Management Permit before moving forward.	Massachusetts Department of Fish and Game: Division of Fisheries and Wildlife (MassWildife) – Natural Heritage Endangered Species Program (NHESP)	Conservation and Management Permit	Scheduled for completion by February 2026

2 Program Purpose and Need

2.1 Introduction

This chapter defines the purpose and need for the Cape Cod Bridges Program (the Program). The "purpose" statement (**Section 2.2**) concisely establishes the fundamental reasons why the Federal Highway Administration (FHWA) is undertaking the Program, which is expressed as a desired transportation outcome. The "need" statement (**Section 2.3**) identifies transportation-related problems that the Program is intended to address or improve. In addition to providing the justification for undertaking the proposed action, the purpose and need is used to identify and determine a range of reasonable alternatives that are evaluated in this Draft Environmental Impact Report (DEIR), establish criteria to compare those alternatives, and ultimately select an alternative that advances into project development. The Massachusetts Department of Transportation (MassDOT) established other goals beyond the desired transportation outcomes stated in the Program's purpose. These goals—related to social, economic and environmental outcomes—are distinct from the Program's purpose and need. **Table 3.5** presents the Program goals and related objectives.

Building upon the analyses and findings of the U.S. Army Corps of Engineers (USACE) and MassDOT's foundational documents (presented in **Chapter 1, Introduction**), MassDOT developed the Program Purpose and Need statement in coordination with the FHWA, Cooperating Agencies, and the public. **Chapter 6, Agency Coordination and Public Involvement**, provides details of agency and public involvement in developing the Program's purpose and need.

2.2 Purpose of the Program

The purpose of the Program is to improve cross-canal mobility and accessibility between Cape Cod and mainland Massachusetts for all road users and to address the increasing maintenance needs and functional obsolescence of the aging Sagamore and Bourne Bridges.

2.3 Need for the Program

The needs for the Program are as follows:

- Address the deteriorating structural condition and escalating maintenance demands of Sagamore and Bourne Bridges.
- Address the substandard design elements of Sagamore and Bourne Bridges, the immediate mainline approaches, and their adjacent interchanges and intersections.
- Improve vehicular traffic operations.
- Improve accommodations for pedestrians and bicyclists.

Sections 2.3.1 through 2.3.4 provide data supporting each of these identified transportation-related needs.

2.3.1 Address the Deteriorating Structural Condition and Escalating Maintenance Demands of Sagamore and Bourne Bridges

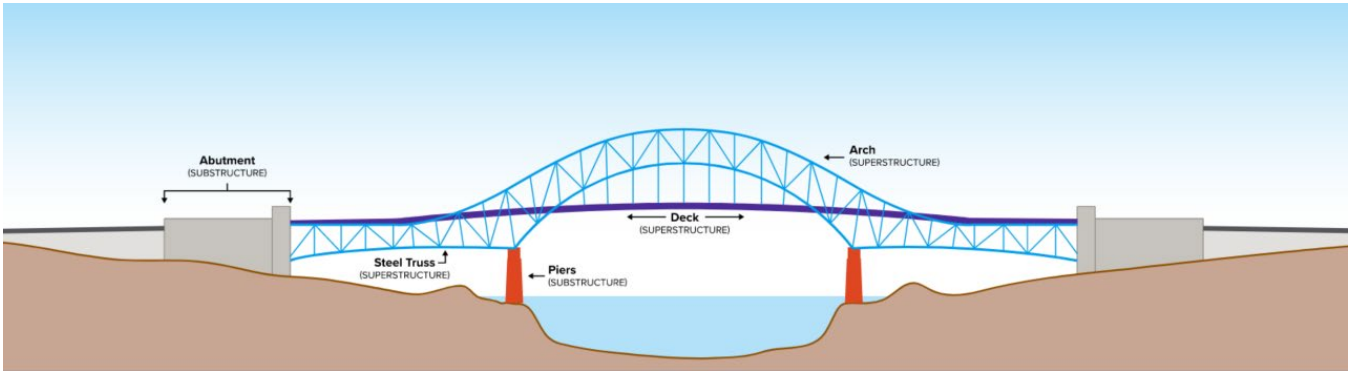
With original construction completed in 1935, Sagamore Bridge and Bourne Bridge have undergone a maintenance, repair, and rehabilitation program, including major rehabilitation between 1979 and 1982. The USACE conducts a regular cycle of inspections of both bridges in accordance with current National Bridge Inspection Standards. These routine inspections are conducted to characterize condition ratings for three main bridge components: the deck, superstructure, and substructure. The deck is the roadway portion of the bridge that supports vehicular and pedestrian traffic. The superstructure is the portion of the bridge above the substructure—including beams, arches, trusses, and other load-bearing elements—that support the bridge deck. The substructure is the portion of the bridge below the superstructure—including the piers, abutments, and foundations—that transfer the loads from the superstructure to the ground. A bridge is rated "structurally deficient" if its deck, superstructure, or substructure is rated in poor condition, which is a rating of 4 or below on the National Bridge Inspection Standards rating scale (**Table 2-1**). **Figure 2-1** identifies the main components of the existing Sagamore and Bourne Bridges.

Table 2-1. Bridge Condition: National Bridge Inspection Ratings and Good/Fair/Poor Classification

Number	Condition	Classification
9	Excellent	**Good**
8	Very Good	
7	Good	
6	Satisfactory	**Fair**
5	Fair	
4	Poor	**Poor**
3	Serious	
2	Critical	
1	Imminent Failure	
0	Fail	

Source: FHWA Pavement and Bridge Condition Performance Measures final rule, January 2017

Figure 2-1. Main Components of the Existing Sagamore and Bourne Bridges



Source: Massachusetts Department of Transportation, 2024

Sagamore Bridge was not considered to be "structurally deficient" as of the latest available inspection conducted by the USACE in September 2021. The deck was in fair condition with an overall rating of 5. The superstructure and substructure were also in fair condition with overall ratings of 5. While Sagamore Bridge was not classified as "structurally deficient," several gusset plates in the bridge superstructure exhibited areas of advanced section loss and deformation due to corrosion. Severe deterioration or warping of gusset plates could lead to localized failures and in extreme cases a progressive collapse of the steel truss superstructure. **Exhibit 2-1** depicts advanced deterioration of gusset plates based on the 2021 USACE Sagamore Bridge inspection.

Exhibit 2-1. Truss Joint Gusset Plate Deterioration (Sagamore Bridge)



Source: U.S. Army Corps of Engineers. 2022. Routine Inspection of Bourne Bridge

Based on the latest information available from a routine inspection conducted by USACE in October 2022, Bourne Bridge was classified as "structurally deficient." The superstructure was in poor condition with a rating of 4 due to the continuing deterioration of the gusset plates that tie the truss members together, the bearings, and the concrete T-beams that support the weight of the bridge deck. The deck was in fair condition with a rating of 5 due to continuing deterioration in the abutment spans. The

substructure was in good condition with a rating of 7, although delamination and spalling were noted in the bridge abutment walls, and the deck joints received a rating of 4. **Exhibit 2-2** depicts advanced deterioration of gusset plates based on the 2022 USACE Bourne Bridge inspection. **Exhibit 2-3** depicts advanced deterioration of concrete T-beams based on the 2022 USACE Bourne Bridge inspection.

Exhibit 2-2. Truss Joint Gusset Plate Deterioration (Bourne Bridge)



Source: U.S. Army Corps of Engineers. 2022. Routine Inspection of Bourne Bridge

Exhibit 2-3. Concrete T-Beam Deterioration (Bourne Bridge)



Source: U.S. Army Corps of Engineers. 2022. Routine Inspection of Bourne Bridge

While Bourne Bridge was found to be "structurally deficient" (as of the 2022 USACE inspection), this classification does not imply that the bridge is unsafe for public travel. However, the classification is an indication that the bridge requires maintenance, repair, and eventual rehabilitation or replacement to address deficiencies and concerns regarding deterioration in the long term.

The age of the bridges—combined with their heavy vehicular demands and the corrosive saltwater environment of Cape Cod Canal—creates an environment where frequent, costly, and escalating maintenance efforts are necessary to maintain the structures in a state of good repair. According to the USACE's March 2020 Major Rehabilitation Evaluation Report and Environmental Assessment for the Cape Cod Canal Highway Bridges, the cost to maintain Bourne Bridge between 1979 and 2017 was just over $41 million, while the cost to maintain Sagamore Bridge between 1981 and 2018 was just over $37 million.

All repair work on the superstructure and bridge deck requires that vehicular lanes be closed to facilitate contractor activities. Typically, these lane closures restrict travel to one lane in each direction. Historically, temporary lane closures last a minimum of nine months during repair contracts.[1] These lane closures for maintenance and repairs result in heavy backups for motorists waiting to cross the bridges, with queues commonly stretching several miles on the approach highways and local roadways. Lane restrictions and heavy traffic congestion during bridge maintenance repairs affect the ability for police, firefighters, and emergency medical responders to operate and respond to incidents safely and efficiently. The USACE schedules bridge maintenance work in off-peak travel seasons between Columbus Day and Memorial Day, when possible, to minimize impacts to the traveling public.

Based on criteria provided in the MassDOT Load and Resistance Factor Design bridge design specifications, Sagamore and Bourne Bridges are designated as "Critical and Essential Bridges," indicating that they must be operational following a natural disaster or other event. Because the bridges were built in the 1930s, they do not meet current seismic design standards. Given the age and underlying structural deficiencies of these bridges, they are vulnerable to damage from major seismic events or extreme weather-related events, such as hurricanes.

2.3.2 Address the Substandard Design Elements of Sagamore and Bourne Bridges, including their immediate Approaches and Interchanges

Sagamore and Bourne Bridges do not meet current MassDOT bridge and highway design standards for key characteristics, such as travel lane width, median barrier separation, shoulder width, and roadway profile grade. Each bridge provides four 10-foot-wide vehicular travel lanes (two lanes in each direction), which are 2 feet narrower than the 12-foot lane width standard for limited access highways.[2] The bridges lack physical separation between opposing travel lanes, which increases the risk of head-on collisions. In addition, they lack shoulder accommodations to allow vehicles to pull out of the travel lanes in emergency situations. In the event of traffic accidents or other incidents on the bridges, damaged or disabled vehicles block travel lanes until they can be removed, resulting in lengthy traffic delays and full bridge closure in one or both directions. Severe congestion and the lack of shoulder accommodations on the bridges pose public safety concerns due to delayed emergency response for police, fire, and paramedic services. The narrow travel lanes, lack of shoulders, and

[1] U.S. Army Corps of Engineers. March 2020. Major Rehabilitation Evaluation Report and Environmental Assessment, Cape Cod Canal Highway Bridges, Bourne, Massachusetts.

[2] American Association of State Highway and Transportation Officials: A Policy on Geometric Design of Highways and Streets (2018)

absence of separation between opposing travel lanes on the bridges result in frequent reports of sideswipe collisions between vehicles travelling in the same or opposite directions. As presented in **Section 2.3.3**, sideswipe collisions (opposite and same-side) and head-on crashes made up over 40% of the reported crashes between January 1, 2017, and December 31, 2019, which can be attributed to the lack of physical separation between opposing travel lanes and shoulders. The traffic safety features of Sagamore and Bourne Bridges—including their bridge railings, transitions, approach guardrails, and approach guardrail ends—do not conform to current MassDOT specifications.

Sagamore and Bourne Bridges connect to interchanges on the north and south sides of Cape Cod Canal. These interchanges are closely spaced and facilitate local and regional movement of traffic. Under current travel patterns, the right-most through travel lanes in each direction on the bridges are often used as acceleration and deceleration lanes to facilitate vehicles entering and exiting the bridges from the adjacent interchange ramps, increasing lane changing maneuvers and reducing the efficiency of cross-canal traffic movement. In addition, the Bourne Rotary has historically been a major bottleneck in the Cape Cod Canal area roadway network due to heavy conflicting traffic flows. The proximity of interchanges and intersections at the end of each bridge and the lack of auxiliary lanes across the bridges and the adjoining roadways result in weaving and merging issues for motorists, which further increases congestion and queueing.

Sagamore and Bourne Bridges and their approaches have steep roadway profile grades of up to 6%, which gradually flatten as the roadway crests at the mid crossing point of the canal. **Exhibit 2-4** illustrates the steep grades approaching Sagamore Bridge. At a 6% grade, the vertical profiles of the bridges and their approaches are steeper than the 4% to 5% maximum grade typical for limited-access highways. Because of the steep roadway profile grades of the bridges and their approaches, it is difficult for vehicles, especially large trucks, to maintain speed. This effect—combined with the narrow 10-foot-wide lanes and lack of auxiliary lanes on the bridges—causes all traffic immediately approaching and on the bridges to slow down in both directions and make abrupt lane changes.

Exhibit 2-4. Steep Roadway Grade Approaching Sagamore Bridge



Source: Massachusetts Department of Transportation, 2024

Approaching Sagamore Bridge from the north, one of the two travel lanes along State Route 3 southbound is dropped to allow travelers from Scenic Highway to merge onto State Route 3 at Exit 1A, reinstating the second travel lane. This lane drop contributes to congestion and delays on State Route 3 southbound, especially during peak travel periods. Additionally, the geometry of U.S. Route 6 Exit 55 westbound (at Cranberry Highway) does not comply with current MassDOT highway design standards due to its short acceleration and deceleration lanes, and the steep grades approaching Sagamore Bridge.

2.3.3 Improve Vehicular Traffic Operations

The 1930s-era Sagamore and Bourne Bridges were designed and built to serve far lower traffic volumes than those served by the bridges today. Estimates of vehicle traffic volumes during design for new highway crossings of Cape Cod Canal in the early 1930s ranged from 1,200 vehicles per day to 4,700 vehicles per day, depending on the time of year.[3] According to MassDOT traffic count data for the 2019 base year condition, the average daily traffic for the fall (tourist off-season) and the summer (tourist peak-season) on Bourne Bridge was 46,380 and 57,870, respectively. The average daily traffic for the fall (tourist off-season) and the summer (tourist peak-season) on the Sagamore Bridge was 62,030 and 79,570, respectively.

Heavy traffic volumes, coupled with the geometrically deficient features of the bridges and their immediate approaches, contribute to poor traffic operations during peak travel periods and crash rates that are considerably higher than the statewide average for similar facilities. Level of Service (LOS) is a letter grade system used to describe operational conditions within a traffic stream and their perception by the traveling public (**Table 2-2**). A designation of LOS A, B, or C represents free-flowing conditions, and a designation of LOS D is generally considered marginally acceptable conditions. A designation of LOS E or F is generally considered unacceptable to most drivers, where operating conditions are near or at capacity with considerable delays. **Table 2-3** presents highway sections along Sagamore and Bourne Bridges and their mainline approaches that operate with considerable delays (LOS E/F) during the fall tourist off-season weekday peak morning and afternoon travel periods based on 2019 Existing Condition VISSIM traffic models.[4] Operating conditions and traffic delays on the bridges and their highway approaches are expected to worsen due to projected growth in annual visitor trips to the Cape Cod region and the continued trend of lower-wage Cape Cod workers living off Cape.

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[3] U.S. Army Corps of Engineers. March 2020. Major Rehabilitation Evaluation Report and Environmental Assessment, Cape Cod Canal Highway Bridges, Bourne, Massachusetts.

[4] VISSIM: microsimulation software used to analyze the roadway network including roadways of differing functional classifications.

Table 2-2. Level of Service Ratings

Letter	Definition
A	**Free-Flow Traffic** (No Delays)
B	**Light/Moderate Traffic** (No Delays)
C	**Steady Traffic** (Minimal Delays)
D	**Speeds Begin to Decline** (Minimal Delays)
E	**Traffic at Capacity** (Significant Delays)
F	**Heaviest Congestion** (Forced Flow)

Source: Highway Capacity Manual (7th Edition), 2022

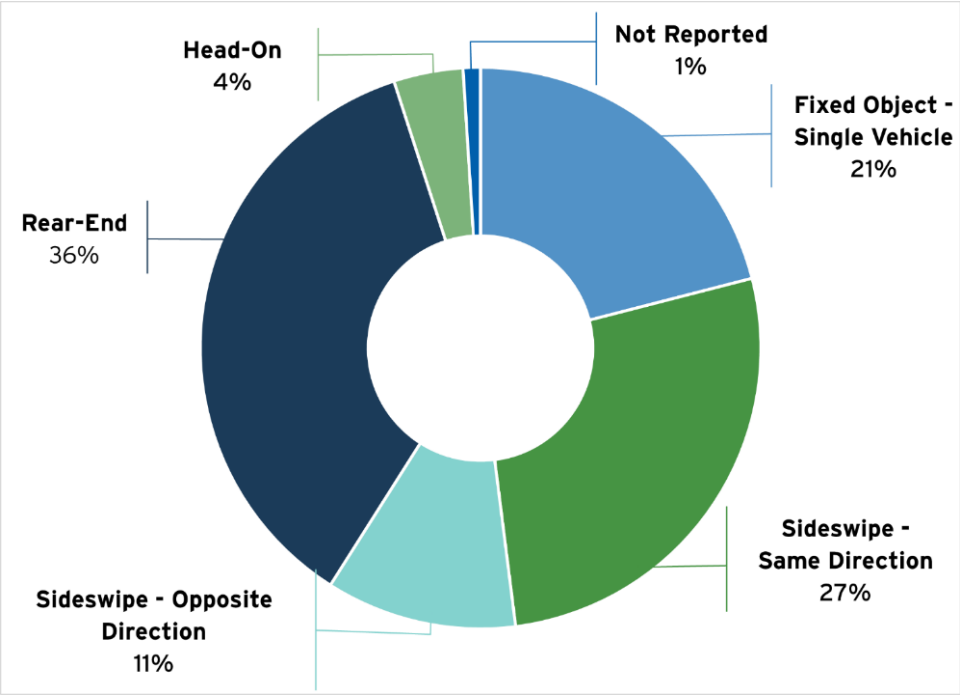
Table 2-3. Bridge and Mainline Approach Sections Operating Near or At Capacity for 2019 (Existing Condition) Fall Weekday Peak Hours

Highway Section	A.M. Peak Hour LOS	P.M. Peak Hour LOS
State Route 3 southbound approaching Sagamore Bridge	F	E
U.S. Route 6 westbound and eastbound on Sagamore Bridge	F	F
State Route 28 southbound on Bourne Bridge	F	F
State Route 28 and MacArthur Boulevard intersection northbound approaching the Bourne Rotary	D	F
State Route 25 approaching the exit for Belmont Circle (Exit 10)	E	F

Source: Massachusetts Department of Transportation. 2025. Cape Cod Bridges Program Environmental Impact Report, Appendix 4.2: Traffic Engineering Technical Report

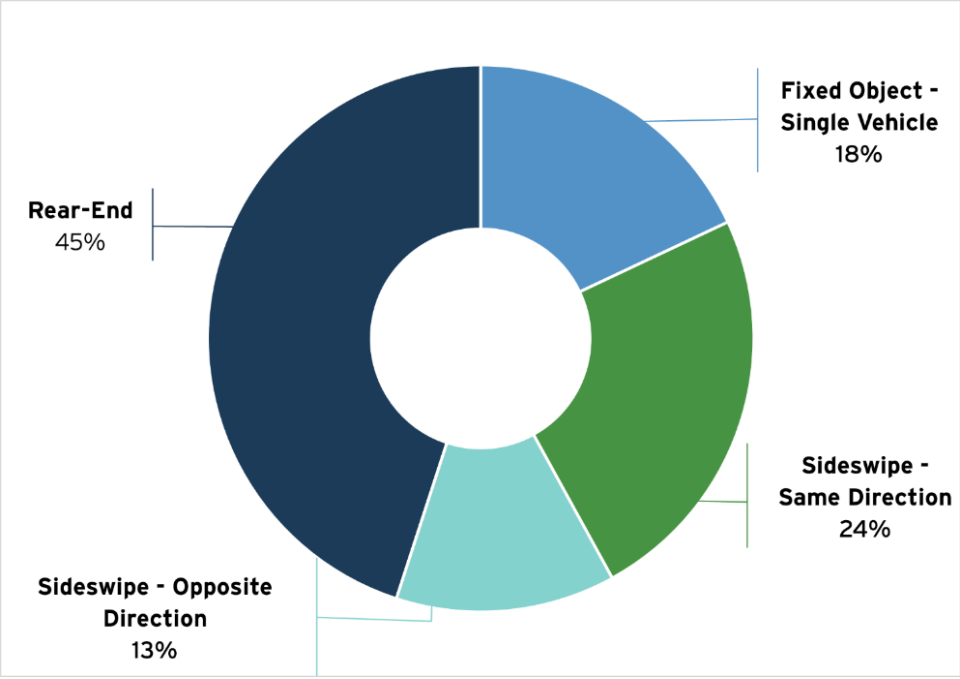
Sagamore and Bourne Bridges experienced a significantly higher crash rate than the MassDOT average crash rate for similar principal arterial roadways between January 1, 2017, and December 31, 2019. The MassDOT crash rate for a similar facility is 0.80 crashes per million vehicle miles traveled (MVMT). Bourne Bridge experienced a crash rate of approximately 1.8 crashes per MVMT or 120% higher than the Massachusetts average crash rate for a principal arterial roadway. Sagamore Bridge experienced a crash rate of approximately 2.6 crashes per MVMT or 228% higher than the Massachusetts average crash rate for a principal arterial roadway. Observed crashes by type during the 2017–2019 study period were partially attributed to existing traffic congestion and the narrow roadway cross-section of the existing bridges. There were 56 observed crashes on Sagamore Bridge and 45 observed crashes on Bourne Bridge during the 2017–2019 study period. **Figure 2-2** and **Figure 2-3** summarize the composition of observed crashes by type during the 2017–2019 study period.

Figure 2-2. Sagamore Bridge Crash Data Summary by Type (2017 through 2019)



Source: Massachusetts Department of Transportation, 2024

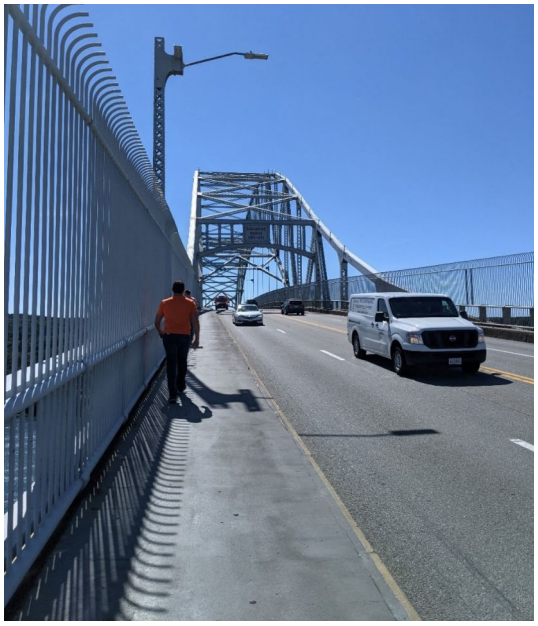
Figure 2-3. Bourne Bridge Crash Data Summary by Type (2017 through 2019)



Source: Massachusetts Department of Transportation, 2024

As illustrated in **Figure 2-2** and **Figure 2-3**, the most common crash type on the bridges is Rear-End (36% and 45% of crashes, respectively). Congestion along the bridges contributes to the high rate of rear-end crashes. The second most common crash type on each bridge is Sideswipe - Same Direction (27% and 24% of crashes, respectively). This crash type, along with the Fixed Object/Single Vehicle Crash type, can be partially attributed to the narrow 10-foot travel lanes on the bridges (**Exhibit 2-5**) and their lack of roadway shoulders. The Sideswipe - Opposite Direction and Head-On crash types can also be partially attributed to the lack of a median or separation of the direction of travel along each bridge.

Exhibit 2-5. Pedestrians Crossing Sagamore Bridge



Source: Massachusetts Department of Transportation, September 2022

Within the past several years, other identified locations in the immediate area of the bridges with a history of high-crash rates include Belmont Circle, Bourne Rotary, and the intersection of Scenic Highway at Meetinghouse Lane. These high-crash locations identify crash clusters that rank within the top 5% of the Cape Cod Commission's planning region.

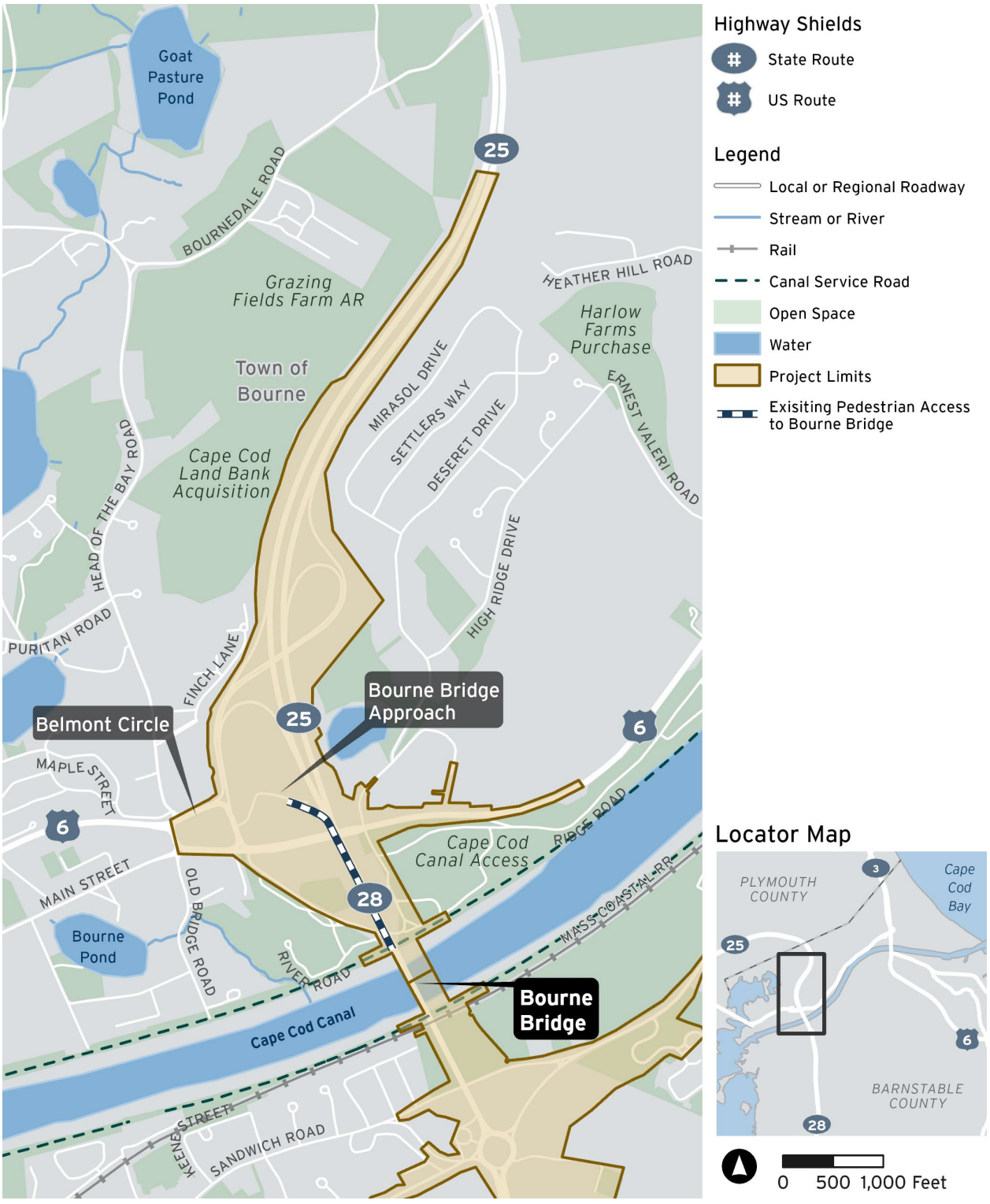
2.3.4 Improve Accommodations for Pedestrians and Bicyclists

The MassDOT Office of Transportation Planning's 2019 Cape Cod Canal Transportation Study recommended improving pedestrian and bicycle connections to and from local roadways over Cape Cod Canal at Sagamore and Bourne Bridges.

Each bridge provides a narrow raised 6-foot 8-inch-wide sidewalk along one side that includes steep roadway profile grades of up to 6%, with no designated accommodations for bicycle travel. Pedestrians and bicyclists must share sidewalk facilities on the bridges. As the existing sidewalks along the bridges are too narrow for shared bicycle and pedestrian use, bicyclists typically dismount and walk their bicycles across the bridges. With the lack of roadway shoulders on the bridges, vehicles travel immediately next to the existing sidewalks. The proximity of vehicular traffic to sidewalks on the bridges creates unsafe and uncomfortable conditions for pedestrians and bicyclists. **Exhibit 2-5** illustrates the narrow width for pedestrian traffic on Sagamore Bridge.

At the approaches to both bridges, existing gaps in the sidewalk network pose access limitations for pedestrians to cross Cape Cod Canal. The only pedestrian access to Bourne Bridge from the north is via an unmarked sidewalk at the end of the Bourne Bridge approach (**Figure 2-4**). To access the sidewalk at the southern end of Bourne Bridge, pedestrians need to enter Bourne Rotary, a high-volume traffic circle that lacks sidewalks. No designated pedestrian facilities connect the southern end of Sagamore Bridge to Cranberry Highway or Sandwich Road.

Figure 2-4. Pedestrian Access to Bourne Bridge via Sidewalk at Bridge Approach Street



Source: Massachusetts Department of Transportation, 2024

There is also a lack of pedestrian and bicycle connections to the Cape Cod Canal service roads, which run below Sagamore and Bourne Bridges along both the north and south banks of Cape Cod Canal. These service roads, which the USACE owns and maintains as part of the Cape Cod Canal Federal Navigation Project, are open to the public and serve as a popular resource for walking, jogging, cycling, and access to saltwater fishing.

2.4 Program Goals and Objectives

MassDOT established other goals beyond the desired transportation outcomes stated in the Program purpose. These goals—related to social, economic and environmental outcomes—are distinct from the Program purpose and need. **Table 3.5** in **Chapter 3, Proposed Action and Alternatives** presents the Program goals and related objectives.

3 Proposed Action and Alternatives

3.1 Introduction

This chapter identifies the alternatives from the U.S. Army Corps of Engineers' (USACE) Major Rehabilitation Evaluation Report/Environmental Assessment (MRER/EA) that the Massachusetts Department of Transportation (MassDOT) evaluated, including those considered but dismissed from further evaluation. It describes the alternatives that are retained for detailed study in this Draft Environmental Impact Report (DEIR), consisting of a No Build Alternative and a Build Alternative, identified as "Replacement Highway Bridges Built to Modern Design Standards." It also summarizes the extensive analyses that MassDOT conducted of multiple bridge design and highway approach interchange options for the Build Alternative.

MassDOT documented its alternatives assessment process in the following reports, provided in **Appendix 3.1, Alternatives Assessments Technical Report**:

- **Attachment 1, Cape Cod Bridges Program Alternatives Analysis Report** (July 2025), which provides the following:
  - Results of the conceptual-level screening of the USACE's MRER/EA alternatives and recommendation for in-kind bridge replacement.
  - Assessments and identification of the recommended bridge highway cross-section and shared-used path, bridge vertical and horizontal clearance, main span length and bridge pier location, bridge deck configuration, mainline alignment location, and bridge type conducted at the 5% through 15% design level.
  - Initial assessment of highway interchange approach options resulting in advancement of 10 options for a more detailed, 15% design-level evaluation.
- **Attachment 2, Cape Cod Bridges Program - Highway Interchange Approaches Detailed Assessment Report** (July 2025), which provides details of the secondary, 15% design-level evaluation of the 10 interchange approach options that passed the initial assessment and resulted in a single pairing of options for each replacement bridge crossing.

This chapter also presents MassDOT's Preferred Alternative for the Cape Cod Bridges Program (Program), including the preferred bridge design parameters and highway interchange approach options. Additionally, this chapter presents an overview of the construction approach for the Program, which is described in further detail in **Chapter 5, Construction Approach**.

3.2 Alternatives Screening

The National Environmental Policy Act (42 United States Code 4321 et. seq.), as amended, requires that environmental impact statements consider a reasonable range of alternatives that are technically and economically feasible and meet the purpose and need of the proposal. As described in 23 Code of

Federal Regulations 771.105, the Federal Highway Administration's (FHWA) National Environmental Policy Act-implementing regulations, it is the U.S. Department of Transportation's policy to evaluate alternative courses of action and determine the proposed action that is in the "best overall public interest based upon a balanced consideration of the need for safe and efficient transportation; of the social, economic, and environmental impacts of the proposed transportation improvement; and of national, State and local environmental protection goals."[1] Alternatives can be rejected as unreasonable based on the inability to meet the purpose and need for a proposed action, in addition to other factors including environmental impacts, engineering, and cost.[2]

Similarly, the Massachusetts Environmental Policy Act (Massachusetts General Law c.30 §§ 61 through 62L) and its implementing regulations (301 Code of Massachusetts Regulations) 11.07(6)(f)) require that environmental impact reports include a comprehensive analysis of alternatives to the proposed project. This includes evaluating all feasible alternatives, including those identified in the project scope and the "no build" alternative to establish a baseline for the environmental impact assessment. The analysis must consider how each alternative aligns with the proponent's objectives and the missions of any involved agencies. It must also compare the environmental impacts of each feasible alternative and briefly explain why any alternatives were dismissed from further consideration.

In coordination with FHWA, MassDOT conducted an independent conceptual screening of 12 alternatives presented by the USACE in the MRER/EA. The 12 alternatives comprised the USACE's "Universe of Alternatives" for addressing the deteriorating Sagamore and Bourne Bridges. MassDOT reviewed the USACE MRER/EA alternatives relative to the Program's Purpose and Need Statement and NEPA guidance for evaluating alternatives for reasonableness.

MassDOT determined that replacing both bridges with two new adjacent bridges at each crossing location, each providing two through-traffic lanes and an auxiliary lane in each direction and built to current design standards, would meet the identified Program needs to address the escalating bridge maintenance demands and improve traffic operations and accommodations for pedestrians and bicyclists. Based on its ability to fully meet the Program needs, while minimizing the approach road modifications necessary to connect the replacement bridges to the regional and local transportation system, MassDOT recommended advancing the Four Travel Lanes and Two Auxiliary Lanes Replacement Alternative (Replacement Highway Bridges Built to Modern Design Standards), the USACE's Preferred Alternative presented in the MRER/EA, for further consideration. MassDOT's recommended alternative, Replacement Highway Bridges Built to Modern Design Standards, was the basis for assessing the Program's bridge and highway design parameters.

Table 3-1 summarizes the 11 remaining alternatives from the MRER/EA that MassDOT evaluated, including reasons for their dismissal.

[1] https://www.ecfr.gov/current/title-23/chapter-I/subchapter-H/part-771

[2] American Association of State Highway and Transportation Officials' (AASHTO) Practitioner's Handbook 07 Defining Purpose and Need and Determining the Range of Alternatives for Transportation Projects

Table 3-1. Summary Evaluation of Other Alternatives Considered

Alternative	MassDOT's Evaluation and Determination
No Build/Base Condition	The No Build Alternative (Major Rehabilitation Evaluation Report/Environmental Assessment Base Condition) would not meet the Purpose and Need Statement. The component deficiencies of the bridges and their increasingly frequent maintenance needs would continue to impede mobility and accessibility for road users crossing Cape Cod Canal. Further, the Base Condition would result in unacceptable safety or operational problems. While the Massachusetts Department of Transportation (MassDOT) determined that this alternative is not reasonable, it is retained as a baseline alternative against which the Build Alternative is evaluated.
Major Rehabilitation of Both Highway Bridges	MassDOT determined that the Major Rehabilitation Alternative is not reasonable, as it would not meet the identified needs of the Cape Cod Bridges Program (Program) for addressing the underlying structural and roadway design deficiencies of the Sagamore and Bourne Bridges and improving accommodations for pedestrians and bicyclists. The component deficiencies of the bridges, combined with prolonged construction period bridge closures and ongoing maintenance requirements, would continue to impede mobility and accessibility for road users crossing Cape Cod Canal. Ongoing deterioration would result in unacceptable safety or operational problems, and the extended construction period with partial and/or full closures of the bridges would result in severe disruption to the town of Bourne and surrounding communities on and off Cape Cod.
Replacement of One or Both Highway Bridges with New Bridges, each Limited to Four Through-Traffic Lanes	MassDOT determined that this alternative is not reasonable, as follows: it would not fully meet current Federal Highway Administration (FHWA) and MassDOT highway design standards; it would not meet the Program needs of addressing the substandard design elements of the bridges or improving vehicular traffic operations; and it would not resolve existing safety and operational problems.
Replacement of One or Both Highway Bridges with New Bridges with Additional (More than Four) Non-Federally Funded Through-Traffic Lanes and Two Auxiliary Lanes	MassDOT determined that this alternative is not reasonable, as it would not meet the Purpose and Need Statement, which does not include increasing traffic capacity. Providing for additional traffic capacity across one or both replacement highway bridges would require considerable traffic capacity upgrades to the regional highway network on both sides of Cape Cod Canal. These upgrades likely would carry substantially high construction costs and extensive environmental, land use, and community impacts.

Alternative	MassDOT's Evaluation and Determination
Replacement of Both Highway Bridges with a Single New Bridge	MassDOT determined that this alternative is not reasonable because it would not meet the Purpose and Need Statement to improve cross-canal mobility and accessibility. One mid-canal bridge crossing would decrease road user accessibility for cross-canal trips, as the replacement bridge would be located farther from developed residential and commercial areas on both the Cape and mainland sides of the canal in the town of Bourne. The single replacement highway bridge would require extensive redesign and realignment of the transportation network on both sides of the canal, including utility corridor relocations, resulting in extensive impacts to residential and commercial land uses, Joint Base Cape Cod, and sensitive environmental resources, including wetlands, open space, and rare species habitat. Further, with a single-bridge crossing, this alternative would introduce a level of risk associated with emergency evacuation, access to national defense facilities, and emergency response.
Construction of a New Third Highway Bridge	MassDOT determined that this alternative is not reasonable, either in combination with the Base Condition or Major Rehabilitation alternatives, as it would not meet the identified Program need to address the underlying structural and roadway design deficiencies of the existing bridges and would result in unacceptable safety or operational problems. Further, MassDOT determined this alternative is not reasonable in combination with a bridge replacement alternative due to its substantial engineering costs and adverse natural resource impacts. MassDOT evaluated the concept of providing a roadway connection from State Route 25 to U.S. Route 6, including a third highway bridge across Cape Cod Canal, in the 2019 *Cape Cod Canal Transportation Study*. This concept was dismissed from further evaluation in the *Cape Cod Transportation Study* based on potential impacts to residential neighborhoods, wetlands and drinking water resources, and sensitive tribal areas.
Replacement of One or Both Highway Bridges with a Single Tunnel or Tunnels	MassDOT determined that this alternative is not reasonable either with replacing one or both highway bridges. Replacing one highway bridge with a tunnel would not meet the Purpose and Need Statement to address the underlying structural and roadway design deficiencies of the existing bridges. Replacing both highway bridges with a single tunnel or tunnels would not meet the Purpose and Need Statement to improve accommodations for pedestrians and bicyclists. Pedestrians and bicyclists would need to be accommodated by other means as they would be prohibited from traveling within the tunnel(s) due to air quality and safety concerns. Tunnels also have substantial vertical clearance restrictions, which would impede mobility for oversized commercial vehicles crossing Cape Cod Canal. Further, this alternative would require extensive reconfiguration of existing approach highways, resulting in extensive impacts to wetlands, recreational facilities, residences, businesses, and Joint Base Cape Cod.

Alternative	MassDOT's Evaluation and Determination
Replacement of One or Both Bridges with Low-Level Draw Spans	MassDOT determined that this alternative is not reasonable, as it would not meet the Purpose and Need Statement to improve cross-canal mobility and accessibility between Cape Cod and the mainland for all road users. Low-level draw spans would require frequent draw span openings for the passage of marine vessels which would result in substantial traffic disruptions and delays to road users crossing Cape Cod Canal. These disruptions and delays would be compounded during the summer months and would be overly burdensome to town of Bourne residents who rely on the bridges for their daily activities and livelihood. Replacing one of the existing highway bridges with a low-level span would not meet the Program's need to address the ongoing maintenance requirements of the existing Sagamore and Bourne Bridges. Low-level draw spans require increased maintenance compared to high-level bridges and are susceptible to operational issues as they age, which would be highly disruptive to traffic crossing Cape Cod Canal.
Replacement of One or Both Bridges with Low-Level Causeways	MassDOT determined that this alternative is not reasonable, as it would not meet the Purpose and Need Statement to improve cross-canal mobility and accessibility between Cape Cod and the mainland for all road users. Low-elevation roadways across Cape Cod Canal would require extensive profile modifications to local roads and regional highway connections on both Cape Cod and mainland sides of the canal, which would carry high infrastructure costs as well as major traffic disruptions. Further, Cape Cod Canal and the areas surrounding Bourne Bridge are mapped within high-risk flood zones. Low-level causeways would be increasingly vulnerable to flooding due to sea level rise and coastal storm surges. Flooding issues along these low-elevation causeways would impair mobility and create unsafe conditions for road users, which threaten efficient and effective responses to public health emergencies and disasters.
Deauthorization and Closure of Cape Cod Canal	MassDOT determined that this alternative is not reasonable based on the high costs, extent of adverse impacts to the coastal environment, and anticipated substantial adverse socioeconomic impacts. Filling in Cape Cod Canal would severely affect environmental resources protected under other federal statutes, including the Essential Fish Habitat of multiple species protected under the Magnuson Stevens Fishery Conservation and Management Act; the endangered North Atlantic Right Whale, protected under the Endangered Species Act (ESA); and non-ESA listed whales, dolphins, porpoises, and seals protected under the Marine Mammal Protection Act. Additionally, because Cape Cod Canal is a federally authorized Civil Works Project, the Canal Deauthorization Alternative is not within MassDOT's authorization. Further, this alternative would result in substantial adverse impacts to Cape Cod residents and visitors who use the canal facilities for recreation.

3.3 Alternatives Retained for Detailed Study

This section describes the No Build Alternative and Build Alternative (Replacement Highway Bridges Built to Modern Design Standards), which are retained for further evaluation in this DEIR.

3.3.1 No Build Alternative

In the No Build Alternative, Sagamore and Bourne Bridges would retain their current configuration:

- Single approximately 48-foot, 8-inch-wide highway deck at each crossing, consisting of four 10-foot-wide travel lanes, two in each direction, separated by a double-yellow centerline
- One 6-foot, 8-inch-wide sidewalk
- A 2-foot-wide safety curb (refer to **Figure 1-2** in **Chapter 1**)
- Steep approach grades of 6% (**Figure 3-1**)

The bridges would retain their vertical clearance of 135 feet above mean high water (MHW). The bridge piers, supporting a 616-foot main span, would be located within the waterway and outside the 500-foot authorized navigation channel.

The USACE would continue to manage and maintain Sagamore and Bourne Bridges as components of the Cape Cod Canal Federal Navigation Project. The No Build Alternative represents the "Fix as Fails" Base Condition of the USACE's MRER/EA, where the USACE would implement an ongoing program of continued inspections and maintenance and repair of both existing bridges as needed to maintain safety. No major rehabilitation efforts involving extensive repairs and replacement of major bridge components would occur. Structural components would be repaired, and critical elements would be replaced only when inspections indicate unsatisfactory reliability ratings. The MRER/EA indicates that the deteriorated condition of both highway bridges is well beyond the state in which actions and funding from the USACE's operations and maintenance program could correct the deficiencies and restore and sustain reliability. The USACE indicated that as the bridges continue to age, routine maintenance and minor component replacement would result in an unacceptable structural condition. As a result, it is likely that lower vehicle weights, traffic volume restrictions, and speed limits would be required and posted to maintain continued bridge safety.

The No Build Alternative would include recently completed and proposed transportation improvement projects identified in the Federal Fiscal Year 2025-2029 Transportation Improvement Program for the Cape Cod Metropolitan Planning Organization.[3] **Table 3-2** identifies the Transportation Improvement Program projects that are part of the No Build Alternative.

[3] The Transportation Improvement Plan was endorsed on May 20, 2024, with subsequent amendments on November 18, 2024; December 16, 2024; February 24, 2025; and an adjustment on March 24, 2025.

As described in **Table 3-1**, the No Build Alternative was dismissed as it would not meet any of the Program's needs. However, in accordance with the Massachusetts Environmental Policy Act, the No Build Alternative serves as a baseline against which the Build Alternative is evaluated in this DEIR.

Table 3-2. Transportation Improvement Program Projects, 2025–2029

Project Number	Year	Transportation Project	Project Description	Status
606900	2020	Belmont Circle Traffic and Multimodal Improvements	Traffic and multimodal improvements at Belmont Circle at U.S. Route 6 and State Route 25 and State Route 28	Completed
608422	2022	Trail Improvements – Sandwich	Shared-use path on Service Road (State Route 130 to Chase Road)	Underway
610542	2023	Bourne Rotary Improvements	• Restriping Bourne Rotary to two lanes and adding a channelized right-turn lane from State Route 28 northbound to Sandwich Road eastbound • Adding signs at Bourne Rotary • Installing flashing beacons at the Bourne Rotary approaches	Underway
613195	2024	Bridge Systematic Maintenance	Bridge deck replacement of the Quaker Meetinghouse Road Bridge over U.S. Route 6/ Mid-Cape Highway as part of an overall bridge preservation strategy	Programmed
609262	2025	Bourne Rail Trail, Phase 1	First phase of four planned phases of the Bourne Rail Trail connection to the Shining Sea Bikeway to the south in Falmouth and to the Cape Cod Canal path (Canal Service Road) in the town of Bourne; Phase 1 is approximately one-half mile long within the existing right-of-way of the Old Colony Railroad (Woods Hole branch line) from the Canal Service Road to Monument Neck Road.	Programmed
610673	—	Bourne Rail Trail, Phase 2	Phase 2 of four planned phases of the Bourne Rail Trail connection to Shining Sea Bikeway to the south in Falmouth and to the Cape Cod Canal path (Canal Service Road) in the town of Bourne; Phase 2 is approximately 2 miles long from Monument Neck Road to Monk's Park/Valley Bars Road.	Not Programmed

Project Number	Year	Transportation Project	Project Description	Status
—	—	Bourne Rail Trail, Phase 3 and Phase 4A	Phase 3 and Phase 4A of four planned phases of the Bourne Rail Trail connection to Shining Sea Bikeway to the south in Falmouth	Not Programmed
607394/ 611998	—	Bourne Rail Trail, Phase 4B	Phase 4B of four planned phases of the Bourne Rail Trail connection to the Shining Sea Bikeway to the south in Falmouth and to the Cape Cod Canal path (Canal Service Road) in the town of Bourne; Phase 4B is approximately 1 mile long, extending the Shining Sea Bikeway from its current terminus in North Falmouth into the town of Bourne.	Not Programmed
606082	2025–2028	U.S. Route 6 Scenic Highway Median Installation	• Resurfacing • Safety improvements, including a raised center median and expanded shoulders to separate eastbound and westbound travel lanes • Drainage improvements • Traffic signal improvements at two intersections • Shared-use path	Programmed
612053	2025	Bourne/Sandwich, Resurfacing and Related Work on U.S. Route 6	Improvements to pavement serviceability, condition, and roadway safety on U.S. Route 6 from Sagamore Bridge to the Sandwich town line (8.55 miles)	Programmed
613200	2026	Chase Road over U.S. Route 6 Bridge	Bridge deck replacement of Chase Road over the U.S. Route 6 (Mid-Cape Highway) bridge structure in the town of Sandwich	Programmed
612063	2028	State Route 28 Resurfacing and Related Work	Improvements to pavement serviceability, condition, and roadway safety on MacArthur Boulevard (State Route 28) from Bourne Rotary to Otis Rotary	Programmed
613199	2028	U.S. Route 6 over State Route 130 Bridge	Bridge deck replacement of U.S. Route 6 (Mid-Cape Highway) bridge structure over State Route 130 in the town of Sandwich	Programmed

Project Number	Year	Transportation Project	Project Description	Status
613271	—	Shared-use path, State Route 130 to Canal Service Road	Shared-use path from State Route 130 to Canal Service Road in the town of Sandwich	Not Programmed

Note: **Table 3-2** includes only those projects in the Study Areas that are part of the No Build Alternative. It does not include Project S13144, the replacement of the Sagamore Bridge, which was added to the Federal Fiscal Year 2025-2029 Transportation Improvement Program as Amendment #2 on December 9, 2024.

— No date available.

3.3.2 Build Alternative: Replacement Highway Bridges Built to Modern Design Standards

This section describes the Build Alternative, which is the replacement of the Sagamore and Bourne Bridges with new bridges built to modern design standards, along with the multiple bridge design parameters and highway interchange approach improvements that comprise the Program.

MassDOT incorporated the MRER/EA's Preferred Alternative and conducted extensive analyses to evaluate the USACE's bridge design recommendations.

As indicated in **Section 1.2, Past Studies and Decisions**, the Program builds upon the USACE's Preferred Alternative (identified in the MRER/EA) to replace both highway bridges with new bridges, consisting of four through-traffic lanes and two auxiliary lanes, and updated to comply with current design standards.

In addition to identifying its Preferred Alternative, the USACE reviewed bridge design parameters and made recommendations for the bridge highway cross-section, bridge clearances, pier location, bridge deck configuration, and mainline alignment location.

Incorporating the USACE's Preferred Alternative, and considering the MRER/EA's additional recommendations for the replacement bridges, MassDOT conducted independent evaluations of the following design parameters for the Build Alternative at the schematic, conceptual (5%), and preliminary (10 through 15% design) level relative to the Program's Purpose and Need Statement, as well as other factors including environmental impacts, public safety, and cost:

- Highway Bridge Cross-Section
- Bridge Vertical and Horizontal Clearances
- Main Span Length and Bridge Pier Location
- Bridge Deck Configuration
- Mainline Alignment Location
- Bridge Type
- Highway Interchange Approach Improvements

Sections 3.3.2.1 through 3.3.2.6 identify the bridge design parameters and summarize the multiple analyses that resulted in the preferred bridge design options for the Build Alternative. **Sections 3.3.3.1 through 3.3.3.5** identify the highway interchange network improvements and summarize the multiple analyses that resulted in the preferred highway interchange approach options for the Build Alternative. Refer to **Appendix 3.1, Alternatives Assessment Technical Report, Attachments 1 and 2**, for further details, including descriptions of the options that were considered and eliminated from further evaluation.

3.3.2.1 Highway Bridge Cross-Section

In accordance with MassDOT and FHWA design criteria, as well as American Association of State Highway and Transportation Officials (AASHTO) guidelines, MassDOT evaluated the proposed highway bridge cross-section and the maximum profile grades relative to the MRER/EA's Preferred Alternative. MassDOT confirmed that each new highway bridge would include the following (consistent with MassDOT and AASHTO design criteria):

MassDOT developed the highway bridge layout using current FHWA directives and guidance and AASHTO highway design standards.

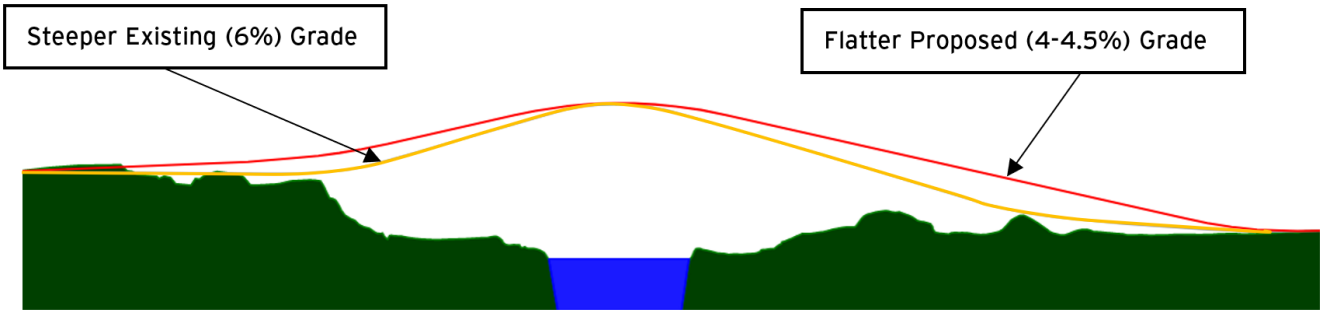
- Four 12-foot-wide through travel lanes (two in each direction)
- Two 12-foot-wide auxiliary lanes (one in each direction)
- A shoulder
- A separation median
- Maximum approach grades typical for a limited-access highway

Additionally, each highway bridge would have one bidirectional shared-use path (SUP) separated from vehicular traffic by a shoulder and barrier.

To confirm the USACE's decision to include auxiliary lanes in the replacement highway bridge roadway design, MassDOT evaluated design criteria that would warrant a continuous auxiliary lane over the bridge structures, including interchange spacing, traffic operations for the No Build Alternative conditions, geometric guidelines, and constructability. Per AASHTO highway design standards for adequate acceleration lane, deceleration lane, and taper lengths for interchange access to the bridges north and south of the canal crossings, a continuous auxiliary lane in each direction for the full length of Sagamore Bridge and in the southbound direction for the full length of Bourne Bridge would be required. For the northbound Bourne Bridge crossing, the constructability of the bridge and the need to accommodate users during construction would necessitate the additional structure width for the full length of Bourne Bridge.

Considering the functional classification and the rolling terrain at both bridge sites, MassDOT evaluated the appropriate profile grade for each highway bridge. In contrast to the steep 6% roadway grade, MassDOT proposed a flatter roadway grade, consisting of a 4.5% grade at Bourne Bridge and 4% grade at Sagamore Bridge (**Figure 3-1**). The flatter grades would improve safety by reducing the speed variations due to grade changes, especially for trucks approaching the crest of the bridges; reduce the likelihood of vehicles having difficulties (stalling) during snow and ice events; and be consistent with current design standards.

Figure 3-1. Highway Bridge Roadway Grade



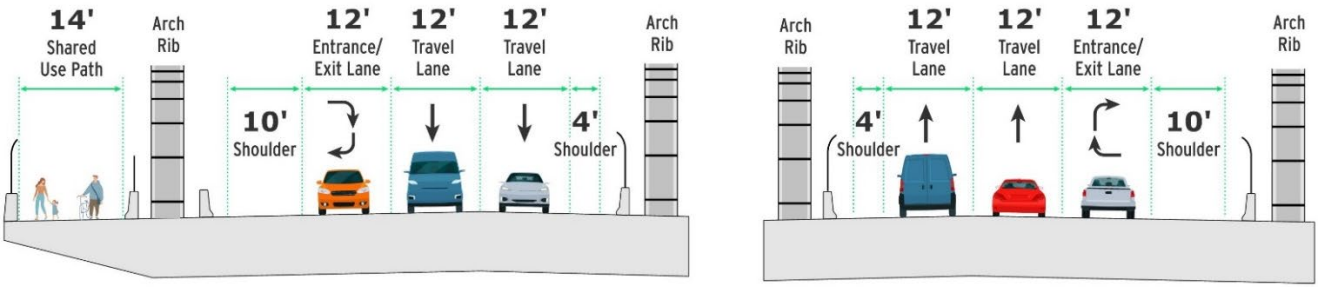
Source: Massachusetts Department of Transportation, 2024

MassDOT evaluated the MRER/EA's decision to include a single dedicated 10-foot-wide SUP for pedestrians and bicyclists for each crossing. MassDOT determined that the proposed SUP at each canal crossing would be designed in accordance with MassDOT, AASHTO, and FHWA design criteria, as well as the guidance of the Americans with Disabilities Act and the Architectural Access Board. The flatter approach grade would improve the rider experience for cyclists (which would make it easier to cycle uphill to the crest of the bridge) and would increase safety for pedestrians (which would reduce the potential for excessive bicycle speed on the downhill). MassDOT recommended the following for the effective width of the SUP (width from edge of pavement to edge of pavement):

- 14 feet wide on the bridge main spans
- 20 feet wide on the interchange approaches
- 12 feet wide on the connecting roadways

Figure 3-2 presents a schematic of the highway bridge cross-section at Sagamore and Bourne Bridges.

Figure 3-2. Replacement Highway Bridge Cross-Section



Source: Massachusetts Department of Transportation, 2024

3.3.2.2 Bridge Vertical and Horizontal Clearances

MassDOT evaluated the vertical and horizontal clearances for the replacement bridges relative to the recommendations presented in the USACE's MRER/EA. The MRER/EA indicated that to maintain the existing vertical clearance of 135 feet above MHW, the height of the new bridges should be increased to accommodate anticipated sea level rise. Additionally, the USACE indicated that horizontal clearance for navigation must be considered with the replacement bridge design.

Based on its evaluations of sea level rise projections from the National Oceanic and Atmospheric Administration and the Massachusetts Climate Change Projections (issued by the Massachusetts Executive Office of Energy and Environmental Affairs), MassDOT recommended an increase in bridge height of 3.3 feet. The total proposed vertical clearance of 138.3 feet above MHW would maintain the existing vertical clearance at 135 feet above MHW for future sea level rise conditions. Incorporating the USACE's preferences regarding navigation, MassDOT recommended that the replacement bridge structures provide a minimum of 500 feet of horizontal navigational width to be consistent with existing conditions. MassDOT's recommendations were confirmed by the First Coast Guard District in its Preliminary Navigation Determination for the Program, issued on March 11, 2025, as referenced in **Section 4.4, Maritime Transportation, Traffic, and Safety**.

3.3.2.3 Main Span Length and Bridge Pier Location

The bridge piers for the existing Sagamore and Bourne Bridges are within Cape Cod Canal and just outside the 500-foot authorized navigation channel and support a mainline center span length of 616 feet. MassDOT evaluated the USACE's preference for locating the proposed bridge piers outside of the canal cut, with a longer mainline center span length, to improve navigation, operations, and maintenance, as indicated in the MRER/EA.

MassDOT identified an out-of-water bridge pier option and conducted an initial assessment of the main span length and bridge pier locations against the applicable bridge design evaluation criteria:

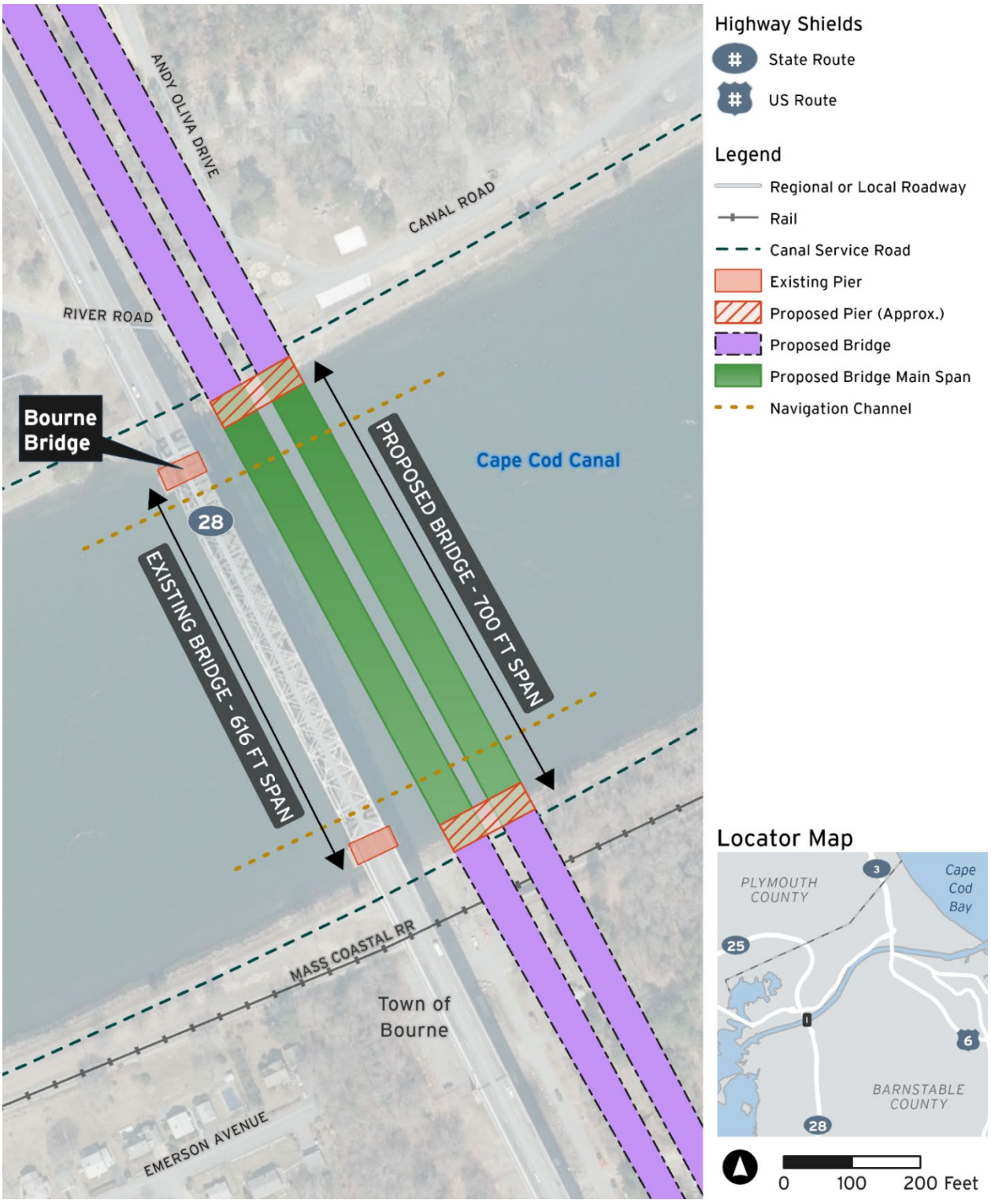
- Costs
- Location of main span footings (including potential for vessel impact and scour)
- Construction (including constructability, navigation, and environmental considerations)

MassDOT incorporated sea level rise considerations and the USACE's recommendations, and the U.S. Coast Guard's determinations for the proposed bridge vertical and horizontal clearances.

This initial assessment resulted in a recommendation for an out-of-water bridge pier option with two potential main span lengths of approximately 700 feet and 820 feet. The out-of-water bridge pier option would minimize the potential for vessel collisions; minimize direct and indirect impacts to marine species and habitats; and reduce or eliminate the potential for bridge scour, where the fast-moving currents would remove sediment from around the piers and potentially compromise its stability. Additionally, by locating the bridge piers farther from the authorized 500-foot navigation channel width, this option would maximize the effective width of the navigation channel, which would improve marine traffic conditions. Finally, MassDOT evaluated the bridge pier options relative to bridge construction. With the out-of-water bridge pier location, all construction activity, including construction work platforms and other temporary support work, would be outside of the navigation channel and would not affect canal operations. In contrast, installing the bridge piers at or near the navigation channel would be more likely to adversely affect marine traffic during bridge construction.

MassDOT further evaluated the two main span lengths as part of a detailed bridge fabrication and erection methodology analysis for the bridge type. The detailed assessment included a review of off-site arch fabrication, float-in operations, and arch lifting operations. Based on a detailed constructability assessment, MassDOT identified the 700-foot main span with the bridge piers located within the riprap slope of the canal and above the low tide line as the preferred option (**Figure 3-3**).

Figure 3-3. Main Span Length and Pier Location (Preferred Option)

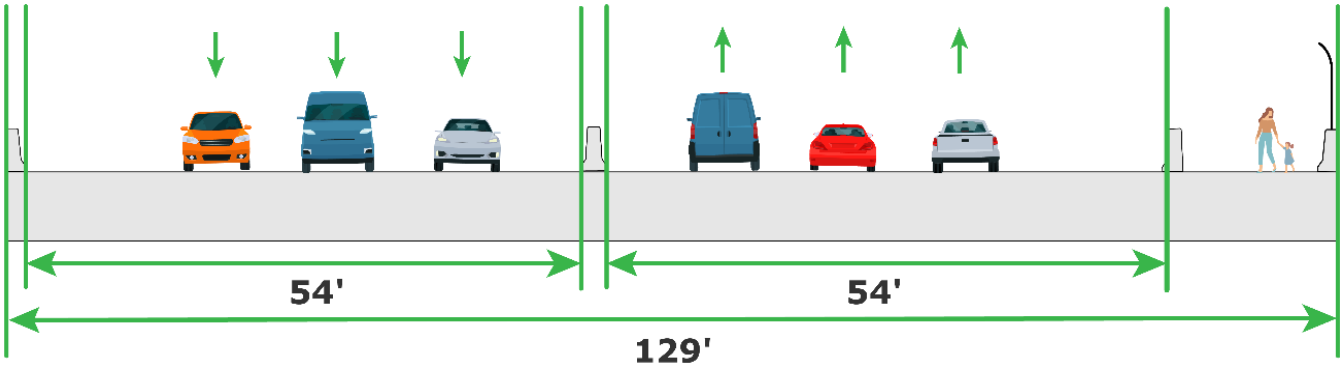


Source: Massachusetts Department of Transportation, 2025

3.3.2.4 Bridge Deck Configuration

The existing Sagamore and Bourne Bridges each provide a single +48-foot-wide highway bridge deck. To update the highway bridges per MassDOT, AASHTO, and FHWA highway design criteria, in the MRER/EA, the USACE proposed an approximate 129-foot-wide single bridge deck at each crossing (**Figure 3-4**).

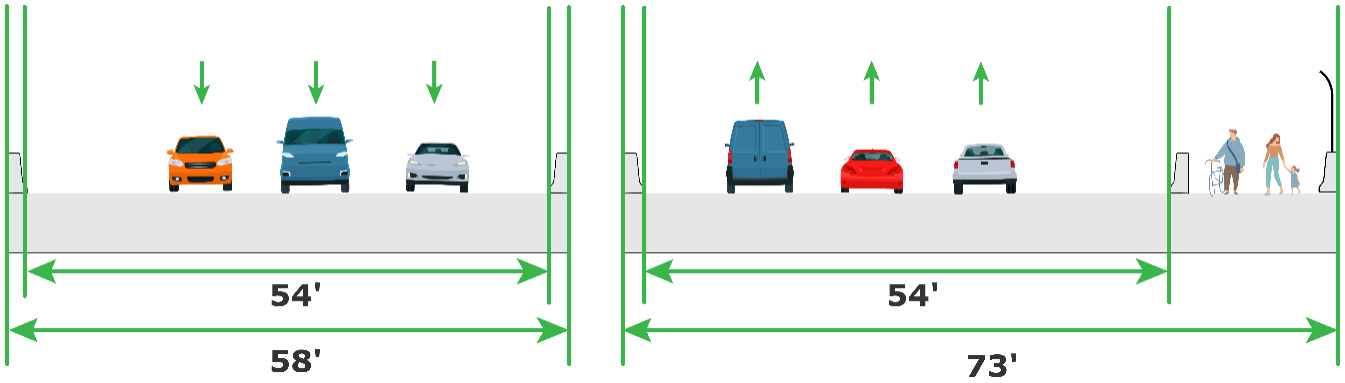
Figure 3-4. Bridge Structure Configuration with a Single Deck



Source: Massachusetts Department of Transportation, 2024

As a variation of the single bridge deck configuration presented in the MRER/EA, MassDOT investigated constructing two separate deck structures for each replacement highway bridge, consisting of two parallel separate decks (main spans) (**Figure 3-5**). In its initial qualitative assessment, MassDOT focused on the constructability aspects of the bridge deck configuration, including duration of construction, construction complexity, and potential for construction phasing. MassDOT also evaluated the durability and structural redundancy aspects of the two bridge deck configuration options.

Figure 3-5. Bridge Structure Configuration with Two Separate Decks



Source: Massachusetts Department of Transportation, 2024

Based on its initial assessment, MassDOT determined that both bridge deck configuration designs would be feasible, depending on the bridge type, and advanced the single deck and two separate deck options for further evaluation as part of the bridge type evaluation. After a secondary evaluation that assessed the bridge deck configuration relative to a short list of bridge types, MassDOT determined

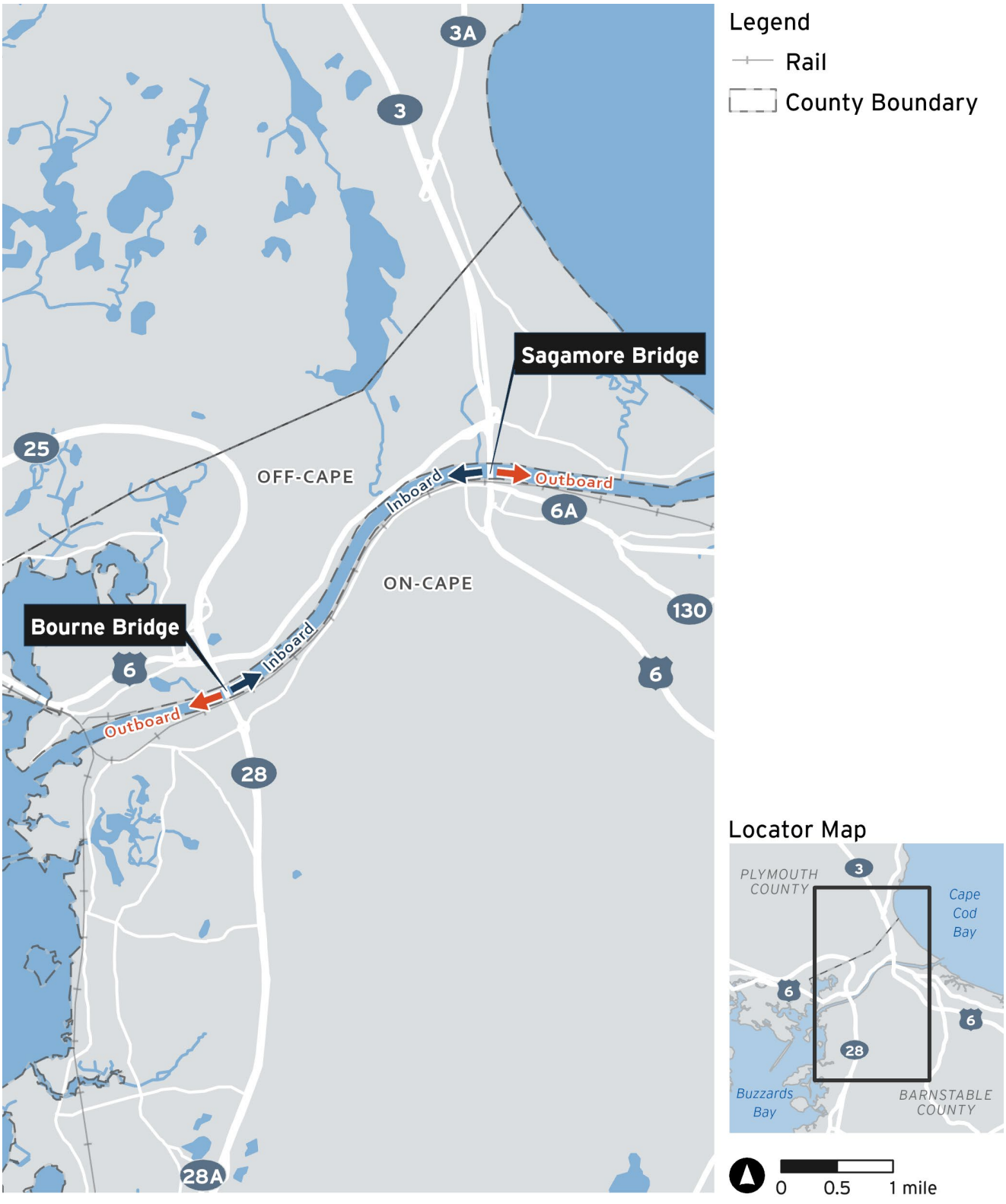
that the option with two separate bridge decks would provide maximum flexibility during construction, including accelerating the schedule for shifting traffic from and decommissioning the existing deteriorated highway bridges. As a result, MassDOT recommended advancing the two separate decks configuration option as the preferred option for each replacement bridge.

3.3.2.5 Mainline Alignment Location

MassDOT assessed the MRER/EA's recommendation to construct the two new highway bridges outside the footprint of, parallel to, and inshore of the existing bridges toward the center of the canal (defined as "offline" and "inboard"). MassDOT identified locations for each highway bridge mainline alignment over Cape Cod Canal relative to the location of the existing bridges, consisting of an inboard location versus an outboard location (defined as the bay side of the existing bridge) (**Figure 3-6**), as well as an offline location versus an online location (defined as within the footprint of the existing bridge). From these combinations, MassDOT evaluated five optional locations based on their ability to meet the identified Program needs regarding traffic operations, connectivity, geometrics, safety, and multimodal accommodations (highway design evaluation criteria), while minimizing environmental and right-of-way impacts.

MassDOT determined that the offline inboard option for both replacement bridges had an overall higher rating than the other mainline alignment location options in meeting the Program needs, as established through the highway design evaluation criteria. At both crossings, MassDOT could implement phased construction of the replacement main spans. Following construction of the first main span, existing traffic could be relocated from the existing bridge to the first replacement main span. After the initial traffic shift, the existing bridge would be demolished and the second replacement main span would be constructed, following by the final traffic reconfiguration. This construction phasing approach would lessen the risk that major repairs and/or rehabilitation of the existing bridges would need to be performed. Additionally, this option would maintain existing traffic flows and would minimally affect existing traffic patterns. Due to its high constructability ratings, MassDOT recommended the offline inboard option as the preferred option for both canal crossings.

Figure 3-6. Replacement Bridge Mainline Alignment Outboard and Inboard Locations



Source: Massachusetts Department of Transportation, 2024

3.3.2.6 Bridge Type

In collaboration with FHWA and USACE, MassDOT conceptually screened a wide range of bridge types and design parameters to identify feasible bridge types and configurations. MassDOT placed the highest priority on bridge types that would be practical and feasible to construct and maintain; bridge types that would not be practical and feasible were not advanced for further evaluation. Additionally, MassDOT placed high priority on a bridge construction method that would minimize Cape Cod Canal navigation impacts. As a result of this initial assessment, MassDOT recommended the advancement of the following three bridge types with various configurations for a secondary evaluation:

- Tied-arch bridge
- Cable-stayed bridge
- Box girder bridge

The detailed analysis incorporated the following:

- Highway geometric assessments
- Additional constructability assessments of the feasible bridge types (including a detailed bridge deck configuration assessment)
- The public's review of the feasible bridge types relative to community considerations and bridge aesthetics

MassDOT incorporated sea level rise considerations and the USACE's recommendations for the bridge vertical and horizontal clearances.

As a result of the detailed bridge type assessment, including public input, MassDOT recommended the following bridge type as the preferred option to be retained for detailed study: parallel, twin tied-arch bridge structures supported on delta frames with an approximate 700-foot main span length. **Figure 3-7** and **Figure 3-8** present renderings of the tied-arch bridge type with delta frame from the viewpoints of Cape Cod Canal and the motor vehicle driver crossing the bridge.

MassDOT determined that the exact span length, arch rib configuration, tie-in with approach ramps, and other parameters for the tied-arch bridge with delta frame would be developed and incorporated into the Program Bridge Type Study to be conducted during preliminary design as part of the Program's Base Technical Concept.

Figure 3-7. Rendering of Tied-Arch Bridge with Delta Frame – Cape Cod Canal Viewpoint



Source: Massachusetts Department of Transportation, 2024

Figure 3-8. Rendering of Tied-Arch Bridge with Delta Frame – Driver Viewpoint



Source: Massachusetts Department of Transportation, 2024

3.3.3 Build Alternative Highway Interchange Approach Improvements

Using the alternatives identified in its 2019 Cape Cod Canal Area Transportation Study as a starting point, MassDOT conceptually identified 97 highway interchange approach concepts (the Universe of Concepts) for the highway interchange approaches at the four quadrants of the canal crossings:

- Sagamore North
- Sagamore South
- Bourne North
- Bourne South

MassDOT eliminated concepts that presented significant geometric or safety challenges, did not provide all necessary connections, or posed infeasible constructability issues. MassDOT identified 22 active concepts as viable options to be carried forward for further design and evaluation.

MassDOT assessed the 22 highway interchange approach options at the 5 to 10% design level based on their performance in meeting the Program's highway design evaluation criteria. The ratings were then compared to identify options for a secondary level of assessment. **Table 3-3** and **Table 3-4** present the 10 highway interchange approach options—two Sagamore North quadrant options, three Sagamore South quadrant options, three Bourne North quadrant options, and two Bourne South quadrant options—that advanced to a secondary, more detailed (15% design level) assessment.

Table 3-3. Initial Assessment of Sagamore Bridge Crossing Interchange Approach Options

Study Area Quadrant	Option	Summary Description	Reason for Advancing to Secondary Assessment
Sagamore North (SN)	SN-1A/ Similar to Existing Configuration	This option is similar to the existing interchange ramp configurations with modifications to support the relocated U.S. Route 6 (Scenic Highway)/State Route 3 alignment.	This option would require fewer modifications than SN-8A to support a relocated U.S. Route 6 (Scenic Highway)/ State Route 3 alignment.
	SN-8A/ Direct Connection to State Road	This option is similar to Option SN-1A but would provide a single exit point for westbound/northbound traffic from a relocated U.S. Route 6 (Scenic Highway)/State Route 3 alignment.	This option would present a different approach to handling exiting westbound/northbound traffic from existing conditions (and Option SN-1A). It rated the highest in its performance ratings relative to the highway design evaluation criteria, with primarily favorable ratings and no unfavorable ratings.

Study Area Quadrant	Option	Summary Description	Reason for Advancing to Secondary Assessment
Sagamore South (SS)	SS-1/ Existing Configuration with Cranberry Highway Extension	This option is similar to the existing interchange ramp configurations with modifications to support the relocated U.S. Route 6 (Scenic Highway) alignment. It would extend Cranberry Highway under U.S. Route 6 (Scenic Highway) to provide a connection to Mid-Cape Connector.	This option would largely maintain the existing ramp configurations with an extension of Cranberry Highway that would present an alternative approach to managing traffic.
	SS-1.1/ Similar to Existing Configuration	This option provides the same interchange configuration as Option SS-1 but would eliminate the Cranberry Highway Extension.	This option would mimic the existing interchange configuration without the Cranberry Highway Extension.
	SS-3.1A/ Westbound On-Ramp Under State Route 6 with Cranberry Highway Extension and Sandwich Road Connector	This option is similar to Option SS-1 but would relocate the westbound on-ramp, so it would share the same entrance point as the eastbound on-ramp off the Mid-Cape Connector. This option would include the Cranberry Highway Extension and would also add a connector road between Cranberry Highway and Sandwich Road.	This option received the highest performance ratings relative to the highway design evaluation criteria.

Table 3-4. Initial Assessment of Bourne Bridge Crossing Interchange Approach Options

Study Area Quadrant	Option	Summary Description	Reason for Advancing to Secondary Assessment
Bourne North (BN)	BN-6.1/ Northbound On-Ramp	This option is similar to the existing interchange configuration, modified to meet the offset mainline while adding a new northbound on-ramp directly from Scenic Highway east of the mainline.	This option would largely mimic the existing interchange configuration. It rated the highest among the options in its performance relative to the highway design evaluation criteria.
	BN-13.1/ Single Exit Partial Interchange	This option builds upon Option BN-6.1 and would add a connection from State Route 25 southbound off-ramp directly to Scenic Highway.	This option received favorable and most favorable performance ratings relative to the highway design evaluation criteria. It would result in medium to fewer environmental and right-of-way impacts.
	BN-14.4b/ Directional Interchange	This option is similar to Option BN-13.1 and would provide a combination of direct connection ramps between State Route 25 and Scenic Highway.	This option received favorable and most favorable performance ratings relative to the highway design evaluation criteria. It would result in medium to less environmental and right-of-way impacts.
Bourne South (BS)	BS-2/ Diamond Interchange	This option would replace the existing Bourne Rotary with a grade-separated diamond interchange.	This option received favorable and most favorable performance ratings relative to the highway design evaluation criteria.
	BS-2.2/ Single-Point Interchange	This option would replace the existing Bourne Rotary with a grade-separated single-point interchange configuration.	This option received favorable and most favorable performance ratings relative to the highway design evaluation criteria.

3.3.3.1 Summary of Detailed Assessment of Highway Interchange Approach Options

MassDOT developed a two-step approach to conduct a more detailed assessment of the 10 highway interchange approach options that passed the initial evaluation. This section summarizes the methodologies and results of the two-step detailed assessment. The results of the two-step evaluation, including further explanations of the methodologies and determinations, are provided in MassDOT's **Highway Interchange Approaches Detailed Assessment Report** (**Appendix 3.1**, **Attachment 2**).

Regional Traffic Operations Assessment: Methodology and Results

In the first step, MassDOT conducted a regional traffic operations assessment to determine if there were options in one area of the network[4] that could adversely affect the performance of options in other areas of the network; options that could adversely affect regional traffic operations would be considered fatally flawed and would be eliminated from further analysis. From an initial identification of 36 possible permutations (pairings) of highway interchange options, MassDOT narrowed the selection to 11 pairings to assess operational trends and impacts relative to travel demand. MassDOT's regional traffic operations assessment, which consisted of four different traffic analysis software and simulation models, included the following:

MassDOT used traffic analysis software to eliminate options that would impact the regional network through congestion, vehicle delay, and excessive traffic queues.

- Evaluation of network performance, which measured the number of processed vehicles and average delay per vehicle
- Evaluation of total travel time, which assessed transportation system efficiency, congestions levels, and origin-destination travel times
- Evaluation of queue length within the network

The results of the analyses indicated that option pairings with Option BN-6.1, the Northbound On-Ramp Option, would adversely affect the regional traffic network in the Build Alternative condition. These pairings with Option BN-6.1 would result in the highest levels of congestion, process the fewest number of vehicles through the network, increase average delay per vehicle, and create queue lengths extending to the mainline of State Route 25. Due to its fatal flaws associated with regional traffic operations, MassDOT recommended that Option BN-6.1 not be carried further for additional evaluation in a Step 2 evaluation. Accordingly, MassDOT advanced nine highway interchange approach options for Step 2 of the detailed assessment.

Program Needs and Goals Assessment: Performance Measures

In the second step, MassDOT identified transportation and contextual performance measures (measures of effectiveness) to evaluate the options in accordance with its Project Development and Design Guide. The guide defines transportation performance measures as the means to evaluate how the transportation facility functions and accommodates its users, and it defines contextual

MassDOT identified performance measures and evaluated options according to the Program's needs, goals, and objectives.

[4] The regional network, consisting of the major roadways, interchanges, and intersections within a 2-mile area centered around the Sagamore and Bourne Bridges, is further described and depicted in **Chapter 4, Section 4.2, Transportation, Traffic, and Safety.**

performance measures as the means to evaluate how the transportation facility relates to its physical surroundings and community function.

In coordination with FHWA and stakeholders, MassDOT identified transportation performance measures related to the four identified Program needs (presented in **Chapter 2, Section 2.3, Need for the Program**) to evaluate the interchange options:

- Operations – Six evaluation criteria and seven performance measures were used to assess whether the option would improve vehicular traffic operations, focusing on congestion on the mainline highways and ramps, regional and local travel times, cross-canal mobility, traffic (queue) spillback from exit or entrance ramps onto the mainline, and separation of regional and local traffic.
- Geometrics and Safety – Seven evaluation criteria and eight performances measures were used to assess whether the option would address the substandard design elements of the bridges and their highway networks, focusing on the compatibility of the exit and entrance ramps with the mainline highways and local roadway network, including weaving, ramp spacing, and speed variances, and the driver's experience within the network, including potential wrong-way driving, complexity of decision points, and overall driving expectation.
- Multimodal Accommodations – Eight evaluation criteria and 11 performance measures were used to assess whether the option would improve accommodations for pedestrians and bicyclists, focusing on accessibility regarding local roads, trails, and transit facilities and the overall user experience.
- Structural/Maintenance – Two evaluation criteria and two performance measures were used to assess whether the option would address the deteriorating structural condition and escalating maintenance demands of Sagamore and Bourne Bridges, focusing on the ability to minimize the risk of disruptive maintenance and/or rehabilitation on the existing bridges, measured by the time required to remove traffic from the existing bridges and discontinue their use, and compatibility of the interchange approaches with the replacement bridge structures.

In accordance with the Secretary's Certificate on the Environmental Notification Form and incorporating agency and public input, MassDOT identified Program goals and objectives focused on socioeconomics, natural resources, resiliency and sustainability, constructability, emergency response, and cost effectiveness. **Table 3-5** presents the six Program goals and their related objectives. MassDOT then developed corresponding contextual performance measures to evaluate the ability of the interchange options to meet the Program's goals and objectives.

Table 3-5. Program Goals and Objectives

Goal	Objectives
Maintain and/or improve the socioeconomic fabric of the surrounding community	• Minimize residential and commercial property impacts, including acquisitions and displacements. • Improve access to commercial properties. • Maintain or improve neighborhood accessibility to community facilities and services. • Maintain or improve neighborhood cohesion. • Avoid disproportionate adverse impacts to Environmental Justice populations. • Minimize construction-period impacts upon the traveling public. • Avoid and/or minimize impacts to open space and recreational facilities.
Protect and/or enhance the environment, including natural and biological resources	• Minimize impacts to Areas of Critical Environmental Concern and wildlife (Natural Heritage and Endangered Species Program) habitats. • Maintain floodplain functions. • Maintain wetlands and surface waters, including protected buffers.
Enhance the resiliency and sustainability of the built environment	• Minimize air quality impacts. • Minimize land alteration and tree clearing (urban heat island effect). • Minimize vulnerability to flooding. • Effectively manage stormwater.
Maximize constructability	• Minimize construction duration. • Maintain existing connections during construction.
Facilitate emergency response	• Improve emergency evacuation capabilities off Cape Cod. • Improve emergency response.
Maximize cost effectiveness	• Maximize construction cost effectiveness.

Program Needs and Goals Assessment: Methodology

In the second step, MassDOT reduced the number of traffic analysis models from 11 pairings to six models, which allowed MassDOT to evaluate the remaining nine options in isolation while also evaluating the options relative to potential network-wide impacts. MassDOT used multiple traffic analysis tools to quantitatively evaluate options based on their performance related to traffic operations as well as to the network within a 2-mile radius of the bridges. To arrive at the results for other quantitative and qualitative performance measures, MassDOT used preliminary (approximately 15%) design plans.

MassDOT developed a rating system to evaluate the highway interchange approach options based on their performance. Relative to meeting Program needs, an option was rated according to the benefits it

would provide compared to other options or the No Build Alternative condition. Regarding meeting Program goals and objectives, an option was rated based on either the impacts it would incur compared to the other options or the opportunities it would provide compared to the other options. **Table 3-6** summarizes MassDOT's evaluation system for rating the highway interchange approach options.

Table 3-6. Highway Interchange Detailed Assessment Rating System

How would the option meet Program needs?	How would the Option meet Program goals and objectives?		Rating
	Impacts	Opportunities	
The option would provide ***Substantial Benefits.***	The option would have ***No, Less, or the Least Impacts***.	The option would provide ***More or the Most Opportunity*** to exceed Program objectives.	Highest
The option would provide ***Marginal/Some Benefits***.	The option would have ***Some Impacts***.	The option would provide ***Some Opportunity*** to meet minimum Program objectives.	Lower
The option would provide ***Insufficient/Negligible Benefits***.	The option would have more or the ***Most Impacts***.	The option would provide ***Less or the Least Opportunity*** to meet Program objectives.	Lowest

All evaluation criteria were equally rated. No scaling system, weighted average, or grading system was used. Except for the Program's constructability goal, ratings were isolated between the Sagamore and Bourne Bridges as well as between the two quadrants (north and south) for each bridge. To assess the option's constructability, the Program phasing, construction schedules, and construction sequencing were considered holistically for each crossing, incorporating both the north and south quadrants.

MassDOT determined that the highway interchange options that performed the best and scored the highest ratings would be incorporated into the Build Alternative, further assessed in the DEIR, and developed to preliminary (25%) design.

Program Needs and Goals Assessment: Results

Based upon Step 2 of the detailed assessment—the Program needs and goals assessment—MassDOT recommended that the following Sagamore and Bourne Bridges highway interchange approach pairings advance for further evaluation in the DEIR as part of the Build Alternative:

- Sagamore North Quadrant Crossing: Option SN-8A, Direct Connection to State Road
- Sagamore South Quadrant Crossing: Option SS-3.1A, Westbound On-Ramp Under U.S. Route 6 with Cranberry Highway Extension and Sandwich Road Connector
- Bourne North Crossing: Option BN-14.4b, Directional Interchange
- Bourne South Crossing: Option BS-2, Diamond Interchange

Sections 3.3.3.2 through 3.3.3.5 present descriptions and figures of the highway interchange approach preferred options that are incorporated into the Build Alternative, including comparison tables of the options that were considered, and MassDOT's conclusions. **Appendix 1, Existing Conditions Plans**, provides enlarged and more detailed existing condition plans, and **Appendix 3.2, Proposed Conditions Plans**, provides preliminary, design-level proposed conditions plans by Program quadrant.

The **Highway Interchange Approaches Detailed Assessment Report** (**Appendix 3.1**, **Attachment 2**) provides details on the transportation and contextual performance measures used to evaluate and rank the ten highway interchange approach options that passed the initial assessment (described in **Appendix 3.1, Attachment 1**). It includes descriptions of the quantitative and qualitative differences among the highway interchange approach options in meeting the Program's needs, goals, and objectives; resulting in recommended paired options for the Sagamore and Bourne bridge crossings.

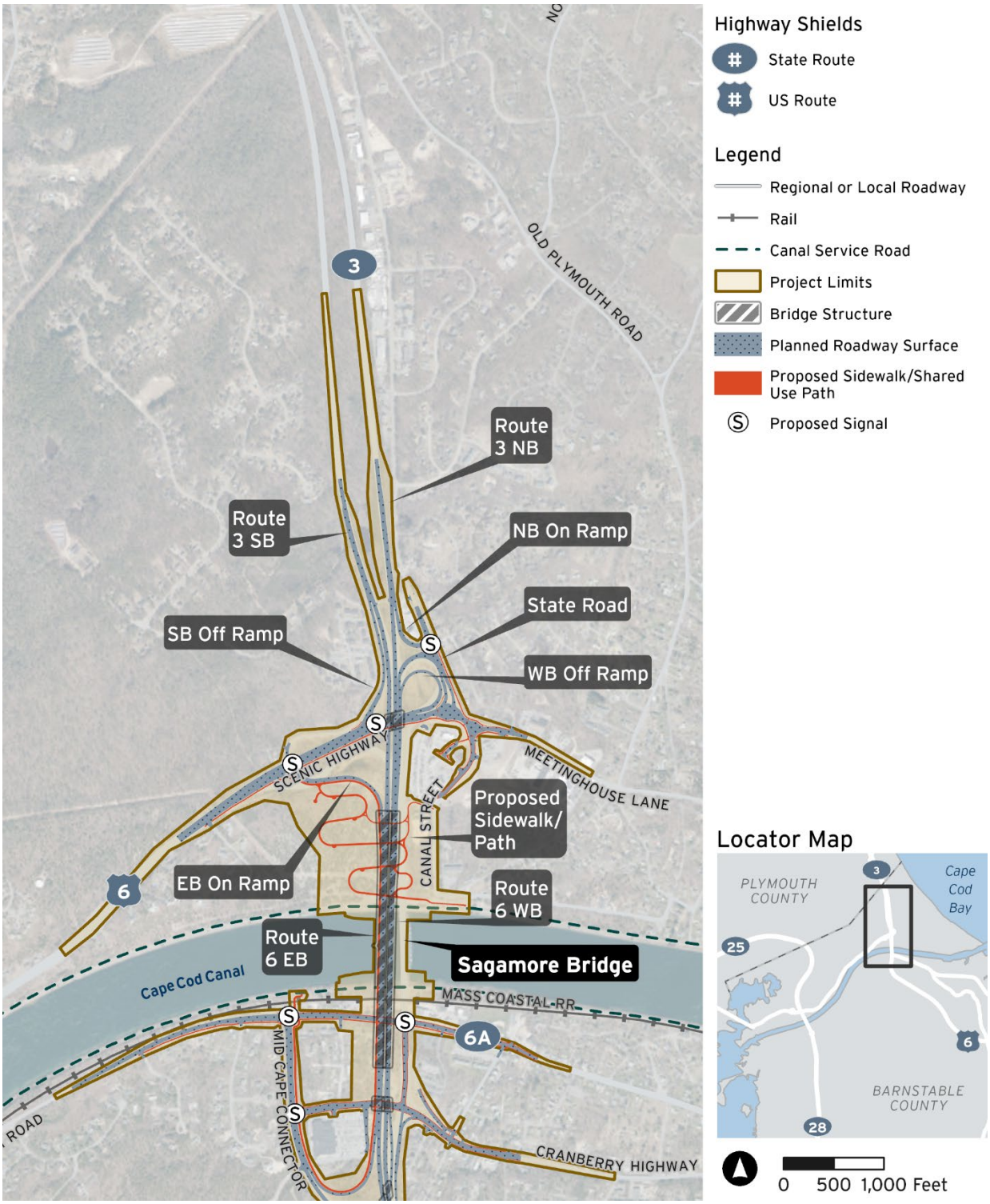
3.3.3.2 Sagamore North Quadrant: Option SN-8A, Direct Connection to State Road

Description of Preferred Option

Of the two Sagamore North quadrant options (Options SN-1A and SN-8A), MassDOT recommended advancing Option SN-8A, Direct Connection to State Road as the Sagamore North quadrant option to be retained for detailed study in the DEIR (**Figure 3-9**).

Option SN-8A would provide a single exit point from a relocated U.S. Route 6/State Route 3. It would remove the Sagamore Bridge northbound off-ramp connection to Scenic Highway/Meetinghouse Lane eastbound, and instead would connect to State Road, north of Scenic Highway/Meetinghouse Lane. The remaining ramp connections would remain similar to existing conditions. MassDOT would modify the signalized intersections along Scenic Highway and Meetinghouse Lane with two roundabouts to accommodate through-travel and turning movements. The intersection of State Road at State Route 3 northbound would be modified to accommodate the addition of the new State Route 3 northbound off-ramp with the installation of a traffic signal. Option SN-8A, Direct Connection to State Road, would include a SUP on the U.S. Route 6 eastbound main span that would provide connections to the south side of the Scenic Highway, Canal Street, and the Canal Service Road. This option would provide SUPs along the southern side of Scenic Highway and Meetinghouse Lane and along the eastern side of State Road to Homestead Avenue.

Figure 3-9. Sagamore North Quadrant Crossing: Option SN-8A, Direct Connection to State Road (Preferred Option)



Source: Massachusetts Department of Transportation, 2025

Comparison of Options

Table 3-7 identifies the Program needs evaluation criteria that were differentiators between Option SN-8A and Option SN-1A in the Step 2 detailed assessment. MassDOT determined that Option SN-8A, Direct Connection to State Road, would provide more benefits in meeting the Program needs than Option SN-1A, Similar to Existing Configuration. In particular, Option SN-8A would perform better than Option SN-1A in its ability to remove traffic from the existing bridge and avoid or minimize the potential for a disruptive maintenance or rehabilitation program for the existing Sagamore Bridge. The differences in benefits provided by the two Sagamore North quadrant options were directly attributable to the ability to meet the Program's Purpose and Need Statement.

Table 3-7. Sagamore North Quadrant Interchange Options: Program Needs Differentiators

Program Need/Total # Evaluation Criteria	Differentiating Evaluation Criteria	SN-1A	SN-8A (Preferred)	Comparison of Options
Operations (6 Evaluation Criteria)	Would the option separate local and regional traffic?	**Insufficient/ Negligible Benefits**	**Marginal/ Some Benefits**	• SN-8A would remove Sagamore Bridge westbound traffic from a local intersection. • SN-1A would maintain existing conditions.
Geometrics and Safety (7 Evaluation Criteria)	Would the option minimize weaving movements?	**Marginal/ Some Benefits**	**Substantial Benefits**	For bridge westbound off-ramp traffic: • SN-8A would have one exit, minimizing merge and weave. • SN-1A would have two exits, increasing merge and weave.
	Would the option minimize wrong-way driving risk?	**Substantial Benefits**	**Marginal/ Some Benefits**	• SN-1A would geometrically restrict wrong-way driving. • SN-8A would have a high potential for wrong-way driving, requiring mitigation.
	Would the option minimize deceleration lane speed variances between ramps and mainline?	**Marginal/ Some Benefits**	**Substantial Benefits**	• SN-8A would have two mainline locations with higher speed differentials. • SN-1A would have three mainline locations with higher speed differentials.

Program Need/Total # Evaluation Criteria	Differentiating Evaluation Criteria	SN-1A	SN-8A (Preferred)	Comparison of Options
Multimodal Accommodations (8 Evaluation Criteria)	Would the option improve pedestrian/bicycle connections at ramp terminals?	**Marginal/ Some Benefits**	**Substantial Benefits**	At Scenic Highway ramp crossings: • SN-8A would have one shared-use path (SUP) crossing. • SN-1A would have two SUP crossings.
	Would the option enhance the pedestrian/bicycle experience?	**Marginal/ Some Benefits**	**Substantial Benefits**	On the Scenic Highway east to west movement: • SN-8A would have four SUP intersection/ramp crossings. • SN-1A would have five SUP intersection/ramp crossings.
Maintenance/ Structural (2 Evaluation Criteria)	Would the option minimize the risk of disruptive maintenance and/or rehabilitation on the existing bridges?	**Insufficient/ Negligible Benefits**	**Substantial Benefits**	Traffic could be shifted off the existing bridge: • For SN-8A, after construction of one main span without ramp closings. • For SN-1A, after construction of two main spans with long duration ramp closings.

Table 3-8 identifies the Program goals and objectives that were differentiators between Option SN-8A and Option SN-1A. MassDOT determined that the two Sagamore North quadrant options scored fairly evenly in meeting the Program's goals and objectives related to natural resource protection, resiliency and sustainability, emergency response, and cost. The differences between these two options were due to construction-period impacts, including construction duration and impacts to the traveling public.

Table 3-8. Sagamore North Quadrant Interchange Options: Program Goal Differentiators

Program Goal/Total # Objectives	Program Objectives	SN-1A	SN-8A (Preferred)	Comparison of Options
Socioeconomics (8 Objectives)	Would the option minimize construction-period impacts upon the traveling public?	**Some Impacts**	**Less Impacts**	• SN-8A would not require vehicular construction detours • SN-1A would require a long duration, complicated vehicular construction detour.
Constructability (2 Objectives)	Would the option minimize the construction duration?	**More Opportunity**	**Some Opportunity**	In opening of second main span, SN-1A would have a time savings of 12 to 18 months over SN-8A.
	Would the option maintain existing connections during construction?	**Some Opportunity**	**More Opportunity Impacts**	• SN-8A would maintain existing connections during construction without detours. • SN-1A would require an extensive detour during construction.

Table 3-9 presents a comparison of quantifiable environmental impacts of the two Sagamore North quadrant options based on the conceptual through preliminary (up to 15% design) level assessments. The environmental impacts identified in the table incorporate the results of the initial bridge design evaluations and recommendations for the shift in the Sagamore Bridge mainline alignment location to offline and inboard (**Appendix 3.1, Attachment 1, Alternatives Analysis Report**). Note that the impacts identified in the table are approximate and may differ from those reported in **Chapter 4, Existing Conditions, Program Impacts, and Mitigation**, and **Chapter 5, Construction Approach**, which are based on more advanced (25% level) design.

Table 3-9. Sagamore North Quadrant Interchange Options: Comparison of Preliminary Quantifiable Environmental Impacts

Program Goal	Program Objective	Performance Measure	SN-1A	SN-8A (Preferred)
Socioeconomics	Would the option minimize residential property impacts, including acquisitions and displacement?	Number of easements, vacant parcels	1	1
		Number of easements, occupied parcels	1	1
		Number of full parcel acquisitions with displacements	11	11
		Number of full parcel acquisitions without displacements	1	1
	Would the option minimize commercial property impacts, including acquisitions and displacement?	Number of easements, vacant parcels	0	0
		Number of easements, occupied parcels	6	6
		Number of full parcel acquisitions with displacements	1	1
		Number of full parcel acquisitions without displacements	1	1

Program Goal	Program Objective	Performance Measure	SN-1A	SN-8A (Preferred)
	Would the option avoid and/or minimize impacts to parks, open space, and recreational facilities?	Acreage of impacts and duration (temporary/permanent) of impacts to parks, open space, and recreational resources	Sagamore Recreation Area: 0.10 acre temporary, 0.15 acre permanent; 0.99 acre Town of Bourne open space	Sagamore Recreation Area: 0.10 acre temporary, 0.15 acre permanent; 0.99 acre Town of Bourne open space
Natural Resource Protection	Would the option minimize impacts to Areas of Critical Environmental Concern (ACEC) and wildlife habitats?	Direct effect to ACECs	13.4 acres, Herring River Watershed ACEC	13.4 acres, Herring River Watershed ACEC
		Direct effect to wildlife (Natural Heritage and Endangered Species Program) habitats	0	0
	Would the option maintain floodplain functions?	Change between the existing and proposed percent vegetative cover in the floodplain	-2.2%	-2.3%
	Would the option maintain wetlands and surface waters, including protected buffers?	Direct effect to protected wetlands and water resources and/or buffer zones	5.99 acres in wetland buffer	5.99 acres in wetland buffer
Resiliency and Sustainability	Would the option minimize air quality impacts?	Total vehicle miles traveled (VMT) within the network, compared to the 2050 No Build Alternative	220,976 VMT	221,612 VMT
		Total vehicle hours traveled (VHT) within the network, compared to the2050 No Build Alternative	6,180 VHT	6,091 VHT
	Would the option minimize land alteration and reduction in tree cover (urban heat island effect)?	Amount of tree clearing	40.7 acres	45.1 acres

Program Goal	Program Objective	Performance Measure	SN-1A	SN-8A (Preferred)
	Would the option effectively manage stormwater?	Impervious area increase (%), compared to 2050 No Build conditions	36%	42%
		Treated impervious area (%), compared to the minimum goal of 65%	80%	79%
		Peak 2-year discharge rate delta (%), compared to the minimum goal of 0%	-16%	-2%
		Peak 10-year discharge rate delta (%), compared to the minimum goal of 0%	+10%	+13%
		Peak 100-year discharge rate delta (%), compared to the minimum goal of 0%	+8%	+23%
		Proposed infiltration volume (% of required volume), compared to the minimum goal of 100%	111%	109%
		Total phosphorus removal (%), compared to the minimum goal of 50%	80%	79%
		Total suspended solids removal (%), compared to the minimum goal of 80%	84%	84%

Note: The approximate environmental impacts identified in this table were determined based on conceptual through preliminary level design; impacts reported in the Draft Environmental Impact Report, Chapters 4 and 5, are based on more advanced (25% level) design.

MassDOT's Conclusions and Recommendation

MassDOT determined that both Sagamore North quadrant options would address the Program's needs in substantially improving operations, geometrics and safety, multimodal accommodations, and maintenance and structural issues relative to the Future No Build condition. In comparing the two options, MassDOT determined that Option SN-8A would provide more opportunities to meet the Program's needs than Option SN-1A. Option SN-8A would provide some separation between local and regional traffic, whereas Option SN-1A would maintain existing traffic patterns. The three geometrics and safety differentiators between Options SN-1A and SN-8A, consisting of weaving movements, wrong-way driving risk, and acceleration and deceleration speed variances between the ramps and mainline, weigh in favor of Option SN-8A. Further, in Option SN-8A, traffic could be shifted off the structurally deficient Sagamore Bridge in an optimal time frame, whereas Option SN-1A would prolong

use of the existing bridge. As a result, Option SN-8A rated substantially higher than Option SN-1A regarding the option's ability to avoid or minimize the potential for a disruptive maintenance program and/or rehabilitation of the existing Sagamore Bridge.

Relative to meeting the Program's goals, MassDOT determined that the two Sagamore North quadrant options scored fairly evenly. Of the four objectives where the two options received different results, the differences canceled each other out. Option SN-8A scored higher than Option SN-1A in minimizing impacts to the traveling public during construction, which was deemed to be particularly important to MassDOT due to the Program's relatively long construction period.

Regarding anticipated environmental impacts, MassDOT determined that, in general, the preliminary impacts of the options were not differentiating factors in determining the preferred option.

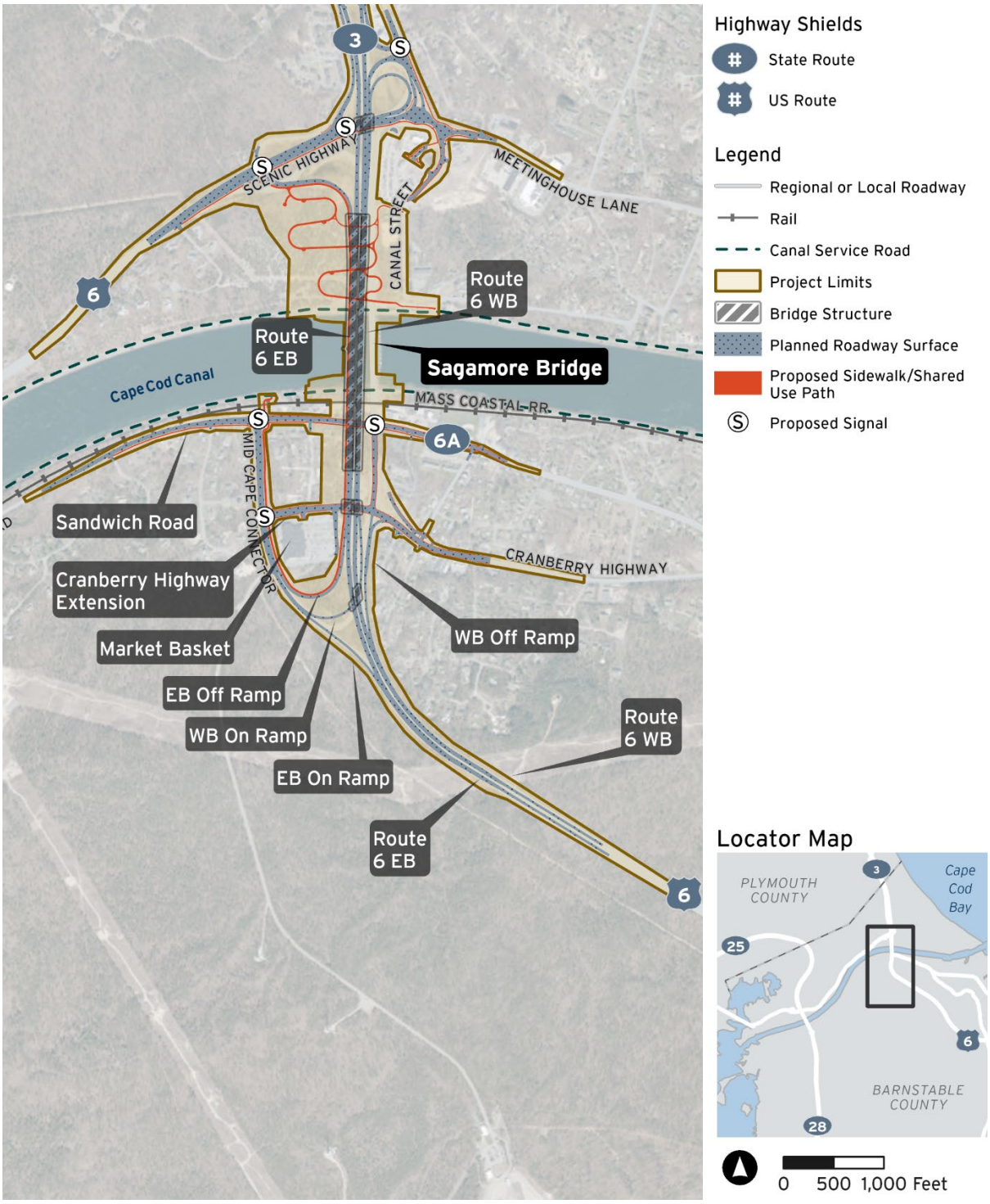
3.3.3.3 Sagamore South Quadrant Crossing: Option SS-3.1A, Westbound On-Ramp Under U.S. Route 6 with Cranberry Highway Extension and Sandwich Road Connector

Description of Preferred Option

Of the three Sagamore South quadrant options (Options SS-1, SS-1.1, and SS-3.1A), MassDOT recommended advancing Option SS-3.1A, Westbound On-Ramp Under U.S. Route 6 with Cranberry Highway Extension and Sandwich Road Connector as the Sagamore South quadrant option to be retained for detailed study in the DEIR (**Figure 3-10**).

Option SS-3.1A, would relocate the westbound on-ramp, so it would share the same entrance point as the eastbound on-ramp off Mid-Cape Connector. It would remove the Cranberry Highway to Sagamore Bridge westbound ramp, and it would provide a new westbound on-ramp connection from Mid-Cape Connector to Sagamore Bridge westbound. Modifications to lane arrangements at the intersections of Mid-Cape Connector with Sandwich Road and Cranberry Highway Extension would accommodate the revised traffic patterns resulting from the extension of Cranberry Highway and relocation of access to U.S. Route 6 eastbound, including modifications to the existing traffic signals. In addition, there would be a connection from Cranberry Road Extension to Sandwich Road east of the new mainline bridge structure (Sandwich Road Connector). A single lane roundabout would be the intersection control at this location. Additionally, west of the new mainline bridge, a single lane roundabout would be provided at the eastern-bound entrance of the existing Market Basket parking lot. Additional improvements would include modified access to Market Basket (Factory Outlet Road) and an access driveway to the former Christmas Tree Shops area. Option SS-3.1A would include a SUP on the U.S. Route 6 eastbound main span that would provide connections to Factory Outlet Road, Sandwich Road, and the Canal Service Road. Bicycle and pedestrian improvements would also be included on Cranberry Highway. This option would add a new connection through Cranberry Highway Extension to Mid-Cape Connector. This new connection would improve multimodal connectivity by providing access between local neighborhoods and businesses that currently does not exist.

Figure 3-10. Sagamore South Quadrant Crossing: Option SS-3.1A, Westbound On-Ramp Under U.S. Route 6 with Cranberry Highway Extension and Sandwich Road Connector (Preferred Option)



Source: Massachusetts Department of Transportation, 2025

Comparison of Options

Table 3-10 identifies the Program needs evaluation criteria that were differentiators among Options SS-1, SS-1.1, and SS-3.1A. MassDOT determined that while the three Sagamore South quadrant options performed comparably in addressing the Program needs related to geometrics and safety and multimodal accommodations, Option SS-3.1A, Westbound On-Ramp Under U.S. Route 6 with Cranberry Highway Extension and Sandwich Road Connector, would provide the most opportunities to meet the Program's needs, particularly regarding the option's ability to remove traffic from the existing bridge and avoid and/or minimize the potential for a disruptive maintenance and/or rehabilitation of the existing Sagamore Bridge. The differences in benefits among the three options were directly attributable to the ability of an option to meet the Program's Purpose and Need Statement.

Table 3-10. Sagamore South Quadrant Crossing: Program Needs Differentiators

Program Need	Needs Evaluation Criteria	SS-1	SS-1.1	SS-3.1A (Preferred)	Comparison of Options
Operations	Would the option reduce local travel times, measured by vehicle hours traveled on local roads, compared to the 2050 No Build Alternative?	**Substantial Benefits**	**Marginal/ Some Benefits**	**Substantial Benefits**	Vehicle hours traveled would be approximately 69.67 for SS-3.1A, 82.9 for SS-1, and 97.2 for SS-1.1, compared to 115.15 for the No Build Alternative.
	Would the option improve cross-canal mobility, measured by vehicle hours traveled from local roads to the bridge's mid-point, compared to the 2050 No Build Alternative?	**Substantial Benefits**	**Marginal/ Some Benefits**	**Substantial Benefits**	Vehicle hours traveled would be approximately 38.13 for SS-3.1A, 42.86 for SS-1, and 56.67 for SS-1.1, compared to 86.39 for the No Build Alternative.
	Would the option separate local and regional traffic?	**Marginal/ Some Benefits**	**Insufficient/ Negligible Benefits**	**Substantial Benefits**	• SS-3.1A would remove regional traffic from Cranberry Highway Extension. • SS-1 would separate some local and regional traffic. • SS-1.1 would maintain existing traffic patterns.

Program Need	Needs Evaluation Criteria	SS-1	SS-1.1	SS-3.1A (Preferred)	Comparison of Options
Geometrics and Safety	Would the option minimize weaving movements on mainline highways?	**Marginal/ Some Benefits**	**Marginal/ Some Benefits**	**Substantial Benefits**	SS-3.1A design improvements would minimize weaving movements over SS-1 and SS-1.1.
Multimodal Accommoda-tions	Would the option improve pedestrian/bicycle connections at ramp terminals?	**Marginal/ Some Benefits**	**Substantial Benefits**	**Substantial Benefits**	• SS-1.1 and SS-3.1A would require one sidewalk crossing. • SS-1 would require two sidewalk crossings at ramp terminals.
	Would the option enhance the pedestrian/bicycle experience?	**Marginal/ Some Benefits**	**Marginal/ Some Benefits**	**Substantial Benefits**	SS-3.1A would provide the highest level of shared-use path and neighborhood connectivity among the three options.
Maintenance/ Structural	Would the option minimize the risk of disruptive maintenance and/or rehabilitation on the existing bridges?	**Insufficient/ Negligible Benefits**	**Insufficient/ Negligible Benefits**	**Substantial Benefits**	• SS-1 and SS-1.1 would prolong use of the existing bridge. • SS-3.1A would accelerate discontinued use of the existing bridge.
	Would the option allow for the most efficient and simplest structural system to accommodate the interchange ramps?	**Insufficient/ Negligible Benefits**	**Insufficient/ Negligible Benefits**	**Substantial Benefits**	• SS-3.1A would have a compatible ramp framing and tie-in with the bridge mainline. • SS-1 and SS-1.1 would have a complex bridge framing system.

Table 3-11 identifies the Program goals and objectives that were differentiators among Options SS-1, SS-1.1, and SS-3.1A. MassDOT determined that the three Sagamore South quadrant options scored fairly evenly for most of the performance measures. Where the three options received different results, the differences were due to the construction-period impacts and constructability issues.

Table 3-11. Sagamore South Quadrant Crossing: Program Goals Differentiators

Program Goal	Program Objectives	SS-1	SS-1.1	SS-3.1A (Preferred)	Comparison of Options
Socioeconomics	Would the option minimize commercial property impacts, regarding the number of easements on occupied parcels?	**Some Impacts**	**Least Impacts**	**Some Impacts**	• SS-1 and SS-3.1A would require 7 and 6 easements, respectively, on occupied commercial parcels. • SS-1.1 would require 3 easements on occupied commercial parcels.
	Would the option improve access to commercial properties?	**Some Opportunity**	**Least Opportunity**	**Some Opportunity**	• SS-1.1 would not improve access. • SS-1 and SS-3.1A would improve accessibility to Market Basket and to neighborhoods via Cranberry Highway Extension.
	Would the option maintain or improve neighborhood accessibility to community facilities and services?	**Most Opportunity**	**Some Opportunity**	**Most Opportunity**	• SS-1 and SS-3.1A would improve accessibility via the Cranberry Highway Extension. • S-1.1 would not improve accessibility via the Cranberry Highway Extension.

Program Goal	Program Objectives	SS-1	SS-1.1	SS-3.1A (Preferred)	Comparison of Options
	Would the option maintain or improve neighborhood cohesion?	**Some Opportunity**	**Least Opportunity**	**Most Opportunity**	• SS-1.1 would mimic existing conditions. • SS-1 and SS-3.1A would reduce the regional traffic volume on local roads. • SS-3.1A would also include the Sandwich Road extension.
	Would the option minimize construction period impacts upon the traveling public?	**Some Impacts**	**Some Impacts**	**Least Impacts**	• SS-1 and SS-1.1 would require detours for the bridge construction. • SS-3.1A would not require detours for bridge construction.
Resiliency and Sustainability	Would the option effectively manage stormwater, regarding an increase in impervious area from the 2050 No Build condition?	**Some Opportunity**	**Most Opportunity**	**Some Opportunity**	• SS-1.1 would increase impervious area by 19%. • SS-1 and SS-3.1A would increase impervious area by 30%.
Constructability	Would the option minimize the construction duration?	**Most Opportunity**	**Most Opportunity**	**Some Opportunity**	SS-1 and SS-1.1 would be completed up to 12 months sooner than SS-3.1A.
	Would the option maintain existing connections during construction?	**Some Opportunity**	**Some Opportunity**	**Most Opportunity**	• SS-3.1A would maintain connections without detours. • SS-1 and SS-1.1 would require detours to maintain existing conditions.

Program Goal	Program Objectives	SS-1	SS-1.1	SS-3.1A (Preferred)	Comparison of Options
Emergency Response	Would the option improve emergency evacuation capabilities off Cape Cod?	**Most Opportunity**	**Some Opportunity**	**Most Opportunity**	• SS-1 and SS-3.1A would improve capabilities via the Cranberry Highway Extension. • SS-1 would minimally improve capabilities.
	Would the option improve emergency response?	**Most Opportunity**	**Some Opportunity**	**Most Opportunity**	• SS-1 and SS-3.1A would improve access to and from Sandwich Road west and the Mid-Cape Connector via the Cranberry Highway Extension. • SS-1.1 would maintain the existing configuration.

Table 3-12 presents a comparison of quantifiable environmental impacts of the three Sagamore South options based on the conceptual through preliminary (up to 15% design) level assessments. The environmental impacts identified in the table also incorporate the results of the initial assessments and recommendations for the shift in the Sagamore Bridge mainline alignment location to offline and inboard (**Appendix 3.1, Attachment 1, Alternatives Analysis Report**). Note that the impacts identified in the table are approximate and may differ from those reported in **Chapters 4** and **5**, which are based on a more advanced (25% level) design.

Table 3-12. Sagamore South Quadrant Crossing: Comparison of Preliminary Quantifiable Environmental Impacts

Program Goal	Program Objective	Performance Measure	SS-1	SS-1.1	SS-3.1A (Preferred)
Socioeconomics	Would the option minimize residential property impacts, including acquisitions and displacement?	Number of easements, vacant parcels	1	1	1
		Number of easements, occupied parcels	16	13	14
		Number of full parcel acquisitions with displacements	22	22	22

Program Goal	Program Objective	Performance Measure	SS-1	SS-1.1	SS-3.1A (Preferred)
		Number of full parcel acquisitions without displacements	6	6	6
	Would the option minimize commercial property impacts, including acquisitions and displacement?	Number of easements, vacant parcels	0	0	0
		Number of easements, occupied parcels	7	3	6
		Number of full parcel acquisitions with displacements	3	3	3
		Number of full parcel acquisitions without displacements	3	3	3
	Would the option avoid and/or minimize impacts to parks, open space, and recreational facilities?	Acreage of impacts and duration (temporary/ permanent) of impacts to parks, open space, and recreational resources	0.99 acre Town of Bourne open space	0.99 acre Town of Bourne open space	0.99 acre Town of Bourne open space
Natural Resource Protection	Would the option minimize impacts to Areas of Critical Environmental Concern and wildlife habitats?	Direct effect to Areas of Critical Environmental Concern	0	0	0
		Direct effect to Natural Heritage and Endangered Species Program habitat	2.60 acres	2.60 acres	2.60 acres
	Would the option maintain floodplain functions?	Change between existing and proposed percent vegetative cover in floodplain.	2%	2%	2%
	Would the option maintain wetlands and surface waters, including protected buffers?	Direct effect to protected wetlands and water resources and/or buffer zones	2.87 acres	2.87 acres	2.87 acres
Resiliency and Sustainability	Would the option minimize air quality impacts?	Total vehicle miles traveled(VMT) within the network, compared to the 2050 No Build Alternative	221,612 VMT	226,407 VMT	219,237 VMT

Program Goal	Program Objective	Performance Measure	SS-1	SS-1.1	SS-3.1A (Preferred)
		Total vehicle hours traveled (VHT) within the network, compared to the 2050 No Build Alternative	6,091 VHT	6,115 VHT	6,175 VHT
	Would the option minimize land alteration and reduction in tree cover (heat island effect)?	Amount of tree clearing	28.2 acres	28.6 acres	30.3 acres
	Would the option effectively manage stormwater?	Impervious area increase (%), compared to the 2050 No Build conditions	30%	19%	30%
		Treated impervious area (%), compared to the minimum goal of 65%	65%	65%	65%
		Peak 2-year discharge rate delta (%), compared to the minimum goal of 0%	-35%	-35%	-31%
		Peak 10-year discharge rate delta (%), compared to the minimum goal of 0%	-20%	-16%	-18%
		Peak 100-year discharge rate delta (%), compared to the minimum goal of 0%	-25%	-20%	-22%
		Proposed infiltration volume (% of required volume), compared to the minimum goal of 100%	112%	113%	124%
		Total phosphorus removal (%), compared to the minimum goal of 50%	68%	68%	68%
		Total suspended solids removal (%), compared to the minimum goal of 80%	81%	82%	81%

Note: The approximate environmental impacts identified in this table were determined based on conceptual through preliminary level design. Impacts reported in the Draft Environmental Impact Report, Chapters 4 and 5, are based on more advanced (25% level) design.

MassDOT's Conclusions and Recommendation

Except for three evaluation criteria, the three Sagamore South options performed comparably in addressing the Program's needs related to geometrics and safety and multimodal accommodations. The three options varied considerably in addressing the Program's needs related to operations and the maintenance/structural needs of the existing Sagamore Bridge. Based on the constructability assessment, Options SS-1 and SS-1.1 would require extensive preparation work, consisting of long-term and potentially complicated detours to maintain connections during construction. As a result, these options would prolong use of the Sagamore Bridge, taking 12 to 18 months longer to remove traffic from the existing bridge than Option SS-3.1A. Of the eight total evaluation criteria differentiators, Option SS-3.1A consistently received the highest rating of *substantial benefits*. As a result, MassDOT determined that Option SS-3.1A would provide the most opportunities to meet the Program's needs, particularly regarding the option's ability to avoid and/or minimize the potential for a disruptive maintenance program and/or rehabilitation of the existing Sagamore Bridge.

Relative to meeting the Program's goals, MassDOT determined that the three Sagamore South options scored fairly evenly. To maintain vehicular travel connections during bridge construction, Options SS-1 and SS-1.1 would require detours, whereas Option SS-3.1A would not require detours. Option SS-3.1A scored highest among the options in maintaining existing connections during Program construction, which was particularly important to MassDOT due to the Program's relatively long construction period.

MassDOT determined that the anticipated environmental impacts of the options were not differentiating factors in determining the preferred option.

3.3.3.4 Bourne North Quadrant Crossing: Directional Interchange Option

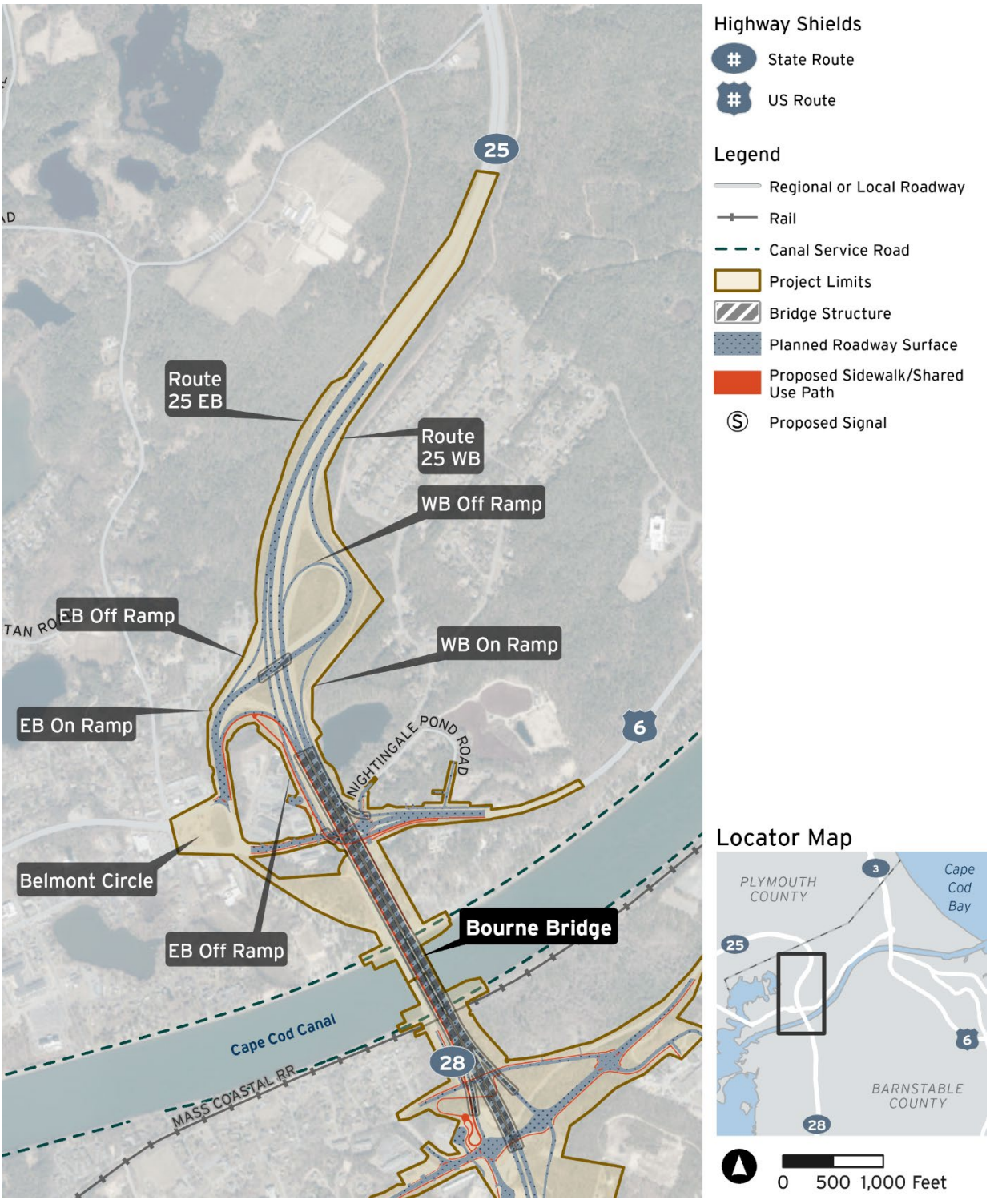
Description of Preferred Option

Of the remaining two interchange approach options for the Bourne North quadrant crossing (Options BN-13.1 and BN-14.4b), MassDOT recommended advancing Option BN-14.4b, Directional Interchange, as the Bourne North quadrant option to be retained for detailed study in the DEIR (**Figure 3-11**).

Option BN-14.4b would provide a combination of direct connection ramps between State Route 25 and U.S. Route 6 (Scenic Highway). The ramp connecting State Route 25 eastbound to Scenic Highway would be a direct connect ramp, allowing access to Scenic Highway eastbound only. The new flyover ramp connecting Scenic Highway to State Route 25 would allow vehicles to bypass Belmont Circle and would not require an additional traffic signal. This ramp would use one of the travel lanes on Scenic Highway and would be a free-flowing movement to reduce congestion. The existing State Route 28 over the State Route 25 bridge would be relocated to widen the bridge to allow for this new southbound-to-eastbound ramp movement. Additionally, the existing southbound off-ramp would be revised to be an option lane, improving the geometry and decision sight distance for drivers. The intersection control at U.S. Route 6/Nightingale Road/Andy Oliva Drive would either be a single-lane roundabout.

In Option BN-14.4b, Directional Interchange, the new flyover ramp over Scenic Highway would provide a SUP and grade-separated crossing for pedestrians and bicyclists. Since the flyover ramp would remove traffic from Belmont Circle, the lane configuration of Scenic Highway would be reduced from four lanes to three lanes, which would provide additional space for multimodal accommodations. Additionally, this option would provide one continuous 12-foot-wide SUP along the south side of Scenic Highway connecting to Belmont Circle and a 6-foot-wide sidewalk along the north side of Scenic Highway.

Figure 3-11. Bourne North Quadrant Crossing: Option BN-14.4b, Directional Interchange (Preferred)



Source: Massachusetts Department of Transportation, 2024

Comparison of Options

Table 3-13 identifies the Program needs evaluation criteria that were differentiators between Option BN-13.1 and Option BN-14.4b. MassDOT determined that Option BN-14.4b, Directional Interchange, would provide more benefits in meeting the Program's Purpose and Need Statement than Option BN-13.1, Single Exit Partial Interchange, particularly regarding multimodal accommodations. The substantial benefits that would be provided by Option BN-14.4b versus the marginal or lower benefits that would be provided by Option BN-13.1 are directly attributable to design.

Table 3-13. Bourne North Quadrant Crossing: Program Needs Differentiators

Program Need	Evaluation Criteria	BN-13.1	BN-14.4b (Preferred)	Comparison of Options
Operations	Would the option separate local and regional traffic?	**Marginal/ Some Benefits**	**Substantial Benefits**	• BN-14.4b would use flyover ramps, allowing for free-flow traffic. • BN-13.1 would use signalized intersections.
Geometrics and Safety	Would the option minimize wrong-way driving risk (at intersection ramp terminals)?	**Marginal/ Some Benefits**	**Substantial Benefits**	• BN-14.4b would geometrically restrict wrong-way driving. • BN-13.1 would use wrong-way detection systems.
Multimodal Accommodations	Would the option improve pedestrian/ bicycle access adjacent to local roads?	**Insufficient/ Negligible Benefits**	**Substantial Benefits**	• BN-14.4b would meet MassDOT's Healthy Transportation Policy Directive. • BN-13.1 would not meet the Healthy Transportation Policy Directive.
	Would the option improve pedestrian/ bicycle access to existing trail facilities?	**Marginal/ Some Benefits**	**Substantial Benefits**	• BN-14.4b would provide a grade-separated crossing. • BN-13.1 would include several at-grade crossings.
	Would the option improve pedestrian/ bicycle connections at ramp terminals?	**Marginal/ Some Benefits**	**Substantial Benefits**	• BN-14.4b would avoid the high-speed ramp through diversion. • BN-13.1 would provide signalized control at ramps.

Program Need	Evaluation Criteria	BN-13.1	BN-14.4b (Preferred)	Comparison of Options
	Would the option enhance the pedestrian/ bicycle experience?	**Marginal/ Some Benefits**	**Substantial Benefits**	• BN-14.4b would require two intersection/ramp crossings. • BN-13.1 would require six intersection/ramp crossings.

Table 3-14 identifies the Program goals and objectives that were differentiators between Option BN-13.1 and Option BN-14.4b. MassDOT determined that the two Bourne North quadrant options scored fairly evenly across many of the Program's goals and objectives.

Table 3-14. Bourne North Quadrant Crossing: Program Goals Differentiators

Program Goal	Program Objectives	BN-13.1	BN-14.4b (Preferred)	Comparison of Options
Socioeconomics	Would the option improve neighborhood access to community facilities and services, specifically, schools, hospitals, and emergency services (police and fire)?	**Some Opportunity**	**More Opportunity**	Along Scenic Highway: • BN-14.4b would add a shared-use path. • BN-13.1 would add sidewalks.
	Would the option maintain or improve neighborhood cohesion?	**Some Opportunity**	**More Opportunity**	From the local roadway network: • BN-14.4b would fully remove State Routes 28/25 traffic. • BN-13.1 would partially remove State Routes 28/25 traffic.
	Would the option avoid and/or minimize impacts to parks, open space, and recreational facilities?	**Some Impacts**	**More Impacts**	Bourne Scenic Park: • BN-13.1 would affect 14.2 acres. • BN-14.4b would affect 14.8 acres.

Program Goal	Program Objectives	BN-13.1	BN-14.4b (Preferred)	Comparison of Options
Resiliency and Sustainability	Would the option effectively manage stormwater, demonstrated by change in 2-year peak discharge rate compared to minimum goal of 0%?	**Some Opportunity**	**More Opportunity**	For the 2-year peak discharge rate: • BN-14.4b would have a 14% decrease. • BN-13.1 would have a 4% increase.
Emergency Response	Would the option improve emergency evacuation capabilities off Cape Cod?	**Some Opportunity**	**More Opportunity**	For westbound departures: • BN-14.4b would provide free-flow traffic conditions. • BN-13.1 would have a signalized intersection.
Cost Effectiveness	Would the option maximize construction cost effectiveness?	**More Opportunity**	**Some Opportunity**	Approximate costs: • BN-13.1 = $178 million • BN-14.4b = $211 million

Table 3-15 presents a comparison of quantifiable environmental impacts of the two Bourne North quadrant options based on the conceptual through preliminary (up to 15% design) level assessments. The environmental impacts identified in the table also incorporate the results of the initial assessments and recommendations for the shift in the Bourne Bridge mainline alignment location to offline and inboard (**Appendix 3.1, Attachment 1, Alternatives Analysis Report**). Note that the impacts identified in the table are approximate and may differ from those reported in **Chapters 4** and **5**, which are based on a more advanced (25% level) design.

Table 3-15. Bourne North Quadrant Crossing: Comparison of Preliminary Quantifiable Environmental Impacts

Program Goal	Objective	Performance Measure	BN-13.1	BN-14.4b (Preferred)
Socioeconomics	Would the option minimize residential property impacts, including acquisitions and displacement?	Number of easements, vacant parcels	0	0
		Number of easements, occupied parcels	2	2
		Number of full parcel acquisitions with displacements	1	1
		Number of full parcel acquisitions without displacements	0	0
	Would the option minimize commercial property impacts, including acquisitions and displacement?	Number of easements, vacant parcels	1	1
		Number of easements, occupied parcels	2	2
		Number of full parcel acquisitions with displacements	1	1
		Number of full parcel acquisitions without displacements	4	4
	Would the option avoid and/or minimize impacts to parks, open space, and recreational facilities?	Acreage of impacts and duration (temporary/permanent) of impacts to parks, open space, and recreational resources	Bourne Scenic Park: 14.22 acres (temporary)	Bourne Scenic Park: 14.84 acres (temporary)
Natural Resource Protection	Would the option minimize impacts to Areas of Critical Environmental Concern and wildlife habitats?	Direct effect to Areas of Critical Environmental Concern	0	0
		Direct effect to Natural Heritage and Endangered Species Program habitat	0	0
	Would the option maintain floodplain functions?	Change between the existing and proposed percent vegetative cover in the floodplain	19.2%	19.4%
	Would the option maintain wetlands and surface waters, including protected buffers?	Direct effect to protected wetlands and water resources and/or buffer zones	4.06 acres in buffer zone	4.28 acres in buffer zone

Program Goal	Objective	Performance Measure	BN-13.1	BN-14.4b (Preferred)
Resiliency and Sustainability	Would the option minimize air quality impacts?	Total vehicle miles traveled (VMT) within the network, compared to the 2050 No Build Alternative	221,747 VMT	221,612 VMT
		Total vehicle hours traveled (VHT) within the network, compared to the2050 No Build Alternative	6,174 VHT	6,091 VHT
	Would the option minimize land alteration and reduction in tree cover (urban heat island effect)?	Amount of tree clearing	14.92 acres	16.86 acres
	Would the option effectively manage stormwater?	Impervious area increase (%), compared to 2050 No Build conditions	55%	59%
		Treated impervious area (%), compared to the minimum goal of 65%	76%	78%
		Peak 2-year discharge rate delta (%), compared to the minimum goal of 0%	4%	-14%
		Peak 10-year discharge rate delta (%), compared to the minimum goal of 0%	-14%	-24%
		Peak 100-year discharge rate delta (%), compared to the minimum goal of 0%	-14%	-22%
		Proposed infiltration volume (% of required volume), compared to the minimum goal of 100%	159%	177%
		Total phosphorus removal (%), compared to the minimum goal of 50%	76%	78%
		Total suspended solids removal (%), compared to the minimum goal of 80%	82%	84%

Note: The environmental impacts identified in this table were determined based on conceptual through preliminary level design. Impacts reported in the Draft Environmental Impact Report, Chapters 4 and 5, are based on more advanced (25% level) design.

MassDOT's Conclusions and Recommendation

Both Bourne North quadrant options would address the Program's needs by providing *substantial benefits* in operations, geometrics and safety, multimodal accommodations, and maintenance and structural issues. MassDOT determined that Option BN-14.b would provide more opportunities to meet the Program's needs than Option BN-13.1, including separating regional and local traffic and geometrically restricting wrong-way driving risk. In particular, Option BN-14.4b rated higher than Option BN-13.1 regarding multimodal accommodations, including providing grade separation over Scenic Highway for pedestrians and bicyclists and meeting the pedestrian and bicycle requirements of MassDOT's Healthy Transportation Directive.

Relative to meeting the Program's goals, MassDOT determined that the two Bourne North options scored fairly evenly across many of the Program's goals and objectives. Of the six differentiating Program objectives, Option BN-14.4b scored higher than Option BN-13.1 in four objectives and scored lower than Option BN-13.1 in two objectives.

MassDOT compared the environmental impacts of the two options and determined that, except for four objectives, the environmental ratings of the two options were comparable and were not differentiating factors in determining the preferred option. Regarding the proposed impacts to parks and recreation areas, Option BN-14.4b would result in more temporary impacts to Bourne Scenic Park than Option BN-13.1. **Section 4.18, Public Parks, Recreational Facilities, and Open Space**, describes how MassDOT is coordinating with the USACE and Bourne Recreation Authority, the owners of Bourne Scenic Park, to mitigate adverse impacts and provide park enhancements, resulting in a net benefit to Bourne Scenic Park.

3.3.3.5 Bourne South Quadrant Crossing: Diamond Interchange

Description of Preferred Option

Of the two Bourne South quadrant options (Options BS-2 and BS-2.2), MassDOT recommended advancing Option BS-2, Diamond Interchange, as the Bourne South quadrant option to be retained for detailed study in the DEIR (**Figure 3-12**).

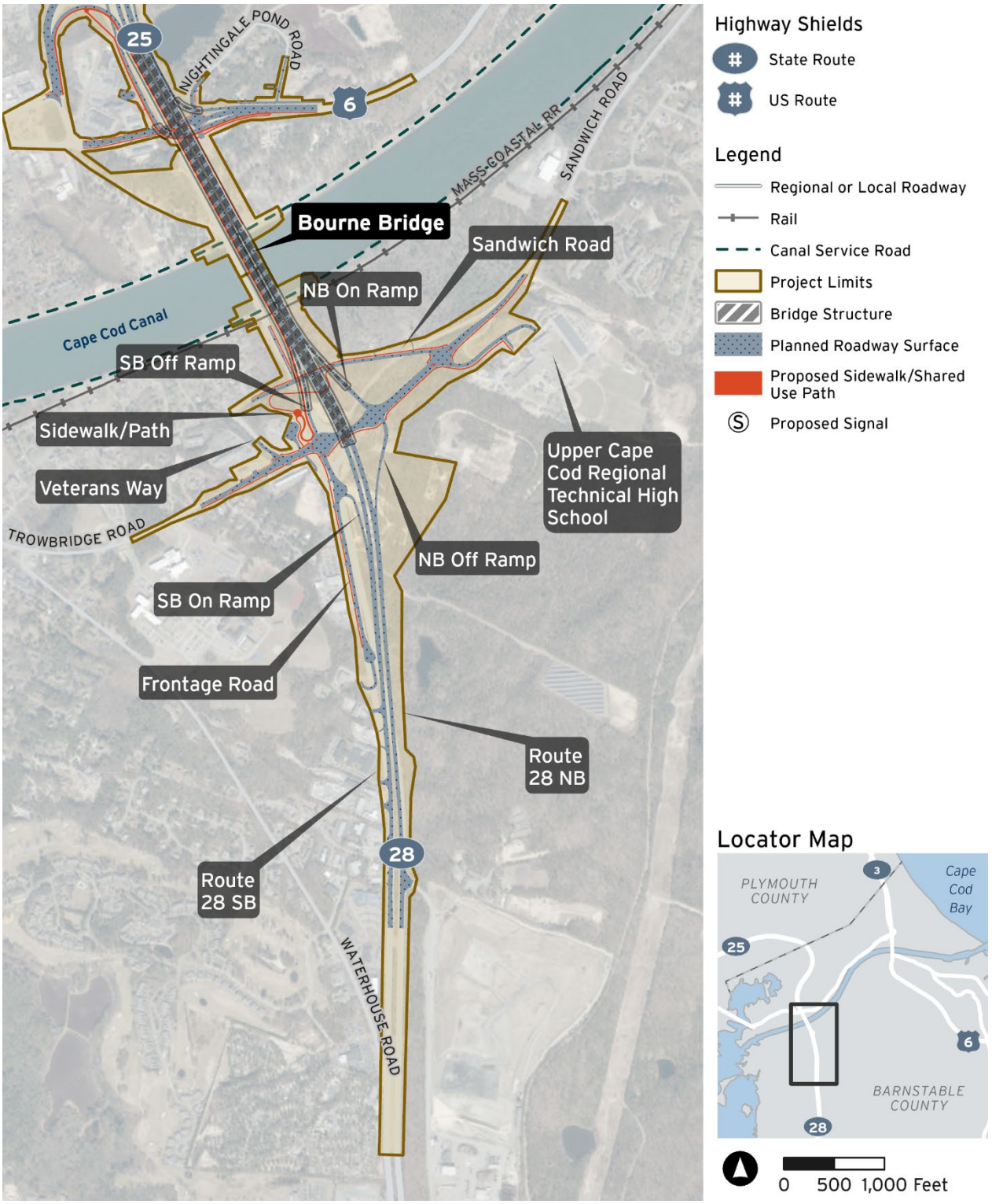
Option BS-2, Diamond Interchange, would eliminate the Bourne Rotary and replace the existing rotary with a grade-separated diamond interchange. This option would allow through movements on State Route 28 to bypass the intersections with the non-mainline roadways. Both intersections within the diamond interchange would require either a traffic signal or a roundabout for intersection control. Based on the traffic analysis, a single-lane dog-bone roundabout option[5] would be provided to maximize the operations of the diamond interchange. A dog-bone roundabout processes more vehicles per hour than a typical roundabout or signalized intersection, resulting in shorter queues and delays. Additionally, a dog-bone roundabout eliminates the inside lane of each roundabout, resulting in a reduced number of conflict points at each intersection and improved safety and operations. Replacing

[6] Project #S131144 was added to the Federal Fiscal Year 2025-2029 Transportation Improvement Program as Amendment #2, December 9, 2024.

the traditional signalized intersection with a dog-bone roundabout option in Option BS-2 would allow better movement and access to the frontage road users from Trowbridge Road and the southbound off-ramp. Additionally, traffic from the frontage road would have direct access to the State Route 28 southbound on-ramp. The dog-bone roundabout would use Pedestrian Hybrid Beacons at each intersection leg for visual enhancements to protect pedestrians and bicyclists and increase driver awareness.

Additional changes to the Trowbridge Road and Sandwich Road underpass in the Diamond Interchange Option would consist of a multi-lane roundabout at a relocated Upper Cape Cod Regional Technical High School Driveway entrance. This option's SUP improvements would include providing connections to Trowbridge Road, the Cape Cod Canal Service Road, and the Bourne Recreation Area.

Figure 3-12. Bourne South Quadrant Crossing: Option BS-2, Diamond Interchange(Preferred)



Source: Massachusetts Department of Transportation, 2024

Comparison of Options

Table 3-16 identifies the Program needs evaluation criteria that were differentiators between Option BS-2 and Option BS-2.2. MassDOT determined that Option BS-2, Diamond Interchange, received much higher ratings than Option BS-2.2, Single-Point Interchange, in three evaluation criteria addressing the Program's needs related to operations, geometrics and safety, and multimodal accommodations. The substantial benefits provided by Option BS-2 versus the marginal benefits provided by Option BS-2.2 are directly attributable to the option's ability to meet the Program's Purpose and Need Statement.

Table 3-16. Bourne South Quadrant Crossing: Program Needs Differentiators

Program Need	Evaluation Criteria	BS-2 (Preferred)	BS-2.2	Comparison of Options
Operations	Would the option improve cross-canal mobility, measured by vehicle hours traveled (VHT) from local roads to bridge mid-point, compared to the 2050 No Build condition?	**Substantial Benefits**	**Marginal/ Some Benefits**	BS-2 would reduce VHT by 20% over BS-2.2.
Geometrics and Safety	Would the option minimize wrong-way driving risk (at intersection ramp terminals)?	**Substantial Benefits**	**Marginal/ Some Benefits**	• BS-2 would geometrically restrict wrong-way driving. • BS-2.2 would have an inherent risk of wrong-way driving.
Multimodal Accommodations	Would the option improve pedestrian/ bicycle connections at ramp terminals?	**Substantial Benefits**	**Marginal/ Some Benefits**	• BS-2 would provide rapid flashing beacons for crossings. • BS-2.2 would provide signalized crossings but would require complicated lane crossings.

MassDOT did not identify any Program goals and objectives that were differentiators between the two Bourne South options. MassDOT determined that the two Bourne South quadrant options scored fairly evenly across the Program's goals and objectives.

Table 3-17 presents a comparison of quantifiable environmental impacts of the two Bourne South options based on the conceptual through preliminary (up to 15% design) level assessments. The environmental impacts identified in the table also incorporate the results of the initial assessments and recommendations for the shift in the Bourne Bridge mainline alignment location to offline and inboard (**Appendix 3.1, Attachment 1, Alternatives Analysis Report**). Note that the impacts identified in the

table are approximate and may differ from those reported in **Chapters 4** and **5**, which are based on more advanced (25% level) design.

Table 3-17. Bourne South Quadrant Crossing: Comparison of Quantifiable Environmental Impacts

Program Goal	Program Objective	Performance Measure	BS-2 (Preferred)	BS-2.2
Socioeconomics	Would the option minimize residential property impacts, including acquisitions and displacement?	Number of easements, vacant parcels	0	0
		Number of easements, occupied parcels	0	0
		Number of full parcel acquisitions with displacements	0	0
		Number of full parcel acquisitions without displacements	0	0
	Would the option minimize commercial property impacts, including acquisitions and displacement?	Number of easements, vacant parcels	1	1
		Number of easements, occupied parcels	8	8
		Number of full parcel acquisitions with displacements	2	2
		Number of full parcel acquisitions without displacements	9	9
	Would the option avoid and/or minimize impacts to parks, open space, and recreational facilities?	Acreage of impacts and duration (temporary/ permanent) of impacts to parks, open space, and recreational resources	Bourne Recreation Area: 4.11 acres	Bourne Recreation Area: 4.11 acres
Natural Resource Protection	Would the option minimize impacts to Areas of Critical Environmental Concern and wildlife habitats?	Direct effect to Areas of Critical Environmental Concern	0	0
		Direct effect to Natural Heritage and Endangered Species Program habitat	8.02 acres	8.82 acres
	Would the option maintain floodplain functions?	Change between the existing and proposed percent vegetative cover in the floodplain	7.6%	7.6%
	Would the option maintain wetlands and surface waters, including protected buffers?	Direct effect to protected wetlands and water resources and/or buffer zones	0.61 acre in buffer zone	0.61 acre in buffer zone

Program Goal	Program Objective	Performance Measure	BS-2 (Preferred)	BS-2.2
Resiliency and Sustainability	Would the option minimize air quality impacts?	Total vehicle miles traveled (VMT) within the network compared to the 2050 No Build Alternative	221,612 VMT	219,657 VMT
		Total vehicle hours traveled (VHT) within the network compared to the 2050 No Build Alternative	6,091 VHT	6,165 VHT
	Would the option minimize land alteration and reduction in tree cover (heat island effect)?	Amount of tree clearing	39.67 acres	38.99 acres
	Would the option effectively manage stormwater?	Impervious area increase (%), compared to the 2050 No Build conditions	69%	77%
		Treated impervious area (%), compared to the minimum goal of 65%	81%	81%
		Peak 2-year discharge rate delta (%), compared to the minimum goal of 0%	-69%	-72%
		Peak 10-year discharge rate delta (%), compared to the minimum goal of 0%	-70%	-73%
		Peak 100-year discharge rate delta (%), compared to the minimum goal of 0%	-71%	-75%
		Proposed infiltration volume (% of required volume), compared to the minimum goal of 100%	216%	223%
		Total phosphorus removal (%), compared to the minimum goal of 50%	81%	81%
		Total suspended solids removal (%), compared to the minimum goal of 80%	86%	86%

Note: The approximate environmental impacts identified in this table were determined based on conceptual through preliminary level design. Impacts reported in the Draft Environmental Impact Report, Chapters 4 and 5, are based on more advanced (25% level) design.

MassDOT's Conclusions and Recommendation

In addressing the Program's needs, both Bourne South quadrants options would substantially improve operations compared to the No Build Alternative. Compared to each other, the Bourne South quadrant options received almost identical scores, except for three evaluation criteria addressing operations, geometrics and safety, and multimodal accommodations, where Option BS-2 received higher ratings than Option BS-2.2. In contrast to Option BS-2.2, which received marginal/some benefits ratings, Option BS-2 received substantial benefits ratings for improving cross-canal mobility via an approximate 20% reduction in vehicle hours traveled, geometrically restricting wrong-way driving risk, and simplified pedestrian/bicyclist crossings at ramp terminals.

Relative to meeting the Program's goals, MassDOT determined that the two Bourne South quadrant options scored fairly evenly.

MassDOT compared the environmental impacts of the two options and determined that the two Bourne South quadrant options scored fairly evenly, with no substantial qualitative or quantifiable differences between the two options.

3.4 Description of the Preferred Alternative

This section describes the Program's Preferred Alternative, including an assessment of the Preferred Alternative relative to the Program's needs. It also provides a summary of MassDOT's preferred bridge (**Sections 3.3.2.1 through 3.3.2.6**) and highway (**Sections 3.3.3.1 through 3.3.3.5**) design parameters resulting from the multiple assessments.

3.4.1 Assessment of Preferred Alternative and Program Needs

MassDOT determined that the Preferred Alternative—incorporating the preferred bridge design options identified in **Sections 3.3.2.1 through 3.3.2.6**, and the preferred highway interchange approach options identified in **Sections 3.3.3.2 through 3.3.3.5**—would fully meet the Program's needs, as listed in **Table 3-18**. The table also identifies the operational benefits of the Preferred Alternative.

Table 3-18. Evaluation of the Preferred Alternative Relative to Program Needs

Program Need	Evaluation of the Preferred Alternative
Address the deteriorating structural condition and escalating maintenance demands of the Cape Cod Canal highway bridges.	**This need would be met.** With both replacement highway bridges, the Massachusetts Department of Transportation (MassDOT) would implement the optimal construction sequence of removing all traffic from the existing bridge and discontinuing its use following construction of the first replacement main span, thereby minimizing the risk of disruptive maintenance and/or rehabilitation of the existing bridges. **Additional operational benefits** would include compatible ramp framing and mainline framing systems at both crossings, allowing for the most efficient and simplest structural system to accommodate the interchange ramps. In particular, the preferred highway interchange network options in the Sagamore quadrants would accelerate the removal of traffic and discontinue use of the existing Sagamore Bridge, minimizing the potential for a disruptive maintenance program and/or rehabilitation of the existing bridge.
Address the substandard design elements of the Cape Cod Canal highway bridges, the immediate mainline approaches and their adjacent interchanges and intersections.	**This need would be met.** The highway bridges and approaches would comply with American Association of State Highway and Transportation Officials (AASHTO) highway and bridge design specifications and MassDOT design standards. **Additional operational benefits** would include geometric improvements and safety features. For example, the preferred highway interchange network would minimize weaving movements; improve merge/weave distances on the mainline; geometrically restrict the potential for wrong-way driving, such as through the replacement of Bourne Rotary with a diamond interchange and the direct connection from State Route 25 to Scenic Highway eastbound; and minimize deceleration speed variances between ramps and the mainline.
Improve vehicular traffic operations.	**This need would be met.** The Preferred Alternative would substantially improve vehicular traffic operations compared to the No Build Alternative conditions, including reduced regional and local travel times and improved cross-canal mobility. **Additional operational benefits** would include interchange improvements designed to separate local and regional traffic. For example, with the preferred highway interchange network, Sagamore Bridge westbound traffic destined for State Road would be removed from the Meetinghouse Lane/Canal Street intersection, a new Cranberry Road extension and new connection between Sandwich Road and Cranberry Highway would improve local traffic conditions with more direct access between neighborhoods and Market Basket, and regional drivers traveling to and from mid-Cape via Scenic Highway could bypass Belmont Circle, thereby reducing traffic at Belmont Circle.

Program Need	Evaluation of the Preferred Alternative
Improve accommodations for pedestrians and bicyclists.	**This need would be met.** Each crossing location would include one bidirectional pedestrian and bicycle shared-use path. **Additional operational benefits** would include substantially improved pedestrian and bicycle access adjacent to local roads, existing trail facilities, and at ramp terminals, resulting in an overall enhanced pedestrian/bicycle experience. For example, the preferred highway interchange network would provide grade separation for pedestrians and bicyclists over Scenic Highway, increase access and connectivity to neighborhoods through shared-use paths, and minimize the number of ramp/intersection crossings for pedestrians and bicyclists.

3.4.2 Preferred Alternative Design Parameters

The Preferred Alternative would replace Sagamore and Bourne Bridges with parallel, twin tied-arch bridge structures supported on delta frames with an approximate 700-foot mainline span length. The replacement bridges would maintain the existing vertical clearance of 135 feet above MHW and would provide a minimum of 500 feet of horizontal channel width consistent with the existing authorized navigational channel. The bridge piers would be located at the waterline adjacent to the Canal Service Roads, within the riprap slope but above the low tide line. At both Sagamore and Bourne Bridges, the replacement bridge mainline alignment location would be offline (outside of the footprint of the existing bridge) and inboard of the existing highway bridges on the side of the canal between the existing Bourne Bridge and Sagamore Bridge. The twin-deck structures would be approximately 10 feet apart and parallel to each other; each main span would include two through-traffic lanes, one auxiliary lane, and shoulders and barriers in compliance with current MassDOT and FHWA standards and guidelines for highway and bridge design. Each crossing location would include one bidirectional pedestrian and bicycle SUP, separated from vehicular traffic by the shoulder and barrier. Additionally, each crossing location would include reconfiguration of the highway interchange approach networks on both sides of Cape Cod Canal to align with the replacement bridges. **Figure 3-13** and **Figure 3-14** present two views of the replacement bridge based on preliminary design.

Table 3-19 summarizes the Program's Preferred Alternative, which is based on analyses of design parameters, as described in **Sections 3.3.2.1 through 3.3.2.6**. **Figure 3-15 through Figure 3-18** present the Preferred Alternatives by Program quadrant, based on preliminary design plans. For a more detailed plan view of the Preferred Alternative for each quadrant, refer to **Appendix 3.2, Proposed Conditions Plans**. Phase 1 of the Program—which would replace Sagamore Bridge, including the replacement of State Route 3 over U.S. Route 6—is listed in the Federal Fiscal Year 2025-2029 Transportation Improvement Program as Project S13144.[6]

[6] Project #S131144 was added to the Federal Fiscal Year 2025-2029 Transportation Improvement Program as Amendment #2, December 9, 2024.

Figure 3-13. Proposed Replacement Bridge: Cape Cod Canal Viewpoint



Source: Massachusetts Department of Transportation, 2024

Figure 3-14. Proposed Replacement Bridge: Driver Viewpoint



Source: Massachusetts Department of Transportation, 2024

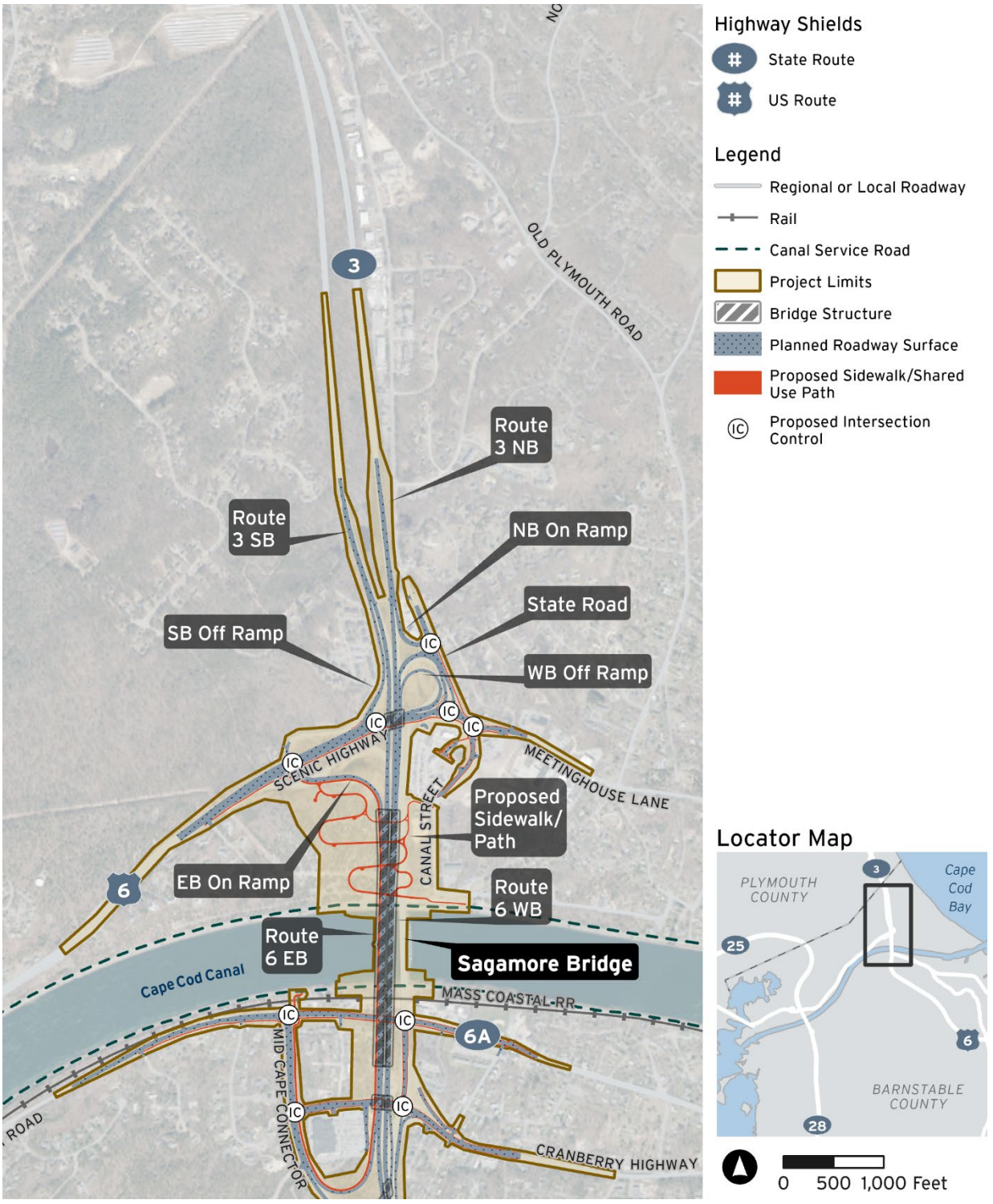
Table 3-19. Cape Cod Bridges Program Preferred Alternative

Program Element/ Program Design Parameter	Description of Program
Highway Bridges	Replacement of Both Highway Bridges with New Bridges with Four Through-Traffic Lanes and Two Auxiliary Lanes (In-Kind Bridge Replacement) (updated to comply with federal and state highway and design safety standards).
Highway Bridge Cross-Section and Shared-Use Path	Each replacement highway bridge would provide four 12-foot-wide through-travel lanes (two in each direction), two 12-foot-wide entrance/exit (auxiliary) lanes, a 4-foot-wide left shoulder, and a 10-foot-wide right shoulder. Right and left barriers would be offset an additional 2 feet beyond the limits of the shoulders. Each crossing location would include one bidirectional pedestrian and bicycle shared-use path, separated from vehicular traffic by the shoulder and barrier. The usable width of the shared-use path would be 14 feet wide on the bridge main spans, 20 feet wide on the interchange approaches, and 12 feet wide on the connecting roadways.
Bridge Vertical and Horizontal Clearances	The replacement bridges would maintain the existing vertical clearance of 135 feet above mean high water and account for 3 feet of future sea level rise, for a total vertical clearance of 138 feet above mean high water. The replacement bridges would provide a minimum of 500 feet of horizontal channel width consistent with the existing authorized navigational channel width.
Main Span Length and Bridge Pier Location	The replacement bridges would have a main span length of approximately 700 feet, which would locate the bridge piers at the waterline adjacent to the service road (shoreline piers) into the riprap slope but above the low tide line.
Bridge Deck Configuration	Each bridge (Sagamore and Bourne) would have two separate decks (twin structures).
Mainline Alignment	The mainline alignment locations at both bridges would be offline inboard. Both spans of the replacement highway bridges would be outside the footprint of the existing bridge, approximately 10 feet apart and parallel to each other, and on the side of Cape Cod Canal between the existing bridges. The replacement main spans at the Sagamore crossing would be west of existing Sagamore Bridge toward Buzzards Bay. The replacement main spans at the Bourne crossing would be east of existing Bourne Bridge toward Cape Cod Bay.
Bridge Type	The replacement bridges would be twin tied-arch bridges, with delta frames supporting an approximate 600-foot arch and 700-foot mainline span.

Program Element/ Program Design Parameter	Description of Program
Interchange Approach Network and Intersection Controls: Sagamore North Quadrant	The Sagamore North interchange approach network would be "Direct Connection to State Road (Option SN-8A)". The interchange approach network would provide a single exit point from a relocated U.S. Route 6/State Route 3. It would remove the Sagamore Bridge northbound off-ramp connection to Scenic Highway/Meetinghouse Lane eastbound and instead would connect to State Road, north of Scenic Highway/Meetinghouse Lane. The remaining ramp connections would remain similar to existing conditions. Signalized intersections along Scenic Highway and Meetinghouse Lane would be modified with two roundabouts to accommodate through-travel and turning movements. The intersection of State Road at State Route 3 northbound would be modified to accommodate the addition of the new State Route 3 northbound off-ramp with installation of a traffic signal. It would provide a SUP on the U.S. Route 6 eastbound main span that would provide connections to the south side of Scenic Highway, Canal Street, and Canal Service Road. SUPs would be provided along the southern side of Scenic Highway and Meetinghouse Lane and along the eastern side of State Road to Homestead Avenue.
Interchange Approach Network and Intersection Controls: Sagamore South Quadrant	The Sagamore South interchange approach network would be "Westbound On-Ramp Under U.S. Route 6 with Sandwich Road Extension (Option SS-3.1A)." The interchange approach network would include Cranberry Highway Extension and would relocate the westbound on-ramp, so it would share the same entrance point as the eastbound on-ramp off Mid-Cape Connector. It would remove the Cranberry Highway to Sagamore Bridge westbound ramp, and it would provide a new westbound on-ramp connection from Mid-Cape Connector to Sagamore Bridge westbound. Modifications to lane arrangements at the intersections of Mid-Cape Connector with Sandwich Road and Cranberry Highway Extension would accommodate the revised traffic patterns resulting from the extension of Cranberry Highway and relocation of access to U.S. Route 6 eastbound, including modifications to the existing traffic signals. There would be a connection from Cranberry Highway Extension to Sandwich Road east of the new mainline bridge structure (Sandwich Road Extension). A single lane roundabout would be the intersection control at this location. Additionally, west of the new mainline bridge, a single lane roundabout would be provided at the eastern-bound entrance of the existing Market Basket parking lot. Additional improvements would include modified access to Market Basket (Factory Outlet Road) and an access driveway to the former Christmas Tree Shops area. It would provide a SUP on the U.S. Route 6 eastbound main span that would provide connections to Factory Outlet Road, Sandwich Road, and the Canal Service Road. Bicycle and pedestrian improvements would be included on Cranberry Highway. A new connection would be added through Cranberry Highway Extension to Mid-Cape Connector.

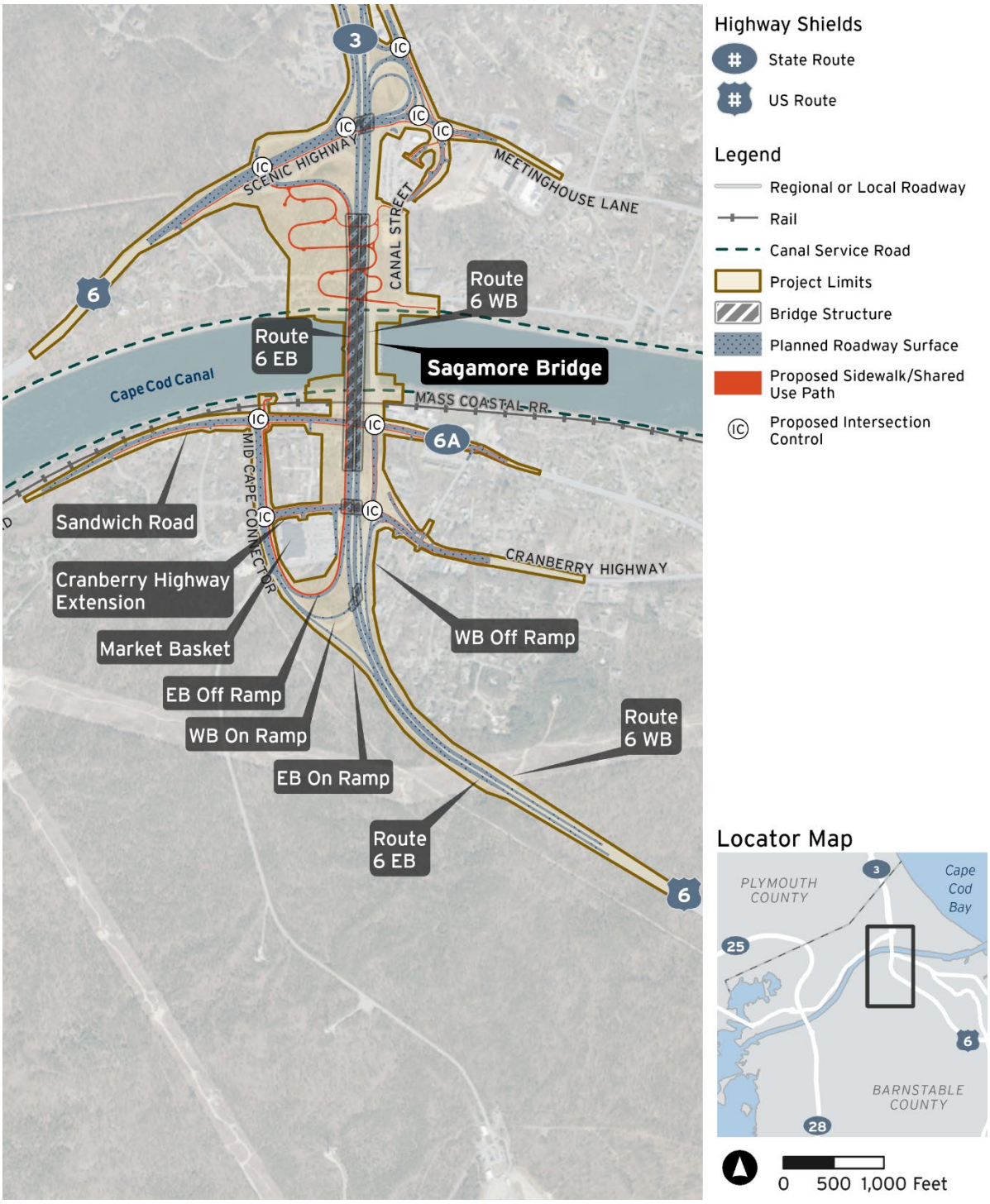
Program Element/ Program Design Parameter	Description of Program
Interchange Approach Network and Intersection Controls: Bourne North Quadrant	The Bourne North interchange approach would be "Directional Interchange (Option BN-14.4b)." The interchange approach would provide a combination of direct connection ramps between State Route 25 and U.S. Route 6. The ramp connecting State Route 25 eastbound to Scenic Highway would be a direct connect ramp, allowing access to Scenic Highway eastbound only. The new flyover ramp connecting Scenic Highway to State Route 25 would allow vehicles to bypass Belmont Circle and would not require an additional traffic signal. This ramp would utilize one of the travel lanes on Scenic Highway and would be a free-flowing movement to reduce congestion. The existing State Route 28 over the State Route 25 bridge would be relocated to widen the bridge to allow for this new southbound to eastbound ramp movement. The existing southbound off-ramp would be revised to be an option lane, improving the geometry and decision sight distance for drivers. The intersection control at U.S. Route 6/Nightingale Road/Andy Oliva Drive would be a single-lane roundabout. It would provide a SUP and a grade-separated crossing for pedestrians and bicyclists via the new flyover ramp over Scenic Highway. The U.S. Route 6 lane configuration would be reduced from four lanes to three lanes, which would provide additional space for multimodal accommodations. It would provide one continuous 12-foot-wide SUP along the south side of U.S. Route 6 connecting to Belmont Circle and a 6-foot-wide sidewalk along the north side of U.S. Route 6.
Interchange Approach Network and Intersection Controls: Bourne South Quadrant	The Bourne South interchange approach network would be "Diamond Interchange (Option BS-2)." It would eliminate Bourne Rotary and replace it with a grade-separated diamond interchange, allowing through movements on State Route 28 to bypass the intersections with the non-mainline roadways. Both intersections within the diamond interchange would require a roundabout for intersection control (a single-lane dogbone-shaped roundabout). Changes to the Trowbridge Road and Sandwich Road underpass in this option would consist of a multi-lane roundabout at a relocated Upper Cape Cod Regional Technical High School Driveway entrance. It would provide SUP connections to Trowbridge Road, the Cape Cod Canal Service Road, and the Bourne Recreation Area.

Figure 3-15. Option SN-8A: Direct Connection to State Road (Sagamore North Quadrant)



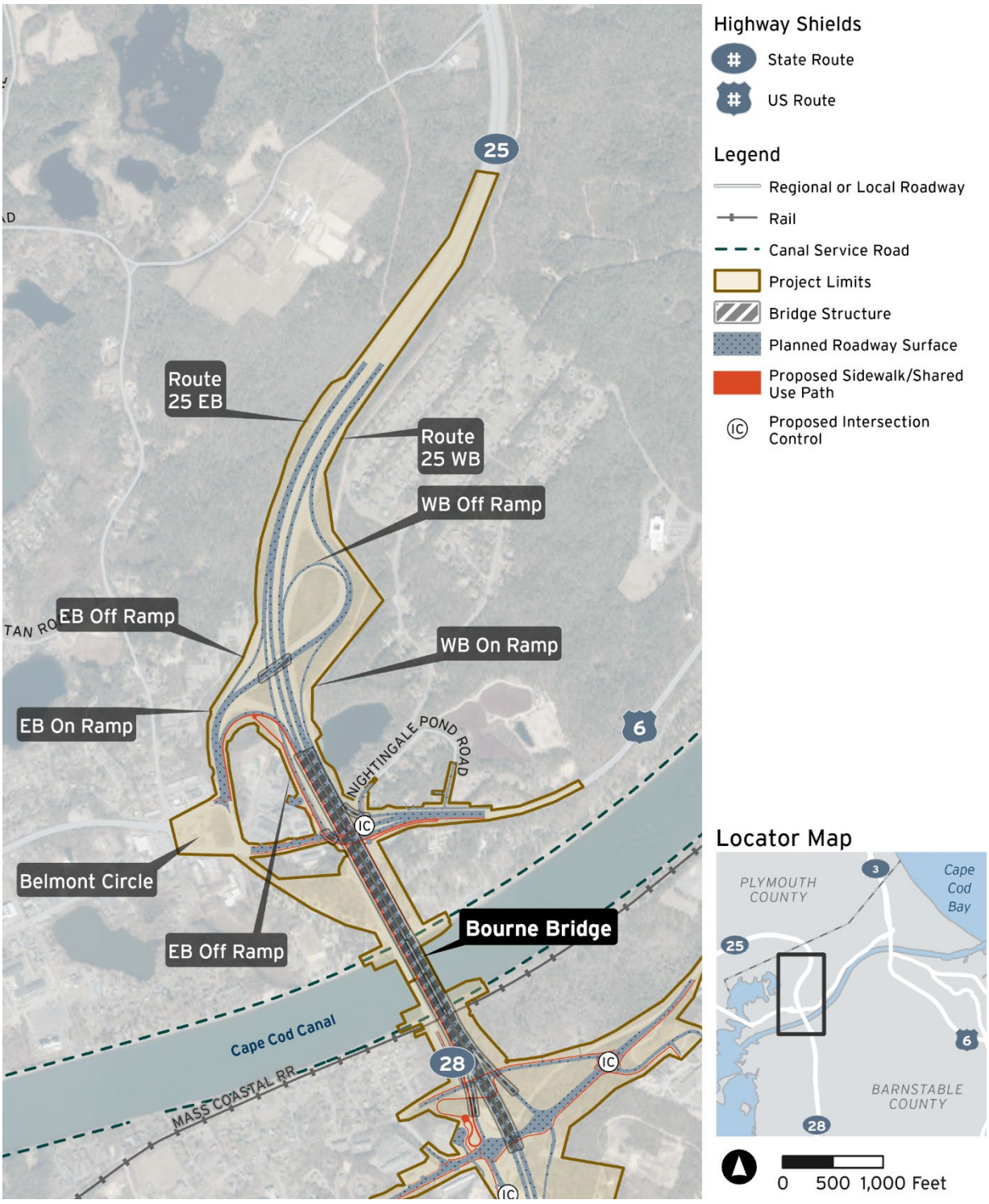
Source: Massachusetts Department of Transportation, 2024

Figure 3-16. Option SS-3.1A: Westbound On-Ramp under U.S. Route 6 with Cranberry Highway Extension and Sandwich Road Connector (Sagamore South Quadrant)



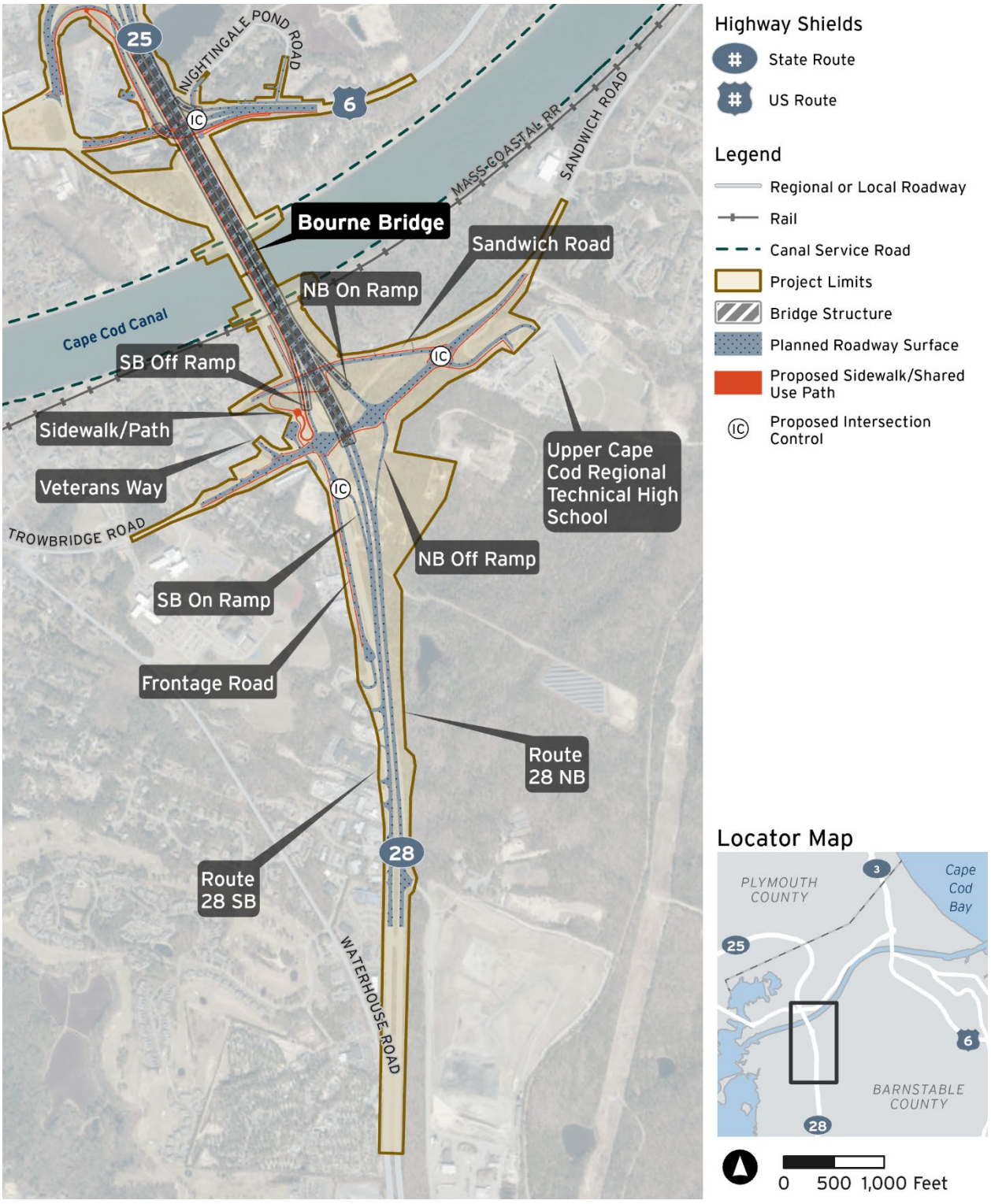
Source: Massachusetts Department of Transportation, 2024

Figure 3-17. Option BN-14.4b: Directional Interchange (Bourne North Quadrant)



Source: Massachusetts Department of Transportation, 2024

Figure 3-18. Option BS-2: Diamond Interchange (Bourne South Quadrant)



Source: Massachusetts Department of Transportation, 2024

3.5 Construction of the Proposed Action

3.5.1 Construction Method

MassDOT proposes to use a "best value" design-build (D-B) procurement method for the construction of the Program, pursuant to Chapter 149A of Massachusetts General Law. A D-B process is a construction delivery system that combines design and construction services within a single contract. A "best value" method is one that provides the highest overall value to MassDOT, considering both cost and quality.[7]

MassDOT proposes to use a Best Value design-build construction method to accelerate project delivery, control costs and schedule, promote innovation, and reduce overall risk.

The D-B construction method can "fast-track" the overall construction process. By awarding one contract under the D-B procurement method, there is no bidding phase, or delay, between the final design and construction phases that is typical of the more traditional design-bid-build approach. In addition to accelerating project delivery by integrating the design and construction phases, the D-B method can result in the following:

- Greater cost and schedule control
- Innovative design and construction methodologies through close collaboration between the designer and contractor
- Reduced overall project risk

Under the D-B procurement method, MassDOT's advertised construction contract will provide the Base Technical Concept, defined as approximately 25% level of design, to establish the minimum baseline requirements the D-B team must equal or exceed. Additionally, MassDOT will secure all necessary environmental approvals and clearances based on the Program's Base Technical Concept.

MassDOT will define the Build Alternative to a Base Technical Concept—defined as 25% design—to establish the minimum baseline requirements for the design-build team.

The awarded D-B team will complete final design and construct the Program in compliance with regulatory permits and approvals, and within the timeframe of the Program schedule, as well as in accordance with the Project Management Plan, Quality Management Plan, Site Control Plan, Construction Staging Plan, Noise and Dust Control Plans, Health and Safety Plan, and all other applicable laws, regulations, ordinances, and other requirements, taking into account right-of-way and other physical constraints affecting the

[7] Per Section 15 of Massachusetts General Law Chapter 149A, quality is defined as the basis on which the Massachusetts Department of Transportation will evaluate the elements of the project that it has determined are most important to a project. For example, these could include quality of design, innovative approach, constructability, life-cycle and other long-term maintenance costs, maintenance-of-traffic, aesthetics, environmental impacts, local impacts, traveler and other user costs, service life, and time to construct.

Program. Refer to **Chapter 5, Construction Approach**, for information on the D-B construction method for the Program.

3.5.2 Construction Schedule and Estimated Construction Costs

3.5.2.1 Schedule

Pending the completion of National Environmental Policy Act/Massachusetts Environmental Policy Act environmental reviews and receipt of federal and state permits and approvals, anticipated in spring 2026, MassDOT proposes to initiate the Program's design-build procurement and construction process in fall 2026. Construction activities for replacement Sagamore and Bourne Bridges are expected to occur over eight to ten years, respectively. Construction of the replacement Sagamore Bridge would begin first, followed by the replacement Bourne Bridge once funding is secured. Bourne Bridge construction would commence one year following commencement of Sagamore Bridge construction. However, timing of construction sequencing depends on funding.

3.5.2.2 Estimated Construction Costs

In May 2023, MassDOT conducted a Cost and Schedule Risk Assessment workshop for the Program, in coordination with the FHWA. The workshop produced a risk-based cost estimate distribution based on inputs from MassDOT's Program Risk Register and output from FHWA's Monte Carlo simulation program. The estimated construction costs—including replacement of the bridge and interchange improvements, right-of-way, utilities, preliminary engineering, and escalation and contingencies—are $2.14 billion for Sagamore Bridge and $2.4 billion for Bourne Bridge. The Program's total estimated construction cost is $4.54 billion. The Sagamore Bridge project will be funded with $1.37 billion from federal grants, $350 million from the USACE, and approximately $430 million from the Commonwealth of Massachusetts. MassDOT and the USACE are actively identifying funding for the Bourne Bridge project.

3.5.3 Overview of Construction Approach

This section provides an overview of the construction approach based on preliminary design. MassDOT evaluated construction scenarios in consultation with a construction specialist. MassDOT expects to contract the Program as a D-B; however, the D-B team could propose different construction means and methods. **Chapter 5, Construction Approach**, provides details on the construction approach, including descriptions of land- and water-based construction activities and conceptual construction plans.

Figure 3-19 presents a simplified schematic of the Program's bridge construction phasing approach, illustrating four key milestones. The replacement bridges would be constructed offline (outside of the existing footprint) and a maximum of 250 feet inboard of the existing highway bridges. Sagamore Bridge would be replaced first, followed by Bourne Bridge. At each site, the inboard main span (inboard bridge) would be constructed first. At the Sagamore Bridge site, this would be the westernmost bridge, which would ultimately carry traffic onto Cape Cod. For the Bourne Bridge site, this would be the easternmost bridge, which would ultimately carry traffic off Cape Cod. After

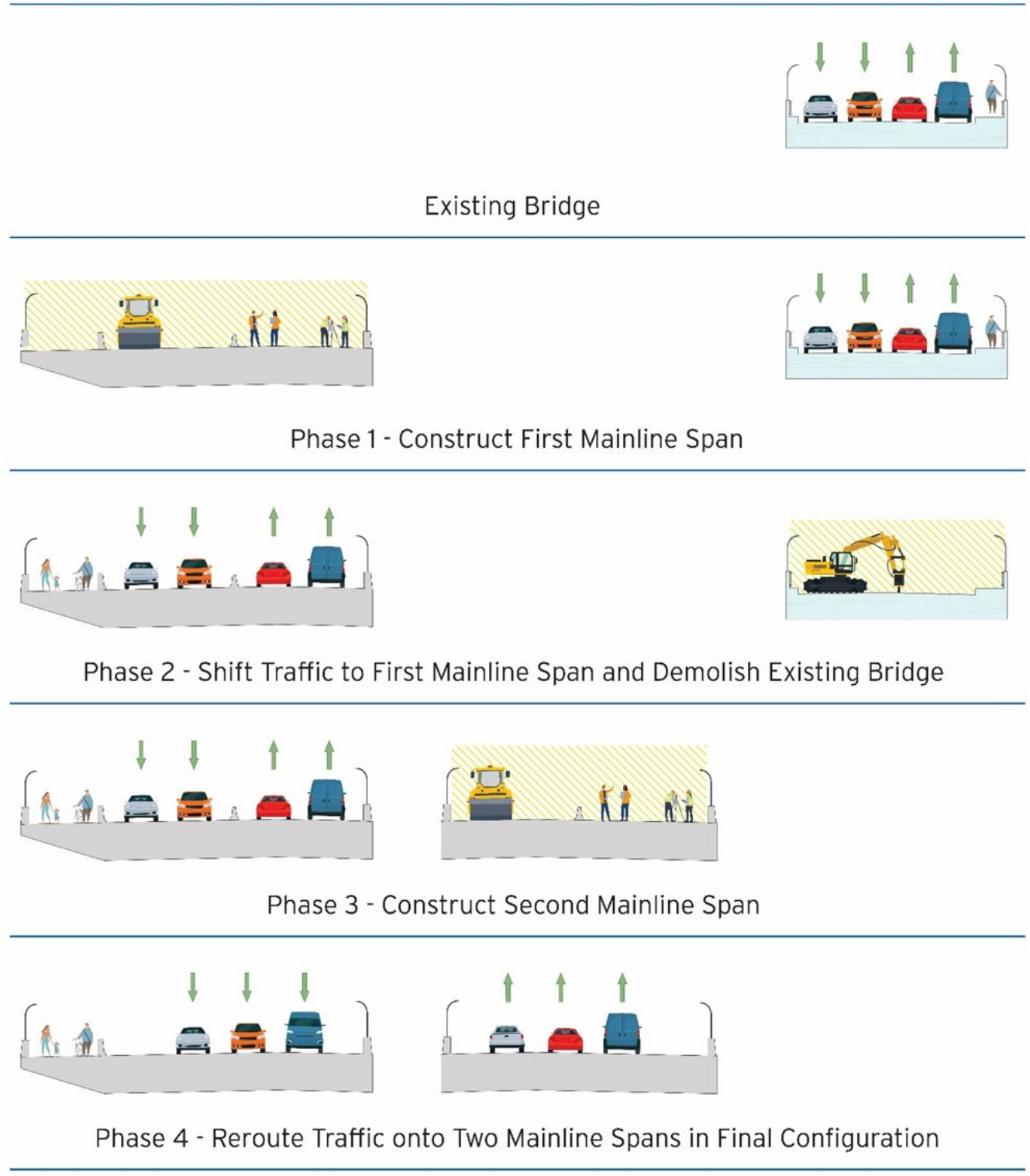
construction of the first new span, all traffic would be shifted onto it so the existing bridge could be demolished, and the second main span (bridge) could be constructed.

Section 4.2, Transportation, Traffic, and Safety further describes the Program's construction staging and sequencing. The Program's construction sequencing approach is a critical element of the highway bridges, interchanges, and surrounding local roadway network's design. The construction sequencing goals for the Program include the following:

- Remove traffic from the existing bridge as quickly as possible.
- Maintain existing roadway and ramp connections through the construction duration.
- Avoid the need for construction detours.
- Reduce or minimize traffic shifts.
- Maintain pedestrian and bicycle connectivity access equal to or better than existing conditions through the construction duration.

Chapter 5, Construction Approach, provides summaries of the interchange approach network construction phases in the four Program quadrants.

Figure 3-19. Proposed Bridge Construction Sequencing Approach



Source:Massachusetts Department of Transportation, 2024

4 Existing Conditions, Program Impacts, and Mitigation

4.1 Introduction

This chapter describes the existing social, economic and environmental conditions that may be affected by the alternatives retained for detailed study in this Draft Environmental Impact Report. It also presents the expected beneficial and adverse social, economic, and environmental impacts of the alternatives, including measures to avoid, minimize, and mitigate adverse impacts, where applicable.

The analysis in this chapter covers a range of environmental resources and topics, as listed in **Table 4.1-1**. Each section identifies a resource-specific study area or study areas to define the geographic extents of the assessment. As applicable, sections of this chapter reference technical reports that present additional details on the methodologies, analyses, and findings related to the subject matter.

Table 4.1-1. Environmental Resources and Topics Assessed in Chapter 4

Chapter Section	Environmental Resources and Topics
4.2	Transportation, Traffic, and Safety
4.3	Pedestrian and Bicycle Facilities
4.4	Maritime Transportation, Traffic, and Safety
4.5	Socioeconomics
4.6	Land Use, Zoning, and Community Cohesion
4.7	Community Facilities
4.8	Property Acquisition, Displacement, and Relocation
4.9	Environmental Justice
4.10	Wetlands and Floodplains
4.11	Water Quality and Stormwater
4.12	Threatened, Endangered, and Protected Species and Habitats
4.13	Coastal Zone Consistency and Chapter 91 Waterways Review
4.14	Air Quality and Greenhouse Gas Emissions
4.15	Noise and Vibration
4.16	Visual Resources
4.17	Cultural Resources
4.18	Public Parks, Recreational Facilities, and Open Space
4.19	Solid and Hazardous Waste Material Management
4.20	Utilities and Services
4.21	Public Health
4.22	Climate Change Adaptation and Resiliency
4.23	Indirect and Cumulative Impacts

4 Existing Conditions, Program Impacts, and Mitigation

4.2 Transportation, Traffic, and Safety

4.2.1 Introduction

This section assesses the potential impacts of the No Build and Build Alternatives on the following:

- Highway-traffic operations and safety
- Freight and public bus transit operations
- Commuter parking
- Rail facilities

This section also discusses existing emergency response travel and emergency evacuation routes, including the effects of the No Build and Build Alternatives on public safety and security. It also discusses proposed construction sequencing for the Build Alternative, in addition to assessing the potential for the Build Alternative to induce travel demand.

4.2.1.1 Methodology

Traffic Operations Methodology

- The collection of traffic counts between 2020 and 2022 was restricted because travel patterns shifted during the COVID-19 pandemic. Therefore, the Massachusetts Department of Transportation (MassDOT) developed a travel demand model using 2014 count data, 2019 count data at select locations, and INRIX Origin-Destination data. Spring and summer 2024 traffic counts were also collected to confirm volume patterns have not changed significantly from the previous data.
- The UMass Donohue Institute prepared a travel demand model for the 2050 design year for MassDOT's Office of Transportation Planning based on demographic projections (population, households, and employment) for the Cape Cod communities and future growth projections specific to visitor trips. This demand model was used to develop the traffic volume projections for the 2050 No Build Alternative and 2050 Build Alternative.

- MassDOT analyzed traffic operations using the following software applications in accordance with applicable Highway Capacity Manual standards,[1] and Federal Highway Administration (FHWA) standards:[2]
  - Synchro: analysis software used to analyze unsignalized and signalized intersections along the local and arterial roadways.
  - Sidra: analysis software used to analyze traffic circles along the local and arterial roadways.
  - Highway Capacity Software: analysis software used to analyze multilane freeway segments, weaving segments, and merge/diverge segments.
  - VISSIM: microsimulation software used to analyze the entire roadway network, including roadways of differing functional classifications.
    - Travel times along critical origin-destination (O-D) routes were estimated for the 2050 No Build Alternative and Build Alternative.
- MassDOT chose the Fall Weekday PM period as the design period in which to evaluate traffic operations. Through a review of the permanent count stations on the bridges, it was determined that the Fall Weekday PM period represents the 85th percentile traffic volumes. This means that 85% of the year, traffic volumes within the Study Area (as defined in **Section 4.2.1.2**) are equal to or lower than the Fall Weekday PM period. It is standard practice to use this method to determine the design period.

Traffic Safety Methodology

- MassDOT compiled and summarized existing crash data based on crash reports provided by MassDOT for the period between January 1, 2017, and December 31, 2019.
- Crash rates for roadway segments are determined based on the number of crashes per million vehicle miles traveled, and crash rates for intersections are determined based on the number of crashes per million entering vehicles. MassDOT's website publishes average crash rates within the state for intersections by control type and roadway functional classification.[3]
- MassDOT used crash modification factors (CMF)[4] to assess the safety on the bridges based on proposed improvements and referenced CMFs for select improvements from the Crash Modification Factor Clearinghouse website that is maintained by the FHWA.[5] The CMFs were used

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[1] National Academies of Sciences, Engineering, and Medicine. 2016. Highway Capacity Manual 6th Edition: A Guide for Multimodal Mobility Analysis. https://doi.org/10.17226/24798

[2] Federal Highway Administration. 2019. Traffic Analysis Toolbox Volume III: Guidelines for Applying Traffic Microsimulation Modeling Software. https://ops.fhwa.dot.gov/publications/fhwahop18036/index.htm

[3] Massachusetts Department of Transportation. 2023. Crash Rates by Roadway Functional Classification. https://www.mass.gov/info-details/intersection-and-roadway-crash-rate-data-for-analysis#intersection-crash-rates-

[4] A crash modification factor is a multiplicative factor used to compute the expected number of crashes after implementing a given countermeasure at a specific site.

[5] https://cmfclearinghouse.fhwa.dot.gov/

to determine relative impact, positive or negative, with respect to safety and were not applied to predicted, expected or observed crash data.

4.2.1.2 Study Area

For the purposes of conducting a detailed traffic operations and safety evaluation, the Study Area consists of the major roadways, interchanges, and intersections approximately within a 2-mile area centered around Sagamore Bridge and Bourne Bridge (**Figure 4.2-1**).

MassDOT also conducted limited traffic operations analysis along additional roadways, interchanges, and intersections beyond the limits indicated in **Figure 4.2-1**. Refer to **Appendix 4.2, Traffic Engineering Technical Report**, for more information on the traffic operations analysis conducted at these locations.

4.2.2 Existing Conditions

Sagamore Bridge and Bourne Bridge provide the only roadway access points to and from Cape Cod. Both bridges provide two 10-foot-wide travel lanes per direction with speed limits of 40 miles per hour. Traffic volumes and congestion levels in the vicinity of Cape Cod Canal are typically highest during the summer when more visitors travel to Cape Cod and the islands of Martha's Vineyard and Nantucket. **Table 4.2-1** lists the Average Annual Daily Traffic (AADT) for the bridges in 2019.

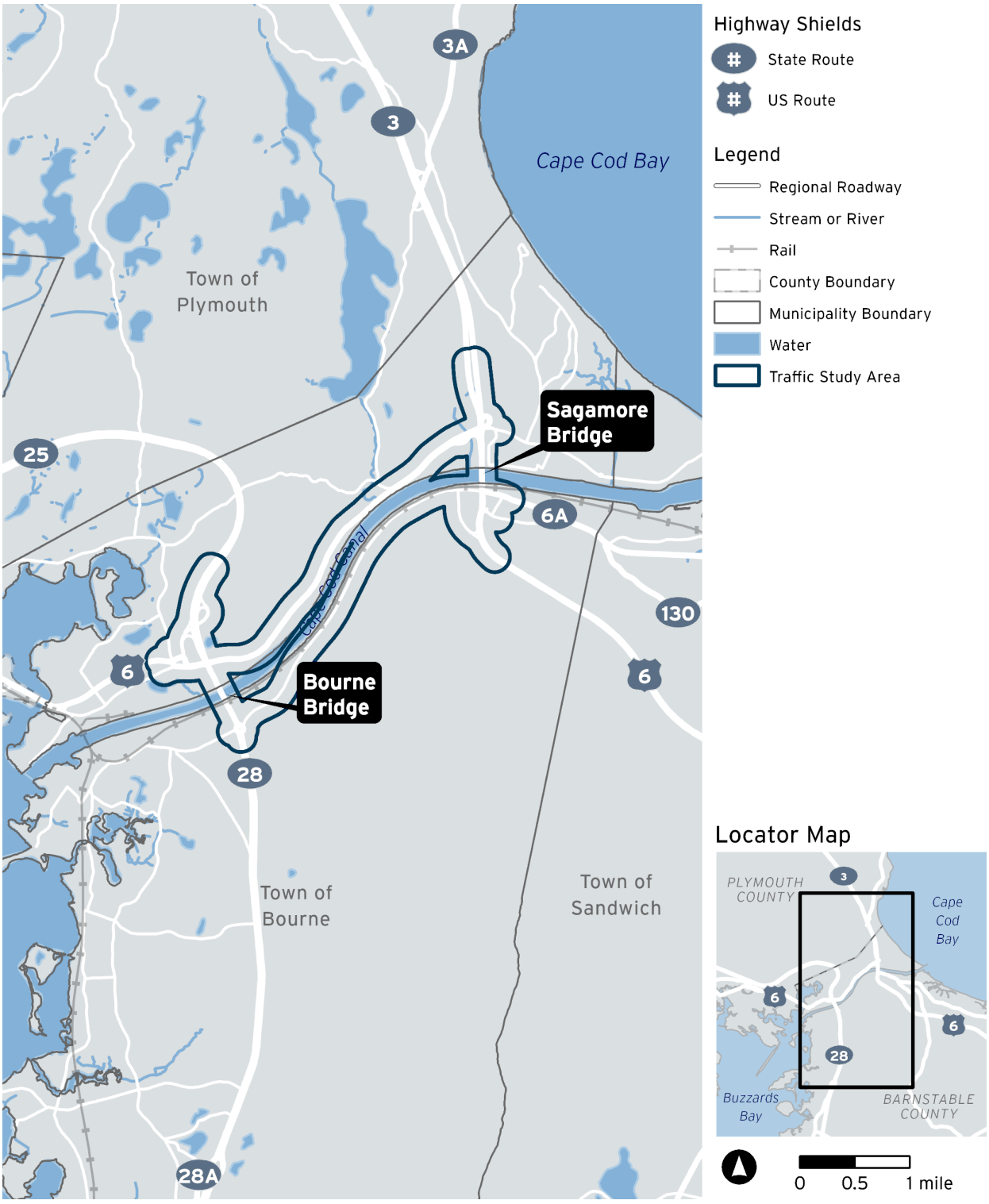
Table 4.2-1. Average Annual Daily Traffic on Sagamore and Bourne Bridges, 2019

Direction	Sagamore Bridge	Bourne Bridge
Northbound	33,120	21,520
Southbound	28,870	24,980
Total	**61,990**	**46,500**

4.2.2.1 Vehicular Traffic Operations

Sagamore Bridge is accessed from points north via State Route 3/Pilgrims Highway and from points on Cape Cod via U.S. Route 6. In the southbound (SB) direction, State Route 3 carries two travel lanes toward Sagamore Bridge and narrows to a single lane as State Route 3 approaches the bridge. The single lane from State Route 3 is joined by an add-lane from the entrance ramp from Scenic Highway (U.S. Route 6) to form the two lanes that are carried over the bridge. Congestion stemming from the steep grade and the narrow lanes on the bridge and the lane reduction on State Route 3 cause queues to extend approximately 2 miles from the bridge during the Fall Weekday PM peak hour (identified as 4 p.m. to 5 p.m.). In the northbound (NB)/westbound (WB) direction, U.S. Route 6 carries two travel lanes toward Sagamore Bridge. A heavy merge from the entrance ramp from Cranberry Highway immediately upstream of the bridge causes traffic on U.S. Route 6 to slow, creating congestion approaching Sagamore Bridge.

Figure 4.2-1. Traffic Study Area



Source: Massachusetts Department of Transportation, 2024

Bourne Bridge is accessed from points north and west via State Route 25, which carries three travel lanes per direction, but narrows to two travel lanes approaching the bridge. Heavy traffic volumes exiting to Belmont Circle and merging from the entrance ramp from Belmont Circle combined with steep inclines on the bridge itself cause congestion on the bridge approach in most peak hours. State Route 25 eastbound (EB) terminates immediately south of Bourne Bridge at Bourne Rotary, which is another source of congestion during peak hours. Difficulty merging into the rotary causes queueing on State Route 25 to extend for several miles during some peak hours. Limited capacity and heavy traffic volumes on the Bourne Rotary also cause queueing to extend onto its other approaches from State Route 28 NB, Sandwich Road WB, and Trowbridge Road EB. Queueing on State Route 28 NB often extends approximately 2 miles during the Fall Weekday PM peak hour (identified as 4 p.m. to 5 p.m.).

Because the bridges are only approximately 3.5 miles apart, drivers traveling regionally via State Route 3 and U.S. Route 6 or State Routes 25 and 28 often use the bridges interchangeably based on congestion levels. Drivers use Scenic Highway and Sandwich Road to reach the other bridge if navigational apps and dynamic message signage along the highways indicate lesser congestion on one of the two bridges during peak hours. Scenic Highway generally carries two lanes of east-west traffic per direction and connects Bourne Bridge with Sagamore Bridge on the north side of the canal. Sandwich Road generally carries one lane of east-west traffic per direction connecting the bridges on the south side of the canal.

Appendix 4.2, Traffic Engineering Technical Report, includes 2019 Existing Conditions traffic analysis including Level of Service for all Study Area intersections and roadways.

MassDOT prepared a VISSIM microsimulation model for the Fall Weekday PM peak hour to understand traffic operations on a network-wide basis. **Table 4.2-2** provides a summary of the 2019 Existing Conditions VISSIM model results for the Fall Weekday PM peak hour. Processed volumes are the number of vehicles that enter the model network that can complete their route within the hour-long simulation run. The network travel times are the summation of the travel times for all vehicles within the network.

Table 4.2-2. 2019 Existing Conditions VISSIM Model Network Results

Metric	Fall Weekday PM Peak
Processed Volumes	10,705
Network Travel Times (vehicle-hours traveled)	2,397

Appendix 4.2, Traffic Engineering Technical Report, includes a detailed summary of the 2019 Existing Conditions VISSIM analysis.

4.2.2.2 Freight Operations, Public Bus Transit, and Parking Facilities

As the only roadway access points between mainland Massachusetts and Cape Cod, Sagamore and Bourne Bridges and their adjoining highways—including State Route 3 and U.S. Route 6 at Sagamore Bridge, and State Route 25 and State Route 28 at Bourne Bridge—are critical arteries for intrastate and interstate freight-truck transportation. The bridges also provide essential routes for freight-truck trips

to and from the islands of Martha's Vineyard and Nantucket via ferry connections at the Woods Hole and Hyannis Harbor terminals on the south shore of Cape Cod.

According to MassDOT traffic count data in 2019, nearly 6,000 trucks crossed the bridges on an average weekday, accounting for approximately 5.4% of all bridge traffic. Because Cape Cod Canal splits the towns of Bourne and Sandwich into Cape Cod and mainland sections, the bridges provide essential school bus transportation links for students living and commuting to school on either side of the canal. According to the Cape Cod Commission, the bridges provide access for 122 daily school bus crossings of Cape Cod Canal.[6]

The Cape Cod Regional Transit Authority (CCRTA) serves as the primary provider of public transportation within the Study Area and Barnstable County. The CCRTA's year-round fixed public transit services operating within the Study Area includes Bourne Run and Sandwich Line. Bourne Run travels between Mashpee Commons and the Buzzards Bay Train Station, via Scenic Highway, County Road, State Route 28A, and State Route 151 (**Figure 4.2-2**). The Sandwich Line travels between the Hyannis Transportation Center in downtown Hyannis, through Sandwich, to the Buzzards Bay Train Station (**Figure 4.2-3**).

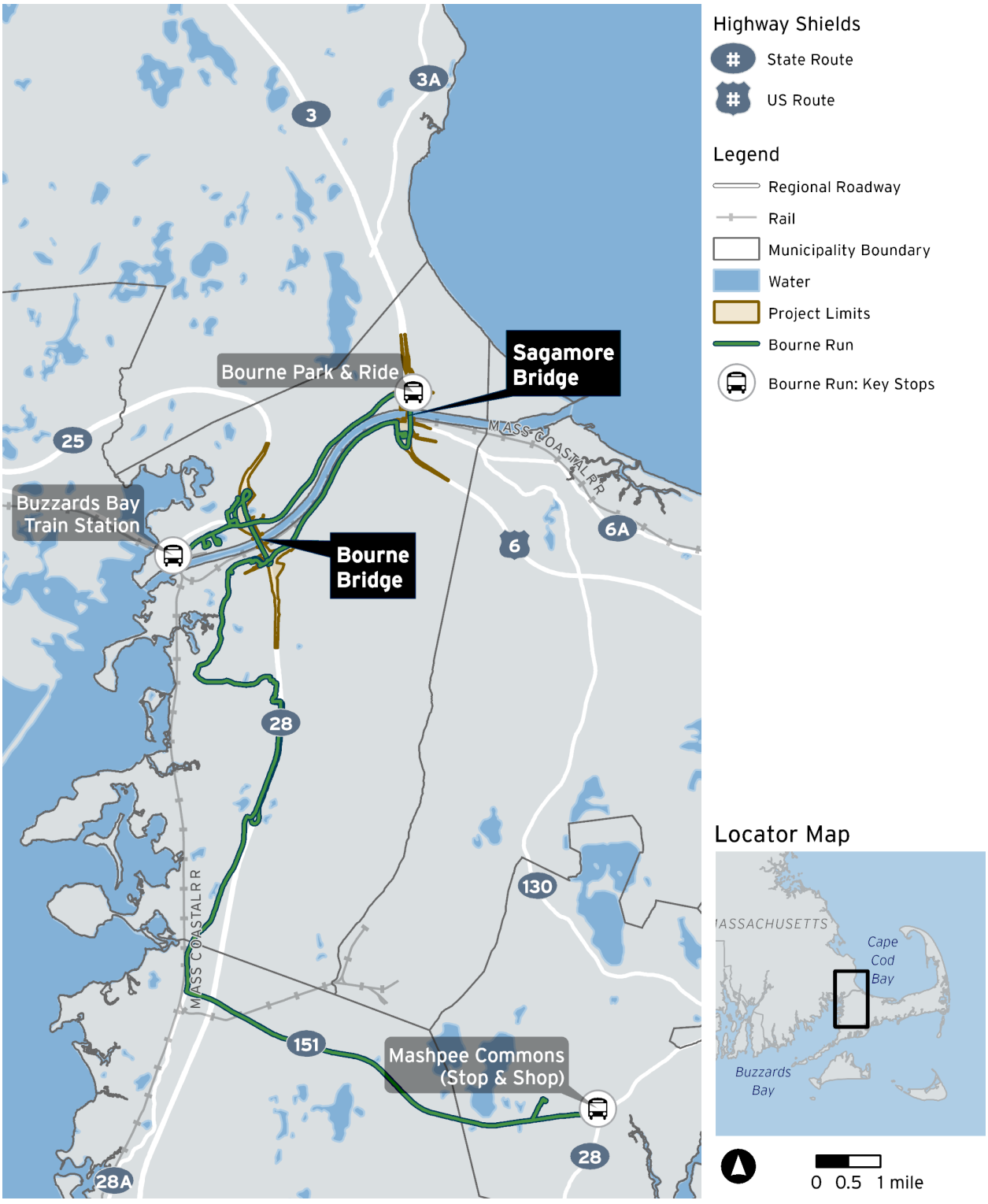
As discussed in **Chapter 2, Purpose and Need**, Sagamore and Bourne Bridges feature the following geometric constraints that affect the speed and efficiency of freight-truck and bus transit operations across Cape Cod Canal:

- Narrow travel lanes
- Lack of shoulders and physical separation between opposing traffic lanes
- Long steep grades of up to 6%

The mainline highway approaches to the bridges and their interchanges also feature geometric constraints that impede efficient freight-truck and bus transit operations. In the Sagamore North Study Area quadrant, the lane drop along State Route 3 SB approaching Sagamore Bridge causes recurring congestion and reduced vehicle speeds. In the Sagamore South Study Area quadrant, the geometry of U.S. Route 6 Exit 55 WB at Cranberry Highway features short acceleration and deceleration lanes, as well as steep grades approaching Sagamore Bridge, which do not allow vehicles—particularly heavy-duty trucks and buses—to gain adequate speed to merge into traffic or to slow down and exit the mainline travel lane. Belmont Circle (in the Bourne North Study Area quadrant) and Bourne Rotary (in the Bourne South Study Area quadrant) are also major bottlenecks for freight-truck and bus transit traffic due to high traffic volumes and cross mixing of local and regional traffic.

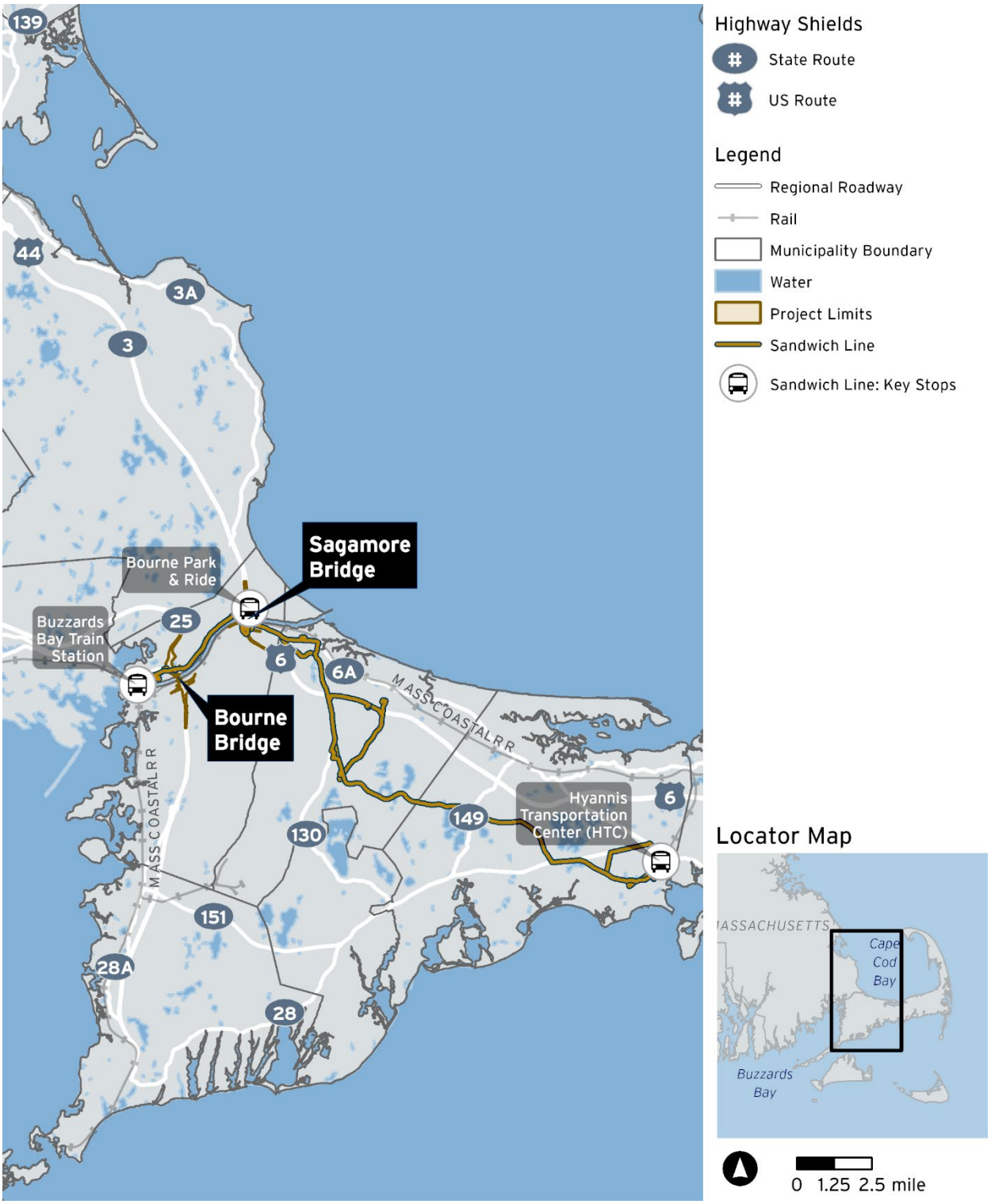
[6] Cape Cod Commission. 2024. 2024 Cape Cod Comprehensive Economic Development Strategy. May 15 (Draft). https://www.capecodcommission.org/resource-library/file?url=/dept/commission/team/Website_Resources/economicdevelopment/CEDS/2024/2024_CapeCodCEDS_Draft.pdf. The Cape Cod Commission met June 13, 2024, and voted to approve the 2024 CEDS.

Figure 4.2-2. Bourne Run (Cape Cod Regional Transit Authority)



Source: Massachusetts Department of Transportation, 2024

Figure 4.2-3. Sandwich Line (Cape Cod Regional Transit Authority)



Source: Massachusetts Department of Transportation, 2024

The Bourne Park and Ride Lot, located north of Cape Cod Canal in the southeast quadrant of the State Route 3/U.S. Route 6 (Scenic Highway) interchange in Bourne, is the only commuter parking facility in the Study Area (**Exhibit 4.2-1**). This lot, which is owned by MassDOT, allows commuters to park their individual vehicles and then transfer to high-occupancy modes of transportation (such as buses, vanpools, or carpools) to complete their commute. The Bourne Park and Ride Lot is serviced by the privately owned Plymouth & Brockton Bus Company, which offers daily bus trips from Woods Hole and Hyannis to downtown Boston and Logan Airport via Sagamore Bridge.

Exhibit 4.2-1. Aerial View of Bourne Park and Ride Lot, facing north, August 2024



In 2009, parking capacity at Bourne Park and Ride Lot was increased from 377 parking spaces to 396 parking spaces. According to data collected by the Cape Cod Commission at various samples during peak travel summer months from 2009 to 2019, the maximum lot utilization was 96% of available spaces, while the average annual lot utilization was 73% of available spaces.[7] Based on more recent data collected by the Cape Cod Commission during the peak travel summer months from 2021 to 2022, the lot was observed at maximum capacity in 2021, and below 60% capacity in 2022.[8]

4.2.2.3 Traffic Safety Analysis

As noted in **Chapter 2, Purpose and Need**, Sagamore Bridge and Bourne Bridge experienced significantly higher crash rates than the MassDOT average crash rate for similar facilities (Principal Arterial-Other Freeway and Expressway) during the most recently studied period between January 1, 2017, and December 31, 2019. **Table 4.2-3** summarizes the number of crashes reported on each bridge as well as the interchanges and local roadways in each Study Area quadrant.

Approximately 40% of the crashes on Sagamore Bridge and Bourne Bridge were reported as rear-end type collisions, which can be attributed to congestion. Approximately 60% of the crashes were reported to be either sideswipe, head-on, or single-vehicle crashes. These types of crashes can be attributed to the narrow 10-foot lanes, lack of shoulders, and lack of median separation between the directions of travel. Road Safety Audits (RSA) were not performed on Sagamore and Bourne Bridges as

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[7] Cape Cod Commission. 2018. Cape Cod Commission Traffic Counting Report 2018 (Counts Conducted 2009-2019), Appendix F: Park and Ride Lot Counts. https://capecodcommission.org/resource-library/file/?url=/dept/commission/team/Website_Resources/transportation/counts/pdf_count/PNR.pdf

[8] Cape Cod Commission. 2023. 2024 Regional Transportation Plan, Technical Appendix G: Congestion Management Plan. July. https://capecodcommission.org/resource-library/file?url=/dept/commission/team/tr/Transportation%20Plans/RTP/2024_RTP/Report/FINAL%20PDF/RTP%20Appendix%20G%20-%20Congestion%20Management%20Plan.pdf

they do not fall within the top 5% of crash locations within the Cape Cod Commission's planning region. However, historical crash data was reviewed and analyzed to better understand the issues and safety needs within the Study Area.

Table 4.2-3. Crash Summary, 2017-2019

Bridge/Study Area Quadrant	2017	2018	2019	Total
Sagamore Bridge	13	24	19	**56**
Sagamore North quadrant	49	37	35	**121**
Sagamore South quadrant	33	37	32	**102**
Bourne Bridge	15	21	9	**45**
Bourne North quadrant	64	88	86	**238**
Bourne South quadrant	177	199	253	**629**

MassDOT performed several RSAs at intersections and roadways within the Study Area to identify potential safety issues and possible safety improvement opportunities, including Scenic Highway, Sandwich Road, and Cranberry Highway **Figure 4.2-4** depicts a map of the locations within the Study Area where RSAs were conducted. **Appendix 4.2, Traffic Engineering Technical Report**, includes the RSA reports that document the existing issues and potential solutions.

4.2.2.4 Rail

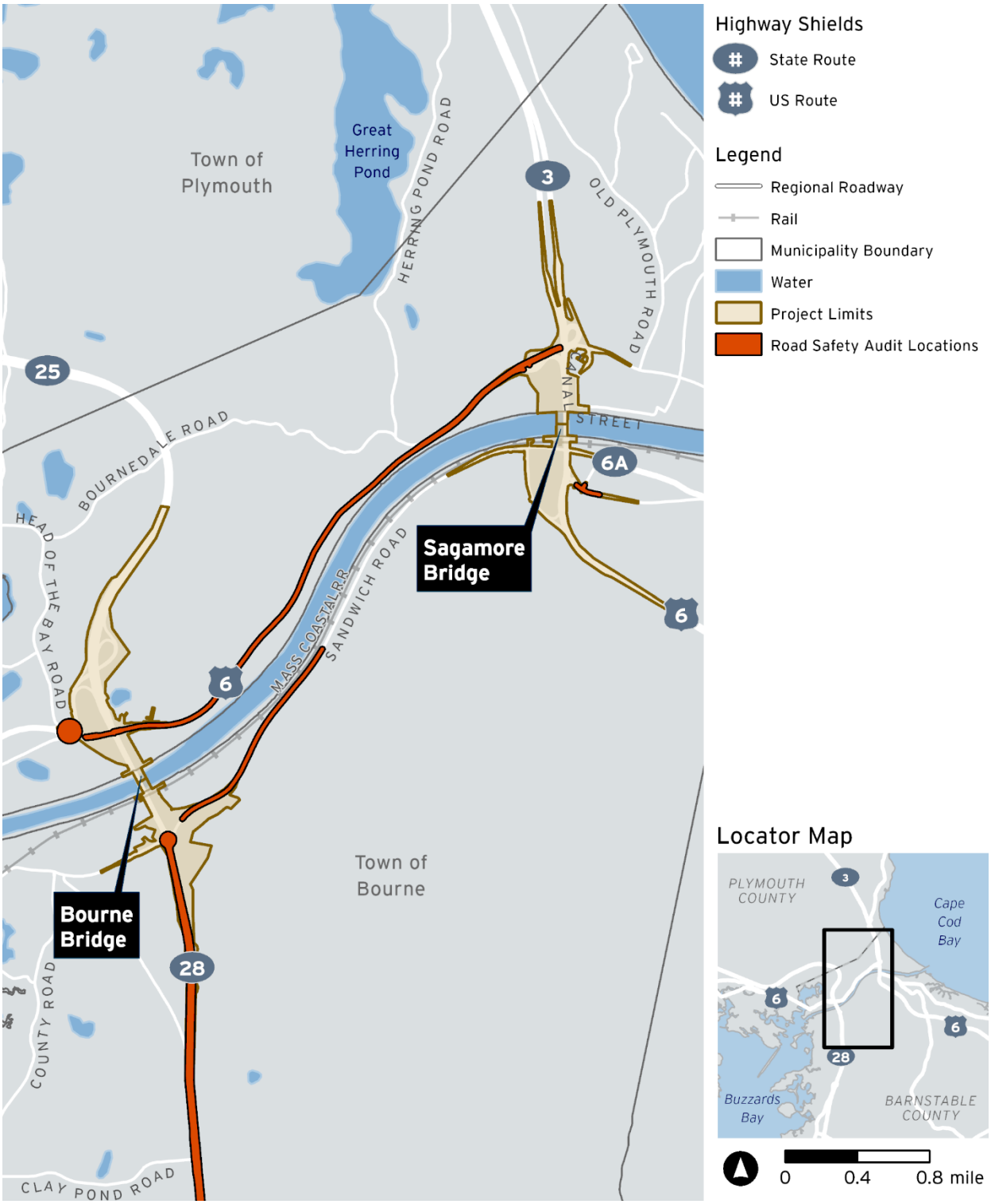
The Cape Cod Canal Railroad Bridge at Buzzards Bay, which carries the Cape Cod Railroad (also referred to as the Cape Main Line) over Cape Cod Canal, provides the only access to Cape Cod by rail. The Cape Cod Canal Railroad Bridge, which is owned and operated by the U.S. Army Corps of Engineers, is a vertical lift bridge that lowers to allow trains to cross the canal and moves up to allow large marine vessels to pass underneath. Freight service is the major user of Cape Cod's rail network in addition to scenic excursions and weekend passenger service.[9] Freight rail facilities within the Study Area include the Cape Main Line, which is owned by MassDOT. The railroad segment of the Cape Main Line within the Study Area runs under Sagamore Bridge and Bourne Bridge (**Exhibit 4.2-2**).

Exhibit 4.2-2. Cape Main Line Railroad Track under Bourne Bridge, October 2024



[9] Cape Cod Commission. 2023. 2024 Regional Transportation Plan, Technical Appendix E: Freight. July https://capecodcommission.org/resource-library/file?url=/dept/commission/team/tr/Transportation%20Plans/RTP/2024_RTP/Report/FINAL%20PDF/RTP%20Appendix%20E%20-%20Freight.pdf

Figure 4.2-4. Road Safety Audit Locations within Study Area



Source: Massachusetts Department of Transportation, 2024

Cape Rail, Inc. operates under contract to provide freight rail service on the Cape Main Line. The Massachusetts Coastal Railroad (a subsidiary of Cape Rail, Inc.) operates freight rail service on the Cape Main Line, which runs from Middleboro (northwest of Cape Cod) to Hyannis and South Yarmouth, and the Falmouth Secondary Line, which runs from Buzzards Bay to North Falmouth and Otis Air Force Base (**Figure 4.2-5**). The Massachusetts Coastal Railroad also operates an "Energy Train" via the Cape Main Line, which transports solid waste from the Yarmouth Transfer Station to a waste-to-energy and recycling facility in Rochester, Massachusetts.

The Cape Main Line is also used for passenger service by the Cape Cod Central Railroad (a subsidiary of Cape Rail, Inc.), and the CCRTA, in coordination with MassDOT and the Massachusetts Bay Transportation Authority (MBTA). The Cape Cod Central Railroad operates seasonal tourist excursion trains, from approximately April through December, on 27 miles of former New Haven Railroad tracks around Cape Cod. The CCRTA operates the CapeFLYER passenger rail service between Boston's South Station and the Hyannis Transportation Center in downtown Hyannis via the MBTA Middleboro/Lakeville Commuter Rail Line and the Cape Main Line on Friday evenings, Saturdays, and Sundays between Memorial Day and Labor Day. The Bourne Station, which serves the CapeFLYER, is within the Study Area under Bourne Bridge (**Exhibit 4.2-3**). According to CCRTA, 922 riders boarded, and 1,417 riders disembarked the CapeFLYER train at Bourne Station during the 2023 season.[10] During the 2022 season, 791 riders boarded and 1,113 riders disembarked the CapeFLYER train at Bourne Station.[11]

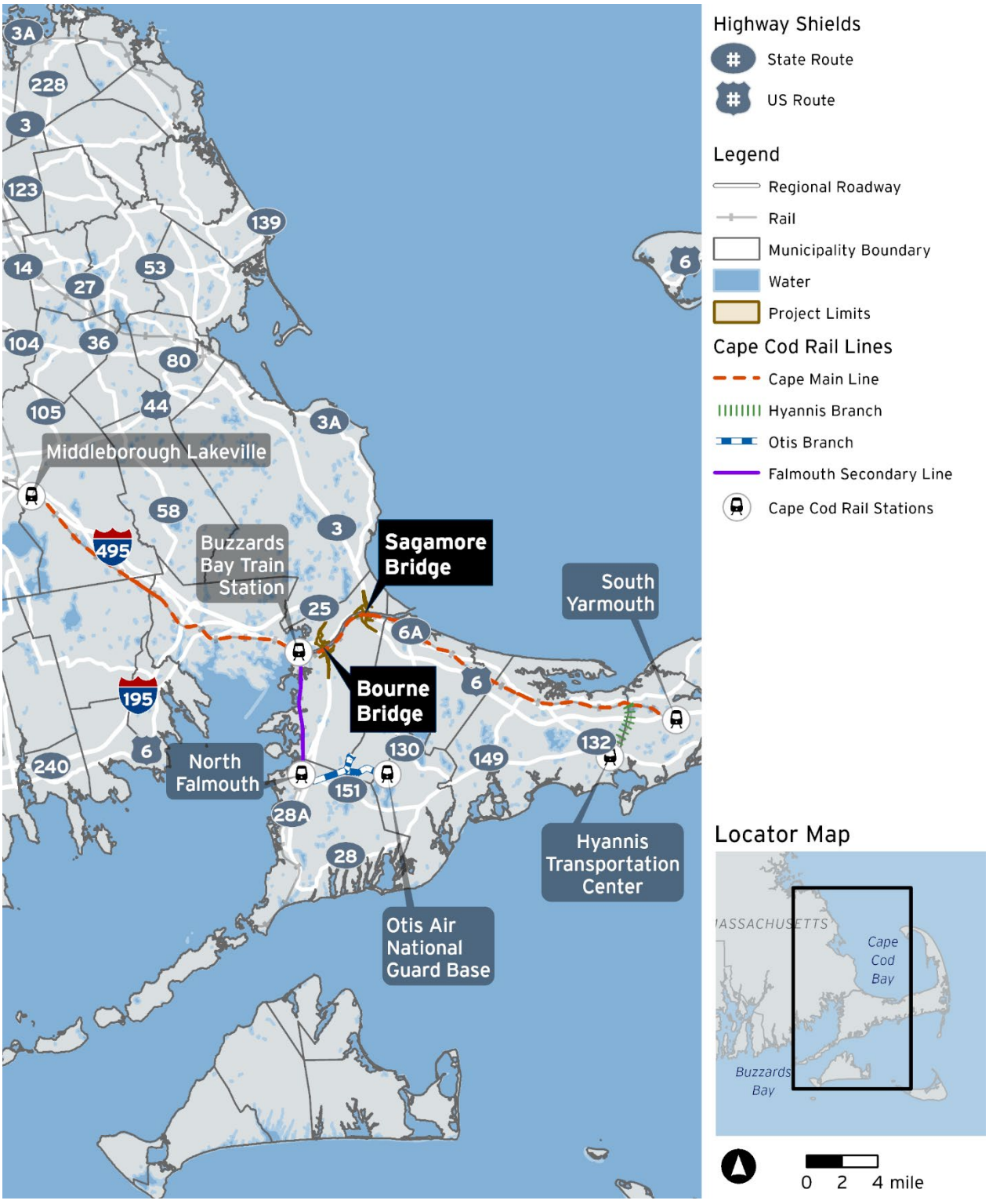
Exhibit 4.2-3. Bourne Station, September 2022



[10] Cape Cod Regional Transit Authority. 2023. CCRTA Bourne Town Report. September. https://capecodrta.org/wp-content/uploads/2023/10/FY23-Bourne.pdf

[11] Cape Cod Regional Transit Authority. 2022. CCRTA Bourne Town Report. September. https://view.officeapps.live.com/op/view.aspx?src=https%3A%2F%2Fcapecodrta.org%2Fwp-content%2Fuploads%2F2022%2F12%2FFY22-Bourne-Final.docx&wdOrigin=BROWSELINK

Figure 4.2-5. Cape Cod Rail Network



Source: Massachusetts Department of Transportation, 2024

In 2021, MassDOT, in partnership with the Cape Cod Commission, published the Cape Rail Study, which evaluated the feasibility of year-round passenger rail service to Cape Cod.[12] The Cape Rail Study considered two alternatives to expand passenger rail service to Cape Cod:

- Alternative 1 would provide weekday commuter service to and from Buzzards Bay, with a transfer required at Middleborough Station for passengers traveling to or from South Station in Boston.
- Alternative 2 would build and expand upon Alternative 1 with extended service south of Cape Cod Canal to Bourne Station along the Cape Main Line. Alternative 2 would provide additional service outside peak commuting periods and add direct service to South Station in Boston without a transfer.

4.2.2.5 Emergency Response

Cape Cod Canal physically divides the town of Bourne into Cape Cod and mainland sections, with Sagamore and Bourne Bridges providing the only roadway access to both sections of the town. Within the town of Bourne, the Bourne Police Department has one station on the mainland side of the canal and the State Police has one barracks on the Cape Cod side of the canal (**Figure 4.2-6**). The town of Bourne's fire stations are on either side of the canal (**Figure 4.2-6**).

In coordination with FHWA, the Military Surface Deployment and Distribution Command Transportation Engineering Agency, a U.S. Department of Defense designated agency for public highways, identifies highways throughout the country that are part of the Strategic Highway Network (STRAHNET), the interstate and non-interstate system that is critical to support a U.S. military defense emergency.[13] Of the nearly 600 miles of highways in Massachusetts that are part of STRAHNET, I-495 and I-195 (approximately 10.4 miles northwest of Bourne Bridge) are closest to the Study Area. Within the Study Area, State Route 28 North connecting to State Route 25 West and crossing Bourne Bridge has been designated a STRAHNET Connector Road (**Figure 4.2-7**), linking Joint Base Cape Cod (JBCC), Camp Edwards, with I-495.[14] Camp Edwards is a U.S. military training site on the 22,000-acre JBCC in Barnstable County, Massachusetts, that houses five military commands from the Department of the Air Force, the U.S. Coast Guard, the Army National Guard, and the Air National Guard. There are several other tenants on JBCC with affiliation to the Department of Defense, the Department of Homeland Security and other federal, state, and county entities. Major missions at the JBCC include training for domestic and international operations; emergency response; airborne search and rescue; and intelligence command and control.

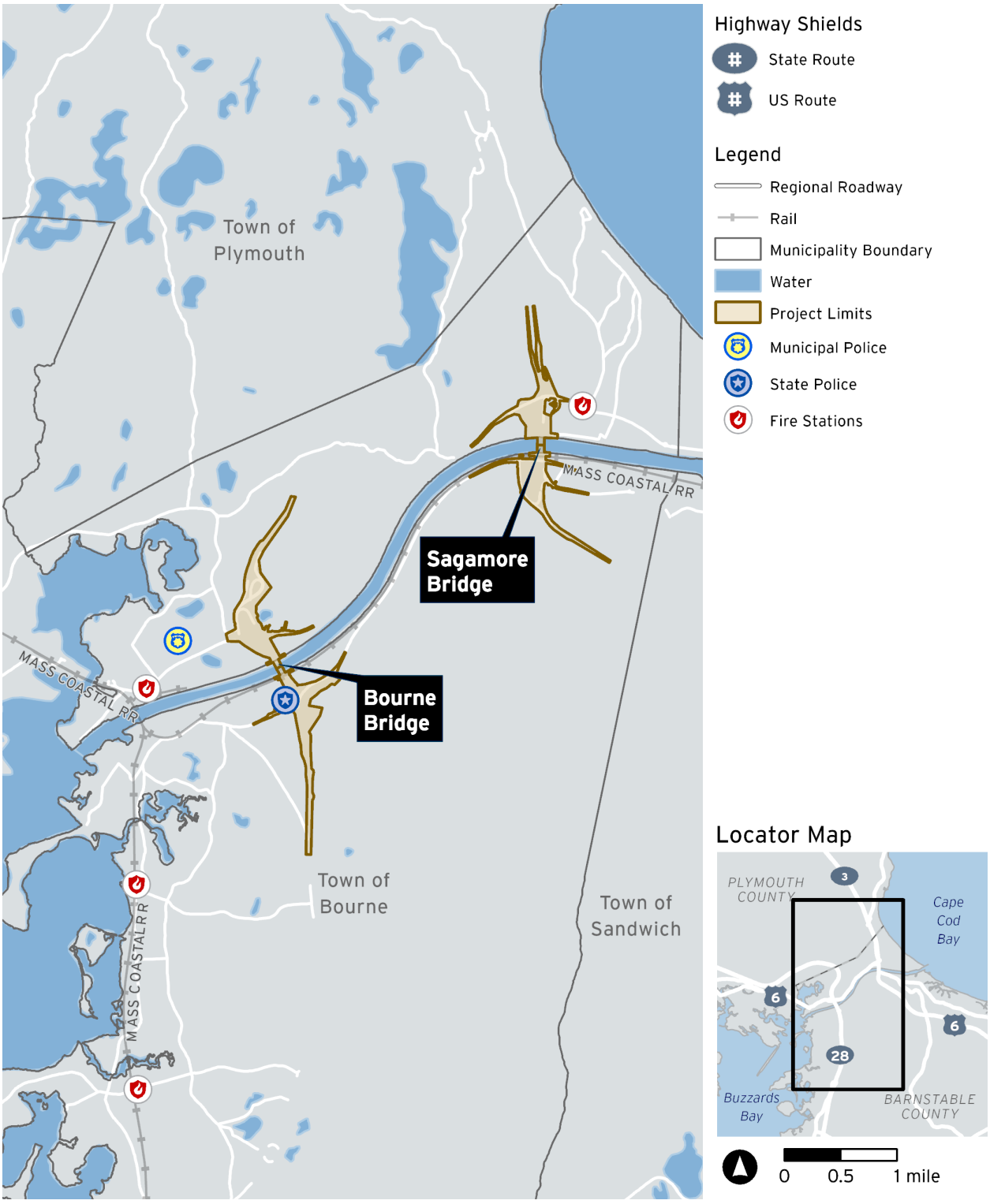
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[12] Massachusetts Department of Transportation. 2021. Cape Rail Study. September. https://www.capecodcommission.org/resource-library/file/?url=/dept/commission/team/Website_Resources/transportation/Transit/Cape%20Rail%20Study%20Report.pdf

[13] The designated STRAHNET highways provide defense access, continuity, and emergency capabilities for moving personnel, materials, and equipment. Federal Highway Administration. 2020. Strategic Highway Network (STRAHNET) Length-2019. September 30. https://www.fhwa.dot.gov/policyinformation/statistics/2019/pdf/hm49.pdf

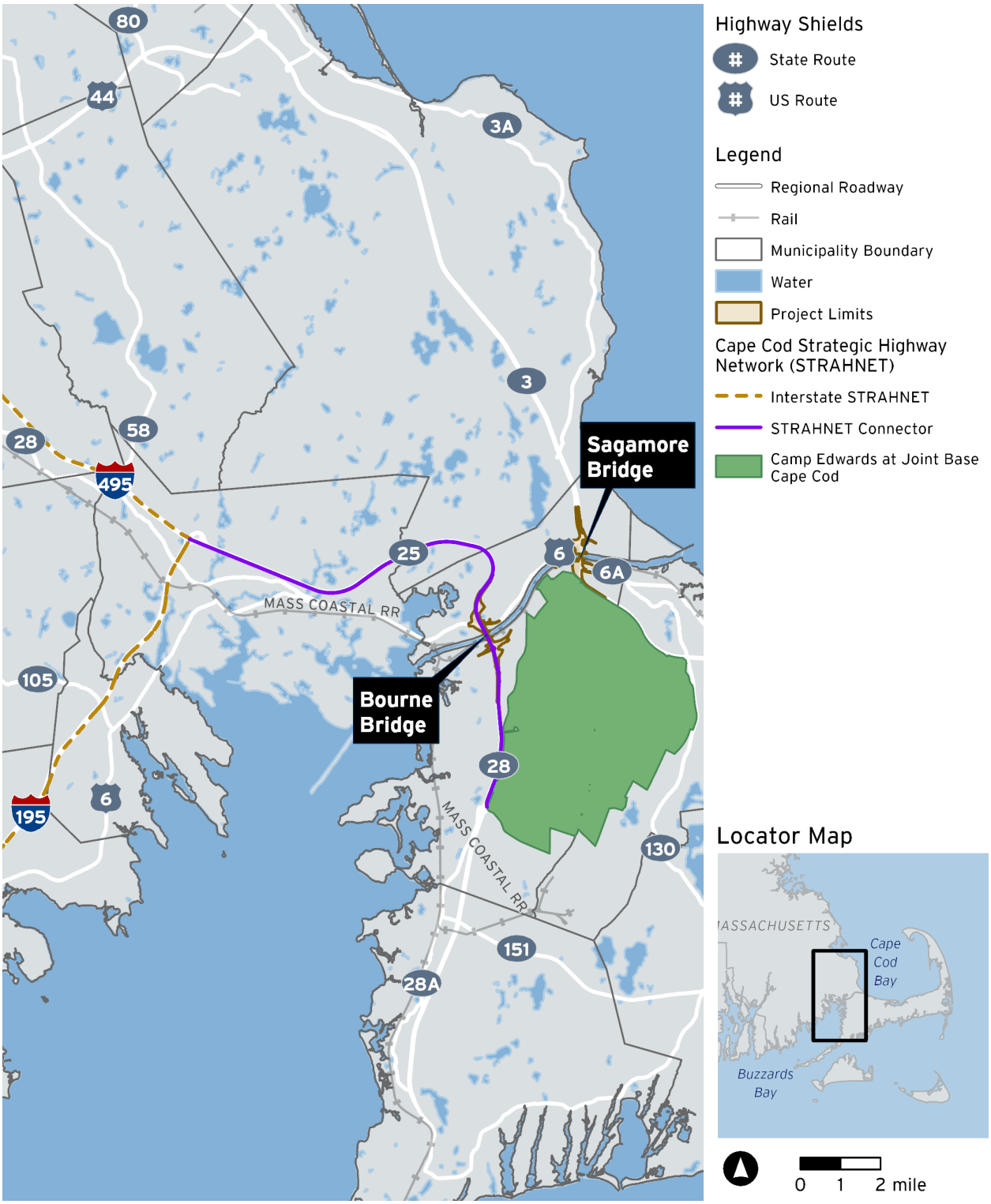
[14] U.S. Army: Transportation Engineering Agency. 2012. Camp Edward, Massachusetts STRAHNET map. June 28. https://www.sddc.army.mil/sites/TEA/functions/specialassistant/strahnet/forms/allitems.aspx

Figure 4.2-6. Police and Fire Stations in the Town of Bourne



Source: Massachusetts Department of Transportation, 2024

Figure 4.2-7. Strategic Highway Network (STRAHNET) Connector Route from I-495 to Camp Edwards



Source: Massachusetts Department of Transportation, 2024

The bridges and their supporting roadway network within the Study Area are essential routes for law enforcement, fire services, and JBCC personnel to respond to emergencies and obtain supplies. In fall 2024, MassDOT consulted with the local police and fire departments in the town of Bourne, the Massachusetts State Police, and the Massachusetts Emergency Management Agency to solicit feedback on transportation challenges within the Study Area that affect emergency response times and accessibility. Based on feedback from these law enforcement and emergency services personnel, general challenges related to emergency response times and accessibility include the following:

- Recurring congestion during the peak summer travel season (Memorial Day through Labor Day) and more frequently during the fall and spring off-peak travel seasons
- Lack of roadway shoulders on the bridges and limited shoulder widths on the immediate bridge approaches
- Lane restrictions during bridge maintenance and repair activities

Emergency Traffic Planning

Cape Cod is vulnerable to climate-related hazards, such as sea level rise, storm surge and flooding, erosion, damaging winds, elevated summer temperatures, and wildfires. Cape Cod is also vulnerable to hurricanes and tropical storms, depending on the storm track.[15] In the Atlantic Basin, hurricane season runs from June 1 to November 30. According to the Barnstable County Regional Government, the most recent hurricanes have affected Bourne and Cape Cod from late August through early September.[16]

The Massachusetts State Police in cooperation with the Massachusetts Emergency Management Agency and several other agencies developed a Cape Cod Emergency Traffic Plan (CCETP) to facilitate the egress of a high volume of traffic from Cape Cod in the event of a hurricane or other potential or actual hazard, particularly during peak tourist season.[17] The primary goal of the CCETP is to ensure the safety of the community in the event of destructive weather or other hazards requiring the orderly but rapid movement of motorists off Cape Cod and the islands of Martha's Vineyard and Nantucket. The CCETP also addresses the process for establishing temporary emergency shelters on the JBCC in case the Sagamore and Bourne Bridges are closed.

The CCETP has identified proposed routes off Cape Cod in recognition of the "localized choke points of both the Sagamore and Bourne Bridges" and the need to reduce congestion and keep traffic moving in the areas of the bridges and their approaches along U.S. Route 6, and State Route 28.

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[15] Cape Cod Commission, Cape Cod Climate Action Plan. 2021. July. https://www.capecodcommission.org/resource-library/file/?url=/dept/commission/team/climate/Shared%20Documents/Climate%20Action%20Plan/Cape-Cod-Climate-Action-Plan.pdf

[16] Barnstable County. 2022. "When is Hurricane Season?" May 24. https://www.capecod.gov/2022/05/24/when-is-hurricane-season-on-cape-cod/

[17] Commonwealth of Massachusetts. 2018. Cape Cod Emergency Traffic Plan. July. https://www.mass.gov/doc/cape-cod-emergency-traffic-plan/download

To meet this need, the CCETP establishes four traffic pattern alterations that:

- Prohibit access to U.S. Route 6 and State Route 28 at the southern, Cape Cod side bases of both bridges.
- Control access to Scenic Highway, Sandwich Road, and U.S. Route 6 to limit traffic attempting to merge into the mainstream of off-Cape traffic.
- Allows the Massachusetts State Police the flexibility in opening and closing exits to expedite off-Cape traffic flow across Sagamore and Bourne Bridges.
- Establishes traffic detours to alternate roadways to reduce congestion.

4.2.3 No Build Alternative

In the No Build Alternative, Sagamore and Bourne Bridges as well as the interchanges immediately north and south of the canal would retain their current configuration, number of lanes, and alignment. While the existing roadway infrastructure would remain unchanged, changes to the demographics within the Cape Cod communities as well as anticipated growth in visitor trips are estimated to result in an overall increase in the number of vehicles crossing the canal daily. **Table 4.2-4** provides a comparison of the 2019 bridge crossing volumes and those projected for 2050 for the No Build Alternative.

Table 4.2-4. 2050 No Build Alternative Average Annual Daily Traffic on Sagamore and Bourne Bridges

Existing/No Build	Direction	Sagamore Bridge	Bourne Bridge
2019 Existing Conditions	Northbound	33,120	21,520
	Southbound	28,870	24,980
	Total	**61,990**	**46,500**
2050 No Build Alternative	Northbound	36,810	27,790
	Southbound	36,850	27,750
	Total	**73,660**	**55,540**

4.2.3.1 Vehicular Traffic Operations

For the 2050 No Build Alternative, congestion would continue to be prevalent on the approaches to Sagamore and Bourne Bridges. With the higher traffic volumes, delays are expected to increase, and queues are anticipated to extend farther along the mainlines. **Table 4.2-5** provides a comparison of the 2019 Existing Conditions and 2050 No Build Alternative VISSIM model network results.

Table 4.2-5. 2019 Existing Conditions and 2050 No Build Alternative: VISSIM Model Network Results – Fall Weekday PM Peak Hour

Metric	2019 Existing Conditions	2050 No Build Alternative	Percentage Change
Processed Volumes	10,705	11,443	6.9%
Network Travel Times (vehicle-hours traveled)	2,397	2,879	20.1%

As **Table 4.2-5** indicates, more vehicles were processed in the 2050 No Build Alternative model because of an increase in traffic volumes, compared to the 2019 Existing Conditions model. However, overall vehicle-hours traveled increased by 20.1% in the No Build Alternative, indicating more delay. **Appendix 4.2, Traffic Engineering Technical Report**, includes a detailed summary of the 2050 No Build Alternative analysis including Level of Service for all Study Area intersections and roadways.

Travel time between O-D points along major routes within the Study Area was measured in VISSIM. The travel-time measurements presented in this section encompass both diagonal bridge crossings and through-bridge crossings.

Diagonal bridge crossings refer to vehicles entering the Study Area from either Sagamore Bridge or Bourne Bridge side, using Scenic Highway or Sandwich Road, and exiting via Bourne Bridge or Sagamore Bridge side. Major diagonal crossing O-D routes include the following:

- State Route 25 EB to U.S. Route 6 EB
- State Route 28 NB to State Route 3 NB
- State Route 3 SB to State Route 28 SB
- U.S. Route 6 WB to State Route 25 WB

The State Route 25 EB to State Route 3 NB travel route is projected to be a major O-D route in the 2050 Design Year and is also presented.

Through-bridge crossings refer to direct passage through the Study Area along State Route 3 and U.S. Route 6 via Sagamore Bridge or along State Route 25 and State Route28 via Bourne Bridge and are defined as follows:

- State Route 25 EB to State Route 28 SB
- State Route 28 NB to State Route 25 WB
- State Route 3 SB to U.S. Route 6 EB
- U.S. Route 6 WB to State Route 3 NB

Table 4.2-6 summarizes the estimated diagonal bridge crossing travel times for predominant O-D routes for the 2050 No Build Alternative in minutes.

Table 4.2-6. 2050 No Build Alternative: Diagonal Bridge Crossing Travel Times (Fall Weekday PM Peak Hour)

Route		No Build Alternative (minutes)
State Route 25 eastbound to U.S. Route 6 eastbound via	Scenic Highway	20.6
	Sandwich Road	24.2
State Route 28 northbound to State Route 3 northbound via	Sandwich Road	15.9
State Route 3 southbound to State Route 28 southbound via	Scenic Highway	21.5
	Sandwich Road	19.1
U.S. Route 6 westbound to State Route 25 westbound via	Scenic Highway	22.9
State Route 25 eastbound to State Route 3 northbound via	Scenic Highway	19.6

Table 4.2-7 summarizes the estimated through-bridge crossing travel times for the 2050 No Build Alternative in minutes.

Table 4.2-7. 2050 No Build Alternative Through-Bridge Crossing Travel Times (Fall Weekday PM Peak Hour)

Route	Direction	No Build Alternative (minutes)
Sagamore Bridge	Southbound	11.4
	Northbound	8.5
Bourne Bridge	Southbound	10.4
	Northbound	14.5

4.2.3.2 Freight Operations, Public Bus Transit and Parking Facilities

For the No Build Alternative, no improvements would be made to the bridges or their roadway approach network, other than routine maintenance activities to maintain public safety. With anticipated growth in future 2050 traffic volumes, escalating maintenance repairs and no major improvements to address the underlying structural and geometric deficiencies of the bridges and their approach roadway network, there would be increased congestion and delays to freight-truck and bus transit traffic. Without major rehabilitation of the bridges, restrictions of vehicle loads, and speed limits would be posted in the future as the structures continue to age. Imposed restrictions on the amount of freight that can be carried in a single truck would lead to more trucks being needed to transport goods and services between Cape Cod and the mainland. As the only roadway crossings between the mainland and Cape Cod, any future bridge restrictions through vehicle weight postings would compound congestion and create significant delays to freight-truck and bus transit traffic.

The No Build Alternative would not have any effect on the Bourne Park and Ride Lot in the Sagamore North quadrant.

4.2.3.3 Traffic Safety Analysis

The higher-than-average crash rates observed for the Sagamore and Bourne Bridges for current conditions are influenced by vehicle congestion and the geometric deficiencies of the cross sections of the bridges. These conditions are anticipated to worsen for the No Build Alternative due to an increase in traffic volumes over time without improvements to address vehicle congestion and geometric deficiencies of the existing bridges and their approaches.

4.2.3.4 Rail

The No Build Alternative would have no effect on rail operations within the Study Area. The expansion of passenger rail service to Cape Cod is not included on any approved transportation improvement plans and therefore is not considered part of the No Build Alternative in this DEIR.

4.2.3.5 Emergency Response and Emergency Traffic Planning

Law enforcement and emergency response vehicles would experience longer response times within the Study Area for the No Build Alternative as traffic volumes and congestion increase over time. The lack of roadway shoulders on the bridges and limited shoulder widths on the immediate bridge approaches would continue to impede access for emergency response vehicles responding to incidents.

As bridge conditions continue to deteriorate, increased maintenance would be required for longer periods with partial- or full-lane closures, depending on the extent of damage to their structural components. Because Sagamore and Bourne Bridges provide the only vehicular access between Cape Cod and the mainland, any lane closures on either bridge, regardless of the duration, would delay emergency response times and impede rapid egress of motor vehicles from areas of Cape Cod in the event of a hurricane or other potential hazard.

4.2.4 Program Impacts

The Build Alternative proposes improvements to the highway interchange networks in the immediate vicinity of the replacement bridges, which is anticipated to change some travel routes with the Study Area. **Table 4.2-8** provides a comparison of the 2050 No Build Alternative and Build Alternative traffic volumes on the bridges.

As indicated, it is anticipated that some vehicles that typically cross over the canal onto Cape Cod via Bourne Bridge, may choose to use Scenic Highway and cross Sagamore Bridge. This would be due to the improvements and new State Route 25 EB to Scenic Highway ramp in the Bourne North quadrant. Similarly, access improvements in the Sagamore South quadrant may draw some vehicles to cross the canal off Cape Cod via Bourne Bridge.

Table 4.2-8. 2050 No Build Alternative compared to 2050 Build Alternative Average Annual Daily Traffic on Sagamore and Bourne Bridges

Alternative	Direction	Sagamore Bridge	Bourne Bridge
2050 No Build Alternative	Northbound	36,810	27,790
	Southbound	36,850	27,750
	Total	**73,660**	**55,540**
	Combined	**129,200**	
2050 Build Alternative	Northbound	34,630	29,970
	Southbound	44,070	20,530
	Total	**78,700**	**50,500**
	Combined	**129,200**	

It is important to note that the estimated total AADT crossing the canal would be 129,200 vehicles per day for both the 2050 No Build Alternative and Build Alternative.

4.2.4.1 Vehicular Traffic Operations

With the improvements on the bridges and at the interchanges on either side of the canal, it is anticipated that there would be significant reductions in delay and congestion throughout the Study Area. During the Fall Weekday PM peak hour, no queues are anticipated to extend onto the mainlines on State Route 25, State Route 28, State Route 3, or U.S. Route 6. **Table 4.2-9** provides a comparison of the VISSIM model network results for 2019 Existing Conditions, the 2050 No Build Alternative, and the 2050 Build Alternative.

Table 4.2-9. VISSIM Model Network Results (Fall Weekday PM Peak Hour)

Metric	2019 Existing Conditions	2050 No Build Alternative	2050 Build Alternative	Percentage Change
Processed Volumes	10,705	11,443	12,402	8.4%
Network Travel Times (vehicle-hours traveled)	2,397	2,879	2,240	-22.2%

As indicated, the 2050 Build Alternative would process more vehicles than the 2050 No Build Alternative. Overall network-wide travel times for the 2050 Build Alternative are estimated to decrease by 22.2% compared to the 2050 No Build Alternative. The overall network-wide travel times estimated for the 2050 Build Alternative are also less than 2019 Existing Conditions, indicating significantly reduced delays despite estimated increases in future traffic volumes. **Appendix 4.2, Traffic Engineering Technical Report**, includes a detailed summary of the 2050 Build Alternative analysis, including Level of Service for all Study Area intersections and roadways.

Table 4.2-10 depicts the estimated diagonal bridge crossing travel times (in minutes) along the predominant O-D routes for both the 2050 No Build Alternative and 2050 Build Alternative. The

estimated diagonal bridge crossing travel times for the 2050 Build Alternative are estimated to decrease compared to the 2050 No Build Alternative, except for State Route 3 SB to State Route 28 SB via Sandwich Road. Further refinements to intersection operations in the Sagamore South quadrant are anticipated to improve the travel time for this route for the 2050 Build Alternative. Refer to **Appendix 4.2, Traffic Engineering Technical Report**, for graphics depicting the vehicle paths along these O-D routes.

Table 4.2-10. 2050 No Build Alternative and 2050 Build Alternative Diagonal Bridge Crossing Travel Times (Fall Weekday PM Peak Hour)

Route		No Build Alternative (minutes)	Build Alternative (minutes)
State Route 25 eastbound to U.S. Route 6 eastbound via	Scenic Highway	20.6	18.4
	Sandwich Road	24.2	14.9
State Route 28 northbound to State Route 3 northbound via	Sandwich Road	15.9	12.6
State Route 3 southbound to State Route 28 southbound via	Scenic Highway	21.5	13.0
	Sandwich Road	19.1	20.2
U.S. Route 6 westbound to State Route 25 westbound via	Scenic Highway	22.9	11.7
State Route 25 eastbound to State Route 3 northbound via	Scenic Highway	19.6	12.1

Table 4.2-11 summarizes (in minutes) the estimated through-bridge crossing travel times for both the 2050 No Build Alternative and 2050 Build Alternative. The estimated through-bridge crossing travel times for the 2050 Build Alternative are estimated to decrease compared to the 2050 No Build Alternative in each direction for both Sagamore and Bourne Bridges. Refer to **Appendix 4.2, Traffic Engineering Technical Report**, for graphics depicting the vehicle paths along these O-D routes.

Table 4.2-11. 2050 No Build Alternative and 2050 Build Alternative Through-Bridge Crossing Travel Times (Fall Weekday PM Peak Hour)

Route	Direction	No Build Alternative (minutes)	Build Alternative (minutes)
Sagamore Bridge	Southbound	11.4	5.5
	Northbound	8.5	6.4
Bourne Bridge	Southbound	10.4	4.7
	Northbound	14.5	5.1

4.2.4.2 Freight Operations, Public Bus Transit, and Parking Facilities

For the Build Alternative, Sagamore and Bourne Bridges would be replaced with new bridges built to modern structural and roadway design standards. The replacement bridges would provide wider traffic lanes, auxiliary lanes, and safety shoulders. The increased through-travel lane widths on the

replacement bridges from 10 feet to 12 feet, along with the addition of shoulders and separation of traffic in each direction on the replacement bridges would better accommodate large freight trucks and buses, thus reducing the risk of sideswipe and lane-departure crashes. The auxiliary lanes, which would span the on- and off-ramps on the replacement bridges, would also provide truck-freight and bus transit drivers with more space and time to adjust their speed before entering or exiting through-traffic lanes, thereby reducing disruptions to traffic flows on the mainline highways. The provision of auxiliary lanes would also eliminate the lane drop on the State Route 3 SB approach to Sagamore Bridge, which is a bottleneck for vehicular traffic heading from the mainland to Cape Cod.

The replacement bridges—each providing a total of four 12-foot-wide through-travel lanes (two in each direction), two 12-foot-wide entrance/exit (auxiliary) lanes, a 4-foot-wide left shoulder, and a 10-foot-wide right shoulder and safety barriers—would reduce the impact to freight-truck and bus transit traffic when performing future maintenance on the bridges. Replacing the bridges to meet current design standards would also avoid the potential for future posting of weight restrictions, which largely affects freight traffic.

The steep 6% roadway grade on the existing bridges would also be reduced to a flatter 4.5% grade at Bourne Bridge and 4% grade at Sagamore Bridge for the Build Alternative. These grade reductions would improve sight distances and consistency of speed between passenger cars and larger vehicles, including trucks and buses.

In the Bourne South quadrant, the Build Alternative would replace Bourne Rotary with a grade-separated diamond interchange, which would allow regional truck-freight through movements on State Route 28 to bypass the intersections with the non-mainline roadways. This grade separation for local and regional traffic would alleviate congestion and improve operations for freight-truck and bus transit traffic.

In the Bourne North quadrant, the combination of new direct connection ramps between State Route 25 and U.S. Route 6 (Scenic Highway) would allow vehicles to bypass Belmont Circle. These direct ramp connections would improve traffic operations and safety at Belmont Circle, in addition to regional freight-truck and bus transit mobility and accessibility.

Overall, the Build Alternative would provide long-term benefits to truck-freight and bus transit operations through improved speeds, more efficient fuel costs, and travel-time savings.

It is anticipated the Build Alternative would result in the displacement of approximately 17 parking spaces on the north side of MassDOT's Bourne Park and Ride Lot due to the realignment of Scenic Highway and construction of a shared-use path on the south side of Scenic Highway. Considering the Bourne Park and Ride Lot has an annual average parking occupancy rate of less than 75% of the maximum number of parking spaces since the facility was expanded in 2009, MassDOT will coordinate with appropriate local and regional entities to assess whether replacement parking spaces are necessary.

4.2.4.3 Traffic Safety Analysis

Based on a preliminary evaluation of the safety performance metrics and CMFs associated with the proposed improvements, predicted crashes experienced along Bourne and Sagamore Bridges could be reduced by as much as 48%.[18] MassDOT does not have a statewide average for crashes by severity.

The physical separation of the directions of travel in the twin bridge configuration for the Build Alternative would reduce the number of fatality and injury crashes by up to 12%,[19] and the number of cross-median crashes (sideswipe in opposite direction and head-on) by up to 97%.[20]

4.2.4.4 Rail

The Build Alternative would have no long-term effect on rail operations within the Study Area. Any future expansion of passenger rail services to Cape Cod would be subject to an independent environmental review process. The Build Alternative would not preclude future expansion and extension of passenger rail services to Cape Cod.

The Build Alternative would have temporary adverse construction-period impacts on freight and seasonal passenger train operations within the Study Area due to required bridge construction and demolition activities over and adjacent to the active Cape Main Line corridor. During final design and construction, the contractor would be required to develop and implement a Rail Operations Coordination Plan that would be coordinated with MassDOT, the MBTA, Cape Rail, Inc., Massachusetts Coastal Railroad, Cape Cod Central Railroad, and CCRTA. All personnel working within the railroad property would be required to complete applicable right-of-way safety training courses. Flaggers would be required for any construction activities that have the potential to foul the tracks. Qualified inspectors would also be used to assess track conditions and monitor the safety of rail operations through the construction limits at both bridges.

The Build Alternative would likely require relocation of Bourne Station to accommodate construction of the replacement Bourne Bridge. The Highway Division of MassDOT will coordinate with the MassDOT Rail and Transit Division and MBTA to finalize details regarding station relocation, as necessary.

4.2.4.5 Emergency Response

With the provision of wider travel lanes, as well as auxiliary lanes, and left and right shoulders across the replacement bridges for the Build Alternative, vehicles could pull over and clear the way for emergency vehicles, resulting in improved response times for police, fire, medical, and emergency

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[18] Combination of the following crash modification factors: (CMF ID: 8336 - Install an Additional Lane) Operational and Safety Trade-offs: Reducing Freeway Lane and Shoulder Width to Permit an Additional Lane. 2016. (CMF ID: 8711 – Widen Shoulder, Lane Width) Evaluation of Safety Effectiveness of Multiple Cross Sectional Features on Urban Arterials. 2016.

[19] AASHTO. 2010. The Highway Safety Manual, American Association of State Highway Transportation Professionals, Washington, D.C., http://www.highwaysafetymanual.org

[20] (CMF ID: 7040) NCHRP Report 794: Median Cross-Section Design for Rural Divided Highways. 2011.

management services. The addition of auxiliary lanes and shoulders on the replacement bridges would also reduce delays for emergency vehicles during any future bridge inspections and maintenance activities conducted by MassDOT.

Replacing the bridges to modern structural and roadway design standards would benefit public safety and security through reduced delays and improved travel-time reliability for emergency vehicle service and operations. Construction of two separate deck structures for the replacement bridges for the Build Alternative would provide additional service redundancy in case of an emergency evacuation or a compromising event impacting a single bridge structure. The Build Alternative would facilitate emergency egress of high traffic volumes from Cape Cod in the event of a hurricane or other potential hazards through replacement of Bourne Rotary with a grade-separated diamond interchange and the construction of a new flyover ramp connection from Scenic Highway to State Route 25 WB. These improvements for the Build Alternative would reduce congestion and keep traffic flowing in the areas of Bourne and Sagamore Bridges and their approaches along U.S. Route 6, and State Route 28, consistent with the Commonwealth's CCETP.

4.2.4.6 Induced Travel Demand

Induced demand is the growth in traffic volumes that results from an increase in capacity. Five different components contribute to induced demand:[21]

- Number of trips
- Change in mode of travel
- Travel routes
- Length of trips
- Time of travel

In general, the Build Alternative would improve traffic operations and safety conditions for the traveling public through geometric upgrades and the separation of local and regional traffic movements in the immediate vicinity of the replacement bridges. As indicated in **Table 4.2-8**, the estimated AADT traffic crossing Sagamore and Bourne Bridges for both the 2050 No Build Alternative and the 2050 Build Alternative would be 129,200 vehicles per day. Projected travel-time improvements for the Build Alternative are not expected to generate additional trips to Cape Cod, as discussed in the following sections.

Change in Number of Trips

Change in number of trips, or latent demand, is a more difficult concept to forecast because many other non-transportation-related factors contribute to demand, including socioeconomic data such as expected changes in households and employment as well as growth in visitor trips. Based on the most recent 2020 census data, population growth on Cape Cod is expected to remain stagnant and in some

[21] U.S. Department of Transportation, Federal Highway Administration, 2010. Interim Guidance on the Application of Travel and Land Use Forecasting in NEPA. March. https://www.environment.fhwa.dot.gov/nepa/Travel_LandUse/travel_landUse_rpt.aspx

areas is expected to decline by the year 2050. Factors limiting visitor growth include availability and cost of seasonal rentals, occupancy limits of major attractions, and parking constraints among others.

In addition, improvements to traffic operations are limited to the bridges and the interchanges directly north and south of the canal. Because Cape Cod attracts visitors from the greater New England region and beyond, improvements in travel time in the immediate vicinity of the replacement Sagamore and Bourne Bridges would represent only a minimal reduction of the overall trip duration. For these reasons, it is not anticipated that there would be a significant increase in the number of trips that would otherwise not travel to Cape Cod due to congestion.

Change in Mode of Travel

Within the Study Area, impacts due to changes in mode of travel are anticipated to be minimal because vehicular traffic makes up most trips across the canal with few other modal options. Improved traffic operations would improve bus travel times and reliability, which may make public transportation a more attractive mode of travel. With improved bicycle and pedestrian facilities, there are also opportunities to convert shorter vehicular trips to alternative modes.

Change in Travel Route and Length of Trips

Sagamore and Bourne Bridges make up the only two roadway access points to and from Cape Cod. Therefore, the travel route choices are limited to one bridge or the other, and trip lengths are limited to the extents of Cape Cod and the neighboring islands. The total number of trips crossing Cape Cod Canal are expected to remain the same, regardless of any potential changes to travel route or length of trips.

Change in Time of Travel

Today, visitors with flexible schedules tend to determine their time of travel based on congestion. For example, if there is consistently congestion at 5 PM on a weekday, visitors may choose to travel earlier in the day or after the afternoon peak period to avoid sitting in traffic. This results in “peak spreading,” a phenomenon that is most apparent in the vicinity of the bridges during summer weekends and other popular vacation times. With improved traffic operations people may choose to shift their travel time. However, the total number of daily vehicle trips are not anticipated to increase as a result of the Cape Cod Bridges Program (Program), as previously discussed.

4.2.4.7 Construction Sequencing and Traffic Management

The construction sequencing and traffic management goals for the Program are as follows:

- Remove traffic from the existing bridges as soon as possible.
- Maintain existing roadway and ramp connections throughout the duration of construction.
- Avoid the need for construction detours.
- Reduce or minimize traffic shifts.
- Reduce schedule delays by providing large work zones at the bridge sites.

- Design temporary roadways at 10 miles per hour less than the existing roadway design speed.
- Maintain pedestrian and bicycle connectivity and access that are equal to or better than existing conditions throughout the duration of construction.

Figure 4.2-8 presents the optimal sequencing approach to constructing both highway bridges. There are four key phases:

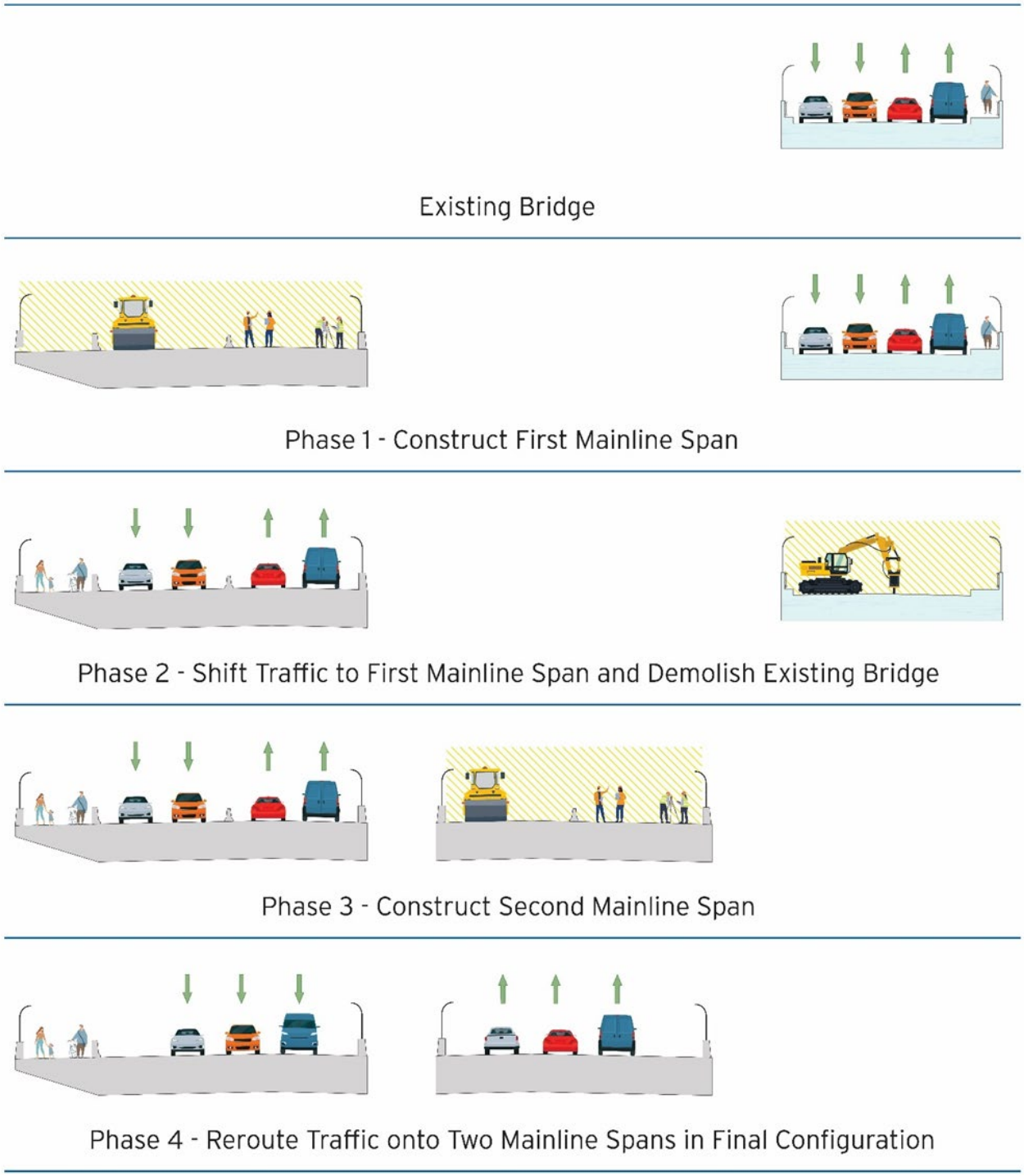
- **Phase 1:** Construct the first mainline span and approaches, consisting of the EB mainline at the Sagamore Bridge crossing and the NB mainline at the Bourne Bridge crossing.
- **Phase 2:** Shift all traffic off the existing bridge and onto the new mainline structure and demolish the existing bridge.
- **Phase 3:** Construct the second mainline span and approaches, consisting of the WB mainline at the Sagamore Bridge crossing and the SB mainline at the Bourne Bridge crossing.
- **Phase 4:** Reroute traffic onto the two mainline spans in the final configuration and open connections to the shared-use path over the canal and supporting path network.

MassDOT proposes to construct the interchange improvements concurrently with the construction of the mainline highway bridges. Using existing, temporary, and new ramp connections, MassDOT's goal for the interchange construction is to seamlessly connect to the new highway bridges. Accordingly, the interchange work would be substantially complete once construction of the second new mainline bridge has been completed for both Sagamore and Bourne Bridges. To minimize the number of traffic shifts, the construction sequencing would allow vehicles to use the same traffic pattern for substantial periods of time, including on the mainlines, ramps, and local roads.

MassDOT's goal is to maintain pedestrian and bicycle connectivity during construction. MassDOT proposes to maintain existing conditions until pedestrian and bicycle traffic can be transferred to the proposed bridge. Temporary connections may be required from the new highway bridges and approach paths to allow pedestrians to continue to travel to and from either side of Cape Cod Canal. MassDOT would not demolish the existing bridges until these temporary and/or new pedestrian/bicycle connections to the new highway bridges are completed.

Chapter 5, Construction Approach, describes the Program's construction approach, including land-based work and water-based work.

Figure 4.2-8. Proposed Bridge Construction Sequencing Approach



Source: Massachusetts Department of Transportation, 2025

4.2.4.8 Design Parameters

MassDOT has established design parameters to be maintained for mainlines (and newly constructed bridges), interchange ramps, and local roads throughout construction:

- Mainlines (and newly constructed bridges)
  - Lane Configuration: 2 lanes minimum in each direction
  - Travel Lane Width: 11-foot minimum
  - Shoulder Width: 0-foot minimum on structure; 2 feet preferred; 1-foot minimum at-grade
  - Vertical Clearance: Maintain existing vertical clearance as a minimum.
- Ramps
  - Travel Lane Width: 11-foot minimum
  - Inside Shoulder Width: 2 feet preferred; 1-foot minimum
  - Outside Shoulder Width: 2 feet preferred; 1-foot minimum
  - Total Ramp Width: 18-foot minimum to accommodate emergency vehicles
  - Entrance/Exit Ramp Design: Taper style ramps preferred; parallel style where necessary.
- Local Roads
  - Travel Lane Width: 10-foot minimum
  - Shoulder Width: 2 feet preferred; 1-foot minimum

4.2.5 Mitigation Measures

No long-term operational mitigation measures will be required for the Build Alternative because it would reduce congestion and improve traffic safety, freight mobility and the resiliency of transportation infrastructure. Such improvements would be consistent with state and regional plans, including the Cape Cod Regional Transportation Regional Transportation Plan.[22]

As discussed in **Section 4.2.4.7**, construction of the Build Alternative will be phased to maintain existing roadway and ramp connections and minimize disruption to the traveling public throughout the duration of construction. Because all existing roadway and ramp connections will be maintained, long-duration detour routes will not be necessary. **Section 4.2.4.8** outlines the minimum design standards that will be maintained for mainlines (and newly constructed bridges), interchange ramps, and local roads throughout construction.

The design-build contractor will be required to submit a Traffic Management Plan (TMP) consistent with their final design for review and acceptance by MassDOT. The TMP will define the strategic plan for managing and communicating work zone impacts to roadway users during construction. Key elements of the TMP will include a Temporary Traffic Control Plan and a Public Involvement and Communication Plan.

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[22] Cape Cod Metropolitan Planning Organization. 2023. Cape Cod 2024 Regional Transportation Plan. July 24. https://www.capecodcommission.org/resource-library/file/?url=/dept/commission/team/tr/Transportation%20Plans/RTP/2024_RTP/Report/FINAL%20PDF/Cape%20Cod%202024%20Regional%20Transportation%20Plan_Endorsed%20072420 23.pdf

The Temporary Traffic Control Plan will include engineered plans detailing traffic control devices, lane tapers, signage and pavement markings to maintain traffic safety and control through the work zone. All temporary roadways, alignments, lane shifts and tapers for the mainlines and interchange ramps within the Project Limits will be required to meet or exceed the design parameters outlined in **Section 4.2.4.8**.

The Public Involvement and Communication Plan will be a comprehensive set of measures to inform affected road users, the public, emergency response personnel (police, fire, ambulance) and other stakeholders of anticipated work zone impacts and changing travel conditions. MassDOT will use all available resources to communicate Project information including, but not limited to, broadcast and print media, variable message signs, a dedicated project webpage, mobile media, existing MassDOT websites and other Commonwealth websites, flyers, fact sheets, social media tools, newsletters, e-mail, briefings, public meetings, and signs.

Additional measures in the TMP to minimize construction-period traffic impacts of the Build Alternative will include the following:

- Designating construction truck routes, construction staging areas, and worker parking areas
- Scheduling major truck deliveries during off-peak traffic hours to avoid conflicts during school arrival and departure periods and during other congested times of the day
- Using police detail to safely direct traffic on roadways as needed

The TMP will be coordinated with the elected, engineering, planning, and public safety officials in the town of Bourne and other municipalities, as necessary.

MassDOT contract specifications will also require the contractor to develop and implement a Rail Operations Coordination Plan to minimize and mitigate construction-period impacts to rail operations within the Study Area. The Rail Operations Coordination Plan will require the contractor to provide advanced notice to freight and seasonal rail service providers of construction schedules and any planned construction activities that necessitate temporary service disruptions during construction. Additionally, the Rail Operations Coordination Plan will require coordination with the public to provide advanced notice of any disruptions to seasonal passenger service along the Cape Main Line.

4 Existing Conditions, Program Impacts, and Mitigation

4.3 Pedestrian and Bicycle Facilities

4.3.1 Introduction

This section assesses the potential construction and operational impacts of the No Build Alternative and Build Alternative on existing pedestrian and bicycle transportation facilities and identifies mitigation measures that will be implemented to avoid or minimize any potential adverse impacts to these resources. This assessment specifically focuses on the impacts of the alternatives on pedestrian and bicycle safety, accessibility, connectivity, and opportunities for future local and regional multimodal connections.

This section also assesses the consistency of the alternatives with federal, state, and municipal plans, policies, and guidelines related to pedestrian and bicycle transportation facilities.

4.3.1.1 Resource Definition

Pedestrian facilities include sidewalks, crosswalks, curb ramps, walkways, paths, and trails that are exclusively for pedestrians in the public right-of-way. Bicycle facilities include a portion of roadway, shoulder, or public right-of-way that has been designated for preferential or exclusive use by bicyclists by pavement markings and/or signage. Bicycle facilities also include bike-share facilities and bicycle parking areas. Pedestrian and bicycle facilities also include off-road shared-use or multi-use facilities commonly used by pedestrians, bicyclists, and other nonmotorized users. In this section, a shared-use path (SUP) refers to infrastructure where pedestrians and bicyclists share the same path of travel, whereas a shared-use facility refers to infrastructure that provides separated space for both pedestrians and bicyclists.

4.3.1.2 Regulatory Context

Bicycle and pedestrian needs must be given due consideration in developing and implementing federal aid transportation projects under federal surface transportation law.[1] The Americans with Disabilities Act (ADA),[2] and Section 504 of the Rehabilitation Act of 1973 require that new construction and alteration of pedestrian facilities be accessible to persons with disabilities.[3]

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[1] 23 United States Code (USC) Section 217: Bicycle transportation and pedestrian walkways. https://uscode.house.gov/view.xhtml?req=granuleid:USC-2010-title23-section217&num=0&edition=2010

[2] 42 USC Sections 12131 through 12164. https://www.ada.gov/

[3] 29 USC Section 794. https://www.hhs.gov/civil-rights/for-individuals/disability/section-504-rehabilitation-act-of-1973/index.html

Policy statements, design guidelines and regulations that apply to pedestrian and bicycle transportation facilities include the following:

- U.S. Department of Transportation Policy Statement on Bicycle and Pedestrian Accommodation Regulations and Recommendations[4]
- FHWA Technical Advisory T 6640.8A[5]
- FHWA Bikeway Selection Guide[6]
- Massachusetts Department of Transportation (MassDOT) Engineering Directive E-20-001[7]
- MassDOT Project Development and Highway Design Guide[8]
- MassDOT Separated Bike Lane Planning and Design Guide[9]
- MassDOT Healthy Transportation Policy[10]
- U.S. Access Board's Public Right-of-Way Accessibility Guidelines[11]

4.3.1.3 Methodology and Study Area

MassDOT obtained mapping and information for existing pedestrian and bicycle transportation facilities through site visits (November 2024) and geographic information systems databases, including MassMapper, Massachusetts GeoDOT Open Data Portal, as well as internet-based sources such as Google Maps. MassDOT identified information on future planned pedestrian and bicycle transportation facilities by reviewing the following:

- Cape Cod 2024 Regional Transportation Plan[12]
- Cape Cod Metropolitan Planning Organization Federal Fiscal Year 2024-2028 Transportation Improvement Program[13]
- Town of Bourne Local Comprehensive Plan[14]

The Study Areas for this assessment include areas within 500 feet of the Project Limits of the Build Alternative at Sagamore Bridge and Bourne Bridge.

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[4] https://www.fhwa.dot.gov/environment/bicycle_pedestrian/guidance/policy_accom.cfm?_gl=1*eiuu5u*_ga*MTQ5MTA0MDQ3Ny4xNzM4NzY0Mjk0*_ga_VW1SFWJKBB*MTczODc2NDI5My4xLjAuMTczODc2NDMwMi4wLjAuMA.

[5] https://www.environment.fhwa.dot.gov/legislation/nepa/guidance_preparing_env_documents.aspx

[6] https://safety.fhwa.dot.gov/ped_bike/tools_solve/docs/fhwasa18077.pdf

[7] https://www.mass.gov/doc/controlling-criteria-and-design-justification-process-for-massdot-highway-division-projects-e/download

[8] https://www.mass.gov/manual/massdot-project-development-and-design-guide

[9] https://www.mass.gov/lists/separated-bike-lane-planning-design-guide

[10] https://www.mass.gov/doc/healthy-transportation-policy-directive/download

[11] https://www.access-board.gov/prowag/technical.html

[12] https://www.capecodcommission.org/our-work/rtp/

[13] https://www.capecodcommission.org/resource-library/file/?url=/dept/commission/team/tr/Transportation%20Plans/TIP/FY2024-2028%20TIP/Endorsement%20Files/Cape_Cod_2024-2028_Transportation_Improvement_Program%20Endorsed%20May%202023.pdf

[14] https://www.townofbourne.com/sites/g/files/vyhlif12841/f/news/2019_final_revision_comprehensive_version_12.5.19.pdf

4.3.2 Existing Conditions

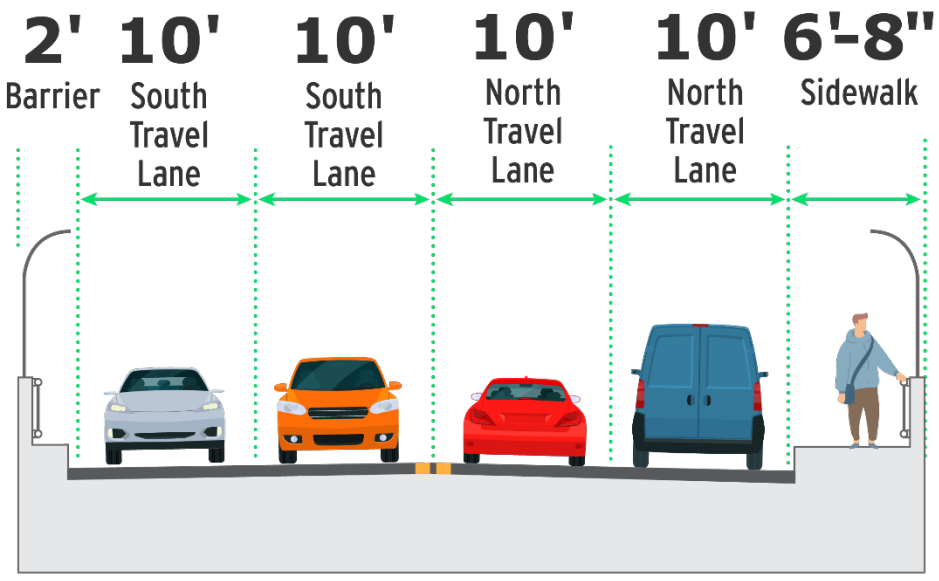
Gaps and unsafe conditions exist in pedestrian and bicycle access across Cape Cod Canal via Sagamore Bridge and Bourne Bridge and between adjacent roadways. There is also a lack of pedestrian and bicycle access to surrounding shared-use facilities within the Study Areas. Many roadways in the Study Areas include a sidewalk on one side of the road. Many sidewalks are discontinuous, noncompliant with ADA standards, or in need of repair. The following sections describe existing pedestrian and bicycle transportation facilities within the Study Areas, with additional details provided for each of the following Study Area quadrants: Sagamore North, Sagamore South, Bourne North, and Bourne South. Discussion of planned pedestrian and bicycle facilities is also presented.

4.3.2.1 Existing Pedestrian and Bicycle Facility Network

Sagamore Bridge and Bourne Bridge

Sagamore Bridge and Bourne Bridge provide the only roadway connections for vehicles and pedestrians across Cape Cod Canal. Each bridge provides a narrow, raised, 6-foot, 8-inch-wide sidewalk along one side that includes steep grades of up to 6%, which are noncompliant with ADA standards. There are no dedicated accommodations for bicycle travel on the bridges. The lack of shoulders and physical barrier separation between the sidewalks and vehicle traffic lanes on the bridges presents safety risks and discomfort for pedestrians due to the proximity of moving motor vehicles. **Figure 4.3-1** provides a representative cross-section of the existing bridges.

Figure 4.3-1. Representative Existing Bridge Cross-Section



Source: Massachusetts Department of Transportation, 2024

For safety reasons, limited-access highways within the Study Areas—State Route 3 and U.S. Route 6 approaching Sagamore Bridge, and State Route 25 approaching Bourne Bridge (north of Cape Cod Canal)—prohibit pedestrian access and do not provide sidewalks. Bicycle access is also prohibited along these limited-access highways.

Cape Cod Canal Service Roads

Within the Study Areas, the Cape Cod Canal Service Roads run along the north and south sides of Cape Cod Canal. The U.S. Army Corps of Engineers (USACE) owns and maintains these service roads as navigational support for the Cape Cod Canal Federal Navigation Project. The North Service Road on the canal is approximately 7 miles long, while the South Service Road is approximately 6.5 miles long. While the purpose of these service roads is primarily for navigation support, they are also popular resources for cycling, walking, and jogging. As illustrated in **Figure 4.3-2**, public access to the Canal Service Roads is provided from three points in the Study Areas:

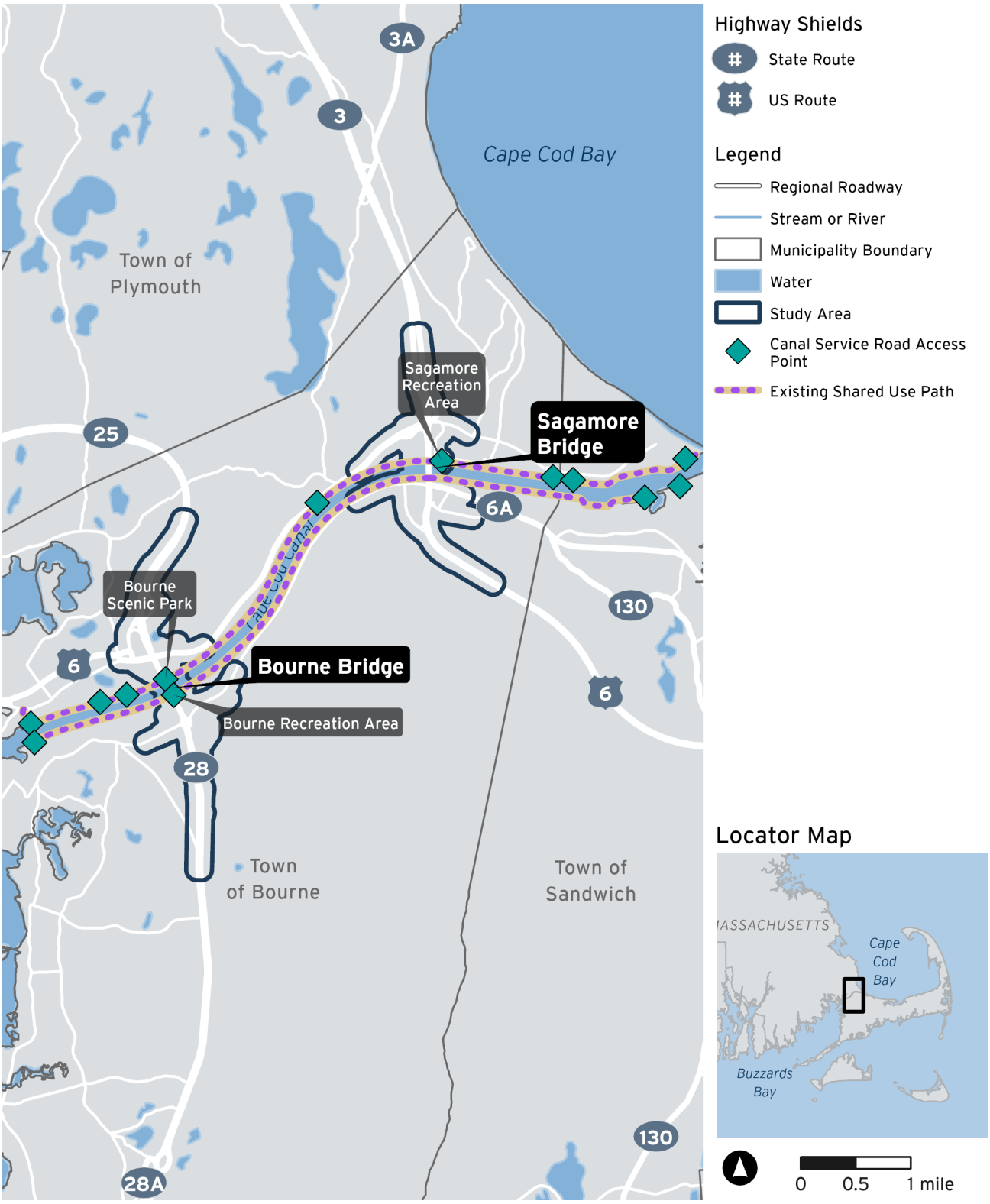
- North of Cape Cod Canal
  - Sagamore Recreation Area
  - Bourne Scenic Park
- South of Cape Cod Canal
  - Bourne Recreation Area

Regional Bicycle and Pedestrian Routes

Within the Study Areas, there are two regional bicycle and pedestrian routes (refer to **Figure 4.3-3** illustrating segments of these routes):

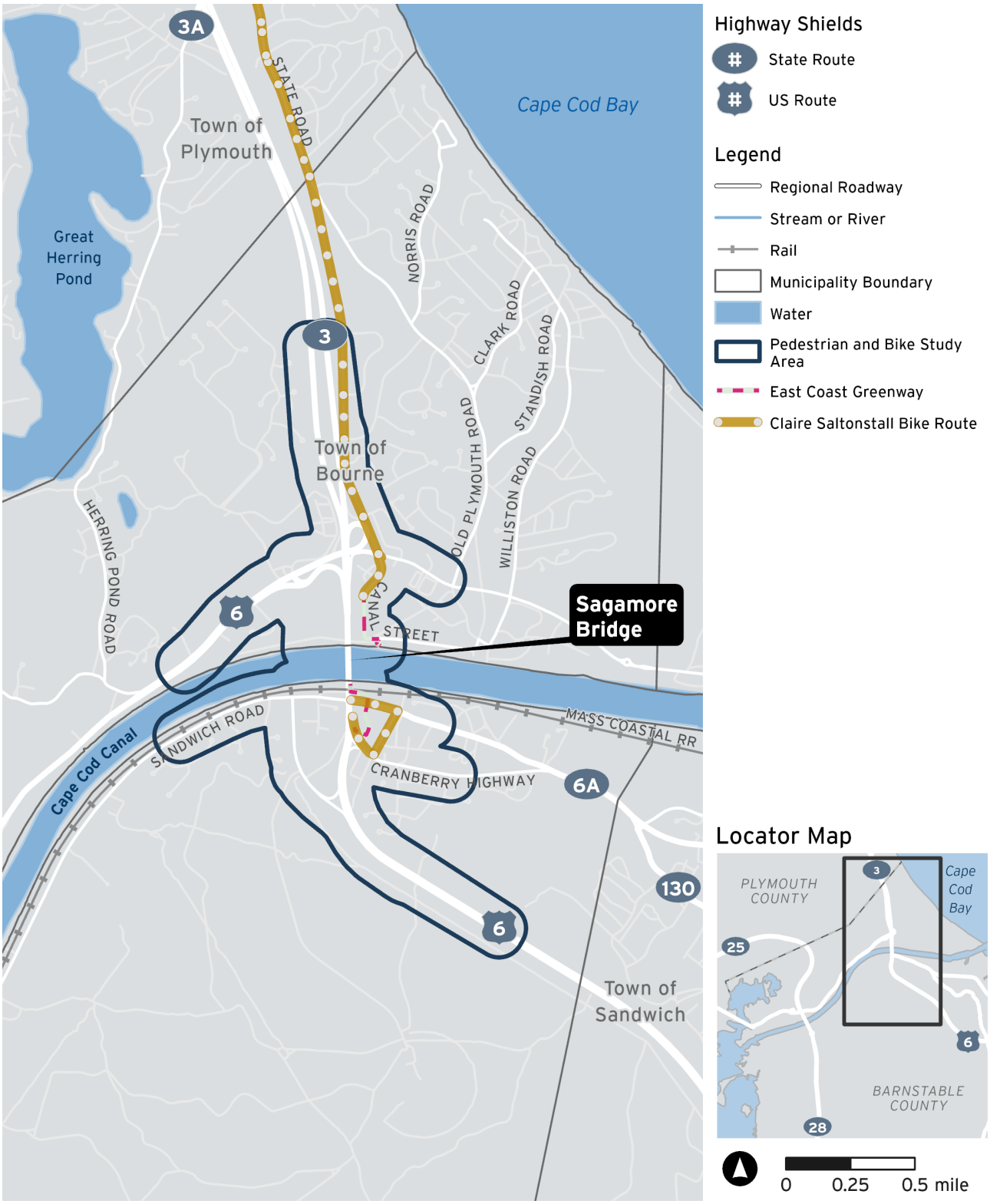
- The Claire Saltonstall Memorial Bikeway is a series of bike paths and on-street routes that travel from the Charles River Bike Path in Boston to both Provincetown and Woods Hole in Cape Cod.
- The East Coast Greenway is a 3,000-mile-long pedestrian and bicycle route between Maine and Florida along the East Coast of the United States.

Figure 4.3-2. Canal Service Road Public Access Points



Source: Massachusetts Department of Transportation, 2024

Figure 4.3-3. Regional Bikeways (Sagamore Bridge Study Area)



Source: Massachusetts Department of Transportation, 2024

Sagamore North Quadrant

North of Cape Cod Canal, the Sagamore Bridge walkway provides pedestrian access to the sidewalk along the east side of Sagamore Bridge at the southern end of the Bourne Park and Ride Lot. **Exhibit 4.3-1** depicts the Sagamore Bridge sidewalk.

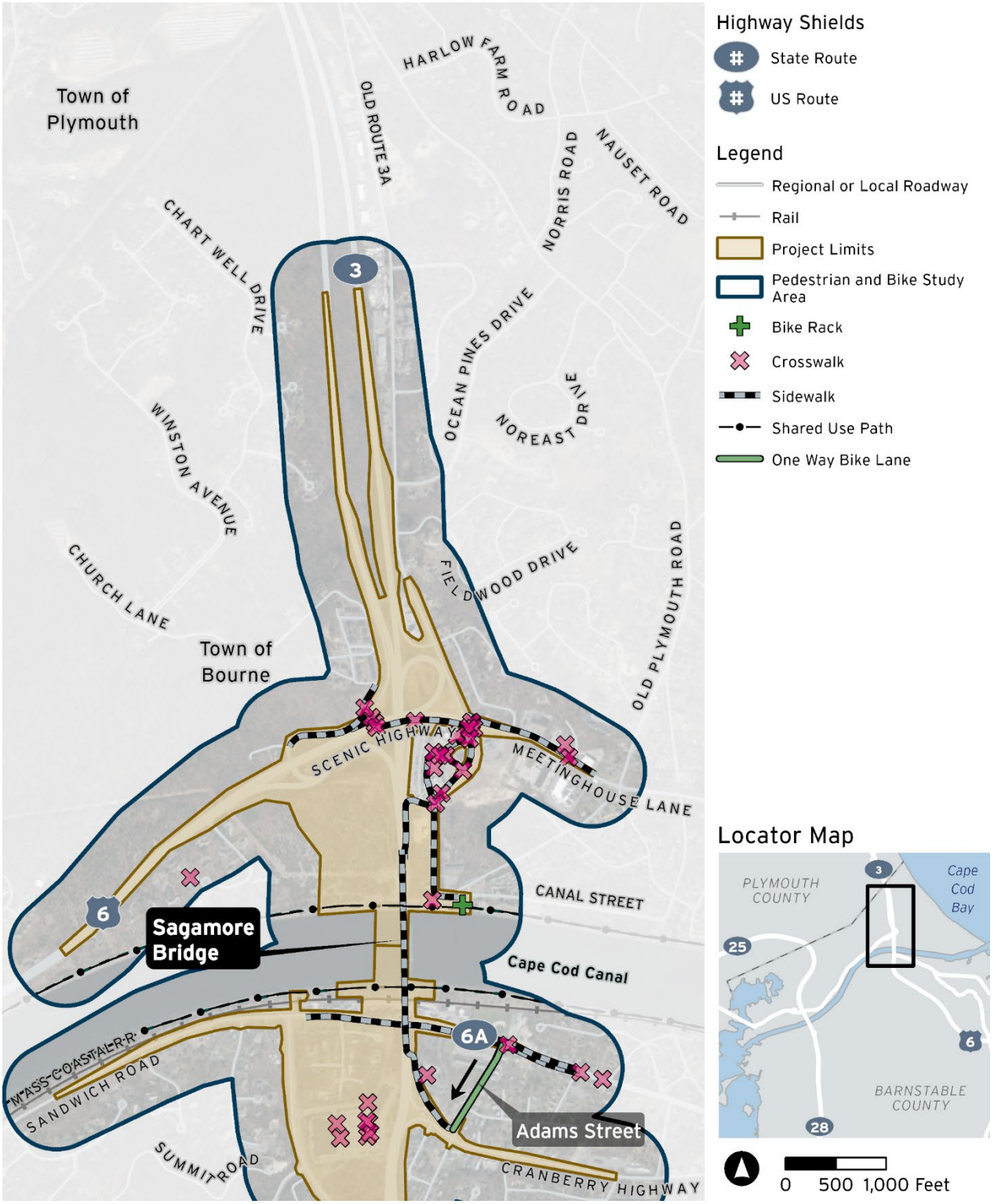
Exhibit 4.3-1. Walkway Leading to Sagamore Bridge



Source: Massachusetts Department of Transportation, 2024

As illustrated in **Figure 4.3-4**, there are missing links or gaps in the network of bicycle and pedestrian facilities from Sagamore Bridge to surrounding neighborhoods south of Scenic Highway and east of State Road (Old Route 3A). There is also a lack of pedestrian and bicycle connectivity to Canal Service Road west of the Sagamore Bridge approach. Apart from the shared use of the Canal Service Road, there is a lack of off-road shared-use facilities in the Sagamore North quadrant.

Figure 4.3-4. Existing Pedestrian and Shared-Use Facilities (Sagamore North Quadrant)



Source: Massachusetts Department of Transportation, 2024

Sagamore South Quadrant

The sidewalk along the east side of Sagamore Bridge ends immediately south of the bridge at a driveway near the windmill at the former Christmas Tree Shops store in Bourne (5 Cranberry Highway). **Exhibit 4.3-2** depicts the Sagamore Bridge sidewalk terminus south of Cape Cod Canal.

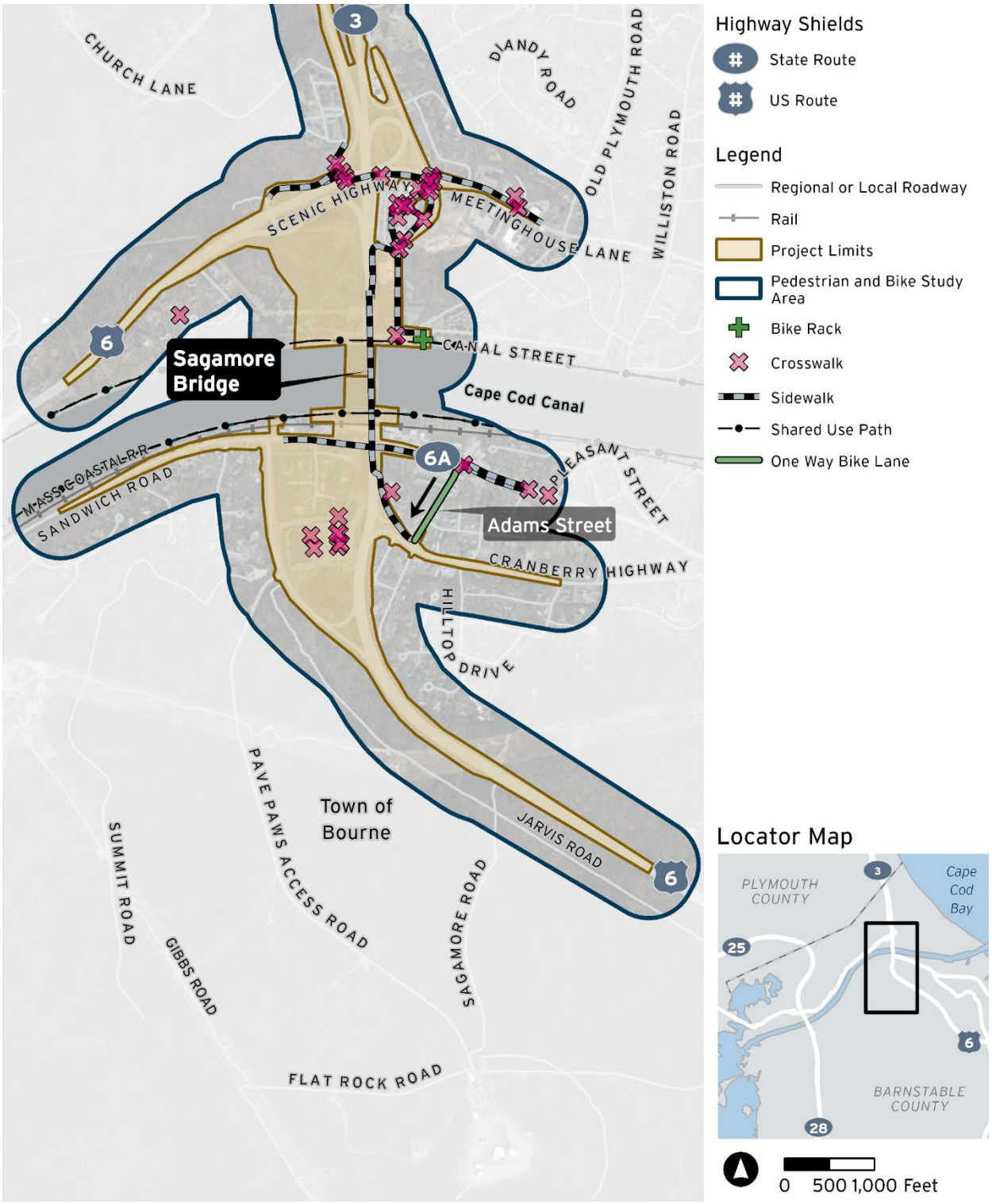
Exhibit 4.3-2. Sagamore Bridge Sidewalk Terminus at Cul-de-Sac (5 Cranberry Highway)



Source: MassDOT, 2024

As illustrated in **Figure 4.3-5**, there are missing links or gaps in the network of bicycle and pedestrian facilities from Sagamore Bridge to surrounding neighborhoods north and south of Sandwich Road and Cranberry Highway. There is also a lack of pedestrian and bicycle connectivity from surrounding neighborhoods to the shared-use Canal Service Road and to Factory Outlet Way, which provides access to a commercial complex, including the Market Basket grocery store and other retail businesses. There is a one-way, marked, on-road bicycle lane along the east side of Adams Street from Sandwich Road ending near its intersection with Cranberry Highway. This marked on-road bicycle lane on Adams Street is part of the Claire Saltonstall Memorial Bikeway (**Figure 4.3-5**). Apart from the shared use of the Canal Service Road, there is a lack of off-road shared-use facilities in the Sagamore North quadrant.

Figure 4.3-5. Existing Pedestrian and Shared-Use Facilities (Sagamore South Quadrant)



Source: Massachusetts Department of Transportation, 2024

Bourne North Quadrant

North of Cape Cod Canal, a narrow, paved walkway from the cul-de-sac at Old Bourne Bridge approach provides pedestrian access to the sidewalk along the west side of Bourne Bridge. **Exhibit 4.3-3** depicts the paved walkway connection from Old Bourne Bridge approach leading to Bourne Bridge.

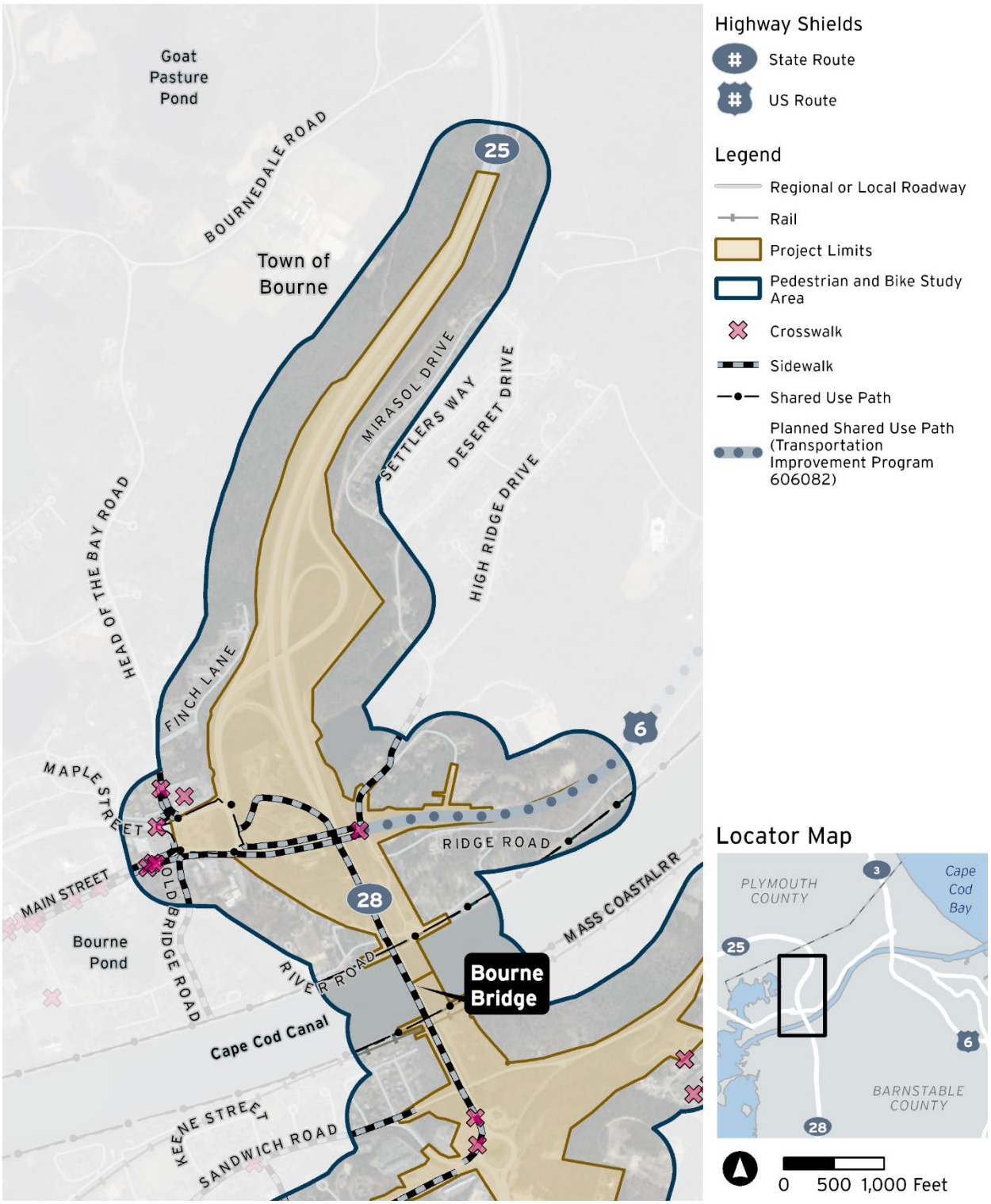
Exhibit 4.3-3. Paved Walkway Leading to Bourne Bridge



Source: Massachusetts Department of Transportation, 2024

In 2023, MassDOT completed traffic and multimodal improvements at Belmont Circle under MassDOT Project File No. 606900. This project installed sidewalks and a SUP along the outer perimeter of the circle, with connections to sidewalks along the roadway approaches to the circle including Scenic Highway, Old Bridge Road, Main Street, Buzzards Bay Bypass, Head of the Bay Road, and Bourne Bridge approach, which provides pedestrian access to Bourne Bridge. In 2025, MassDOT plans to construct a SUP on the south side of Scenic Highway under Project File No. 606082 that would run west to east from the intersections at Nightingale Road/Andy Oliva Drive to Edgehill Road. The western terminus of the planned SUP under MassDOT Project File No. 606082 will be within the Bourne North quadrant. **Figure 4.3-6** depicts existing and planned pedestrian and bicycle facilities within the Bourne North quadrant.

Figure 4.3-6. Existing and Planned Pedestrian and Shared-Use Facilities (Bourne North Quadrant)



Source: Massachusetts Department of Transportation, 2024

Bourne South Quadrant

The sidewalk along the west side of Bourne Bridge ties into a short section of a SUP that continues through the northwest quadrant of Bourne Rotary to the second driveway of the District 7 State Police barracks, where it ends near the intersection at Veterans Way and Trowbridge Road. **Exhibit 4.3-4** depicts the SUP terminus from the Bourne Bridge sidewalk near the intersection at Veterans Way and Trowbridge Road. There is no crosswalk at this intersection to facilitate pedestrian crossing to the sidewalk on Trowbridge Road, which leads to the Bourne Intermediate, Middle, and High Schools.

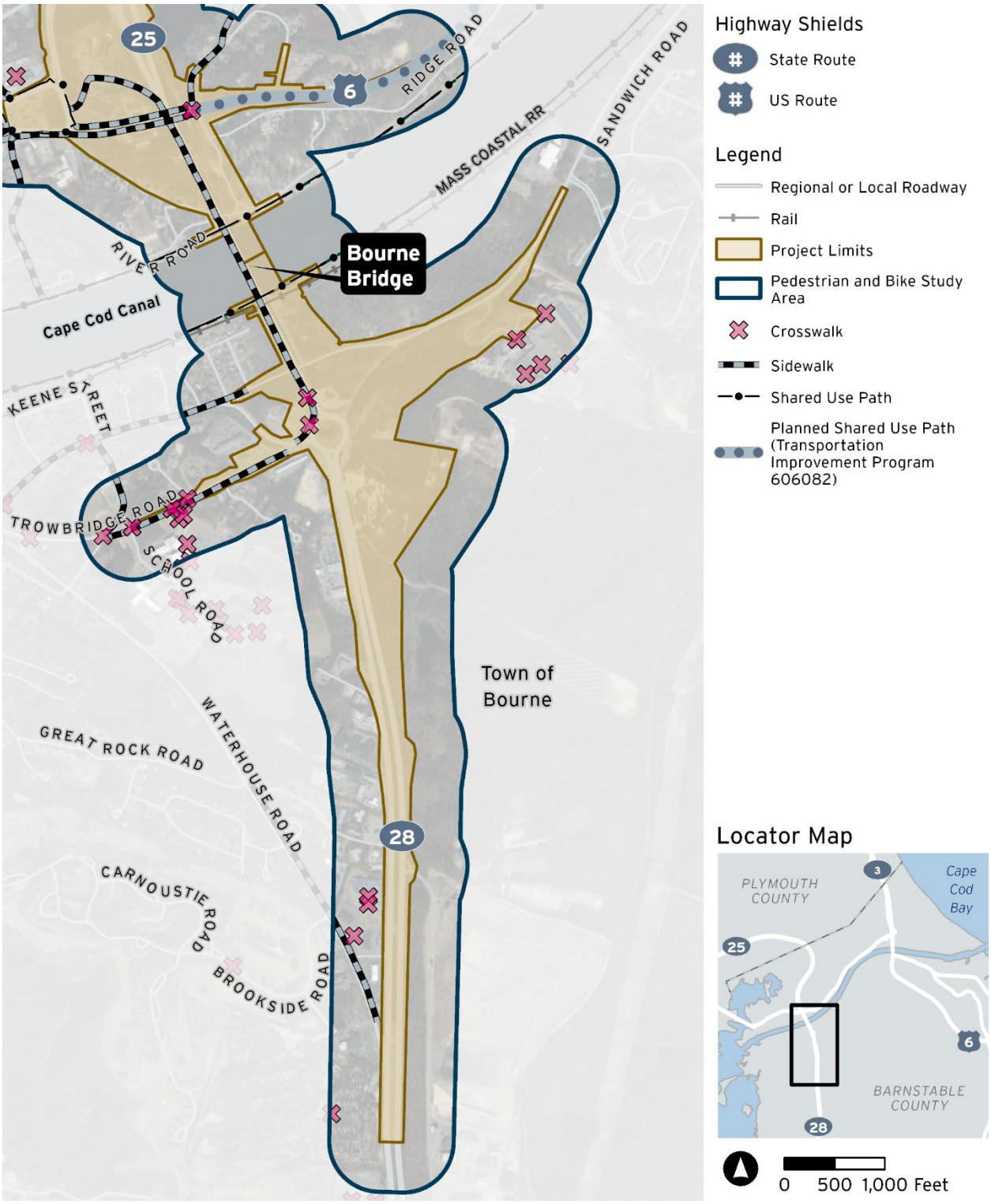
Exhibit 4.3-4. Shared-Use Path Terminus at District 7 State Police Barracks Driveway



Source: Massachusetts Department of Transportation, 2024

As illustrated in **Figure 4.3-7**, there are gaps in the network of pedestrian facilities from Bourne Bridge to neighborhoods along Sandwich Road and Trowbridge Road, and to the Upper Cape Cod Regional Technical High School at 220 Sandwich Road. Apart from the shared use of the Canal Service Road and the short section of the SUP in the northwest quadrant of the Bourne Rotary that ties into the sidewalk on Bourne Bridge, there is a lack of off-road shared-use facilities in the Bourne South quadrant.

Figure 4.3-7. Existing Pedestrian and Shared-Use Facilities (Bourne South Quadrant)



Source: Massachusetts Department of Transportation, 2024

Pedestrian and Bicycle Crash Records

High traffic volumes, narrow roadways and gaps in the pedestrian and bicycle network within the Study Areas pose risks to pedestrian and bicyclist safety. According to pedestrian and bicycle crash records from 2018 to 2023, there were four reported incidents of vehicular collisions with pedestrians within the Sagamore Bridge Study Area. **Table 4.3-1** provides details of the reported vehicle-pedestrian crashes within the Project Limits in the Sagamore Bridge Study Area. Based on available crash records from 2018 to 2023, there were no reported incidents of vehicular collisions with cyclists in the Sagamore Bridge Study Area during this period. **Figure 4.3-8** illustrates the map IDs in **Table 4.3-1** that correspond to pedestrian crash locations within the Project Limits in the Sagamore Bridge Study Area.

Table 4.3-1. Vehicle-Pedestrian Crashes, 2018 to 2023 (Sagamore Bridge Study Area)

Map ID	Street Address	Severity	Vehicle Maneuver
24	Commerce Way (near Sagamore Park and Ride Lot)	Nonfatal injury	Backing up
25	778 Sandwich Road (near the intersection with the Mid-Cape Connector)	No apparent injury	Turning left
26	1 Factory Outlet Way at Market Basket Parking Lot	Nonfatal injury	Backing up
27	880 Sandwich Road (near the intersection with Adams Street)	Suspected serious injury	Traveling straight ahead

Source: Massachusetts Department of Transportation, 2024

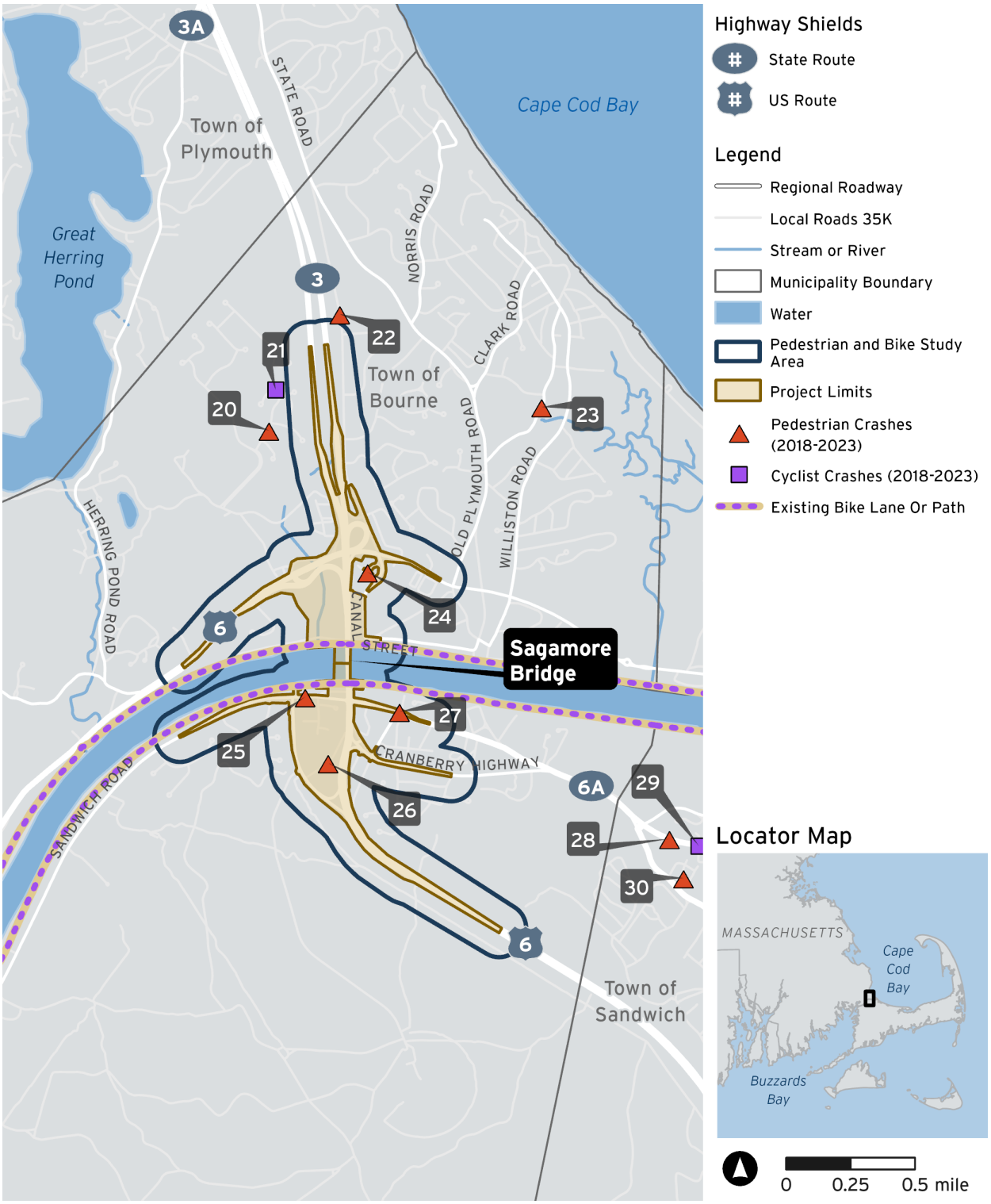
According to pedestrian and bicycle crash records from 2018 to 2023, there were four reported incidents of vehicle collisions with pedestrians and bicyclists from 2018 to 2023, which are listed in **Table 4.3-2**. **Figure 4.3-9** illustrates the map IDs in **Table 4.3-2** that correspond to pedestrian and bicyclist crash locations within the Project Limits in the Bourne Bridge Study Area.

Table 4.3-2. Vehicle-Pedestrian and Bicyclist Crashes, 2018 to 2023 (Bourne Bridge Study Area)

Map ID	Street Address	Severity	Vehicle Maneuver
11	East Rotary Route/Route 25 On-Ramp Route	Nonfatal injury	Vehicle traveling straight ahead
13	370 Scenic Highway (near Andy Oliva Drive intersection at Bourne Scenic Park)	Nonfatal injury	Sideswipe with bicyclist
14	105 Trowbridge Road (near Cape Side Convenience Store)	Suspected serious injury	Slowing or stopped in traffic; vehicle traveling straight
15	290 McArthur Boulevard (near Harbor Hill Drive)	Suspected serious injury	Angle crash with bicyclist in shoulder

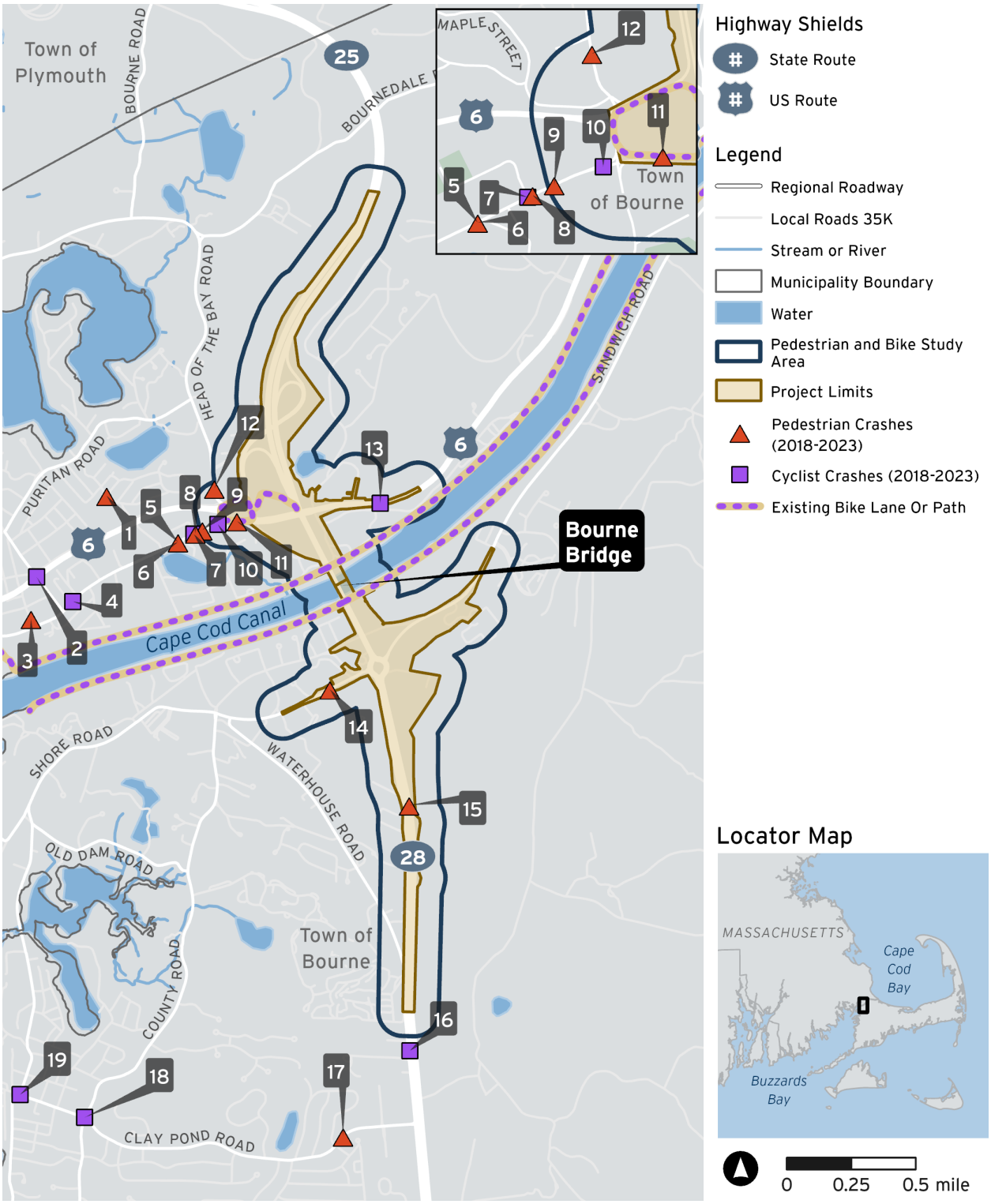
Source: Massachusetts Department of Transportation, 2024

Figure 4.3-8. Vehicle-Pedestrian and Bicyclist Crashes, 2018 to 2023 (Sagamore Bridge Study Area)



Source: Massachusetts Department of Transportation, 2024

Figure 4.3-9. Pedestrian and Bicyclist Crashes, 2018–2023 (Bourne Bridge Study Area)



Source: Massachusetts Department of Transportation, 2024

4.3.3 No Build Alternative

As described in **Section 3.2.1**, the No Build Alternative would involve continual maintenance and repairs to Sagamore Bridge and Bourne Bridge and their approaches to ensure the safety of the traveling public.

While recently completed and proposed transportation improvement projects on the Transportation Improvement Program (**Table 3-2**) would improve conditions and expand opportunities for bicycling and walking on Cape Cod, the No Build Alternative would result in continued limitations to pedestrian and bicycle safety and mobility due to geometric and multimodal deficiencies of Sagamore Bridge and Bourne Bridge, which provide the only roadway access points to and from Cape Cod.

The No Build Alternative would not improve pedestrian and bicycle accommodations, mobility, or accessibility across Cape Cod Canal, which fails to satisfy the Cape Cod Bridges Program's purpose and need. Without improvements to pedestrian and bicycle accommodations across the bridges and connections to the local roadway network, the No Build Alternative would fail to satisfy the goals of the Statewide Bicycle and Statewide Pedestrian Plans, which seek to make walking and biking safe, comfortable, and convenient options for short trips.

4.3.4 Program Impacts

For the Build Alternative, each replacement bridge would provide designated pedestrian and bicycle infrastructure separated from vehicular traffic. At minimum, there would be 14 feet of separation due to a 12-foot highway shoulder and a 2-foot concrete barrier and at maximum, the separation would exceed 20 feet at the network tied arch. Because Sagamore Bridge and Bourne Bridge serve high traffic volumes (more than 6,000 vehicles per day) with vehicle speeds exceeding 35 mph, separated facilities for bicycle and pedestrian users are proposed to reduce potential conflicts with vehicles.[15] The replacement bridges would provide a 20-foot-wide cross-section for pedestrians and bicyclists along the approach spans. The 20-foot-wide structure width would vary in effective width[16] over the main span. The cross-section design evaluated the most efficient use of the available width to accommodate the comfort level of the anticipated users and the safety of each mode. The maximum longitudinal grade for all shared-use facilities, including bridge profiles, is 4.5% to meet ADA requirements of 5.0%. According to the AASHTO Guidelines,[17] separation is recommended for facilities that anticipate large speed differentials between users. Because the bridge profiles sustain long stretches of 4.0% (Sagamore Bridge) and 4.5% (Bourne Bridge) downgrades on the approaches, increased speeds of 30 mph are anticipated for bicyclists on the descent, and separation between modes is proposed for user safety and comfort.

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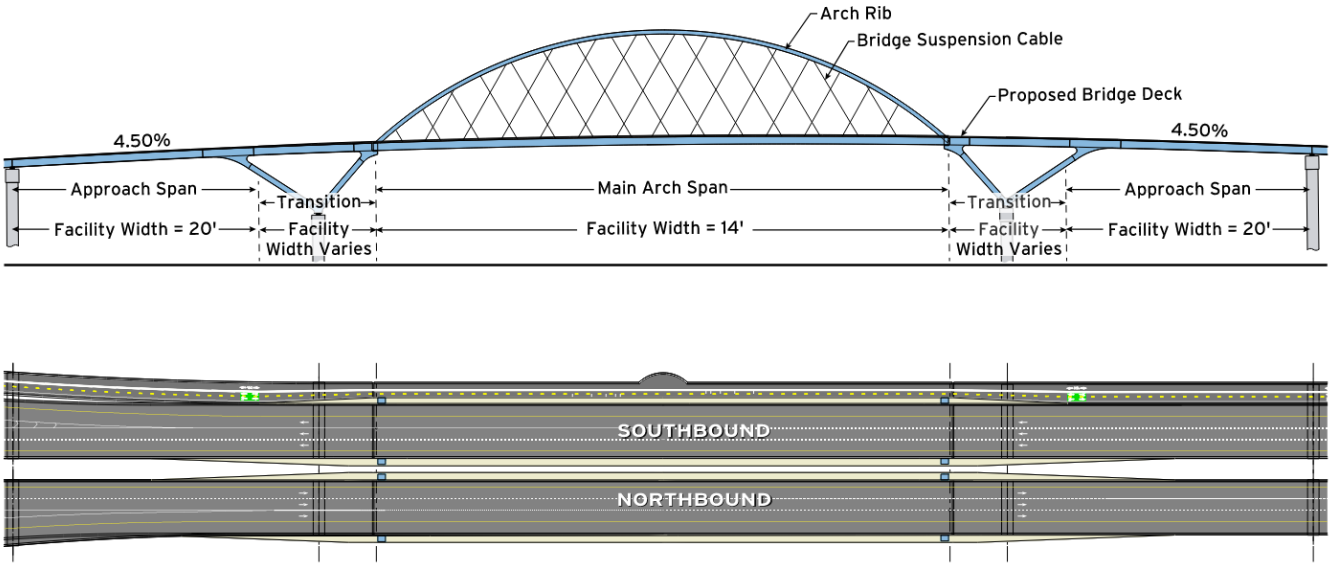
[15] Federal Highway Administration. 2019. Bikeway Selection Guide. February. https://safety.fhwa.dot.gov/ped_bike/tools_solve/docs/fhwasa18077.pdf

[16] The width of the facility from edge of pavement to edge of pavement defines the effective width.

[17] American Association of State Highway and Transportation Officials. 2012. Guide for the Development of Bicycle Facilities (Fourth Edition). https://njdotlocalaidrc.com/perch/resources/aashto-gbf-4-2012-bicycle.pdf

There are two cross-sections over the replacement bridges: at the approach span and at the arch span. **Figure 4.3-10** provides a rendering of the bridge main span and the limits of the bridge approaches, the arch span and suspension cables, and the locations of the arch ribs. The approach cross-section uses the full 20-foot effective width because this is where the greatest speed differential is anticipated between pedestrians and bicyclists. The structure width remains 20 feet at the arch span; however, the effective width of the facility narrows to 14 feet due to the presence of the bridge arch ribs and cables required for suspension. As the arch span signifies the crest of the bridge profile, it is anticipated that bicyclists will be beginning their descent or finishing their climb and will therefore be traveling at lower speeds and not require the additional width needed for the approaches.

Figure 4.3-10. Bridge Main Span and Limits of Approach and Arch Spans (Rendering)



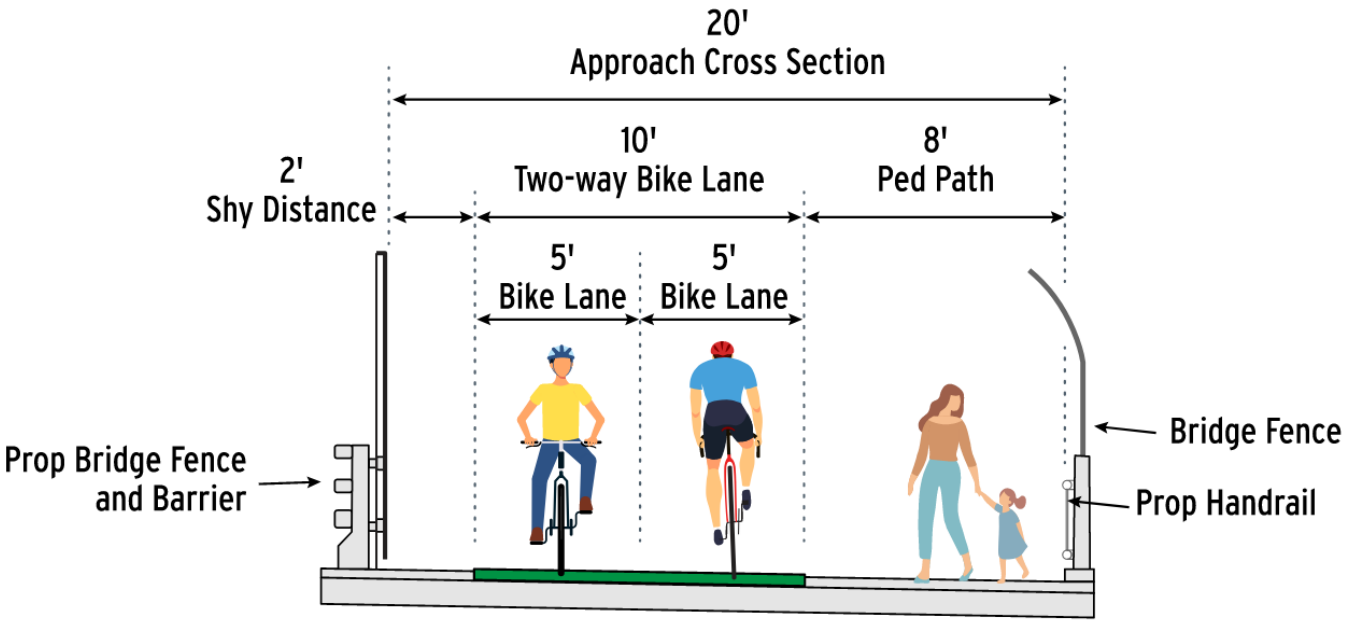
Source: Massachusetts Department of Transportation, 2025

The approach cross-section, using the full effective width of 20 feet, would provide a 10-foot-wide, two-way separated bicycle lane and an 8-foot-wide pedestrian path. The two-way separated bicycle lane would accommodate the recommended width of 5-foot-wide bicycle lanes in each direction and enable passing movements per MassDOT Guidelines.[18] The bicycle facility would be offset 2 feet from the bridge fence and barrier on the vehicle side to accommodate shy distance. The 8-foot-wide pedestrian path would allow for bidirectional travel and the ability to walk in groups. Bridge fence and railing are proposed on the outside edge of the facility to provide pedestrians with unobstructed views of the canal and aid accessibility for the visually and physically impaired. The proposed design would allow pedestrians to stay on the outside edge of the facility with immediate access to the overlook and views of the canal, while bicyclists would remain on the roadway side of the facility to minimize

[18] Massachusetts Department of Transportation. 2015. "Chapter 3, General Design Considerations," Separated Bike Lane Planning & Design Guide. https://www.mass.gov/doc/chapter-3-general-design-considerations/download

conflicts of mixed-use lanes and crossing pedestrian traffic. **Figure 4.3-11** provides a typical cross-section of the approach cross-section.

Figure 4.3-11. Typical Section of Shared-Use Facility at Approach Span (looking southbound)

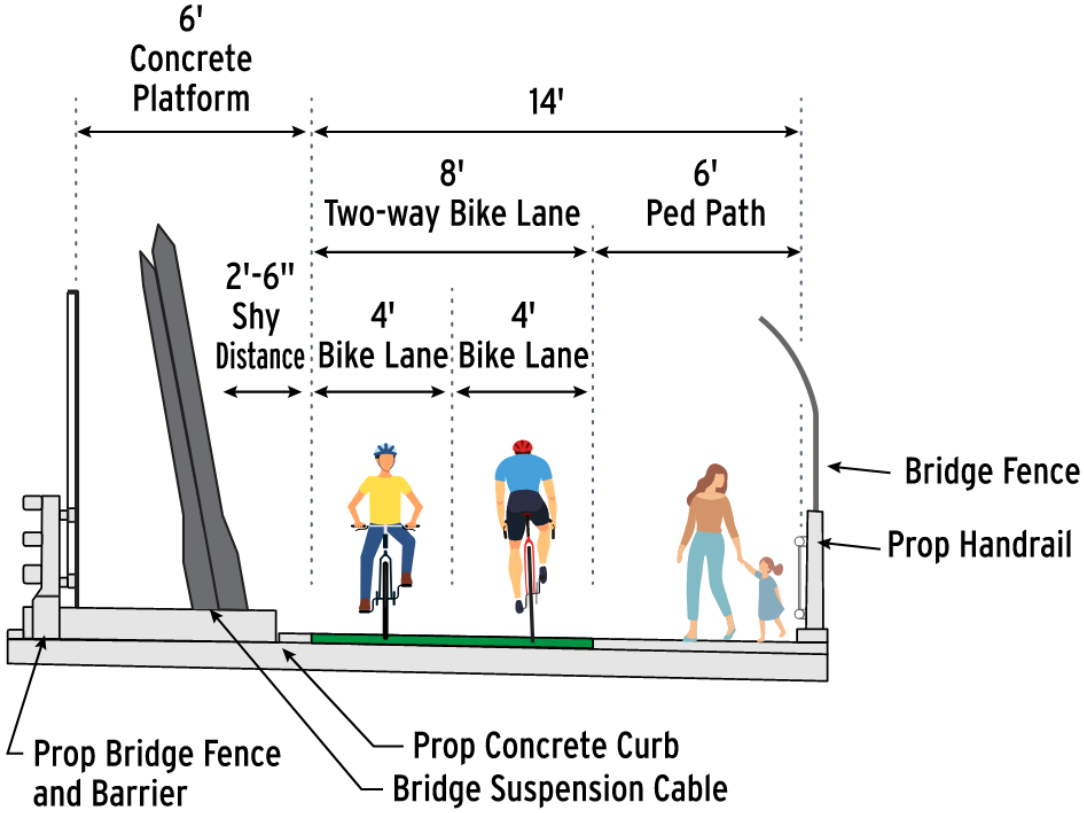


Source: Massachusetts Department of Transportation, 2025

The arch cross-section would narrow its effective width from 20 feet to 14 feet. The alignment of the facilities would remain the same; however, both facilities would be narrowed to meet minimum width requirements and shy distance offsets. The two-way bicycle lane would narrow to 8 feet, which would meet the minimum width for bidirectional bicycle lanes outlined in MassDOT's Guidelines (Chapter 3).[19] Although a 10-foot width is preferred for this type of facility, narrowing the facility to 8 feet within the arch span is required due to the constrained width. This would still allow bidirectional movement but would restrict the ability for passing movements. The arch span is expected to maintain lower speeds than the approaches because bicyclists would be reaching the crest of the bridge profile or just starting their descents. The pedestrian path would narrow to 6 feet wide and would remain on the outside of the facilities to maintain continuity and provide uninterrupted views of the canal over the bridges. The proposed shy distances and offsets to vertical objects and obstructions would meet MassDOT Guidelines (Chapter 11).[20] **Figure 4.3-12** provides a typical cross-section of the approach cross-section. **Figure 4.3-13** provides a rendering of the proposed shared-use facility at the arch span on the replacement bridge.

[19] https://www.mass.gov/doc/chapter-3-general-design-considerations/download
[20] https://www.mass.gov/info-details/pddg-chapter-11-shared-use-paths

Figure 4.3-12. Typical Section of 14-foot-wide Shared-Use Facility on Arch Span (Southbound)



Source: Massachusetts Department of Transportation, 2025

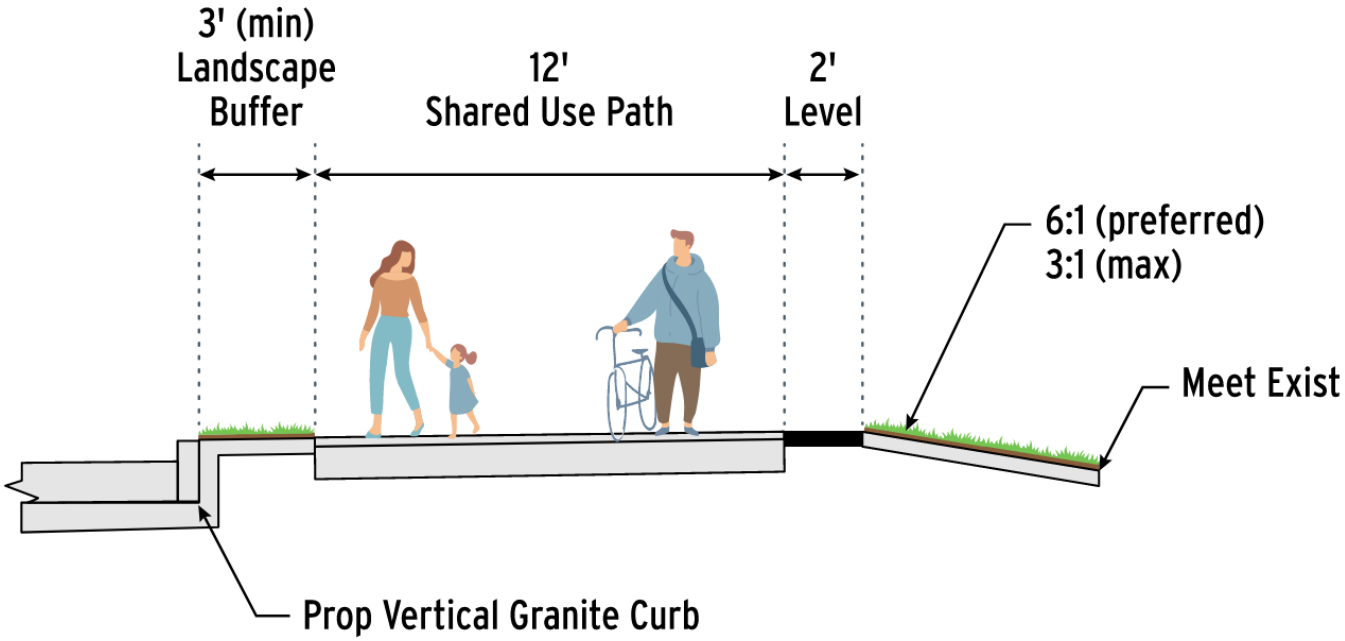
Figure 4.3-13. Shared-Use Facility on Replacement Bridge (Rendering)



Source: Massachusetts Department of Transportation, 2024

The addition of the shared-use facilities along the replacement bridge main spans and interchange approaches would provide connections to local roadways and to the USACE's Canal Service Roads in all four Study Area quadrants (i.e., Sagamore North, Sagamore South, Bourne North, and Bourne South). Off the main spans and the structure, designated space for bicycles and pedestrians would also be accommodated within the typical section for local roadways. Once off the bridge, the local roadway profiles would follow the landscape, and the differential between design speeds for pedestrians and bicyclists would not be significant enough to justify separation of modes. Additionally, the lack of bridge barrier, curbing, and fencing off-structure would allow for the ability to share space without needing to accommodate shy distance for obstructions. The facility off-structure would provide a consistent 12-foot-wide SUP with a minimum 3-foot-wide landscaped buffer on the roadway side and a minimum 2-foot-wide level area on the opposite side. **Figure 4.3-14** provides a typical section of the SUP applied off-structure for the rest of the Project Limits and local roadways.

Figure 4.3-14. Typical Section of 12-foot-wide Shared-Use Path Off-Structure



Source: Massachusetts Department of Transportation, 2025

4.3.4.1 Sagamore North Quadrant

As described in the previous section, a 20-foot-wide shared-use facility would be provided along the eastbound side of U.S. Route 6 on the Sagamore Bridge approach. The 20-foot-wide elevated facility would narrow to a 12-foot-wide SUP along the eastbound on-ramp and the south side of Scenic Highway. The Build Alternative proposes new pedestrian and bicycle connections from Sagamore Bridge to all four quadrants of the interchange. The facility along Scenic Highway would now extend to the Brigantine Passage Drive neighborhood at the western end of the Study Area and Commerce Way, State Road, and Meeting House Lane at the eastern end of the Study Area. There is an existing sidewalk connection from Church Lane at the southbound off-ramp across Scenic Highway. These connections would now allow the residential neighborhoods within the Study Area to have safe and comfortable, separated facilities to access the Sagamore Park and Ride Lot, Bus Depot, and the shared-use Canal Service Road. An additional connection would be provided from the eastbound on-ramp to the shared-use Canal Service Road along the canal. Scenic overlooks, park benches, lighting, trash cans, and other amenities would also be provided along the SUP connection to the shared-use Canal Service Road. **Figure 4.3-15**. depicts the conceptual layout of proposed SUP facilities and sidewalks in the Sagamore North quadrant.[21]

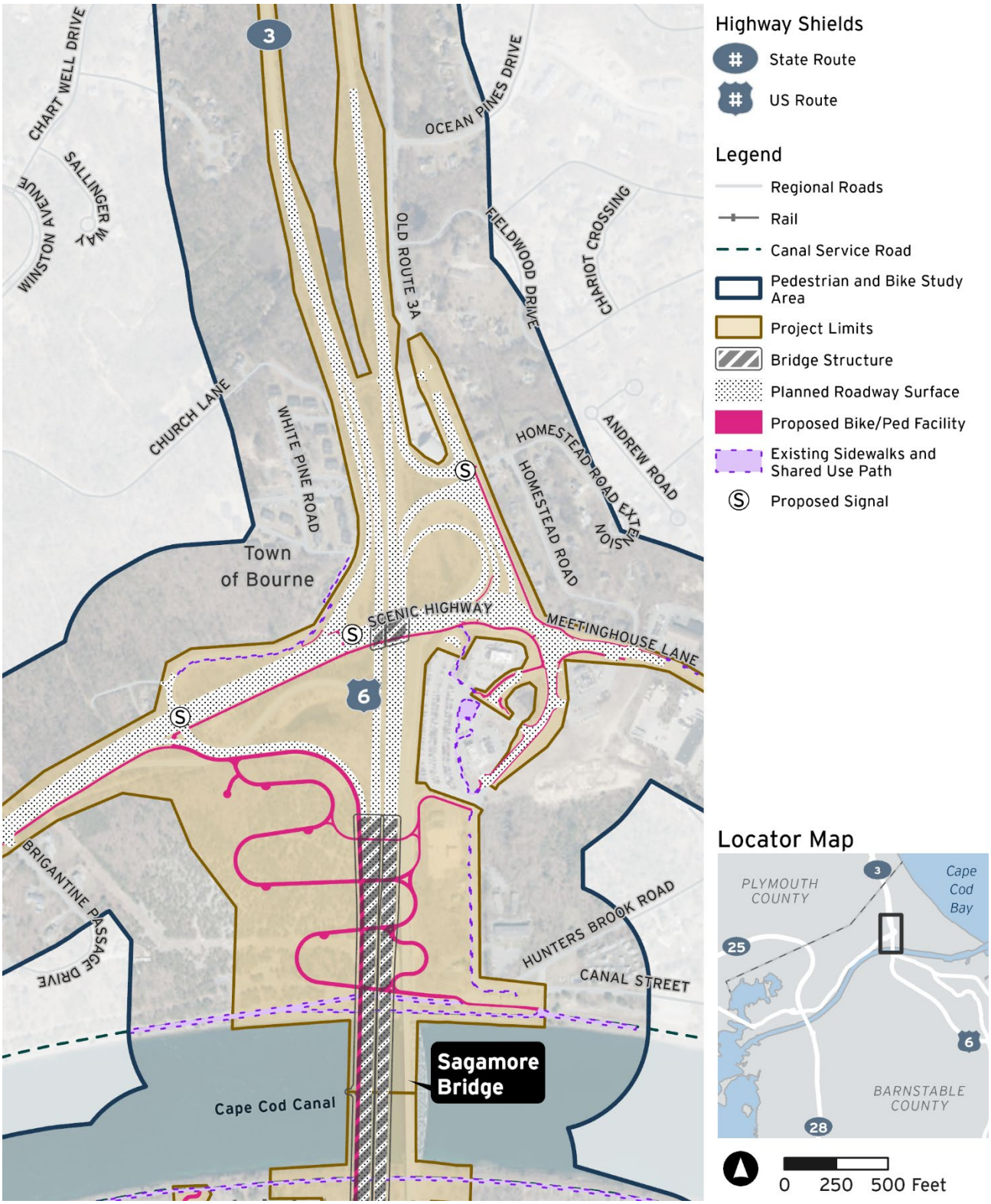
4.3.4.2 Sagamore South Quadrant

A 20-foot-wide shared-use facility would be provided along the eastbound side of Route 6 on the Sagamore Bridge, which continues along the eastbound off-ramp and Mid-Cape Connector to the intersection of Cranberry Highway. At Cranberry Highway, the shared-use facility would transition to a 12-foot-wide SUP that would extend west to Autumn Way, north to the shared-use Canal Service Road, and east to Adams Street. The SUP at-grade crossing of the Massachusetts Coastal Railroad tracks to the shared-use Canal Service Road would be signalized with flashing warning beacons for public safety. A 12-foot-wide SUP would be provided along the perimeter of the dual roundabouts and would connect to Cranberry Highway and Adams Street. Buffered bicycle lanes and sidewalks would connect the gap between the Mid-Cape Connector and the dual roundabouts and would provide a key connection to Market Basket. **Figure 4.3-16**. depicts the conceptual layout of proposed pedestrian and bicycle facilities in the Sagamore South quadrant.[22]

[21] This shared-use path configuration is based on a preliminary design as of August 2024. Any subsequent updates will be included in the Final Environmental Impact Report.

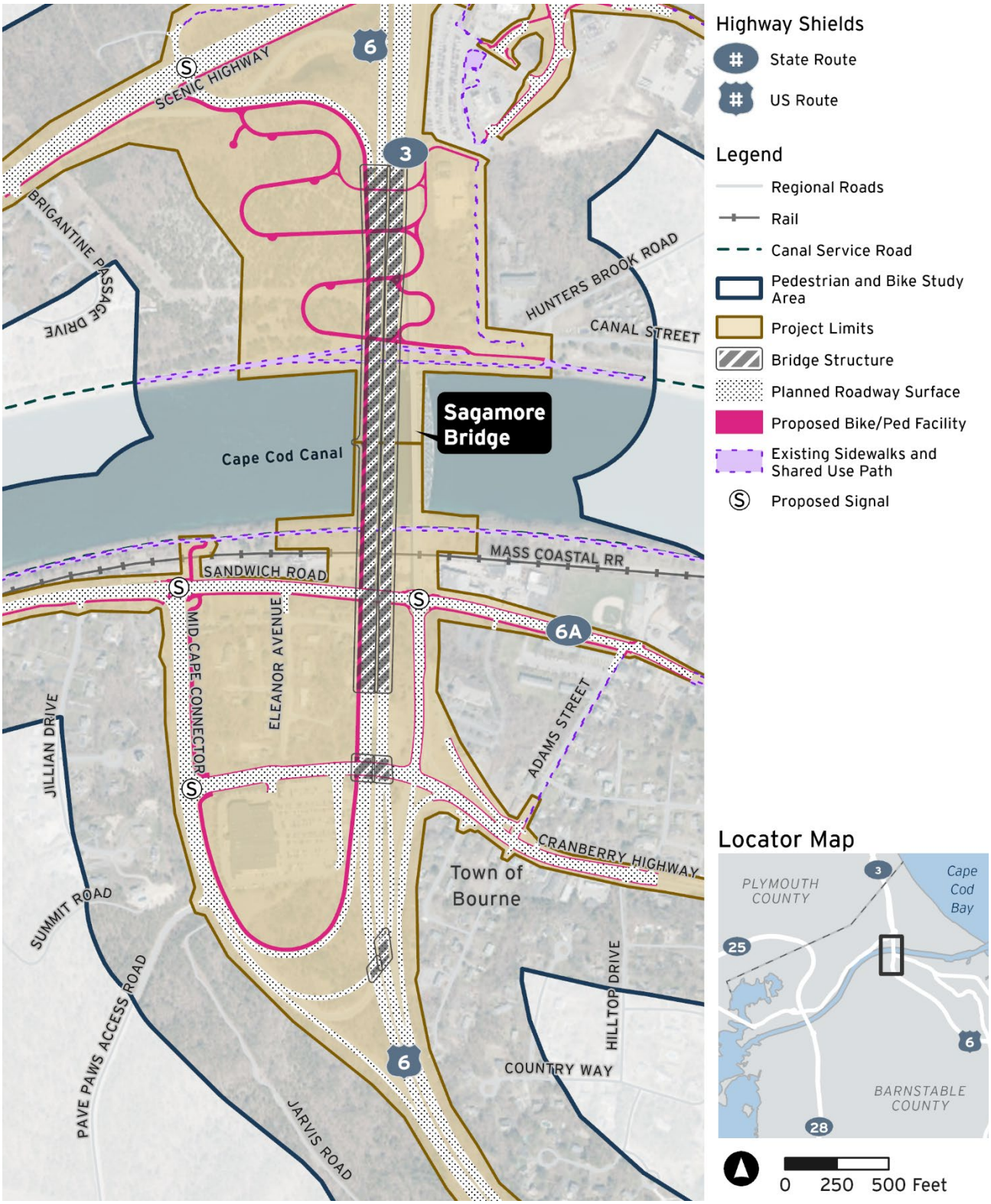
[22] This shared-use path configuration is based on a preliminary design as of August 2024. Any subsequent updates will be included in the Final Environmental Impact Report.

Figure 4.3-15. Pedestrian and Bicyclist Facilities (Sagamore North Quadrant)



Source: Massachusetts Department of Transportation, 2024

Figure 4.3-16. Pedestrian and Bicycle Facilities (Sagamore South Quadrant)



Source: Massachusetts Department of Transportation, 2024

4.3.4.3 Bourne North Quadrant

A 20-foot-wide shared-use facility would be provided on the approach spans and off-structure along the southbound side of State Route 28 over Bourne Bridge and would continue along the eastbound off-ramp toward Belmont Circle. Once off-structure, the shared-use facility would transition to a 12-foot-wide SUP that would connect Belmont Circle to U.S. Route 6 (Scenic Highway). The SUP would connect to the 12.5-foot-wide SUP constructed along the south side of Scenic Highway from Nightingale Road to Edgehill Road as part of MassDOT Project No. 606082. A SUP connection from U.S. Route 6 to the shared-use Canal Service Road would also be provided to connect the town center of Bourne to the campground and the existing recreational facilities along the canal. A sidewalk and bicycle ramps to shoulder bicycle lanes are proposed connections to the existing facilities on Nightingale Road. **Figure 4.3-17** depicts the conceptual layout of proposed SUPs and sidewalks in the Bourne North quadrant.[23]

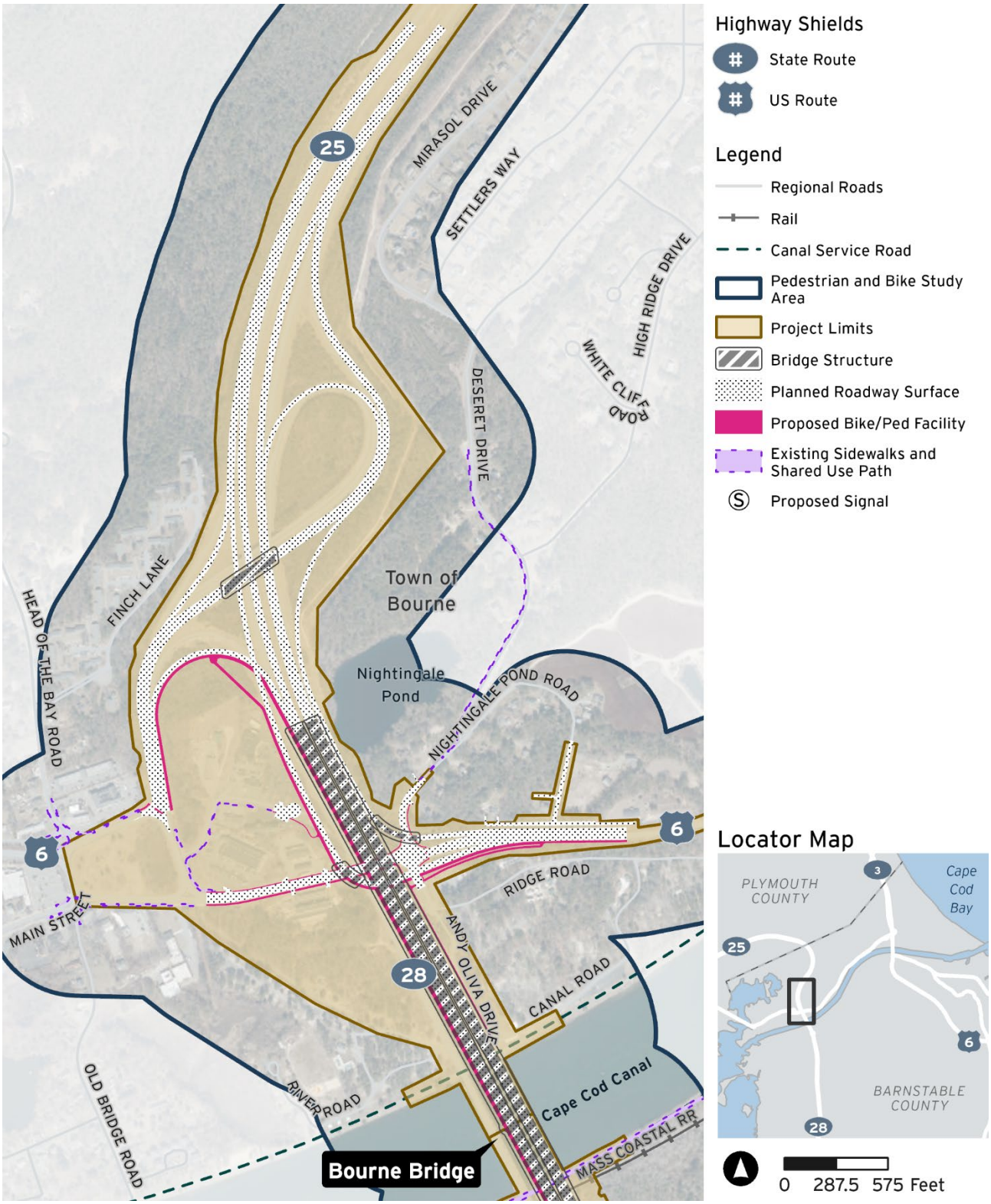
4.3.4.4 Bourne South Quadrant

A 20-foot-wide shared-use facility would be provided along the southbound side of State Route 28 over Bourne Bridge and would continue along the southbound off-ramp toward the District 7 State Police barracks. At this transition from on-structure to off-structure, a mixing zone with wayfinding signs and landscape features would be provided. The shared-use facility would transition to a 12-foot-wide SUP at the mixing zone and would provide desired connections to the Canal Service Road at the northern end of the Project Limits, the Upper Cape Vocational School, and the Gallo Ice Arena at the eastern end of the Project Limits, and Sandy Lane at the western end of the Project Limits. There is a rail crossing at the connection to the Canal Service Road and the existing SUP facilities along the canal. The rail crossing would be signalized with warning beacons. With the proposed design, residents within the Bourne South quadrant would have safe, comfortable, and separated facilities to access the local schools, bus depot, businesses, and recreational facilities. **Figure 4.3-18** and **Figure 4.3-19** depict the conceptual layout of the proposed shared-use facilities and sidewalks in the Bourne South quadrant.[24]

[23] This shared-use path configuration is based on a preliminary design as of August 2024. Any subsequent updates will be included in the Final Environmental Impact Report.

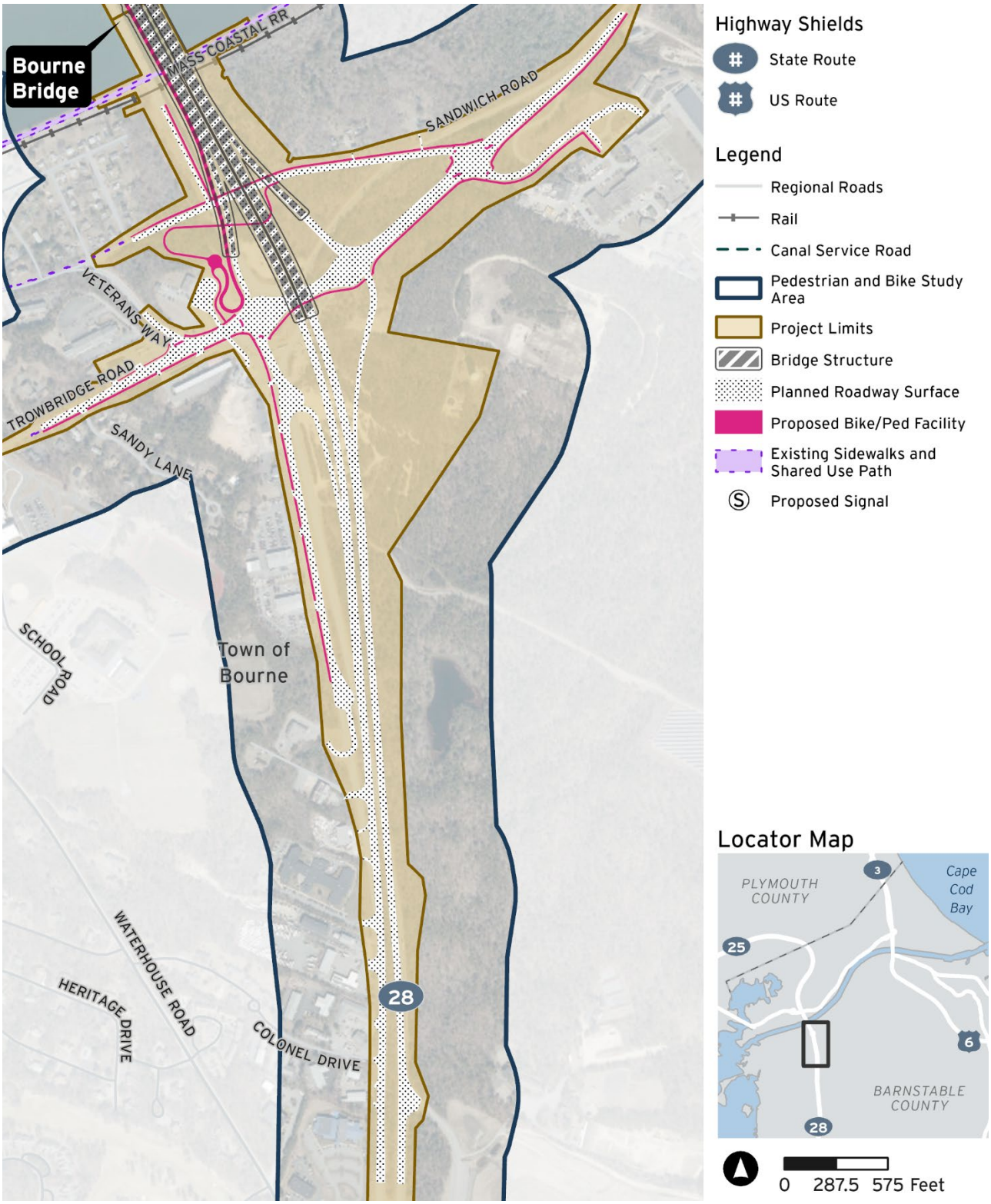
[24] This shared-use path configuration is based on a preliminary design as of August 2024. Any subsequent updates will be included in the Final Environmental Impact Report.

Figure 4.3-17. Pedestrian and Bicyclist Facilities (Bourne North Quadrant)



Source: Massachusetts Department of Transportation, 2024

Figure 4.3-18. Pedestrian and Bicyclist Facilities (Bourne South Quadrant Westernmost Figure)



Source: Massachusetts Department of Transportation, 2024

4.3.4.5 Operational Impacts

The Build Alternative would provide pedestrians and bicyclists with safe and comfortable connections to schools, jobs, essential services, recreational areas, and other destinations within the Study Areas. The provision of off-road SUPs and facilities would reduce potential conflicts with pedestrians, cyclists, and motorists by providing physically separated travel areas for nonmotorized road users. Connected networks of walking and bicycling infrastructure would provide long-term public health benefits due to increased opportunity for active transportation and improved air quality by reducing reliance on motor vehicles for short trips.

The Build Alternative would improve accommodations, mobility, and accessibility for pedestrians and bicyclists, consistent with the Cape Cod Bridges Program's purpose and need. Proposed SUP connections from the replacement bridges and adjacent roadways to the USACE Canal Service Roads would support bicycle-pedestrian connections to recently completed and future planned regional SUP projects.

The Build Alternative would expand and close gaps in the bicycle and ADA-accessible sidewalk networks, consistent with the goals of the Cape Cod Regional Transportation Plan.[25] These infrastructure improvements would make walking and biking more convenient, comfortable, and safer options for short trips than driving, which are consistent with the goals of MassDOT's Massachusetts Pedestrian Transportation Plan and Bicycle Transportation Plan.[26]

4.3.4.6 Construction-Period Impacts

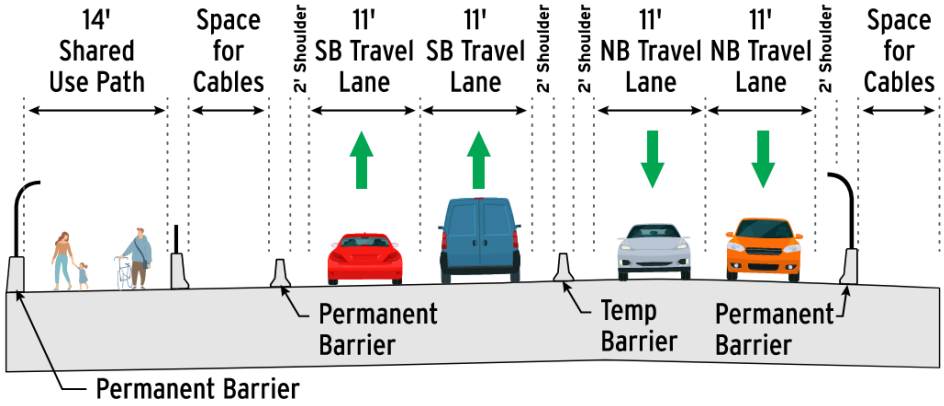
The Build Alternative would provide pedestrian and bicycle facilities that meet or exceed existing conditions throughout the duration of construction. For Sagamore Bridge and Bourne Bridge, existing and temporary connections on each side of the bridges would be used. Crossing the canal via Sagamore Bridge, pedestrian and bicycle accommodations would use the existing bridge during construction of the new southbound bridge. Once the new southbound bridge is constructed, the proposed shared-use facility discussed in **Section 4.3.3** would be open for use (**Figure 4.3-19**). Crossing the canal via Bourne Bridge, pedestrian and bicycle accommodations would use the existing bridge during construction of the new northbound bridge. Once the new northbound bridge is constructed, temporary pedestrian and bicycle facilities would use the new northbound bridge outside shoulder, westbound on-ramp for the Bourne North quadrant and the new northbound on-ramp for the Bourne South quadrant via a barrier separation (**Figure 4.3-20**). Once the new southbound bridge is constructed, the shared-use facility discussed in **Section 4.3.4** would be open for use.

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[25] Cape Cod Commission. 2023. Cape Cod 2024 Regional Transportation Plan (2024–2044). July. https://www.capecodcommission.org/resource-library/file/?url=/dept/commission/team/tr/Transportation%20Plans/RTP/2024_RTP/Report/FINAL%20PDF/Cape%20Cod%202024%20Regional%20Transportation%20Plan_Endorsed%20072420 23.pdf

[26] Massachusetts Department of Transportation. 2019. Massachusetts Pedestrian Transportation Plan. May. https://www.mass.gov/info-details/pedestrian-plan
Massachusetts Department of Transportation. 2019. Massachusetts Bicycle Transportation Plan. May. https://www.mass.gov/info-details/bicycle-plan

Figure 4.3-19. Temporary Typical Main Span Section (Sagamore Bridge Southbound Crossing, facing north)

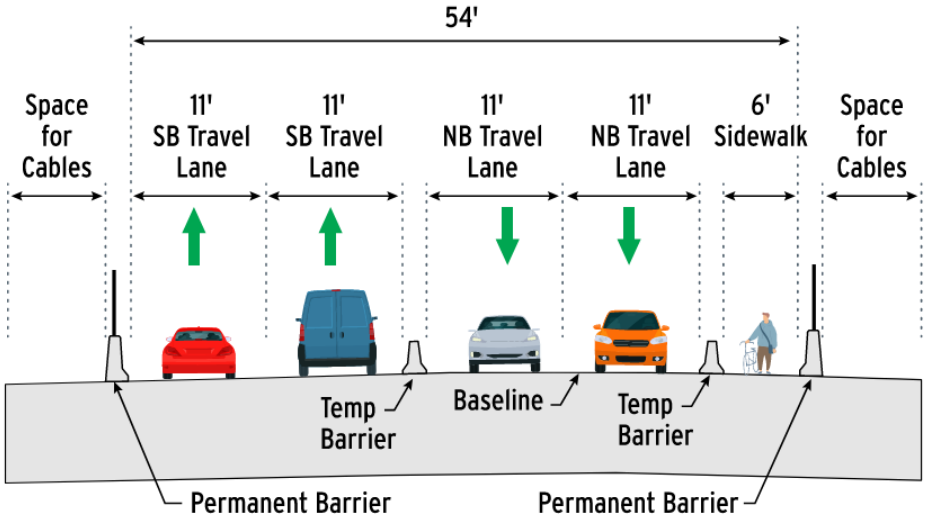


Typical Main Span Section - Temporary Condition
(Looking North)

Source: Massachusetts Department of Transportation, 2025

NB = northbound, SB = southbound

Figure 4.3-20. Temporary Typical Main Span Section (Bourne Bridge Northbound Crossing, facing north)



Typical Main Span Section - Temporary Condition
(Looking North)

Source: Massachusetts Department of Transportation, 2025

NB = northbound, SB = southbound

The Build Alternative would require temporary closures of pedestrian and bicycle facilities that run under the bridge mainline structures including Scenic Highway, Sandwich Road, and the Canal Service Roads. These temporary closures would be necessary to facilitate bridge construction and demolition activities within the work zones at both crossings. The duration of closures is still to be determined, but closures could be several weeks or maybe as much as seven to eight years, depending on location and proximity to construction of the main span structures. **Section 4.3.5** provides measures to avoid, minimize and mitigate potential construction-period impacts associated with the Build Alternative.

4.3.5 Mitigation

4.3.5.1 Operational Impacts

As described in **Section 4.3.4**, the Build Alternative would provide long-term improvements to bicycle and pedestrian facilities within the Study Areas through construction of shared-use facilities on the new bridge approach and arch spans with connections to new shared-use facilities (off-structure). Therefore, no long-term mitigation measures would be required.

4.3.5.2 Construction-Period Impacts

Based on coordination with the USACE, MassDOT will be required to deploy signage warning of service road closure and distance to closure at all official trail heads. Fencing and barricades will be used to prevent pedestrian access into unsafe areas within the construction work zone. The phasing for pedestrian and bicycle connectivity during construction will be sequenced to maintain existing conditions until a time when pedestrian and bicycle traffic can be transferred to the proposed bridge. Appropriate signage will be designated for any required temporary detour routes during construction.

4 Existing Conditions, Program Impacts, and Mitigation

4.4 Maritime Transportation, Traffic, and Safety

4.4.1 Introduction

This section assesses the potential impacts of the Build and No Build Alternatives on the Cape Cod Federal Navigation Project (FNP), including the waterway and the abutting lands. This section also assesses the construction-period impacts on marine traffic—including commercial and recreational vessel traffic—and navigational safety and security, and it identifies measures to minimize impacts.

4.4.1.1 Regulatory Context

The U.S. Army Corps of Engineers (USACE) regulates navigation through the Cape Cod Canal (the canal), per 33 Code of Federal Regulations (CFR) 207.20, Navigation Regulations, Cape Cod Canal, Massachusetts; Use, Administration and Navigation.[1] This section was prepared using federal regulatory directives and guidance, including the following:

- U.S. Coast Guard's (USCG) Office of Bridge Programs, Bridge Permit Application Guide[2]
- USACE polices for altering a federally authorized civil works project pursuant to 33 United States Code (USC) 408[3]
- State guidance regarding consideration of climate change

4.4.1.2 Methodology and Study Area

This section was developed in consultation with the USACE and the USCG. Data on the canal FNP, including information on marine traffic, were obtained from the USACE New England District[4] and the USACE's Major Rehabilitation Evaluation Report/Environmental Assessment (MRER/EA).[5] Data on historical freight and cargo vessels were obtained from the USACE's Waterborne Commerce Statistics Center (WCSC).[6]

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[1] https://www.ecfr.gov/current/title-33/chapter-II/part-207/section-207.20

[2] U.S. Coast Guard. 2025. https://www.dco.uscg.mil/Portals/9/CG_Bridge_Permit_App_Guide_Apr2025.pdf

[3] U.S. Army Corps of Engineers. 2018. Engineering Circular 1165-2-220, Policy and Procedural Guidance for Processing Requests to Alter US Army Corps of Engineers Civil Works Projects pursuant to 33 USC 408. September 10. https://www.publications.usace.army.mil/Portals/76/Publications/EngineerCirculars/EC_1165-2-220.pdf

[4] U.S. Army Corps of Engineers. n.d. Cape Cod Navigation Project. https://www.nae.usace.army.mil/Missions/Civil-Works/Navigation/Massachusetts/Cape-Cod-Canal/

[5] U.S. Army Corps of Engineers. n.d. Cape Cod Canal Bridges Major Rehabilitation Study Project Information. https://www.nae.usace.army.mil/Missions/Projects-Topics/Cape-Cod-Canal-Bridges-Major-Rehabilitation-Study/

[6] U.S. Army Corps of Engineers. n.d. Waterborne Commerce Statistics Center. https://www.iwr.usace.army.mil/About/Technical-Centers/WCSC-Waterborne-Commerce-Statistics-Center-2/

The Maritime Study Area consists of the 8.1-mile-long land cut of Cape Cod Canal and the adjacent lands of the canal FNP (**Figure 4.4-1** and **Figure 4.4-2**) and the marinas and major docking facilities, public boat ramps, and boat repair facilities within a 1-mile radius of the entrance to the canal land cut from Buzzards Bay and Cape Cod Bay (**Figure 4.4-3**).

4.4.2 Existing Conditions

4.4.2.1 Background and Setting

Cape Cod Canal is a sea-level 17.4-mile navigable waterway that offers the shortest deep-draft passage between New York City and Boston. It has an approach channel length of 9.3 miles and an 8.1-mile-long land cut connecting Buzzards Bay in the southwest and Cape Cod Bay in the northeast. It has an average width of 540 feet and a depth of 32 feet at mean low water.

The Massachusetts Bay Colony and later the Commonwealth of Massachusetts studied the potential for a canal between the heads of Cape Cod Bay and Buzzards Bay from the 1690s through much of the 19th century. After several failed attempts, in June 1889, the Massachusetts legislature granted a charter to the Boston, Cape Cod and New York Canal Company for construction of a canal. From 1909 to 1914, the canal was created by widening and deepening two inland rivers, located three miles apart: Monument River (which flows into Buzzards Bay) and Scusset River (which flows into Cape Cod Bay). The charter also included the requirement to provide ferries, bridges, or tunnels for passengers and vehicles, including highways to connect with the ferries, bridges, or tunnels. In 1918, Cape Cod Canal was deemed complete with a design depth of 25 feet, width of 200 to 300 feet and its seaward approaches, and 100 to 150 feet through its 7.7-mile-long land cut.[7]

The U.S. government assumed control over Cape Cod Canal in 1928, and between 1933 and 1940, the USACE substantially improved the canal—including constructing Sagamore and Bourne Bridges—through the Federal Emergency Administration of Public Works under the National Industrial Recovery Act.

Cape Cod Canal is part of the Atlantic Intracoastal Waterway that extends from Boston, Massachusetts, to Key West, Florida, connecting the eastern New England ports and those of southern New England, New York, and points farther south along the Atlantic coast. The USACE's MRER/EA notes that traveling via the Atlantic Intracoastal Waterway between Cape Cod Bay and Buzzards Bay saves commercial and recreational vessels between 65 and 150 miles versus traveling by the open Atlantic Ocean side of Cape Cod. Additionally, the shorter, less costly, inshore route is better protected and less risky than travel via the open ocean route.[8]

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[7] U.S. Army Corps of Engineers. 2020. Cape Cod Canal Highway Bridges, MA, Major Rehabilitation Evaluation Report and Environmental Assessment, Appendix B: Project History. March. https://www.nae.usace.army.mil/Portals/74/docs/Topics/Cape%20Cod%20Canal%20Bridges/Reports/MRERAppendicesA-B.pdf

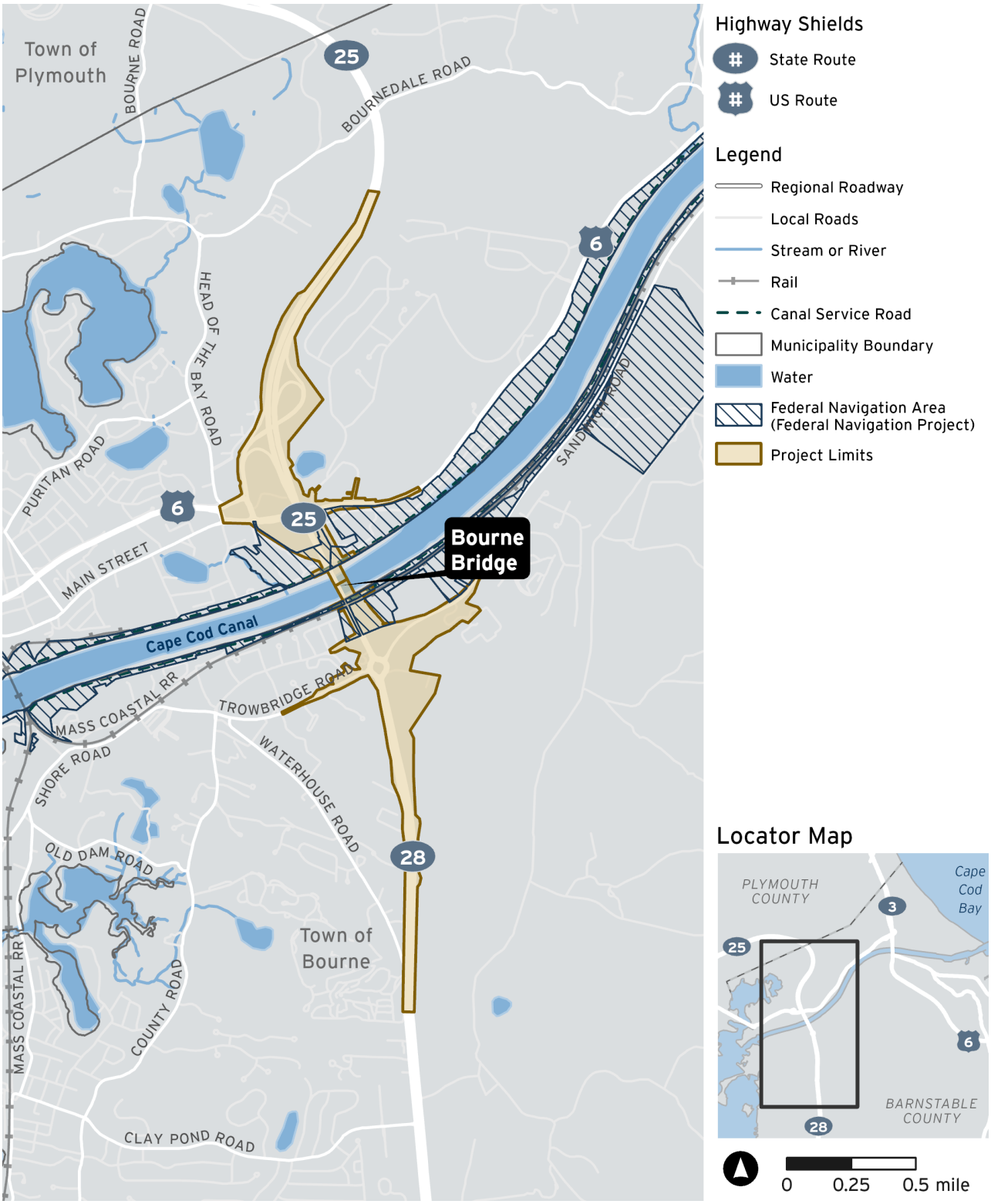
[8] U.S. Army Corps of Engineers. 2022. Cape Cod Canal Highway Bridges, MA, Major Rehabilitation Evaluation Report and Environmental Assessment. March. page EA-7. https://www.nae.usace.army.mil/Portals/74/docs/Topics/Cape%20Cod%20Canal%20Bridges/Reports/FinalMRERDocument.pdf.

Figure 4.4-1. Maritime Study Area: Sagamore Bridge



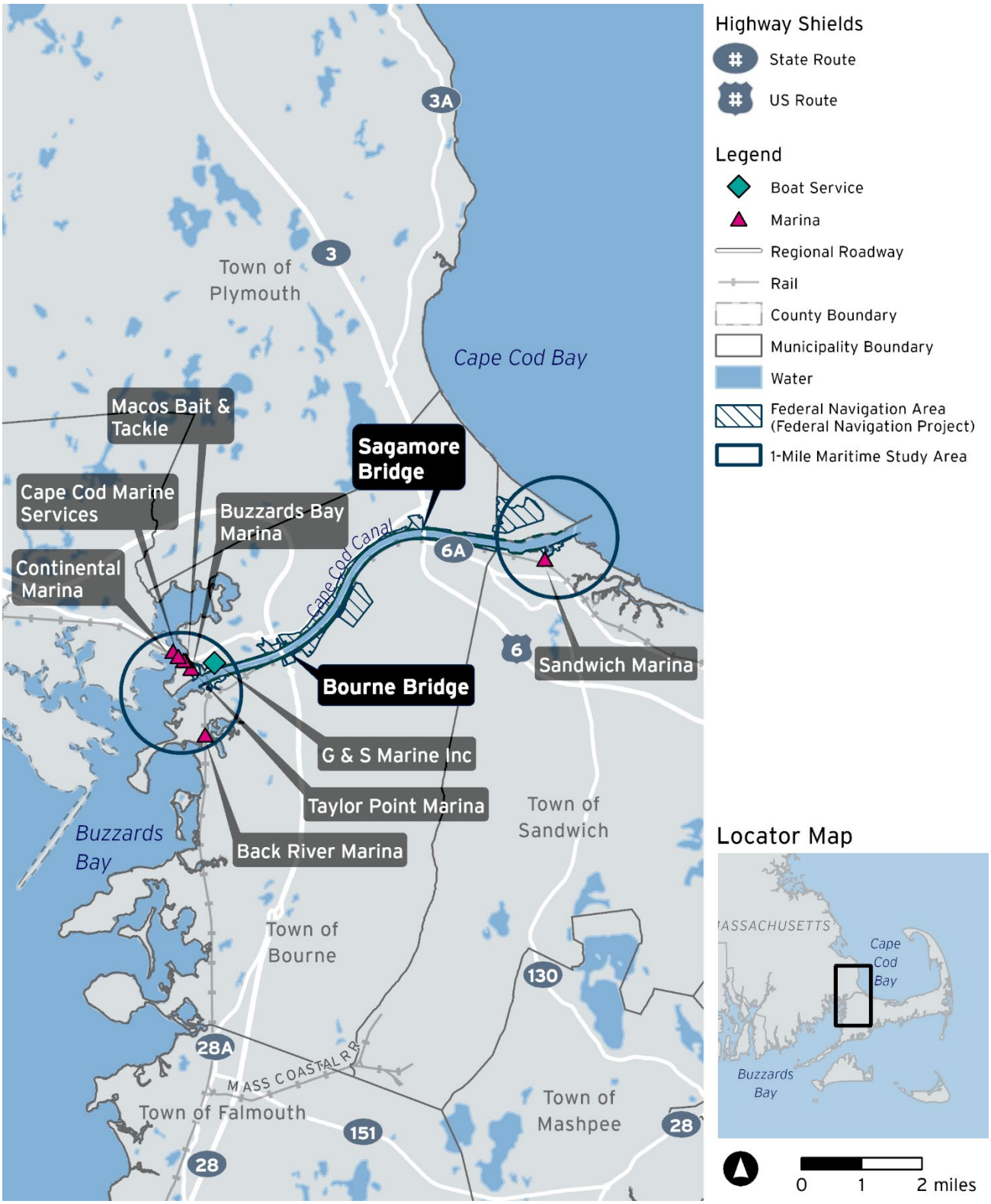
Source: Massachusetts Department of Transportation, 2024

Figure 4.4-2. Maritime Study Area: Bourne Bridge



Source: Massachusetts Department of Transportation, 2024

Figure 4.4-3. Maritime Study Area: Marine-Support Facilities



Source: Massachusetts Department of Transportation, 2024

The canal provides a minimum channel width of 480 feet—the widest sea-level canal on the eastern seaboard—and an authorized (minimum) depth of 32 feet below mean low low water. Transit through the canal is toll free. Both Sagamore and Bourne Bridges provide a vertical clearance of 135 feet above mean high water (mean high water is almost 1.5 feet higher at Sagamore Bridge than Bourne Bridge) and a minimum horizontal clearance of 500 feet.[9]

Because engineers of the first canal followed the Monument and Scusset Rivers and natural terrain to find the easiest path connecting Cape Cod Bay and Buzzards Bay, the channel is not straight. Two significant bends in the canal make sight lines difficult for large vessels with limited turning capabilities (refer to **Exhibit 4.4-1** and **Exhibit 4.4-2**).

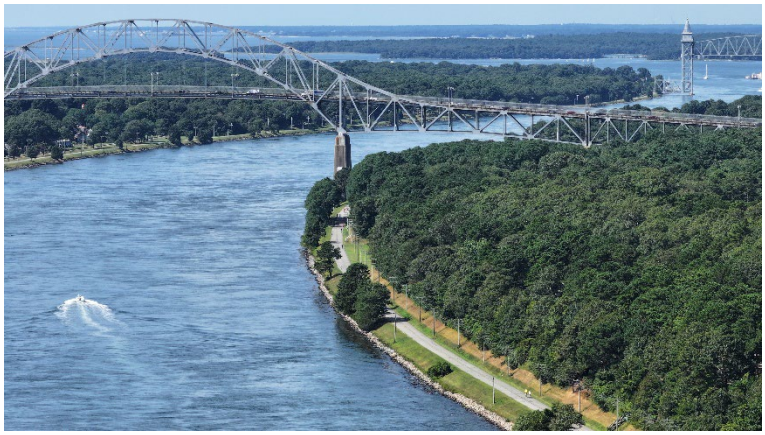
Figure 4.4-4 provides the National Oceanic and Atmospheric Administration (NOAA) nautical chart showing the entirety of the 17.4-mile-long waterway, the 9.3-mile-long approach channel, and the location of the existing bridges on the 8.1-mile-long land cut of the canal. The 32-foot-deep approach channel extends from the vicinity of Cleveland Ledge in Buzzards Bay to the canal itself. The approach channel is 700 feet wide from Cleveland Ledge to Wings Neck in Pocasset (Cleveland Ledge Channel), then narrows to 500 feet wide from Wings Neck to the canal (Hog Island Channel).

Exhibit 4.4-1. View of Cape Cod Canal, facing west toward Sagamore Bridge, September 2023



Source: Massachusetts Department of Transportation, 2023

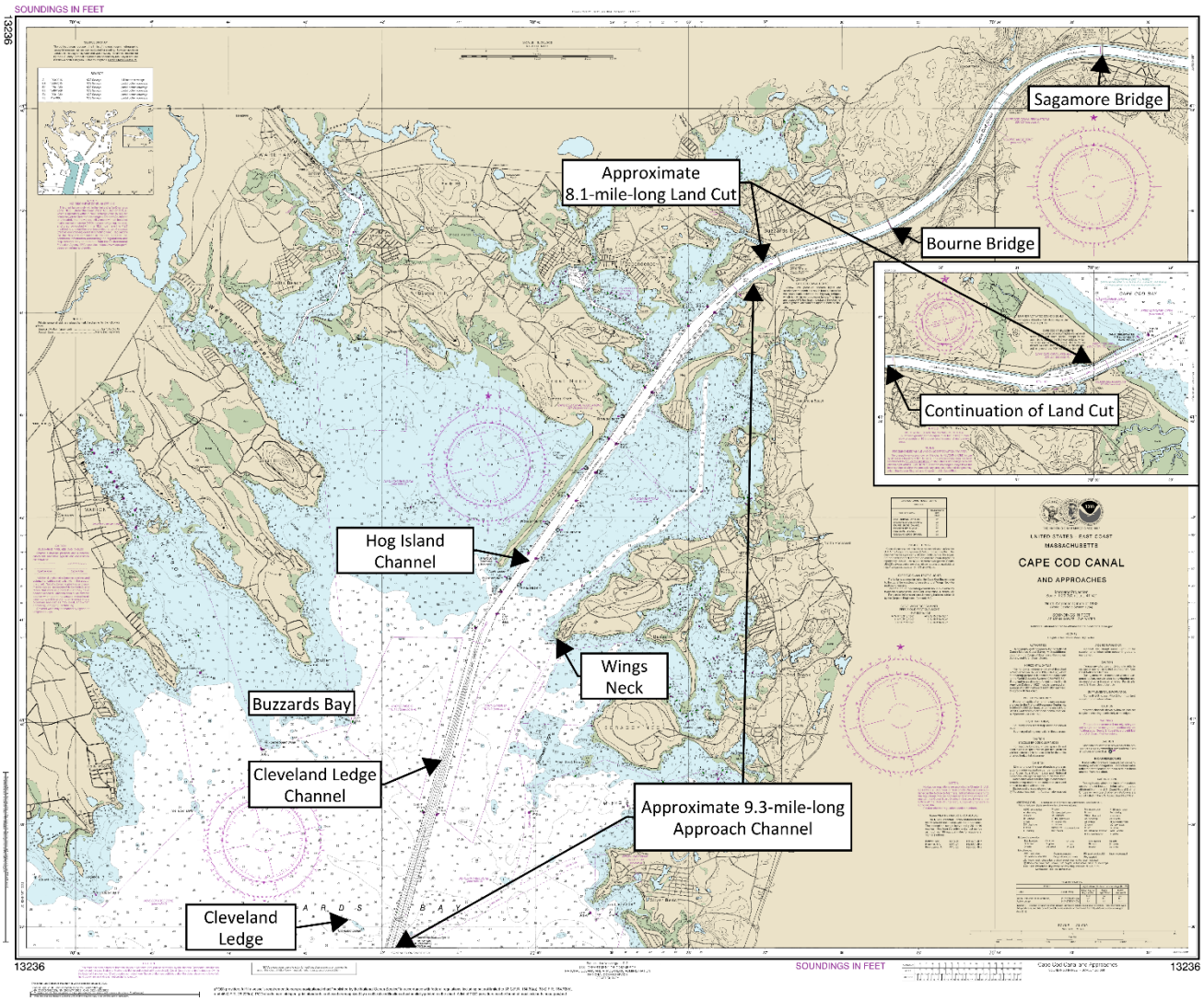
Exhibit 4.4-2. View of Cape Cod Canal, facing west toward Bourne Bridge and Buzzards Bay Railroad Bridge, September 2023



Source: Massachusetts Department of Transportation, 2023

[9] U.S. Army Corps of Engineers. 2022. Cape Cod Canal Highway Bridges, MA, Major Rehabilitation Evaluation Report and Environmental Assessment. March. page EA-15. https://www.nae.usace.army.mil/Portals/74/docs/Topics/Cape%20Cod%20Canal%20Bridges/Reports/FinalMRERDocument.pdf

Figure 4.4-4. Cape Cod Canal, National Oceanic and Atmospheric Administration Nautical Chart



Source: National Oceanic and Atmospheric Administration, 2025

4.4.2.2 Cape Cod Canal Features and Uses

The USACE New England District is responsible for operating and managing the federally authorized Cape Cod Canal FNP, which includes the 17.4-mile-long waterway and existing Sagamore and Bourne Bridges, Buzzards Bay Railroad Bridge, and the 1,150-acre adjoining federal property. Buzzards Bay Railroad Bridge, a vertical lift bridge, was built simultaneously with the highway bridges and has the

same clearances as the two highway bridges.[10] Additional canal features of the FNP managed by the USACE include the following (**Figure 4.4-5**):[11]

- Two mooring basins, consisting of the 3,300-foot-long West Mooring Basin at the head of Buzzards Bay on the east side of Hog Island Channel; and the 2,500-foot-long East Mooring Basin on the north side of the canal just inside the canal's entrance from Cape Cod Bay.
- A 600-foot-long jetty and a 3,000-foot-long breakwater, both at the entrance to the canal from Cape Cod Bay.
- A dike between Hog Island and Rocky Point in Bourne.
- Two basins for small boats, consisting of the 1-acre West Boat Basin, west of the railroad bridge immediately adjacent to the canal field office; and the 2.3-acre East Boat Basin, on the south side of the canal opposite the East Mooring Basin.

4.4.2.3 Cape Cod Canal Navigation and Operating Rules

Congress established the current operating rules for the canal, which the USACE implements under 33 CFR 207.20(b). The USACE staffs a marine traffic control office 24-hours a day, seven days a week from the traffic control center at the Canal Administrative Office. The USACE uses an integrated marine traffic control system to monitor all ship traffic in the canal and communicate directly with ships transiting the waterway, as well as a system of continuously operating traffic lights for vessels 65 feet long and over. The USACE has a fleet of two 38-foot patrol boats and two 25-foot SAFE boats;[12] patrolling is staffed and operational 16 hours a day.

Powered vessels with a maximum boat length of 825 feet, maximum boat draft of 32 feet, and maximum boat air draft of 135 feet are authorized to use the canal (**Exhibit 4.4-3**).[13] Sailing vessels are required to have and use auxiliary power when transiting the canal.

Exhibit 4.4-3. View of Sagamore Bridge, facing west, November 2022



Source: Massachusetts Department of Transportation, 2022

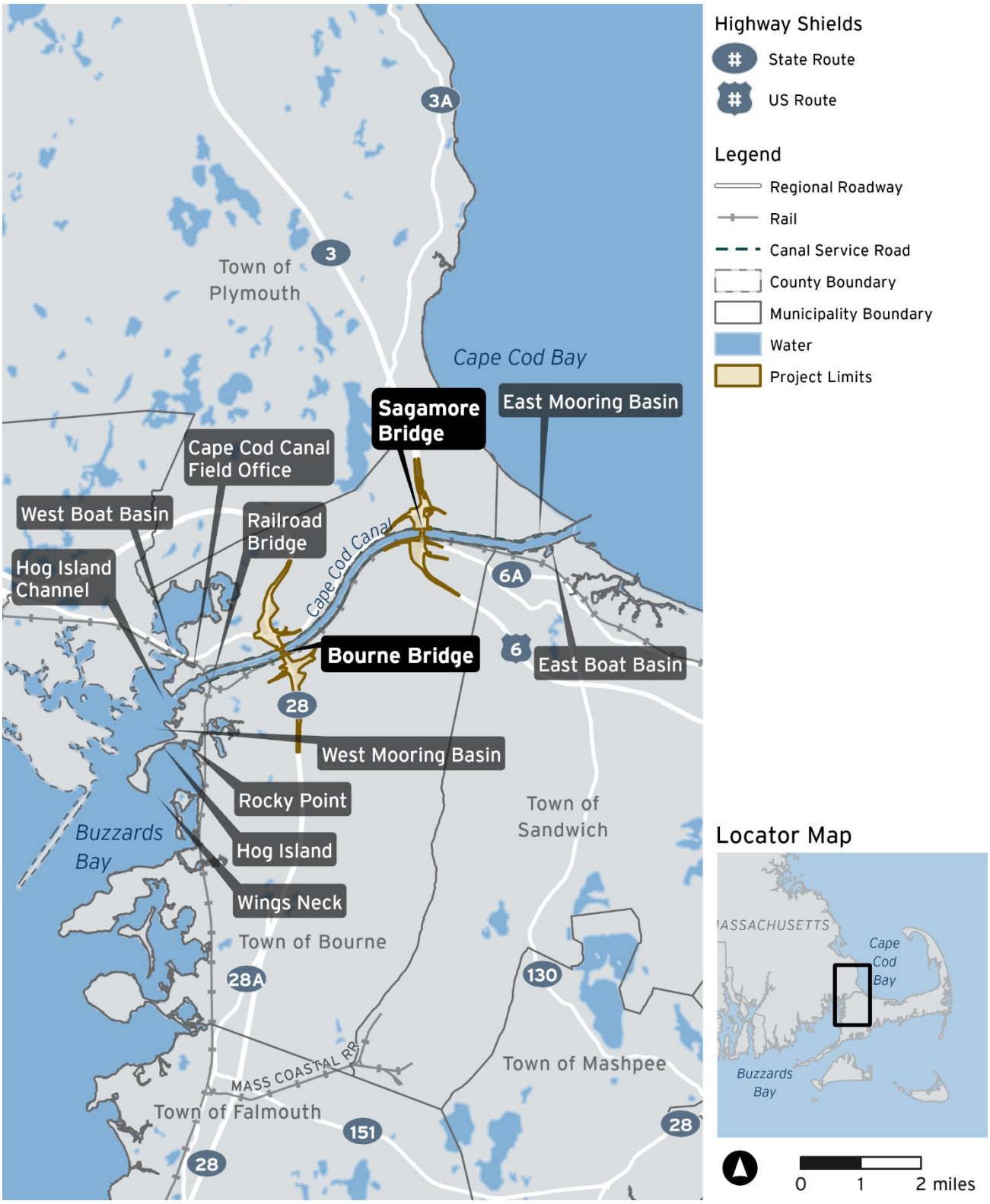
[10] U.S. Army Corps of Engineers. 2007. Cape Cod Canal Navigation Project map. April 20.

[11] U.S. Army Corps of Engineers. n.d. Cape Cod Canal Navigation Project. https://www.nae.usace.army.mil/Missions/Civil-Works/Navigation/Massachusetts/Cape-Cod-Canal//

[12] SAFE = Secure All-Around Flotation Equipped. https://safeboats.com/about-safe/

[13] Vessels greater than 825 feet long or taller than 135 feet high above the waterline are not permitted to enter the canal due to potential navigational safety and bridge-strike concerns. Vessels 65 feet long and over, and/or more than 28 feet deep are required to obtain clearance from and/or consult with the U.S. Army Corps of Engineers' Marine Traffic Controller before entering the canal.

Figure 4.4-5. Features of the Cape Cod Canal Federal Navigation Project

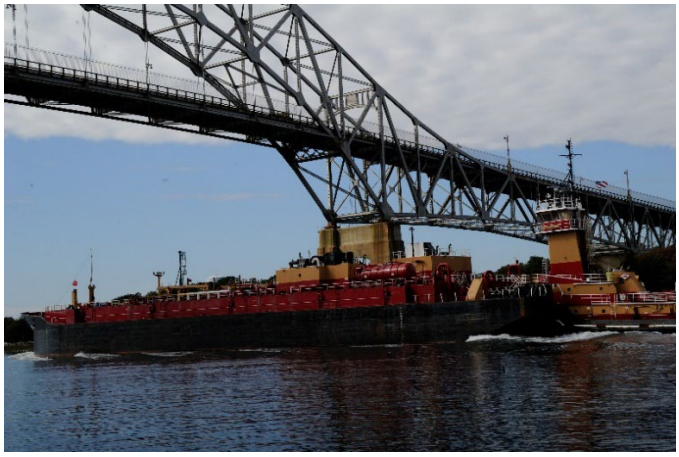


Source: Massachusetts Department of Transportation, 2024

4.4.2.4 Marine Traffic

The canal is an economically important navigation channel that provides passage for a wide variety of navigation. The largest commercial vessels that transit the eastern seaboard, such as large oil tankers and container ships, typically have drafts too deep to use the canal. However, other large civilian, military, and commercial vessels with drafts of 32 feet or less (**Exhibit 4.4-4**) use the canal on a regular basis. The USACE's MRER/EA indicates that many of the automobile carriers and cruise ships (the largest ships to use the canal) have designs that include 135-foot clearances.[14]

Exhibit 4.4-4. View of Tanker at Bourne Bridge, November 2022



Source: Massachusetts Department of Transportation, 2022

According to the MRER/EA, canal traffic in 2018 totaled more than 21,700 vessels. The USACE reports vessels according to length:

- Vessels 65 feet or more in length, consisting of tankers, cargos, barges, fishing vessels, yachts, military vessels (and other types), totaled more than 7,400.
- Vessels under 65 feet in length, including fishing vessels and pleasure craft (among others), totaled more than 14,000.[15]

The USACE reports that the largest ships transiting the canal are typically about 600 feet long.[16]

Freight and Cargo Vessel Transits

The USACE's WCSC provides statistics on foreign and domestic waterborne commerce moved on waters of the United States, defined as ports, harbors, waterways, and canals.[17] **Table 4.4-1** presents the total commodities transiting the canal from 2016 through 2022 (the most recently reported year) in thousands of short tons.

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[14] U.S. Army Corps of Engineers. 2022. Cape Cod Canal Highway Bridges, MA. Major Rehabilitation Evaluation Report/Environmental Assessment. March. page EA-8. https://www.nae.usace.army.mil/Portals/74/docs/Topics/Cape%20Cod%20Canal%20Bridges/Reports/FinalMRERDocument.pdf

[15] U.S. Army Corps of Engineers. 2022. Cape Cod Canal Highway Bridges, MA. Major Rehabilitation Evaluation Report, Final Appendix D, Economics. March. page D-42. https://www.nae.usace.army.mil/Portals/74/docs/Topics/Cape%20Cod%20Canal%20Bridges/Reports/MRERAppendicesC-D.pdf

[16] Hinkle, J. 2021. "Could a ship get stuck sideways in the Cape cod Canal? It's unlikely but yes." Cape Cod Times. March 27. https://www.capecodtimes.com/story/news/2021/03/27/could-ship-get-stuck-sideways-cape-cod-canal-ever-given-suez/7016039002/

[17] https://www.iwr.usace.army.mil/About/Technical-Centers/WCSC-Waterborne-Commerce-Statistics-Center-2/

Table 4.4-1. Commodities Transiting Cape Cod Canal (thousand short tons, rounded), 2016–2022

Commodities	2016	2017	2018	2019	2020	2021	2022
Domestic	6,375	5,446	5,600	5,969	1,492	17	1,956
Foreign	500	627	398	746	531	801	0
Total	**6,875**	**6,073**	**5,998**	**6,715**	**2,023**	**818**	**1,956**

Source: U.S. Army Corps of Engineers, Institute for Water Resources, Waterborne Commerce Statistics Center, Cape Cod Canal, 5-Year Cargo Report, 2017 (https://ndc.ops.usace.army.mil/wcsc/webpub/#/report-landing/year/2017/region/1/location/171); 5-Year Cargo Report, 2022 (https://ndc.ops.usace.army.mil/wcsc/webpub/#/report-landing/year/2022/region/1/location/171)

In calendar year (CY) 2019, the most recent pre-COVID-19 pandemic year, the WCSC reported that all foreign and domestic freight traffic through the canal totaled approximately 6,715,000 short tons.[18] Domestic freight represented almost 89% of this total and foreign freight accounted for approximately 11% of the total. Most commodities consisted of petroleum and petroleum products (e.g., gasoline, kerosene, fuel oils), followed by chemicals and related products. Current freight commodity characteristics are similar to CY 2019. In CY 2022, of the total 1,956,000 short tons of commodities, petroleum products represented almost 76%; the remaining commodities consisted of chemicals and related products, crude materials, and primary manufactured goods. In contrast to CY 2019, however, in CY 2022, domestic freight represented 100% of all commodities transiting Cape Cod Canal.

Per 33 CFR 207.20(f), Navigation Regulations, Cape Cod Canal, Massachusetts; Use, Administration and Navigation (Dangerous Cargoes),[19] vessels carrying petroleum and other potentially hazardous cargo must comply with specific restrictions, including notifying the Marine Traffic Controller prior to entering the canal and transiting only during daylight hours.

As reported by the WCSC, **Table 4.4-2** presents the total number of cargo vessel trips and **Table 4.4-3** and **Table 4.4-4** identify the types of vessel trips transiting the canal from 2016 through 2022, by upbound destinations (to ports north of the canal) and downbound destinations (to ports south of the canal). The WCSC classifies vessel types by self-propelled (with engine) and non-self-propelled (towed) vessels,[20] consisting of the following:

- Towboats, including pushboats and tugboats
- Self-propelled dry cargo vessels, including, but not limited to, general cargo freighters, bulk carriers, containerships, vehicle carriers, passenger vessels, ferries, and excursion/sightseeing vessels

[18] U.S. Army Corps of Engineers, Institute for Water Resources, Waterborne Commerce Statistics Center, Cape Cod Canal, 5-Year Cargo Report, 2019. https://ndc.ops.usace.army.mil/wcsc/webpub/#/report-landing/year/2019/region/1/location/171. Calendar Year 2019 is the most recent pre-COVID-19 pandemic year with a 5-year Cargo Report and 5-year Trips Report.

[19] https://www.ecfr.gov/current/title-33/chapter-II/part-207/section-207.20.

[20] Waterborne Commerce Statistics Center vessel types. https://www.iwr.usace.army.mil/Portals/70/Data%20Dictionary.pdf

- Self-propelled tankers, including petroleum carriers, chemical carriers, liquid bulk tankers, and liquid gas carriers
- Non-self-propelled dry cargo vessels, including, but not limited to open and covered hopper barges, open and covered dry cargo barges, and container barges
- Non-self-propelled tanker, consisting of liquid cargo barges

As indicated in the tables, liquid barge tankers represented the largest percentage of cargo vessels transiting the canal.[21]

Table 4.4-2. Cargo Vessel Trips through Cape Cod Canal, 2016–2022

Trip Types	2016	2017	2018	2019	2020	2021	2022
Upbound (ports north of canal)	1,080	1,701	536	511	388	7	293
Downbound (ports south of canal)	756	1,160	112	164	77	3	249
Total	**1,836**	**2,861**	**648**	**675**	**465**	**10**	**542**

Source: U.S. Army Corps of Engineers, Institute for Water Resources, Waterborne Commerce Statistics Center, Cape Cod Canal, 5-Year Trips Report, 2017 (https://ndc.ops.usace.army.mil/wcsc/webpub/#/report-landing/year/2017/region/1/location/171); 5-Year Trips Reports, 2022 (https://ndc.ops.usace.army.mil/wcsc/webpub/#/report-landing/year/2022/region/1/location/171)

Table 4.4-3. Cargo Vessel Type Upbound Trips through Cape Cod Canal, 2016–022

Vessel Type	2016	2017	2018	2019	2020	2021	2022
Towboat (Self-Propelled)	300	308	75	38	68	2	36
Self-Propelled Dry Cargo	86	265	27	43	50	0	0
Non-Self-Propelled Dry Cargo	48	72	7	32	24	3	15
Non-Self-Propelled Tanker Liquid Barge	622	984	394	348	150	2	242
Self-Propelled Tanker	24	72	33	50	96	0	0
Total	**1,080**	**1,701**	**536**	**511**	**388**	**7**	**293**

Source: U.S. Army Corps of Engineers, Institute for Water Resources, Waterborne Commerce Statistics Center, Cape Cod Canal, 5-Year Trips Report, 2017 (https://ndc.ops.usace.army.mil/wcsc/webpub/#/report-landing/year/2017/region/1/location/171); 5-Year Trips Reports, 2022 (https://ndc.ops.usace.army.mil/wcsc/webpub/#/report-landing/year/2022/region/1/location/171)

[21] U.S. Army Corps of Engineers. Institute for Water Resources. Waterborne Commerce of the United States, Calendar Year 2022. Part 1 – Waterways and Harbors Atlantic Coast. IWR-WCUS-22-1.

Table 4.4-4. Cargo Vessel Type Downbound Trips through Cape Cod Canal, 2016-2022

Vessel Type	2016	2017	2018	2019	2020	2021	2022
Towboat (Self-Propelled)	180	162	23	15	0	0	19
Self-Propelled Dry Cargo	65	198	4	8	8	0	0
Non-Self-Propelled Dry Cargo	33	50	10	21	12	2	14
Non-Self-Propelled Tanker Liquid Barge	470	706	60	90	8	1	215
Self-Propelled Tanker	8	44	15	30	49	0	1
Total	**756**	**1,160**	**112**	**164**	**77**	**3**	**249**

Source: U.S. Army Corps of Engineers, Institute for Water Resources, Waterborne Commerce Statistics Center, Cape Cod Canal, 5-Year Trips Report, 2017 (https://ndc.ops.usace.army.mil/wcsc/webpub/#/report-landing/year/2017/region/1/location/171); 5-Year Trips Reports, 2022 (https://ndc.ops.usace.army.mil/wcsc/webpub/#/report-landing/year/2022/region/1/location/171)

Even with the current physical and operating constraints of the canal, and the decline in freight traffic and commodities after the COVID-19 pandemic, Cape Cod Canal moves substantial volumes of cargo, and the use of the canal provides substantial transportation cost savings over having to transit the entire length of Cape Cod. The MRER/EA calculates that the canal presents annual waterborne transportation cost savings of about $1.7 million annually for U.S. flag cargo vessels transiting the canal over having to circumnavigate the entirety of Cape Cod. This was estimated to be a lower-bound estimate of the navigation benefits provided by the canal. Combined with trips made by other types of vessels, the USACE estimates that the economic value for other vessels, including foreign vessels, would accrue an additional $0.47 million of waterborne transportation cost savings, for a total cost savings of $2.17 million annually (in 2020 dollars).[22]

4.4.2.5 Cape Cod Canal Maintenance

Since its original direction in March 1928 under the Rivers and Harbors Act of 1927, the USACE has operated and improved the canal.[23] Due to the strong tidal current and shifting shoals, the USACE conducts maintenance dredging every five to seven years to restore the canal to its authorized dimensions.[24] In 2015–2016, approximately 130,000 cubic yards of material were dredged, and the

[22] U.S. Army Corps of Engineers. 2022. Cape Cod Canal Highway Bridges, MA. Major Rehabilitation Evaluation Report, Final Appendix D, Economics. March. pages D-47 through D-48. https://www.nae.usace.army.mil/Portals/74/docs/Topics/Cape%20Cod%20Canal%20Bridges/Reports/MRERAppendicesC-D.pdf.

[23] Public Law 70-560, The Rivers and Harbors Act. 1927. https://www.iwr.usace.army.mil/Library/IWR-Library/308-Reports-Program-Series/

[24] Buzzards Bay (to the southwest) and Cape Cod Bay (to the northeast) have very different tidal cycles and ranges. The current in the canal changes direction every six hours, with a maximum velocity of 5.2 miles per hour (6 knots). The USACE notes that the extremely strong tidal currents and shifting shoals that form throughout the canal create hazardous conditions for deep-draft vessels using the canal, leading to the need for regular dredging by the USACE to maintain a safe channel.

material was pumped directly on the 2,500-foot-long Town Neck Beach in the town of Sandwich as a mitigation measure to address the substantial erosion along the downdrift shoreline in the town.[25]

The USACE issued a Public Notice in February 2023 to remove approximately 150,000 cubic yards of material within the 17.4-mile-long channel and the West and East Mooring Basins, including (but not limited to) areas adjacent to both sides of Sagamore Bridge.[26] The USACE proposed to conduct dredging between October 1 and March 15 to protect threatened and endangered species, eelgrass fields, and shellfish spawning seasons. The maintenance dredging event was completed between October and December 2023; it removed 73,426 cubic yards of sandy material and beneficially placed it on Town Neck Beach in the town of Sandwich. The USACE expects the next cycle of maintenance to be undertaken in five to seven years as funds are appropriated by Congress.

4.4.2.6 Marinas and Marine Services in the Maritime Study Area

Table 4.4-5 lists the marinas and marine services that are within a 1-mile radius of the land cut of the canal from Buzzards Bay and Cape Cod Bay, in geographic order starting from Cape Cod Bay moving west to Buzzards Bay, including docks and boat repair businesses (**Figure 4.4-3**).

Table 4.4-5. Marinas and Marine-Support Facilities within 1 Mile of the Cape Cod Canal Land Cut

Facility	Facility Type	Location	Amenities/Services
Sandwich Marina[1]	Public Marina	12 Freezer Road, Sandwich	140 recreational seasonal slips; 42 commercial slips; 24 transient slips. Fuel dock, boat ramp, pump-out facilities, boat storage, public facilities/restrooms
G & S Marine Inc.[2]	Boat sales and services	134 Main Street, Buzzards Bay	Boat sales and service
Buzzards Bay Marina[3]	Marina	2 Main Street, Bourne	Pending
Cape Cod Marine Services[4]	Private Marina	3251 Cranberry Highway, Buzzards Bay	35 slips, dock, boat storage
Continental Marina[5]	Private Marina	3236 Cranberry Highway, Buzzards Bay	47 slips, dock
Taylor Point Marina[6]	Municipal Marina	1 Academy Drive, Buzzards Bay	148 slips, fuel dock, boat ramp, pump-out facilities

[25] U.S. Army Corps of Engineers, New England District. 2016. "Cape Cod Canal Dredging, Town Neck Beach sand placement complete," Yankee Engineer, Building Strong. January. Volume 49, No. 4. https://www.nae.usace.army.mil/Portals/74/docs/YankeeEngineer/2016/January2016.pdf?ver=2016-02-03-091033-813

[26] U.S. Army Corps of Engineers, New England District. 2023. 30-Day Public Notice: Maintenance Dredging of the Cape Cod Canal Federal Navigation Project, Bourne and Sandwich, Massachusetts. February 10. https://www.nae.usace.army.mil/Portals/74/docs/PublicServices/PublicNotice/2023/CCC-Dredging-FinalPN-2023.pdf?ver=PguTCOB66maesDqo55pDRw%3D%3D

Facility	Facility Type	Location	Amenities/Services
Back River Marina[7]	Private Marina	266-284 Shore Road, Buzzards Bay	Docks, boat repair, boat rental

Sources: [1] https://sandwichmarina.com/; [2] https://www.gandsmarine.com/; [3] https://buzzardsbaymarina.com/index.html; [4] https://marinas.com/view/marina/vgcz2ww_Cape_Cod_Marine_Properties_Wareham_MA_United_States; [5] https://marinas.com/view/marina/63c33q_Continental_Marina_Buzzards_Bay_MA_United_States; [6] https://www.townofbourne.com/natural-resources/pages/marinas; [7] https://www.seamagazine.com/locations/ramp-back-river-marina-buzzards-bay-massachusetts-24981

Of the seven facilities, Sandwich Marina is the only facility within FNP property. Located in the East Boat Basin, the marina is leased by the USACE to the Town of Sandwich and operated by the Sandwich Harbormaster. Taylor Point Marina, owned and operated by the Town of Bourne, is just outside of the canal land cut east of the head of Buzzards Bay.

4.4.3 No Build Alternative

In the No Build Alternative, Sagamore and Bourne Bridges would retain their current configuration, alignment, and vertical clearance of 135 feet above mean high water and a minimum 480-foot channel horizontal clearance (and a 500-foot horizontal clearance at the two bridges). The existing piers would remain just outside the navigation channel but within the navigable waterway.

By retaining the current location of the bridge piers, the No Build Alternative would not improve navigation safety. In the MRER/EA, the USACE indicated the need to consider horizontal clearance relative to navigational safety and deferred the final decision regarding the location of the piers to a future development phase. While the USACE acknowledged that likelihood of allisions from large vessels with the existing piers is low, due to the distance from the channel to the shallow adjacent waters, the MRER/EA nevertheless recommended the landward relocation of the replacement bridge piers.

Because the No Build Alternative would not incorporate considerations for future sea level rise, both bridges would not be able to accommodate any projected sea-level change. Over time, it is expected that the canal would not be able to accommodate the largest vessels currently using the canal, such as automobile carriers and cruise ships that require a clearance of 135 feet. To access northern New England ports, these large vessels would need to circumnavigate the entirety of Cape Cod (approximately 60 nautical miles), increasing transportation costs.

In addition to transportation cost savings, the MRER reports that use of the canal increases navigation safety, noting that prior to its construction, shipwrecks occurred along the route around the Cape due to fog, shoals, and exposure to bad weather.

In the MRER/EA, the USACE determined that the “Fix as Fails” Base Condition, which is consistent with the Cape Cod Bridges Program’s (Program) No Build Alternative, could adversely affect navigation due to channel closures. The USACE noted that substructure deterioration (such as localized concrete defects on vertical surfaces of piers or degradation of concrete under bearings on the piers) could require channel closures or result in delays to marine vessels to stage equipment. Further, the USACE

noted that a bridge collapse or other major failure would likely close the canal for some period of time (from weeks to months).

4.4.4 Program Impacts

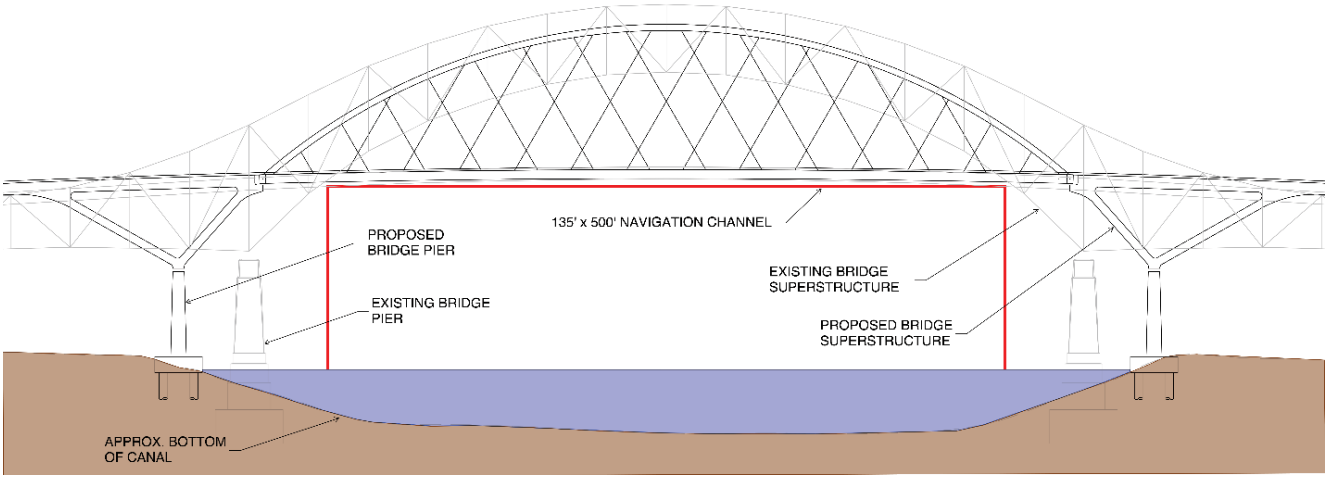
This section describes the potential operational and construction-period impacts of the Build Alternative on the canal federal navigation channel, including vessel traffic.

4.4.4.1 Operational Impacts

The operation of the replacement bridges would not affect the waterway, nor would it alter the federally authorized horizontal and vertical clearances. MassDOT developed the design of the replacement bridges in cooperation with the USACE to improve the navigability and the navigational safety in the canal.

In the Build Alternative, the location of the bridge piers and superstructure further outside of the navigation channel and within the riprap slope (within and above the intertidal zone) would effectively increase the navigational opening, thereby improving navigational safety. By locating the proposed piers along the shoreline, the Build Alternative would reduce the risk of vessel allision, as large vessels (with drafts of 20 feet or greater) would run aground before directly striking the pier. **Figure 4.4-6** presents a schematic of vessel impact risk mitigation that would be incorporated into the Build Alternative. Further, the bridge piers and superstructure would be designed to meet current American Association of State Highway and Transportation Officials (AASHTO) provisions for appropriate vessel impact loads.[27]

Figure 4.4-6. Vessel Impact Risk Mitigation of the Build Alternative



Source: Massachusetts Department of Transportation, 2025

[27] American Association of State Highway and Transportation Officials (AASHTO) Load and Resistance Factor Design (LRFD) Bridge Design Specifications, 10th Edition/2024 https://aashtojournal.transportation.org/aashto-issues-10th-lrfd-bridge-design-spec-edition/

In accordance with the USCG's Preliminary Navigation Determination, in the Build Alternative, the replacement bridge deck elevation would account for a future sea level rise of approximately 3.3 feet to maintain the existing 135-foot vertical clearance above mean high water (MHW), for a total vertical clearance of 138.3 feet above MHW. This proposed vertical clearance would not affect the maximum vessel class types and sizes that currently transit the canal for the expected design life of the replacement bridges. The USACE scenario-based sensitivity analysis for future conditions estimated less than 3 feet of sea level rise by 2125 based on an intermediate rise rate, and by 2070 at a high rate, relative to mean sea level established for the present tidal epoch (1983–2001).[28]

4.4.4.2 Construction Impacts

MassDOT developed the Program construction approach in coordination with a construction specialist. **Chapter 5, Construction Approach**, provides details. The approach and durations of activities could vary based on the design-build team's construction means and methods or based on contract packaging, however.

MassDOT estimates that construction of each replacement bridge and demolition of each existing bridge would take approximately 8 to 10 years, with in-water work occurring over multiple phases. Construction in the north and south quadrants of each bridge site is anticipated to occur concurrently. Except for six short-term closures, replacement bridge construction and existing bridge demolition would be outside of the navigation channel and would not affect ongoing navigation.

Construction of the in-water temporary works, drilled shafts, and substructures at the canal delta piers would require approximately two years for each new span. MassDOT plans to construct the delta frames either from cranes on work trestles (platforms) over the water near the shore or from cranes on land near the shoreline.

Construction of each new delta frame would require approximately one year. Each new 616-foot-long bridge arch would be constructed off-site, floated on barges to the bridge site, and lifted into place by cable jacks mounted on the previously constructed delta frames. Demolition of the existing bridge approach spans would require nine months per bridge and demolition of the existing piers within cofferdams would require six months per bridge. The deconstructed bridge arches would be lowered onto barges and floated out of the canal to an off-site construction/staging area.

No temporary construction works associated with new bridge construction or existing bridge demolition would encroach into the navigation channel or close the canal for navigation. The new piers would be located within and above the intertidal zone of the canal and well outside the navigation channel. They would be constructed within cofferdams from temporary work platforms near the edge of the canal and would not affect navigation. The existing piers, located in the waterway and outside the navigation channel, would be surrounded by containment cells for demolition. MassDOT proposes

[29] U.S. Army Corps of Engineers. 2018. Engineering Circular (EC) 1165-2-220, Department of the Army, U.S. Army Corps of Engineers, Water Resource Policies and Authorities. Policy and Procedural Guidance for Processing Requests to Alter US Army Corps of Engineers Civil Works Projects Pursuant to 33 United States Code 408. September 10. Note that the use of EC 1165-2-220 was extended per Memorandum, November 14, 2023.

to remove the existing piers to the mudline; the exact depth of removal would be determined as design advances. Some demolished materials could be lifted away by crane, and some could be reduced to rubble in the containment cell and then removed by clamshell; demolition materials would be disposed off-site.

Construction of new elements farther from the canal, such as the proposed approach spans, would occur from cranes located either on work trestles or land at the shoreline and would not directly affect navigation. Similarly, the portions of the existing structure beyond the canal zone could be demolished without directly affecting navigation.

Dredging would be necessary to ensure an appropriate draft for construction support vessels, and post-construction efforts would be needed to restore the canal bottom profile for final riprap installation. However, this work would take place outside of the navigation channel and would not affect navigation.

The Program's vessels would increase marine traffic in the canal. As indicated in **Chapter 3, Proposed Action and Alternatives**, as many as 16 vessels, consisting of work barges, delivery barges, tugboats, and support launches, could be used on each side of the canal (Sagamore North and South; Bourne North and South) during daily marine-based construction activities, including installing and removing temporary works, and assisting in construction of some permanent works. In many cases, the work vessels could be located outside the 500-foot navigation channel; however, there are instances where the work barges and associated vessels would encroach into the navigation channel. Each instance of encroachment would require coordination with the USACE Marine Traffic Controller. However, even with the minor encroachment by construction support vessels, a minimum navigational width of 350 feet would be maintained for vessel passage.

In-water work requiring closure of the navigation channel would be limited to six short-term, full canal closures associated with the float-in of the new bridge arch and float-out of the deconstructed bridge arch. Four canal closures (each lasting approximately three to five days) would be required for the float-in of the new bridge arches. Two canal closures (each lasting approximately three to five days) would be required for the float-out of the existing bridge arches. Once started, the float-in and float-out operations cannot be halted or paused. MassDOT would coordinate all canal closures and, as applicable, canal encroachments, with the USACE and the USCG for advance notifications to mariners.

Because the canal would be available for navigation for nearly the entirety of the construction period (with only six short-term closures), and through planned coordination with the USACE Marine Traffic Controller and the USCG for advance notifications to mariners, MassDOT does not anticipate adverse impacts to navigation due to the Program.

4.4.4.3 Federal and State Approvals and Permits

Section 14 of the Rivers and Harbors Act

In accordance with Section 14 of the Rivers and Harbors Act (33 USC 408), and in compliance with USACE's Policy and Procedural Guidance for Processing Requests to Alter US Army Corps of Engineers

Civil Works Projects Pursuant to 33 USC 408,[29] MassDOT will apply to the USACE for Section 408 review and permission for anticipated temporary and permanent alteration[30] of the waterway and abutting lands of the Cape Cod Canal FNP. The primary determinations of the USACE in a Section 408 review focus on whether the use of the FNP would affect the "usefulness of the project" or be "injurious to the public interest."

MassDOT is working with the USACE to define potential impacts of the replacement bridges, including the construction staging areas and the permanent incorporation of the USACE's land holdings within the replacement bridge footprints, to ensure the ability of the FNP to function as authorized. Additionally, MassDOT's request for Section 408 permission will demonstrate that the use of the Civil Works project will be protective of the public interest, including the following:

- Navigability
- Economic resources
- Shore erosion
- Wildlife, habitat, and the environment
- Water quality
- Flood hazards and floodplains
- Recreational resources
- Historic resources

As needed, MassDOT will identify measures to ensure the USACE's ability to fulfill its mission of the FNP during and after construction.

General Bridge Act of 1946

Pursuant to the General Bridge Act of 1946 (33 USC 525), and in compliance with the USCG Office of Bridge Programs Bridge Permit Application Guide,[31] MassDOT will apply to the USCG for individual bridge permits for the replacement Sagamore and Bourne Bridges.

The First Coast Guard District issued a Preliminary Navigation Clearance Determination dated March 11, 2025, to MassDOT and USACE. The determination stated that the replacement Sagamore and Bourne Bridges should provide at least 138.3 feet of vertical clearance above MHW and at least

[29] U.S. Army Corps of Engineers. 2018. Engineering Circular (EC) 1165-2-220, Department of the Army, U.S. Army Corps of Engineers, Water Resource Policies and Authorities. Policy and Procedural Guidance for Processing Requests to Alter US Army Corps of Engineers Civil Works Projects Pursuant to 33 United States Code 408. September 10. Note that the use of EC 1165-2-220 was extended per Memorandum, November 14, 2023.

[30] Alteration refers to any action that builds upon, alters, improves, moves, obstructs, occupies, or uses an existing U.S. Army Corps of Engineers project.

[31] U.S. Coast Guard. Bridge Permit Application Guide, COMDTPUB P16591.3E, March 2025. https://www.dco.uscg.mil/Portals/9/CG_Bridge_Permit_Application_Guide_Mar2025.pdf

500 feet of horizontal clearance to not unreasonably obstruct the free navigation of the waters over which the bridges are constructed.[32]

4.4.5 Mitigation

4.4.5.1 Operations-Related Mitigation

Because the Build Alternative would improve navigability and maintain existing marine transportation conditions within the canal, permanent mitigation measures would not be required.

4.4.5.2 Construction-Related Mitigation

MassDOT would coordinate construction and demolition activities with the USACE Marine Operations Section and the USCG First Coast Guard District. Through the construction period, the Marine Operations Section would monitor vessel traffic for potential impacts, provide marine traffic control and enforce restrictions as needed, and support construction site safety. As required by the USACE and USCG, temporary aids to navigation—including navigation lighting, notices to mariners, channel closure signs, stop/slow signs, advance warning signs and lateral guidance—would be used to assist vessels during construction.

During construction, MassDOT would advise the public of in-water construction work through the Program website and would maintain communications with the Town of Bourne Harbormaster, the USCG, and USACE, including notifications of channel closures. As needed, MassDOT would meet with marinas and marine-related uses within the Study Area to advise them of channel closures.

[32] Gregory P. Hitchen, Bridge Program Manager, U.S. Coast Guard, First Coast Guard District, to Jenifer Thalhauser, Navigation Section Chief, U.S. Army Corps of Engineers, New England District. Re: Preliminary Navigation Clearance Determination for Cape Cod Bridges Program, March 11, 2025.

4 Existing Conditions, Program Impacts, and Mitigation

4.5 Socioeconomics

4.5.1 Introduction

This section provides a socioeconomic profile of the local and regional project areas and assesses the socioeconomic impacts of the No Build Alternative and the Build Alternative. **Appendix 4.5, Socioeconomics Technical Report**, supplements this section.

4.5.1.1 Regulatory Context

The Massachusetts Department of Transportation (MassDOT) prepared this socioeconomic assessment in accordance with Federal Highway Administration Technical Advisory T6640.8A, *Guidance for Preparing and Processing Environmental and Section 4(F) Documents*.

4.5.1.2 Methodology and Study Area

This assessment addresses existing socioeconomic conditions, including population, households, housing, employment, and real estate, as well as projections of population growth. Sources include the following:

- U.S. Census Bureau American Community Survey 5-year estimates
- Massachusetts Executive Office of Labor and Workforce Development
- U.S. Department of Commerce
- UMass Donahue Institute population, household, and employment projections
- Proprietary data sources: CoStar *Property Information Systems* and Claritas *Site Reports*

The assessment of impacts for the Build Alternative included traffic data and analyses provided by the following:

- TREDIS transportation impact model for assessing the regional economic impacts of the Build Alternative compared to the No Build Alternative in 2050
- Construction cost data provided by the Massachusetts Department of Transportation
- R/ECON input-output model for assessing the economic and tax impacts of construction expenditures on the economy of Massachusetts

For the No Build Alternative, analysis includes review of interviews and reports prepared by the following:

- Cape Cod Commission

- Senators Elizabeth Warren and Ed Markey and Representative Bill Keating, Cape Cod Bridges Replacement: An Urgent Need, October 2023

The analysis examines data for 10 geographic areas (where data are available) (**Figure 4.5-1**):

- Census Tracts: 3700, 3800, and 3900 in the town of Bourne (Local Program Area for the purposes of the socioeconomic analysis)
- Towns: Bourne, Plymouth, and Sandwich
- Counties: Barnstable, Dukes, and Nantucket
- State: Massachusetts

4.5.2 Existing Conditions

4.5.2.1 Population

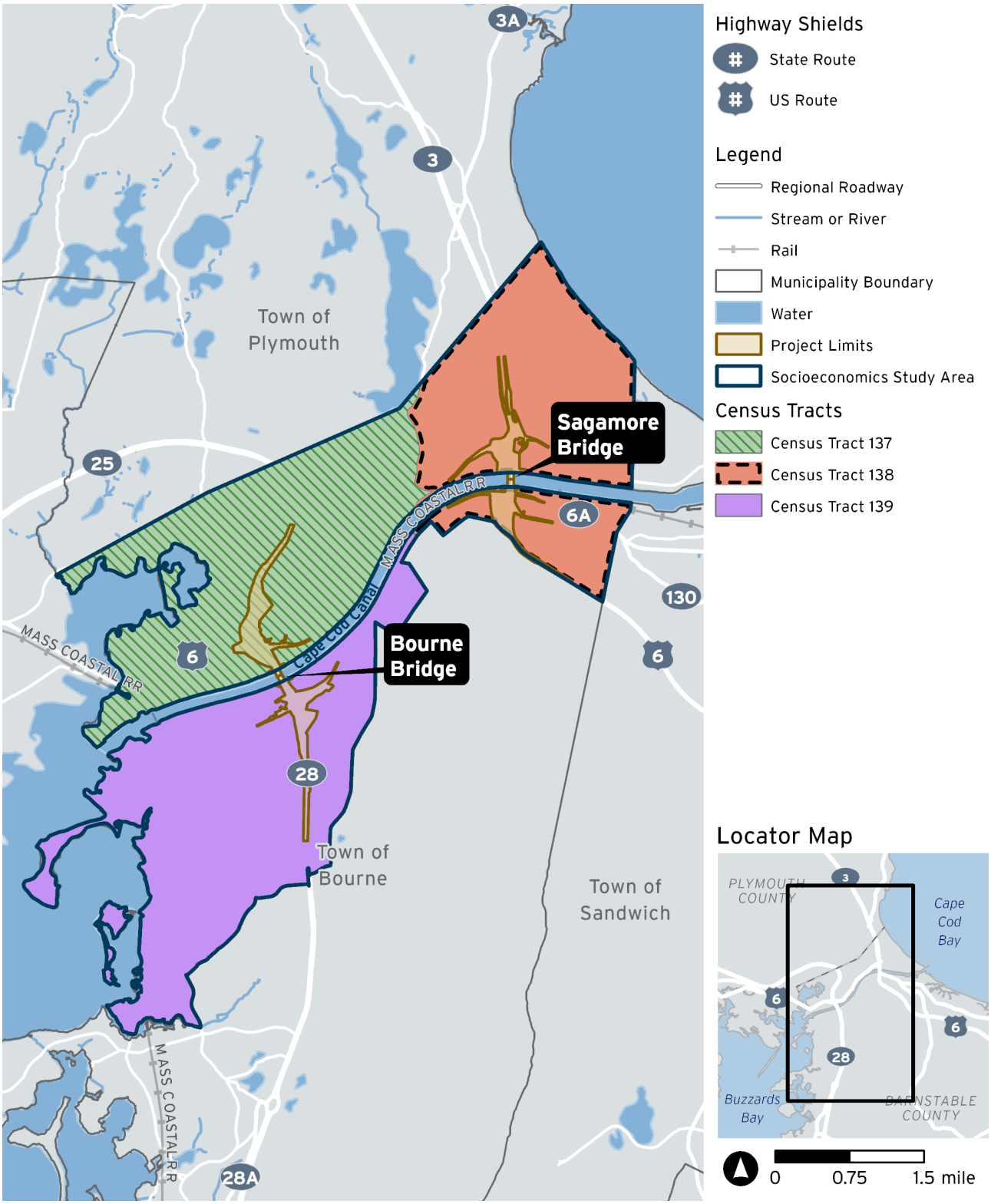
Table 4.5-1 presents population changes across each geographic area between 2010 and 2022. Most areas experienced population growth during this period. Dukes County (27%) and Nantucket County (nearly 40%) experienced the greatest increases. The population in the town of Sandwich declined while the other areas increased.

Table 4.5-1 Population, 2010 and 2022

Geographic Area	2010	2022	Percentage Change
Census Tract 137 (Bourne)	4,865	4,285	-11.9%
Census Tract 138 (Bourne)	4,968	5,504	10.8%
Census Tract 139 (Bourne)	4,497	5,046	12.2%
Town of Bourne	19,577	20,455	4.5%
Town of Plymouth	55,606	61,628	10.8%
Town of Sandwich	20,628	20,419	-1.0%
Barnstable County	217,483	229,436	5.5%
Dukes County	16,155	20,543	27.2%
Nantucket County	10,069	14,065	39.7%
Massachusetts	6,477,096	6,984,205	7.8%

Source: American Community Survey 5-year estimates 2006-2010 and 2018-2022, Table DP05

Figure 4.5-1. Socioeconomics Study Area



Source: Massachusetts Department of Transportation, 2024

4.5.2.2 Population Projections

The town of Plymouth and Dukes County are expected to experience overall population growth, with increases of 14.3% and 14.2%, respectively (**Table 4.5-2**), between 2019 and 2050. Nantucket County shows moderate growth initially, but by 2050 it is projected to decline by 12.8% from 2040 levels. In contrast, Barnstable County exhibits the steepest overall decline, with a projected 17.4% population decrease by 2050.

Table 4.5-2. Population Projections, 2019-2050

Geographic Area	2019	2030	2040	2050	Change (2019-2050)	Change (2030-2050)	Change (2040-2050)
Town of Bourne	19,762	18,032	21,352	18,916	-4.3%	4.9%	-11.4%
Town of Plymouth	61,528	71,487	64,342	70,312	14.3%	-1.6%	9.3%
Town of Sandwich	20,169	19,387	21,412	19,893	-1.4%	2.6%	-7.1%
Barnstable County	212,990	216,048	190,000	176,007	-17.4%	-18.5%	-7.4%
Dukes County	17,332	20,923	19,975	19,793	14.2%	-5.4%	-0.9%
Nantucket County	11,399	15,873	14,000	12,212	7.1%	-23.1%	-12.8%

Source: Estimates are from UMass Donahue Institute V2024 Population Projections, May 2024. Data for census tracts are not available.

4.5.2.3 Households

Household growth trends diverged between 2010 and 2022. The census tracts and towns have experienced growth in the number of households, with some areas seeing increases of nearly 20%. The counties and the Commonwealth of Massachusetts have shown more moderate growth, with only marginal changes in household numbers in certain areas (**Table 4.5-3**).

Table 4.5-3. Change in Number of Households and Household Size, 2010 and 2022

Geographic Area	Total Households (2010)	Total Households (2022)	Change (2010-2022)	Average Household Size (2010)	Average Household Size (2022)
Census Tract 137 (Bourne)	1,587	1,916	20.7%	2.11	2.09
Census Tract 138 (Bourne)	1,879	2,217	18.0%	2.64	2.47
Census Tract 139 (Bourne)	1,943	2,314	19.1%	2.31	2.18
Town of Bourne	7,730	8,715	12.7%	2.34	2.30
Town of Plymouth	21,177	25,217	19.1%	2.52	2.38
Town of Sandwich	7,635	7,977	4.5%	2.66	2.54
Barnstable County	98,164	99,969	1.8%	2.17	2.27

Geographic Area	Total Households (2010)	Total Households (2022)	Change (2010-2022)	Average Household Size (2010)	Average Household Size (2022)
Dukes County	5,530	6,899	26.2%	2.92	2.94
Nantucket County	3,623	4,659	28.6%	2.58	2.96
Massachusetts	2,512,552	2,740,995	9.1%	2.48	2.46

Source: American Community Survey 5-year estimates 2006-2010 and 2018-2022, Table DP02.

The data show variations in household size across Massachusetts, with Barnstable County having the smallest average household size. Conversely, Nantucket and Dukes Counties have the largest average household size.

Household Projections

The variations in household size can significantly influence household projection data by shaping assumptions about future population growth, housing needs, and demographic shifts. Regions with smaller household sizes, like Barnstable County, may see slower household growth despite stable or declining populations, leading to increased demand for single-occupancy units or senior housing. Conversely, areas with larger household sizes, such as Nantucket and Dukes Counties, may experience faster household growth tied to younger or expanding populations. However, Dukes and Nantucket Counties have highly seasonal economies, so their current higher household sizes might not reflect long-term trends.

The household projection data from 2019 to 2050 vary across the study area. Dukes County and the town of Plymouth are projected to increase by 38.3% and 29.7%, respectively. Nantucket County is also projected to grow initially, but then decline, leading to an overall 28.7% increase by 2050. In contrast, Barnstable County and the town of Bourne are projected to experience declines, with Barnstable County losing 12.7% of households and the town of Bourne decreasing by 4.8%. The town of Sandwich is projected to see growth of 4.4% (**Table 4.5-4**).

Table 4.5-4. Number of Households, Projections 2019-2050

Geography	2019	2030	2040	2050	Change (2019-2050)	Change (2030-2050)	Change (2040-2050)
Town of Bourne	8,611	8,289	8,960	8,200	-4.8%	-1.1%	-8.5%
Town of Plymouth	23,345	28,869	28,465	30,283	29.7%	4.9%	6.4%
Town of Sandwich	7,818	7,991	8,232	8,159	4.4%	2.1%	-0.9%
Barnstable County	94,323	100,263	86,173	82,313	-12.7%	-17.9%	-4.5%
Dukes County	6,765	9,085	9,170	9,359	38.3%	3.0%	2.1%
Nantucket County	3,713	6,026	5,875	4,780	28.7%	-20.7%	-18.6%

Source: Estimates are from UMass Donahue Institute Population, Household, and Employment Projections 2010 – 2050, Statewide Model Run 97, July 2023.

Median Household Income

Median household incomes vary across geographic areas (**Table 4.5-5**). Nantucket County stands out with the highest median income, followed by the towns of Sandwich and Plymouth. In contrast, Dukes County and Census Tract 139 have the lowest median income, falling below $80,000, while Massachusetts has a median income of just under $100,000.

Between 2010 and 2022, Census Tract 137 and Nantucket County saw the largest percentage increases in nominal incomes. Barnstable County and Massachusetts also experienced substantial growth, with nominal increases of around 50%. In comparison, Dukes County and Census Tract 139 saw the smallest nominal changes, with increases of 24.0% and 21.7%, respectively (**Table 4.5-5**).

Table 4.5-5. Median Household Income, 2010-2022

Geographic Area	Median Household Income (2010$)	Median Household Income (2022$)	Percentage Change
Census Tract 137 (Bourne)	$53,274	$88,370	65.9%
Census Tract 138 (Bourne)	$68,597	$100,152	46.0%
Census Tract 139 (Bourne)	$70,197	$85,429	21.7%
Town of Bourne	$61,418	$90,640	47.6%
Town of Plymouth	$74,767	$107,067	43.2%
Town of Sandwich	$83,325	$121,038	45.3%
Barnstable County	$60,317	$90,447	50.0%
Dukes County	$62,407	$77,392	24.0%
Nantucket County	$83,347	$135,590	62.7%
Massachusetts	$64,509	$96,505	49.6%

Source: American Community Survey 5-year estimates 2006-2010 and 2018-2022, Table DP03.

4.5.2.4 Housing

Table 4.5-6 indicates increases in the number of occupied housing units across all regions from 2010 to 2022. The town of Plymouth experienced the largest rise (adding more than 4,000 housing units) followed by Barnstable County (1,805 additional units). Nantucket and Dukes Counties also saw notable increases in occupied housing. Nantucket and Dukes Counties also show the highest growth rates, at 28.6% and 24.8%, respectively. The towns of Plymouth and Bourne also experienced growth, nearing 20% and 13%, respectively. Barnstable County and the town of Sandwich showed smaller increases.

Owner Versus Renter-Occupied Housing Units

Owner-occupied housing dominates in most areas, particularly in the town of Sandwich and Barnstable County, where over 80% of housing units are owner-occupied. Nantucket County and Dukes County

have higher proportions of renter-occupied units, yet most areas show a clear preference for homeownership when compared to the statewide average (Table 4.5-7).

Table 4.5-6. Occupied Housing Units, 2010-2022

Geographic Area	Occupied Housing Units (2010)	Occupied Housing Units (2022)	Absolute Change	Percentage Change
Census Tract 137 (Bourne)	1,587	1,916	329	20.7%
Census Tract 138 (Bourne)	1,879	2,217	338	18.0%
Census Tract 139 (Bourne)	1,943	2,314	371	19.1%
Town of Bourne	7,730	8,715	985	12.7%
Town of Plymouth	21,177	25,217	4,040	19.1%
Town of Sandwich	7,635	7,977	342	4.5%
Barnstable County	98,164	99,969	1,805	1.8%
Dukes County	5,530	6,899	1,369	24.8%
Nantucket County	3,623	4,659	1,036	28.6%
Massachusetts	2,512,552	2,740,995	228,443	9.1%

Source: American Community Survey 5-year estimates 2006-2010 and 2018-2022, Table DP04

Table 4.5-7. Owner- Versus Renter-Occupied Housing Units, 2022

Geographic Area	Owner-Occupied Housing Units (percentage)	Renter-Occupied Housing Units (percentage)
Census Tract 137 (Bourne)	73.8%	26.2%
Census Tract 138 (Bourne)	79.8%	20.2%
Census Tract 139 (Bourne)	81.5%	18.5%
Town of Bourne	76.5%	23.5%
Town of Plymouth	79.7%	20.3%
Town of Sandwich	88.9%	11.1%
Barnstable County	81.4%	18.6%
Dukes County	76.6%	23.4%
Nantucket County	71.1%	28.9%
Massachusetts	62.4%	37.6%

Source: American Community Survey 5-year estimates 2006-2010 and 2018-2022, Table DP04

Median Home Value

Most areas experienced a substantial increase in median home values from 2010 to 2020. In Dukes County, median home values surged by 154.2%, far exceeding other regions. Nantucket County, while already having the highest median home values, saw a more moderate increase of 26.6% but still maintained the highest absolute home values (**Table 4.5-8**).

Table 4.5-8. Median Home Value, 2010-2022

Geographic Area	Median Home Value (2010$)	Median Home Value (2022$)	Percentage Change
Census Tract 137 (Bourne)	$306,300	$441,600	44.2%
Census Tract 138 (Bourne)	$373,800	$488,300	30.6%
Census Tract 139 (Bourne)	$370,900	$473,900	27.8%
Town of Bourne	$364,000	$482,600	32.6%
Town of Plymouth	$354,500	$461,500	30.2%
Town of Sandwich	$381,200	$482,300	26.5%
Barnstable County	$392,700	$519,100	32.2%
Dukes County	$392,700	$998,100	154.2%
Nantucket County	$1,000,000	$1,265,600	26.6%
Massachusetts	$352,300	$483,900	37.4%

Source: American Community Survey 5-year estimates 2006-2010 and 2018-2022, Table DP04t

4.5.2.5 Employment

Total Employment and Business Characteristics

From 2010 to 2022, employment increased across all listed areas, with Nantucket County experiencing the highest percentage growth at 39.6% (2,259 jobs). Other notable increases include the town of Sandwich (16.9%) and Dukes County (16.1%). The town of Plymouth saw the largest absolute growth among the towns, adding 3,297 jobs (14.5%), while Barnstable County added 6,076 jobs (6.9%). Massachusetts experienced a 14.1% increase in employment, with 444,943 new jobs (**Table 4.5-9**).

Table 4.5-10 provides the projected employment for each of the towns and counties (latest projection data available). All geographies except the town of Plymouth are projected to lose jobs by 2050. The projected employment decline in most areas likely reflects an aging population, with retirees leaving the workforce and fewer young workers replacing them. Seasonal economies in Dukes and Nantucket Counties further limit year-round job opportunities, while outmigration of younger residents and shifts in local industries contribute to shrinking employment. The town of Plymouth's modest growth may result from its more diversified economy and proximity to employment hubs.

A decline in employment could reduce the number of vehicle trips and average miles traveled as fewer workers commute to jobs, especially in areas with aging populations or seasonal economies. Outmigration of younger workers may further decrease travel demand, while retirees and remaining residents might generate fewer daily trips due to reduced work-related travel. Conversely, areas like the town of Plymouth, with modest employment growth, could see stable or slightly increased vehicle trips and miles traveled. However, the effect on Cape Cod bridge traffic might be limited, as the town of Plymouth is located off Cape Cod.

Table 4.5-9. Employment, 2010 and 2022

Geographic Area	2010	2022	Absolute Change (2010-2022)	Percentage Change (2010-2022)
Town of Bourne	7,273	8,101	828	11.4%
Town of Plymouth	22,779	26,076	3,297	14.5%
Town of Sandwich	5,291	6,185	894	16.9%
Barnstable County	88,699	94,775	6,076	6.9%
Dukes County	7,735	8,981	1,246	16.1%
Nantucket County	5,704	7,963	2,259	39.6%
Massachusetts	3,151,206	3,596,149	444,943	14.1%

Source: Massachusetts Executive Office of Labor and Workforce Development, ES202 dataset. Data for census tracts are not available.

Table 4.5-10. Projected Total Employment, 2019-2050

Geographic Area	2019	2030	2050	Change (2019-2050)	Percentage Change (2019-2050)
Town of Bourne	8,350	7,236	6,183	-2,167	-26.0%
Town of Plymouth	26,627	27,764	27,247	620	2.3%
Town of Sandwich	6,159	5,885	4,312	-1,847	-30.0%
Barnstable County	97,672	90,863	75,299	-22,373	-22.9%
Dukes County	9,069	7,330	8,362	-707	-7.8%
Nantucket County	7,789	7,085	6,212	-1,577	-20.3%

Source: UMass Donahue Institute and Massachusetts Department of Transportation, Planning, 2024

Average Annual Wage

While most areas fall below the state's wage level, particularly the towns of Plymouth and Sandwich, the gap has narrowed. The state's 2022 average wage still stands higher than all the Study Areas. In terms of nominal wage growth, all regions have experienced increases from 2010 to 2022, with Dukes County showing the most increase, more than doubling its average wage over this period. Similarly, the town of Bourne, Barnstable County, and Nantucket County have also posted gains, with nominal growth rates close to or exceeding 100% (**Table 4.5-11**).

Table 4.5-11. Annual Average Nominal Wages, 2010 and 2022

Geographic Area	Average Wage (2010$)	Average Wage (2022$)	Percentage Change (2010-2022)
Town of Bourne	$41,080	$63,648	54.9%
Town of Plymouth	$43,056	$58,708	36.4%
Town of Sandwich	$38,844	$54,028	39.1%
Barnstable County	$39,156	$57,980	48.1%
Dukes County	$41,912	$66,716	59.2%
Nantucket County	$45,552	$75,296	65.3%
Massachusetts	$57,824	$89,804	55.3%

Source: Massachusetts Executive Office of Labor and Workforce Development, ES202 dataset. Data are not inflation adjusted. Data for census tracts are not available.

4.5.2.6 Real Estate

Existing conditions and historical trends in the inventory, occupancy, vacancies, and lease prices for commercial real estate in Barnstable County reveal a market that has seen little growth in the supply or occupancy of retail and office space over the past 18 years (2006-2024) (**Table 4.5-12**). Lease prices have been flat except for industrial space. Only industrial space (primarily warehouse) is projected to grow on an average annual basis greater than the historical average and to have high enough lease prices to support modest additional development.

Table 4.5-12. Existing (2024) Conditions and Historical Growth in Commercial Real Estate in Barnstable County

Category	Inventory (square feet) (2024)	Average Annual Supply Growth (square feet) (2006-2024)	Occupancy (square feet) (2024)	Average Annual Occupancy Growth (square feet) (2006-2024)
Retail	16,000,000	14,000	15,700,000	7,000
Office	5,900,000	20,000	5,733,000	15,000
Industrial	5,000,000	26,000	4,800,000	26,000

Source: CoStar Property Information Systems, 2024

4.5.3 No Build Alternative

The primary source of information for the analysis of the No Build Alternative is a report prepared by Senator Elizabeth Warren, Senator Ed Markey, and Representative Bill Keating, together representing the Congressional Delegation for Cape Cod, Martha's Vineyard, and Nantucket.[1] The senators and representatives sent 36 "letters of inquiry" to stakeholders on July 21, 2023, including state elected officials, local elected officials, Tribal leaders, and community organizations. The letters asked respondents about the following:

- Impacts on communities of the state of disrepair of the bridges to date—including economic impacts to tourism, local workers, businesses, families, and community members—and impacts to supply chains and the availability and accessibility of goods
- The potential future impacts if the bridges continue to deteriorate
- The benefits of replacing the bridges, including the job creation and economic benefits of the Cape Cod Bridges Program (Program)

Of the 36 letters sent, the following entities responded:

- Cape Cod Region Chamber of Commerce
- Cape Cod Chamber of Commerce
- Town of Bourne
- Town of Oak Bluffs
- Town of Provincetown
- Town of Sandwich
- Association to Preserve Cape Cod
- Cape Cod Commission
- State Senator Julian Cyr
- State Senator Susan Moran
- Barnstable County Board of Regional Commissioners

For those who replied, the replacement of the bridges is of paramount importance to their constituents and members. The commonality of congestion-related issues, across towns and across agencies and institutions, strongly supports the fundamental arguments that underpin the report.

The following findings and observations explain how repeated lane closures required for the No Build Alternative would continue (as they have in the past) to affect Cape Cod communities:

- Sagamore Bridge and Bourne Bridge are of "significant" importance to businesses and workers, including as the daily conduit of 31,000 jobs filled by workers residing on Cape Cod who work off Cape Cod and 21,000 jobs on Cape Cod held by off-Cape residents. Delays affect worker

[1] Senators Elizabeth Warren and Ed Markey and Representative Bill Keating. 2023. Cape Cod Bridges: An Urgent Need. October. https://www.warren.senate.gov/imo/media/doc/Final%20Cape%20Cod%20Bridges%20Report.pdf

productivity and the ability of local businesses to attract workers, as well as freight costs on and off Cape Cod. Additional freight costs affect the price of goods on Cape Cod as well as the ability of local firms to serve off-Cape markets. The prospect of ongoing delays during maintenance required for the No Build Alternative, as well as the unpredictability of the magnitude of lane closures and delays, would constrain the prospects of new business developing on Cape Cod.

- Possible future delays and bridge closures could affect tourism. A report for the Cape Cod Commission[2] posited the following scenarios:
  - A complete shutdown of one bridge for two to five years
  - A complete shutdown of one bridge for six months
  - 16 months of lane closures

  The firm's analyses suggested that there would be a substantial loss of jobs and business output for any of these scenarios.
- Continued service disruptions already affect the health and welfare of local area residents by inducing stress getting to and from work and other appointments, as well as the time students spent traveling to and from school because the canal splits the town of Bourne in two. The northern section of the town of Bourne, where the business and historic centers are located, is subjected to traffic backups of as much as 10 miles during routine maintenance of the bridges, effectively isolating them from the rest of town. These problems are expected to be exacerbated for the No Build Alternative, where more frequent and extensive lane closures will worsen current conditions.

4.5.4 Program Impacts

4.5.4.1 Operational Impacts

This section assesses potential social and economic impacts of the Build Alternative following completion of the Program. These impacts are called "operational" (or ongoing annual) impacts to distinguish them from those that would occur on a one-time (not annually recurring) basis during the construction phase. The travel times and other impacts of the Build Alternative compared to the No Build Alternative in 2050 reflect improvements in transportation efficiency. These reduce the costs of goods movements and lower the travel times for workers, each of which boosts productivity for businesses.

Regional Economic Impacts

MassDOT used TREDIS software to evaluate and compare predicted economic impacts for the No Build Alternative and Build Alternative for 2050. To isolate the regional economic impacts that would result in response to the Build Alternative, the induced economic impacts were estimated using TREDIS. This analysis considered the amount of "ripple effect" economic activity that would be created because of

[2] Technical Memorandum from the Eastern Research Group, Inc. (ERG) Team to the Cape Cod Commission, August 9, 2024.

bridge replacement. The induced economic impacts of a potential bridge replacement for the No Build Alternative would be zero, as the No Build Alternative does not propose replacing the bridges. The induced economic impacts of a potential bridge replacement for the Build Alternative are provided in **Table 4.5-13**.

As presented in **Table 4.5-13**,[3] the results of this analysis show that for 2050 there would be a net increase in economic output, value added, jobs, and labor income for Cape Cod and the Islands, Plymouth County, and the rest of Massachusetts for the Build Alternative when compared to the No Build Alternative. The net increase in economic output within Cape Cod and the Islands would be 49% of the total increase for Massachusetts. While the net increase in the total headcount of jobs for Cape Cod and the Islands in 2050 would comprise over half of the total increase in Massachusetts, the increase in labor income generated from these jobs is estimated to be only 43% of the total increase in labor income for Massachusetts.

Table 4.5-13. Economic Impacts: TREDIS Analysis, 2050

Region	Output (2022$)	Output as % of State Total	Value Added (2022 $)	Jobs (headcount)	Head count as % of State Total	Labor Income (2022$)	Labor Income as % of State
Cape Cod and Islands	$10,380,000	49%	$4,570,000	21	53%	$2,610,000	43%
Plymouth County	$3,360,000	16%	$1,650,000	8	20%	$1,030,000	17%
Rest of Massachusetts	$7,370,000	35%	$3,960,000	11	28%	$2,440,000	40%
Total Massachusetts	$**21,100,000**		$**10,180,000**	40		$**6,080,000**	

Source: TREDIS Analysis

The TREDIS analysis also compares tax collection for state and local taxes, including both those levied on households and businesses, for the No Build Alternative and Build Alternative. As presented in **Table 4.5-14**, net tax collections for the Build Alternative would be about $426,000 (in 2022 dollars) greater than that of the No Build Alternative. Of this, 49% would be garnered from Cape Cod and Islands.

[3] These and other tables may not total due to rounding, especially in the case of jobs measures.

Table 4.5-14. State and Local Tax Impacts, 2050 (2022 dollars)

Region	Tax Revenue
Cape Cod and Islands	$209,000
Plymouth County	$90,000
Rest of Massachusetts	$127,000
Total Massachusetts	**$426,000**

Source: TREDIS Analysis

TREDIS estimates total social benefits as well as economic impacts. The social benefits include cost savings that are adapted and used to inform the economic impact analysis but also benefits that do not result in monetary transfers. These savings—in the form of saved time, crashes, and pollutants emitted—are monetized following U.S. Department of Transportation guidance. Some social benefits are enjoyed directly by travelers, but others, such as environmental benefits or business time savings, are enjoyed by other stakeholders, such as local firms or the community.

Among monetary benefits, households—and to some degree businesses—would enjoy savings in vehicle maintenance costs and fuel. Businesses would also benefit from shipping costs saved. These items (represented by Vehicle Operating Costs, Business Time, and Shipper/Logistics Costs categories in **Table 4.5-15**) were inputs into the economic analysis model that produced the results shown in **Table 4.5-13** and **Table 4.5-14**.

Table 4.5-15. Social Benefits in 2050 (2022 dollars)

Benefits Category	Value
Vehicle Operating Costs Savings	$8,600,000
Business Time Savings	$11,600,000
Shipper/Logistics Costs Savings	$200,000
Value of Personal Time Savings	$82,100,000
Safety Cost Savings	$10,300,000
Environmental Cost Savings	$4,100,000
Total	**$116,900,000**

Source: TREDIS Analysis

At the same time, all system users would enjoy time savings (valued under the categories Value of Personal Time and Business Time). Averted crashes—which result in saved lives, injuries, and property damage—were monetized per the U.S. Department of Transportation guidance to find a total Safety Cost category. Finally, reduced volumes of pollutants in the environment were monetized and reported in the Environmental category.

Local Economic Impacts

According to the traffic analysis (refer to **Section 4.2, Transportation, Traffic, and Safety**), the Build Alternative is expected to result in an average 3-minute travel-time savings from the vicinity of each bridge. For an average commute of 30 minutes, the Build Alternative would increase the effective reach of jobs for workers and the labor pool for employers by about one-third compared to the No Build Alternative (**Table 4.5-16**). This means, for example, that a worker commuting 30 minutes under No Build conditions would have access to a third more jobs with the Build Alternative, all because of a 3-minute time savings. To put it another way, a 30-minute trip for this worker for the Build Alternative would have taken 33 minutes for the No Build Alternative.

Table 4.5-16. Access to Jobs with 3-minute Travel-Time Saving from Each Bridge

Bridge	No Build Alternative Jobs within 30-minute Drive	Build Alternative Jobs within 30-minute Drive	Number Increase	Percentage Increase
Sagamore Bridge	145,400	191,000	45,400	31%
Bourne Bridge	192,000	256,000	64,000	33%

Source: TREDIS Analysis

Extended market areas for retailers would accrue further benefits from the average travel-time savings for the Build Alternative compared to the No Build Alternative (**Table 4.5-17**). Retailers typically define market areas in terms of drive times, with a 20-minute drive time considered to be the maximum time consumers are willing to drive for all but the largest stores and highly specialized store types. A travel-time savings of 3 minutes would enable retailers to expand their effective market areas and consumers to expand their consumption opportunities.

Table 4.5-17. Increase in Access to Consumer Expenditures with 3-minute Travel-Time Saving from Vicinity of Each Bridge

Bridge	No Build Alternative Retail Expenditures within 20-minute Drive (2024$)	Build Alternative Retail Expenditures within 20-minute Drive (2024$)	Difference (2024$)	Percentage Difference
Sagamore Bridge	$1,844,275,000	$2,555,444,000	$711,169,000	39%
Bourne Bridge	$1,861,995,000	$2,709,828,000	$847,832,740	45%

Source: TREDIS Analysis

4.5.4.2 Economic Impacts of Construction

Based on the May 2024 Cape Cod Bridges Program Conceptual Program construction expenditures estimate, MassDOT assessed the direct, indirect, and induced economic impacts of these one-time (construction period) impacts using the R/ECON Input-Output Model (**Table 4.5-18**).[4]

The direct, indirect, and induced expenditures for the Program were also estimated to generate $604,000,000 in taxes, which include the following approximate amounts:

- $70 million in local taxes (primarily real estate taxes paid by workers within their communities of residence)
- $129 million in state taxes (primarily corporate and individual income taxes)
- $405 million in federal taxes

Table 4.5-18. Economic and Fiscal Impacts in Massachusetts of Cape Cod Bridges Replacement Conceptual Program Expenditure Estimates

Distribution of Impacts	Output (2024$)	Employment (Jobs)	Earnings (2024$)	Gross Domestic Product (2024$)
Direct Impacts	$3,242,081,600	16,000	$1,418,259,200	$1,521,945,800
Indirect Impacts	$1,268,506,000	5,154	$437,377,800	$1,521,945,800
Induced Impacts	$1,246,224,400	6,717	$417,744,600	$733,412,400
Total Impacts	**$5,756,812,100**	**27,879**	**$2,273,381,700**	**$2,917,736,700**

Source: R/ECON Input-Output Model

4.5.5 Mitigation

Potential impacts, and mitigation, during construction on households and businesses are addressed in **Section 4.2, Transportation, Traffic, and Safety**. With only minor projected increases in jobs (21 net new jobs on Cape Cod and the Islands) for the Build Alternative, impacts on land use would be negligible as discussed in **Section 4.23, Indirect and Cumulative Impacts**.

[4] "Direct impacts" reflect the initial expenditures, jobs, and income attributable to the construction project and its immediate suppliers. "Indirect impacts" reflect the inputs of suppliers to the industries supporting direct expenditures. Induced impacts" reflect the spending of workers engaged in the direct and indirect impacts serving industries on personal consumption. **Appendix 4.5, Socioeconomics Technical Report**, explains the terms "output," "employment," "earnings," and "gross domestic product."

4 Existing Conditions, Program Impacts, and Mitigation

4.6 Land Use, Zoning, and Community Cohesion

4.6.1 Introduction

This section provides a qualitative assessment of the direct and indirect, and temporary and permanent impacts of the No Build Alternative and Build Alternative on land use in the Sagamore Bridge and Bourne Bridge Study Areas (Study Areas). This includes a review of existing land use[1] and zoning policies[2] and the identification of local and regional master plans influencing land usage. Existing conditions for protected land uses,[3] land use growth assumptions, and community cohesion[4] are documented, and the impacts of the No Build Alternative and Build Alternative on each of these categories are assessed. This section also identifies and assesses the potential for the Build Alternative to incorporate measures to avoid, minimize, and/or mitigate land alteration impacts.

Section 4.19, Solid and Hazardous Waste Material Management, addresses potential impacts on environmentally affected land uses and associated mitigation measures. **Section 4.8, Property Acquisition, Displacement, and Relocation** addresses potential impacts on property and associated mitigation measures.

4.6.1.1 Regulatory Framework

Table 4.6-1 details the resources providing the regulatory context and guidance for this analysis.

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[1] Land use describes the human use of land, and represents the economic and cultural activities (e.g., agricultural, residential, industrial, mining, and recreational uses) that are practiced at a given place.

[2] Zoning refers to the process of dividing land into designated areas, or "zones," where the use of land and buildings are regulated, and specific land uses are permitted or restricted.

[3] Protected land uses include federally owned and managed property; Town of Bourne-owned property; and lands acquired for conservation or recreational purposes by state agencies under Massachusetts Executive Office of Energy and Environmental Affairs, as well as municipalities, boards and commissions, quasi-public agencies, and other public instrumentalities and subdivisions of the Commonwealth.

[4] Community cohesion refers to the strength of relationships and sense of connection among individuals and groups within a community.

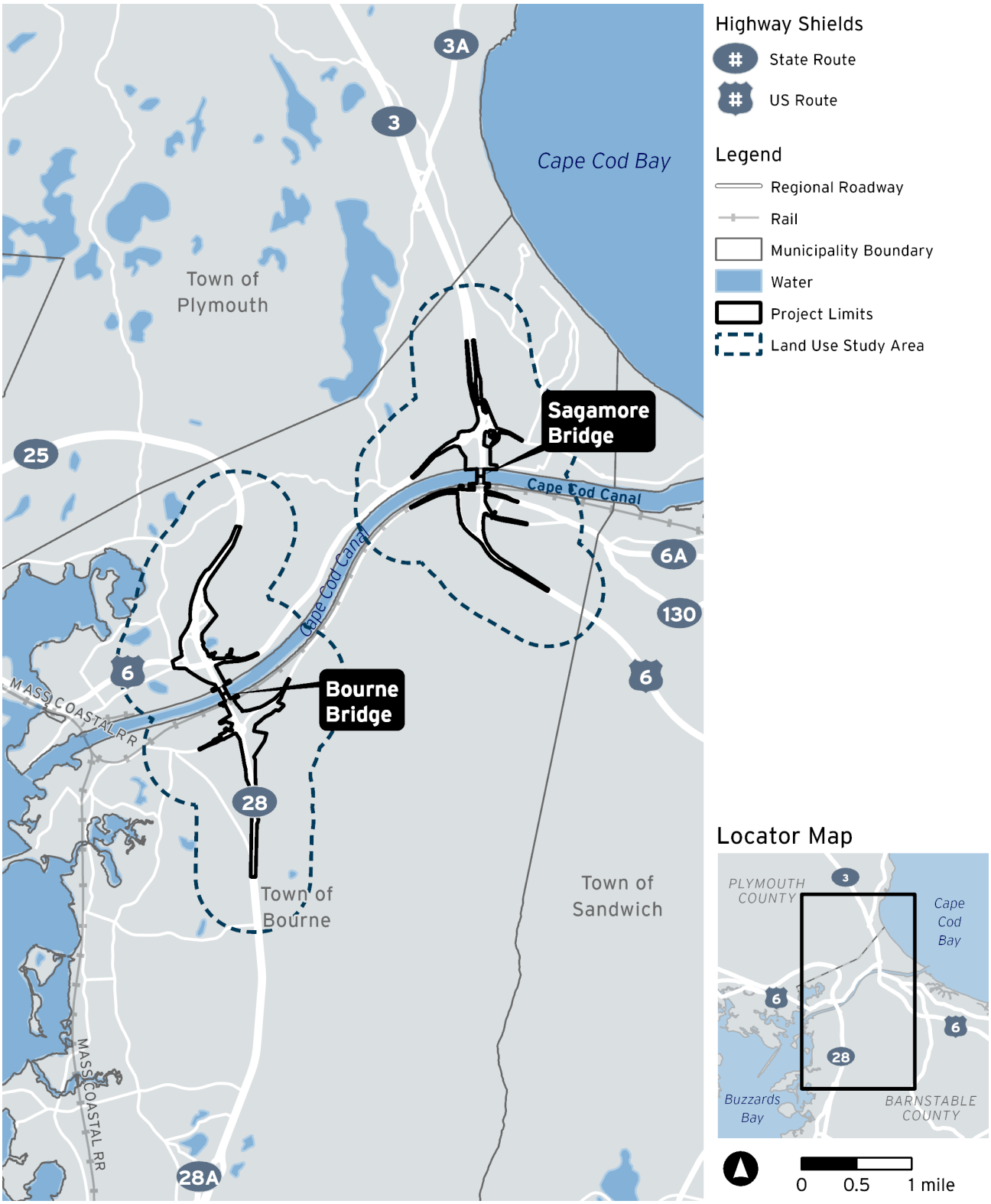
Table 4.6-1. Regulatory Framework for Land Use Assessment

Regulatory Jurisdiction	Regulatory Framework/Guidance
Federal	• Safe Drinking Water Act of 1974 (Sole Source Aquifer Protection Program: Section 1424(e); Public Law 93-523, 42 USC et seq.)
State	• Massachusetts Zoning Act (Massachusetts General Law Chapter 40A) • Massachusetts Contingency Plan (Massachusetts General Law Chapter 21E: 310 CMR 40.00) • Areas of Critical Environmental Concern (Authorized under the Executive Office of Energy and Environmental Affairs: 301 CMR 12.00)
Local/Regional	• Cape Cod Commission Regional Policy Plan. 2019. • Cape Cod Metropolitan Planning Organization. July 2023. Cape Cod 2024-2044 Regional Transportation Plan. • Town of Bourne Local Comprehensive Plan. 2019. • Town of Bourne. Open Space and Recreation Plan. February 2018. • Town of Bourne. Zoning Bylaw. October 2022.

4.6.1.2 Study Areas

The land use Study Areas consist of 0.5-mile buffers from the construction limits for the Build Alternative at Sagamore Bridge and Bourne Bridge (**Figure 4.6-1**). Massachusetts Department of Transportation (MassDOT) defined these Study Areas to evaluate the direct and indirect impacts of the Build Alternative on land use. “Direct impacts” are caused by the action and occur at the same time and place, whereas “indirect impacts” are caused by the action and are later in time or farther removed in distance but are still reasonably foreseeable.

Figure 4.6-1. Land Use Study Areas



Source: Massachusetts Department of Transportation, 2024

4.6.1.3 Methodology

To determine the affected environment and understand existing land use conditions in the Study Areas, this assessment used the following:

- Geospatial zoning data from the Cape Cod Commission[5]
- Land use and zoning documents from the Towns of Bourne, Sandwich, and Plymouth[6]
- Open space and protected land use geospatial data from MassGIS[7]

MassDOT identified local land use, zoning, and master plans in the Study Areas using the Town of Bourne's Local Comprehensive Plan (LCP)[8] and the Cape Cod Regional Commission's Regional Policy Plan (RPP),[9] and reviewed growth assumptions, travel demand, and traffic forecasting.

To understand existing conditions for community cohesion, MassDOT reviewed local planning documents and interviewed local officials to develop an understanding of community characteristics that contribute to, or that have adverse impacts on, community cohesion.

To determine the potential impacts of the No Build Alternative and Build Alternative on land use and community cohesion, MassDOT performed a qualitative analysis by overlaying the Project Limits and Study Areas with land use, zoning, and open space geospatial layers. Property acquisition and environmentally affected land impacts were referenced from respective chapter analyses, and impacts on land use were summarized. MassDOT qualitatively assessed and summarized the impacts on community cohesion based on the anticipated impacts of the Build Alternative on neighborhood connectivity and access to heritage sites, recreational areas, and community facilities.

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[5] Cape Cod Commission. 2014. Zoning. April (updated August 2024). https://gis.data.mass.gov/datasets/CCCommission::zoning/about

[6] Town of Bourne. 2011. Zoning Map. October. https://www.townofbourne.com/sites/g/files/vyhlif12841/f/file/file/zoning_map_102511.pdf;
Town of Sandwich. 2017. Zoning Map. November. https://www.sandwichmass.org/DocumentCenter/View/3830/November-2017-Zoning-Map;
Town of Plymouth. 2012. Zoning Map. https://www.plymouth-ma.gov/DocumentCenter/View/1435/Standard-Zoning-PDF
Town of Bourne. 2022. Zoning Bylaw. October. https://www.townofbourne.com/sites/g/files/vyhlif12841/f/uploads/zoning_bylaw_2022_for_website_1.pdf
Town of Sandwich. 2024. Zoning Bylaw. May. https://www.sandwichmass.org/DocumentCenter/View/9660/May-2024-Zoning-Bylaw
Town of Plymouth. 2024. Zoning Bylaw. https://www.plymouth-ma.gov/DocumentCenter/View/7334/Zoning-Bylaw-10-2024

[7] MassGIS Data. 2024. Protected and Recreational OpenSpace. June. https://www.mass.gov/info-details/massgis-data-protected-and-recreational-openspace
Mass.gov. ACEC Program Overview. https://www.mass.gov/info-details/acec-program-overview

[8] Town of Bourne. 2019. Bourne Local Comprehensive Plan. https://www.townofbourne.com/planning/news/local-comprehensive-final-certified-plan

[9] Cape Cod Regional Commission. 2019. Cape Cod Regional Policy Plan. https://www.capecodcommission.org/our-work/rpp/

4.6.2 Existing Conditions

4.6.2.1 Land Use Overview

This section provides a detailed overview of the existing land use conditions and zoning districts within the Study Areas and identifies local and regional master plans, along with their associated goals and policies, relevant to the land use assessment. Protected open space, environmentally affected land uses, and potentially affected property in the affected environment are identified and described in **Section 4.18, Public Parks, Recreational Facilities, and Open Space**, **Section 4.19, Solid and Hazardous Waste Material Management**, and **Section 4.8, Property Acquisition, Displacement, and Relocation**, respectively.

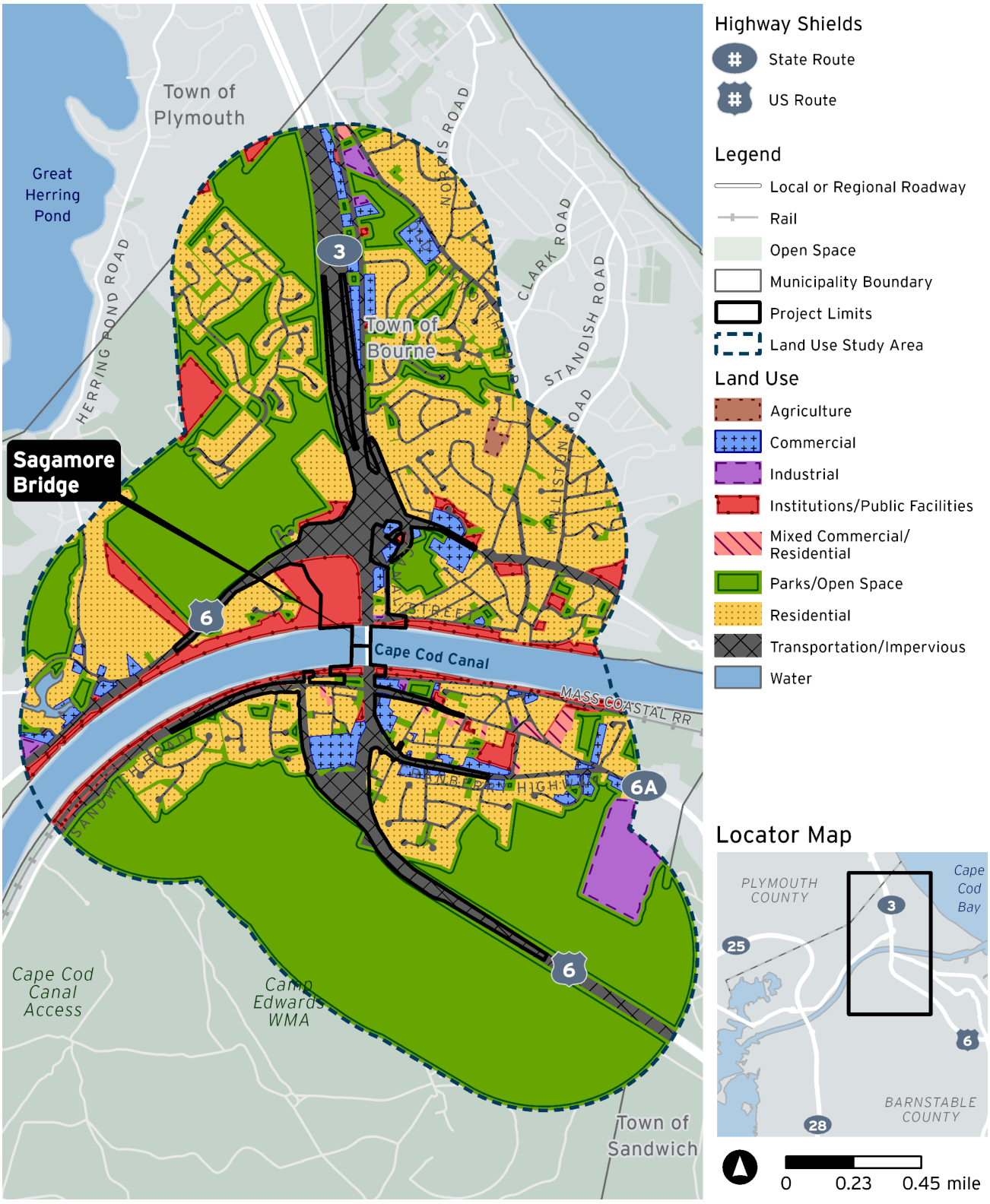
4.6.2.2 Existing Land Use

The Study Areas consist of a variety of land uses, as illustrated in **Figure 4.6-2** and **Figure 4.6-3**, and listed in **Table 4.6-2** and **Table 4.6-3**. The land use assessment excludes the Cape Cod Canal area featured in each bridge's Study Area when calculating total land use acreage. For the purposes of the land use categorization, "Parks/Open Space" refers to land that is undeveloped or preserved for environmental, recreational, or aesthetic purposes, including parks, natural areas, greenways, farmland, forests, conservation land, wetlands, and other landscapes that provide ecological, social, and recreational benefits.

The Sagamore Bridge Study Area primarily comprises park/open space (45.1% of the Study Area), followed by residential (25.0%), and transportation/impervious land uses (13.3%). Water comprises 6.2% of the Study Area (inclusive of the canal), institutions/public facilities comprise 5.4%, , while commercial land uses comprise 2.9%, and the remaining land uses (mixed commercial/residential industrial, and agriculture) consist of 2% or less of the Study Area (**Table 4.6-2**).

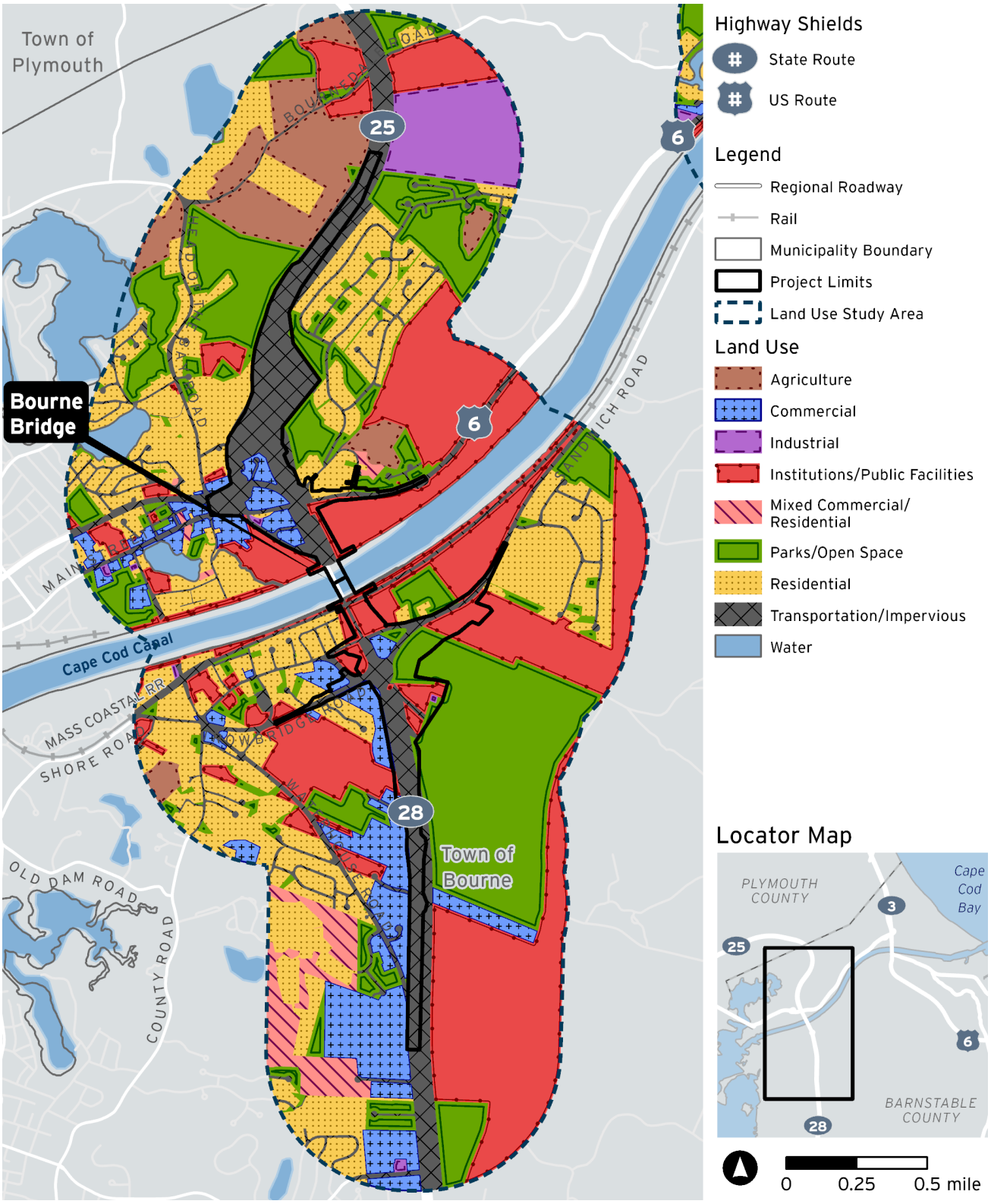
The Sagamore Bridge Study Area is within the Sagamore Beach and Sagamore communities of the town of Bourne (**Figure 4.6-2**). North of Cape Cod Canal, land uses east and west of State Route 3 consist of medium-density residential development, with commercial development around the Canal Street and Meetinghouse Lane intersection, and along the eastern side of State Route 3. Institution and public facility uses are concentrated north of and adjacent to Cape Cod Canal, while park and open space uses are primarily found west of State Route 3 and north of U.S. Route 6.

Figure 4.6-2. Land Use Classifications (Sagamore Bridge Study Area)



Source: Massachusetts Department of Transportation, 2024

Figure 4.6-3. Land Use Classifications (Bourne Bridge Study Area)



Source: Massachusetts Department of Transportation, 2024

Table 4.6-2. Land Use Classifications (Sagamore Bridge Study Area)

Land Use Category	Acres in Sagamore Bridge Study Area	Percentage of Study Area (%)
Agriculture	4.53	0.2%
Commercial	87.72	2.9%
Industrial	48.02	1.6%
Institutions/Public Facilities	162.77	5.4%
Mixed Commercial/Residential	10.04	0.3%
Parks/Open Space	1,349.69	45.1%
Residential	748.29	25.0%
Transportation/Impervious	397.20	13.3%
Water	185.84	6.2%
Total	**2,994.11**	**100.0%**

Note: Land Use category subtotals may not add to total due to rounding.

Table 4.6-3. Land Use Classifications (Bourne Bridge Study Area)

Land Use Category	Acres in Bourne Bridge Study Area	Percentage of Study Area (%)
Agriculture	168.92	4.8%
Commercial	237.19	6.7%
Industrial	99.71	2.8%
Institutions/Public Facilities	840.11	23.9%
Mixed Commercial/Residential	71.43	2.0%
Parks/Open Space	755.49	21.5%
Residential	698.82	19.9%
Transportation/Impervious	460.40	13.1%
Water	182.47	5.2%
Total	**3,514.55**	**100.0%**

Note: Land Use category subtotals may not add to total due to rounding.

South of the canal, large commercial developments are interspersed among low-density residential development east of the Mid-Cape Connector to Cranberry Highway. Extending south on U.S. Route 6 from Sagamore Bridge, land uses include a portion of the Camp Edwards Wildlife Management Area (part of Joint Base Cape Cod) to the west of U.S. Route 6 and to the east of U.S. Route 6, medium-density residential development and a portion of the 624-acre Shawme-Crowell State Forest.[10] Riprap embankments mark the Cape Cod Canal shoreline, and service roads run along both sides of the canal, which are used for canal maintenance and public recreational access.[11]

The Bourne Bridge Study Area primarily comprises institutions/public facilities (23.9% of Study Area), park/open space (21.5% of Study Area), residential (19.9%), and transportation/impervious land uses (13.1%). Commercial land uses amount to 6.7%, water comprise 5.2% (inclusive of the canal), and agricultural uses amount to 4.8% of the Study Area. Lastly, industrial consists of 2.8% and mixed commercial/residential consists of 2.0% of the Study Area (**Table 4.6-3**).

The Bourne Bridge Study Area is within the Buzzards Bay community of the town of Bourne, which is characterized by medium- to high-density residential development and commercial development (**Figure 4.6-3**). North of Cape Cod Canal, land uses along State Route 25 consist of parks/open space including forested areas, Nightingale Pond Conservation Area, and natural areas, interspersed with protected open space and institutions/public facilities. Agricultural land uses are concentrated northwest of State Route 25, and institutions and public facility land uses are northeast of State Route 25 and north of and adjacent to the canal. Bournedale Elementary School is directly north of U.S. Route 6 on the eastern side of the Bourne North quadrant. Commercial development is centered around Belmont Circle, which includes retail businesses, restaurants, and the Main Street commercial area.

South of the canal, land uses include higher-density residential, institutional, and commercial development. Commercial land uses adjacent to the Bourne Rotary include restaurant and retail establishments. The Massachusetts State Police barracks is adjacent to the northwest side of the Bourne Rotary. Extending south from the Bourne Rotary, State Route 28 is bordered to the west by the Bourne High School, flanked on both sides by commercial development; and to the area east by portions of the Massachusetts Military Reservation (Camp Edwards), on Joint Base Cape Cod.[12] The Upper Cape Cod Regional Vocational Technical School, municipal canal access, and skating rink form a concentration of institutions/public facilities in the northeast portion of the Bourne South quadrant.

[10] Massachusetts Department of Transportation. 2023. Cape Cod Bridges Program Environmental Notification Form. April.
[11] U.S. Army Corps of Engineers. 2022. Environmental Assessment and Finding of No Significant Impact for Major Rehabilitation Evaluation. Cape Cod Canal Highway Bridges, Massachusetts. March. https://www.nae.usace.army.mil/Portals/74/docs/Topics/Cape%20Cod%20Canal%20Bridges/Reports/MREREnvAssessment.pdf
[12] Massachusetts Department of Transportation. 2023. Cape Cod Bridges Program Environmental Notification Form. April.

4.6.2.3 Zoning

According to the Bourne,[13] Sandwich, and Plymouth zoning maps[14] and zoning bylaws,[15] the Sagamore Bridge Study Area comprises approximately 1,348.29 acres of Residential Districts (47.9% of the Sagamore Bridge Study Area), 689.44 acres of Government Districts (24.5%), 326.92 acres of Scenic Development Districts (11.6%), 261.71 acres of Business Districts (9.3%), and 27.54 acres of Village Business Districts (1%). The remaining approximately 160.79 acres in the Study Area comprise unclassified right-of-way (5.7%).[16] Within the Sagamore Bridge Study Area, land abutting the Project Limits is primarily zoned for residential or business use, with some sections zoned for scenic development and governmental use.

The Bourne Bridge Study Area comprises 1,808.09 acres of Residential Districts (53.8% of the Bourne Study Area), 706.99 acres of Business Districts (21.0%), 215.86 acres within the Downtown District (6.4%), 205.61 acres of Scenic Development Districts (6.1%), and 6.85 acres of Village Business Districts (<1%). The remaining approximately 239.92 acres in the Study Area comprises unclassified right-of-way (7.1%). Within the Bourne Bridge Study Area, land abutting the Project Limits is primarily zoned for residential or business use, with some sections zoned for scenic development, and some zoned under the Downtown District.

The Downtown District comprises Downtown Core, Gateway, Neighborhood, and Waterfront classifications.[17] In the Bourne Bridge Study Area, 80.73 acres (2.4%) are classified as Downtown Neighborhood, 76.21 acres (2.3%) are classified as Downtown Gateway, 56.71 acres (1.7%) are classified as Downtown Core, and 2.21 acres (<1%) are classified as Downtown Neighborhood. The Downtown Overlay District is zoned for several uses, including higher-density public works, landscaping, construction, and retail. In the eastern section of downtown, the historic Bourne Village is zoned to preserve the character of the town, featuring compact buildings with traditional architecture.

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[13] The Sagamore Bridge Study Area primarily overlaps Bourne, but small portions of the Study Area also overlap Sandwich and Plymouth. The Bourne Bridge Study Area only overlaps Bourne.

[14] Town of Bourne. 2011. Zoning Map. October. https://www.townofbourne.com/sites/g/files/vyhlif12841/f/file/file/zoning_map_102511.pdf; Town of Sandwich. 2017. Zoning Map. https://www.sandwichmass.org/DocumentCenter/View/3830/November-2017-Zoning-Map; Town of Plymouth. 2012. Zoning Map. https://www.plymouth-ma.gov/DocumentCenter/View/1435/Standard-Zoning-PDF

[15] Town of Bourne. 2022. Zoning Bylaw. October. https://www.townofbourne.com/sites/g/files/vyhlif12841/f/uploads/zoning_bylaw_2022_for_website_1.pdf ; Town of Sandwich. 2024. Zoning Bylaw. https://www.sandwichmass.org/DocumentCenter/View/9660/May-2024-Zoning-Bylaw ; Town of Plymouth. 2024. Zoning Bylaw. https://www.plymouth-ma.gov/DocumentCenter/View/7334/Zoning-Bylaw-10-2024 ;

[16] The canal is excluded from zoning, so it is not included in the total Study Area acreage for the zoning calculations.

[17] Town of Bourne. 2011. Zoning Map. October. https://www.townofbourne.com/sites/g/files/vyhlif12841/f/file/file/zoning_map_102511.pdf

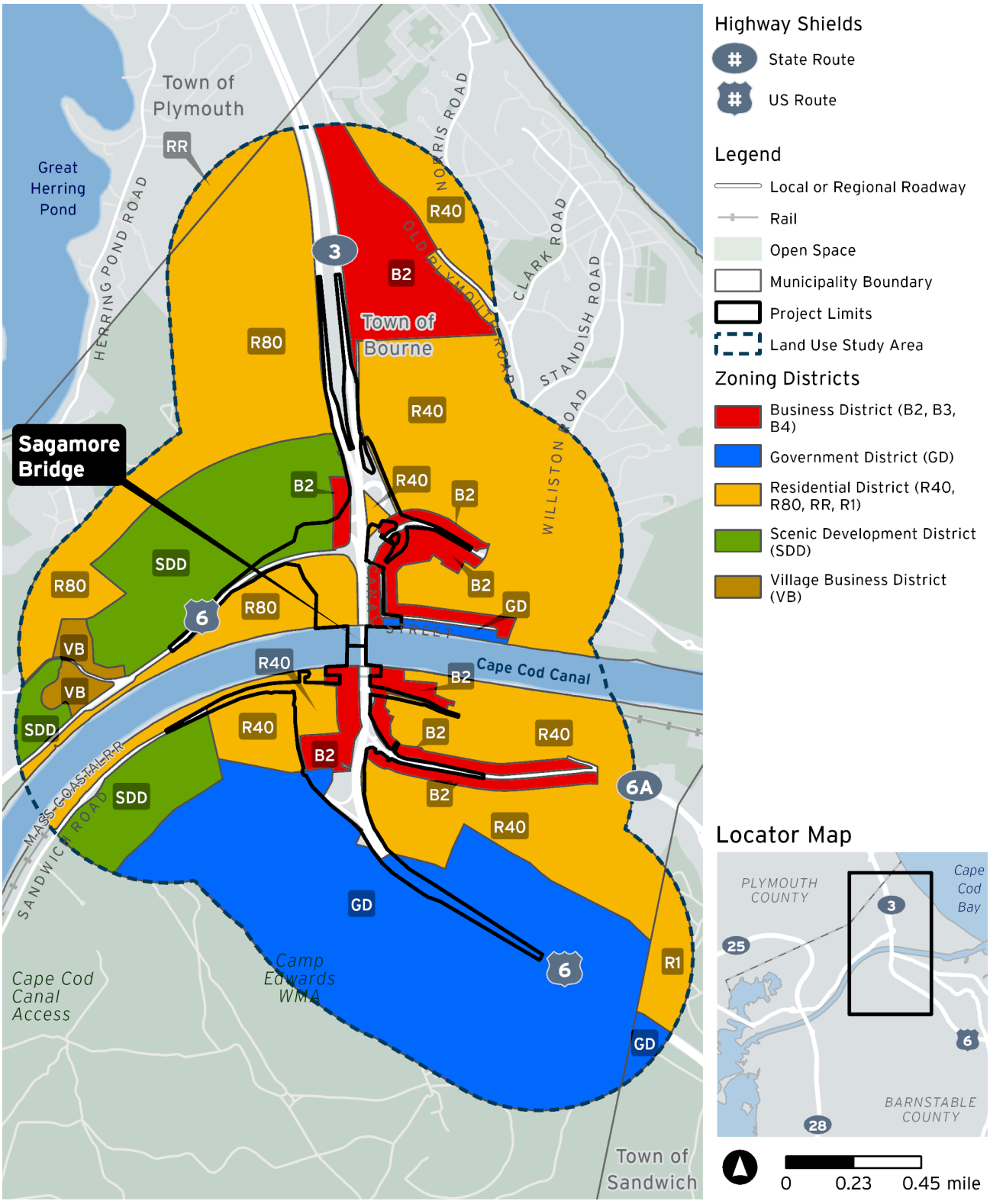
Other sections of downtown are zoned to protect the waterfront, and much of the area along the canal is zoned for scenic development.[18]

Figure 4.6-4 and **Figure 4.6-5** illustrate the Study Areas' zoning districts.[19]

[18] U.S. Army Corps of Engineers. 2022. Environmental Assessment and Finding of No Significant Impact for Major Rehabilitation Evaluation. Cape Cod Canal Highway Bridges, Massachusetts. March. https://www.nae.usace.army.mil/Portals/74/docs/Topics/Cape%20Cod%20Canal%20Bridges/Reports/MREREnvAssessment.pdf

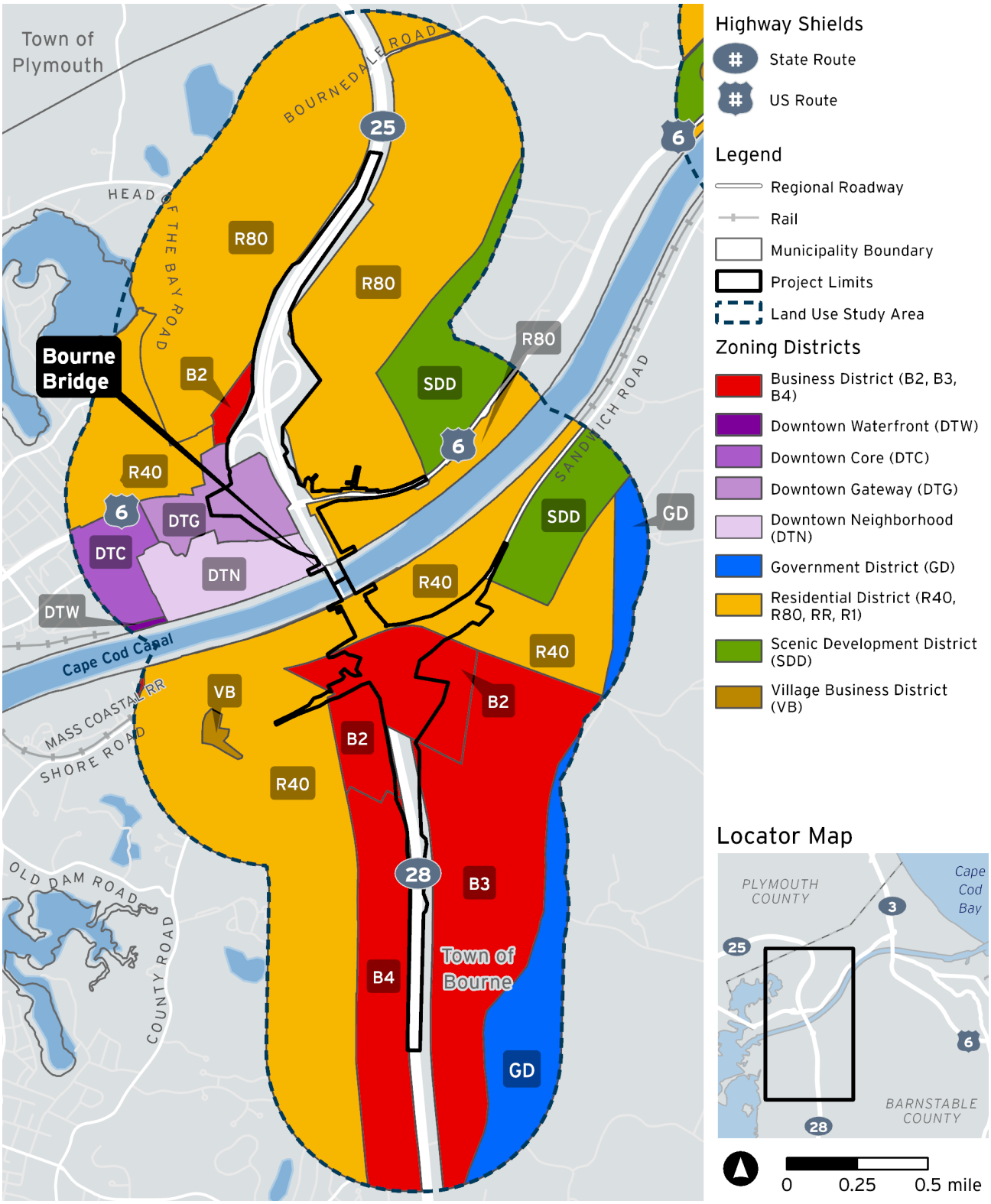
[19] Cape Cod Commission. 2014. Zoning. Updated August 2024. https://gis.data.mass.gov/datasets/CCCommission::zoning/about

Figure 4.6-4. Zoning Classifications (Sagamore Bridge Study Area)



Source: Massachusetts Department of Transportation, 2024

Figure 4.6-5. Zoning Classifications (Bourne Bridge Study Area)



Source: Massachusetts Department of Transportation, 2024

4.6.2.4 Identification of Master Plans

The Town of Bourne LCP, revised 2019, was approved by Town Meeting on October 29, 2019, and certified by the Cape Cod Commission in December 2019.[20] Of relevance to land use, the LCP's open space policy is to protect the public rights for recreation, enhance public access to existing conservation land, and to establish green corridors and/or connections. The LCP's cultural heritage goal is to protect and preserve historical and cultural features of the town's landscape and to ensure that future development respects the town's historical traditions.

The Cape Cod RPP, prepared by the Cape Cod Commission in December 2018, was approved by Barnstable County Ordinance #19-01, effective March 30, 2021.[21] Of relevance to land use, the RPP's open space goal is to conserve, preserve, or enhance a network of open space that contributes to the region's natural and community resources and systems. The RPP's community design goal is to protect and enhance the unique character of the region's built and natural environment based on the local context. Lastly, the RPP's cultural heritage goal is to protect and preserve the significant cultural, historical, and archaeological values and resources of Cape Cod.

4.6.2.5 Protected Land Uses

This section provides an overview of protected land uses in the Study Areas.

Open Space

The Study Areas feature multiple publicly owned and designated protected open space parcels. For the purposes of this assessment, "open space" refers to publicly owned, undeveloped lands including parks, recreation areas, greenways, forests, or other land uses that may be accessible for public use, and protect and preserve the environment and/or scenic and cultural resources.[22] **Section 4.18, Public Parks, Recreational Facilities, and Open Space**, provides a detailed identification and review of protected open space parcels near and adjacent to Bourne Bridge and Sagamore Bridge, including details regarding ownership, applicable regulatory protections, and relevant mitigation measures to offset adverse impacts to protected open space as a result of the Build Alternative.

Areas of Critical Environmental Concern

An Area of Critical Environmental Concern (ACEC) is a designation used in Massachusetts to identify and protect areas of significant environmental importance. These areas are recognized for their critical natural resources, which may include wildlife habitats, wetlands, estuaries, rivers, coastal areas, or

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[20] Town of Bourne. 2019. Bourne Local Comprehensive Plan. December. https://www.townofbourne.com/planning/news/local-comprehensive-final-certified-plan

[21] Cape Cod Regional Commission. 2021. Cape Cod Regional Policy Plan. https://www.capecodcommission.org/our-work/rpp/

[22] American Planning Association. 2000. Parks, Recreation, and Open Space: A Twenty-first Century Agenda. PAS Report Number 497/498. https://planning-org-uploaded-media.s3.amazonaws.com/publication/download_pdf/PAS-Report-497-498.pdf

other ecosystems that play an essential role in maintaining environmental quality.[23] The designation is intended to preserve these areas by ensuring careful land use and development practices.[24]

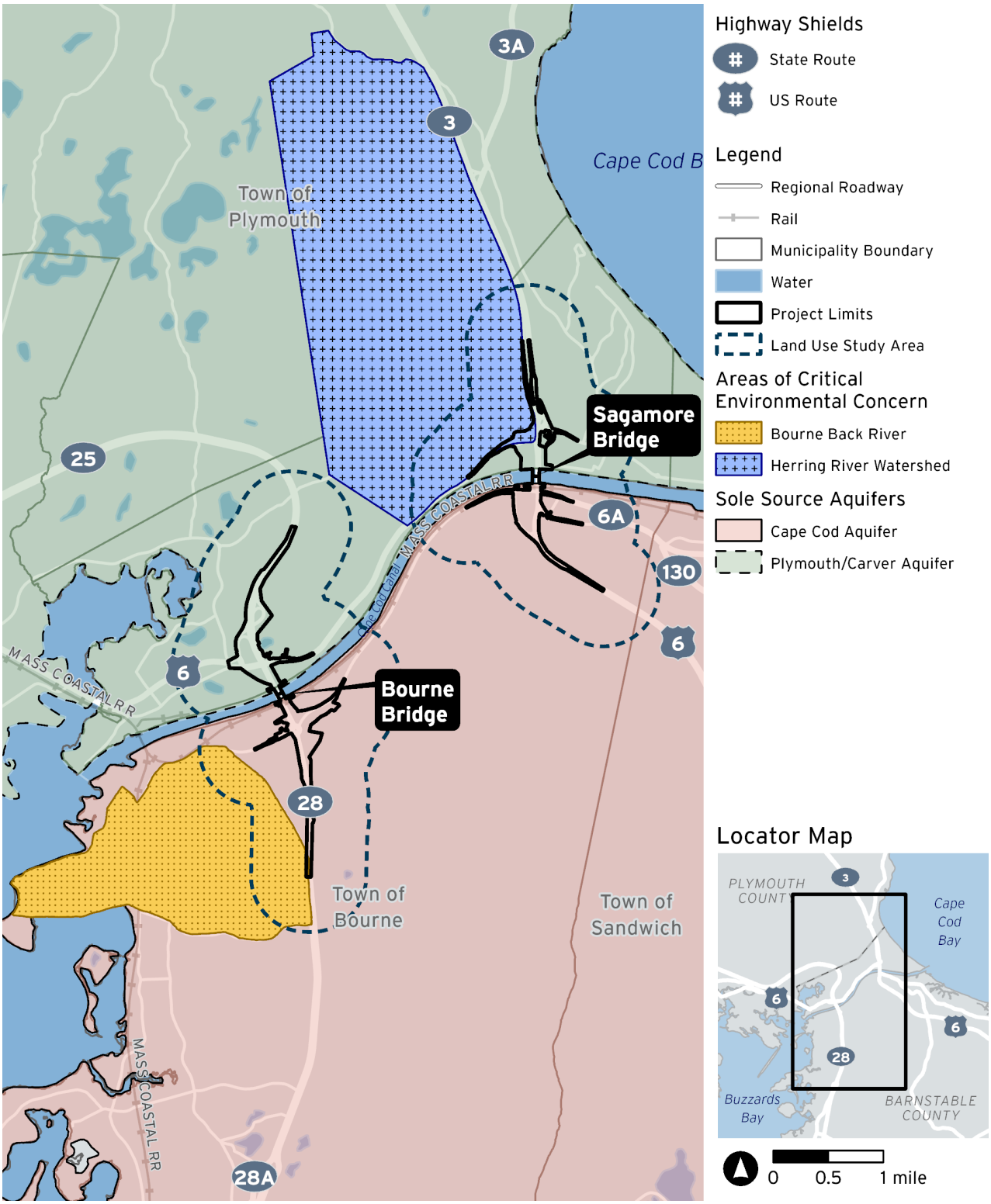
The Study Areas comprise two ACECs (**Figure 4.6-6**):

- Sagamore Bridge Study Area: The Herring River Watershed ACEC, a 4,450-acre area comprising open space, lakes and ponds, freshwater wetlands, and cranberry bogs, is north of the Sagamore Bridge and west of State Route 3. Approximately 686.47 acres of the ACEC are within the Sagamore Bridge Study Area, representing about 22.9% of the Study Area.[25]
- Bourne Bridge Study Area: The Bourne Back River ACEC, a 1,850-acre area comprising salt marshes, tidal flats, and coastal habitats, is south of Bourne Bridge and west of State Route 28. Approximately 451.12 acres of the ACEC is within the Bourne Bridge Study Area, representing about 12.8% of the Study Area.[26]

Section 4.10, Wetlands and Floodplains, includes additional details about ACECs within the Study Areas, including an assessment of potential impacts of the Build Alternative on ACECs, and relevant mitigation measures to offset any adverse impacts.

[23] MassGIS. 2009. Areas of Critical Environmental Concern. April. https://www.mass.gov/info-details/massgis-data-areas-of-critical-environmental-concern
[24] Mass.gov. ACEC Program Overview. https://www.mass.gov/info-details/acec-program-overview
[25] MassGIS. 2009. Areas of Critical Environmental Concern. April. https://www.mass.gov/info-details/massgis-data-areas-of-critical-environmental-concern
[26] MassGIS. 2009. Areas of Critical Environmental Concern. April. https://www.mass.gov/info-details/massgis-data-areas-of-critical-environmental-concern

Figure 4.6-6. Areas of Critical Environmental Concern and Sole Source Aquifers (Land Use Study Areas)



Source: Massachusetts Department of Transportation, 2024

Sole Source Aquifers

The U.S. Environmental Protection Agency (EPA) designates sole source aquifers (SSA) as aquifers that supply at least 50% of the drinking water consumed in the area overlying the aquifer. The SSA protection program is designed to protect drinking water supplies in areas with few or no alternative sources to the ground water resource that could "physically, legally, and economically" supply all those who depend on the aquifer for drinking water. The SSA designation protects an area's groundwater resource by requiring the EPA to review proposed projects receiving federal funds within the designated area to ensure that they do not endanger the water source.[27]

The Study Areas comprise two SSAs (**Figure 4.6-6**):

- North of Cape Cod Canal: Plymouth/Carver SSA, designated by the EPA in 1990, is a critical groundwater resource that supplies drinking water to approximately 200,000 residents across several towns, including Plymouth, Carver, Plympton, Wareham, Kingston, Middleboro, Halifax, and Brockton. As the second-largest aquifer in the state, the Plymouth/Carver SSA covers about 128,000 acres and is characterized by its highly permeable sand and gravel deposits, making it vulnerable to saltwater intrusion and susceptible to contamination. The SSA supports local ecosystems, including lakes, ponds, wetlands, and cranberry bogs. Approximately 1,565.26 acres of the Plymouth/Carver SSA are within the Bourne Bridge Study Area, representing about 44.6% of the Study Area, and approximately 1,523.24 acres is within the Sagamore Bridge Study Area, representing about 50.9% of the Study Area.[28]
- South of Cape Cod Canal: Cape Cod SSA, designated by the EPA in 1982, serves as the primary drinking water source for the entire Cape Cod region, supporting approximately 230,000 permanent residents as of 2023 and upwards of 500,000 seasonal residents.[29] The SSA is the largest in the state, and encompasses the entire Cape Cod peninsula, covering an area of about 281,600 acres. Composed of unconsolidated sand and gravel deposits from glacial outwash plains, it is highly susceptible to contamination. The SSA sustains the region's freshwater ponds, wetlands, and open spaces. Approximately 1,836.37 acres of the SSA are within the Bourne Bridge Study Area, representing about 52.3% of the Study Area, and approximately 1,318.29 acres are within the Sagamore Bridge Study Area, representing about 44.0% of the Study Area.[30]

Section 4.11, Water Quality and Stormwater, includes additional details about the SSAs within the Study Areas, including an assessment of potential impacts of the Build Alternative on these SSAs, and relevant mitigation measures to offset any adverse impacts.

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[27] MassGIS. 2020. EPA Designated Sole Source Aquifers. September. https://www.mass.gov/info-details/massgis-data-epa-designated-sole-source-aquifers

[28] U.S. Environmental Protection Agency. EPA Region 1 - Sole Source Aquifer Program: Plymouth/Carver. https://www3.epa.gov/region1/eco/drinkwater/plymcarv.html

[29] Data Cape Cod. 2023. Year-Round Population. https://datacapecod.org/pf/barnstable-county-year-round-population/

[30] Environmental Protection Agency. 1982. Cape Cod Aquifer Determination. https://www3.epa.gov/region1/eco/drinkwater/solecape.html

4.6.2.6 Growth Assumptions

This section reviews regional development trends and growth assumptions of Barnstable County. **Section 4.23, Indirect and Cumulative Impacts**, includes a list of existing and proposed developments in the Study Areas and also provides an assessment of future travel demand, traffic forecasting, and the potential for induced demand.

According to Decennial Census estimates, in Barnstable County, from 2000 to 2010, population decreased 2.9% over the ten-year period, and from 2010 to 2020, population increased 5.8% over the same duration. According to the census's yearly county population estimates, from 2020 to 2021, during the COVID-19 pandemic, population growth in Barnstable County increased 1.9%, likely resulting from flexible remote work policies and the associated influx of city-dwellers into suburban areas.[31] From 2021 to 2024, the Barnstable County population remained steady, increasing or decreasing by less than 0.1% per year.[32]

The decrease in population growth seen in Barnstable County from 2000 to 2010 can likely be attributed to the historical pattern of retirees moving to Cape Cod, countered by younger adults leaving Cape Cod for work or school. Although the population increased 5.8% from 2010 to 2020, as of 2020, Barnstable County's median age was 55 years, significantly higher than Massachusetts median age of 40 years. Additionally, as of 2023, 34.0% of the population is aged 65 and over (compared to 18.5% of the Massachusetts population), while only 13.7% are under 18 (compared to 19.2% of the Massachusetts population).[33]

Although population grew over 1% in Barnstable County from 2020 to 2021, in all other years from 2000 to 2024, population growth grew at a rate of <1% per year. An average annual growth rate of less than 1% per year is expected to have little to no potential for land use change in the Study Areas,[34] and can likely be attributed to limited and seasonal employment opportunities on Cape Cod combined with the high cost of living and housing.

When considering estimated housing growth, a 2012 Cape Cod Commission buildout analysis determined that 27,842 units were available for development in Barnstable County, and a 2017 UMass Donahue Institute housing market analysis estimated potential future demand for 26,000 residential units over a 10-year period. An updated housing market analysis was released in 2023 by the UMass Donahue Institute's analysis which predicted housing unit demand and supply in Barnstable County for

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[31] U.S. Census Bureau. More Exurban Communities Now Among Nation's Fastest Growing Places. May 2024. https://www.census.gov/library/stories/2024/05/exurbs-city-population.html#:~:text=Multiple%20factors%20are%20likely%20behind,from%20home%20also%20likely%20contributed.

[32] U.S. Census Bureau. County Population Totals and Components of Change: 2020-2024. ; U.S. Census Bureau. County Population Totals and Components of Change: 2010-2019 ; U.S. Census Bureau. County Population Totals and Components of Change: 2000-2010

[33] U.S. Census Bureau. QuickFacts: Barnstable County, MA. https://www.census.gov/quickfacts/fact/table/barnstablecountymassachusetts/AGE295221?utm_

[34] ECONorthwest & Portland State University. 2001. A Guidebook For Evaluating the Indirect Land Use and Growth Impacts of Highway Improvements: Final Report. April. Prepared for Oregon Department of Transportation. https://www.oregon.gov/odot/Programs/ResearchDocuments/AGuidebookforUsingIndirLand.pdf

2030, 2040, and 2050. The updated analysis determined that the demand for housing in Barnstable County is projected to exceed housing supply through 2050. Based on a projection of 2020 population figures, the gap between supply and demand for housing units in Barnstable County is estimated at 13,273 units in 2025 and 13,436 in 2030.[35] As a result, residential housing in Barnstable County is expected to be at or above capacity,[36] and any near-term housing growth is expected to consume the remaining supply of developable land regardless of the addition of the bridge projects. Residential development in Barnstable County is further stymied by high construction costs,[37] wastewater infrastructure limitations,[38] water supply constraints,[39] and municipal service capacity constraints.

In addition to these housing growth limitations, the existing Barnstable County road network has several bottlenecks that would limit the impact of bridge replacement on future growth and development. According to the 2024-2044 Cape Cod Metropolitan Planning Organization Regional Transportation Plan,[40] and the 2018 Cape Cod Emergency Traffic Plan,[41] there has been a steady increase in traffic throughout Barnstable County, and a proliferation of challenges managing these traffic conditions due to restrictions in route options and capacity.

4.6.2.7 Community Cohesion

This section identifies the existing community characteristics that contribute to community cohesion and features that currently divide neighborhoods. MassDOT developed this section based on a review of local planning documents and interviews with local officials to describe community characteristics and identify aspects that contribute to or detract from community cohesion in the town of Bourne.

For the purposes of this assessment, "community cohesion" refers to the strength of relationships and sense of connection among individuals and groups within a community. It reflects the extent to which community members are able to connect, interact, and spend time with one another, and feel a shared sense of belonging based on shared community characteristics. Community cohesion is an important

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[35] Cape Cod Commission. Cape Cod Housing Needs. UMass Donahue Institute. 2023. https://capecodcommission.org/resource-library/file/?url=/dept/commission/team/Website_Resources/housing/CC-Housing-Needs-Assessment-2023.pdf&_gl=1*a51bx9*_ga*NzA5NzU0NDAzLjE3Mjk1NDAwMzc.*_ga_LTW77CPM1M*MTc0MTE5NDYwNi4yNC4xLjE3NDExOTYyOTUuMC4wLjA.

[36] U.S. Army Corps of Engineers. 2022. Environmental Assessment and Finding of No Significant Impact for Major Rehabilitation Evaluation. Cape Cod Canal Highway Bridges, Massachusetts. March. https://www.nae.usace.army.mil/Portals/74/docs/Topics/Cape%20Cod%20Canal%20Bridges/Reports/MREREnvAssessment.pdf

[37] County of Barnstable. 2023. Barnstable County HOME Consortium Program Year 2023 Annual Action Plan. July. https://www.capecod.gov/wp-content/uploads/2022/03/AAP-2023-Approved.pdf

[38] Cape Cod Commission. Our Work: Wastewater. Accessed December 2024. https://www.capecodcommission.org/our-work/wastewater/

[39] Cape Cod Commission. 2015. Cape Cod Area Wide Water Quality Management Plan Update. June. https://www.capecodcommission.org/resource-library/file/?url=/dept/commission/team/208/208%20Final/Cape_Cod_Area_Wide_Water_Quality_Management_Plan_Update_June_15_2015.pdf

[40] Cape Cod Commission. Cape Cod Regional Transportation Plan 2024-2044. https://www.capecodcommission.org/our-work/rtp

[41] Commonwealth of Massachusetts. 2018. Cape Cod Emergency Traffic Plan. July. https://www.mass.gov/doc/cape-cod-emergency-traffic-plan/download

component of sustainable urban planning, community development, and social policy, because it strengthens the fabric of society and fosters resilience in the face of social, economic, and environmental challenges.

The physical divide resulting from Cape Cod Canal influences the community cohesion in the town of Bourne neighborhoods. Existing gaps in local and regional transportation networks and congestion and travel delays resulting from increased seasonal traffic volume also present challenges to community cohesion. Drivers of and contributing elements for community cohesion in town of Bourne neighborhoods are defined by access and connectivity to recreation and natural resources, leisure activities, and historical sites and architecture, and is enabled by the existing connectivity provided by Sagamore Bridge and Bourne Bridge.

Challenges To Community Cohesion

Community cohesion is directly affected by Cape Cod Canal, which divides the town of Bourne into two distinct segments. The only vehicle access on or off Cape Cod and over the canal is via the bridges, which creates a bottleneck due to capacity limitations and seasonal volume increases. Residents are required to regularly cross the canal via the two bridges to access key destinations, such as places of employment, medical facilities, grocery stores, schools, places of worship, and recreational facilities. According to the 2020 Census, approximately 31,000 off-Cape jobs are filled by workers living on Cape Cod, and 21,500 on-Cape jobs are filled by people living off Cape Cod who must commute over the bridges daily. This results in over 50,000 workers who rely on the bridges for daily commuting.[42] Town of Bourne school children travel to school by bus across the bridges, and the Cape Cod Regional Transit Authority's Bourne Run route crosses both bridges as part of its seasonal operating route. In summary, town of Bourne residents and workers are regularly required to cross the bridges as a part of daily life, which serves as a constant challenge to community cohesion.[43, 44]

Cohesion is further hindered by the locations of town of Bourne services in relation to the canal, which has implications for disaster and emergency response. The Bourne Police Department is north of the canal, while the state police has a station south of the canal. Two fire stations are on either side of the bridges. As of 2017, the fire and police departments required 10 to 12 daily trips across the bridges on average for supplies, fuel, to conduct inspections and training, and to respond to emergencies.[45] Summer congestion on the bridges results in delayed emergency responses, limitations in terms of

[42] Cape Cod Commission. 2023. Cape Cod Bridges Replacement: An Urgent Need. October.

[43] U.S. Army Corps of Engineers. 2022. Environmental Assessment and Finding of No Significant Impact for Major Rehabilitation Evaluation. Cape Cod Canal Highway Bridges, Massachusetts. March. https://www.nae.usace.army.mil/Portals/74/docs/Topics/Cape%20Cod%20Canal%20Bridges/Reports/MREREnvAssessment.pdf

[44] Town of Bourne. Virtual Interviews: Local Officials. August 2024.

[45] U.S. Army Corps of Engineers. 2022. Environmental Assessment and Finding of No Significant Impact for Major Rehabilitation Evaluation. Cape Cod Canal Highway Bridges, Massachusetts. March. https://www.nae.usace.army.mil/Portals/74/docs/Topics/Cape%20Cod%20Canal%20Bridges/Reports/MREREnvAssessment.pdf

hospital access, altered work schedules, and the hiring of additional staff on overtime to accommodate traffic delays.[46, 47]

As the number of older adults moving to Cape Cod increases, an additional community concern is the low number of primary care providers serving Barnstable County, which is 30% lower than the Massachusetts average. This may cause retirees who moved to Cape Cod to stay with their prior primary care providers, resulting in the need to travel off Cape Cod for appointments. There are no Veterans Administration hospitals on Cape Cod, and veterans must rely on the bridges to travel off Cape Cod to Providence, RI, or Jamaica Plain, MA, for Veterans Administration services. Additionally, no Level I or II medical trauma centers are on Cape Cod, so most trauma patients are transported to Boston.[48] Considering that many older residents travel off Cape Cod for medical appointments or emergencies, bottlenecks on the bridge from seasonal road congestion can hinder access to essential care, creating significant barriers in elder-care support and challenging community cohesion.[49]

Existing gaps in local and regional transportation networks exacerbate the impact of Cape Cod Canal on community cohesion. There is a need for road network fortification and expansion to handle seasonal volume increases in traffic, as well as the creation and expansion of sidewalks, road shoulders, and shared-use paths (SUP) throughout Cape Cod to enable safe and connected pedestrian and bike travel opportunities. Congestion and travel delays resulting from seasonal traffic prohibit efficient and reliable vehicular travel across the bridges, whether travel is to access essential services or for recreation. Through travelers use local roads to try to bypass bottlenecks on state highways, which interrupts local traffic by town of Bourne residents. This creates barriers to community cohesion, because residents and workers are unable to reach essential destinations and services in a timely manner, must alter their travel behavior in response to these traffic patterns, and may choose not to travel at all as a result.[50, 51]

Drivers of Community Cohesion

All cars, trucks, buses, bikes, and pedestrians traveling onto Cape Cod must pass over Sagamore Bridge or Bourne Bridge, which serve as the physical foundation for community cohesion.[52] Physical cohesion is further enabled through the town of Bourne's 190 miles of roadway, including 120 miles of local roads and three major arteries (U.S. Route 6, and State Routes 28 and 6A) that residents and visitors use to travel within the town of Bourne and to connect with the rest of Cape Cod. The Canal Service

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[46] U.S. Army Corps of Engineers. 2022. Environmental Assessment and Finding of No Significant Impact for Major Rehabilitation Evaluation. Cape Cod Canal Highway Bridges, Massachusetts. March. https://www.nae.usace.army.mil/Portals/74/docs/Topics/Cape%20Cod%20Canal%20Bridges/Reports/MREREnvAssessment.pdf

[47] Town of Bourne. Virtual Interviews: Local Officials. August 2024.

[48] Cape Cod Healthcare is actively working towards Level III trauma certification.

[49] Town of Bourne. Virtual Interviews: Local Officials. August 2024.

[50] U.S. Army Corps of Engineers. 2022. Environmental Assessment and Finding of No Significant Impact for Major Rehabilitation Evaluation. Cape Cod Canal Highway Bridges, Massachusetts. March. https://www.nae.usace.army.mil/Portals/74/docs/Topics/Cape%20Cod%20Canal%20Bridges/Reports/MREREnvAssessment.pdf

[51] Town of Bourne. Virtual Interviews: Local Officials. August 2024.

[52] Town of Bourne. 2019. Bourne Local Comprehensive Plan. https://www.townofbourne.com/planning/news/local-comprehensive-final-certified-plan

Roads connect pedestrians and bicyclists with 7 miles of SUP with seven roadway crossings on the northern side, and 6.5 miles of SUP with two roadway crossings on the southern side. The bridges' approaches feature segments of SUPs for bikes and pedestrians, although roads in the Study Areas generally lack sidewalks, and are prohibited on U.S. Route 6, and State Routes 3 and 25. The Cape Cod Line rail service travels through and stops in the town of Bourne, while the Cape Cod Regional Transit Authority and Greater Attleboro-Taunton Regional Transit Authority operate bus transit routes that travel in and around Bourne.[53] Specifically, the Cape Cod Regional Transit Authority operates the Bourne Run and Sandwich Line bus routes that travel over the bridges, and circulate in and around the town of Bourne (more information provided in **Section 4.2, Transportation, Traffic, and Safety**).These routes and paths serve as the existing transportation network in the town of Bourne, which connect residents to key destinations and promote neighborhood cohesion.

Within the Study Areas, the Canal Service Roads connect community members to bridge-adjacent recreation areas, including Sagamore Bridge and Bourne Bridge Recreation Areas, Sagamore Bridge and Bourne Bridge Areas, Bourne Scenic Park, Bourne High School Recreational Fields, and Sandwich Road Conservation Area. The Shawme-Crowell State Forest and the Nightingale Pond Conservation Area are additionally accessible by vehicle within the Study Areas. According to the Town of Bourne's Open Space and Recreation Plan, all municipally owned open space in the Bourne Bridge Study Area is accessible to the public.[54] The conservation of and access to ample recreation area in the town of Bourne illustrates the value the town places on preserving natural resources and in ensuring recreational access.

Beyond the Study Areas, Bourne's transportation network links communities and neighborhoods with Cape Cod's plethora of recreational opportunities and leisure activities. Access and connectivity to beaches, hiking trails, and biking/walking facilities are valued as community assets by Cape residents. Rail trails and multi-use paths throughout Cape Cod enable safe and protected recreational opportunities for bikes and pedestrians. Connectivity to accessible leisure activities is particularly valued as a community characteristic by older adults who relocated to Cape Cod for retirement.[55] According to a 2013 survey by the Chesapeake Group, communal activities including live music concerts, theater performances, and spending time at the beach are reported to be the most popular recreational activities that residents participate in. Additional leisure activities that foster community cohesion include water sports, fishing, boating, golfing, camping, picnicking, shopping, and dining out.[56] Providing access and connections to these activities is essential in supporting cohesion.

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[53] Cape Cod Regional Commission. 2019. Cape Cod Regional Policy Plan. https://www.capecodcommission.org/our-work/rpp/

[54] Town of Bourne Open Space and Recreation Plan. Prepared for the Bourne Open Space Committee. Prepared by Worsley Witten Group, Inc. February 8, 2018.

[55] Town of Bourne. Virtual Interviews: Local Officials. August 2024.

[56] U.S. Army Corps of Engineers. 2022. Environmental Assessment and Finding of No Significant Impact for Major Rehabilitation Evaluation. Cape Cod Canal Highway Bridges, Massachusetts. March. https://www.nae.usace.army.mil/Portals/74/docs/Topics/Cape%20Cod%20Canal%20Bridges/Reports/MREREnvAssessment.pdf

In addition to recreation opportunities and leisure activities, the preservation of and access to historical architecture is valued and prioritized by the Town of Bourne as a defining community characteristic. Historic Bourne Village is zoned to preserve the character of the town and features compact buildings with traditional architecture. The Massachusetts Cultural Resource Information System has cited 866 buildings, structures, burial grounds, and areas in the town of Bourne as having potential historical significance.[57] To preserve the town of Bourne's cultural heritage and continue fostering a sense of community, the town's LCP advocates that historic sites and buildings should be protected, new development should complement historical development, and the importance of traditional cultural events (e.g., the Main Street Festival and the County Fair) should be recognized and strengthened.[58] **Section 4.17, Cultural Resources**, provides additional information on cultural resources and historical places of significance in and near the Study Areas.

4.6.3 No Build Alternative

This section considers the direct and indirect operational impacts of the No Build Alternative on land use in the Study Areas. For the No Build Alternative, the bridges would be maintained in their current alignments. Existing easements would be used to access and maintain the current structures, and no additional property would be required for staging or construction of the new structures or interchange approaches. No changes to land use or development patterns would occur.

The No Build Alternative would not result in direct changes to land use or development patterns but may have indirect impacts on quality of life and community cohesion for existing neighborhoods in the Study Areas. Since the No Build Alternative would result in the maintenance of the existing bridges, traffic congestion and challenges in travel access would continue due to reduced travel network connectivity and a lack of multimodal options. This would impede existing residents' abilities to travel freely across Cape Cod Canal to access community facilities and essential services, affecting the physical cohesion of existing neighborhoods.

The No Build Alternative would not further the goals and objectives identified in local and regional land use policies and plans, which call for the enhancement of public access to conservation land, establishing green corridors/connections, and enhancing the open space network. The No Build Alternative would continue to hinder public access to existing conservation land and would not create new connections or green corridors. The No Build Alternative would not further the conservation, preservation, or enhancement of the open space network.

For the No Build Alternative, existing neighborhoods would continue to rely heavily on the aging Sagamore Bridge and Bourne Bridge as key links to access cross-canal services and destinations. Existing access, and community cohesion, would continue to be hindered by traffic congestion and travel-flow impediments caused by roadway capacity limitations and increases in seasonal traffic volume as described by the No Build Alternative traffic analysis results in **Section 4.2, Transportation,**

[57] https://mhc-macris.net/queryresults

[58] Town of Bourne. 2019. Bourne Local Comprehensive Plan. https://www.townofbourne.com/planning/news/local-comprehensive-final-certified-plan

Traffic, and Safety. Travel congestion on the bridges would continue to result in delayed emergency responses, limitations in terms of hospital access, scheduling medical appointments during off-peak travel hours, and altering work schedules and commute times to accommodate for traffic delays. The lack of multimodal accommodations and network connectivity throughout the Study Areas would result in reduced community connectivity, and diminished access to recreational opportunities, leisure activities, cultural events, and historical sites, hindering community cohesion in the town of Bourne.

4.6.4 Program Impacts

This section assesses the direct and indirect operational and construction-period impacts of the Build Alternative on land use in the Study Areas and evaluates its consistency with master plans. Assessed land use impacts include land alteration impacts and neighborhood and community cohesion impacts. Property impacts, ACECs, SSAs, protected open space, and environmentally affected land use—along with associated mitigation measures—are evaluated and assessed, respectively, in the following sections:

- **Section 4.8, Property Acquisition, Displacement, and Relocation**
- **Section 4.10, Wetlands and Floodplains**
- **Section 4.11, Water Quality and Stormwater**
- **Section 4.18, Public Parks, Recreational Facilities, and Open Space**
- **Section 4.19, Solid and Hazardous Waste Material Management**

For the Build Alternative, the new alignment and the areas needed for construction staging and the demolition of the existing bridges and interchange improvements would result in unavoidable temporary and permanent property impacts. MassDOT proposes to mitigate these impacts by providing a buffer area to separate residential areas from the transportation land uses. In addition, the Build Alternative would strengthen overall community cohesion and provide quality-of-life benefits for existing neighborhoods through improved access, mobility, and connectivity throughout the Study Areas. Refer to **Section 4.6.5** for additional details. For additional information regarding permanent property impacts, refer to **Section 4.8, Property Acquisition, Displacement, and Relocation**.

4.6.4.1 Land Use, Zoning, and Master Plan Impacts

The Build Alternative would be designed to minimize impacts to adjacent land uses during construction and operation, and to maintain consistency with the goals and policies of local and regional master plans. This section summarizes these impacts, and additional details are provided in later sections.

Direct land use impacts from the Build Alternative would include an estimated 306.39 acres of land alteration (**Table 4.6-4**), including 132.14 acres of tree clearing to allow for temporary roadways, permanent roadways, and SUP installation. This would result in a 50.84-acre increase in impervious area comprising new roadway and SUP areas, which represents a permanent land use change to right-of-way/transportation (**Table 4.6-5**).

The Build Alternative would be consistent with the open space policy of the LCP to protect public rights for recreation, enhance public access to existing conservation land, and to establish green corridors and/or connections. The Build Alternative would also be consistent with the open space goal of the RPP to conserve, preserve, or enhance a network of open space that contributes to the region's natural and community resources and systems. This consistency is evidenced through the incorporation of a pedestrian and bicycle SUP for each highway bridge that would include connections to the local roadway network and existing rail trails on both sides of the canal. The Build Alternative would also minimize impacts to open space, including the USACE-leased property on the canal, to the greatest extent practicable.

The Build Alternative would be consistent with the LCP's cultural heritage goal to protect and preserve historical and cultural features of the town of Bourne's landscape and to ensure that future development respects the town's historical traditions. The Build Alternative would also be consistent with the RPP's cultural heritage goal to protect and preserve the significant cultural, historical, and archaeological values and resources of Cape Cod. To ensure consistency, MassDOT will develop and execute a Programmatic Agreement with the State Historic Preservation Office and other consulting parties to mitigate adverse impacts associated with the demolition of the National Register-eligible Sagamore and Bourne Bridges in accordance with Section 106 of the National Historic Preservation Act.

4.6.4.2 Land Alteration Impacts

The Build Alternative would result in approximately 306.39 acres of total land alteration, including 132.14 acres of tree clearing, 74.77 acres of alteration to existing pavement (e.g., mill and overlay, roadway reconstruction, etc.), and 99.48 acres of alteration to previously disturbed areas (e.g., grassy areas, stormwater best management practices, etc.). To mitigate these impacts, MassDOT will implement a landscaping plan that will provide new landscaping and vegetation for over 200 acres within the Study Areas through landscape restoration and reforestation; street tree, buffer, and roundabout planting; lawn re-seeding; and the creation of stormwater basins and rain gardens. **Table 4.6-6** outlines the landscaping plan in greater detail. **Table 4.6-4** provides a breakdown of the proposed land use alteration impacts by Study Area quadrant.

Table 4.6-4. Land Alteration (Sagamore Bridge and Bourne Bridge Study Areas)

Study Area Quadrant	Tree Clearing (acres)	Alterations to Existing Pavement (acres)	Alterations to Previously Disturbed Areas (acres)	Total Land Alteration (acres)	Total Land Alteration as Percentage of Study Areas
Sagamore North	38.77	18.04	17.98	74.79	2.7%
Sagamore South	23.83	20.76	17.27	61.87	2.2%
Bourne North	23.83	21.70	41.20	86.73	2.6%
Bourne South	45.71	14.27	23.03	83.00	2.5%
Total	**132.14**	**74.77**	**99.48**	**306.39**	**5.0%***

Note: Limits of land alteration will be refined as design progresses. Calculations based on analysis of land alteration are associated with Build Alternative bridge design.

*Percentage of total Sagamore Bridge and Bourne Bridge Study Areas.

Of the 132.14 acres (2.8% of the total Sagamore Bridge and Bourne Bridge Study Areas) of tree cover that would be removed as a result of the Build Alternative, the majority would comprise forested land cover (76.01 acres), but the affected land would also contain right-of-way (22.06 acres), scrub-shrub (13.02 acres), grassland (6.74 acres), impervious surface (5.19 acres), bare land (2.24 acres) and tax exempt (2.10 acres) land cover types.[59] Tree clearing would be required to allow new roadways to be constructed and temporary roadways to facilitate construction phasing operations, and to ensure proper sightlines are achieved for safety. Furthermore, approximately 13.8% of the total clearing would be associated with installation of a SUP to improve public access to and from Cape Cod Canal, as well as to improve multimodal connectivity and safety in the Study Areas. This would provide safe and accessible mobility opportunities for residents of the town of Bourne to exercise, access recreation areas, visit cultural heritage sites, travel to community facilities, and access essential services. Refer to **Appendix 4.6, Preliminary Tree Clearing Plans**, for plans that identify the limits of tree clearing in relation to the proposed work. Refer to **Chapter 5, Construction Approach**, for additional details on tree removal activities.

Of the land affected by tree clearing for the Build Alternative, 75.07 acres—or 57.1% of the total area to be affected by tree clearing—is currently used for transportation purposes. Tree cover within these designated transportation land use areas is typically found along major thoroughfares. Due to harsh growing conditions—such as increased air pollution, decreased water quality from stormwater runoff, and elevated surface temperatures—invasive species often outcompete native species. In these areas, trees of all species tend to be in poorer health compared to those in traditional forest environments, which can reduce ecosystem benefits and lower the overall quality of the forest.

[59] These classifications are based on a combination of MassGIS data and a review of aerials. A forest inventory has not been conducted. The remaining land use cover types that would comprise less than 1 acre include the following: Forested Wetland, Pasture/Hay, Non-forested Wetland, Water, Industrial, Residential, Open Land, and Commercial.

The Build Alternative would result in a 50.84-acre increase in impervious area comprising new roadway (32.80 acres), sidewalk (2.06 acres), and SUP area (16.04 acres), which would represent a permanent change in land use for affected areas to transportation and right-of-way (**Table 4.6-5**). The Build Alternative would minimize new impervious area to the maximum extent practicable while still meeting the Program's purpose and need, with approximately 35% of the new impervious area associated with new sidewalk and SUP installation. Furthermore, the approximate 50.84-acre increase in impervious area would represent <1% of the total Study Areas.

Table 4.6-5. Change in Impervious Area (Sagamore Bridge and Bourne Bridge Study Areas)

Study Area Quadrant	Existing Impervious Area (acres)	Proposed Impervious Area (acres)	Impervious Area Increase (acres)	Increase as Percentage of Study Areas
Sagamore North	23.91	34.11	10.20	0.4%
Sagamore South	19.00	34.05	15.05	0.5%
Bourne North	23.27	36.70	13.43	0.4%
Bourne South	20.74	32.90	12.16	0.4%
Total	**86.92**	**137.76**	**50.84**	**0.8%***

Note: Calculations based on analysis of changes in impervious surface in **Section 4.11, Water Quality and Stormwater**.

*Percentage of total Sagamore Bridge and Bourne Bridge Study Areas.

The Build Alternative's stormwater management system, which would implement best management practices (as described in **Section 4.11, Water Quality and Stormwater**) to collect and treat stormwater, would mitigate indirect impacts from this increase in impervious surface. The Build Alternative's stormwater management system will prioritize the use of low-impact, green infrastructure (such as rain gardens and infiltration basins) and will improve the treatment and quality of the runoff that is eventually discharged to Cape Cod Canal and the Plymouth/Carver and Cape Cod SSAs. During construction, MassDOT will implement measures to reduce adverse impacts according to the Program's Construction Stormwater General Permit and will prepare and implement a Storm Water Pollution Prevention Plan in accordance with the EPA's 2022 National Pollutant Discharge Elimination System General Permit for Discharges from Construction Activities.

4.6.4.3 Neighborhood and Community Cohesion Impacts

For the Build Alternative, during construction, existing neighborhoods would continue to rely heavily on the existing Sagamore Bridge and Bourne Bridge, and post construction, on the new bridges, as a key link to access cross-canal services and destinations. During construction, the construction zone designated for the crane placement for bridge demolition and construction would affect the Canal Service Road and Bourne Recreation Area in the Bourne South quadrant, and Sagamore Recreation Area in the Sagamore North quadrant. The temporary closure of the Canal Service Road would affect approximately 0.31 acre, including the parking lot along the Canal Service Road (additional discussion of construction-period effects and associated mitigation measures is included in **Section 4.18, Public Parks, Recreational Facilities, and Open Space**). However, the Build Alternative would minimize

construction-period impacts upon local communities, and during construction would maintain the existing pedestrian and bicycle connections with detours or temporary connections as needed. All existing vehicular traffic movements would be maintained throughout construction without the requirement of detours.

As described in **Section 4.2, Transportation, Traffic, and Safety**, post-bridge construction, travel congestion on the bridges would decrease and local travel flow would improve for existing neighborhoods accessing medical facilities and appointments, community facilities, places of employment, and schools. Community service providers and emergency responders would experience reduced travel delays, which would result in improved quality-of-life benefits for existing residents.

The inclusion of Americans with Disabilities Act-compliant sidewalks and SUPs throughout the Study Areas would enable access to community facilities and would improve accessibility and safety for all community members, including those with disabilities. The provision of active transportation accommodations in the Sagamore South quadrant would provide east-west connectivity along Cranberry Highway, as well as more direct access between the neighborhoods on the east side of U.S. Route 6 and Market Basket on the west side of U.S. Route 6. In addition to reducing the volume of regional traffic on Adams Street and Ben Abbey Road, the Build Alternative would include the Sandwich Road Extension, which would allow drivers to directly access Sandwich Road and avoid the Cranberry Highway Extension and the Market Basket Plaza driveways on Factory Outlet Road. This would improve local neighborhood navigability and accessibility, which would result in enhanced cohesion.

The Build Alternative in the Bourne North quadrant would provide grade separation over Scenic Highway for pedestrians and bicyclists, as well as a sidewalk and SUP on Scenic Highway. By providing SUPs along Scenic Highway and from the canal crossing to Belmont Circle, the Build Alternative would provide more opportunity to improve neighborhood accessibility to community facilities and services, specifically to the Nightingale Pond subdivision. In addition to the pedestrian and bicycle facilities, the Build Alternative would substantially improve neighborhood cohesion by fully removing mainline State Route 28/State Route 25 traffic from the local roadway network.

The addition of pedestrian and bicycle accommodations and improved network connectivity throughout the Study Areas would result in enhanced community connectivity and improved access to recreational opportunities, leisure activities, cultural events, and historical sites. The replacement bridges would feature outlooks and benches that would encourage use by bicyclists and pedestrians and serve as informal gathering spaces and/or places for community members to interact and spend time together that would help strengthen community cohesion in the town of Bourne.

Furthermore, the Build Alternative would not eliminate any critical connections that contribute to community connectivity, and access to community facilities would be maintained during and after bridge construction (refer to **Section 4.7, Community Facilities**, for more details). The existing bridges would remain to provide critical connections until the new bridges are in place. **Section 4.16, Visual Resources**, provides additional details regarding visual changes to communities. **Section 4.15, Noise and Vibration**, describes temporary and permanent noise impacts of the Build Alternative on existing neighborhoods.

4.6.5 Mitigation Measures

Table 4.6-6 summarizes mitigation measures that will be employed to minimize adverse land use impacts resulting from the Build Alternative. Relevant mitigation measures are provided for each section included in the land use assessment, but additional details on subject-specific mitigation measures can be found in the following:

- **Section 4.3, Pedestrian and Bicycle Facilities**
- **Section 4.8, Property Acquisition, Displacement, and Relocation**
- **Section 4.11, Water Quality and Stormwater**
- **Section 4.15, Noise and Vibration**
- **Section 4.16, Visual Resources**
- **Chapter 5, Construction Approach**

Table 4.6-6. Land Use Mitigation Measures

Land Use Effect	Mitigation Measures
Land Alteration	• The Massachusetts Department of Transportation (MassDOT) will implement a substantial landscaping plan that will provide new landscaping and vegetation for over 200 acres within the Study Areas to repair, restore, and enhance the landscape flanking the mainline highways, bridges, and local roads and connections. The landscape plan will include the following landscape types to restore disturbed sites and integrate the new infrastructure into the landscape: – Landscape restoration will consist of open meadow with scattered groupings of shrubs and clusters of trees. This landscape will stabilize highway edges and slopes, will blend with the edges of stormwater basins and forested areas, and will require minimal maintenance. Landscape restoration areas will be attractive to pollinators (such as birds and insects), which will aid in progressing the succession of this landscape. – Reforestation will consist of areas that are intended at maturity to have greater than 25% tree canopy coverage and will aim to establish a tree canopy and understory in the more immediate future following construction. – Street tree planting will be proposed where pedestrians, bicyclists, and motorists occupy the streetscape to shade pedestrian pavements, the SUP, and other hardscape surfaces. – Lawn will be placed along sidewalks and shared-use paths, in median strips, along Canal Service Roads, and in front of businesses and residences to blend with existing lawn. – Stormwater basins and rain gardens will be areas that allow the proposed stormwater basins to blend with the landscape in as naturalistic a way as possible while still maintaining their stormwater function. – Buffer planting will be areas intended to be an evergreen screen for abutters whose properties are adjacent to new infrastructure (such as walls, bridges, and roadways). This planting type is typically used along residential properties in a project area and is

Land Use Effect	Mitigation Measures
	proposed mainly where space may be too limited for reforestation and immediate visual screening is desired. Buffer planting will consist of a mix of evergreen trees of varying heights and sizes. – Roundabout planting will comply with MassDOT's Guidelines for the Planning and Design of Roundabouts planting recommendations outlined in Chapter 13 of the MassDOT Project Development and Design Guide and will be adapted to the specific site conditions and context for each proposed roundabout. – Special planting will be reserved for highly visible areas in proximity to pedestrians, bicyclists, and motorists on local roads and where access is easy for regular maintenance. Special planting will consist of trees, shrubs, perennials, grasses, and groundcovers. • The landscape plan will be responsive to site conditions, the unique landscape and cultural history of the region, and the needs and requirements of the Federal Highway Administration and the U.S. Army Corps of Engineers. The following will be considered for the landscape design and will be tailored to the specific Study Area quadrants as appropriate: – Revegetate all areas disturbed by construction around the new Sagamore Bridge and Bourne Bridge, adjacent highways, local roadways, shared-use paths, stormwater and utility infrastructure, and construction staging areas. – Develop landscape zones that restore and/or enhance existing habitats and reinforce the unique landscape character of the region. – Screen undesirable views for both users of the Project Limits as well as abutters. Improve sight lines and views while mitigating the appearance of undesirable areas within and beyond the bridge sites. – Provide shade in hardscape areas including along local streetscapes and over the shared-use paths. This will improve the experience for site users while reducing the Urban Heat Island Effect. – Use landscape to create gateways as visitors approach Cape Cod. – Enhance pedestrian zones with planting at trailheads, in medians, and in roundabouts in lieu of impervious surfaces. – Integrate stormwater basins with the surrounding restored landscapes so they appear natural and contribute to the creation of habitat as much as possible. – Maintain site visibility for safety along highways and roadways and around pedestrian zones and off-road areas for site security. – Planting: Provide primarily native, site-appropriate planting throughout the Project Limits through the following actions: i) Use low maintenance planting that is self-sustaining to improve the longevity of the new landscape. ii) Diversify the plant material to reduce possible mass devastation from future pests.

Land Use Effect	Mitigation Measures
	iii) Propose hardy, coastal tolerant and urban tolerant plant material to survive the site conditions. iv) Use species that are attractive to pollinators and wildlife. v) Propose drought tolerant plant species for adaptability and suitability for minimally maintained areas of the project site. vi) Account for sun / wind exposure – The availability of sunlight adjacent to and below bridges will dictate the appropriate plant species at certain locations around the site. • Implement measures intended to reduce adverse impacts from construction according to a Construction Stormwater General Permit. • Stabilize disturbed areas immediately when construction has ceased and resume for no more than 14 days. • Implement plant protection fencing for trees that will not be cleared for public places and staging or other construction activity to preserve trees. • Utilize plant protection fencing to minimize impacts to visual natural resources as applicable. • Restore acquired areas that are not used for the State Highway Layout to pre-existing conditions to the maximum extent practicable following completion of the land-based construction activities. • Maintain adequate provisions for stormwater management during construction to prevent safety and maintenance issues. • Prepare and implement a Storm Water Pollution Prevention Plan in accordance with the U.S. Environmental Protection Agency's 2022 National Pollutant Discharge Elimination System General Permit for Discharges from Construction Activities. • The minimum practices required in the Storm Water Pollution Prevention Plan will include the following: – Install sediment controls (such as silt fence and/or compost filter tubes) along the top of Cape Cod Canal bank and inland wetland resource areas. – Stabilize construction exits to prevent sediment tracking from the work area onto public ways. – Provide site-specific construction phasing plans to minimize the extent of the disturbance at any one time. – Provide catch basin inlet protection, including geotextile filter fabric. – Provide soil stockpile protection, including temporary erosion measures and perimeter controls. – Provide dust suppression, including watering. – Provide good housekeeping pollution prevention measures, including secondary containment.

Land Use Effect	Mitigation Measures
	– Adhere to maintenance requirements. – Adhere to temporary and permanent stabilization requirements. – Adhere to recordkeeping/inspection requirements. • Implement a stormwater treatment system for Build Alternative operations, which will prioritize the use of low-impact, green infrastructure (such as rain gardens and infiltration basins). • Install bioretention areas/rain gardens adjacent to proposed sidewalks and paths for treatment of pavement runoff when feasible. • Treat stormwater runoff from the replacement bridges and roadway approaches using infiltration basins.
Neighborhood and Community Cohesion	• Provide clear signage and mapping for alternative routes to reduce confusion, which will ensure accessibility for community members during the temporary closure of the Canal Service Road. • Maintain existing pedestrian and bicycle accommodations and routes in the Study Areas. • Ensure access to community facilities will be maintained during and after bridge construction. • Reduce regional traffic on local roads (e.g., Adams Street, Ben Abbey Road) and improve neighborhood accessibility through the following: – Improve access between the neighborhoods on the east side of U.S. Route 6 and Market Basket on the west side of U.S. Route 6. – Include the Sandwich Road Extension, which will allow drivers to directly access Sandwich Road and avoid the Cranberry Highway Extension and the Market Basket Plaza driveways on Factory Outlet Road. – Fully remove mainline State Routes 28/25 traffic from the local roadway network. • Provide Americans with Disabilities Act-compliant pedestrian and bicycle accommodations throughout the Study Area to improve community connectivity, provide multimodal travel options to community facilities, and improve the accessibility of existing neighborhoods. • Install outlooks and benches along the replacement bridges that will encourage use by bicyclists and pedestrians and serve as informal gathering spaces and/or places for community members to interact and spend time together.

4 Existing Conditions, Program Impacts, and Mitigation

4.7 Community Facilities

4.7.1 Introduction

This section identifies existing community facilities within the Sagamore and Bourne Study Areas and assesses the potential impacts of the No Build and Build Alternatives on these facilities. Community facilities are identified as facilities that provide essential services to the public, including places for people to gather and participate in cultural activities. Such facilities include libraries, schools, hospitals, community health centers, fire departments, police stations, town halls, and places of worship. **Section 4.18, Public Parks, Recreational Facilities, and Open Space**, discusses parklands and recreational facilities.

A project can adversely affect community facilities and services through the following:

- **Physical impacts** – A project physically displaces or alters a community facility.
- **Changes in accessibility** – A project interferes with the ability of people to access the facility, such as restricting pedestrian access, adding street closures, or reducing parking.
- **Changes in population** – A project encourages a growth in population, thereby increasing the number of people served by a facility.

4.7.1.1 Regulatory Context

Guidance for consideration of potential impacts on community facilities is derived from the following:

- Federal Highway Administration's (FHWA) Technical Advisory document T6640.8A[1]
- FHWA's Community Impact Assessment: A Quick Reference for Transportation, 2018 Update (Publication Number: FHWA-HEP-18-055)[2]
- Town of Bourne's Local Comprehensive Plan (2019)[3]
- Cape Cod Commission's Regional Policy Plan (2019)[4]

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[1] Federal Highway Administration. 1987. Guidance for Preparing and Processing Environmental and Section 4(f) Documents. https://www.environment.fhwa.dot.gov/legislation/nepa/guidance_preparing_env_documents.aspx

[2] Federal Highway Administration. 2018. Community Impact Assessment: A Quick Reference for Transportation. https://www.fhwa.dot.gov/livability/cia/quick_reference/index.cfm

[3] Cape Cod Commission. Town of Bourne Local Comprehensive Plan. 2019. https://www.capecodcommission.org/our-work/town-of-bourne-local-comprehensive-plan

[4] Cape Cod Commission. Regional Policy Plan. 2019. https://www.capecodcommission.org/our-work/rpp/

4.7.1.2 Study Areas and Methodology

The Study Areas for this community facilities assessment encompass 0.5-mile buffers from the construction limits for the Build Alternative at the Sagamore and Bourne Bridges (**Figure 4.7-1**). These 0.5-mile Study Areas were developed to identify community facilities that could be potentially affected by the Build Alternative.

Community facilities within the Study Areas were identified using the Town of Bourne's Local Comprehensive Plan, the Cape Cod Commission's Regional Policy Plan, Massachusetts GIS spatial data layers, and Google Maps. Interviews conducted with local officials during spring-summer 2024 informed this evaluation's understanding of the current impacts of bridge-related traffic on community facility access and the importance of community facilities on the Upper Cape.[5]

4.7.2 Existing Conditions

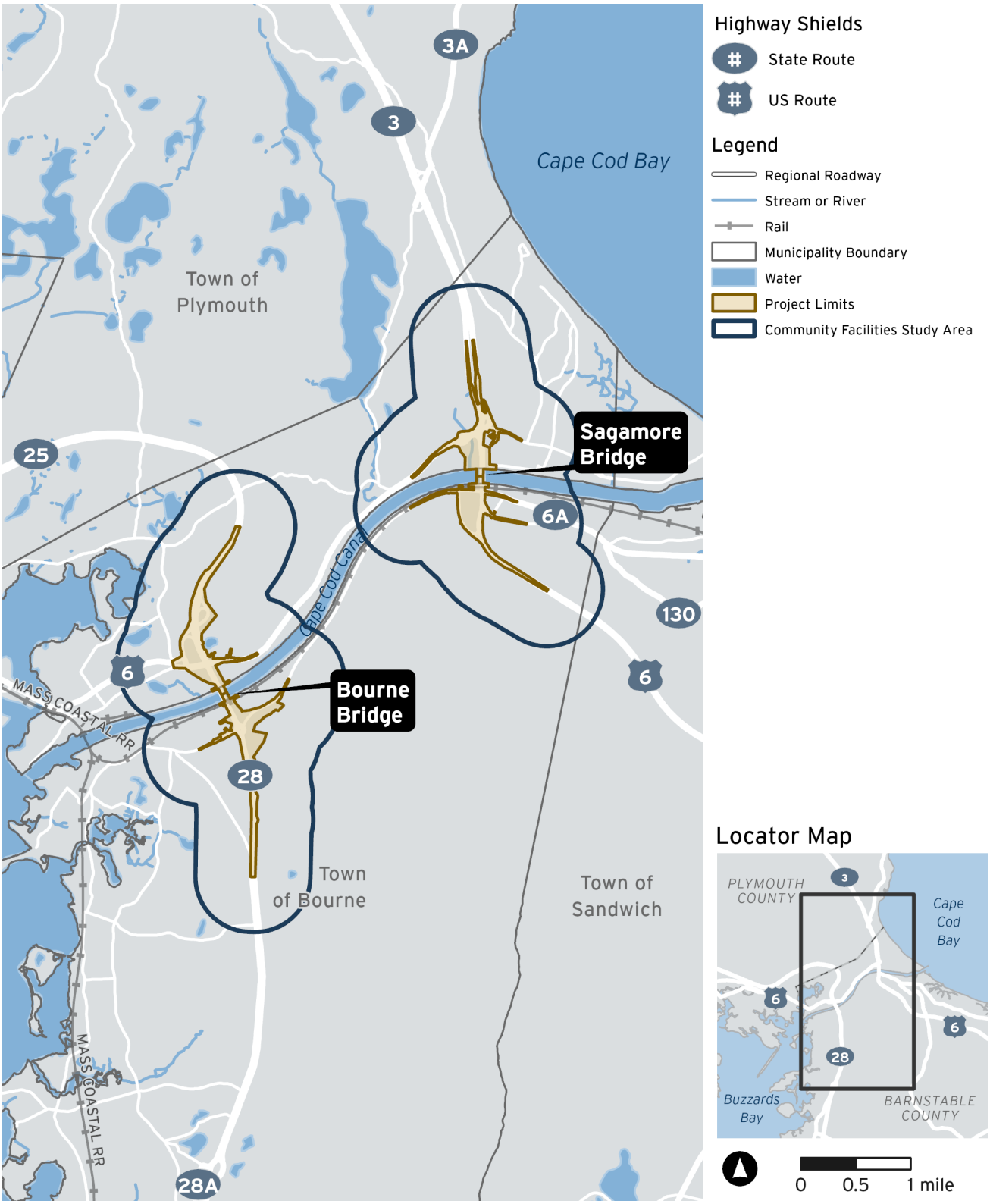
The Sagamore and Bourne Study Areas include several community facilities (**Table 4.7-1**). The community facilities in and around the Sagamore and Bourne Study Areas are documented in **Figure 4.7-2** and **Figure 4.7-3**. The map identification numbers listed in **Table 4.7-1** correspond to community facility number labels in **Figure 4.7-2** and **Figure 4.7-3**.

4.7.3 No Build Alternative

The No Build Alternative would not physically displace, alter, or change accessibility to any community facilities within the Study Areas. The No Build Alternative is not expected to significantly change patterns in population, employment, or community facility use. Projected traffic growth within the Study Areas would increase congestion and continue to hamper mobility and accessibility to community facilities and services for the No Build Alternative. Additionally, there would be no improvements to pedestrian and bicycle access to community facilities for the No Build Alternative.

[5] The Upper Cape includes the municipalities of Bourne, Falmouth, Sandwich, and Mashpee.

Figure 4.7-1. Community Facilities (0.5-Mile Study Area)

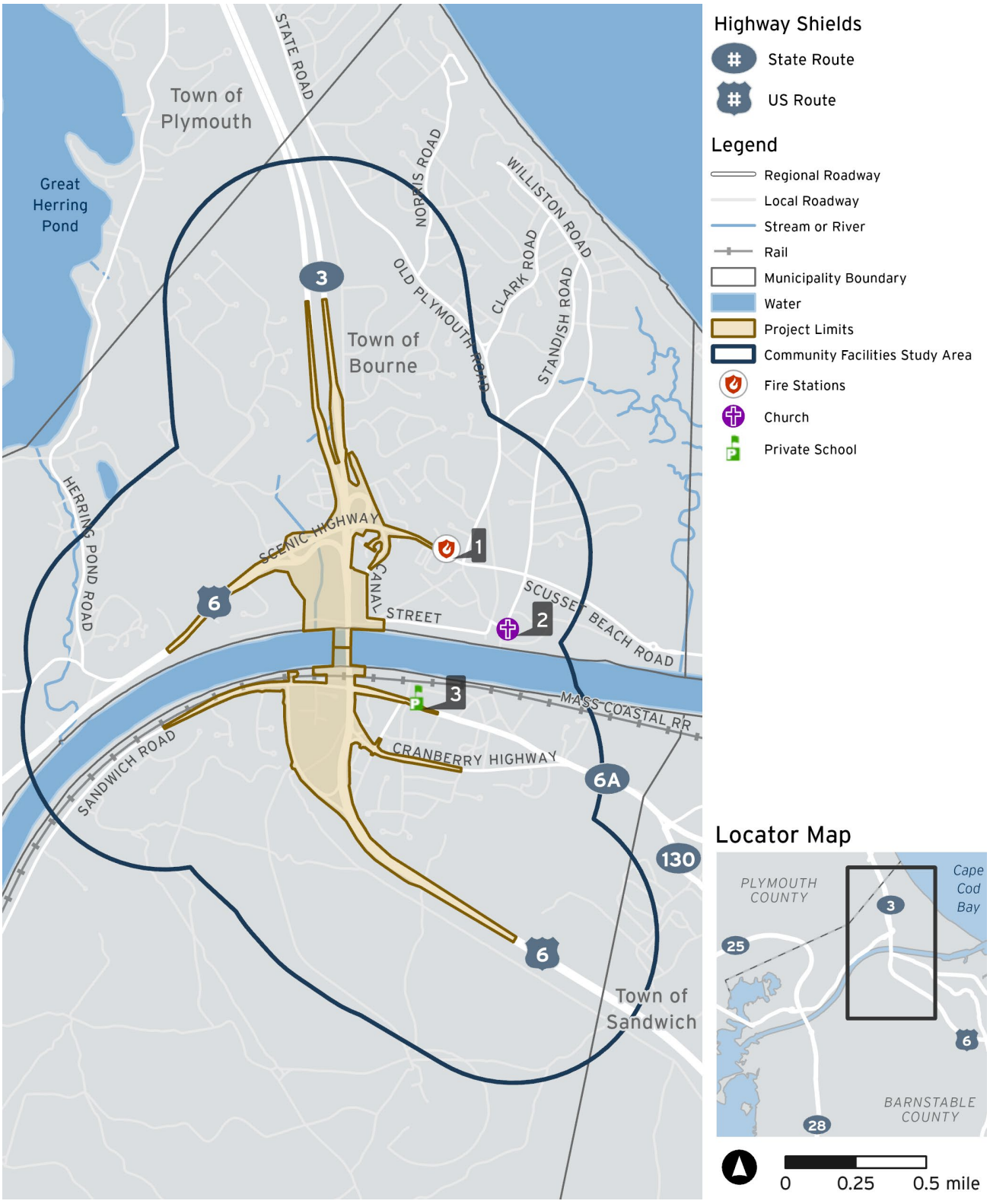


Source: Massachusetts Department of Transportation, 2024

Table 4.7-1. Community Facilities in the Sagamore and Bourne Study Areas

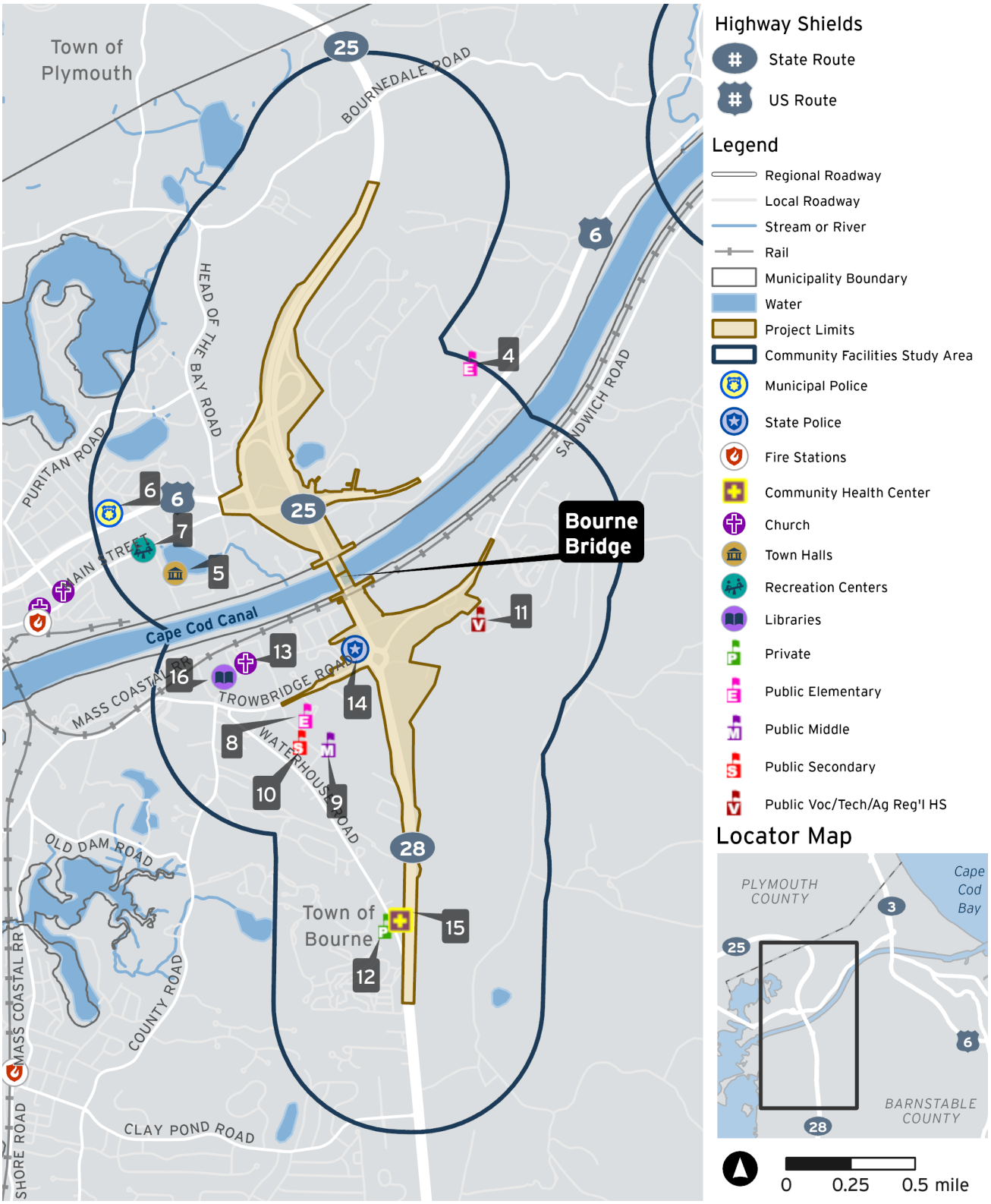
Map Identification Number	Facility Name	Facility Type	Address	Study Area Quadrant
1	Bourne Fire Department Headquarters (Station 3)	Fire Station	51 Meetinghouse Ln, Sagamore Beach, MA 02562	Sagamore North
2	Swift Memorial United Methodist Church	Place of Worship	10 Williston Rd, Sagamore Beach, MA 02562	Sagamore North
3	Bridgeview Montessori School	School	885 Sandwich Rd, Sagamore, MA 02561	Sagamore South
4	Bournedale Elementary School	School	41 Ernest Valeri Rd, Bourne, MA 02532	Bourne North
5	Bourne Town Hall	Town Hall	24 Perry Ave, Bourne, MA 02532	Bourne North
6	Bourne Police Department	Police Station	175 Main St, Buzzards Bay, MA 02532	Bourne North
7	Bourne Veterans Memorial Community Center	Community Recreation Center	239 Main St, Buzzards Bay, MA 02532	Bourne North
8	Bourne Intermediate School	School	70 Trowbridge Rd, Buzzards Bay, MA 02532	Bourne South
9	Bourne Middle School	School	77 Waterhouse Rd, Bourne, MA 02532	Bourne South
10	Bourne High School	School	75 Waterhouse Rd, Bourne, MA 02532	Bourne South
11	The Upper Cape Cod Regional Technical High School	School	220 Sandwich Rd, Bourne, MA 02532	Bourne South
12	Independence Academy	School	118 Waterhouse Road, Suite B, Bourne, MA 02532	Bourne South
13	Bourne United Methodist Church	Place of Worship	37 Sandwich Rd, Bourne, MA 02532	Bourne South
14	State Police Station D7 – Bourne	Police Station	Bourne Rotary S, Bourne, MA 02532	Bourne South
15	Community Health Center of Cape Cod Bourne	Community Health Center	123 Waterhouse Rd, Bourne, MA 02532	Bourne South
16	Jonathan Bourne Public Library	Library	19 Sandwich Rd, Bourne, MA 02532	Bourne South

Figure 4.7-2. Community Facilities In and Near Sagamore Study Area



Source: Massachusetts Department of Transportation, 2024

Figure 4.7-3. Community Facilities In and Near Bourne Study Area



Source: Massachusetts Department of Transportation, 2024

4.7.4 Program Impacts

4.7.4.1 Operational Impacts

The Build Alternative would not physically displace, alter, or change accessibility to any community facilities within the Study Areas. As the Build Alternative does not propose to add vehicular capacity to the existing transportation system or provide new transportation access to undeveloped areas, it would not result in changes in population that would increase demand for existing community services.

According to the results of the Noise and Vibration Analysis, detailed in **Section 4.15, Noise and Vibration**, the Build Alternative would not result in an exceedance of the FHWA Noise Abatement Criteria thresholds for land uses supporting community facilities (FHWA Activity Categories C[6] and D[7]) within the common noise environment locations tested.[8] As a result, it is anticipated that the Build Alternative would not result in adverse operational noise impacts to community facilities.

The Build Alternative would reduce congestion and improve traffic operations for access to community facilities within the Study Areas. Additionally, the construction of shared-use paths across the replacement bridges with connections to local roadways and the Cape Cod Canal service roads for the Build Alternative would improve multimodal access to community facilities between the mainland and Cape Cod.

4.7.4.2 Construction Impacts

The Build Alternative would have temporary construction-period impacts on surrounding community facilities relative to traffic circulation and noise. The overarching construction staging and sequencing goals for the Build Alternative are focused on maintaining all vehicle, bicycle, and pedestrian connections through construction. Accessibility to community facilities will not be limited or eliminated during construction. The contractor will also be required to submit a construction-period traffic management plan to MassDOT prior to initiating work. The Traffic Management Plan will ensure connectivity is maintained throughout construction and the public is made aware of any temporary impacts to traffic patterns.

Construction noise and vibration impacts will be most pronounced for bridge demolition and construction of new bridge piers, and less pronounced for interchange approach construction activities. Considering the location of existing community facilities in relation to the existing bridges and the proposed construction staging areas, it is anticipated that the Build Alternative would not result in significant, adverse construction-period noise and vibration impacts on community facilities.

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[6] "Activity Category C" refers to land use that includes non-residential areas like parks, recreation areas, and certain commercial properties.

[7] "Activity Category D" refers to interior spaces of non-residential facilities, including auditoriums, medical facilities, and places of worship.

[8] FHWA, "Procedures for Abatement of Highway Traffic Noise and Construction Noise" (23 CFR 772, as amended 75 FR 39820, July 13, 2010; Effective date July 13, 2011). https://www.ecfr.gov/current/title-23/chapter-I/subchapter-H/part-772

Any construction-period noise and vibration impacts on community facilities would be temporary and would be mitigated in compliance with the applicable state and federal regulations.

4.7.5 Mitigation

No long-term operational mitigation measures are required, as the Build Alternative would not physically displace, alter, or change accessibility to any community facilities within the Study Areas.

Any adverse construction impacts of the Build Alternative on community facilities related to transportation, noise, and vibration, would be short term with provision of necessary mitigation measures, as discussed in **Section 4.2, Transportation, Traffic, and Safety**, and **Section 4.15, Noise and Vibration**.

4 Existing Conditions, Program Impacts, and Mitigation

4.8 Property Acquisition, Displacement, and Relocation

4.8.1 Introduction

This section evaluates the potential impacts of the No Build and Build Alternatives on existing residential and commercial properties in the Study Area, including a discussion of the potential temporary construction-related impacts and permanent parcel acquisitions, displacements, relocation, and access associated with the Build Alternative. This section also describes avoidance and minimization strategies that the Massachusetts Department of Transportation (MassDOT) has taken to eliminate or reduce the need for acquisition displacements, as well as mitigation measures that will be taken to offset impacts related to property acquisitions. Additionally, this section addresses the preliminary tasks that would occur for the Build Alternative as part of relocation planning.

This section discusses the following types of property impacts:

- Acquisitions: Property acquisitions can be either partial or full and involve the eminent domain taking of fee-simple land ownership rights of all or a portion of a property.
  - Partial acquisitions occur when MassDOT permanently acquires a portion of a larger property. This is typically done to alter the state highway layout line to accommodate activities such as roadway widening, adjustments to a road's geometry or alignment, or the installation of sidewalks, shared-use paths, and stormwater management systems. Partial acquisitions may require relocation of personal property items such as business signs.
  - Full acquisitions occur when MassDOT permanently acquires an entire property, dissolving its private ownership and potentially requiring relocation of residents or businesses.
- Easements: Easements provide MassDOT the right to use a portion of a property. An easement is usually documented in a property deed and allows permanent access to a property for a designated purpose. Easements provide a right of use not a right of possession. Easements can be either permanent or temporary:
  - Permanent easements are used for ongoing use of and access to a property for installation and maintenance of transportation infrastructure, such as slopes, guardrails, and drainage structures.
  - Temporary easements are used when a portion of a property is required for construction activities or access.

Displacements result from full or partial acquisitions and the conversion of the existing land use to a transportation use. Displacements are measured by the number of households or businesses that require relocation. For example, the acquisition of an apartment building on a single property containing 10 dwelling units would result in multiple residential displacements.

Section 4.5, Socioeconomics, discusses the potential socioeconomic impacts of the Cape Cod Bridges Program (Program) and resulting displacements. **Section 4.20, Utilities and Services**, discusses the potential impacts of the Program on utility connections and/or septic tanks. The determination of impacts to the U.S. Army Corps of Engineers' (USACE) Federal Navigation Project will be coordinated with the USACE as part of the Section 408 Permit review process for permission to alter or use a federal public works project (33 United States Code 408) and potentially as an outgrant/lease. **Section 4.18, Public Parks, Recreational Facilities, and Open Space**, addresses the impacts of the Program on USACE park and recreation uses within the Study Area, including the USACE-operated and -leased facilities and the Bourne Recreation Authority (BRA)-operated facilities. **Section 4.3, Pedestrian and Bicycle Facilities**, addresses the impacts of the Program on existing public pedestrian and bicycle facilities, including the Canal Service Roads.

4.8.1.1 Regulatory Context

Federally funded projects involving property acquisition and relocation must adhere to the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970 (Uniform Act) (42 United States Code 61; 49 Code of Federal Regulations 24), as amended. The Uniform Act sets minimum standards for federally funded projects that involve property acquisition or displacement of individuals from their homes or businesses. Its purpose is to ensure fair treatment for affected people and guarantee that property owners receive a fair market price. Additionally, the Uniform Act requires the provision of relocation assistance to those who are displaced and need to relocate. This includes referrals to suitable replacement housing, help with relocation payments, and other support to minimize the impact of the move.

In the Commonwealth of Massachusetts, acquisition of real property must also adhere to Massachusetts General Law, Chapter 79A and its implementing regulations at 760 CMR 27.00 (Relocation Assistance), which requires the provision of advisory services and relocation assistance for displaced individuals.

MassDOT will conduct the acquisition and relocation process in accordance with these applicable state and federal laws and will make relocation resources available without discrimination to all displaced residents and businesses.

4.8.1.2 Methodology and Study Area

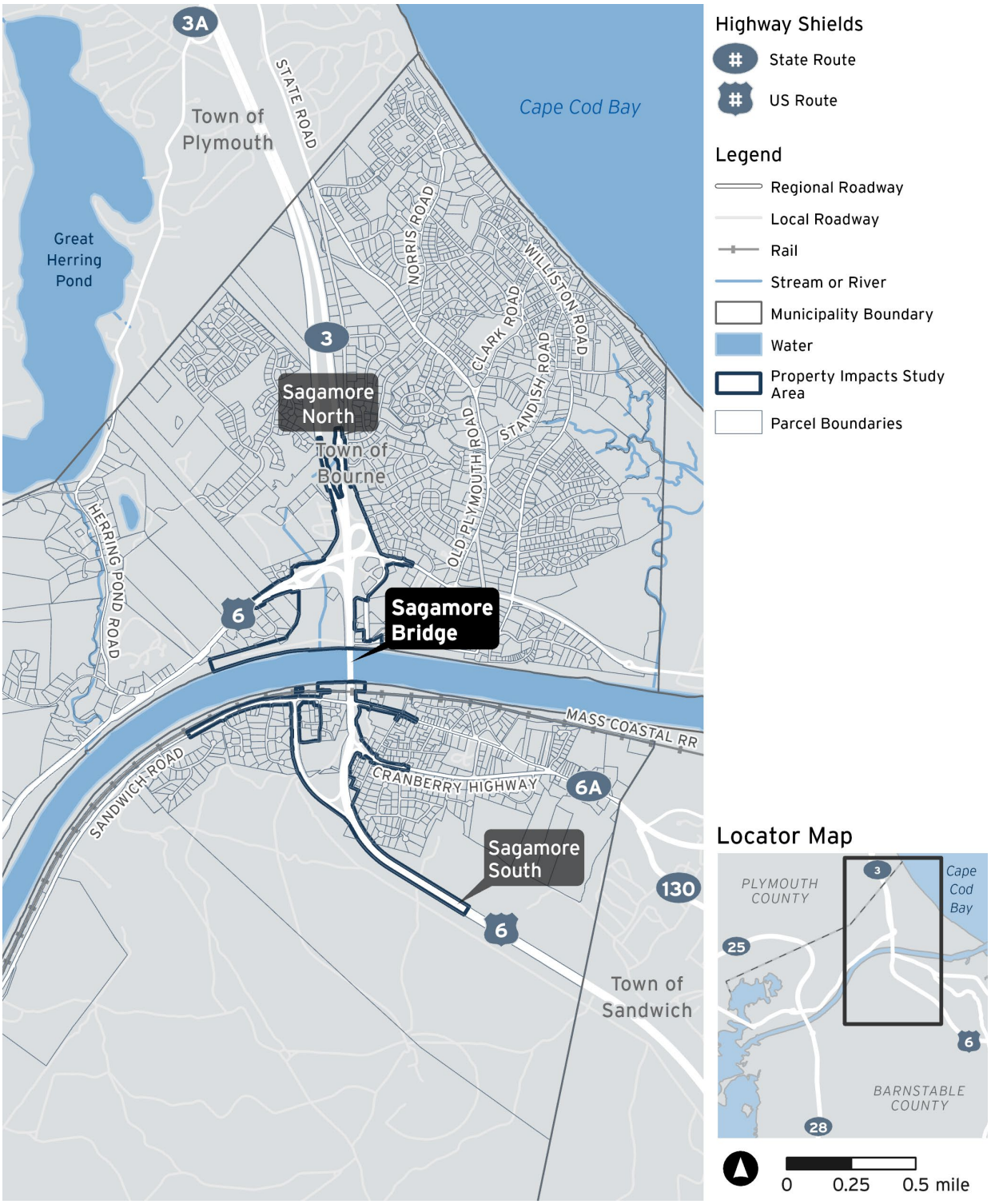
Based on the anticipated area and duration (permanent versus temporary) of impact, MassDOT determined the type of property impact. Properties that could be fully or partially acquired or could be subject to an easement were identified using the Project Limits for each bridge and interchange approach. The Project Limits (i.e., the outer limit of the work boundary) also represents the Study Area for this evaluation (**Figure 4.8-1** and **Figure 4.8-2**). MassDOT developed the Study Area—which encompasses the area within which construction, demolition, materials storage, grading, landscaping, and related activities would occur—using computer aided design and drafting (CADD) drawings of the anticipated work. In most cases, the Study Area also incorporates a 15-foot buffer to provide a conservative approach in identifying potential property impacts and right-of-way needs. MassDOT used data obtained from the MassGIS (Bureau of Geographic Information) standardized assessors'

parcel mapping dataset to graphically depict parcel-level data and identify potentially affected parcels within the Study Area.[1] This dataset includes property boundaries and information from the Town of Bourne's assessor database, which provides details such as parcel size, property ownership, and property use.[2] MassDOT reviewed each parcel within the Study Area and determined the type of property impact based on the area and duration (temporary versus permanent) of the impact to the parcel.

[1] MassGIS (Bureau of Geographic Information). 2024. Property Tax Parcels. October. https://www.mass.gov/info-details/massgis-data-property-tax-parcels

[2] Department of Revenue/Division of Local Services – Bureau of Local Assessment. 2019. Property Type Classification Codes: Non-arm's Length Codes and Sales Report Spreadsheet Specifications. Revised April. https://www.mass.gov/doc/property-type-classification-codes-non-arms-length-codes-and-sales-report-spreadsheet/download

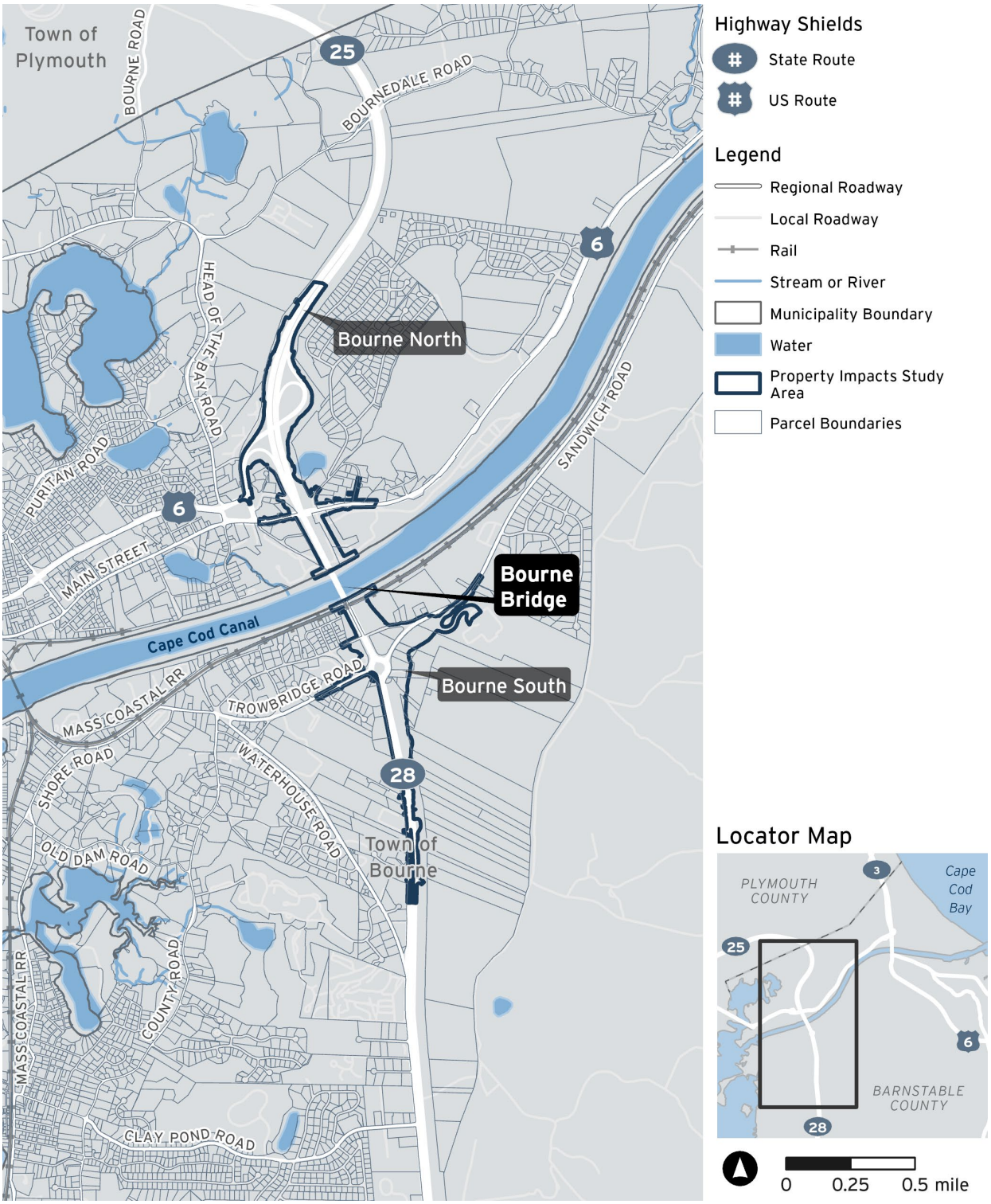
Figure 4.8-1. Sagamore Bridge Property Impacts Study Area



Source: Massachusetts Department of Transportation, 2024

Note: Figure shows only parcel boundaries for the town of Bourne.

Figure 4.8-2. Bourne Bridge Property Impacts Study Area



Source: Massachusetts Department of Transportation, 2024

Note: Figure shows only parcel boundaries for the town of Bourne.

4.8.2 Existing Conditions

This section provides a summary of the 176 total properties that would potentially be affected by acquisitions or easements in order to construct and maintain the Build Alternative. These properties are located on both sides of Cape Cod Canal within the town of Bourne, MA.

Table 4.8-1 identifies the number of properties that would be affected and the current property use, which was derived from the Massachusetts Department of Revenue's Land Use Codes provided in the Town of Bourne's assessor data.[3] Note that further design refinement and assessment of future functional capacity could alter the full extent of the acquisitions identified in this Draft Environmental Impact Report.

Table 4.8-1. Potentially Affected Parcels

Type	Number of Properties	Proposed Acquisition (Acres)	Property Use		
			Number	Residential, Commercial, or Vacant Land	Occupied/ Vacant
Potential Full Acquisitions	28	25.47	14	Residential	Occupied
			8	Land Accessory to Commercial Parcel	Vacant
			2	Land in Residential Zone	Vacant
			1	Land - Municipal	Vacant
			2	Land - State	Vacant
			1	Retail	Occupied
Potential Partial Acquisitions*	34	23.59	17	Residential	Occupied
			3	Retail	Occupied
			3	Land – State	Vacant
			2	Land in Residential Zone	Vacant
			2	Land Accessory to Commercial Parcel	Vacant
			1	State Owned Building (State Police)	Occupied
			1	Land – Municipal	Vacant
			1	Recreational	Occupied
			1	Public Service (Post Office)	Occupied
			1	Education	Occupied
			1	Hospital (Veterinarian)	Occupied
			1	Retail (Tanks Holding Fuel/Oil Products for Retail Distribution)	Occupied

[3] Department of Revenue/Division of Local Services – Bureau of Local Assessment. 2019. Property Type Classification Codes: Non-arm's Length Codes and Sales Report Spreadsheet Specifications. Revised April. https://www.mass.gov/doc/property-type-classification-codes-non-arms-length-codes-and-sales-report-spreadsheet/download

Type	Number of Properties	Proposed Acquisition (Acres)	Property Use		
			Number	Residential, Commercial, or Vacant Land	Occupied/ Vacant
Easement Only	114	Easement areas under development**	48	Residential	Presumed Occupied
			11	Land in Residential Zone	Vacant
			7	Land – State Owned	Vacant
			7	Retail	Occupied
			6	Automotive Retail	Occupied
			5	Land – Municipal Owned (Conservation)	Vacant
			4	Storage, Warehouse, or Distribution	Occupied
			3	Restaurants	Occupied
			3	Land Accessory to Commercial Parcel	Vacant
			2	Parking Lots	Occupied
			2	Car Wash	Occupied
			1	Education	Occupied
			1	Funeral Home	Occupied
			4	Gasoline Service Stations	Occupied
			1	Health Club	Occupied
			1	Manufacturing	Occupied
			2	Motels	Occupied
			1	Municipal Property – Education	Occupied
			1	Municipal Property – Recreation	Occupied
			1	Nursing Home	Occupied
			2	Office Building	Occupied
			1	Land Accessory to Industrial Parcel	Vacant

Note: Table excludes property owned by the U.S. Army Corps of Engineers, which **Section 4.18, Public Parks, Recreational Facilities, and Open Space**, addresses.

* All the parcels potentially affected by partial acquisitions would also be potentially affected by easements, except for one residential property.

** The area (square feet) and nature (temporary versus permanent) of the required potential easements would be determined as design progresses.

4.8.3 No Build Alternative

The No Build Alternative would have no long-term or temporary impacts on the properties within the Study Area. The bridges would be maintained in their current alignments. Existing easements would be used to access and maintain the current structures, and no additional property would be required for staging or construction of the new structures or interchange approaches.

4.8.4 Program Impacts

As indicated in **Chapter 3, Proposed Action and Alternatives**, for the Build Alternative the new structures would be situated adjacent to and inboard of the footprint of the existing structures. The Program would also reconfigure the highway interchange approach networks north and south of Cape Cod Canal to align with the new highway bridges.

The new alignment and the areas needed for construction staging and the demolition of the existing bridges and interchange improvements would result in unavoidable property impacts. The following sections provide information on the parcels that would be affected by acquisitions or easements and identify potential displacements.

4.8.4.1 Potential Property Acquisitions

Implementation of the Build Alternative would require the potential full acquisition of 28 parcels and potential partial acquisition of an additional 34 parcels, affecting a total of 62 parcels. Construction of the Sagamore Bridge will result in the potential full acquisition of 20 parcels and potential partial acquisition of 17 parcels. Construction of Bourne Bridge will result in the potential full acquisition of 8 parcels and potential partial acquisition of 17 parcels. **Table 4.8-2** lists properties identified for potential full acquisition, and **Table 4.8-3** lists properties identified for potential partial acquisition. The tables include the map and parcel information, address, current land use, and the parcel size for each affected property. **Figure 4.8-3** and **Figure 4.8-4** (Sagamore North and Sagamore South) and **Figure 4.8-5** and **Figure 4.8-6** (Bourne North and Bourne South) show the potential full and partial acquisitions. MassDOT will continue to refine this initial assessment of property acquisition as engineering plans are finalized, and additional information will be presented in the Final Environmental Impact Report (FEIR).

Potential full acquisitions are identified where entire parcels would be needed to implement the Build Alternative or where the Build Alternative would affect a parcel's current or future use. Full acquisitions of occupied residential or commercial properties would result in potential displacement and would require potential relocation of the existing use.

Potential partial acquisitions are identified where portions or strips of property would be needed to implement the Build Alternative. Most of the potential partial acquisitions needed (26 properties) would generally involve less than 15% of the total parcel area. Properties affected by partial acquisitions are expected to be able to continue their existing uses on the remaining portions of the property, except for one potential partial acquisition that would result in displacement of one multitenant (2 units) commercial use.

Table 4.8-2. Potential Full Property Acquisitions

#	Program Quadrant*	Bourne Assessor's Map_Parcel ID	Address	Land Use	Parcel Size (square feet)
1	SN	11.0_033.00	34 Canal Street	Residential Occupied	33,890
2	SN	11.0_025.00	1025 Scenic Highway	Municipal Vacant	39,200
3	SS	11.4_038.00	4 Cecilia Terrace	Residential Occupied	23,261
4	SS	11.4_044.00	7 Cecilia Terrace	Residential Occupied	20,038
5	SS	11.4_049.02	8 Cecilia Terrace	Residential Occupied	17,654
6	SS	11.4_045.00	11 Cecilia Terrace	Residential Occupied	10,019
7	SS	11.4_046.00	15 Cecilia Terrace	Residential Occupied	10,019
8	SS	11.4_047.00	16 Cecilia Terrace	Vacant Land (in a residential zone)	33,780
9	SS	11.4_039.00	15 Eleanor Avenue	Residential Occupied	29,055
10	SS	11.4_040.00	17 Eleanor Avenue	Residential Occupied	14,941
11	SS	11.4_054.00	0 Garfield Avenue	Vacant Land (accessory to commercial parcel)	653
12	SS	17.2_002.00	0 Garfield Avenue	Vacant Land (in a residential zone)	2,265
13	SS	17.2_003.00	4 Garfield Avenue	Residential Occupied	12,415
14	SS	11.4_049.00	3 Johns Lane	Residential Occupied	57,830
15	SS	11.4_049.03	4 Johns Lane	Residential Occupied	27,816
16	SS	11.4_049.01	5 Johns Lane	Residential Occupied	29,160
17	SS	11.4_041.00	24 Johns Lane	Residential Occupied	12,023
18	SS	11.4_055.00	0 Route 6	State Property Vacant	69,696
19	SS	11.4_005.00	815 Sandwich Road	Vacant Land (accessory to commercial parcel)	48,526
20	SS	11.4_006.00	825 Sandwich Road	Vacant Land (accessory to commercial parcel)	26,397
21	BN	20.0_014.00	2 Nightingale Pond Road	Residential Occupied	40,249
22	BS	24.0_009.00	170 Sandwich Road	Vacant Land (accessory to commercial parcel)	72,745
23	BS	24.0_013.00	4 Bourne Rotary	Vacant Land (accessory to commercial parcel)	106,603

#	Program Quadrant*	Bourne Assessor's Map_Parcel ID	Address	Land Use	Parcel Size (square feet)
24	BS	24.0_042.00	0 Sandwich Road	Vacant Land (accessory to commercial parcel)	63,778
25	BS	24.0_043.00	0 Sandwich Road	Vacant Land (accessory to commercial parcel)	64,000
26	BS	24.0_044.00	0 Bourne Rotary	Vacant Land (accessory to commercial parcel)	50,730
27	BS	24.0_007.00	2 Bourne Rotary	Retail Occupied	152,896
28	BS	24.0_014.00	0 Route 28	Municipal Vacant	6,839

* Program Quadrants: SN = Sagamore North; SS = Sagamore South; BN = Bourne North; BS = Bourne South

Table 4.8-3. Potential Partial Property Acquisitions

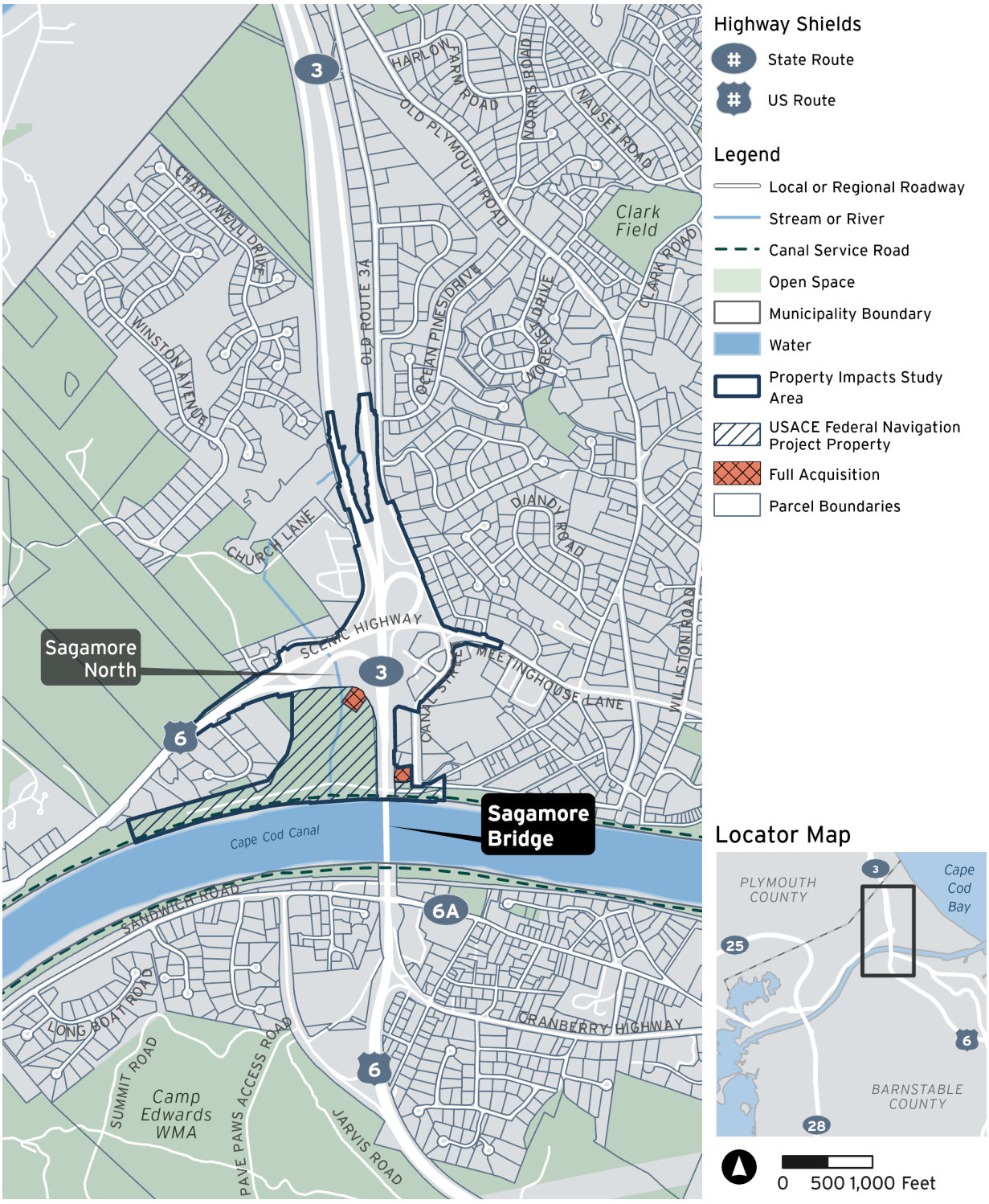
#	Program Quadrant*	Bourne Assessor's Map_Parcel ID	Address	Land Use	Parcel Size (square feet)
1	SS	11.4_067.00	5 Cranberry Highway	Retail Occupied	183,170
2	SS	11.4_111.00	91 Cranberry Highway	Residential Occupied	24,219
3	SS	11.4_028.00	2 Eleanor Avenue	Residential Occupied	16,422
4	SS	11.4_035.01	26 Eleanor Avenue	Residential Occupied	88,862
5	SS	11.4_052.00	1 Factory Outlet Road	Retail Occupied	534,774
6	SS	11.4_023.00	6 Louis Avenue	Residential Occupied	52,708
7	SS	11.4_021.00	0 Mid Cape Connector	Vacant Land in a residential zone	10,831
8	SS	17.0_003.00	0 Route 6	State Property Vacant	28,519,168
9	SS	11.4_011.00	0 Sandwich Road	Municipal Property Vacant	8,407
10	SS	11.4_014.00	774 Sandwich Road	Residential Occupied	41,982
11	SS	11.4_015.00	776 Sandwich Road	Residential Occupied	18,818
12	SS	11.4_001.00	783 Sandwich Road	Residential Occupied	21,301
13	SS	11.4_022.00	788 Sandwich Road	Residential Occupied	55,761
14	SS	11.4_027.01	794 Sandwich Road	Residential Occupied	20,604
15	SS	11.4_058.00	860 Sandwich Road	Residential Occupied	175,547
16	SS	11.4_079.00	880 Sandwich Road	Residential Occupied	6,665
17	SS	11.4_012.00	883 Sandwich Road	Public Service Occupied (post office)	27,138

#	Program Quadrant*	Bourne Assessor's Map_Parcel ID	Address	Land Use	Parcel Size (square feet)
18	BN	20.3_067.00	2 Bourne Bridge Approach	Retail Occupied	131,987
19	BN	20.4_001.00	11 Bourne Bridge Approach	Hospital (veterinary) Occupied	81,893
20	BN	20.3_135.00	328 Main Street	Residential Occupied	20,691
21	BN	20.0_088.00	72 Nightingale Pond Road	Vacant Land (in a residential zone)	92,524
22	BN	20.4_002.00	343 Scenic Highway	Retail Occupied (tanks holding fuel/oil products for retail distribution)	84,022
23	BN	20.0_013.00	370 Scenic Highway	Recreation Occupied	246,550
24	BN	20.0_015.00	385 Scenic Highway	Residential Occupied	84,942
25	BN	20.0_024.00	391 Scenic Highway	Residential Occupied	69,402
26	BS	24.0_017.00	0 Bourne Rotary	State Property Vacant	108,900
27	BS	24.0_016.00	0 Bourne Rotary	State Property Vacant	239,580
28	BS	24.0_013.01	0 Bourne Rotary	Vacant Land accessory to commercial parcel	213,820
29	BS	25.0_002.00	0 Bourne Rotary	Vacant Land (accessory to commercial parcel)	1,176,120
30	BS	24.0_006.00	1 Bourne Rotary	State Property Occupied (State Police Building)	254,826
31	BS	25.0_001.00	220 Sandwich Road	Education Occupied	3,297,492
32	BS	M_276637_833422	230 Sandwich Road	Residential Occupied	58,237
33	BS	24.4_009.00	1 Sandy Lane	Residential Occupied	16,030
34	BS	24.4_008.00	2 Sandy Lane	Residential Occupied	20,038

Note: Table excludes property owned by the USACE, which **Section 4.18, Public Parks, Recreational Facilities, and Open Space**, addresses.

* Program Quadrants: SS = Sagamore South; BN = Bourne North; BS = Bourne South

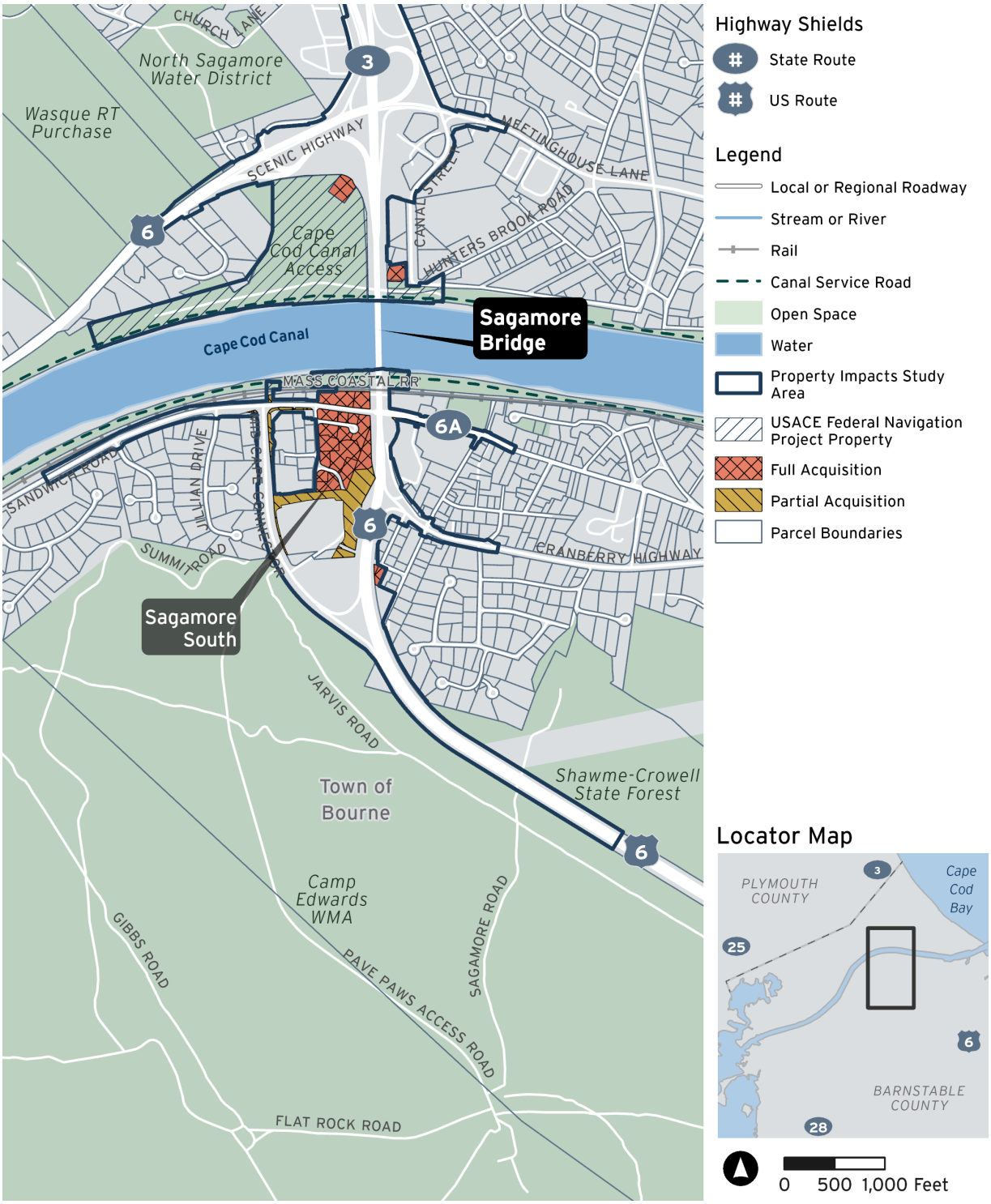
Figure 4.8-3. Potential Property Acquisitions (Sagamore North Quadrant)



Source: Massachusetts Department of Transportation, 2024

Note: The limits of partial acquisitions are approximate. Not all partial acquisitions are visible at this scale. Refer to Table 4.8-2 and Table 4.8-3 for the properties identified for full or partial acquisition to-date.

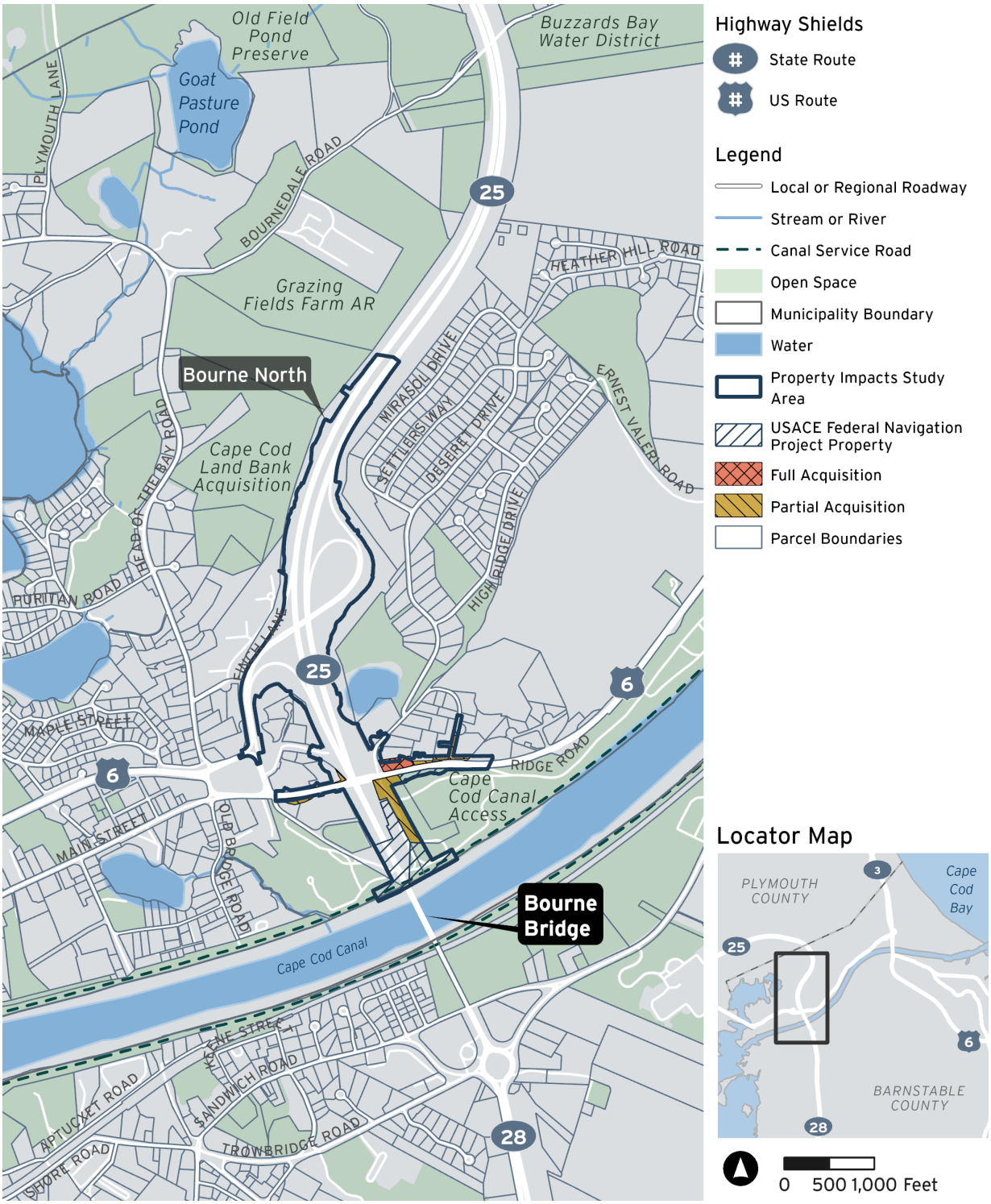
Figure 4.8-4. Potential Property Acquisitions (Sagamore South Quadrant)



Source: Massachusetts Department of Transportation, 2024

Note: The limits of partial acquisitions are approximate. Not all partial acquisitions are visible at this scale. Refer to Table 4.8-2 and Table 4.8-3 for the properties identified for full or partial acquisition to-date.

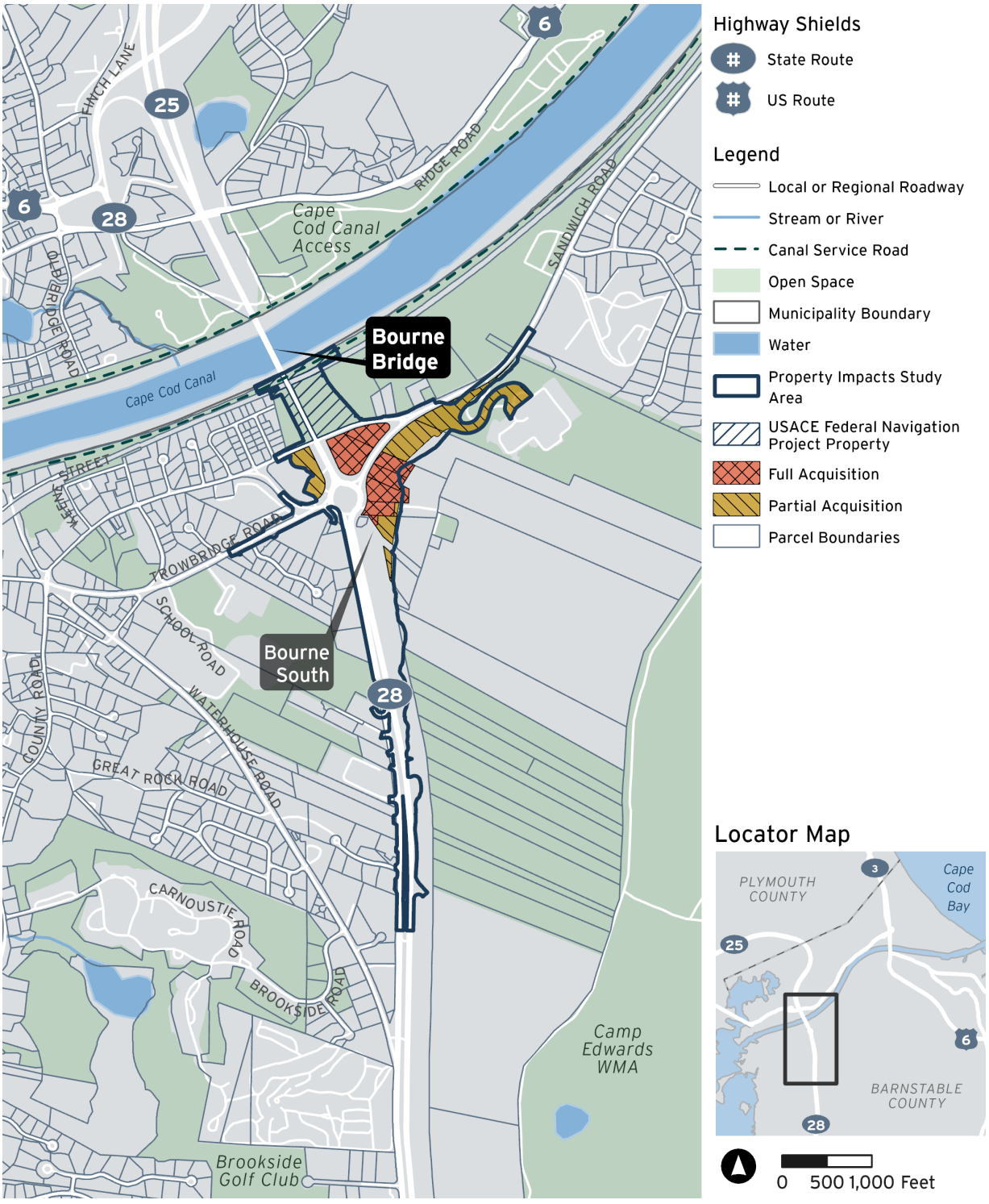
Figure 4.8-5. Potential Property Acquisitions (Bourne North Quadrant)



Source: Massachusetts Department of Transportation, 2024

Note: The limits of partial acquisitions are approximate. Not all partial acquisitions are visible at this scale. Refer to Table 4.8-2 and Table 4.8-3 for the properties identified for full or partial acquisition to-date.

Figure 4.8-6. Potential Property Acquisitions (Bourne South Quadrant)



Source: Massachusetts Department of Transportation, 2024

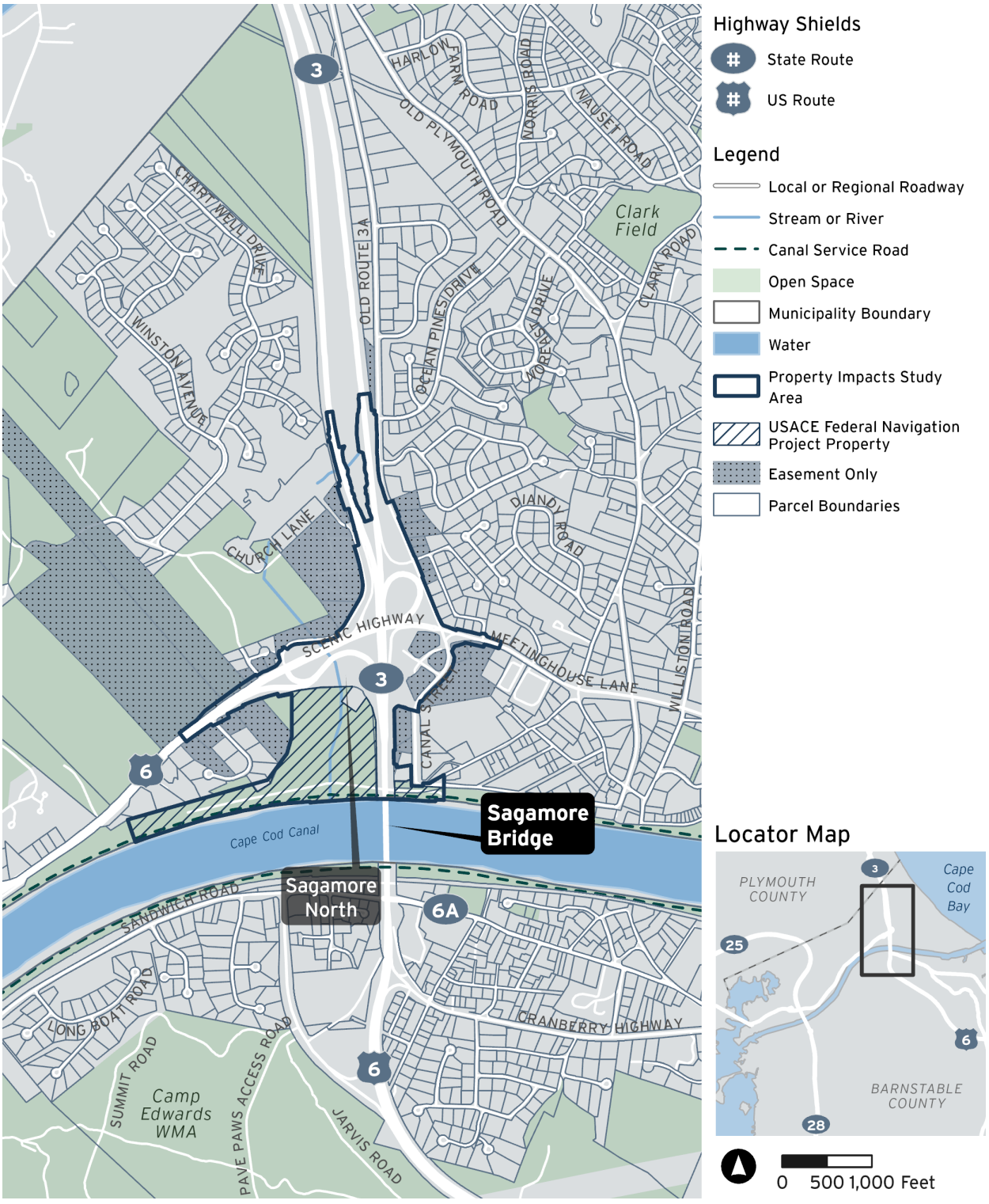
Note: The limits of partial acquisitions are approximate. Not all partial acquisitions are visible at this scale. Refer to Table 4.8-2 and Table 4.8-3 for the properties identified for full or partial acquisition to-date.

4.8.4.2 Potential Easements

Based on design to-date, the Build Alternative would necessitate potential easements on 147 properties. Of this total, 33 properties would also be affected by potential partial acquisitions, while 114 properties would be affected solely by potential easements. The area (square feet) and nature (temporary versus permanent) of the required potential easements would be determined as design progresses, and additional information will be presented in the FEIR. Temporary easements are anticipated during construction for construction access, grading to match new roadway and back of sidewalks, temporary pedestrian pathways, roadway detours, and temporary utility relocations. Potential permanent easements are anticipated for future maintenance and access of stormwater infrastructure, utilities and the bridge structures, highway interchange approaches, shared-use paths, slopes, guardrails, walls, highway lighting and signage.

Figure 4.8-7 and **Figure 4.8-8** (Sagamore Bridge) and **Figure 4.8-9** and **Figure 4.8-10** (Bourne Bridge) identify properties that would be affected by easements at the parcel level. MassDOT is continuing to evaluate the requirements for easements, including whether they will be temporary or permanent; this initial assessment of properties that would be affected by easements will be further refined as engineering plans are finalized. The FEIR will present additional information.

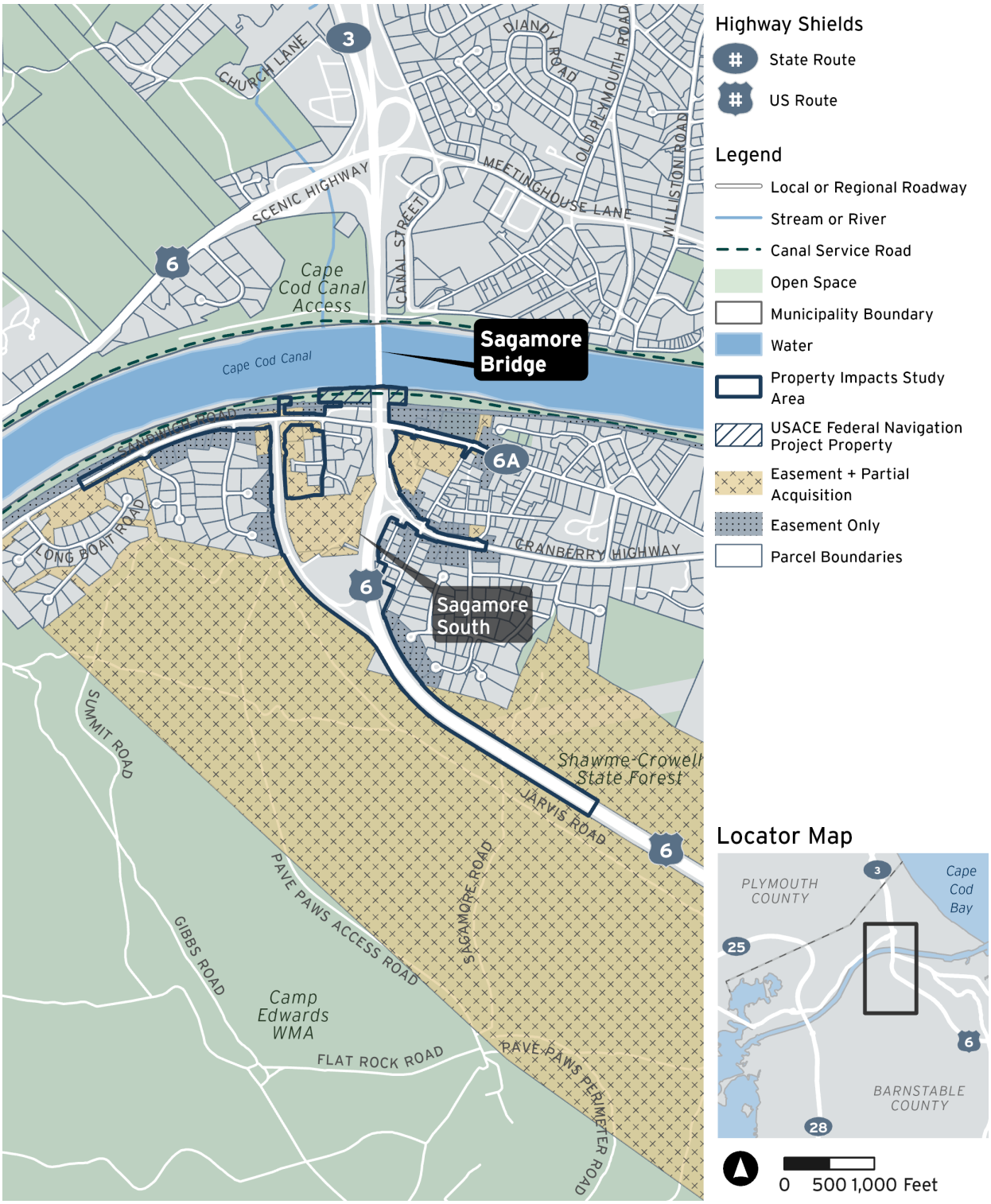
Figure 4.8-7. Properties Potentially Affected by Easements (Sagamore North Quadrant)



Source: Massachusetts Department of Transportation, 2024

Note: Figure identifies properties affected by easements at the parcel level.

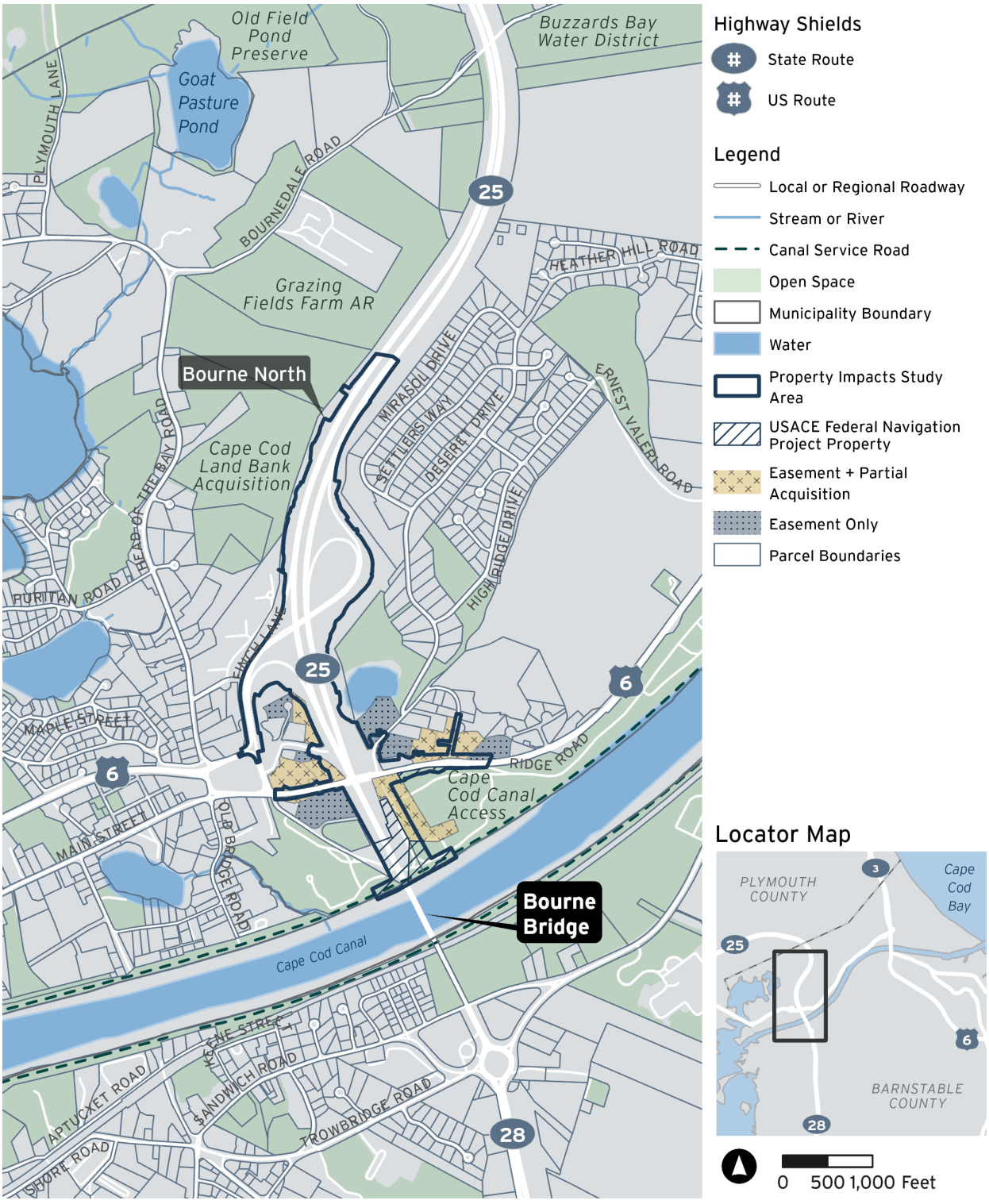
Figure 4.8-8. Properties Potentially Affected by Easements (Sagamore South Quadrant)



Source: Massachusetts Department of Transportation, 2024

Note: Figure identifies properties affected by easements at the parcel level.

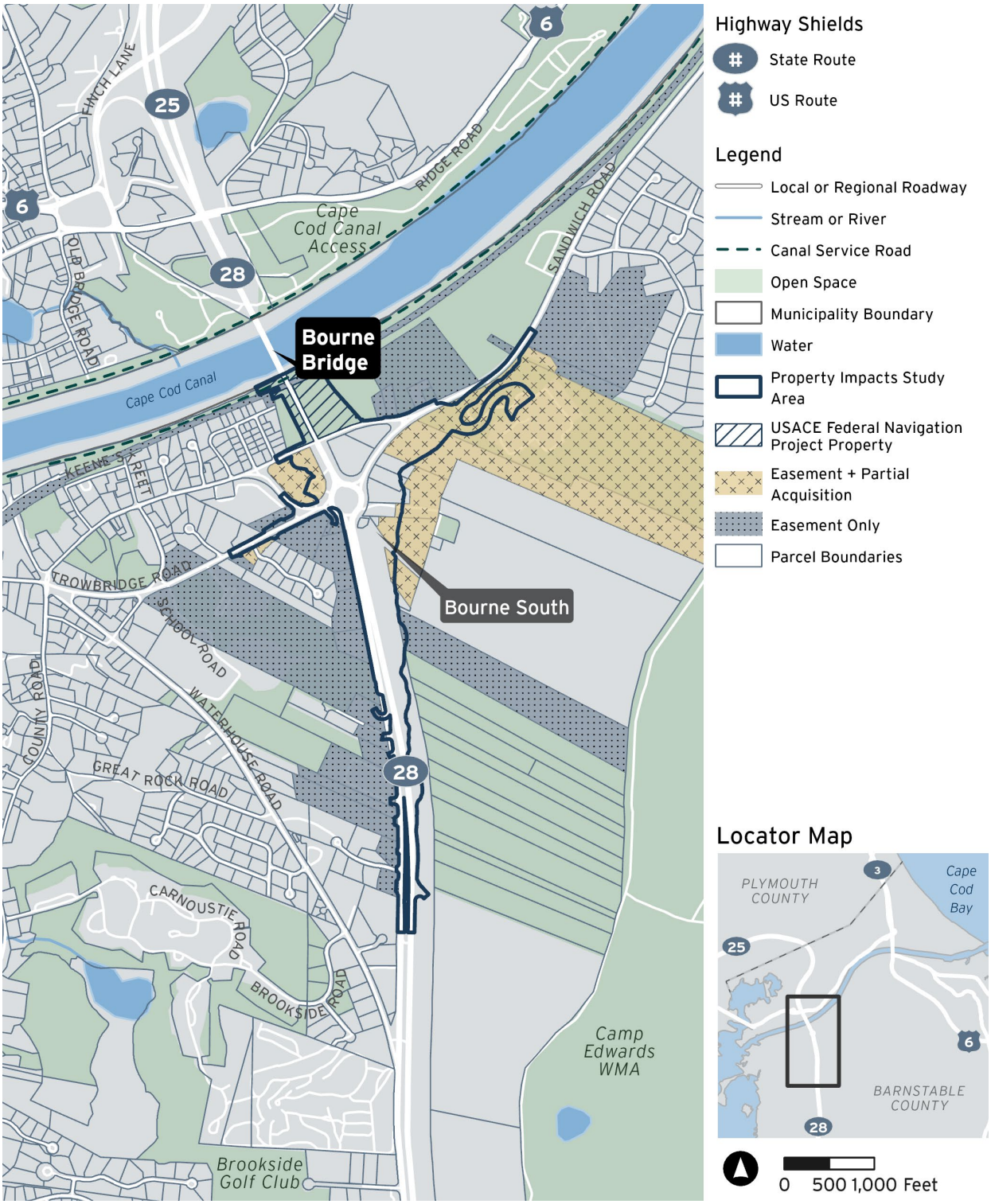
Figure 4.8-9. Properties Potentially Affected by Easements (Bourne North Quadrant)



Source: Massachusetts Department of Transportation, 2024

Note: Figure identifies properties affected by easements at the parcel level.

Figure 4.8-10. Properties Potentially Affected by Easements (Bourne South Quadrant)



Source: Massachusetts Department of Transportation, 2024

Note: Figure identifies properties affected by easements at the parcel level.

4.8.4.3 Potential Displacements

Of the 62 properties identified for potential full or partial acquisition, 14 occupied residential properties and 2 occupied commercial properties would require potential displacement of the occupants. Based on information from the Town of Bourne assessors' office, these residential properties are single-family homes, which would result in the displacement of 14 households, at a minimum. Interviews with residents to determine the status of the occupants (renters versus owners) commenced in May 2025. The number of businesses that would be displaced was determined based on a desktop review of publicly available information and will be verified during the subsequent interview process. One of the two businesses that would potentially be displaced is a multitenant commercial structure, which is occupied by two tenants. In total, the Program would result in 3 potential commercial displacements. **Table 4.8-4** identifies the potential residential displacements.

Table 4.8-4. Potential Residential Displacements

#	Program Quadrant*	Bourne Assessor's Map_Parcel ID	Address
1	SN	11.0_033.00	34 Canal Street
2	SS	11.4_038.00	4 Cecilia Terrace
3	SS	11.4_044.00	7 Cecilia Terrace
4	SS	11.4_049.02	8 Cecilia Terrace
5	SS	11.4_045.00	11 Cecilia Terrace
6	SS	11.4_046.00	15 Cecilia Terrace
7	SS	11.4_039.00	15 Eleanor Avenue
8	SS	11.4_040.00	17 Eleanor Avenue
9	SS	17.2_003.00	4 Garfield Avenue
10	SS	11.4_049.00	3 Johns Lane
11	SS	11.4_049.03	4 Johns Lane
12	SS	11.4_049.01	5 Johns Lane
13	SS	11.4_041.00	24 Johns Lane
14	BN	20.0_014.00	2 Nightingale Pond Road

* Program Quadrants: SN = Sagamore North; SS = Sagamore South; BN = Bourne North

Table 4.8-5 identifies the commercial properties that would be affected and would result in potential commercial displacements. The table also identifies the number of associated potential displacements.

Table 4.8-5. Potential Commercial Displacements

#	Program Quadrant*	Bourne Assessor's Map_Parcel ID	Address	Use	Number of Displacements
1	SS	11.4_052.00	2 Factory Outlet Way	Retail (multitenant)	2
2	SS	11.4_005.00	815 Sandwich Road	Vacant Land (accessory to commercial parcel)	TBD**
3	SS	11.4_006.00	825 Sandwich Road	Vacant Land (accessory to commercial parcel)	TBD**
4	BS	24.0_007.00	2 Bourne Rotary	Retail	1

* Program Quadrants: SS = Sagamore South; BS = Bourne South

** The properties at 815 and 825 Sandwich Road are under common ownership. Based on a desktop review, these properties are used to store vehicles, equipment, and landscaping materials. Neither property contains any structures. The potential impact of the acquisitions on its operations would be determined based on information gathered from future interviews with occupants.

4.8.5 Mitigation

Federal and state regulations govern most aspects of mitigation for property acquisition and the displacement of residents and businesses. These regulations require that property be purchased at fair market value and that all displaced residents be provided with decent, safe, and sanitary replacement housing. The Uniform Act establishes the standards and procedures for providing replacement housing, tailored to the needs of individual households. In the Commonwealth of Massachusetts, acquisition of real property must also adhere to the Massachusetts General Law, Chapter 79A and its implementing regulations at 760 CMR 27.00 (Relocation Assistance), which requires the provision of advisory services and relocation assistance for displaced individuals. Relocation assistance typically includes replacement housing for both owners and renters, moving costs, and help in finding new housing. For businesses, relocation assistance covers items such as but not limited to moving costs, site search expenses, and business re-establishment expenses. Relocation assistance would be made available to all relocatees without discrimination with sufficient lead-time prior to the need for replacement housing. As part of the relocation process, MassDOT would prepare one or more Program-specific Relocation Plans that would include a detailed analysis of available replacement properties and means for providing replacement housing for residential occupants displaced by the Program and moving assistance for businesses that would be displaced by the Program.

MassDOT has prepared a preliminary Relocation Plan for 15 total properties (12 residential and 3 commercial) that would require full acquisition to construct the new Sagamore Bridge structure and the mainline approaches. The preliminary Relocation Plan identifies comparable residential replacement properties, including price ranges and rental rates, and estimates the availability of replacement business sites. The Federal Highway Administration accepted the preliminary Relocation Plan on November 1, 2024. MassDOT started scheduling interviews with the residents of these 15 properties in May 2025. The following information will be gathered during interviews and incorporated into the final Relocation Plan:

- Individual household characteristics
- Residential relocation needs and preferences
- Size of businesses to be displaced
- Approximate number of employees who would be affected
- Specific business replacement requirements and preferences

Other preliminary acquisition activities that have occurred to date to support this process include initiation of the title examinations of the 15 affected properties in the preliminary Relocation Plan and preparation of preliminary property maps. MassDOT will prepare similar Relocation Plans for the remaining properties that would be acquired to implement the Program.

According to available data from the Cape Cod Commission, the number of homes for sale in the town of Bourne in 2023 peaked during June at 24 homes.[4] For 2024, data is available only through April, with the highest inventory recorded at 13 homes. MassDOT has identified the following strategies to facilitate the relocation process in a limited real estate market:

- Early Acquisition(s) – MassDOT anticipates submitting multiple early acquisition requests to the Federal Highway Administration for review and approval. This will allow the interview and appraisal process to commence before completing the National Environmental Policy Act process[5] and help ensure that MassDOT identifies the replacement properties in a timely manner. It will also enable MassDOT to identify early on any housing preferences (such as accessibility features or proximity to medical care) or special relocation advisory services that may be necessary.
- Phased Relocations – Given current market availability, it is unlikely that all occupants of affected residential properties can be relocated at once. Given this, MassDOT will conduct residential relocations in multiple phases to manage the relocation process more effectively and ensure that suitable housing is secured for all displaced residents.
- Collaboration with Builders – MassDOT will identify builders who are constructing homes on available lots in the area. This strategy could provide a unique solution for maintaining a sense of neighborhood.
- Tailored Mitigation Solutions – MassDOT will continue to assess property impacts associated with easements or partial acquisitions on a parcel-by-parcel basis and will work in coordination with property owners to develop specific mitigation strategies.

[4] Cape Cod Commission. 2024. DataCapeCod: Real Estate Trends for Single-Family Homes. https://datacapecod.org/pf/real-estate-trends/

[5] Completion of the National Environmental Policy Act process means the Federal Highway Administration issues its Record of Decision.

4 Existing Conditions, Program Impacts, and Mitigation

4.9 Environmental Justice

4.9.1 Introduction

This section assesses the potential impacts of the No Build and Build Alternative (i.e., the Program) on minority, low-income, and limited English proficiency Environmental Justice (EJ) populations and identifies whether these populations would experience disproportionate adverse construction-related or operational impacts due to implementation of the Program. This section includes an assessment of any existing unfair or inequitable environmental burdens and related public health consequences that are experienced by EJ populations as it relates to the No Build Alternative. This section also outlines outreach efforts undertaken to provide meaningful opportunities for public involvement to EJ populations who may be affected by the Program.

4.9.1.1 Regulatory Context

The following provides the regulatory context and guidance for this analysis:

- Final Massachusetts Environmental Policy Act Interim Protocol for Analysis of Project Impacts on Environmental Justice Populations (January 1, 2022) (MEPA EJ Impact Analysis Protocol)[1] and the following mapping and/or analysis tools specified in the:
  - Massachusetts Department of Public Health EJ Tool[2]
  - Resilient Massachusetts Action Team (RMAT) Climate Resilience Design Standards Tool[3]
  - U.S. Environmental Protection Agency's (EPA) Environmental Justice Screening and Mapping Tool (EJScreen)[4]
- Final MEPA Public Involvement Protocol for Environmental Justice Populations (January 1, 2022) (MEPA EJ Public Involvement Protocol)[5]
- An Act Creating a Next Generation Roadmap for Massachusetts Climate Policy (Chapter 8 of the Acts of 2021) (the Act)[6]

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[1] https://www.mass.gov/doc/final-mepa-interim-protocol-for-analysis-of-project-impacts-on-environmental-justice-populations-effective-date-of-january-1-2022/download
[2] https://matracking.ehs.state.ma.us/Environmental-Data/ej-vulnerable-health/environmental-justice.html
[3] https://resilientma.org/rmat_home/designstandards/
[4] https://www.epa.gov/ejscreen; currently available at https://pedp-ejscreen.azurewebsites.net/
[5] https://www.mass.gov/doc/final-mepa-public-involvement-protocol-for-environmental-justice-populations-effective-date-of-january-1-2022/download
[6] https://malegislature.gov/Laws/SessionLaws/Acts/2021/Chapter8

- Executive Office of Energy and Environmental Affairs Environmental Justice Policy (MA EEA EJ Policy) (June 2021)[7]

4.9.1.2 Methodology

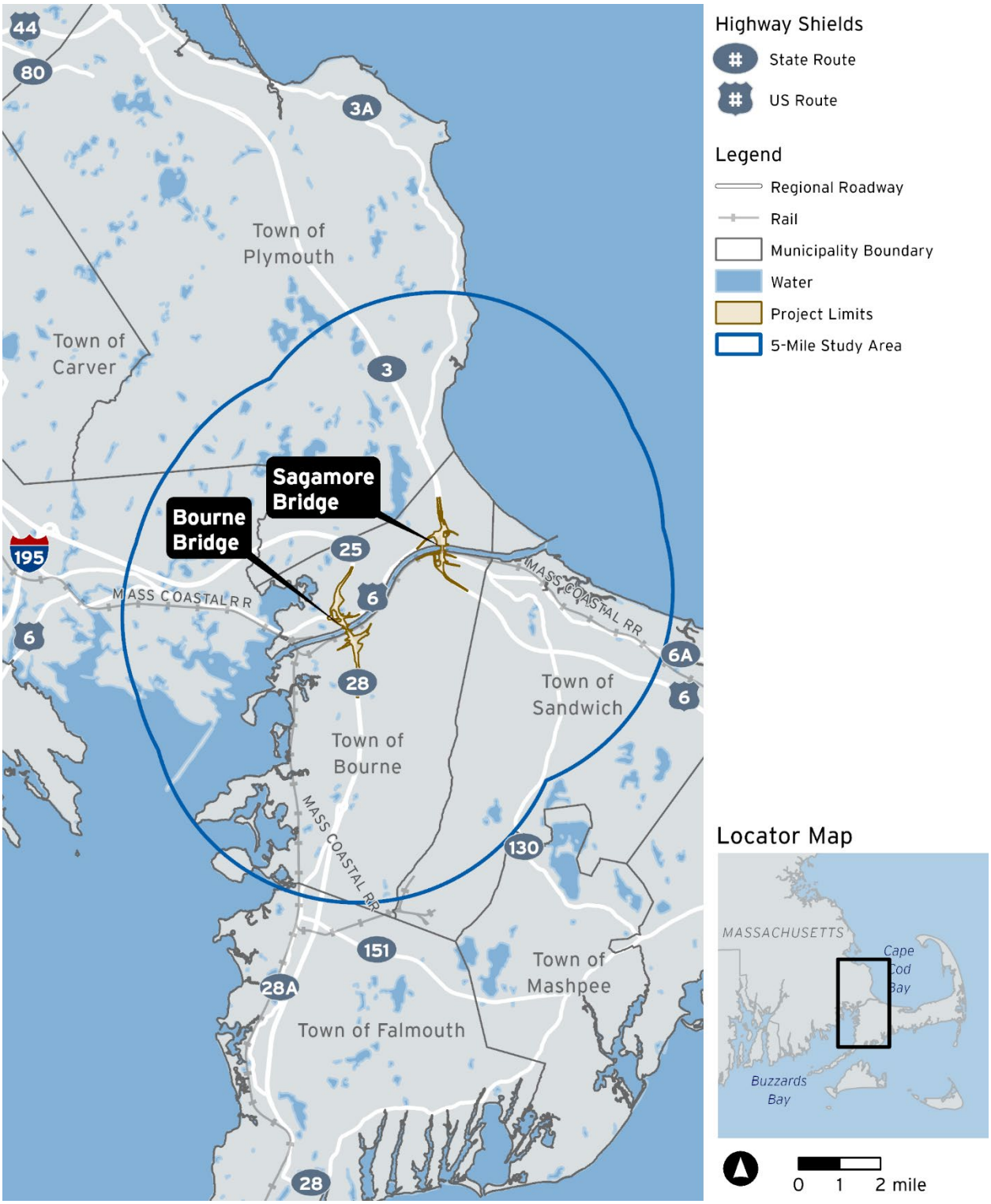
EJ populations were identified, potential Program impacts on these communities were assessed, and public outreach was carried out in accordance with MEPA's EJ Public Involvement and Impact Analysis Protocols as described in the following sections.

4.9.1.3 Study Area

In accordance with the MEPA EJ Impact Analysis Protocol, the Study Area for this EJ assessment encompasses a 5-mile radius from the Program Limits for the Build Alternative at Sagamore and Bourne Bridges. This represents the Designated Geographic Area for the Program. **Figure 4.9-1** illustrates the Study Area. MassDOT used a 5-mile radius because the construction of the Program is anticipated to generate 150 or more new diesel vehicle trips over the duration of 1 year or more.

[7] https://www.mass.gov/doc/environmental-justice-policy6242021-update/download

Figure 4.9-1. Environmental Justice Study Area



Source: Massachusetts Department of Transportation, 2024

4.9.2 Identification of Environmental Justice Populations

In accordance with MEPA's EJ Policies, the MA EEA EJ Maps viewer was used to identify potential EJ populations within the 5-mile Study Area. EJ populations were identified at the U.S. Census block group level as a neighborhood where one or more of the following criteria are true:

- The annual median household income (MHHI) is 65% or less of the statewide annual MHHI
- Minorities make up 40% or more of the population
- 25% or more of households identify as speaking English less than "very well"
- Minorities make up 25% or more of the population and the annual MHHI of the municipality in which the neighborhood is located does not exceed 150% of the statewide annual MHHI

Based on a review of the MA EEA's EJ Maps viewer, the Project Limits are not located within a mapped EJ population. However, one EJ population is partially within a 1-mile radius:

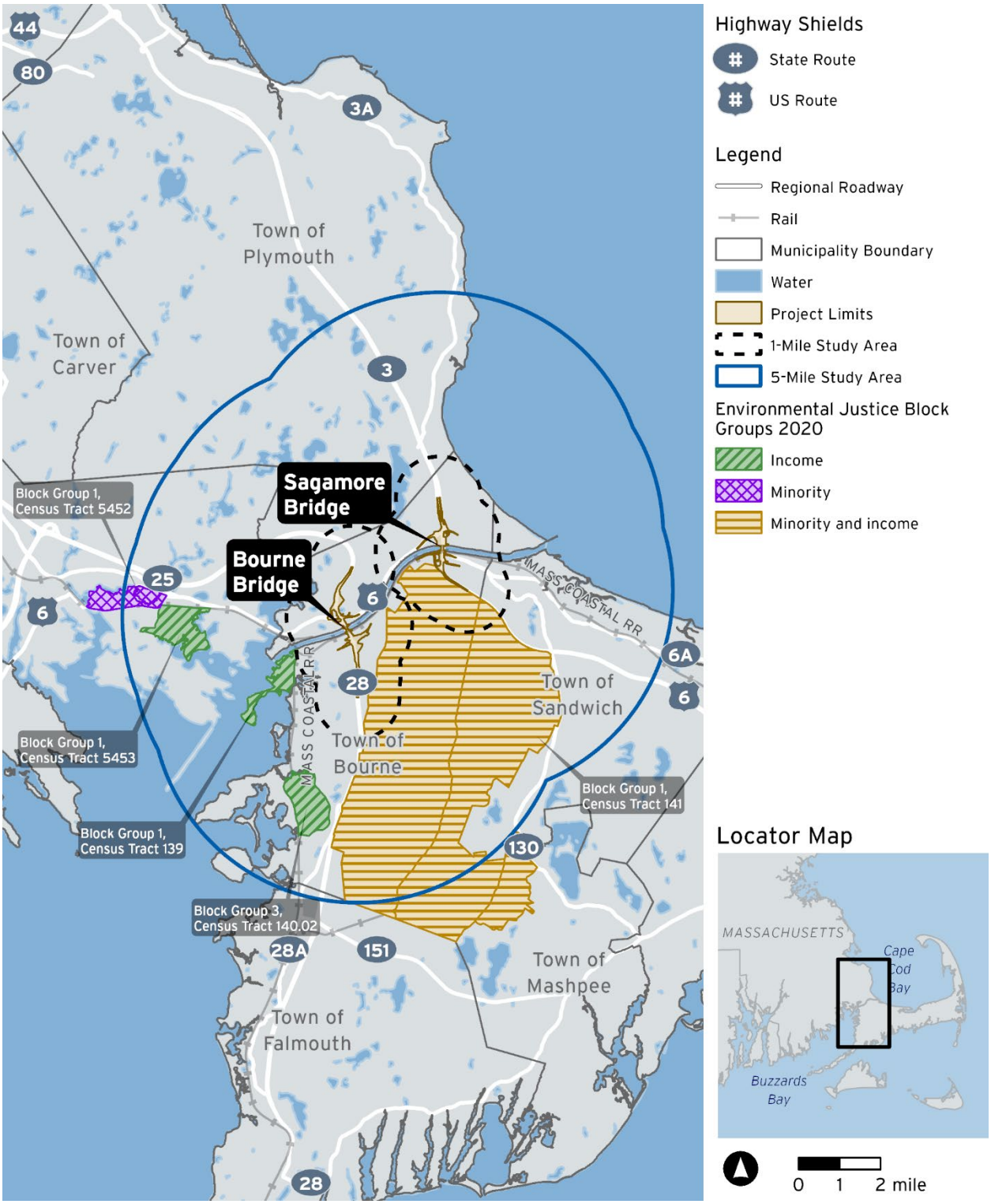
- Bourne, Sandwich, and Mashpee: Block Group (BG) 1, Census Tract (CT) 141 (minority and low income). This BG constitutes the entirety of Joint Base Cape Cod (JBCC).

The Project Limits are also within 5 miles of four additional EJ populations:

- Bourne: BG 1, CT 139 (low income)
- Bourne: BG 3, CT 140.02 (low income)
- Wareham: BG 1, CT 5452 (minority)
- Wareham: BG 1, CT 5453 (low income)

Figure 4.9-2 graphically depicts these EJ populations in relation to the Project Limits.

Figure 4.9-2. Environmental Justice Populations



Source: Massachusetts Department of Transportation, 2024

4.9.2.1 Identification of Languages Spoken within the Study Area

MassDOT consulted the "Languages Spoken in Massachusetts" tab of the EJ Maps Viewer to identify languages spoken by 5% or more of residents who identify as not speaking English "very well" (i.e., have limited English proficiency). As depicted on **Figure 4.9-3**, the 5-mile Study Area does not contain any census tracts where languages are spoken by 5% or more of residents who identify as not speaking English "very well." Regardless, MassDOT has provided translated meeting materials and interpreters at public events to ensure that outreach is reaching as broad an audience as possible. **Section 4.9.3** provides additional information regarding these efforts.

4.9.2.2 Demographic Summary

Table 4.9-1 provides a summary of the demographic data for the EJ populations in whole or partially within the 5-mile Study Area.

Table 4.9-1. Environmental Justice Populations within Study Area

Block Group No.	Census Tract	Municipality	Environmental Justice Criteria Met	Block Group MHHI ($)	Block Group MHHI as a Percentage of Statewide MHHI (%)	Minority Population (%)	Households with English Isolation (%)
Block Groups within 1 mile							
1	141	• Bourne • Mashpee • Sandwich	Minority and Income	$53,108	62.9%	32.5%	0.0%
Block Groups within 5 miles							
1	139	Bourne	Income	$42,569	50.4%	4.7%	0.0%
3	140.02	Bourne	Income	$31,266	37.1%	4.5%	0.0%
1	5452	Wareham	Minority	$61,199	72.5%	30.9%	0.0%
1	5453	Wareham	Income	$33,614	39.8%	23.9%	0.0%

Note: Environmental Justice analysis conducted November 2022 using information obtained from MassGIS Data: 2020 Environmental Justice Populations (https://www.mass.gov/info-details/massgis-data-2020-environmental-justice-populations).

MHHI = median household income

Figure 4.9-3. Languages Spoken in Massachusetts Data



Source: Massachusetts Department of Transportation, 2024

4.9.2.3 Comparison of Environmental Justice Criteria within the Study Area to Regional and State Data

MassDOT compared EJ statistics for these CTs and BGs—including race, per capita income/populations below poverty and limited English proficiency—with averages for the town of Bourne, Barnstable County, and Massachusetts. Discussions with Community Based Organizations (CBO), faith-based organizations, and other stakeholders did not yield any additional EJ populations than what was previously identified (refer to **Table 4.9-1**). **Table 4.9-2** provides a summary of this comparison.

Table 4.9-2. Comparison of Environmental Justice Indicators: Study Area, Region, and State

Geography	Municipality	Proximity to Project Limits	Block Group EJ Classification	Percentage Minority Population (%)	Percentage of Households with English Isolation (%)	Median Household Income ($)
Bourne	—	—	NA	10.8%	0.0%	$76,823
Barnstable County	—	—	NA	15.0%	1.5%	$76,863
Massachusetts	—	—	NA	32.4%	5.8%	$84,385
BG 1, CT 141	Bourne	Within 1 Mile	EJ	32.5%	0.0%	$53,108
BG 1, CT 139	Bourne	Within 5 Miles	EJ	4.7%	0.0%	$42,569
BG 3, CT 140.02	Bourne	Within 5 Miles	EJ	4.5%	0.0%	$31,266
BG 1, CT 5452	Wareham	Within 5 Miles	EJ	30.9%	0.0%	$61,199
BG 1, CT 5453	Wareham	Within 5 Miles	EJ	23.9%	0.0%	$33,614
BG 1, CT 137	Bourne	Within 1 Mile	Non-EJ	11.4%	0.0%	$77,943
BG 1, CT 138	Bourne	Within 1 Mile	Non-EJ	12.2%	0.0%	$84,777
BG 2, CT 137	Bourne	Within 1 Mile	Non-EJ	8.8%	0.0%	$82,500
BG 2, CT 138	Bourne	Within 1 Mile	Non-EJ	6.7%	0.0%	$91,250
BG 2, CT 140.02	Bourne	Within 1 Mile	Non-EJ	10.2%	0.0%	$81,607
BG 3, CT 137	Bourne	Within 1 Mile	Non-EJ	14.3%	0.0%	$77,109
BG 3, CT 138	Bourne	Within 1 Mile	Non-EJ	12.0%	0.0%	$83,750
BG 3, CT 139	Bourne	Within 1 Mile	Non-EJ	7.9%	0.0%	$91,474
BG 4, CT 137	Bourne	Within 1 Mile	Non-EJ	8.5%	0.0%	$56,146
BG 4, CT 139	Bourne	Within 1 Mile	Non-EJ	12.2%	0.0%	$62,444
BG 1, CT 5309.04	Plymouth	Within 1 Mile	Non-EJ	11.7%	1.8%	$110,326
BG 2, CT 5309.04	Plymouth	Within 1 Mile	Non-EJ	7.9%	0.0%	$72,118
BG 1, CT 133	Sandwich	Within 1 Mile	Non-EJ	8.0%	0.0%	$76,000
BG 1, CT 140.02	Bourne	Within 5 Miles	Non-EJ	11.2%	0.0%	$81,111
BG 2, CT 139	Bourne	Within 5 Miles	Non-EJ	8.0%	0.0%	$91,250
BG 4, CT 140.02	Bourne	Within 5 Miles	Non-EJ	14.6%	0.0%	—

Geography	Municipality	Proximity to Project Limits	Block Group EJ Classification	Percentage Minority Population (%)	Percentage of Households with English Isolation (%)	Median Household Income ($)
BG 1, CT 5308.01	Plymouth	Within 5 Miles	Non-EJ	6.1%	0.0%	$106,850
BG 1, CT 5309.02	Plymouth	Within 5 Miles	Non-EJ	8.9%	1.6%	$120,550
BG 1, CT 5309.03	Plymouth	Within 5 Miles	Non-EJ	10.5%	0.0%	$93,889
BG 2, CT 5308.02	Plymouth	Within 5 Miles	Non-EJ	7.2%	0.0%	$112,557
BG 2, CT 5309.02	Plymouth	Within 5 Miles	Non-EJ	8.3%	1.5%	$89,628
BG 2, CT 5309.03	Plymouth	Within 5 Miles	Non-EJ	11.2%	0.0%	$82,127
BG 3, CT 5306	Plymouth	Within 5 Miles	Non-EJ	9.3%	0.0%	$106,799
BG 3, CT 5309.03	Plymouth	Within 5 Miles	Non-EJ	12.4%	0.0%	$128,209
BG 1, CT 134	Sandwich	Within 5 Miles	Non-EJ	6.7%	0.0%	$100,259
BG 1, CT 135	Sandwich	Within 5 Miles	Non-EJ	9.6%	0.0%	$133,558
BG 1, CT 136	Sandwich	Within 5 Miles	Non-EJ	11.5%	0.0%	$75,329
BG 2, CT 133	Sandwich	Within 5 Miles	Non-EJ	4.9%	0.0%	$71,319
BG 2, CT 134	Sandwich	Within 5 Miles	Non-EJ	5.9%	0.0%	$80,781
BG 2, CT 136	Sandwich	Within 5 Miles	Non-EJ	12.9%	0.0%	$84,167
BG 3, CT 133	Sandwich	Within 5 Miles	Non-EJ	7.6%	0.0%	$98,691
BG 3, CT 134	Sandwich	Within 5 Miles	Non-EJ	6.2%	0.0%	$119,438
BG 3, CT 136	Sandwich	Within 5 Miles	Non-EJ	8.2%	0.0%	$127,115
BG 1, CT 5454	Wareham	Within 5 Miles	Non-EJ	14.3%	0.0%	$85,662
BG 2, CT 5452	Wareham	Within 5 Miles	Non-EJ	18.1%	2.4%	$91,176
BG 2, CT 5453	Wareham	Within 5 Miles	Non-EJ	14.8%	0.0%	$59,708
BG 2, CT 5454	Wareham	Within 5 Miles	Non-EJ	16.3%	0.0%	$70,703
BG 3, CT 5452	Wareham	Within 5 Miles	Non-EJ	17.1%	0.0%	$67,583
BG 3, CT 5453	Wareham	Within 5 Miles	Non-EJ	16.9%	0.0%	$87,500
BG 4, CT 5452	Wareham	Within 5 Miles	Non-EJ	20.6%	0.0%	$60,797
BG 4, CT 5453	Wareham	Within 5 Miles	Non-EJ	13.9%	0.0%	$65,250

Sources: U.S. Decennial Census 2020, Table P2: Hispanic or Latino, and Not Hispanic or Latino, by Race; American Community Survey (ACS) 2020; Table C16002: Household Language by Household Limited English-Speaking Status; and ACS 2020, Table B19013: Median Household Income in the Past 12 Months (in 2020 inflation-adjusted dollars)

Note: Environmental Justice analysis conducted using information obtained from https://www.mass.gov/info-details/massgis-data-2020-environmental-justice-populations.

BG = block group; CT = census tract; EJ = Environmental Justice

4.9.3 Public Outreach and Engagement

Section III of the MEPA Public Involvement Protocol requires that proponents provide a plan to maintain the same level of outreach and community engagement throughout the MEPA process. In accordance with the MEPA Public Involvement Protocol, this section describes measures that MassDOT took to provide meaningful engagement with surrounding EJ populations. MassDOT has carried out a comprehensive process to inform and engage local communities and EJ populations within the 5-mile Study Area and the region. Given the wide geographic impacts of the Program, and the burdens faced by EJ populations as well as other populations, MassDOT has involved a broad diversity of users from across the Commonwealth. Refer to **Chapter 6, Agency Coordination and Public Involvement**, for additional information.

As depicted on **Figure 4.9-3**, the 5-mile Study Area does not contain any census tracts where languages are spoken by 5% or more of residents who identify as not speaking English "very well". Regardless, MassDOT has provided translated meeting materials and interpreters at public events to ensure that outreach is reaching as broad an audience as possible. The specific efforts to engage and inform EJ populations and ensure they are represented in the public involvement process include the following:

- Providing Spanish and Portuguese translations of Program materials. Translated materials include the Program's comment form, flyers, public notices, and newspaper advertisements.
- Providing Spanish, Portuguese, and American Sign Language interpreters at public events.
- Providing interpretation services and translations of specific materials in other languages beyond Spanish and Portuguese upon request.
- Posting Program materials in an accessible format (i.e., compatible with screen readers, etc.) to the Program website to ensure a broad and comprehensive distribution.
- Advertising public events in non-English media publications and distributing press releases to non-English media outlets.
- Posting recordings of public meetings online so that members of the public who are unable to attend or participate when the events are hosted are not excluded from the public involvement process.
- Hosting both in-person and virtual events, which accommodate both individuals who have limited technology capabilities (or prefer in-person engagement) and individuals who may have limited means to travel to in-person events (or prefer engaging at their convenience).
- Scheduling open houses during both daytime and evening hours to maximize attendance and accommodate the schedules of the community, as well as including interactive activities for youth.
- Coordinating with CBOs, churches, and faith-based organizations. Program information is shared with leaders and their members, and they are provided with opportunities to connect directly with MassDOT.
- Attending farmers markets and meeting community members where they are.

- Forming an Advisory Group, which comprises members with numerous interests and constituents. Many members represent or serve EJ populations and have valuable insight and relationships with these communities.

Refer to **Chapter 6, Agency Coordination and Public Involvement**, which discusses agency coordination and public involvement efforts conducted by the Federal Highway Administration (FHWA) and MassDOT in the development of this Draft Environmental Impact Report.

4.9.3.1 Targeted Outreach Efforts

MassDOT conducted a targeted effort to verify these findings regarding EJ populations, ensuring that no EJ populations smaller than the BG level were omitted from outreach. This effort consisted of two strategies: attending local events and coordinating with local CBOs, churches, and stakeholders.

MassDOT attended four farmers markets in the vicinity of the Program during the summer of 2024. This included the Sandwich Farmers' Market on July 13, 2024, and August 20, 2024, and the Falmouth Farmers Market on August 15, 2024, and September 5, 2024.

The purpose of attending these events was to meet members of the public at convenient and existing locations of congregation, inform them of the Program, and collect input and answer questions, and verify that EJ populations were correctly identified and no populations were being excluded. At these farmers markets, MassDOT not only engaged with EJ populations about the Program but also asked questions about EJ populations in the Program area and their ability to participate in the public outreach process for the Program. For example, MassDOT asked if attendees were aware of any individuals or groups who were unable to engage in the Program's public outreach process due to financial barriers, mobility access, or language access barriers, or if they themselves were unable to engage with the Program due to these factors.

Throughout all these events, no comments were raised regarding the identification of new EJ populations or the efficacy of engagement activities. No individuals or attendees answered affirmatively when asked about EJ populations or individuals facing language, mobility access or financial barriers to engaging with the Program. These events did not yield any evidence of underrepresented or new EJ populations.

MassDOT also held coordination calls with 11 local CBOs, churches, and stakeholders. These organizations were selected because they are representative of the local community and have strong local and regional connections. The purpose of this coordination was to ask questions regarding EJ populations, engagement methods, the ability of populations to participate in the Program's public outreach process, and data and demographics. These calls also afforded MassDOT with an opportunity to learn more about the work of these organizations in support of EJ populations and establish a partnership to collect and share Program information with organizations and their memberships.

Highlights of the findings from this coordination include the following:

- Participants were aware of the Program and the status and potential future impacts. Most had participated in previous Program-related public outreach efforts, such as public meetings or open houses.
- Several participants were complimentary of the Program's outreach efforts. One stated they would be surprised if anyone in the local region had not heard of the Program.
- No participants were aware of any members of the public or individuals who did not know about the Program.
- Several participants confirmed they know of, or their organizations serve, EJ populations. These populations are all represented in existing EJ data and are not new to the Program.
- No participants had any data to offer regarding new EJ populations.
- No participants were aware of individuals or members of their organizations or churches who were unable to participate in the Program's public outreach process due to financial, mobility access, or language challenges.
- Participants endorsed using a comprehensive outreach strategy because their organizations use several engagement methods, including virtual or in-person tools.

4.9.3.2 Analysis of Outreach and Engagement

As detailed in **Chapter 6, Agency Coordination and Public Involvement**, MassDOT has used the Public Involvement Management Application (PIMA) and the Equity Outreach Dashboard (EOD) to collect and analyze engagement data. PIMA is the tool through which stakeholder comments and basic demographic data are collected. To leave a comment in PIMA, a stakeholder must enter their first name, last name, email address, the city/town in which they live, and their ZIP code. Optional fields include phone number, mailing address, state, the option to subscribe to Program emails, stakeholder type (e.g., business, resident) and primary mode of transportation used (i.e., driver, cyclist, pedestrian, or transit). The intent of these questions is to gather information that will enable MassDOT to:

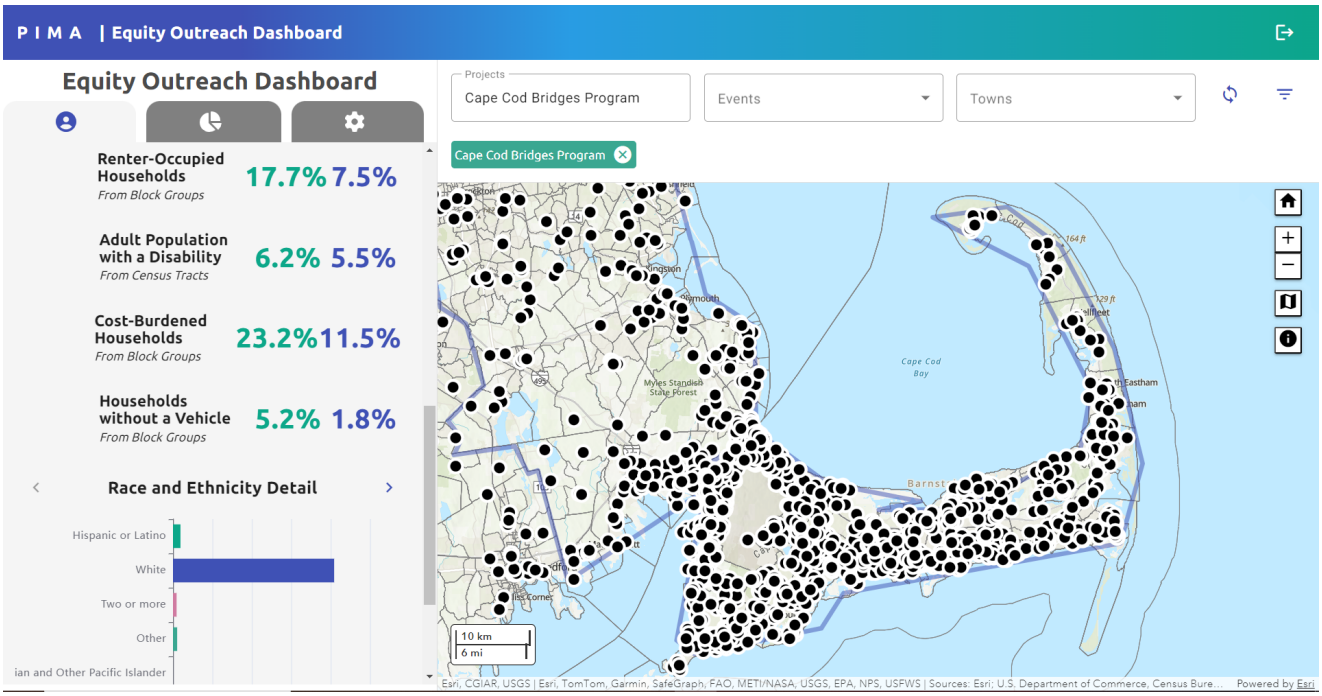
- Communicate with the stakeholder to best answer their questions and notify them of Program updates and events.
- Visualize the geographic diversity of stakeholders and extrapolate demographic data to understand if there are gaps in engagement.

Data collected in PIMA is aggregated in the EOD, where it is compared against census data at both the CT and BG levels through key metrics around EJ, education, housing, and other demographics. As described below, MassDOT uses the EOD to conduct detailed analyses assessing the effectiveness of outreach efforts and identifying areas for improvement. **Figure 4.9-4** shows the PIMA EOD, stakeholder data geolocated from the American Community Survey 2019, and highlights examples of the various key metrics available for analysis in the dashboard.

The following bullets provide an exhaustive list of the key metrics available:

- Limited English Proficiency Population
- Minority Population
- Households without Internet
- Population with a Disability
- Adult Population with a Disability
- Employed Population
- In-Poverty Population
- Low Income (200% Federal Poverty) Population
- Senior Population (above 64)
- Youth Population (under 18)
- Veteran Population
- Population with College or Professional Degree
- Population with High School Diploma or GED
- Renter-Occupied Households
- Cost-Burdened Households
- Households without a Vehicle

Figure 4.9-4. Public Involvement Management Application (PIMA) Equity Outreach Dashboard



Source: Massachusetts Department of Transportation, 2024

For each metric, stakeholder data is measured against census data at the CT and BG levels, depending on data available. When a stakeholder provides only a ZIP code, PIMA EOD assigns the demographics of the CT where the ZIP code's centroid is located. This aggregated data, along with information from stakeholders who provide full addresses, forms the basis of overall stakeholder demographic analysis. In the dashboard, these demographics are displayed alongside census data to support evaluation.

Following each outreach round, MassDOT uses the EOD to conduct detailed analyses assessing the effectiveness of outreach efforts and identifying areas for improvement. These analyses include reviewing website traffic—such as device types and preferred languages—and evaluating outreach strategies like flyering, social media promotion, and event attendance. As a result, MassDOT has refined its outreach by targeting additional locations and engaging more CBOs, helping to reach

underrepresented populations. These insights have also guided the inclusion of both virtual and in-person engagement options to better serve diverse community needs.

4.9.3.3 Planned Community Outreach and Engagement

MassDOT anticipates continuing to engage in a robust public involvement effort throughout the duration of the Program. This will include hosting and attending numerous events and opportunities for members of the public to participate and provide input and feedback. Events are expected to include open houses, public meetings, briefings with local leaders, businesses, and organizations, as well as attending community events. MassDOT will provide public notice of these events in similar manner to past events and publicized through means such as newspaper advertisements, media advisories, email blasts, social media posts, and website updates. Additionally, MassDOT will provide appropriate accommodations and interpretation services at these events.

4.9.4 Assessment of Existing Unfair or Inequitable Environmental Burden

The MEPA EJ Impact Analysis Protocol provides guidance on how to address the analysis requirements identified in the Climate Roadmap Act, which requires each project that is required to submit an Environmental Impact Report pursuant to 301 CMR 11.06(7)b include "statements about the results of an assessment of any existing unfair or inequitable environmental burden and related public health consequences impacting the EJ population from any prior or current private, industrial, commercial, state, or municipal operation or project that has damaged the environment."

Under the MEPA EJ Impact Analysis Protocol, the Environmental Impact Report must include:

- An assessment of existing unfair or inequitable environmental burden
- An analysis of the project's impacts to determine disproportionate adverse effect on the EJ population (if the prior assessment identified existing unfair or inequitable environmental burdens exist)
- An analysis of the project's impacts to determine Climate Change Impacts (if existing unfair or inequitable environmental burdens exist)
- Mitigation and Draft Section 61 Findings (if the project causes a disproportionate adverse effect of increased climate change risks on the EJ population)

This section provides information on vulnerable health criteria, potential sources of pollution within the 5-mile Study Area, and climate change impacts to help assess whether the project will exacerbate an existing unfair or inequitable environmental burden related to public health consequences.

4.9.4.1 Vulnerable Health Criteria

The MEPA EJ Impact Analysis Protocol requires the use of the Department of Public Health's (DPH) EJ Tool to identify whether any municipality or census tract that includes any of the identified EJ populations exhibits any "Vulnerable Health EJ Criteria". Vulnerable Health Criteria are the following

four environmentally related health indicators used to identify populations with evidence of higher-than-average rates of environmentally related health outcomes:[8]

- Heart attack hospitalization
- Childhood asthma
- Childhood blood lead levels
- Low birth weight

Heart attack hospitalization and childhood asthma are tracked on a municipal level and childhood blood lead levels and low birth weight are tracked at the census tract level.[9] The occurrence rate of the health indicator must be measured to be 110% above statewide rates based on a five-year average for the EJ population to qualify as a "Vulnerable Health EJ Population". Any EJ population that exists within those municipalities or census tracts may exhibit a "vulnerable health EJ criteria," and would therefore bear an "unfair or inequitable" environmental burden and related public health consequences. Each of these criteria are described in **Table 4.9-3**.

Table 4.9-3. Overview of Vulnerable Health Criteria

Criteria	Description
Heart Attack Hospitalizations	Exposure to air pollution can increase the risk for heart attack and other forms of heart disease, and it is indicative of a serious chronic illness that can lead to disability, decreased quality of life, and premature death.
Childhood Asthma	People of color and low-income individuals are at greater risk for asthma exacerbations due to increased exposure to asthma triggers, and uncontrolled asthma can impact an individual's overall health and wellbeing.
Childhood Blood Lead Levels	Lead exposure disproportionately impacts lower income communities and communities of color, and childhood exposure to relatively low levels can cause severe and irreversible health impacts, including damage to a child's mental and physical development.
Low Birth Weight	Exposure to environmental contaminants can increase the risk of delivering a baby with a low birth weight, which is a significant predictor of maternal and infant health.

Note: Description from Massachusetts Department of Public Health Environmental Justice Tool.

MassDOT evaluated the heart attack hospitalization and childhood asthma indicators for the towns of Bourne, Mashpee, Sandwich, and Wareham—the four municipalities within the 5-mile Study Area that contain EJ populations. Note that the portion of the EJ population within the town of Mashpee is

[8] Massachusetts Executive Office of Energy and Environmental Affairs' Environmental Justice Policy, updated June 24, 2021

[9] At the time of preparing this report, the Massachusetts Department of Public Health website included the following notation: "The Vulnerable Health EJ by Census Tract" data layers are in the process of being updated to 2020 Census Tract boundaries. The "Vulnerable Health EJ by Census Tract" data layers currently displayed, are mapped to 2010 Census Tract boundaries."

outside the 5-mile Study Area. **Table 4.9-4** provides a summary of the vulnerable health criteria analysis for the EJ populations within the Study Area.

Table 4.9-4. Summary of Vulnerable Health Criteria

Vulnerable Health Criteria	Municipality or Census Tract	Rate	110% Statewide Rate	Meets Criteria?
Heart Attack Hospitalization	Bourne	40.4 per 10,000	28.0 per 10,000	**Yes**
	Mashpee	28.8 per 10,000		**Yes**
	Sandwich	22.2 per 10,000		No
	Wareham	38.2 per 10,000		**Yes**
Childhood Asthma	Bourne	44.6 per 10,000	65.7 per 10,000	No
	Mashpee	21.4 per 10,000		No
	Sandwich	15.2 per 10,000		No
	Wareham	81.7 per 10,000		**Yes**
Childhood Blood Lead Levels	BG 1, CT 5452	17.7 per 1,000	17.8 per 1,000	No
	BG 1, CT 5453	NS		NA
	BG 1, CT 139	17.4 per 1,000		No
	BG 3, CT 140.02	NS		NA
	BG 1, CT 141	NS		NA
Low Birth Weight	BG 1, CT 5452	191.7 per 1,000	238.5 per 1,000	No
	BG 1, CT 5453	NS		NA
	BG 1, CT 139	NS		NA
	BG 3, CT 140.02	NS		NA
	BG 1, CT 141	0		No

Notes:

NS = Not shown due to low sample size to protect privacy.

NA = Not applicable. Exceedance of vulnerable health criteria cannot be determined as rates withheld due to low sample size.

As summarized in **Table 4.9-4**, all municipalities within the 5-mile Study Area **meet** the vulnerable health criteria for heart attack hospitalization, with the exception of the town of Sandwich. At the municipal level, only the town of Wareham **meets** the vulnerable health criteria for childhoods asthma rates. The Program is not anticipated to exacerbate or impact these risk factors as it will not emit pollutants and any air quality impacts will be temporary, limited to the construction period, and will be mitigated using best management practices. At the CT level, data on childhood blood lead levels and low birth weight for the areas comprising the above referenced census tracts was suppressed for

confidentiality reasons due to the reported low case rates. One CT is approaching the vulnerable health criteria for childhood blood lead levels but does not exceed it. According to MA DPH, lead paint is the primary cause of childhood lead exposure, and the most common sources of exposure are lead-contaminated house dust or soil and loose or deteriorating lead paint. As this risk is associated with an individual's residence, the Program will not impact this risk factor.

4.9.4.2 Potential Sources of Pollution

In accordance with the MEPA EJ Impact Analysis Protocol, MassDOT reviewed additional data layers in the DPH EJ tool to identify potential sources of pollution within the boundaries of the EJ populations. The following list identifies the additional data layers that MassDOT reviewed and the number of facilities within EJ groups that are entirely or partially within the 5-mile Study Area:

- Massachusetts Department of Environmental Protection (MassDEP) Major Air and Waste Facilities (2 identified)
- Massachusetts General Law Chapter 21E Sites (5 identified)
- "Tier II" toxics use reporting facilities (14 identified)
- MassDEP sites with AULs (1 identified)
- MassDEP groundwater discharge permits (2 identified)
- Wastewater treatment plans (1 identified)
- MassDEP public water suppliers (1 identified)
- USTs (3 identified)
- EPA facilities (3 identified; including 1 Superfund site)
- Energy generation and supply (3 power plants identified; multiple transmission lines)
- Road infrastructure (1 identified)
- Massachusetts Bay Transportation Authority bus and rapid transit (1 identified)
- Other transportation infrastructure (1 identified)
- Regional transit agencies (3 identified)

The following section provides additional information regarding the facilities that MassDOT identified, including identification of the facilities that are both within EJ populations *and* within the 5-mile Study Area. The following section also provides information regarding the enforcement history of the facilities permitted by the MassDEP. MassDOT obtained information regarding enforcement actions from the MA EEA Data Portal – Enforcements (accessed January 2025). **Appendix 4.19, Solid and Hazardous Waste Materials Technical Report**, provides additional information regarding potential sources of pollution.

Massachusetts Department of Environmental Protection Major Air and Waste Facilities

Two MassDEP Major Air and Waste Facilities are within EJ populations and within the 5-mile Study Area. **Table 4.9-5** summarizes these facilities.

Table 4.9-5. Massachusetts Department of Environmental Protection Major Air and Waste Facilities

Facility Name	Address	Site Information	Massachusetts Executive Office of Energy and Environmental Affairs Enforcement Action
Cape Cod Space Force Station	1 Flatrock Hill Road, Bourne	Large Quantity Generator	Notice of Non-Compliance* – Issued 05/18/2012
MA Army National Guard Camp Edwards	26th Yankee Division Boulevard, Buzzards Bay	Large Quantity Generator	Notices of Non-Compliance – Issued 02/02/2007, 09/12/2012

* According to Massachusetts Department of Environmental Protection's (MassDEP) "General Terms and Definitions" document, a Notice of Non-Compliance is a written notice given to a regulated entity by MassDEP and that says that the regulated entity has failed to comply on any specified occasion with one or more requirements.

Massachusetts General Law Chapter 21E Sites

Five Massachusetts General Law Chapter (MGL) 21E sites are within EJ populations and within the 5-mile Study Area. **Table 4.9-6** summarizes these facilities.

Table 4.9-6. Massachusetts General Law Chapter 21E Sites

Facility Name	Address	Site Information	Massachusetts Executive Office of Energy and Environmental Affairs Enforcement Action
Residence	6 13th Street, Wareham	Tier ID	None listed.
Impact Area Steel Lined Pit – J1 Range	Greenway Road, Sandwich	Tier II	None listed.
Impact Area KD Range	Pocassett Forestdale Road, Sandwich	Tier II	None listed.
Impact Area	Camp Edwards, Bourne	Tier ID	Notices of Non-Compliance – Issued 02/02/2007, 09/12/2012
Impact Area 17 GP7	Mitton Road, Bourne	Tier II	None listed.

"Tier II" Toxics Use Reporting Facilities

There are 14 "Tier II" Toxics Use Reporting Facilities within EJ populations and within the 5-mile Study Area. **Table 4.9-7** summarizes these facilities.

Table 4.9-7. "Tier II" Toxics Use Report Facilities

Facility Name	Address	Massachusetts Executive Office of Energy and Environmental Affairs Enforcement Action
MA ARNG AASF #1	Camp Edwards	Notices of Non-Compliance – Issued 02/02/2007, 09/12/2012
MA ARNG Camp Edwards Fuel Point	Camp Edwards	
MA ARNG Cap Edwards Range Control	Camp Edwards	
Cape Cod Air Force Station – U.S. DOD USAF	1 Flatrock Hill Road, Bourne	Notice of Non-Compliance – Issued 05/18/2012
Barnstable County Correctional Facility	6000 Sheriff's Place, Bourne	Notices of Non-Compliance – Issued 04/11/2005, 03/23/2006, 08/14/2008, 08/31/2011, 07/21/2023
MOUT Site	Camp Edwards	Notices of Non-Compliance – Issued 02/02/2007, 09/12/2012
NSTAR Station 915 – Otis 115 kV Substation	333 MacArthur Boulevard, Bourne	None listed.
Tactical Training Base Kelley	Adams Road, Bourne	None listed.
Training Support Center MRAP Building Camp Edwards	Weaver Road, Bourne	None listed.
Unit Training Equipment Site Camp Edwards	Fire Arm Road, Bourne	None listed.
United Rentals Branch 94B	72 Minot Avenue, Wareham	None listed.
U.S. Coast Guard Base Cape Cod	2515 E. Hospital Road, Bourne	None listed.
Pump Station MMR	325 Route 130, Sandwich	None listed.
Shoothouse Classroom Camp Edwards	1 Yellowstone Drive, Sandwich	None listed.

Massachusetts Department of Environmental Protection Sites with Activity and Use Limitations

One MassDEP site with an AUL is within EJ populations and within the 5-mile Study Area. Specifically, Bryant Oil Inc. (Superior Oil) at 140 Sandwich Road in the town of Wareham. The Program does not require any work on or near this property.

Massachusetts Department of Environmental Protection Groundwater Discharge Permits

One facility with a MassDEP Groundwater Discharge Permit is within EJ populations and within the 5-mile Study Area. The Otis Air Force Base, at 971 South Outer Road in Sandwich, is within an EJ

population. An additional facility, the Senior Residences of Pocasset, at 100 Dr. Julius Kelley Lane, is within an EJ population that is partially within the 5-mile Study Area.

Wastewater Treatment Plants

The Wareham Pollution Control Facility, at 6 Tony's Lane in the town of Wareham, is within an EJ population in the 5-mile Study Area.

Underground Storage Tanks

Three underground storage tanks (UST) are within EJ populations and within the 5-mile Study Area. **Table 4.9-8** summarizes these facilities.

Table 4.9-8. Underground Storage Tanks

Facility Name	Address	Massachusetts Executive Office of Energy and Environmental Affairs Enforcement Action
Water Pollution Control Center	6 Tony's Lane, Wareham	Notices of Non-Compliance – Issued 12/21/2020, 02/15/2022, 08/28/2023
Atlantic Boats Inc. CBA Stonebridge Marina	5 East Boulevard, Wareham	Notices of Non-Compliance – Issued 10/05/2016, 02/25/2021, 01/25/2022, 02/26/2024
Depot Automotive Services	447 Onset Avenue, Wareham	Notices of Non-Compliance – Issued 10/11/2016, 05/22/2017, 11/02/2022, 08/20/2024, 10/28/2024

U.S. Environmental Protection Agency Facilities

One Superfund site and one Toxics Release Inventory (TRI) facility is within EJ populations and within the 5-mile Study Area. One additional TRI facility (U.S. Coast Guard Base Cape Cod) is within an EJ population that is partially within the 5-mile Study Area. **Table 4.9-9** summarizes these facilities.

Table 4.9-9. U.S. Environmental Protection Agency Facilities

Facility Name/Type	Address	Site Information
U.S. Army National Guard Camp Edwards Range/ Toxics Release Inventory (TRI) Facility	Frank Perkins Road, Bourne	None listed.
U.S. Coast Guard Base Cape Cod/TRI Facility	5215 East Hospital Road – EHS Building, Bourne	Notices of Non-Compliance – Issued 03/25/2005, 07/26/2006, 12/12/2006 Reporting Penalty Assessment Notice* – Issued 06/30/2008 ($500)
Otis Air National Guard Base-Camp Edwards (Superfund)	Otis Air Force Base, Herbert Road, Falmouth	Notices of Non-Compliance – Issued 01/11/1999, 12/17/1999, 03/09/2000, 10/21/2004, 05/18/2006, 02/04/2008, 11/29/2013, 11/25/2014, 05/24/2019 Unilateral Administrative Order* – Issued 09/20/2021

* According to Massachusetts Department of Environmental Protection's (MassDEP) "General Terms and Definitions" document, a Reporting Penalty Assessment Notice includes a pre-assessed penalty for violation of required submittal requirements for several MassDEP programs. A Unilateral Administrative Order is issued unilaterally by MassDEP to a regulated entity and will specify the obligations with which the regulated entity has purportedly failed to comply, the dates on which such purported non-compliance was discovered, and the requirements and timelines that the regulated entity must implement and fulfill in order to achieve and maintain regulatory compliance. Unilateral Administrative Orders are subject to appeal.

Energy Generation and Supply

Three power plants and multiple transmission lines are within EJ populations and within the 5-mile Study Area. **Table 4.9-10** summarizes the power plants.

Table 4.9-10. Energy Generation and Supply Facilities

Facility Name	Address	Site Information
Cape Cod Air Force Station – 6 SWS	Not provided	None listed.
Air Force Civil Engineer Center MMR Wind Project	Not provided	None listed.
USCG Air Station	3162 Herbert Road, Bourne	None listed.

Transportation Infrastructure

One MassDOT roadway is within EJ populations and within the 5-mile Study Area. Specifically, State Route 6 crosses an EJ population in the town of Wareham.

One Massachusetts Bay Transportation Authority (MBTA) bus and rapid transit facility is within EJ populations and within the 5-mile Study Area. Specifically, the MBTA Cape Cod Line crosses an EJ population in the town of Wareham. This same line is also identified as "other transportation infrastructure" and is identified as a rail line that MassDOT-Rail owns, with freight operations by MassCoastal and passenger operations by MBTA. The 5-mile Study Area is within the Cape Cod

Regional Transit Authority and the Greater Attleboro-Taunton Regional Transit Authority's (GATRA) service areas. GATRA operates the following bus routes within EJ populations and within the 5-mile Study Area:

- Wareham Plymouth Connector
- Wareham/Onset/Wareham
- Wareham-New Bedford Connector

4.9.4.3 Climate Change Impacts

The RMAT Climate Resilience Design Standards Tool (RMAT Tool) is intended to be used as a basis-of-discussion for incorporating resilience into capital projects. The RMAT Tool provides a preliminary climate change exposure and risk rating for projects and recommended climate resilience design standards for physical assets based on user-provided information, project location, and existing statewide climate data for sea level rise/storm surge, precipitation, temperature.

As described in **Section 4.22, Climate Change Adaptation and Resiliency**, and the associated technical report, MassDOT used the RMAT Tool for the Project Limits for both Bourne Bridge and Sagamore Bridge. The RMAT Tool identified the Program as "high risk" for the following climate parameters: sea level rise/coastal storm surge, extreme heat, and extreme precipitation: urban/riverine flooding. A "high risk" rating could be an indicator of elevated climate risks for EJ populations within the 5-mile Study Area. As presented in **Section 4.22, Climate Change Adaptation and Resiliency**, the Program would incorporate measures into the design to mitigate the impacts of climate change. Additionally, the Program would improve traffic operations and multimodal accommodations, which would result in a qualitative decrease in greenhouse gas (GHG) emissions that would benefit the proximate EJ populations and the region. Based on this, the Program is not anticipated to increase the impacts of climate change to identified EJ populations. Copies of the RMAT Tool Output Report for the Sagamore and Bourne Bridges are provided as **Attachments 1 and 2**, respectively, of **Appendix 4.22, Climate Change Adaptation and Resiliency Technical Report**.

4.9.4.4 U.S. Environmental Protection Agency's EJScreen Tool

The EPA's EJScreen Tool[10] was consulted to assess potential environmental exposures within the BGs containing the EJ populations located in the 5-mile Study Area as compared to statewide averages, which could serve as a potential indicator of "unfair or inequitable" environmental burden impacting the EJ population. In accordance with the MEPA EJ Impact Analysis Protocol, the EPA EJScreen Tool was run with the "compared to state" option enabled, and the "EJ Index" data layer disabled, for the BGs within the 5-mile Study Area. The EPA's EJScreen Tool provides data on 13 environmental indicators, as summarized in **Table 4.9-11**.

[10] Environmental Justice analysis conducted November 2022 when the U.S. Environmental Protection Agency's (EPA) EJScreen Tool was still available. The EPA EJScreen tool is no longer available; however, the data may still be accessed via an alternative source: https://pedp-ejscreen.azurewebsites.net/

Table 4.9-11. Environmental Indicators from U.S. Environmental Protection Agency's EJScreen Tool

Indicator	Exposure versus Risk	Key Medium
National Air Toxics Assessment (NATA) Air Toxics Cancer Risk (lifetime exposure)	Risk/Hazard	Air
Toxic Releases to Air	Potential Exposure	Air
NATA Respiratory Hazard Index Ratio	Risk/Hazard	Air
NATA Diesel Particulate Matter	Potential Exposure	Air
Particulate Matter (PM2.5) (annual average)	Potential Exposure	Air
Ozone (summer seasonal average, daily 8-hour maximum)	Potential Exposure	Air
Lead Paint (percentage of housing built before 1960)	Potential Exposure	Dust/lead paint
Traffic Proximity and Volume Count of Vehicles (average annual)	Proximity/Quantity	Air
Proximity to Risk Management Plan / Hazardous Waste Cleanup Sites	Proximity/Quantity	Waste/Water/Air
Proximity to Hazardous Waste Treatment, Storage, and Disposal Facilities	Proximity/Quantity	Waste/Water/Air
Proximity to National Priority List/Superfund Sites	Proximity/Quantity	Waste/Water/Air
Proximity to Underground Storage Tanks and Leaking Underground Storage Tanks	Proximity/Quantity	Waste/Water/Air
Wastewater Discharge Toxicity (based on National Pollution Discharge Elimination System permitted discharge locations)	Proximity/Quantity	Water

Of the 13 indicators that are measured in the EPA's EJScreen Tool, the following five indicators are elevated at or above the 80th percentile compared to the statewide average within one or more BGs within the 5-mile Study Area:

- Lead Paint
- Underground Storage Tanks
- Superfund Proximity
- Drinking Water Non-compliance

An indicator that exceeds the 80th percentile compared to the statewide average is typically considered to be a potential environmental burden to EJ populations such that even a small addition of impacts could be viewed as creating a disproportionate effect. As discussed in the following sections,

the Program is not anticipated to exacerbate these existing unfair or inequitable public health burdens experienced by the EJ populations within the 5-mile Study Area.

Lead Paint

Portions of the Study Area rank above the 80th percentile for lead paint. This number is based on the percentage of housing units built before 1960, which is a proxy for how much lead paint people might be exposed to. The Program would require the demolition of buildings and the existing bridges, which are likely to contain lead paint. Materials will be tested for the presence of lead paint prior to demolition, and hazardous waste management will be conducted in accordance with 310 CMR 30.00 and 310 CMR 40.0000. MassDOT contract specifications will require the contractor to develop and implement an approved Lead Abatement Plan that establishes specific protective measures for proper demolition of and removal of buildings or bridge components containing lead-based paint. These specifications will require specific protective measures for land and water during building and bridge removal. Based on this, the Program is not anticipated to affect this risk factor.

Underground Storage Tanks

Storage of oil and hazardous material in USTs occurs at all gasoline service stations and at many large commercial and municipal properties. Several USTs are near the Program Limits, which present potential sources of contamination that could affect soil and/or groundwater from an unknown or unreported release. If relocation or removal of an UST is necessary during construction, the contractor will be required to ensure that removal and relocation operations are conducted in accordance with MassDEP UST regulations. While USTs are within identified EJ populations, the Program would not disturb these tanks and thus would not affect this risk factor. Refer to **Appendix 4.19, Solid and Hazardous Waste Materials Technical Report**.

Superfund Proximity

The Study Area is near the Otis Air National Guard Base/Camp Edwards on JBCC, which is a Superfund site and an identified EJ population. Refer to **Appendix 4.19, Solid and Hazardous Waste Materials Technical Report**, for additional information regarding this Superfund site. The Program would not affect this Superfund site. Additionally, any oil and/or hazardous materials that may be encountered during construction will be managed and disposed of in accordance with the Massachusetts Contingency Plan (310 CMR 40.0000).

Drinking Water Non-Compliance

In addition to supporting military training operations and national security interests, the northern 15,000 acres of JBCC lie above the Upper Cape Water Supply Reserve, which is the sole source aquifer that provides drinking water to JBCC and neighboring towns in Upper Cape Cod. Portions of the Study Area rank above 50% for drinking water non-compliance, which highlights populations served by community water systems that have challenges complying with Safe Drinking Water Act requirements. The Program would avoid work within the Upper Cape Water Supply Reserve. The combination of planned stormwater management improvements, measures for erosion and sedimentation control, and avoidance of work within the Upper Cape Water Supply Reserve under the Program would protect the sole source aquifer that provides drinking water to JBCC and neighboring towns in Upper Cape Cod.

EJScreen Community Report

MassDOT also used the EJScreen mapping tool to generate an "EJScreen Community Report" for the 5-mile Study Area. The EJScreen tool creates the EJScreen Community Report by aggregating parts of BGs within or intersecting the Study Area, weighted by population. This approach ensures that the data represents the entire Study Area, accounting for population variation and dispersion within the BGs. For each indicator, the result is a population-weighted average, reflecting the BG indicator values averaged across all residents estimated to be within the buffer. In addition to the environmental burden indicators, the EJScreen Community Report also presents data on climate change indicators, socioeconomic indicators, and critical service gap indicators. **Appendix 4.9, EJScreen Community Report**, provides a copy of the report, and **Table 4.9-12** details these findings.

Table 4.9-12. EJScreen Community Report Results

Selected Variables	Value*	State Average	State Percentile	U.S. Average	U.S. Percentile
Environmental Burden Indicators					
Particulate Matter 2.5 (ug/m^3)	5.63	6.52	5	8.45	3
Ozone (ppb)	60	56.7	91	61.8	48
Nitrogen Dioxide (NO_2) (ppb)	3.4	8.8	7	7.8	9
Diesel Particulate Matter (ug/ m^3)	0.0772	0.176	10	0.191	19
Toxic Releases to Air (toxicity-weighted concentration)	300	2,800	21	4,600	38
Traffic Proximity (daily traffic count/distance to road)	920,000	6,100,000	9	1,700,000	52
Lead Paint (% Pre-1960 Housing)	0.32	0.51	29	0.3	60
Superfund Proximity (site count/km distance)	0.72	0.34	89	0.39	88
RMP Facility Proximity (facility count/km distance)	0	0.37	0	0.57	0
Hazardous Waste Proximity (facility count/km distance)	0.93	11	9	3.5	44
Underground Storage Tanks (count/km^2)	0.98	3.3	36	3.6	52
Wastewater Discharge (toxicity-weighted concentration/m distance)	330	760	93	700,000	65
Drinking Water Non-Compliance (points)	2.8	3.2	73	2.2	87
Socioeconomic Indicators					
Demographic Index USA	0.57	NA	NA	1.34	18
Supplemental Demographic Index USA	1.24	NA	NA	1.64	31
Demographic Index State	0.66	1.19	34	NA	NA

Selected Variables	Value*	State Average	State Percentile	U.S. Average	U.S. Percentile
Supplemental Demographic Index State	1.31	1.52	48	NA	NA
People of Color	12%	31%	28	40%	24
Low Income	16%	22%	49	30%	31
Unemployment Rate	5%	5%	57	6%	57
Limited English-Speaking Households	0%	6%	45	5%	57
Less Than High School Education	4%	9%	42	11%	31
Under Age 5	4%	5%	43	5%	38
Over Age 64	26%	18%	82	18%	81
Health Indicators					
Low Life Expectancy	11%	17%	3	20%	1
Heart Disease	5.7	5.2	68	5.8	50
Asthma	11.1	11.2	55	10.3	76
Cancer	7.7	6.9	68	6.4	78
Persons with Disabilities	14.5%	12.1%	72	13.7%	61
Climate Indicators					
Flood Risk	11%	12%	64	12%	70
Wildfire Risk	0%	0%	0	14%	0
Critical Service Gaps					
Broadband Internet	8%	9%	54	13%	42
Lack of Health Insurance	3%	3%	57	9%	15
Housing Burden	No	NA	NA	NA	NA
Transportation Access Burden	Yes	NA	NA	NA	NA
Food Desert	Yes	NA	NA	NA	NA

* Created by aggregating portions of the block groups that are within or intersect the Study Area, weighted by population, to create a representative set of data for the entire Study Area, honoring variation and dispersion of the population in the block groups within it. For each indicator, the result is a population-weighted average, which equals the block group indicator values averaged over all residents who are estimated to be inside the buffer.

count/km^2 = number of storage tanks per square kilometer; km = kilometer; m = meter; NA = not applicable; ppb = parts per billion; U.S. = United States; ug/m^3 = microgram per cubic meter

MassDOT carefully reviewed these demographics from the EJScreen Community Report before initiating the Program's public outreach process. Refer to **Appendix 4.9, EJScreen Community Report**, for a copy of the document. The Program would not negatively affect these populations and may provide employment opportunities. A construction program of this magnitude would result in an

estimated 16,000 high-quality, good-paying construction jobs.[11] MassDOT will enter into a Project Labor Agreement for this Program that it would bring new, registered apprenticeship opportunities in MassDOT's training programs and focused recruitment of local residents, tradeswomen, and people of color. To support an inclusive and equitable workforce, MassDOT will coordinate with regional transit authorities regarding shuttle services from a convenient park-and-ride facility for labor personnel to commute to and from the project sites. Firms constructing the new bridges and approach roadways would draw employees from the surrounding urban areas of New Bedford, Plymouth, Brockton, Fall River, and other communities with historically underrepresented groups and unemployment higher than the state average.

Several portions of the Study Area are shown to have a flood risk and are within a 100-year floodplain. A review of downscaled and sea level rise projections relative to bridge superstructure elevations indicates that the bridge superstructure would remain well outside anticipated future mean high-water elevations through its design life. The Program is not expected to exacerbate climate change impacts on EJ populations, particularly because the Program would provide improved stormwater drainage and open space and would not result in increased GHG emissions.

Portions of the Study Area suffer from greater health disparities, including heart disease, asthma and persons with disabilities. With regards to air quality as it relates to asthma and other conditions, the Program would not increase GHG emission or create a new stationary source of air pollutants once constructed. A Dust and Emissions Control Plan would be developed and implemented to prevent generation of fugitive dust emissions and reduce construction vehicle emissions during construction. With regards to heart disease, new shared-used paths would provide additional choices for transportation mode use and recreation and may support better health outcomes. For persons with disabilities, paths would be Americans with Disabilities Act compliant and meet the needs of a diversity of users.

Portions of the Study Area also experience critical service gaps, including broadband gaps, housing burdens, transportation access burdens, and food deserts. By reducing congestion-related delays and enhancing bike and pedestrian connectivity, the Program may bring positive outcomes for transportation access and access to food. The Program would not worsen or otherwise affect broadband gaps and housing burdens.

4.9.4.5 Summary of Assessment of Existing or Inequitable Environmental Burden

Based on the analysis provided in the prior sections, the EJ communities within the 5-mile Study Area are considered vulnerable and are subject to existing "unfair or inequitable" environmental burden or related public health consequence.

[11] Refer to **Appendix 4.5, Socioeconomics Technical Report**, for additional information.

4.9.5 Analysis of Program Impacts to Environmental Justice Populations

This section identifies the range of potential beneficial and adverse impacts of the Program for both the construction (temporary) and operational (permanent) periods, based on the results of the impacts analyses from other resources and disciplines evaluated in **Sections 4-2 through 4-23**. In accordance with the MEPA EJ Impact Analysis Protocol, this section further examines potential impacts to determine whether the nature and severity of Program impacts would materially exacerbate any existing unfair or inequitable environmental or public health burden affecting the EJ populations that appear to be related to air quality issues and potential exposure to environmental contaminants. MassDOT considered both the magnitude and duration of Program impacts when performing this evaluation. This analysis also considers the environmental impacts and other benefits that the Program would provide to EJ populations.

4.9.5.1 Transportation, Traffic, and Safety

The roadway and transportation improvements proposed as the Program are not within EJ populations. However, construction of the Program may result in traffic delays due to increased construction traffic. This temporary construction-period impact may be felt regionally. **Table 4.9-13** identifies measures to reduce this temporary impact. Similarly, the benefits provided by the Program would be felt regionally, including improved traffic operations and safety, emergency response times, and bicycle and pedestrian accommodations.

4.9.5.2 Bicycle and Pedestrian Accommodations

The bicycle and pedestrian improvements proposed as the Program would not be within EJ populations. Construction of the Program would require temporary closures of Canal Service Roads due to bridge demolition and construction; however, these closures would not be within identified EJ populations. Because a temporary construction-period impact may be felt regionally; measures to reduce this temporary impact are identified in **Table 4.9-13**. Similarly, though not within an EJ population, the improved bicycle and pedestrian mobility provided by the Program may be used by proximate EJ populations within the 5-mile Study Area.

4.9.5.3 Socioeconomics

The Program is anticipated to result in both regional and local economic benefits. Regionally, it would result in a net increase in economic output, value added, jobs, and labor income for Cape Cod and the Islands, Plymouth County, and the rest of Massachusetts. Locally it would result in an average 3-minute travel-time savings from the vicinity of each bridge. For an average commute of 30 minutes, the Program would increase the effective reach of jobs for workers and the labor pool for employers by about one-third compared to the No Build Alternative. This means, for example, that a worker commuting 30 minutes under No Build Alternative conditions would have access to a third more jobs with the Build Alternative, all because of a 3-minute time savings. A travel-time savings of 3 minutes would enable retailers to expand their effective market areas and consumers to expand their consumption opportunities. These benefits would be experienced regionally and may extend to EJ populations within the 5-mile Study Area.

4.9.5.4 Community Facilities

Community facilities within EJ populations that are entirely or partially within the 5-mile Study Area include the following:

- Three fire stations
- A library
- A school
- A police station
- A recreation center
- Three places of worship
- A grocery store
- A hospital

Drivers accessing community facilities during construction of the Program may experience traffic delays due to an influx of construction vehicles and equipment. Construction staging and sequencing would be implemented to minimize impacts to the traveling public. The Program would not physically displace, alter, or change accessibility to any community facilities. Additionally, accessibility to community facilities would not be limited or temporarily eliminated during construction.

4.9.5.5 Right-of-Way/Property Impacts

Temporary or permanent easements are not required within EJ populations. While the Program would require partial and full acquisition of multiple properties, none of the acquisitions would occur within identified EJ populations.

4.9.5.6 Wetlands and Floodplains

Temporary wetland impacts to construct the new bridges would be moderate because the work area would occupy a large portion of Cape Cod Canal for months at a time. However, temporary impacts to resource areas would be restored in-kind to preconstruction conditions in terms of functions and values. Permanent wetland impacts associated with the new bridge piers and riprap protection for navigation purposes would be mitigated through the removal of the existing bridge piers. Temporary and permanent impacts to federal and state inland resource areas associated with the interchange approaches would be restored in-kind or mitigated. Wetland impacts would be localized and would occur outside of mapped EJ populations and would not exacerbate existing public health or environmental burdens on proximate EJ populations that appear to be related to air quality issues.

4.9.5.7 Air Quality

Construction of the Program may result in fugitive dust emissions from construction equipment and direct emissions from construction vehicles. This temporary construction-period impact may be felt regionally. **Table 4.9-13** identifies the measures to reduce this temporary impact. Similarly, the benefits provided by the Program would be felt regionally: reduced greenhouse gas emissions due to improved traffic operations. Based on this, the Program would not exacerbate existing public health or environmental burdens on proximate EJ populations that appear to be related to air quality issues.

4.9.5.8 Noise

Construction of the Program is not proposed within identified EJ populations. However, construction of the Sagamore South interchange improvements would occur directly adjacent to an identified EJ population (BG 1, CT 141; comprising the JBCC). The Program would generate noise during the construction period. Noise levels from construction equipment would be dependent on the types and number of equipment used, construction schedule, and the proximity of operating construction equipment to noise-sensitive receptors within the Study Area. While construction noise is unavoidable, any construction noise impacts due to the Program would be temporary and cease once the Program is completed. A Construction Noise Control Plan would be developed and implemented in compliance with MassDOT specifications for construction noise control.

4.9.5.9 Parks, Recreation, and Open Space

The Program would not directly affect, alter, or change accessibility of any parks or recreational facilities within identified EJ populations. The Program would result in temporary and permanent impacts to recreational facilities—including Bourne Scenic Park, the Bourne Recreational Area, and the Sagamore Recreation Area—and open space areas owned by MassDOT and the Town of Bourne. However, these recreational and open space properties are not within EJ populations. Coordination would be conducted with the respective officials with jurisdiction to identify appropriate mitigation measures and achieve a net benefit determination for these resources. Improvements identified through this process would provide a regional benefit for all users of these resources. Additionally, accessibility to parks and recreational facilities would not be limited or temporarily eliminated during construction.

4.9.5.10 Hazardous Materials

The Program may result in potential exposure to oil and hazardous materials due to demolition and ground-disturbing activities and dredging within Cape Cod Canal. These activities would not occur within identified EJ populations. Construction of the Program would be managed in accordance with applicable federal and state regulations regarding the use, storage, handling, disposal, and transport of hazardous materials. Compliance with applicable laws and regulations governing the use, storage, transportation, and disposal of hazardous materials would reduce the risk of human and environmental exposure to these materials. With these measures in place, the Program would not have the potential for significant adverse impacts related to hazardous materials during construction. Based on this, the Program would not exacerbate existing public health or environmental burdens on proximate EJ populations.

4.9.5.11 Public Health

The Program would replace the existing bridges to modern design standards with upgrades to their approach roadway networks, which would yield substantial benefits to public health conditions in the Study Area due to:

- Improved traffic operations and reduced delays accessing healthcare and other essential services.
- Improved access for emergency vehicles crossing Cape Cod Canal.
- Enhanced active transportation (pedestrians and bicycle) network and improved pedestrian and bicycle safety through provision of off-road multi-use facilities on the replacement bridges with connections to new shared-use paths along the local roadway network.
- Provision of Americans with Disabilities Act-accessible accommodations for pedestrians (including sidewalks, crosswalks, curb ramps, detectable warnings, and signals.
- Improved community cohesion by enhancing local connectivity to neighborhoods, transit services, jobs, schools, recreational facilities, grocery stores, and other community destinations.
- Improved air quality through reduced vehicular GHG emissions.

The Program proposes an increase in impervious surface due to construction of the replacement bridges and reconfiguration of their approaches, which could impact water quality due to resultant runoff volume and/or pollutant load. The proposed stormwater control measures under the Program would improve the treatment and quality of the runoff that is eventually discharged to Cape Cod Canal and the Plymouth/Carver and Cape Cod sole source aquifers.

The Program would not exacerbate public health conditions within the Study Area due to the long-term benefits it would provide through improved traffic mobility, pedestrian and bicycle mobility and safety, Americans with Disabilities Act accessibility upgrades and improved air quality. These benefits would contribute to improved public health outcomes within the Study Area in the long term. Based on this, the Program would not exacerbate existing public health or environmental burdens on proximate EJ populations that appear to be related to air quality issues. Refer to **Section 4.21, Public Health**, of the Draft Environmental Impact Report for additional information regarding public health.

4.9.5.12 Climate Change

MassDOT used the RMAT Tool to assess climate risks to proximate EJ populations. The RMAT Tool identified preliminary high exposure and risk ratings for sea level rise/coastal storm surge, urban/riverine flooding, and extreme heat. The design incorporates numerous measures intended to mitigate the impacts of climate change, including sea level rise/storm surge, extreme precipitation, extreme heat, and extreme wind. Refer to **Section 4.22, Climate Change Adaptation and Resiliency**, and **Appendix 4.22, Climate Change Adaptation and Resiliency Technical Report**, for a detailed description of these measures. Additionally, the Program would improve traffic operations and multimodal accommodations, which would result in a qualitative decrease in GHG emissions that would benefit the proximate EJ populations and the region. Based on this, the Program is not anticipated to increase the impacts of climate change to identified EJ populations.

4.9.5.13 Comparative Impacts on Environmental Justice versus Non-Environmental Justice Populations

The FHWA EJ Reference Guide and the MEPA EJ Impact Analysis Protocol require consideration as to whether adverse impacts to EJ populations are greater or less than those on non-EJ populations. The purpose of this analysis is to assess whether the Program would result in impacts to an already burdened area in a "targeted" way that is disproportionate when compared to non-EJ populations. Work associated with the Program would not occur within identified EJ populations. As discussed in **Section 4.9.5**, the Program is not anticipated to directly result in adverse impacts to EJ populations, and the majority of direct impacts would occur within non-EJ populations. Additionally, the majority of the Program benefits—such as improved traffic operations and safety, emergency response time, multimodal accommodations, and air quality—would be experienced regionally. Similarly, the design incorporates a number of measures intended to mitigate the impacts of climate change, including prioritization of green infrastructure to mitigate both extreme precipitation and heat impacts and consideration of shading features for pedestrian areas and lighter-colored surface materials in areas where glare will not impact road user safety. These measures will reduce the impacts of climate change upon all users, including those from proximate EJ populations.

4.9.6 Mitigation

The Program would have unavoidable construction-period adverse impacts related to transportation, traffic, and safety; bicycles and pedestrians; community facilities; right-of-way; natural resources; air quality; noise; and hazardous materials. These short-term impacts would be minimized through appropriate mitigation measures that will be developed and implemented in accordance with contract specifications and in compliance with applicable regulatory requirements. Additionally, although EJ populations are on both sides of the bridges, they are not in the immediate proximity of the Project Limits and would be buffered from construction. **Table 4.9-13** provides a summary of measures proposed to mitigate these construction-period impacts.

Once constructed, the replacement structures would improve safety, accessibility, and mobility for all users, including motorists, pedestrians, and bicyclists. When considering the mitigation and the benefits that would be provided during the operational phase of the Program, adverse impacts to human health and the environment are not anticipated. **Table 4.9-13** provides a summary of the operational benefits and potential impacts and associated mitigation measures.

Table 4.9-13. Construction-Period Mitigation Measures

Discipline	Impact	Located within EJ Population?	Measures to Avoid, Minimize, or Mitigate Impacts
Transportation, Traffic, and Safety	Traffic delays due to increased construction traffic.	Adverse effect may be experienced regionally.	• Construction staging and sequencing will be implemented to minimize impacts to the traveling public. • A Traffic Management Plan will be developed and implemented to ensure the safety and efficiency of roadways during construction. This plan will identify designated truck routes for material hauling during construction. • Contract specifications will be implemented to restrict parking and routing of truck traffic through residential neighborhoods. • It is anticipated that barges will also be used to transport large quantities of construction materials to the bridge sites via Cape Cod Canal, thereby minimizing the impact of construction-period congestion on state highway routes.
Pedestrian and Bicycle Facilities	Temporary closures of sections of Canal Service Roads due to bridge demolition and construction. These closures will not be within identified EJ populations.	Adverse effect may be experienced regionally.	• Temporary detours will be provided for bicyclists and pedestrians to ensure safe pedestrian and bicycle travel around work zones.
Community Facilities	Traffic delays due to influx of construction vehicles and equipment.	Adverse effect may be experienced regionally.	• Construction staging and sequencing will be implemented to minimize impacts to the traveling public.
Right-of-Way	Temporary easements necessary to undertake construction activities.	Temporary easements are not required within EJ populations.	• Any temporary construction easement areas will be restored upon completion of construction.

Discipline	Impact	Located within EJ Population?	Measures to Avoid, Minimize, or Mitigate Impacts
Natural Resources	Potential erosion and sedimentation of wetland and water resource areas due to stormwater runoff.	Stormwater runoff will be localized and will not occur within identified EJ populations.	• A Stormwater Pollution Prevention Plan will be developed and implemented in compliance with National Pollutant Discharge Elimination System Construction General Permit to prevent erosion and sedimentation impacts during construction.
	Tree cutting would be required due to construction activities.	Tree cutting is not anticipated to occur within identified EJ populations.	• Tree cutting will be conducted in accordance with time-of-year restrictions for protected and endangered species.
Air Quality	Temporary fugitive dust emissions from construction equipment and direct emissions from construction vehicles.	Adverse effect may be experienced regionally.	• A Dust and Emissions Control Plan will be developed and implemented to prevent generation of fugitive dust emissions and to reduce construction vehicle emissions during construction.
Noise	Temporary increase in noise levels generated by construction vehicles and construction equipment.	No	• A Construction Noise Control Plan will be developed and implemented in compliance with MassDOT specifications for construction noise control.
Hazardous Waste Materials	Potential exposure to oil and hazardous materials due to demolition and ground-disturbing activities.	No	• Construction and Demolition Waste Management Plan will be developed and implemented prior to the start of construction and demolition activities. • Materials will be tested for the presence of lead paint prior to demolition, and hazardous waste management will be conducted in accordance with 310 CMR 30.00 (Hazardous Waste) and 310 CMR 40.00 (Massachusetts Contingency Plan).

Table 4.9-14. Operational Benefits, Impacts, and Mitigation Measures

Discipline	Beneficial or Adverse Impacts	Located within EJ Population?	Measures to Avoid, Minimize, or Mitigate Adverse Impacts
Transportation, Traffic, and Safety	**Benefit:** Improved traffic operations, increased safety, and reduction in delays and travel times.	Benefits would be experienced regionally.	No mitigation required.
	Benefit: Emergency response benefits through geometric improvements and reduction in travel times.	Benefits would be experienced regionally.	No mitigation required.
	Benefit: Facilitates emergency egress of high traffic volumes from Cape Cod in the event of hurricane or other potential hazards.	Benefits would be experienced regionally.	No mitigation required.
Pedestrian and Bicycle Facilities	**Benefit:** Improved bicycle and pedestrian mobility through provision of accessible sidewalk and accessible shared-use path facilities	Benefits would be experienced regionally.	No mitigation required.
Socioeconomic	**Benefit:** Net increase in economic output, value added jobs, and labor income for Cape Cod and the Islands.	Benefits would be experienced regionally.	No mitigation required.
Land Use	**Benefit:** Proposed improvements consistent with land use and public policies	Benefits would be experienced regionally.	No mitigation required.
Community Facilities	**Benefit:** Improved access for vehicles, bicyclists, and pedestrians to community facilities including police and fire stations	Benefits would be experienced regionally.	No mitigation required.
Right-of-Way	**Adverse Effect:** Full acquisition of 29 parcels and partial acquisition of 34 parcels.	None of the acquisitions would occur within identified EJ populations.	All relocations will be conducted in accordance with the Uniform Relocation Assistance and Real Property Acquisition Policies Act, 1971, and Massachusetts General Laws, primarily Chapter 79.

Discipline	Beneficial or Adverse Impacts	Located within EJ Population?	Measures to Avoid, Minimize, or Mitigate Adverse Impacts
Natural Resources	**Benefit:** Improvements to water quality through implementation of storm water control measures	Benefits would be experienced regionally.	No mitigation required.
	Adverse Effect: Temporary and permanent alteration of wetlands.	Impacts will be localized and not within identified EJ populations.	• Permanent impacts to vegetated wetlands will be replicated in compliance with MassDEP requirements. • Temporary impacts to vegetated wetlands will be restored in place in compliance with MassDEP requirements.
Air Quality	**Benefit:** Reduced greenhouse gas emissions due to improved traffic operations.	Benefits would be experienced regionally.	No mitigation required.
Noise	**Adverse Effect:** Increase in traffic noise due to horizontal and vertical changes in bridge and/or roadway alignment.	No. Developed areas of EJ block groups are over 500 feet from construction limits.	Noise barriers will be considered where they are found to be both feasible and cost reasonable.
Cultural Resources	**Adverse Effect:** Demolition of National Register Eligible Sagamore and Bourne Bridges.	The bridges are not located within identified EJ populations.	Section 106 Programmatic Agreement will be developed between the Federal Highway Administration, Massachusetts Department of Transportation, and other Consulting Parties to mitigate adverse impacts to historic properties.

Discipline	Beneficial or Adverse Impacts	Located within EJ Population?	Measures to Avoid, Minimize, or Mitigate Adverse Impacts
Parks and Recreation	**Adverse Effect:** Use and alteration of recreational facilities including Bourne Scenic Park, the Bourne Recreation Area, and the Sagamore Recreation Area.	These facilities are not located within identified EJ populations.	Coordination will be conducted with the respective officials with jurisdiction to identify appropriate mitigation measures and achieve a net benefit determination for these resources.
Solid and Hazardous Waste Material Management	**Benefit:** Reduced exposure to oil and hazardous materials due to removal of the existing bridges, including excavation and disposal of contaminated media.	Benefits would be experienced regionally.	No mitigation required.
Public Health	**Benefit:** Increased opportunities for active recreation through improved bicycle and pedestrian accommodations	Benefits would be experienced regionally.	No mitigation required.
	Benefits: Improved air quality due to reduced greenhouse gas emissions	Benefits would be experienced regionally.	No mitigation required.
	Benefit: Improved water quality due to implementation of stormwater control measures	Benefits would be experienced regionally.	No mitigation required.
Climate Change	**Benefit:** More adaptive and resilient to climate and extreme weather events due to roadway and bridge infrastructure improvements	Benefits would be experienced regionally.	No mitigation required.

4.9.7 Conclusion

The MEPA EJ Impact Analysis Protocol states that when determining whether an action would have a "disproportionate adverse effect" on EJ population, a project's benefits that improve environmental conditions or the public health of the EJ populations should be considered. **Section 4.9.6** details the Program mitigation measures and benefits. Per the MEPA EJ Impact Analysis Protocol, a "disproportionate adverse effect" on EJ populations occurs when a project will have adverse impacts on the EJ population that will materially exacerbate any existing unfair of inequitable environmental or public health burdens impacting the EJ population.

As detailed in **Table 4.9-13**, temporary construction adverse impacts would occur relative to the Program. MassDOT will develop and implement appropriate mitigation measures in accordance with contract specifications and in compliance with applicable regulatory requirements. Although EJ populations are on both sides of the bridges, they are not in the immediate proximity of the Program Limits and would be buffered from construction. These adverse impacts, which would be temporary, would not be within identified EJ populations and would not affect EJ populations to a greater degree than non-EJ populations. Additionally, the temporary construction adverse impacts would not materially exacerbate any existing environmental or public health burden. impacts

As detailed in **Table 4.9-14**, the Program would include some permanent adverse impacts that MassDOT will mitigate. The permanent impacts of the Program would not be within identified EJ populations and would not be disproportionately high and adverse to EJ populations compared to non-EJ populations when considering beneficial impacts, adverse impacts, and corresponding mitigation. Additionally, the Program would not materially exacerbate any existing environmental or public health burdens. The Program would also provide numerous beneficial impacts, including the replacement of the bridges built to modern standards, which would provide improved traffic operations and expanded opportunities for bicycle and pedestrian mobility. The replacement bridges would maintain a vital local, regional, and national connection across Cape Cod Canal to and from numerous key destinations. These improvements would provide benefits for all users of the transportation network, including passenger vehicles, truck freight, emergency services, JBCC personnel, and bicycles and pedestrians.

The Program is not anticipated to directly result in adverse impacts to EJ populations and would not exacerbate pre-existing conditions related to air, water, or soil pollution. Additionally, most majority of the Program benefits—such as improved traffic operations and safety, emergency response time, multimodal accommodations, and air quality—would be experienced regionally. The Program would also improve the quality of stormwater runoff over existing conditions. Similarly, the design incorporates a number of measures intended to mitigate the impacts of climate change, including prioritization of green infrastructure to mitigate both extreme precipitation and heat impacts and consideration of shading features for pedestrian areas and lighter-colored surface materials in areas where glare will not impact road user safety. These improvements would provide an overall benefit to the EJ populations within the 5-mile Study Area. Based on this, the Program **would not** result in a disproportionate adverse effect or increase the impacts of climate change upon EJ populations.

4 Existing Conditions, Program Impacts, and Mitigation

4.10 Wetlands and Floodplains

4.10.1 Introduction

This section assesses the potential construction and operational impacts of the No Build Alternative and Build Alternative on wetlands and floodplains. This section also identifies measures that would be implemented to avoid, minimize, and mitigate construction and operational impacts of the Build Alternative on wetlands and floodplains.

4.10.1.1 Regulatory Context for Wetland and Floodplain Resources

The Program Limits , including the Bourne and Sagamore interchange approaches and Cape Cod Canal, contains wetland and floodplain resources subject to jurisdiction under the following acts, regulation, and order:

- Federal Water Pollution Control Act of 1972 (33 USC 1251-1376), as amended by U.S. Clean Water Act (1977) and U.S. Water Quality Act (1987), Section 401 and Section 404
- Rivers and Harbors Act of 1899 (33 USC 403), Section 10
- Massachusetts Wetlands Protection Act (MA WPA; Massachusetts General Laws Chapter 131 Section 40) and its implementing regulations (310 CMR 10.00)
- Location and Hydraulic Design of Encroachments on Flood Plains, 23 Code of Federal Regulations (CFR) 650
- Executive Order 13112, Invasive Species

The USACE New England District issues a Department of the Army permit pursuant to Section 10 of the Rivers and Harbors Act of 1899 and section 404 of the Clean Water Act. The federal Clean Water Act regulates the discharge of dredge or fill materials into Waters of the United (WOTUS), which include, but are not limited to, navigable waters and tidal wetlands, and which also include many non-tidal wetlands and other waterbodies. WOTUS are subject to federal jurisdiction under the Clean Water Act (CWA), of which Section 404 requires authorization from the USACE for the discharge of dredged or fill material into WOTUS, including wetlands. Navigable WOTUS are also subject to federal jurisdiction under Section 10 of the Rivers and Harbors Act of 1899 (33 USC 403) (RHA). Any work in or over, or outside the limits of the navigable WOTUS that would affect the navigable water requires authorization from the USACE. In Massachusetts, the MassDEP administers Section 401 of the CWA through the Massachusetts Surface Water Quality Standards (314 CMR 4.00) and 401 Water Quality Certification regulations (314 CMR 9.00) to ensure compliance with state water quality standards for any activity impacting WOTUS within Massachusetts.

At the state level, coastal and inland wetlands are subject to protection under the MA WPA and its regulations (310 CMR 10.00), which is administered by municipal conservation commissions. Freshwater resources subject to protection include banks, freshwater wetland, marsh or swamp bordering on any creek, river, stream, pond or lake; land under any listed water body, land subject to flooding; and riverfront area. Coastal resources subject to protection include coastal banks (CB); salt marsh; coastal beach; coastal dune; land under ocean (LUO); land subject to tidal action (LSTA); rocky intertidal shore (RIS); land containing shellfish; banks of and land under the ocean, ponds, streams, rivers, lakes or creeks that underlie an anadromous/catadromous fish run; and land subject to coastal storm flowage (LSCSF).

The floodplain is defined as any land area susceptible to being inundated by flood waters from any source. The Federal Emergency Management Agency (FEMA) identifies the 100-year floodplain as the boundary of the flood that has a 1% chance of being equaled or exceeded in any given year (also known as the base flood). FEMA identifies the 500-year floodplain as the boundary of flood that has a 0.2% chance of being equaled or exceeded in any given year. The 100-year floodplain is considered LSCSF and Bordering Land Subject to Flooding (BLSF) under the MA WPA.

In Massachusetts, an Area of Critical Environmental Concern (ACEC) designation is a formal state designation of a significant ecological area. A designated ACEC receives special recognition because of the quality, uniqueness, and significance of its natural and cultural resources. The ACEC regulations (301 CMR 12.00) require agencies under the Executive Office of Energy and Environmental Affairs to review projects subject to their jurisdiction to avoid and minimize adverse impacts to ACEC resources.

Vernal Pools are areas typically filled with water in the autumn or winter due to rainfall and rising groundwater and remain ponded through the spring and into summer. Vernal pools provide habitat for amphibians, such as wood frogs, salamanders and fairy shrimp. Certified Vernal Pools are regulated under the MA WPA and Section 401 of the CWA.

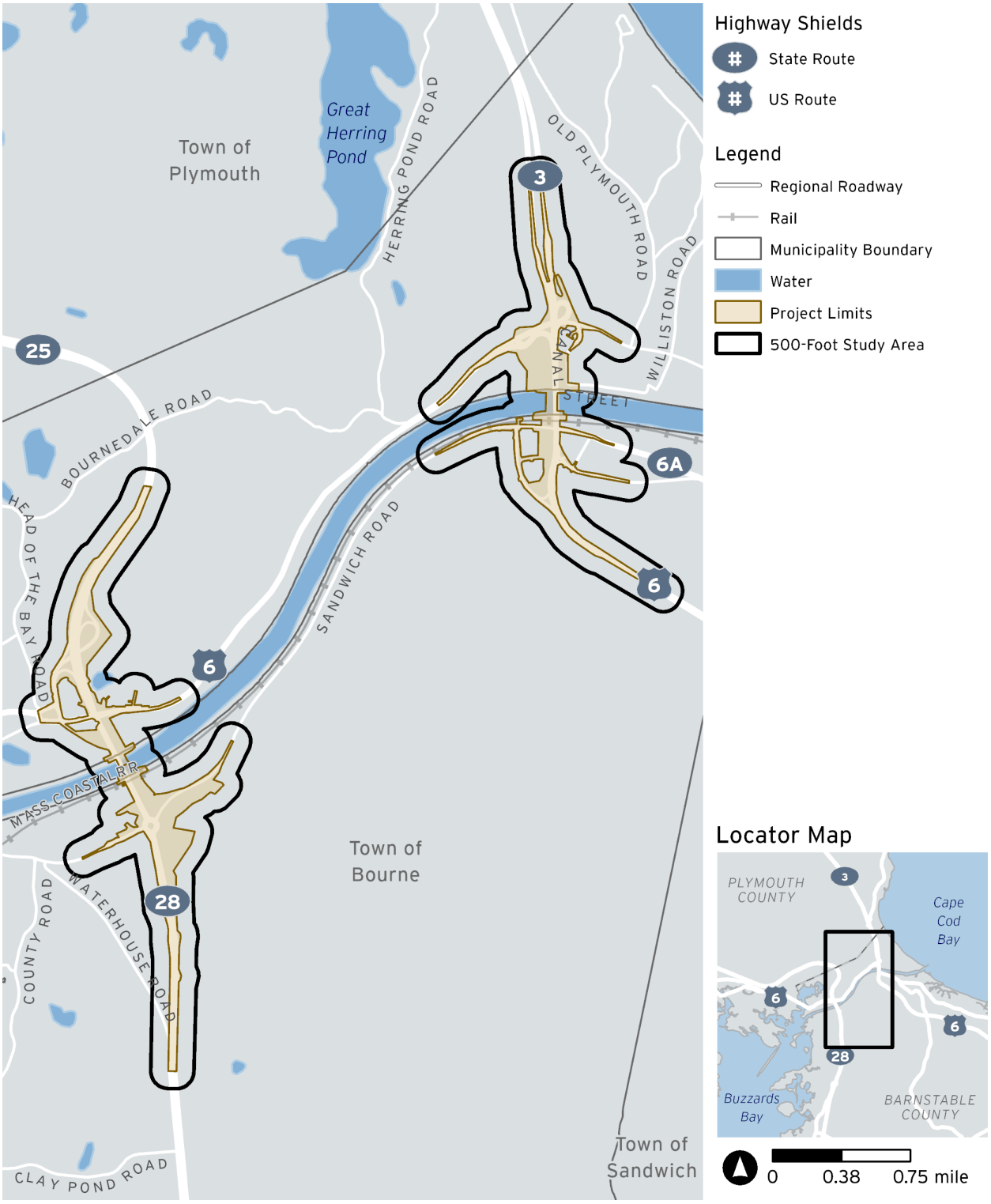
4.10.1.2 Methodology and Study Area

The Study Areas for the wetlands and floodplain analysis includes the Project Limits where physical work would occur within a construction zone as well as a 500-foot buffer from the construction zone. The 500-foot buffer represents areas beyond the physical work zone that may contain natural resources and associated buffer zones that could potentially be indirectly impacted during construction. **Figure 4.10-1** shows the wetlands and floodplain Study Area and Project Limits.

Wetlands, WOTUS, floodplains, vernal pools, and ACECs within the Study Area were identified using a range of data sources including the following:

- GIS Mapping
- Field wetland delineations (2020, 2021, and 2024)
- Vernal pool surveys (May 2020)
- FEMA Flood Insurance Rate Maps (FIRM)
- Coastal Zone Management Mapping
- USACE Major Rehabilitation Evaluation Environmental Assessment

Figure 4.10-1. Study Areas



Source: Massachusetts Department of Transportation, 2024

Wetlands in the Study Areas were delineated June 12 through September 18, 2020, and on February 10, 2021. Vernal pool surveys were conducted within the Study Areas between May 13 and May 15, 2020. An Abbreviated Notice of Resource Area Delineation (HNTB 2021) was submitted to the Bourne Conservation Commission on December 6, 2021, and revised information was submitted on April 22, 2022 (HNTB 2022) (**Appendix 4.10**). The Bourne Conservation Commission issued an Order of Resource Area Delineation (ORAD) on May 6, 2022, which was valid until May 6, 2025. The Permit Extension Act signed by Governor Healey on November 20, 2024 extends the permit for a 2-year period until May 6, 2027. Since the time of the delineation and issuance of the ORAD, further field investigations were performed in October and November 2024 to delineate and document the resource areas associated with Cape Cod Canal and a review of the stormwater pipe network connections was conducted. The field investigations resulted in the delineation of the resource areas within Cape Cod Canal, and review of the pipe network connections resulted in updates to several inland state resource area qualifications. Prior to May 6, 2027, a request for an Amended ORAD and 3-year extension will be filed with the Bourne Conservation Commission to include Cape Cod Canal, reflect the recent field investigations, and extend the ORAD (if necessary). The resource areas described herein reflect the updated delineation effort.

4.10.2 Existing Conditions

4.10.2.1 State Inland Resource Areas

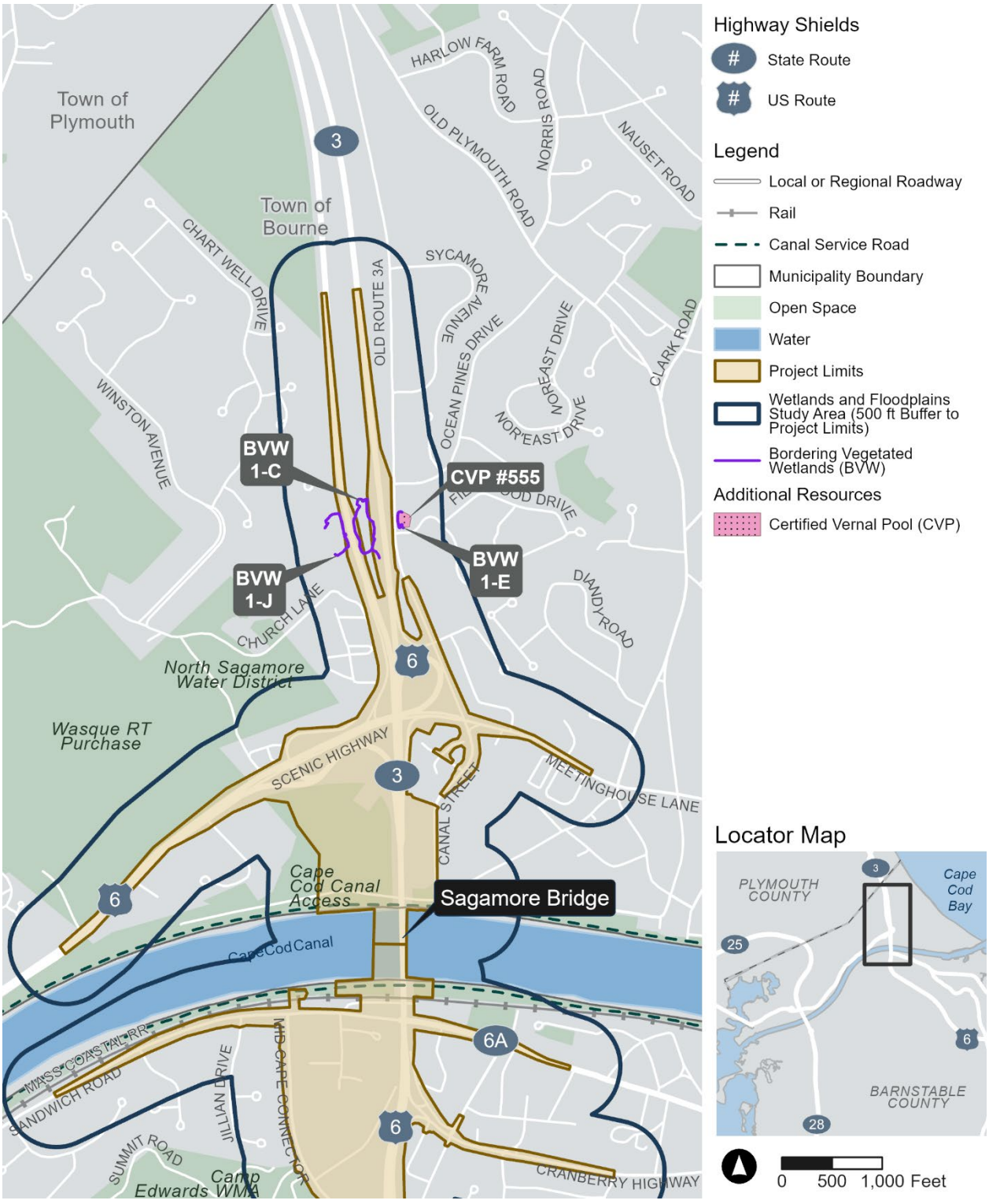
State inland jurisdictional resource areas were identified and approved in the ORAD. The resource areas were further qualified by additional investigations. There were a number of areas identified in the field, but many of them did not qualify under the MA WPA as jurisdictional areas due to their size and/or because they are human made stormwater management features constructed in uplands. The Abbreviated Notice of Resource Area Delineation also included WOTUS. The state and federal resource areas were also confirmed based on field investigations, pipe network, and surface connections to Cape Cod Canal. Those resource areas discussed herein include only those with the potential to be affected.

In the Study Areas, the following inland resource areas were identified in the Sagamore North, and Bourne North and Bourne South interchange approaches: Bank, BLSF, Bordering Vegetated Wetland (BVW), and Land Under Water Bodies and Waterways (LUW). In addition, there are 100-foot buffer zones from the edges of both bank and BVW. These resources are defined in **Table 4.10-1** and depicted in **Figure 4.10-2 through Figure 4.10-4**. No inland wetland resource areas were identified in the Sagamore South interchange approach area.

Table 4.10-1. Definitions of State Inland Wetland Resources

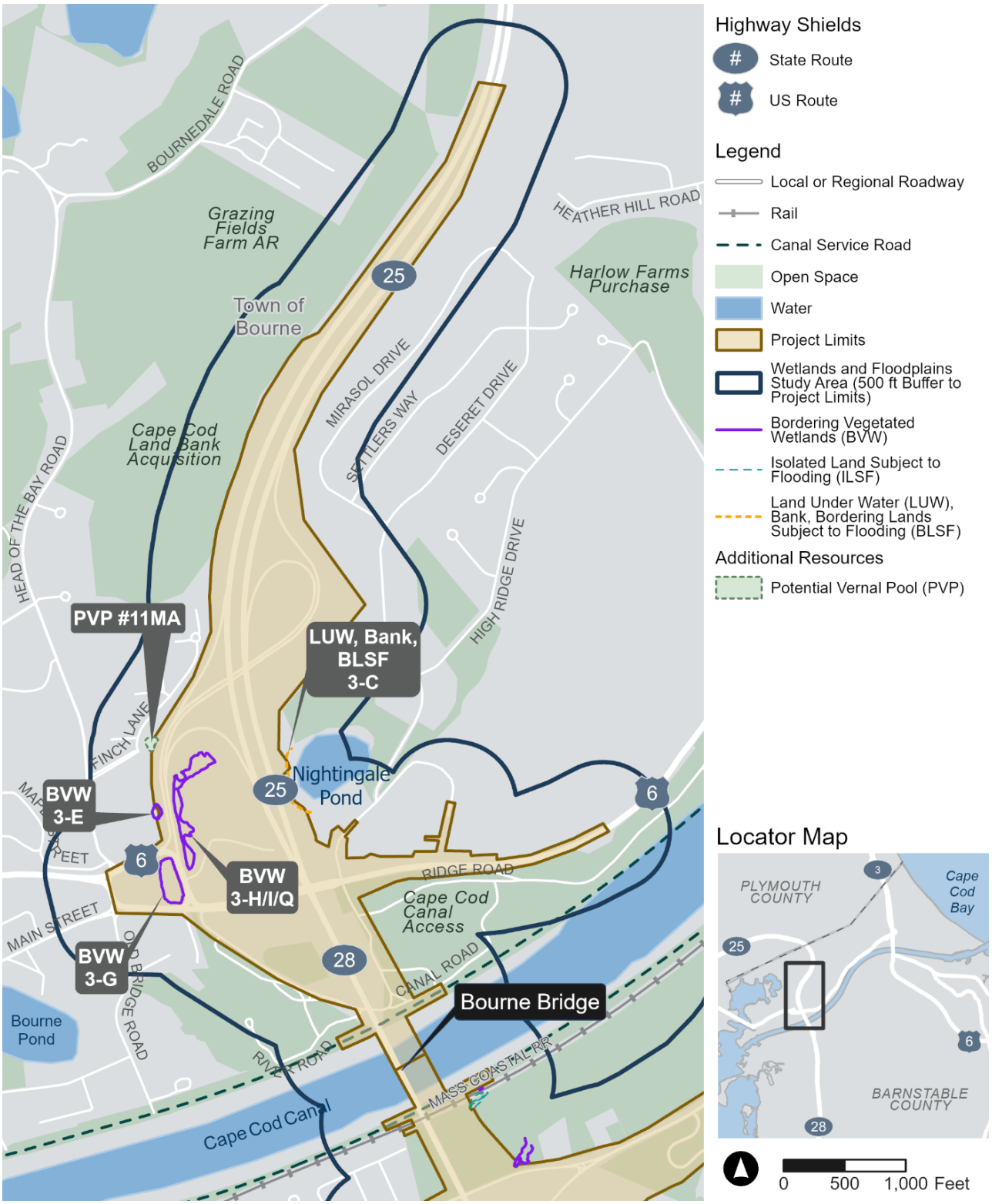
Resource	Definition
Bank	The portion of the land surface that normally abuts and confines a water body (stream lake or pond).
Bordering Land Subject to Flooding (BLSF)	An area with low, flat topography adjacent to and inundated by flood waters rising from creeks, rivers, streams, ponds or lakes. It extends from the banks of these waterways and water bodies; where a BVW occurs, it extends from said wetland.
Bordering Vegetated Wetland (BVW)	Freshwater wetlands that border on creeks, rivers, streams, ponds, and lakes, including wet meadows, marshes, swamps, and bogs. These wetlands are areas where the soils are saturated and/or inundated such that they support a predominance of wetland indicator plants.
Land Under Water Bodies and Waterways (LUW)	The bottom of, or land underneath, any creek, river, stream, pond, or lake.

Figure 4.10-2. State Inland Wetland Resource Areas (Sagamore North Quadrant Interchange Approach)



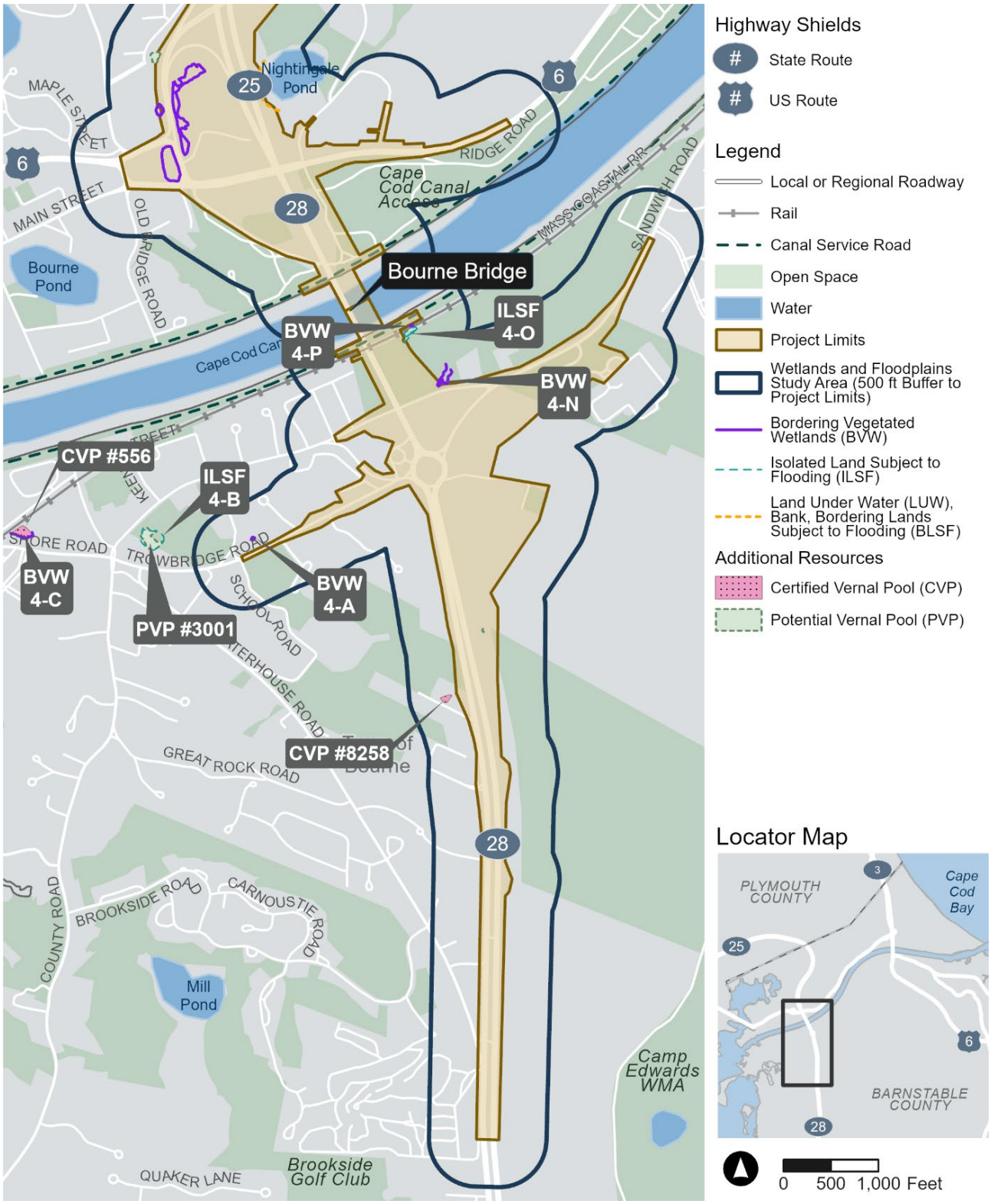
Source: Massachusetts Department of Transportation, 2025

Figure 4.10-3. State Inland Wetlands (Bourne North Quadrant Interchange Approach)



Source: Massachusetts Department of Transportation, 2025

Figure 4.10-4. State Inland Wetlands (Bourne South Quadrant Interchange Approach)



Source: Massachusetts Department of Transportation, 2025

Of those wetland areas identified, three—all of which are within the Bourne North quadrant interchange approach—would be impacted. **Table 4.10-2** lists these three wetland areas.

Table 4.10-2. State Inland Wetlands (Bourne North Quadrant Interchange Approach)

Figure No.	Wetland ID[1]	State Resource Area Type	Location	Description
Figure 4.10-3	Series 3-E	Bordering Vegetated Wetland	Northeast of CVS parking lot on the west side of State Route 25 eastbound off-ramp to US Route 6/State Route 28; connected to 3-H/I/Q via culvert under State Route 25 ramps; eventually flows to Cape Cod Canal	Sparsely vegetated forested wetland dominated by alder buckthorn (*Frangula alnus*), red maple (*Acer rubrum*), and sensitive fern (*Onoclea sensibilis*).
Figure 4.10-3	Series 3-H/I/Q	Bordering Vegetated Wetland	East side of US Route 6/State Route 28 southbound ramp to State Route 25; connected to wetland resource 3-G via culvert under US Route 6/State Route 28 ramp; eventually flows to Cape Cod Canal via culvert	Dominant vegetation includes arrowwood (*Viburnum dentatum*), red maple, gray birch (*Betula populifolia*), steeplebush (*Spiraea tomentosa*), and small cranberry (*Vaccinium oxycoccos*).
Figure 4.10-3	Series 3-C	• Bordering Vegetated Wetland • Land Under Water • Bank • Bordering Land Subject to Flooding	Nightingale Pond; east of State Route 25 northbound	Dominant vegetation on edge of pond includes black gum (*Nyssa sylvatica*), sweet pepperbush (*Clethra alnifolia*), and highbush blueberry (*Vaccinium corymbosum*).

[1] As identified in the Abbreviated Notice of Resource Area Delineation (HNTB 2021, 2022) and additional field investigations.

Associated with wetland flag Series 3-C, the FEMA Flood Insurance Rate Study and Map, revised effective date of July 6, 2021, shows a Zone A flood zone (i.e., 1% annual chance flood hazard or BLSF) with no Base Flood Elevation associated with Nightingale Pond. Considering there is no FEMA Base Flood Elevation, the MA WPA regulations require a hydrologic analysis to determine the elevation of BLSF in accordance with 310 CMR 10.57(2)(a)3. The elevation of BLSF was calculated using a design storm of 7.5 inches of precipitation in 24 hours as set forth in the National Oceanic and Atmospheric Administration's 14 Precipitation-Frequency Atlas of the United States. The model calculates the peak elevations within the flooded area representing the elevation of BLSF or the 1% annual chance flood hazard. The analysis determined the BLSF elevation to be 14.5 feet North American Vertical Datum of 1988 (NAVD88). The model also calculates the 10% annual chance flood hazard area using a design storm of 5 inches of precipitation in 24 hours. The analysis determined the 10% annual chance flood elevation to be 9.3 feet NAVD88.

4.10.2.2 Vernal Pools

Vernal pools are confined basin depressions which, in most years, hold water for a minimum of two continuous months during the spring and/or summer, are free of adult fish populations, and provide specialized and critical breeding habitat for frogs, salamanders, and invertebrates. Although vernal pools are not an area subject to protection under the MA WPA they are designated as an Outstanding Resource Water pursuant to the Massachusetts Surface Water Quality Standards and subject to regulation under Section 401 of the CWA through the Water Quality Certification regulations (314 CMR 9.00). The Massachusetts Division of Fisheries and Wildlife's Natural Heritage & Endangered Species Program (NHESP) administers the state's official vernal pool certification program. Certified vernal pools are those where NHESP has reviewed and officially certified biological and physical documentation that a vernal pool meets the NHESP's Guidelines for the Certification of Vernal Pool Habitat[1]. Vernal pools that comprise these biological and physical characteristics but have not been certified by NHESP are referred to as potential vernal pools.

Five vernal pools were identified in the Wetlands and Floodplains Study Areas (refer to **Figure 4.10-2 through Figure 4.10-4** and **Table 4.10-3**).

[1] https://www.mass.gov/doc/guidelines-for-the-certification-of-vernal-pool-habitat/download

Table 4.10-3. Summary of Spring 2020 Vernal Pool Surveys

Figure No.	Survey Area / Wetland ID[1]	Vernal Pool ID[2]	Vernal Pool ID[3]	Comments
Figure 4.10-2	Sagamore North Quadrant/BVW 1-E	05DN	Certified #555	Within 100 feet of proposed work
Figure 4.10-3	Bourne North Quadrant/BVW 3-F	11MA	None	Does not meet biological criteria for certification
Figure 4.10-4	Bourne South Quadrant/ILSF 4-B	03MA	Potential #3001	Does not meet biological criteria for certification
Figure 4.10-4	Bourne South Quadrant/IVW 4W	05MA	None	Does not meet biological criteria for certification
Figure 4.10-4	Bourne South Quadrant/BVW	07MA	Certified #8258	Within 100 feet of proposed work

BVW = Bordering Vegetated Wetlands, ILSF = Isolated Land Subject to Flooding

[1] As identified in the Abbreviated Notice of Resource Area Delineation (HNTB 2021, 2022) and additional field investigations

[2] As identified in Bourne and Sagamore Bridge Improvement Projects – Rare, Threatened, and Endangered Species Habitat Assessment (Stantec 2020)

[3] As identified by Massachusetts Department of Fish and Wildlife Natural Heritage and Endangered Species Program

4.10.2.3 State Coastal Resource Areas

State coastal resource areas that were identified within the Sagamore and Bourne Bridge Study Areas include LUO, CB, RIS, LSTA, Banks of or Land Under the Ocean Underlying an Anadromous/ Catadromous Fish Run, Land Containing Shellfish, and LSCSF. These resources are defined in **Table 4.10-4**, and their locations are depicted in **Figure 4.10-5** through **Figure 4.10-8** and described in **Table 4.10-6**. These state coastal resources are associated with Cape Cod Canal, which connects Cape Cod Bay to Buzzards Bay.

Table 4.10-4. Definitions of State Coastal Resource Areas

Resource	Definition
Land Under the Ocean	Land extending from the mean low water (MLW) line seaward to the boundary of the municipality's jurisdiction and includes land under estuaries.
Coastal Bank	The seaward face or side of any elevated landform, other than a coastal dune, which lies at the landward edge of a coastal beach, land subject to tidal action, or other wetland.
Rocky Intertidal Shore	Naturally occurring rocky areas, such as bedrock or boulder-strewn areas between the mean high water line and the Mean Low Water line.
Land Containing Shellfish	Land under the ocean, tidal flats, rocky intertidal shores, salt marshes and land under salt ponds when any such land contains shellfish.
Land Subject to Tidal Action	Land subject to the periodic rise and fall of a coastal water body, including spring tides.
Banks of or Land Under the Ocean Underlying an Anadromous/Catadromous Fish Run	Area within estuaries, ponds, streams, creeks, rivers, lakes or coastal waters, which is a spawning or feeding ground or passageway for anadromous or catadromous fish and which is identified by the Division of Marine Fisheries or has been mapped on the Coastal Atlas of the Coastal Zone Management Program.
Land Subject to Coastal Storm Flowage	Land subject to inundation caused by coastal storms up to and including that caused by the 100-year storm surge of record or storm of record.

Water elevations within Cape Cod Canal were obtained from the USACE Environmental Assessment and Finding of No Significant Impact for Major Rehabilitation Evaluation Report (USACE 2022). Elevations in the USACE report were based on mean sea level datum and converted to NAVD88 to establish the state jurisdictional limits. Water elevations pertinent to state jurisdictional limits are presented in **Table 4.10-5**. Variations in the values presented in **Table 4.10-5** result from differences in the timing and amplitude of the tides in Buzzards Bay and Cape Cod Bay – Buzzards Bay tidal range is approximately 6 feet compared to Cape Cod Bay's range of approximately 10 feet, and the high and low tides precede that of Cape Cod Bay by about 3 hours.

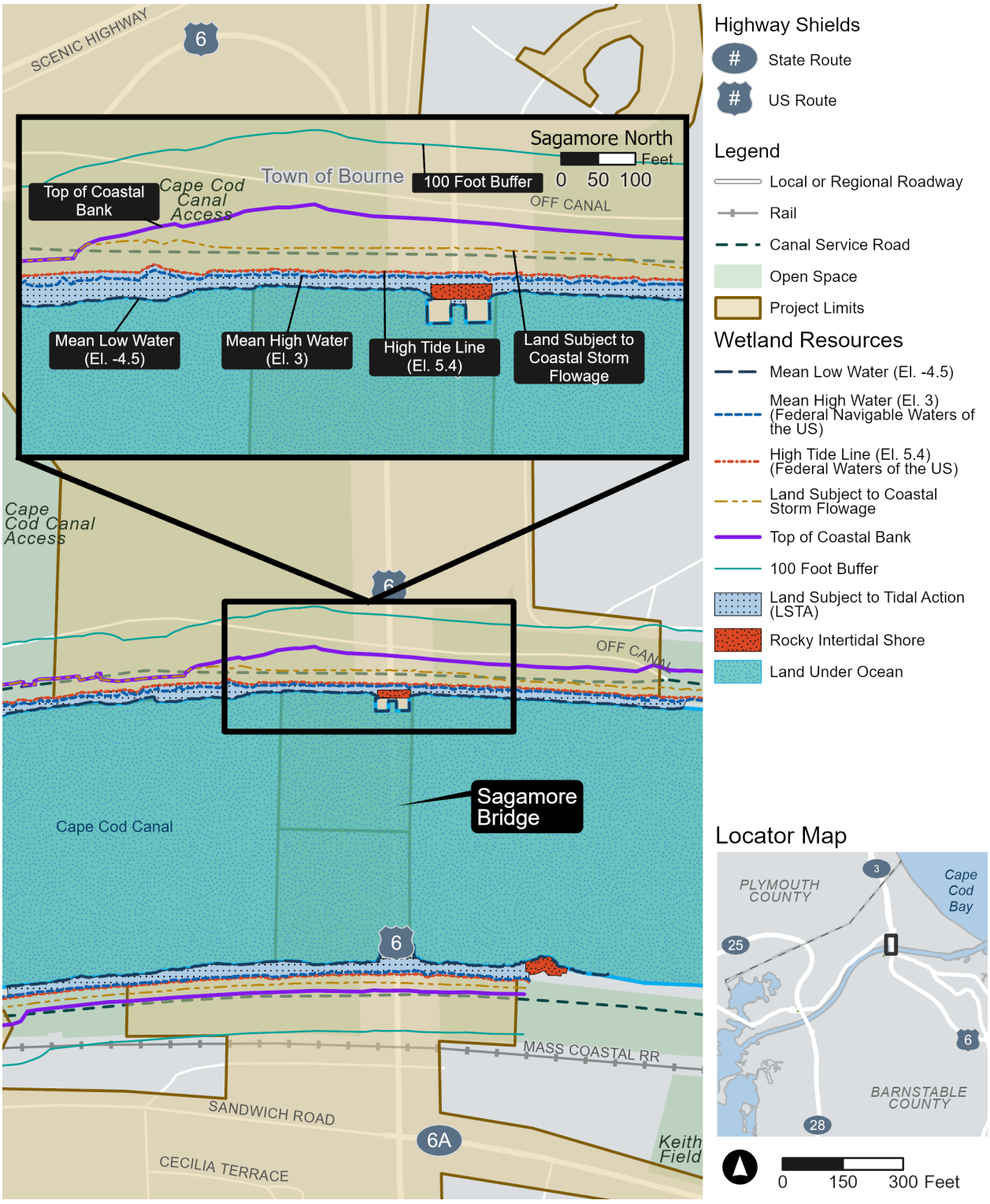
Table 4.10-5. Cape Cod Canal Water Elevations in Feet (Based on NAVD88)

Location	High Tide Line	Mean High Water	Mean Low Water
Sagamore Bridge	5.4	3.0	-4.5
Bourne Bridge	2.9	1.5	-3.0

Table 4.10-6. State Coastal Resource Areas

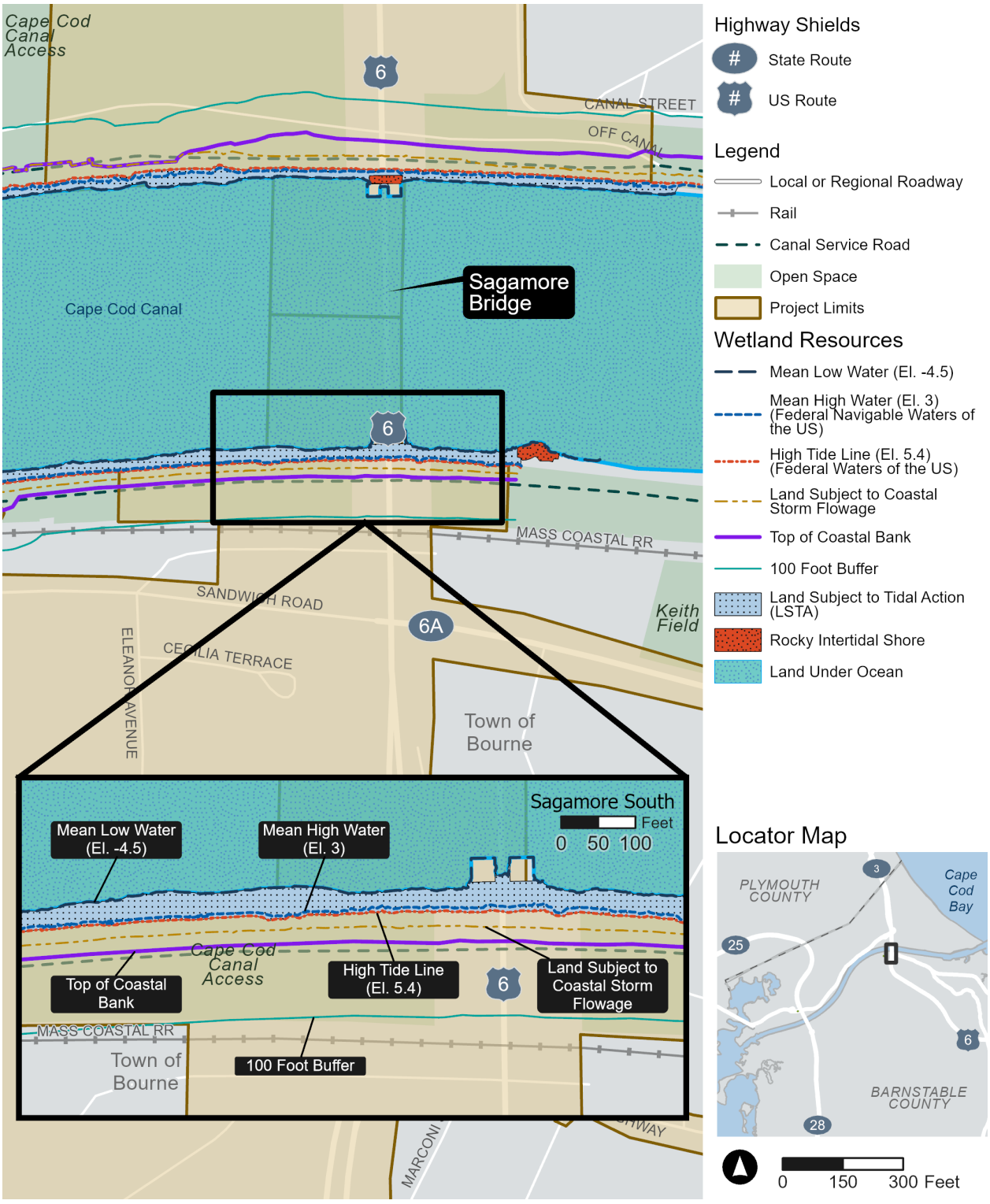
Resource Area Type	Location	How Determined
Land Under Ocean	Within Cape Cod Canal	Below Mean Low Water elevation based on U.S. Army Corps of Engineers (2022)
Coastal Bank	Along north and south shorelines of entire length of Cape Cod Canal; 100-foot buffer applies	Massachusetts Department of Environmental Protection Wetlands Program Policy 92-1 Coastal Banks
Rocky Intertidal Shore	1,652 square feet at the Sagamore North quadrant approach and 1,167 square feet at the Bourne North quadrant approach	Based on field observations between Mean High Water and Mean Low Water
Land Subject to Tidal Action	Within Cape Cod Canal	Between Mean Low Water and High Tide Line (including spring tides) based on U.S. Army Corps of Engineers (2022)
Banks of or Land Under the Ocean Underlying an Anadromous/ Catadromous Fish Run	Along north and south shorelines of entire length of Cape Cod Canal	As mapped by the Massachusetts Department of Fish and Game Division of Marine Fisheries
Land Containing Shellfish	Within Cape Cod Canal	As mapped by the Massachusetts Department of Fish and Game Division of Marine Fisheries
Land Subject to Coastal Storm Flowage or 1% annual chance flood hazard	Elevation 14 feet North American Vertical Datum of 1988 (NAVD88) at Sagamore Bridge, elevation 16 feet NAVD88 west of Bourne Bridge, and elevation 15 feet NAVD88 east of Bourne Bridge	Based on Federal Emergency Management Agency Flood Insurance Study and Rate Map and elevation verified by survey

Figure 4.10-5. State and Federal Coastal Resource Areas (Sagamore North Quadrant)



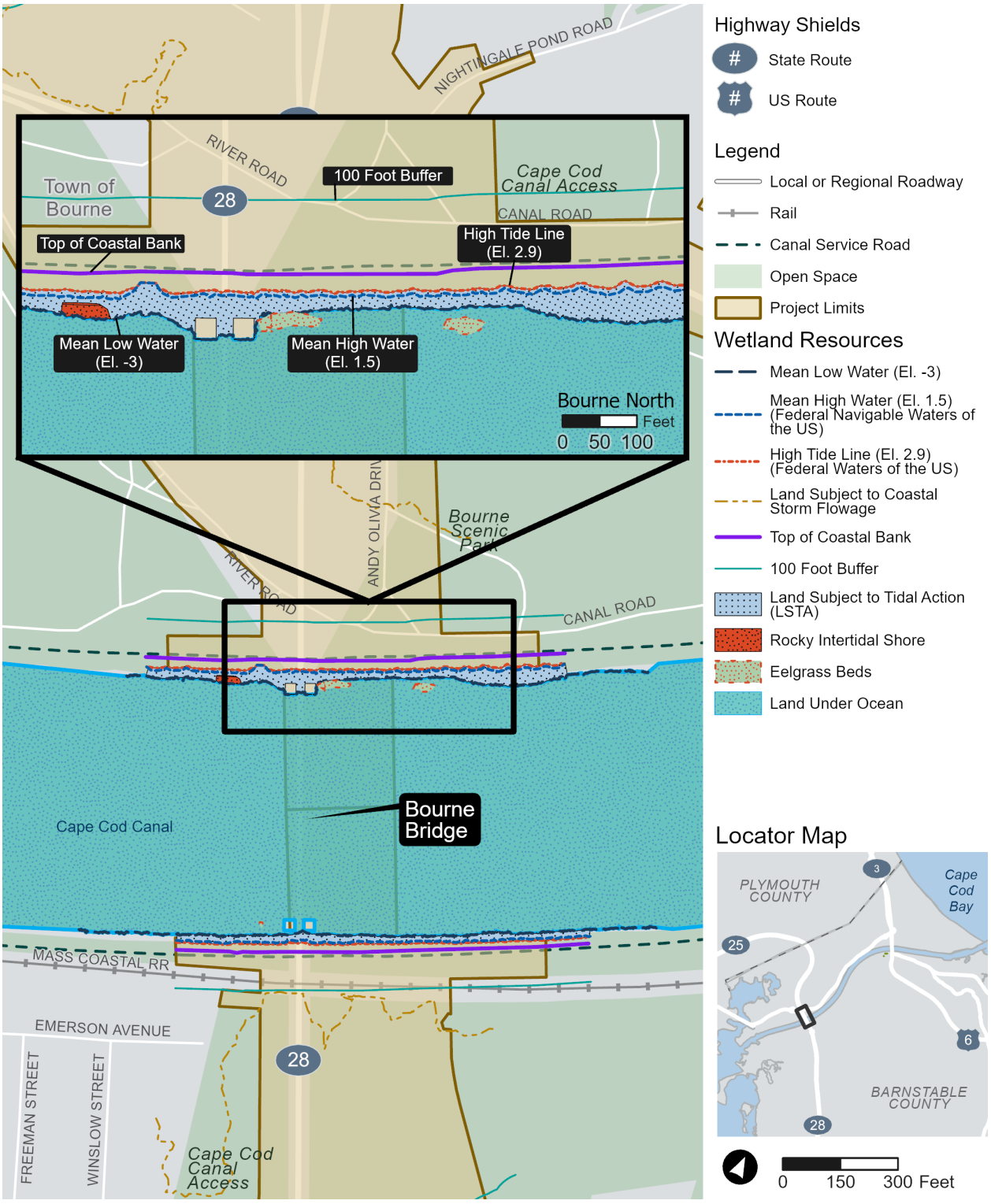
Source: Massachusetts Department of Transportation, 2025

Figure 4.10-6. State and Federal Coastal Resource Areas (Sagamore South Quadrant)



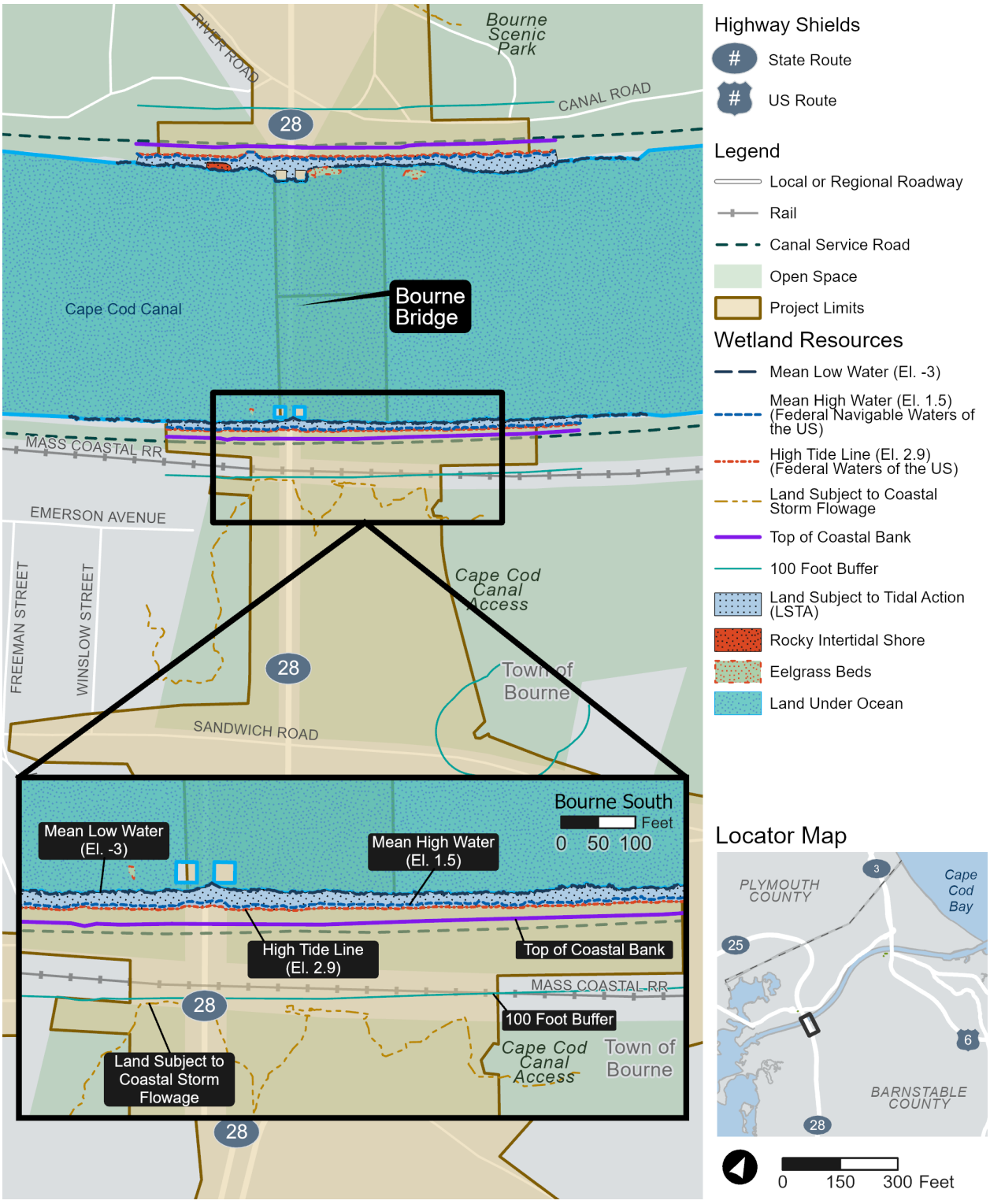
Source: Massachusetts Department of Transportation, 2025

Figure 4.10-7. State and Federal Coastal Resource Areas (Bourne North Quadrant)



Source: Massachusetts Department of Transportation, 2025

Figure 4.10-8. State and Federal Coastal Resource Areas (Bourne South Quadrant)



Source: Massachusetts Department of Transportation, 2025

Exhibit 4.10-1 through Exhibit 4.10-8 depict the canal resource areas. As depicted in these exhibits, riprap comprises much of the shoreline along the canal.

The Study Areas was reviewed for the presence/absence of other state coastal resources (i.e., coastal beach, coastal dune, barrier beach, salt marsh, and land under salt ponds). These coastal resources were not observed.

Exhibit 4.10-1. Banks of Cape Cod Canal Adjacent to Sagamore North Quadrant Bridge Piers, Looking East



Source: Massachusetts Department of Transportation, 2024

Exhibit 4.10-2. Banks of Cape Cod Canal Adjacent to Sagamore North Quadrant Bridge Piers, Looking South



Source: Massachusetts Department of Transportation, 2024

Exhibit 4.10-3. Banks of Cape Cod Canal Adjacent to Sagamore South Quadrant Bridge Piers, Looking East



Source: Massachusetts Department of Transportation, 2024

Exhibit 4.10-4. Banks of Cape Cod Canal Adjacent to Sagamore South Quadrant Bridge Piers, Looking East-Northeast



Source: Massachusetts Department of Transportation, 2024

Exhibit 4.10-5. Banks of Cape Cod Canal Adjacent to Bourne North Quadrant Bridge Piers, Looking East



Source: Massachusetts Department of Transportation, 2024

Exhibit 4.10-6. Banks of Cape Cod Canal Adjacent to Bourne North Quadrant Bridge Piers, Looking South



Source: Massachusetts Department of Transportation, 2024

Exhibit 4.10-7. Banks of Cape Cod Canal Adjacent to Bourne South Quadrant Bridge Piers, Looking East



Source: Massachusetts Department of Transportation, 2024

Exhibit 4.10-8. Banks of Cape Cod Canal Adjacent to Bourne South Quadrant Bridge Piers, Looking East



Source: Massachusetts Department of Transportation, 2024

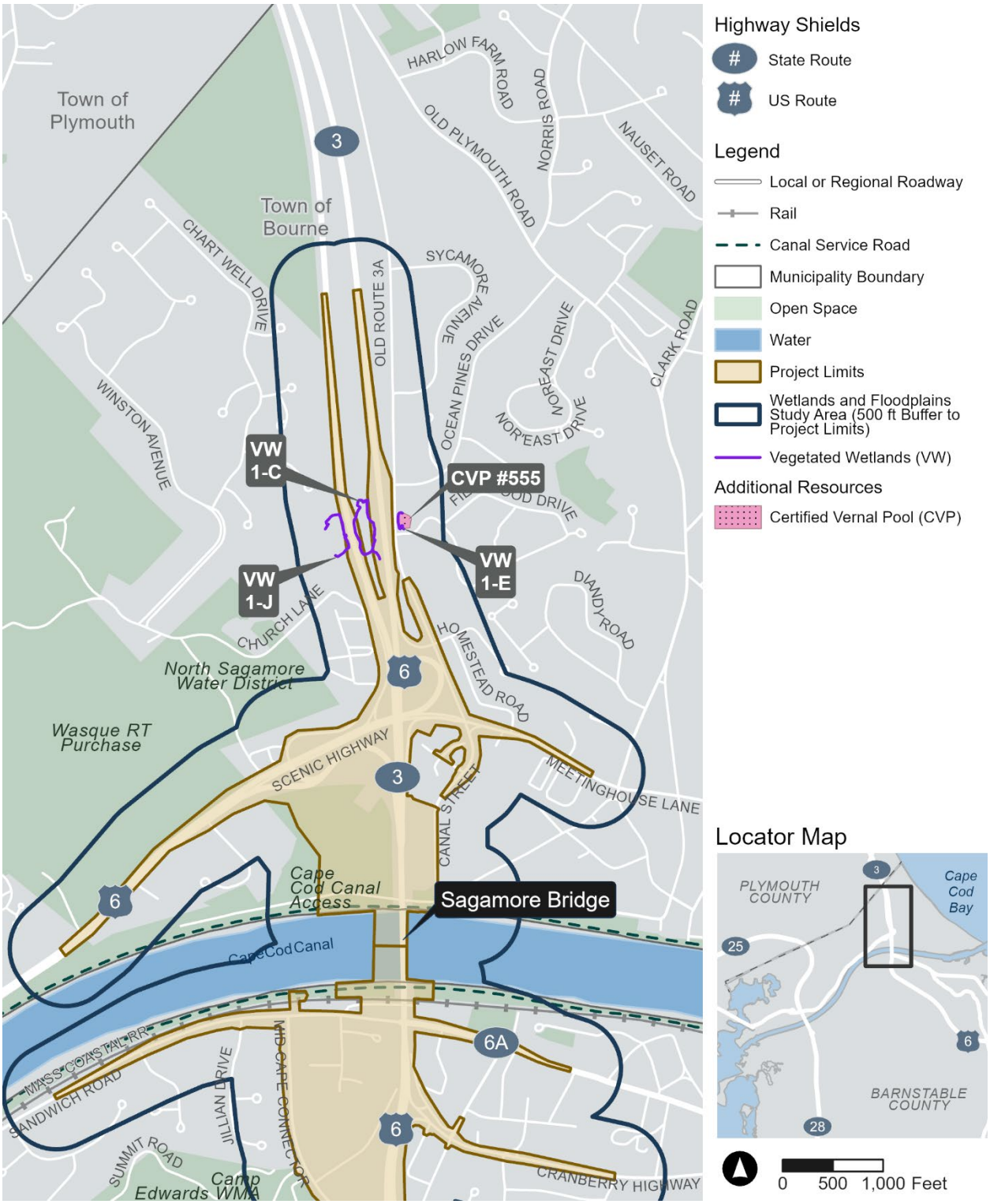
4.10.2.4 Federally Regulated Waters of the United States

The Program is currently proceeding under the presumption that aquatic resources that meet the CWA definition of wetlands and any Relatively Permanent Water (RPW) with a High Tide Line (HTL), Mean High Water (MHW) mark, or Ordinary High Water mark are subject to USACE jurisdiction pursuant to the CWA and/or Section 10 of the Rivers and Harbors Act of 1899. The terms WOTUS and federal are used interchangeably to refer to these aquatic resources.

Inland Waters of the United States

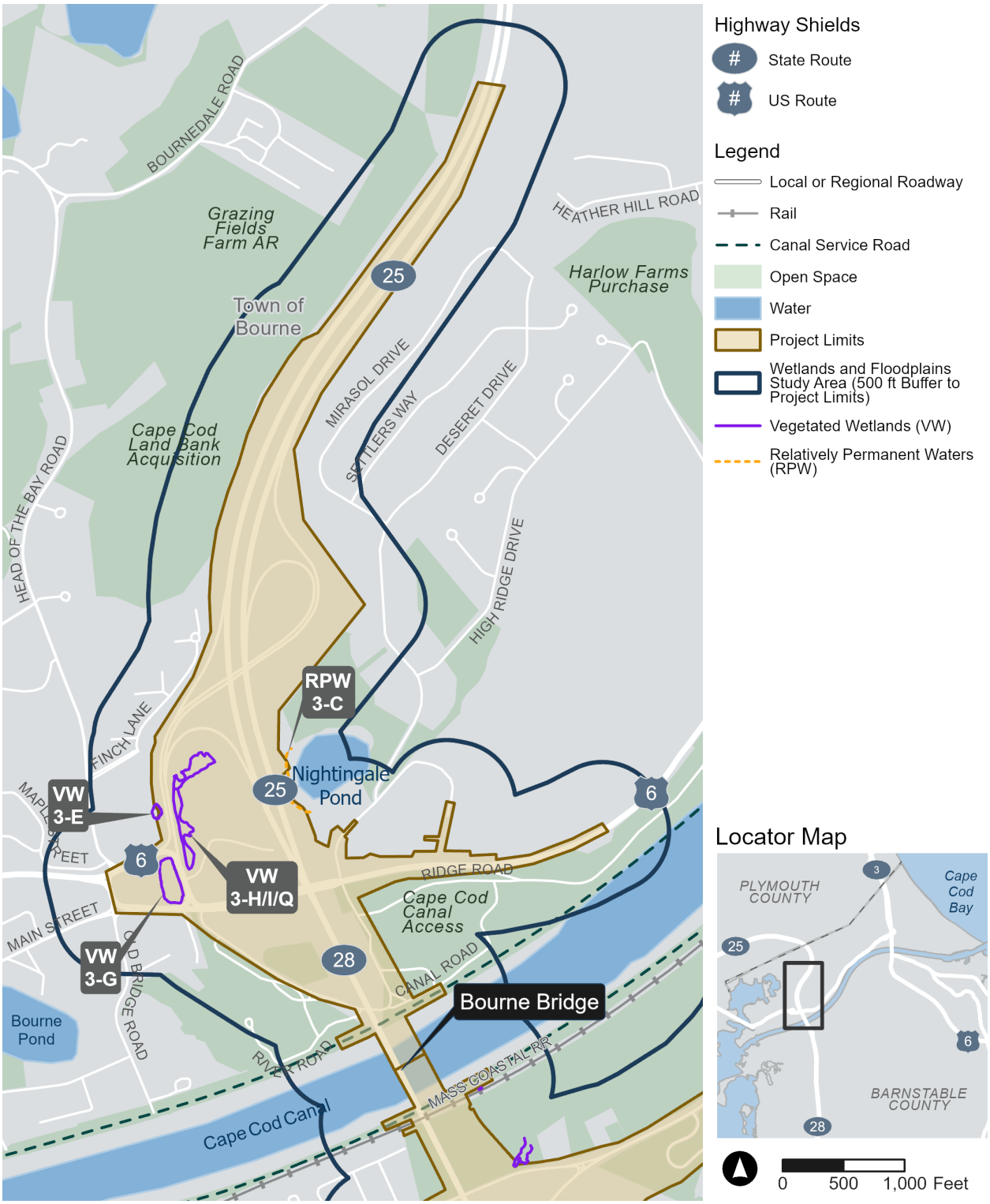
Inland WOTUS were identified in the Sagamore North quadrant, Bourne North quadrant, and Bourne South quadrant interchange approaches. **Figure 4.10-9** through **Figure 4.10-11** depict these wetland resources. Of those wetland resources identified, three, all of which are within the Bourne North quadrant interchange approach (**Figure 4.10-10**) would be impacted. **Table 4.10-7** identifies these three WOTUS.

Figure 4.10-9. Federally Regulated Inland Wetland Resource Areas (Sagamore North Quadrant Interchange Approach)



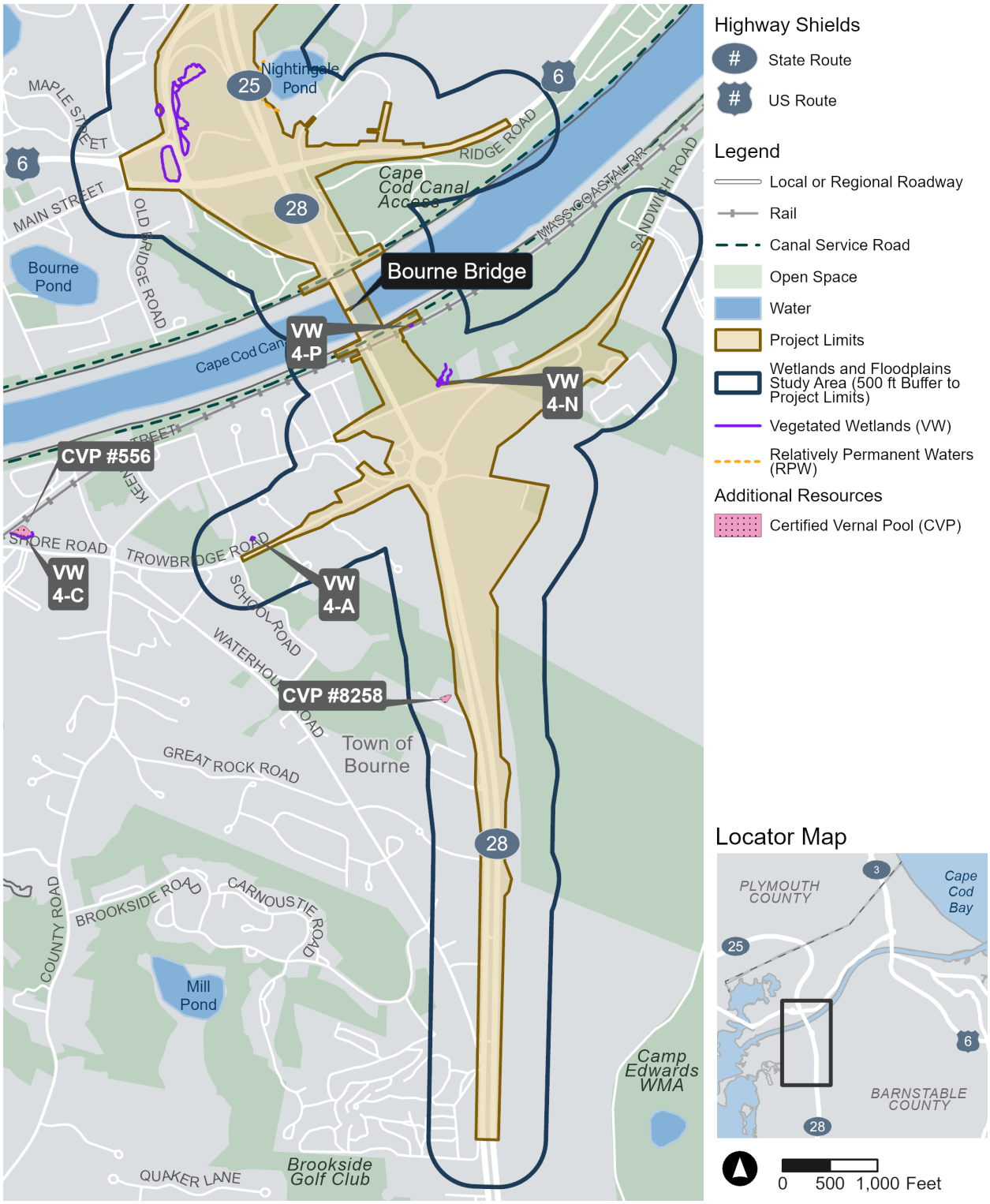
Source: Massachusetts Department of Transportation, 2024

Figure 4.10-10. Federally Regulated Inland Wetland Resource Areas (Bourne North Quadrant Interchange Approach)



Source: Massachusetts Department of Transportation, 2024

Figure 4.10-11. Federally Regulated Inland Wetland Resource Areas (Bourne South Quadrant Interchange Approach)



Source: Massachusetts Department of Transportation, 2024

Table 4.10-7. Federally Regulated Inland Wetland Resource Areas (Bourne North Quadrant Interchange Approach)

Figure No.	Wetland ID[1]	Resource Area Type	Location	Description
Figure 4.10-10	Series 3-E	Vegetated Wetland	Northeast of CVS parking lot on the west side of State Route 25 eastbound off-ramp to U.S. Route 6/State Route 28; connected to 3-H/I/Q via culvert under State Route 25 ramps; eventually flows to Cape Cod Canal.	Sparsely vegetated forested wetland dominated by alder buckthorn, red maple, and sensitive fern.
Figure 4.10-10	Series 3-H/I/Q	Vegetated Wetland	East side of U.S. Route 6/State Route 28 southbound ramp to State Route 25; connected to wetland resource 3-G via culvert under U.S. Route 6/State Route 28 ramp; eventually flows to Cape Cod Canal via culvert	Dominant vegetation includes arrowwood, red maple, gray birch, steeplebush, and small cranberry
Figure 4.10-10	Series 3-C	Vegetated Wetland and Relatively Permanent Water	Nightingale Pond; east of State Route 25 northbound	Dominant vegetation on edge of pond includes black gum, sweet pepperbush, and highbush blueberry

*Note: Table only includes wetlands where impacts are proposed.

[1] As identified in the Abbreviated Notice of Resource Area Delineation (HNTB 2021, 2022) and additional field investigations

Coastal (Tidal) Waters of the United States

Coastal WOTUS are those waters that are subject to the ebb and flow of the tide. Cape Cod Canal is a tidal Navigable WOTUS. Coastal WOTUS identified within the Study Areas at both bridge locations are depicted in **Figure 4.10-5 through Figure 4.10-11**. Water elevations pertinent to federal jurisdictional limits are as presented for state jurisdictional limits in **Table 4.10-5** and were obtained from the USACE MRER/EA (USACE 2022). The Bourne North quadrant includes two eelgrass beds totaling 2,345 square feet that are located east of the existing piers. The Bourne South quadrant includes one 100-square-

foot eelgrass bed that is located west of the existing piers along with isolated eelgrass sprigs farther west. The Sagamore Bridge Study Area does not include areas vegetated with eelgrass.[2]

4.10.2.5 Floodplains

FEMA FIRM panels (25001C0316K, 25001C0318K, 25001C0311K, 250010C4K, 25001C0501J, and 25001C0502J), identify the 1% annual chance flood hazard (i.e., 100-year floodplain) boundary within the Study Areas. The limits of the FEMA-delineated floodplain within the Study Areas are illustrated in **Figure 4.10-12** and **Figure 4.10-13**.

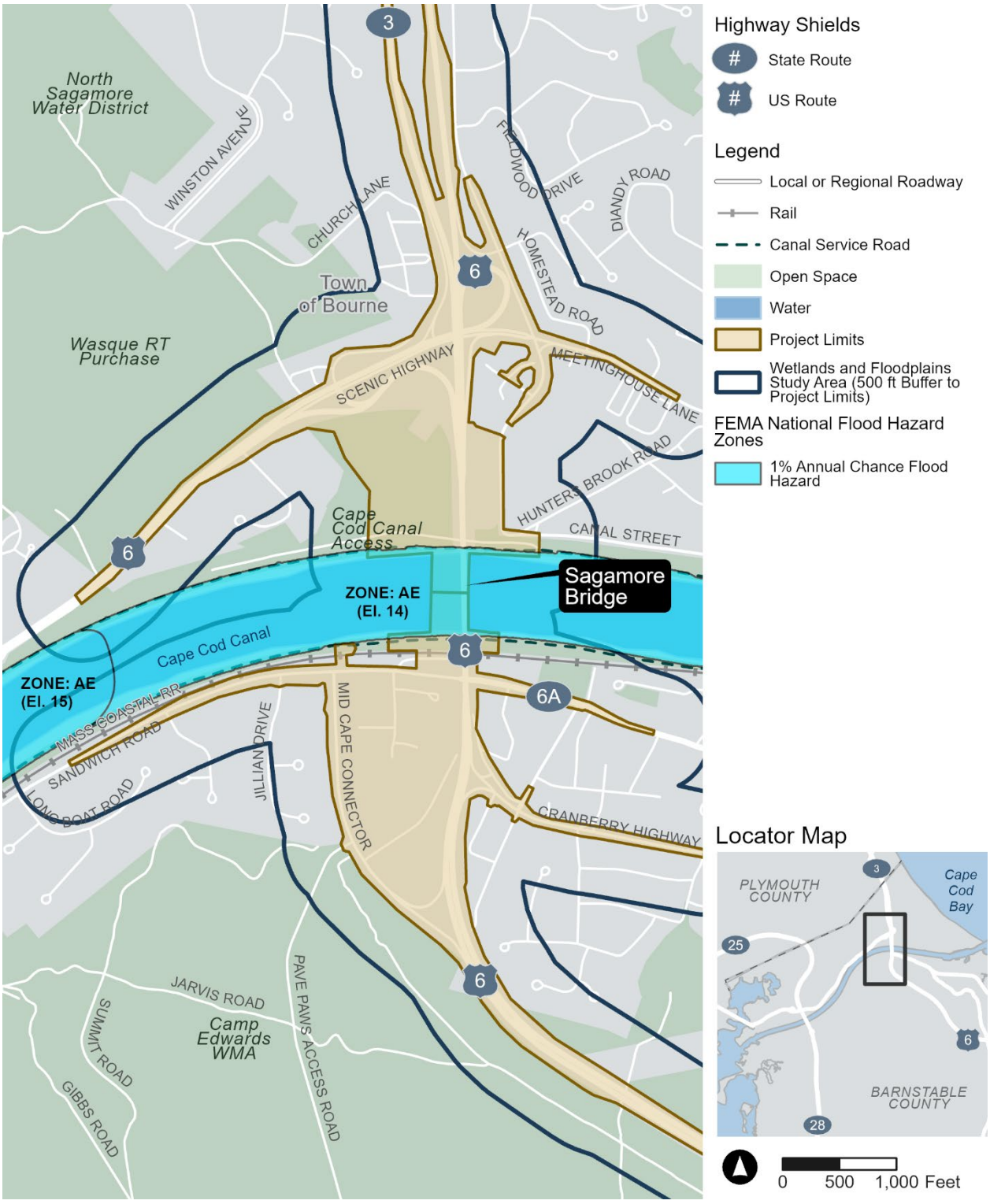
The FEMA Flood Insurance Study and Map, with a revised effective date of July 6, 2021, shows Cape Cod Canal as Zone AE, 1% annual chance flood hazard ranging between elevation 16 feet NAVD88 to the west of Bourne Bridge to elevation 15 feet NAVD88 to the east of Bourne Bridge. At the Sagamore Bridge location, the 1% annual chance flood hazard is elevation 14 feet NAVD88.

At the Bourne North Interchange Approach, Zone AE extends beyond the banks of Cape Cod Canal into Belmont Circle. At the Bourne South Interchange Approach, the flood zone extends into the adjacent properties on either side of the bridge. At the Sagamore North Interchange Approach, Zone AE is located along the landward edge of the existing pedestrian path, and at Sagamore South Approach, Zone AE is confined to the banks of Cape Cod Canal.

Zone A flood zone (i.e., 1% annual chance flood hazard) with no Base Flood Elevation is associated with Nightingale Pond which is in the Bourne North quadrant. Refer to **Section 4.10.2.1** for a discussion of how the Base Flood Elevation was calculated in this area.

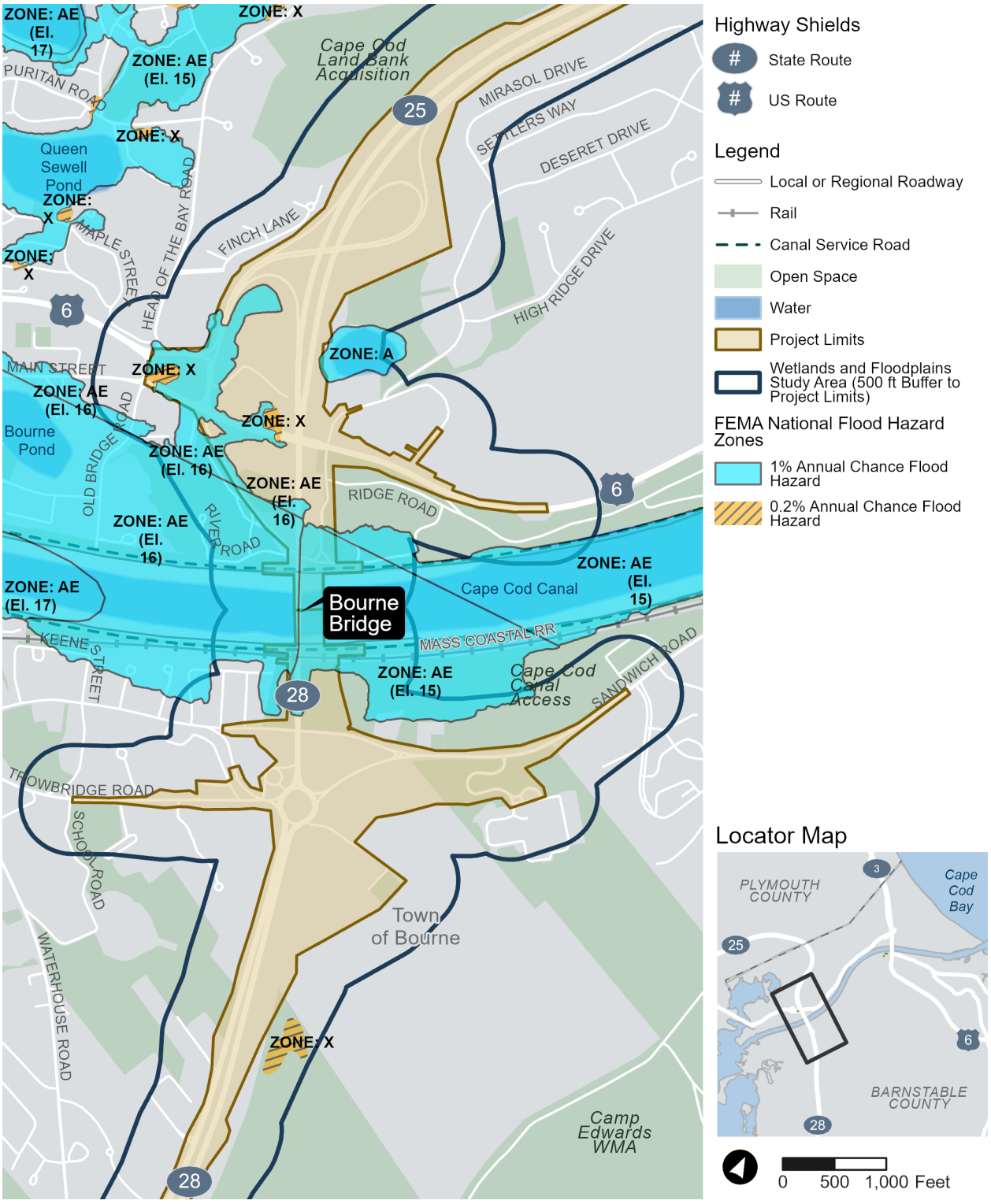
[2] The Eelgrass Survey Report is provided in **Appendix 4.12, Attachment 3**.

Figure 4.10-12. Floodplains (Sagamore Bridge)



Source: Massachusetts Department of Transportation, 2025

Figure 4.10-13. Floodplains (Bourne Bridge)

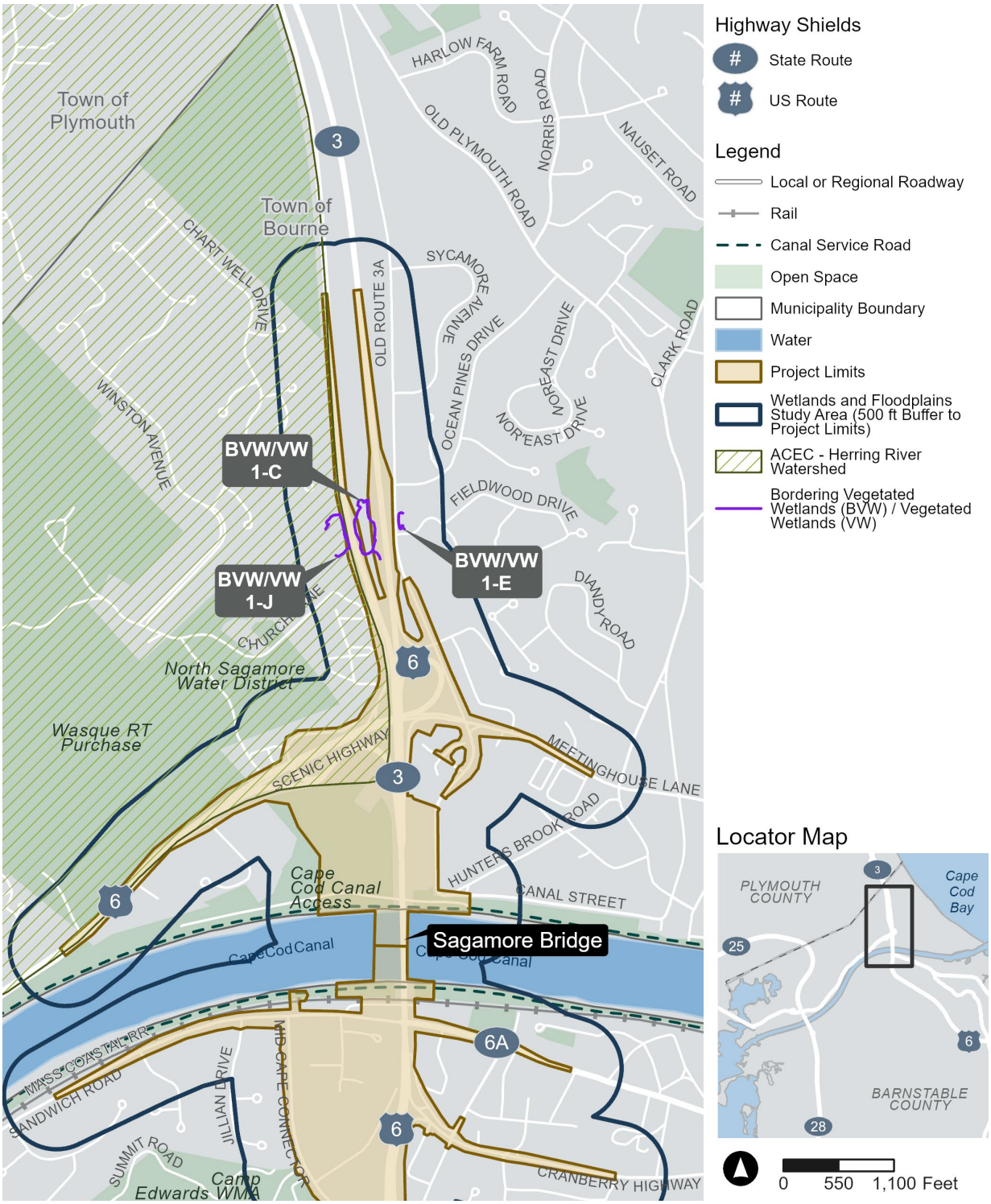


Source: Massachusetts Department of Transportation, 2025

4.10.2.6 Areas of Critical Environmental Concern

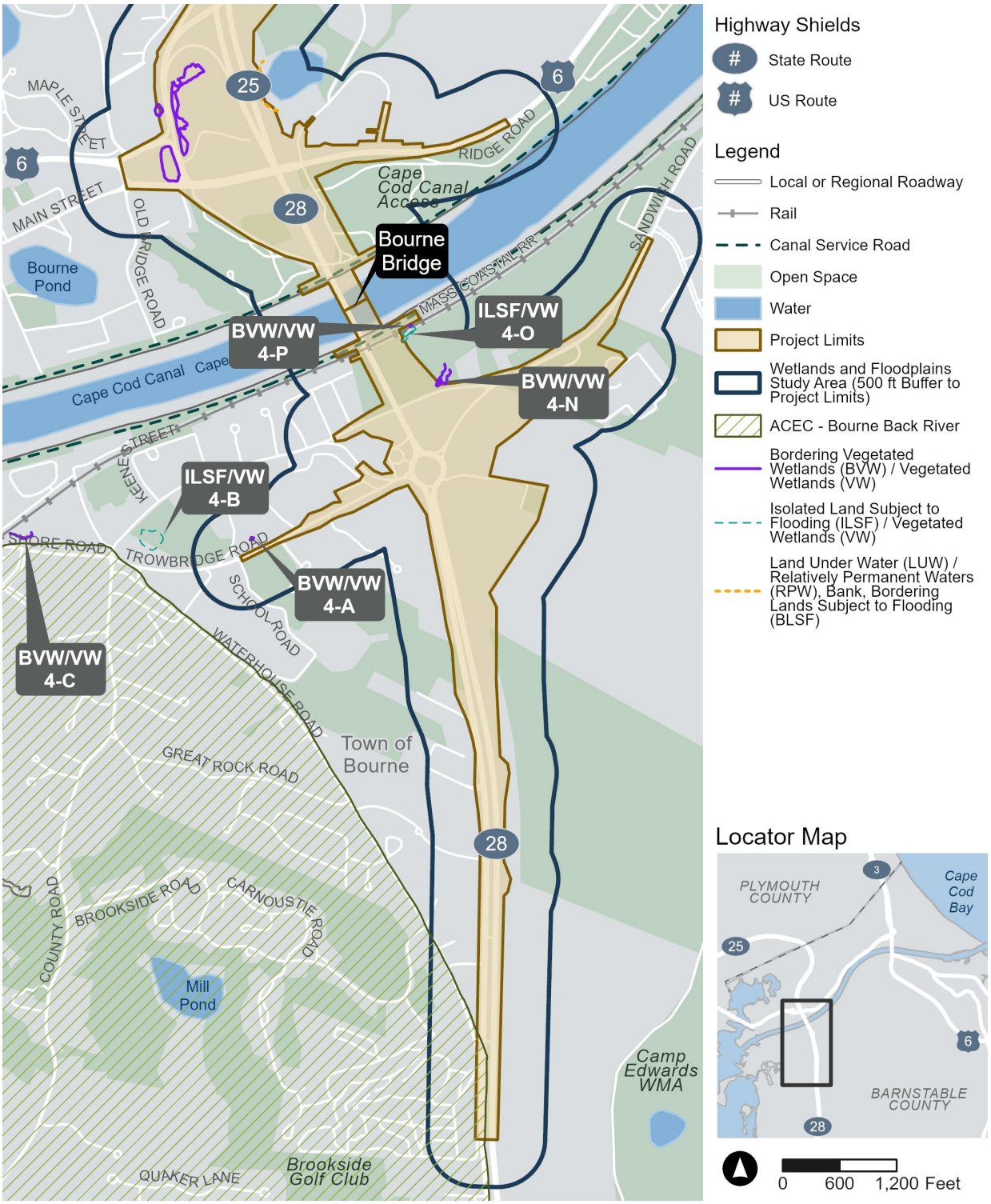
The Herring River Watershed is a mapped ACEC that occurs within the Sagamore North Interchange Approach (**Figure 4.10-14**). The ACEC is mapped on the west side of State Route 3 and includes BVW Series 1-J. At the southern end of the Bourne South Interchange Approach, the Project Limits overlap with the Bourne Back River ACEC (**Figure 4.10-15**). The wetlands within the ACEC are considered Outstanding Resource Waters, which are regulated under Section 401 of the CWA.

Figure 4.10-14. Areas of Critical Environmental Concern (Sagamore North Quadrant Interchange Approach)



Source: Massachusetts Department of Transportation, 2025

Figure 4.10-15. Areas of Critical Environmental Concern (Bourne South Quadrant Interchange Approach)



Source: Massachusetts Department of Transportation, 2025

4.10.3 No Build Alternative

For the No Build Alternative, the Sagamore and Bourne Bridges would not be replaced. The USACE would continue to conduct maintenance activities at both bridges. These activities would not result in permanent impacts to state or federal wetland resource areas. Impacts would be similar to those that occurred during prior maintenance activities.

4.10.4 Program Impacts

4.10.4.1 Construction-Term Impact Assessment

The Build Alternative would result in temporary and permanent impacts to both state and federal resources and in both inland and coastal areas. Temporary construction-term alterations would include filling, excavating, and installing structures. Permanent alterations would result from project components including new bridge piers, riprap pier protection, and retaining walls. Dredging would also be required to provide marine vessels access to support construction activities during low tide cycles.

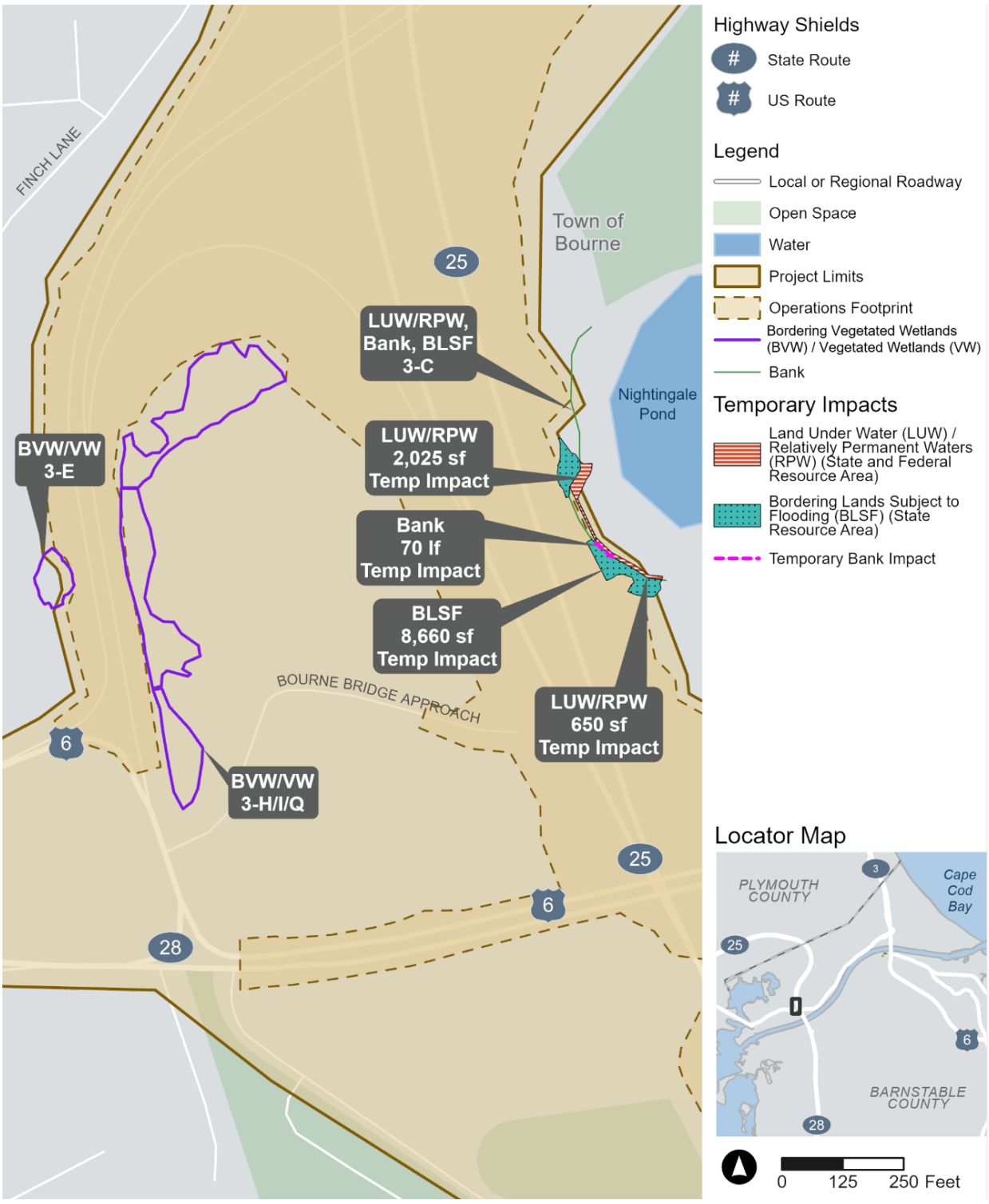
Organized by the location of the construction activities, the following subsections discuss resource area impacts, design considerations to avoid impacts, measures to avoid and minimize impacts, and mitigation for unavoidable impacts. The Sagamore and Bourne interchange approaches would also occupy the 100-foot buffer zone to state wetlands. Activities within the buffer zone would include temporary construction work zones, installation of permanent highway ramps and shared-use paths (SUPs), landscaping, and mitigation areas.

Potential Impacts to State and Federal Inland Wetland Resource Areas

Construction in the Sagamore North quadrant, Sagamore South quadrant, and Bourne South quadrant interchange approaches would not result in impacts to inland wetland resources. However, part of this work would occur proximal to two vernal pools (**Table 4.10-8**), one in Sagamore North quadrant (Vernal Pool #555) and one in Bourne South quadrant (Vernal Pool #8258) interchange approaches. Work is proposed within 75 feet of Vernal Pool #555, but the work would be separated by a roadway. Vernal Pool #8258 is located along the driveway of a car wash, north of Angelo Drive. Approximately 1,150 square feet of the existing driveway within 100 feet of the vernal pool would be repaved.

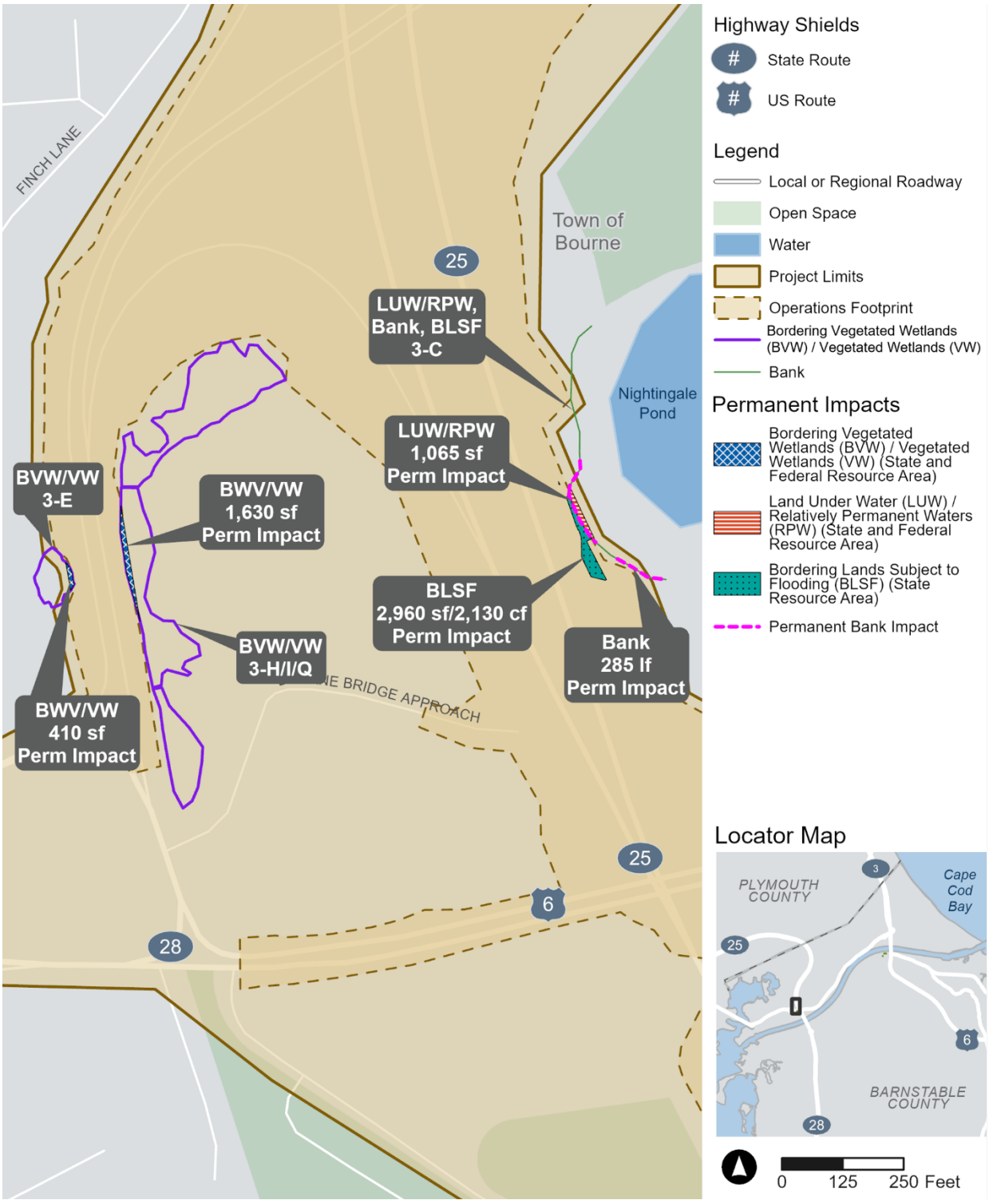
The Bourne North Interchange Approach would include roadway widening, additional lanes, and/or accommodations for a SUP in three locations that would affect state and federal wetlands. In each location, retaining walls would be constructed to minimize the extent of fill in jurisdictional resources. The temporary alteration at Nightingale Pond would allow for an 11.5-foot-wide work zone to construct a retaining wall. For post-construction, this 11.5-foot-wide work zone would be narrowed to a 10-foot-wide grass surface access path for future maintenance purposes during operations. The 10-foot-wide path would be considered a permanent impact. Unavoidable impacts to wetlands are presented in **Figure 4.10-16** and **Figure 4.10-17** and described and quantified in **Table 4.10-9**. Details on proposed conditions for the Program are provided in **Appendix 3.2, Proposed Condition Plans**.

Figure 4.10-16. Potential Temporary Impacts to State Inland Wetland Resource Areas (Bourne North Quadrant Interchange Approach)



Source: Massachusetts Department of Transportation, 2025

Figure 4.10-17. Potential Permanent Impacts to State and Federal Inland Wetland Resource Areas (Bourne North Quadrant Interchange Approach)



Source: Massachusetts Department of Transportation, 2025

Table 4.10-8. Potential Work for Sagamore North Quadrant and Bourne North Quadrant Interchange Approaches Proximate to Vernal Pools

Survey Area/ Wetland ID[1]	Vernal Pool ID[2]	Vernal Pool ID[3]	Work Within 100 Feet of Resource	Comment
Sagamore North/ BVW 1-E	05DN	Certified #555	Roadway widening for extension of acceleration lane within 75 feet of Vernal Pool	Work to occur along State Route 3 northbound and separated by State Road.
Bourne South/ BVW	07MA	Certified #8258	Work limited to repaving 1,150 square feet of existing driveway	Work to occur approximately 70 feet from Vernal Pool

[1] As identified in the Abbreviated Notice of Resource Area Delineation (HNTB 2021, 2022) and additional field investigations.

[2] As identified in Stantec (2020).

[3] As identified by Massachusetts Department of Fish and Wildlife Natural Heritage and Endangered Species Program.

Table 4.10-9. Potential Impacts to State and Federal Inland Wetland Resource Areas

Resource[1]	Temporary Impacts	Permanent Impacts	Reason for Impact
BVW 3-E *VW 3-E*[2]	—	410 square feet (<0.01 acre)	Fill for widening State Route 25 east- and westbound off-ramps to U.S. Route 6/State Route 28 and add second travel lane
BVW 3-H/I/Q *VW 3-H/I/Q*[2]	—	1,630 square feet (0.03 acre)	Fill for widening State Route 25 east- and westbound on-ramps from U.S. Route 6/State Route 28 and accommodate SUP
LUW 3-C *RPW 3-H/Q/I*[2]	2,675 square feet (0.06 acre)	1,065 square feet (0.02 acre)	Fill for new westbound on-ramp to State Route 25 from U.S. Route 6 and add auxiliary lane on State Route 25 westbound
Bank 3-C	70 linear feet	285 linear feet	Fill for new westbound on-ramp to State Route 25 from U.S. Route 6 and add auxiliary lane on State Route 25 westbound
BLSF 3-C	8,660 square feet	2,960 square feet 2,130 cubic feet	Fill for new westbound on-ramp to State Route 25 from U.S. Route 6 and add auxiliary lane on State Route 25 westbound

[1] As identified in the Abbreviated Notice of Resource Area Delineation (HNTB 2021, 2022) and additional field investigations.

[2] Identified as federally regulated Waters of the United States.

Potential Impacts to State and Federal Coastal Resource Areas

Replacing the Sagamore and Bourne bridges would remove eight piers from below MHW and construct eight new piers in Cape Cod Canal. Each bridge would be supported by four new piers to accommodate both the north- and southbound decks over Cape Cod Canal. Each pier would be partially located within the riprap banks of the canal shoreline and partially below MHW and HTL.

Temporary structures would include barge docks, cofferdams surrounding the work areas for pier removal and installation, and bulkheads to create a level work area platform on two sides of each pier cofferdam and pile-supported work trestles. These temporary structures would facilitate work from above the water surface, and bollards and pile-supported dolphins to accommodate work barges. The existing riprap along the shoreline would be temporarily removed to accommodate the sheet pile installations. Excavation would occur to remove the existing piers to a minimum of two feet below the mudline and to install the new piers. Dredging would also be required to facilitate marine vessel access to the temporary work structures. Temporary impacts to state and federal coastal resources are shown in **Figure 4.10-18 through Figure 4.10-25**, which are represented on two sets of figures due to the overlap of the trestles and other structures.

Most of the temporary occupations of water sheet below the MHW and HTL would extend to the limit of the navigational channel boundary. For temporary alterations to resource areas, the proposed bridge pier construction along the north and south sides of the canal at the Sagamore and Bourne Bridges would occupy an in-water work zone that varies between 80,000 and 90,000 square feet at each set of piers, this is the area expected to be needed by the design-build contractor to stage, access, and construct the new piers and demolish the existing piers. Following construction, all temporary structures would be removed.

Permanent structures would include the new bridge piers and their foundations and riprap protection. The eelgrass beds within the Bourne North and Bourne South quadrants would be permanently impacted by the proposed pier protection riprap. Permanent impacts to state and federal coastal resources are shown in **Figure 4.10-26 through Figure 4.10-29**.

Table 4.10-10 and **Table 4.10-11** summarize the potential temporary and permanent impacts to state and federal coastal resources for the Sagamore and Bourne Bridges. **Table 4.10-12 through Table 4.10-15** provide detailed assessments of these impacts by proposed activity for each bridge quadrant.

Note: The following is provided in support of the information presented in **Table 4.10-10 through Table 4.10-15**:

- Quantities are provided below HTL as an estimate based on the current level of design. Future permit applications will include dredge quantities below MHW based on regulatory requirements.
- LSCSF impacts are calculated for permanent impacts or losses only.
- The temporary and permanent impacts to resource areas presented herein are preliminary and subject to change as the design advances.

- The Build Alternative would result in temporary impacts to Coastal Bank, which occurs along the width of the Project Limits at both bridges.
- The Build Alternative would result in impacts to Land Containing Shellfish and Land Under the Ocean underlying an Anadromous/Catadromous Fish Run, both of which are regulated under the Massachusetts Wetlands Protection Act and its implementing regulations. Impacts to Land Containing Shellfish are calculated by summing impacts to LUO and RIS. Impacts to Land Under the Ocean underlying an Anadromous/Catadromous Fish Run are calculated by summing impacts to LSTA and LUO. Because these impact values are calculated from a subset of resource area impacts already reflected in the tables, they are not listed separately.
- The Massachusetts Department of Transportation (MassDOT) is coordinating the design of the bridge pier protection system with the USACE. As design advances, MassDOT will finalize the area of protection and quantities of riprap, which will be included in the Final Environmental Impact Report and federal and state permit applications.

Table 4.10-10. Potential Impacts to State and Federal Coastal Resource Areas (Sagamore Bridge)

Resource Area		Temporary Impacts	Permanent Impacts	Reason for Impact
Federal	WOTUS	121,675 square feet (2.79 acres)	54,035 sf (1.24 acres)	• Temporary: cofferdams, bulkheads, shoreline sheeting, trestles, bollards, docks, and dolphins • Permanent: new bridge piers and riprap pier protection
	WOTUS – (Excavation/ Dredge)	51,000/139,600 square feet (1.17/3.20 acres) 28,000/39,000 cubic yards	Refer to note [1]	• Excavation within cofferdams and dredge for navigation access to temporary structures and riprap/structure removal
State	Land Under Ocean	68,799 square feet	38,523 square feet	• Temporary: cofferdams, bulkheads, work trestle piles, bollards, docks, dolphins, and excavation/dredge • Permanent: piers and riprap pier protection
	Coastal Bank	1,299 linear feet	420 linear feet	• Temporary: cofferdams, shoreline sheeting, work trestle piles, bollards, and docks • Permanent: piers and riprap pier protection

Resource Area		Temporary Impacts	Permanent Impacts	Reason for Impact
	Rocky Intertidal Shore	Refer to note [1]	1,652 square feet	• Temporary: cofferdams and work trestle piles • Permanent: piers and riprap pier protection
	Land Subject to Tidal Action	52,876 square feet	17,112 square feet	• Temporary: cofferdams, shoreline sheet piles, bulkhead, work trestle piles, bollards, docks, dolphins, and excavation/dredge • Permanent: piers and riprap pier protection
	Land Subject to Coastal Storm Flowage	—	6,900 square feet	• Temporary: cofferdams, work trestle piles, bollards, and docks • Permanent: piers and riprap pier protection

[1] The Massachusetts Department of Transportation (MassDOT) is coordinating the design of the bridge pier protection system with the U.S. Army Corps of Engineers. As design advances, MassDOT will finalize the area of protection and quantities of riprap, which will be included in the Final Environmental Impact Report and federal and state permit applications.

Table 4.10-11. Potential Impacts to State and Federal Coastal Resource Areas (Bourne Bridge)

Resource Area		Temporary Impacts	Permanent Impacts	Reason for Impact
Federal	WOTUS	119,730 square feet (2.75 acres)	53,510 square feet (1.23 acres)	• Temporary: cofferdams, bulkheads, shoreline sheeting, trestle, bollards, docks, and dolphins • Permanent: new bridge piers and riprap pier protection (Includes 2,445 square feet of impact to eelgrass beds)
	WOTUS - dredge	51,000/139,600 square feet (1.17/3.20 acres) 28,000/39,000 cubic yards	Refer to note [1]	• Excavation within cofferdams and dredge for navigation access to temporary structures and riprap/structure removal

Resource Area		Temporary Impacts	Permanent Impacts	Reason for Impact
State	Land Under Ocean (square feet)	71,296 square feet	38,445 square feet	• Temporary: cofferdams, bulkheads, work trestle piles, bollards, docks, dolphins and excavation/dredge • Permanent: piers and riprap pier protection
	Coastal Bank (linear feet)	1,300 linear feet	440 linear feet	• Temporary: cofferdams, shoreline sheeting, work trestle piles, bollards, and docks • Permanent: piers and riprap pier protection
	Rocky Intertidal Shore (square feet)	1,167 square feet	Refer to note [1]	• Temporary: bulkheads and excavation/dredge • Permanent: piers and riprap pier protection
	Land Subject to Tidal Action	47,267 square feet	15,118 square feet	• Temporary: cofferdams, shoreline sheet piles, bulkhead, work trestle piles, bollards, docks, dolphins and excavation/dredge • Permanent: piers and riprap
	Land Subject to Coastal Storm Flowage	—	9,000 square feet	• Temporary: cofferdams, work trestle piles, bollards, and docks • Permanent: piers and riprap pier protection

[1] The Massachusetts Department of Transportation (MassDOT) is coordinating the design of the bridge pier protection system with the U.S. Army Corps of Engineers. As design advances, MassDOT will finalize the area of protection and quantities of riprap, which will be included in the Final Environmental Impact Report and federal and state permit applications.

Table 4.10-12. Detailed Potential Impacts to State and Federal Coastal Resource Areas (Sagamore North Quadrant)

Activity	Federal Impacts Below High Tide Line	State Impacts	Excavation/Dredge Below High Tide Line
Sagamore North: Temporary Impacts			
Cofferdams, shoreline sheeting, bulkheads, docks and excavation/dredge	• 55,260 square feet (1.27 acres)	• 31,604 square feet Land Under Ocean (LUO) • 856 linear feet Coastal Bank (CB) • 23,656 square feet Land Subject to Tidal Action (LSTA)	—
Trestle and dolphins	• 5,425 square feet (0.12 acre)	5,425 square feet LUO	—
Excavation within cofferdams and dredge for navigation access to temporary structures and riprap/structure removal	—	—	• 25,500/69,800 square feet (0.59/1.60 acres) • 14,000/19,500 cubic yards
Sagamore North: Permanent Impacts			
New bridge piers	• 3,771 square feet (0.09 acre)	• 123 square feet LUO • 160 linear feet CB • 3,629 square feet LSTA • 2,648 square feet Land Subject to Coastal Storm Flowage	—
Riprap pier protection	• 24,000 square feet (0.55 acre)	• 19,200 square feet LUO • 1,652 square feet Rocky Intertidal Shore • 4,800 square feet LSTA	—

Table 4.10-13. Detailed Potential Impacts to State and Federal Coastal Resources (Sagamore South Quadrant)

Activity	Federal Impacts Below High Tide Line	State Impacts	Excavation/Dredge Below High Tide Line
Sagamore South: Temporary Impacts			
Cofferdams shoreline sheeting, bulkheads, docks, and excavation/ dredge	• 55,565 square feet (1.28 acres)	• 26,345 square feet Land Under the Ocean (LUO) • 863 linear feet Coastal Bank • 29,220 square feet Land Subject to Tidal Action (LSTA)	—
Trestle and dolphins	• 5,425 square feet (0.12 acre)	• 5,425 square feet LUO	—
Excavation within cofferdams and dredge for navigation access to temporary structures and riprap/structure removal	—	—	• 25,500/69,800 square feet (0.59/1.60 acres) • 14,000/19,500 cubic yards
Sagamore South: Permanent Impacts			
New bridge piers	• 2,264 square feet (0.52 acre)	• 3,883 square feet LSTA • 2,517 square feet Land Subject to Coastal Storm Flowage	—
Riprap pier protection	• 24,000 square feet (0.55 acre)	• 19,200 square feet LUO • 4,800 square feet LSTA	—

Table 4.10-14. Detailed Potential Impacts to State and Federal Coastal Resources (Bourne North Quadrant)

Activity	Federal Impacts Below High Tide Line	State Impacts	Excavation/Dredge Below High Tide Line
Bourne North: Temporary Impacts			
Cofferdams, shoreline sheeting, bulkheads, docks, and excavation/ dredge	• 54,190 square feet (1.24 acre)	• 24,427 square feet Land Under the Ocean (LUO) • 875 linear feet Coastal Bank (CB) • 1,167 square feet Rocky Intertidal Shore (RIS) • 28,596 square feet Land Subject to Tidal Action (LSTA)	—
Trestle and dolphins	• 5,425 square feet (0.12 acre)	• 5,425 square feet LUO	—
Excavation within cofferdams and dredge for navigation access to temporary structures and riprap/structure removal	—	—	• 25,500/69,800 square feet (0.59/1.60 acres) • 14,000/19,500 cubic yards
Bourne North: Permanent Impacts			
New bridge piers	• 2,181 square feet (0.05 acre)	• 160 linear feet CB • 2,448 square feet LSTA • 3,952 square feet Land Subject to Coastal Storm Flowage	—
Riprap pier protection	• 24,000 square feet (0.55 acre)[1]	• 19,200 square feet LUO • 4,800 square feet LSTA	—

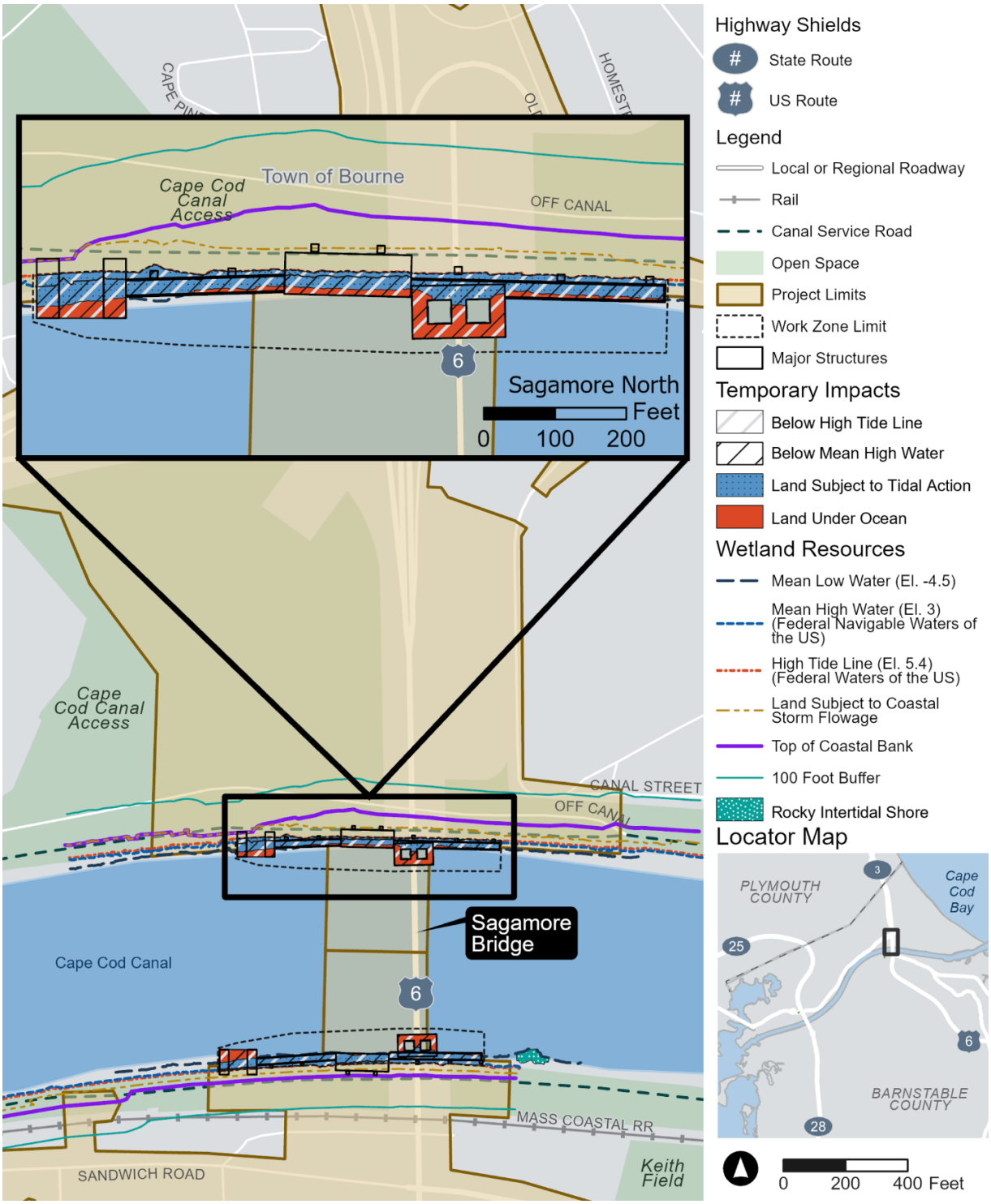
[1] Includes eelgrass bed impact of 2,345 square feet.

Table 4.10-15. Detailed Potential Impacts to State and Federal Coastal Resources (Bourne South Quadrant)

Activity	Federal Impacts Below High Tide Line	State Impacts	Excavation/Dredge Below High Tide Line
Bourne South: Temporary Impacts			
Cofferdams, shoreline sheeting, bulkheads, docks, and excavation/dredge	• 54,690 square feet (1.26 acre)	• 36,019 square feet Land Under the Ocean (LUO) • 867 linear feet Coastal Bank (CB) • 18,671 square feet Land Subject to Tidal Action (LSTA)	—
Trestle and dolphins	• 5,425 square feet (0.12 acre)	• 5,425 square feet LUO	—
Excavation within cofferdams and dredge for navigation access to temporary structures and riprap/structure removal	—	—	• 25,500/69,800 square feet (0.59/1.60 acres) • 14,000/19,500 cubic yards
Bourne South: Permanent Impacts			
New bridge piers	• 3,329 square feet (0.08 acre)	• 45 square feet LUO • 160 linear feet CB • 3,070 square feet LSTA • 3,285 square feet Land Subject to Coastal Storm Flowage	—
Riprap pier protection	• 24,000 square feet (0.55 acre)[1]	• 19,200 square feet LUO • 4,800 square feet LSTA	—

[1] Includes eelgrass bed impact of 100 square feet.

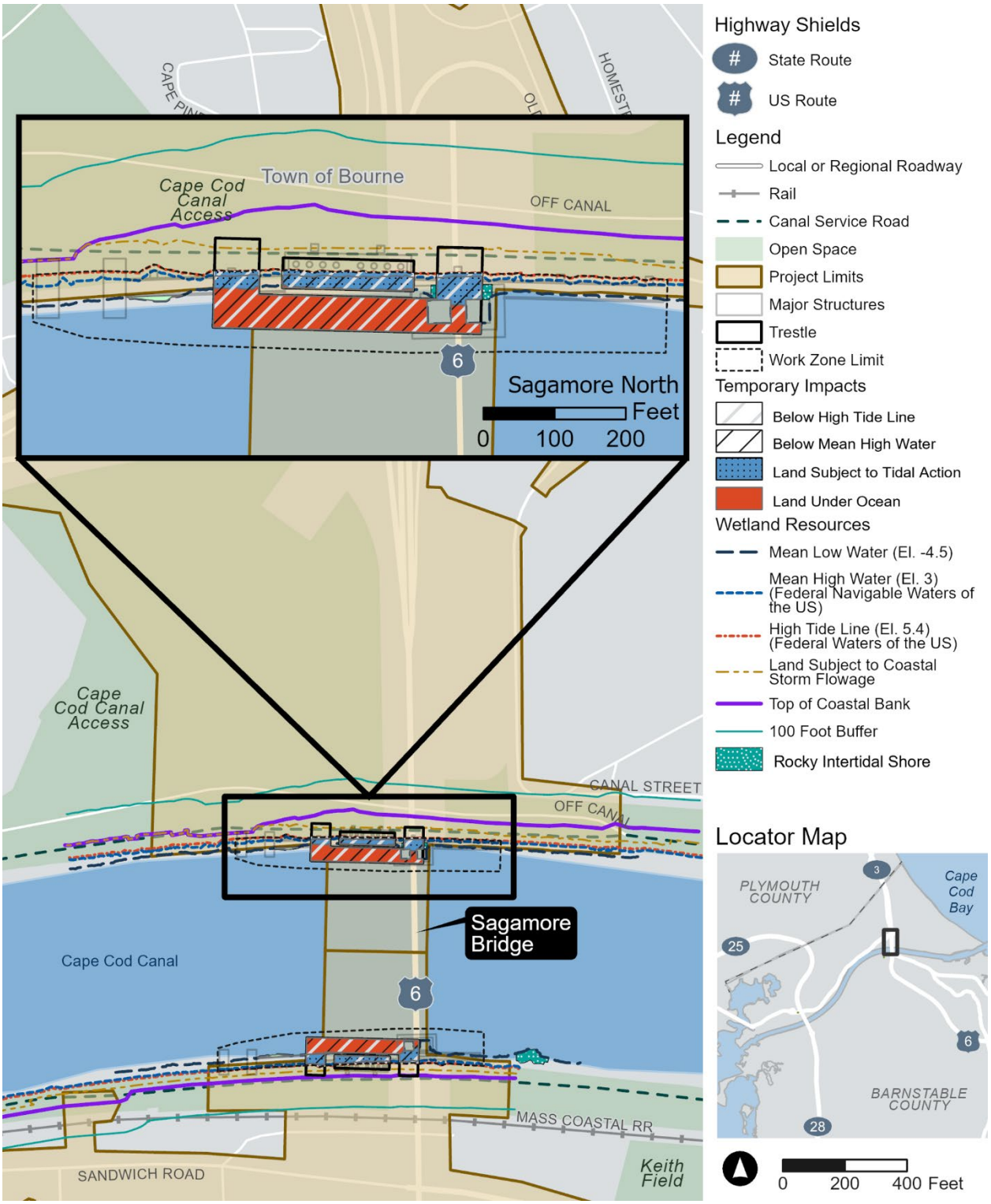
Figure 4.10-18. Potential Temporary Impacts to State and Federal Coastal Resource Areas (Sagamore North Quadrant)



Source: Massachusetts Department of Transportation, 2025

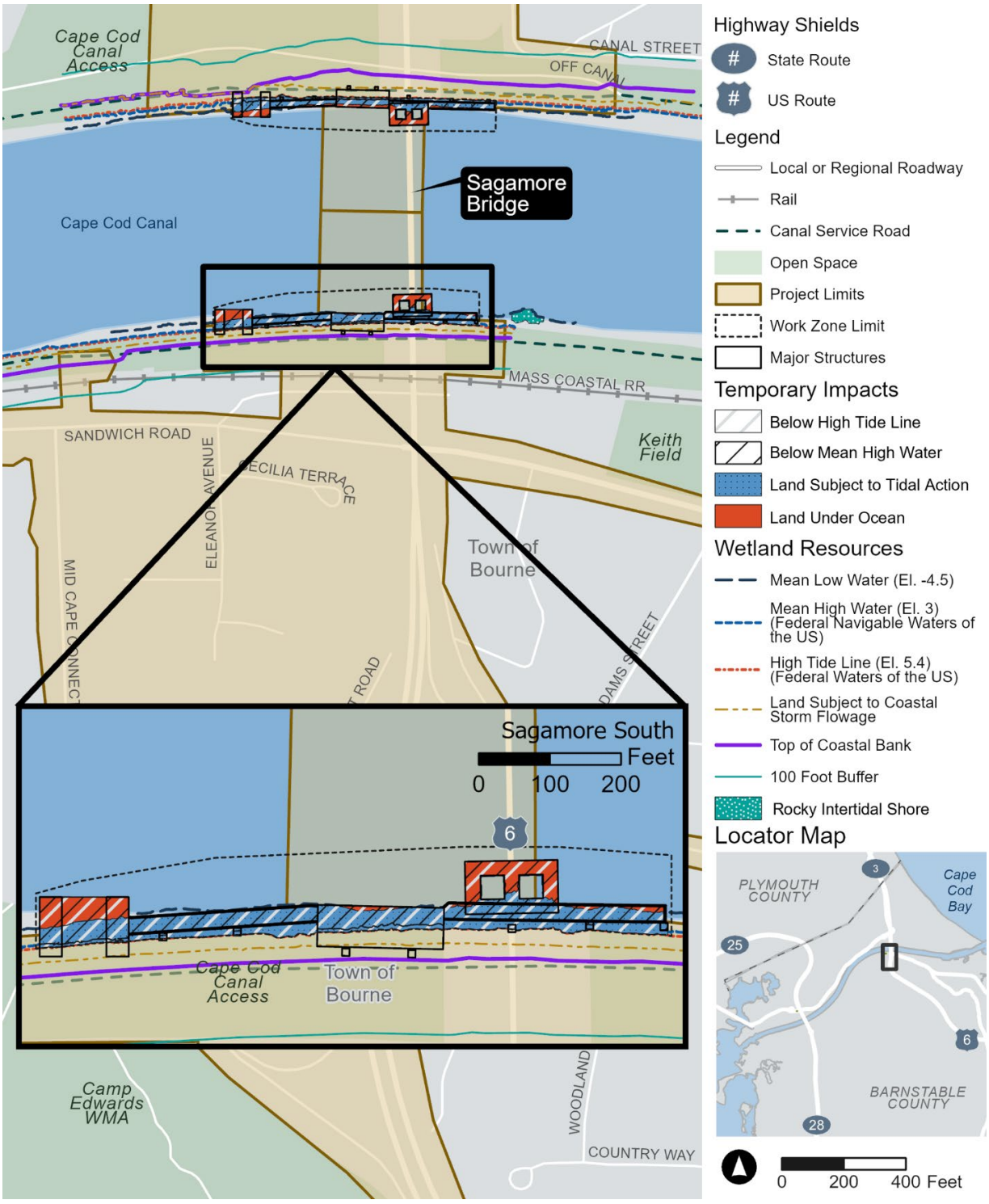
Note: Approximately 69,800 square feet/19,500 cubic yards of dredging will be required within the work zone. For visual clarity, impacts to Coastal Bank areas are not depicted in this figure.

Figure 4.10-19. Potential Temporary Trestle Impacts to State and Federal Coastal Resource Areas (Sagamore North Quadrant)



Source: Massachusetts Department of Transportation, 2025

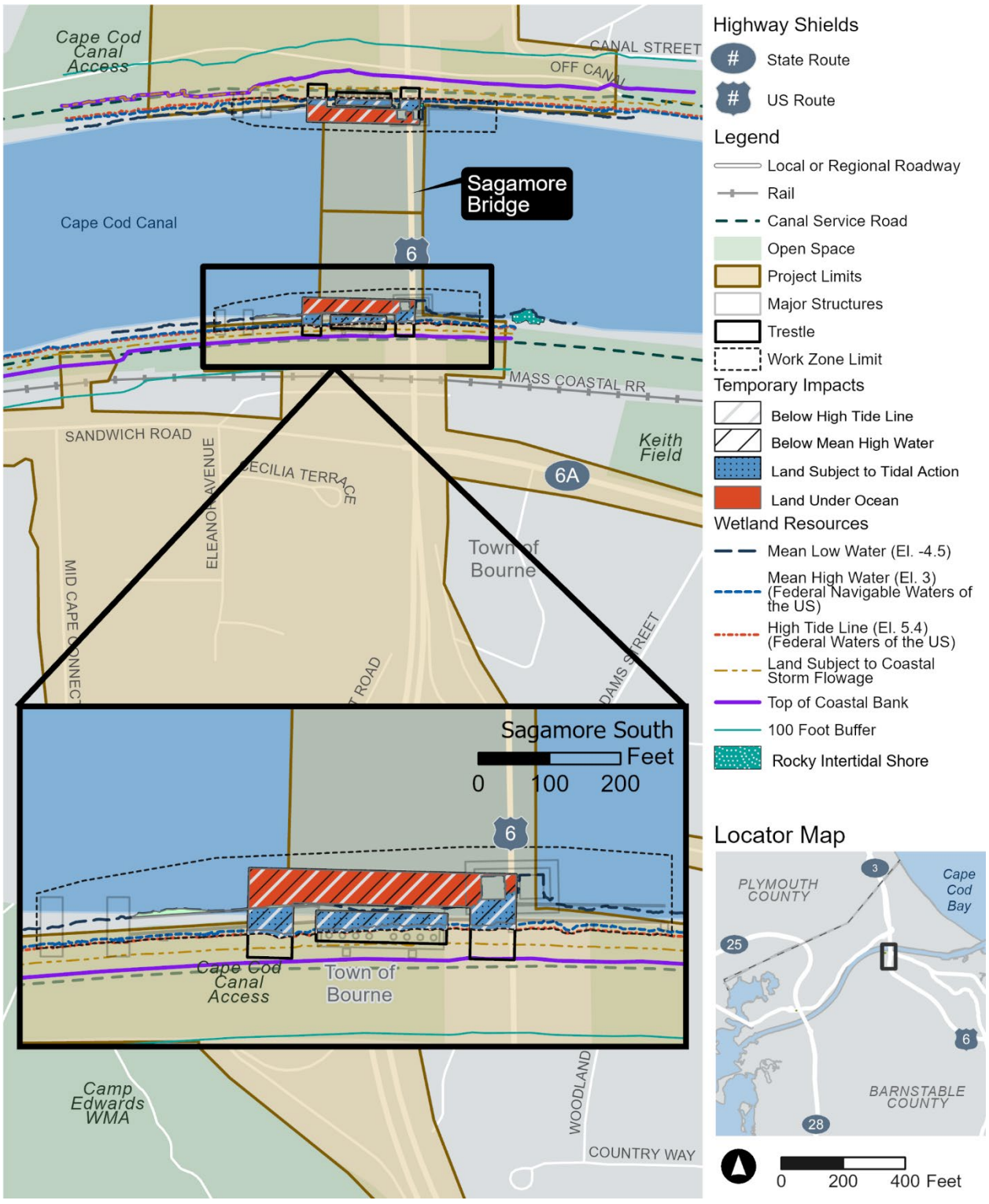
Figure 4.10-20. Potential Temporary Impacts to State and Federal Coastal Resource Areas (Sagamore South Quadrant)



Source: Massachusetts Department of Transportation, 2025

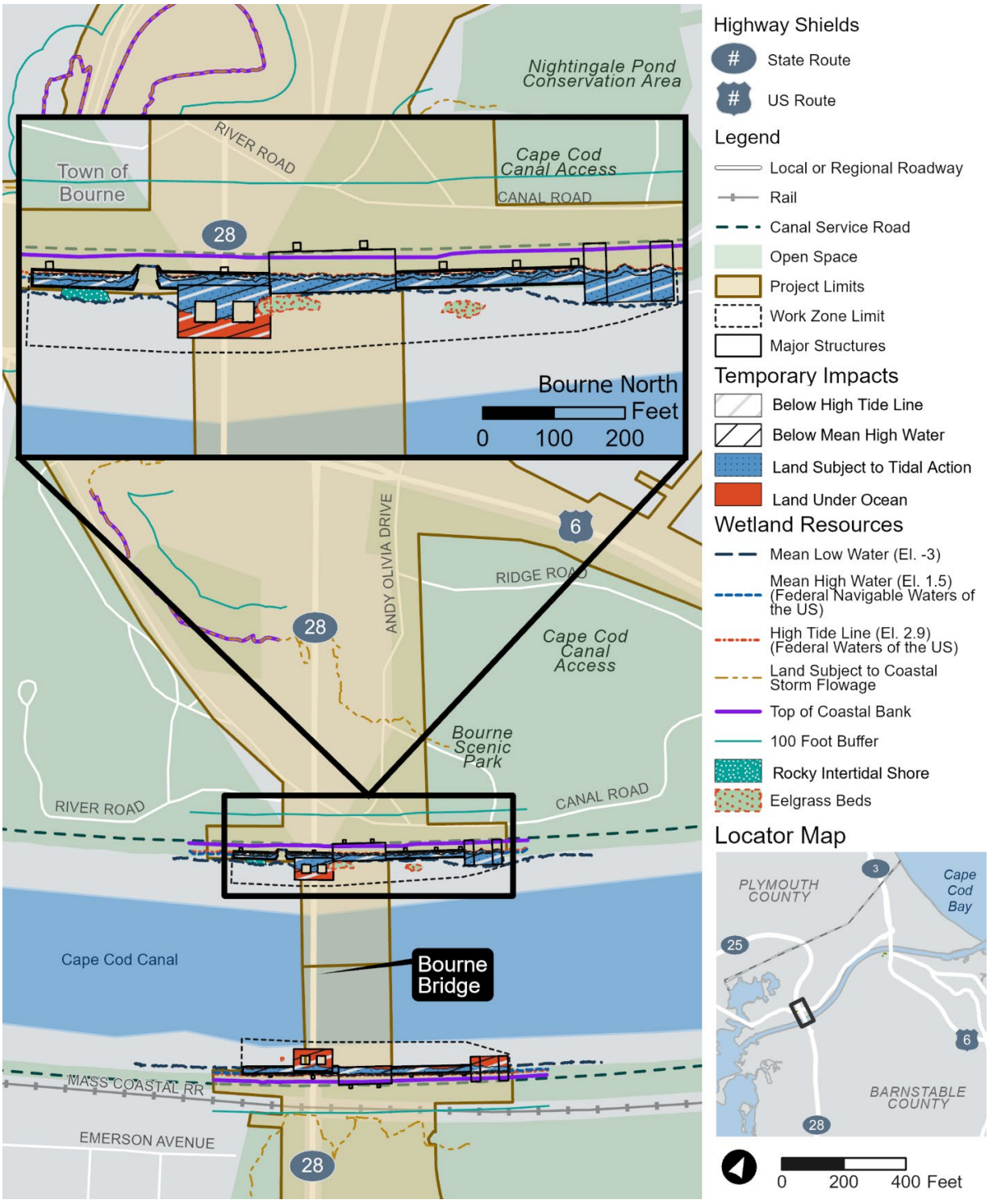
Note: Approximately 69,800 square feet/19,500 cubic yards of dredging will be required within the work zone. For visual clarity, impacts to Coastal Bank areas are not depicted in this figure.

Figure 4.10-21. Potential Temporary Trestle Impacts to State and Federal Coastal Resource Areas (Sagamore South Quadrant)



Source: Massachusetts Department of Transportation, 2025

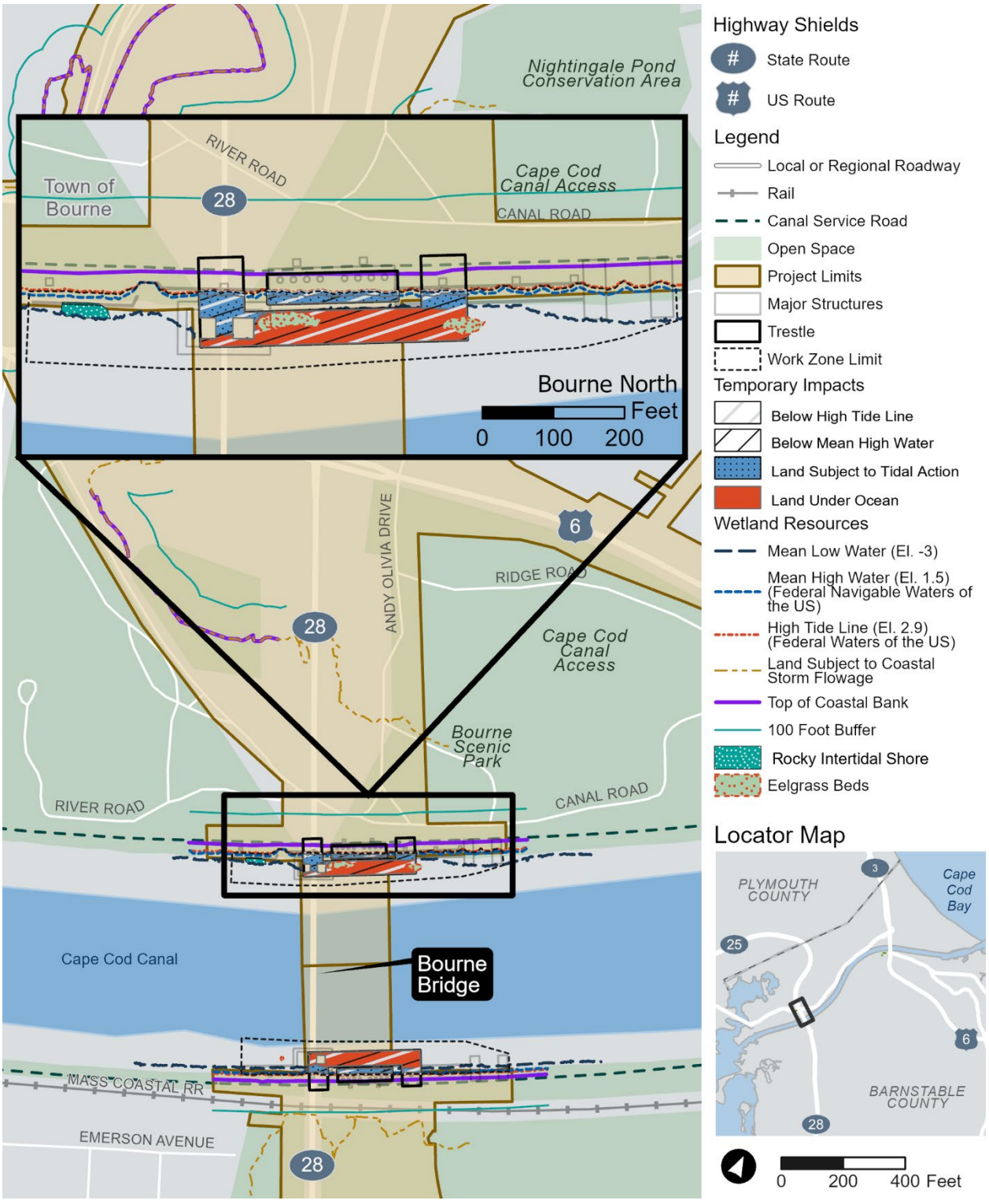
Figure 4.10-22. Potential Temporary Impacts to State and Federal Coastal Resource Areas (Bourne North Quadrant)



Source: Massachusetts Department of Transportation, 2025

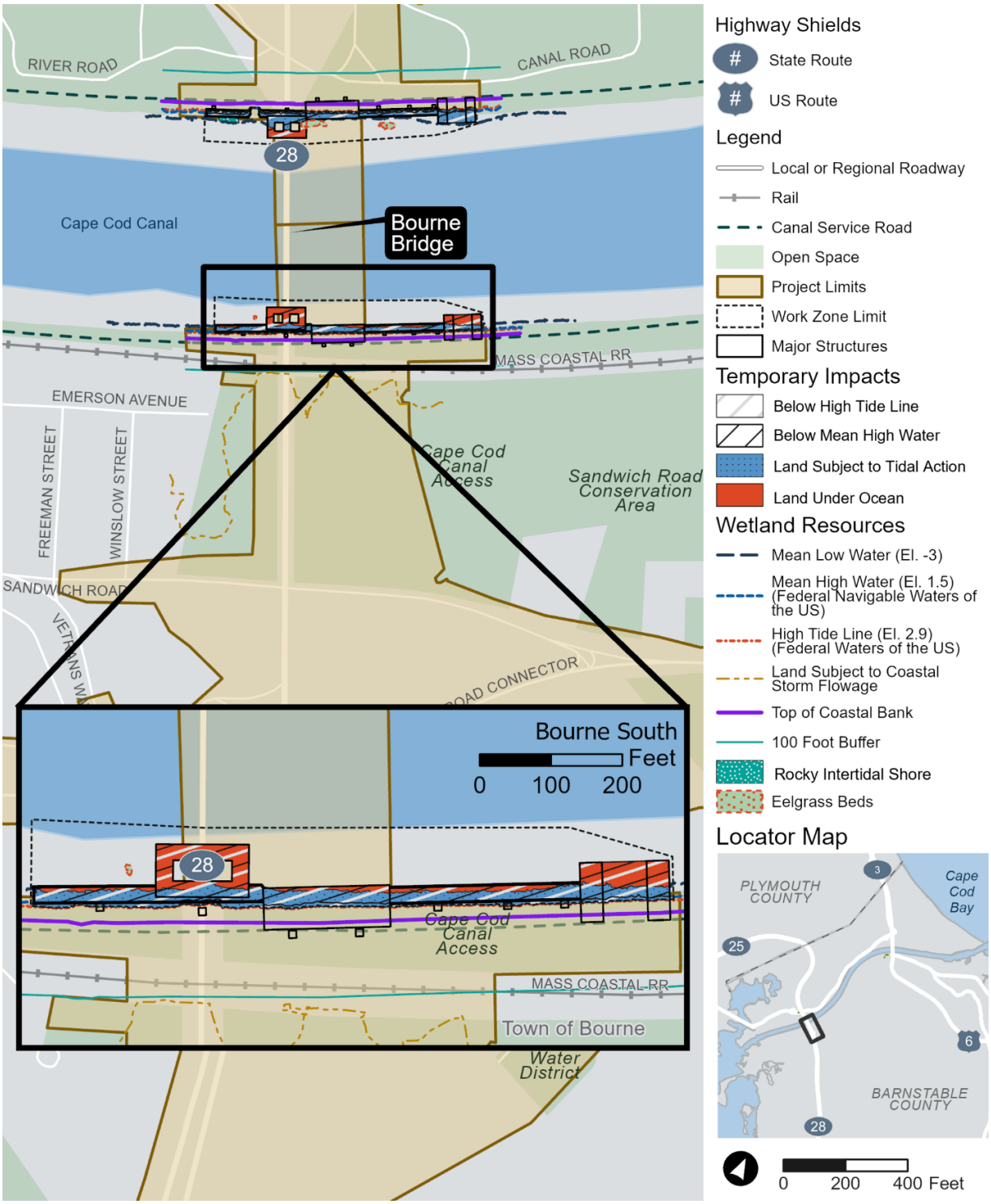
Note: Approximately 69,800 square feet/19,500 cubic yards of dredging will be required within the work zone. For visual clarity, impacts to Coastal Bank areas are not depicted in this figure.

Figure 4.10-23. Potential Temporary Trestle Impacts to State and Federal Coastal Resource Areas (Bourne North Quadrant)



Source: Massachusetts Department of Transportation, 2025

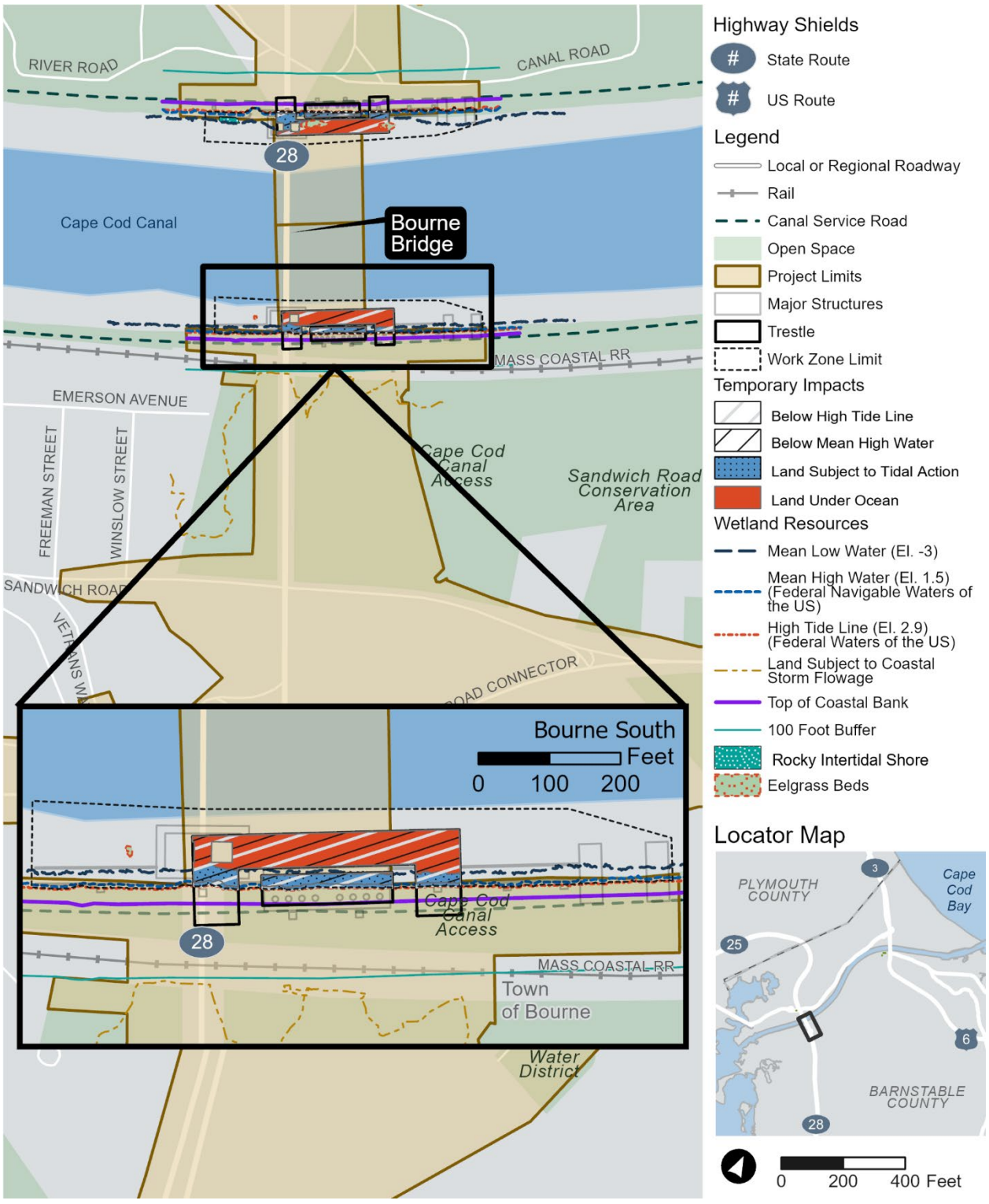
Figure 4.10-24. Potential Temporary Impacts to State and Federal Coastal Resource Areas (Bourne South Quadrant)



Source: Massachusetts Department of Transportation, 2025

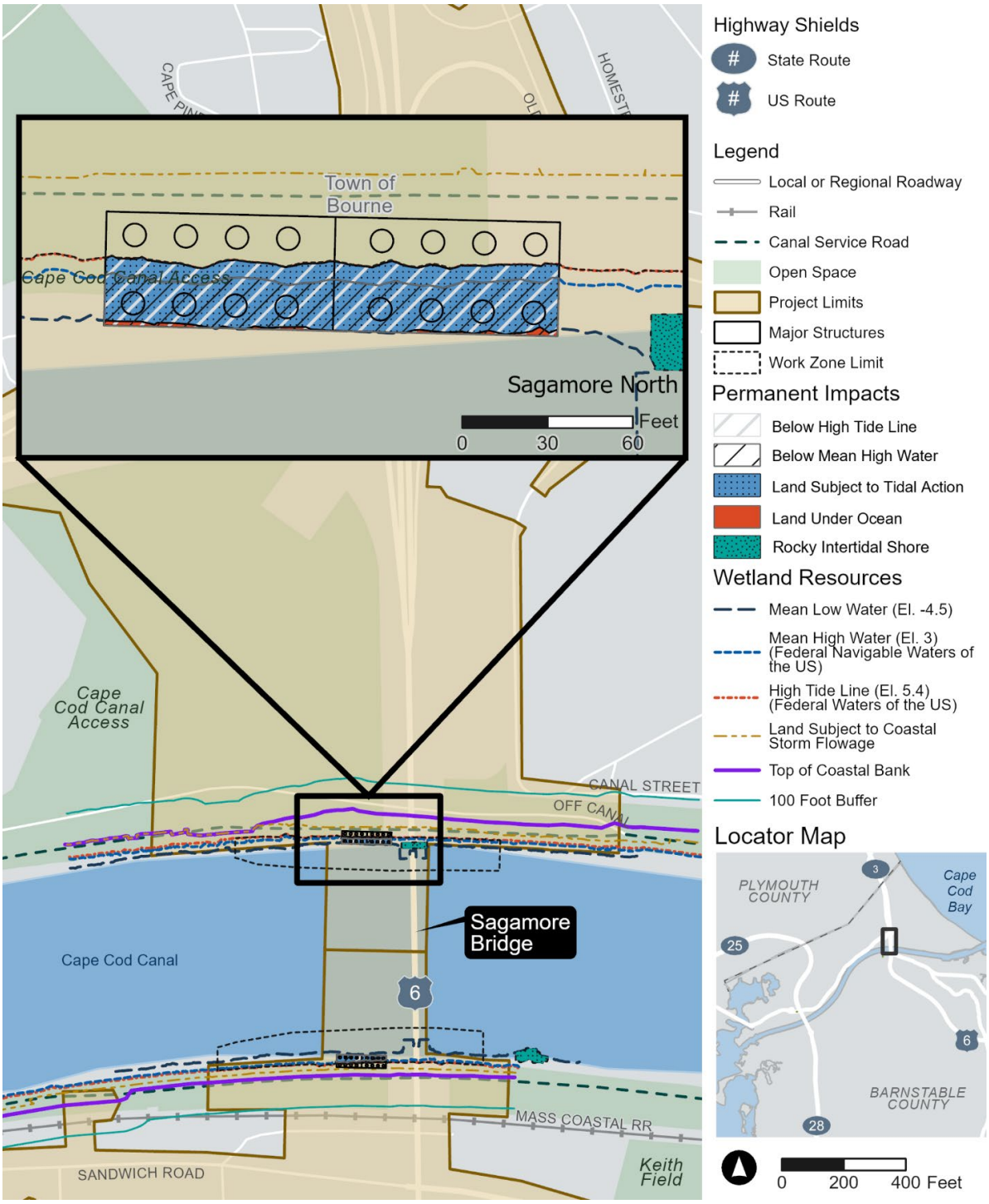
Note: Approximately 69,800 square feet/19,500 cubic yards of dredging will be required within the work zone. For visual clarity, impacts to Coastal Bank areas are not depicted in this figure.

Figure 4.10-25. Potential Temporary Trestle Impacts to State and Federal Coastal Resource Areas (Bourne South Quadrant)



Source: Massachusetts Department of Transportation, 2025

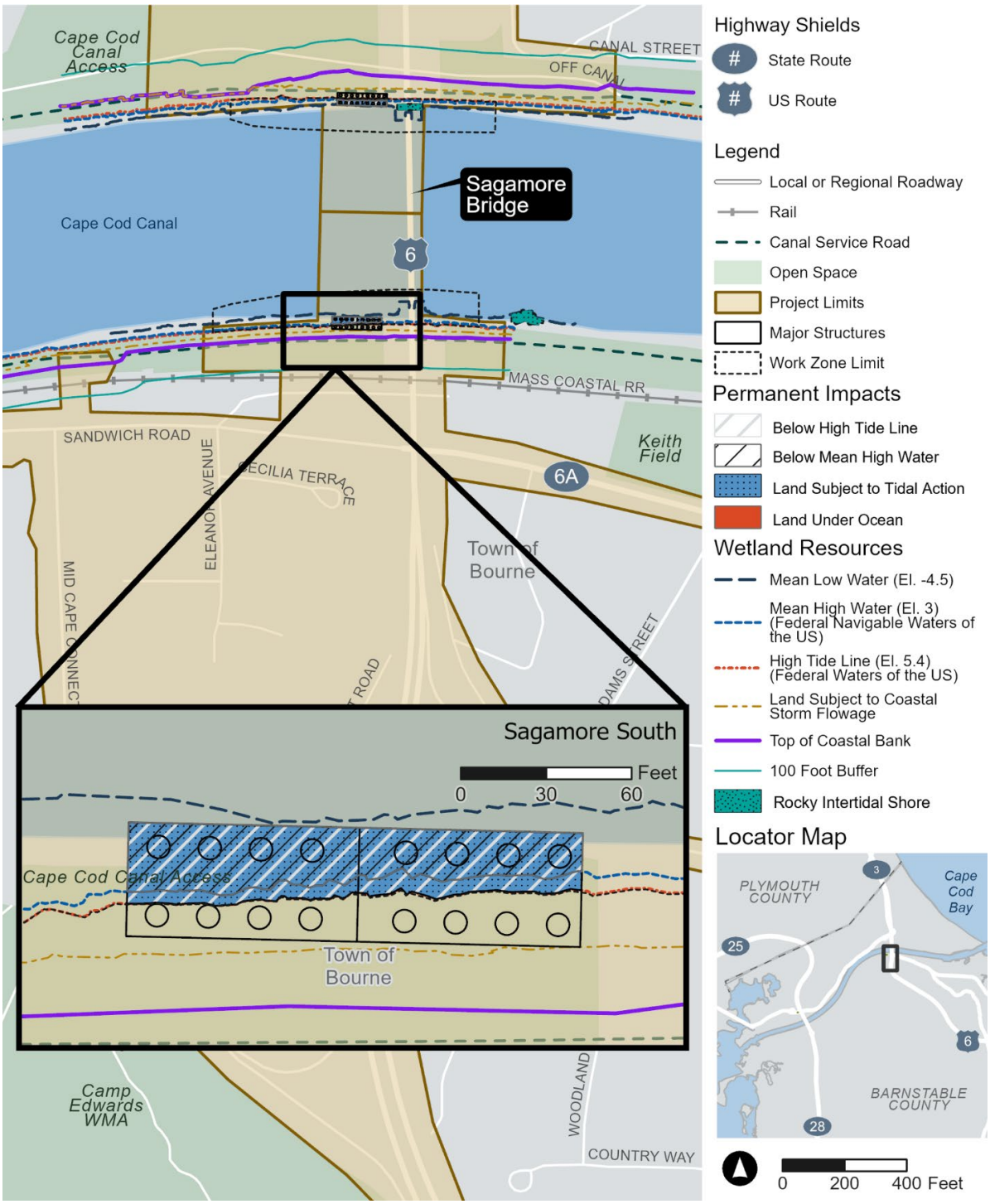
Figure 4.10-26. Potential Permanent Impacts to State and Federal Coastal Resource Areas (Sagamore North Quadrant)



Source: Massachusetts Department of Transportation, 2025

Note: Approximately 24,000 square feet of riprap for pier protection will occur below High Tide Line. Additionally, 34,000 square feet/7,000 cubic yards of post-construction dredging will be required. The footprint for both will be developed during design advancement.

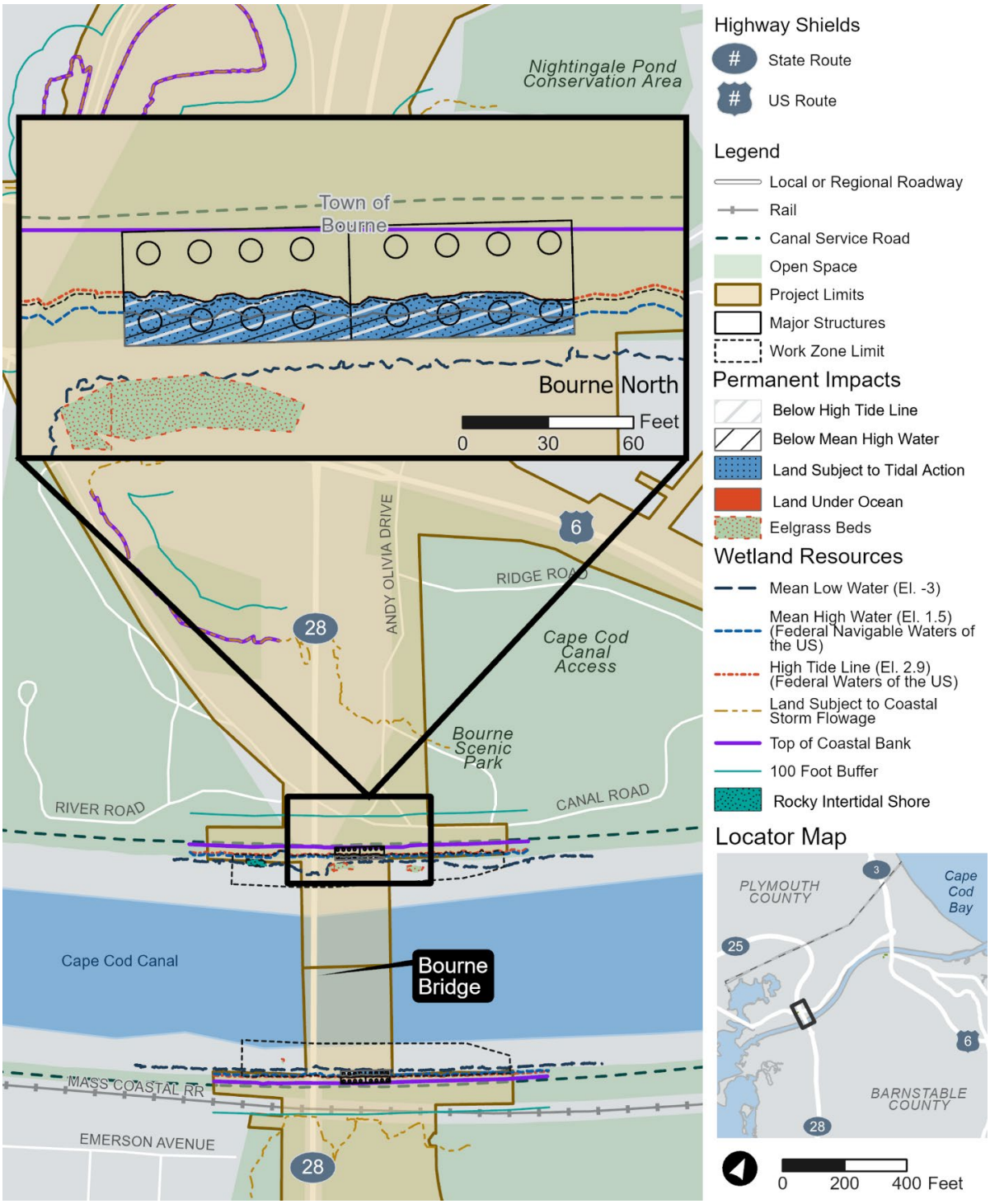
Figure 4.10-27. Potential Permanent Impacts to State and Federal Coastal Resource Areas (Sagamore South Quadrant)



Source: Massachusetts Department of Transportation, 2025

Note: Approximately 24,000 square feet of riprap for pier protection will occur below the High Tide Line; additionally, 34,000 sf/7,000 cubic yards of post-construction dredging will be required. The footprint for both will be developed during design advancement.

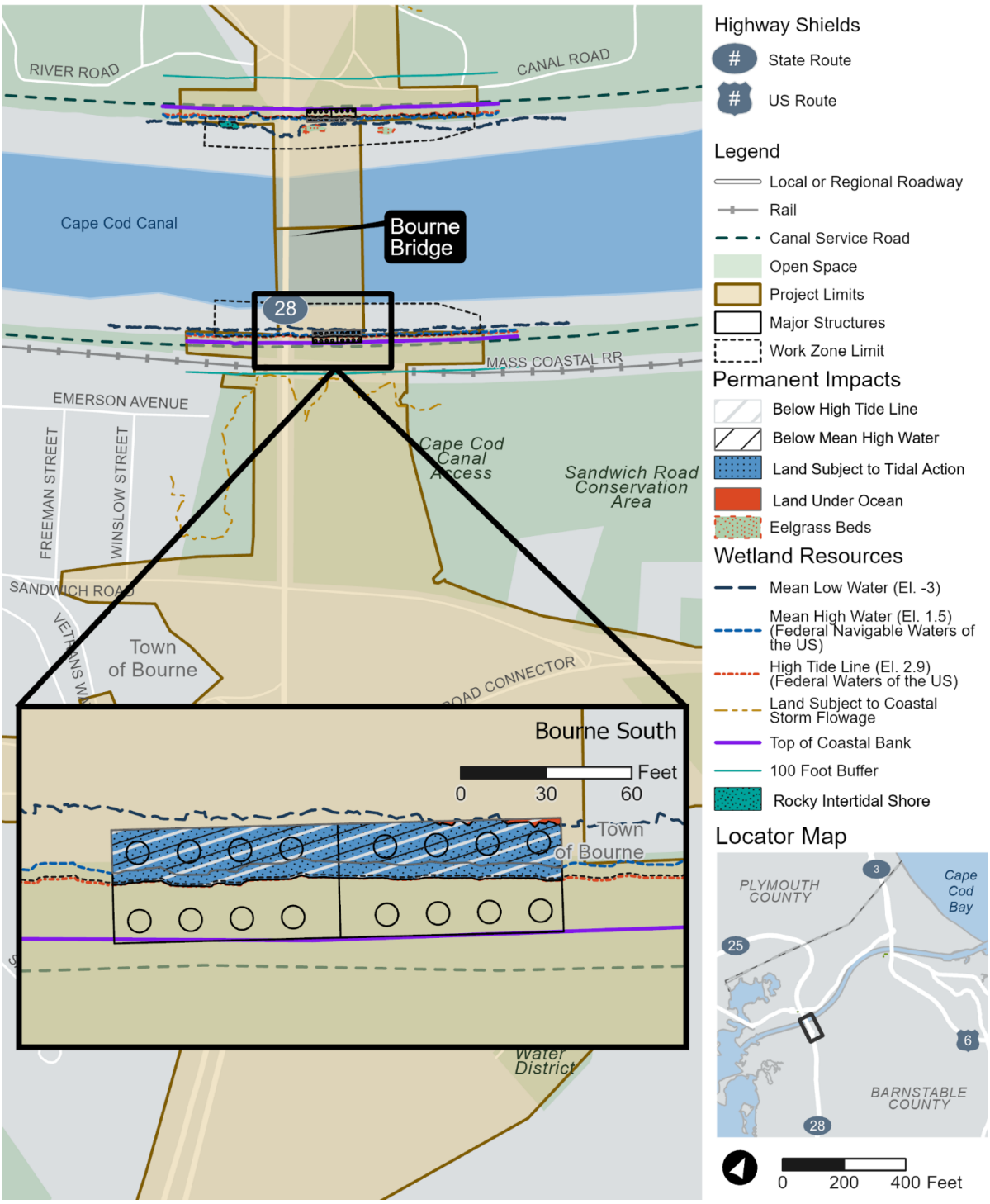
Figure 4.10-28. Potential Permanent Impacts to State and Federal Coastal Resource Areas (Bourne North Quadrant)



Source: Massachusetts Department of Transportation, 2025

Note:Approximately 24,000 square feet of riprap for pier protection will occur below high tide level. Additionally, 34,000 square feet/7,000 cubic yards of post-construction dredging will be required. The footprint for both will be developed during design advancement.

Figure 4.10-29. Potential Permanent Impacts to State and Federal Coastal Resource Areas (Bourne South Quadrant)



Source: Massachusetts Department of Transportation, 2025

Note:Approximately 24,000 square feet of rip rap for pier protection will occur below High Tide Line; additionally, 34,000 square feet/7,000 cubic yards of post-construction dredging will be required. The footprint for both will be developed during design advancement.

Indirect Impacts

Indirect impacts are those impacts which are caused by the action and are later in time or farther removed in distance but are still reasonably foreseeable. Indirect impacts may include related impacts on air and water and other natural systems, including ecosystems. There are no indirect impacts to inland or coastal resources that would result in changes to the functions and values in terms of the overall wetland hydrology, or fragmentation. The project impacts would not result in isolated fragments of wetlands or waterways. Potential indirect impacts are limited to the unintended introduction of invasive plant species.

Floodplains

Construction of the westbound ramp from U.S. Route 6 to State Route 25 and auxiliary lane on State Route 25 within the Bourne North quadrant would result in potential temporary impacts (8,660 square feet) and permanent impacts (2,960 square feet; 2,130 cubic feet) to the floodplain associated with Nightingale Pond (3-C). The new piers at both Sagamore and Bourne Bridges would result in 15,900 square feet of permanent impacts to the floodplain associated with riprap placement for pier protection in Cape Cod Canal.

Areas of Critical Environmental Concern

Within the Sagamore North Approach Interchange, Series 1-J BVW is mapped within the Herring River Watershed ACEC. Wetlands within an ACEC are considered Outstanding Resource Waters, which are regulated under Section 401 of the CWA. There are no permanent or temporary impacts proposed within wetland 1-J. At its closest location, the existing pavement edge along State Route 3 southbound is approximately 28 feet from the edge of the wetland, separated by a forested 2:1 slope. The roadway would be widened at this location and the proposed edge of the new roadway would be approximately 18 feet from the wetland. Although pavement widening of approximately 10 feet would occur within the ACEC, it would be located within the existing roadway shoulder of MassDOT's existing right-of-way. The widening and introduction of pavement within this area is a continuation of the use of an existing transportation corridor and it would not result in impacts to the wetlands, Outstanding Resource Waters, the sole source aquifer, or threatened and endangered species. Therefore, it is not expected to adversely affect protected resources associated with the ACEC. Construction-term impacts may occur; however, the implementation of erosion prevention and sediment controls will minimize impacts to the resource area.

Within the Bourne South Approach Interchange Area, the Bourne Back River ACEC is mapped on the west side of the State Route 28 southbound travel lane and extending 15 feet east into the median. At its closest point, the Project Limits are approximately 1,200 feet north of the ACEC limit within State Route 28 southbound. Therefore, no temporary or permanent impacts are proposed within the Bourne Back River ACEC.

4.10.4.2 Operation-Term Impact Assessment

Once the highway approaches and bridges are constructed, operation-term impacts would be limited to the maintenance of project components including the stormwater management system. The stormwater management system would be maintained in accordance with the project specific

Operations and Maintenance Plan, details of which are presented in **Section 4.11, Water Quality and Stormwater**.

4.10.4.3 Summary

Construction of the Bourne North quadrant interchange approach would result in temporary and permanent impacts to inland wetland resources. Construction of both bridges would result in temporary and permanent impacts to coastal wetland resources in all four quadrants. Indirect impacts resulting from construction may include the unintended introduction of invasive plant species. Operation-term impacts would be limited to the maintenance of project components including the stormwater management system.

4.10.5 Mitigation Measures

4.10.5.1 Requirements and Guidance

State Resources

For any impacts that are unable to be avoided or minimized, the MA WPA regulations contain performance standards for each resource area, intended to ensure protection of their functions and values. The performance standards require that projects first seek to avoid and minimize impacts to wetland resource areas, and where impacts are unavoidable, ensure no adverse effects on the interests protected by the WPA such as flood control, water quality, and wildlife habitat. Refer to **Section 4.10.6.1** for a discussion of the Program's conformance with performance standards of the MA WPA regulations.

Federal Resources

After practicable measures have been taken to avoid and minimize impacts to WOTUS, Section 404(b)(1) of the federal CWA requires compensation for unavoidable, permanent impacts to WOTUS. The USACE New England District has Compensatory Mitigation Standard Operating Procedures (SOP) (dated April 26, 2024), which provides guidance for developing mitigation plans for, among other resources, vegetated wetlands, RPW, and submerged aquatic vegetation. According to the SOP, the use of mitigation banks and/or In-Lieu Fee Program (ILFP) mitigation is preferred over permittee-responsible mitigation (PRM) unless the permittee demonstrates PRM is more ecologically appropriate.

There are no USACE-approved wetland mitigation banks in Massachusetts. However, the Massachusetts Department of Fish and Game (DFG) has a USACE-approved ILFP. Because PRM compensation would be required for impacts to state wetland resources, as discussed in **Section 4.10.5.2**, compensation for permanent impacts would be provided through PRM in the form of vegetated wetland and RPW creation within the project area along with participation in DFG's ILFP.

4.10.5.2 Compensation for Impacts to Inland Wetlands

Proposed compensation for permanent impacts to inland resources is summarized in **Table 4.10-16**. Inland resources impacted include state-regulated BVW, Bank, Land Under Water (LUW), and BLSF and federally regulated VW and RPW. Details for the compensatory wetlands would be included in the final compensatory mitigation plan to be prepared in conjunction with the permit applications to federal and state agencies, which the design-build contractor, on behalf of MassDOT, would be responsible for updating to account for final impacts to habitat types (e.g., forested, emergent, etc.), permit conditions, and design changes, as applicable.

Success of the proposed PRM compensation areas would be documented through completion of annual monitoring reports developed in accordance with the USACE SOP and MassDEP Guidelines.

Table 4.10-16. Proposed Compensation for Permanent Impacts to Inland Resources

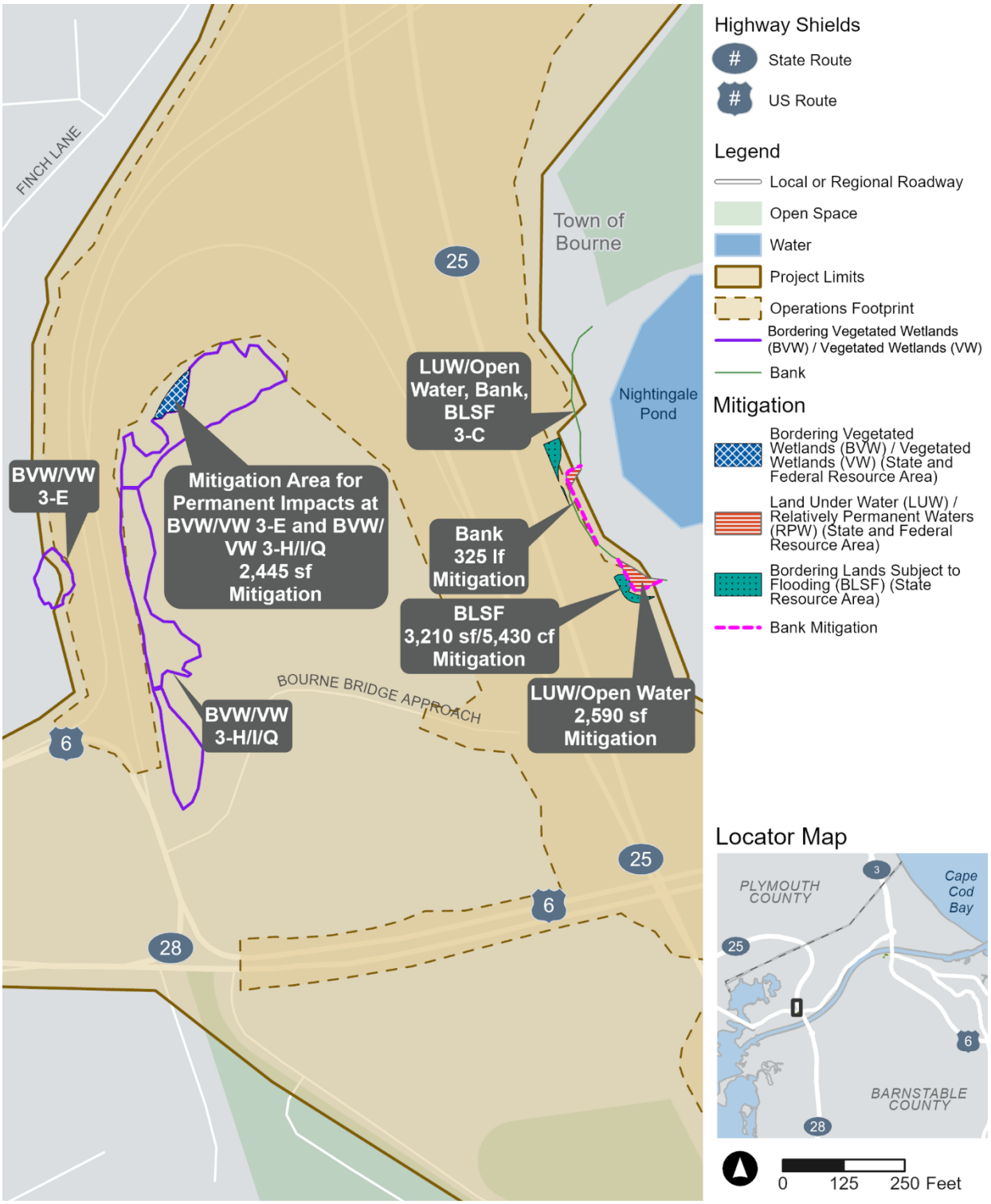
Wetland Series ID[1]	State Resource		Federal Resource		Impact to Compensation (Creation) Ratio
	Impact Type and Extent	Compensation	Impact Type and Extent	Compensation[2]	
3-E	Bordering Vegetated Wetland (BVW): 410 square feet	BVW: 615 square feet	Vegetated Wetland (VW): 410 square feet	VW: 615 square feet	1:1.5
3-H/I/Q	BVW: 1,630 square feet	BVW: 2,445 square feet	VW: 1,630 square feet	VW: 2,445 square feet	1:1.5
3-C (Nightingale Pond)	Bank: 285 linear feet	Bank: 325 linear feet	Not applicable	Not applicable	1:1.1
	Land Under Water (LUW): 1,065 square feet	LUW: 2,590 square feet	Relatively Permanent Water: 2,590 square feet	Not applicable	1:2.4
	Bordering Land Subject to Flooding (BLSF): 2,130 cubic feet/ 2,960 square feet	BLSF: 3,210 square feet/5,430 cubic feet	Not applicable	Not applicable	1:2.5

[1] As identified in the Abbreviated Notice of Resource Area Delineation (HNTB 2021, 2022) and additional field investigations

[2] In addition to the creation of vegetated wetland, credits would be purchased through the Massachusetts Department of Fish and Wildlife In-Lieu Fee Program.

Permanent impacts to vegetated wetlands would be compensated through the creation of vegetated wetlands adjacent to Series 3-H/I/Q. Locating the proposed compensation site adjacent to Series 3-H/I/Q would allow the functions impacted by the permanent alterations to be compensated appropriately. For BVW, the 1:1.5 ratio of impact to compensation is proposed, which exceeds the 1:1 requirement of the performance standards (310 CMR 10.55(4)(b)1) contained in the Wetland Protection regulations (310 CMR 10.00). The USACE SOP includes a recommended impact to compensation ratio of 1:4 for permanent impacts to forested wetlands, which would be met through both wetland creation and purchasing credits from the DFG ILFP. The general location of the wetland creation area is depicted on **Figure 4.10-30**.

Figure 4.10-30. Potential Mitigation for State and Federal Inland Wetland Resource Areas



Source: Massachusetts Department of Transportation, 2025

Permanent impacts to state resource areas of Bank and LUW and federal RPW at Nightingale Pond would be compensated through the creation of Bank along the limit of the permanent impact area and expansion of Nightingale Pond to the north and south of the proposed permanent impact area. The compensation area would be graded to approximate that of the permanent impact area. The surface layer of the subaqueous soils within the impact area would be removed prior to filling and used as the surface layer in the compensation area. The general location of the Bank, LUW and RPW mitigation is depicted on **Figure 4.10-30**.

Impacts to BLSF would be mitigated by providing compensatory flood storage on a foot-by-foot basis at each elevation. **Table 4.10-17** demonstrates the excavation required to compensate for the corresponding fill at each elevation.

Table 4.10-17. Compensatory Flood Storage Analysis for Nightingale Pond

Elevation (feet)	Incremental Volume of Fill (cubic feet) (between each elevation)	Incremental Volume of Excavation (cubic feet) (between each elevation)
6		
	170	260
7		
	240	250
8		
	40	290
9		
	20	360
10		
	40	480
11		
	80	690
12		
	240	730
13		
	630	1,240
14		
	670	1,130
14.5		
Total Volume	**2,130**	**5,430**
Total Area	**2,960**	**3,210**

Temporary impacts to Bank and LUW would result from the construction of the compensation area at Nightingale Pond. Prior to disturbance, the temporary impact areas would be photographed to document existing ground conditions and surveyed to confirm preconstruction elevations or baseline conditions. Vegetation within the impact area would be reestablished through the application of a wetland seed mix and/or plant plugs and trees and shrubs as applicable, which are native to southeast Massachusetts and Cape Cod. Soil within the restoration area would be similar to preconstruction soils (e.g., depth of surface layer, organic matter content, texture).

4.10.5.3 Compensation for Impacts to Coastal Resources

Permanent Impacts

The removal of the existing bridge piers will result in the restoration of approximately 8,000 square feet of Navigable WOTUS and of LUO. Additional compensation for net permanent impacts to federal and state coastal resource areas will be coordinated with the USACE and MassDEP and presented in the Final Environmental Impact Report.

Temporary Impacts

Temporary impacts to state and federal coastal resource areas will be compensated through in-kind restoration and natural reestablishment.

4.10.5.4 Mitigation for Construction-Term Impacts

Construction impacts to wetland resources from construction-related pollutants, stormwater runoff and dewatering activities may impact resource areas. These potential impacts would be minimized through the development and implementation of a Stormwater Pollution Prevention Plan (SWPPP), required pursuant to the U.S. Environmental Protection Agency's National Pollutant Discharge Elimination System General Permit for Discharges from Construction Activities. The SWPPP would include best management practices to prevent erosion, minimize sediment transport and other associated construction-term potential pollution sources. Construction-term impacts are associated with all Program activities for inland and coastal resource areas within the Study Areas.

For conformance with Executive Order 13112 (Invasive Species) the contract will include specifications for the management and disposal of soil and plant material and prevention of the spread of invasive species via equipment.

4.10.6 Regulatory Compliance

The Program would require federal and state permits for temporary and permanent impacts to inland and coastal resource areas. The following addresses regulatory compliance with respect to state and federal requirements:

4.10.6.1 Massachusetts Wetland Protection Act

The MA WPA regulations (310 CMR 10.00) include performance standards to be met when state-regulated resource areas are altered. For the Program, this includes temporary and permanent alterations to Bank, LUW, BVW, BLSF, LUO, RIS, CB, LSTA, and LSCSF. The Project's compliance with each of these performance standards is described below for each regulated area.

Inland Resource Areas

For the Build Alternative, the Bourne North Interchange Approach would impact state inland resource areas.

Bordering Vegetated Wetlands

Table 4.10-18 addresses the Program's conformance with the General Performance Standards for BVW per 310 CMR 10.55 (4) (a) through (e) for the anticipated 2,040 square feet of permanent impact to BVW Series 3-E and 3-H/I/Q within the Bourne North Interchange Approach area.

Table 4.10-18. Performance Standards for Bordering Vegetated Wetlands and Program Conformance

Performance Standard	Program Conformance
10.55(4)(a) Where the presumption set forth in 310 CMR 10.55(3) is not overcome, any proposed work in a Bordering Vegetated Wetland shall not destroy or otherwise impair any portion of said area.	Met through conformance with 10.55(4)(b).
10.55(4)(b) Notwithstanding the provisions of 310 CMR 10.55(4)(a), the issuing authority may issue an Order of Conditions permitting work which results in the loss of up to 5000 square feet of Bordering Vegetated Wetland when said area is replaced in accordance with the following general conditions and any additional, specific conditions the issuing authority deems necessary to ensure that the replacement area will function in a manner similar to the area that will be lost:	
1. the surface of the replacement area to be created ("the replacement area") shall be equal to that of the area that will be lost ("the lost area");	Permanent impacts to Bordering Vegetated Wetland (BVW) will be mitigated by providing a replacement area to offset impacts. The conceptual mitigation plan includes a proposed wetland replacement area at a creation to impact ratio of 1.5:1 to offset permanent alterations to BVW. Refer to Figure 4.10-30. This standard will be met.
2. the ground water and surface elevation of the replacement area shall be approximately equal to that of the lost area;	The surface elevation of the replacement area will approximate the impact areas. This standard will be met.
3. the overall horizontal configuration and location of the replacement area with respect to the bank shall be similar to that of the lost area;	The horizontal configuration and location of the replacement area is similar with respect to the existing bank. This standard will be met.
4. the replacement area shall have an unrestricted hydraulic connection to the same water body or waterway associated with the lost area;	The replacement area has an unrestricted hydraulic connection to the same waterway as the lost area. This standard will be met.

Performance Standard	Program Conformance
5. the replacement area shall be located within the same general area of the water body or reach of the waterway as the lost area;	The lost areas are associated with headwater wetlands; the wetland replacement area is similarly located adjacent to the headwater wetlands lost. This standard will be met.
6. at least 75% of the surface of the replacement area shall be reestablished with indigenous wetland plant species within two growing seasons, and prior to said vegetative reestablishment any exposed soil in the replacement area shall be temporarily stabilized to prevent erosion in accordance with standard U.S. Soil Conservation Service methods; and	The design plans and specifications will include provisions for the contractor to meet the requirement for 75% of the replacement area to be reestablished with indigenous wetland plants within two growing seasons. The specifications will require the contractor to obtain coverage under and comply with the U.S. Environmental Protection Agency's Construction General Permit, which requires temporary and permanent stabilization of exposed soils. This standard will be met.
7. the replacement area shall be provided in a manner which is consistent with all other General Performance Standards for each resource area in Part III of 310 CMR 10.00. In the exercise of this discretion, the issuing authority shall consider the magnitude of the alteration and the significance of the project site to the interests identified in M.G.L. c. 131, § 40, the extent to which adverse impacts can be avoided, the extent to which adverse impacts are minimized, and the extent to which mitigation measures, including replication or restoration, are provided to contribute to the protection of the interests identified in M.G.L. c. 131, § 40.	There are no other resource areas with performance standards applicable to the series 3-E and 3-H/I/Q BVW replacement area. This standard does not apply.
10.55(4)(c) Notwithstanding the provisions of 310 CMR 10.55(4)(a), the issuing authority may issue an Order of Conditions permitting work which results in the loss of a portion of Bordering Vegetated Wetland when;	
1. said portion has a surface area less than 500 square feet;	This standard does not apply.
2. said portion extends in a distinct linear configuration ("finger-like") into adjacent uplands; and	This standard does not apply.

Performance Standard	Program Conformance
3. in the judgment of the issuing authority, it is not reasonable to scale down, redesign or otherwise change the proposed work so that it could be completed without loss of said wetland	The Program has been designed to avoid and minimize impacts as practicable and provide mitigation for the unavoidable impacts. This standard will be met as determined during the permitting process.
10.55(4)(d) Notwithstanding the provisions of 310 CMR 10.55(4)(a), (b) and (c), no project may be permitted which will have any adverse effect on specified habitat sites of rare vertebrate or invertebrate species, as identified by procedures established under 310 CMR 10.59.	The proposed area of work is not mapped as Estimated Habitat of Rare Wildlife by the Massachusetts Wildlife's Natural Heritage and Endangered Species Program. This standard does not apply.
10.55(4)(e) Any proposed work shall not destroy or otherwise impair any portion of a Bordering Vegetated Wetland that is within an Area of Critical Environmental Concern designated by the Secretary of Energy and Environmental Affairs under M.G.L. c. 21A, § 2(7) and 301 CMR 12.00: Areas of Critical Environmental Concern. 310 CMR 10.55(4)(e):	The Program would not impact any BVW within an Area of Critical Environmental Concern. This standard does not apply.

Bank

Table 4.10-19 addresses the Program's conformance with the General Performance Standards for Bank per 310 CMR 10.54(4)(a) through (c). Anticipated temporary impacts to Bank are limited to 70 linear feet and anticipated permanent impacts of 285 linear feet along Nightingale Pond (Series 3-C) within the Bourne North Interchange Approach area.

Table 4.10-19. Performance Standards for Bank and Program Conformance

Performance Standard	Program Conformance
10.54(4)(a) Proposed work on a Bank shall not impair the following:	
1. Physical stability of the Bank	The existing Bank at Nightingale Pond consists of a relatively short, vegetated slope. The bank will be replaced by a new bank constructed adjacent to the fill area (for the maintenance access road) and will be similar in terms of slope, elevation, and vegetated surface treatment. The in-kind bank replacement will duplicate the physical stability of the impacted bank. This standard will be met.

Performance Standard	Program Conformance
2. Water carrying capacity of the existing channel within the Bank	Nightingale Pond does not contain an existing channel that conveys or carries flows. The Bank at Nightingale Pond acts to confine fluctuating water elevations. The replacement or reconstruction in-kind in terms of topography will allow for continued confinement of fluctuating water levels. This standard does not apply.
3. Ground water and surface water quality	The Bank created adjacent to the impact area at Nightingale Pond will not impair ground water quality. The additional bank associated with the construction of the Land Under Water Bodies and Waterways (LUW) mitigation area will continue to allow for surface and ground water recharge. This standard will be met.
4. Capacity of the bank to provide breeding habitat, escape cover and food for fisheries	The in-kind restoration of the bank in terms of topography, soil structure, and vegetation will continue to provide habitat for fisheries. Also, an additional 40 linear feet of Bank will be provided with the construction of the LUW mitigation area. Refer to **Figure 4.10-30**. This standard will be met.
5. Capacity of the Bank to provide important wildlife habitat functions. A project or projects on a single lot, for which Notice(s) of Intent is filed on or after November 1, 1987, that (cumulatively) alter(s) up to 10% or 50 feet (whichever is less) of the length of the bank found to be significant to the protection of wildlife habitat, shall not be deemed to impair its capacity to provide important wildlife habitat functions.	The Program would result in the alteration of more than 50 linear feet of Bank. However, Bank will be created adjacent to the impact area, and an additional 40 linear feet of Bank will be provided through the construction of the LUW mitigation area. A detailed wildlife habitat analysis will be conducted to ascertain the presence/absence of important wildlife habitat and provided in the Notice of Intent. As applicable, restoration/replication of altered habitat will be provided in accordance with 310 CMR10.60(3); no loss in the capacity of Bank to provide important wildlife habitat functions will occur. This standard will be met.
6. Work on a stream crossing	The Program does not include a stream crossing. This standard does not apply.
10.54(4)(b) Notwithstanding the provisions of 310 CMR 10.54(4)(a), structures may be permitted in or on a Bank when required to prevent flood damage to facilities, buildings and roads….	There are no structures or facilities proposed in conjunction with flood damage prevention. This standard does not apply.

Performance Standard	Program Conformance
10.54(4)(c) Notwithstanding the provisions of 310 CMR 10.54(4)(a) or (b), no project may be permitted which will have any adverse effect on specified habitat sites of Rare Species, as identified by procedures established under 310 CMR 10.59.	The proposed area of work is not mapped as Estimated Habitat of Rare Wildlife by the Natural Heritage and Endangered Species Program. This standard does not apply.

Land Under Water Bodies and Waterways

Table 4.10-20 addresses the Program's conformance with the General Performance Standards for LUW per 310 CMR 10.56(4)(a) through (c). The Build Alternative would result in approximately 2,675 square feet of temporary impacts and approximately 1,065 square feet of permanent impacts to LUW. These impacts are associated with Nightingale Pond (Series 3-C) within the Bourne North Interchange Approach Area.

Table 4.10-20. Performance Standards for Land Under Water Bodies and Waterways and Program Conformance

Performance Standard	Program Conformance
10.56(4)(a) Proposed work within LUW shall not impair the following:	
1. Water carrying capacity within the defined channel, which is provided by said land in conjunction with the banks.	Nightingale Pond does not contain an existing channel that conveys or carries flows. The bank at Nightingale Pond acts to confine fluctuating water elevations. The replacement or reconstruction in-kind in terms of topography will allow for continued confinement of fluctuating water levels. This standard does not apply.
2. Ground water and surface water quality	The impact to Land Under Water Bodies and Waterways (LUW) at Nightingale Pond will not impair ground water quality or surface water quality as the expanded LUW area will continue to allow for surface and ground water recharge. This standard will be met.
3. Capacity of said land to provide breeding habitat, escape cover and food for fisheries	Although LUW will be permanently altered, the Program will provide compensation through the construction of LUW adjacent to Nightingale Pond. The creation of the in-kind LUW in terms of topography, soil structure, and vegetation will compensate for the lost LUW and corresponding habitat. Refer to **Figure 4.10-30**. This standard will be met.

Performance Standard	Program Conformance
4. Capacity of said land to provide important wildlife habitat functions. A project or projects on a single lot, for which Notice(s) of Intent is filed on or after November 1, 1987, that (cumulatively) alter(s) up to 10% or 5,000 square feet (whichever is less) of land in this resource area found to be significant to the protection of wildlife habitat, shall not be deemed to impair its capacity to provide important wildlife habitat functions.	The Program would not result in the alteration of more than 10% or 5,000 square feet of LUW. This standard does not apply.
5. Work on a stream crossing	The Program does not include a stream crossing. This standard does not apply.
10.56(4)(b) Notwithstanding the provisions of 310 CMR 10.54(4)(a), the issuing authority may issue an Order in accordance with M.G.L. ch. 131, § 40 to maintain or improve boat channels ….	The Program is not proposing boat channel maintenance. This standard does not apply.
10.56(4)(c) Notwithstanding the provisions of 310 CMR 10.54(4)(a) or (b), no project may be permitted which will have any adverse effect on specified habitat sites of Rare Species, as identified by procedures established under 310 CMR 10.59.	The proposed area of work is not mapped as Estimated Habitat of Wildlife by the Natural Heritage and Endangered Species Program. This standard does not apply.

Bordering Land Subject to Flooding

Table 4.10-21 addresses the Program's conformance with the General Performance Standards for BLSF per 310 CMR 10.57(4)(a). The Build Alternative would result in approximately 8,660 square feet of temporary impacts and approximately 2,960 square feet/2,130 cubic feet of permanent impacts to BLSF. These impacts are associated with Nightingale Pond wetland series 3-C within the Bourne North Interchange Approach area.

Table 4.10-21. Performance Standards for Bordering Land Subject to Flooding and Program Conformance

Performance Standard	Program Conformance
10.57(4)(a) Bordering Land Subject to Flooding	
1. Compensatory storage shall be provided for all flood storage volume that will be lost as a result of a proposed project within Bordering Land Subject to Flooding, when in the judgment of the issuing authority said loss will cause an increase or contribute incrementally to an increase in the horizontal extent and level of flood water during peak flows. Compensatory storage shall mean a volume not previously used for flood storage and shall be incrementally equal to the theoretical volume of flood water at each elevation, up to and including the 100-year flood elevation, which would be displaced by the proposed project. Such compensatory volume shall have an unrestricted hydraulic connection to the same waterway or water body.	Impacts to Bordering Land Subject to Flooding will be mitigated by providing compensatory flood storage on a foot-by-foot basis at each elevation in an area not previously used for flood storage and having an unrestricted hydraulic connection to Nightingale Pond. This standard will be met.
2. Work within Bordering Land Subject to Flooding, including that work required to provide the above-specified compensatory storage, shall not restrict flows so as to cause an increase in flood stage or velocity.	The proposed work at Nightingale Pone, including that required for compensatory storage will not cause an increase in flood stage or velocity. This standard will be met.
3. Work in those portions of bordering land subject to flooding found to be significant to the protection of wildlife habitat shall not impair its capacity to provide important wildlife habitat functions. Except for work which would adversely affect vernal pool habitat, a project or projects on a single lot, for which Notice(s) of Intent is filed on or after November 1, 1987, that (cumulatively) alter(s) up to 10% or 5,000 square feet (whichever is less) of land in this resource area found to be significant to the protection of wildlife habitat, shall not be deemed to impair its capacity to provide important wildlife habitat functions. Additional alterations beyond the above threshold, or altering vernal pool habitat, may be permitted if they will have no adverse effects on wildlife habitat, as determined by procedures contained in 310 CMR 10.60.	The Program would exceed the performance standard threshold; however, the impacted wildlife habitat will be restored in accordance with 310 CMR 10.60 (3). This standard will be met.
10.57(4)(b) Isolated Land Subject to Flooding	This standard does not apply.

Performance Standard	Program Conformance
10.57(4)(c) Protection of Rare Wildlife Species Notwithstanding the provisions of 310 CMR 10.57(4)(a) or (b), no project may be permitted which will have any adverse effect on specified wildlife habitat sites of rare vertebrate or invertebrate species, as identified by procedures established under 310 CMR 10.59.	The proposed area of work is not mapped as Estimated Habitat of Wildlife by the Natural Heritage and Endangered Species Program. This standard does not apply.

Coastal Resources

Under the Build Alternative, the Program would affect coastal resources within Cape Cod Canal in association with removing and replacing both the Sagamore and Bourne Bridges.

Land Under Ocean

Table 4.10-22 addresses the Program's conformance with the Performance Standards for LUO per 310 CMR 10.25(3) through (7). The Build Alternative would result in approximately 140,095 square feet of temporary alteration and approximately 76,968 square feet of permanent alteration to LUO.

Table 4.10-22. Performance Standards for LUO and Program Conformance

Performance Standard	Program Conformance
10.25(3) *Improvement dredging for navigational purposes affecting land under the ocean shall be designed and carried out using the best available measures so as to minimize adverse effects on such interests caused by changes in:*	The Project does not include improvement dredging. This standard does not apply.
10.25(4) *Maintenance dredging for navigational purposes affecting land under the ocean shall be…*	The Program does not include maintenance dredging. This standard does not apply.
10.25(5) *Projects not included in 310 CMR 10.25(3) or (4) which affect nearshore areas of land under the ocean shall not cause adverse effects by altering the bottom topography so as to increase storm damage or erosion of coastal beaches, coastal banks, coastal dunes, or salt marshes.*	There are no coastal beaches, coastal dunes or salt marshes within the Program limits or within the vicinity of it. Coastal bank adjacent to the proposed dredging will be protected by construction support structures (e.g. bulkheads, cofferdams, sheeted docks), no adverse impacts to coastal bank will occur. This standard will be met.
10.25(6) *Projects not included in 310 CMR 10.25(3) which affect land under the ocean shall if water-dependent be designed and constructed, using best available measures, so as to minimize adverse effects, and if non-water-dependent, have no adverse effects, on marine fisheries habitat or wildlife habitat caused by:*	

Performance Standard	Program Conformance
(a) alterations in water circulation;	In-water construction activities would be limited to the Cape Cod Canal shorelines within approximately 100 feet of the mean high-water line at four discreet locations. This would leave approximately 500 feet of open water (i.e., no construction materials in the canal) between the construction locations on the north and south shores of each bridge site. This standard will be met.
(b) destruction of eelgrass (Zostera marina) or widgeon grass (Rupia maritina) beds;	Compensation for impacts to eelgrass will be coordinated through consultation with the USACE and NOAA Fisheries. This standard will be met.
(c) alterations in the distribution of sediment grain size;	Temporary removal of Cape Cod Canal sediment during construction excavation at the four discreet bridge construction locations will be restored through in-kind restoration and natural reestablishment. This standard will be met.

Performance Standard	Program Conformance
(d) changes in water quality, including, but not limited to, other than natural fluctuations in the level of dissolved oxygen, temperature or turbidity, or the addition of pollutants; or	Construction would not affect salinity, temperature, or nutrients beyond natural fluctuations in the Cape Cod Canal. The construction would not cause substantial changes to natural drainage from adjacent land. Therefore, the Program would not cause measurable changes to freshwater input in the Cape Cod Canal and, in turn, would not be expected to affect salinity concentrations. Construction activities may temporarily increase turbidity, which, generally, can lead to reductions in dissolved oxygen. However, given the strong currents of the Cape Cod Canal, increases in turbidity during construction activities would be temporary and quickly flushed from the area and, therefore, would be unlikely to affect dissolved oxygen. Likewise, the Program would implement best management practices to minimize the risk of hazardous liquid spills entering the canal (e.g., oil or gas from construction vessels). However, if small quantities of pollutants enter the Canal, they would quickly flush from the area by the strong currents and are unlikely to cause adverse effects on shellfish or marine fisheries. This standard will be met.
(e) alterations of shallow submerged lands with high densities of polychaetes, mollusks or macrophytic algae.	Since the Cape Cod Canal is a dynamic, high-energy environment exposed to regular dredging by the USACE for canal maintenance, wave action, storms and vessel activity, recovery of both soft and hard habitats is expected to be rapid; therefore, sessile organisms are anticipated to recover and recolonize after direct impact areas have been restored or settle and develop on newly introduced hard structure.
10.25(7) *Notwithstanding the provisions of 310 CMR 10.25(3) through (6), no project may be permitted which will have any adverse effect on specified habitat sites of rare vertebrate or invertebrate species, as identified by procedures established under 310 CMR 10.37.*	The proposed area of work is not mapped as Estimated Habitat of Rare Wildlife by the NHESP. This standard does not apply.

Coastal Bank

Table 4.10-23 addresses the Program's conformance with the Performance Standards for Coastal Bank, 310 CMR 10.30(3) through (5) and 310 CMR 10.30(6) through (8). The Coastal Bank has been determined to be significant to storm damage prevention or flood control because it is a vertical buffer to storm damage. The Build Alternative would result in approximately 2,599 linear feet of temporary alteration and approximately 860 square feet of permanent alteration to Coastal Bank.

Table 4.10-23. Performance Standards for Coastal Bank and Program Conformance

Performance Standard	Program Conformance
When a Coastal Bank is determined to be significant to storm damage prevention or flood control because it supplies sediment to coastal beaches, coastal dunes, or barrier beaches, 310 CMR 10.30(3) through (5) shall apply…	Within Cape Cod Canal, the majority of the bank is armored with riprap, and the strip of land between the riprap and the canal path is vegetated. However, there is evidence of erosion from the land side where rills and gullies have formed over time due to surface runoff and/or pedestrian use for access to the water's edge. In this case, the sediment is located above the riprap and does not contribute to a coastal beach, dune, or barrier beach. Although the banks experience wave action during storm events and have the potential to erode, they are not located proximate to a coastal beach, dune, or barrier beach where it would act as a sediment supply. The Coastal Bank along the canal is not significant to flood damage prevention or flood control as a sediment supplier. These standards do not apply.
When a Coastal Bank is determined to be significant to storm damage prevention or flood control because it is a vertical buffer to storm waters, 310 CMR 10.30(6) through (8) shall apply:	
10.30(6) Any project on such a coastal bank or within 100 feet landward of the top of such coastal bank shall have no adverse effects on the stability of the coastal bank.	The Program would temporarily impact the coastal bank during construction. The bank will be restored in-kind, except for the new bridge piers that replace sections of the existing riprap slope. These areas will consist of the concrete bridge footing/pier and will continue to act as a stable bank. This standard will be met.

Performance Standard		Program Conformance
10.30(7)	Bulkheads, revetments, seawalls, groins or other coastal engineering structures may be permitted on such a coastal bank except when such bank is significant to storm damage prevention or flood control because it supplies sediment to coastal beaches, coastal dunes, and barrier beaches.	The Coastal Bank of the canal does not act as a sediment source to coastal beaches, dunes, or barrier beaches. This standard does not apply.
10.30(8)	Notwithstanding the provisions of 310 CMR 10.30(3) through (7), no project may be permitted which will have any adverse effect on specified habitat sites of rare vertebrate or invertebrate species, as identified by procedures established under 310 CMR 10.37.	The proposed area of work is not mapped as Estimated Habitat of Rare Wildlife by the Natural Heritage and Endangered Species Program. This standard does not apply.

Rocky Intertidal Shore

Table 4.10-24 addresses the Program's conformance with the Performance Standards for RIS, 310 CMR 10.31(3) through (5). The location of RIS is in discrete, non-contiguous isolated sections along the north bank of the Canal at both bridge locations. Within the Sagamore North quadrant, the RIS that would be temporarily impacted is located between the existing bridge piers and the armored slope along the Canal. The alterations within the Sagamore North quadrant would result in the permanent alteration of approximately 1,652 square feet of RIS from placement of rip rap.

Within the Bourne North quadrant, RIS occurs within the footprint of the proposed temporary bulkhead sheeting/fill to facilitate construction access. While only a 130-square foot section of RIS would be directly impacted by the bulkhead, the remaining RIS on the waterside of the bulkhead would most likely be altered during the operation of barges and marine vessels and/or dredge footprint, and the Program is considering the 1,167-square foot area in its entirety to be temporarily altered. The RIS has been determined to be significant to storm damage prevention, flood control, protection of marine fisheries, wildlife habitat, and protection of land containing shellfish.

Table 4.10-24. Performance Standards for Rocky Intertidal Shore and Program Conformance

Performance Standard	Program Conformance
10.31(3) When a Rocky Intertidal Shore Is Determined to Be Significant to Storm Damage Prevention, Flood Control, or Protection of Wildlife Habitat, any proposed project shall be designed and constructed, using the best practical measures, so as to minimize adverse effects on the form and volume of exposed intertidal bedrock and boulders.	Upon completion of construction and removal of the temporary bulkhead within the Bourne North quadrant, RIS will be restored. Rocky Intertidal Shore (RIS) will be permanently altered within the Sagamore North quadrant through the placement of rip rap, and although this does not meet the "naturally occurring" requirement included in the definition of RIS (310 CMR 10.31(2)), it will function similarly. This standard will be met.
10.31(4) When a Rocky Intertidal Shore is Determined to Be Significant to the Protection of Marine Fisheries or Wildlife Habitat, any proposed project shall if water-dependent be designed and constructed, using best available measures, so as to minimize adverse effects, and if non-water-dependent, have no adverse effects, on water circulation and water quality. Water quality impacts include, but are not limited to, other than natural fluctuations in the levels of dissolved oxygen, temperature or turbidity, or the addition of pollutants.	The impacts to RIS will be restored in-kind or replaced with rip rap which will function similarly. As such, there will be no long-term adverse effects on water circulation and quality. This standard will be met.
10.31(5) Notwithstanding the provisions of 310 CMR 10.31(3) and (4), no project may be permitted which will have any adverse effect on specified habitat sites of rare vertebrate or invertebrate species, as identified by procedures established under 310 CMR 10.37	The proposed area of work is not mapped as Estimated Habitat of Rare Wildlife by the Natural Heritage and Endangered Species Program. This standard does not apply.

Land Containing Shellfish

Table 4.10-25 addresses the Program's conformance with the Performance Standards for Land Containing Shellfish, 310 CMR 10.34(4) through (8). The Build Alternative would result in approximately 141,262 square feet of temporary alteration and approximately 78,620 square feet of permanent alteration to Land Containing Shellfish.

Table 4.10-25. Performance Standards for Land Containing Shellfish and Program Conformance

Performance Standard	Program Conformance
10.34(4) Except as provided in 310 CMR 10.34(5), any project on land containing shellfish shall not adversely affect such land or marine fisheries by a change in the productivity of such land caused by:	

Performance Standard	Program Conformance
(a) alterations of water circulation;	In-water construction activities would be limited to the Cape Cod Canal shorelines within approximately 100 feet of the Mean High Water line at four discreet locations. This would leave approximately 500 feet of open water (i.e., no construction materials in the canal) between the construction locations on the north and south shores of each bridge site. This standard will be met.
(b) alterations in relief elevation;	Changes to relief elevation within the Program footprint are limited to construction-term impacts as the areas will be allowed to restore naturally. As such, there will be no long-term adverse effects on productivity. This standard will be met.
(c) the compacting of sediment by vehicular traffic;	Construction would not entail vehicular traffic within the intertidal or subtidal construction footprint. This standard will be met.
(d) alterations in the distribution of sediment grain size;	Areas where sediment would be removed during construction will be allowed to restore naturally. As such there will be no long-term adverse effects in the distribution of sediment grain size. This standard will be met.
(e) alterations in natural drainage from adjacent land; or	Approximately 780 linear feet of shoreline at each of the bridge sites would be removed during construction. After the removal of the riprap, approximately 600 linear feet of steel sheeting would be installed along the shoreline at each of the bridge sites. These changes to the shoreline could temporarily alter drainage rates from adjacent land at the specific locations of the construction sites. However, stormwater drainage from the lands along the canal surrounding the Bourne and Sagamore bridges is engineered via stormwater drains. Additionally, the linear extents of the alterations of the shorelines at these sites relative to the rest of the canal would be relatively minor, and therefore, any potential changes in drainage rates are likely to be too small to be meaningfully measured or detected in Cape Cod Canal. Additionally, these changes would be temporary, lasting the duration of construction activities at the given sites, and reversed once post-construction removal of the shoreline sheeting and replacement of riprap occurred. This standard will be met.

Performance Standard	Program Conformance
(f) changes in water quality, including, but not limited to, other than natural fluctuations in the levels of salinity, dissolved oxygen, nutrients, temperature or turbidity, or the addition of pollutants.	Construction would not affect salinity, temperature, or nutrients beyond natural fluctuations in Cape Cod Canal. As noted in (e), the Program would not cause substantial changes to natural drainage from adjacent land. Therefore, the Program would not cause measurable changes to freshwater input in Cape Cod Canal and, in turn, would not be expected to affect salinity concentrations. Construction activities may temporarily increase turbidity, which, generally, can lead to reductions in dissolved oxygen. However, given the strong currents of Cape Cod Canal, increases in turbidity during construction activities would be temporary and quickly flushed from the area and, therefore, would be unlikely to affect dissolved oxygen. Likewise, the Program would implement best management practices to minimize the risk of hazardous liquid spills entering the canal (e.g., oil or gas from construction vessels). However, if small quantities of pollutants enter the Canal, they would quickly flush from the area by the strong currents and are unlikely to cause adverse effects on shellfish or marine fisheries. This standard will be met.
10.34(5) Notwithstanding the provisions of 310 CMR 10.34(4), projects which temporarily have an adverse effect on shellfish productivity but which do not permanently destroy the habitat may be permitted if the land containing shellfish can and will be returned substantially to its former productivity in less than one year from the commencement of work, unless an extension of the Order of Conditions is granted, in which case such restoration shall be completed within one year of such extension.	Construction is expected to temporarily displace shellfish (e.g., blue mussels) within the construction footprint. However, the extent of shellfish displacement is not expected to cause an adverse effect on shellfish productivity. Massachusetts Division of Marine Fisheries Shellfish Suitability GIS layer (https://www.mass.gov/info-details/massgis-data-shellfish-suitability-areas) indicates the entirety of Cape Cod Canal north and south shorelines provide suitable habitat for blue mussels. While the Program would remove hard substrate in the form of riprap during construction activities (and, in so doing, displace blue mussels and blue mussel habitat) for a period greater than one year, this substrate would be replaced during the post-construction replacement of the removed riprap and a request for an extension of the Order of Conditions will be requested. The loss of hard substrate suitable for blue mussel growth during construction would be a minor and temporary decrease in available shellfish habitat within the larger Cape Cod Canal. This standard will be met as determined during the permitting process.

Performance Standard	Program Conformance
10.34(6) In the case of land containing shellfish defined as significant in 310 CMR 10.34(3)(b) (i.e., those areas identified on the basis of maps and designations of the Shellfish Constable), except in Areas of Critical Environmental Concern, the issuing authority may, after consultation with the Shellfish Constable, permit the shellfish to be moved from such area under the guidelines of, and to a suitable location approved by, the Division of Marine Fisheries, in order to permit a proposed project on such land. Any such project shall not be commenced until after the moving and replanting of the shellfish have been commenced.	Shellfish are not anticipated to be relocated for the Program. The shorelines of Cape Cod Canal that would be affected by Program construction activities are not considered significant as defined in 310 CMR 10.34(3)(b). Per the Massachusetts Division of Marine Fisheries Shellfish Growing Areas GIS layer (https://www.mass.gov/info-details/massgis-data-designated-shellfish-growing-areas), the entirety of Cape Cod Canal is designated as Prohibited for shellfish harvest for direct human consumption. Therefore, the area does not hold historical or current importance for recreational or commercial shell fishing as stated in 310 CMR 10.34(3)(b). This standard does not apply.
10.34(7) Notwithstanding 310 CMR 10.34(4) through (6), projects approved by the Division of Marine Fisheries that are specifically intended to increase the productivity of land containing shellfish may be permitted. Aquaculture projects approved by the appropriate local and state authority may also be permitted.	The Program is not specifically intended to increase the productivity of land containing shellfish; nor is it an aquaculture project. This standard does not apply.
10.34(8) Notwithstanding the provisions of 310 CMR 10.34(4) through (7), no project may be permitted which will have any adverse effect on specified habitat of rare vertebrate or invertebrate species, as identified by procedures established under 310 CMR 10.37.	The proposed area of work is not mapped as Estimated Habitat of Rare Wildlife by the Natural Heritage and Endangered Species Program. This standard does not apply.

Banks of or Land under the Ocean, Ponds, Streams, Rivers, Lakes, or Creeks that Underlie an Anadromous/Catadromous Fish Run

Table 4.10-26 addresses the Program conformance with the Performance Standards for LUO underlying an Anadromous/Catadromous Fish Run, 310 CMR 10.35(3) through (6). The Build Alternative would result in approximately 240,238 square feet of temporary alteration and approximately 109,198 square feet of permanent alteration to LUO.

Table 4.10-26. Performance Standards for Banks of LUO and Land Under Ocean Underlying an Anadromous/Catadromous Fish Run and Program Conformance[1]

Performance Standard	Program Conformance
10.35(3) Any project on such land or bank shall not have an adverse effect on the anadromous or catadromous fish run by:	
(a) impeding or obstructing the migration of the fish, unless DMF has determined that such impeding or obstructing is acceptable, pursuant to its authority under M.G.L. c. 130, § 19;	Due to the nature of the proposed construction activities, the migration of fish through Cape Cod Canal to reach the Herring River would not be impeded or obstructed. In-water construction activities would be limited to the Cape Cod Canal shorelines within approximately 100 feet of the Mean High Water line at four discreet locations. This would leave approximately 500 feet of open water (i.e., no construction materials in the canal) between the construction locations on the north and south shores of each bridge site, thus allowing migrating fish to pass unimpeded. This standard will be met.
(b) changing the volume or rate of flow of water within the fish run; or	The majority of Cape Cod Canal would be unimpeded by construction activities or equipment, and the Program would not affect the volume or rate of water flowing into the Canal from the Herring River. This standard will be met.
(c) impairing the capacity of spawning or nursery habitats necessary to sustain the various life stages of the fish.	The Cape Cod Canal does not serve as spawning or nursery habitat. This standard does not apply.
10.35(4) Unless otherwise allowed by DMF pursuant to M.G.L. c. 130, § 19, dredging, disposal of Dredged Material or filling in a fish run shall be prohibited between March 15 and June 15 in any year.	In accordance with Program consultations with National Oceanic and Atmospheric Administration Fisheries under the Magnuson-Stevens Fishery Conservation and Management Act and Section 7 of the Endangered Species Act, Program dredging activities would not occur between March 1 and August 30 of any year. This standard will be met.
10.35(5) Notwithstanding the provisions of 310 CMR 10.35(3), no project may be permitted which will have any adverse effect on specified habitat sites of rare vertebrate or invertebrate species, as identified by procedures established under 310 CMR 10.37	The proposed area of work is not mapped as Estimated Habitat of Rare Wildlife by the Natural Heritage and Endangered Species Program. This standard does not apply.

Performance Standard	Program Conformance
10.35(6) Any person proposing a new stream crossing of a Fish Run shall demonstrate to the issuing authority that there are no practicable alternatives to the crossing, that the impacts of the crossing have been minimized and that mitigation measures have been provided to contribute to the protection of the interests identified in M.G.L. c. 131, § 40. An applicant will be presumed to have made this showing if the project is designed as follows:	
(a) If the project includes the construction of a new non-tidal crossing, the applicant demonstrates to the satisfaction of the issuing authority that the crossing complies with the Massachusetts Stream Crossing Standards by consisting of a span or embedded culvert in which, at a minimum, the top of the structure is above the elevation of the top of the bank and the structure spans the channel width by a minimum of 1.2 times the bankfull width.	No new non-tidal stream crossing is proposed. This standard does not apply.
(b) If the project includes the construction of a new tidal crossing, the applicant demonstrates to the satisfaction of the issuing authority that the project is designed in a manner that does not restrict tidal flow over the full natural tidal range by consisting of a span or embedded culvert in which, at a minimum, the top of the structure is above the elevation of the top of the bank and the structure spans the channel width by a minimum of 1.2 times the bankfull width.	Conformance with this standard will be assessed during the permitting process.

[1] The Massachusetts Division of Marine Fisheries Technical Report TR-47 (Evans et al. 2015), does not list the Cape Cod Canal as a spawning run. TR-47 provides time-of-year restrictions (TOY) for protection of marine resources in Massachusetts based on the best available life history information on marine fisheries resources in Massachusetts (Evans et al. 2015). TR-47 does not list any TOYs for marine fisheries in Cape Cod Canal and specifically states Cape Cod Canal is not a spawning run for alewife, blueback herring, American eel, white perch. TR-47 states American shad, rainbow smelt, and Atlantic tomcod are not present in the Cape Cod Canal. TR-47 does note that Herring Pond (via Herring River) is a spawning run and/or contains critical life stages or habitat for alewife, American eel, and white perch. The outlet of the Herring River is Cape Cod Canal between the Sagamore and Bourne Bridges.

Land Subject to Coastal Storm Flowage

The current MA WPA regulations do not include performance standards for LSCSF, however, MassDEP has published Proposed Revisions to 310 CMR 10.00, expected to be in effect in 2025, which include performance standards for Land Subject to Coastal Storm Flowage. **Table 4.10-27** addresses the Program's conformance with the proposed performance standards for Land Subject to Coastal Storm Flowage, 310 CMR 10.36. According to the proposed 310 CMR 10.36(4), Application of Performance Standards, the proposed performance standards at 310 CMR 10.36(8) apply to Redevelopment within Land Subject to Coastal Storm Flowage which does not overlie another coastal Resource Area. Because other coastal resource areas exist or underlie the flood zone, including Coastal Bank and discrete areas of Rocky Intertidal Shore, 4(b) and 4(c) apply as follows:

- (4)(b) For work on a Coastal Bank that does not supply sediment to Coastal Beach, Coastal Dune, or Barrier Beach, the provisions of 310 CMR 10.36(5) through (8) and 310 CMR 10.30 shall apply. Refer to **Table 4.10-27** for conformance with 310 CMR 10.36(5) through (8) and **Table 4.10-23** for conformance with 310 CMR 10.30.
- (4)(c) For work on a Rocky Intertidal Shore, the provisions of 310 CMR 10.36(5) through (8) and 310 CMR 10.31 shall apply. Refer to **Table 4.10-27** for conformance with 310 CMR 10.36(5) through (8) and **Table 4.10-24** for conformance with 301 CMR 10.31.

Table 4.10-27. Proposed Performance Standards for Land Subject to Coastal Storm Flowage and Program Conformance

Performance Standard	Program Conformance
10.36(5) Adverse Effects in the V-Zone and MoWA Zone.	The Program as it is not located within a V-Zone or MoWA Zone This standard does not apply.
10.36(6) Activities in the V-Zone and MoWA Zone.	The Program as it is not located within a V-Zone or MoWA Zone. This standard does not apply.
10.36(7) Activities in the MiWA Zone. Any Applicant proposing development in the Minimum Wave Action (MiWA) Zone shall use Best Available Measures to minimize adverse effects on the critical characteristics of Land Subject to Coastal Storm Flowage identified in 310 CMR 10.36(1)(a) through (e) by:	

Performance Standard	Program Conformance
(a) Allowing flood waters to spread inland and laterally by avoiding fill, structures, or topographic alterations which would increase velocity or redirect flow and cause increased erosion, channelization, storm damage, or flooding;	A preliminary analysis regarding the impact of changes to fill, structure, and topography (within Land Subject to Coastal Storm Flowage that does not overlie another coastal Resource Area) on the velocity, path, and extent of overland coastal surge is provided in **Section 4.22.4.4.** Conformance with this standard will be confirmed if required during the permitting process, including the potential impacts of the proposed piers within Land Subject to Coastal Storm Flowage for the Bourne Bridge.
(b) Avoiding fill, structures, or topographic alterations that would, in the judgment of the Issuing Authority, contribute incrementally to an increase in flood velocity, volume, or elevation on other properties resulting in storm damage;	Conformance with this standard will be confirmed if required during the permitting process.
(c) Avoiding, or mitigating through flood easements or other means, any fill, structure, or topographic alteration that would increase flood velocity, volume, or elevations within a topographic depression or confined basin that can be identified using LiDAR or on a USGS topographic map where a manmade or natural feature significantly impedes or prevents the return flow of coastal flood waters;	A preliminary analysis regarding the impact of changes to fill, structure, and topography (within Land Subject to Coastal Storm Flowage that does not overlie another coastal Resource Area) on the velocity, path, and extent of overland coastal surge is provided in **Section 4.22.4.4.** Conformance with this standard will be confirmed if required during the permitting process, including the potential impacts of the proposed piers within Land Subject to Coastal Storm Flowage for the Bourne Bridge.
(d) Preserving soils and vegetation at the site to reduce erosion to the maximum extent practicable and allow coastal flood waters to percolate downward;	The Program would preserve soils and vegetation to the maximum extent practicable. This standard will be met.
(e) Reducing impervious surfaces to increase permeability and avoid increasing the velocity of floodwater;	Impervious surfaces will be reduced to the maximum extent practicable. This standard will be met.

Performance Standard	Program Conformance
(f) Managing stormwater as required by 310 CMR 10.05(6)(k) through (q); and	Stormwater management will be designed in accordance with Massachusetts Department of Environmental Protection Standards. This standard will be met.
(g) Elevating any building on Open Piles or a solid foundation as allowed under the Massachusetts State Building Code.	The Program does not include buildings. This standard does not apply.
10.36(8) Redevelopment Within Previously Developed Land Subject to Coastal Storm Flowage. Notwithstanding the provisions of 310 CMR 10.36(5) through (7) which apply to new development, the Issuing Authority may allow work to redevelop a previously developed area within Land Subject to Coastal Storm Flowage; provided that the work promotes resiliency by improving existing conditions to the maximum extent practicable. Redevelopment means the replacement, rehabilitation, or expansion of existing structures, Improvement of an Existing Public Roadway, or reuse of previously developed areas. A previously developed area is one that contains structures or portions of structures, fill or other vertical impediments to flow, construction debris, or pavement. Activities shall conform to the standards specified in 310 CMR 10.36(4) through (7) when a site was previously developed but is not currently developed. Work to redevelop Land Subject to Coastal Storm Flowage shall conform to the following criteria:	

Performance Standard	Program Conformance
(a) At a minimum, proposed work shall result in an improvement over existing conditions of the capacity of the Land Subject to Coastal Storm Flowage to protect the interests of storm damage prevention and flood control to the maximum extent practicable. Existing conditions may be improved by topographical alterations to provide flood storage, planting of vegetation, reducing impervious surfaces, increasing permeability, removing vertical impediments to flowage, and restoring or creating coastal Resource Areas where they do not currently exist or are currently covered by impervious surfaces. Where a previously developed coastal Resource Area has not been regulated under the applicable performance standards to protect the interests of flood control and storm damage prevention, the proposed work shall restore those interests to the extent practicable;	Conformance with this standard will be assessed if required during the permitting process.
(b) Stormwater management is implemented as required by 310 CMR 10.05(6)(k) through (q);	Provisions for stormwater management will be made. This standard will be met.
(c) No portion of any proposed new building may be located within the V-Zone and no portion of any newly reconstructed building may be located more seaward than its previously developed location within the MoWA Zone area of the lot.	The Program does not include construction of new buildings. This standard does not apply.
(d) Mitigation, such as flood easements or other means, is implemented or any fill, structure, or topographic alteration that would increase flood velocity, volume, or elevations within a confined basin that can be identified using LiDAR or on a USGS topographic map, where a manmade or natural feature significantly impedes or prevents the return flow of coastal flood waters;	A preliminary analysis regarding the impact of changes to fill, structure, and topography (within Land Subject to Coastal Storm Flowage that does not overlie another coastal Resource Area) on the velocity, path, and extent of overland coastal surge is provided in **Section 4.22.4.4.** Conformance with this standard will be confirmed if required during the permitting process, including the potential impacts of the proposed piers within Land Subject to Coastal Storm Flowage for the Bourne Bridge.
(e) Additional elevation shall be provided in the MoWA and MiWA Zones where the building official has determined under 780 CMR: Massachusetts State Building Code that the project includes certain work.	The Program does not include the construction of buildings. This standard does not apply.

Performance Standard	Program Conformance
(f) The placement of fill for flood control purposes may be allowed in a MiWA Zone where impervious surfaces have predominantly replaced the natural coastal floodplain; provided that there shall be no redirection of wave energy or of flood waters to other properties, and other requirements of 310 CMR 10.36(7) and (8) have been met; and	No fill for flood control purposes is proposed. This standard does not apply.
(g) The elevation in height of an existing seawall or the construction of a berm with associated fill for flood control purposes in a V-Zone or a MoWA Zone of Land Subject to Coastal Storm Flowage in an area where impervious surfaces have predominantly replaced the natural coastal floodplain may be allowed when conducted by the public agency responsible for the infrastructure, or in the case of private seawalls or berms, when supported by the municipality.	The Program site is not mapped within a V-Zone or MoWA Zone. This standard does not apply.

4.10.6.2 Water Quality Certification (Section 401 of the Clean Water Act)

The Massachusetts Water Quality regulations (314 CMR 9.00) include performance standards to be met for dredging and the discharge of dredged or fill material. A Major Dredge Project Certification for more than 5,000 cubic yards will be required. In addition, because the project would result in the loss of more than 5,000 square feet of LUW for the discharge of dredged or fill material, a Major Project Certification for Fill/Excavation will be required. The following information demonstrates conformance with the criteria outlined in 314 CMR 9.06 Criteria for the Evaluation of Applications for the Discharge of Dredged or Fill Material and 314 CMR 9.07 Criteria for the Evaluation of Applications for Dredging and Dredged Material Management.

The following address conformance with 9.06: Criteria for the Evaluation of Applications for Discharge of Dredged or Fill Material:

Standard 9.06 (1)

No discharge of dredged or fill material shall be permitted if there is a practicable alternative to the proposed discharge that would have less adverse impact on the aquatic ecosystem, so long as the alternative does not have other significant adverse environmental consequences.

Response

An alternatives analysis of this water-dependent project selected a Build Alternative considering a range of both in-water and terrestrial interests, including navigational clearances, structural integrity of the bridge, the location of the existing Canal Service Road, and construction impacts. Additionally, alternatives were reviewed in relation to their performance at meeting screening criteria related to operations, connectivity, geometrics safety, constructability, multimodal connections, utility impacts, environmental impacts (including avoidance of wetland resources), and right-of-way impacts.

Standard 9.06 (2)

No discharge of dredged or fill material shall be permitted unless appropriate and practicable steps have been taken which will avoid and minimize potential adverse impacts to the bordering or isolated vegetated wetlands, land under water or ocean, or the intertidal zone. However, no such project may be permitted which will have any adverse impact on specified habitat sites of Rare Species.

Response

The Program has been designed in accordance with Clean Water Act 404(b)(1) guidelines, to avoid and minimize impacts as practicable and to provide mitigation for the unavoidable impacts.

The Project Limits do not include areas mapped as Estimated Habitat of Rare Wildlife by the Massachusetts Wildlife's Natural Heritage and Endangered Species Program (NHESP).

Standard 9.06 (3)

Except as otherwise provided in 314 CMR 9.06(3), no discharge of dredged or fill material shall be permitted to Outstanding Resource Waters. The discharge of dredged or fill material to an Outstanding Resource Water in association with an activity listed in 314 CMR 9.06(3)(a) Effective 10/through (k) may be permitted without requiring the applicant to obtain a variance in accordance with 314 CMR 9.08 provided that the Department determines that the discharge of dredged or fill material may be permitted in accordance with 314 CMR 9.06(1), (2), (4), (5), and (7), and is not identified in 314 CMR 9.06(4) as a discharge of dredged or fill material that requires a variance.

Response

The Program does not involve a discharge of dredged or fill material to Outstanding Resource Waters.

Standard 9.06 (4)

The discharge of dredged or fill material into wetlands or waters of the Commonwealth within 400 feet of the high water mark of a Class A surface water (exclusive of tributaries) requires a variance issued by the Department pursuant to 314 CMR 9.08 unless the discharge of dredged or fill material is associated with an activity conducted by a public water system under 310 CMR 22.00: Drinking Water or by a public agency or authority for the maintenance or repair of existing public roads or railways. The discharge of dredged or fill material to a vernal pool certified by the Division of Fisheries and Wildlife requires a variance pursuant to 314 CMR 9.08

Response

The Program does not involve the discharge of dredged or fill material into wetlands or waters of the Commonwealth within 400 feet of the high water mark of a Class A surface water. The Program does not involve the discharge of dredged or fill material to a vernal pool certified by the Division of Fisheries and Wildlife.

Standard 9.06 (5)

No discharge of dredged or fill material is permitted for the impoundment or detention of stormwater for purposes of controlling sedimentation or other pollutant attenuation. Discharge of dredged or fill material may be permitted to manage stormwater for flood control purposes only where there is no

practicable alternative and provided that best management practices are implemented to prevent sedimentation or other pollution. No discharge of dredged or fill material is permitted for the impoundment or detention of stormwater in Outstanding Resource Waters for any purpose.

Response

The Program does not involve the discharge of dredged or fill material for the impoundment or detention of stormwater for purposes of controlling sedimentation or other pollutant attenuation (refer to **Section 4.11, Water Quality and Stormwater**).

The Program does not involve a discharge of dredged or fill material to Outstanding Resource Waters.

Standard 9.06 (6)(a)

Except as otherwise provided in 314 CMR 9.06, stormwater discharges shall be provided with best management practices to attenuate pollutants and to provide a setback from the receiving water or wetlands in accordance with the Stormwater Management Standards as further defined and specified in the Massachusetts Stormwater Handbook.

Response

The project has been designed in accordance with the Stormwater Management Standards as further defined and specified in the Massachusetts Stormwater Handbook (refer to **Section 4.11, Water Quality and Stormwater**).

The following addresses Project conformance with 9.07: Criteria for the Evaluation of Applications for Dredging and Dredged Material Management

Standard 9.07 (1)(a)

No dredging shall be permitted unless appropriate and practicable steps have been taken which would first avoid, and if avoidance is not possible then minimize, or if neither avoidance or minimization are possible, then mitigate, potential adverse impacts to land under water or ocean, intertidal zone and special aquatic sites. No dredging shall be permitted if there is a practicable alternative that would have less impact on the aquatic ecosystem. However, no such dredging may be permitted which would have any adverse impact on specified habitat sites of Rare Species unless the work is subject to a Conservation and Management Permit or Determination of No Take issued by the Division of Fisheries and Wildlife.

Response

The Program has been designed in accordance with CWA 404(b)(1) guidelines, to avoid and minimize impacts as practicable and to provide mitigation for the unavoidable impacts.

The Project Limits do not include areas mapped as Estimated Habitat of Rare Wildlife by the Massachusetts Wildlife's Natural Heritage and Endangered Species Program (NHESP).

An alternatives analysis of this water-dependent project selected a Build Alternative considering a range of both in-water and terrestrial interests, including navigational clearances, structural integrity of the bridge, the location of the existing Canal Service Road, and construction impacts. Additionally, alternatives were reviewed in relation to their performance at meeting screening criteria related to

operations, connectivity, geometrics safety, constructability, multimodal connections, utility impacts, environmental impacts (including avoidance of wetland resources), and right-of-way impacts.

The Program does not involve a discharge of dredged or fill material to Outstanding Resource Waters.

Cape Cod Canal has undergone recent maintenance dredging. Testing of the dredged material found that the material was appropriate for beach nourishment and the dredged material has been used for beach nourishment at Town Beach in Sandwich.

Standard 9.07 (2)

Sampling and Analysis Requirements. The applicant shall submit the results of all relevant sampling with the application unless an alternative schedule is specifically authorized by the Department in writing.

Response

The Project will comply with all sampling requirements.

Standard 9.07 (3)

Dredging Performance Standards. Dredging shall be planned and conducted to minimize short-term, long-term, impacts on the aquatic ecosystem and to provide protection to human health.

Response

The project will plan and conduct dredging to minimize short-term, long-term, impacts on the aquatic ecosystem and to provide protection to human health.

4.10.6.3 Section 404 of the Clean Water Act

The Build Alternative would require a Section 404 permit for the placement of fill material in WOTUS. These impacts are evaluated under the Section 404 (b)(1) Guidelines, the intent of which is to avoid unnecessary filling of waters and wetlands. The Section 404 (b)(1) Guidelines (40 CFR Section 230) which states:

> "Except as provided under section 404(b)(2) of the CWA, no discharge of dredged or fill material shall be permitted if there is a practicable alternative to the proposed discharge which would have less adverse impact on the aquatic ecosystem, so long as the alternative does not have other significant adverse environmental consequences., the intent of which is to avoid unnecessary filling of waters and wetlands (40 CFR § 230.10(a)). An alternative is practicable if it is available and capable of being done after taking into consideration cost, existing technology, and logistics in light of overall project purposes. If it is otherwise a practicable alternative, an area not presently owned by the applicant which could reasonably be obtained, utilized, expanded or managed in order to fulfill the basic purpose of the proposed activity may be considered (40 CFR § 230.10(a)(2)). Where the activity associated with a discharge which is proposed for a special aquatic site (as defined in subpart E) does not require access or proximity to or siting within the special aquatic site in question to fulfill its basic purpose (i.e., is not "water-dependent"),

practicable alternatives that do not involve special aquatic sites are presumed to be available, unless clearly demonstrated otherwise. In addition, where a discharge is proposed for a special aquatic site, all practicable alternatives to the proposed discharge which do not involve a discharge into a special aquatic site are presumed to have less adverse impact on the aquatic ecosystem, unless clearly demonstrated otherwise (40 CFR § 230.10(a)(3)).”

“Except as provided under Section 404(b)(2), no discharge of dredged or fill material shall be permitted unless appropriate and practicable steps have been taken which will minimize potential adverse impacts of the discharge on the aquatic ecosystem (40 CFR § 230.10(d)).”

Alternatives

An alternatives analysis of this water-dependent project selected a Build Alternative considering a range of both in-water and terrestrial interests, including navigational clearances, structural integrity of the bridge, the location of the existing Canal Service Road, and construction impacts. Additionally, alternatives were reviewed in relation to their performance at meeting screening criteria related to operations, connectivity, geometrics safety, constructability, multimodal connections, utility impacts, environmental impacts (including avoidance of wetland resources), and right-of way impacts. For further discussion regarding the alternatives analysis, refer to **Chapter 3, Proposed Action and Alternatives**.

Minimization

The Program has been designed minimize adverse impacts as appropriate and practicable (refer to **Section 4.10.6.1**).

4.10.6.4 23 CFR 650 Subpart A (Floodplain)

23 CFR Part 650 Subpart A – Location and Hydraulic Design of Encroachments on Flood Plains prescribes Federal Highway Administration (FHWA) policies and procedures for the location and hydraulic design of highway encroachments on flood plains, including direct federal highway projects administered by the FHWA. Conformance with applicable requirements of Subpart A is provided in **Table 4.10-28**.

Table 4.10-28. 23 CFR Part 650 Subpart A Conformance

Performance Standard	Conformance
Sec. 650.111 Location hydraulic studies.	
a) National Flood Insurance Program (NFIP) maps or information developed by the highway agency, if NFIP maps are not available, shall be used to determine whether a highway location alternative will include an encroachment.	National Flood Insurance Program maps were used to determine the presence of an encroachment.
b) Location studies shall include evaluation and discussion of the practicability of alternatives to any longitudinal encroachments.	An alternatives analysis is included in **Chapter 3.**
c) Location studies shall include discussion of the following items, commensurate with the significance of the risk or environmental impact, for all alternatives containing encroachments and for those actions which would support based floodplain development: (1) The risks associated with implementation of the action, (2) The impacts on natural and beneficial flood-plain values, (3) The support of probable incompatible flood-plain development, (4) The measures to minimize flood-plain impacts associated with the action, and (5) The measures to restore and preserve the natural and beneficial flood-plain values impacted by the action.	The Draft Environmental Impact Report includes a discussion of these items regarding encroachment. The Program does not support floodplain development.
d) Location studies shall include evaluation and discussion of the practicability of alternatives to any significant encroachments or any support of incompatible flood-plain development	The Program would not result in a significant encroachment and does not support incompatible floodplain development.
e) The studies required by Sec. 650.111 (c) and (d) shall be summarized in environmental review documents prepared pursuant to 23 CFR Part 771	The Program's Draft Environmental Impact Report provides a summary.
f) Local, State, and Federal water resources and flood-plain management agencies should be consulted to determine if the proposed highway action is consistent with existing watershed and flood-plain management programs and to obtain current information on development and proposed actions in the affected watersheds	The Program would comply with the Massachusetts Wetlands Protection Act and its implementing regulations, which regulate natural and beneficial floodplain values.

Performance Standard	Conformance
Sec. 650.113 Only practicable alternative finding.	
a) A proposed action which includes a significant encroachment shall not be approved unless the FHWA finds that the proposed significant encroachment is the only practicable alternative. This finding shall be included in the final environmental document (final environmental impact statement or finding of no significant impact) and shall be supported by the following information: (1) The reasons why the proposed action must be located in the flood plain, (2) The alternatives considered and why they were not practicable, and (3) A statement indicating whether the action conforms to applicable State or local flood-plain protection standards.	The proposed action is not considered a significant encroachment. This standard is not applicable to the Program.

4 Existing Conditions, Program Impacts, and Mitigation

4.11 Water Quality and Stormwater

4.11.1 Introduction

This section assesses the potential construction period and operational effects of the No Build Alternative and the Build Alternative on water quality, including surface water, groundwater, and stormwater conditions. This section also identifies mitigation measures that will be implemented to avoid or minimize the potential construction-related and operational effects of the Build Alternative relative to water quality resources, including the Cape Cod Sole Source Aquifer and the Plymouth/Carver Sole Source Aquifer.

4.11.2 Regulatory Context

Stormwater management and water quality are governed by various federal and state regulatory programs. The Federal Water Pollution Control Act Amendments of 1972,[1] also known as the Clean Water Act (CWA), is the primary federal law governing surface water quality protection in the United States. Stormwater management in Massachusetts is governed by sections of the Massachusetts Wetlands Protection Act Regulations,[2] and the state's 401 Water Quality Certification regulations.[3]

Further details on the relevant federal and state regulations and programs governing water quality and stormwater are provided in the following sections.

4.11.2.1 Federal Regulations and Water Quality

Federal Water Pollution Control Act (Clean Water Act) of 1972 (33 USC 1251-1376) as amended by the U.S. Clean Water Act (1977) and the Water Quality Act (1987)

The CWA establishes the basic structure for regulating discharges of pollutants into the Waters of the United States (WOTUS) and regulating quality standards for surface waters.[4] The CWA requires that industrial facilities, construction sites, and municipal separate storm sewer systems (MS4) have

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[1] Federal Water Pollution Control Act (Clean Water Act) of 1972 (33 U.S. Code 1251-1376) as amended by the U.S. Clean Water Act (1977) and the Water Quality Act (1987); Sections 401 and 404 of the Clean Water Act (33 U.S. Code 1251-1376). https://www.epa.gov/laws-regulations/summary-clean-water-act

[2] Massachusetts Department of Environmental Protection. 2014. Massachusetts Wetlands Protection Act Regulations (310 Code of Massachusetts Regulations [CMR] 10.00). October. https://www.mass.gov/regulations/310-CMR-1000-wetlands-protection-act-regulations

[3] Massachusetts Department of Environmental Protection. 2014. Massachusetts 401 Water Quality Certification Regulations (314 CMR 9.00). October. https://www.mass.gov/regulations/314-CMR-9-401-water-quality-certification.

[4] U.S. Environmental Protection Agency. n.d. Summary of the Clean Water Act. https://www.epa.gov/laws-regulations/summary-clean-water-act

measures in place to prevent pollution from being discharged with stormwater into nearby waterways.[5]

Section 401 of the Clean Water Act

Under Section 401 of the CWA, a federal agency may not issue a permit or license to conduct any activity that may result in any discharge into WOTUS unless a Section 401 Water Quality Certification is issued, or certification is waived. In Massachusetts, Massachusetts Department of Environmental Protection (MassDEP) administers Section 401 of the CWA through 401 Water Quality Certification regulations.

Section 402 of the Clean Water Act

Section 402 of the CWA establishes the National Pollutant Discharge Elimination System (NPDES) permit program, which regulates point source discharges of pollutants into WOTUS. The NPDES permit program requires operators of construction sites that disturb 1 acre or more of land, where those discharges enter WOTUS, to obtain coverage under an NPDES Construction General Permit (CGP) for their stormwater discharges. The NPDES CGP requires operators of such construction sites to prepare and implement a Stormwater Pollution Prevention Plan (SWPPP) in accordance with the provisions of the CWA. The SWPPP requires documentation of stormwater controls, erosion and sedimentation controls, pollution prevention controls, and construction dewatering controls to be implemented during construction. In Massachusetts, the U.S. Environmental Protection Agency (EPA) issues NPDES CGPs.

Section 404 of the Clean Water Act

Section 404 of the CWA requires authorization from the Secretary of the Army, acting through the USACE, for the discharge of dredged or fill material into all WOTUS, including wetlands. The term "dredged material" means material that is excavated or dredged from WOTUS. The term "fill material" means any material that has the effect of either replacing any portion of a WOTUS with dry land or changing the bottom elevation of any portion of a WOTUS.

Total Maximum Daily Loads and Section 303(d) Program

The EPA requires states to establish priority rankings for waters and develop Total Maximum Daily Loads (TMDL) for these waters under Section 303(d) of the CWA to address pollution from point and non-point source discharges. TMDLs represent a pollution budget that establishes the maximum amount of a pollutant that can occur in a waterbody and still meet Massachusetts Surface Water Quality Standards (WQS). States are required to submit lists of impaired waters to the EPA for approval. "Impaired" status means that the waterway does not meet state WQS. These are waters that are too polluted or otherwise degraded to meet WQS. Once approved under the Section 303(d) Program, the state then continues to study and test the waterway and if the quality degrades further, then eventually a TMDL is developed for a specific pollutant. A TMDL serves as a planning tool and

[5] U.S. Environmental Protection Agency. n.d. Water Enforcement. https://www.epa.gov/enforcement/water-enforcement#stormwater

potential starting point for restoration or protection activities with the goal of attaining or maintaining WQS.

- Section 303(d) Listed Impairments in Cape Cod Canal – According to the Massachusetts Year 2022 Integrated List of Waters by MassDEP, Cape Cod Canal, identified as MA95-14, is listed as impaired for fecal coliform.
- TMDLs in the Cape Cod Canal – There is one TMDL that applies to Cape Cod Canal within the Study Area: the Final Pathogen TMDL for the Buzzards Bay Watershed dated March 2009.

The Final Pathogen TMDL for the Buzzards Bay Watershed indicates that the source for pathogens in the Study Area is bacteria and fecal-related pollution, where the majority of the pollutant is from illicit sewer connections to storm drains, urban stormwater runoff that contains pet and/or animal waste, and illicit boat discharges. The Massachusetts WQS also set criteria for fecal coliform in Class SB marine waters, which state that the geometric mean of a representative set of fecal coliform samples will not exceed 35 colonies per 100 milliliters and no more than 10% of the samples shall exceed 130 colonies per 100 milliliters. The MassDEP may apply these standards on a seasonal basis. The TMDL document analyzed and calculated the percentage of pathogen reductions required to meet WQS for the canal. In Cape Cod Canal, identified in the TMDL document as segment MA 95-14, the TMDL is 9.07E+09 colonies per day. The target reduction for illicit sources is 100%. The target reduction for pathogens in stormwater is two to three orders of magnitude, which is generally expected to be achieved by the implementation of stormwater control measures (SCM).

Municipal Separate Storm Sewer System (MS4) Program

The MS4 owners operate their stormwater management systems in accordance with permits issued by the EPA and MassDEP, as authorized by the CWA, under the NPDES program where they are required to develop and implement stormwater management programs to meet specific water quality criteria for their respective stormwater discharges. The Massachusetts Department of Transportation (MassDOT) is currently covered by the General Permit that was issued in 2003 for urbanized areas of Massachusetts. A new permit was issued in 2016, but MassDOT was not named as a regulated entity in that version of the permit. MassDOT is seeking coverage under an individual Transportation Separate Storm Sewer System (TS4) Permit for its stormwater discharges. The TS4 Permit has not been released yet, but it is expected to follow the same general requirements as the MS4 Permit. The town of Bourne is currently covered under the 2016 MS4 Permit.

4.11.2.2 State Regulations and Water Quality

The Massachusetts Stormwater Management Standards are enforced through sections of the Massachusetts Wetlands Protection Act Regulations (310 Code of Massachusetts Regulation [CMR] 10.00) and the 401 Water Quality Certification regulations (314 CMR 9.00). The Massachusetts Stormwater Management Standards set treatment targets for water quality and quantity and require the implementation of SCMs to meet those targets. MassDEP is revising the Massachusetts Stormwater Management Standards, but the release date is unknown.

Massachusetts Wetlands Protection Act Regulations (310 CMR 10.00)

These regulations establish procedures for local conservation commissions and MassDEP to follow in issuing permits for work in areas protected under the Wetlands Protection Act.[6] The Massachusetts Stormwater Management Standards are incorporated into the Wetlands Protection Act at 310 CMR 10.05(6)(b)(1)(a).

Massachusetts 401 Water Quality Certification Regulations (314 CMR 9.00)

The Massachusetts 401 Water Quality Certification regulations establish procedures and criteria for administration of Section 401 of the CWA for the discharge of dredged or fill material in WOTUS within the Commonwealth of Massachusetts, which require federal licenses or permits. MassDEP administers the 401 Water Quality Certification regulations to ensure compliance with the Massachusetts Surface WQS (314 CMR 4.00).[7] The Massachusetts Stormwater Management Standards are incorporated into the Water Quality Certification Regulations at 310 CMR 9.06(6)(a).

Massachusetts Stormwater Handbook and Stormwater Standards, February 2008

The Massachusetts Stormwater Handbook was revised and updated in February 2008 in accordance with revisions to the wetlands regulations (310 CMR 10.00), and the Water Quality Regulations (314 CMR 9.00) relating to stormwater.[8] The handbook presents the legal and regulatory framework, stormwater best management practices (BMP), and technical guidance for documenting compliance.

Massachusetts Erosion and Sediment Control Guidelines for Urban and Suburban Areas; A Guide for Planners, Designers, and Municipal Officials, May 2003 (reprint)

This guide presents planning principles and BMPs for controlling erosion and sedimentation.

Massachusetts Surface Water Quality Regulations (314 CMR 4.00)

The Massachusetts Surface Water Standards classify surface waters in the state and establish minimum criteria to protect and enhance uses. The state regulations classify Cape Cod Canal as a Class SB coastal waterway with shell fishing qualifier. Class SB waters include designated uses as habitat for fish, other aquatic life, and wildlife, as well as for primary and secondary contact recreation. The WQS set criteria to sustain the listed designated uses for discharges of potential pollutants, including dissolved oxygen, pH, solids, color and turbidity, aesthetics, and nutrients.

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[6] Massachusetts Department of Environmental Protection. 2014. Massachusetts Wetlands Protection Act Regulations (310 Code of Massachusetts Regulations [CMR] 10.00). October. https://www.mass.gov/regulations/310-CMR-1000-wetlands-protection-act-regulations

[7] Massachusetts Department of Environmental Protection. 2014. Massachusetts 401 Water Quality Certification Regulations (314 CMR 9.00). October. https://www.mass.gov/regulations/314-CMR-9-401-water-quality-certification.

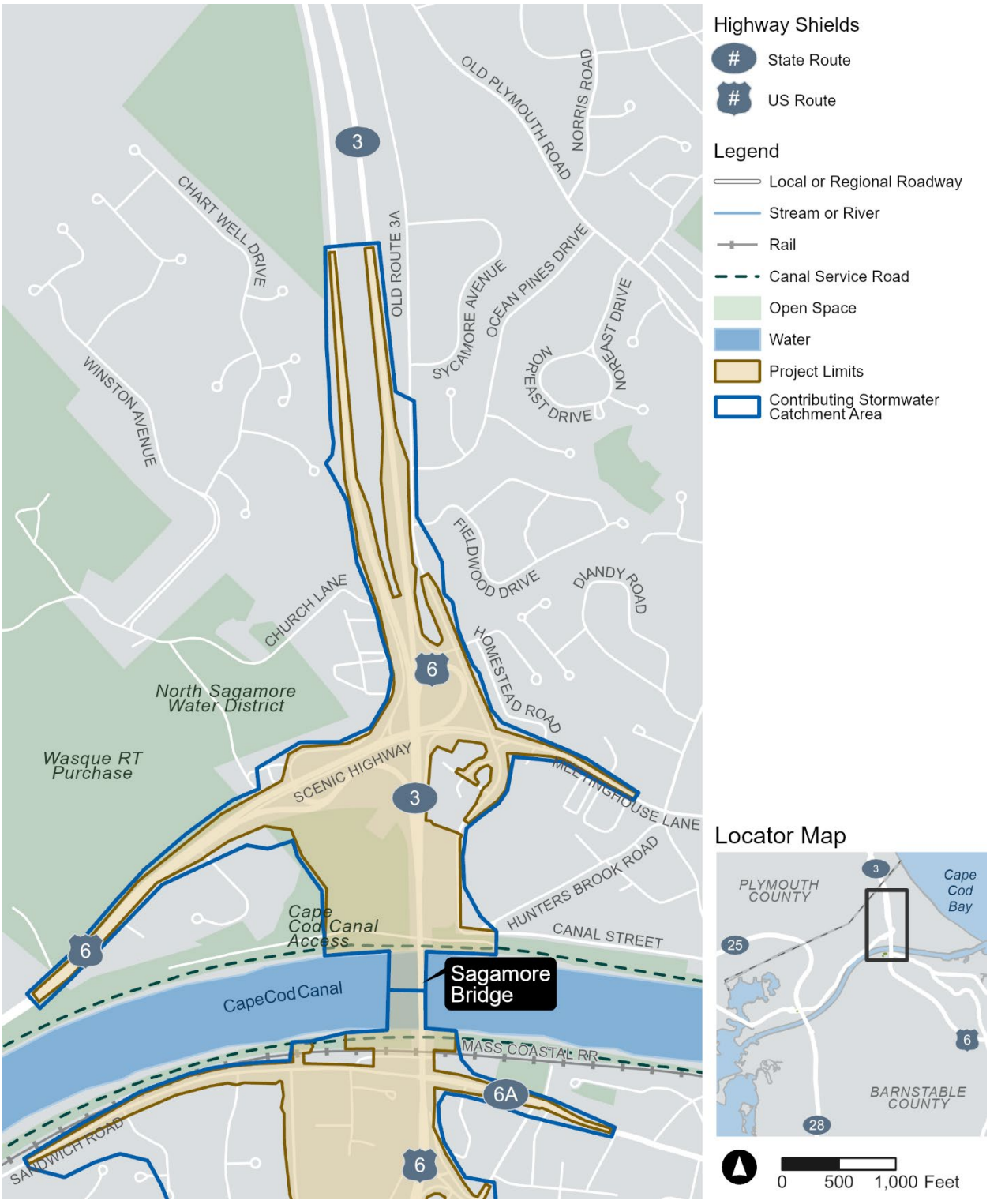
[8] Massachusetts Department of Environmental Protection. 2008. Massachusetts Stormwater Handbook and Stormwater Standards. February. https://www.mass.gov/guides/massachusetts-stormwater-handbook-and-stormwater-standards#-stormwater-handbook-volume-1-

4.11.3 Methodology and Study Area

4.11.3.1 Study Area

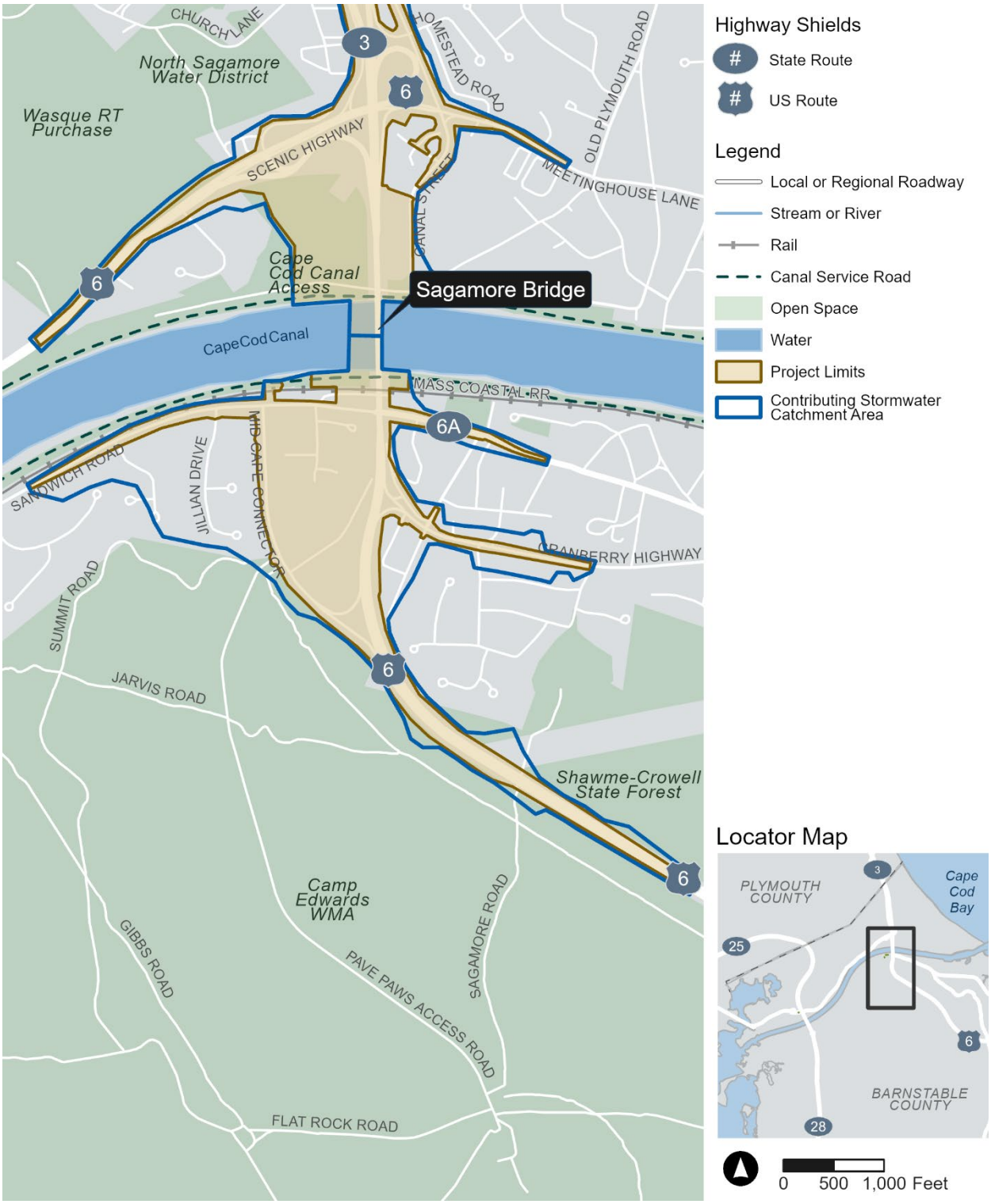
The Study Area for the water quality and stormwater assessment includes the construction footprint of the Build Alternative, as well as the areas of land that contribute flow to the construction footprint and ultimately Cape Cod Canal. **Figure 4.11-1 through Figure 4.11-4** identify the watershed boundaries within each of the following Study Area quadrants: Sagamore North, Sagamore South, Bourne North, and Bourne South. The contributing stormwater catchment area is the same for existing and proposed conditions. They were delineated using a combination of topographic survey and record plans that define the existing closed drainage system. The contributing stormwater catchment area depicts the Study Area that was delineated and included in the site-specific hydrologic model for comparison of existing and proposed conditions. Areas outside of the Project Limits that will not change due to the proposed construction were not included in the hydrologic study.

Figure 4.11-1. Contributing Stormwater Catchment Area (Sagamore North Quadrant)



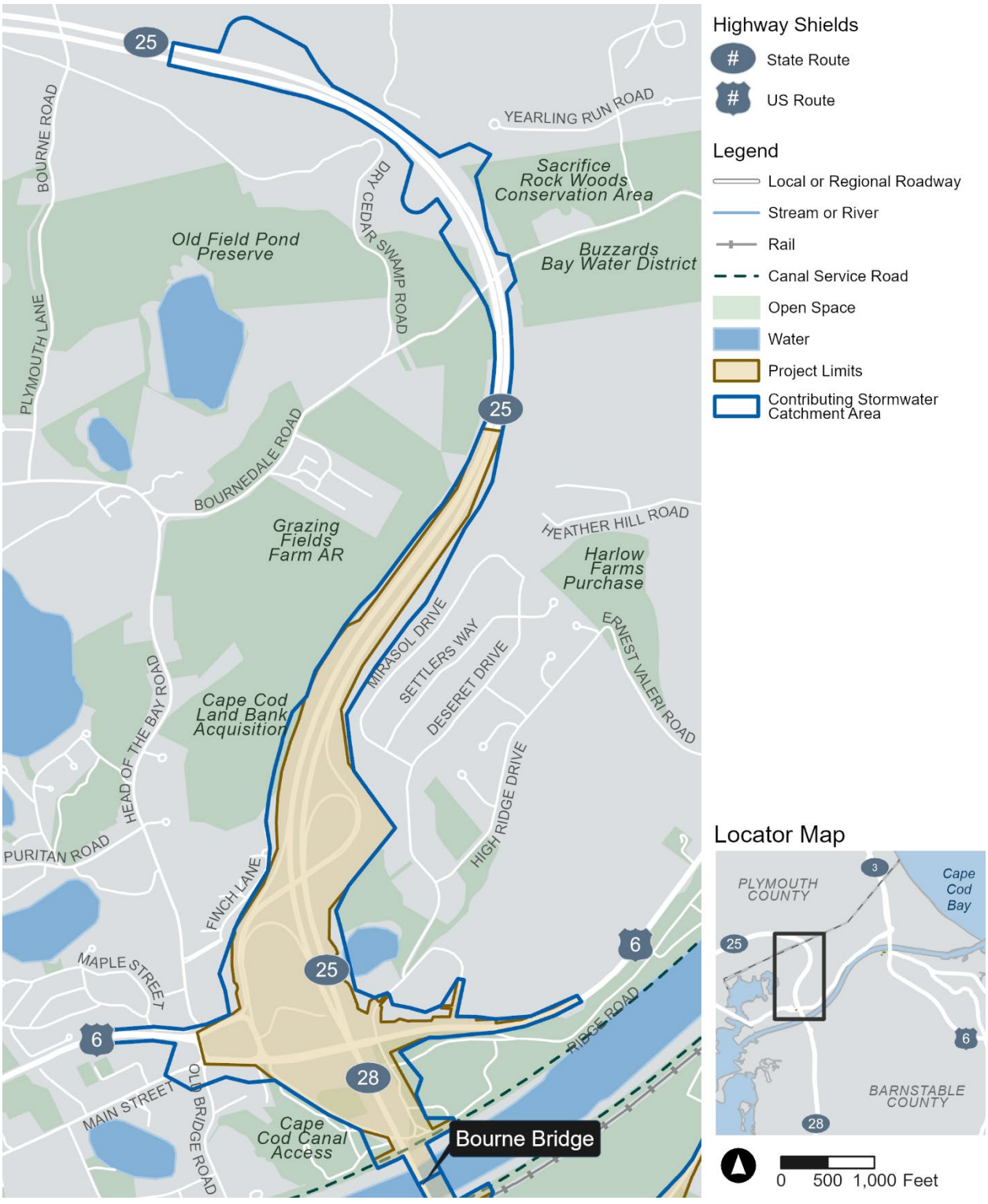
Source: Massachusetts Department of Transportation, 2024

Figure 4.11-2. Contributing Stormwater Catchment Area (Sagamore South Quadrant)



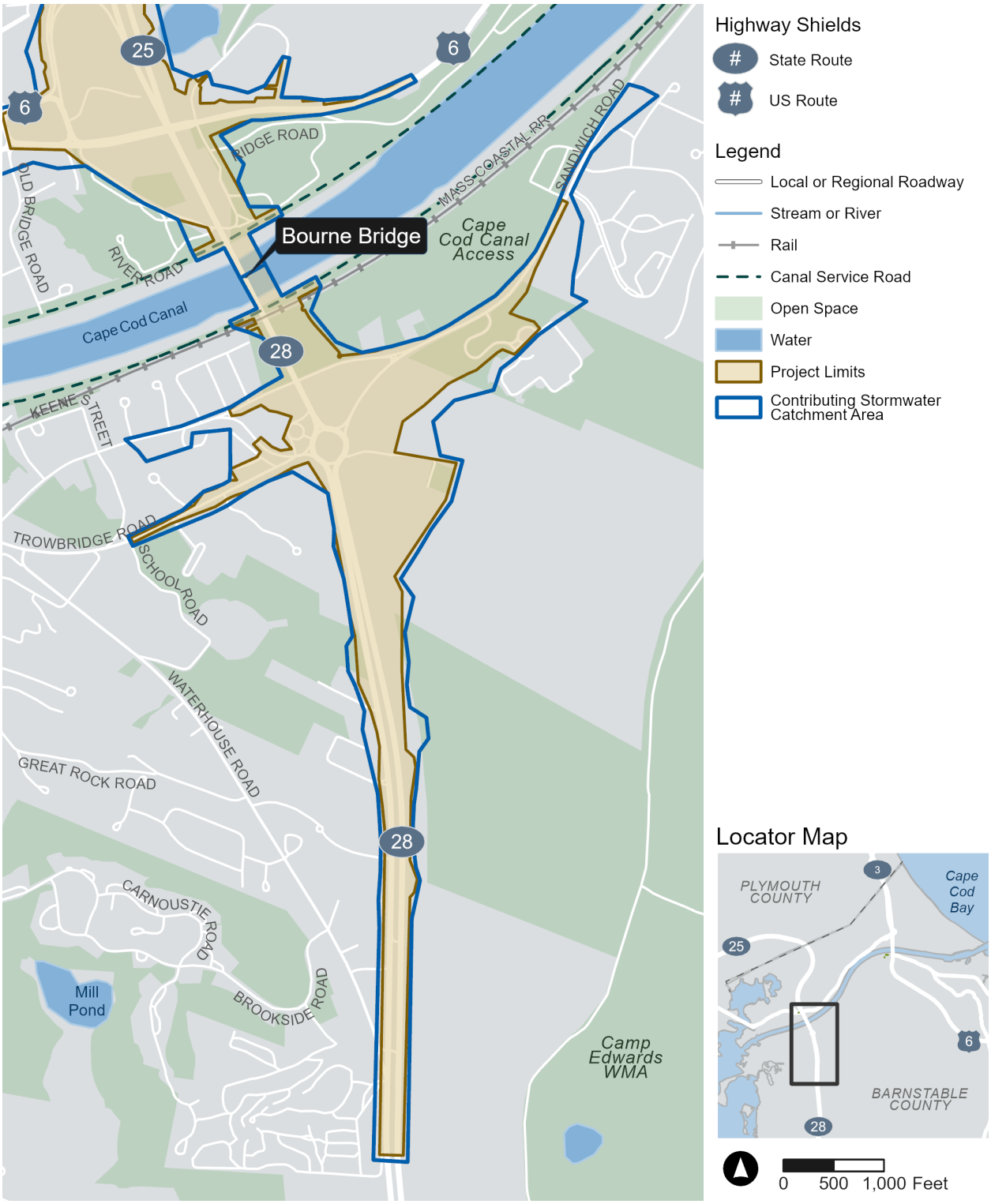
Source: Massachusetts Department of Transportation, 2024

Figure 4.11-3. Contributing Stormwater Catchment Area (Bourne North Quadrant)



Source: Massachusetts Department of Transportation, 2024

Figure 4.11-4. Contributing Stormwater Catchment Area (Bourne South Quadrant)



Source: Massachusetts Department of Transportation, 2024

4.11.3.2 Assessment Methodologies

Surface and groundwater resource areas within the Study Area were identified and characterized by location. The existing stormwater collection and treatment system infrastructure, including outfall locations, was identified using topographic survey data and record plans. No potential connections to combined sewer overflows were found.

Potential direct and indirect effects to receiving waters were assessed for temporary (construction period) and long-term (operational) for the Build Alternative. Effects were addressed quantitively and qualitatively. Temporary and No Build Alternative effects were assessed qualitatively. The quantitative assessment for the Build Alternative includes the total alteration to impervious cover (refer to **Table 4.11-4**), a comparison of peak flow rates for storm events under existing and proposed conditions (refer to **Table 4.11-5** through **Table 4.11-7**), the recharge compliance requirements (refer to **Table 4.11-8**), and the water quality requirements (refer to **Table 4.11-9**).

The potential temporary and operational effects of the Build Alternative to groundwater were assessed, including measures to protect the sole source aquifers. Minimization and mitigation strategies for construction and operational effects were identified. Quantitative results were provided for peak flow reduction (refer to **Table 4.11-5** through **Table 4.11-7**), recharge volume (refer to **Table 4.11-8**), and pollutant removal achieved (refer to **Table 4.11-9**) by the proposed stormwater management system for the Build Alternative.

Rainfall predictions were used to design a stormwater management system that would provide adequate flood storage given a. The Resilient MA Action Team, co-led by Massachusetts Executive Office of Energy and Environmental Affairs and Massachusetts Emergency Management Agency, developed a Climate Resilience Design Standards Tool to help Massachusetts agencies and municipalities integrate climate change data and methodologies into the planning and design of projects with physical assets. For the Build Alternative, this design standards tool recommended accommodating the 2070, 100-year return period. The tool predicts that in the year 2070, the 100-year (or 1% probability) storm event will result in 9.8 inches of rainfall in 24 hours for the Sagamore Bridge watersheds and 9.9 inches of rainfall in 24 hours for the Bourne Bridge watersheds. These rainfall depths were used to assess the vulnerability of the stormwater management system and design sustainable infrastructure.

A qualitative comparative assessment was provided of the stormwater management system improvements for the Build Alternative to existing conditions and the No Build Alternative. The Build Alternative was evaluated for consistency with the Massachusetts Stormwater Management Standards in accordance with applicable state regulations.

Method of Calculation

The design flood[9] frequency for stormwater conveyance design elements was selected in accordance with MassDOT and FHWA guidelines. **Table 4.11-1** summarizes the design flood frequencies for the Build Alternative.

Table 4.11-1. Design Flood Frequency

Highway Functional Class	Cross Culverts and Open Channels	Storm Drain System and Pavement Drainage	Underpasses and Depressed Sections
Interstate	2% (50-year)	10% (10-year)	2% (50-year)
Arterial	2% (50-year)	10% (10-year)	2% (50-year)

Note: A culvert is a pipe crossing under a road, sidewalk, etc. that is open to daylight on both ends.

Hydrologic Analysis

The hydrology of the Study Area was analyzed in HydroCAD software using the Soil Conservation Service (SCS) Technical Release No. 20 (SCS unit hydrograph procedures),[10] and SCS Technical Release No. 55 (for Times of Concentration and Runoff Curve Numbers).[11] The SCMs were analyzed using the Dynamic Storage Indication Method.[12] The Type III 24-hour storm was used for stormwater runoff calculations.

Table 4.11-2 presents the 24-hour precipitation depths that were used to evaluate various storm event probabilities. The precipitation depths were estimated using the National Oceanic and Atmospheric Administration Atlas 14 data source.[13]

Table 4.11-2. Precipitation Depth

Storm Event Probability	24-Hour Depth (inches)
50% (2-year)	3.4
10% (10-year)	5.0
2% (50-year)	6.7
1% (100-year)	7.5

[9] A design flood is a hypothetical precipitation event used for analyzing or designing a stormwater management structure that is tied to the probability of that event occurring (e.g., a 2-year storm has a 50% probability of occurring in any given year and a 100-year storm has a 1% probability of occurring in any given year).

[10] Natural Resources Conservation Service. n.d. TR-20: Project Formulation – Hydrology. https://hydrocad.net/tr-20.htm

[11] Natural Resources Conservation Service. n.d. TR-55: Uban Hydrology for Small Watersheds. https://www.hydrocad.net/tr-55.htm

[12] Natural Resources Conservation Service. n.d. Using the Dynamic Storage-Indication Method. https://hydrocad.net/dsi.htm

[13] National Oceanic and Atmospheric Administration, National Weather Service. n.d. Hydrometeorological Design Studies Center: NOAA Atlas 14 Point Precipitation Frequency Estimates. https://hdsc.nws.noaa.gov/pfds/pfds_map_cont.html

Hydraulic Analysis

The proposed storm drainage collection system was designed for the design flood frequencies listed in **Table 4.11-1** using the Rational Method. Bentley® StormCAD software was used to perform the hydraulic analysis for the storm drainage system.

Table 4.11-3 presents the precipitation intensities that were used to evaluate the storm drain conveyance system. The precipitation intensities were estimated using the National Oceanic and Atmospheric Administration Atlas 14 data source.

Table 4.11-3. Precipitation Intensity

Duration (minutes)	10-Year Intensity (inches per hour)	50-Year Intensity (inches per hour)
5	6.9	9.7
10	4.9	6.9
15	3.8	5.4
30	2.8	3.9
60	1.8	2.5

4.11.4 Existing Conditions

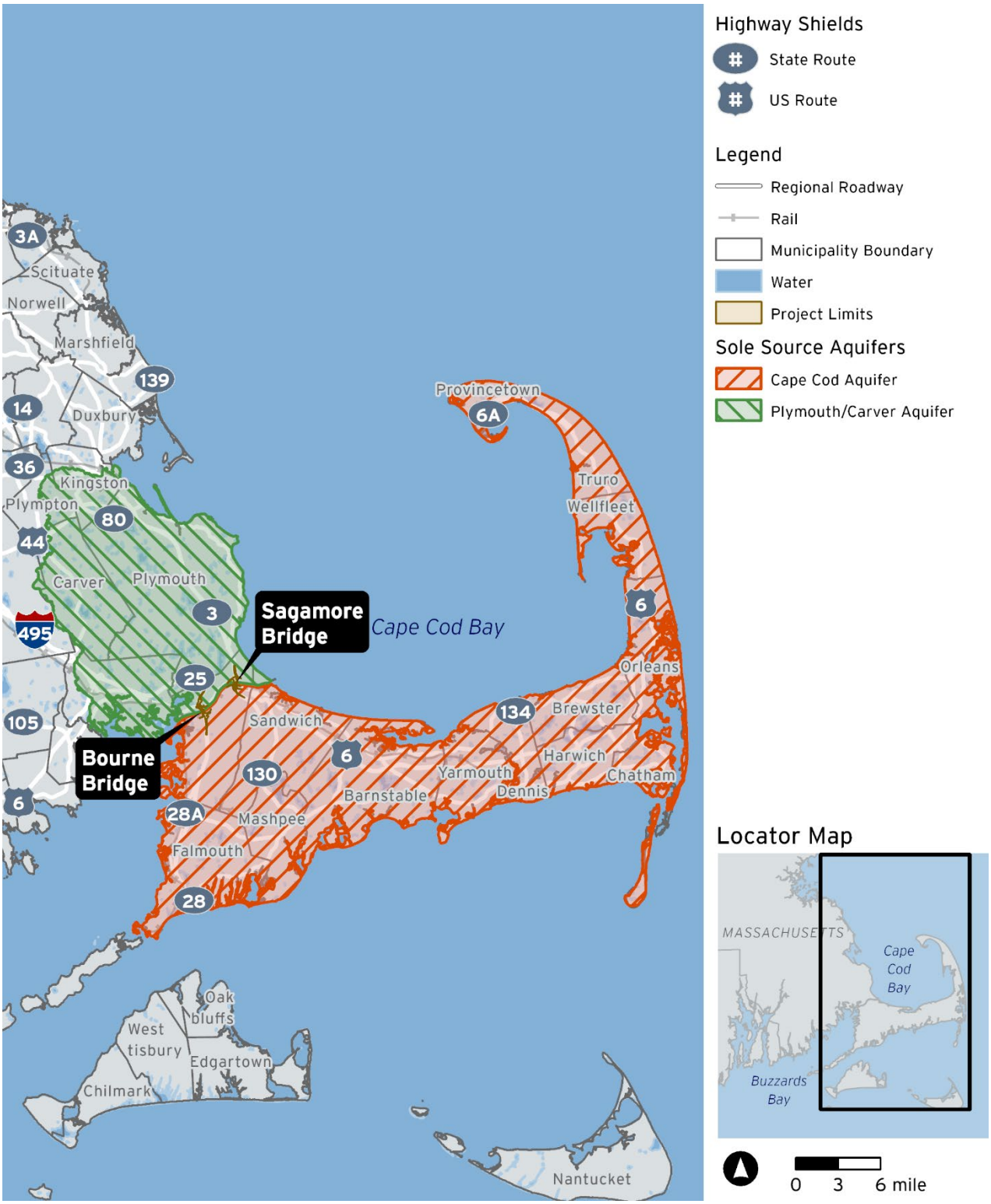
4.11.4.1 Drinking Water Supplies

The Study Area lies within two sole source aquifers, as designated by the EPA. The Cape Cod Sole Source Aquifer encompasses the entire Study Area south of Cape Cod Canal. The Plymouth/Carver Sole Source Aquifer encompasses the entire Study Area north of Cape Cod Canal. The designation ensures that no commitment for federal financial assistance may be provided for any project that the EPA determines may contaminate the aquifer through its recharge area to create a significant hazard to public health.[14] The EPA defines a sole source aquifer as one which supplies at least 50% of the drinking water consumed in the area overlying the aquifer. EPA guidelines also require that these areas have no alternative drinking water sources(s) that could physically, legally, and economically supply water to all who depend on the aquifer for drinking water.[15] **Figure 4.11-5** illustrates the extent of the two sole source aquifers within the Study Area.

[14] U.S. Environmental Protection Agency, Region 1. 2008. Sole Source Aquifer Program. https://www3.epa.gov/region1/eco/drinkwater/pc_solesource_aquifer.html

[15] U.S. Environmental Protection Agency, Region 1. 2008. Sole Source Aquifer Program. https://www3.epa.gov/region1/eco/drinkwater/pc_solesource_aquifer.html

Figure 4.11-5. Sole Source Aquifers



Source: Massachusetts Department of Transportation, 2024

Groundwater within these watersheds generally flows toward Cape Cod Canal, except for the portion of the Bourne North quadrant located north of Nightingale Pond, which flows toward Buttermilk Bay. As discussed in **Section 4.19, Solid and Hazardous Waste Material Management**, there are release sites within the Program Limits documented by MassDEP. All release sites are closed, having achieved a level of no significant risk under 310 CMR 40.000, the Massachusetts Contingency Plan. The releases are predominantly petroleum in nature, generally small in magnitude, and limited in extent based upon the tendency for petroleum to naturally attenuate over time and over relatively short distances (i.e., several hundreds of feet). Individually, each release would not contribute significantly to adverse groundwater quality within the sole source aquifers. The available groundwater quality data is specific to the individual releases but are not expected to include contaminants unrelated to each specific site. The available data is also spread out over time, in some cases by decades, making any comparison among data sets misleading or not representative of current conditions. Release sites are required to meet applicable risk standards to achieve regulatory closure. Based upon the sole source aquifers, applicable groundwater cleanup standards are the drinking water standards. However, some portions of these aquifers have been designated as non-potential drinking water source areas. Impacted soil and groundwater in these areas would not have to meet the most stringent drinking water cleanup standards. Disposal sites with residual groundwater impacts may have contaminant levels that are higher than drinking water standards in the non-potential drinking water source areas.

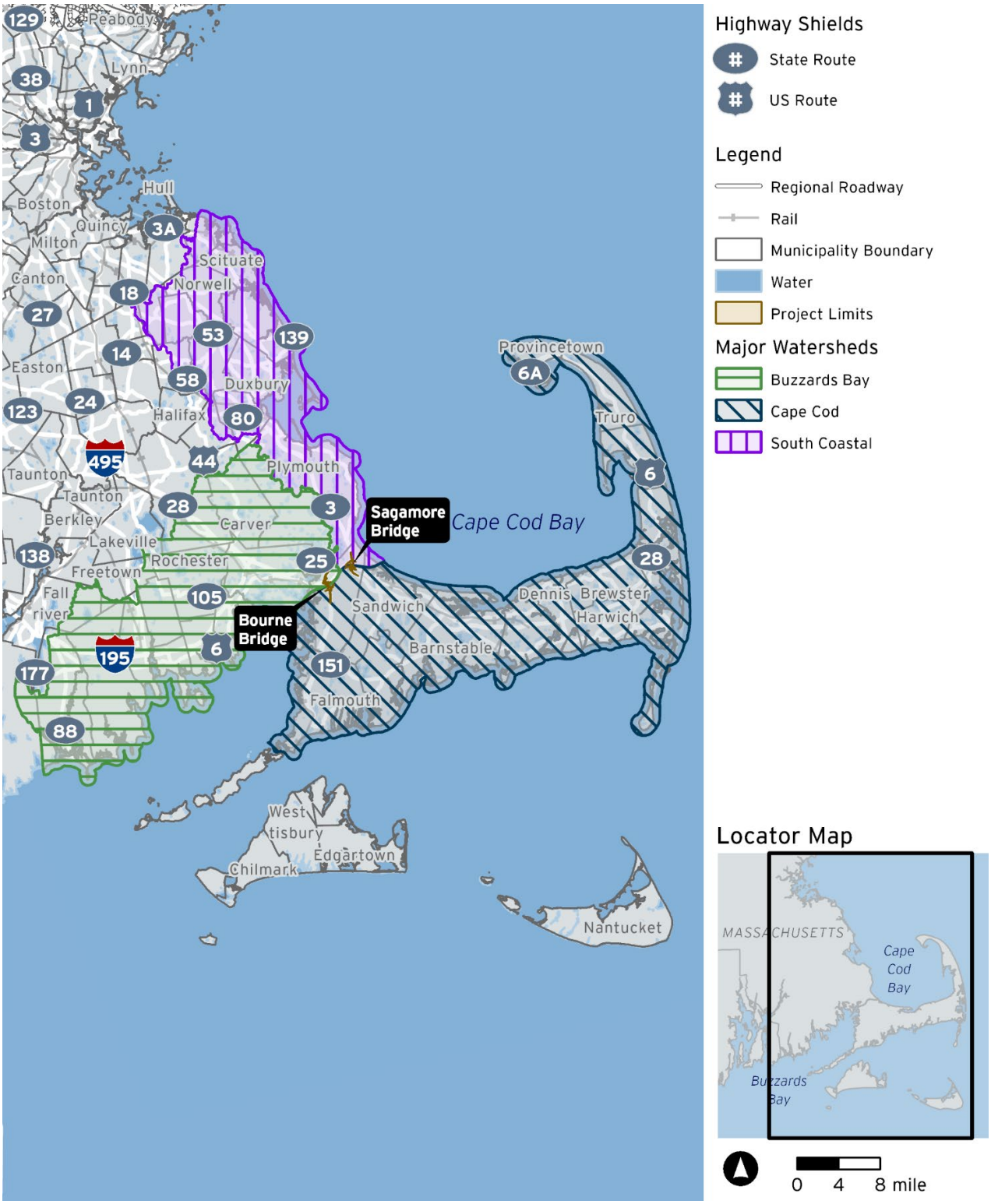
4.11.4.2 Study Area Watersheds

The Study Area also lies within three major watersheds: South Coastal, Cape Cod, and Buzzards Bay. Stormwater runoff within the Study Area flows to Cape Cod Canal with a portion captured by catch basins or similar structures and conveyed through underground pipes that discharge along the bank of the canal. Stormwater runoff within the Study Area is also captured and conveyed via pipe network to low-lying areas and existing stormwater basins where it recharges to the groundwater, which is part of the Cape Cod and Plymouth/Carver Sole Source Aquifers. **Figure 4.11-6** illustrates the three major watersheds within the Study Area.

All developed land covers convey natural and human-made materials, including sediment, nutrients, metals, salts, organic chemicals, litter, and bacteria that are either deposited on surfaces by wind, air pollution fallout, and rain or generated by land-use activities. Roadways and other impervious urban areas can convey naturally deposited materials, materials of their construction, and materials that are tracked on or deposited by vehicular traffic as well as other sources. Roadways and parking lots may also receive de-icing chemicals and/or winter maintenance sands applied to maintain safe operating conditions. The U.S. Geological Survey, in cooperation with MassDOT, has characterized, quantified, and interpreted the quality of runoff from highways and bridges in Massachusetts.[16]

[16] U.S. Geological Survey Scientific Investigations Report 2009–5269 (https://doi.org/10.3133/sir20095269)
U.S. Geological Survey Scientific Investigations Report 2018–5033 (https://doi.org/10.3133/sir20185033)

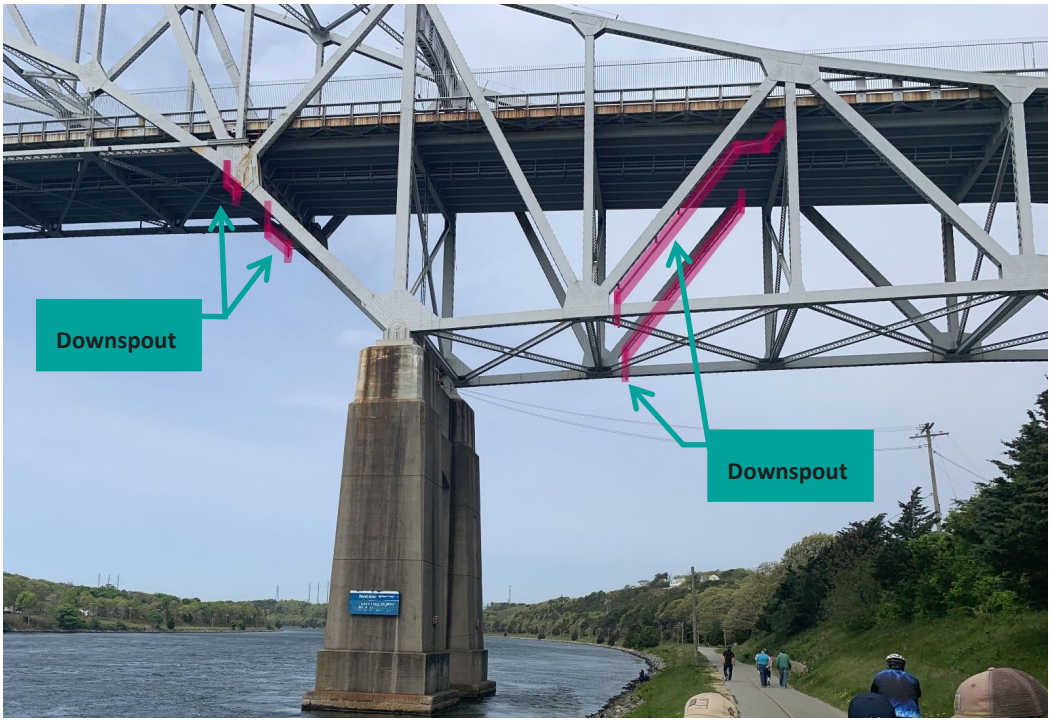
Figure 4.11-6. Major Watersheds Relevant to Study Area



Source: Massachusetts Department of Transportation, 2024

New or more current stormwater management systems typically have in-line treatment devices or practices to reduce the pollutants in the stormwater prior to discharge to wetlands or waterways. Most of the existing pipe networks discharging to Cape Cod Canal in the Study Area were constructed before MassDEP issued the Stormwater Policy in 1996 that established Stormwater Management Standards and provide a minimal level of treatment of pollutants prior to discharge. The exception is the Sagamore North quadrant, which was reconstructed in the early 2000s during MassDOT's Sagamore Rotary Grade Separation Project and includes stormwater treatment basins. Stormwater runoff from the Sagamore and Bourne Bridges discharges directly to the water and land below the bridge deck through openings called scuppers, which are connected to downspouts. **Exhibit 4.11-1** illustrates downspouts originating from the Sagamore Bridge deck and ending at the bottom of the bridge truss where water falls to the ground.

Exhibit 4.11-1. Downspouts (Sagamore Bridge)



Source: Massachusetts Department of Transportation, 2023

MassDOT conducts snow and ice management consistent with the practices outlined in the MassDOT Snow and Ice Control Program Environmental Status and Planning Report, formerly known as the Snow and Ice Control Generic Environmental Impact Report (EEA# 11202).

Cape Cod is a Reduced Salt Zone due to its sandy soils and sole source aquifer. The standard 240-pound-per-lane-mile sodium chloride roadway treatment is replaced with 120 pounds sodium chloride mixed with 120 pounds sand in Reduced Salt Zones. MassDOT collects the sand from roadways and stormwater basins after the winter season.

MassDOT updates the snow and ice control program report annually and revamps it every five years. The report details BMPs employed by MassDOT's snow and ice program to limit the environmental

repercussions from its winter roadway maintenance to the extent possible. MassDOT also works with individual well owners to alleviate concerns related to salinity and participates in discussions with water authorities with an interest in the snow and ice management practices. All proposed infiltration basins for the Program would be outside the Zone II areas, which contribute to Wellhead Protection Areas via groundwater flow.

The following sections describe existing conditions within each Study Area quadrant: Sagamore North, Sagamore South, Bourne North and Bourne South.

4.11.4.3 Sagamore North Quadrant

The Sagamore North quadrant is the portion of the Study Area north of Sagamore Bridge. The Sagamore North quadrant lies within drainage subbasin 21089 of the South Coastal major watershed. The area drains via surface runoff and pipe conveyance to Cape Cod Canal. Stormwater runoff also recharges to groundwater within the Plymouth/Carver Sole Source Aquifer. Portions of the Sagamore North quadrant drain to inland wetlands 1-C, 1-E, and 1-J (**Figure 4.11-7**). Wetland series 1-E contains a certified vernal pool. Wetland series 1-J is mapped within the Herring River Watershed Area of Critical Environmental Concern (ACEC).[17] Vernal pools and ACECs are critical environmental resource areas that provide ecological benefit.

The existing stormwater management system for the Sagamore North quadrant includes catch basin inlets that capture roadway runoff and convey it via underground pipes to stormwater treatment basins. **Figure 4.11-8** illustrates the locations of the existing SCMs within the Study Area. **Exhibit 4.11-2** and **Exhibit 4.11-3** illustrate two of the existing stormwater treatment basins. The existing stormwater basins include a micropool (an area that retains stormwater) as well as overflow areas that allow ponded water to infiltrate after treatment. Most runoff from this Study Area discharges to groundwater after treatment. There is also an existing 24-inch pipe that runs down Canal Street and discharges to Cape Cod Canal; this pipe conveys runoff from portions of State Route 3 located south of Scenic Highway and a portion of the Sagamore Park and Ride Lot (Commerce Way, Bourne).

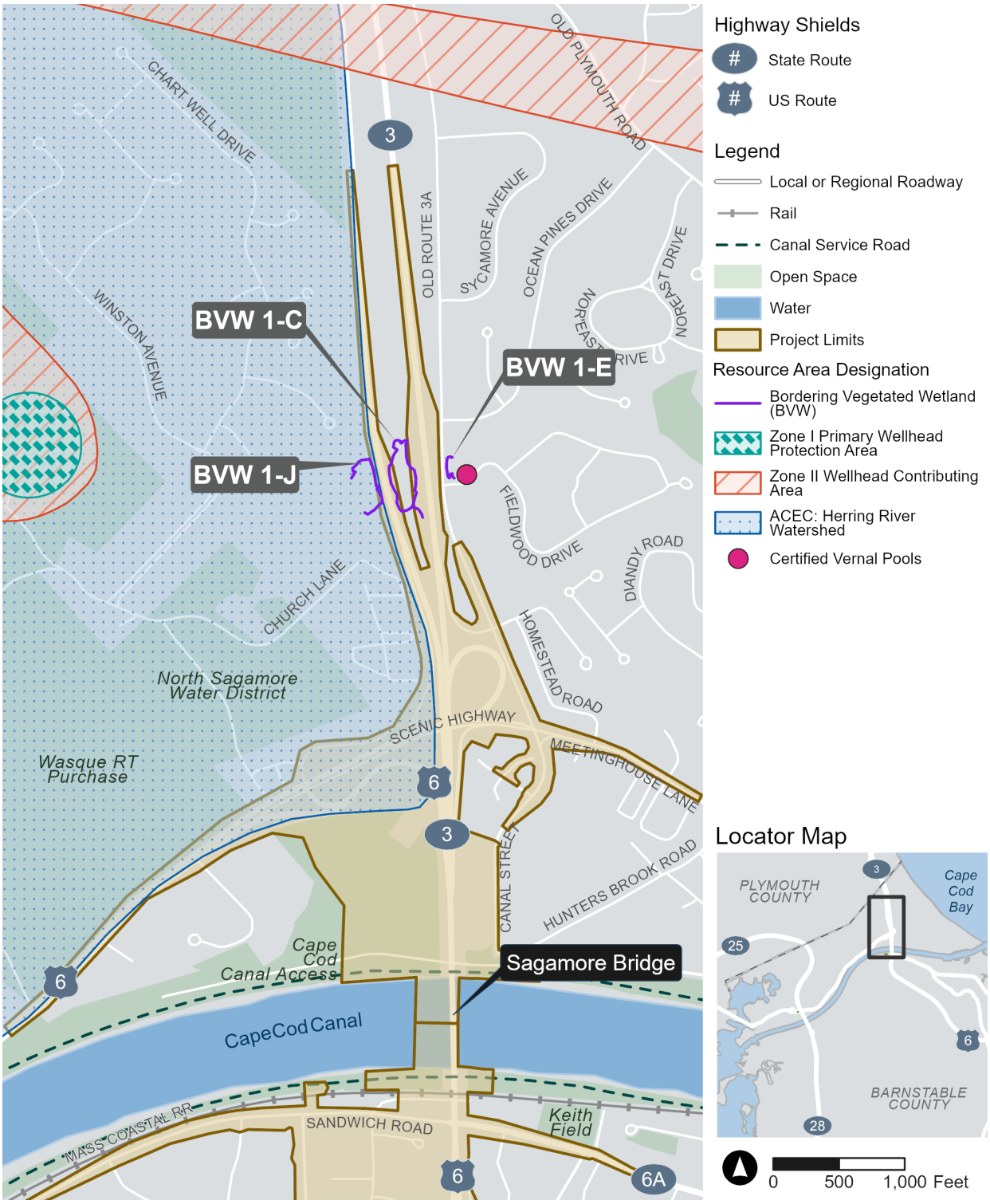
Figure 4.11-9 illustrates the groundwater depth contours, flow direction, and location of public and private wells in the Sagamore North quadrant. The U.S. Geological Survey developed the groundwater contours on the north side of the canal as part of the Water-Resources Investigations Report 90-4204, Plate 1.[18]

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[17] An Area of Critical Environmental Concern is a place in Massachusetts that receives special recognition because of the quality, uniqueness, and significance of its natural and cultural resources. Such an area is identified and nominated at the community level and is reviewed and designated by the state's Secretary of Energy and Environmental Affairs. The Department of Conservation and Recreation administers the ACEC Program on behalf of the Secretary. Source: Massachusetts Department of Conservation & Recreation. n.d. ACEC Program Overview. https://www.mass.gov/info-details/acec-program-overview

[18] Hanson, B. P. and W. W. Lapham. 1992. Geohydrology and Simulated Ground-Water Flow, Plymouth-Carver Aquifer, Southeastern Massachusetts. U.S. Geological Survey Water-Resources Investigations Report 90-4204. 1992. https://pubs.usgs.gov/wri/wri904204/pdfs/wri904204.PDF

Figure 4.11-7. Resource Area Designations (Sagamore North Quadrant)



Source: Massachusetts Department of Transportation, 2024

Figure 4.11-8. Existing Storm Control Measures (Sagamore North Quadrant)



Source: Massachusetts Department of Transportation, 2024

Exhibit 4.11-2. Stormwater Basin at Canal Street and Commerce Way (Sagamore North Quadrant)



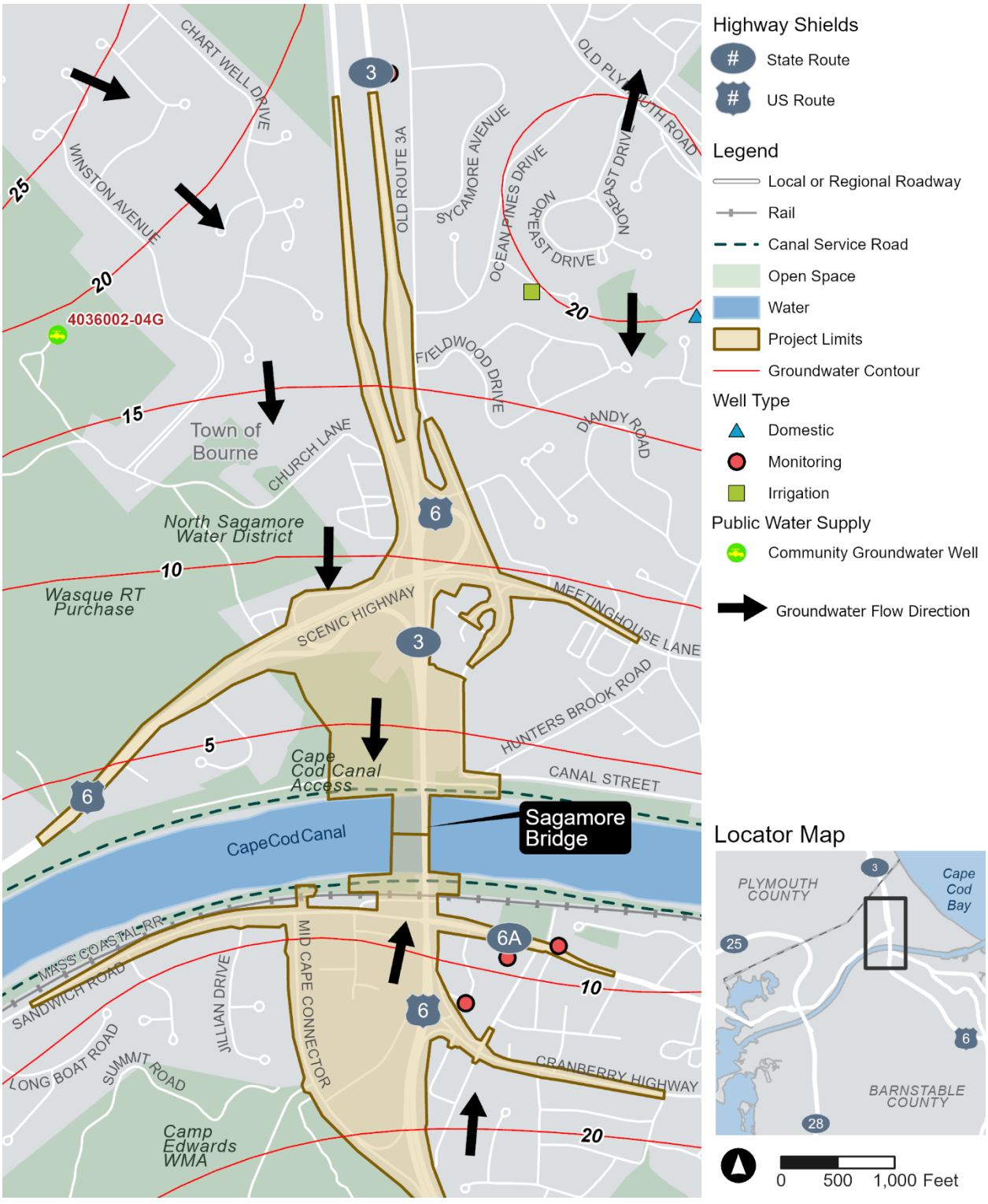
Source: Massachusetts Department of Transportation, 2023

Exhibit 4.11-3. Stormwater Basin at State Route 3 North Off-Ramp to U.S. Route 6 West (Sagamore North Quadrant)



Source: Massachusetts Department of Transportation, 2023

Figure 4.11-9. Groundwater Hydrology (Sagamore North Quadrant)



Source: Massachusetts Department of Transportation, 2024

Note: Groundwater elevations shown are referenced to the National Geodetic Vertical Datum of 1929 (NGVD29).

4.11.4.4 Sagamore South Quadrant

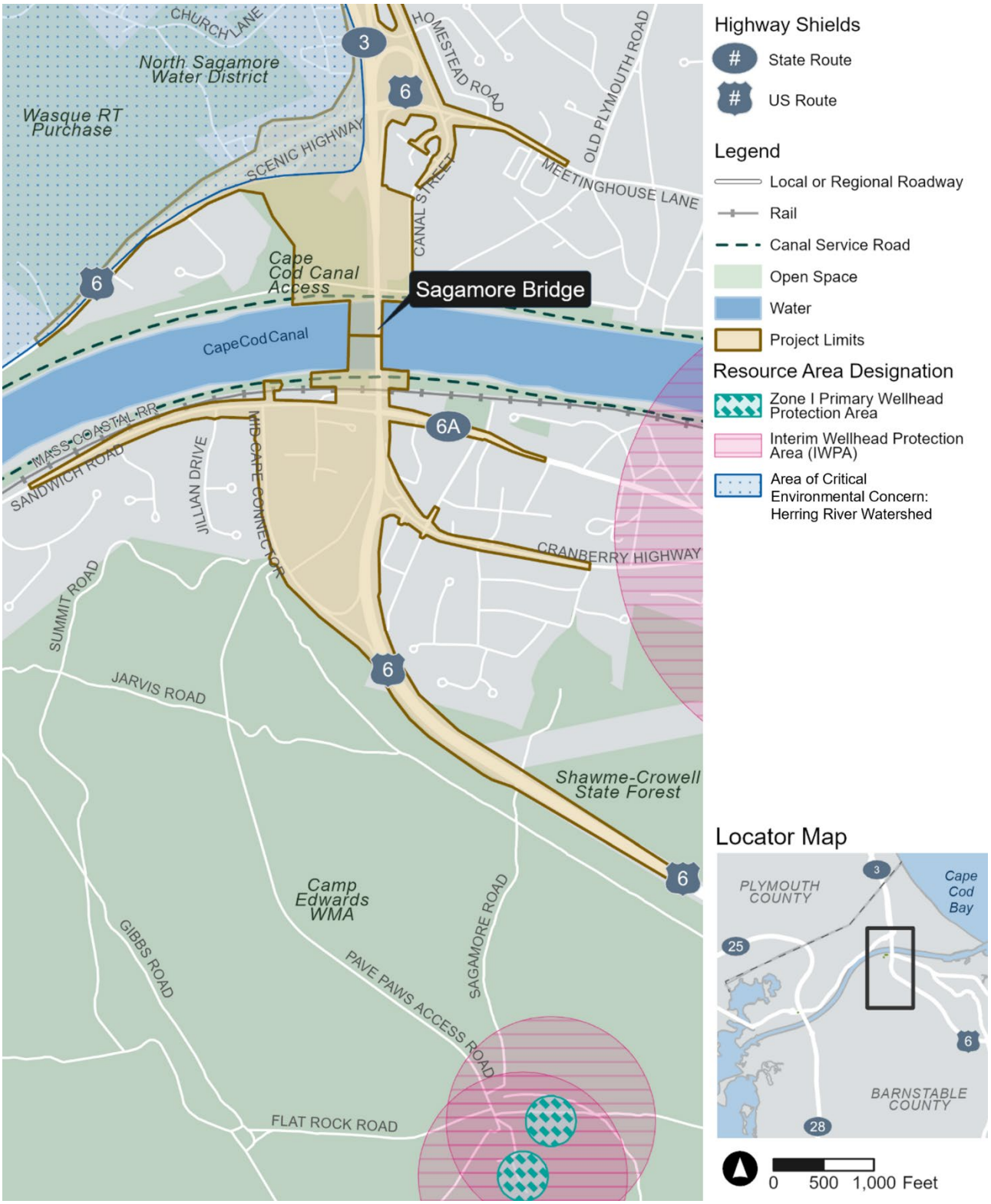
The Sagamore South quadrant is the portion of the Study Area south of the Sagamore Bridge. The Sagamore South quadrant lies within drainage subbasin 22001 of the Cape Cod major watershed. The area drains via surface runoff and pipe conveyance to Cape Cod Canal. Stormwater runoff also recharges to groundwater within the Cape Cod Sole Source Aquifer. There are no inland wetland resource areas within the Sagamore South quadrant. **Figure 4.11-10** illustrates the MassDEP Wellhead Protection Areas relative to the Project Limits. Zone I refers to the primary protection area around a well, which must be controlled by the water supplier. Zone II is an area that contributes to the well water supply under severe pumping and recharge conditions. The Interim Wellhead Protection Area (IWPA) serves the same purpose as Zone II but is applied to public supply wells that lack a MassDEP approved Zone II boundary.

The existing stormwater management system for the Sagamore South quadrant includes catch basin inlets that capture roadway runoff and convey it via underground pipes to ditches, low-lying areas, and outfalls at the canal. There are two main pipe outfalls at Cape Cod Canal for this Study Area. The first is a 36-inch pipe outfall opposite Mid-Cape Connector that discharges stormwater runoff from Mid-Cape Connector and Sandwich Road. The second is a 36-inch pipe outfall approximately 50 feet east of Sagamore Bridge that discharges stormwater runoff from U.S. Route 6 and Cranberry Highway. Roadway runoff from U.S. Route 6 south of Mid-Cape Connector on- and off-ramps discharges to low-lying areas where it infiltrates to groundwater.

Figure 4.11-11 illustrates the groundwater depth contours, flow direction, and location of public and private wells in the Sagamore South quadrant. The groundwater contours on the south side of the canal were developed by the U.S. Army Corps of Engineers as part of the Impact Area Groundwater Study Program at Joint Base Cape Cod.[19]

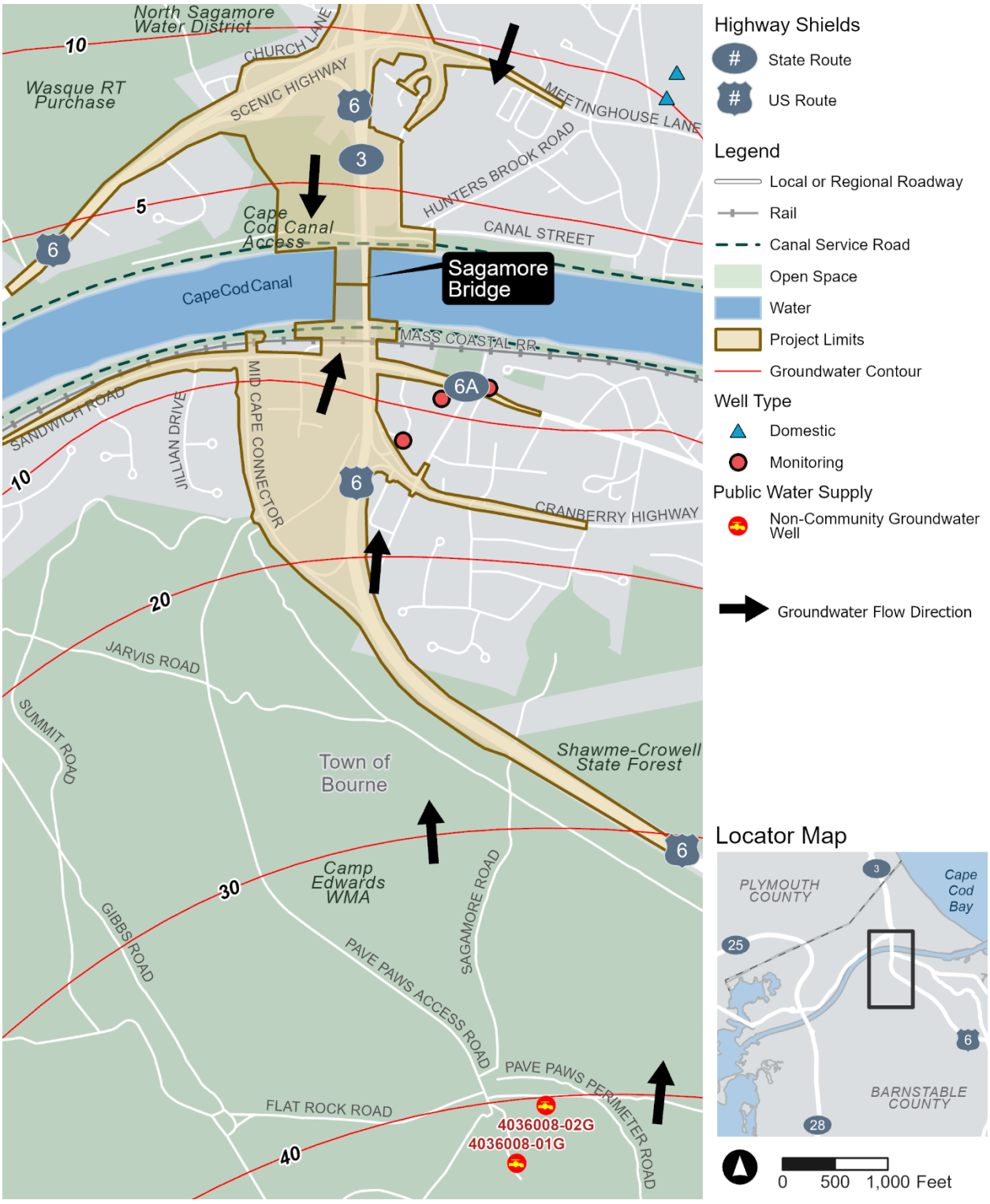
[19] U.S. Army Corps of Engineers, New England District. Impact Area Groundwater Study Program T Range Soil & Groundwater Investigation Report, Camp Edwards Massachusetts Military Reservation, Cape Cod Massachusetts. June 4, 2007. https://archive.epa.gov/region1/mmr/web/pdf/269651.pdf

Figure 4.11-10. Resource Area Designations (Sagamore South Quadrant)



Source: Massachusetts Department of Transportation, 2024

Figure 4.11-11. Groundwater Hydrology (Sagamore South Quadrant)



Source: Massachusetts Department of Transportation, 2024

Note: Groundwater elevations shown are referenced to the National Geodetic Vertical Datum of 1929 (NGVD29).

4.11.4.5 Bourne North Quadrant

The Bourne North quadrant is the portion of the Study Area north of Bourne Bridge. The Bourne North quadrant lies within the drainage subbasin 24001 of the Buzzards Bay major watershed. The area drains via surface runoff and pipe conveyance to Cape Cod Canal. Stormwater runoff recharges to groundwater within the Plymouth/Carver Sole Source Aquifer. Portions of the Bourne North quadrant drain to inland wetlands 3-C (Nightingale Pond), 3-E, and 3-H/I/Q (**Figure 4.11-12**). There are two Wellhead Protection Areas within the Bourne North quadrant: an IWPA for Sandy's Restaurant and a Zone II wellhead protection area for Buzzards Bay Water District. As stated in 310 CMR 22.02, a Zone II is:

> "That area of an aquifer which contributes water to a well under the most severe pumping and recharge conditions that can be realistically anticipated (180 days of pumping at safe yield, with no recharge from precipitation). It is bounded by the groundwater divides which result from pumping the well and by the contact of the aquifer with less permeable materials such as till or bedrock. In some cases, streams or lakes may act as recharge boundaries. In all cases, Zone IIs shall extend up gradient to its point of intersection with prevailing hydrogeologic boundaries (a groundwater flow divide, a contact with till or bedrock, or a recharge boundary)."[20]

In the absence of an approved Zone II, MassDEP has adopted the IWPA as the primary, protected recharge area for public water supply[21] groundwater sources.[22]

The existing stormwater management system for the Bourne North quadrant includes catch basin inlets that capture roadway runoff and convey it via underground pipes to ditches, low-lying areas, and an outfall at the canal. Within the groundwater Wellhead Protection Areas north of the State Route 25 ramps, all stormwater runoff is collected and conveyed to Cape Cod Canal via twin 43-inch by 68-inch elliptical pipes. Refer to **Exhibit 4.11-4** and **Exhibit 4.11-5**.

Figure 4.11-13 illustrates the groundwater depth contours, flow direction, and location of public and private wells in the Bourne North quadrant.

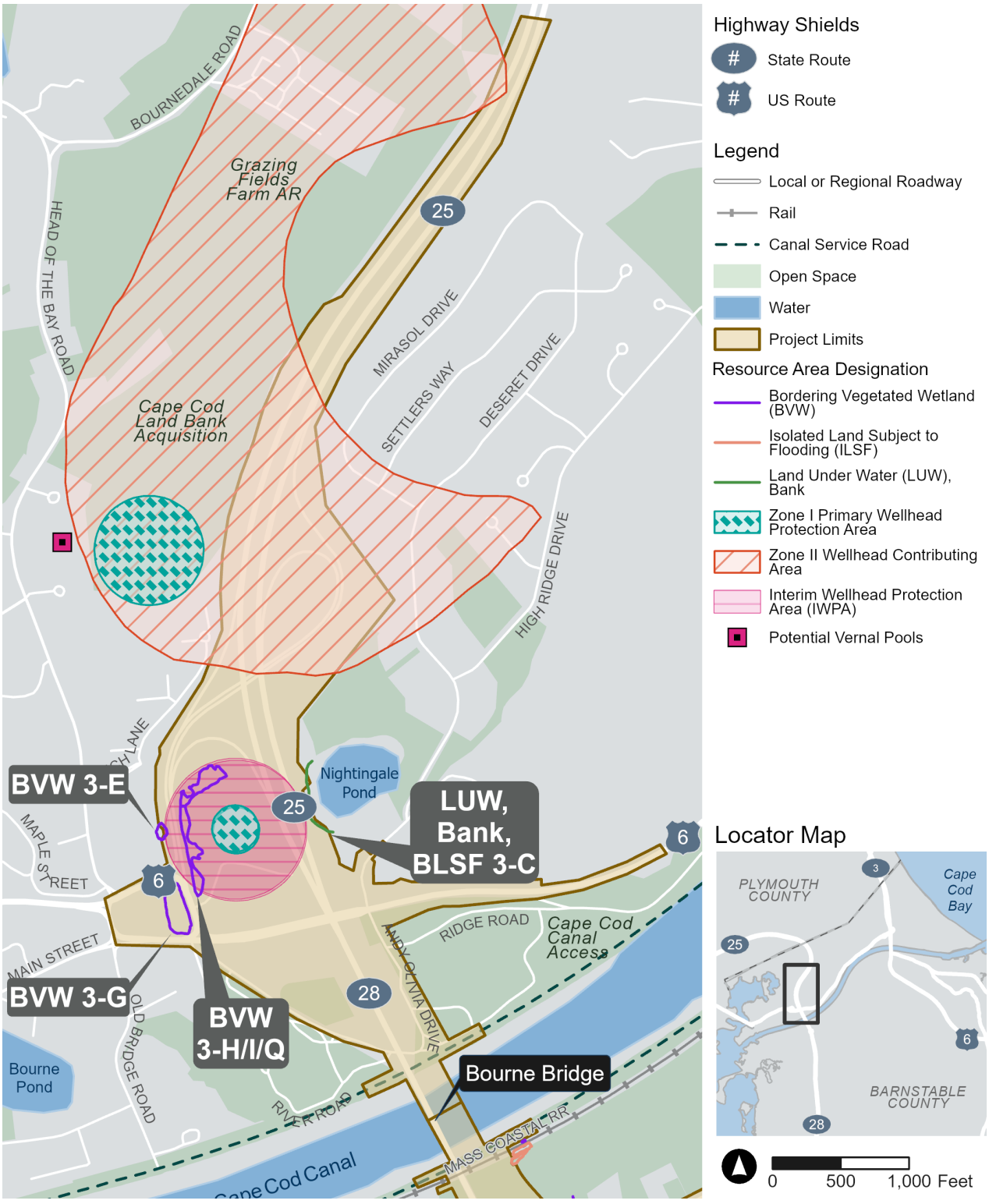
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[20] Executive Office of Technology Services and Security. 2024. MassGIS Data: MassDEP Wellhear Protection Areas (Zone II, Zone I, IWPA). April. https://www.mass.gov/info-details/massgis-data-massdep-wellhead-protection-areas-zone-ii-zone-i-iwpa

[21] A system for the provision to the public of water for human consumption, through pipes or other constructed conveyances, if such system has at least 15 service connections or regularly serves an average of at least 25 individuals daily at least 60 days of the year.
Source: Massachusetts Department of Environmental Protection. 2015. 310 CMR 22.02, Definitions of Public Water Systems. https://www.mass.gov/info-details/determining-if-a-water-system-is-public-or-private

[22] Executive Office of Technology Services and Security. 2024. MassGIS Data: MassDEP Wellhear Protection Areas (Zone II, Zone I, IWPA). April. https://www.mass.gov/info-details/massgis-data-massdep-wellhead-protection-areas-zone-ii-zone-i-iwpa

Figure 4.11-12. Resource Area Designations (Bourne North Quadrant)



Source: Massachusetts Department of Transportation, 2024

Exhibit 4.11-4. Pipe Outfall Location at Cape Cod Canal (Bourne North Quadrant)



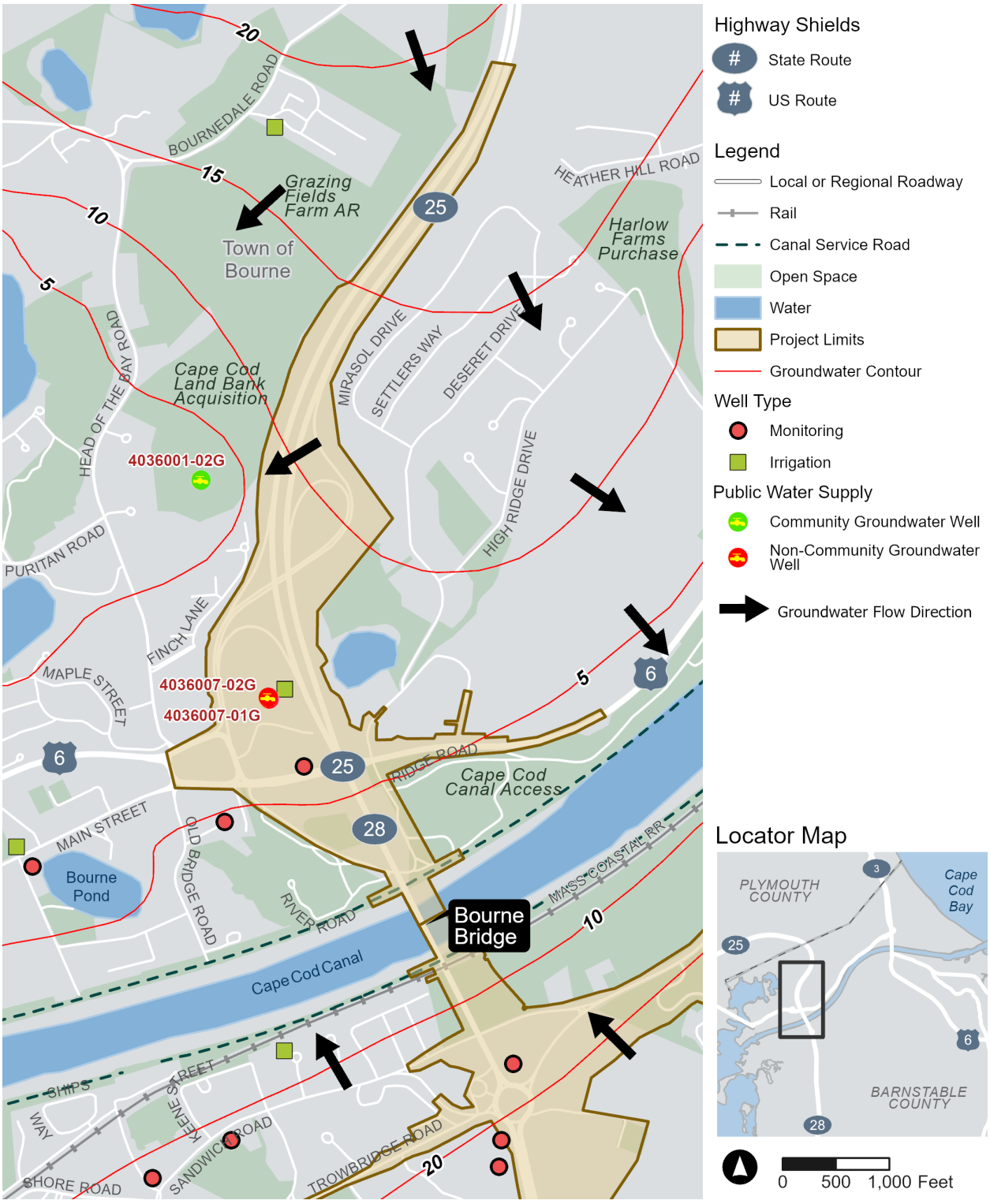
Source: Massachusetts Department of Transportation, 2023

Exhibit 4.11-5. Twin 43-inch by 68-inch Elliptical Pipe Outfalls (Bourne North Quadrant)



Source: Massachusetts Department of Transportation, 2023

Figure 4.11-13. Groundwater Hydrology (Bourne North Quadrant)



Source: Massachusetts Department of Transportation, 2024

Note: Groundwater elevations shown are referenced to the National Geodetic Vertical Datum of 1929 (NGVD29).

There is an impervious shoulder, which consists of hot mix asphalt buried approximately 4 feet, in all pervious medians and shoulders within the wellhead protection area that prevents stormwater from infiltrating to groundwater. Snow melt or runoff from large storms that is not captured by the catch basin inlets in the roadway is collected in a subdrain system and conveyed to Cape Cod Canal via the twin 43-inch by 68-inch elliptical pipes. Roadway runoff from the southern portion of State Route 25 and Main Street discharges to low-lying areas where it infiltrates to groundwater.

4.11.4.6 Bourne South Quadrant

The Bourne South quadrant is the portion of the Study Area south of Bourne Bridge. The Bourne South quadrant lies within the drainage subbasin 22141 of the Cape Cod major watershed. The area drains via surface runoff and pipe conveyance to Cape Cod Canal. Stormwater runoff recharges to groundwater within the Cape Cod Sole Source Aquifer. Portions of the Bourne South quadrant drain to inland wetland 4-N. **Figure 4.11-14** illustrates the ACEC and vernal pools relative to the Project Limits.

The existing stormwater management system for the Bourne South quadrant includes catch basin inlets that capture roadway runoff and convey it via underground pipes to ditches, low-lying areas, and an outfall at the canal. There is a 24-inch pipe outfall approximately 150 feet west of Bourne Bridge that discharges stormwater runoff from the Bourne Rotary and Sandwich Road (refer to **Exhibit 4.11-6**). Roadway runoff from State Route 28 south of the rotary discharges to low-lying areas where it infiltrates to groundwater.

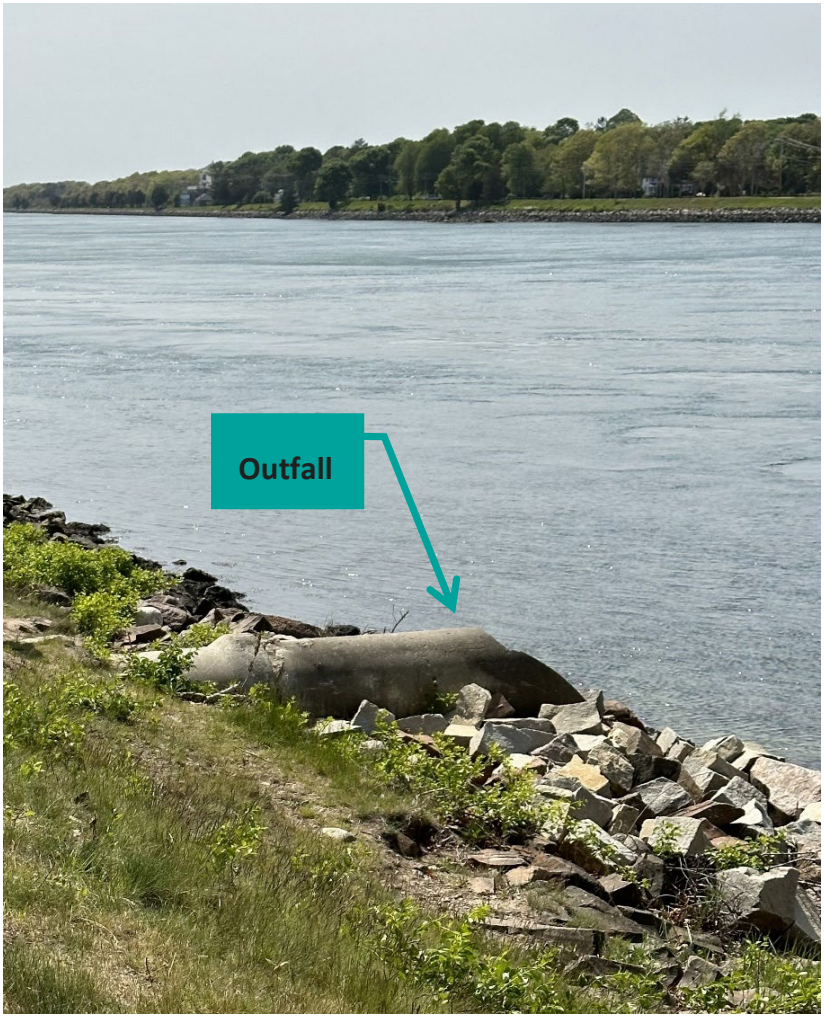
Figure 4.11-15 illustrates the groundwater depth contours, flow direction, and location of public and private wells in the Bourne South quadrant.

Figure 4.11-14. Resource Area Designations (Bourne South Quadrant)



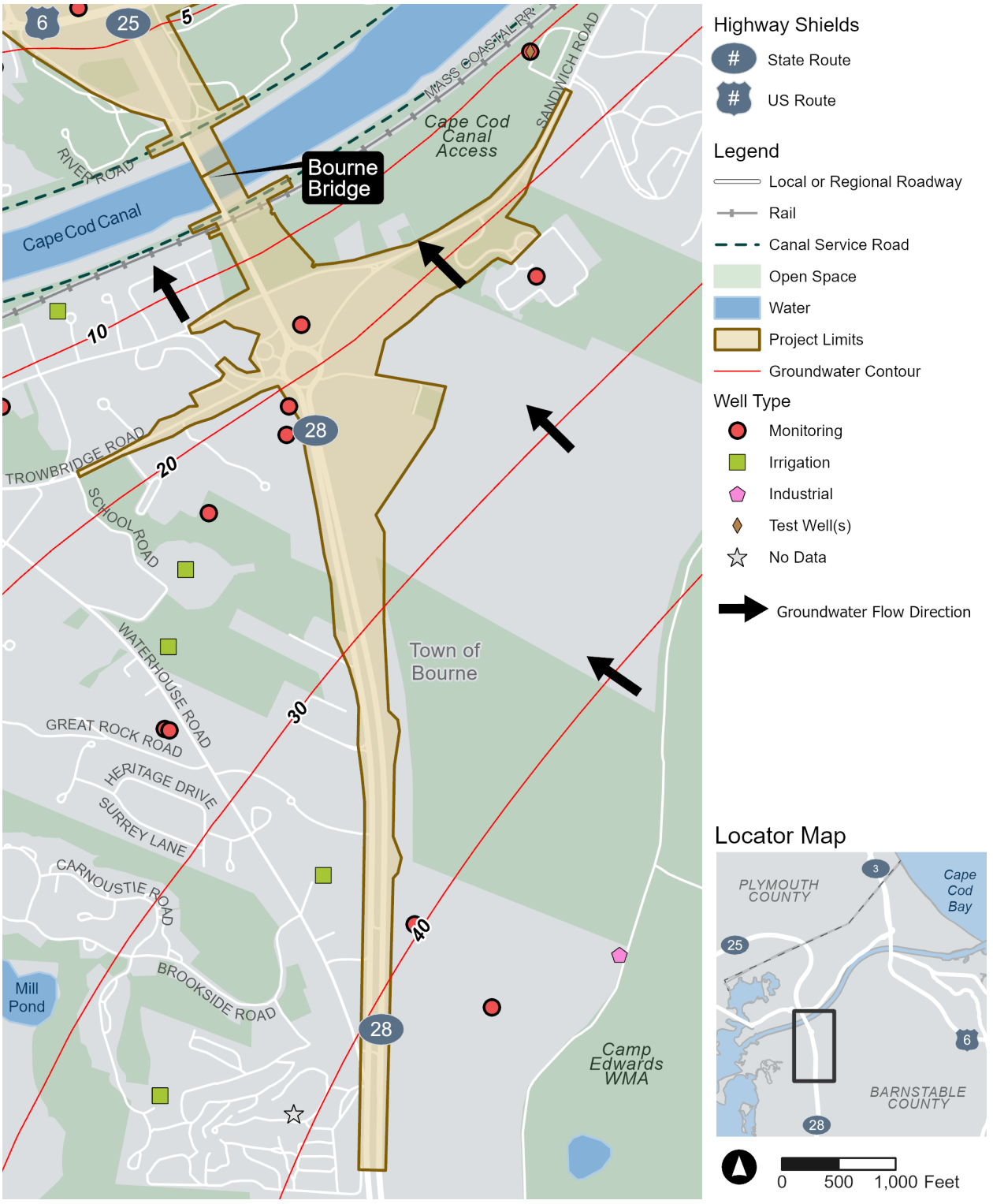
Source: Massachusetts Department of Transportation, 2024

Exhibit 4.11-6. 24-Inch Pipe Outfall at Cape Cod Canal (Bourne South Quadrant)



Source: Massachusetts Department of Transportation, 2023

Figure 4.11-15. Groundwater Hydrology (Bourne South Quadrant)



Source: Massachusetts Department of Transportation, 2024

Note: Groundwater elevations shown are referenced to the National Geodetic Vertical Datum of 1929 (NGVD29).

4.11.5 No Build Alternative

The No Build Alternative includes maintenance of existing facilities as well as recently completed and near-term projects included in the Cape Cod region's Federal Fiscal Year 2025–2029 Transportation Improvement Program. For the No Build Alternative, most of the existing impervious surface area along roadways in the Study Area would remain untreated, which has the potential for long-term adverse effects to surface water and groundwater quality within the Study Area. The projected increase in traffic volumes for the future 2050 No Build Alternative could increase the amount of pollutants deposited on roadways, leading to higher potential pollutant load in stormwater runoff.

4.11.6 Program Impacts

4.11.6.1 Construction Impacts

Sedimentation from earth-disturbing activities and stormwater runoff generated during construction can be substantial sources of pollution to surface waters, groundwater, and drinking water supplies, if SCMs are not in place. The Build Alternative would disturb greater than 1 acre of land and discharge to a WOTUS (Cape Cod Canal) and, therefore, would require the preparation and implementation of an SWPPP in accordance with the EPA's 2022 NPDES General Permit for Discharges from Construction Activities. The CGP authorizes discharge from construction activities and imposes monitoring requirements to protect water quality.

The SWPPP will include a detailed description, with timelines, of all controls, applicable BMPs, and mitigation measures that will be implemented at the construction sites for each construction phase identified as major soil disturbing activities. Refer to **Section 4.11.7.1** for a listing of the BMPs and control measures that will be implemented and enforced as part of the SWPPP to prevent pollutants from entering stormwater runoff during construction.

4.11.6.2 Operational Impacts

As illustrated in **Table 4.11-4**, the Build Alternative would result in an increase of approximately 51 acres of new impervious surface area compared to existing conditions.

The Build Alternative has the potential to affect water quality by changing the land cover and ultimately the hydrology of the site. Increased impervious surface without associated stormwater treatment could lead to increased surface runoff, higher peak flows during storm events, higher pollutant loads, and reduced groundwater recharge.

For the Build Alternative, new collection and conveyance systems would be constructed for the proposed bridges and approach roadway systems. Stormwater detention and recharge, and improved water quality, would be provided through installation of low-impact SCMs, as discussed in **Section 4.11.7.2**. The proposed SCMs under the Build Alternative would improve the treatment and quality of the runoff that is eventually discharged to Cape Cod Canal and the Plymouth/Carver and Cape Cod Sole Source Aquifers.

The stormwater management system for the Build Alternative will be designed to comply with the Massachusetts Stormwater Management Standards in accordance with the Massachusetts Wetlands

Protection Act Regulations and the 401 Water Quality Certification Regulations, which are discussed in Section 4.11.8.

Table 4.11-4. Build Alternative: Impervious Area

Study Area Quadrant	Existing Impervious Area (acres)	Proposed Impervious Area (acres)	Impervious Area Increase (acres)	Impervious Area Increase	Treated Impervious Area (acres)
Sagamore North	23.9	34.1	10.2	43%	27.4
Sagamore South	19.0	34.1	15.1	79%	28.2
Bourne North	23.3	36.7	13.4	58%	29.0
Bourne South	20.7	32.9	12.2	59%	32.1
Total	**86.9**	**137.8**	**50.9**	—	116.7

4.11.7 Mitigation Measures

This section describes mitigation measures that will be implemented to avoid or minimize the potential construction and operational effects of the Build Alternative relative to stormwater runoff and water quality.

4.11.7.1 Construction Impacts

Mitigation measures that will be implemented to avoid or minimize the potential for adverse impacts to groundwater, surface water, and stormwater runoff during construction will be specified in the SWPPP. The minimum practices that will be included in the SWPPP, will include, but will not be limited to the following:

- Installation of sediment controls along the top of the bank of Cape Cod Canal and inland wetland resource areas, such as silt fence and/or compost filter tubes.
- Stabilized construction exits to prevent sediment tracking from the work area onto public ways.
- Site-specific construction phasing plans to minimize the extent of the disturbance at any one time.
- Soil stockpile protection, including temporary erosion measures and perimeter controls.
- Dust suppression, including watering.
- Good housekeeping pollution prevention measures, including secondary containment.
- Maintenance requirements.
- Temporary and permanent stabilization requirements.
- Recordkeeping/inspection requirements.

A copy of the SWPPP will be provided to the Bourne Conservation Commission in conjunction with the requirements of Stormwater Management Standard 8. The contractor will implement the SWPPP. The

stormwater team, including the SWPPP preparer and the contractor, will hold a kick-off meeting to review the SWPPP and conditions required by the CGP.

4.11.7.2 Operational Impacts

SCMs, such as rain gardens and infiltration basins, will be implemented to meet the required targets for peak-rate attenuation, recharge, and water quality treatment including TSS, nitrogen, phosphorus, metals and pathogens removal in accordance with the Massachusetts Stormwater Management Standards.

The feasibility and applicability of SCMs to treat stormwater runoff, especially for the purpose of infiltration and recharge, is dependent on the suitability of soils, including permeability and depth to groundwater and the limiting layer (clay/bedrock). Record soils and groundwater information from the U.S. Department of Agriculture National Resources Conservation Services and U.S. Geological Survey along with pilot borings strategically spaced throughout the Study Area have informed the preliminary layout and design of the proposed stormwater management system. During the 25% design and permitting phase, detailed subsurface analysis will be performed to determine the feasibility of implementing SCMs with infiltration capabilities. The results will identify maximum water table fluctuations, hydraulic conductivities and site-specific geologic information that will be used to evaluate long-term hydrogeologic effects. The following sections describe SCMs that will be implemented and maintained for the Build Alternative to protect and improve the quality of stormwater runoff post-construction.

Bioretention Area/Rain Garden

Bioretention areas/rain gardens will be implemented adjacent to proposed sidewalks and paths for treatment of pavement runoff, where feasible. This design allows decentralized treatment of runoff close to the source, which is preferred over concentrated end-of-the-line treatment. Bioretention is considered a Low Impact Development technique and allows for aesthetic appeal with the appropriate plantings, which will be integrated into the streetscape. Plants selected for use in bioretention areas and rain gardens will be native and salt-tolerant species to the extent feasible. **Exhibit 4.11-7** illustrates a typical rain garden planter between a sidewalk and a roadway.

Exhibit 4.11-7. Typical Rain Garden



Source: Massachusetts Department of Transportation, 2024

Infiltration Basin

Infiltration basins will be implemented to treat stormwater runoff from the replacement bridges and their approach roadway networks. The bottom of the basins will be at least 2 feet above seasonal, high groundwater and bedrock as required under MassDEP's Stormwater Management Standards. The elevation of seasonal, high groundwater will be confirmed prior to final design to determine the viability of infiltration basin locations. Each basin will be designed to hold the required recharge volume, allowing stormwater to filter through the subsurface, which removes pollutants, prior to reaching groundwater. Runoff from larger storm events will discharge through an outlet control structure, enter a collector pipe, and eventually discharge either to Cape Cod Canal via pipe outfall or to the groundwater via infiltration through the soils. Linear infiltration will be used as a retrofit technique to transform existing conveyance swales and ditches into stormwater treatment practices. Linear infiltration will also be used when physical constraints preclude the use of infiltration basins. Infiltration is considered a goal of many Low Impact Development techniques. **Exhibit 4.11-8** illustrates a typical infiltration basin with sediment forebay.

Exhibit 4.11-8. Typical Infiltration Basin with Sediment Forebay



Source: Massachusetts Department of Transportation, 2013

Sediment Forebay

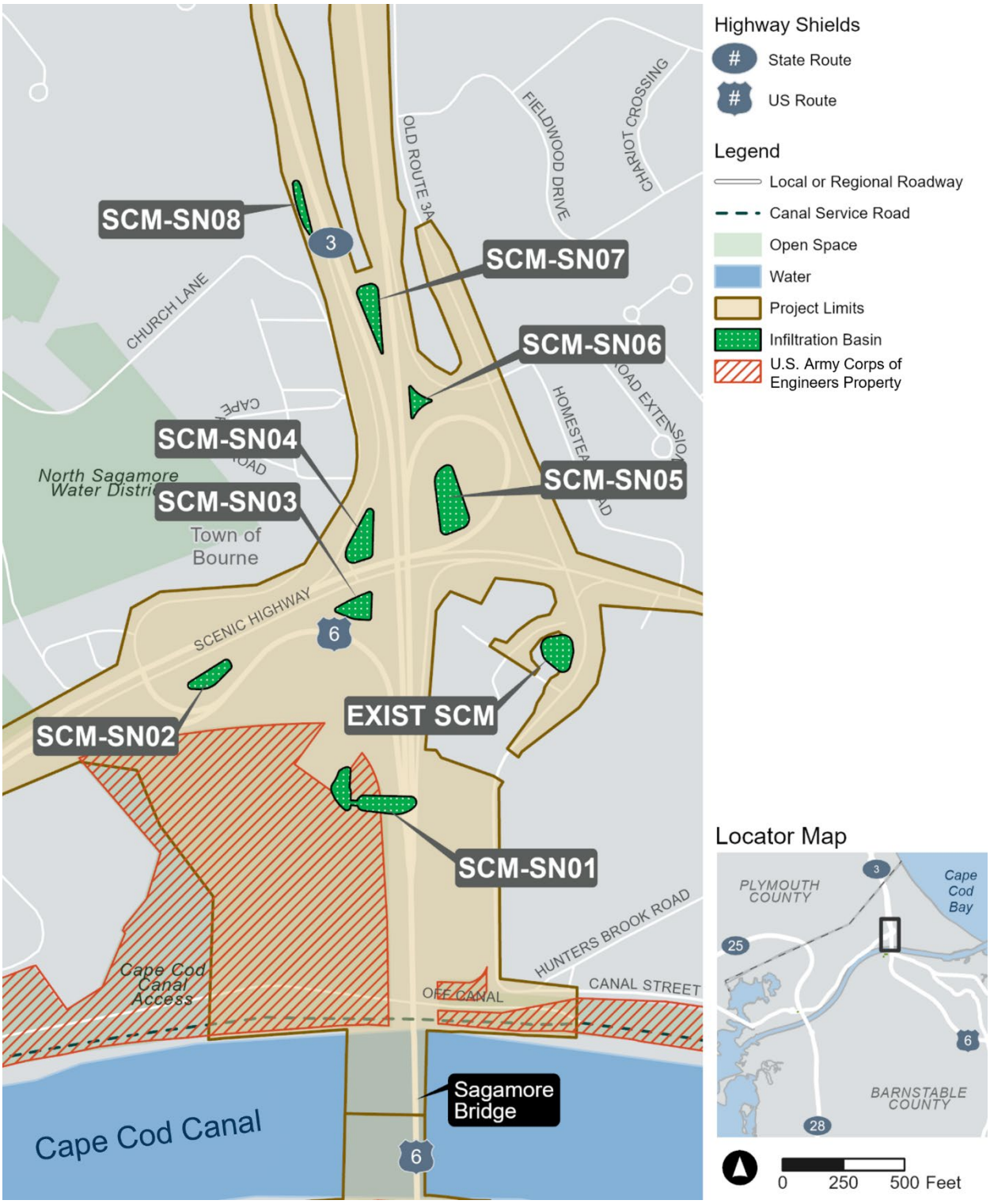
Sediment forebays are considered part of the infiltration basin and rain garden. They provide a storage area at the point where the discharge pipe enters, for solids and sediment to settle out, providing pretreatment prior to entering the main part of the SCM. The forebays will be sized to treat an equivalent of 0.1 inch of runoff from the contributing impervious area, consistent with MassDEP sizing guidelines. In addition to the total suspended solids (TSS) removal, the forebays will also provide velocity dissipation where higher flows will be dissipated to minimize erosion.

Deep Sump Catch Basin

Deep sump catch basins will be implemented on all roadways within the proposed limits of construction. Bicycle-friendly catch basin grates will be installed on those sections of roadway where cycling is allowed. Deep sump catch basins contribute towards water quality treatment. The treatment train consisting of deep sump catch basin to sediment forebay reduces TSS by 44%, which is required prior to infiltration for soils with rapid infiltration rates (>2.4 inches/hour) and discharges to critical areas.

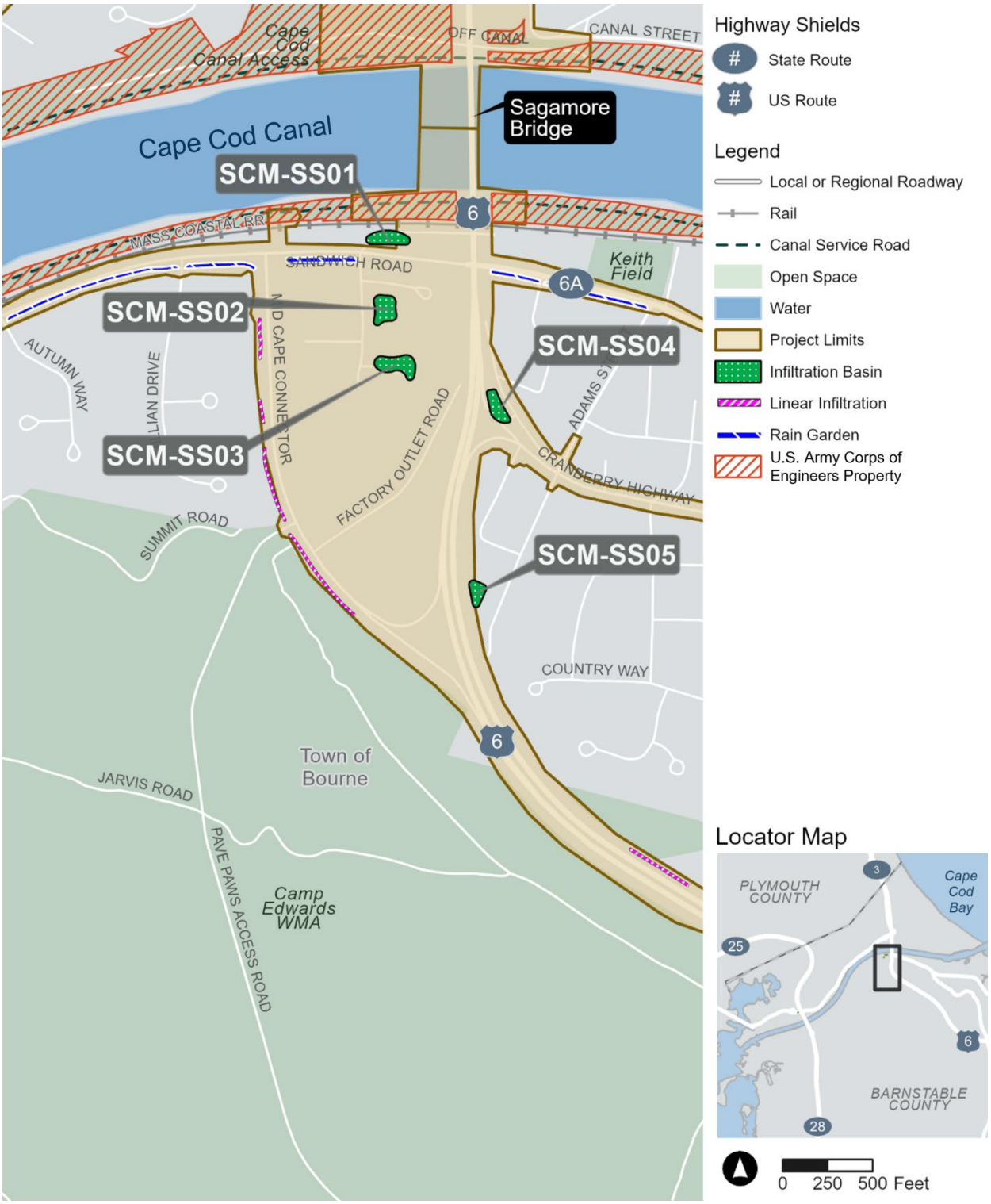
Figure 4.11-16 to Figure 4.11-19 present potential SCM types and locations within the Study Area.

Figure 4.11-16. Potential Stormwater Control Measures (Sagamore North Quadrant)



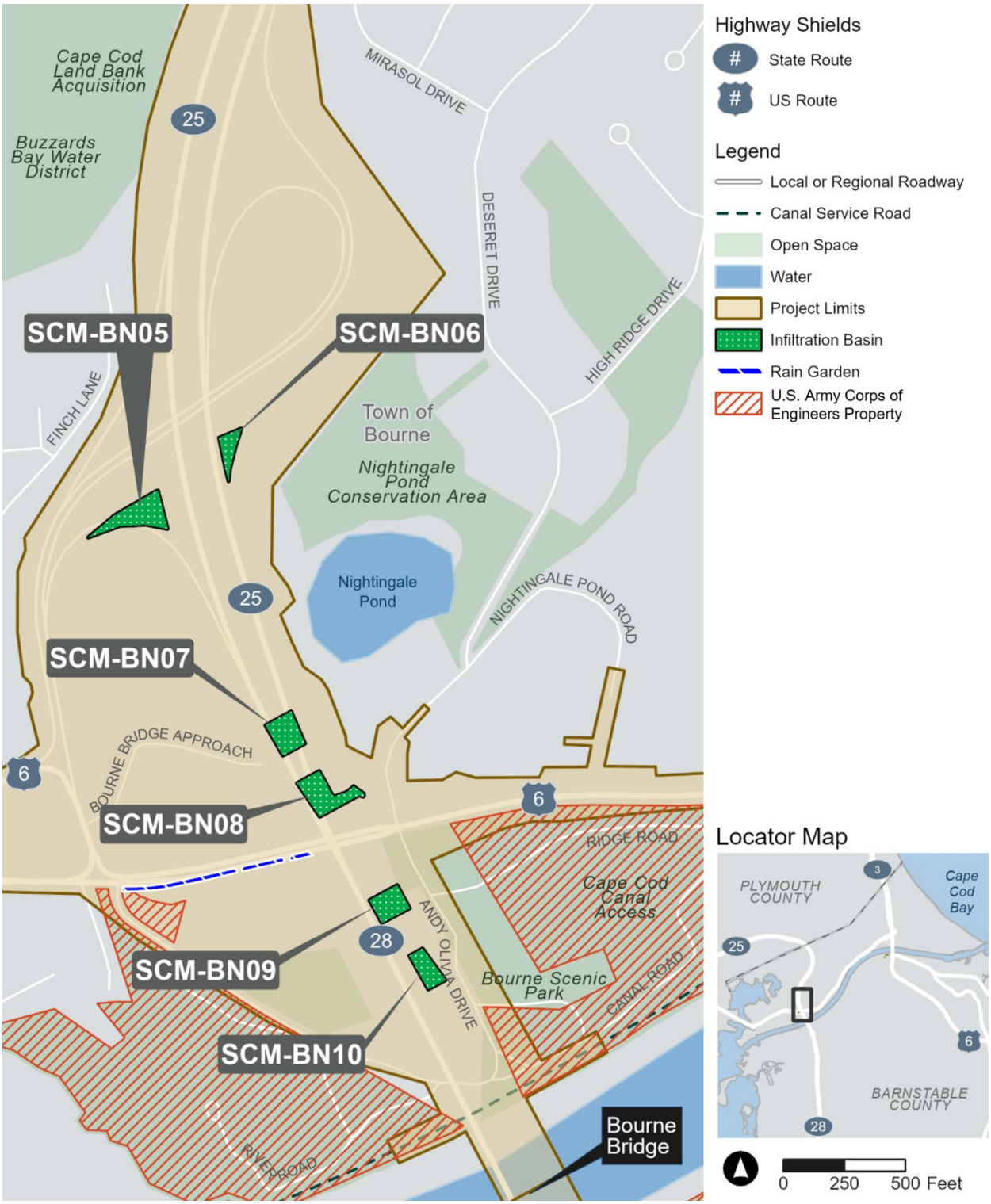
Source: Massachusetts Department of Transportation, 2024

Figure 4.11-17. Potential Stormwater Control Measures (Sagamore South Quadrant)



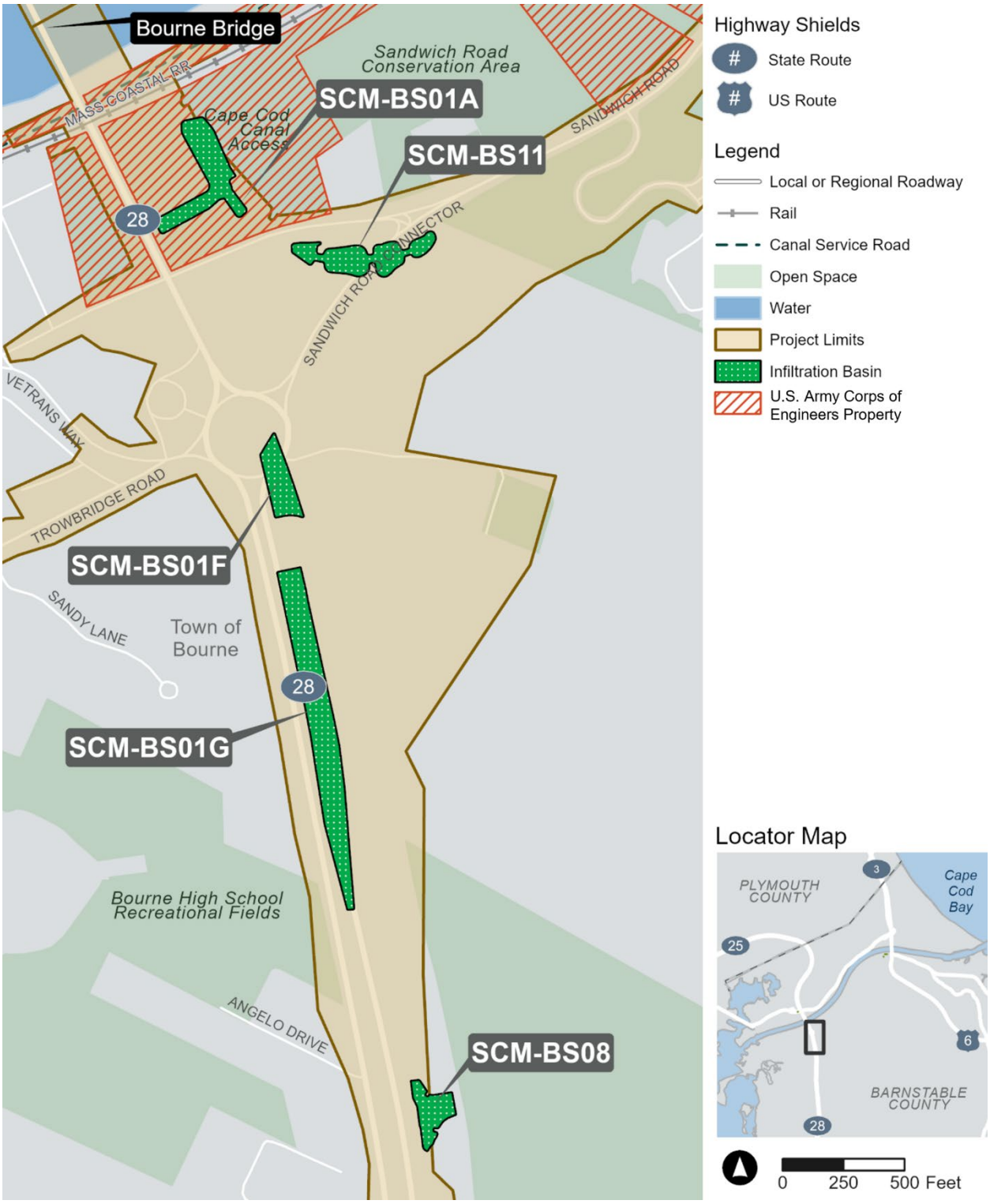
Source: Massachusetts Department of Transportation, 2024

Figure 4.11-18. Potential Stormwater Control Measures (Bourne North Quadrant)



Source: Massachusetts Department of Transportation, 2024

Figure 4.11-19. Potential Stormwater Control Measures (Bourne South Quadrant)



Source: Massachusetts Department of Transportation, 2024

4.11.8 Regulatory Compliance

The proposed stormwater management system for the Build Alternative will be designed to comply with the Massachusetts Stormwater Management Standards, as enforced through the Massachusetts Wetlands Protection Act Regulations (310 CMR 10.00) and the 401 Water Quality Certification Regulations (314 CMR 9.00). The following sections discuss how the Build Alternative would be designed, operated, and maintained in compliance with each of the 10 Massachusetts Stormwater Management Standards.

4.11.8.1 Standard 1 – No New Untreated Discharges

No new outfalls are proposed for the Build Alternative. Existing outfalls will be reused, and treatment will be provided for stormwater runoff prior to discharge, as demonstrated under Standard 4. Scour protection measures (such as stone aprons) and bank stabilization (such as plantings) will be implemented to prevent erosion of wetland resource areas when the proposed velocity exceeds the permissible velocity.

4.11.8.2 Standard 2 – Peak-Rate Control

SCMs will be designed to reduce post-development peak discharge rates[23] to less than or equal to pre-development peak discharge rates for the 2-year, 10-year, and 100-year, 24-hour design events. This standard may be waived for discharges to land subject to coastal storm flowage as defined by 310 CMR 10.04, "land subject to any inundation caused by coastal storms up to and including that caused by the 100-year storm, surge of record or storm of record, whichever is greater," which includes Cape Cod Canal. The standard applies to intermediate discharge points to inland resource areas or within buffer zones. **Table 4.11-5 through Table 4.11-7** list existing and proposed peak-rate discharges at Cape Cod Canal for each Study Area quadrant. Detailed analysis will be performed during the 25% design and permitting phase to ensure compliance with this standard at intermediate discharge points.

Table 4.11-5. Build Alternative: 2-Year Storm Peak-Rate Comparison

Study Area Quadrant	Existing Peak Discharge Rate (cubic feet per second)	Proposed Peak Discharge Rate (cubic feet per second)	Difference Peak Discharge Rate (cubic feet per second)
Sagamore North	26.9	16.7	-10.2
Sagamore South	25.7	17.2	-8.5
Bourne North	58.0	42.5	-15.5
Bourne South	20.2	12.8	-7.4

[23] Discharge rate is the volumetric flow rate used to measure how much stormwater runoff leaves a given site. The discharge rate depends upon the roughness of the surface, the location of the impervious area in relation to the point of analysis, the slope of the ground surface, and the total distance that the runoff must travel to the point of analysis.

Table 4.11-6. Build Alternative: 10-Year Storm Peak-Rate Comparison

Study Area Quadrant	Existing Peak Discharge Rate (cubic feet per second)	Proposed Peak Discharge Rate (cubic feet per second)	Difference Peak Discharge Rate (cubic feet per second)
Sagamore North	55.8	42.9	-12.9
Sagamore South	86.3	73.4	-12.9
Bourne North	167.1	151.0	-16.1
Bourne South	78.8	72.7	-6.1

Table 4.11-7. Build Alternative: 100-Year Storm Peak-Rate Comparison

Study Area Quadrant	Existing Peak Discharge Rate (cubic feet per second)	Proposed Peak Discharge Rate (cubic feet per second)	Difference Peak Discharge Rate (cubic feet per second)
Sagamore North	106.9	102.2	-4.7
Sagamore South	237.8	196.0	-41.8
Bourne North	395.4	395.2	-0.2
Bourne South	234.4	185.5	-48.9

4.11.8.3 Standard 3 – Recharge

The use of environmentally sensitive site design and Low Impact Development technique features will be maximized to the extent practicable. At least 65% of impervious cover for the Build Alternative will be directed to infiltration SCMs or the required recharge volume will be increased using the capture area adjustment calculation. The additional pretreatment requirements for soils with rapid infiltration rates and discharges to critical areas will be met. All infiltration SCMs will be located outside of Zone I, Zone II, and IWPAs. The required recharge volume equals 0.6-inch runoff times total impervious area. **Table 4.11-8** presents the required and proposed recharge volumes for the Build Alternative.

Table 4.11-8. Build Alternative: Recharge Compliance

Study Area Quadrant	Required Recharge Volume for Redevelopment (cubic feet)	Required Recharge Volume for New Development (cubic feet)	Combined Required Recharge Volume (cubic feet)	Impervious Area Directed to Infiltration Stormwater Control Measures (percentage)	Proposed Recharge Volume (cubic feet)
Sagamore North	52,100	22,200	74,300	>100%	154,500
Sagamore South	41,400	32,800	74,200	>100%	160,500
Bourne North	50,700	29,000	79,700	>100%	196,500
Bourne South	45,200	26,500	71,700	>100%	262,600

4.11.8.4 Standard 4 – Water Quality

SCMs will be designed to meet additional treatment requirements (1-inch water quality volume) for soils with rapid infiltration rates and discharges to critical areas. SCMs will provide 80% TSS reduction from total impervious area within the Study Area, as feasible. The removal will be quantified using the EPA pollutant removal curves.[24] MassDOT will develop a Long-Term Pollution Prevention Plan and submit it to the Bourne Conservation Commission for review during the permitting process. The use of environmentally sensitive site design and Low Impact Development techniques will be prioritized. The target reduction for pathogens in stormwater is two to three orders of magnitude, which is generally expected to be achieved by the implementation of SCMs. **Table 4.11-9** presents the required and proposed water quality volumes and TSS removal for the Build Alternative.

[24] U.S. Environmental Protection Agency. 2010 (revised). Stormwater Best Management Practices (BMP) Performance Analysis. March. https://www3.epa.gov/region1/npdes/stormwater/tools/BMP-Performance-Analysis-Report.pdf

Table 4.11-9. Build Alternative: Water Quality Compliance

Study Area Quadrant	Required Water Quality Volume for Redevelopment (cubic feet)	Required Water Quality Volume for New Development (cubic feet)	Combined Required Water Quality Volume (cubic feet)	Proposed Water Quality Volume (cubic feet)	Total Suspended Solids Removal (percentage)
Sagamore North	86,800	37,100	123,900	154,500	88%
Sagamore South	69,000	54,600	123,600	160,500	86%
Bourne North	84,500	48,300	132,800	196,500	84%
Bourne South	75,300	44,200	119,500	262,600	100%

4.11.8.5 Standard 5 – Land Uses with Higher Potential Pollutant Loads

This standard is not applicable because roadways and bridges are not considered land uses with higher potential pollutant loads.

4.11.8.6 Standard 6 – Critical Areas

The Study Area includes the following critical areas:

- Zone I, Zone II, and IWPAs (Buzzards Bay Water District and Sandy's Restaurant)
- Class SB coastal waterway with shell fishing qualifier and bordering vegetated wetlands[25] (Cape Cod Canal)
- Certified vernal pools
- Herring River Watershed ACEC

SCMs will be designed to avoid new discharges to all Wellhead Protection Areas and meet additional treatment and pretreatment requirements for discharges to Cape Cod Canal and bordering wetlands and discharges to certified vernal pools. The Build Alternative would relocate existing discharges to provide buffer and treatment, when feasible. The Build Alternative would implement treatment measures that minimize standing water and promote infiltration to address pathogen reduction to shellfish areas.

The Long-Term Pollution Prevention Plan will include spill containment measures and procedures. Response procedures will be implemented at all SCMs within the Study Areas for any significant release of hazardous materials such as fuels, oils, or chemical materials that have the potential of discharging to the Cape Cod Sole Source Aquifer or the Plymouth/Carver Sole Source Aquifer.

[25] Freshwater wetlands that border creeks, rivers, streams, ponds, and lakes (including wet meadows, marshes, swamps, and bogs). These wetlands are areas where the soils are saturated and/or inundated such that they support a predominance of wetland indicator plants.

Reportable quantities will immediately be reported to the applicable federal, state, and local agencies as required by law. Reportable quantities of chemical, fuels, or oils are established under the CWA and enforced through MassDEP. The MassDEP Emergency Response Program will be immediately notified by telephone at (888) 304-1133 in accordance with required procedures for the report of a release.

MassDOT works with first responders and/or public water supply owners to determine the best approach to protect water supplies and provides training and materials to carry out action plans. In the case of a spill, applicable containment and cleanup procedures will be performed immediately. These procedures will be implemented in accordance with the Unified Response Manual at the local level by first responders, which includes the Town of Bourne's local public safety departments (e.g., fire, police, public works, board of health). MassDOT will be on-site to aid with traffic control and to provide cleanup supplies, as necessary. Spill material collected during the response will be promptly removed and disposed of in accordance with federal, state, and local requirements. If necessary, a licensed emergency response contractor will assist in cleanup of releases, depending on the amount of the release and the ability of the responsible party to perform the required response.

4.11.8.7 Standard 7 – Redevelopment

Redevelopment, which equals the amount of existing impervious area, will be treated to the maximum extent practicable. Reconfiguration of the four interchanges on both approaches of the Sagamore and Bourne Bridges would result in ample open space that would be used in part for stormwater treatment. The maximum extent practicable for the Build Alternative would result in full compliance with all Massachusetts Stormwater Management Standards for total impervious area, including both new development and redevelopment areas.

4.11.8.8 Standard 8 – Erosion and Sediment Control

Erosion and sediment control plans, details, and pay items will be included in the contract documents. The Build Alternative would require coverage under the EPA 2022 NPDES CGP. MassDOT contract specifications will require the contractor to prepare and implement a SWPPP that will include BMPs to control pollutants, sediment from erosion, stormwater runoff, and other construction-related impacts. A single plan that satisfies the SWPPP requirements of the CGP and the construction-period erosion, sedimentation and pollution prevention plan (CP4) requirements of Standard 8 will be submitted for approval to the Bourne Conservation Commission and MassDEP and implemented prior to starting land disturbing construction activities.

4.11.8.9 Standard 9 – Operation and Maintenance Plan

MassDOT will prepare a post-construction Operations and Maintenance Plan, which will be included in the Stormwater Management Report to be filed in accordance with permitting requirements under MA WPA. MassDOT uses a performance-based inspection and maintenance program for SCMs and catch basins. For SCMs, MassDOT's overall approach is to inspect SCMs, and based on the results of the inspections, perform maintenance to preserve functionality. For catch basins, MassDOT's overall approach is to perform maintenance at an interval that maintains the functionality of the catch basin

(e.g., sump is less than 50% full of sediment). Catch basin inspections, including documentation of sediment accumulation, and maintenance will occur simultaneously.

MassDOT's operations and maintenance program is data driven. Inspections and maintenance are recorded by personnel using hand-held tablets in the field to document sediment accumulation, maintenance action performed, and follow-up actions needed. Data are recorded in MassDOT's asset management system, which is accessible in the field (mobile) or the office (desktop).

Table 4.11-10 summarizes data that is generally collected for each asset type. For all assets, the inspector and inspection date are recorded. Photo documentation of structure condition is taken and attached to the inspection record.

Table 4.11-10. Data Collection

Inspection Form	Applicable Stormwater Assets	Information Collected
Inlets	• Catch basins • Outlet control structures	• Sediment accumulation • Trash/Debris accumulation • Signs of contamination • Frame and grate condition • Overall structure condition
Stormwater Control Measures (SCM)	• Infiltration SCMs • Bioretention SCMs	• SCM accessibility • Presence of standing water • Level of erosion • Sediment accumulation • Trash/Debris accumulation • Vegetation condition • Overall SCM condition
Storm Discharge Points	• Outlets to SCMs	• Presence of flow • Signs of contaminated flow • Sediment accumulation • Level of erosion • Pipe condition • Scour protection condition • Overall structure condition

Maintenance actions will not occur at any set frequency but rather will be based on the condition and impact to functionality. **Table 4.11-11** lists potential maintenance activities to be performed on the stormwater system.

Table 4.11-11. Potential Maintenance Activities

Stormwater Feature	Potential Maintenance Actions
Surface Stormwater Control Measures (SCM)	• Remove and properly dispose of accumulated material (e.g., sediment, trash, leaf litter, debris). • Mow vegetated areas and remove and dispose of grass clippings. • Regrade areas that show signs of unwanted ponding and channelization. • Stabilize or reconstruct eroded areas and reseed. • Replace stones/soil and/or replant vegetation. • Remove woody growth. • Treat invasive plants according to MassDOT Landscape Design Section. • Infiltration and bioretention SCMs only: – Address issues of standing water. – Drain and reconstruct SCM. • If rehabilitation is not possible, then retrofit to be a wet SCM while considering safety implications.
Underground SCMs	• Remove and properly dispose of trash, sediment, debris, and root intrusions. • Clean out sumps at an interval to maintain functionality (less than 50% full of sediment). • Jet and repair pipes. • Rehabilitate filtering and infiltration materials (e.g., geotextile fabric, crushed stone). • Stabilize and replace deteriorated structures. • Perform evaluations (e.g., test pits) to evaluate subsurface conditions.
Inlets and Outlets to SCMs	• Clear inlet and remove and properly dispose of sediment, trash, leaf litter, debris, and vegetation. • Regrade areas that show signs of ponding and channelization. • Repair or replace structural components. • Repair damaged or eroded areas. • Provide or rehabilitate erosion control at the outlet. • Regrade and replace the channel materials. • Remove woody growth. • Stabilize or reconstruct eroded areas. • Treat invasive plants according to MassDOT Vegetation Management Plan.

Based on the results of the inspection, repairs will be made in accordance with MassDOT standard practices. Maintenance will be prioritized given the urgency of the required maintenance and availability of staff, contracts, etc. Maintenance may require contracting if existing contracts are unavailable to perform the work. More intensive remedial activities may require permitting and/or an engineering solution.

4.11.8.10 Standard 10 – Illicit Discharge Detection and Elimination

An illicit discharge compliance statement will be included with the Stormwater Management Report that will be filed in accordance with permitting requirements under the MA WPA. The drainage plans will be reviewed for interconnections to the stormwater management system. Interconnections identified during this process will be coordinated with the District Permits Engineer to determine status of authorization. Should any illicit discharges be identified during construction, they will be reported to the Resident Engineer or MassDOT District 5 Environmental Engineer and MassDOT Stormwater Management Unit to determine the source and potential for resolution through MassDOT's Illicit Discharge Detection and Elimination Program.

4 Existing Conditions, Program Impacts, and Mitigation

4.12 Threatened, Endangered, and Protected Species and Habitats

4.12.1 Introduction

This section addresses the potential impacts of the No Build and Build Alternatives on federal- and state-protected terrestrial (land)-based and marine-based rare, threatened, or endangered species and their designated critical or priority habitats, including essential fish habitat (EFH). Additionally, it identifies consultation with federal and state agencies and describes required mitigation. This section is supported by **Appendix 4.12, Threatened, Endangered and Protected Species and Habitats Material**.

4.12.1.1 Regulatory Context

As joint lead agencies for the Cape Cod Bridges Program (Program), the Federal Highway Administration (FHWA) and the Massachusetts Department of Transportation (MassDOT) are required to comply with the federal and state regulatory statutes listed in **Table 4.12-1** for the protection of terrestrial-based and marine-based species and their habitats. Accordingly, consulting with and obtaining approvals from the U.S. Fish and Wildlife Service (USFWS), the National Oceanic and Atmospheric Administration's National Marine Fisheries Service (NOAA Fisheries), and the Massachusetts Division of Fisheries and Wildlife's Natural Heritage and Endangered Species Program (NHESP), as applicable, in coordination with the National Environmental Protection Act (NEPA) and Massachusetts Environmental Protection Act (MEPA) review processes.

Wildlife and wildlife resources, defined in 16 USC 666b, include birds, fish, mammals, and all other classes of wild animals and all types of aquatic and land vegetation upon which wildlife is dependent. National Oceanic and Atmospheric Administration (NOAA) Trust Resources are defined as living marine resources and their habitats, including but not limited to commercial and recreational fishery resources (marine and estuarine fish and shellfish, including diadromous fish species); endangered and threatened marine species (including diadromous fish species) and their designated critical habitats; marine mammals and marine turtles; marshes, mangroves, seagrass beds, coral reefs, and other coastal habitats; areas identified as EFH; and marine habitats and resources associated with national marine sanctuaries, national marine monuments, and other protected places.[1] Designated critical habitats are areas that contain features essential to the conservation and/or recovery of an Endangered Species Act of 1973 (ESA)-listed species and may require special management and protection.[2] EFH is defined as waters and substrate necessary to fish for spawning, breeding, feeding, or growing to maturity. Included within EFH are Habitat Areas of Particular Concern (HAPC), which are

[1] https://www.noaa.gov/organization/administration/noaa-administrative-orders-chapter-216-program-management/nao-216-123-noaa-mitigation-policy-for-trust-resources

[2] https://www.fisheries.noaa.gov/national/endangered-species-conservation/critical-habitat#definition-of-critical-habitat

rare, stressed by development, provide important ecological functions for federally managed species, and/or are especially vulnerable to anthropogenic (or human impact) degradation.[3]

Table 4.12-1. Federal and State Regulatory Statutes and Requirements

Statute	Regulatory Citation	Description
Federal		
Endangered Species Act of 1973 (ESA)	16 United States Code (USC) 1531-1544; 50 Code of Federal Regulations (CFR) 402	Requires federal agencies to avoid actions that would jeopardize threatened or endangered species or their critical habitats and describes the steps for informal and formal consultation with USFWS for terrestrial and freshwater species or with NOAA Fisheries for marine species and diadromous fish species [ESA Section 7(a)(2)].
Migratory Bird Treaty Act (MBTA)	16 USC 703-712	Prohibits the take (including killing, capturing, selling, trading, and transport) of protected migratory bird species (including any part of the bird, active nests, eggs, or its young) without prior authorization (permit) by the USFWS. The regulations governing migratory bird permits are provided in 50 CFR 13 and 21. The list of migratory birds protected under the MBTA, provided as 50 CFR 10.13, was most recently updated in 2023.
Bald and Golden Eagle Protection Act (BGEPA)	16 USC 668-668d	Provides criminal penalties for persons who "take, possess, sell, purchase, barter, offer to sell, purchase or barter, transport, export or import, at any time or any manner, any Bald Eagle ... [or any Golden Eagle], alive or dead, or any part (including feathers), nest, or egg thereof." The act defines "take" as "pursue, shoot, shoot at, poison, wound, kill, capture, trap, collect, molest or disturb." The USFWS enforces the BGEPA and issues permits for incidental take in accordance with 50 CFR 13 and 22.
Fish and Wildlife Coordination Act (FWCA)	16 USC 2901-2911	Requires federal agencies to consult with the federal and state agencies responsible for fish and wildlife resource management regarding projects which may affect these resources. For the Program, these agencies include the USFWS, NOAA Fisheries, and the NHESP.
Magnuson-Stevens Fishery Conservation and Management Act	16 USC Chapter 38 Section 1801 et seq.	Requires federal agencies to consult with NOAA Fisheries on any action or proposed action authorized, funded, or undertaken by such agency that may adversely affect designated Essential Fish Habitat (EFH) identified under the Magnuson-Stevens Fishery Conservation and Management Act per 50 CFR 600.905 and 600.920.

[3] https://www.fisheries.noaa.gov/southeast/habitat-conservation/habitat-areas-particular-concern-within-essential-fish-habitat

Statute	Regulatory Citation	Description
Marine Mammal Protection Act (MMPA)	16 USC Chapter 31 Sections 1361–1362	Prohibits take or attempted take of any marine mammal species in U.S. waters per 50 CFR 216. Incidental take may occur during non-fishing activities including construction projects if approved by NOAA Fisheries through issuance of permits and authorizations to ensure mitigation measures are implemented to reduce the impact of the activities and keep track of the activities and how they impact protected species.
State		
Massachusetts Endangered Species Act (MESA)	Massachusetts General Law Chapter131A	Protects rare species and their habitats by prohibiting the "take" of any plant or animal species listed as Endangered, Threatened, or Special Concern by the Natural Heritage and Endangered Species Program. Take is defined as, "to harass, harm, pursue, hunt, shoot, hound, kill, trap, capture, collect, process, disrupt the nesting, breeding, feeding or migratory activity or attempt to engage in any such conduct, or to assist such conduct." Proponents with projects or activities within state-listed species Priority Habitat must file with the NHESP for review and approval before project initiation. Projects resulting in a take of MESA species must meet the performance standards for a Conservation and Management Permit [CMP; 321 Code of Massachusetts Regulations (CMR) 10.23]. To do so, an applicant agrees to carry out a Conservation and Management Plan that provides a long-term net benefit to the conservation of the affected MESA-listed species.

Source:Massachusetts Department of Transportation, 2024

4.12.1.2 Methodology and Study Areas

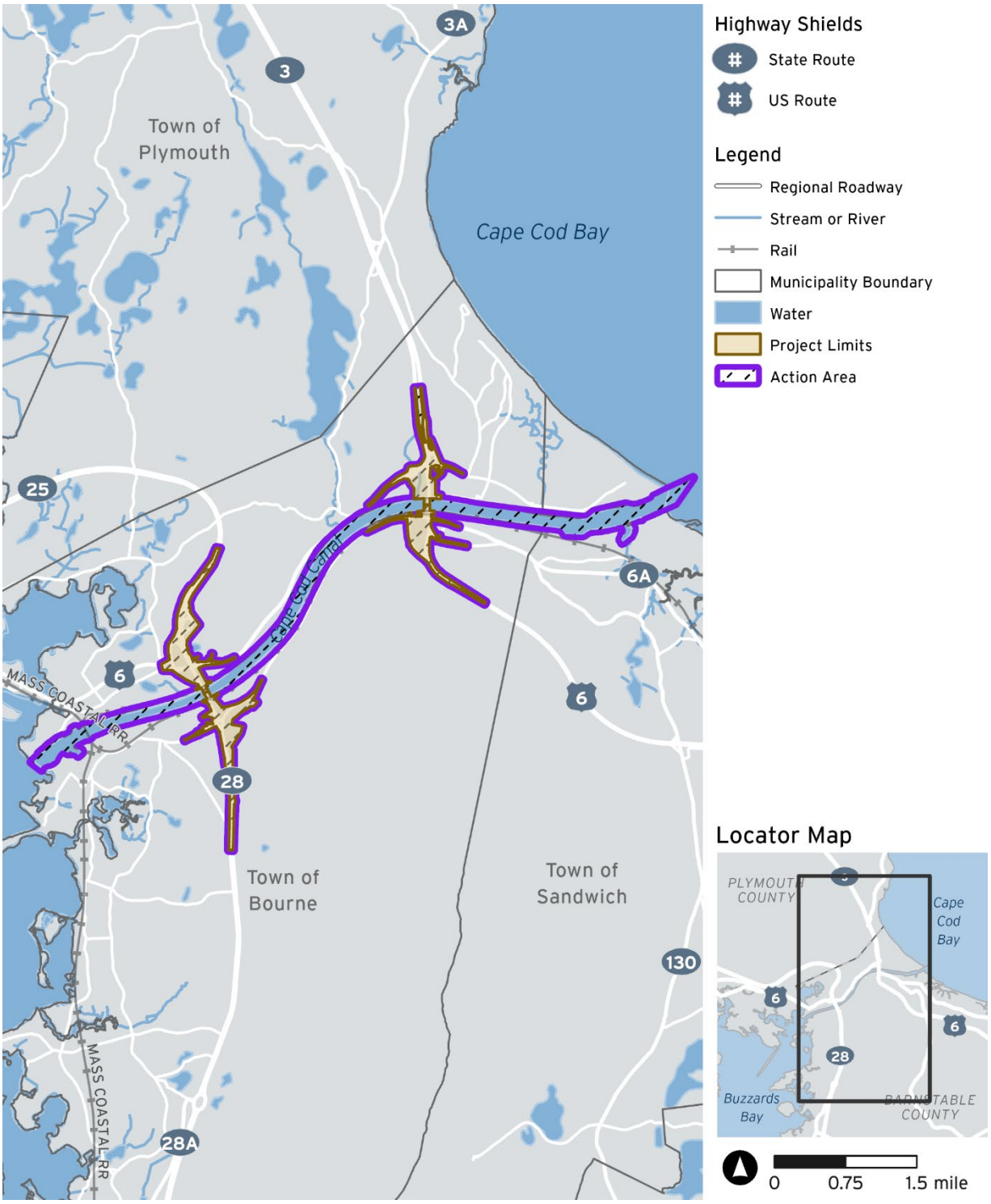
MassDOT initiated early Program coordination in 2018 with NHESP and USFWS to identify concerns for federal- and state-protected species. Since June 2023, USFWS, NOAA Fisheries, and the Massachusetts Department of Fish and Game have participated as Cooperating Agencies for the Program.[4] MassDOT held multiple Cooperating Agencies meetings for the Program in 2023 and 2024 in part to discuss the species protected under the ESA and MESA that the Program would potentially affect.

MassDOT provided Biological Assessments (BA) to the USFWS and NOAA Fisheries that detailed potential Program impacts on these species and provided impacts determinations for the terrestrial and marine species protected under the ESA. MassDOT provided an EFH Assessment and Fish and Wildlife Coordination Act (FWCA) Consultation Worksheet to NOAA Fisheries describing potential impacts on EFH and Trust Resources considered under the FWCA. The BA for Terrestrial Species, the BA for Marine Species, and the EFH Assessment and FWCA Consultation Worksheet are provided in **Appendix 4.12, Threatened, Endangered, and Protected Species and Habitats Material, Attachments 1, 2, and 3**, respectively.

MassDOT developed a Terrestrial Species Study Area and Aquatic Species Study Area for the analysis of Program impacts on protected species and habitats, presented as **Figure 4.12-1**. Combined, these study areas comprise the Program Action Area, defined by the ESA as "all areas to be affected directly or indirectly by the federal action and not merely the immediate area involved in the action."[5] The Action Area encompasses the Project Limits, which comprise the construction footprints of the existing and proposed Sagamore and Bourne Bridges, the interchange approach networks for the highway bridges, and shared-use paths, and their surrounding areas of disturbance. In addition, the Action Area extends to include Cape Cod Canal where it connects with Buzzards Bay in the southwest and Cape Cod Bay in the northeast, as well as potential routes of Program vessels to and from ports (not shown on **Figure 4.12-1**).

[4] FHWA and MassDOT identified Cooperating Agencies in accordance with the National Environmental Policy Act (NEPA).
[5] 50 Code of Federal Regulation (CFR) 402.2.

Figure 4.12-1.Terrestrial and Aquatic Species Study Areas



Source:Massachusetts Department of Transportation, 2024

Note: The aquatic portions of the Program Study Areas also include potential routes Program vessels may take to and from ports, not shown on this figure.

4.12.2 Existing Conditions

4.12.2.1 Terrestrial Resources

ESA-PROTECTED SPECIES

Table 4.12-2 lists the terrestrial species protected under the ESA that may occur in the Terrestrial Species Study Area, as determined by the USFWS.[6] The Program is within the range of five species listed, proposed, or is a candidate for listing by USFWS under the ESA. The BA for Terrestrial Species, provided as **Appendix 4.12, Threatened, Endangered, and Protected Species and Habitats Material, Attachment 1**, contains details on the potential presence of these species in the Terrestrial Species Study Area.

Table 4.12-2. Federally Protected Species Potentially Present in the Terrestrial Species Study Area

Species	Status	Federally Designated Critical Habitat in Study Area?	Description of Habitat
Mammals			
Northern Long-eared Bat (*Myotis septentrionalis*)	Endangered	No	Wide variety of forested habitats for roosting, foraging, and traveling; adjacent and interspersed non-forested habitat such as emergent wetlands and field edges. Occasionally roost in structures such as barns or sheds (particularly when suitable roost trees are unavailable). Hibernate in caves and mines.
Tricolored Bat (*Perimyotis subflavus*)	Proposed Endangered	No	Primarily roost among live and dead leaf clusters of live or recently dead deciduous hardwood trees. Often forage in patches adjacent to roosting habitat including forest, fields, and over water. Hibernate in caves and mines.
Reptiles			
Northern red-bellied cooter (*Pseudemys rubriventris*)/ Plymouth red-bellied turtle (*Pseudemys rubriventris bangsi*)[a]	Endangered	No	Coastal plain ponds, river systems, cranberry bogs, and other wetlands in the seaboard lowland section of New England; require unforested, upland habitats with well-drained soils in proximity to aquatic habitat for nesting; female turtles require adequate upland connectivity between aquatic habitat and suitable nest sites.

[6] U.S. Fish and Wildlife Service. 2024. Information for Planning and Consultation. https://ipac.ecosphere.fws.gov/

Species	Status	Federally Designated Critical Habitat in Study Area?	Description of Habitat
Plants			
Sandplain Gerardia (*Agalinis acuta*)	Endangered	No	Open dry grasslands, including roadsides, pine/oak scrub forest openings, and managed cemeteries with native plants species; poor soil conditions and a disturbance regime that provides open and low competition conditions; a hemiparasite often associated with considerable lichen growth and areas of scattered, bare soil where little bluestem (*Schizachyrium scoparium*) is present.
Insects			
Monarch Butterfly (*Danaus plexippus*)	Proposed Threatened	No	Healthy and abundant milkweed for migration, breeding, and early life stage development; nectar providing flowers for breeding and migration; clean water sources.

Sources: U.S. Fish and Wildlife Service (USFWS). 2021.
Species Status Assessment (SSA) Report for the Massachusetts Population of the Northern Red-bellied Cooter (*Pseudemys rubriventris*). Version 1.0. U.S. Fish and Wildlife Service Northeast Region. Hadley, MA
https://iris.fws.gov/APPS/ServCat/DownloadFile/209859;
USFWS. 2024. Plymouth red-bellied turtle species account. https://www.fws.gov/species/plymouth-red-bellied-turtle-pseudemys-rubriventris-bangsi; Range-wide Indiana Bat and Northern Long-eared Bat Survey Guidelines. https://www.fws.gov/media/range-wide-indiana-bat-and-northern-long-eared-bat-survey-guidelines; Sandplain gerardia species account. https://www.fws.gov/species/sandplain-gerardia-agalinis-acuta.
USFWS. n.d. Northern Long-eared Bat. https://www.fws.gov/species/northern-long-eared-bat-myotis-septentrionalis; Tricolored Bat. https://www.fws.gov/species/tricolored-bat-perimyotis-subflavus; Monarch Butterfly. https://www.fws.gov/species/monarch-danaus-plexippus.
[a] This species was formerly known as Plymouth redbelly turtle (*Pseudemys rubriventris bangsi*).

MESA-PROTECTED SPECIES AND HABITATS

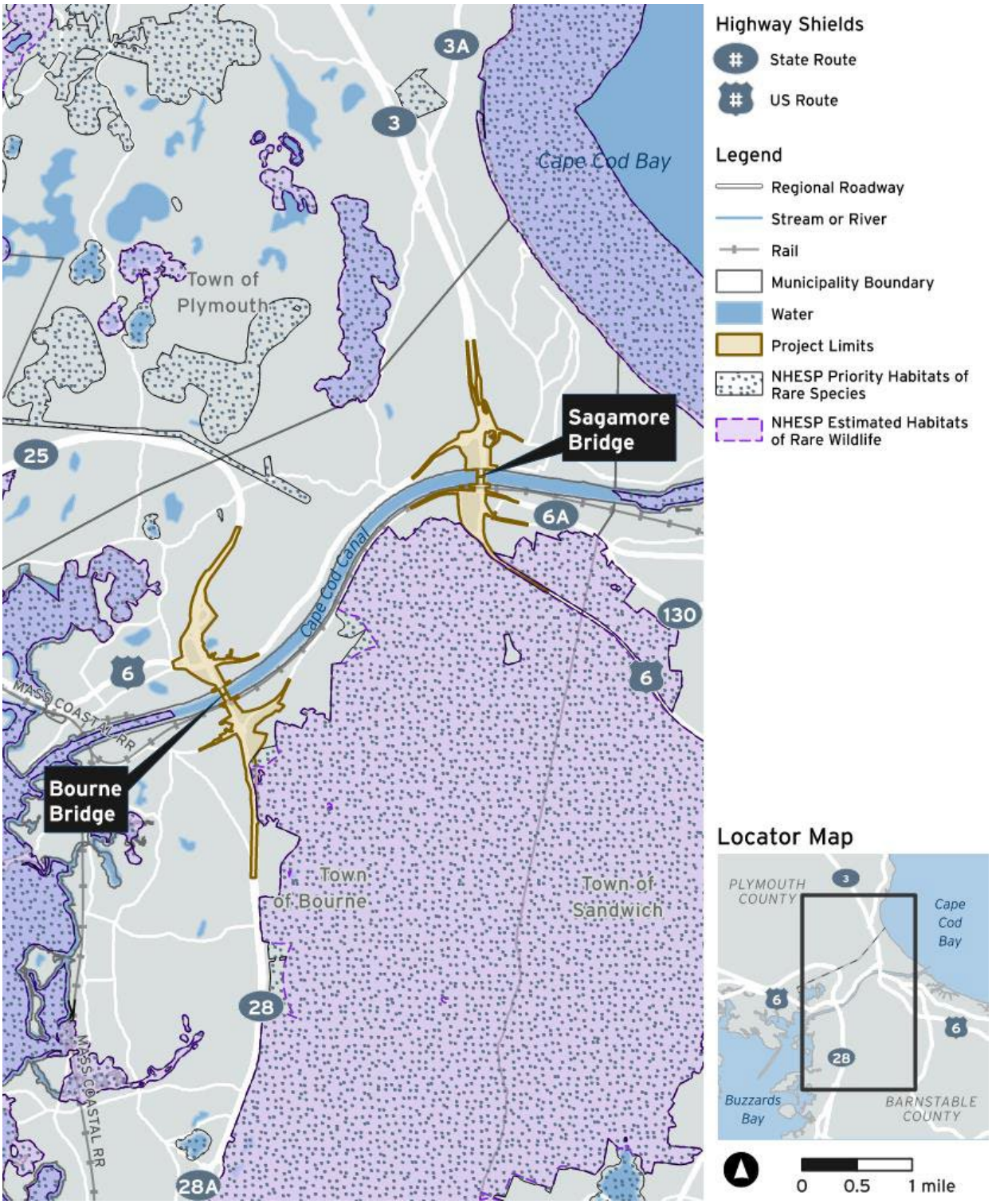
Figure 4.12-2 identifies locations where the Terrestrial and Aquatic Species Study Areas overlap Priority and Estimated Habitat for MESA-listed species. Estimated Habitats of Rare Wildlife are a mapped subset of these Priority Habitats that pertain to rare wetland wildlife observed within the last 25 years and documented in the NHESP database.

The undeveloped area within and adjacent to the Terrestrial Species Study Area in Sagamore South is primarily composed of maintained road shoulder, edge habitat associated with the pitch pine-oak forest matrix community type, and dry xeric shrubland community maintained within the existing utility right-of-way along Route 6. Two eastern box turtle road mortalities were previously documented along the southbound shoulder of Route 6 and reported to the NHESP. No additional visual observations of state-listed wildlife or plants have been documented in the Sagamore South portion of the Terrestrial Species Study Area.

The undeveloped areas within and adjacent to the Terrestrial Species Study Area in the Bourne South quadrant predominately include maintained road shoulder; edge and outer portion of a large forest block of the pitch pine-oak forest matrix community type contiguous with Joint Base Cape Cod; and smaller inclusions of pitch pine-oak community types typical of the coastal sandplain. No visual observations of state-listed plant or wildlife species have been documented in the Bourne South quadrant of the Terrestrial Species Study Area.

Figure 4.12-2 lists Priority Habitats for species protected under MESA that occur in the Terrestrial Species Study Area, as determined by NHESP. The ESA-protected northern long-eared bat, tricolored bat, and northern red-bellied cooter are listed as endangered under MESA. However, these species do not have Priority Habitats as mapped by NHESP in the Terrestrial Species Study Area.

Figure 4.12-2.MESA-Protected Species in the Study Areas



Source:Massachusetts Department of Transportation, 2024

Table 4.12-3. State-Protected Species With Priority Habitat in the Terrestrial Species Study Area[a]

Species	Status	Description of Habitat
Reptiles		
Eastern box turtle (*Terrapene carolina*)	Special Concern	Dry and moist woodlands, brushy fields, thickets, marsh edges, bogs, swales, fens, stream banks, and well-drained bottomland. Overwinter in upland forests with leaf litter and woody debris.
Insects		
Barrens dagger moth (*Acronicta albarufa*)	Threatened	Xeric, open pitch pine-scrub oak barrens and scrub oak thickets on sandy soil. Host plants: Scrub oak (*Quercus ilicifolia*) and occasionally other oak species.
Herodias underwing moth (*Catocala herodias)*	Special Concern	Xeric, open pitch pine-scrub oak barrens and scrub oak thickets on sandy soil or rocky summits and ridges. Host plant: scrub oak.
Melsheimer's sack bearer (*Cicinnus melsheimeri*)	Threatened	Sandplain pitch pine-scrub oak barrens, especially scrub oak thickets. It may also be found in shrubby grasslands and heathlands with a component of scrub oak. Host plant: scrub oak.
Buck Moth (*Hemileuca maia*)	Special Concern	Xeric, open habitats with extensive scrub oak thickets, particularly sandplain pitch pine-scrub oak barrens. Host plants: scrub oak and occasionally other shrubby oak species.
Heath metarranthis (*Metarranthis pilosaria*)	Special Concern	Sandplain pitch pine-scrub oak barrens and heathlands, as well as acidic swamps and bogs. Host plants: Blueberries and cranberries (*Vaccinium* spp.) and likely leatherleaf (*Chamaedaphne calyculata*).
Pine barrens speranza (*Speranza exonerate*)	Special Concern	Pitch pine-scrub oak barrens on sandplains and rocky summits and ridges. Host plant: scrub oak.
Scrub euchlaena (*Euchlaena madusaria*)	Special Concern	Sandplain pitch pine-scrub oak barrens, heathlands, and shrubby grasslands. Host plant: Lowbush blueberries (*Vaccinium angustifolium* and *V. pallidum).*
Slender clearwing sphinx moth (*Hemaris gracilis*)	Special Concern	Pitch pine-scrub oak barrens and heathlands on sandplains or rocky summits and ridges, as well as acidic bogs and swamps. Host plants: Lowbush blueberry (*Vaccinium pallidum*) and likely other blueberry species.
Chain dot geometer (*Cingilia catenaria*)	Special Concern	Coastal plain shrublands, including sandplain grasslands and heathlands, dunes, bluffs, and maritime shrublands; occasionally also open pitch pine/scrub oak barrens. Host plants: Huckleberry (*Gaylussacia baccata*), blueberry (*Vaccinium* spp.), bayberry (*Morella caroliniensis*), and sweet gale (*Myrica gale*).

Sources:Nazdrowicz, N., J. Bowman, and R. Roth. 2008. Population Ecology of the Eastern Box Turtle in a Fragmented Landscape. Journal of Wildlife Management 72(3): 745-753; Erb, L. 2012. Eastern Box Turtle Conservation Plan for Massachusetts. Massachusetts Division of Fisheries and Wildlife. Natural Heritage and Endangered Species Program. Westborough, Massachusetts; Ernest, C., and J. Lovich. 2009. Turtles of the United States and Canada. Second Edition. The John Hopkins University Press. Baltimore, Maryland;
Natural Heritage and Endangered Species Program (NHESP). 2015.
Chain dot geometer (*Cingilia catenaria*) Fact Sheet. https://www.mass.gov/doc/chain-dotted-geometer/download.
NHESP. 2019. Little Brown Bat (Myotis lucifugus) Fact Sheet. https://www.mass.gov/doc/little-brown-bat/download;
Barrens Dagger Moth (*Acronicta albarufa*) Fact Sheet. https://www.mass.gov/doc/barrens-dagger-moth/download;

Herodias underwing moth (*Catocala Herodias*) Fact Sheet. https://www.mass.gov/doc/herodias-underwing-moth/download; Melsheimer's sack bearer (*Cicinnus melsheimeri*) Fact Sheet. https://www.mass.gov/doc/melsheimers-sack-bearer/download; Buck Moth (*Hemileuca maia*) Fact Sheet. https://www.mass.gov/doc/buck-moth/download; Heath metarranthis (*Metarranthis pilosaria*) Fact Sheet. https://www.mass.gov/doc/heath-metarranthis/download; Pine barrens speranza (*Speranza exonerata*) Fact Sheet. https://www.mass.gov/doc/pine-barrens-speranza/download; Scrub euchlaena (*Euchlaena madusaria*) Fact Sheet. https://www.mass.gov/doc/scrub-euchlaena/download; Slender clearwing sphinx moth (*Hemaris gracilis*) Fact Sheet. https://www.mass.gov/doc/slender-clearwing-sphinx-moth/download.

[a] The ESA-protected northern long-eared bat, tricolored bat, and northern red-bellied cooter are listed as endangered under MESA but do not have Priority Habitat as mapped by NHESP in the Terrestrial Species Study Area.

OTHER PROTECTED SPECIES

As noted in **Table 4.12-1**, migratory birds, including Bald and Golden Eagles, are protected under the Migratory Bird Treaty Act and Bald and Golden Eagle Protection Act. **Table 4.12-4** lists the migratory birds that may occur in the Terrestrial Species Study Area that are on the USFWS Birds of Conservation Concern list[7] or are protected by the Bald and Golden Eagle Protection Act. There are no known Bald Eagle nests in or within 660 feet of the Terrestrial Species Study Area, which is the closest an activity should be conducted relative to a Bald Eagle nest, based on the USFWS National Bald Eagle Management Guidelines.[8] Golden Eagles are not known to breed in the United States east of the Mississippi River,[9] and migrating Golden Eagles are rare in Massachusetts.[10]

Table 4.12-4. Birds of Conservation Concern Potentially Present in the Terrestrial and Aquatic Species Study Areas

Species	Level of Concern	Breeding Season
American oystercatcher (*Haematopus palliatus)*	Birds of Conservation Concern	April 15 – August 31
Bald Eagle (*Haliaeetus leucocephalus*)	Non-Birds of Conservation Concern vulnerable	October 15 – August 31
Black Skimmer (*Rynchops niger*)	Birds of Conservation Concern	May 20 – September 15
Black-billed Cuckoo (*Coccyzus erythropthalmus*)	Birds of Conservation Concern	May 15 – October 10
Blue-winged Warbler (*Vermivora cyanoptera*)	Birds of Conservation Concern	May 1 – June 30
Bobolink (*Dolichonyx oryzivorus*)	Birds of Conservation Concern	May 20 – July 31
Canada Warbler (*Cardellina canadensis*)	Birds of Conservation Concern	May 20 – August 10
Chimney Swift (*Chaetura pelagica*)	Birds of Conservation Concern	March 15 – August 25
Eastern Whip-poor-will (*Antrostomus vociferus*)	Birds of Conservation Concern	May 1 – August 20
Kentucky Warbler (*Oporornis Formosus*)	Birds of Conservation Concern	April 20 – August 20
Least Tern (*Sternula antillarum antillarum*)	Birds of Conservation Concern	April 25 – September 5
Lesser Yellowlegs (*Tringa flavipes*)	Birds of Conservation Concern	Breeds elsewhere
Pectoral Sandpiper (*Calidris melanotos*)	Birds of Conservation Concern	Breeds elsewhere
Prairie Warbler (*Setophaga discolor*)	Birds of Conservation Concern	May 31 – July 31
Prothonotary Warbler (*Protonotaria citrea*)	Birds of Conservation Concern	April 1 – July 31
Purple Sandpiper (*Calidris maritima*)	Birds of Conservation Concern	Breeds elsewhere

[7] https://www.fws.gov/sites/default/files/documents/birds-of-conservation-concern-2021.pdf

[8] https://www.fws.gov/sites/default/files/documents/national-bald-eagle-management-guidelines_0.pdf.

[9] Katzner, Todd, B.W. Smith, T.A., Miller, et. al. 2012. Status, Biology, and Conservation Priorities for North America's Eastern Golden Eagle (*Aguila chrysaetos*) population. The Auk. 129(1): 168-176.

[10] Mass Audubon. 2024. Birds of Prey. https://www.massaudubon.org/nature-wildlife/birds/birds-of-prey

Species	Level of Concern	Breeding Season
Ruddy Turnstone (*Arenaria interpres morinella*)	Birds of Conservation Concern	Breeds elsewhere
Rusty Blackbird (*Euphagus carolinus*)	Birds of Conservation Concern	Breeds elsewhere
Saltmarsh Sparrow (*Ammospiza caudacuta*)	Birds of Conservation Concern	May 15 – September 5
Scarlet Tanager (*Piranga olivacea*)	Birds of Conservation Concern	May 10 – August 10
Semipalmated Sandpiper (*Calidris pusilla*)	Birds of Conservation Concern	Breeds elsewhere
Short-billed Dowitcher (*Limnodromus griseus*)	Birds of Conservation Concern	Breeds elsewhere
Whimbrel (*Numenius phaeopus hudsonicus*)	Birds of Conservation Concern	Breeds elsewhere
Willet (*Tringa semipalmata*)	Birds of Conservation Concern	April 20 – August 5
Wood Thrush (*Hylocichla mustelina*)	Birds of Conservation Concern	May 10 – August 31

Source: U.S. Fish and Wildlife Service. 2021b. Birds of Conservation Concern 2021. https://www.fws.gov/sites/default/files/documents/birds-of-conservation-concern-2021.pdf

4.12.2.2 Aquatic Resources

ESA-PROTECTED SPECIES

Aquatic resources include marine habitats in the Aquatic Species Study Area. **Table 4.12-5** lists the species protected under the ESA that may occur in the Aquatic Species Study Area as determined by NOAA Fisheries and the NOAA Fisheries ESA Section 7 Mapper.[11] The Program is within the range of eight species listed by NOAA Fisheries under the ESA, and within Critical Habitat designated for one species. The BA for Marine Species, provided as **Appendix 4.12, Threatened, Endangered, and Protected Species and Habitats Material, Attachment 2**, contains details on the potential presence of these species in the Aquatic Species Study Area.

Table 4.12-5. Federally Protected Species Potentially Present in the Aquatic Species Study Area

Species	Federal	Federally Designated Critical Habitat in Study Area?	Description of Habitat
Marine Mammals			
Fin whale (*Balaenoptera physalus*)	Endangered	No	Deep waters offshore migrating from low latitude breeding grounds in winter to high latitude feeding areas in summer; evidence exists of adult and juvenile wintering areas in Stellwagen Bank and the eastern perimeter of Georges Bank, but individuals may occur at this latitude year-round.
North Atlantic right whale (*Eubalaena glacialis*)	Endangered	Yes	Occur off Newfoundland, Canada to the Gulf of Mexico; adults and juveniles forage from Maine to Cape Cod, Massachusetts, with most sightings in Massachusetts in spring and summer before their northerly migration, although there is increasing evidence of overwintering in Cape Cod Bay.

[11] National Oceanic and Atmospheric Administration Fisheries. 2023. The Greater Atlantic Region ESA Section 7 Mapper. https://www.fisheries.noaa.gov/resource/map/greater-atlantic-region-esa-section-7-mapper

Species	Federal	Federally Designated Critical Habitat in Study Area?	Description of Habitat
Sea Turtles			
Green Turtle (*Chelonia mydas*)	Threatened	No	Juveniles and adults migrate north to mid-Atlantic waters at the beginning of June and migrate south at the end of November as water temperatures cool; primarily feed on algae and seagrass.
Kemp's Ridley Turtle (*Lepidochelys kempii*)	Endangered	No	Primarily found in Gulf of Mexico; however, juveniles and adults migrate north to Nova Scotia and the eastern Atlantic in the spring and migrate south as water temperatures cool. Feed in nearshore waters; omnivores but primarily feed on swimming crabs and crustaceans.
Leatherback Turtle (*Dermochelys coriacea*)	Endangered	No	Most extensive range of any reptile; migrate north to mid-Atlantic waters in spring as water temperatures increase and migrate south in the fall as water temperatures cool; feed primarily in pelagic waters on jellyfish, siphonophores, pyrosomes, and salps.
Loggerhead Turtle (*Caretta caretta*)	Threatened	No	Occur in U.S. Atlantic and Gulf of Mexico coastal waters as juveniles and adults. Migrate and forage from south of Cape Cod, Massachusetts to Virginia from the beginning of May to the end of November. Feed primarily on shellfish including whelks and conchs.
Fish			
Atlantic Sturgeon (*Acipenser oxyrinchus oxyrinchus*)	Threatened, Endangered[a]	No	Anadromous, demersal fish. Spawn in freshwater rivers but spend most of life in marine and estuarine waters. May migrate long distances along U.S. coast while in marine waters. Frequently inhabit gravel and sand substrates near bays, inlets, and river mouths to forage. Winter in deeper offshore marine waters.
Shortnose Sturgeon (*Acipenser brevirostrum*)	Endangered	No	Anadromous, demersal fish. Spawn in freshwater rivers but may also inhabit estuarine and marine waters during portions of life history. May migrate in marine waters between river systems, typically in late spring or late fall months.

Sources: Atlantic Sturgeon Status Review Team. 2007. 2007 Status Review of Atlantic sturgeon (Acipenser oxyrinchus oxyrinchus). Report to National Marine Fisheries Service, Northeast Regional Office. February 23, 2007. 174 pp.
National Oceanic and Atmospheric Administration National Marine Fisheries Service (NOAA Fisheries). 1992. Recovery Plan for Leatherback Turtles in the U.S. Caribbean, Atlantic, and Gulf of Mexico.

https://www.fisheries.noaa.gov/resource/document/recovery-plan-leatherback-turtles-us-caribbean-atlantic-and-gulf-mexico
NOAA Fisheries. 2008. Recovery Plan for the Northwest Atlantic Population of the Loggerhead Sea Turtle (Caretta caretta). https://www.fisheries.noaa.gov/resource/document/recovery-plan-northwest-atlantic-population-loggerhead-sea-turtle-caretta-caretta.
NOAA Fisheries. 2015. Kemp's Ridley Sea Turtle (Lepidochelys Kempii) 5-Year Review: Summary and Evaluation. noaa_17048_DS1.pdf **Error! Hyperlink reference not valid.**
NOAA Fisheries. 2024. Stock Assessment Report. June 2024. Fin Whale (Balaenoptera physalus): Western North Atlantic Stock.
NOAA Fisheries. 2024. Stock Assessment Report. November 2024. North Atlantic Right Whale, Western Atlantic.
Seminoff, Jeffrey Aleksandr, Camryn D. Allen, George H. Balazs, Peter Howard Dutton, Tomoharu Eguchi, Heather Haas, Stacy A. Hargrove et al. 2015. Status review of the green turtle (Chelonia mydas) under the Endangered Species Act. https://www.fisheries.noaa.gov/resource/document/status-review-green-turtle-chelonia-mydas-under-endangered-species-act
Shortnose Sturgeon Status Review Team. 2010. A Biological Assessment of shortnose sturgeon (Acipenser brevirostrum). Report to National Marine Fisheries Service, Northeast Regional Office. November 1, 2010. 417 pp. https://www.fisheries.noaa.gov/resource/document/biological-assessment-shortnose-sturgeon-acipenser-brevirostrum
[a] On February 6, 2012, NOAA Fisheries listed five Distinct Population Segments of Atlantic sturgeon under the Endangered Species Act: the Chesapeake Bay, New York Bight, Carolina, and South Atlantic Distinct Population Segments were listed as endangered; the Gulf of Maine DPS was listed as threatened (77 Federal Register 5880). 77 FR 5880 - Endangered and Threatened Wildlife and Plants; Threatened and Endangered Status for Distinct Population Segments of Atlantic Sturgeon in the Northeast Region - Content Details - 2012-1946

MESA-PROTECTED SPECIES

The marine species that may occur in the Aquatic Species Study Area, as listed in **Table 4.12-5**, are also protected under MESA. However, there is no Priority Habitat mapped by NHESP for these species or any other species in the Aquatic Species Study Area.

ESSENTIAL FISH HABITAT AND NOAA FISHERIES TRUST RESOURCES

A total of 28 finfish and invertebrate species have designated EFH within the Aquatic Species Study Area. Within this total, there are two types of Habitat Areas of Particular Concern (HAPC): Inshore Juvenile Atlantic Cod (*Gadus morhua*) HAPC and Summer Flounder (*Paralichthys dentatus*) HAPC. Additionally, there are 16 NOAA Trust Resources, protected by NOAA Fisheries under the authority of the FWCA, with the potential to be present in the Aquatic Species Study Area.[12] NOAA Trust Resources include 2,445 square feet (sf) of eelgrass (*Zostera marina*) [submerged aquatic vegetation (SAV)], located at the Bourne Bridge site. Additionally, the U.S. Environmental Protection Agency identifies eelgrass as a "special aquatic site," pursuant to 40 CFR 230 Section 404(b) (1) of the Federal Clean Water Act; and the Mid-Atlantic Fishery Management Council has designated eelgrass as a HAPC when overlapped with summer flounder EFH.[13]

[12] In the context of the FWCA, NOAA Trust Resources refer to anadromous fish, shellfish, crustaceans, or their habitats, that are not managed under a federal fisheries management plan.
[13] Louis A. Chiarella, Assistant Regional Administrator for Habitat Ecosystem Services. Correspondence to David Paulson, Wildlife and Endangered Species Unit Supervisor, MassDOT. February 12, 2025.

Table 4.12-6 lists the species with designated EFH throughout the Aquatic Species Study Area (A), in the Sagamore Bridge portion of the Aquatic Species Study Area (S), and in the Bourne Bridge portion of the Aquatic Species Study Area (B). Eelgrass and shellfish were confirmed present during site surveys.

Table 4.12-6. Species with Designated Essential Fish Habitat in the Aquatic Species Study Area

Species	Life Stage			
	Eggs	Larvae	Juvenile	Adults/ Spawning Adults
American Plaice (*Hippoglossoides platessoides*)	S	S	S	S
Albacore Tuna (*Thunnus alalunga*)[†]	—	—	A	—
Atlantic Butterfish (*Peprilus triacanthos*)	A	B	—	A
Atlantic Cod (*Gadus morhua*)	A	A	A[*]	A
Atlantic Herring (*Clupea harengus*)	—	S	A	A
Atlantic Mackerel (*Scomber scombrus*)[†]	A	S	A	A
Atlantic Sea Scallop (*Placopecten magellanicus*)	S	S	S	S
Atlantic Surfclam (*Spisula solidissima*)	—	—	A	A
Atlantic Wolffish (*Anarhichas lupus*)[†]	A	A	A	A
Black Sea Bass (*Centropristis striata*)	B	B	A	A
Bluefin Tuna (*Thunnus thynnus*)[†]	—	—	—	A
Bluefish (*Pomatomus saltatrix*)	—	—	A	A
Little Skate (*Leucoraja erinacea*)	—	—	A	A
Longfin Inshore Squid (*Doryteuthis* [*Amerigo*] *pealeii*)	B	—	A	A
Northern Shortfin Squid (*Illex illecebrosus*)	—	—	—	A
Ocean Pout (*Macrozoarces americanus*)	A	—	S	S
Pollock (*Pollachius virens*)		S	S	S
Red Hake (*Urophycis chuss*)	A	A	A	A
Scup (*Stenotomus chrysops*)	B	B	A	A
Silver Hake (*Merluccius bilinearis*)	S	S	—	S
Smoothhound Shark Complex (Atlantic Stock)	A	A	A	A
Spiny Dogfish (*Squalus acanthias*)	—	—	—	A[**]
Summer Flounder (Paralichthys dentatus)	—	B	B	A[*]
Thorny Skate (*Amblyraja radiata*)	—	—	S	—
White Hake (*Urophycis tenuis*)	S	S	S	S
Windowpane Flounder (*Scophthalmus aquosus*)	A	A	A	A
Winter Flounder (*Pseudopleuronectes americanus*)	A	A	A	A

Species	Life Stage			
	Eggs	Larvae	Juvenile	Adults/ Spawning Adults
Winter Skate (*Leucoraja erinacea*)	—	—	A	A
Yellowtail Flounder (*Limanda ferruginea*)	S	S	A	A

Sources: Evans, N.T., K.H. Ford, B.C. Chase, J.J. Sheppard. 2015. Recommended Time of Year Restrictions (TOYs) for Coastal Alteration Projects to Protect Marine Fisheries Resources in Massachusetts. Massachusetts Division of Marine Fisheries. April 2011. Revised January 2015. https://www.mass.gov/doc/time-of-year-recommendations-tr-47/download.
New England Fishery Management Council (NEFMC). 2017. Omnibus essential fish habitat amendment 2. Volume 2: EFH and HAPC designation alternatives and environmental impacts. New England Fishery Management Council, Newburyport, and National Marine Fisheries Service, Gloucester, Massachusetts, USA. October 25.
National Oceanic and Atmospheric Administration (NOAA). 1999. Essential Fish Habitat Source Document: Atlantic Mackerel, *Scomber scombrus*, Life History and Habitat Characteristics.
NOAA Fisheries. 2017. Final Amendment 10 to the 2006 consolidated Atlantic highly migratory species fishery management plan: Essential Fish Habitat and environmental assessment. Highly Migratory Species Management Division, Silver Spring, Maryland. 1 September.

Key – A: Present throughout the Aquatic Species Study Area; B: Present in Bourne Bridge Aquatic Species Study Area; S: Present in Sagamore Bridge Aquatic Species Study Area; —: not present.
Notes:
[†] Species with habitat preferences outside of Cape Cod Canal
[*] Species life stage has a Habitat Area of Particular Concern in the area.
[**] Sagamore Bridge has designated adult female and male, sub-adult female, whereas Bourne Bridge only has adult female designated.

MMPA-PROTECTED MARINE MAMMALS

As noted in **Table 4.12-1**, the Marine Mammal Protection Act (MMPA) protects marine mammals in the United States. There are 35 species with potential to occur in the Aquatic Species Study Area. Of those 35 species, the following 11 species were determined to have a regular, common, or uncommon presence likelihood:

- Fin whale
- Humpback whale (*Megaptera novaeangliae*)
- North Atlantic right whale
- Sei whale (*Balaenoptera borealis*)
- Minke whale (*Balaenoptera acutorostrata*)
- Long-finned pilot whale (*Globicephala melas*)
- Atlantic white-sided dolphin (*Lagenorhynchus acutus*)
- White-beaked dolphin (*Lagenorhynchus albirostris*)
- Harbor porpoise (*Phocoena phocoena*)
- Gray seal (*Halichoerus grypus*)
- Harbor seal (*Phoca vitulina*)

The remaining 24 species were determined to have a rare presence likelihood.

4.12.3 No Build Alternative

In the No Build Alternative, baseline conditions would persist for the foreseeable future and there would be no impacts on threatened, endangered, and protected species. The U.S. Army Corps of Engineers (USACE) would continue to carry out activities to ensure protection of bats if conducting work on the bridge abutments in coordination with USFWS and would continue to conduct dredging of Cape Cod Canal's navigation channel and other canal maintenance in coordination with NOAA Fisheries.

4.12.4 Program Impacts

In the Build Alternative, impacts could occur to federal and state threatened and endangered species, migratory birds, EFH, and marine mammals, as described in the following sections. Further details are provided in the BA for Terrestrial Species, BA for Aquatic Species, and EFH Assessment and FWCA Consultation Worksheet, included as **Attachments 1, 2, and 3**, respectively, to **Appendix 4.12, Threatened, Endangered, and Protected Species and Habitats Material**. Note that the BA for Terrestrial Species was prepared and submitted to USFWS in April 2025. The land clearing numbers presented in **Section 4.6.4.2, Land Alteration Impacts,** of the DEIR reflect the most current design and supersede those presented in the BA.

4.12.4.1 Impacts to Terrestrial Resources

Due to the construction and operation of the Program, potential impacts to protected species and their habitat primarily consist of habitat alteration. The following sections summarize potential impacts to ESA-protected species; MESA-protected species; other protected species including migratory birds and FWCA-jurisdictional wildlife resources. Refer to **Appendix 4.12, Attachment 1**, for details of land-based construction activities and anticipated impacts.

ESA-PROTECTED SPECIES

The Build Alternative would clear approximately 132.14 acres of suitable summer habitat for northern long-eared bats and tricolored bats within the Terrestrial Study Area. However, for both species, no known roost trees are present within or adjacent to the Terrestrial Species Study Area; no maternity colonies have been documented in the Terrestrial Species Study Area; and no winter hibernacula are expected to be affected by the Build Alternative. Further, all proposed tree clearing is within 1,000 feet of suitable summer roosting habitat that would remain intact. Forested habitat near the Terrestrial Study Area includes the large areas of Camp Edwards and Red Brook Wildlife Management Areas, and smaller parks and forested areas within and adjacent to the Terrestrial Study Area. Refer to **Section 4.6.3.2, Land Alteration Impacts**, for further descriptions of the proposed tree clearing and **Appendix 4.6, Preliminary Tree Clearing Plans**, for plans that identify the limits of tree clearing for the proposed work.

To implement the Build Alternative, MassDOT would acquire properties and demolish existing structures. In addition to the existing bridge abutments, up to 21 structures would be demolished within the Project Limits.

In coordination with the USFWS, MassDOT and FHWA determined that no forest clearing activities would occur during the species' summer occupancy period from March 15 to November 30 on the Cape Cod side of Cape Cod Canal and from April 15 to October 31 on the mainland side of Cape Cod Canal. Further, MassDOT would follow Massachusetts Division of Fisheries and Wildlife guidance[14] for implementing exclusionary measures to ensure bats are not present in, or are removed from, structures and bridge abutments, including conducting inspections prior to structure demolition. Therefore, MassDOT and FHWA have determined that the Build Alternative would be **not likely to adversely affect** northern long-eared bats and tricolored bats. The USFWS concurred with this determination on May 2, 2025 (**Appendix 4.12, Attachment 1**).

The Terrestrial Species Study Area is outside of the range of known occurrences of the northern red-bellied cooter, and appropriate habitat for the species is not present in the Terrestrial Species Study Area. Therefore, MassDOT and FHWA have determined the Build Alternative would have **no effect** on the northern red-bellied cooter.

No observations of sandplain gerardia were recorded during Build Alternative habitat surveys in 2020.[15] Agency correspondence with the USFWS and NHESP did not identify concerns for this species in the Terrestrial Species Study Area. Therefore, MassDOT and FHWA have determined that the Build Alternative would have **no effect** on sandplain gerardia.

Suitable habitat for monarch butterflies may occur along the roadsides and other undeveloped, unforested portions of the Terrestrial Species Study Area. Construction of the Build Alternative could cause incidental take of monarch butterflies through vegetation clearing and removal or disturbance of breeding or migration habitat, or through direct mortality of individual butterflies. Following construction completion, cleared areas would be revegetated to the maximum extent possible, using native plant and tree species. Additionally, MassDOT has enrolled in the Nationwide Candidate Conservation Agreement with Assurances for the Monarch Butterfly (CCAA), a voluntary agreement between the USFWS, and, among others, state departments of transportation (including MassDOT).[16] Through enrollment in the CCAA, MassDOT will implement conservation measures designed to support monarch butterfly breeding and/or foraging on a portion of MassDOT lands, which would result in a net gain of habitat and/or species population numbers. In return for MassDOT's voluntary conservation measures, the USFWS would issue an Enhancement of Survival (EOS) Permit under Section 10(a)(1)(A)

[14] Massachusetts Division of Fisheries and Wildlife (MassWildlife). 2020. Massachusetts Homeowner's Guide to Bats. Produced by Massachusetts Division of Fisheries and Wildlife. 7th Edition. https://www.mass.gov/doc/massachusetts-homeowners-guide-to-bats/download. Accessed January 2025.

[15] Stantec Consulting Services, Inc. 2020. Bourne and Sagamore Bridge Improvement Projects – Rare, Threatened, and Endangered Species Habitat Assessment. Conducted for Massachusetts Department of Transportation. December 16. MassDOT Project No. 14-33419.

[16] Cardno, Inc. 2020. Nationwide CCAA/CCA (Candidate Conservation Agreement with Assurances/Candidate Conservation Agreement) for Monarch Butterfly on Energy and Transportation Lands. Prepared for The Monarch CCAA/CCAA Development Advisory Team and the Energy Resources Center at the University of Illinois at Chicago. March 2020.

of the ESA. The EOS Permit would go into effect as of the listing date of the monarch butterfly, should a listing occur. Under the EOS Permit, incidental take of monarch butterflies would be authorized for the conservation measures and construction activities associated with the Build Alternative.[17] Therefore, MassDOT and FHWA have determined that Build Alternative would be **not likely to jeopardize the continued existence** of the monarch butterfly. The USFWS concurred with this determination on May 2, 2025 (**Appendix 4.12, Attachment 1**).

MESA-PROTECTED SPECIES

MassDOT has engaged in pre-filing consultations with the NHESP regarding potential impacts within the Terrestrial Species Study Area to support compliance with state-listed species regulatory performance standards during advancement of the potential Build Alternative. The Terrestrial Species Study Area intersects with NHESP mapped Priority and Estimated Habitats of Rare Species south of the Sagamore and Bourne Bridges **(Figure 4.12-3** and **Figure 4.12-4)**. The potential Build Alternative is not located in Priority or Estimated Habitat north of either bridge. **Table 4.12-7** presents the approximate amount of Priority and Estimated Habitats within each quadrant and Program-wide.

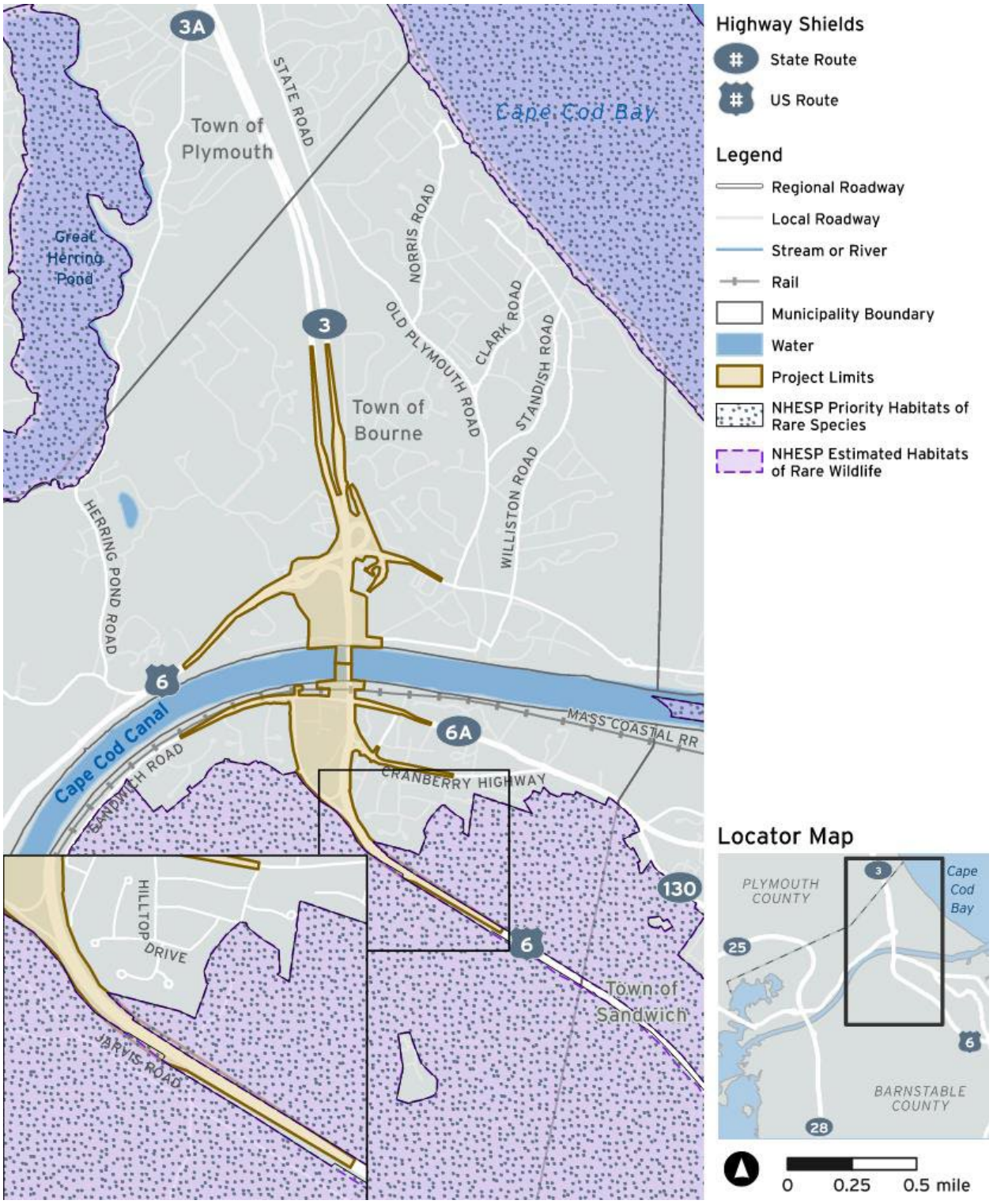
Table 4.12-7. Mapped Rare Species Habitats within the Project Limits

Program Quadrant	Priority Habitat (Acres)	Estimated Habitat (Acres)
Sagamore North	0	0
Sagamore South	2.48	2.08
Bourne North	0	0
Bourne South	8.17	4.96
Estimated Program-wide Total	**10.65**	**7.04**

The undeveloped areas within Sagamore South and Bourne South that compose Priority Habitats primarily include maintained road shoulders and edge habitat, as illustrated in **Figure 4.12-3** and **Figure 4.12-4**, respectively.

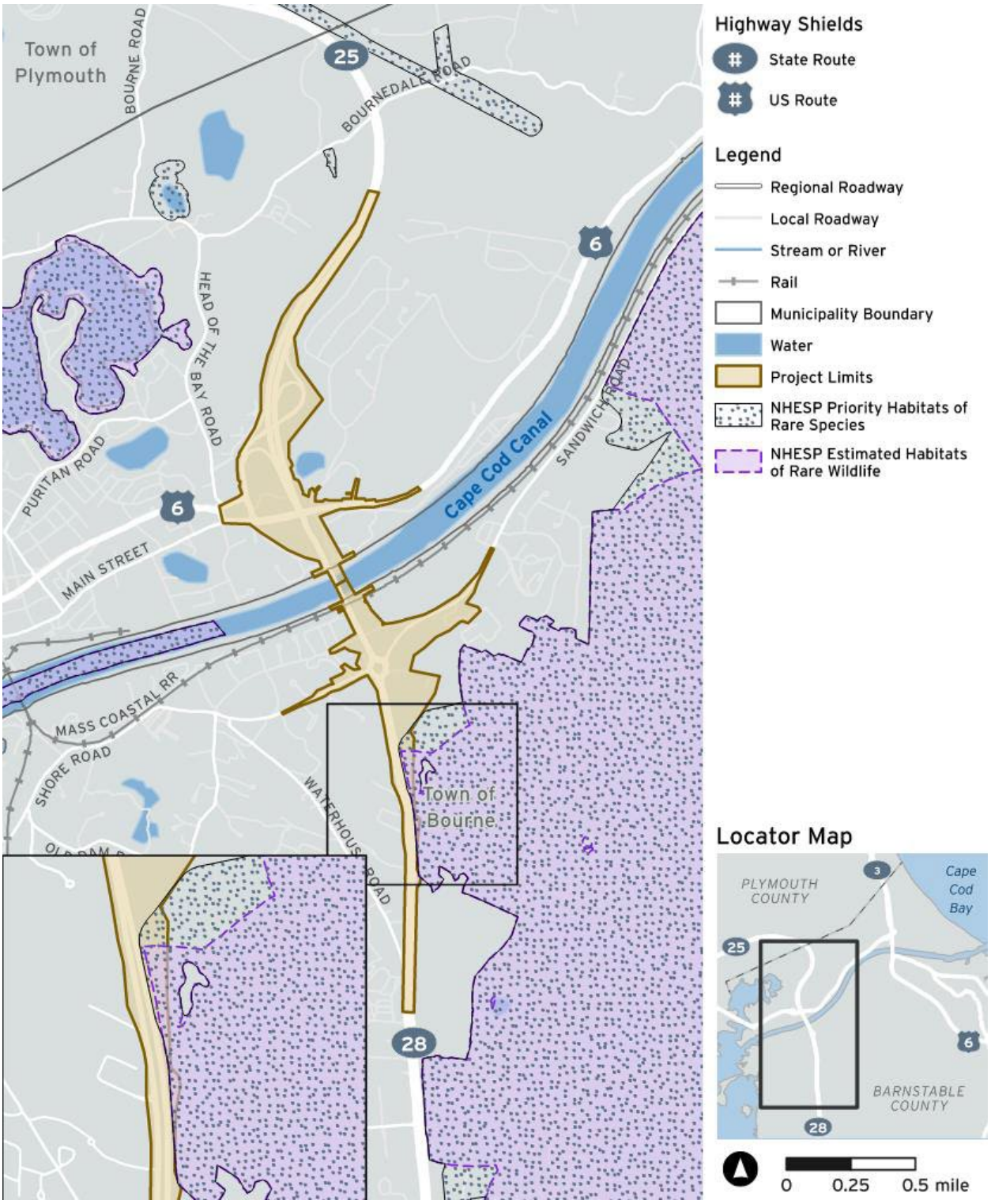
[17] The premise of the Candidate Conservation Agreement with Assurances for the Monarch Butterfly (CCAA) is that benefits from implementation of the conservation measures would outweigh the potential adverse effects on monarch butterflies, including injury or death of individuals, resulting from project construction activities.

Figure 4.12-3.Priority Habitat at Sagamore Bridge



Source:Massachusetts Department of Transportation, 2024

Figure 4.12-4.Priority Habitat at Bourne Bridge



Source:Massachusetts Department of Transportation, 2024

The Terrestrial Species Study Area within the Bourne South and Sagamore South quadrants is dominated by developed areas, including commercial, residential, and transportation infrastructure.

The undeveloped area within and adjacent to the Terrestrial Species Study Area in Sagamore South is primarily composed of maintained road shoulder, edge habitat associated with the pitch pine-oak forest matrix community type, and dry xeric shrubland community maintained within the existing utility right-of-way along US Route 6. Two eastern box turtle road mortalities were previously documented along the southbound shoulder of Route 6 and reported to the NHESP. No additional visual observations of state-listed wildlife or plants have been documented in the Sagamore South portion of the Terrestrial Species Study Area. Potentially suitable habitat for state-listed wildlife species is present in both Sagamore South and Bourne South quadrants, and there is a potential for take resulting from unavoidable project impacts. Further MESA consultation with the NHESP would be required to support the advancement of the Build Alternative.

The undeveloped areas within and adjacent to the Terrestrial Species Study Area in the Bourne South quadrant predominately include maintained road shoulder; edge and outer portion of a large forest block of the pitch pine-oak forest matrix community type contiguous with Joint Base Cape Cod, and smaller inclusions of pitch pine-oak community types typical of the coastal sandplain. No visual observations of state-listed plant or wildlife species have been documented in the Bourne South quadrant of the Terrestrial Species Study Area. Potentially suitable habitat for state-listed wildlife is present in this area, particularly adjacent to Bourne Rotary, and unavoidable impacts may result in a take. Further MESA consultation with the NHESP is required.

MassDOT will continue pre-filing consultations with the NHESP to support ongoing project planning and design; and will file for MESA review with the NHESP to determine whether the Build Alternative would result in a take, no take, or conditional no take of state-listed species (321 CMR 10.00). Further refinement of the limit of work and the outcome of future MESA consultation will be required to calculate potential MESA-impacts to the Terrestrial Species Study Area. MESA pre-filing consultation with the NHESP is expected to resume in the early summer of 2025. If a MESA take is expected, further consultation with the NHESP would be required to identify the necessary compliance with the performance standards for the issuance of a Conservation Management Permit (CMP; 321 CMR 10.23).

OTHER PROTECTED SPECIES

As part of the measures implemented to protect ESA-listed bats, trees would not be cleared between March 15 and November 30 on the Cape Cod side of Cape Cod Canal and from April 15 to October 31 on the mainland side of the canal. These windows encompass the nesting season for migratory birds generally and most of the Birds of Conservation Concern listed in **Table 4.12-4**. The nesting seasons of Prothonotary Warblers and Bald Eagles may extend outside of this window; however, the USFWS Information for Planning and Consultation guidance indicates a low probability of prothonotary warbler presence in the Terrestrial Species Study Area during April, when tree clearing could occur.[18]

If a Bald Eagle nest is documented in or near the Terrestrial Species Study Area, FHWA would follow guidance provided in the National Bald Eagle Management Guidelines to minimize impacts on Bald

[18] U.S. Fish and Wildlife Service (USFWS). 2024. Information for Planning and Consultation. https://ipac.ecosphere.fws.gov/

Eagles.[19] Given this approach and the unlikelihood of Golden Eagles occurring in the Terrestrial Species Study Area, the Build Alternative would cause no adverse effect on Bald or Golden Eagles. Based on the tree clearing restrictions and implementation of guidance to protect eagles, MassDOT and the FHWA have determined that the Build Alternative would cause no adverse effect on migratory birds.

The Build Alternative would include additional conservation and mitigation measures that would protect migratory birds. Following construction completion, MassDOT would revegetate cleared areas to the maximum extent possible, using native plant species to provide suitable habitat. MassDOT would follow conservation mowing practices in its right-of-way, including following recommended times of year for mowing (October 1 through May 1 in Massachusetts), to avoid the nesting season for most Birds of Conservation Concern potentially present in the Terrestrial and Aquatic Species Study Areas.

FWCA-JURISDICTIONAL WILDLIFE RESOURCES

MassDOT requested consultation with the USFWS for compliance with the FWCA through its submittal of the BA for Terrestrial Species. In addition to the previously cited determinations provided on May 2, 2025, the USFWS noted that the Build Alternative would not have any substantial impacts on wildlife resources under its jurisdiction relative to the FWCA (**Appendix 4.12, Attachment 1**).

4.12.4.2 Impacts to Aquatic Resources

Due to the Program's in-water construction activities, potential impacts to protected species, their habitat, and their prey species could include a combination of direct or indirect and temporary or permanent stressors to the surrounding environment. Stressors may include underwater noise, entrapment, changes in water quality/turbidity, benthic disturbance, reduction in fish passage, habitat alteration and/or conversion, and vessel interaction. The following sections summarize potential impacts to ESA-protected species, MESA-protected species, EFH and NOAA Fisheries Trust Resources, and MMPA-protected resources. Refer to **Appendix 4.12, Attachments 2 and 3**, for details of in-water construction activities and anticipated impacts.

ESA-PROTECTED SPECIES

NOAA Fisheries stated that fin whale and North Atlantic right whale presence in Cape Cod Canal would be rare and anomalous.[20] Direct impacts from Build Alternative construction would not extend beyond Cape Cod Canal. The risk of Build Alternative impacts on whales would likely be limited to vessel strikes. The Build Alternative would avoid such impacts by employing the conservation and mitigation measures listed in **Section 4.12.5.2**. Additionally, MassDOT would follow a NOAA Fisheries-approved Marine Mammal and Sea Turtle Monitoring and Mitigation Plan throughout construction.

Build Alternative vessels would transit through areas designated as North Atlantic right whale critical habitat. However, vessel impacts on the physical and biological features of the critical habitat would be too small to be meaningfully measured or detected, and therefore insignificant, or would have no

[19] U.S. Fish and Wildlife Service (USFWS). 2007. National Bald Eagle Management Guidelines. May 2007.

[20] Coordination with NOAA Fisheries and additional details are provided in the BA for Marine Species, provided as **Appendix 4.12, Attachment 2**.

effect. Therefore, MassDOT and FHWA have determined the Build Alternative **may affect but is not likely to adversely affect** fin whales or North Atlantic right whales and North Atlantic right whale critical habitat. NOAA Fisheries concurred with this determination on April 7, 2025 (**Appendix 4.12, Attachment 2**).

Sea turtles are unlikely to be present in Cape Cod Canal. Literature indicates that most sea turtle sightings in the vicinity of the Aquatic Species Study Area occur in Cape Cod Bay and a lesser amount in Buzzards Bay.[21] As with marine mammals, impacts on sea turtles would likely be limited to vessel strikes related to Build Alternative vessels. The measures implemented by the Build Alternative to protect marine mammals would reduce the risk for Build Alternative impacts on sea turtles. Therefore, MassDOT and FHWA have determined that the Build Alternative **may affect but is not likely to adversely affect** the four sea turtle species listed in **Table 4.12-5**. NOAA Fisheries concurred with this determination on April 7, 2025.

There is a lack of documentation for Atlantic sturgeon or shortnose sturgeon presence in Cape Cod Canal; further, the NHESP does not list either species as occurring within the canal.[22] Sturgeon may be present in Cape Cod Canal during migratory movements; however, their presence is likely to be uncommon and transient. The Build Alternative would implement multiple mitigation measures to avoid or minimize impacts on sturgeon, as listed in **Section 4.12.5**. Additionally, Build Alternative vessel traffic would not be expected to have direct effects on sturgeon. Sturgeon primarily occupy the bottom of the water column and would likely be below the draft of Build Alternative vessels. Therefore, MassDOT and FHWA have determined that the Build Alternative **may affect but is not likely to adversely affect** the Atlantic or shortnose sturgeon. NOAA Fisheries concurred with this determination on April 7, 2025.

MESA-PROTECTED SPECIES

The Aquatic Species Study Area does not contain Priority Habitat for any MESA-protected species. Therefore, take of marine mammals, sea turtles, or fishes would not be anticipated in the Build Alternative. Accordingly, the Build Alternative would not cause adverse impacts on aquatic MESA-protected species.

ESSENTIAL FISH HABITAT AND NOAA FISHERIES TRUST RESOURCES

Table 4.12-8 presents estimated direct impacts to EFH within the approximate zone of marine disturbance at each bridge site, identified on **Figure 4.12-5 through Figure 4.12-8**. **Appendix 4.12, Attachment 3**, provides tables identifying estimated impacts due to construction components and a breakdown of estimated impacts by habitat type.

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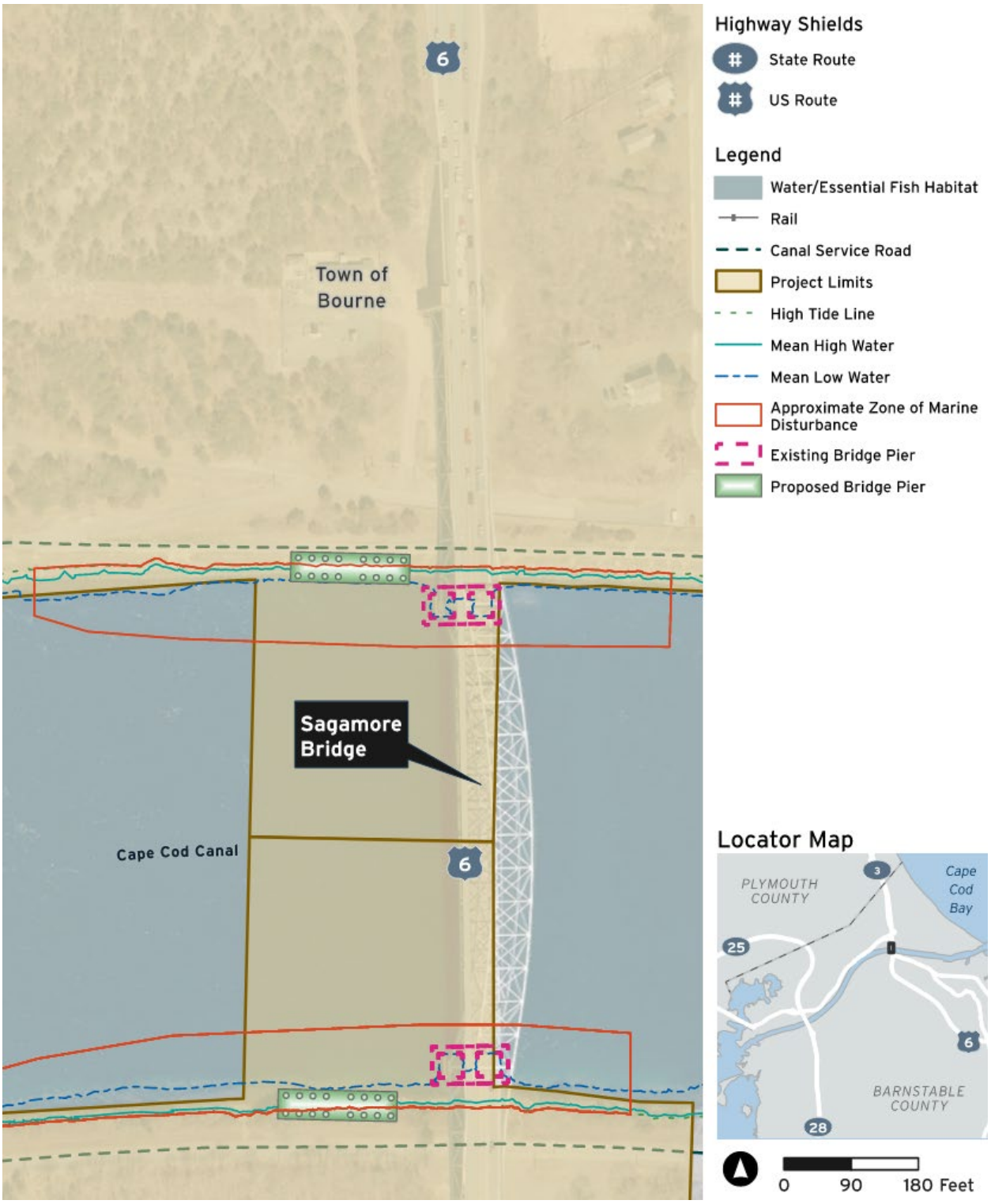
[21] Halpin, P.N., A.J. Read, E. Fujioka, B.D. Best, B. Donnelly, L.J. Hazen, C. Kot, K. Urian, E. LaBrecque, A. Dimatteo, J. Cleary, C. Good, L.B. Crowder, and K.D. Hyrenbach. 2009. OBIS-SEAMAP: The world data center for marine mammal, sea bird, and sea turtle distributions. Oceanography 22(2):104-115. https://seamap.env.duke.edu/species/948946

[22] Massachusetts Division of Fisheries and Wildlife. 2015. Natural Heritage & Endangered Species Program. Atlantic Sturgeon *Acipenser oxyrinchus* Fact Sheet (https://www.mass.gov/doc/atlantic-sturgeon/download) and Shortnose Sturgeon *Acipenser brevirostrum* Fact Sheet (https://www.mass.gov/doc/shortnose-sturgeon/download)

Table 4.12-8. Estimated Direct Effects to EFH Within Zones of Marine Disturbance

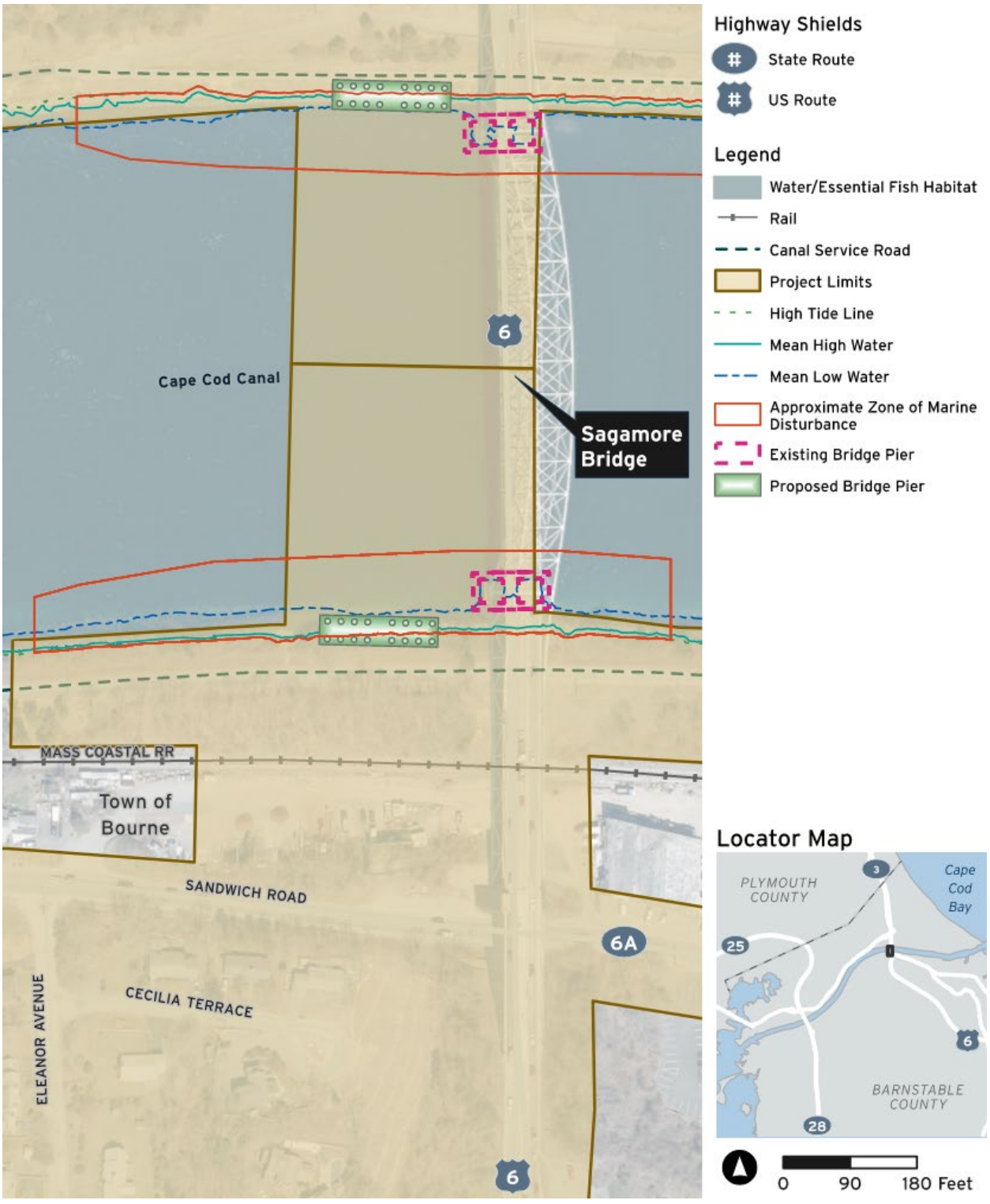
Program Quadrant	Estimated Direct Effects (acres, rounded)
Sagamore North	1.96
Sagamore South	2.05
Bourne North	1.84
Bourne South	2.03
Total	**7.88**

Figure 4.12-5.Approximate Zone of Marine Disturbance – Sagamore North Quadrant



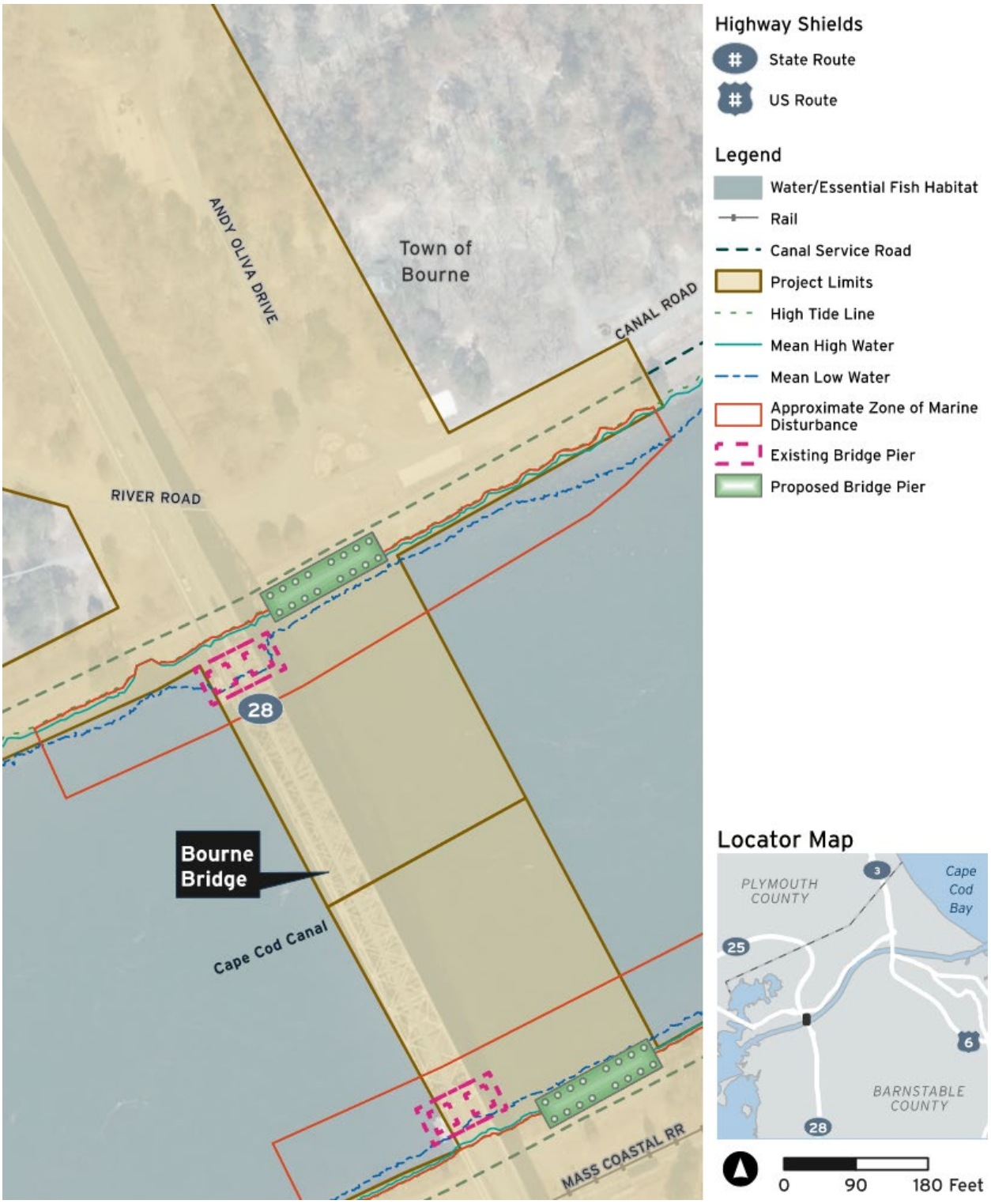
Source:Massachusetts Department of Transportation, 2024

Figure 4.12-6.Approximate Zone of Marine Disturbance – Sagamore South Quadrant



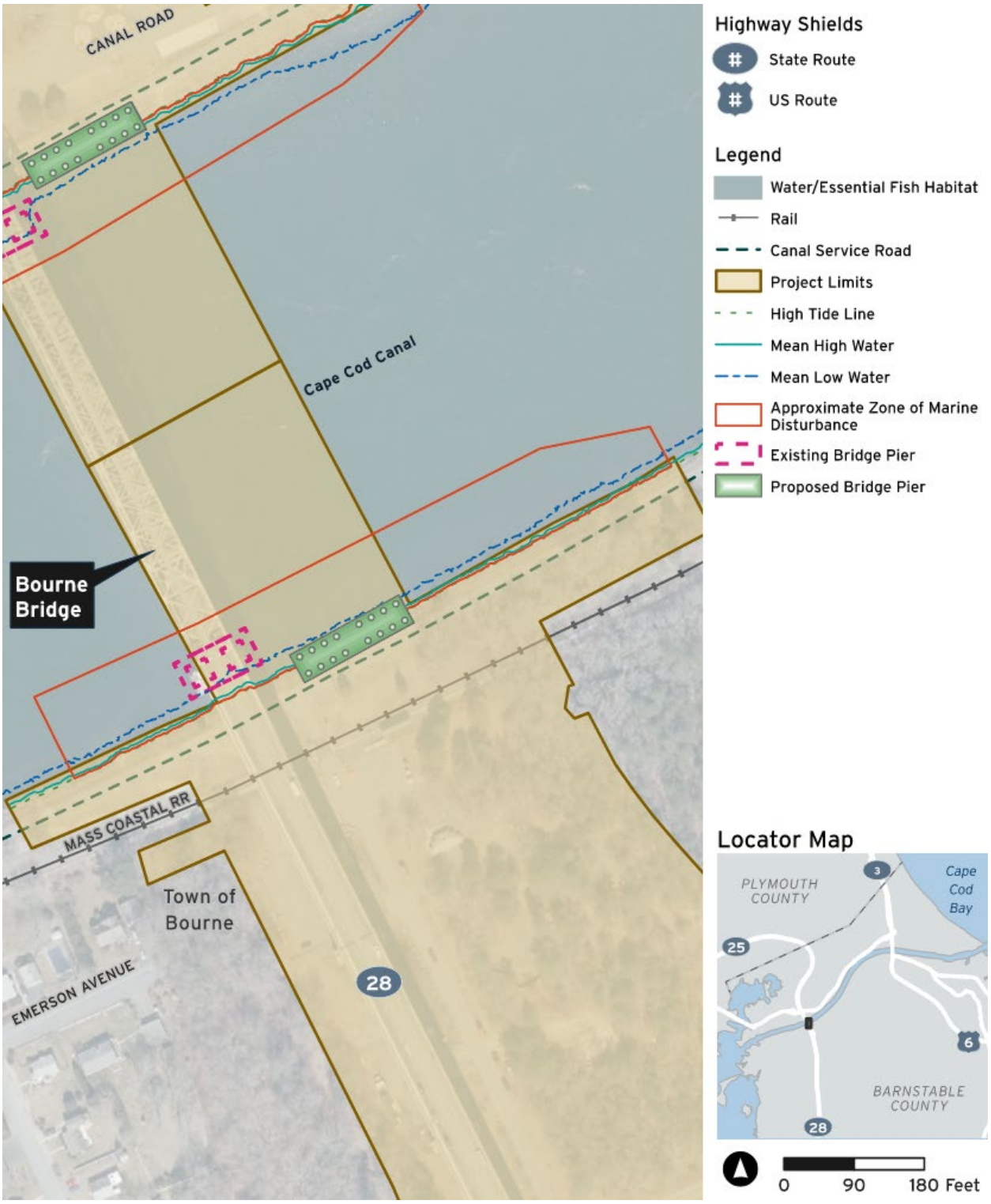
Source:Massachusetts Department of Transportation, 2024

Figure 4.12-7.Approximate Zone of Marine Disturbance – Bourne North Quadrant



Source:Massachusetts Department of Transportation, 2024

Figure 4.12-8.Approximate Zone of Marine Disturbance – Bourne South Quadrant



Source:Massachusetts Department of Transportation, 2024

To avoid the early life stage development and spawning seasons of most EFH species and Trust Resources, the Build Alternative would follow a time-of-year restriction prohibiting in-water construction activities that could cause acoustic impacts or turbidity from March 1 through August 31. The early life stages of three species whose spawning timeframes have the potential to overlap work outside of the time-of-year restriction window—Atlantic cod, pollock and winter flounder—could experience impacts if larvae or eggs were to drift into or settle within the Build Alternative footprint from adjacent spawning grounds. Mitigation for these species, listed in **Section 4.12.5.2**, would minimize impacts to individuals, eggs, or larvae using the canal corridor. Additionally, the Build Alternative's in-water activity would be intermittent across a six- to eight-year period, allowing for a greater possibility for spawning to occur outside of active construction time periods. Based upon the best management practices that would be incorporated into the design and construction plans and the proposed minimization and avoidance measures for protecting EFH and diadromous fish, NOAA Fisheries determined that the Build Alternative would not cause adverse impacts to finfish and shellfish species (**Appendix 4.12, Attachment 3**).

The Build Alternative would affect approximately 2,445 sf of SAV present at the Bourne Bridge site: two eelgrass beds, totaling 2,345 sf, are located in the Bourne North quadrant, and one eelgrass bed of 100 sf is located in the Bourne South quadrant. As an EFH Conservation Recommendation, NOAA Fisheries recommended that MassDOT monitor the SAV beds with photographic surveys before and after construction, provide the survey results to NOAA Fisheries, and provide compensatory mitigation for impacts to eelgrass beds.

MassDOT is developing an Eelgrass Survey and Mitigation Plan that contains the photographic survey requirements and options for mitigating the amount of eelgrass affected per the pre-construction field surveys. MassDOT is consulting with the USACE and NOAA Fisheries to pursue the most effective approach to mitigate for the loss of the SAV. Documentation of coordination between NOAA Fisheries and MassDOT is provided as **Appendix 4.12, Attachment 3**.

MMPA-PROTECTED SPECIES

As previously described, the Build Alternative could result in vessel strikes to marine mammals. Underwater noise from Build Alternative construction has the potential to cause harassment, in the form of behavioral or injurious impacts, of marine mammals. MassDOT has developed a Marine Mammal and Sea Turtle Monitoring and Mitigation Plan which incorporates monitoring protocols, operational procedures, and best management practices to avoid and minimize potential impacts on marine mammals. Based upon the proposed avoidance and conservation measures and in response to consultation with NOAA Fisheries Office of Protected Resources, MassDOT has determined that it would not be necessary to pursue a take authorization under the Marine Mammal Protection Act. Through adherence to the Marine Mammal and Sea Turtle Monitoring and Mitigation Plan procedures for avoiding marine mammal takes, MassDOT and FHWA have determined that the potential for take of MMPA-protected species is not likely to occur for the Build Alternative. As needed, MassDOT would coordinate with the NOAA Fisheries Office of Protected Resources throughout construction.

4.12.5 Mitigation

This section identifies measures MassDOT will incorporate through the construction of the Build Alternative to protect terrestrial and aquatic resources. With implementation of these proposed conservation and mitigation measures, and the Build Alternative construction methods described in **Chapter 5, Construction Approach**, the Build Alternative would not be expected to cause adverse permanent or construction-related impacts on threatened, endangered, and protected species or EFH.

As previously cited, MassDOT is coordinating with the USACE and NOAA Fisheries to identify the most effective compensatory mitigation approach for anticipated impacts to eelgrass.

4.12.5.1 Measures to Protect Terrestrial Resources

MassDOT will implement the following mitigation measures to protect terrestrial resources:

- Trees will not be cleared during the summer occupancy period for bats and typical nesting season for migratory birds, defined as March 15 to November 30 on the Cape side of Cape Cod Canal and April 15 to October 31 on the mainland side of Cape Cod Canal.
- Inspections of structures and bridge abutments will be conducted prior to demolition, and pending the proposed demolition method and timing, entry points will be sealed in the late summer period and before the start of the hibernation period, to prevent potential bat entry during the winter. Methods will follow the Massachusetts Division of Fisheries and Wildlife (MassWildlife) guidance.[23]
- Conservation mowing practices will be used on a portion of MassDOT lands, including MassDOT rights-of-way, to protect monarch butterflies and butterfly habitat, as part of enrollment in the CCAA.
- Cleared areas will be revegetated following construction completion to the maximum extent possible, using native plant species to provide suitable habitat for bat species, pollinators, and other native species.

Additional mitigation measures could be required if NHESP determines that the Build Alternative would result in a take of MESA-protected species with Priority Habitat. Further, mitigation would be necessary for the Build Alternative to meet the performance standards for the issuance of a CMP.

4.12.5.2 Measures to Protect Aquatic Resources

MassDOT will implement the following mitigation measures and best management practices to protect aquatic resources:

- In-water construction activities (excluding vessel traffic) would be confined to the Cape Cod Canal, which will allow for early detection of ESA-listed species through regular communication with canal operators and users during in-water construction activities.

[23] https://www.mass.gov/info-details/bats-in-the-home.

- In-water construction activities with the potential to cause acoustic or turbidity impacts would be prohibited from March 1 through August 31.[24] Dredging outside of cofferdams would not occur from March 1 through August 31 of any year. Once cofferdams are installed, work within the cofferdams can occur at any time of year.
- Clamshell buckets would be used for dredging and dredging equipment speeds would be slow and cautious, following USACE excavation guidance.
- Vessels traveling within Cape Cod Canal and between Cape Cod Canal, Buzzards Bay, Cape Cod Bay, and supply ports, would operate at speeds not to exceed 10 knots (unless higher speeds are necessary to maintain safe vessel maneuverability).[25]
- A fisheries biologist, trained observer, or protected species observer would be present on vessels and at construction sites during cofferdam construction in accordance with the Marine Mammal and Sea Turtle Monitoring and Mitigation Plan; the protected species observer would maintain the authority to stop work if a protected species is observed in the construction area.
- Soft starts or equipment ramp-ups following NOAA Fisheries guidance would be required for in-water, sound producing construction activities such as impact and vibratory pile driving.
- Dolphins and bollards would be used to anchor construction vessels rather than repetitive barge spudding.
- Cushion blocks would be used and when feasible, vibratory driving or rotary drilling would be used to drive piles to refusal instead of impact driving.
- Cofferdams, fabricated from steel sheet piling, would be used to allow in-the-dry construction of the new bridge piers and demolition of the existing bridge pier columns. Diver surveys would be conducted to confirm cofferdams are clear before dewatering.

Further details on proposed mitigation measures and best management practices are included in **Appendix 4.12, Threatened, Endangered, and Protected Species and Habitats Material, Attachments 1, 2, and 3**.

[24] The BA for Terrestrial Species also includes this mitigation measure to protect terrestrial species.
[25] The BA for Terrestrial Species also includes this mitigation measure to protect terrestrial species.

4 Existing Conditions, Program Impacts, and Mitigation

4.13 Coastal Zone Consistency and Chapter 91 Waterways Review

4.13.1 Introduction

This section assesses the consistency of the Build Alternative with the policies of the Massachusetts Coastal Zone Management Program (MA CZMP). Analyses presented in the following relevant sections of the Draft Environmental Impact Report guided the potential impacts of the Build Alternative relative to coastal zone resources:

- **Section 4.3, Pedestrian and Bicycle Facilities**
- **Section 4.6, Land Use, Zoning, and Community Cohesion**
- **Section 4.10, Wetlands and Floodplains**
- **Section 4.11, Water Quality and Stormwater**
- **Section 4.12, Threatened, Endangered, and Protected Species and Habitats**
- **Section 4.17, Cultural Resources**
- **Section 4.18, Public Parks, Recreational Facilities, and Open Space**

This section also assesses whether the Build Alternative could affect any "trust lands" held by the Commonwealth of Massachusetts.

4.13.1.1 Resource Definitions

The term "coastal zone resources" refers to any land or water use (including natural resources) that exist within the state's designated coastal zone. Examples of coastal land or water uses include public access to active and passive recreation, and fishing, as well as historic and cultural preservation, development, energy infrastructure and use, hazards management, marinas, floodplain management, and resource creation or restoration.

The term "coastal zone" means the coastal zone of Massachusetts established pursuant to the Coastal Zone Management Act.[1] In Massachusetts, the coastal zone includes Cape Cod and the Islands,[2] transitional and intertidal areas, coastal wetlands, beaches, tidal rivers and adjacent uplands, and anadromous fish[3] runs, as well as their floodplains, within coastal towns.

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[1] 16 United States Code Section 1451 et seq. Chapter 33, Coastal Zone Management. https://uscode.house.gov/view.xhtml?req=(title:16%20section:1451%20edition:prelim)

[2] Cape Cod and the Islands include Barnstable County, Dukes County (including Martha's Vineyard and the Elizabeth Islands), and Nantucket County.

[3] Fish that enter freshwater from the ocean to spawn.

The term "trust lands" means present and former waterways in which the fee simple, any easement, or other proprietary interest is held by the Commonwealth in trust for the benefit of the public.[4] All geographic areas subject to the jurisdiction of Massachusetts General Law Chapter 91 (MGL Chapter 91), as specified in 310 Code of Massachusetts Regulations (CMR) 9.04, are generally considered to be trust lands.

4.13.1.2 Regulatory Context

The Coastal Zone Management Act of 1972 requires federal agencies conducting activities—including development projects that directly affect a state's coastal zone—to comply to the maximum extent practicable with an approved state coastal zone management program.[5] The Massachusetts Office of Coastal Zone Management (MA CZM) within the Massachusetts Executive Office of Environmental Affairs administers the MA CZMP. Within this authority, the MA CZM reviews federal agency actions—including federally funded projects and federal permit activities—that affect coastal uses or resources to ensure consistency with MA CZMP policies in accordance with the MA CZM regulations.[6] The MA CZMP policies are divided into nine categories:

- Coastal Hazards
- Energy
- Growth Management
- Habitat
- Ocean Resources
- Ports and Harbors
- Protected Areas
- Public Access
- Water Quality

MGL Chapter 91, as implemented by the Massachusetts Waterways Regulation,[7] governs certain trust lands, subjecting them to licensing and permitting. Trust lands subject to MGL Chapter 91 jurisdiction in Massachusetts include the following:[8]

- Flowed tidelands

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[4] Massachusetts Department of Environmental Protection. 310 Code of Massachusetts Regulations (CMR) 9.02: The Massachusetts Waterways Regulation. https://www.mass.gov/regulations/310-CMR-900-the-massachusetts-waterways-regulation

[5] 16 United States Code 1456(c). Chapter 33, Coastal Zone Management: Coordination and Cooperation. https://www.govinfo.gov/app/details/USCODE-2014-title16/USCODE-2014-title16-chap33-sec1456

[6] Massachusetts Department of Environmental Protection. 301 CMR 21.00: Procurement of commodities or services, including human and social services. https://www.mass.gov/regulations/801-CMR-2100-procurement-of-commodities-or-services-including-human-and-social-services

[7] Massachusetts Department of Environmental Protection. 310 CMR 9.00: The Massachusetts Waterways Regulation. https://www.mass.gov/regulations/310-CMR-900-the-massachusetts-waterways-regulation

[8] Massachusetts Department of Environmental Protection. 310 CMR 9.04: Waterways: Geographic Areas Subject to Jurisdiction. https://www.mass.gov/doc/310-cmr-900-waterways-regulations/download

- Filled tidelands (except for landlocked tidelands)
- Great Ponds
- Certain non-tidal rivers and streams

The Public Benefit Determination regulations at 301 CMR 13.00 establishes the procedures and standards to implement the "public benefit determination" requirement under MGL Chapter 91, Section 18B, which was enacted by St. 2007, Chapter 168, Section 8. St. 2007, Chapter 168, Section 8 expressly exempts uses and structures in "landlocked tidelands" from the licensing requirements under MGL Chapter 91 and requires the Secretary of the Massachusetts Executive Office of Energy and Environmental Affairs (the Secretary) to issue a public benefit determination for certain projects in tidelands, including landlocked tidelands.

4.13.1.3 Methodology and Study Area

The Study Areas for this assessment include areas within the Build Alternative's Project Limits, plus a 500-foot buffer around the Project Limits.

The Massachusetts Department of Transportation (MassDOT) used the following data sources to assess the potential impacts to coastal zone resources within the Study Areas:

- Wetland field delineations conducted in summer 2020 and winter 2021[9]
- Federal Emergency Management Agency (FEMA) Flood Insurance Rate Maps[10]
- Massachusetts Office of Coastal Zone Management Act Policy Guide[11]
- Massachusetts Department of Environmental Protection (MassDEP) and MA CZM Policy Guide for applying the Massachusetts Coastal Zone Regulations[12]
- U.S. Army Corps of Engineers (USACE) Cape Cod Canal Major Rehabilitation Evaluation Report/Environmental Assessment[13]
- MassDEP List of Great Ponds[14]

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[9] The Bourne Conservation Commission confirmed these delineations via Order of Resource Area Delineation in May 2022.

[10] https://msc.fema.gov/portal/home

[11] Massachusetts Office of Coastal Zone Management. 2011. Policy Guide. October. https://www.mass.gov/doc/massachusetts-office-of-coastal-zone-management-policy-guide-october-2011/download

[12] Commonwealth of Massachusetts. 2017. Applying the Massachusetts Coastal Wetlands Regulations: A Practical Manual for Conservation Commissions to Protect the Storm Damage Prevention and Flood Control Functions of Coastal Resource Areas. https://www.mass.gov/doc/czm-coastal-manual-applying-the-massachusetts-coastal-wetlands-regulations/download

[13] U.S. Army Corps of Engineers, New England District. 2020. Major Rehabilitation Evaluation Report and Environmental Assessment: Cape Cod Canal Highway Bridges. March. https://www.nae.usace.army.mil/Portals/74/docs/Topics/Cape%20Cod%20Canal%20Bridges/Reports/FinalMRERDocument.pdf

[14] Massachusetts Great Ponds List. 2017. https://www.mass.gov/doc/massachusetts-great-ponds-list/download

- U.S. Fish and Wildlife Service Information for Planning and Consultation Tool[15]
- Massachusetts Natural Heritage and Endangered Species Program 15th Edition Natural Heritage Atlas[16]

4.13.2 Existing Conditions

4.13.2.1 Designated Coastal Zone

The Study Areas for this assessment are entirely within the Massachusetts designated coastal zone (**Figure 4.13-1**).

4.13.2.2 Coastal Zone Resources

Wetlands and Floodplain

The Study Areas feature the following state-jurisdictional coastal wetland resources:

- Land Under Ocean
- Coastal Bank
- Rocky Intertidal Shore
- Land Subject to Tidal Action
- Banks of or Land Under Ocean Underlying an Anadromous/Catadromous Fish Run
- Land Containing Shellfish
- Land Subject to Coastal Storm Flowage, as identified through FEMA mapping

No Regulatory Floodway has been designated for Cape Cod Canal based on available FEMA mapping.

The Study Areas also feature the following state-jurisdictional inland wetland resource areas:

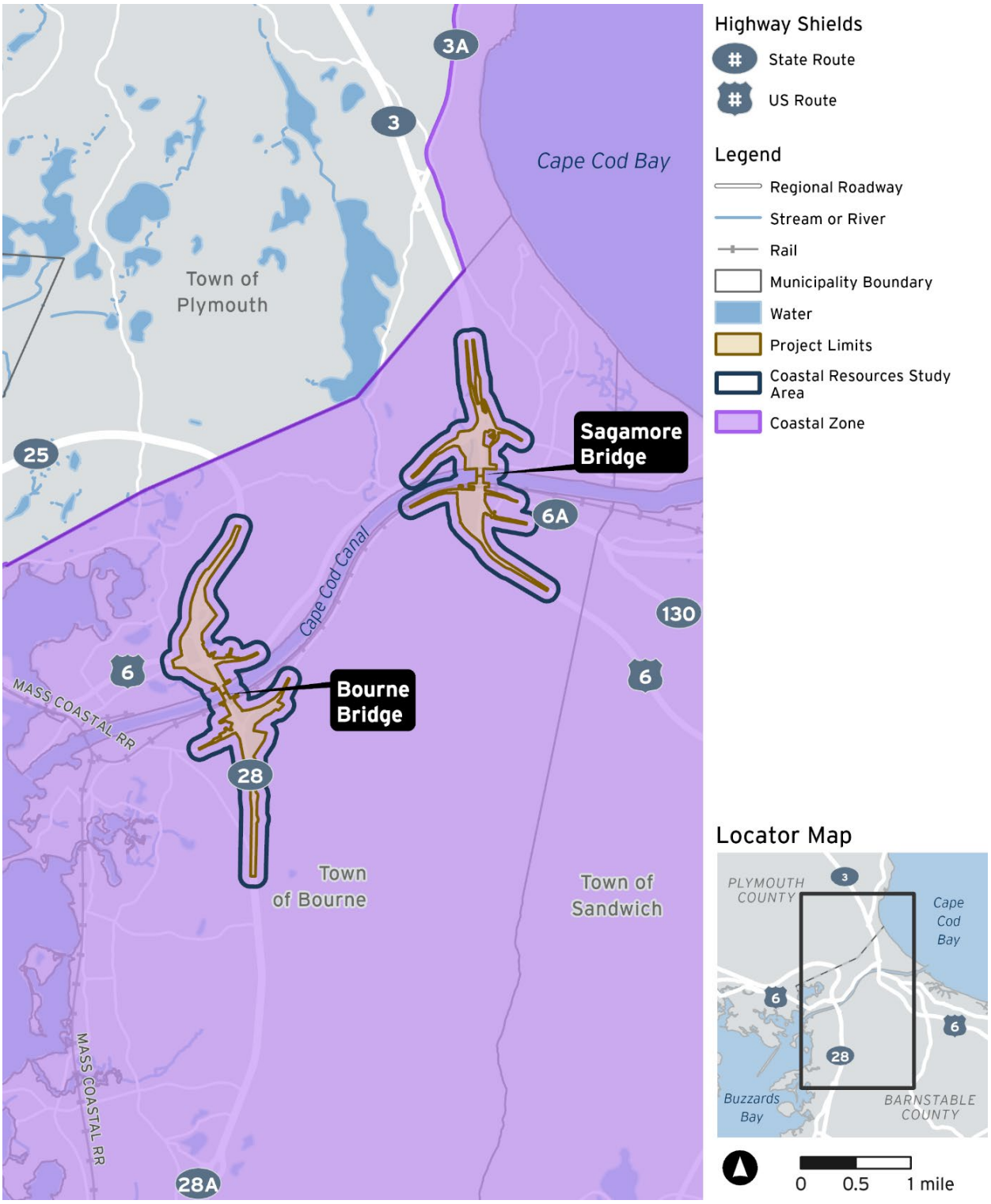
- Land under Waterbodies or Waterways
- Bank
- Vernal Pools
- Bordering Vegetated Wetlands

Section 4.10, Wetlands and Floodplains, provides detailed information and mapping of the identified state-jurisdictional coastal and inland wetland resource areas within the Study Areas.

[15] U.S. Fish & Wildlife Service. IPaC Project Planning Tool. https://ipac.ecosphere.fws.gov/

[16] Massachusetts Division of Fisheries and Wildlife. 2021. 15th Edition Natural Heritage Atlas. August. https://www.mass.gov/news/15th-edition-natural-heritage-atlas-released-august-1

Figure 4.13-1. Designated Massachusetts Coastal Zone Boundary



Source: Massachusetts Department of Transportation, 2024

Federal and State-Protected Species Habitat

The Study Areas are mapped within areas designated as habitat for federal and state-protected species, including plants, fish, and wildlife. **Section 4.12, Threatened, Endangered, and Protected Species and Habitats**, provides detailed information on the protected species, including mapping of their potential habitats within the Study Areas.

Water Supply Areas

The Study Areas are within two sole source aquifers, as designated by the U.S. Environmental Protection Agency:

- Cape Cod Sole Source Aquifer encompasses the entire Study Area south of Cape Cod Canal.
- Plymouth/Carver Sole Source Aquifer encompasses the entire Study Area north of Cape Cod Canal.

Section 4.11, Water Quality and Stormwater, provides detailed information and mapping of these aquifers.

Public Recreation Areas

The Study Areas feature publicly owned park and recreation areas owned and operated by the USACE and the Town of Bourne. **Section 4.18, Public Parks, Recreational Facilities, and Open Space**, provides a list of the parks and recreational resources within the Study Areas. While the Canal Service Roads provide for public recreational use of these facilities, the USACE determined that the roads' primary purpose is for navigation in support of the Cape Cod Canal Federal Navigation Project.

Other Protected Areas

Sagamore Bridge and Bourne Bridge are each eligible for individual listing in the National Register of Historic Places (NRHP) and are contributing resources to the NRHP-eligible Cape Cod Canal Historic District. MassDOT conducted field surveys within the Study Areas and did not identify any archaeological resources that were determined to be eligible for listing in the NRHP. **Section 4.17, Cultural Resources,** provides more information on historic and cultural resources within the Study Areas. The Sagamore Bridge Study Area is within the boundary of the Herring River Watershed Area of Critical Environmental Concern, as discussed in **Section 4.10, Wetlands and Floodplains**. No National Wild and Scenic Rivers are within the Study Areas.

According to the U.S. Fish and Wildlife Service's Coastal Barrier Resources System Maps for Massachusetts, there are no Coastal Barrier Resource Units[17] or Otherwise Protected Areas[18] within the Study Areas.[19] The closest Coastal Barrier Resource Unit is Phinney's Harbor (MA-33), which is west

[17] A Coastal Barrier Resource Unit is a designated area of land located along the U.S. coasts that is part of the Coastal Barrier Resources System. These units are identified and managed under the Coastal Barrier Resources Act, which was enacted in 1982.

[18] Otherwise Protected Areas are coastal barriers within the Coastal Barrier Resource System. They are undeveloped and primarily used for wildlife refuges and sanctuaries, and recreational or natural resource conservation purposes.

[19] https://fwsprimary.wim.usgs.gov/CBRSMapper-v2/

of the Bourne South quadrant, within Buzzards Bay. The closest Otherwise Protected Areas is Scusset Beach (MA 38-P), which is east of the Sagamore Bridge Study Area, along Cape Cod Bay. The southern boundaries of the Scusset Beach Otherwise Protected Areas overlap the bayside of Cape Cod Canal.

4.13.2.3 Trust Lands

As discussed in **Section 4.13.2.2**, Cape Cod Canal is a federally controlled waterway for the primary purpose of navigation. Because Cape Cod Canal is not held in trust by the Commonwealth of Massachusetts for the benefit of the public, MassDOT is coordinating with MassDEP to confirm that the canal is not subject to state jurisdiction under MGL Chapter 91. Nightingale Pond, in the Bourne North quadrant, does not meet the criteria of a "Great Pond"[20] subject to jurisdiction under Chapter 91. No Designated Port Areas[21] are within the Study Areas. To date, the Town of Bourne does not have an approved Municipal Harbor Plan.[22]

4.13.3 No Build Alternative

The No Build Alternative would not include any new construction activities that would affect coastal zone resources within the Study Areas. Routine bridge maintenance activities and future dredging operations within Cape Cod Canal conducted by USACE for the No Build Alternative could have potential impacts to coastal zone resources, including sedimentation. Protective measures, including Stormwater Control Measures, would be implemented per permit requirements to ensure consistency with the MA CZMP policies. The No Build Alternative would not improve pedestrian and bicycle accommodations to water-dependent recreational uses along the canal, which would not advance the goals of the MA CZMP's public access policies.

4.13.4 Program Impacts

The Build Alternative would replace Sagamore Bridge and Bourne Bridge with resilient structures that meet modern design standards. The replacement highway bridges would improve pedestrian and bicycle accommodations within the Study Areas in support of public access to the water-dependent uses along the shoreline of Cape Cod Canal.

The Build Alternative would have unavoidable impacts to coastal and inland wetland resources, federal and state-protected species habitat, recreational resources, and other protected areas, as identified in

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[20] Great Ponds are those which contain more than 10 acres in its natural state, as calculated based on the surface area of lands lying below the natural high-water mark.

[21] Designated Port Areas are land and water areas with certain physical and operational features that have been identified to have state, regional, and national significance with respect to the promotion of water-dependent industrial uses and commercial activities that rely on marine transportation or the withdrawal or discharge of large volumes of water.

[22] A Municipal Harbor Plan establishes a community's objectives, standards, and policies for guiding public and private use of land and water within the jurisdiction of Chapter 91.

Section 4.13.2.2. Additionally, the Build Alternative proposes ground-disturbing activities during construction that could affect water quality due to erosion and sedimentation.

4.13.4.1 Coastal Zone Consistency Determination Assessment of Build Alternative

Table 4.13-1 through Table 4.13-6 provide an assessment of the Build Alternative's consistency with the applicable MA CZMP policies. Any policies that were determined to be not applicable to the Build Alternative, including energy, ocean resources, and ports and harbors, are not listed.

Table 4.13-1. Coastal Hazard Policies

Policy Number	Policy Summary Statement	Consistency
Coastal Hazards Policy #1 [Enforceable]	Preserve, protect, restore, and enhance beneficial functions of storm damage prevention and flood control provided by natural coastal landforms, such as dunes, beaches, barrier beaches, coastal banks, land subject to coastal storm flowage, salt marshes, and land under ocean.	The Build Alternative was designed to minimize impacts to coastal and inland wetland resource areas. Unavoidable adverse impacts will be mitigated in accordance with applicable federal and state regulations.
Coastal Hazards Policy #2 [Enforceable]	Ensure that construction in water bodies and contiguous land areas will minimize interference with water circulation and sediment transport. Flood or erosion control projects must demonstrate no significant adverse impacts on the project site or adjacent downcoast areas.	A Stormwater Pollution Prevention Plan will be developed and implemented during construction to minimize potential erosion and sedimentation impacts to water bodies and contiguous land areas in accordance with U.S. Environmental Protection Agency National Pollutant Discharge Elimination System permit requirements.

Policy Number	Policy Summary Statement	Consistency
Coastal Hazards Policy #3 [Enforceable]	Ensure that state and federally funded public works projects proposed for location within the coastal zone will not exacerbate existing hazards or damage natural buffers or other natural resources; be reasonably safe from flood and erosion-related damage; not promote growth and development in hazard-prone or buffer areas, especially in velocity zones and Areas of Critical Environmental Concern.	The Build Alternative was designed to avoid impacts to coastal and inland wetland resource areas to the maximum extent practicable. Where impacts are unavoidable, MassDOT would employ necessary mitigation measures in compliance with applicable federal and state regulations. The Build Alternative would provide bridge piers founded on deep foundations that would be resilient to anticipated flooding and scour. The Build Alternative would replace and reconstruct existing transportation infrastructure and is not expected to induce any new development in hazard-prone areas. Rather, it would improve public access to the Canal Service Roads to encourage active transportation and recreational uses, including fishing, jogging, cycling, and skating.
Coastal Hazards Policy #4	Prioritize acquisition of hazardous coastal areas that have high conservation and/or recreation values and relocation of structures out of coastal high-hazard areas, giving due consideration to the impacts of coastal hazards at the location to the use and manageability of the area.	This policy is not applicable.

Table 4.13-2. Growth Management Policies

Policy Number	Policy Summary Statement	Consistency
Growth Management Policy #1	Encourage sustainable development that is consistent with state, regional, and local plans and supports the quality and character of the community	The Build Alternative would replace the substandard Sagamore Bridge and Bourne Bridge with new bridges designed to modern standards. The Build Alternative would improve cross-canal mobility, accessibility, and safety for all road users, including bicyclists and pedestrians, which is consistent with and supports the goals outlined in the Town of Bourne Local Comprehensive Plan and the Cape Cod Regional Policy Plan.
Growth Management Policy #2	Ensure that state and federally funded infrastructure projects in the coastal zone primarily serve existing developed areas, assigning highest priority projects that meet the needs of urban and community development centers	The Build Alternative would serve the existing developed areas within the town of Bourne and would meet the transportation needs of the Cape Cod Bridges Program, as identified in **Section 2.3, Need for the Program.**
Growth Management Policy #3	Encourage the revitalization and enhancement of existing development centers in the coastal zone through technical assistance and financial support for residential, commercial, and industrial development	This policy is not applicable.

Table 4.13-3. Habitat Policies

Policy Number	Policy Summary Statement	Consistency
Habitat Policy #1 [Enforceable]	Protect coastal, estuarine, and marine habitats—including salt marshes, shellfish beds, submerged aquatic vegetation, dunes, beaches, barrier beaches, banks, salt ponds, eelgrass beds, tidal flats, rocky shores, bays, sounds, and other ocean habitats—and coastal freshwater streams, ponds, and wetlands to preserve critical wildlife habitat and other important functions and services including nutrient and sediment attenuation, wave and storm damage protection, and landform movement processes	The Build Alternative would avoid or minimize impacts to coastal, estuarine, and marine habitats to the maximum extent practicable. Any unavoidable impacts to protected coastal and inland wetland resources will be mitigated in accordance with applicable federal and state permit requirements.
Habitat Policy #2 [Enforceable]	Advance the restoration of degraded or former habitats in coastal and marine areas	Areas of coastal bank to be temporarily disturbed by construction activities will be restored in-kind.

Table 4.13-4. Protected Areas Policies

Policy Number	Policy Summary Statement	Consistency
Protected Areas Policy #1 [Enforceable]	Preserve, restore, and enhance coastal Areas of Critical Environmental Concern, which are complexes of natural and cultural resources of regional or statewide significance.	The Build Alternative would not affect any natural coastal resources associated with the Herring River Watershed Area of Critical Environmental Concern (ACEC). Work within the ACEC would be confined to previously disturbed areas of the State Highway Layout. Where feasible, the Massachusetts Department of Transportation (MassDOT) will install retaining walls to minimize disturbance within the ACEC.
Protected Areas Policy #2 [Enforceable]	Protect state designated scenic rivers in the coastal zone.	This policy is not applicable.

Policy Number	Policy Summary Statement	Consistency
Protected Areas Policy #3 [Enforceable]	Ensure that proposed developments in or near designated or registered historic places respect the preservation intent of the designation and that potential adverse impacts are minimized.	MassDOT will execute a Programmatic Agreement with the State Historic Preservation Office (SHPO) and other Section 106 consulting parties to mitigate the adverse impacts on the National Register of Historic Places (NHRP)-eligible Sagamore Bridge and Bourne Bridge in accordance with 36 Code of Federal Regulations (CFR) 800.14(b). MassDOT has determined that the preferred bridge type would be compatible with the NRHP-eligible Cape Cod Canal Historic District. MassDOT will coordinate with the SHPO for concurrence with the determination of No Adverse Effect to the Cape Cod Canal Historic District.

Table 4.13-5. Public Access Policies

Policy Number	Policy Summary Statement	Consistency
Public Access Policy #1 [Enforceable]	Ensure that development (both water-dependent or non-water-dependent) of coastal sites subject to state waterways regulation will propose general public use and enjoyment of the water's edge, to an extent commensurate with the Commonwealth's interests in flowed and filled tidelands under the Public Trust Doctrine.	While the Massachusetts Department of Transportation (MassDOT) determined that there are no Massachusetts General Law Chapter 91 jurisdictional areas within the Study Areas, the Build Alternative would improve and expand upon water-dependent uses through construction of new shared-use path facilities with connections to the local roadway network and the Canal Service Roads. These upgrades would provide opportunities for the public to access Cape Cod Canal for recreation, fishing, and other water-dependent uses consistent with the Massachusetts Public Trust Doctrine.

Policy Number	Policy Summary Statement	Consistency
Public Access Policy #2	Improve public access to the existing coastal recreation facilities and alleviate auto traffic and parking problems through improvements in public transportation and trail links (land- or water-based) to other nearby facilities. Increase capacity of existing recreation areas by facilitating multiple use and by improving management, maintenance, and public support facilities. Ensure that the adverse impacts of developments proposed near existing public access and recreation sites are minimized.	The Build Alternative would improve public access to the Canal Service Roads abutting Cape Cod Canal to encourage active transportation and recreational uses, including fishing, jogging, cycling, and skating. The proposed shared-use facilities would also provide critical off-road connections to other local roadways within the Study Areas. The Federal Highway Administration intends on issuing a Section 4(f) *de minimis* determination for Bourne Scenic Park, Sagamore Recreation Area, and Bourne Recreation Area. This determination may be made when the transportation use of the Section 4(f) resource, together with any impact avoidance, minimization, and mitigation or enhancement measures incorporated into the project, does not adversely affect the activities, features, and attributes that qualify the resource for protection under Section 4(f), pending agreement with the Official with Jurisdiction and opportunity for public comment.
Public Access Policy #3	Expand existing recreation facilities and acquire and develop new public areas for coastal recreational activities, giving highest priority to regions of high need or limited site availability. Provide technical assistance to developers of both public and private recreation facilities and sites that increase public access to the shoreline to ensure that both transportation access and the recreation facilities are compatible with social and environmental characteristics of surrounding communities.	The Build Alternative would improve and expand on existing recreation facilities through construction of the shared-use paths with connections to local roadways and Cape Cod Canal. These improvements would increase public access to the shoreline, which is consistent with the social and environmental characteristics of the local community.

Table 4.13-6. Water Quality Policies

Policy Number	Policy Summary Statement	Consistency
Water Quality Policy #1 [Enforceable]	Ensure that point-source discharges and withdrawals in or affecting the coastal zone do not compromise water quality standards and protect designated uses and other interests.	The Build Alternative would be designed to comply with the Massachusetts Department of Environmental Protection Stormwater Management Standards, as enforced through the Massachusetts Wetlands Protection Act and the 401 Water Quality Certification Regulations.
Water Quality Policy #2 [Enforceable]	Ensure the implementation of nonpoint source pollution controls to promote the attainment of water quality standards and protect designated uses and other interests.	Construction-phase and post-construction Storm Control Measures will be implemented to protect water quality in accordance with applicable federal and state regulatory requirements.
Water Quality Policy #3 [Enforceable]	Ensure that subsurface waste discharges conform to applicable standards, including the siting, construction, and maintenance requirements for on-site wastewater disposal systems, water quality standards, established Total Maximum Daily Load limits, and prohibitions on facilities in high-hazard areas.	The Study Areas are not located within high-hazard areas;[1] therefore, this policy is not applicable.

[1] "High-hazard areas" are those areas mapped as Federal Emergency Management Agency (FEMA) Zone V or VE, indicated areas with high-velocity wave action and a significant risk of damage from storm surges and flooding.

4.13.4.2 Public Benefit Determination

The Sagamore and Bourne Bridges, including their operationally related approaches, ramps, and interchanges, are classified as "Infrastructure Crossing Facilities," defined under 310 CMR 9.02 of the Chapter 91 Waterways Regulations as:

> "Any infrastructure facility which is a **bridge**, tunnel, pipeline, aqueduct, conduit, cable, or wire, including associated piers, bulkheads, culverts, or other vertical support structures, which is located over or under the water and which connects existing or new infrastructure facilities located on the opposite banks of the waterway. **Any structure which is operationally related to such crossing facility and requires an adjacent location shall be considered an ancillary facility thereto**. Such ancillary facilities generally include, but are not limited to, power transmission substations, gas meter stations, sewage headworks and pumping facilities, toll booths, tunnel ventilation buildings, drainage structures, and **approaches, ramps, and interchanges which connect bridges or tunnels to adjacent highways or railroads**."

310 CMR 9.12 (2)(d) states:

> "In the case of an infrastructure crossing facility, or any ancillary facility thereto, for which an EIR is submitted, the Department (the Massachusetts Department of Environmental Protection) shall find such facility to be water-dependent only if the Secretary of the Executive Office of Energy and Environmental Affairs has determined that such facility cannot reasonably be located or operated away from tidal or inland waters, based on a comprehensive analysis of alternatives and other information analyzing measures that can be taken to avoid or minimize adverse impacts on the environment, in accordance with MEPA" (Massachusetts General Law Chapter 30, Sections 61 through 62H).

Accordingly, MassDOT requests that the Secretary make a determination that that addresses the criteria at 310 CMR 9.12(2)(d) and confirms the bridges are water-dependent uses. The Sagamore and Bourne Bridges cannot reasonably be located or operated away from tidal waters, as they provide the only roadway connections across Cape Cod Canal (a tidal waterway), which separates Cape Cod from the state's mainland. **Section 3.2** of the DEIR provides an analysis of alternatives considered, including reasons for their dismissal. **Table 3-18** of the DEIR identifies the operational benefits of the Preferred Alternative for the Program. **Section 8.6** of the DEIR identifies measures proposed to avoid, minimize, and mitigate adverse impacts on the environment.

The Public Benefit Determination regulations at 301 CMR 13.04(1), include a presumption that water-dependent projects provide adequate public benefit and meet the criteria for the determination.

4.13.5 Mitigation

In addition to the enhancements provided by the Build Alternative through improved public access and resilient infrastructure, MassDOT will implement resource-specific mitigation measures that will ensure that any unavoidable adverse impacts to coastal zone resources are minimized in accordance with the applicable federal and state regulations. These mitigation measures, in combination with the enhancements proposed by the Build Alternative, will ensure consistency with the applicable policies of the MA CZMP.

Table 4.13-7 lists the mitigation measures MassDOT will implement to minimize and compensate for any unavoidable adverse impacts to coastal resources.

Table 4.13-7. Coastal Resources Mitigation Measures

Resource	Mitigation
Wetlands and Floodplain	• Temporary impacts to coastal and inland bank, Land Under Ocean, and vegetated wetlands will be restored in-kind. • Permanent impacts to vegetated wetlands and inland banks will be replicated at a ratio consistent with applicable federal and state regulations. • Compensatory flood storage will be provided for floodplain encroachment at Nightingale Pond.
Federal and State-Protected Species Habitat	• Construction within Cape Cod Canal will be completed within isolated work areas to minimize potential impacts to aquatic species and their habitats. • The Massachusetts Department of Transportation (MassDOT) will consult with the Natural Heritage and Endangered Species Program to identify whether a Conservation Management Permit is required for impacts to mapped Rare and Estimated Habitats.
Protected Areas	• Retaining walls will be installed, where feasible, to minimize impacts to the Herring River Watershed Area of Critical Environmental Concern. • MassDOT is developing a Programmatic Agreement that will mitigate the adverse impacts on the National Register of Historic Places (NRHP)-eligible Sagamore Bridge and Bourne Bridge, in coordination with the Section 106 consulting parties. • MassDOT has determined that the preferred bridge type would be compatible with the NRHP-eligible Cape Cod Canal Historic District.
Water Supply Areas	• MassDOT will develop a Stormwater Pollution Prevention Plan, which will be implemented during construction to minimize potential erosion and sedimentation. • MassDOT will design and install post-construction Stormwater Control Measures to manage the quantity and quality of surface run-off discharged to receiving waterbodies and/or groundwater.
Public Recreation Areas	• The Federal Highway Administration intends on issuing a Section 4(f) *de minimis* determination for Bourne Scenic Park, Sagamore Recreation Area, and Bourne Recreation Area. This determination may be made when the transportation use of the Section 4(f) resource, together with any impact avoidance, minimization, and mitigation or enhancement measures incorporated into the project, does not adversely affect the activities, features, and attributes that qualify the resource for protection under Section 4(f), pending agreement with the Official with Jurisdiction and opportunity for public comment.

4 Existing Conditions, Program Impacts, and Mitigation

4.14 Air Quality and Greenhouse Gas Emissions

4.14.1 Introduction

This section assesses the potential impacts of the No Build Alternative and Build Alternative on air quality and greenhouse gas (GHG) emissions, including impacts of construction, maintenance, and marine vessel operations. This section also identifies mitigation measures that will be implemented to alleviate any potential adverse impacts on the local environment and to minimize exposure of construction-related emissions to the public and the environment.

4.14.1.1 Resource Descriptions

- Air quality describes the degree to which the ambient air is pollution-free, which is assessed by the measured or calculated amount of air pollution the public is exposed to in the environment.
- GHGs are gases that trap heat in the atmosphere. Fossil fuel combustion from mobile sources (cars, trucks, ships) generate GHG emissions, which contribute to rising global temperatures. Common examples of GHGs include carbon dioxide, methane, and nitrogen oxides.

4.14.1.2 Regulatory Context

Clean Air Act – National Ambient Air Quality Standards

The Clean Air Act of 1970[1] is the primary federal law that regulates air quality in the United States and is administered by the U.S. Environmental Protection Agency (EPA). The Clean Air Act requires the EPA to establish, and states to adopt, National Ambient Air Quality Standards (NAAQS) for major pollutants known as "criteria pollutants."[2] The EPA regulates six criteria pollutants:

- Carbon monoxide (CO)
- Lead
- Nitrogen dioxide
- Particulate matter:
  - Particulate matter with a diameter less than or equal to 10 microns (PM10)
  - Particulate matter with a diameter less than 2.5 microns (PM2.5)
- Ozone
- Sulfur dioxide (SO2)

[1] 42 U.S.C. 7401 et seq
[2] 40 Code of Federal Regulations part 50

The NAAQS are two-tiered:

- First tier (primary) is intended to protect public health.
- Second tier (secondary) is intended to protect public welfare and prevent degradation of the environment.

Table 4.14-1 presents the primary and secondary NAAQS established by the EPA for the six criteria pollutants.

Table 4.14-1. National Ambient Air Quality Standards

Pollutant		Primary/ Secondary	Averaging Time	Level	Form
Carbon Monoxide		Primary	8 hours	9 ppm	Not to be exceeded more than once per year
			1 hour	35 ppm	
Lead		Primary and Secondary	Rolling 3-month average	0.15 µg/m^3[1]	Not to be exceeded
Nitrogen Dioxide		Primary	1 hour	100 ppb	98th percentile of 1-hour daily maximum concentrations, averaged over 3 years
		Primary and Secondary	1 year	53 ppb[2]	Annual Mean
Ozone		Primary and Secondary	8 hours	0.070 ppm[3]	Annual fourth-highest daily maximum 8-hour concentration, averaged over 3 years
Particulate Matter (PM)	PM2.5	Primary	1 year	9.0 µg/m^3	Annual mean, averaged over 3 years
		Secondary	1 year	15.0 µg/m^3	Annual mean, averaged over 3 years
		Primary and Secondary	24 hours	35 µg/m^3	98th percentile, averaged over 3 years
	PM10	Primary and Secondary	24 hours	150 µg/m^3	Not to be exceeded more than once per year on average over 3 years
Sulfur Dioxide		Primary	1 hour	75 ppb[4]	99th percentile of 1-hour daily maximum concentrations, averaged over 3 years
		Secondary	3 hours	0.5 ppm	Not to be exceeded more than once per year

Source: U.S. Environmental Protection Agency. 2025. National Ambient Air Quality Standards table. https://www.epa.gov/criteria-air-pollutants/naaqs-table.

Notes: ppm = parts per million; ppb = parts per billion; µg/m^3 = microgram per cubic meter

[1] In areas designated nonattainment for the Pb standards prior to the promulgation of the current (2008) standards, and for which implementation plans to attain or maintain the current (2008) standards have not been submitted and approved, the previous standards (1.5 µg/m^3 as a calendar quarter average) also remain in effect.

[2] The level of the annual NO_2 standard is 0.053 ppm. It is shown here in terms of ppb for the purposes of clearer comparison to the 1-hour standard level.

[3] Final rule signed October 1, 2015, and effective December 28, 2015. The previous (2008) O_3 standards are not revoked and remain in effect for designated areas. Additionally, some areas may have certain continuing implementation obligations under the prior revoked 1-hour (1979) and 8-hour (1997) O_3 standards.

[4] The previous SO_2 standards (0.14 ppm 24-hour and 0.03 ppm annual) will additionally remain in effect in certain areas: (1) any area for which it is not yet 1 year since the effective date of designation under the current (2010) standards, and (2)any area for which an implementation plan providing for attainment of the current (2010) standard has not been submitted and approved and which is designated nonattainment under the previous SO_2 standards or is not meeting the requirements of a State Implementation Plan call under the previous SO_2 standards (40 CFR 50.4(3)). A State Implementation Plan call is an EPA action requiring a state to resubmit all or part of its State Implementation Plan to demonstrate attainment of the required NAAQS.

The EPA has designated specific areas as NAAQS attainment or non-attainment areas. Attainment areas are those areas that meet all NAAQS criteria pollutant standards. Non-attainment areas are those areas that exceed the NAAQS for one or more criteria pollutants. If an area is designated as "non-attainment," a state or region must develop a State Implementation Plan (SIP) to demonstrate how they will attain and maintain the NAAQS. Once an area has attained the relevant standard, the EPA may redesignate the area as an attainment/maintenance area, which are typically referred to as "maintenance areas."

The EPA promulgated a Transportation Conformity Rule pursuant to requirements of the Clean Air Act.[3] The rule applies only in EPA-designated non-attainment or maintenance areas.[4]

Massachusetts Greenhouse Gas Emissions Policy and Protocol

The Massachusetts Environmental Policy Act (MEPA) requires that all major projects proposed in the Commonwealth that have state involvement (in the form of state permits, land transfers, or financial assistance, for example) undertake an assessment of project impacts and alternatives to avoid, minimize, and mitigate damage to the environment to the maximum extent feasible. MEPA does include the emissions of GHGs caused by projects subject to MEPA review under the Greenhouse Gas Emissions and Protocol.[5] The policy became mandatory for certain categories of projects that filed an Environmental Notification Form with the MEPA Office after November 1, 2007.

4.14.1.3 Methodology and Study Areas

Microscale (Localized) Carbon Monoxide Analysis

EPA project-level ("hot-spot") transportation conformity requirements for CO do not apply because the Cape Cod Bridges Program (Program) is in a region that is in attainment of the NAAQS. However, a qualitative analysis was conducted to evaluate potential CO impacts from the Build Alternative compared to the No Build Alternative.

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[3] 40 Code of Federal Regulations Parts 51 and 93

[4] 40 Code of Federal Regulations 93.102(b).

[5] https://www.mass.gov/files/documents/2016/08/rp/ghg-policy-final-summary.pdf

The Microscale (Local) Air Quality Study Area corresponds to the Transportation and Traffic Study Area described in **Section 4.2, Transportation, Traffic, and Safety**, and consists of the major roadways, interchanges, and intersections within a 2-mile area centered around the Sagamore and Bourne Bridges (**Figure 4.14-1**).

Mesoscale (Regional) Emission Analysis

MassDOT conducted a mesoscale analysis to evaluate the potential regional air quality impacts of the Build Alternative from motor vehicles as a measure of the total daily emissions of volatile organic compounds (VOC), nitrogen oxides, CO, PM10, and PM2.5, and SO2. Mobile-source emission calculations were performed for nearby affected roadway segments utilizing the traffic data and roadway speeds, and the EPA Motor Vehicle Emissions Simulator (MOVES, latest version of MOVES4) emission factors.

The Mesoscale (Regional) Air Quality Study Area includes freeway, arterial, and collector roadways within an approximate 5-mile radius of the bridges (**Figure 4.14-2**).

Greenhouse Gas Emission Analysis

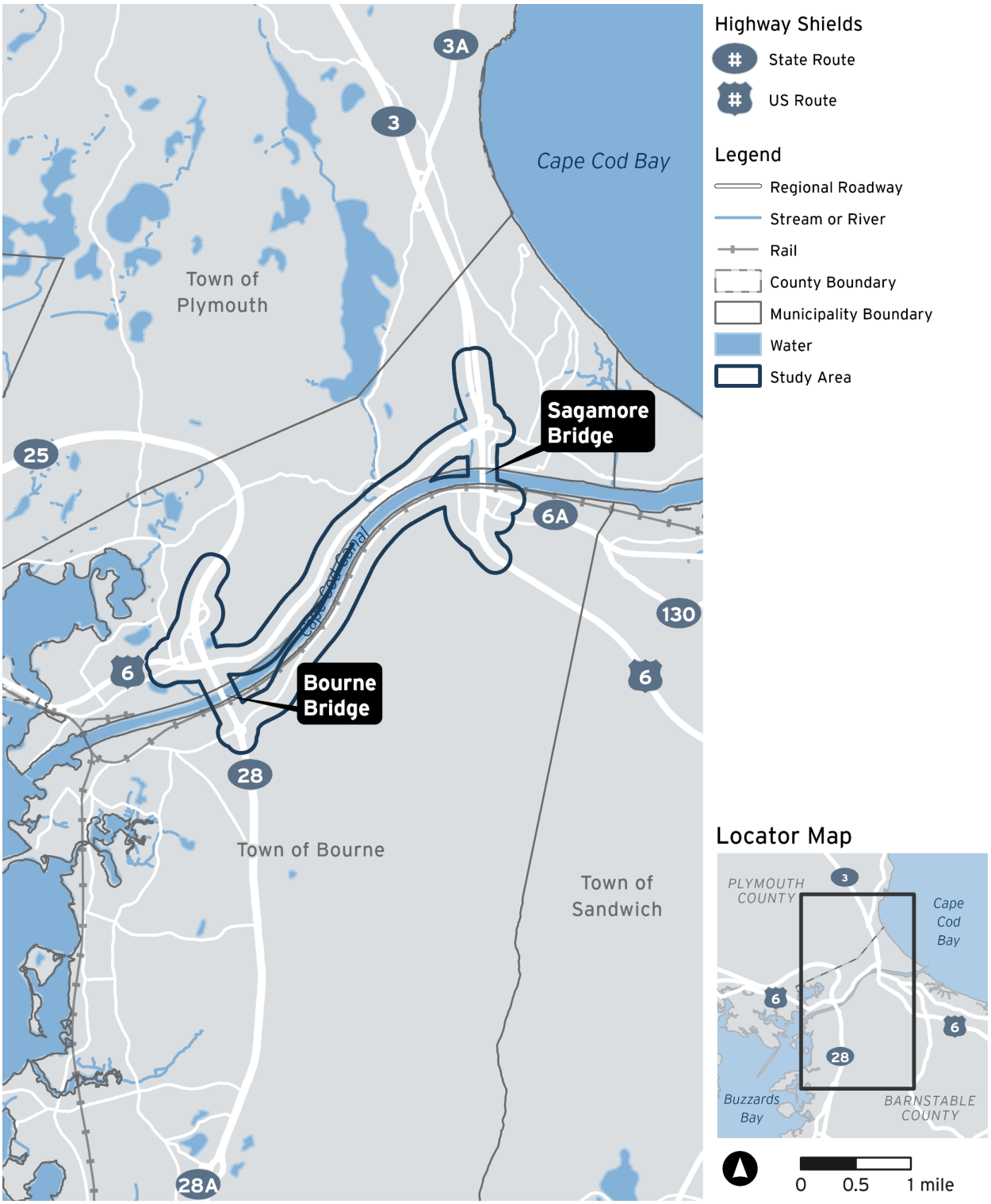
MassDOT conducted a GHG emissions analysis to evaluate the potential regional air quality impact of the Build Alternative from motor vehicles within the Mesoscale (Regional) Air Quality Study Area as a measure of the total annual emissions of GHGs including carbon dioxide (CO2), methane, and nitrogen oxides. Calculations were performed using the traffic data and the EPA MOVES Version 4 consistent with the mesoscale methodology to compare area-wide emissions for the 2019 Base Year (existing conditions) and the 2050 Design-Year No Build Alternative and Build Alternative. The GHG mesoscale analysis includes direct emissions from vehicles, indirect emissions from the full life cycle of emissions (i.e. fuel consumption, upstream emissions, etc.), and construction and maintenance operations. The Argonne National Laboratory's Greenhouse gases, Regulated Emissions, and Energy use in Technologies (GREET) model (v.2021) provides fuel-cycle multipliers for indirect emissions and the FHWA Infrastructure Carbon Estimator tool was used to estimate GHG emissions from construction and maintenance operations.

Mobile-Source Air Toxics

MassDOT conducted a qualitative assessment of mobile-source air toxics (MSAT) impacts in accordance with FHWA's Updated Interim Guidance on Mobile Source Air Toxic Analysis in NEPA Documents.[6] According to this guidance, the Cape Cod Bridges Program would qualify as a "Project with Low Potential MSAT Effects" because design-year traffic is projected to be less than 140,000 to 150,000 annual average daily traffic.

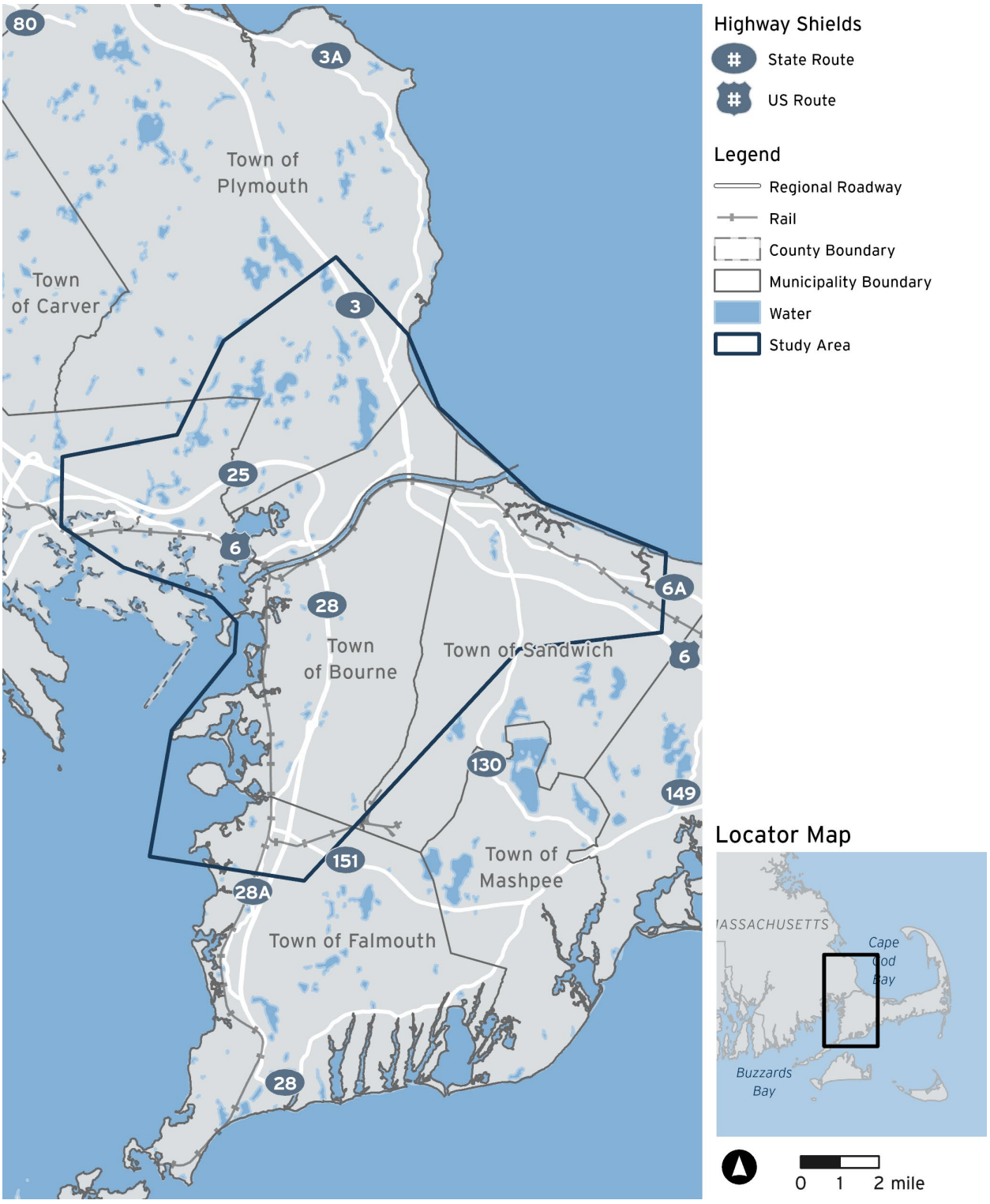
[6] https://www.fhwa.dot.gov/environMent/air_quality/air_toxics/policy_and_guidance/msat//fhwa_nepa_msat_memorandum_2023.pdf

Figure 4.14-1. Microscale (Local) Air Quality Study Area



Source: Massachusetts Department of Transportation, 2024

Figure 4.14-2. Mesoscale (Regional) Air Quality Study Area



Source: Massachusetts Department of Transportation, 2024

Construction Emissions

MassDOT conducted a qualitative assessment of the potential adverse construction-period impacts of the Build Alternative on local air quality, including identification of measures to mitigate those impacts. A qualitative assessment of construction-related air quality impacts of the Build Alternative was conducted to identify potential exposures to sensitive populations, including Environmental Justice (EJ) populations. Anticipated construction travel routes for trucks and vessels were also evaluated to determine if they would extend through or pass by EJ populations.

4.14.2 Existing Conditions

4.14.2.1 Air Quality Attainment Status

The Microscale (Localized) and Mesoscale (Regional) Air Quality Study Areas are in Plymouth and Barnstable Counties, which are designated as attainment areas for all criteria pollutants with the EPA NAAQS.[7]

4.14.2.2 Project Status in a Regional Transportation Plan and Program

Federal conformity requirements at 40 CFR 93.114[8] and 40 CFR 93.115[9] (as incorporated by reference into the Massachusetts conformity SIP) apply as the area in which the Program is located is an area under a federal court decision affecting former maintenance areas nationwide for the 1997 ozone NAAQS.[10] Accordingly, there must be a currently conforming transportation plan (i.e. Transportation Improvement Plan and a Long Range Transportation Plan) at the time of issuance of the NEPA Record of Decision, and the Program must come from a conforming plan or otherwise meet the criteria specified in 40 CFR 93.109(b).[11] As of the date of preparation of this analysis, Phase 1 of the Program (Replacement of Sagamore Bridge) is currently included in the FY 2025-2029 Transportation Improvement Program (TIP) Amendment 2.[12] The Program is also included in the Draft FY 2026-2030 TIP currently being reviewed by the Cape Cod Metropolitan Planning Organization (Cape Code MPO) as of April 2025.[13] The Program is also included in the Regional Air Conformity Assessment for the Cape

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[7] https://www3.epa.gov/airquality/greenbook/anayo_ma.html

[8] https://www.ecfr.gov/current/title-40/chapter-I/subchapter-C/part-93#93.114

[9] https://www.ecfr.gov/current/title-40/chapter-I/subchapter-C/part-93#93.115

[10] Per a February 16, 2018, court decision (South Coast Air Quality Management District v. EPA), all areas in the country that were in nonattainment or maintenance for the 1997 eight-hour ozone NAAQS before its revocation by the EPA in 2015 were again made subject to conformity for that standard. This decision in part affects "orphan areas" (as defined in the ruling), which in Virginia includes Fredericksburg, Richmond/Tri-Cities, and Hampton Roads. https://law.justia.com/cases/federal/appellate-courts/cadc/15-1115/15-1115-2018-02-16.html

[11] https://www.ecfr.gov/current/title-40/chapter-I/subchapter-C/part-93#93.109

[12] https://www.capecod.gov/2024/11/19/public-review-notice-transportation-improvement-program/)

[13] https://www.capecodcommission.org/resource-library/file/?url=/dept/commission/team/tr/ccmpo/Outreach/OUTREACH%202025/Documents%20for%20Public%20Review/Cape_Cod_2026%202030_Transportation_Improvement_Program_draft%20for%20CCMPO%20review.pdf

Cod 2024 Regional Transportation Plan 2024-2044, which received approval by the Cape Cod MPO dated July 24, 2023.[14]

4.14.2.3 Ambient Air Quality Data and Trends

MassDEP issues an annual report summarizing air quality monitoring data for the previous year, covering criteria pollutants (those for which the EPA has established NAAQS) and other pollutants including air toxics. The 2023 annual report was reviewed for the criteria pollutants and the monitoring results show that ambient pollutant concentrations measured by MassDEP are below the NAAQS. In addition, the trends over the past ten years show that ambient concentrations have been decreasing. This decrease is primarily attributed to the implementation of more stringent vehicle emissions and fuel quality standards.

4.14.3 Program Impacts

4.14.3.1 Microscale (Localized) Carbon Monoxide Analysis

Based upon the design-year 2050 traffic analysis, the Build Alternative is expected to substantially improve traffic operations compared to the No Build Alternative. Study Area intersections, expressway mainline, and merging-diverging segments are expected to operate at improved levels of service during the weekday fall PM design periods. Travel times between major origin-destination points along major routes within the study area are also estimated to improve for the Build Alternative compared to the No Build Alternative. Despite processing more vehicles, the Build Alternative model recorded less total travel time (2,240 hours) in the network roadway than the No Build Alternative (2,879). Improved traffic operations and mobility within the Study Area for the 2050 Build Alternative is anticipated to reduce CO emission rates compared to the 2050 No Build Alternative. Refer to **Section 4.2, Transportation, Traffic and Safety**, and the supporting **Appendix 4.2, Traffic Engineering Technical Report**, for detailed information on the traffic analyses conducted for the 2019 Base Year and 2050 Design Year.

4.14.3.2 Mesoscale (Regional) Emission Analysis

Table 4.14-2 presents the 2050 forecast vehicle miles traveled (VMT), vehicle hours traveled (VHT), daily trips and average vehicle speeds for roadway segments within the regional mesoscale study area. **Table 4.14-3** presents the corresponding air quality reductions associated with the Build Alternative compared to the No Build Alternative. A reduction in VMT, VHT, daily trips and vehicle speeds is expected with the Build Alternative when compared to the No Build Alternative due to more efficient traffic flow within the study area. Correspondingly, emissions are also expected to decrease with fewer VMT and higher speeds for the Build Alternative compared to the No Build Alternative.

[14] https://www.capecodcommission.org/resource-library/file/?url=/dept/commission/team/tr/Transportation%20Plans/RTP/2024_RTP/Report/FINAL%20PDF/Cape%20Cod%202024%20Regional%20Transportation%20Plan_Endorsed%20072420 23%20With%20Appendix.pdf

Table 4.14-2 2050 Projected Daily Vehicle Miles Traveled, Vehicle Hours Traveled, Daily Trips, Average Vehicle Speeds (Mesoscale [Regional] Air Quality Study Area)

Category	2050 No Build Alternative	2050 Build Alternative	Difference (No Build vs Build)
Daily Vehicle Miles Traveled	3,476,000	3,416,153	-59,847
Daily Vehicle Hours Traveled	94,715	86,788	-7,927
Daily Trips	421,866	421,686	0
Average Speed	37 mph	39 mph	+2 mph

Source: Massachusetts Department of Transportation, 2025

Table 4.14-3. Projected Daily Pollutant Emissions (tons per day) (Mesoscale [Regional] Air Quality Study Area)

Category	2050 No Build Alternative	2050 Build Alternative	Change (No Build to Build)
Vehicle Miles Traveled (millions of miles per day)	3.476	3.416	-0.06
Carbon Monoxide	3.24	2.99	-0.25
Volatile Organic Compounds	0.07	0.07	-0.01
Nitrogen Oxides	0.11	0.10	-0.01
Sulfur Dioxide	0.004	0.004	-0.0020
PM10	0.18	0.14	-0.04
PM2.5	0.03	0.02	-0.01

Source: Massachusetts Department of Transportation, 2025

Notes: Totals may not exactly match due to rounding.
PM10/PM2.5 = particulate matter with a diameter less than or equal to 10/2.5 microns

4.14.3.3 Mobile-Source Air Toxics

Technical shortcomings of emissions and dispersion models and uncertain science with respect to health impacts prevent meaningful or reliable estimates of MSAT emissions and impacts of the Build Alternative. While it is possible that localized increases in MSAT emissions may occur as a result of the Build Alternative, emissions in the 2050 Build Alternative would likely be lower than present levels as a result of the EPA's national control programs that are projected in FHWA guidance (2023) to reduce annual MSAT emissions by 76% between 2020 and 2060 even as VMT increases nationally by 31%. Although local conditions may differ from these national projections in terms of fleet mix and turnover, VMT growth rates (and local control measures), the magnitude of the EPA-projected reductions is so great (even after accounting for VMT growth) that MSAT emissions in the Microscale (Localized) and Mesoscale (Regional) Air Quality Study Areas are likely to be lower in the future in nearly all cases.

4.14.3.4 Greenhouse Gas Emissions Analysis

Table 4.14-4 presents the GHG mesoscale emission estimates for the Build Alternative compared to the No Build Alternative. As presented in Table 4.14-4, a reduction in VMT, VHT, daily trips and vehicles speeds is expected with the Build Alternative when compared to the No Build Alternative due to more efficient traffic flow within the Mesoscale [Regional] Air Quality Study Area. Correspondingly, CO2e emissions are also expected to decrease with fewer VMT and higher speeds for the Build Alternative compared to the No Build Alternative.

Table 4.14-4. Projected Annual Greenhouse Gas Emissions (tons per year) (Mesoscale [Regional] Air Quality Study Area

Category	2050 No Build Alternative	2050 Build Alternative	Change (No Build to Build)
Vehicle Miles Traveled (millions of miles per year)	1,268.7	1,246.9	**-21.8**
Methane	12.49	10.81	**-1.68**
Nitrogen Oxide	7.52	7.17	**-0.35**
Atmospheric Carbon Dioxide	307,957	293,536	**-14,422**
Carbon Dioxide Equivalent	310,383	295,817	**-14,566**
Upstream Indirect Emissions	112,356	108,261	**-4,095**
Construction and Maintenance	1,651	1,651	**0**
Total Carbon Dioxide Equivalent Emissions	**424,390**	**405,729**	**-18,661**

Note: Totals may not exactly match due to rounding.

Greenhouse Gas Social Costs

For transparency and disclosure, to provide a contextualized monetary measure of GHGs, MassDOT calculated the social cost of GHG for direct CO2, methane, and nitrogen oxides emissions associated with the 2050 No Build and Build Alternatives. Table 4.14-5 presents the social costs of CO2e of the alternatives.

Table 4.14-5. No Build Alternative and Build Alternative: Social Cost of Carbon Dioxide Equivalents from Direct Emissions by Interagency Working Group Average Discount Rates (U.S. Dollars)

Alternative	Discount Rates	Carbon Dioxide	Methane	Nitrogen Dioxide	Total
2050 No Build	5%	$9,731,441	$21,233	$97,760	**$9,850,434**
	3%	$26,299,528	$38,719	$248,160	**$26,586,407**
	2.5%	$35,846,195	$47,462	$338,400	**$36,232,057**
	3% 95th Percentile	$80,007,229	$102,418	$661,760	**$80,771,407**
2050 Build	5%	$9,275,738	$18,377	$93,210	**$9,387,325**

Alternative	Discount Rates	Carbon Dioxide	Methane	Nitrogen Dioxide	Total
	3%	$25,067,974	$33,511	$236,610	**$25,338,095**
	2.5%	$34,167,590	$41,078	$322,650	**$34,531,318**
	3% 95th Percentile	$76,260,653	$88,642	$630,960	**$76,980,255**

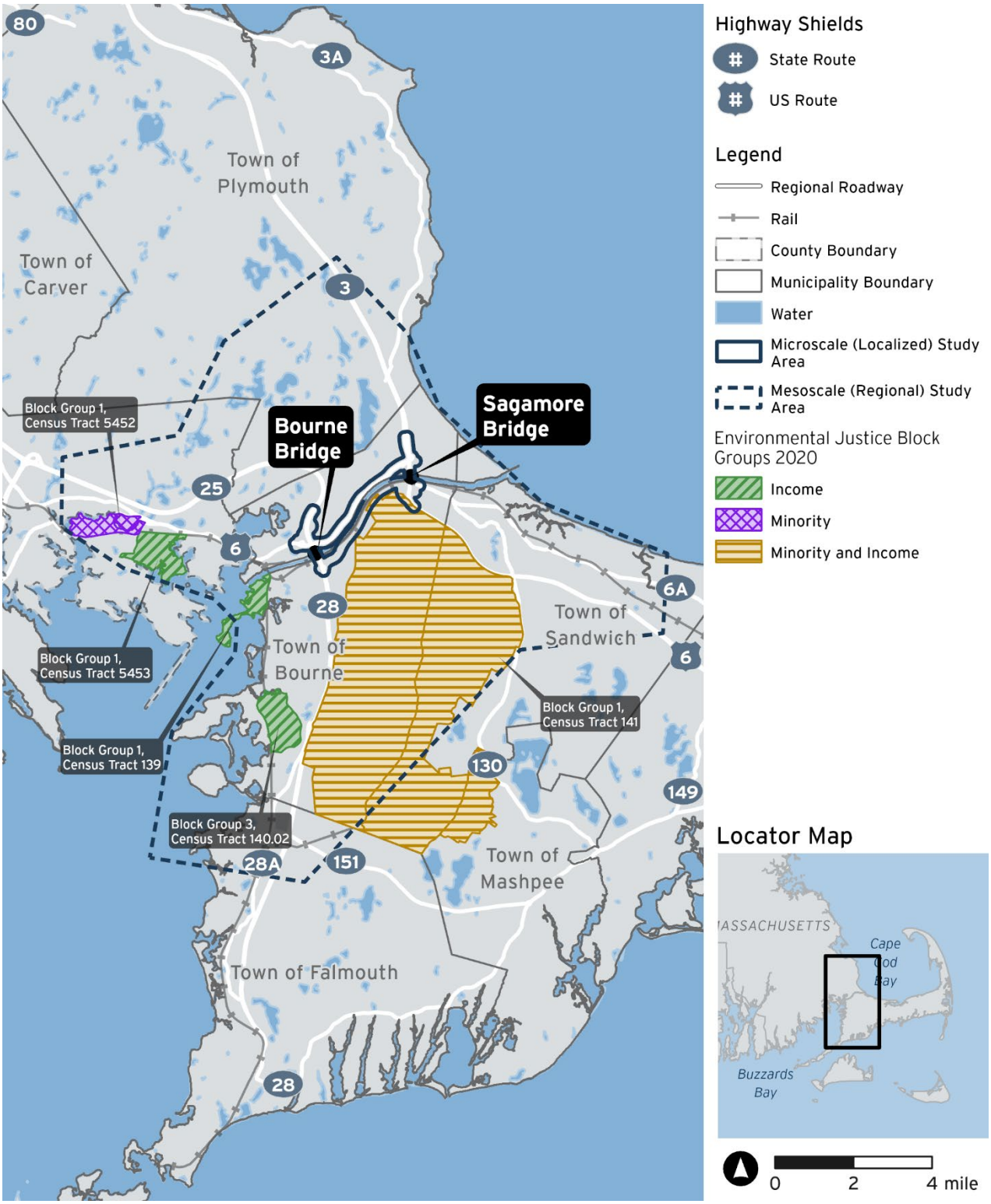
Notes:
1. All costs represent direct emissions for carbon dioxide, methane, and nitrogen oxides, which were derived from the EPA MOVES runs for each alternative.
2. Social costs derived from the Whitehouse Technical Support Document social costs and interpolated from range years.

4.14.3.5 Environmental Justice

Section 4.9, Environmental Justice, identifies one EJ population (Block Group 1, Census Tract 141) within 1 mile of the Project Limits. This EJ population meets the EJ criteria for minority and low income, constitutes the entirety of Joint Base Cape Cod, and is within the towns of Bourne, Sandwich, and Mashpee. Four additional EJ populations are located within five-miles of the Project Limits. Refer to **Figure 4.14-3,** which depicts these EJ populations relative to the freeway, arterial, and collector roadways located within the Air Quality Study Areas.

Construction of the Build Alternative is expected to generate 230,368 construction-period truck trips. The origin of these trips will depend on various factors that are currently unknown, such as the locations of suppliers for construction materials, waste disposal sites, staging areas, and the contractor's office or equipment yards. However, MassDOT anticipates that these trips will primarily use State Routes 3, 130, and 28, and U.S. Routes 6 and 25. State Route 130 passes through an EJ population within 5 miles of the Project Limits. The other State and U.S. Routes travel adjacent to, but do not extend through, identified EJ populations. According to a review of the EPA's EJ Screen, identified EJ populations do not have air quality indicators that are elevated at or above the 80th percentile compared to the statewide average. Refer to **Section 4.9, Environmental Justice,** for additional information.

Figure 4.14-3. Environmental Justice Populations Relative to the Air Quality Study Areas



Source: Massachusetts Department of Transportation, 2025

4.14.3.6 Marine Vessel Traffic

Table 4.14-6 presents the estimated annual criteria pollutant emissions from marine transport vessels from fossil fuel fired engines for one year of operation. MassDOT expects that these operations would continue daily over a six-year construction period. These emissions were estimated for tugs and launches using EPA emission factors and expected annual trips per year for each vessel.

Table 4.14-6. Projected Annual Pollutant Emissions (Tons Per Year) for the Marine Vessel Trips

Activity	Trips Per Year	CO	VOC	NOX	SO2	PM10	PM2.5
Tugs	4,380	2.24	0.30	3.16	0.01	0.07	0.07
Launches	2,920	1.07	0.41	2.52	0.41	0.17	0.16
	Total Emissions	**3.30**	**0.71**	**5.68**	**0.42**	**0.25**	**0.24**

Source: Massachusetts Department of Transportation, 2025

Note: Assumes a total of 7, 300 trips of tugs and launches per year to support the Sagamore Bridge and Bourne Bridge construction operations.
CO = carbon monoxide; VOC = volatile organic compounds; NOX = oxides of nitrogen; SO2 = sulfur dioxide; PM10/PM2.5 = particulate matter with a diameter less than or equal to 10/2.5 microns

The origin of the vessel trips will depend on factors that are unknown (such as the locations of suppliers for construction materials, waste disposal sites, and the location of the marina or docking facilities). However, regardless of their origins, the vessels will enter Cape Cod Canal from either the north or south and will pass by many non-EJ populations and one EJ population adjacent to the southern entrance to the canal. Furthermore, the emission plume from the vessel stacks will be dispersed and diluted due to meteorological conditions (i.e., wind speed and wind direction) and constant moving nature of the activities, which will help mitigate concentrated ground level concentrations and exposure as compared to a stationary source. Therefore, vessel traffic is not anticipated to result in a disproportionate adverse effect on EJ populations.

4.14.3.7 Construction Emissions

During construction, there is potential for short-term increases in particulate matter emissions (airborne dust) due to site preparation and roadway reconstruction activities, including land clearing, demolition, excavation, grading, compaction, removing or improving existing roadways, and paving roadway surfaces. In addition to airborne dust, the operation of diesel-fueled off-road equipment and heavy-duty trucks have the potential to adversely affect air quality due to direct emissions of CO, oxides of nitrogen, and VOCs. According to the EPA, research has shown that sensitive receptors—including older adults (over age 65), children (under age 18), people with heart or lung diseases, minority populations, and low socioeconomic status populations—are more vulnerable to adverse impacts of exposure to air pollution relative to the general population.[15] Land uses considered sensitive receptors include residences, schools, daycare centers, parks and playgrounds, and medical

[15] Research on Health Effects from Air Pollution. https://www.epa.gov/air-research/research-health-effects-air-pollution

facilities. MassDOT's Standard Specifications for Road and Bridge Construction includes construction-related specifications and contract special provisions for dust control, use of cleaner diesel fuel, idling reduction requirements, and installation of emission control devices on contractor vehicles. MassDOT's contractors will comply with all air quality contract specifications to minimize impacts of fugitive dust and construction equipment and vehicle exhaust including ozone precursors VOCs and NOx). **Section 4.14.4** outlines specific measures that will be implemented to reduce air quality impacts during construction.

Demolition of the Sagamore and Bourne Bridges would involve lead paint disturbance, which can generate airborne lead dust and fumes. The contractor will be required to comply with MassDOT specifications for proper removal of bridge components coated with lead-based paint. These specifications will require the contractor(s) to develop a Lead Abatement Plan—including containment measures, lead paint removal methods, worker protection measures, waste disposal procedures, and post-abatement protocols—for review and approval by MassDOT. Any demolition activities with the potential to disturb identified or suspected lead-based paint would be performed in accordance with the Occupational Safety and Health Administration Lead in Construction Standard.[16]

4.14.4 Mitigation

The Build Alternative is expected to improve traffic operations and reduce air quality impacts compared to the No Build Alternative in the future 2050 Design Year. Therefore, no mitigation is required for the operational phase of the Build Alternative. Further, the Build Alternative would improve bicycle and pedestrian accommodations and connectivity within the Program Limits. Increased opportunities for walking and bicycling would help to reduce traffic related air pollution and improve public health.

During construction, MassDOT will implement emission reduction measures to minimize air quality impacts of criteria pollutants including ozone precursors to surrounding sensitive receptors and the environment in accordance with MassDOT Contract Specifications and applicable laws and regulations. Such measures will include, but will not be limited to, the following:

- Use ultra-low-sulfur diesel fuel in construction equipment (mitigate sulfur dioxides and particulates).
- Use alternative-fueled or electric equipment where feasible (mitigate all criteria pollutants, including ozone precursors).
- Maintain construction equipment in proper working order (mitigate criteria pollutants, including ozone precursors).

[16] https://www.osha.gov/laws-regs/regulations/standardnumber/1926/1926.62

- Install on-site anti-idling signage at loading and drop-off/pick-up/waiting areas, requiring that engines idle for no more than five minutes (mitigate criteria pollutants, including ozone precursors).
- Use dust suppression wetting agents where needed on a routine basis (mitigate particulate matter).
- Apply seeding or soil stabilizers to the surface of inactive stockpiles (mitigate particulate matter).
- Adjust work schedules when weather conditions, such as dry soil or high wind speeds, could lead to dust impacts (mitigate particulate matter).
- Cover active stockpiles with plastic tarps or other suitable containment measures (mitigate particulate matter).
- Cover and wet all transported loads of dust-producing materials (e.g., dirt or demolition debris) prior to hauling operations on public roadways (mitigate particulate matter emissions).
- Locate stationary construction equipment as far as possible from sensitive receptors (mitigate pollutant concentrations to nearby neighborhoods).
- Conduct frequent construction site inspections (mitigate all criteria pollutants, including ozone precursors).
- Designate construction truck routes through areas that would cause the least disturbance to sensitive receptors (mitigate pollutant concentrations to nearby neighborhoods).
- Evaluate cleaner fuels for marine vessels such as marine gas oil, which is cleaner than heavy fuel oil. Other options could be very low sulfur fuel oil, ultra-low sulfur fuel oil, biofuels, and liquid natural gas (mitigate all criteria pollutants, including ozone precursors).
- Prepare and implement a Lead Abatement Plan to mitigate lead emissions during bridge demolition.

4 Existing Conditions, Program Impacts, and Mitigation

4.15 Noise and Vibration

4.15.1 Introduction

This section presents the potential operational traffic noise and construction-related noise and vibration impacts of the No Build Alternative and Build Alternative, including measures that will be implemented to mitigate adverse impacts on surrounding sensitive receptors.

4.15.1.1 Resource Definition

- Noise is generally defined as sound that is undesirable because it interferes with speech, causes sleep disturbance, or is otherwise annoying (unwanted sound). The individual human response to noise is subject to considerable variability because there are many emotional and physical factors that contribute to the differences in reaction to noise.
- Vibration is an oscillatory motion, which can be described in terms of displacement, velocity, or acceleration. Displacement refers to the distance an object has moved from its equilibrium position during vibration. Velocity represents the speed at which the object is moving during vibration. Acceleration describes the rate at which the velocity of a vibrating object changes over time. Construction activity can generate varying degrees of ground-borne vibration, depending on the equipment and methods employed, distance between source and receptor, duration, and subsurface conditions.
- Sensitive receptors are defined as land uses that are considered sensitive to noise and vibration impacts. Examples of noise-sensitive receptors include residences, schools, hospitals, libraries, places of worship, hotels, television and recording studios, and passive recreation areas. Vibration-sensitive receptors are generally the same as noise-sensitive receivers but may also include buildings in poor structural condition, and businesses, such as research facilities and laboratories that use vibration-sensitive equipment.

4.15.1.2 Regulatory Context

The Cape Cod Bridges Program is classified as a Type I project[1] in accordance with the following:

- Federal Highway Administration's (FHWA) Noise Regulations (23 Code of Federal Regulations [CFR] 772) — Procedures for Abatement of Highway Traffic Noise and Construction Noise[2]
- Massachusetts Department of Transportation's (MassDOT) Noise Abatement Policies (effective July 13, 2011)[3]

FHWA Noise Regulation 23 CFR 772 and MassDOT's Noise Abatement Policies require that traffic noise levels associated with Type I projects are calculated, the results are compared to the noise abatement criteria, and, if noise impacts are identified, noise mitigation measures are evaluated to reduce noise impacts in a study area. Type 1 projects also require analysis of construction noise and abatement measures and prediction of noise impacts on undeveloped lands to inform local officials on land use compatible planning.

No FHWA regulations are specific to construction-related vibration. MassDOT derived the guidance for the assessment of construction-related vibration impacts from the Federal Transit Administration (FTA) Transit Noise and Vibration Impact Assessment Manual.[4]

4.15.1.3 Methodology and Study Area

Operational Traffic Noise

The operational traffic noise analysis involved monitoring existing noise conditions to validate the project-specific noise model and modeling existing 2019 and future 2050 No Build Alternative and Build Alternative noise conditions with the FHWA-approved computerized Traffic Noise Model, version 2.5 (TNM). MassDOT conducted the noise analysis using traffic data that was representative of the Loudest Traffic Hour (LTH), which was identified as the AM traffic peak hour for all Noise Study Areas except the Sagamore North quadrant where the LTH was identified as the PM peak traffic hour. MassDOT used existing 2019 Fall AM and PM peak-hour traffic data to evaluate existing noise levels within the Noise Study Areas. MassDOT used future 2050 Fall AM and PM peak-hour traffic data to

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[1] A Type I project is a project that involves (1) The construction of a highway on new location; (2) The physical alteration of an existing highway where there is either a substantial horizontal alteration or a substantial vertical alteration; (3) The addition of a through traffic lane(s); (4) The addition of an auxiliary lane, except for when the auxiliary lane is a turn lane; (5) The addition or relocation of interchange lanes or ramps added to a quadrant to complete an existing partial interchange; (6) Restriping existing pavement for the purpose of adding a through traffic lane or an auxiliary lane; or, (7) The addition of a new or substantial alteration of a weigh station, rest stop, ride-share lot or toll plaza.

[2] Federal Highway Administration. 2011. Procedures for Abatement of Highway Traffic Noise and Construction Noise. July. https://www.ecfr.gov/current/title-23/chapter-I/subchapter-H/part-772

[3] Massachusetts Department of Transportation. 2011. Type I and Type II Noise Abatement Policies and Procedures. July. https://studylib.net/doc/13043513/massachusetts-department-of-transportation-type-i-and-typ...

[4] Federal Transit Administration. 2018. Transit Noise and Vibration Impact Assessment Manual. September. https://www.transit.dot.gov/sites/fta.dot.gov/files/docs/research-innovation/118131/transit-noise-and-vibration-impact-assessment-manual-fta-report-no-0123_0.pdf

evaluate No Build Alternative and Build Alternative noise levels. Traffic noise impacts were assessed for different categories of noise-sensitive land use using the FHWA Noise Abatement Criteria (NAC), as presented in **Table 4.15-1**. The following sections provide an overview of the Noise Study Areas and methodologies used to support this analysis.

Table 4.15-1. Federal Highway Administration Noise Abatement Criteria

Activity Category	Leq(h)[a]	Description of Activity Category
A	57 (Exterior)	Lands on which serenity and quiet are of extraordinary significance and serve an important public need and where the preservation of those qualities is essential if the area is to continue to serve its intended purpose
B[b]	67 (Exterior)	Residential
C[b]	67 (Exterior)	Active sport areas, amphitheaters, auditoriums, campgrounds, cemeteries, day care centers, hospitals, libraries, medical facilities, parks, picnic areas, places of worship, playgrounds, public meeting rooms, public or nonprofit institutional structures, radio studios, recording studios, recreation areas, Section 4(f) sites, schools, television studios, trails, and trail crossings
D	52 (Interior)	Auditoriums, day care centers, hospitals, libraries, medical facilities, places of worship, public meeting rooms, public or nonprofit institutional structures, radio studios, recording studios, schools, and television studios
E[b]	72 (Exterior)	Hotels, motels, offices, restaurants/bars, and other developed lands, properties or activities not included in A-D or F
F[c]	—	Agriculture, airports, bus yards, emergency services, industrial, logging, maintenance facilities, manufacturing, mining, rail yards, retail facilities, shipyards, utilities (water resources, water treatment, electrical), and warehousing
G[c]	—	Undeveloped lands that are not permitted (without building permits)

Source: Federal Highway Administration, "Procedures for Abatement of Highway Traffic Noise and Construction Noise" (23 Code of Federal Regulations [CFR] 772, as amended 75 CFR 39820, July 13, 2010; effective date July 13, 2011). https://www.ecfr.gov/current/title-23/chapter-I/subchapter-H/part-772

[a] Hourly Equivalent A-weighted Sound Level (dBA)

[b] Includes undeveloped lands permitted for this category

[c] "—" indicates no Noise Abatement Criteria value established by the Federal Highway Administration and Massachusetts Department of Transportation

Definition of Noise Study Areas

In general, the Noise Study Areas correspond to the same Study Area described in **Section 4.2, Transportation, Traffic, and Safety**, which consisted of a 2-mile area centered around the Sagamore and Bourne Bridges. Specifically, the Noise Study Areas extend approximately 500 feet beyond the operational limits of the Build Alternative at the Sagamore and Bourne Bridges.

Definition of Criteria for Traffic Noise Impact

FHWA established the NAC for different categories of land use to assess the degree of traffic noise impact on human activity, which are provided in **Table 4.15-1**. The NAC is given in terms of the hourly,

A-weighted, equivalent sound level in decibels (dBA). Because most environmental noise (and the A-weighted sound level) fluctuates from moment to moment, it is common practice to characterize the fluctuating level by a single number called the equivalent sound level (Leq).[5]

Traffic noise impact occurs when the predicted future Design Year predicted noise levels approach (within 1 dBA) or exceed the FHWA NAC levels presented in **Table 4.15-1**, or when future Design Year predicted noise levels substantially exceed the existing noise levels. MassDOT defines "substantially exceed" as a 10 dB increase in Design Year noise levels, relative to existing noise levels.

Identification of Noise-Sensitive Land Uses

Identified receptors within the Noise Study Areas were grouped into Common Noise Environments (CNE), which are groups of receptors usually within the same Activity Category that are exposed to similar noise sources and levels. Factors considered in the identification of CNEs included traffic volumes, topographic features, and secondary noise sources such as interchanges, cross-roads, and intersections. **Figure 4.15-1 through Figure 4.15-4** illustrate the boundaries of the identified CNEs within the Noise Study Areas. **Appendix 4.15, Noise and Vibration Technical Report**, provides detailed descriptions of each CNE, including noise-sensitive land use within those boundaries.

Determination of Existing Noise Levels

Noise Measurement Program

MassDOT conducted a noise measurement program to document existing ambient noise levels at noise-sensitive locations in the Study Areas, which consisted of primarily residential land uses. Noise measurements were conducted at 18 sites on May 16, May 17, and May 18, 2023. In general, the short-term measurements characterized existing noise levels in the Noise Study Area but were not necessarily conducted during the loudest hour of the day. **Figure 4.15-1 through Figure 4.15-4** illustrate the noise measurement locations within the Study Areas. **Appendix 4.15, Noise and Vibration Technical Report**, provides additional details related to the noise measurement program.

Noise Model Validation and Prediction of Existing Noise Levels

According to FHWA and MassDOT policies, the accuracy of the noise prediction model must be verified on a project-by-project basis. Therefore, noise model validation was conducted to compare field-measured noise levels to predicted noise levels using the FHWA TNM with field-documented traffic volumes, speeds and vehicle types as well as existing horizontal and vertical roadway geometries. At all 18 sites, the differences between measured and predicted noise levels were within the +/-3 dB(A) tolerance allowed by FHWA. Therefore, the existing noise model is considered validated, and existing condition year 2019 LTH volumes and vehicle types were used to predict existing noise levels at additional receptors in the Noise Study Area.

[5] The Leq is the value or level of a steady, non-fluctuating sound that represents the same sound energy as the actual time-varying sound evaluated over the same period. For traffic noise assessment, Leq is typically evaluated over a 1-hour period and may be denoted as Leq(h).

Prediction of Future Design Year Traffic Noise Levels

Future 2050 traffic noise levels for the No Build Alternative and Build Alternative were predicted using the FHWA TNM 2.5 with Design Year 2050 LTH traffic volumes, vehicle types, and posted speeds included within **Appendix 4.2, Traffic Engineering Technical Report**. Existing roadway geometry was used for the No Build Alternative models, while proposed roadway design data (including horizontal and vertical geometries) were used as input components for the 2050 Build Alternative models.

Undeveloped lands with issued building permits for future development were identified through coordination with the Town of Bourne and included in the 2050 No Build Alternative noise models. One permitted development was identified within the Sagamore North quadrant (Cape View Way), and one permitted development was identified within the Bourne North quadrant (340 Main Street).

Identification of Traffic Noise Impacts

Highway traffic noise impacts were identified where predicted 2050 Build Alternative highway traffic noise levels at any receptor location approach (within 1 dBA) or exceed the FHWA NAC presented in **Table 4.15-1**. Noise impact would also occur wherever predicted noise levels substantially exceed existing noise levels by 10 dBA or more.

Evaluation of Noise Abatement Measures and MassDOT Criteria for Recommending Noise Barriers

When traffic noise impacts are identified, noise abatement must be considered and evaluated for feasibility and reasonableness. Noise abatement is any measure used to reduce highway traffic noise levels. In general, FHWA-approved abatement measures include traffic management, the alteration of horizontal and vertical alignment, property acquisition for buffer zones, noise insulation (for Category D impacts only), and noise barriers.

For this traffic noise study, MassDOT evaluated noise barriers for feasibility and reasonableness in the areas of predicted highway traffic noise impacts. The feasibility of an abatement measure usually relates to a combination of acoustic and engineering factors. Acoustic factors include the amount of noise reduction achieved by the barrier, while engineering factors consider safety, impacts on drainage and utilities, maintenance of the abatement measure, and access to adjacent properties. Reasonableness considers the combination of social, economic, and environmental factors in the evaluation of a noise abatement measure and implies that good judgment and common sense were used in making a decision about barrier construction. Three primary reasonableness factors that must be achieved in determining if noise abatement is reasonable include cost effectiveness, achieving a noise reduction design goal, and gaining the support of property owners and residents for the abatement measures.[6]

According to MassDOT Noise Policy, noise barrier cost is determined by multiplying the square footage of the proposed noise barrier (as modeled by the FHWA TNM) by a unit cost per square foot. Pursuant to 23 CFR 772.13(d)(2)(ii), state highway agencies will reevaluate noise abatement costs on a regular

[6] Federal Highway Administration, "Procedures for Abatement of Highway Traffic Noise and Construction Noise" (23 Code of Federal Regulations 772, as amended 75 FR 39820, July 13, 2010; Effective date July 13, 2011). https://www.ecfr.gov/current/title-23/chapter-I/subchapter-H/part-772

interval, not to exceed five years. In 2021, MassDOT submitted an updated unit cost to FHWA of $60 per square foot. MassDOT considers a noise barrier to be cost effective if the cost is less than or equal to the Cost Effectiveness Index, which was increased to $10,080 per decibel of noise reduction per residential dwelling unit benefited in 2021 when MassDOT submitted a revised unit cost to FHWA.[7]

Construction Noise

MassDOT conducted a construction noise analysis to generally disclose potential impacted receptors, describe potential ranges in construction noise levels, and identify measures to be included in project plans and specifications. Data on construction equipment noise levels for the analysis is derived from the FHWA's Roadway Construction Noise Model (version 1.1) database.[8]

Construction Vibration

MassDOT derived guidance for the assessment of construction-related vibration impacts from the FTA's guidance manual. A quantitative construction vibration assessment was conducted to identify distances within which there would be a potential for vibration-induced structural damage and annoyance from heavy construction activities.

4.15.2 Existing Conditions

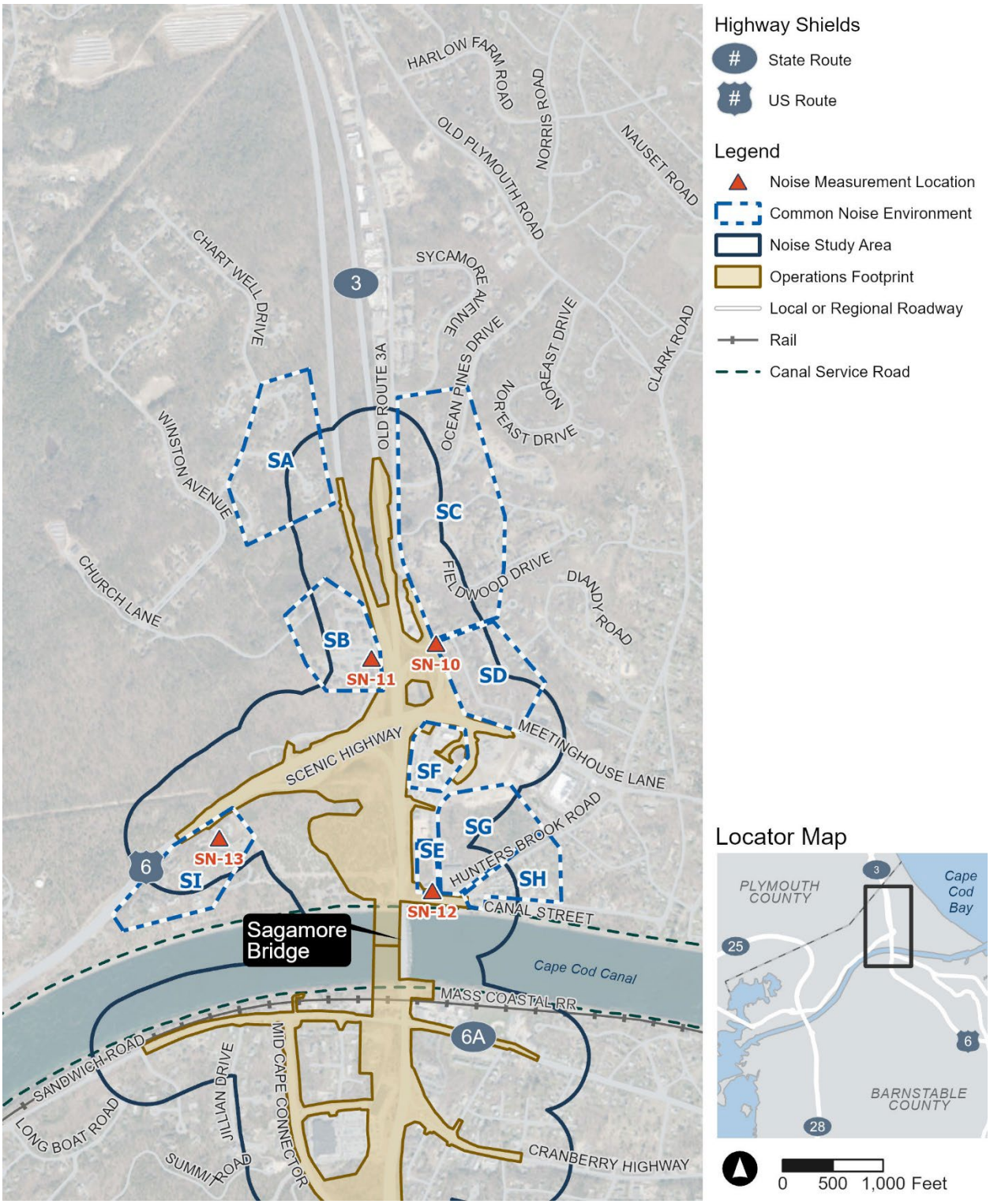
Based on noise measurements conducted in May 2023, the dominant source of noise in the Study Areas was vehicular traffic from automobiles and trucks on State Route 3, U.S. Route 6, State Route 25, and other major arterials. Noise-sensitive land uses within the Study Areas include primarily single- and multi-family residential developments (Activity Category B). Other noise-sensitive land uses that were identified within the Study Areas include parks and recreation areas (Activity Category C), schools with exterior use areas (Activity Category C), as well as restaurants and hotels with exterior use areas (Activity Category E). Noise-sensitive receptor sites within the Noise Study Areas were grouped into 33 CNEs (**Figure 4.15-1 through Figure 4.15-4**).

Table 4.15-2 and **Table 4.15-3** summarize 2019 existing condition noise levels and the number of receptors predicted to approach or exceed the Activity Categories B and C NAC of 67 dBA Leq and the Activity E Category NAC of 72 dBA Leq within the Sagamore North quadrant and Sagamore South quadrant. **Table 4.15-4** and **Table 4.15-5** summarize the 2019 existing condition noise levels and number of receptors predicted to approach or exceed the Activity Categories B and C NAC of 67 dBA Leq and the Activity E Category NAC of 72 dBA Leq within the Bourne North quadrant and Bourne South quadrant.

[7] The Massachusetts Department of Transportation defines a benefited receptor as one that achieves a noise level reduction of at least 5 dBA (A-weighted decibels) with a noise abatement measure. A benefited receptor does not have to be one that is impacted.

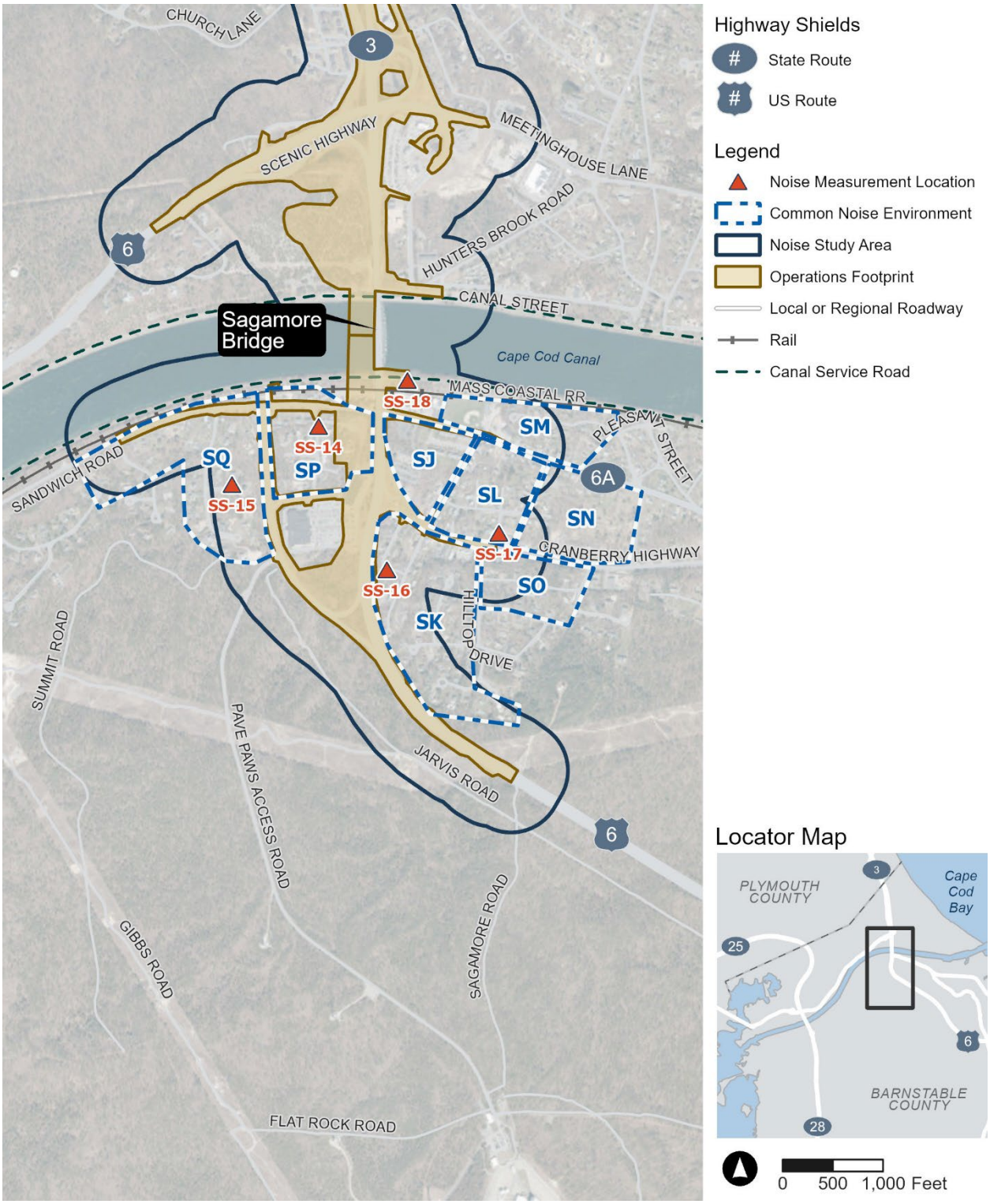
[8] https://www.fhwa.dot.gov/environment/noise/construction_noise/rcnm/

Figure 4.15-1 Common Noise Environment Boundaries and Noise Measurement Locations (Sagamore North Quadrant)



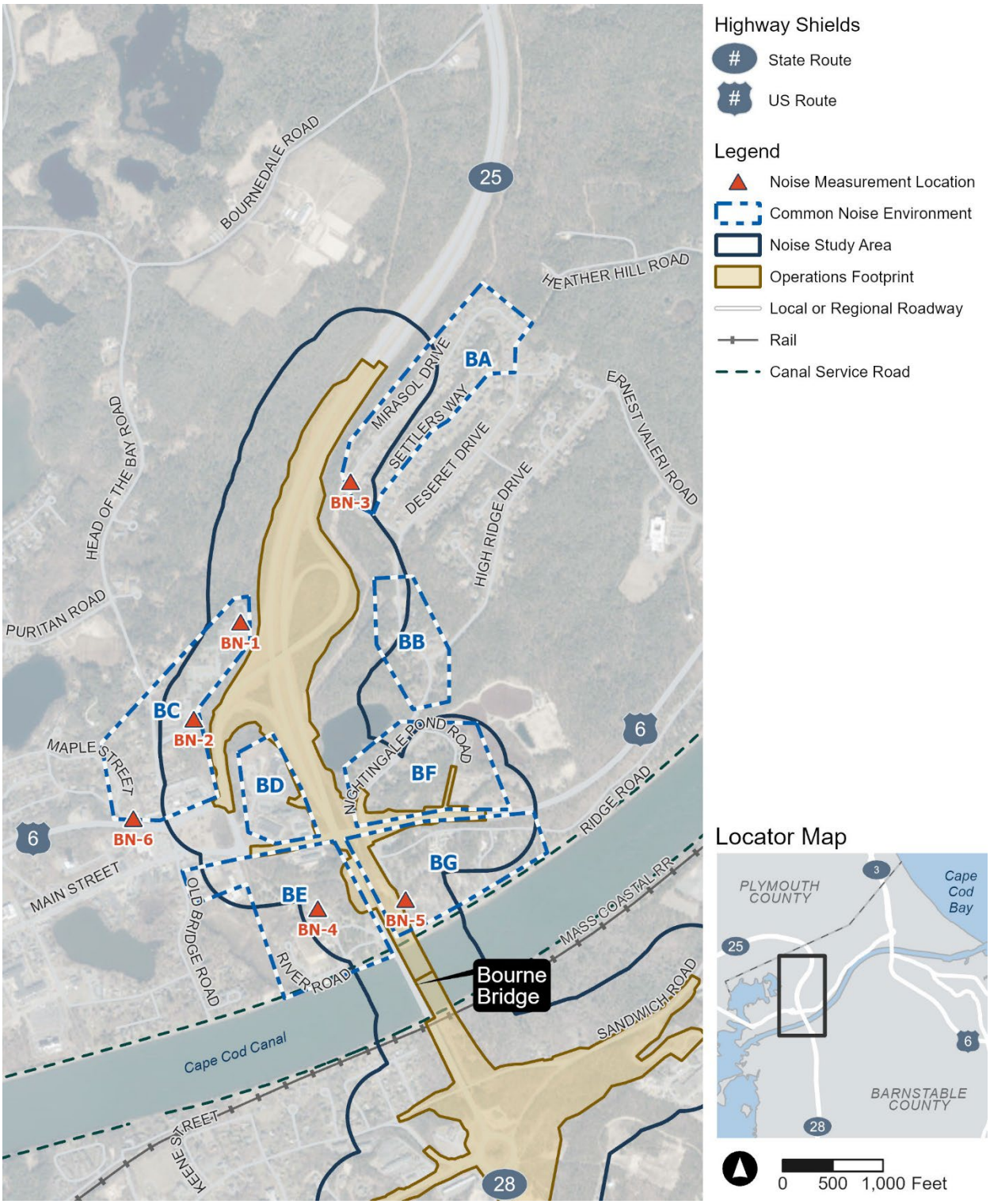
Source: Massachusetts Department of Transportation, 2024

Figure 4.15-2. Common Noise Environment Boundaries and Noise Measurement Locations (Sagamore South Quadrant)



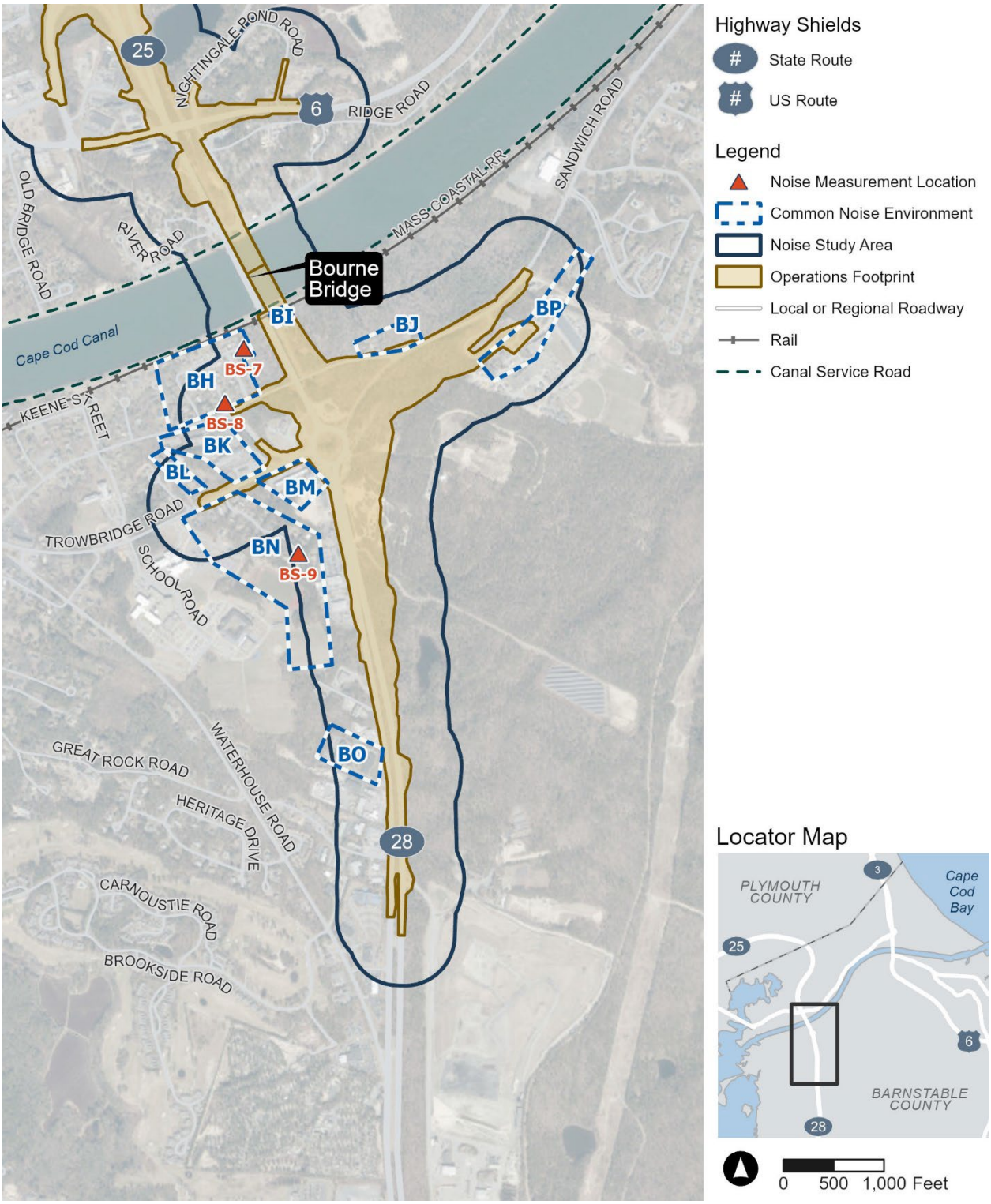
Source: Massachusetts Department of Transportation, 2024

Figure 4.15-3. Common Noise Environment Boundaries and Noise Measurement Locations (Bourne North Quadrant)



Source: Massachusetts Department of Transportation, 2024

Figure 4.15-4. Common Noise Environment Boundaries and Noise Measurement Locations (Bourne South Quadrant)



Source: Massachusetts Department of Transportation, 2024

In the Sagamore North quadrant for the 2019 existing conditions (**Table 4.15-2**), four single-family residential dwelling units within CNEs SC and SD approach or exceed the FHWA Category B NAC. No Activity Categories C, D, or E land uses approach or exceed the respective NAC thresholds for the 2019 existing condition in the Sagamore North quadrant.

Table 4.15-2. 2019 Existing: Loudest Traffic Hour Noise Levels (Sagamore North Quadrant)

Common Noise Environment	Adjacent Roadways	2019 Existing Condition Noise Level Ranges Leq	Federal Highway Administration Activity Category	2019 Existing Condition Approach or Exceed Noise Abatement Criteria
SA	State Route 3 Southbound	44–60	B	0
SB	State Route 3 Southbound	51–65	B	0
SC	State Route 3 Northbound	49–67	B	3
SD	State Route 3 Northbound	46–68	B	1
SE	U.S. Route 6 Northbound	60–61	B	0
SF	U.S. Route 6 Northbound	61–63	C	0
			E	0
SG	U.S. Route 6 Northbound	55–60	B	0
	Canal Street			
SH	U.S. Route 6 Northbound	49–60	B	0
	Canal Street		C	0
SI	Scenic Highway	52–65	B	0

Source: Massachusetts Department of Transportation, 2024

Note: Refer to **Figure 4.15-1** for Common Noise Environment locations.

Leq = equivalent sound level

In the Sagamore South quadrant for the 2019 existing conditions (**Table 4.15-3**), 36 residential dwelling units approach or exceed the FHWA Category B NAC. Existing noise levels also approach or exceed the FHWA Activity Category C NAC at Keith Field on the field behind home plate in the catcher's position. To determine the number of equivalent receptors predicted to experience noise levels that approach or exceed the FHWA Category C NAC at Keith Field, a schedule of events on the Bourne Recreation website was reviewed.[9] The calendar for booking usage of Keith Field shows that, on average, there is either one game or practice at the field per day. Behind home plate, a maximum of three people per day (i.e., the batter, catcher, and potentially one umpire if the field is being used for a game) for a total of approximately three hours would experience noise levels that approach or exceed the FHWA

[9] https://bournema.myrec.com/info/facilities/details.aspx?FacilityID=14558

Category C NAC. No Activity Category E land uses approach or exceed the respective NAC thresholds for the 2019 existing conditions in the Sagamore South quadrant.

Table 4.15-3. 2019 Existing: Loudest Traffic Hour Noise Levels (Sagamore South Quadrant)

Common Noise Environment	Adjacent Roadways	2019 Existing Condition Noise Level Ranges Leq	Federal Highway Administration Activity Category	2019 Existing Condition Approach or Exceed Noise Abatement Criteria
SJ	Sandwich Road	54–68	B	20
SK	U.S. Route 6 Northbound	53–71	B	5
	Sandwich Road		C	0
SL	Sandwich Road	51–67	B	2
	Cranberry Highway		E	0
SM	Sandwich Road	48–67	B	7
			C	3
SN	Sandwich Road	49–65	B	0
	Cranberry Highway		C	0
			E	0
SO	Cranberry Highway	50–64	B	0
SP	U.S. Route 6 Southbound	53–61	B	0
	Mid-Cape Connector			
	Sandwich Road			
SQ	Mid-Cape Connector	49–69	B	2
	Sandwich Road			

Source: Massachusetts Department of Transportation, 2024

Note: Refer to **Figure 4.15-2** for Common Noise Environment locations.

Leq = equivalent sound level

In the Bourne North quadrant for the 2019 existing conditions (**Table 4.15-4**), there are no residential dwelling units that approach or exceed the FHWA Category B NAC. No Activity Categories C, D, or E land uses approach or exceed the respective NAC thresholds for the 2019 existing condition in the Bourne North quadrant.

Table 4.15-4. 2019 Existing: Loudest Traffic Hour Noise Levels (Bourne North Quadrant)

Common Noise Environment	Adjacent Roadways	2019 Existing Noise Level Ranges Leq	Federal Highway Administration Activity Category	2019 Existing Condition Approach or Exceed Noise Abatement Criteria
BA	State Route 25 Northbound	45–63	B	0
BB	State Route 25 Northbound and northbound/southbound on-ramps	52–55	B	0
BC	State Route 25 Southbound	48–65	B	0
			E	
BD	State Route 25 Southbound	60–65	E	0
BE	State Route 28 Southbound	53–63	B	0
			C	
			E	
BF	State Route 28 Northbound	53–65	B	0
	U.S. Route 6/Main Street			
BG	State Route 28 Northbound	53–62	C	0
	U.S. Route 6/Main Street			

Source: Massachusetts Department of Transportation, 2024

Note: Refer to **Figure 4.15-3** for Common Noise Environment locations.

Leq = equivalent sound level

In the Bourne South quadrant for the 2019 existing conditions (**Table 4.15-5**), no residences approach or exceed the FHWA Category B NAC. One bench on the north side of the Bourne Manor Extended Care facility approaches or exceeds the FHWA Activity Category C NAC for the 2019 existing condition. No FHWA Activity Categories D or E land uses approach or exceed the respective NAC thresholds for the 2019 existing condition in the Bourne South quadrant.

Table 4.15-5. 2019 Existing: Loudest Traffic Hour Noise Levels (Bourne South Quadrant)

Common Noise Environment	Adjacent Roadways	2019 Existing Noise Level Ranges Leq	Federal Highway Administration Activity Category	2019 Existing Condition Approach or Exceed Noise Abatement Criteria
BH	State Route 28 Southbound	52–60	B	0
BI	State Route 28 Northbound	57–58	C	0
BJ	Sandwich Road	59–64	B	0
BK	Veterans Way	42–64	B	0
	Sandwich Road		C	0
	Trowbridge Road		E	0
BL	Sandwich Road	51–53	B	0
	Trowbridge Road			
BM	State Route 28 Southbound	52–64	E	0
	Trowbridge Road			
BN	State Route 28 Southbound	46–60	B	0
	Trowbridge Road		C	0
BO	State Route 28 Southbound	54–67	C	1
BP	Sandwich Road	28–55	B	0
			C	0

Source: Massachusetts Department of Transportation, 2024

Note: Refer to **Figure 4.15-4** for Common Noise Environment locations.

Leq = equivalent sound level

4.15.3 No Build Alternative

This section presents the operational traffic noise impacts of the future 2050 No Build Alternative on noise-sensitive receptors within the Study Area quadrants.

No construction activities would occur for the No Build Alternative. Therefore, no construction-related noise or vibration would be generated.

4.15.3.1 Operational Traffic Noise Impacts

Table 4.15-6 and **Table 4.15-7** summarize the 2050 No Build Alternative noise levels and number of receptors predicted to approach or exceed the Activity Categories B and C NAC of 67 dBA Leq and the Activity E Category NAC of 72 dBA Leq within the Sagamore North and Sagamore South quadrants, respectively. **Table 4.15-8** and **Table 4.15-9** summarize the 2050 No Build Alternative noise levels and number of receptors predicted to approach or exceed the Activity Categories B and C NAC of 67 dBA Leq and the Activity E Category NAC of 72 dBA Leq within the Bourne North and Bourne South quadrants, respectively.

For the 2050 No Build Alternative in the Sagamore North quadrant (**Table 4.15-6**), seven residential dwelling units within CNEs SB, SC, and SD would approach or exceed the Activity Category B NAC for the 2050 No Build Alternative. In addition, one permitted development (Cape View Way) was identified and includes a plan for 42 residential apartment units (FHWA Activity Category B) on five parcels north of Meetinghouse Lane (refer to **Figure 4.15-5f**). A building permit was issued for this development on September 24, 2024, and construction is underway. Due to the development's distance from the State Route 3/U.S. Route 6 mainline travel lanes and Meetinghouse Lane, noise levels would not approach or exceed the Activity Category B NAC for the 2050 No Build Alternative at this development. No Activity Categories C, D, or E land uses would approach or exceed the respective NAC thresholds for the 2050 No Build Alternative in the Sagamore North quadrant.

In the Sagamore South quadrant for the 2050 No Build Alternative (**Table 4.15-7**), 46 residential dwelling units would approach or exceed the FHWA Category B NAC within CNEs SJ, SK, SL, SM, SN, and SQ. The 2050 No Build Alternative noise levels would approach or exceed the FHWA Activity Category C NAC at Keith Field on the field behind home plate in the catcher's position. To determine the number of equivalent receptors predicted to experience noise levels that approach or exceed the FHWA Category C NAC at Keith Field, a schedule of events on the Bourne Recreation website was reviewed.[10] The calendar for booking usage of Keith Field shows that, on average, there is either one game or practice at the field per day. Behind home plate, a maximum of three people per day (i.e., the batter, catcher, and potentially one umpire if the field is being used for a game) for a total of approximately three hours would experience noise levels that approach or exceed the FHWA Category C NAC. No Activity Category E land uses would approach or exceed the respective NAC thresholds for the 2050 No Build Alternative in the Sagamore South quadrant.

[10] https://bournema.myrec.com/info/facilities/details.aspx?FacilityID=14558

For the 2050 No Build Alternative in the Bourne North quadrant (**Table 4.15-8**), two residential dwelling units would approach or exceed the FHWA Category B NAC within CNE BF along U.S. Route 6/Main Street westbound. In addition, one permitted future development (340 Main Street) was identified that includes a plan for 24 townhome style residences (FHWA Activity Category B) along U.S. Route 6/Main Street behind and west of Bourne Bridge and behind the Sav-On gas station. A building permit was issued for this development on March 5, 2022, and construction is anticipated to commence in winter 2025. Noise levels are not predicted to approach or exceed the Activity Category B NAC for the 2050 No Build Alternative at this permitted development due to their distance from U.S. Route 6/Main Street and the Bourne Bridge mainline travel lanes. No Activity Categories C, D or E land uses would approach or exceed the respective NAC thresholds for the 2050 No Build Alternative in the Bourne North quadrant.

In the Bourne South quadrant for the 2050 No Build Alternative (**Table 4.15-9**), no residences would approach or exceed the FHWA Category B NAC. One bench on the north side of the Bourne Manor Extended Care facility would approach or exceed the FHWA Activity Category C NAC for the 2050 No Build Alternative. No FHWA Activity Categories D or E land uses would approach or exceed the respective NAC thresholds for the 2050 No Build Alternative in the Bourne South quadrant.

Table 4.15-6. 2050 No Build Alternative: Loudest Traffic Hour Noise Levels (Sagamore North Quadrant)

Common Noise Environment	Adjacent Roadways	2050 No Build Alternative Noise Level Ranges Leq	Federal Highway Administration Activity Category	2050 No Build Alternative Approach or Exceed Noise Abatement Criteria
SA	State Route 3 Southbound	45–61	B	0
SB	State Route 3 Southbound	52–67	B	2
SC	State Route 3 Northbound	51–69	B	3
SD	State Route 3 Northbound	47–69	B	2
SE	U.S. Route 6 Northbound	61–62	B	0
SF	U.S. Route 6 Northbound	61–65	C	0
			E	0
SG	U.S. Route 6 Northbound	56–61	B	0
	Canal Street			
SH	U.S. Route 6 Northbound	49–61	B	0
	Canal Street		C	0
SI	Scenic Highway	53–65	B	0

Common Noise Environment	Adjacent Roadways	2050 No Build Alternative Noise Level Ranges Leq	Federal Highway Administration Activity Category	2050 No Build Alternative Approach or Exceed Noise Abatement Criteria
Permitted Development – Cape View Way[a]	Meetinghouse Lane	49–52	B	0

[a] Cape View Way is a proposed residential development (Federal Highway Administration Activity Category B) that received a building permit on September 24, 2024, to construct 42 residential dwelling units.

Note: Refer to **Figure 4.15-1** for Common Noise Environment locations.

Leq = equivalent sound level

Table 4.15-7. 2050 No Build Alternative: Loudest Traffic Hour Noise Levels (Sagamore South Quadrant)

Common Noise Environment	Adjacent Roadways	2050 No Build Alternative Noise Level Ranges Leq	Federal Highway Administration Activity Category	2050 No Build Alternative Approach or Exceed Noise Abatement Criteria
SJ	Sandwich Road	55–69	B	20
SK	U.S. Route 6 Northbound	54–72	B	7
	Sandwich Road		C	0
SL	Sandwich Road	52–68	B	4
	Cranberry Highway		E	0
SM	Sandwich Road	50–69	B	8
			C	3
SN	Sandwich Road Cranberry Highway	51–67	B	3
			C	0
			E	0
SO	Cranberry Highway	51–65	B	0
SP	U.S. Route 6 Southbound	54–63	B	0
	Mid-Cape Connector			
	Sandwich Road			
SQ	Mid-Cape Connector	51–70	B	4
	Sandwich Road			

Note: Refer to **Figure 4.15-2** for Common Noise Environment locations.

Leq = equivalent sound level

Table 4.15-8. 2050 No Build Alternative: Loudest Traffic Hour Noise Levels (Bourne North Quadrant)

Common Noise Environment	Adjacent Roadways	2050 No Build Alternative Noise Level Ranges Leq	Federal Highway Administration Activity Category	2050 No Build Alternative Approach or Exceed Noise Abatement Criteria
BA	State Route 25 Northbound	46–63	B	0
BB	State Route 25 Northbound and northbound/southbound on-ramps	53–56	B	0
BC	State Route 25 Southbound	49–65	B	0
			E	
BD	State Route 25 Southbound	61–66	E	0
BE	State Route 28 Southbound	54–65	B	0
			C	
			E	
BF	State Route 28 Northbound	54–66	B	2
	U.S. Route 6/Main Street			
BG	State Route 28 Northbound	54–63	C	0
	U.S. Route 6/Main Street			
Permitted Development – 340 Main Street[a]	State Route 28 Northbound	58–65	B	0
	U.S. Route 6/Main Street			

[a] 340 Main Street is a part of a mixed-use development, where Phase I has been completed and includes six second-story apartment units above first floor commercial property. Phase II includes construction of 24 rental townhome style units behind the commercial property. Phase II building permit was issued on March 5, 2022.

Note: Refer to **Figure 4.15-3** for Common Noise Environment locations.

Leq = equivalent sound level

Table 4.15-9. 2050 No Build Alternative: Loudest Traffic Hour Noise Levels (Bourne South Quadrant)

Common Noise Environment	Adjacent Roadways	2050 No Build Alternative Level Ranges Leq	Federal Highway Administration Activity Category	2050 No Build Alternative Approach or Exceed Noise Abatement Criteria
BH	State Route 28 Southbound	53–60	B	0
BI	State Route 28 Northbound	59–60	C	0
BJ	Sandwich Road	60–65	B	0
BK	Veterans Way	42–63	B	0
	Sandwich Road		C	0
	Trowbridge Road		E	0
BL	Sandwich Road	52–55	B	0
	Trowbridge Road			
BM	State Route 28 Southbound	53–65	E	0
	Trowbridge Road			
BN	State Route 28 Southbound	47–61	B	0
	Trowbridge Road		C	
BO	State Route 28 Southbound	54–67	C	3
BP	Sandwich Road	29–55	B	0
			C	

Note: Refer to **Figure 4.15-4** for Common Noise Environment locations.

Leq = equivalent sound level

4.15.4 Program Impacts

4.15.4.1 Operational Traffic Noise Impacts

Table 4.15-10, **Table 4.15-11**, **Table 4.15-12**, and **Table 4.15-13** summarize the 2050 Build Alternative noise levels and number of receptors predicted to approach or exceed Activity Categories B and C NAC (67 dBA Leq) and the Activity Category E NAC (72 dBA Leq) within the Sagamore North, Sagamore South, Bourne North, and Bourne South quadrants, respectively.

Figures 4.15-5a through 4.15-5i, **Figures 4.15-6a through 4.15-6h**, **Figures 4.15-7a through 4.15-7i**, and **Figures 4.15-8a through 4.15-8g** provide location maps for the CNEs, noise-sensitive receptors and barriers evaluated (refer to **Section 4.15.5.1** for a discussion of evaluated noise barriers) within the Sagamore North, Sagamore South, Bourne North, and Bourne South quadrants, respectively. On each figure, triangles represent noise measurement locations, while squares, pentagons, and hexagons represent impacted receptors with different noise level reductions from evaluated noise barriers (insertion loss). Squares represent impacted receptors as well as impacted receptors that would achieve less than 5 dB noise reduction with noise abatement measures, pentagons represent impacted receptors that would achieve noise level reductions ranging between 5 and 9 dB, and hexagons represent impacted receptors that would achieve 10 dB or greater noise reduction. Large circles represent receptors that would not be impacted but would achieve at least a 5 dB noise reduction with a noise barrier, while small circles represent receptors that would not be impacted and would also not achieve a 5 dB noise reduction.

Nine residential dwelling units are within CNEs SB, SC, and SD that would approach or exceed the Activity Category B NAC. The 2050 Build Alternative noise levels are not predicted to approach or exceed the Activity Category B NAC at the proposed Cape View Way permitted development. No Activity Categories C, D, or E land uses would approach or exceed the respective NAC thresholds for the 2050 No Build Alternative in the Sagamore North quadrant (**Table 4.15-10**). In addition, no substantial noise increases are predicted within the Sagamore North quadrant.

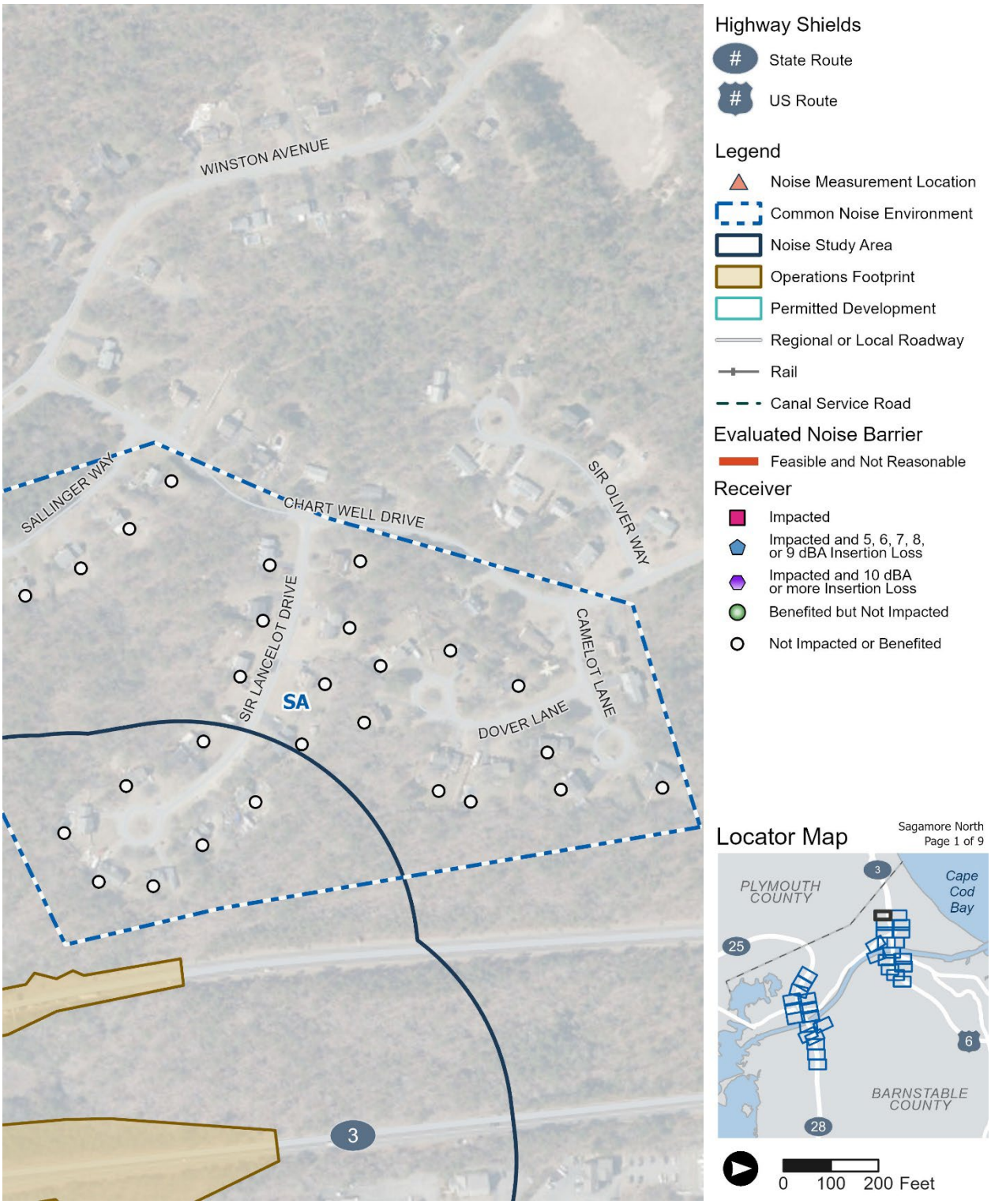
Table 4.15-10. 2050 Build Alternative: Loudest Traffic Hour Noise Levels (Sagamore North Quadrant)

Common Noise Environment	Adjacent Roadways	2019 Existing Condition Noise Level Ranges Leq	2050 Build Alternative Noise Level Ranges Leq	Federal Highway Administration Activity Category	2050 Build Alternative Approach or Exceed Noise Abatement Criteria
SA (Figures 4.15-5a, 5c)	State Route 3 Southbound	44–60	46–61	B	0
SB (Figures 4.15-5c, 5e)	State Route 3 Southbound	51–65	52–66	B	3
SC (Figures 4.15-5b, 5d, 5f)	State Route 3 Northbound	49–67	51–68	B	3
SD (Figures 4.15-5d, 5f)	State Route 3 Northbound	46–68	48–66	B	2
SE (Figures 4.15-5h, 5i)	U.S. Route 6 Northbound	60–61	62–62	B	0
SF (Figures 4.15-5e, 5f, 5h, 5i)	U.S. Route 6 Northbound	61–63	58–62	C	0
				E	0
SG (Figure 4.15-5i)	U.S. Route 6 Northbound Canal Street	55–60	57–61	B	0
SH (Figure 4.15-5i)	U.S. Route 6 Northbound	49–60	50–62	B	0
	Canal Street			C	0
SI (Figures 4.15-5g, 5h)	Scenic Highway	52–65	54–66	B	1
Permitted Development – Cape View Way[a]	Meetinghouse Lane	N/A	50–52	B	0

[a] Cape View Way is a proposed residential development (Federal Highway Administration Activity Category B) that received a building permit on September 24, 2024, for construction of 42 residential dwelling units. The 2019 existing noise levels are not reported for permitted developments because they do not yet exist.

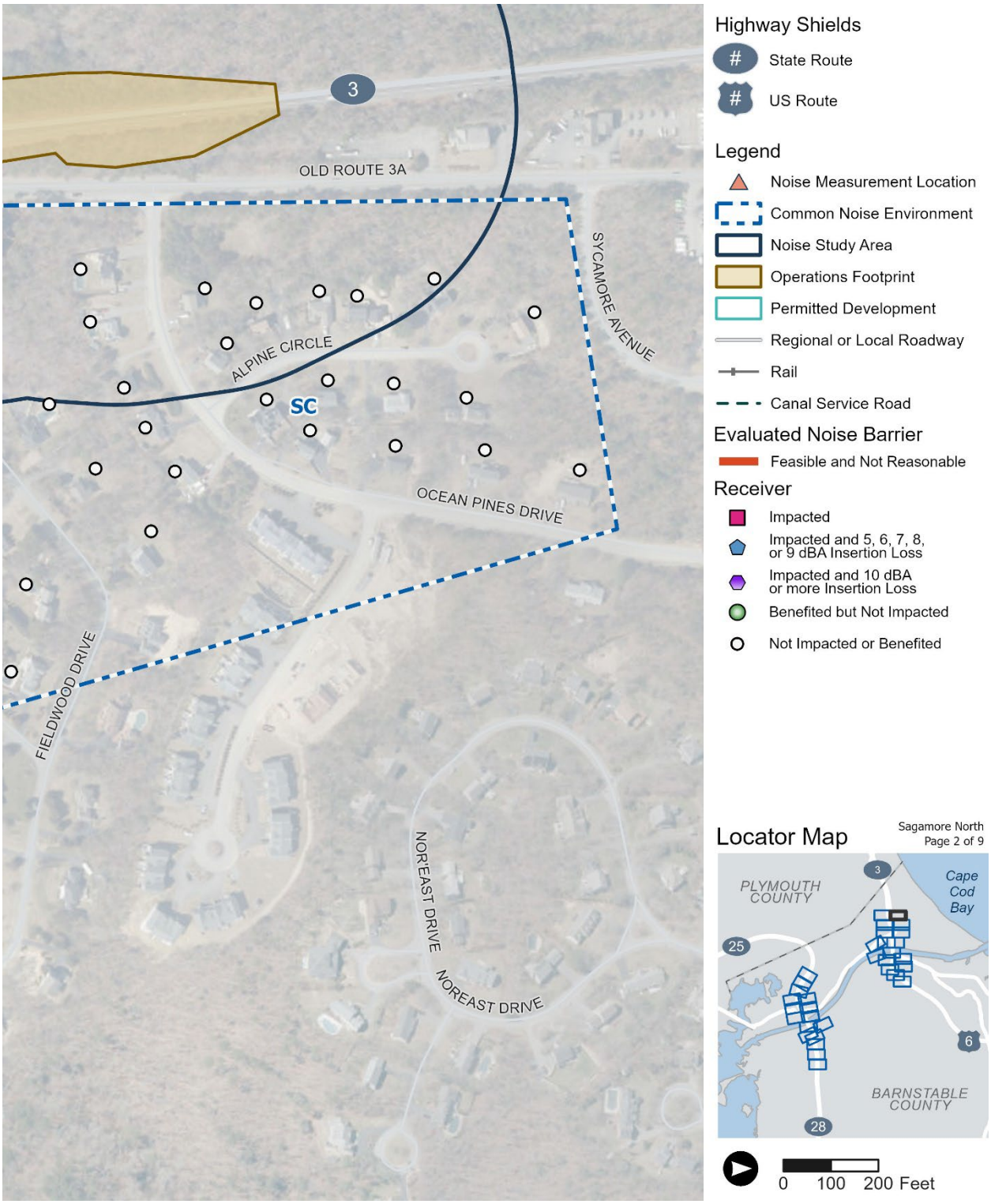
Leq = equivalent sound level

Figure 4.15-5a. Build Alternative: Locations for Barriers, Common Noise Environments, and Receptors (Sagamore North Quadrant)



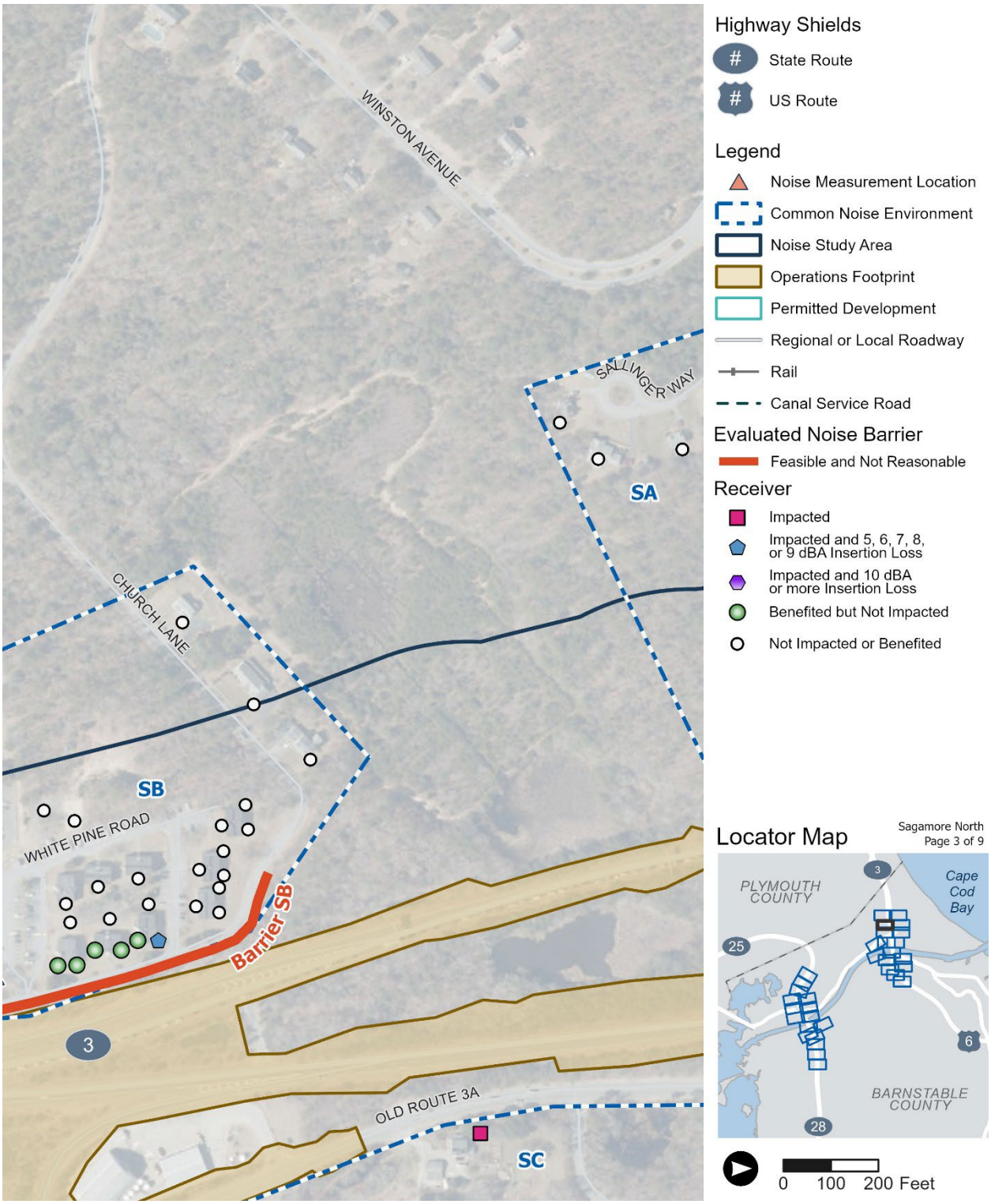
Source: Massachusetts Department of Transportation, 2024

Figure 4.15-5b. Build Alternative: Locations for Barriers, Common Noise Environments, and Receptors (Sagamore North Quadrant)



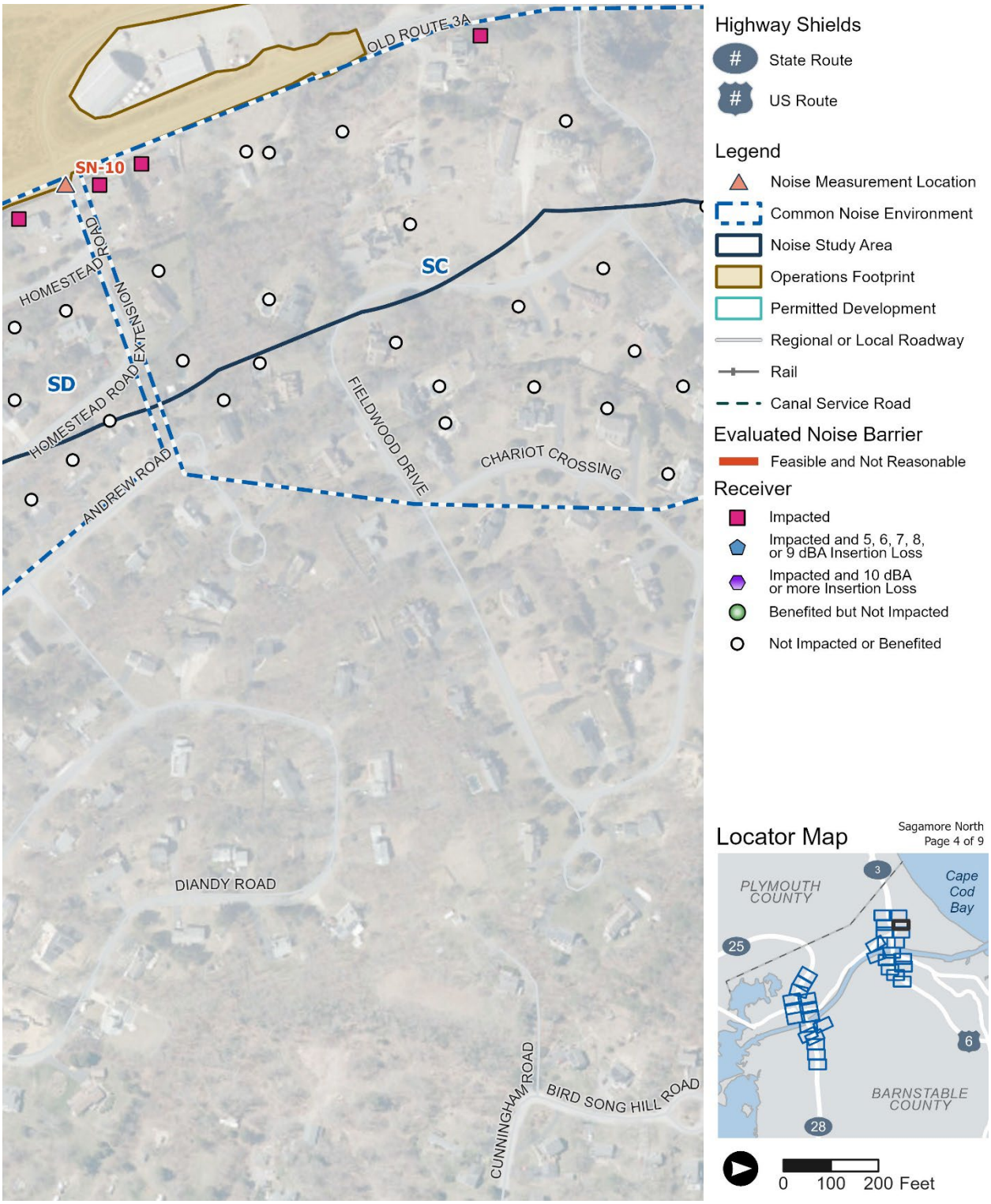
Source: Massachusetts Department of Transportation, 2024

Figure 4.15-5c. Build Alternative: Locations for Barriers, Common Noise Environments, and Receptors (Sagamore North Quadrant)



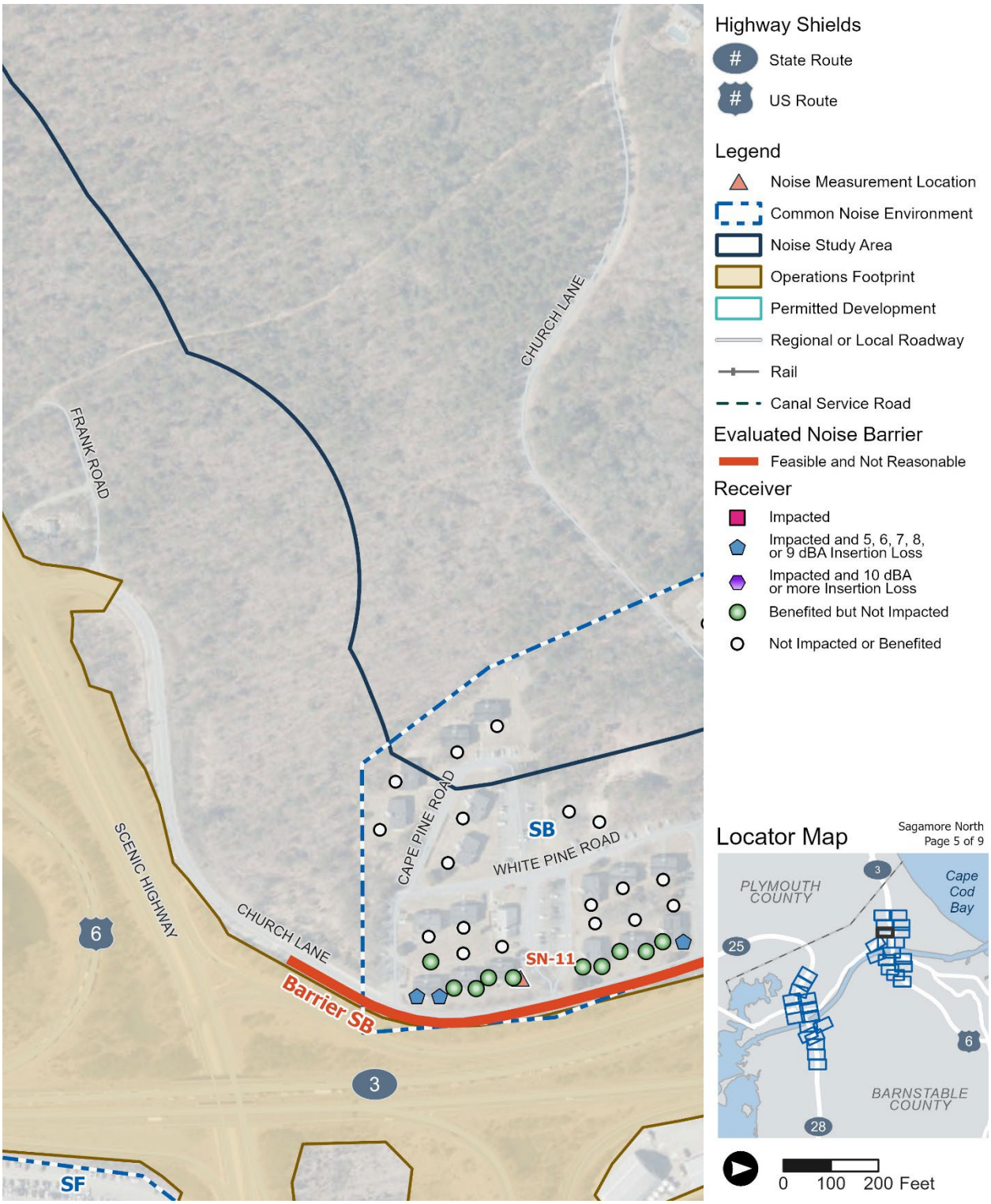
Source: Massachusetts Department of Transportation, 2024

Figure 4.15-5d. Build Alternative: Locations for Barriers, Common Noise Environments, and Receptors (Sagamore North Quadrant)



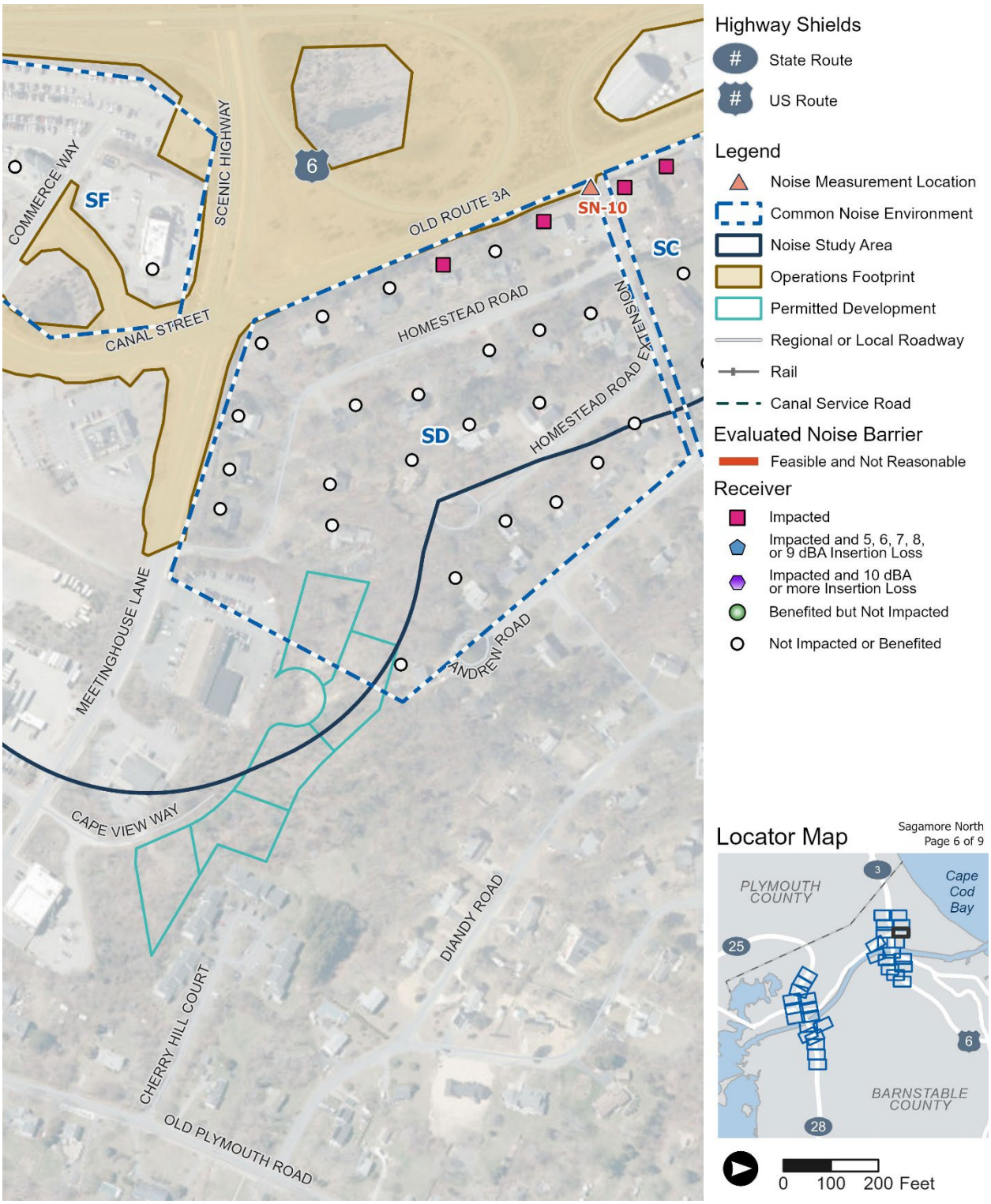
Source: Massachusetts Department of Transportation, 2024

Figure 4.15-5e. Build Alternative: Locations for Barriers, Common Noise Environments, and Receptors (Sagamore North Quadrant)



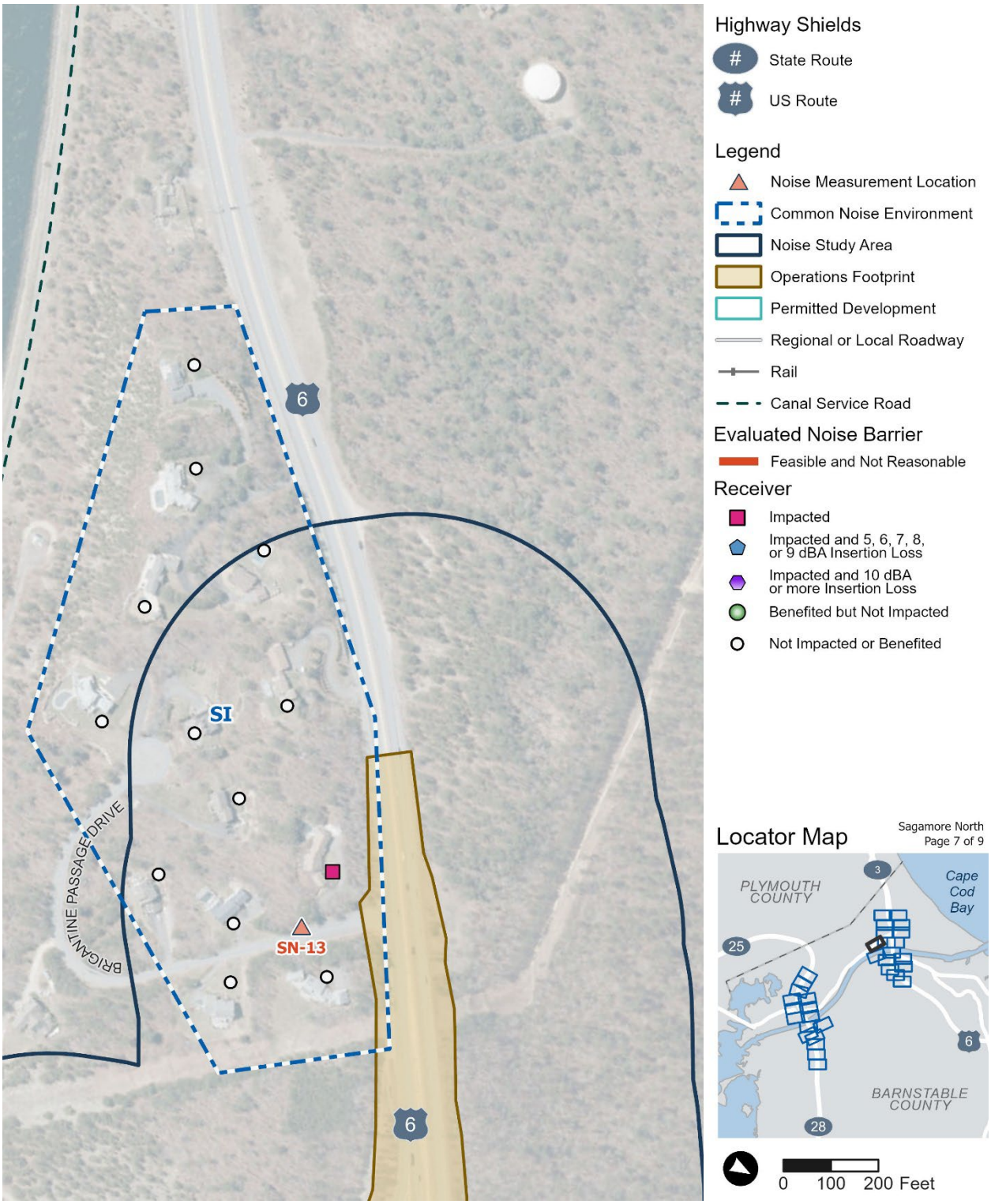
Source: Massachusetts Department of Transportation, 2024

Figure 4.15-5f. Build Alternative: Locations for Barriers, Common Noise Environments, and Receptors (Sagamore North Quadrant)



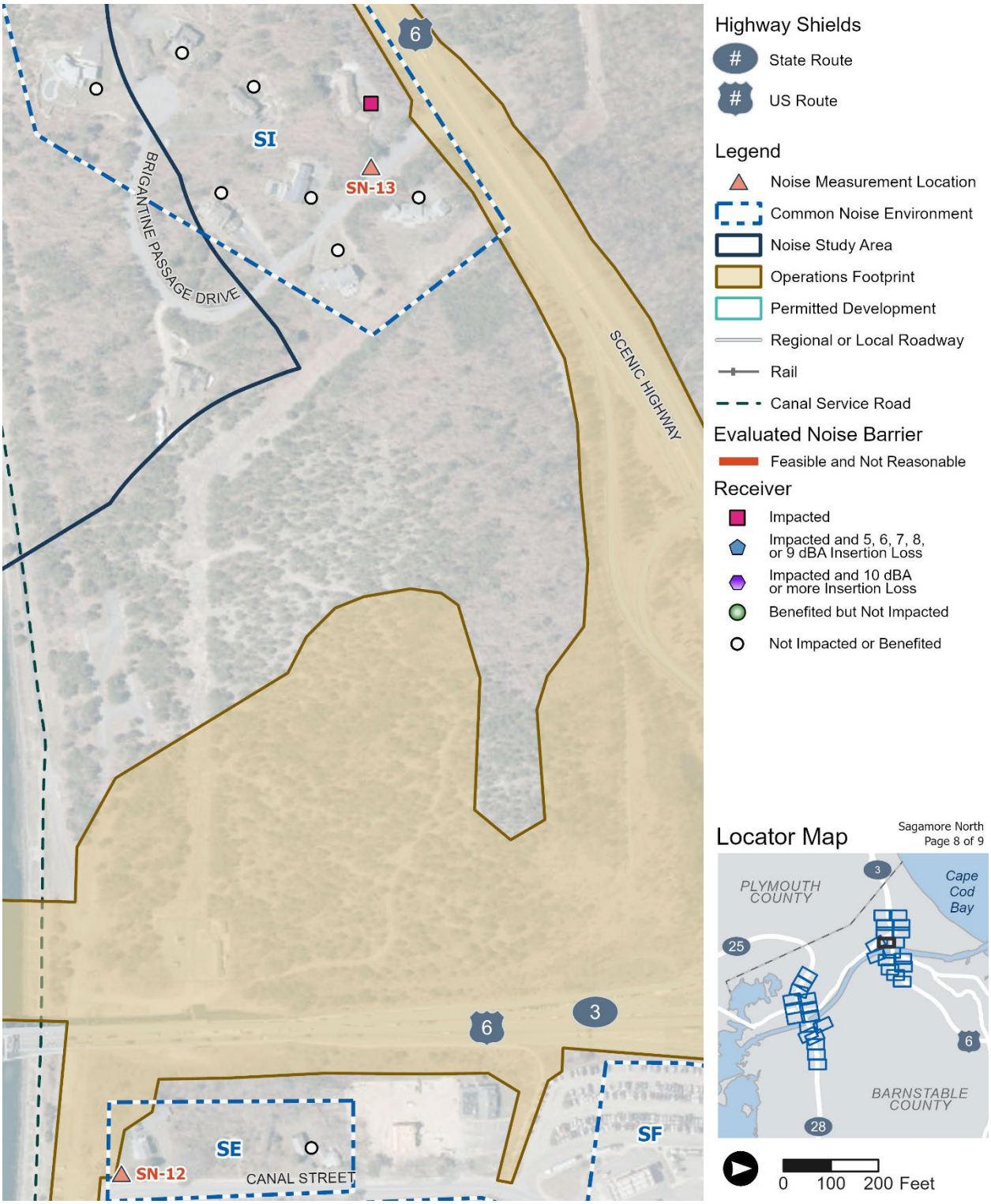
Source: Massachusetts Department of Transportation, 2024

Figure 4.15-5g. Build Alternative: Locations for Barriers, Common Noise Environments, and Receptors (Sagamore North Quadrant)



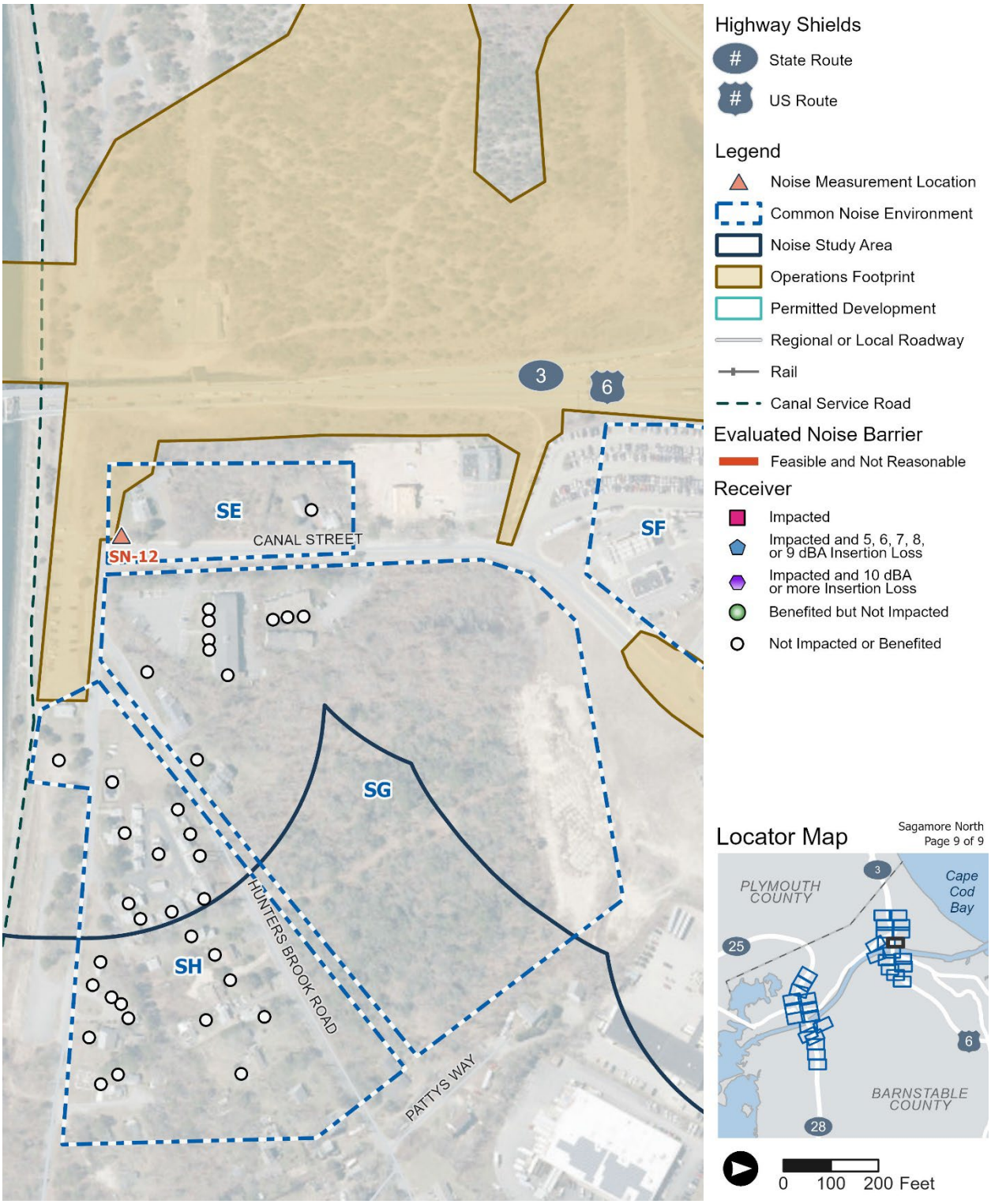
Source: Massachusetts Department of Transportation, 2024

Figure 4.15-5h. Build Alternative: Locations for Barriers, Common Noise Environments, and Receptors (Sagamore North Quadrant)



Source: Massachusetts Department of Transportation, 2024

Figure 4.15-5i. Build Alternative: Locations for Barriers, Common Noise Environments, and Receptors (Sagamore North Quadrant)



Source: Massachusetts Department of Transportation, 2024

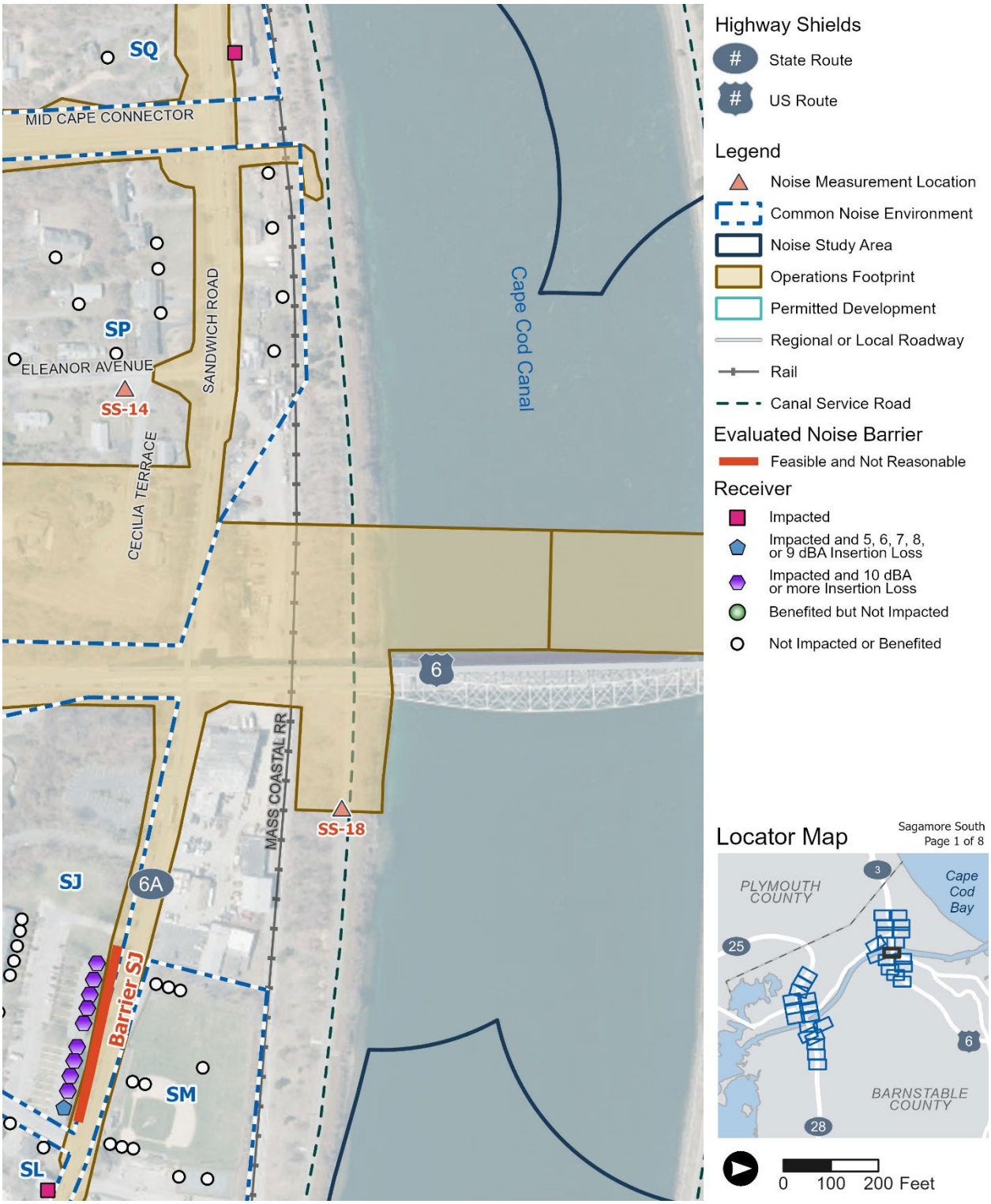
Within the Sagamore South quadrant (**Table** 4.15-11), 45 residential dwelling units would approach or exceed the FHWA Category B NAC within CNEs SJ, SK, SL, SM, SN, and SQ. No Activity Category C, D, or E land uses would approach or exceed the respective NAC thresholds for the 2050 Build Alternative in the Sagamore South quadrant. In addition, no substantial noise increases are predicted within the Sagamore South quadrant.

Table 4.15-11. 2050 Build Alternative: Loudest Traffic Hour Noise Levels (Sagamore South Quadrant)

Common Noise Environment	Adjacent Roadways	2019 Existing Condition Noise Level Ranges Leq	2050 Build Alternative Noise Level Ranges Leq	Federal Highway Administration Activity Category	2050 Build Alternative Approach or Exceed Noise Abatement Criteria
SJ (**Figures 4.15-6a**, **6c**, **6d**, **6e**)	Sandwich Road	54–68	56–67	B	20
SK (**Figures 4.15-6c**, **6d**, **6e**, **6f**, **6g**)	U.S. Route 6 Northbound	53–71	56–69	B	5
	Sandwich Road			C	0
SL (**Figures 4.15-6a**, **6d**, **6e**)	Sandwich Road	51–67	54–67	B	5
	Cranberry Highway			E	0
SM (**Figures 4.15-6a**, **6d**)	Sandwich Road	48–67	50–66	B	7
				C	0
SN (**Figures 4.15-6d**, **6e**)	Sandwich Road	49–65	52–66	B	1
	Cranberry Highway			C	0
				E	0
SO (**Figure 4.15-6e**)	Cranberry Highway	50–64	53–69	B	1
SP (**Figures 4.15-6aSSQa**, **6b**, **6c**)	U.S. Route 6 Southbound	53–61	61–64	B	0
	Mid-Cape Connector				
	Sandwich Road				
SQ (**Figures 4.15-6a**, **6b**, **6c**, **6f**)	Mid-Cape Connector	49–69	52–71	B	6
	Sandwich Road				

Leq = equivalent sound level

Figure 4.15-6a. Build Alternative: Locations for Barriers, Common Noise Environments, and Receptors (Sagamore South Quadrant)



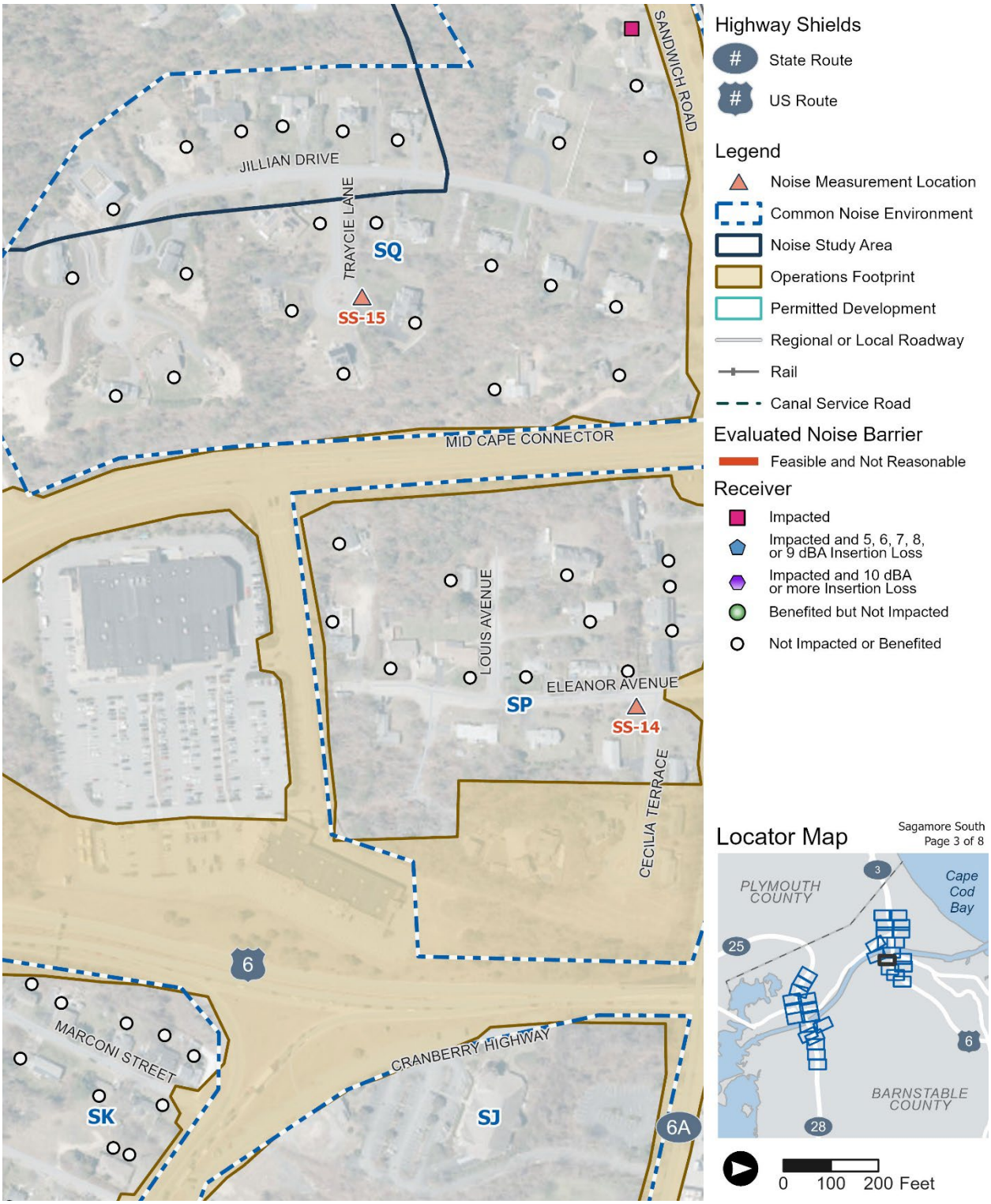
Source: Massachusetts Department of Transportation, 2024

Figure 4.15-6b. Build Alternative: Locations for Barriers, Common Noise Environments, and Receptors (Sagamore South Quadrant)



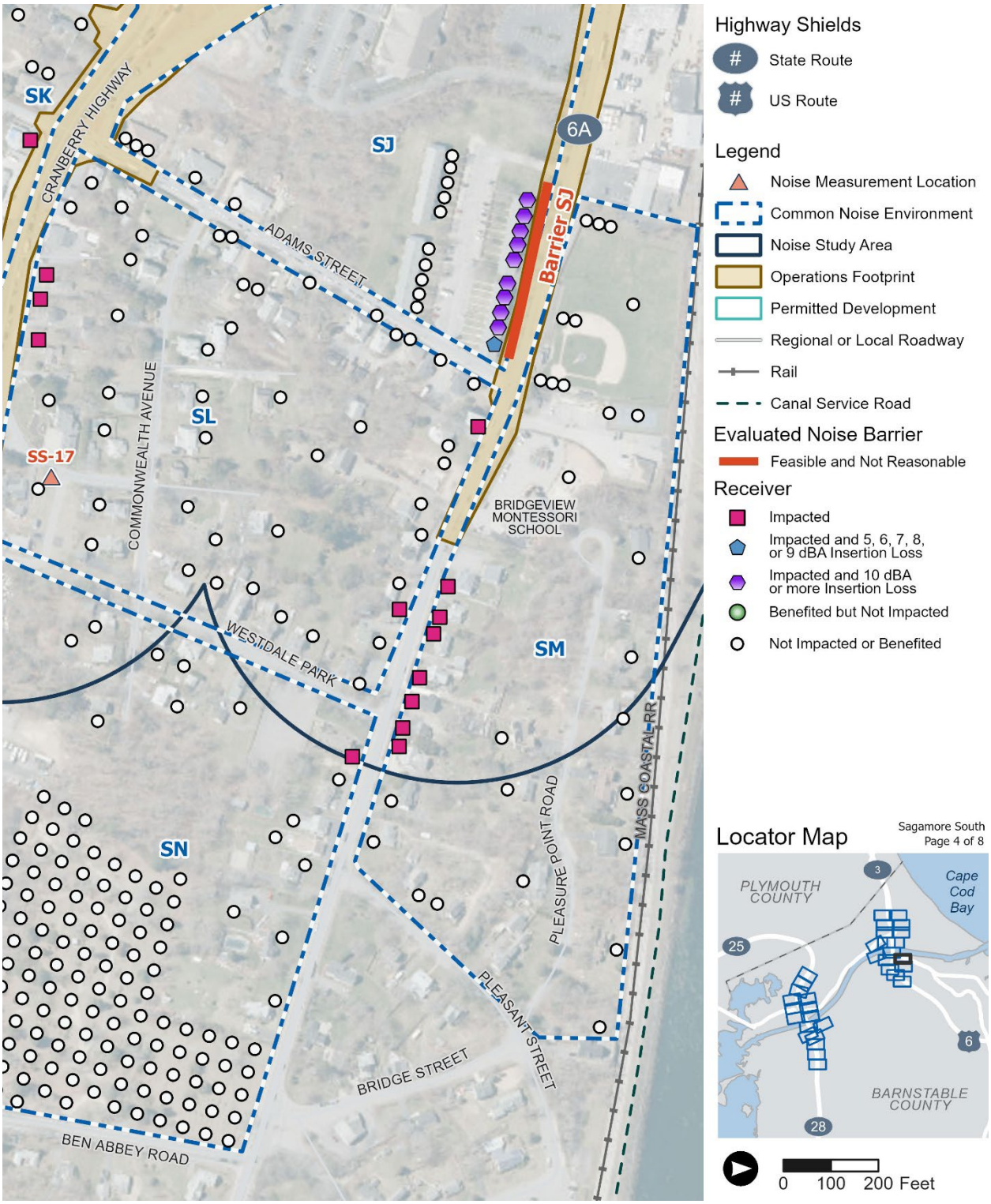
Source: Massachusetts Department of Transportation, 2024

Figure 4.15-6c. Build Alternative: Locations for Barriers, Common Noise Environments, and Receptors (Sagamore South Quadrant)



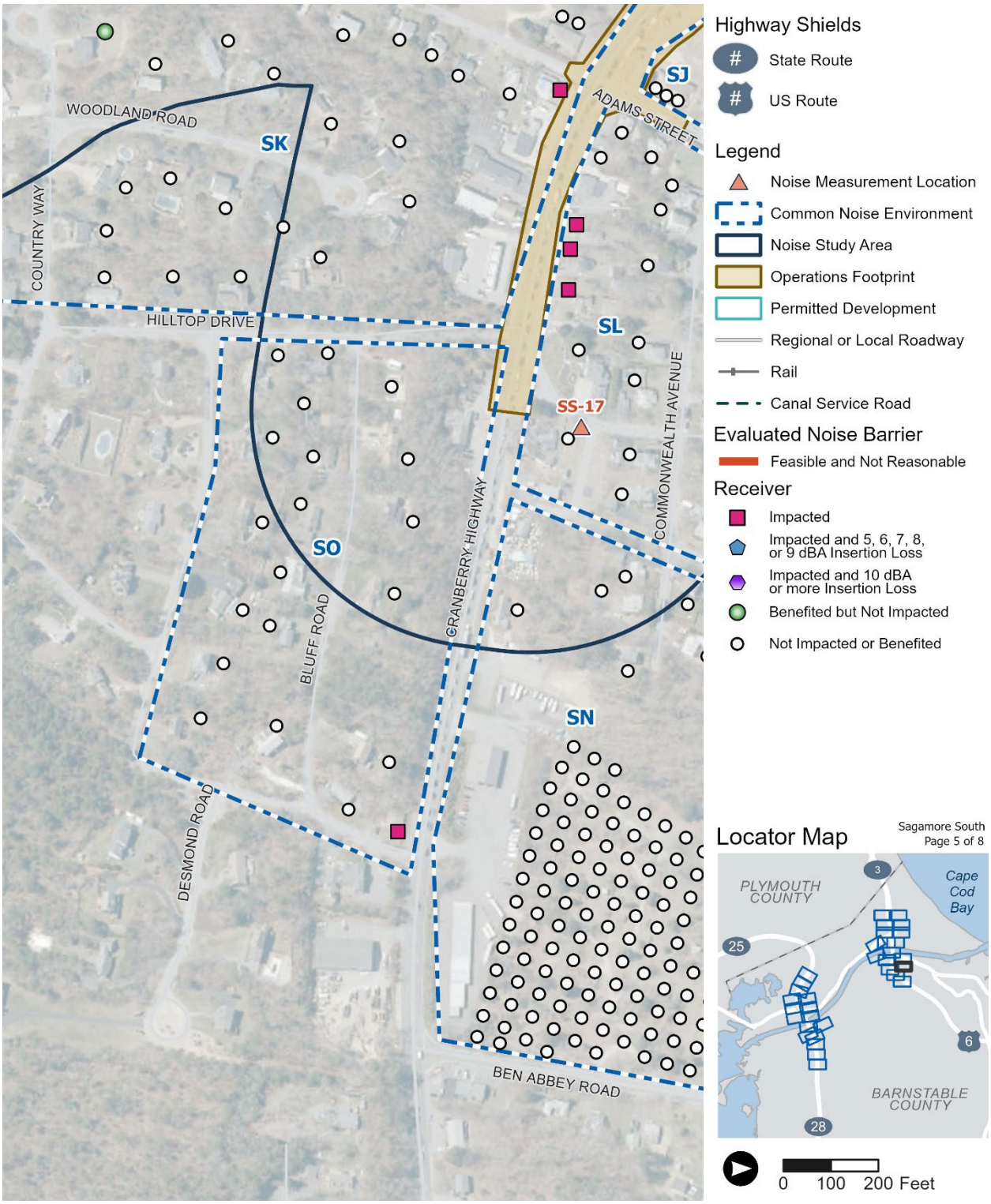
Source: Massachusetts Department of Transportation, 2024

Figure 4.15-6d. Build Alternative: Locations for Barriers, Common Noise Environments, and Receptors (Sagamore South Quadrant)



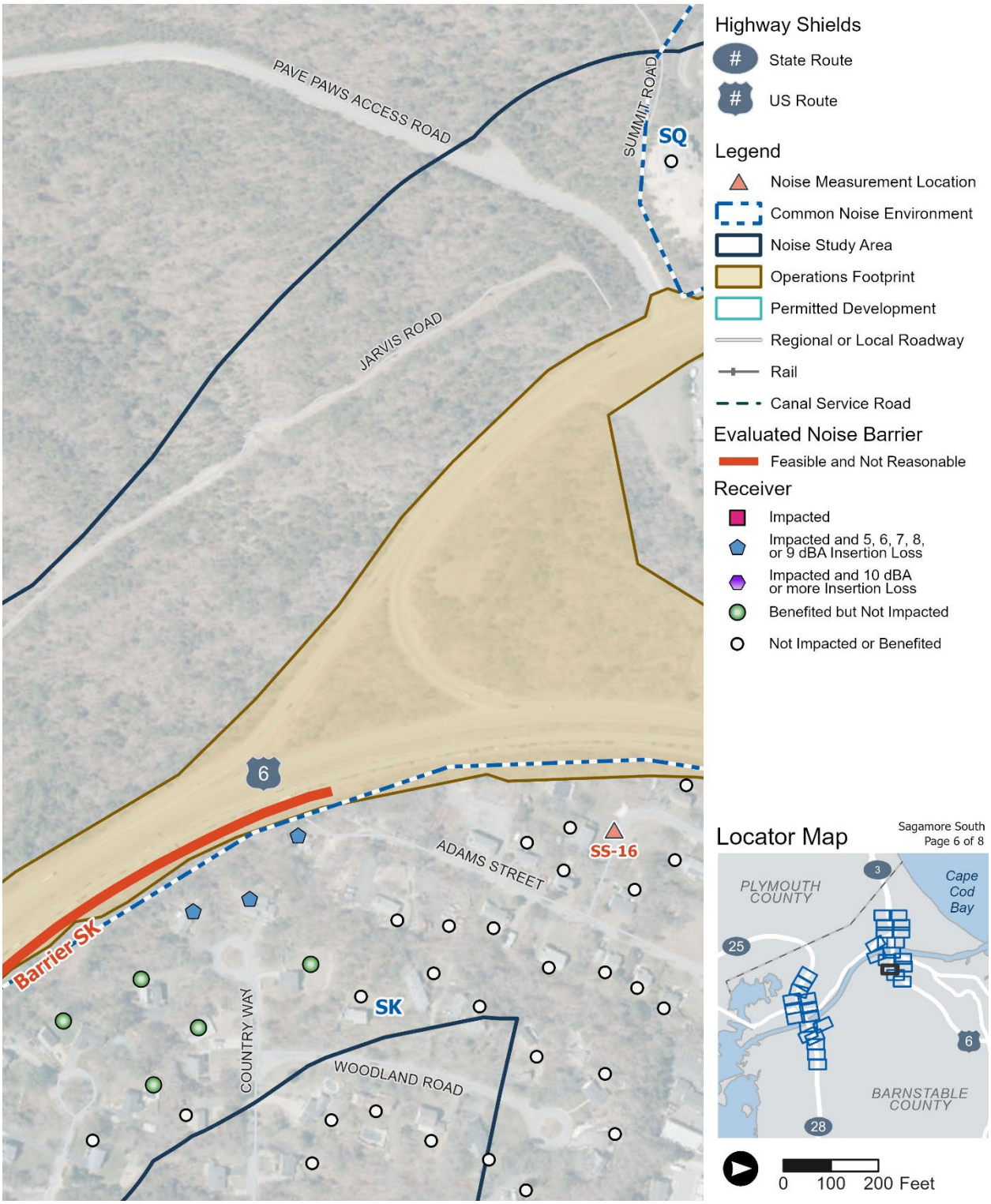
Source: Massachusetts Department of Transportation, 2024

Figure 4.15-6e. Build Alternative: Locations for Barriers, Common Noise Environments, and Receptors (Sagamore South Quadrant)



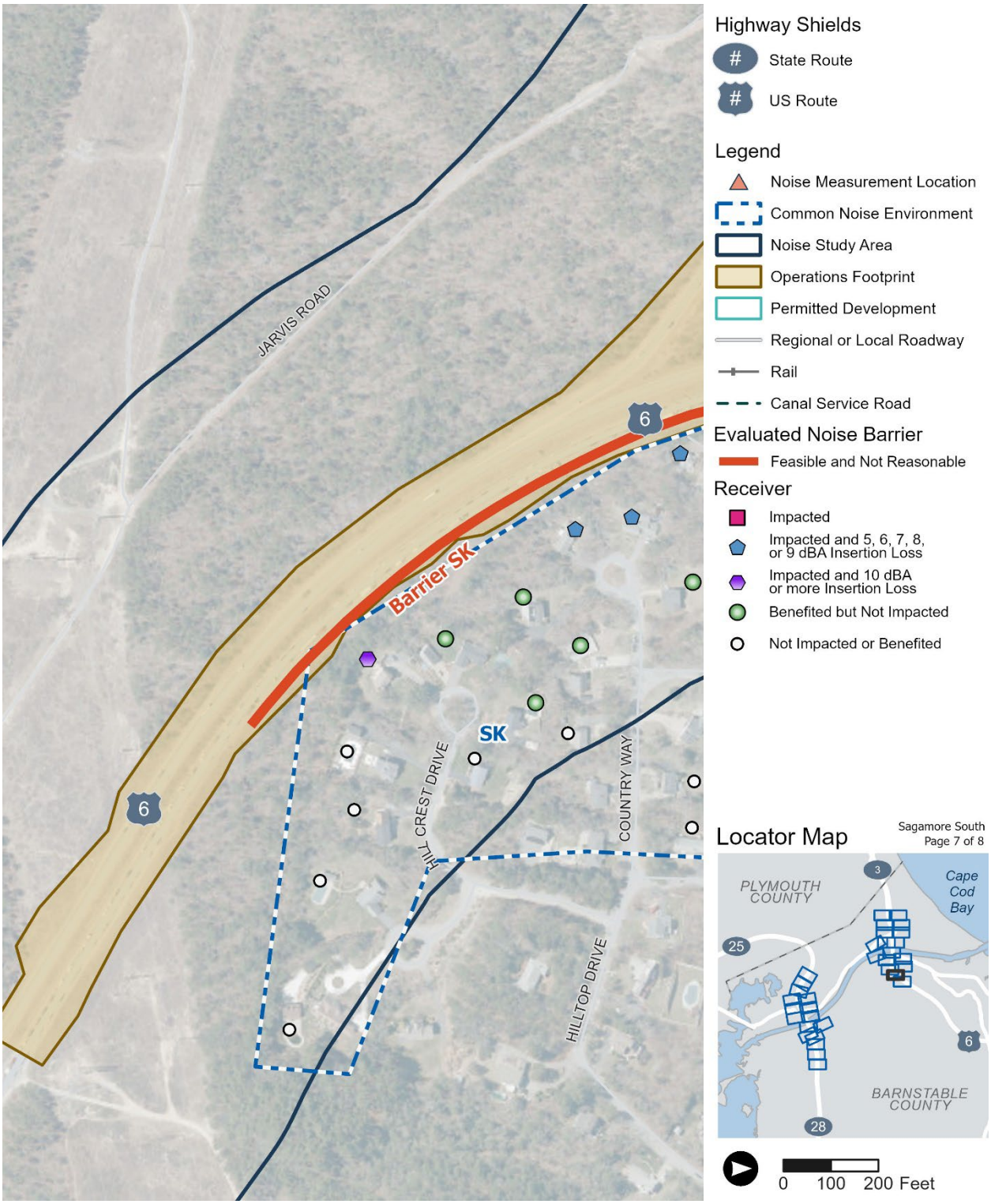
Source: Massachusetts Department of Transportation, 2024

Figure 4.15-6f. Build Alternative: Locations for Barriers, Common Noise Environments, and Receptors (Sagamore South Quadrant)



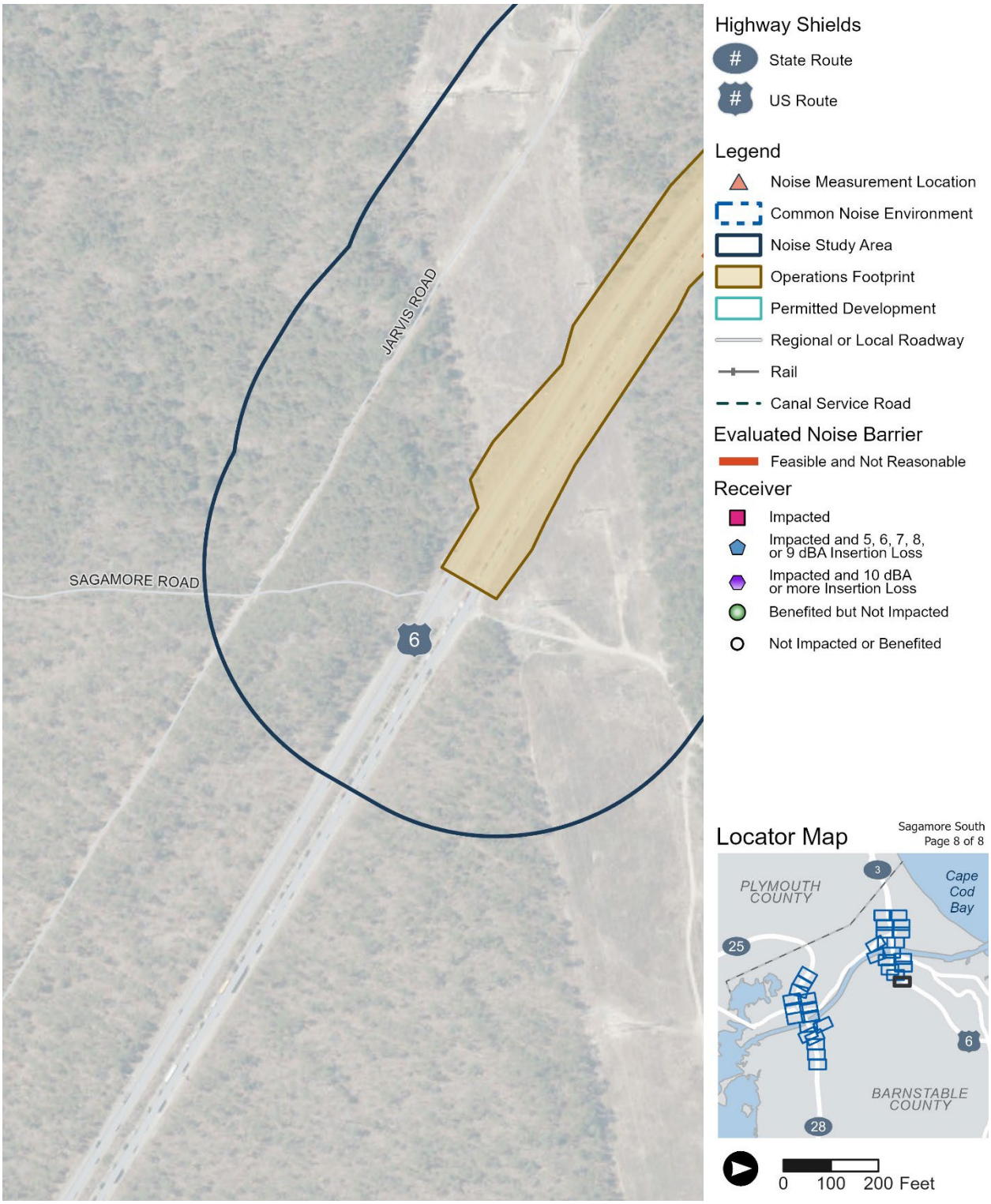
Source: Massachusetts Department of Transportation, 2024

Figure 4.15-6g. Build Alternative: Locations for Barriers, Common Noise Environments, and Receptors (Sagamore South Quadrant)



Source: Massachusetts Department of Transportation, 2024

Figure 4.15-6h. Build Alternative: Locations for Barriers, Common Noise Environments, and Receptors (Sagamore South Quadrant)



Source: Massachusetts Department of Transportation, 2024

Within the Bourne North quadrant (**Table 4.15-12**), two total residential dwelling units would approach or exceed the FHWA Category B NAC within CNE BC (one single-family residence along Head of the Bay Road) and CNE BF (one residence along U.S. Route 6/Main Street westbound). No impacts are predicted at the permitted proposed development (340 Main Street) for the 2050 Build Alternative. No Activity Categories C, D, or E land uses would approach or exceed the respective NAC thresholds for the 2050 Build Alternative in the Bourne North quadrant. In addition, no substantial noise increases are predicted within the Bourne North quadrant.

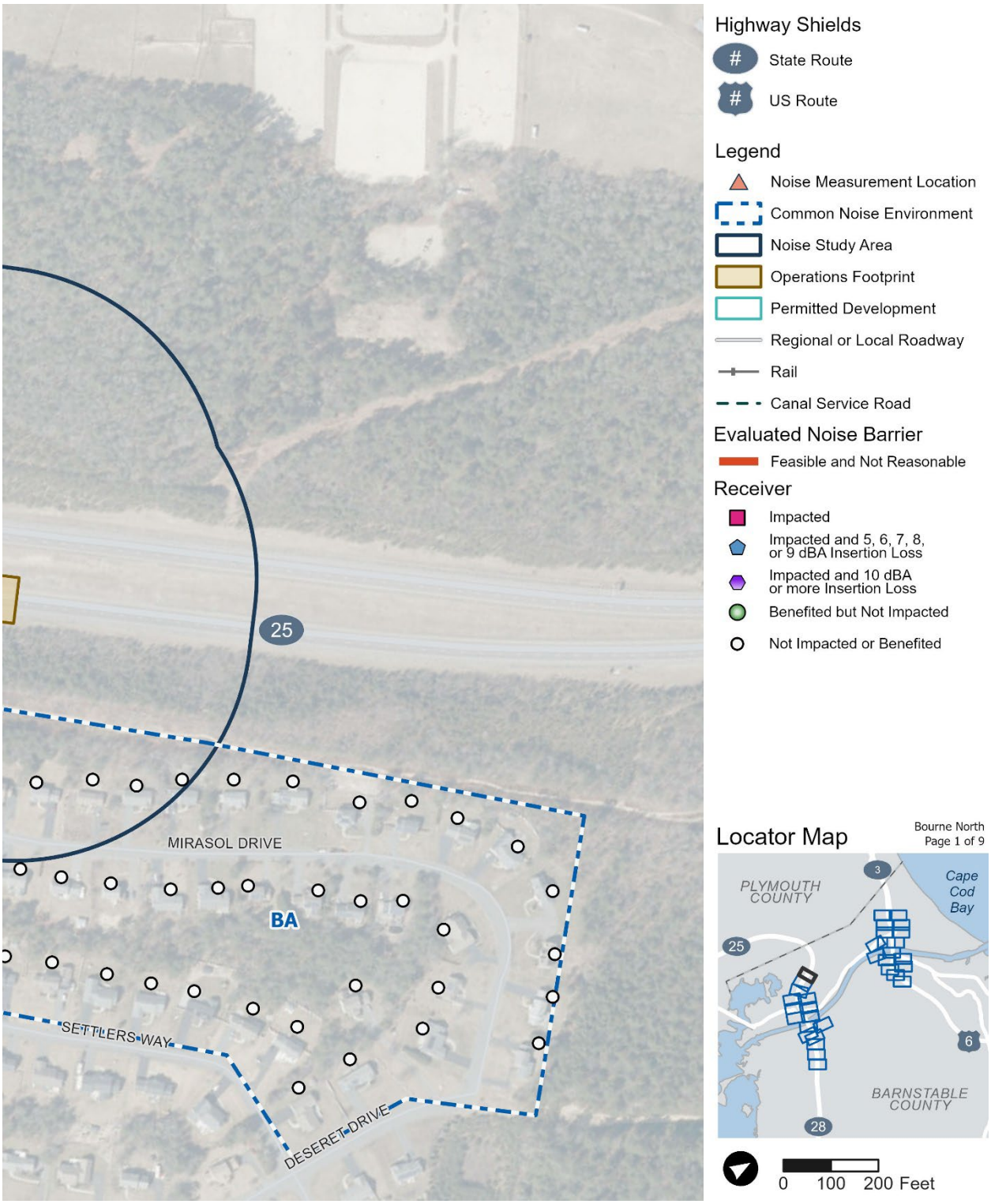
Table 4.15-12. 2050 Build Alternative: Loudest Traffic Hour Noise Levels (Bourne North Quadrant)

Common Noise Environment	Adjacent Roadways	2019 Existing Condition Noise Level Ranges Leq	2050 Build Alternative Noise Level Ranges Leq	Federal Highway Administration Activity Category	2050 Build Alternative Approach or Exceed Noise Abatement Criteria
BA (**Figures 4.15-7a, 7b, 7c**)	State Route 25 Northbound	45–63	46–64	B	0
BB (**Figures 4.15-7c, 7e**)	State Route 25 Northbound and northbound/southbound on-ramps	52–55	52–56	B	0
BC (**Figures 4.15-7d, 7f**)	State Route 25 Southbound	48–65	48–66	B	1
				E	0
BD (**Figure 4.15-7f**)	State Route 25 Southbound	60–65	59–64	E	0
BE (**Figures 4.15-7g, 7h, 7i**)	State Route 28 Southbound	53–63	55–64	B	0
				C	0
				E	0
BF (**Figures 4.15-7e, 7f, 7g**)	State Route 28 Northbound	53–65	55–67	B	1
	U.S. Route 6/Main Street				
BG (**Figures 4.15-7g, 7h, 7i**)	State Route 28 Northbound	53–62	57–64	C	0
	U.S. Route 6/Main Street				
Permitted Development – 340 Main Street[a] (**Figure 4.15-7g**)	State Route 28 Northbound	N/A	58–65	B	0
	U.S. Route 6/Main Street				

[a] The permitted development at 340 Main Street is a part of a mixed-use development, where Phase I has been completed and includes six second-story apartment units above first floor commercial property. Phase II includes construction of 24 rental townhome style units behind the commercial property. Phase II building permit was issued on March 5, 2022. Since the development does not exist for the 2019 existing condition, reported sound levels for the 2019 existing condition are not available.

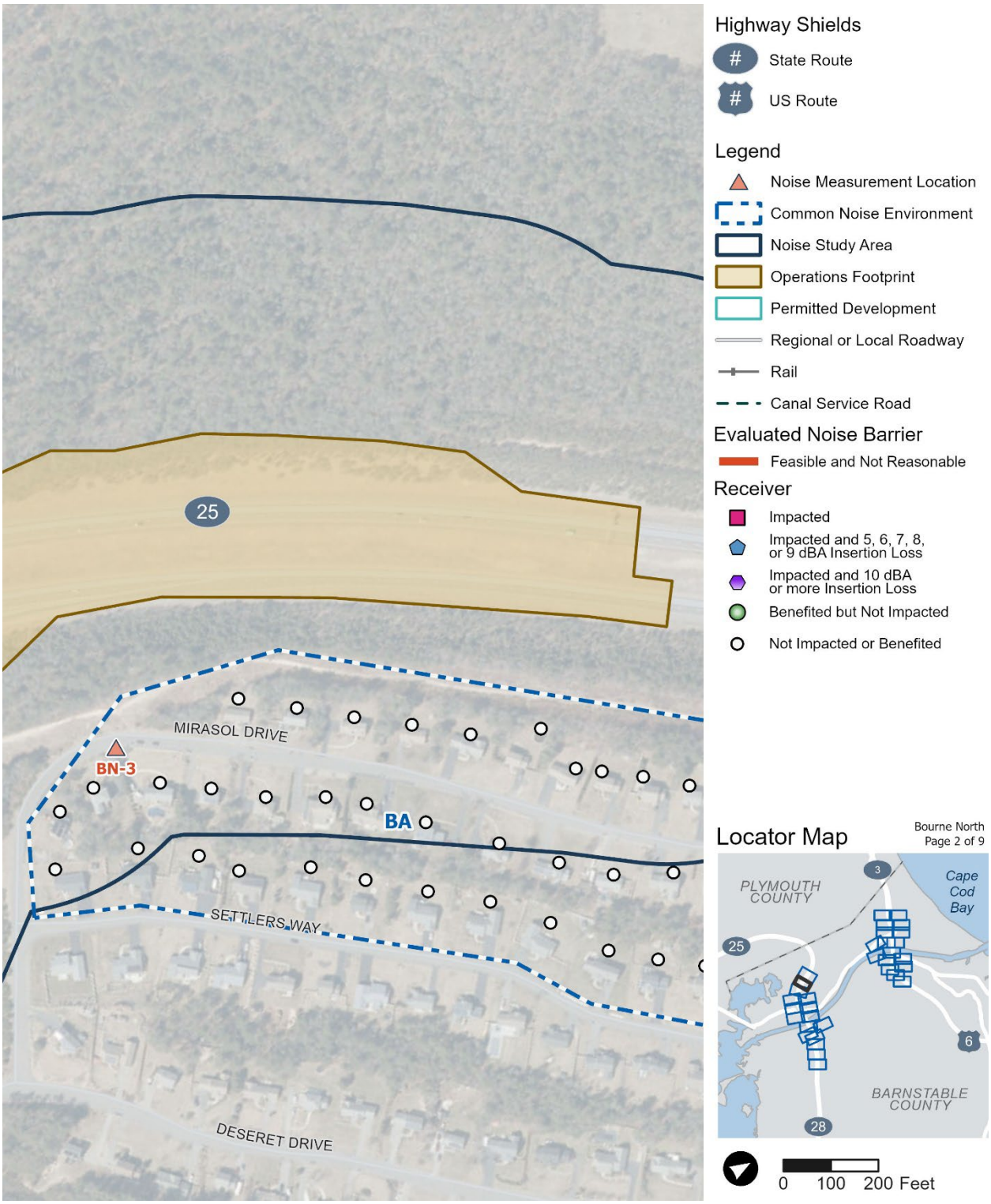
Leq = equivalent sound level

Figure 4.15-7a. Build Alternative: Locations for Barriers, Common Noise Environments, and Receptors (Bourne North Quadrant)



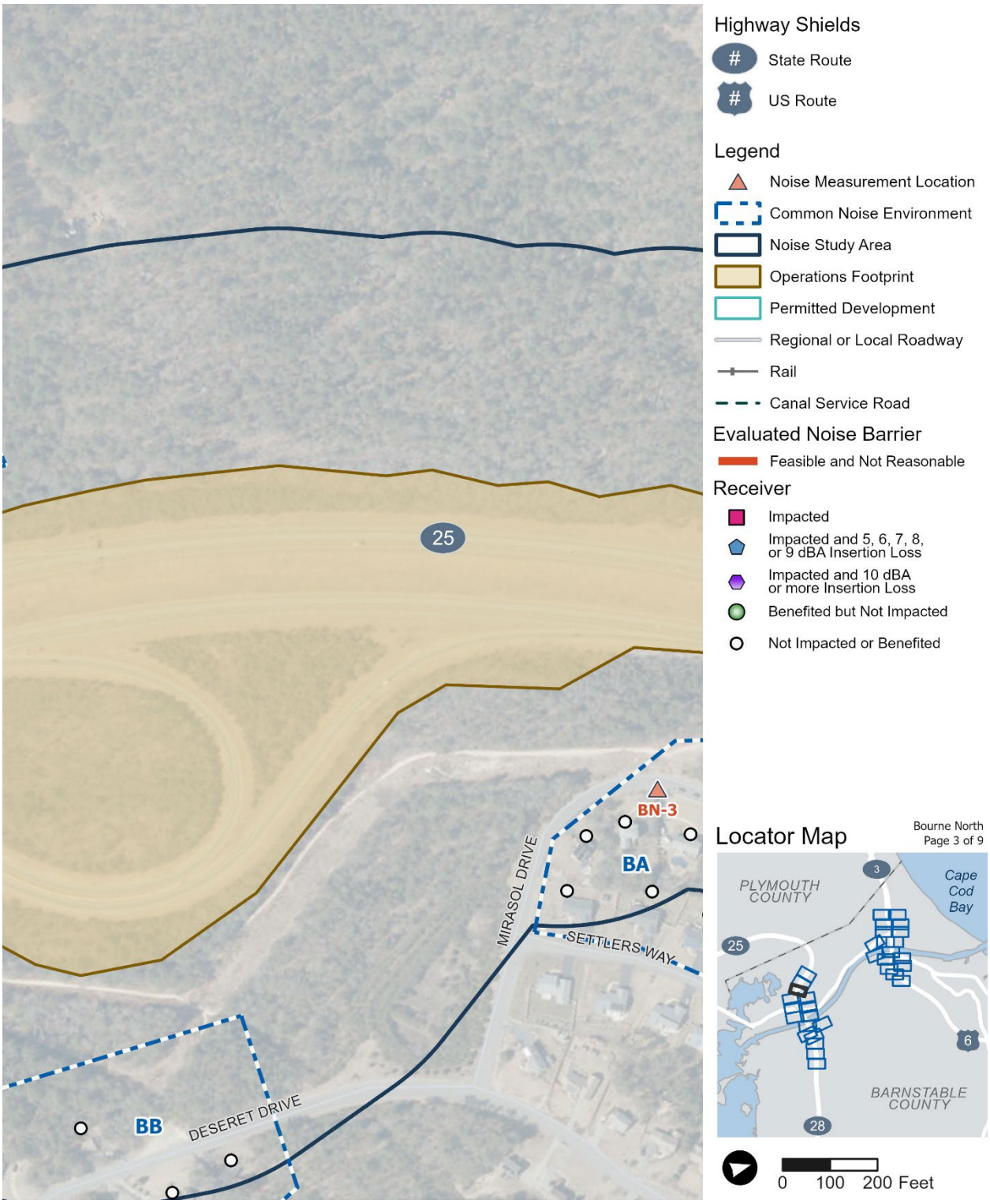
Source: Massachusetts Department of Transportation, 2024

Figure 4.15-7b. Build Alternative: Locations for Barriers, Common Noise Environments, and Receptors (Bourne North Quadrant)



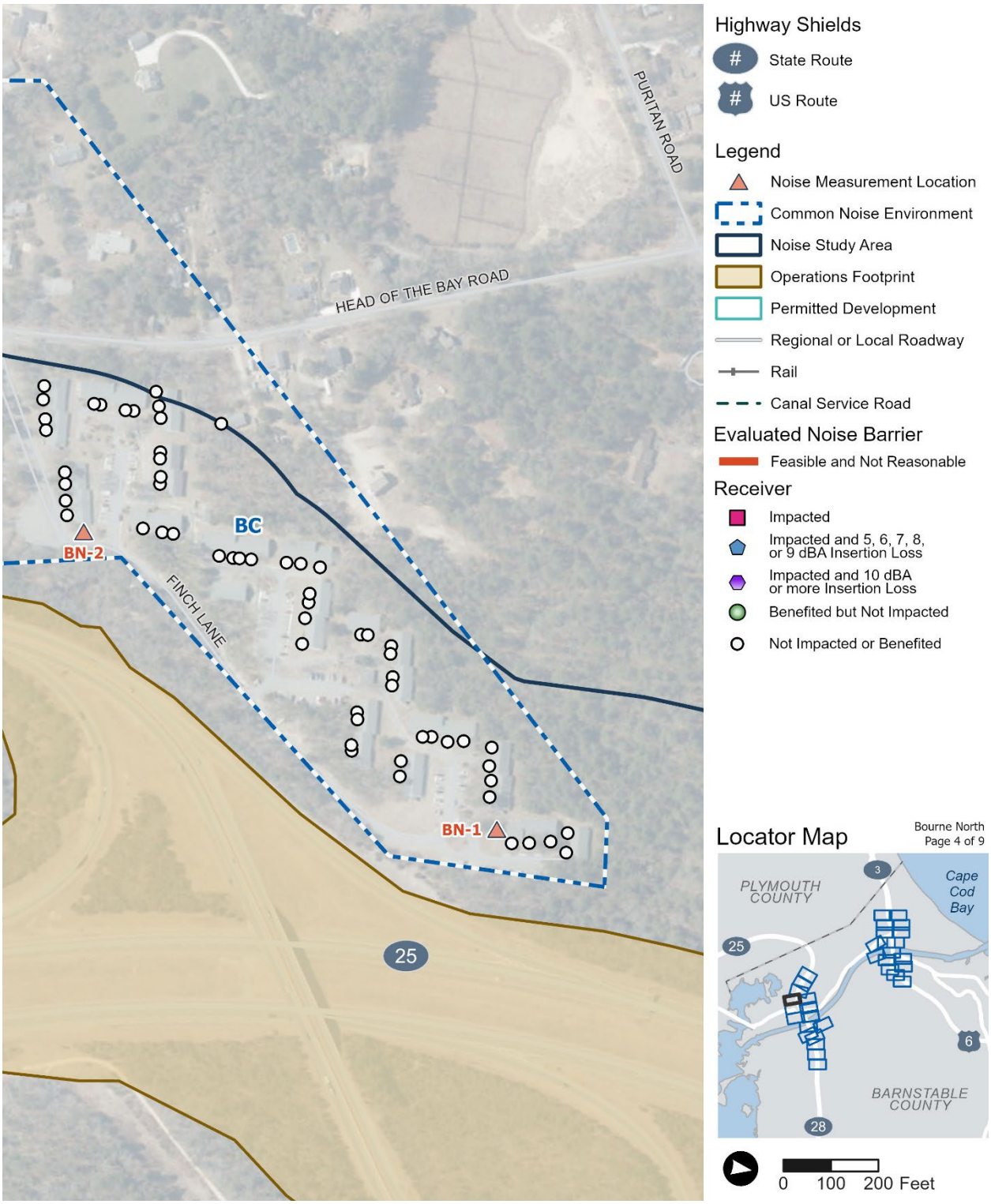
Source: Massachusetts Department of Transportation, 2024

Figure 4.15-7c. Build Alternative: Locations for Barriers, Common Noise Environments, and Receptors (Bourne North Quadrant)



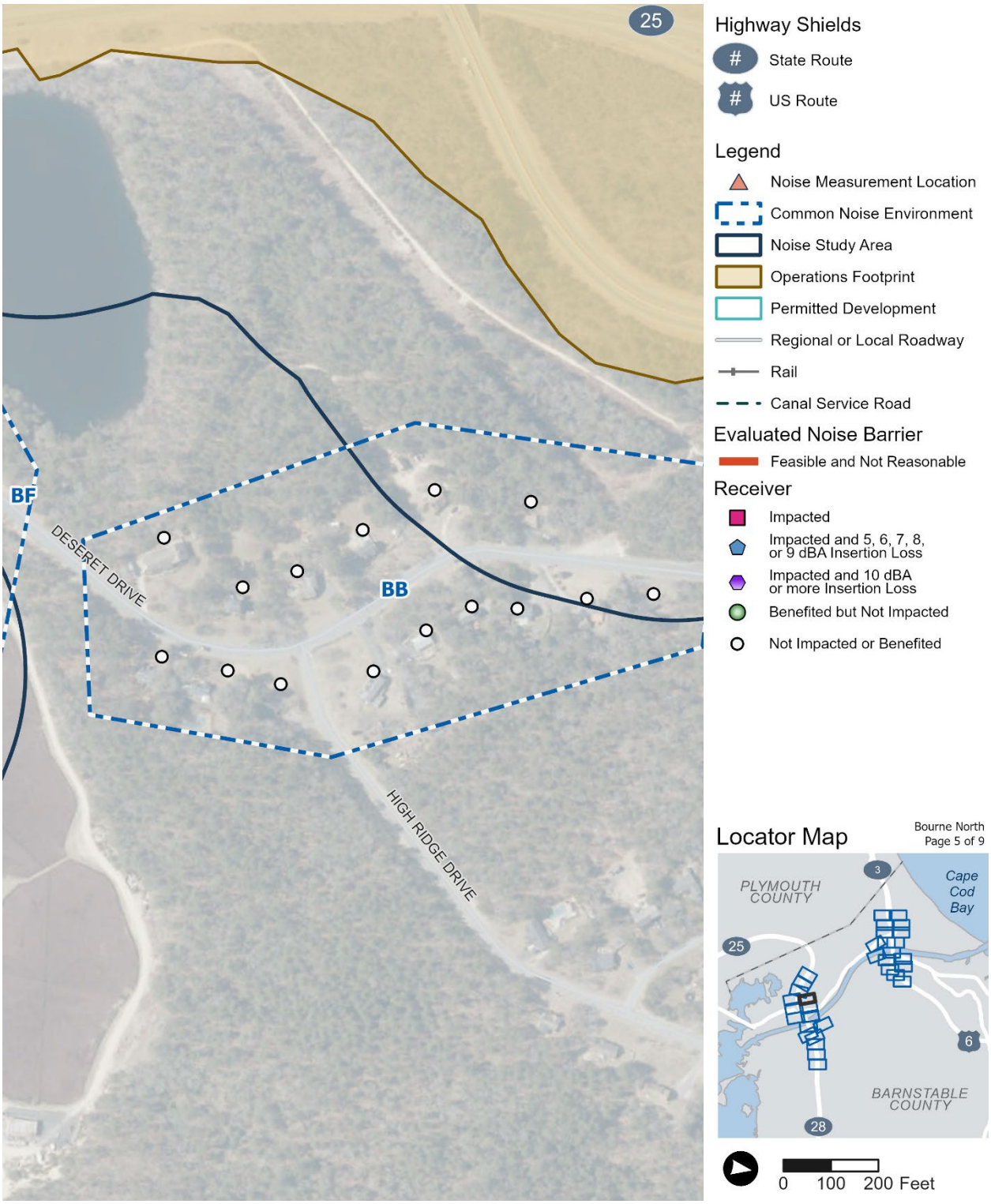
Source: Massachusetts Department of Transportation, 2024

Figure 4.15-7d. Build Alternative: Locations for Barriers, Common Noise Environments, and Receptors (Bourne North Quadrant)



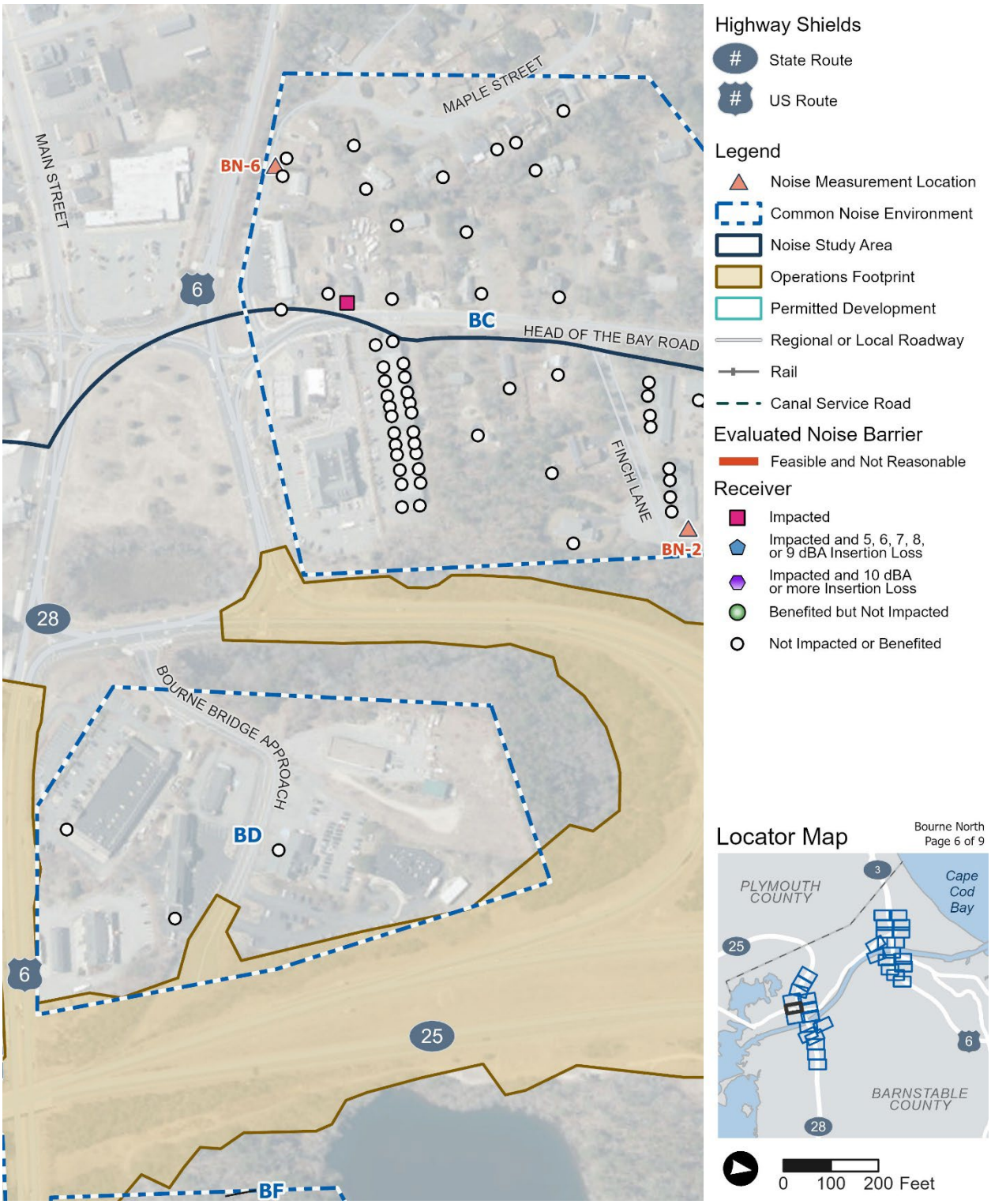
Source: Massachusetts Department of Transportation, 2024

Figure 4.15-7e. Build Alternative: Locations for Barriers, Common Noise Environments, and Receptors (Bourne North Quadrant)



Source: Massachusetts Department of Transportation, 2024

Figure 4.15-7f. Build Alternative: Locations for Barriers, Common Noise Environments, and Receptors (Bourne North Quadrant)



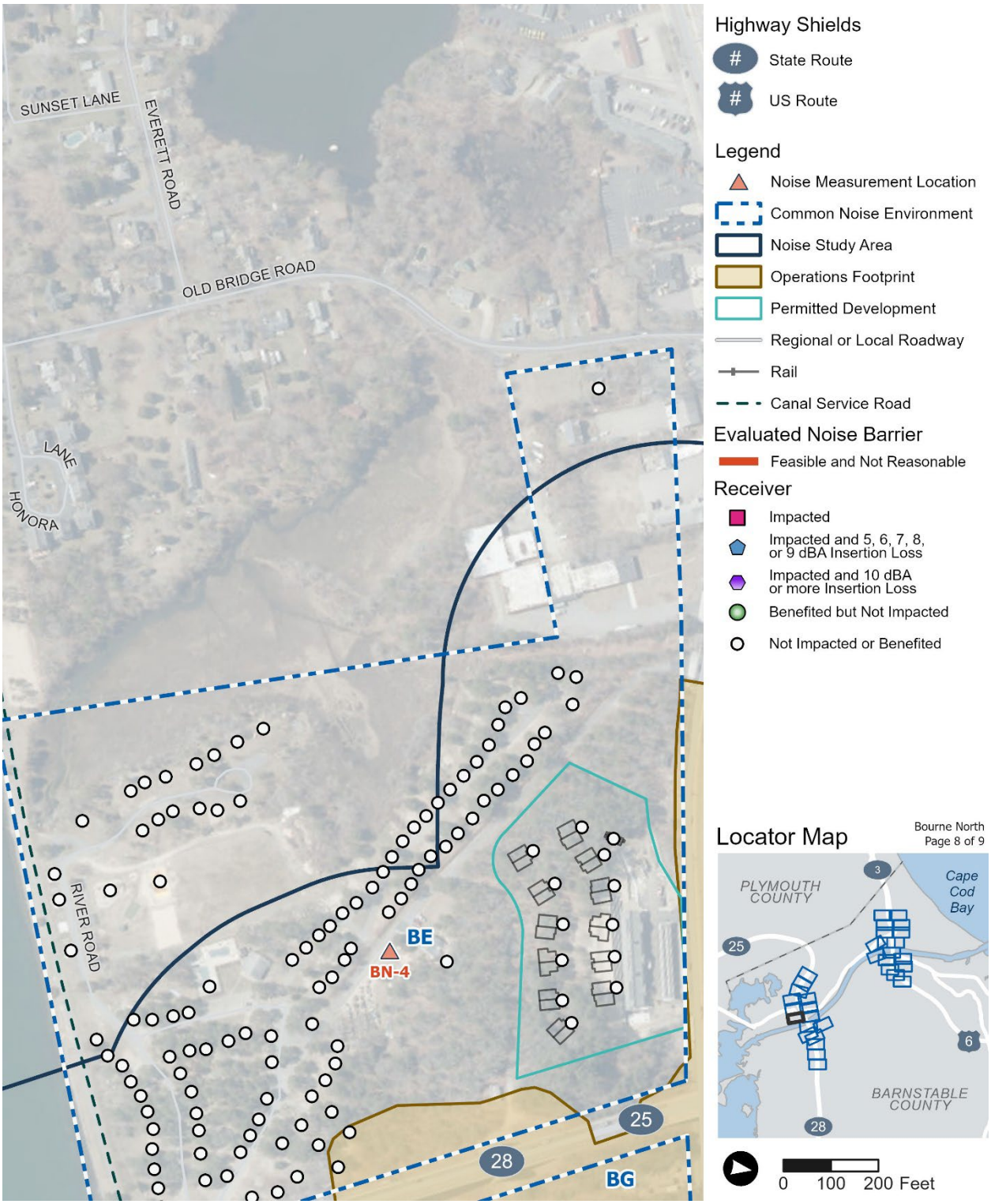
Source: Massachusetts Department of Transportation, 2024

Figure 4.15-7g. Build Alternative: Locations for Barriers, Common Noise Environments, and Receptors (Bourne North Quadrant)



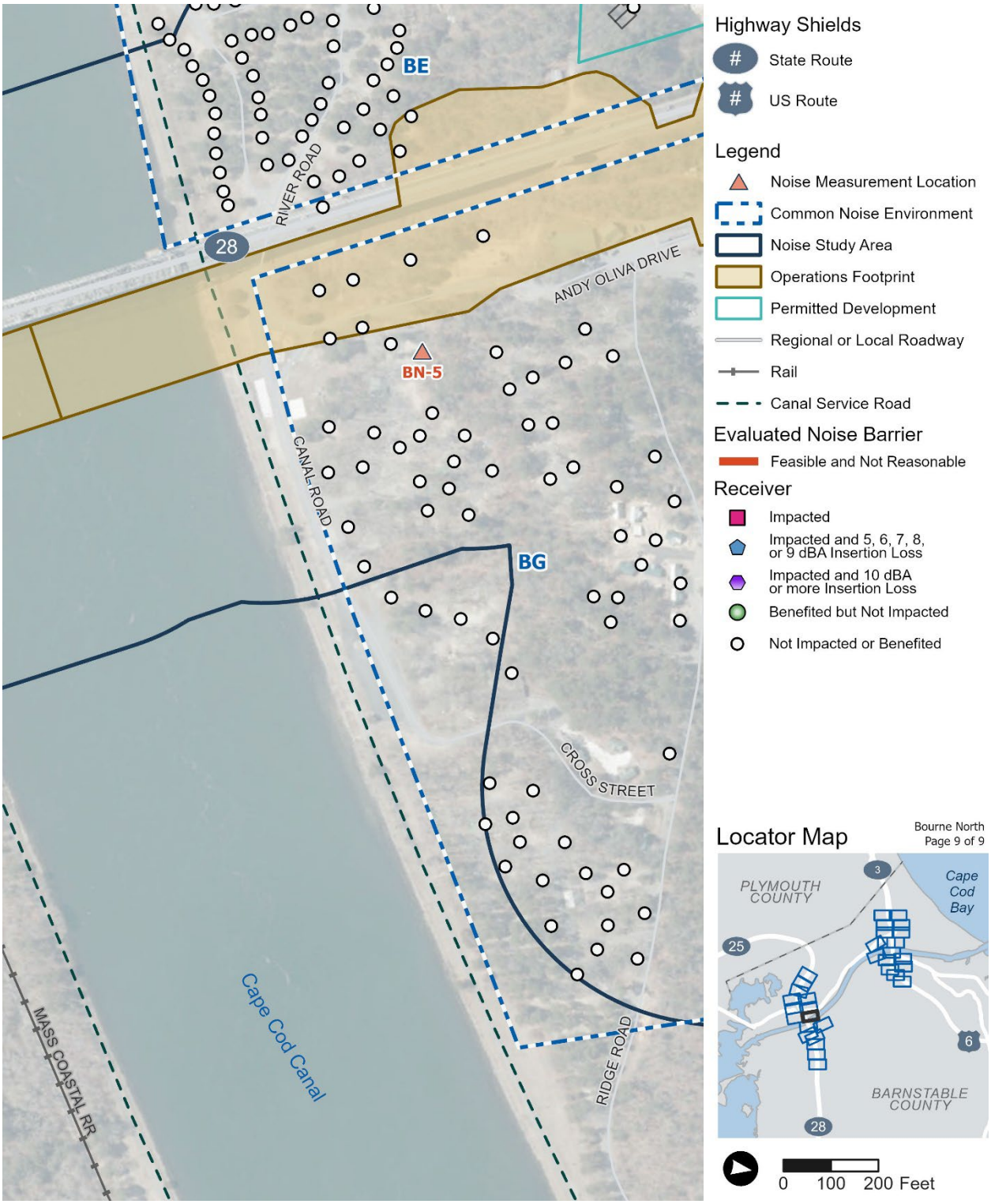
Source: Massachusetts Department of Transportation, 2024

Figure 4.15-7h. Build Alternative: Locations for Barriers, Common Noise Environments, and Receptors (Bourne North Quadrant)



Source: Massachusetts Department of Transportation, 2024

Figure 4.15-7i. Build Alternative: Locations for Barriers, Common Noise Environments, and Receptors (Bourne North Quadrant)



Source: Massachusetts Department of Transportation, 2024

In the Bourne South quadrant for the 2050 Build Alternative (**Table 4.15-13**), no residential dwelling units would approach or exceed the FHWA Category B NAC. Two benches on the north side of the Bourne Manor Extended Care facility would approach or exceed the FHWA Activity Category C NAC for the 2050 Build Alternative. No FHWA Activity Categories D or E land uses would approach or exceed the respective NAC thresholds for the 2050 Build Alternative in the Bourne South quadrant. In addition, no substantial noise increases are predicted within the Bourne South quadrant.

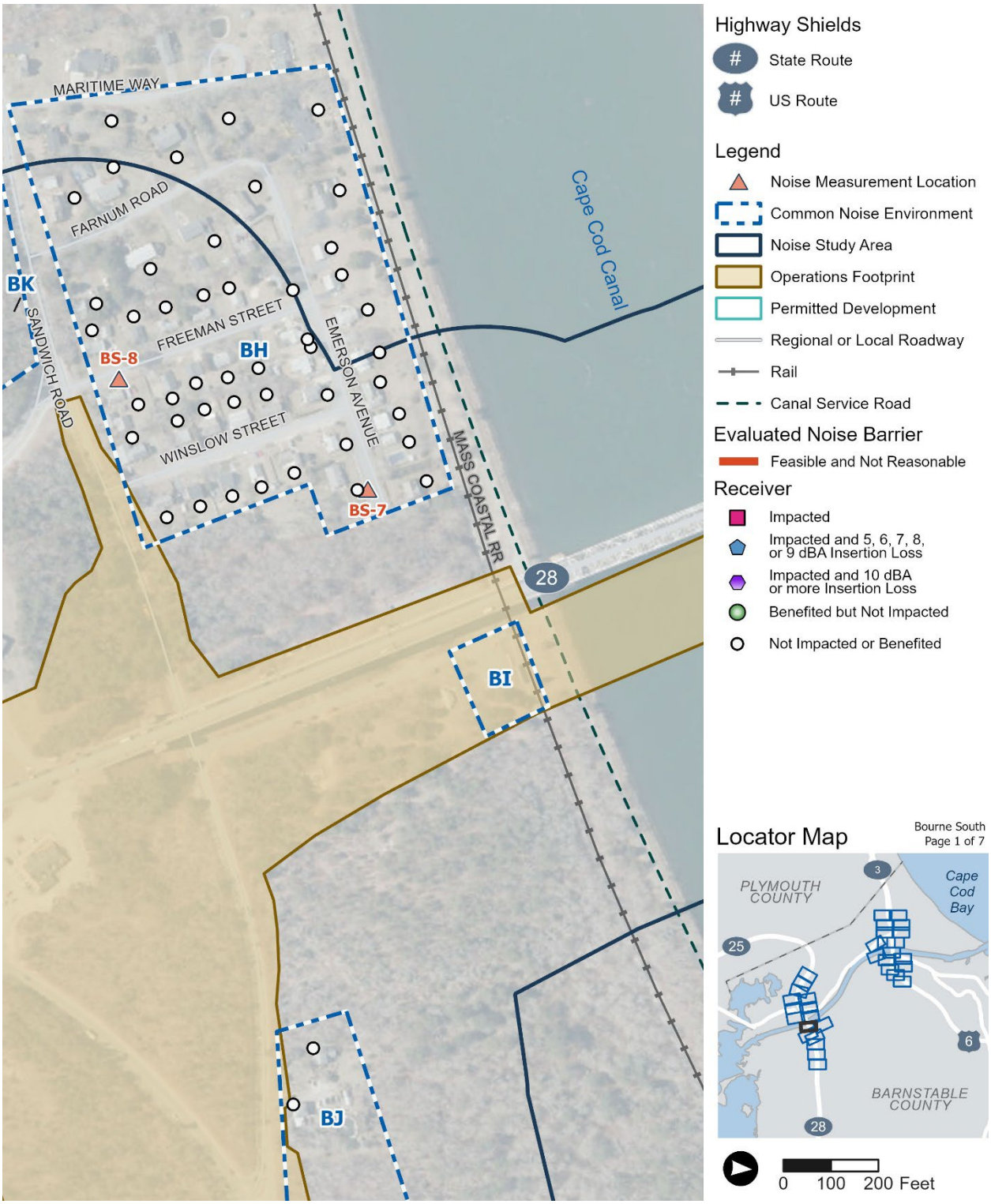
Table 4.15-13. 2050 Build Alternative: Loudest Traffic Hour Noise Levels (Bourne South Quadrant)

Common Noise Environment	Adjacent Roadways	2019 Existing Condition Noise Level Ranges Leq	2050 Build Alternative Noise Level Ranges Leq	Federal Highway Administration Activity Category	2050 Build Alternative Approach or Exceed Noise Abatement Criteria
BH (**Figure 4.15-8a**)	State Route 28 Southbound	52–60	53–60	B	0
BI (**Figure 4.15-8a**)	State Route 28 Northbound	57–58	*	C	*
BJ (**Figures 4.15-8a, 8c**)	Sandwich Road	59–64	57–59	B	0
BK (**Figures 4.15-8a, 8b**)	Veterans Way	42–64	41–63	B	0
	Sandwich Road			C	0
	Trowbridge Road			E	0
BL (**Figure 4.15-8b**)	Sandwich Road	51–53	52–56	B	0
	Trowbridge Road				
BM (**Figures 4.15-8b, 8d**)	State Route 28 Southbound	52–64	53–61	E	0
	Trowbridge Road				
BN (**Figures 4.15-8b, 8d, 8e**)	State Route 28 Southbound	46–60	47–60	B	0
	Trowbridge Road			C	
BO (**Figure 4.15-8f**)	State Route 28 Southbound	54–67	56–67	C	2
BP (**Figure 4.15-8c**)	Sandwich Road	28–55	30–58	B	0
				C	0

* The Bourne Recreation Area would be relocated for the 2050 Build Alternative. The U.S. Army Corps of Engineers is still determining the relocation site. Therefore, the Build Alternative noise levels for the Bourne Recreation Area will be presented in the Final Environmental Impact Report.

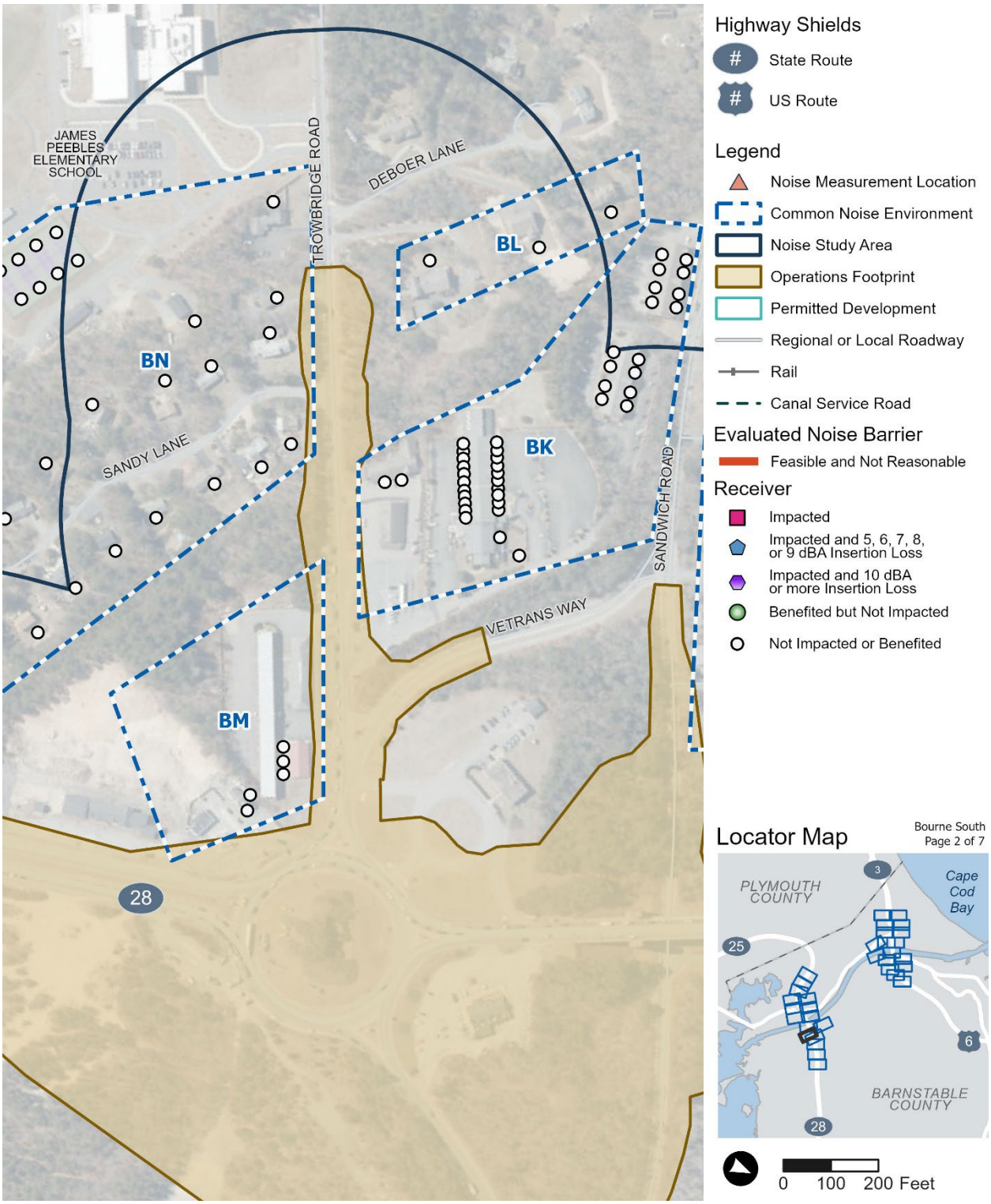
Leq = equivalent sound level

Figure 4.15-8a. Build Alternative: Locations for Barriers, Common Noise Environments, and Receptors (Bourne South Quadrant)



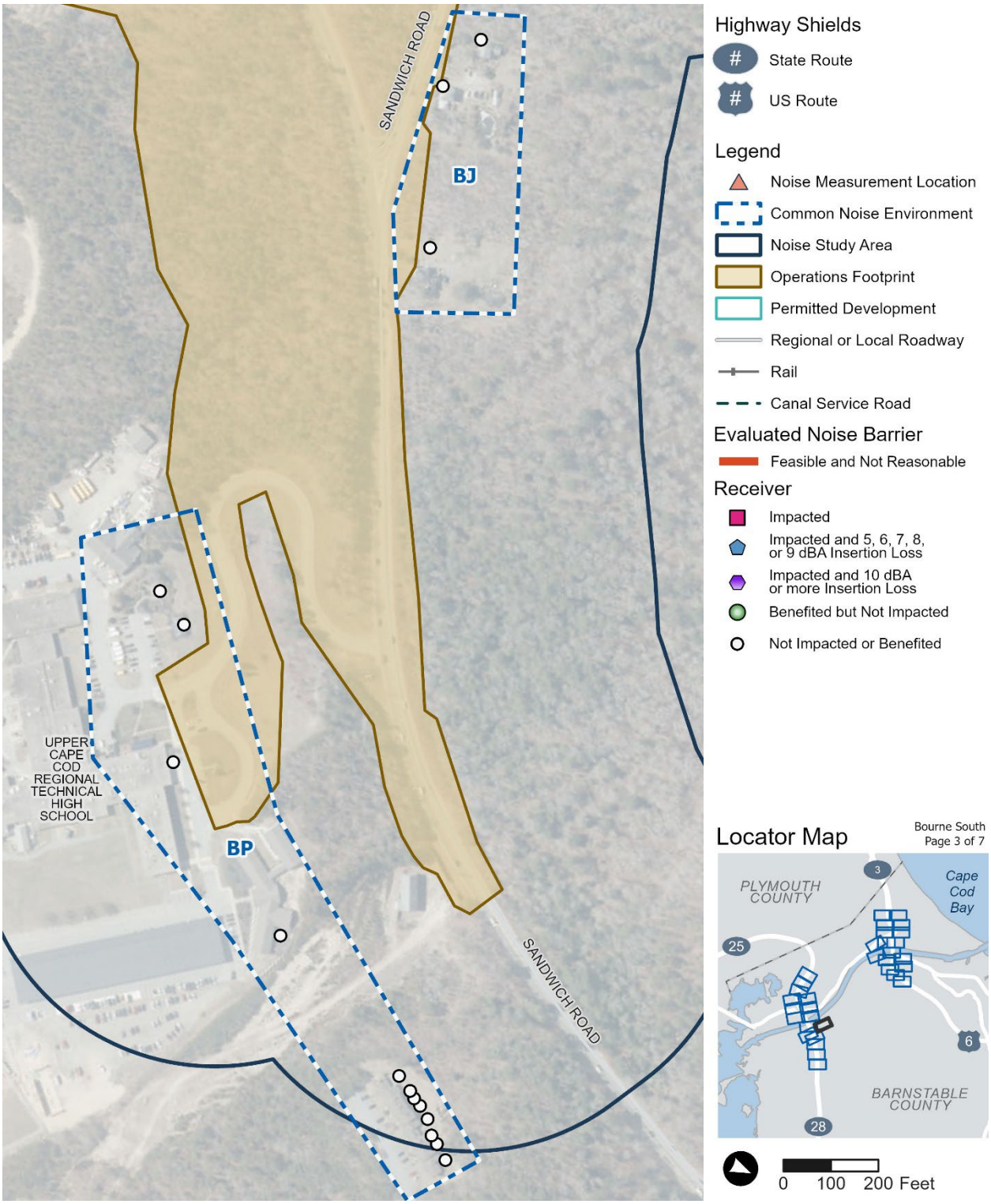
Source: Massachusetts Department of Transportation, 2024

Figure 4.15-8b. Build Alternative: Locations for Barriers, Common Noise Environments, and Receptors (Bourne South Quadrant)



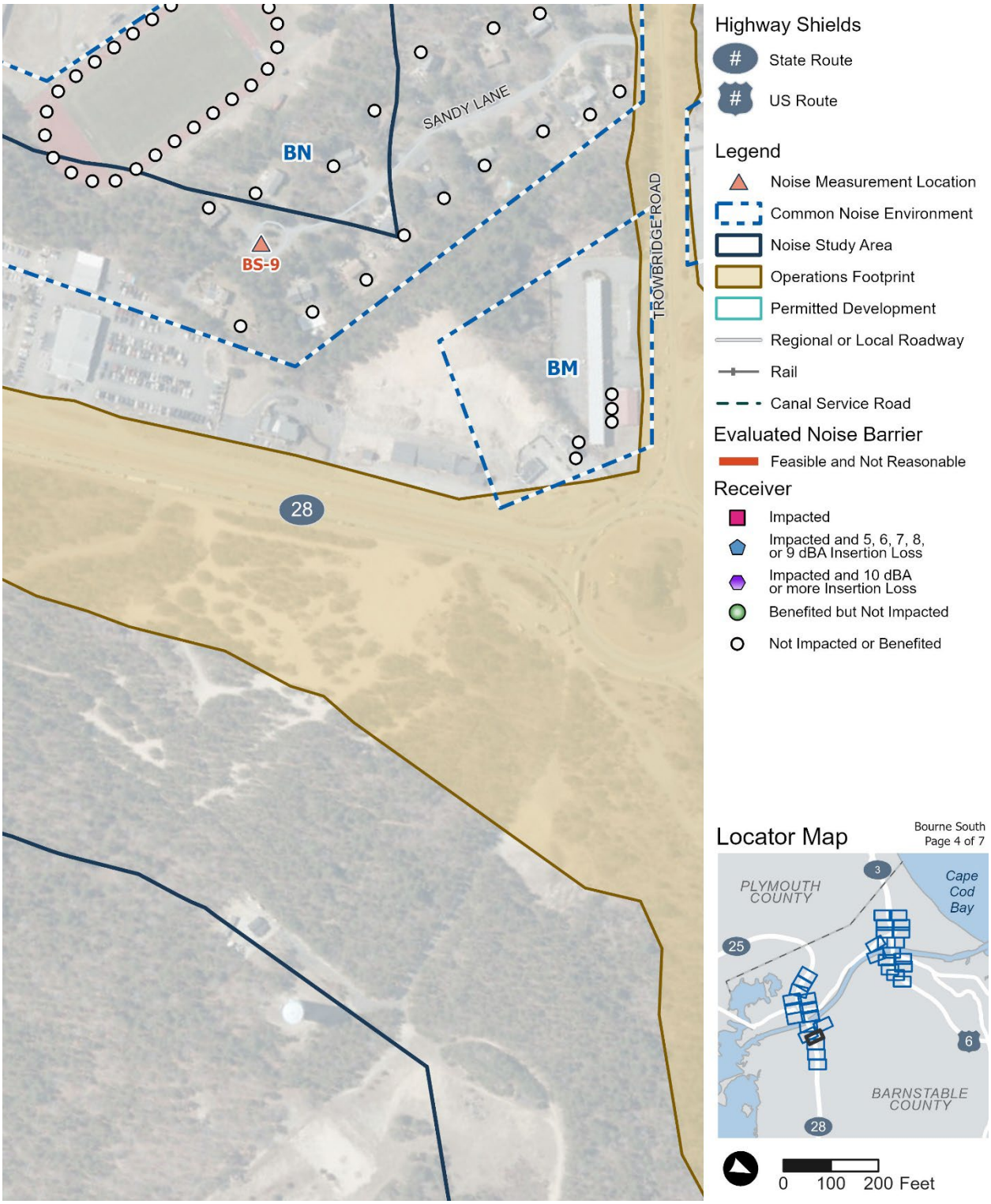
Source: Massachusetts Department of Transportation, 2024

Figure 4.15-8c. Build Alternative: Locations for Barriers, Common Noise Environments, and Receptors (Bourne South Quadrant)



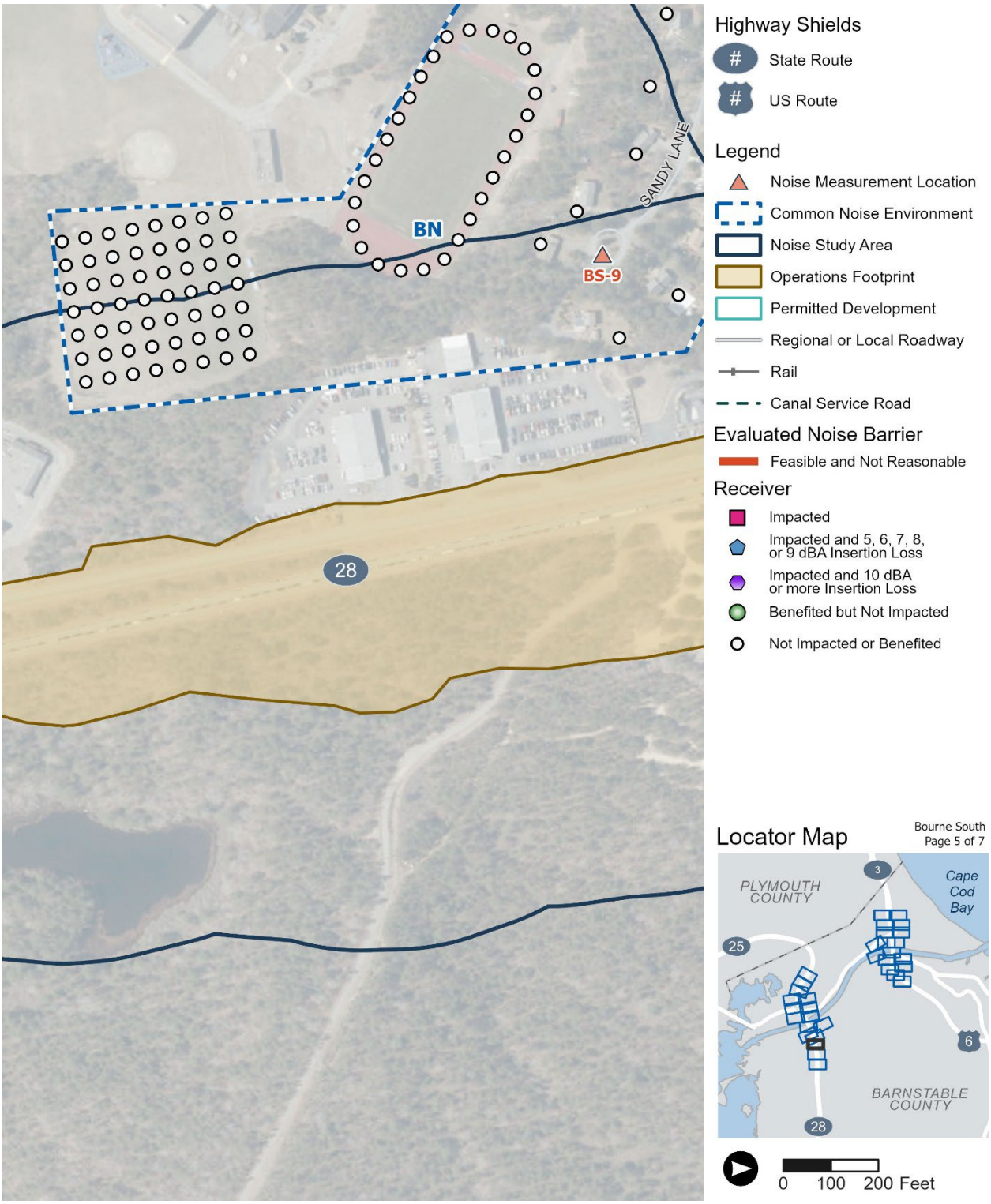
Source: Massachusetts Department of Transportation, 2024

Figure 4.15-8d. Build Alternative: Locations for Barriers, Common Noise Environments, and Receptors (Bourne South Quadrant)



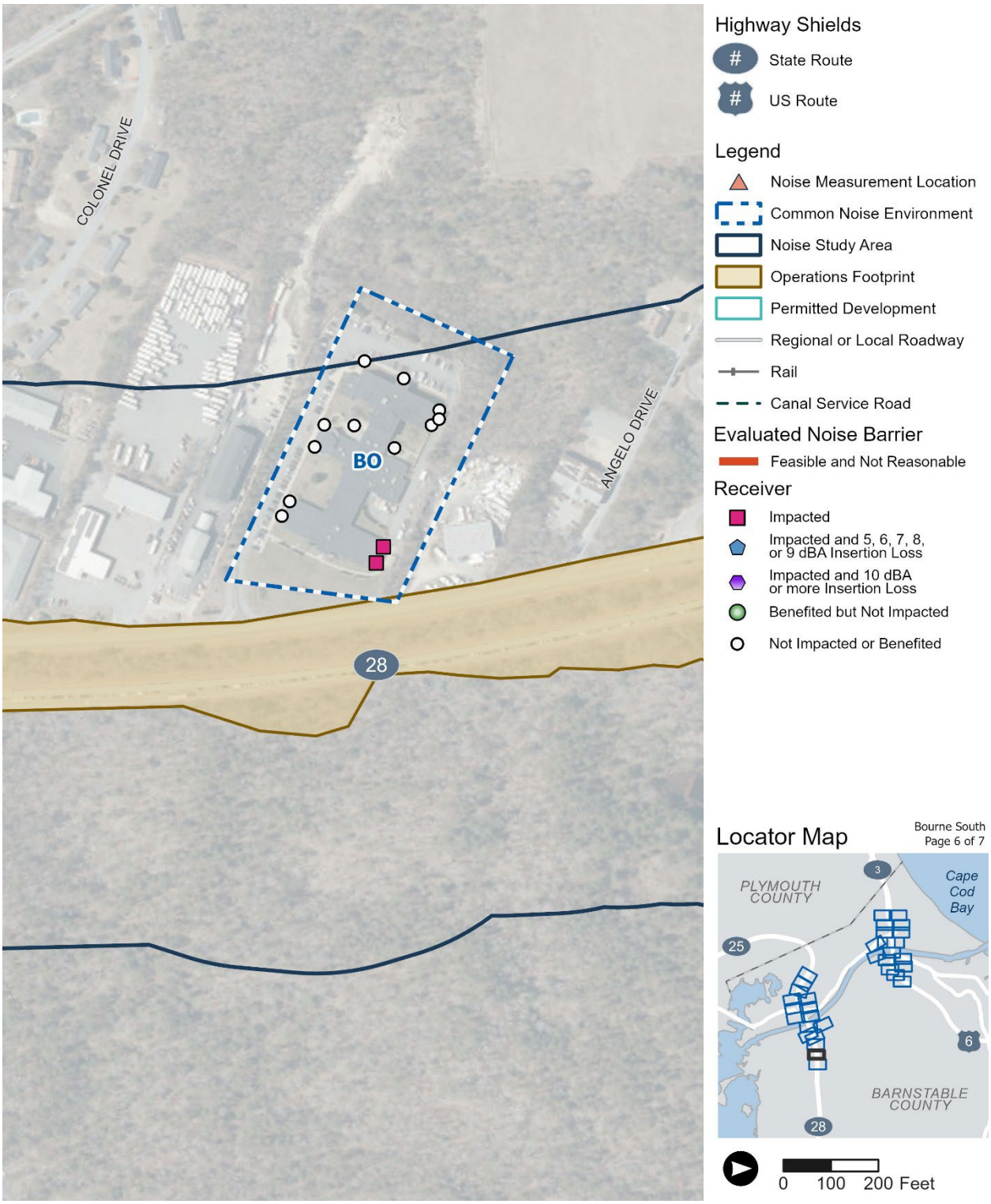
Source: Massachusetts Department of Transportation, 2024

Figure 4.15-8e. Build Alternative: Locations for Barriers, Common Noise Environments, and Receptors (Bourne South Quadrant)



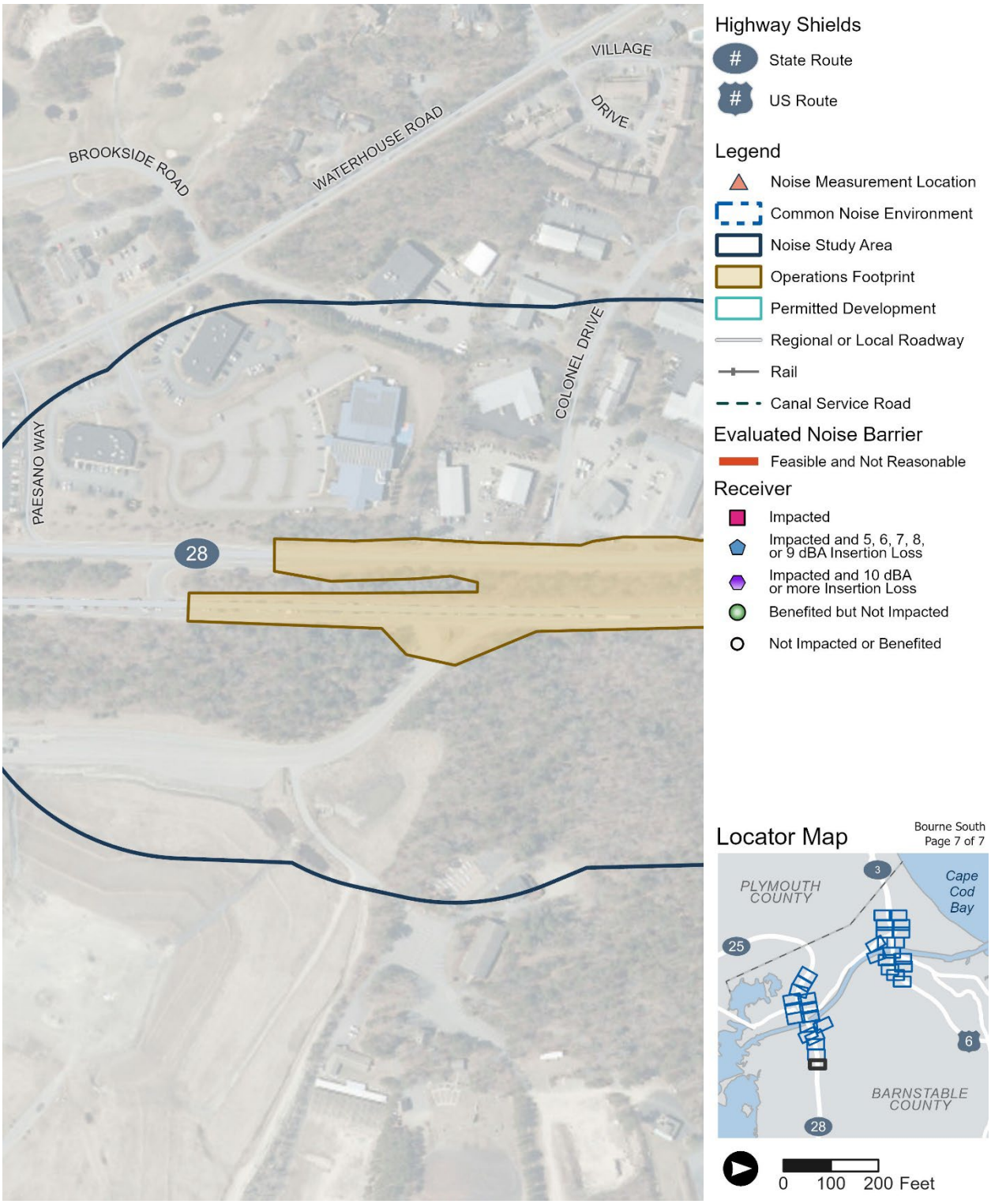
Source: Massachusetts Department of Transportation, 2024

Figure 4.15-8f. Build Alternative: Locations for Barriers, Common Noise Environments, and Receptors (Bourne South Quadrant)



Source: Massachusetts Department of Transportation, 2024

Figure 4.15-8g. Build Alternative: Locations for Barriers, Common Noise Environments, and Receptors (Bourne South Quadrant)



Source: Massachusetts Department of Transportation, 2024

4.15.4.2 Construction Noise Impacts

Construction of the Build Alternative would result in intermittent fluctuations in noise levels due to the following:

- Construction vehicle operations and construction equipment performing earth disturbing work
- Bridge demolition and construction
- Roadway reconstruction

Noise levels from construction would depend on the following:

- Types and number of equipment used
- Condition of equipment
- Type of construction activity being performed
- Construction schedule
- Proximity of operating construction equipment to noise-sensitive receptors

Table 4.15-14 provides a list of common construction equipment and their maximum noise levels at a reference distance of 50 feet. This equipment list is included in the FHWA's Roadway Construction Noise Model (version 1.1) construction equipment database.[11]

Table 4.15-14. Federal Highway Administration Roadway Construction Noise Model Equipment Noise Emissions Database

Equipment Description	Impact Device?	Acoustical Usage Factor (%)[a]	Spec. Lmax at 50 feet[b]	Measured Lmax at 50 feet[b]
All Other Equipment > 5 horsepower	No	50%	85	NA
Auger Drill Rig	No	20%	85	84
Backhoe	No	40%	80	78
Bar Bender	No	20%	80	NA
Blasting	Yes	NA	94	NA
Boring Jack Power Unit	No	50%	80	83
Chain Saw	No	20%	85	84
Clam Shovel (dropping)	Yes	20%	93	87
Compactor (ground)	No	20%	80	83
Compressor (air)	No	40%	80	78
Concrete Batch Plant	No	15%	83	NA

[11] https://www.fhwa.dot.gov/environment/noise/construction_noise/rcnm/

Equipment Description	Impact Device?	Acoustical Usage Factor (%)[a]	Spec. Lmax at 50 feet[b]	Measured Lmax at 50 feet[b]
Concrete Mixer Truck	No	40%	85	79
Concrete Pump Truck	No	20%	82	81
Concrete Saw	No	20%	90	90
Crane	No	16%	85	81
Dozer	No	40%	85	82
Drill Rig Truck	No	20%	84	79
Drum Mixer	No	50%	80	80
Dump Truck	No	40%	84	76
Excavator	No	40%	85	81
Flat Bed Truck	No	40%	84	74
Front End Loader	No	40%	80	79
Generator	No	50%	82	81
Generator (<25 volt-amperes, variable message signs)	No	50%	70	73
Gradall	No	40%	85	83
Grader	No	40%	85	NA
Grapple (on backhoe)	No	40%	85	87
Horizontal Boring Hydr. Jack	No	25%	80	82
Hydra Break Ram	Yes	10%	90	NA
Impact Pile Driver	Yes	20%	95	101
Jackhammer	Yes	20%	85	89
Man Lift	No	20%	85	75
Mounted Impact hammer (hoe ram)	Yes	20%	90	90
Pavement Scarafier	No	20%	85	90
Paver	No	50%	85	77
Pickup Truck	No	40%	55	75
Pneumatic Tools	No	50%	85	85
Pumps	No	50%	77	81
Refrigerator Unit	No	100%	82	73

Equipment Description	Impact Device?	Acoustical Usage Factor (%)[a]	Spec. Lmax at 50 feet[b]	Measured Lmax at 50 feet[b]
Rivit Buster/chipping gun	Yes	20%	85	79
Rock Drill	No	20%	85	81
Roller	No	20%	85	80
Sand Blasting (Single Nozzle)	No	20%	85	96
Scraper	No	40%	85	84
Shears (on backhoe)	No	40%	85	96
Slurry Plant	No	100%	78	78
Slurry Trenching Machine	No	50%	82	80
Soil Mix Drill Rig	No	50%	80	NA
Tractor	No	40%	84	NA
Vacuum Excavator (Vac-truck)	No	40%	85	85
Vacuum Street Sweeper	No	10%	80	82
Ventilation Fan	No	100%	85	79
Vibrating Hopper	No	50%	85	87
Vibratory Concrete Mixer	No	20%	80	80
Vibratory Pile Driver	No	20%	95	101
Warning Horn	No	5%	85	83
Welder/Torch	No	40%	73	74

Source: Federal Highway Administration Roadway Construction Noise Model (version 1.1) User's Guide, January 2006.

[a] The acoustical usage factor is the percentage of time a piece of equipment is operating at full power during a construction operation.

[b] "Spec" refers to noise levels provided in the manufacturer's specifications, while "measured" refers to noise levels measured at 50 feet from the equipment as part of the Central Artery Tunnel Project in Boston, Massachusetts. Lmax = maximum sound level.

The noisiest construction activities would generally be associated with the existing bridge demolition and construction of new bridge piers, which may require saw cutting and/or hoe ramming to demolish the existing bridge and drilling and/or pile driving for pier construction. Saw cutting and hoe ramming could produce maximum noise levels of approximately 90 dBA at 50 feet, while drilling and/or pile driving of new bridge piers could produce maximum noise levels ranging between 84 and 101 dBA at 50 feet. Construction of interchange approaches and roadways would require site preparation and grading, potentially necessitating backhoes, excavators, dozers, graders, and dump trucks. Maximum noise levels associated with these pieces of equipment may range between 77 and 85 dBA at 50 feet.

Roadway construction would also require pavers, rollers, and dump trucks with maximum noise levels generally ranging between 77 and 80 dBA.

4.15.4.3 Construction Vibration Impacts

During construction, the highest vibration levels would result from pile driving. Pile driving is typically required during bridge construction to install bridge piers and support excavation. Assuming most buildings proximate to proposed construction activities would be non-engineered timber and masonry buildings, structural damage has the potential to occur for these types of structures if they are within approximately 72 feet of impact pile driving and approximately 21 feet of vibratory pile driving. When pile driving occurs beyond these distances, there would be no potential for structural damage to non-engineered timber and masonry buildings. The potential for structural damage to non-engineered timber and masonry structures from auger drilling, hoe ramming, and use of large bulldozers would occur within approximately 11 feet of these activities/pieces of equipment.

Construction-induced vibration is typically considered "infrequent" in nature. Therefore, MassDOT used the applicable annoyance threshold of 80 dBA for FTA Land Use Category 2 to evaluate potential vibration annoyance at nearby residences. The applicable annoyance threshold of 83 dBA for FTA Land Use Category 3 was used to evaluate potential vibration annoyance at nearby institutional land uses (e.g., schools). Based on the annoyance assessment prescribed within the FTA manual, should an impact pile driver be used, the annoyance threshold would be exceeded at any residential (FTA Land Use Category 2) structures within 157 feet and any institutional structures within 125 feet. Should a vibratory pile driver be used, the distance within which residences and institutional land uses would potentially experience vibration-induced annoyance would be reduced to 67 feet and 53 feet, respectively.

During construction activities that would require auger drilling, hoe ramming, and use of large bulldozers, the annoyance threshold would be exceeded at any residential (FTA Land Use Category 2) structures within 42 feet and at any institutional structures within 33 feet. Loaded trucks would cause vibration-induced annoyance when driving within 39 feet of residences and 31 feet of institutional uses.

While these distances offer some guidance on vibration exposure based on receptor to source activity distances, other factors also influence ground-borne vibration impacts, including subsurface conditions, vibration frequency, contractor means/methods, etc. MassDOT's Contract Specification will include provisions for pre-construction surveys, vibration monitoring, adherence to vibration limit thresholds, and equipment restrictions, as necessary. **Section 4.15.5.3** provides additional information on construction vibration mitigation measures.

4.15.5 Mitigation

4.15.5.1 Operational Traffic Noise Impacts

As required by FHWA and MassDOT's highway traffic noise assessment policy, noise abatement was considered for noise-sensitive receivers that were predicted to be impacted by highway traffic noise for the 2050 Build Alternative. **Table 4.15-15** summarizes the noise barrier evaluation results by Study

Area quadrant and CNE. **Figure 4.15-5c** and **Figure 4.15-5e** (Barrier SB), **Figure 4.15-6a** and **Figure 4.15-6d** (Barrier SJ), **Figure 4.15-7f** and **Figure 4.15-7g** (Barrier SK), and **Figure 4.15-8g** (Barrier BF) illustrate the locations of all modeled and evaluated noise barriers.

Table 4.15-15. Noise Barrier Evaluation Summary Table

Noise Barrier ID and Location	Barrier SB Sagamore North Quadrant	Barrier SJ Sagamore South Quadrant	Barrier SK Sagamore South Quadrant	Barrier BF Bourne North Quadrant
Average Noise Reduction (dBA)	7	11	7	10
Length (feet)	1,072	380	1,200	442
Height (feet)	25	15	25	15
Surface Area (square feet)	23,821	5,704	29,994	6,626
Total Cost[a]	$1,429,260	$342,240	$1,799,640	$397,560
Number of Impacted and Benefited Receptors[b]	3	20	4	1
Number of Not Impacted and Benefited Receptors	17	0	5	0
Total Benefited	20	20	9	1
Cost Effectiveness Index[c]	$11,489	$1,596	$29,026	$41,848
Barrier Status	Feasible and Not Reasonable	Feasible and Not Reasonable[d]	Feasible and Not Reasonable	Feasible and Not Reasonable

[a] Total cost calculated based on a unit cost of $60 per square foot, in accordance with the Massachusetts Department of Transportation's 2021 cost update, submitted to the Federal Highway Administration, pursuant to 23 Code of Federal Regulations 772.13(d)(2)(ii).

[b] A benefited receptor is a receptor in the Noise Study Area that attains at least a 5 decibel (dB) noise reduction or greater with a noise abatement measure. A benefited receptor does not have to be an impacted receptor.

[c] An index that is based on cost, the average noise level reduction provided by a noise barrier, and the number of receptors that achieve a 5 dB or more reduction in noise levels. The Cost-Effectiveness Index is one of several criteria used to determine the reasonableness[12] of noise abatement.

[d] Barrier SJ was determined to be "not reasonable" based on the combination of environmental impacts this abatement measure would impose on the Canal View Apartments, which is eligible for listing on the National Register of Historic Places.

dBA = A-weighted decibels

[12] 23 Code of Federal Regulations 772.5 defines reasonableness as "the combination of social, economic, and acoustical factors considered in the evaluation of proposed noise abatement measures." Reasonableness implies that good judgment and common sense have been applied in arriving at a decision on the construction or installation of proposed noise abatement measures.

One noise barrier (Barrier SJ), at the Canal View Apartments within the Sagamore South quadrant was determined to meet MassDOT's acoustic feasibility criteria as well as the Noise Reduction Design Goal and Cost Effectiveness Index. The Canal View Apartments (Sagamore South Quadrant) is eligible for listing on the National Register of Historic Places. A noise barrier approximately 380 feet in length was analyzed for 20 impacted residential dwelling units (FHWA Activity Category B). The noise barrier was modeled along the eastbound edge of pavement on Sandwich Road at various uniform heights ranging from a minimum height of 10 feet to a maximum height of 25 feet. At a height of 15 feet, the modeled noise barrier would provide a 5 dBA reduction (benefit) to all 20 impacted first-row residential dwelling units and would reduce noise levels by 10 dB at 18 first-row residential dwelling units, thereby achieving MassDOT's acoustic feasibility goal and noise reduction design goal, respectively. The barrier would also achieve a weighted average insertion loss of approximately 11 dBA and would benefit 20 residential dwelling units. Using MassDOT's 2021 updated unit cost of $60 per square foot, the total barrier cost would be $342,240, yielding a Cost Effectiveness Index of $1,596, which would be below MassDOT's 2021 updated Cost Effectiveness Index of $10,080 per decibel of noise reduction (insertion loss) per residential dwelling unit benefited.

23 CFR 772.5 defines reasonableness, specific to noise abatement, as "the combination of social, economic, and environmental factors considered in the evaluation of a noise abatement measure." Given the Canal View Apartments eligibility for listing on the National Register of Historic Places, the installation of a noise barrier at location CNE SJ would likely result in an Adverse Effect under Section 106 of the National Historic Preservation Act, necessitating Individual evaluation under Section 4(f) of the U.S. Department of Transportation Act for the "use" of a historic resource. The installation of a noise barrier at this location would also require the removal of 10 or more mature shade trees that currently provide the only buffer between the apartments and Sandwich Road. MassDOT recognizes the environmental and aesthetic benefits provided by these shade trees. Further, a noise barrier would be a visual obstruction for some residents of the Canal View Apartments and impede views of Cape Cod Canal, which is a defining attribute of the property. In consideration of this location's existing noise level range (54–68 dBA) and the 2050 Build Alternative noise level range (56–67 dBA), the likely adverse effect to and use of a historic property under Section 106 and Section 4(f), and the environmental conditions described above, MassDOT has determined construction of noise barrier SJ is not reasonable due to environmental impacts.

Appendix 4.15, Noise and Vibration Technical Report, provides further details regarding additional noise barriers that were evaluated as part of this noise analysis and other areas of impact where noise barriers were not evaluated due to engineering constraints.

4.15.5.2 Construction Noise Impacts

MassDOT will include special provisions for noise control during construction. The special provision will require the contractor to submit a Noise Control Plan for approval by MassDOT prior to commencement of construction. The Noise Control Plan will describe the procedure for predicting construction noise levels prior to performing construction activities, including identification of noise reduction measures required to meet the noise level limitations and minimize nuisance noise

conditions. An acoustical engineer will develop the Noise Control Plan, which the contractor will employ.

MassDOT will implement the following additional measures to minimize the impacts of construction noise on noise-sensitive receptors:

- Schedule the loudest construction activities during daytime hours near residential neighborhoods.
- Ensure that all construction equipment is in good working order and equipped with mufflers and other noise-reducing features.
- Limit the frequency and duration of equipment idling on the construction sites.
- Conduct noise monitoring to document compliance with recommended construction noise limits outlined in the Noise Control Plan. Measured noise levels that exceed or approach construction noise limits in the Noise Control Plan will implement corrective action in coordination with local communities.
- Route construction-related truck traffic along roads that would cause the least disturbance to residents.
- Use noise control measures such as temporary noise barriers/curtain systems and portable enclosures for small equipment (i.e., jackhammers and concrete saws), where feasible.
- Implement an active and responsive public outreach program during construction to coordinate construction activities and schedules and work with local communities to address concerns.

4.15.5.3 Construction Vibration Impacts

MassDOT's contract specifications will include special provisions for vibration control during construction. The special provision will require the contractor to submit a Vibration Control and Mitigation Plan for approval by MassDOT prior to commencement of construction. The Vibration Control and Mitigation Plan will describe the procedure for predicting vibration levels prior to performing construction activities, will provide results of a pre-construction buildings survey (identifying structures of concern), will identify vibration reduction measures required to meet established vibration limits set forth to preclude structural damage and minimize vibration-induced annoyance, and will provide a third-party compliance monitoring plan. An acoustical engineer or vibration specialist will develop the Vibration Control and Mitigation Plan, which the contractor will employ.

MassDOT will implement the following additional measures to minimize the impacts of construction vibration:

- Establish construction vibration structural damage response action and stop-work levels.
- Sequence operations to reduce total vibration levels by separating significant vibration-inducing activities.
- Limit vibration-inducing activities to daytime hours, where feasible.
- Require selection of alternative means and methods, where conditions permit.

4 Existing Conditions, Program Impacts, and Mitigation

4.16 Visual Resources

4.16.1 Introduction

This section assesses the effects of the No Build Alternative and Build Alternative on visual resources in the Cape Cod Bridges Program (Program) Study Areas. This section also discusses measures that the Massachusetts Department of Transportation (MassDOT) is proposing to mitigate for visual changes to the environment and compensate for adverse impacts. This section summarizes the Program's **Appendix 4.16, Visual Impact Assessment**.

4.16.1.1 Regulatory Context

This section has been prepared pursuant to the Federal Highway Administration's (FHWA) Guidelines for the Visual Impact Assessment of Highway Projects (2015) (FHWA Guidelines).[1] This section also incorporates information and direction from the following regulatory and guidance documents:

- Section 106 of the National Historic Preservation Act,[2] 36 Code of Federal Regulations (CFR) Section 800
- Programmatic Agreement between the U.S. Army Corps of Engineers (USACE) and the Massachusetts Historic Preservation Officer (MA SHPO) regarding the Cape Cod Canal Highway Bridges Project,[3] March 11, 2022, executed concurrently with the Finding of No Significant Impact for the USACE's Major Rehabilitation and Evaluation Report/Environmental Assessment (MRER/EA)
- Section 4(f) of the U.S. Department of Transportation Act of 1966, 23 CFR 774[4]
- MassDOT, Project Development and Design Guide, Context Sensitive Design[5]
- Town of Bourne Open Space and Recreation Plan, February 8, 2018[6]
- Town of Bourne Local Comprehensive Plan, approved October 29, 2019[7]
- Cape Cod Commission, Cape Cod Regional Policy Plan, December 2018[8]

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[1] https://www.environment.fhwa.dot.gov/env_topics/other_topics/VIA_Guidelines_for_Highway_Projects.aspx
[2] https://www.achp.gov/digital-library-section-106-landing/section-106-regulations
[3] https://www.nae.usace.army.mil/Portals/74/docs/Topics/Cape Cod Canal Bridges/Reports/MRER-Appendix-K.pdf
[4] https://www.environment.fhwa.dot.gov/env_topics/4f_tutorial/overview.aspx?h=e
[5] https://www.mass.gov/manual/massdot-project-development-and-design-guide
[6] https://www.townofbourne.com/sites/g/files/vyhlif12841/f/uploads/open_space_and_rec_plan_final_2018.pdf
[7] https://www.townofbourne.com/planning/news/local-comprehensive-final-certified-plan
[8] https://www.capecodcommission.org/our-work/rpp/

4.16.1.2 Methodology and Study Area

As an initial step, MassDOT defined the Study Areas for the visual impacts assessment. MassDOT used geographic information system software to identify areas where the proposed bridges would be visible, accounting for visual obstructions, such as topography, vegetation, and buildings. These viewsheds comprise the visual resources Areas of Visual Effect (AVE). **Figure 4.16-1** presents the Sagamore Bridge and Bourne Bridge AVEs.

To determine the Build Alternative's visual impacts, MassDOT photographed the existing conditions from different viewpoints of each bridge's AVEs that abut the existing roadways in the four Study Areas' quadrants (Sagamore North, Sagamore South, Bourne North, and Bourne South). These viewpoints include the following:

- Static viewsheds, defined as what neighbors of the bridges or roadways see from their stationary location.
- Dynamic viewsheds, defined as what travelers on the bridge or road see as they travel through the Program Limits.

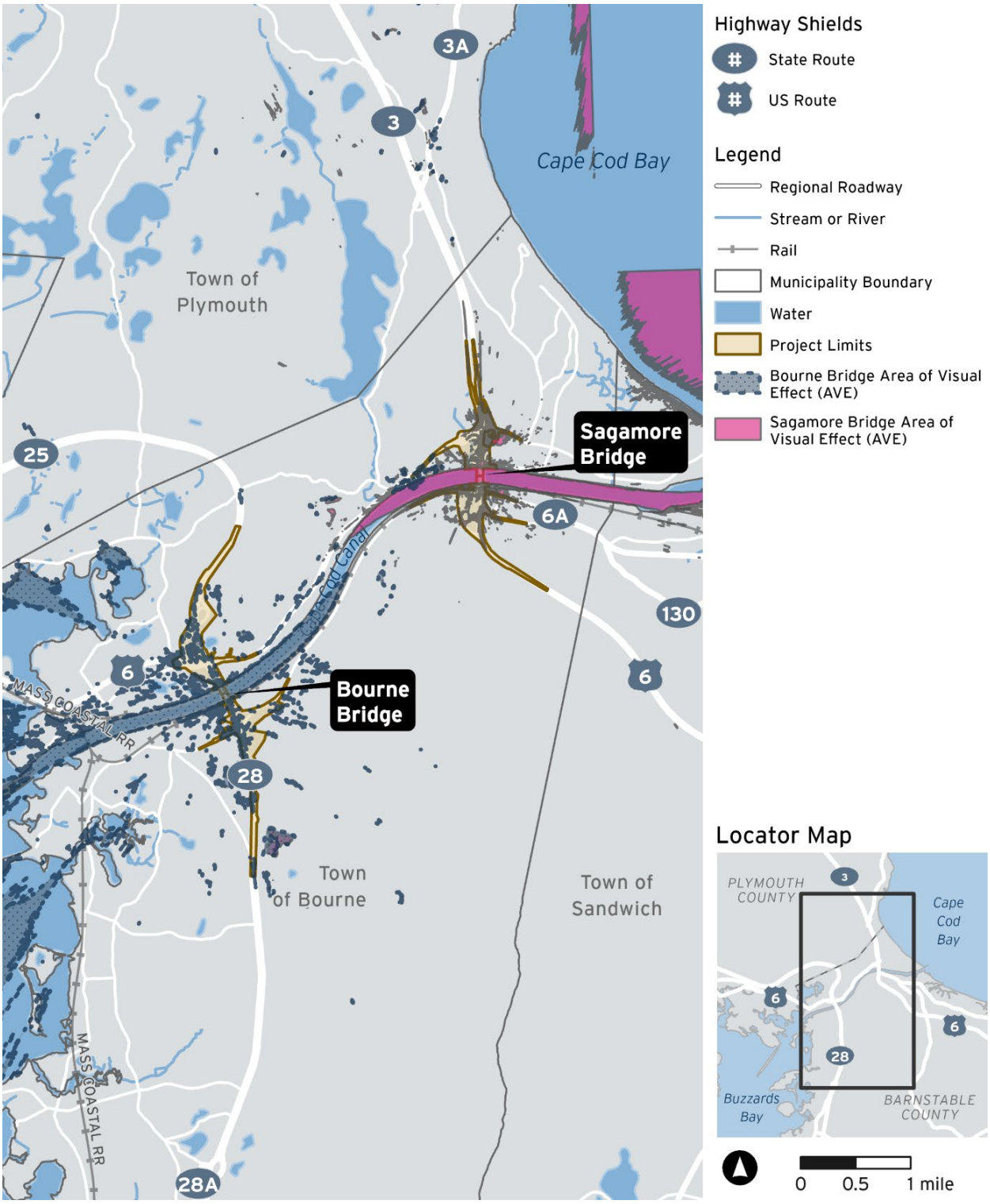
From these photographs, MassDOT identified 17 visual inventory locations in the Sagamore Bridge and Bourne Bridge AVEs consisting of key views of and from the bridges and highway interchange networks. Simulations were prepared of the Build Alternative at these locations using proposed 3D design models developed from Computer Aided Design software.

As directed in the FHWA Guidelines, MassDOT then assessed the visual inventory locations with respect to the following:

- Compatibility of the visual impact
- Viewer sensitivity to the visual impact
- Resulting degree of impact

The FHWA Guidelines define a visual impact as a change to the environment—measured by the compatibility of the impact with the visual character of the environment—or a change to the viewer's reaction to the impact, which is measured by their sensitivity to the impact. Compatibility of the impact is defined as the ability of the environment to visually absorb a proposed project, because the project and the environment have compatible visual characters (elements), such as project size and scale, form, and materials. The Guidelines assign the ratings for compatibility of the proposed impacts as compatible or incompatible.

Figure 4.16-1. Areas of Visual Effect (Sagamore Bridge and Bourne Bridge)



Source: Massachusetts Department of Transportation, 2024

The FHWA Guidelines define a viewer's sensitivity to the impact as the ability of viewers to see and care about a project's impacts. Viewer sensitivity to an impact is the result of viewer exposure to the impact and viewer awareness of the impact. The greater the exposure and awareness, the more viewers will be concerned about visual impacts. The FHWA Guidelines assign the ratings for viewer sensitivity to proposed impacts as low, moderate, or high sensitivity.

Together, the compatibility of the impact and the viewer's sensitivity to the impact determine the degree of impact to visual quality. The FHWA Guidelines assign the ratings for degree of proposed impacts as a beneficial change to the visual quality, a neutral change to the visual quality, or an adverse change to the visual quality.

4.16.2 Existing Conditions

4.16.2.1 Existing Visual Environment

The existing visual environment within the Sagamore Bridge and Bourne Bridge AVEs includes natural visual resources, defined as the following

- Natural visual resources, defined as areas with limited human-made structures
- Cultural visual resources, referring to the built environment
- Program-related visual resources, the elements of the visual environment directly relating to the Build Alternative

Cape Cod Canal is the most prominent natural visual resource within the Sagamore Bridge and Bourne Bridge AVEs. Sagamore Bridge and Bourne Bridge are the most prominent cultural visual resources. In addition to the bridges, project-related visual resources consist of the Sagamore Bridge and Bourne Bridge highway interchange networks on both sides of the canal.

4.16.2.2 Affected Populations

Per FHWA's Guidelines, the Build Alternative would affect two distinct viewers (or populations):

- Neighbors, defined as people who view the bridges and/or interchange network
- Travelers, defined as people who use and have views from the bridge and the interchange network

The affected populations in the Sagamore Bridge and Bourne Bridge AVEs include residential, recreational, commercial, and institutional and civic neighbors; and travelers. Travelers include motorists, pedestrians, and bicyclists, and include local and regional commuters, tourists, and shipping and freight travelers using the bridges and highway networks.

4.16.2.3 Visual Quality of the Environment

Visual quality consists of identifying what people like and dislike about the visual character of the AVEs. To ascertain the visual quality of the Sagamore Bridge and Bourne Bridge AVEs, MassDOT reviewed local and regional policy and planning documents addressing visual quality and the viewshed-related stipulations of the Programmatic Agreement between the USACE and the MA SHPO regarding the

Program. Additionally, MassDOT polled the public to assess viewers' preferences during its public meetings presenting optional bridge types.

Visual Preferences Identified by Local and Regional Policy and Planning Documents

In its 2019 revision, the Town of Bourne Local Comprehensive Plan[9] (Comprehensive Plan) cites the vision for the town of Bourne that was established in its first (2009) Local Comprehensive Plan:

> "a vision of a town of village centers serving the daily needs of surrounding neighborhoods, with an active downtown in Buzzards Bay that would be a center for government, marine research, and education. Regional commercial and industrial uses would be located on MacArthur Boulevard and other areas with good highway access. Village centers would be connected by pedestrian and bicycle paths, as well as local roads that were off the path of regional traffic."

The Comprehensive Plan notes that over the 10 years since the initial comprehensive planning effort, substantial progress has been made toward achieving the town's vision.

The Town of Bourne Open Space and Recreation Plan[10] (Recreation Plan) identifies the town as a medium-sized rural community that is unique due to its community of villages, its abundance of cultural and natural resources, its home to Cape Cod Canal, and its reputation as the "Gateway to Cape Cod."

As integral elements of Cape Cod Canal and as contributing resources to the Cape Cod Canal Historic District, Sagamore and Bourne Bridges occupy prominent roles in the AVEs, including protections through community and regional goals and zoning.

The Recreation Plan provides context for defining the visual quality of the AVEs, as well as the visual preferences within the town. According to the Recreation Plan, the most distinctive landform and physically impressive element of the town of Bourne's landscape is Cape Cod Canal. Nearly all of Cape Cod Canal is within the town. The Recreation Plan notes that the canal's "scenic and recreational value is an indisputable asset to the community." The Recreation Plan includes the following "community character" goal focused on natural and cultural resources, developed with input from the public:

> "Protect existing cultural and landscape assets. Such features are critical to Bourne's self-understanding and sense of community. They provide linkages between the history and the present and help shape the Town's unique character."

The Comprehensive Plan acknowledges the need for the bridges to be replaced and cites the importance of constructing replacement bridges that "respect the iconic natures of these bridges to the Cape's image," noting that the bridges are integral to the local heritage of Cape Cod. The Cape Cod

[9] https://www.townofbourne.com/sites/g/files/vyhlif12841/f/uploads/2019_final_revision_comprehensive_version_2.14.20.pdf

[10] https://www.townofbourne.com/sites/g/files/vyhlif12841/f/uploads/open_space_plan_fina_2018.pdf

Commission's Cape Cod Regional Policy Plan[11] (Policy Plan) includes two policy goals applicable to the existing bridges and their replacements:

- Community Design, to "protect and enhance the unique character of the region's built and natural environment based on the local context."
- Cultural Heritage, to "protect and preserve the significant cultural, historic, and archaeological values and resources of Cape Cod."

Further, the Policy Plan's vision for historic areas, including local and/or National Register of Historic Places (NRHP) districts, is to protect historic resources and to support development that respects the form, scale, and character of existing historic areas.

Visual Preferences Identified in the Programmatic Agreement

The Programmatic Agreement between the USACE and the MA SHPO for the Cape Cod Canal Highway Bridges Project[12] (i.e., the Program) addresses the importance of viewsheds of and from the NRHP-eligible Cape Cod Canal Historic District. The agreement states that viewshed analyses of the existing and proposed bridges shall be prepared to determine if historic properties within the Cape Cod Canal Historic District and outside the Cape Cod Canal Federal Navigation Project have views that could be affected by the construction of the proposed bridges. Further, the agreement states that the USACE and MassDOT shall "make a good faith effort to design, position, and construct new bridges that will avoid adverse effects" to the Cape Cod Canal Historic District and any NRHP-eligible properties within the viewshed of the proposed undertaking.

Visual Preferences Identified through Public Involvement

As part of its series of public meetings to identify recommendations for Program elements, in November 2022, MassDOT conducted two virtual public meetings to review preliminary recommendations of the feasible bridge types, obtain public sentiment on the bridge types, and confirm the bridge type to be advanced for further design. MassDOT conducted a poll to determine the community's visual preferences relative to the existing bridges and preferences for the replacement bridges via two questions:

- How important is it that the new Cape Cod Bridges resemble the current Bourne and Sagamore Bridges?
- How important is it to replace the Cape Cod Bridges with landmark structures?

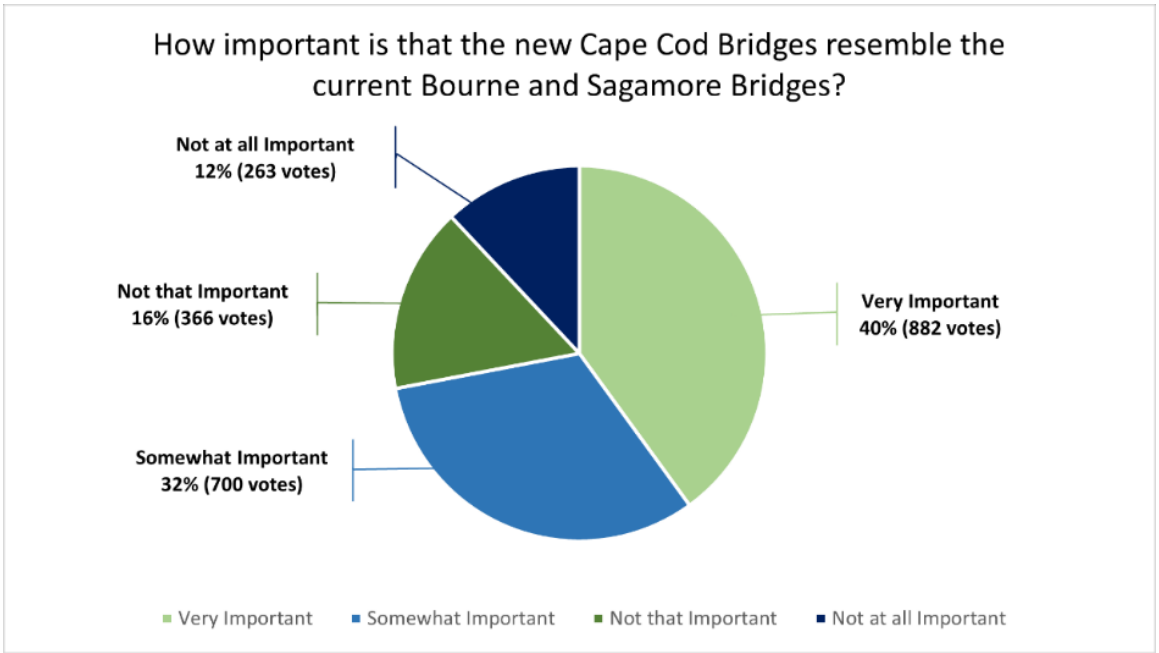
MassDOT received over 2,200 responses during and following the two public meetings. As indicated in **Figure 4.16-2** and **Figure 4.16-3**, most respondents indicated that it is somewhat to very important that

[11] https://www.capecodcommission.org/resource-library/file/?url=/dept/commission/team/Website_Resources/RPP/2018_Cape_Cod_Regional_Policy_Plan_for_web.pdf

[12] https://www.nae.usace.army.mil/Portals/74/docs/Topics/Cape%20Cod%20Canal%20Bridges/Agreements/USACE-MassDOTCapeCodCanalBridgesApproachesCollaborativeMemorandumofUnderstanding.pdf

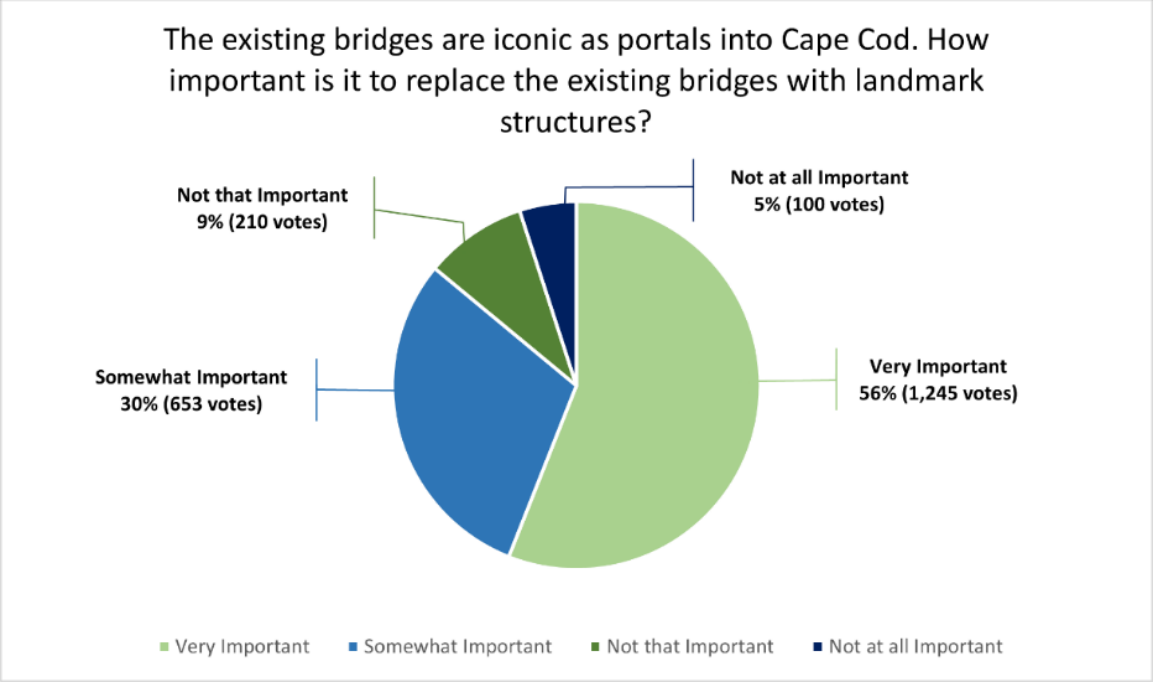
the replacement bridges resemble the existing Sagamore and Bourne Bridges, indicating a high level of viewer sensitivity to the bridges.

Figure 4.16-2. Assessment of Community Visual Preferences, Public Polling Question #1



Source: Massachusetts Department of Transportation, 2024

Figure 4.16-3. Assessment of Community Visual Preferences, Public Polling Question #2



Source: Massachusetts Department of Transportation, 2024

4.16.3 No Build Alternative

The No Build Alternative would not alter the visual quality of Sagamore and Bourne Bridges or affect the visual landscape of the interchange highway networks because they would retain their current configurations. It is not anticipated that the USACE's program of continued inspections and maintenance and repair of both existing bridges as needed ("Fix as Fails") in the No Build Alternative would substantially alter the viewsheds of the motorist crossing the bridges or the views of the bridges from the Canal Service Roads.

The No Build Alternative would include proposed transportation improvements projects in and near the Project Limits within the interchange improvements network (identified in **Chapter 3, Proposed Action and Alternatives**), consisting primarily of traffic safety improvements at Belmont Circle, Bourne Rotary, Scenic Highway, and State Route 28. It is not anticipated that these improvements, such as restriping, additional lanes, signage, and flashing beacons, raised medians, and deck replacement, would alter the existing visual landscape.

The No Build Alternative would include changes to the viewsheds of travelers on the regional and local roadways networks due to proposed development, such as the proposed Cumberland Farms retail development on MacArthur Boulevard, the proposed storage unit facility at Bourne Rotary, and the proposed mixed-use development on Canal Street. However, travelers are expected to have low viewer sensitivity due to their generally narrow viewshed and the short amount of time that drivers would be exposed to the new views. As a result, the degree of effect from new development abutting the highway networks would likely be neutral.

4.16.4 Program Impacts

This section describes the visual impacts of the Build Alternative using the 17 visual inventory locations that MassDOT identified in the Sagamore Bridge and Bourne Bridge AVEs. **Figure 4.16-4 through Figure 4.16-7** present the visual inventory locations. In **Section 4.16.4.1 through Section 4.16.4.5**, MassDOT compares existing and simulated viewsheds and assesses the impacts to viewsheds of the highway bridges and interchange networks within the four Study Area quadrants. **Section 4.16.4.6** presents a summary of the visual impacts of the Build Alternative. This visual assessment was conducted based on MassDOT's preliminary recommendations for intersection control, as presented in Section 3.4.3, Intersection Control Preliminary Recommendations.

4.16.4.1 Visual Assessment of Replacement Sagamore and Bourne Bridges

MassDOT identified two visual inventory locations for Sagamore Bridge and Bourne Bridge. These views apply to both bridges.

Comparison of Existing and Simulated Viewsheds

B1. View from Motorist, Sagamore and Bourne Bridges

Exhibit 4.16-1a and **Exhibit 4.16-1b** present existing and simulated viewsheds of motorists on the bridges (**Figure 4.16-7**, B1). **Table 4.16-1** provides detailed descriptions of the exhibits in this section.

Exhibit 4.16-1a. Existing View from Motorist on Sagamore Bridge or Bourne Bridge



Source: Massachusetts Department of Transportation, 2024

Exhibit 4.16-1b. Simulated View from Motorist on Sagamore Bridge or Bourne Bridge



Source: Massachusetts Department of Transportation, 2024

B2. View of Sagamore and Bourne Bridges from Cape Cod Canal Service Road

Exhibit 4.16-2a and **Exhibit 4.16-2b** present existing and simulated views of the bridges from the Cape Cod Canal Service Road (**Figure 4.16-4**, B2). **Table 4.16-1** provides detailed descriptions of the exhibits in this section.

Exhibit 4.16-2a. Existing View of Sagamore Bridge or Bourne Bridge from Cape Cod Canal Service Road



Source: Massachusetts Department of Transportation, 2024

Exhibit 4.16-2b. Simulated View of Sagamore Bridge or Bourne Bridge from Cape Cod Canal Service Road



Source: Massachusetts Department of Transportation, 2024

Viewshed Effect Assessment: Replacement Highway Bridges

Table 4.16-1 presents a summary comparison of existing and proposed viewsheds of the highway bridges. The table assesses impact compatibility and, incorporating viewer sensitivity, presents the anticipated degree of visual effect due to the Build Alternative.

Table 4.16-1. Anticipated Impacts to Viewsheds: Replacement Bridges

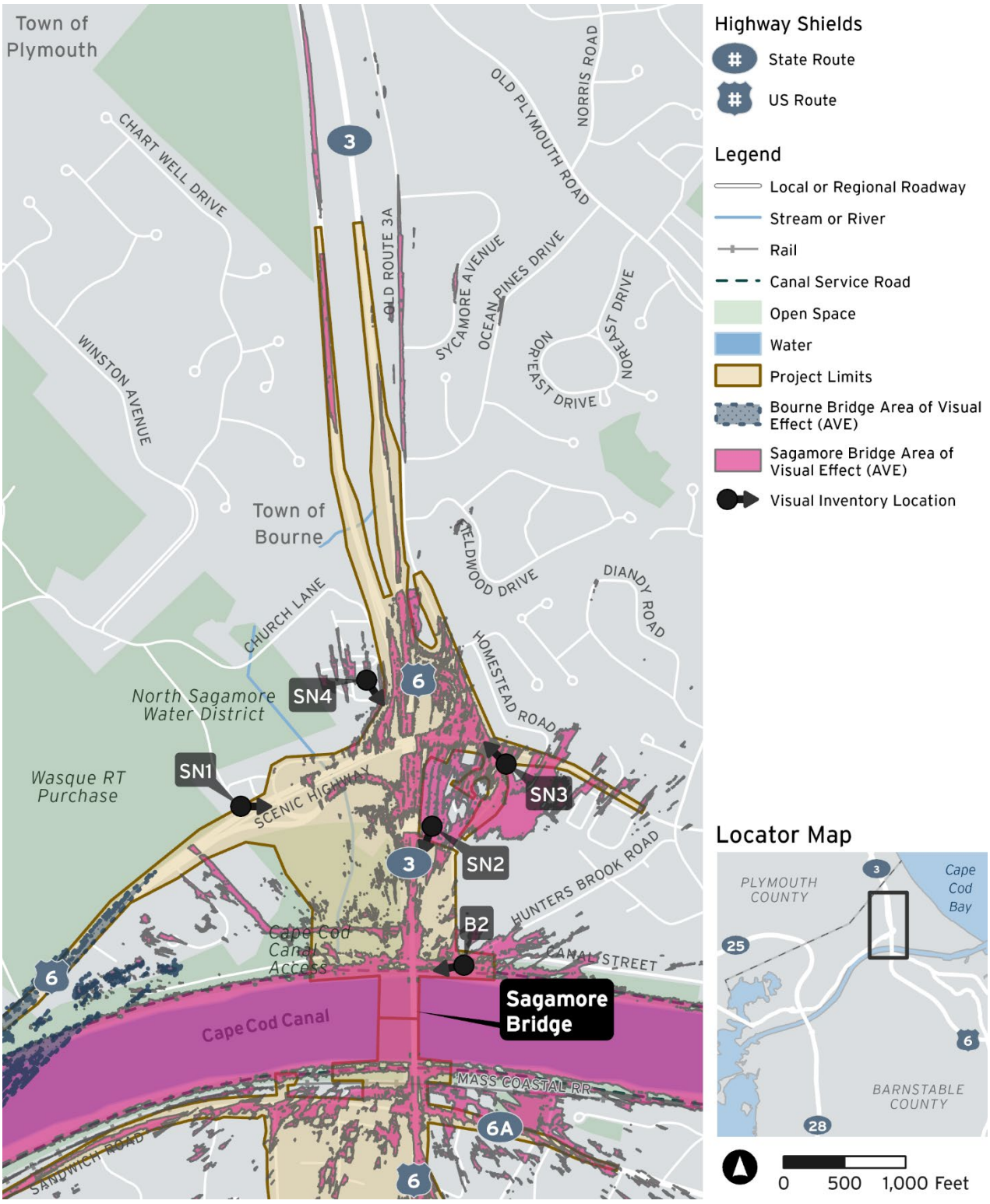
Visual Inventory Location*	Changes in Viewshed	Impact Compatibility	Viewer Types/ Sensitivity	Degree of Impact
B1 (Figure 4.16-7)	**View from Motorist on Sagamore Bridge or Bourne Bridge.** **Existing:** Viewshed of a portal entry onto the bridge, with prominent historic plaque at the portal entrance, reinforced by tall safety/visual fences on both sides of the highway and heavily trafficked narrow traffic lanes. Minimal roadway lighting is provided. **Proposed:** The overall shape of the delta-frame-supported arches would replicate the rounded arches of the existing steel truss bridges and would be compatible with the existing steel truss bridge in scale and form. It would successfully mimic the portal "gateway" entrance of the existing bridges. The proposed use of steel and concrete, with grey as the finish color, would provide a traditional look consistent with the appearance of the existing bridge. The separation of opposing traffic and the additional width of the travel lanes would provide travelers with a sense of visual separation and orderliness that is not present in the existing conditions. Lighting would be provided on the roadway and selected bridge elements.	Compatible	Travelers/ High	Neutral
B2 (Figure 4.16-4)	**View of Sagamore and Bourne Bridges from Cape Cod Canal Service Road** **Existing:** Viewshed includes the expanse of the waterway and the extensive length of the parallel service road, with the curve of the waterway in the distant view. **Proposed:** The views of the replacement bridges from the Canal Service Roads would be consistent with the existing views of the bridges. The increased height of the bridge deck and the lower height of the top of the arch would not be obvious. The placement of the new piers into the riprap portion of the canal would open views of the waterway from the Canal Service Roads, enhancing the natural vista. The piers would be physically closer to the Canal Service Roads and due to the depth of the delta frame, would be approximately 10 feet lower in height than the existing piers; however, the visual differences would be negligible.	Compatible	Recreational Neighbors/ High	Neutral

* The bridge visual inventory locations apply to all figures.

4.16.4.2 Visual Assessment of Sagamore North Quadrant Interchange Network

MassDOT identified four visual inventory locations in the Sagamore North quadrant highway interchange approach network Project Limits, presented in **Figure 4.16-4**.

Figure 4.16-4. Visual Inventory Locations (Sagamore North Quadrant Interchange Approach Network)



Source: Massachusetts Department of Transportation, 2024

Comparison of Existing and Simulated Viewsheds

SN1. View From Scenic Highway at Church Lane

Exhibit 4.16-3a and **Exhibit 4.16-3b** present existing and simulated views from Scenic Highway, facing east, at its intersection with Church Lane (**Figure 4.16-4**, SN1). **Table 4.16-2** provides detailed descriptions of the exhibits in this section.

Exhibit 4.16-3a. Existing View from Scenic Highway at Church Lane, facing east



Source: Massachusetts Department of Transportation, 2024

Exhibit 4.16-3b. Simulated View from Scenic Highway at Church Lane, facing east



Source: Massachusetts Department of Transportation, 2025

SN2. View from Sagamore Park and Ride Lot

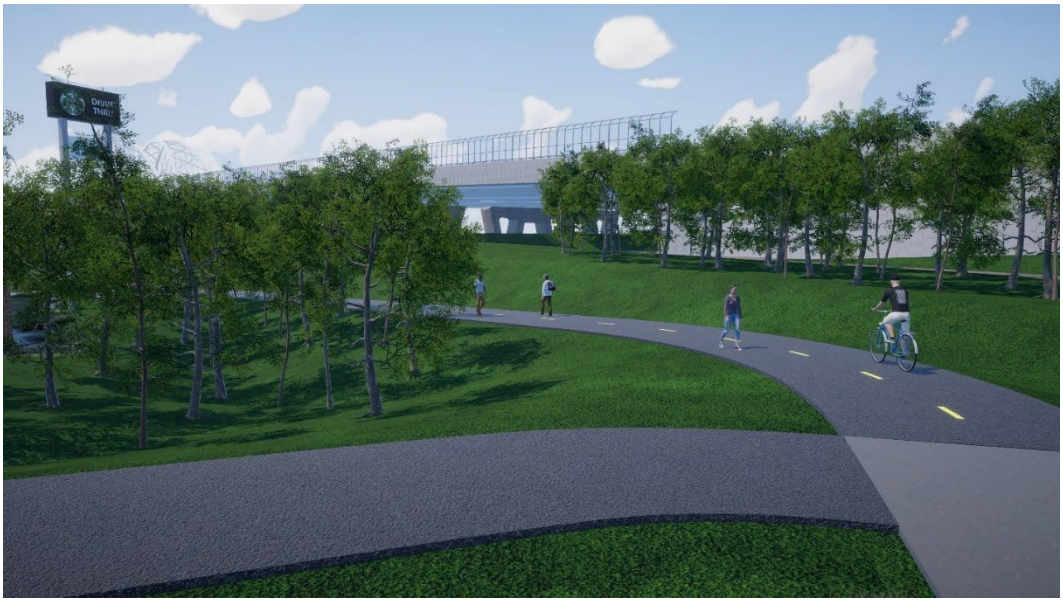
Exhibit 4.16-4a and **Exhibit 4.16-4b** present existing and simulated views from Sagamore Park and Ride Lot facing south toward Sagamore Bridge (**Figure 4.16-4**, SN2). **Table 4.16-2** provides detailed descriptions of the exhibits in this section.

Exhibit 4.16-4a. Existing View from Sagamore Park and Ride Lot, facing south



Source: Massachusetts Department of Transportation, 2024

Exhibit 4.16-4b. Simulated View from Sagamore Park and Ride Lot, facing south



Source: Massachusetts Department of Transportation, 2025

SN3. View From Meetinghouse Lane at State Road

Exhibit 4.16-5a and **Exhibit 4.16-5b** present existing and simulated views from Meetinghouse Lane at State Road, facing northwest (**Figure 4.16-4**, SN3). **Table 4.16-2** provides detailed descriptions of the exhibits in this section.

Exhibit 4.16-5a. Existing View from Meetinghouse Lane at State Road, facing northwest



Source: Massachusetts Department of Transportation, 2024

Exhibit 4.16-5b. Simulated View from Meetinghouse Lane at State Road, facing northwest



Source: Massachusetts Department of Transportation, 2025

SN4 View from Church Lane at Cape Pine Road

Exhibit 4.16-6a and **Exhibit 4.16-6b** present existing and simulated views from Church Lane at Cape Pine Road, facing south (**Figure 4.16-4**, SN4). **Table 4.16-2** provides detailed descriptions of the exhibits in this section.

Exhibit 4.16-6a. Existing View from Church Lane at Cape Pine Road, facing south



Source: Massachusetts Department of Transportation, 2024

Exhibit 4.16-6b. Simulated View from Church Lane at Cape Pine Road, facing south



Source: Massachusetts Department of Transportation, 2025

Viewshed Effect Assessment: Sagamore North Quadrant Interchange Approach Network

Table 4.16-2 presents a summary comparison of existing and proposed viewsheds within the Sagamore North quadrant interchange approach network. It assesses impact compatibility and, incorporating viewer sensitivity, presents the anticipated degree of visual effect due to the Build Alternative.

Table 4.16-2. Anticipated Impacts to Viewsheds: Sagamore North Quadrant Interchange Approach Network

Visual Inventory Location*	Changes in Viewshed	Impact Compatibility	Viewer Types/ Sensitivity	Degree of Impact
SN1	**View from Scenic Highway at Church Lane, facing east.** *Existing:* Viewshed includes a string of overhead signals across 4-lane divided Scenic Highway (with a State Route 3 turning lane) and the State Route 3 south on-ramp from Scenic Highway, directional signage, and forested areas bordering both sides of Scenic Highway. *Proposed:* The proposed view would be consistent with the existing view. Views of the shared-use path on the south side of Scenic Highway would provide visual interest. The removal of overhead utilities would present a more harmonious and coherent view to travelers.	Compatible	Residential Neighbors, Travelers/ Moderate	Neutral

Visual Inventory Location*	Changes in Viewshed	Impact Compatibility	Viewer Types/ Sensitivity	Degree of Impact
SN2	**View from Sagamore Park and Ride Lot, facing south.** **Existing:** Viewshed includes parked vehicles, dense vegetation, sidewalk to Canal Street, commercial building (Starbucks) and signs, and Sagamore Bridge arch to the west. **Proposed:** Sagamore Bridge would be less prominent, as the bridge location would shift to the west, but proposed State Route 3 would be more prominent to viewers than in existing conditions. The State Route 3 mainline would be approximately 15 feet higher than the existing roadway along the length of the Sagamore Park and Ride lot, on average. The elevation difference would range from approximately 7 feet closer to Scenic Highway, to a maximum 20-foot difference at the abutment of the replacement bridge, which would align with the existing Starbucks parking lot. The hardness of the concrete mainline would be softened by extensive landscaping. The natural environmental features of the setting and views of the new shared-used path that would start at the Sagamore Park and Ride Lot would be visually appealing, introducing a harmonious view that would provide both visual interest and visual relief.	Compatible	Travelers/ Low	Beneficial

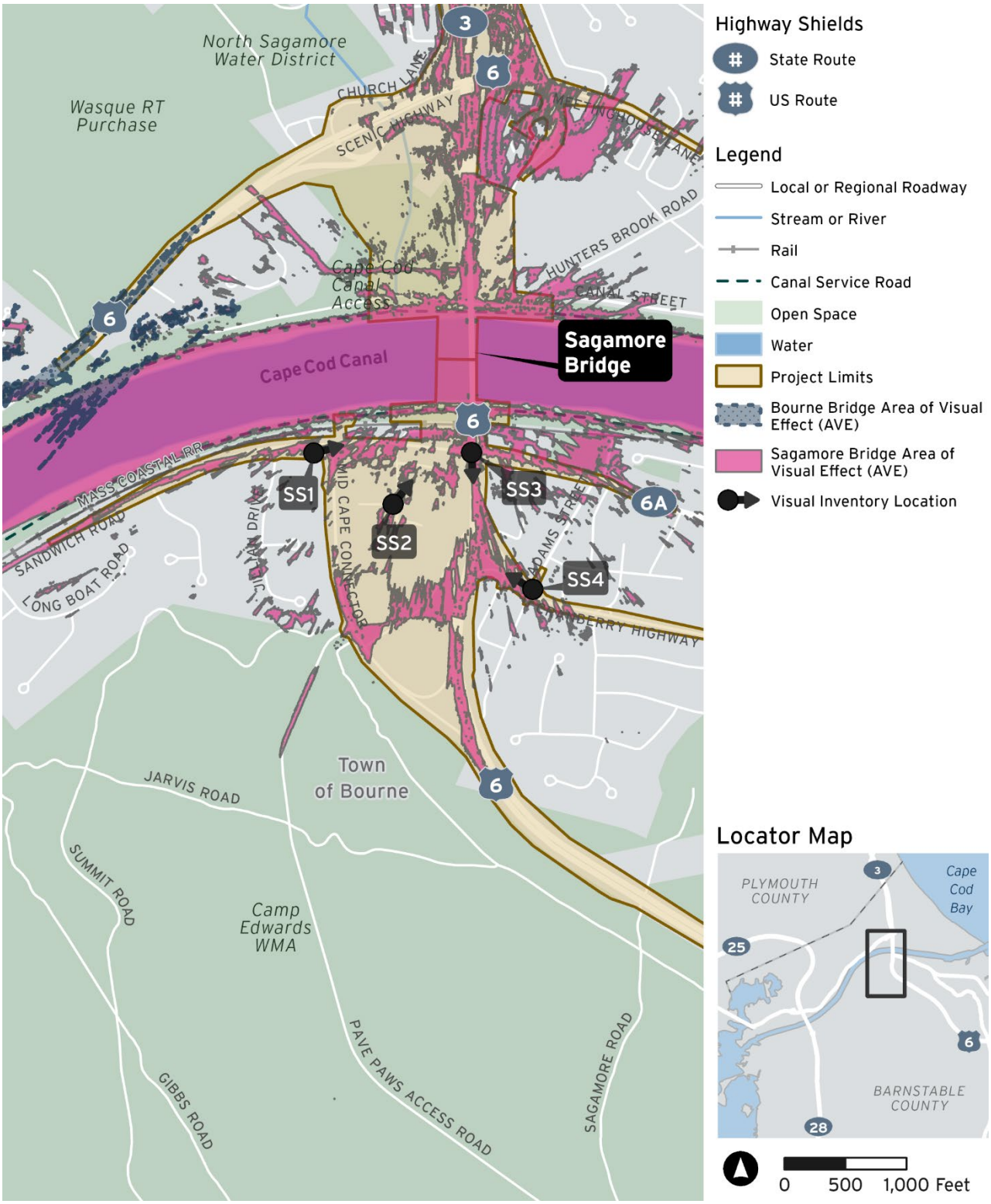
Visual Inventory Location*	Changes in Viewshed	Impact Compatibility	Viewer Types/ Sensitivity	Degree of Impact
SN3	**View from Meetinghouse Lane at State Road, facing northwest.** **Existing:** Viewshed includes high abutment wall and State Road to the north, overhead and side traffic signals, utility poles and overhead wiring, directional signage, and divided 4-lane Scenic Highway directly west. **Proposed:** The removal of the utility poles, overhead signals, and wiring would eliminate visual clutter and present a more harmonious and coherent view. The roundabout would be more visually appealing than the existing signalized intersection; it would reduce the amount of paved area and the landscape treatment in the center island would provide a natural feature and visual relief. The channelized entry of the roundabout would provide a sense of orderliness that is not present in the existing condition.	Compatible	Commercial Neighbors, Travelers/ Moderate	Beneficial
SN4	**View from Church Lane at Cape Pine Road, facing south.** **Existing.** Viewshed includes the Sagamore Bridge arch in the distance. **Proposed.** The proposed view generally would be consistent with the existing view, where the residential neighbors would have only a distant view of the Sagamore Bridge. The change in bridge alignment would not be readily apparent from this distant view.	Compatible	Residential Neighbors/ Low	Neutral

* **Figure 4.16-4** shows the Sagamore North quadrant visual inventory locations.

4.16.4.3 Visual Assessment of Sagamore South Quadrant Interchange Approach Network

MassDOT identified four visual inventory locations in the Sagamore South quadrant highway interchange approach network Project Limits (**Figure 4.16-5**).

Figure 4.16-5. Visual Inventory Locations (Sagamore South Quadrant Interchange Approach Network)



Source: Massachusetts Department of Transportation, 2024

Comparison of Existing and Simulated Viewsheds

SS1. View From Sandwich Road at Mid-Cape Connector

Exhibit 4.16-7a and **Exhibit 4.16-7b** present existing and simulated views from Sandwich Road at its intersection with Mid-Cape Connector, facing east (**Figure 4.16-5**, SS1). **Table 4.16-3** provides detailed descriptions of the exhibits in this section.

Exhibit 4.16-7a. Existing View from Sandwich Road at Mid-Cape Connector, facing east



Source: Massachusetts Department of Transportation, 2024

Exhibit 4.16-7b. Simulated View from Sandwich Road at Mid-Cape Connector, facing east



Source: Massachusetts Department of Transportation, 2025

SS2. View From Eleanor Avenue

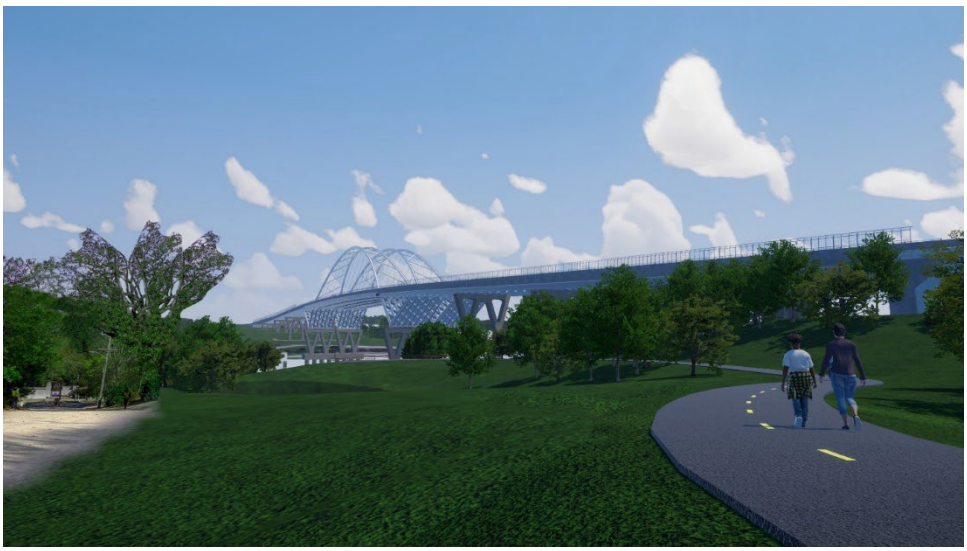
Exhibit 4.16-8a and **Exhibit 4.16-8b** present existing and simulated views from Eleanor Avenue, facing northeast (**Figure 4.16-5**, SS2). **Table 4.16-3** provides detailed descriptions of the exhibits in this section.

Exhibit 4.16-8a. Existing View from Eleanor Avenue, facing northeast



Source: Massachusetts Department of Transportation, 2024

Exhibit 4.16-8b. Simulated View from Eleanor Avenue, facing northeast



Source: Massachusetts Department of Transportation, 2025

S3. View from Sandwich Road at Sagamore Bridge South Abutment

Exhibit 4.16-9a presents an existing view from Sandwich Road at the Sagamore Bridge south abutment, facing south. **Exhibit 4.16-9b** presents a simulated view from Sandwich Road at the new Sandwich Connector, facing south (**Figure 4.16-5**, SS3). **Table 4.16-3** provides detailed descriptions of the exhibits in this section.

Exhibit 4.16-9a. Existing View from Sandwich Road at Sagamore Bridge South Abutment, facing south



Source: Massachusetts Department of Transportation, 2024

Exhibit 4.16-9b. Simulated View of Sandwich Road Connector at Sandwich Road, facing south



Source: Massachusetts Department of Transportation, 2025

SS4. View from Cranberry Highway at Adams Street

Exhibit 4.16-10a presents an existing view of Cranberry Highway at its intersection with Adams Street, facing west. **Exhibit 4.16-10b** presents a simulated view of the new Cranberry Highway Connector from Cranberry Highway at its intersection with Adams Street, facing west (**Figure 4.16-5**, SS4). **Table 4.16-3** provides detailed descriptions of the exhibits in this section.

Exhibit 4.16-10a. Existing View from Cranberry Highway at Adamas Street, facing west



Source: Massachusetts Department of Transportation, 2024

Exhibit 4.16-10b. Simulated View from Cranberry Highway at Adams Street, facing west



Source: Massachusetts Department of Transportation, 2025

Viewshed Effect Assessment: Sagamore South Quadrant Interchange Approach Network

Table 4.16-3 presents a summary comparison of existing and proposed viewsheds within the Sagamore South quadrant interchange approach network. The table assesses impact compatibility and, incorporating viewer sensitivity, presents the anticipated degree of visual effect due to the Build Alternative.

Table 4.16-3. Anticipated Impacts to Viewsheds: Sagamore South Quadrant Interchange Approach Network

Visual Inventory Location*	Changes in Viewshed	Impact Compatibility	Viewer Types/ Sensitivity	Degree of Impact
SS1	**View from Sandwich Road at Mid-Cape Connector, facing east.** **Existing:** Viewshed includes median island, a crossarm with three overhead signals, two ground-level signal lights, utility pole and overhead wiring, directional signage, Sagamore Bridge arch and span, and residential and commercial uses on both sides of Sandwich Road. **Proposed:** The signalized intersection would remain, but the overhead wiring and utility poles would be removed, providing a more coherent and harmonious view. Views of a new shared-use path on the south side of Sandwich Road would provide visual interest. Views of the existing residences and commercial uses along Sandwich Road would not change. The relocated Sagamore Bridge would be a more prominent feature in the viewshed; however, the difference in height between the existing and proposed arches would be difficult to discern.	Compatible	Residential and Commercial Neighbors, Travelers/ Moderate	Neutral

Visual Inventory Location*	Changes in Viewshed	Impact Compatibility	Viewer Types/ Sensitivity	Degree of Impact
SS2	**View from Eleanor Avenue, facing northeast.** **Existing:** Viewshed includes the intersection with John's Lane, single-family residential houses on the east side of Eleanor Avenue, trees lining the roadway, dense canopy cover at rear of houses, and Sagamore Bridge arch in the background. **Proposed:** MassDOT would potentially acquire and demolish the residences along the east side of Eleanor Avenue, because this area would be needed to construct the new bridge and demolish the existing bridge. The replacement Sagamore Bridge and reconfigured State Route 6 mainline would be closer to the neighborhood on the west side of Eleanor Avenue and would be more prominent features in viewsheds. At the southern end of Eleanor Avenue, the mainline would be approximately 37 feet higher than in existing conditions, increasing to a 103-foot height difference at the northern end of Eleanor Avenue. The dense tree canopy along the embankment of the existing State Route 6 would be removed and replaced with a buffer area. While the buffer area would separate the Round Hill neighborhood on the west side of Eleanor Avenue from the elevated State Route 6 mainline, the loss of residential units and the existing dense tree canopy (and the resulting view of the more prominent transportation elements) would substantially alter the neighborhood's existing visual character and would adversely affect the sensitivity of the residential viewers.	Incompatible	Residential Neighbors/High	Adverse

Visual Inventory Location*	Changes in Viewshed	Impact Compatibility	Viewer Types/ Sensitivity	Degree of Impact
SS3	**View from Sandwich Road at Sagamore Bridge South Abutment, facing south.** **Existing:** Viewshed includes concrete abutment of Sagamore Bridge against steep embankment, overhead wires, and sidewalk in front of abutment. The vertical under-clearance of the bridge over Sandwich Road is 21 feet. **Proposed:** The existing Sagamore Bridge would be eliminated; the existing bridge and State Route 6 mainline footprint would be replaced with a new road connecting Sandwich Road with the new Cranberry Highway Extension via a new roundabout. The new Sandwich Road Connector would parallel the relocated State Route 6 mainline, which would be located approximately 100 feet to the west; travelers would have views of the elevated concrete roadway. Sidewalks would be provided on both sides of the Sandwich Road Connector. With its distinct and straight lines, the new connector would introduce a sense of orderliness and a vista of the roundabout in the distance. The viewshed would include the windmill of the former Christmas Tree Shops development, giving viewers a sense of familiarity and placemaking within the new vista. Due to the rolling terrain at this location, construction of the Sandwich Road Connector would require substantial excavation of up to 58 feet; the areas bordering the road would be landscaped. The connector road would introduce a new appealing view to an area from Sandwich Road with an existing void. While the new view would substantially differ from the existing view of the bridge abutment, it would be generally consistent with the character of the transportation network in this section of Sandwich Road. Travelers typically would have low sensitivity to this travel corridor because the purpose of Sandwich Road Connector would be to bypass local traffic with destinations to Market Basket and Mid-Cape Connector.	Compatible	Travelers/Low	Neutral

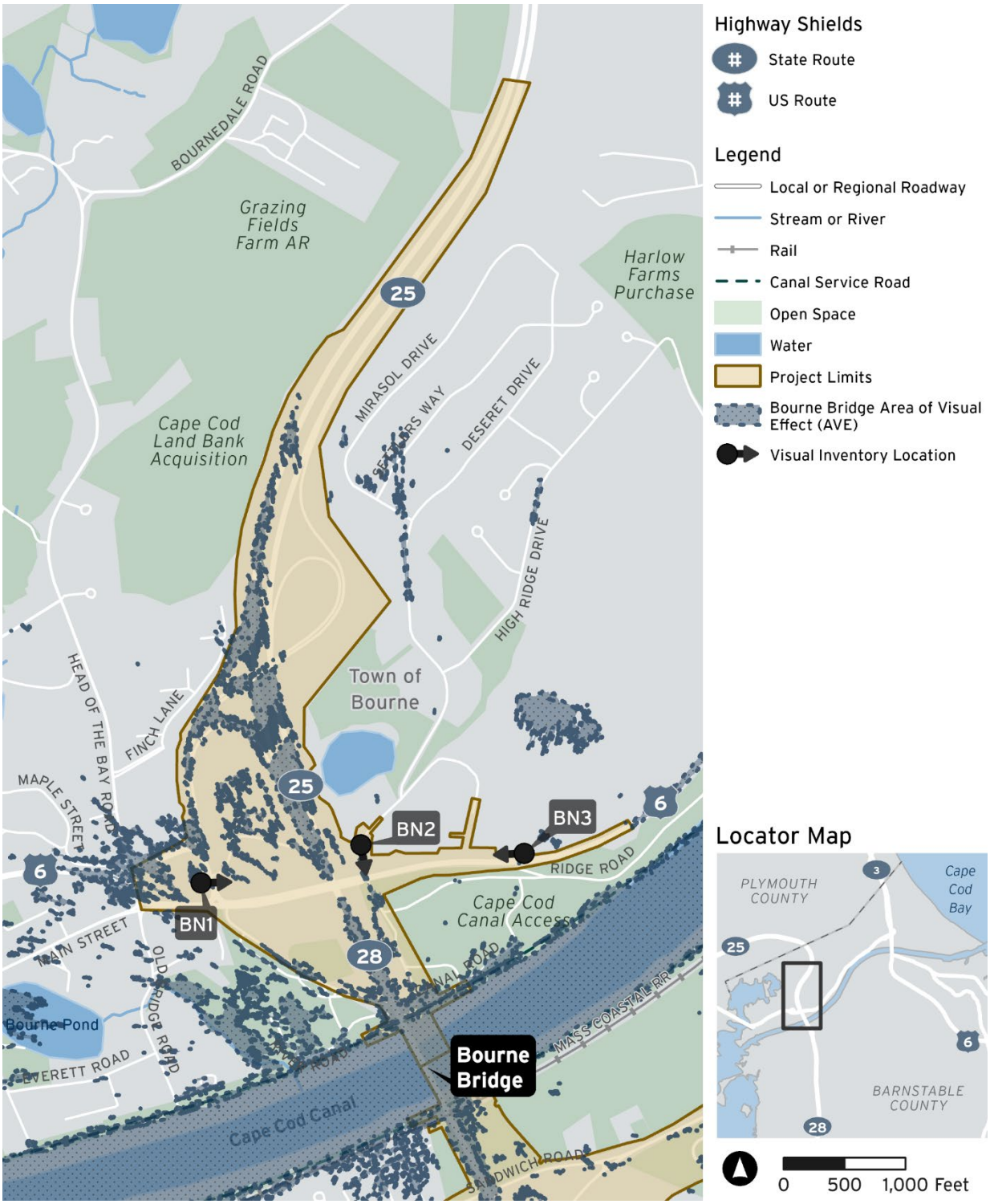
Visual Inventory Location*	Changes in Viewshed	Impact Compatibility	Viewer Types/ Sensitivity	Degree of Impact
SS4	**View from Cranberry Highway at Adams Street, facing west.** **Existing:** Viewshed includes two-lane, striped roadway separated from frontage road by narrow, grassed median strip with utility poles and overhead electrical wiring; scattered individual residential and commercial buildings; distant view of facades of shopping development; and minimal landscaping. **Proposed:** The removal of the utility poles and overhead wiring would eliminate visual clutter and present a more harmonious and coherent view. The roundabout would be more visually appealing than the existing diverging roadways that lack visual directional cues; it would reduce the paved area and incorporate a landscaped treatment in the center island, providing visual relief. The channelized entry of the roundabout would provide travelers with a sense of orderliness that is not present in the existing condition and would be a visual entry for travelers to the Market Basket commercial area. Travelers and residential and commercial neighbors would have prominent views of the elevated State Route 6 mainline beyond the roundabout. While the elevated structure would be a new viewshed element, it would be consistent with the character of the transportation corridor.	Compatible	Residential and Commercial Neighbors/ Moderate	Beneficial

* **Figure 4.16-5** shows the Sagamore South quadrant visual inventory locations.

4.16.4.4 Bourne North Quadrant Interchange Network

MassDOT identified three visual inventory locations in the Bourne North quadrant highway interchange approach network Project Limits (**Figure 4.16-6**).

Figure 4.16-6. Visual Inventory Locations (Bourne North Quadrant Interchange Approach Network)



Source: Massachusetts Department of Transportation, 2024

Comparison of Existing and Simulated Viewsheds

BN1. View From Belmont Circle

Exhibit 4.16-11a and **Exhibit 4.16-11b** present existing and simulated views from Belmont Circle, facing east (**Figure 4.16-6**, BN1). **Table 4.16-4** provides detailed descriptions of the exhibits in this section.

Exhibit 4.16-11a. Existing View from Belmont Circle, facing east



Source: Massachusetts Department of Transportation, 2024

Exhibit 4.16-11b. Simulated View from Belmont Circle, facing east



Source: Massachusetts Department of Transportation, 2025

BN2. View From Nightingale Road at Scenic Highway

Exhibit 4.16-12a and Exhibit 4.16-12b present existing and simulated views from Nightingale Road at its intersection with Scenic Highway, facing south (**Figure 4.16-6**, BN2). **Table 4.16-4** provides detailed descriptions of the exhibits in this section.

Exhibit 4.16-12a. Existing View from Nightingale Road at Scenic Highway, facing south



Source: Massachusetts Department of Transportation, 2024

Exhibit 4.16-12b. Simulated View from Nightingale Road at Scenic Highway, facing south



Source: Massachusetts Department of Transportation, 2025

BN3. View from Scenic Highway

Exhibit 4.16-13a and **Exhibit 4.16-13b** present existing and simulated views from Scenic Highway, facing west (**Figure 4.16-6**, BN3). **Table 4.16-4** provides detailed descriptions of the exhibits in this section.

Exhibit 4.16-13a. Existing View from Scenic Highway, facing west



Source: Massachusetts Department of Transportation, 2024

Exhibit 4.16-13b. Simulated View from Scenic Highway, facing west



Source: Massachusetts Department of Transportation, 2025

Viewshed Effect Assessment: Bourne North Quadrant Interchange Approach Network

Table 4.16-4 presents a summary comparison of existing and proposed viewsheds within the Bourne North quadrant interchange approach network. It assesses impact compatibility and, incorporating viewer sensitivity, presents the anticipated degree of visual effect due to the Build Alternative.

Table 4.16-4. Anticipated Impacts to Viewsheds: Bourne North Quadrant Interchange Approach Network

Visual Inventory Location*	Change in Viewshed	Impact Compatibility	Viewer Types/ Sensitivity	Degree of Impact
BN1	**View from Belmont Circle, facing east.** **Existing:** Viewshed includes circular rotary, sidewalk in front of shopping development plaza with parking and storefronts; overhead traffic lights and directional signage. **Proposed:** Viewshed of the new 18-foot-high flyover ramp connecting Scenic Highway to State Route 25 would add a higher structural element than existing conditions; however, the new flyover ramp would be consistent with the visual character of the existing transportation environment. Commercial neighbors and travelers would not be sensitive to these visual changes; as in the current view, the altered transportation elements in the background would not occupy a prominent position in their viewshed. The visibility of and access to existing commercial uses in Belmont Circle would not be affected.	Compatible	Commercial Neighbors, Travelers/ Low	Neutral

Visual Inventory Location*	Change in Viewshed	Impact Compatibility	Viewer Types/ Sensitivity	Degree of Impact
BN2	**View from Nightingale Road at Scenic Highway, facing south.** **Existing:** Viewshed includes roadway with left and right turning lanes, overhead traffic signals, directional signage, and entrance sign to Bourne Scenic Park, with a prominent Bourne Bridge arch in background. **Proposed:** The relocated Bourne Bridge would be diminished by the approximate 80-foot relocated State Route 25 mainline and the approximate 30-foot-high new elevated flyover ramp connecting State Route 25 eastbound to Scenic Highway eastbound, which would be the dominant visual structural elements in the viewshed. The removal of the utility poles, overhead signals, and wiring would eliminate visual clutter and present a more harmonious and coherent view. The roundabout would be more visually appealing than the existing signalized intersection; it would reduce the amount of paved area and the landscape treatment in the center island would provide a natural feature and visual interest. The shared-use path would provide a new element of visual interest to the viewshed. The viewshed of neighbors exiting the Nightingale Pond neighborhood onto Scenic Highway would substantially change from existing conditions, however, conveying an urban form with hard lines of the highways in contrast to their current view of the natural, park setting of the Bourne Scenic Park entrance.	Incompatible	Residential Neighbors/ Moderate	Adverse

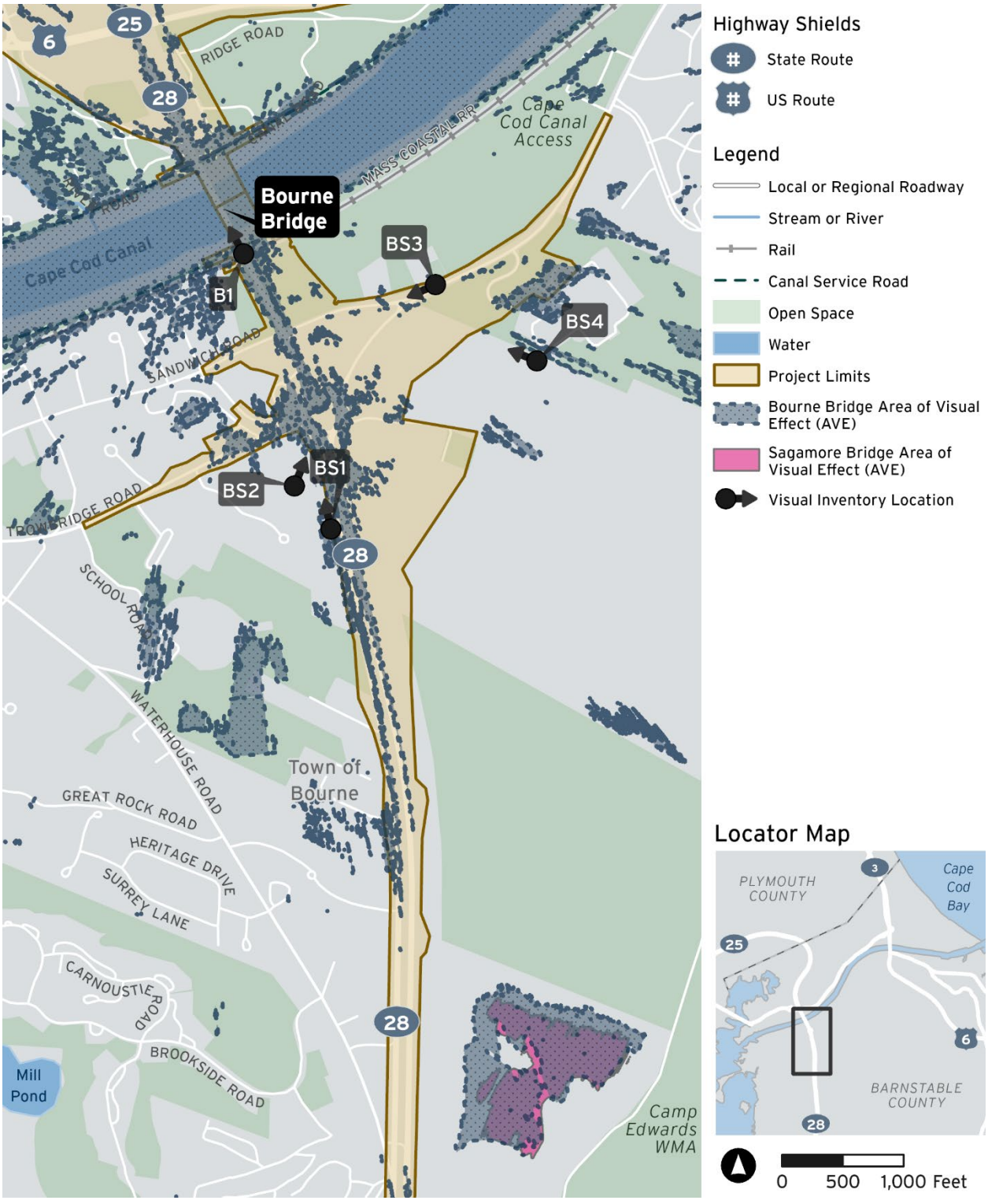
Visual Inventory Location*	Change in Viewshed	Impact Compatibility	Viewer Types/ Sensitivity	Degree of Impact
BN3	**View from Scenic Highway, facing west.** **Existing:** Viewshed of striped divided highway with two lanes in each direction, distant overpass highway; densely forested landscape paralleling Scenic Highway. **Proposed:** Travelers would have views of the elevated State Route 25 mainline, the elevated flyover ramp connecting State Route 25 eastbound to Scenic Highway eastbound, and the new State Route 28 northbound on-ramp. In the proposed view, the existing dense canopy of trees on both sides of Scenic Highway would be replaced with an extensive roadway network, creating a more developed, urban character in this portion of Scenic Highway. The reconfigured State Route 25, approximately 28 feet higher than existing conditions, and the new ramps would be dominant structures within the viewshed. The single-lane roundabout would be a traffic calming measure; it would provide travelers with a sense of orderliness and serve as a visual entry to the Belmont Circle commercial area. The landscaped treatment in the center of the roundabout would add visual interest. The reconfigured State Route 25 would be 28 feet higher than existing conditions and would be a dominant structure within the viewshed. While the more physically dominating presence of the transportation network would constitute a substantial change from existing conditions, travelers along this portion of Scenic Highway typically would have low sensitivity to this travel corridor. Further, the inclusion of the roundabout, sidewalks, and landscaping would provide visually appealing features to the viewshed.	Incompatible	Travelers/ Low	Neutral

Note: **Figure 4.16-6** shows the Bourne North quadrant visual inventory locations.

4.16.4.5 Bourne South Quadrant Interchange Network

MassDOT identified four visual inventory locations in the Bourne South quadrant highway interchange approach network Project Limits (**Figure 4.16-7**).

Figure 4.16-7. Visual Inventory Locations (Bourne South Quadrant Interchange Approach Network)



Source: Massachusetts Department of Transportation, 2024

Comparison of Existing and Simulated Viewsheds

BS1. View from Nickerson-Bourne Funeral Home Parcel

Exhibit 4.16-14a and **Exhibit 4.16-14b** present existing and simulated views from Nickerson-Bourne Funeral Home on State Route 28, facing north (**Figure 4.16-7**, BS1).

Exhibit 4.16-14a. Existing View from Nickerson-Bourne Funeral Home, facing north



Source: Massachusetts Department of Transportation, 2024

Exhibit 4.16-14b. Simulated View from Nickerson-Bourne Funeral Home, facing north



Source: Massachusetts Department of Transportation, 2025

BS2. View from Cumberland Farms Parcel

Exhibit 4.16-15a and **Exhibit 4.16-15b** present existing and simulated views from the Cumberland Farms parcel at the Bourne South Rotary, facing northeast (**Figure 4.16-7**, BS2).

Exhibit 4.16-15a. Existing View from Cumberland Farms Parcel, facing northeast



Source: Massachusetts Department of Transportation, 2024

Exhibit 4.16-15b. Simulated View from Cumberland Farms Parcel, facing northeast



Source: Massachusetts Department of Transportation, 2025

BS3. View from Sandwich Road

Exhibit 4.16-16a and **Exhibit 4.16-16b** present existing and simulated views from Sandwich Road, facing west (**Figure 4.16-7**, BS3).

Exhibit 4.16-16a. Existing View from Sandwich Road, facing west



Source: Massachusetts Department of Transportation, 2024

Exhibit 4.16-16b. Simulated View from lower Sandwich Road, facing west

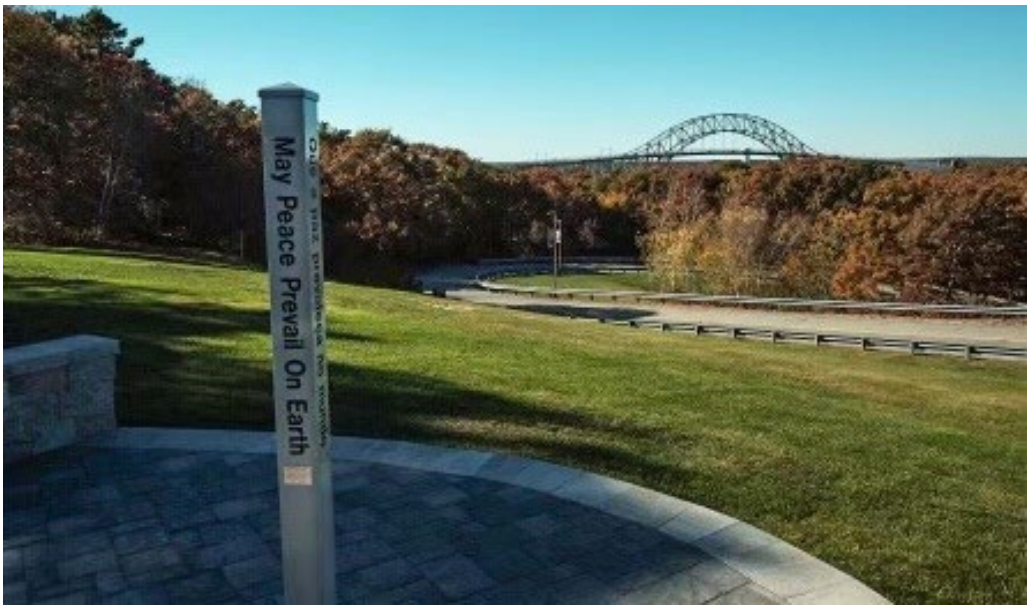


Source: Massachusetts Department of Transportation, 2025

BS4. View from Upper Cape Cod Regional Technical High School Scenic Overlook

Exhibit 4.16-17a and **Exhibit 4.16-17b** present existing and simulated views from the scenic overlook at Upper Cape Cod Regional Technical High School, facing northwest (**Figure 4.16-7**, BS4).

Exhibit 4.16-17a. Existing View from Upper Cape Cod Regional Technical High School Scenic Overlook, facing northwest



Source: Massachusetts Department of Transportation, 2024

Exhibit 4.16-17b. Simulated View from Upper Cape Cod Regional Technical High School Scenic Overlook, facing northwest



Source: Massachusetts Department of Transportation, 2025

Viewshed Effect Assessment: Bourne South Quadrant Interchange Approach Network

Table 4.16-5 presents a summary comparison of existing and proposed viewsheds within the Bourne South quadrant interchange approach network. The table assesses impact compatibility and, incorporating viewer sensitivity, presents the anticipated degree of visual effect due to the Build Alternative.

Table 4.16-5. Anticipated Impacts to Viewsheds: Bourne South Quadrant Interchange Approach Network

Visual Inventory Location*	Changes in Viewshed	Impact Compatibility	Viewer Types/ Sensitivity	Degree of Impact
BS1	**View from Nickerson-Bourne Funeral Home, facing north.** **Existing:** Viewshed includes entrance driveway from State Route 28 to fenced and signed commercial property; utility poles and overhead wiring; divided State Route 28, separated by guardrail and median strip; and dense vegetation bordering State Route 28 northbound; and the Bourne Bridge arch in the distance on the west. **Proposed:** The new frontage road along State Route 28, implemented for safety and access management, would provide a continuity of visibility of and accessibility to commercial neighbors who would be sensitive to project changes: it would be similar to existing conditions where commercial businesses and their patrons have access and visibility to and from State Route 28. The new shared-use path along the frontage road would provide visual interest. The forested area along existing State Route 28 would be removed; the highway would be relocated approximately 35 feet to the east, elevated by approximately 5 feet, and separated from the frontage road by a landscaped area. Views of Bourne Bridge would be more prominent with the change in realignment, but the difference in the arch height would not be discernible from this distance. Views of the project along this heavily trafficked corridor would be consistent with the visual character of the existing transportation elements.	Compatible	Commercial Neighbors/ High	Neutral

Visual Inventory Location*	Changes in Viewshed	Impact Compatibility	Viewer Types/ Sensitivity	Degree of Impact
BS2	**View from Cumberland Farms Parcel, facing northeast.** **Existing:** Viewshed includes commercial signage, off-ramp to State Route 28 south, directional signage, circular drive around rotary with irregular landscaping and vegetation in the center, and utility poles with overhead wiring. **Proposed:** The removal of the utility poles and overhead wiring would eliminate visual clutter and present a more harmonious and coherent view. Replacement of the two-lane Bourne Rotary with a single-lane, double (dog-bone) roundabout would serve as a traffic calming measure and the channelized entry would allow for visual traffic separation, providing travelers with a sense of orderliness that is not present with the existing rotary that allows for higher speeds. The dog-bone roundabout would improve visibility and access to commercial neighbors. The two center islands of the dog-bone roundabout would provide opportunities for landscaping to add natural elements and visual interest.	Compatible	Commercial Neighbors, Travelers/ Moderate	Beneficial

Visual Inventory Location*	Changes in Viewshed	Impact Compatibility	Viewer Types/ Sensitivity	Degree of Impact
BS3	**View from Sandwich Road, facing west.** **Existing:** Viewshed includes Sandwich Road at a fork—proceeding southwest on two-lane upper Sandwich Road to State Route 28 or northwest on two-lane lane lower Sandwich Road to Bourne Recreation Area/Bourne Village—one directional sign, and densely forested/brush bordering both sides of Sandwich Road. **Proposed:** The existing fork separating upper and lower Sandwich Road would be replaced with a multilane roundabout. The existing dense forested canopy bordering Sandwich Road would be removed and replaced with landscaped sloped areas and relocated State Route 28 as prominent features. Upper Sandwich Road would be barely visible from lower Sandwich Road. While the more prominent elevated roadway and the loss of the existing tree canopy would alter the existing rural character along this portion of Sandwich Road, travelers generally would be less sensitive to viewshed changes. Further, the newly landscaped area, and the shared-use path on the north side of lower Sandwich Road would create a harmonious, visually appealing viewshed. Additionally, the substantially improved sight lines for travelers on Sandwich Road due to the new roundabout would enhance traveler safety and promote a sense of orderliness.	Incompatible	Travelers/ Low	Neutral
BS4	**View from Upper Cape Cod Regional Technical School Scenic Overlook, facing northwest.** **Existing:** Viewshed of landscaped and paved scenic overlook with aesthetic visual elements includes Bourne Bridge in the distance as the single focal point. **Proposed:** The view of the replacement bridge would be consistent with the existing view of Bourne Bridge. Due to the distance from this focal point, the lower height of the top of the arch would not be discernible to the viewer.	Compatible	Institutional and Recreational Neighbors/ High	Neutral

* **Figure 4.16-7** shows the Bourne South quadrant visual inventory locations.

4.16.4.6 Visual Impacts of the Build Alternative

Beneficial Changes to the Visual Quality of the AVEs

MassDOT determined that the degree of visual impact would be beneficial for the following four visual inventory locations in the interchange approach networks:

- View from Sagamore Park and Ride Lot (SN2)
- View from Meetinghouse Lane at State Road (SN3)
- View from Cranberry Highway at Adams Street (SS4)
- View from Cumberland Farms Parcel (BS2)

MassDOT determined that **beneficial changes** to the visual quality of the Sagamore Bridge and Bourne Bridge AVEs would result from the following:

- Removing utility poles and overhead signals and wiring at roadway intersections would present more harmonious and coherent views to travelers and neighbors.
- Replacing existing intersections or rotaries with roundabouts would result in reduced paved areas, increased landscaping, and a sense of orderliness that is not present in the existing condition.
- Incorporating landscaping and shared use paths or pedestrian walkways into the transportation network, thereby providing visual interest and relief from the concrete environment.

Neutral Changes to the Visual Quality of the AVEs

For nine visual inventory locations in the interchange approach networks, MassDOT determined that **neutral changes** to the visual quality of the Sagamore Bridge and Bourne Bridge AVEs would result from the Build Alternative. This total number included the following locations where shifts in the bridge or roadway location and elevation would not be discernible by the viewer:

- View from Church Lane at Cape Pine Road (SN4)
- View from Upper Cape Cod Regional Technical High School Scenic Overlook (BS4)

It also included the following locations with low to moderate viewer sensitivity where proposed impacts, including the introduction of new infrastructure, would be consistent with the visual character of the existing transportation environment and/or elements:

- View from Scenic Highway at Church Lane (SN1)
- View from Sandwich Road at Mid-Cape Connector (SS1)
- View from Sandwich Road facing south (SS3)
- View from Belmont Circle (BN1)

A neutral rating was given to one location where the new transportation infrastructure would provide a continuity of access and visibility to commercial neighbors who would be sensitive to project changes:

- View from Nickerson-Bourne Funeral Home (BS1)

The visual inventory included two locations where the more dominant and physically imposing transportation elements would introduce incompatible elements into the existing viewshed, thereby altering the roadway's rural visual character with a more urban appearance. However, due to low viewer sensitivity at these portions of the roadways, and through the incorporation of minimization and mitigation measures, these locations received neutral ratings:

- View from Scenic Highway (BN3)
- View from Sandwich Road facing west (BS3)

MassDOT determined that the visual changes would be neutralized through the introduction of landscaping and pedestrian/bicycle paths to soften the hardscape and provide visual interest, as well as other improvements, such as increased safety, which would enhance the traveler's driving experience.

MassDOT determined that with the minimization measures incorporated into the Build Alternative, the degree of visual impact would be **neutral** for the two visual inventory locations at the bridge sites:

- View from Motorist on Sagamore and Bourne Bridges (B1)
- View of Sagamore and Bourne Bridges from Cape Cod Canal Service Road (B2)

While the demolition of Sagamore Bridge and Bourne Bridge would be an adverse effect on those NRHP-eligible structures, MassDOT selected a replacement bridge design that would closely resemble the existing structures and complement their setting within Cape Cod Canal, to avoid and/or minimize impacts to the NRHP-eligible Cape Cod Canal Historic District. **Section 4.16.5** further describes measures that MassDOT will incorporate into the Build Alternative to compensate for the loss of the historic structures.

Adverse Changes to the Visual Quality of the AVEs

For the following two visual inventory locations in the interchange approach networks, MassDOT determined that **adverse changes** to the visual quality of the Sagamore Bridge and Bourne Bridge AVEs would result from the Program:

- View from Eleanor Avenue (SS2) – MassDOT determined that the proposed Program impacts—potentially acquiring residences for construction of the new bridge, demolition of the existing bridge, and incorporation of stormwater control measures—would adversely affect the sensitivity of the Round Hill residential viewers on the west side of Eleanor Avenue.
- View from Nightingale Road (BN2) – MassDOT determined that the elevated relocated State Route 25 mainline and flyover ramp would introduce incompatible elements to the existing views of residential neighbors, who would be sensitive to their altered views of the landscaped Bourne Scenic Park entrance.

To address these adverse visual impacts, MassDOT is proposing minimization and mitigation measures, which are described in **Section 4.16.5**.

4.16.5 Mitigation

This section describes MassDOT's proposed design-related and construction-related mitigation measures, encompassing minimization, restoration, maintenance, and compensation, for visual impacts that cannot be avoided, including the adverse visual impacts to the Round Hill neighborhood on the west side of Eleanor Avenue and the Nightingale Road neighborhood viewers resulting from new and realigned transportation infrastructure.

In coordination with the MA SHPO, FHWA and MassDOT will identify mitigation measures to compensate for the loss of the NRHP-eligible Sagamore and Bourne Bridges; these measures will be memorialized as stipulations in the Section 106 Programmatic Agreement for the Program, further discussed in **Section 4.17, Cultural Resources**. As design advances, MassDOT will continue to refine the proposed mitigation measures, as well as identify additional mitigation measures, in coordination with stakeholders and the public.

4.16.5.1 Design-Related Mitigation

Bridge Design

Because of the historic significance of Sagamore and Bourne Bridges and Cape Cod Canal, and the high sensitivity of neighbors and travelers to the loss of the NRHP-eligible structures, MassDOT has selected a design for the replacement bridges that would resemble the overall shape of the historic bridge arches, while also incorporating modern elements into the design and maximizing constructability. For example, the 115-foot rise of the bridge arch was selected to echo the appearance of the existing bridges; the height would also be the upper bound limit that would meet clearance requirements for the anticipated construction method of floating in the completed arch on barges. The number of delta frames in the superstructure has been minimized to create clean lines. Additionally, the series of connected Y-shapes of the proposed piers would introduce a more contemporary version of the straight, vertical pier stems of the existing bridges.

Aesthetic Bridge Lighting

Existing bridge lighting is limited to minimal roadway lighting. MassDOT proposes to provide standard roadway and pedestrian-scale lighting along the highway bridges, the approach highway networks, and shared-use paths (SUP). In keeping with the historic nature of Cape Cod Canal, MassDOT is considering aesthetic bridge lighting concepts that propose understated, low-level lighting of the bridge arch and different bridge components, such as the bridge cables, inner piers, outer piers, and inner delta frames. As design advances, MassDOT will continue to evaluate incorporating aesthetic lighting for the new bridges.

Incorporation of Recreational Amenities as Visual Enhancements

At each bridge crossing, MassDOT is proposing to create a walkway/fishing platform at the top of the delta pier footing, at the same elevation as the Canal Service Road. Additionally, at each bridge crossing, MassDOT proposes to incorporate a scenic overlook at the top of the bridge arch. The overlook would be constructed by widening the proposed pedestrian/bicycle SUP.

Both of these recreational amenities would provide visual enhancements of the Cape Cod Canal Historic District by providing new vistas of Cape Cod Canal as a visual natural resource and cultural resource.

Exhibit 4.16-18 provides a conceptual plan of the pier walkway/fish platform, and **Exhibit 4.16-19** provides a conceptual plan of the scenic overlook at the bridge arch.

Exhibit 4.16-18. Conceptual Plan of Pier Walkway/Fishing Platform



Source: Massachusetts Department of Transportation, 2024

Exhibit 4.16-19. Conceptual Plan of Bridge Scenic Overlook



Source: Massachusetts Department of Transportation, 2024

Landscaping

To compensate for the disturbance and clearing required for the Program, including bridge replacements and connections to the local roadway networks on the mainland and on Cape Cod, MassDOT proposes to implement a substantial landscaping plan to repair, restore, and enhance the landscape flanking the mainline highways, bridges, and local roads and connections. MassDOT's goals for the landscaping plan correlate with the goal of **Appendix 4.16, Visual Impact Assessment**, to maintain and enhance visual quality:

- Revegetate all areas disturbed by construction around the new Sagamore and Bourne Bridges, adjacent highways, local roadways, SUPs, stormwater and utility infrastructure, and construction staging areas.
- Develop landscape zones that restore and/or enhance existing habitats and reinforce the unique landscape character of the region.
- Screen undesirable views for both users of the Project Limits as well as abutters.
- Improve sight lines and views while mitigating the appearance of undesirable areas within and beyond the bridge sites.
- Soften the visual appearance of new and expanded infrastructure to maintain the character of the region.

- Utilize landscape to create gateways as visitors approach Cape Cod, including placemaking opportunities as visitors enter and exit Cape Cod.
- Enhance pedestrian zones with planting at trailheads, in medians, and in roundabouts in lieu of impervious surfaces.
- Integrate stormwater basins with the surrounding restored landscapes so they appear natural and contribute to the creation of habitat as much as possible.
- Maintain site visibility for safety along highways and roadways and around pedestrian zones and off-road areas for site security.

MassDOT's landscape plan consists of developing several landscape types to restore the disturbed site and to integrate the new infrastructure into the landscape. These landscape types include landscape restoration, reforestation, street tree planting, limited areas for lawn, stormwater basins and rain gardens, buffer planting, roundabout planting, and special plantings. **Exhibit 4.16-4b, Exhibit 4.16-8b, Exhibit 4.16-12b**, and **Exhibit 4.16-16b** present examples of landscape treatments that are incorporated into the Program infrastructure to restore, maintain, and enhance visual quality.

Coordinated Shared-Use Path Site Elements

In recognition of the community's goals to protect its existing cultural and landscape assets, MassDOT is designing features and amenities of the Program's pedestrian and bicycle zones and SUPs to provide a coherent and coordinated appearance and complement the town's unique character. Examples include designating trailheads, overlooks, and waysides through special pavements or stamped/colored concrete; using natural and color-coordinated site furnishings along the SUPs, such as bench seating, trash receptacles, and railings; and providing themed interpretive and wayfinding signage.

Aesthetic Wall Treatments

MassDOT is investigating the visual/aesthetic treatment of bridge abutment walls and retaining walls required throughout the Sagamore Bridge and Bourne Bridge AVEs. Based on their visibility to travelers and neighbors, different finish materials, including materials echoing the rural character of Cape Cod, may be utilized. MassDOT has categorized walls in the AVEs by priority:

- **High Priority Walls** would be very visible to the public, including where the Cape Cod character would be important to highlight. An example of a high priority wall would be the retaining wall supporting the SUP at the Bourne South quadrant where the State Route 28 south off-ramp connects to Trowbridge Road. In this location, a cast-in-place retaining wall with New England fieldstone veneer would be aesthetically pleasing and appropriate for the site character. Interpretive features could also be incorporated into the wall. Other high priority walls would include smaller retaining walls along SUPs that would be visible to recreation neighbors.
- **Medium Priority Walls** would include most bridge abutments and wingwalls that are near and visible from local roadways and SUPs, and walls that retain local roadways that would be visible to residential and commercial neighbors. An example treatment for the cast-in-place concrete walls

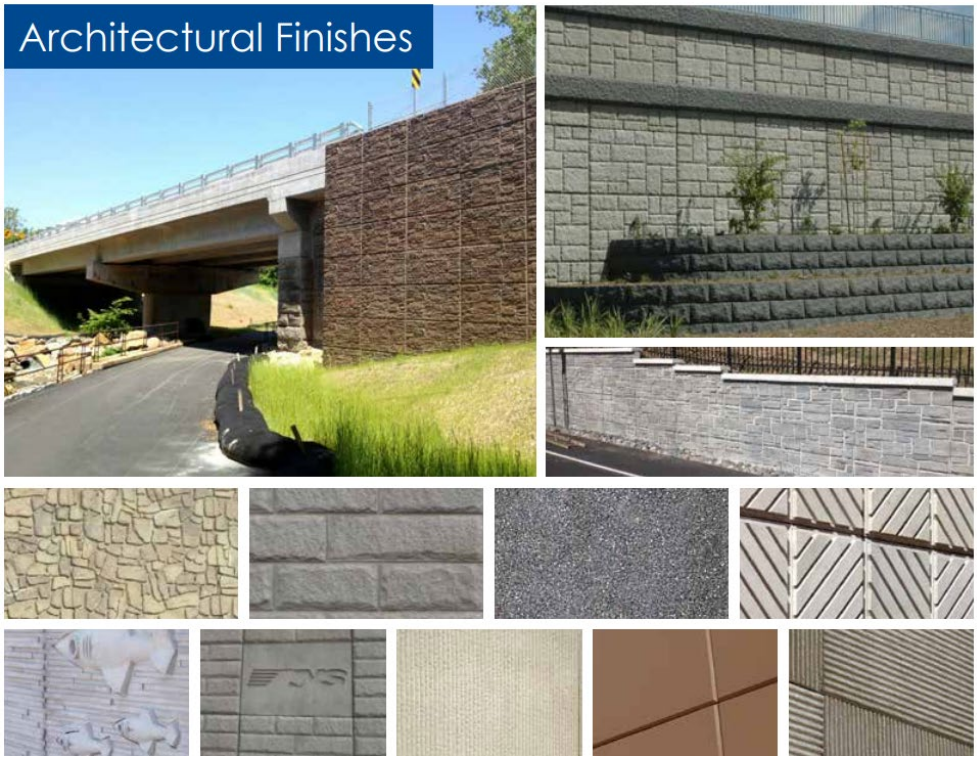
would be a formliner to create a pattern on the wall face.[13] Plant material could also be used to screen portions of these walls.

- **Low Priority Walls** would include retaining walls that support highways and ramps facing naturalized areas, interiors to off- and on-ramps, and walls that are distant from local roads and residential neighbors. Example treatments could include concrete block gravity walls.

As design advances and as appropriate for the wall location, MassDOT is investigating the use of different types of walls and wall treatments to minimize impacts to visual quality. Wall treatments could also be applied to noise barrier walls. **Section 4.15.7** addresses the potential use of noise barriers to address operational impacts of the Program.

The many wall types being evaluated include stone masonry walls; mechanically stabilized earth (MSE) walls or prefabricated walls with stamped, textured, and/or colored designs; pre-fabricated modular walls; and cast-in-place concrete walls, which can include precast concrete veneers with a variety of textures and finishes. **Exhibit 4.16-20** presents an example of architectural wall finishes.

Exhibit 4.16-20. Examples of Aesthetic Wall Treatments



Source: Massachusetts Department of Transportation, 2025

[13] A wall formliner consists of a plastic or rubber liner that is used to create a texture or pattern onto a concrete surface.

4.16.5.2 Construction-Related Mitigation

To minimize visual impacts in the Sagamore Bridge and Bourne Bridge AVEs, MassDOT would incorporate construction-related mitigation into the Program through permits, special provisions and guidance documents, and its Standard Specifications for Highways and Bridges (2024 Edition, Division II).

The Program's Construction Stormwater General Permit would contain multiple measures to reduce adverse impacts from construction, including, among other control measures, the requirement to stabilize disturbed areas immediately when construction has ceased and will not resume for more than 14 days.

MassDOT has issued extensive guidance for tree preservation, including plant protection fencing for public places and staging or other construction activity near desirable vegetation. As applicable, MassDOT will use plant protection fencing to minimize impacts to visual natural resources.

MassDOT's manual of Standard Specifications for Highways and Bridges contains standard specifications to mitigate for temporary construction-related impacts, including potential impacts to visual quality. Construction-related mitigation to be incorporated into the Program would include minimizing fugitive light from portable sources and directing light sources away from residential areas and restoring all disturbed areas at the completion of construction.

4 Existing Conditions, Program Impacts, and Mitigation

4.17 Cultural Resources

4.17.1 Introduction

This section considers the potential impacts of the No Build Alternative and the Build Alternative on architectural and archaeological historic properties that are listed in or eligible for listing in the National Register of Historic Places (NRHP). Historic architectural properties refer to aboveground historic resources, including buildings, structures, objects, sites, and districts of historical importance. Archaeological resources are subsurface physical remains of pre-contact (prehistoric, or the remains of Indigenous American societies) or post-contact (historical, between Native Americans and Europeans) activities.

Where the Massachusetts Department of Transportation (MassDOT) has determined that the Build Alternative would result in unavoidable adverse impacts to any historic properties, this section also identifies mitigation measures that will be implemented to resolve those impacts.

4.17.1.1 Regulatory Context

The following sections describe the two key federal regulations governing potential impacts to historic resources.

Section 106 of the National Historic Preservation Act

Section 106 of the National Historic Preservation Act (Section 106) (54 United States Code [USC] 506.108) requires a federal agency with direct or indirect jurisdiction over a proposed federal or federally assisted undertaking (project) or with licensing or permitting authority, to:

> "take into account the effects of the undertaking on historic properties, which includes any prehistoric or historic district, site, building, structure, or object that is included in, or eligible for inclusion in, the NRHP maintained by the Secretary of the Interior."

The Section 106 implementing regulations (36 Code of Federal Regulations [CFR] 800) require that a project's Lead Federal Agency consult with the State Historic Preservation Officer (SHPO) to:

1. Initiate the Section 106 process.
2. Identify historic properties within the Area of Potential Effects (APE), defined as "the geographic area(s) within which an undertaking may directly or indirectly cause alterations in the character or use of historic properties."[1]

[1] Section 106 Tutorial: Key Terms. https://www.environment.fhwa.dot.gov/env_topics/section_106_tutorial/keyterms.aspx

3. Assess adverse impacts to historic properties within the APE.
4. Resolve any adverse impacts on historic properties within the APE.

The Section 106 regulations prescribe a consultation process, involving the SHPO, the Advisory Council on Historic Preservation (ACHP), federally recognized Indian Tribes/Tribal Historic Preservation Officers (THPO), local governments, and the public, that the Lead Federal Agency must follow to "avoid, minimize, or mitigate" adverse impacts to historic properties that might be caused by the project.

Section 4(f) of the Department of Transportation Act of 1966

Section 4(f) of the Department of Transportation Act of 1966 (Section 4(f)) (49 USC 303) requires U.S. Department of Transportation agencies to coordinate with the SHPO before using land from a historic site of national, state, or local significance for transportation projects.

4.17.2 Methodology

Identifying Consulting Parties

The Federal Highway Administration (FHWA) initiated the Section 106 process with the SHPO in March 2023. In addition to the SHPO, FHWA and MassDOT identified the following consulting parties to provide advice and guidance during the Section 106 process regarding the identification of historic properties and the assessment of impacts to those properties:

- THPO of the Wampanoag Tribe of Gay Head (Aquinnah)
- THPO of the Mashpee Wampanoag Tribe
- THPO of the Narragansett Indian Tribe
- Chairperson of the Herring Pond Wampanoag Tribe
- Executive Director of the Massachusetts Commission on Indian Affairs
- Massachusetts Board of Underwater Archaeological Resources
- Massachusetts Executive Office of Energy and Environmental Affairs
- Bourne Historical Commission
- Sandwich Historical Commission
- Cape Cod Commission
- U.S. Army Corps of Engineers
- National Trust for Historic Preservation
- Advisory Council on Historic Preservation

Defining the Areas of Potential Effects

MassDOT defined APEs in consultation with the Massachusetts Historic Commission (MHC), the state agency designated as the SHPO. Separate and distinct APEs (Construction APEs) were identified to assess impacts upon historic properties due to the construction of each replacement bridge, including construction or demolition activities, approach highway realignment, interchange reconstruction, construction of new bicycle and pedestrian accommodations, establishment of temporary construction staging or laydown areas, and right-of-way (ROW) acquisitions. These Construction APEs match the

boundaries of the Sagamore and Bourne Project Limits. MassDOT identified a single, more expansive APE (Viewshed APE) to assess potential viewshed impacts due to the replacement bridges. The Viewshed APE was established using Geographic Information System (GIS) mapping and Light Detection and Ranging (LiDAR) data, which considered topography and the influence of trees and buildings within the landscape, to identify where the existing and replacement bridges would be visible. **Section 4.17.3** presents the Construction APEs and the Viewshed APE for the Sagamore and Bourne Bridges based on preliminary design.

The SHPO concurred with the APEs on July 7, 2023. The FHWA and MassDOT presented the APEs to the other Section 106 consulting parties on January 22, 2024. None of the consulting parties objected to the geographical limits established for the APEs. The FHWA will seek approval from the SHPO, in coordination with the Section 106 consulting parties, for any updates to the approved APEs warranted by design development, as necessary.

Identifying and Evaluating Historic Properties

MassDOT's identification and evaluation of historic properties within the Construction and Viewshed APEs focused on the State Register of Historic Places (SRHP)/NRHP criteria of eligibility, as defined by the National Register Criteria for Evaluation:

> The quality of significance in American history, architecture, archeology, engineering, and culture is present in districts, sites, buildings, structures, and objects that possess integrity of location, design, setting, materials, workmanship, feeling, and association and
>
> (a) that are associated with events that have made a significant contribution to the broad patterns of our history; or
>
> (b) that are associated with the lives of persons significant in our past; or
>
> (c) that embody the distinctive characteristics of a type, period, or method of construction, or that represent the work of a master, or that possess high artistic values, or that represent a significant and distinguishable entity whose components may lack individual distinction; or
>
> (d) That have yielded, or may be likely to yield, information important in prehistory or history.[2]

To identify historic architectural properties in the Construction and Viewshed APEs, MassDOT reviewed its Historic Bridge Inventory Files, the online Massachusetts Cultural Resources Information System that contains MHC's Inventory of Historic and Archaeological Assets of the Commonwealth (MHC Inventory), which is managed through the online Massachusetts Cultural Resources Information System (MACRIS),[3] and other state, regional, and local resources. Additionally, in 2023, MassDOT conducted a Reconnaissance Level Architectural Resources Survey within the Construction and Viewshed APEs to identify historic architectural properties that could be temporarily and/or

[2] https://www.ecfr.gov/current/title-36/chapter-I/part-60/section-60.4
[3] https://mhc-macris.net/

permanently affected by the Build Alternative based on preliminary plans. In its field walkover, MassDOT identified historic architectural properties that would be at least 40 years old as of 2027 (the construction start date) that were not previously evaluated for SRHP/NRHP eligibility or included in the MHC Inventory, but which could meet the SRHP/NRHP criteria of eligibility based on the National Register Criteria for Evaluation. Based on the criteria, MassDOT then prepared NRHP Inventory (Determinations of Eligibility) Forms for those properties, for the SHPO's review.

MassDOT conducted a search of the MACRIS to identify previously recorded archaeological sites and reviewed reports of cultural resource management investigations in the Cape Cod Bridges Program (Program) APEs. MassDOT conducted an Archaeological Reconnaissance Survey (Archaeological Sensitivity Assessment) in fall 2023 to identify known and potential pre-contact and post-contact archaeological sites within the Construction APEs, to assess the archaeological sensitivity of the Construction APEs, and to make recommendations for the protection of cultural resources or additional investigations. MassDOT used the information collected during the archival research and walkover survey to develop a predictive model for archaeological sensitivity, with rankings of low, moderate, or high archaeological sensitivity. Based on the results of the predictive model, MassDOT identified areas where further archaeological testing would be warranted.

4.17.3 Existing Conditions

4.17.3.1 Historic Architectural Properties within the Construction Areas of Potential Effects

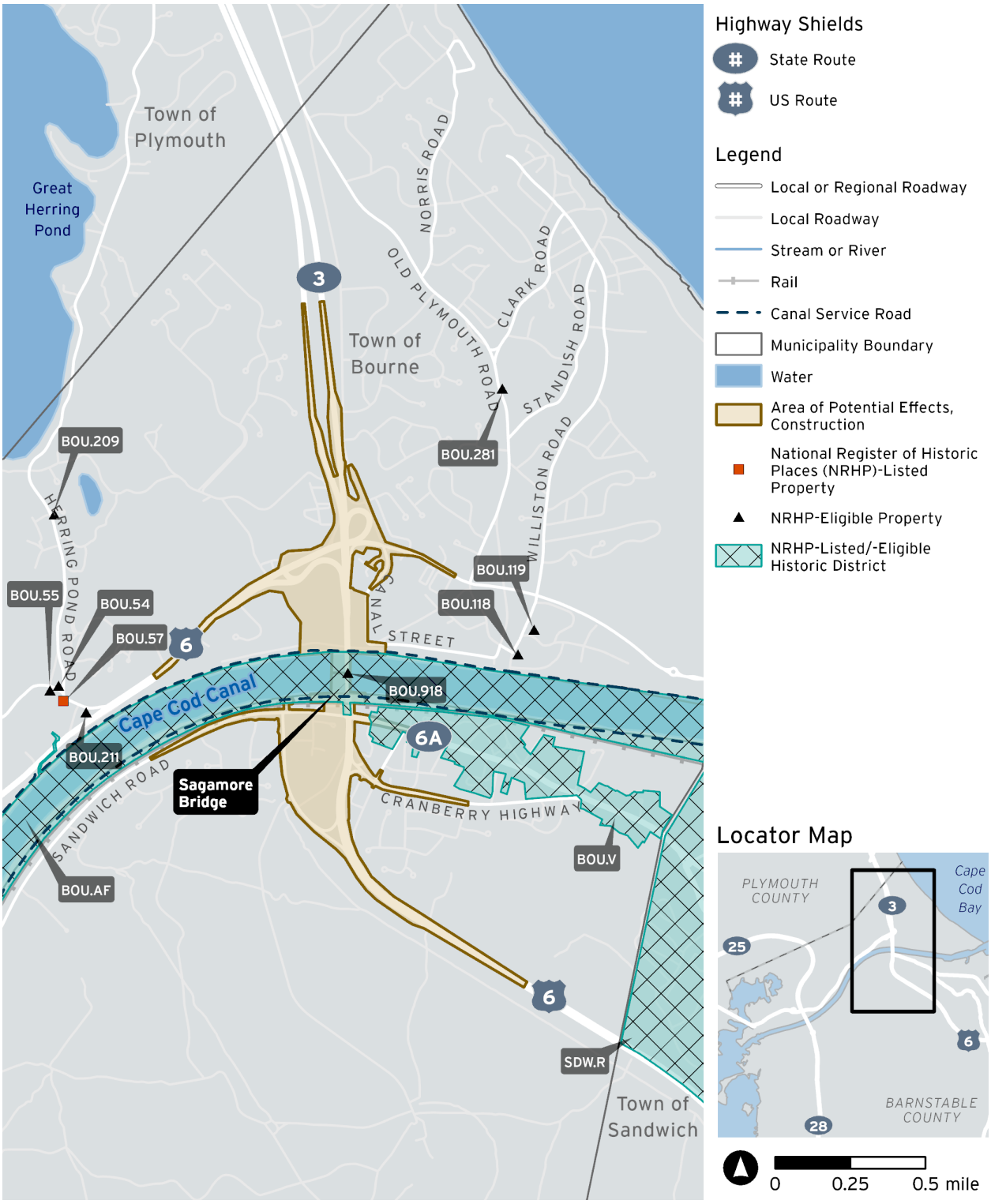
Figure 4.17-1 presents the Sagamore Bridge Construction APE, and **Figure 4.17-2** presents the Bourne Bridge Construction APE. Sagamore Bridge, Bourne Bridge, and the Cape Cod Canal Historic District are the only historic architectural properties identified within the Construction APEs that are eligible for listing in the NRHP. No NRHP-listed properties were identified within the Construction APEs.

Sagamore Bridge

Sagamore Bridge is a three-span, 1,408-foot-long bridge and consists of a 616-foot-long center span over Cape Cod Canal supported by two granite-stone facing concrete piers on each side of the channel. The center span is flanked by two 396-foot-long spans. There are hollow abutments at either end of the bridge that are approximately 220 feet long.

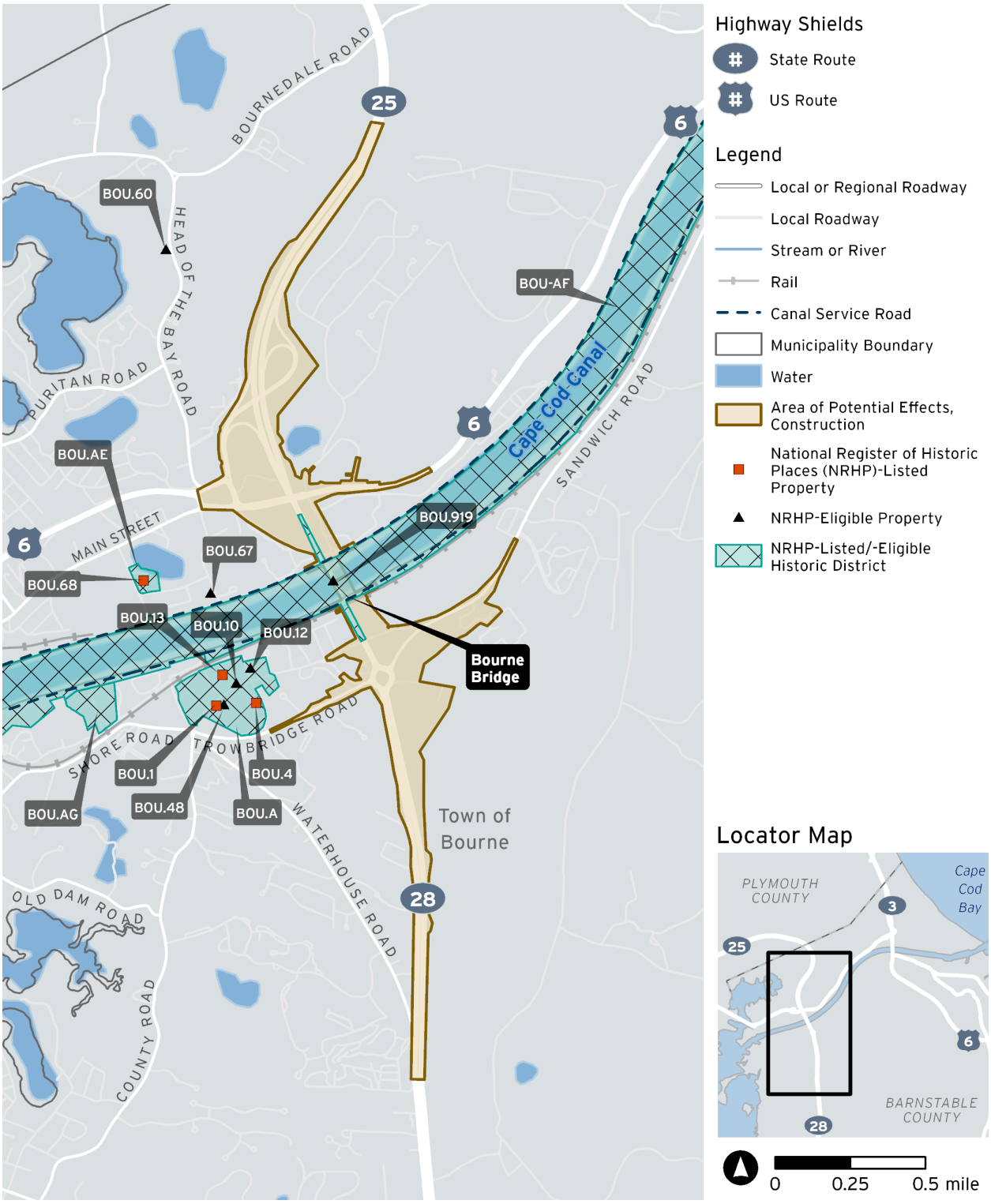
It was funded under the National Industrial Recovery Act of 1933 and constructed between 1933 and 1935 by the American Bridge Company through the Depression-era Public Works Administration. Sagamore Bridge was determined individually eligible for listing in the NRHP at the state level under Criteria A and C on March 6, 1991. Additionally, the bridge is a contributing resource to the NRHP-eligible Cape Cod Canal Historic District.

Figure 4.17-1. Construction Area of Potential Effects (Sagamore Bridge)



Source: Massachusetts Department of Transportation, 2025

Figure 4.17-2. Construction Area of Potential Effects (Bourne Bridge)



Source: Massachusetts Department of Transportation, 2025

According to the original USACE design drawings, Sagamore Bridge is comprised of three continuous spans with span lengths of 396 feet, 616 feet, and 396 feet. The arched 616-foot-long center span over Cape Cod Canal is supported by two granite-stone facing concrete piers on each side of the channel. There are hollow abutments at either end of the bridge that are approximately 220 feet long.[4]

Sagamore Bridge is an exceptional example of the continuous arched through truss type—a rare bridge type in Massachusetts. The center span crossing Cape Cod Canal consists of deck truss side spans transitioning into an arched through truss with a "swinging" deck suspended from the lower chord of the arch by 44 suspension cables. The bridge has concrete open-web column piers and concrete abutments with stylized Art Deco pylons. The continuous arched through truss span is a particularly graceful example of this form, which has been perfected by nationally acclaimed engineers Fay, Spofford and Thorndike. The main arched span has a cleaner, boxed appearance to the built-up, riveted truss members, since flat plates were applied to the outward faces of the beams and the connecting angles were turned inward. The bridge is further distinguished by its well-detailed Art Deco architectural elements, including the massive Art Deco pylons set at the abutments to provide a gateway to the bridge.

Sagamore Bridge is included in the MHC Inventory as BOU.918. The MHC Inventory Form notes that in a national competition for the most beautiful steel bridges erected each year, Sagamore Bridge was awarded an Honorable Mention – Class A – 1935 Award from the American Institute of Steel Construction for its graceful design.[5]

Bourne Bridge

Bourne Bridge is a seven-span, 2,384-foot-long steel riveted Warren continuous truss bridge that carries State Route 28 over Cape Cod Canal, Sandwich Road, and the Massachusetts Coastal Railroad. Like Sagamore Bridge, Bourne Bridge was funded under the National Industrial Recovery Act of 1933 and constructed between 1933 and 1934 by the American Bridge Company through the Depression-era Public Works Administration.

According to the original 1934 USACE design drawings, Bourne Bridge is comprised of two simple spans with spans lengths of 242 feet and 274.5 feet; three continuous spans with span lengths of 398.5 feet, 616 feet, and 398.5 feet; and two simple spans with span lengths of 244.5 feet and 210 feet. The arched 616-foot-long center span over Cape Cod Canal is supported by two granite-stone facing concrete piers on each side of the channel. There are hollow abutments at either end of the bridge that are approximately 150 feet long.[6] Like Sagamore Bridge, the main span crossing Cape Cod Canal consists of deck truss side spans transitioning into an arched through truss with a "swinging" deck suspended from the lower chord of the arch by 44 suspension cables. The approach spans flanking the main span are deck truss spans, leading into the deck truss approach spans. The superstructure is

[4] MassDOT, Bridge Type Selection Worksheet, Bridge No. B-17-005, Sagamore Bridge Arch/Delta Spans, April 2025. Draft.
[5] https://mhc-macris.net/details?mhcid=BOU.918

supported by six reinforced open-web concrete column piers and reinforced concrete abutments with stylized Art Deco pylons.

Along with Sagamore Bridge, Bourne Bridge was determined individually eligible for listing in the NRHP at the state level under Criteria A and C on March 6, 1991, and it is a contributing resource to the NRHP-eligible Cape Cod Canal Historic District. Nearly identical to Sagamore Bridge, Bourne Bridge is an exceptional example of the continuous arched through truss type designed by Fay, Spofford and Thorndike. Like Sagamore Bridge, in identifying its NRHP Significance Criteria, MACRIS notes that the continuing "swinging" truss represents an unusual or unique style, the design provides a valuable contribution to bridge technology, the bridge retains its integrity, the builder is known and important, and the bridge is historically important to the area.

Bourne Bridge is included in the MHC Inventory as BOU.919. The MHC Inventory Form notes that Bourne Bridge was awarded the First Place – Class A – 1934 and is included in American Institute of Steel Construction's Prize Bridges 1928-1938.[7]

Cape Cod Canal Historic District

Explorations into the concept of a canal to encourage commerce among European colonists and Indigenous tribes date to the early 1600s.[8] After several failed attempts to dig the canal in the late eighteenth century, Cape Cod Canal was constructed by the privately owned Boston, Cape Cod and New York Canal Company from 1909 to 1914. The U.S. government acquired Cape Cod Canal in 1928 and implemented a widening and improvement program from 1933 to 1940, which included construction of the highway bridges and the NRHP-eligible Buzzards Bay Vertical Lift Railroad Bridge.[9] Cape Cod Canal has been recognized as a masterful effort of engineering and for the significant effect it had on both the surrounding communities and on maritime transportation and economic development in New England. Additionally, the canal had an important role in coastal defense during World War II.

The 8.1-mile-long land cut portion of Cape Cod Canal, including the multiple buildings, structures, features, and sites associated with the construction and operation of the canal, has been determined eligible for listing in the NRHP as a historic district[10] and is eligible at the state level under Criteria A and C. Cape Cod Canal is included in the MHC Inventory as BOU.AF/FAL.BG/SDW.Z/WRH.V.

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[7] https://mhc-macris.net/details?mhcid=BOU.919

[8] Historic Bridge Detail for Bourne Bridge. https://mhc-macris.net/details?mhcid=BOU.AF

[9] Massachusetts Historical Commission, Massachusetts Cultural Resource Information System. https://mhc-macris.net/details?mhcid=BOU.901

[10] The U. S. Army Corps of Engineers (USACE) issued a formal determination that the Bourne Bridge, the Sagamore Bridge, and the Cape Cod Canal Historic District are eligible for listing in the National Register of Historic Places (NRHP) as part of a Programmatic Agreement with the State Register of Historic Places (SHPO), related to the USACE's Major Rehabilitation Evaluation Report and Environmental Assessment and Finding of No Significant Impact for the Cape Cod Canal Highway Bridges. The USACE signed and fully executed the Programmatic Agreement on March 11, 2022.

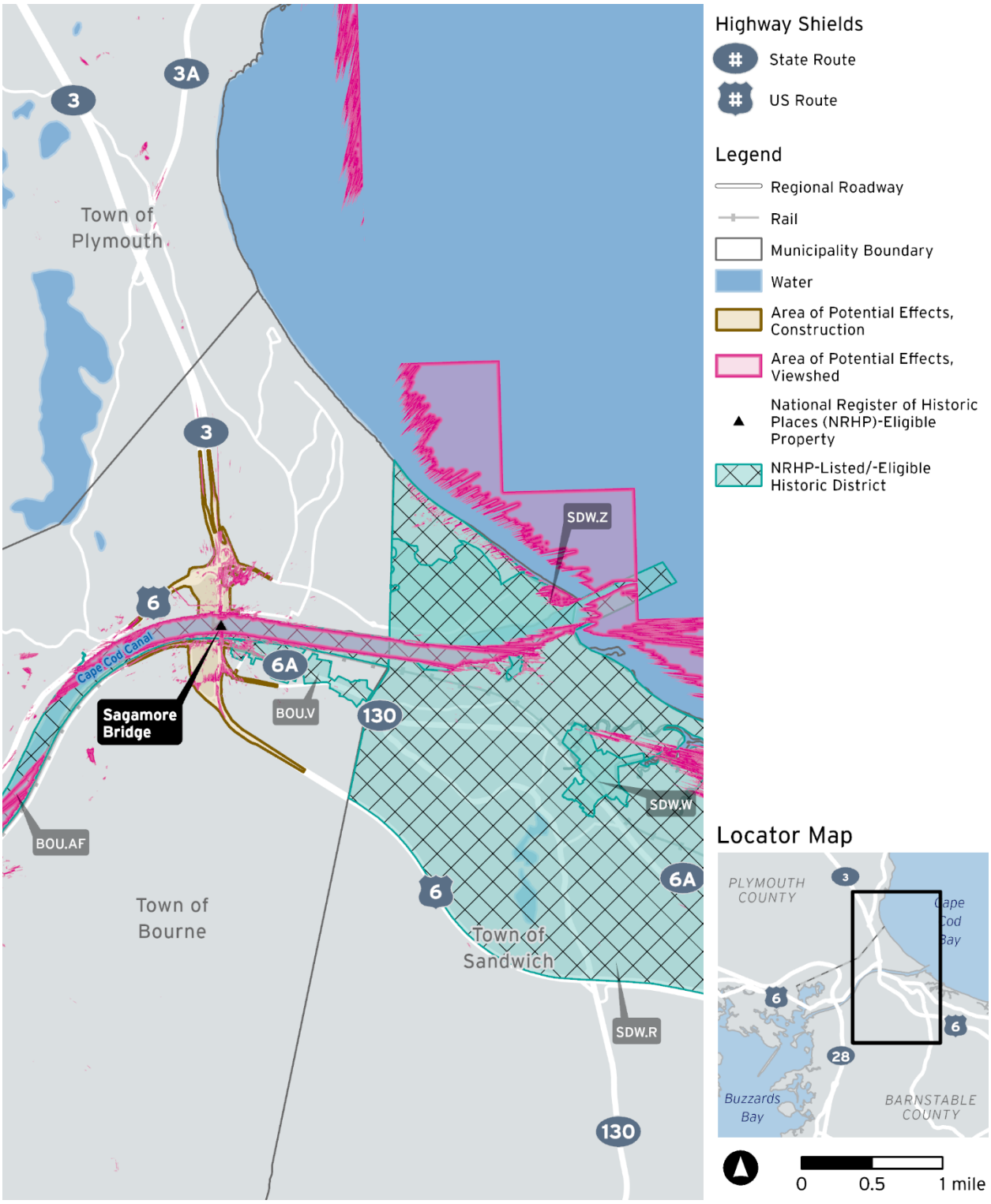
4.17.3.2 Other Architectural Properties within and Adjacent to the Construction Area of Potential Effects

MassDOT evaluated architectural properties and areas within or immediately adjacent to the Sagamore Bridge and Bourne Bridge Construction APEs that are more than 40 years old and were not previously included in the MHC Inventory. Of the three individual structures and two areas that MassDOT evaluated in the Sagamore Bridge Construction APE, none were determined eligible for the NRHP. MassDOT evaluated one historic area within the Bourne Bridge Construction APE and determined it was not eligible for the NRHP. Additionally, MassDOT determined that one previously inventoried area in the Bourne Bridge Construction APE was not NRHP eligible, and that one previously inventoried property no longer exists.

4.17.3.3 Historic Architectural Properties within the Viewshed Area of Potential Effects

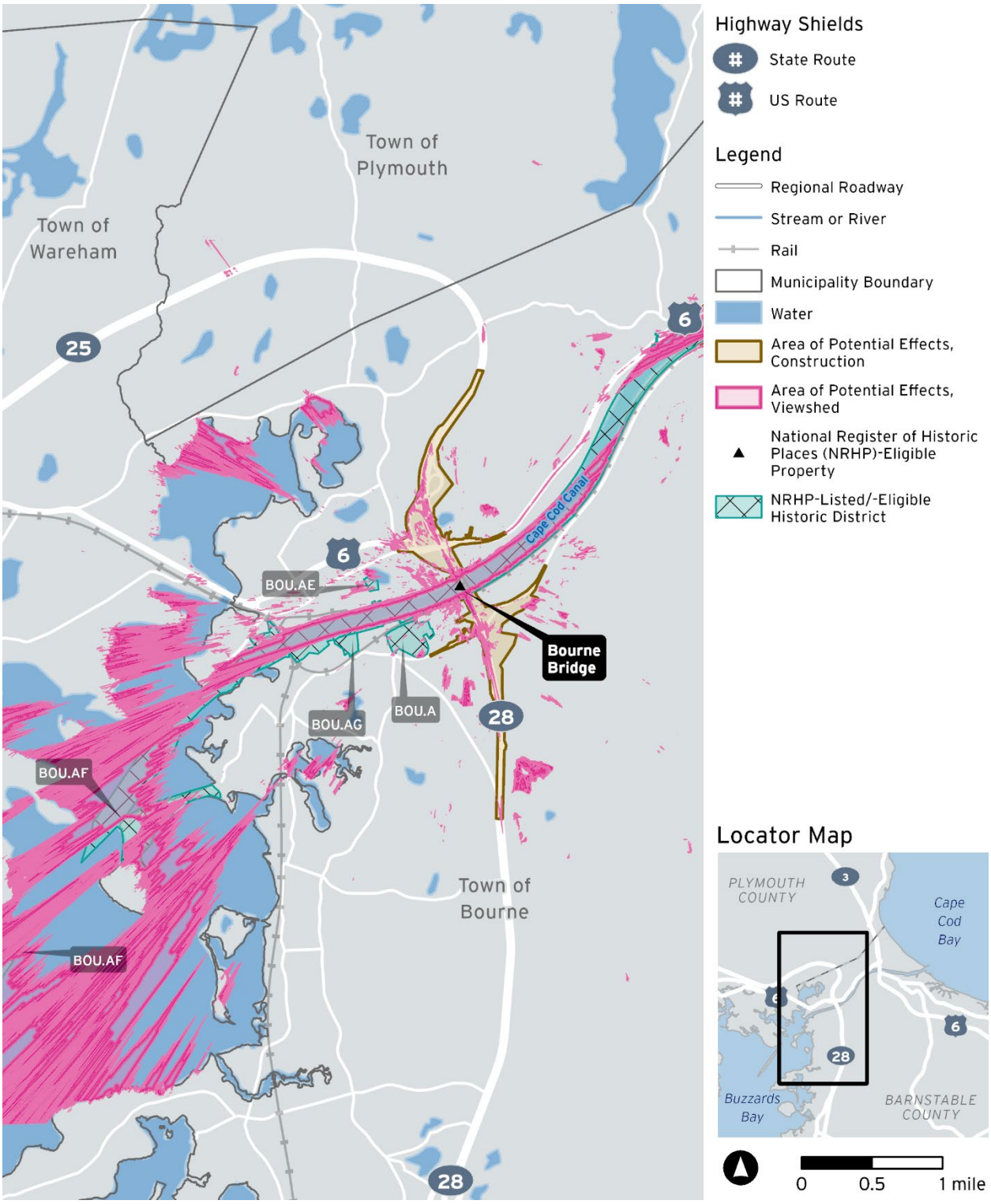
Figure 4.17-3 and **Figure 4.17-4** present the Viewshed APE, which includes the viewsheds for the Sagamore and Bourne Bridges, respectively. **Table 4.17-1** identifies NRHP-listed and NRHP-eligible historic architectural properties, including structures and areas, within the Viewshed APE of the Sagamore and/or Bourne Bridge.

Figure 4.17-3. Viewshed Area of Potential Effects (Sagamore Bridge)



Source: Massachusetts Department of Transportation, 2025

Figure 4.17-4. Viewshed Area of Potential Effects (Bourne Bridge)



Source: Massachusetts Department of Transportation, 2025

Table 4.17-1. Historic Architectural Properties within the Viewshed Area of Potential Effects (Sagamore and Bourne Bridges)

Historic Properties/ Area	Address	Massachusetts Historical Commission Inventory Number	Bridge Viewshed	Protection
Cape Cod Canal Historic District	Cape Cod Canal	BOU.AF, FAL.BG, SDW.Z, WRH.V.	Sagamore & Bourne Bridges	National Register of Historic Places (NRHP)-eligible
South Sagamore Area	Sandwich Road area/Sagamore Village	BOU.V	Sagamore Bridge	NRHP-eligible
Bournedale Village School	29 Herring Pond Road	BOU.57	Sagamore Bridge	NRHP-listed
Mason White-Battles House	6 Bournedale Road	BOU.54	Sagamore Bridge	NRHP-eligible
William D. Bent, Sr., House	9 Bournedale Road	BOU.55	Sagamore Bridge	NRHP-eligible
Josiah Ellis House	166 Herring Pond Road	BOU.209	Sagamore Bridge	NRHP-eligible
Nathan Bourne Ellis House	854 Scenic Highway	BOU.211	Sagamore Bridge	NRHP-eligible
Swift Memorial Methodist Episcopal Church	10 Williston Road	BOU.118	Sagamore Bridge	NRHP-eligible
Sagamore Grammar School	30 Williston Road	BOU.119	Sagamore Bridge	NRHP-eligible
Capt. William Crowell Gibbs House	252 Old Plymouth Road	BOU.281	Sagamore Bridge	NRHP-eligible
Keene Street-Sandwich Road Area	Keene Street- Sandwich Road area/Bourne Village	BOU.A	Bourne Bridge	NRHP-eligible
Aptucxet Trading Post Museum Historic District	6 Aptucxet Road	BOU.AG	Bourne Bridge	NRHP-listed
George I. Briggs House	22 Sandwich Road	BOU.1	Bourne Bridge	NRHP-listed
Bourne High School	85 Cotuit Road	BOU.4	Bourne Bridge	NRHP-listed

Historic Properties/ Area	Address	Massachusetts Historical Commission Inventory Number	Bridge Viewshed	Protection
Jonathan Bourne Public Library	30 Keene Street	BOU.13	Bourne Bridge	NRHP-listed
Bourne Town Hall	24 Perry Avenue	BOU.68	Bourne Bridge	NRHP-listed
Albert R. Eldridge House	43 Sandwich Road	BOU.10	Bourne Bridge	NRHP-eligible
Moses Calvin Waterhouse House	59 Keene Street	BOU.12	Bourne Bridge	NRHP-eligible
Alonzo E. Booth Blacksmith Shop	22 Sandwich Road	BOU.48	Bourne Bridge	NRHP-eligible
Gibbs House	291 Head of the Bay Road	BOU.60	Bourne Bridge	NRHP-eligible
Abram F. Swift House	37 Old Bridge Road	BOU.67	Bourne Bridge	NRHP-eligible

4.17.3.4 Archaeological Resources Within and Near the Construction Area of Potential Effects

The MHC Inventory files indicate that there are nine recorded archaeological sites within and near the Sagamore Bridge Construction APE and 15 recorded archaeological sites within and near the Bourne Bridge Construction APE. Prior to the construction of Cape Cod Canal, the areas around the Sagamore and Bourne Bridges had high archaeological sensitivity, based on the presence of known Native American and early European settlements in proximity to the Monument and Scusset Rivers. However, construction of the canal resulted in large-scale disturbances that most likely destroyed any sites near the rivers. Further, investigations conducted by the U.S. Army Corps of Engineers (USACE) in 1994, and subsequent investigations, indicate that most of the areas immediately adjacent to the existing bridges have been disturbed by bridge construction.

Based on the results of its 2023 Archaeological Reconnaissance Survey, MassDOT determined that much of the surveyed landscape has low archaeological sensitivity for intact archaeological resources due to disturbances caused by previous canal, roadway, bridge, railroad, utility, and drainage construction and residential and commercial development. In the segments of the surveyed area where prior disturbance is evident, no further archaeological investigations are recommended.

MassDOT conducted an intensive (locational) archaeological survey in the following five locations within the Construction APEs with intact soils to assess their sensitivity:

- Sagamore Bridge South Interchange, wooded terrace west of the Market Basket parking lot
- Bourne Bridge North Interchange, north of Nightingale Pond

- Bourne Bridge North Interchange, east of Nightingale Pond
- Bourne Bridge South Interchange, low ridge off Sandwich Road east of the interchange
- Bourne Bridge South Interchange, south of the interchange along proposed State Route 28 northbound

No significant archaeological resources were identified during the locational survey. Further, MassDOT determined that one previously recorded site and three new pre-contact spots within the Bourne Bridge Construction APE are not eligible for listing in the NRHP. MassDOT received concurrence from the SHPO on its level of investigation and findings on January 14, 2025. No other comments were received from consulting parties on the Reconnaissance Survey or the results of the intensive archaeological survey.

4.17.4 No Build Alternative

The No Build Alternative would involve continued operation of the NRHP-eligible Sagamore and Bourne Bridges. In the No Build Alternative, which is consistent with the No Action Alternative identified in the USACE's Major Rehabilitation Evaluation Report/Environmental Assessment, major rehabilitation efforts would not be conducted and components of the structures would be repaired and critical elements replaced as they deteriorate and before they fail. It is anticipated that there would be no impacts on the bridges or other historic architectural properties, as there would be no change in appearance or location of the bridges.[11]

In the No Build Alternative, MassDOT would comply with Section 106 and Massachusetts-related historic regulations as needed to maintain the highway interchange approach networks at the two bridges and implement the Transportation Improvement Program projects (identified in **Chapter 3, Proposed Action and Alternatives**).

4.17.5 Program Impacts

4.17.5.1 Historic Architectural Properties

The demolition of the Sagamore and Bourne Bridges in the Build Alternative would have an unavoidable adverse effect on each of those NRHP-eligible structures in accordance with 36 CFR 800.5(a)(2)(i). Additionally, the Build Alternative would result in the loss of the two historic structures that are contributing resources to the NRHP-eligible Cape Cod Canal Historic District. Further, construction of new bridges to replace Sagamore and Bourne Bridges would affect the lands within the historic district.

To minimize impacts to the feeling and setting of the Cape Cod Canal Historic District, and in coordination with the FHWA and with input from the public, MassDOT selected the replacement bridge type design in part because it would have a kinship with the existing historic high-level through truss bridges and would provide a similar monumental gateway experience across Cape Cod Canal. By

[11] Cape Cod Canal Bridges Major Rehabilitation Study. https://www.nae.usace.army.mil/Missions/Projects-Topics/Cape-Cod-Canal-Bridges-Major-Rehabilitation-Study/

incorporating a network arch main span across the canal and maintaining the arched bridge profiles similar to the existing structures, MassDOT determined that the proposed replacement bridges—parallel, twin steel tied-arch bridges supported on delta frames—would be compatible with the existing historic through truss bridges in scale and form. As a result, MassDOT determined that the replacement bridges would not have an adverse effect on the Cape Cod Canal Historic District.

MassDOT determined that due to their similar arched bridge profiles, the views of the replacement bridges from historic properties would be comparable to current views of the existing bridges. In accordance with 36 CFR 800.5(b), MassDOT determined that the replacement bridges would avoid adverse impacts on historic architectural properties, including districts and individual structures within the Viewshed APE.

4.17.5.2 Archaeological Resources

As the Program's plans develop during the design-build process, MassDOT will continue to consult with the ACHP, SHPO, THPOs, and other Section 106 consulting parties. Although the Archaeological Reconnaissance Survey confirmed that much of the surveyed landscape within the Construction APEs has low archaeological sensitivity and the intensive survey did not identify any significant archaeological resources, MassDOT will continue to monitor the need for additional archaeological investigations through final design and construction of the Build Alternative as follows:

1. MassDOT will require the Program's contractor(s) to regularly provide updated construction plans for review and assessment by MassDOT's Archaeologist.
2. MassDOT's Archaeologist will consult with the State Archaeologist, the USACE's Archaeologist, and the Section 106 consulting parties regarding the need for and scope of additional archaeological surveys.

Additionally, MassDOT will include a Discovery of Unanticipated Archaeological and Skeletal Remains Special Provision in the construction contract.

4.17.6 Mitigation

MassDOT has prepared a Draft Programmatic Agreement among the FHWA, MassDOT, and SHPO in accordance with 36 CFR 800.14(b) (provided as **Appendix 4.17, Draft Programmatic Agreement**). The Programmatic Agreement commits the FHWA and MassDOT to certain stipulations to mitigate the adverse impacts on the NRHP-eligible Sagamore and Bourne Bridges and to guide the Program through Section 106 consultation process. The mitigation stipulations include the following:

- Design and construct new, high-level bridges comprising parallel, twin steel tied-arch superstructures supported on delta frames at each crossing. Each new bridge will provide four through-traffic lanes (two lanes in either direction), two auxiliary (acceleration/deceleration) lanes, and a single shared-use path for bicycle and pedestrian use.
- Prepare historic recordation documentation for submittal to the Historic American Engineering Record maintained by the National Park Service.

- Prepare and fabricate at least one interpretive historic panel for installation at each of the pedestrian overlooks along each bridge.
- Salvage original bridge plaques at both existing bridges.
- Provide updated construction plans to the MassDOT Archaeologist, who will review the plans to determine whether additional archaeological survey is needed in consultation with the State Archaeologist and the Section 106 consulting parties.
- Include a Special Provision in the Construction Contract for the Discovery of Unanticipated Archaeological and Skeletal Remains.

The Programmatic Agreement also includes stipulations regarding the design-build process, including specifying that the Agreement will be included in the Request for Qualifications, Request for Proposals, and construction contracts for both bridge replacement projects. Additional details on the proposed mitigation stipulations are included in the Draft Programmatic Agreement (provided in **Appendix 4.17**). The FHWA and MassDOT will consult with the ACHP, the SHPO, THPOs, and other Section 106 consulting parties before finalizing the Programmatic Agreement. The Final Environmental Impact Report will include the signed, executed Programmatic Agreement.

4 Existing Conditions, Program Impacts, and Mitigation

4.18 Public Parks, Recreational Facilities, and Open Space

4.18.1 Introduction

This section assesses the No Build and Build Alternatives for construction-period impacts and potential future operational impacts to public parks, recreational facilities, and open space within the Study Area (defined in **Section 4.18.1.2**). Where potential adverse impacts to surrounding public park, recreational facilities, and open space are identified, this section also discusses mitigation measures that will be undertaken to minimize and compensate for these impacts.

Other recreational resources are discussed elsewhere in Chapter 4. **Section 4.4, Maritime Transportation, Traffic, and Safety**, addresses the impacts of the No Build and Build Alternatives on public boat launches and docks. **Section 4.3, Pedestrian and Bicycle Facilities**, addresses the impacts of the No Build and Build Alternatives upon existing public pedestrian and bicycle facilities, including the Canal Service Roads.

4.18.1.1 Regulatory Context

Rules and Regulations Governing Public Use of Water Resources Development Projects Administered by the Chief of Engineers

According to the regulations governing public use of U.S. Army Corps of Engineers (USACE) water resource development projects,[1] it is the policy of the Secretary of the Army, acting through the Chief of Engineers, to manage the natural, cultural, and developed resources of each project in the public interest by providing recreational opportunities while also protecting and enhancing the civil works projects. Since 1963, the USACE has actively managed recreational uses within the Cape Cod Federal Navigation Project (FNP), either through directly operating parks and recreational facilities or leasing portions of its property to public entities that provide parks and recreational facilities, as long as those uses are compatible with the FNP's primary mission of navigation. The USACE's Master Plan for the Development of Recreational Resources[2] provides the planning for recreational use of the FNP, while the Federal Navigation Regulations provide the regulations for recreational use of the FNP.

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[1] U.S. Army Corps of Engineers. 2000. Title 36 CFR Part 327: Rules and Regulations Governing Public Use of Corps of Engineers Water Resources Development Projects Administered by the Chief of Engineers. February 11 (amended May 5). https://www.swf-wc.usace.army.mil/canyon/title36.pdf

[2] Department of the Army, New England Division, Corps of Engineers. 1975 Cape Cod Canal, Massachusetts: Master Plan for the Development of the Recreational Resources. October. https://apps.dtic.mil/sti/tr/pdf/ADA099242.pdf

Section 4(f) of the U.S. Department of Transportation Act of 1966

For transportation projects funded by the Federal Highway Administration (FHWA), publicly owned parks and recreational areas are protected under Section 4(f) of the Department of Transportation Act of 1966 [Section4(f)],[3] and FHWA's implementing Section 4(f) regulations.[4] The Massachusetts Department of Transportation (MassDOT) verifies Section 4(f) applicability through consultation with FHWA via a Presence/Absence Determination, with concurrence from the Official with Jurisdiction. The Official with Jurisdiction is the legal representative of the agency or agencies that own or administer the property.

Section 6(f) of the U.S. Land and Water Conservation Act

Section 6(f) of the U.S. Land and Water Conservation Fund Act[5] provides protections for public parks and recreational areas that were established or improved with grants from the National Park Service through the act. According to the Trust for Public Land and information updates, no Section 6(f) properties are located within the Study Area; accordingly, Section 6(f) protections are not discussed further.[6, 7]

Article 97 Land Disposition Policy

As indicated in **Section 4.6, Land Use, Zoning, and Community Cohesion**, Article 97 of the Amendments to the Constitution of the Commonwealth protects public land, including state-owned and municipal lands, that were acquired for conservation or recreational purposes. Article 97 does not apply to federal land. Under Massachusetts Executive Office of Energy and Environmental Affairs' (MA EEA) Article 97 Land Disposition Policy,[8] the MA EEA and its agencies are prohibited from selling, transferring, leasing, relinquishing, or changing the control or use of any Article 97 land unless exceptional circumstances exist, and specific conditions are met. It also provides that land or

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[3] Title 49 U.S. Code 303 (as amended), Policy on lands, wildlife and waterfowl refuges, and historic sites. https://uscode.house.gov/view.xhtml?req=granuleid:USC-2012-title49-section303&num=0&edition=2012

[4] Title 23 Part 774, Parks, Recreation Areas, Wildlife and Waterfowl Refuges, and Historic Sites (Section 4(f)), https://www.ecfr.gov/current/title-23/chapter-I/subchapter-H/part-774

[5] Title 36 Part 59, Land and Water Conservation Fund Program of Assistance to States; Post-Completion Compliance Responsibilities. https://www.ecfr.gov/current/title-36/chapter-I/part-59

[6] The Trust for Public Land, Land and Water Conservation Fund Summary Report, Massachusetts; Barnstable County. https://lwcf.tplgis.org/mappast/. Land and Water Conservation Fund (LWCF)-funded places databases were updated in June 2022.

[7] Executive Office of Energy and Environmental Affairs. 2023. Healey-Driscoll Administration Announces Over $6 Million in Land and Water Conservation Grants to Support Parks and Open Spaces. October 18. https://www.mass.gov/news/healey-driscoll-administration-announces-over-6-million-in-land-and-water-conservation-grants-to-support-parks-and-open-spaces.
Boston Real Estate times. 2024. Massachusetts Awards Over $27 Million for Conservation, open space, and Park Projects. September 24. https://bostonrealestatetimes.com/massachusetts-awards-over-27-million-for-conservation-open-space-and-park-projects/.
Subsequent October 2023 and September 2024 announcements of LWCF grants indicate that no other public park or recreational facilities in the Study Area have received LWCF funding.

[8] Executive Office of Environmental Affairs. 1998. Article 97, Land Disposition Policy. February. https://www.mass.gov/files/dcsarticle97.pdf

easements subject to Article 97 shall not be used for other purposes or disposed of without a two-thirds roll call vote of the Legislature. The Public Lands Preservation Act (PLPA; MGL c.3 § 5A) codified the policy of "no net loss" of public land and established a formal process for submitting petitions to the Legislature to permanently change the use or dispose of Article 97 land. [9,10] The PLPA applies to the MA EEA and other state agencies, municipalities, boards and commissions, quasi-public agencies, and other public instrumentalities and subdivisions of the Commonwealth. The Article 97 Land Disposition Policy, including compliance with the PLPA, stipulate that applicants are to:

- Notify the public and the Secretary of MA EEA of the impacts.
- Prepare an alternatives analysis demonstrating that all options to avoid or minimize the use have been applied and no feasible alternative exists.
- Provide replacement land with comparable or greater recreational or natural resource value, acreage, and monetary value.
- Draft legislation and authorization for filing the bill to the Massachusetts legislature and obtain a two-thirds roll call vote of approval by the legislature.

In limited circumstances, the PLPA provides that the replacement land requirements may be waived or modified, or funding may be provided to the municipality or public entity that holds the Article 97 land in lieu of replacement land. In the latter circumstance, the municipality or public entity must use the funds to purchase replacement land within three years.

4.18.1.2 Methodology and Study Area

The MassDOT obtained information on public parks, recreational facilities, and open space in the Study Area from the MassMapper GIS database, the Town of Bourne Open Space & Recreation Plan,[11] and through coordination with the USACE and the Bourne Recreation Authority. Additional parcel information was obtained through the Town of Bourne, MA GIS Viewer, and Assessor's database. MassDOT also reviewed Title Exams that were conducted on property within the Study Area in association with the Median Installation on Route 6 Project (EEA# 16739). MassDOT obtained information on applicable federal, state, and local protection mechanisms through coordination with the FHWA, review of the Town of Bourne Open Space & Recreation Plan, and MassMapper.[12]

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[9] An Article 97 land disposition is defined as a) any transfer or conveyance of ownership or other interests; b) any change in physical or legal control; and c) any change in use, in and to Article 97 land or interests in Article 97 land owned or held by the Commonwealth or its political subdivisions, whether by deed, easement, lease or any other instrument effectuating such transfer, conveyance or change.

[10] Massachusetts General Law, Chapter 3, Section 5A: Change in the use or disposition of land by public entity; alternatives analysis; replacement land or funding; petition. https://malegislature.gov/Laws/GeneralLaws/PartI/TitleI/Chapter3/Section5A

[11] Bourne Open Space Committee. 2018. Town of Bourne Open Space & Recreation Plan. February 8. https://www.townofbourne.com/sites/g/files/vyhlif12841/f/uploads/open_space_plan_fina_2018.pdf

[12] https://www.mass.gov/info-details/massgis-data-protected-and-recreational-openspace

The Study Area for this assessment encompasses 0.125-mile buffer areas from the construction limits at the Sagamore Bridge and Bourne Bridge Project Limits (refer to **Section 4.18.2**). MassDOT established these Study Area buffers to identify public parks, recreational resources, and open space that could be potentially affected by the Build Alternative.

4.18.2 Existing Conditions

Figure 4.18-1 through Figure 4.18-4 present public parks, recreational facilities, and open space and applicable levels of protection within the Study Area.

The public uses Cape Cod Canal and the Canal Service Roads within the four Study Area quadrants extensively for recreation. The Cape Cod Canal is designated for motorized recreational boating only; per 33 CFR 207(q)(3)-(5), the following recreational activities are considered obstructions to navigation and are prohibited in the canal:

- Swimming
- Diving
- Snorkeling
- Scuba diving
- Personal watercraft, such as kayaks, canoes, wind surfers, or other, nonmotorized watercraft

Fishing or lobstering by boat within the land cut of the canal or in the confines of the approach channels of the canal is also prohibited. Fishing from the banks of the canal is allowed, except where expressly prohibited by the USACE. The public uses the Canal Service Roads for walking, bicycling, and other non-motorized recreational activities, as discussed in **Section 4.3, Pedestrian and Bicycle Facilities**.

4.18.2.1 Public Parks, Recreational Facilities, and Open Space Study Area (Sagamore North Quadrant)

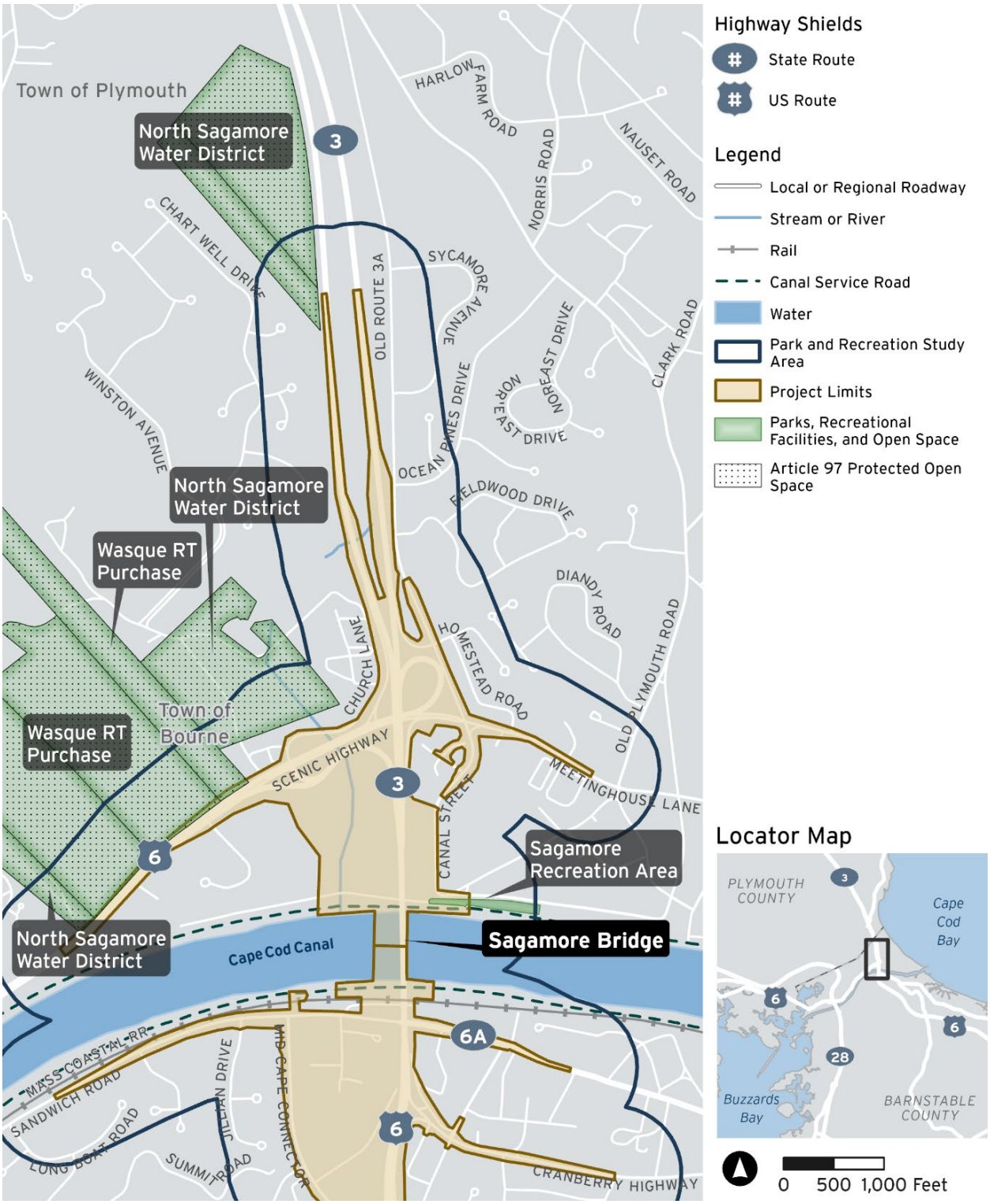
Table 4.18-1 lists public parks, recreational facilities, and open space (and applicable levels of protection) in the Sagamore North quadrant (**Figure 4.18-1**).

Table 4.18-1. Public Parks, Recreational Facilities, and Open Space (Sagamore North Quadrant)

Facility	Owner/Operator	Description	Protection
North Sagamore Water District Parcel	Town of Bourne, North Sagamore Water District	• Four water-supply protection parcels (104 acres) • Limited or no public access and no recreation development	Limited to water-supply protection under Article 97[a]
Wasque RT Purchase Parcels	Town of Bourne	• Three land bank parcels (134.16 acres) acquired for open space[b] • No recreational development	Article 97[c]
Sagamore Recreation Area[d]	U.S. Army Corps of Engineers	• Two acres within the Federal Navigation Project supporting recreational use of north side of canal • Provides an accessible seasonal comfort station with the following: – Potable water and sanitary facilities with a 3,500-gallon septic tank – Park benches – Picnic tables – Interpretive signage – Paved and unpaved parking – Three access gates to the North Canal Service Road	Section 4(f)[e]

[a] Protection identified in Town of Bourne Open Space & Recreation Plan.
[b] Land bank acquisitions by the Town of Bourne using Commonwealth of Massachusetts funds.
[c] https://www.mass.gov/info-details/massgis-data-protected-and-recreational-openspace
[d] Acreage calculated from USACE GIS shapefile.
[e] Protection determined by John Simkins, U.S. Department of Transportation, Federal Highway Administration. Email to Craig Martin, U.S. Army Corps of Engineers, "Cape Cod Canal Bridges – Section 4(f) Concurrence letter – USACE Official with Jurisdiction," August 22, 2024.

Figure 4.18-1. Public Parks, Recreational Facilities, and Open Space Study Area (Sagamore North Quadrant)



Source: Massachusetts Department of Transportation, 2024

4.18.2.2 Public Parks, Recreational Facilities, and Open Space Study Area (Sagamore South Quadrant)

Table 4.18-2 lists public parks, recreational facilities, and open space (and applicable levels of protection), in the Sagamore South quadrant (**Figure 4.18-2**).

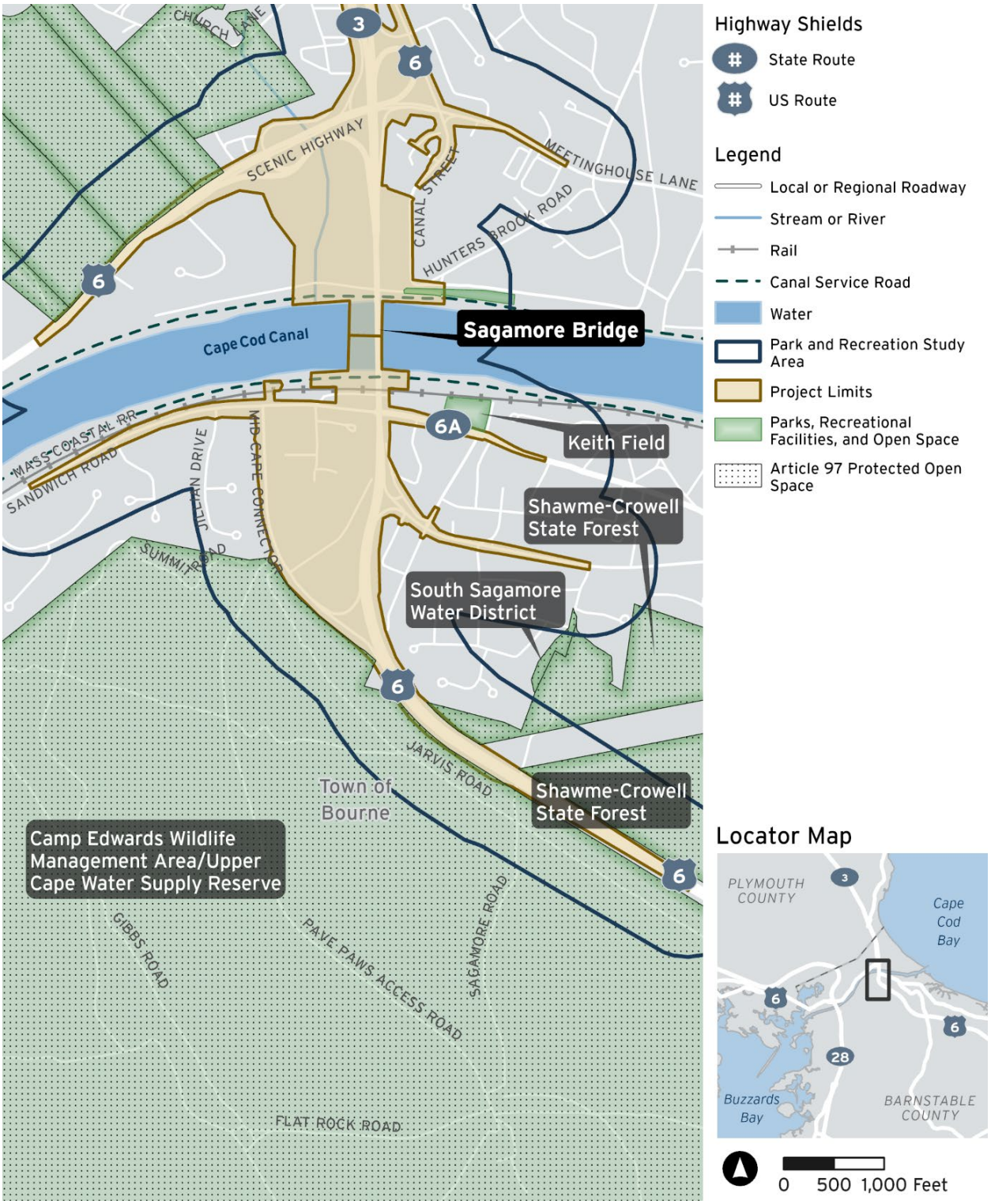
Table 4.18-2. Public Parks, Recreational Facilities, and Open Space (Sagamore South Quadrant)

Facility	Owner/Operator	Description	Protection
South Sagamore Water District Parcels	Town of Bourne, South Sagamore Water District	• 1.9-acre water-supply protection parcel • Limited or no public access and no recreational development	Limited to water-supply protection under Article 97[a]
Keith Field Recreation Area	Town of Bourne	• 2.88-acre parcel consisting of a Babe Ruth baseball field and a hard surface tennis court	Section 4(f)
Camp Edwards Wildlife Management Area /Upper Cape Water Supply Reserve	Massachusetts Department of Fisheries, Wildlife, and Environmental Law Enforcement, Division of Fisheries and Wildlife	• 15,000 acres consisting of the coterminous boundaries of the following: – Camp Edwards Wildlife Management Area (on the Massachusetts Military Reservation/Camp Edwards Training Area on Joint Base Cape Cod) – A remnant of the North Atlantic coastal pine barrens ecosystem – The Upper Cape Water Supply Reserve (atop the sole-source Cape Cod Aquifer) • Restricted public access • Portions open to the public for seasonal hunting	Article 97[b]
Shawme Crowell State Forest	Massachusetts Department of Conservation and Recreation	• 700-acre parcel accessible to the public for camping and hiking • Provides active and passive recreation facilities	Article 97[b], Section 4(f)

[a] Protection identified in Town of Bourne Open Space & Recreation Plan.

[b] MassGIS Data: Protected and Recreational Open Space. https://www.mass.gov/info-details/massgis-data-protected-and-recreational-openspace

Figure 4.18-2. Public Parks, Recreational Facilities, and Open Space Study Area (Sagamore South Quadrant)



Source: Massachusetts Department of Transportation, 2024

4.18.2.3 Public Parks, Recreational Facilities, and Open Space Study Area (Bourne North Quadrant)

Table 4.18-3 lists public parks, recreational facilities, and open space (and applicable levels of protection) in the Bourne North quadrant (**Figure 4.18-3**).

Table 4.18-3. Public Parks, Recreational Facilities, and Open Space (Bourne North Quadrant)

Facility	Owner/Operator	Description	Protection
Buzzards Bay Water District Parcel	Town of Bourne, Buzzards Bay Water District	• 9.5-acre water-supply protection parcel • Limited or no public access and no recreational development	Limited to water-supply protection under Article 97[a]
Cape Cod Land Bank Acquisition Parcels[b]	Town of Bourne	• Two land bank parcels (77.11 acres) acquired for open space • No recreational development	Article 97[c]
Nightingale Pond Conservation Area	Town of Bourne Conservation Commission	• 23-acre conservation parcel • Recreation potential for trails	Section 4(f)
Bourne Scenic Park	Bourne Recreation Authority (Owner) (6.28-acre parcel)	• 112-acre Bourne Scenic Park provides seasonal, weekly, and daily camping during its in-season (mid-June through the end of August) and off-season periods (end of March through mid-June and end of August through end of October) • Amenities include the following: – Electric service for recreational vehicles – A designated non-electric tent camping area – Water hookups – Wi-Fi – Restroom and shower facilities – Passive and active recreation amenities – Direct access to the North Canal Service Road through at-grade access and five stairways from individual camping areas	Section 4(f)[d] Article 97[e]
	U.S. Army Corps of Engineers (Owner)/ Bourne Recreation Authority (Operator) (106 acres within the Federal Navigation Project)		Section 4(f)[f]

[a] Protection identified in Town of Bourne Open Space & Recreation Plan.

[b] Land bank acquisitions by the Town of Bourne using Commonwealth of Massachusetts funds.

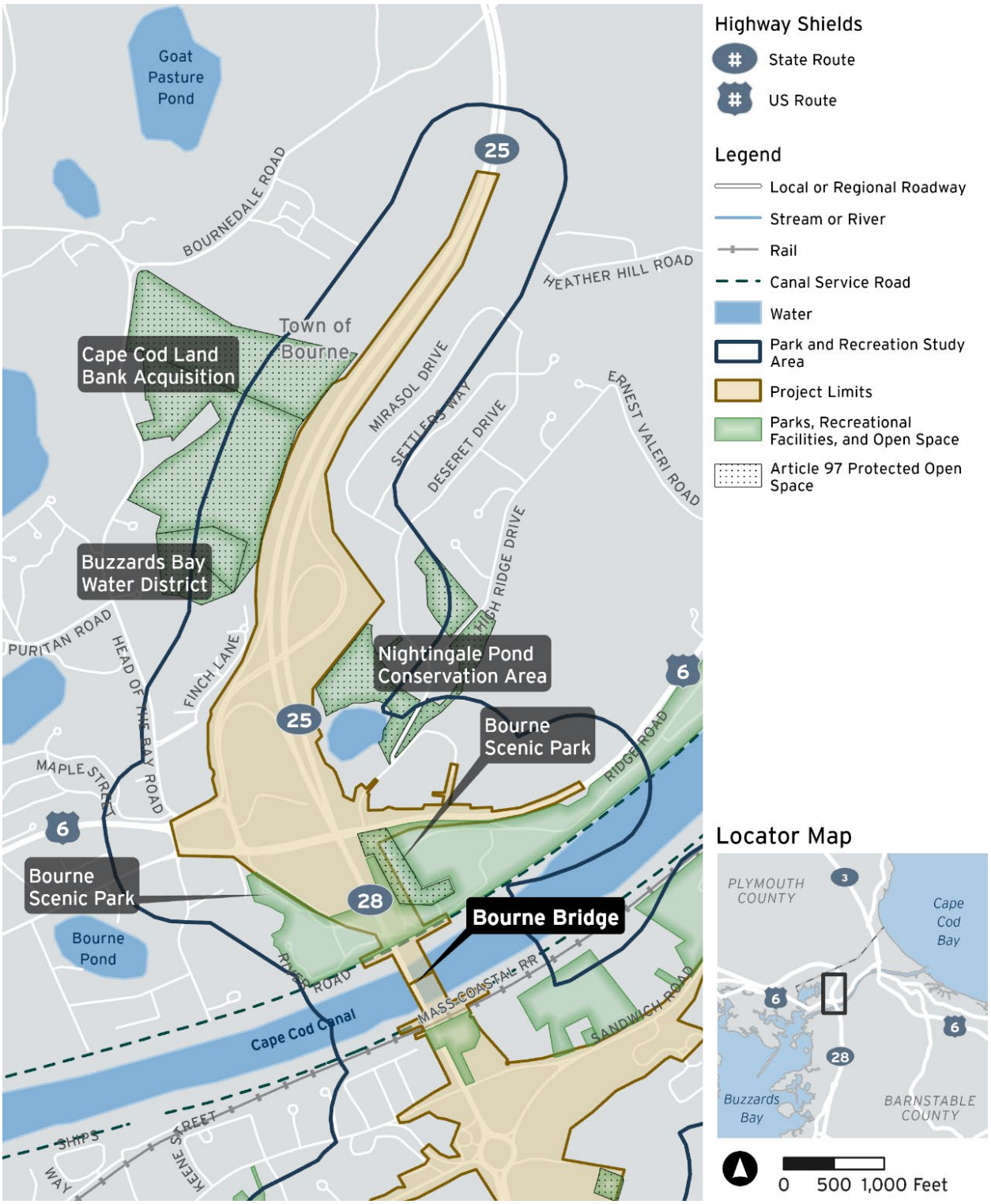
[c] MassGIS Data: Protected and Recreational Open Space. https://www.mass.gov/info-details/massgis-data-protected-and-recreational-openspace

[d] Section 4(f) protection to be confirmed by Town of Bourne as the Official with Jurisdiction, pursuant to 23 CFR 774.

[e] Massachusetts Department of Transportation, Right of Way Bureau. Title report: Bourne Recreation Authority, 370 Scenic Highway, Bourne, MA. Conducted for Bourne Median Installation on Route 6 (MassDOT Project No. 606082), January 30, 2024.

[f] Protection determined by John Simkins, U.S. Department of Transportation, Federal Highway Administration. Email to Craig Martin, U.S. Army Corps of Engineers, "Cape Cod Canal Bridges – Section 4(f) Concurrence letter – USACE Official with Jurisdiction," August 22, 2024.

Figure 4.18-3. Public Parks, Recreational Facilities, and Open Space Study Area (Bourne North Quadrant)



Source: Massachusetts Department of Transportation, 2024

4.18.2.4 Public Parks, Recreational Facilities, and Open Space Study Area (Bourne South Quadrant)

Table 4.18-4 lists public parks, recreational facilities, and open space, and applicable levels of protection, in the Bourne South quadrant (**Figure 4.18-4**).

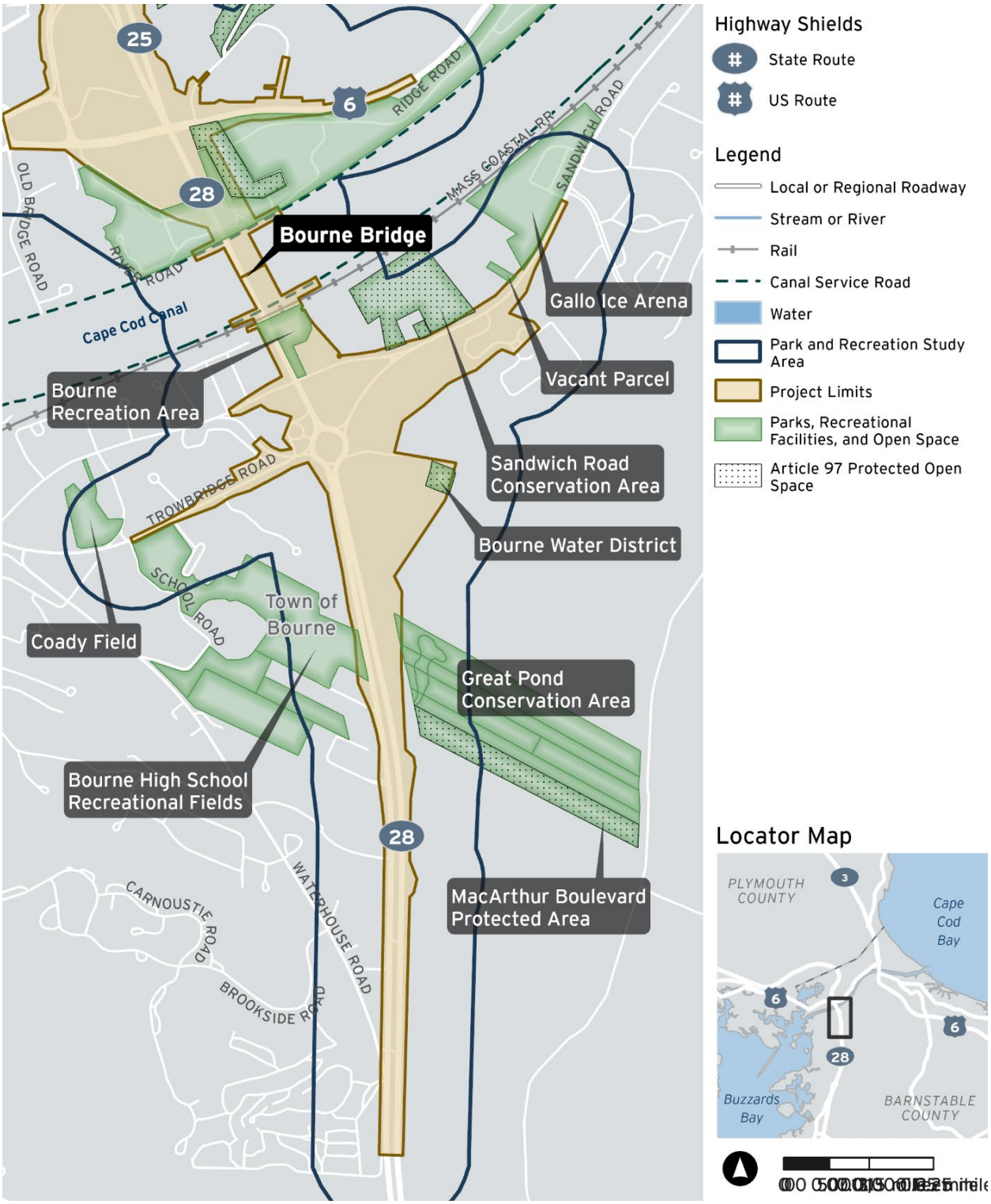
Table 4.18-4. Public Parks, Recreational Facilities, and Open Space (Bourne South Quadrant)

Facility	Owner/Operator	Description	Protection
Bourne Water District Parcel	Town of Bourne, Bourne Water District	• 1.46-acre water-supply protection parcel • Limited or no public access and no recreational development	Limited to water-supply protection under Article 97[a]
Sandwich Road Conservation Area	Town of Bourne Conservation Commission	• 15.11-acre conservation parcel with no recreational development	Article 97[b]
John Gallo Ice Arena	U.S. Army Corps of Engineers/ Bourne Recreation Authority	• Indoor public ice-skating rink and parking area on 33 acres within the Federal Navigation Project	Section 4(f)[c]
Vacant Parcel	Bourne Recreation Authority	• 0.5-acre vacant parcel	Limited[a]
Bourne Recreation Area[d]	USACE	• Four acres within the Federal Navigation Project supporting recreational use of south side of canal • Provides an accessible seasonal comfort station with the following: – Potable water and sanitary facilities with a 3,500-gallon septic tank – Park benches – Picnic tables – Interpretive signage – Paved and unpaved parking – Access to the South Canal Service Road	Section 4(f)[c]
MacArthur Boulevard Protected Area	Town of Bourne	• 12.5-acre open space parcel • Publicly accessible with no recreational development	Article 97[b]
Great Pond Conservation Area	Bourne Conservation Trust	• Four privately-owned conservation parcels (37.92 acres) • Publicly accessible with no recreational development	In perpetuity[a]
Coady Field	Town of Bourne	• 5.14-acre baseball field • Accessible to the public	Limited[a]

Facility	Owner/Operator	Description	Protection
Bourne High School Recreational Fields	Town of Bourne	• 48.66 acres of recreational fields • Accessible to the public	Limited[a]

[a] Protection identified in Town of Bourne Open Space & Recreation Plan.
[b] MassGIS Data: Protected and Recreational Open Space. https://www.mass.gov/info-details/massgis-data-protected-and-recreational-openspace
[c] Protection determined by John Simkins, U.S. Department of Transportation, Federal Highway Administration. Email to Craig Martin, USACE, "Cape Cod Canal Bridges – Section 4(f) Concurrence letter – USACE Official with Jurisdiction," August 22, 2024.
[d] Acreage calculated from USACE GIS shapefile.

Figure 4.18-4. Public Parks, Recreational Facilities, and Open Space Study Area (Bourne South Quadrant)



Source: Massachusetts Department of Transportation, 2024

4.18.3 No Build Alternative

As indicated in **Chapter 3, Proposed Action and Alternatives**, in the No Build Alternative, the USACE would continue to own and maintain the existing Sagamore and Bourne Bridges. Due to their locations under or immediately adjacent to the bridges, the USACE-operated Sagamore Recreation Area and Bourne Recreation Area and the USACE-leased and -owned Bourne Scenic Park could experience temporary construction-related impacts associated with the USACE's routine and/or emergency repairs. Additionally, routine and/or emergency repairs in the No Build Alternative could require temporary closures of the Canal Service Roads for recreational use. Section 4(f) and Article 97 do not apply to the No Build Alternative if undertaken solely by USACE with no participation from FHWA or MassDOT.

Except for these parks and facilities immediately adjacent to the bridges, the No Build Alternative would not impact additional parks, recreational facilities, or open space area in the Study Area.

4.18.4 Program Impacts

Table 4.18-5 lists anticipated approximate temporary and permanent impacts on federally and/or state-protected public park, recreational facilities, and open space in the Study Area due to the construction and operation of the Build Alternative. The majority of the impacts identified in **Table 4.18-5** occur on land subject to federal protection under Section 4(f). An update on these impacts and the status of their review under Section 4(f) will be provided in the Final Environmental Impact Report (FEIR).

While MassDOT anticipates requiring a temporary easement of approximately 0.08 acre on the Bourne High School parcel, the temporary easement would be located on the southeastern limits of the parcel immediately adjacent to State Route 28, outside the boundaries of the recreational fields. The temporary easement would not directly or indirectly affect the school's recreational fields. As such, the following table does not identify impacts to this property.

As noted in **Table 4.18-5**, construction of the Program would result in approximately 1.27 acres of permanent impacts to the Bourne Recreation Authority-owned Bourne Scenic Park parcel. The Bourne Recreation Authority-owned parcel is protected under Article 97 and represents a small portion (6.28 acres) of the adjacent USACE-owned Bourne Scenic Park (approximately 106 acres). A partial property acquisition, or the establishment of a permanent easement, would be required on the Bourne Recreation Authority-owned parcel to accommodate a proposed elevated southbound off ramp to Scenic Highway eastbound off-ramp to U.S. Route 6 and associated bridge structure abutments. This structure would be elevated over the Bourne Recreation Authority-owned parcel, with abutments located within the property. Additionally, the site's existing access drive (Andy Oliva Drive) would be realigned to connect with a proposed single-lane roundabout at its intersection with U.S. Route 6 and Nightingale Road and a shared use path would be constructed along the site's frontage with U.S. Route 6. These improvements are depicted on the **Proposed Conditions Plans (Appendix 3.2)** and the approximate boundaries of the potential acquisition and temporary easement are depicted in **Figure 4.18-5**.The partial property acquisition or permanent easement necessary to construct these improvements are not anticipated to eliminate or require the relocation of any existing recreational

uses on the Bourne Recreation Authority-owned parcel. A temporary easement would be required on the parcel for construction access. MassDOT will continue to refine impacts to account for design modifications and access needs for future maintenance or inspection of the proposed bridge structure and will present updated impact numbers in the Final Environmental Impact Report.

At this time, temporary easements on other Article 97 properties are not anticipated. As the design progresses, MassDOT will confirm the need for temporary easements on the Wasque RT parcels and/or other protected open space parcels and provide any updates in the Final Environmental Impact Report. It should be noted that temporary easements and revocable permits do not constitute a disposition of Article 97 land.

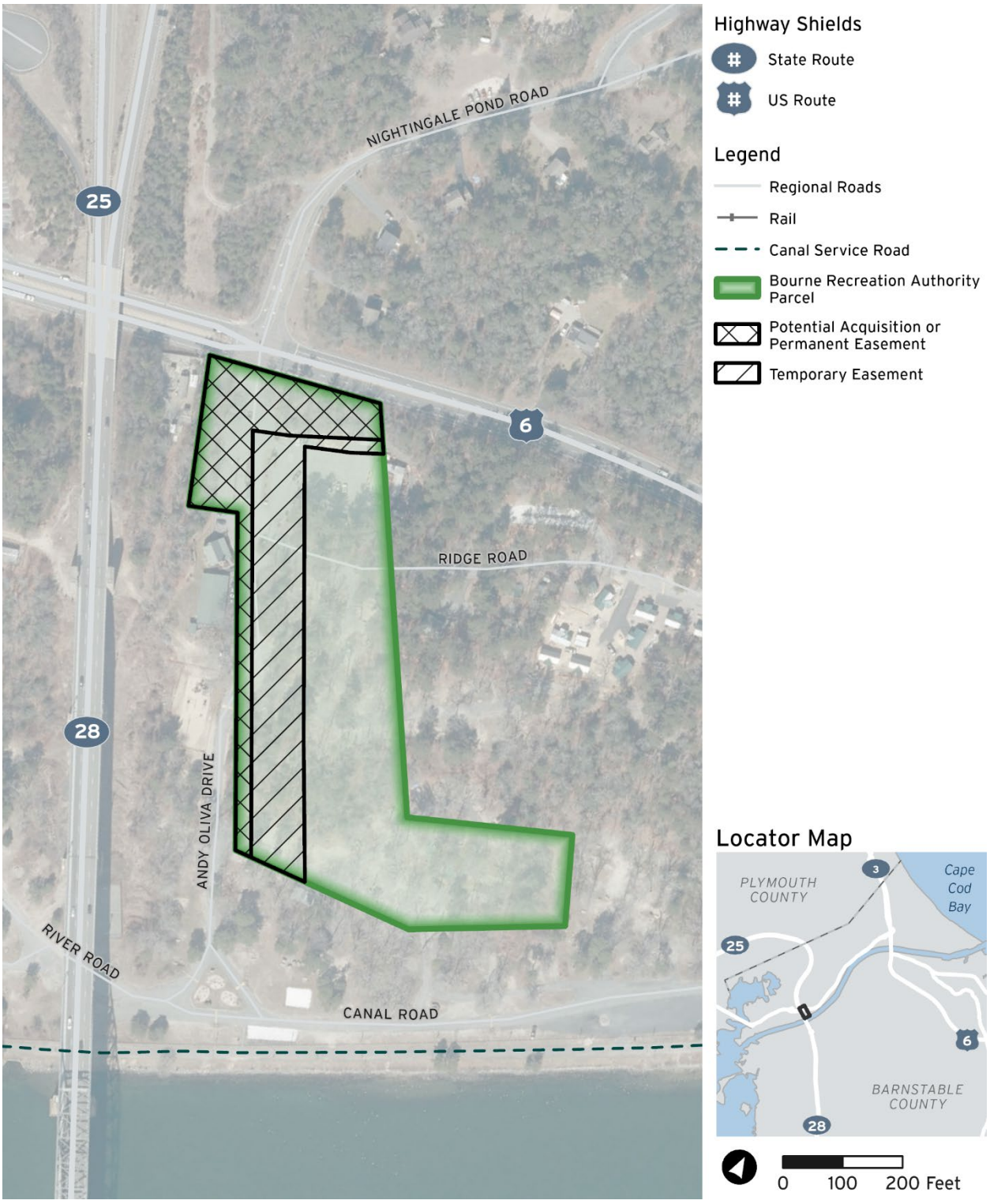
Table 4.18-5. Approximate Anticipated Impacts to Public Parks, Recreational Facilities, and Open Space

Program Quadrant (Figure #)	Resource	Owner	Approximate Physical Impacts[a]	Regulatory Impacts and Other Requirements
Sagamore North (**Figure 4.18-1**)	Sagamore Recreation Area	U.S. Army Corps of Engineers	• Use of approximately 1.0 acre consisting of a temporary easement for construction of replacement Sagamore Bridge and a permanent easement for maintenance of replacement bridge and/or partial acquisition for conversion to state highway layout, representing 50% of park acreage.	Section 4(f) Review; *De Minimis* Impact
Sagamore South (**Figure 4.18-2**)	Keith Field Recreation Area	Town of Bourne	• Use of approximately 0.40 acre, including temporary easement of 0.35 acre for access to temporary shared use path and permanent easement of 0.05 acre for utility pole relocations. • Total easements would represent approximately 14% of parcel acreage.	Section 4(f) Review; *De Minimis* Impact
Bourne North (**Figure 4.18-3**)	Bourne Scenic Park	Bourne Recreation Authority	• Use of approximately 2.8 acres for construction of replacement Bourne Bridge; of this total, approximately 1.27 acre would be a permanent easement for maintenance of replacement bridge and/or partial acquisition for conversion to state highway layout. This permanent impact area represents 20% of parcel acreage.	Section 4(f) Review; *De Minimis* Impact Article 97 Land Disposition

Program Quadrant (Figure #)	Resource	Owner	Approximate Physical Impacts[a]	Regulatory Impacts and Other Requirements
		U.S. Army Corps of Engineers	• Use of approximately 11.9 acres, for construction of replacement Bourne Bridge; of this total, approximately 4.4 acres would be a permanent easement for maintenance of replacement bridge and/or partial acquisition for conversion to state highway layout, representing 11% of park acreage.	Section 4(f) Review; *De Minimis* Impact
Bourne South (**Figure 4.18-4**)	Bourne Recreation Area	U.S. Army Corps of Engineers	• Use of approximately 4.0 acres, consisting of a temporary easement for construction of replacement Bourne Bridge and permanent easement for maintenance of replacement bridge and/or partial acquisition for conversion to state highway layout, representing 100% of park acreage.	Section 4(f) Review; *De Minimis* Impact
	Sandwich Road Conservation Area	Town of Bourne Conservation Commission	• Temporary easement of approximately 0.09 acre for grading associated with Sandwich Road improvements, representing less than 1% of parcel acreage.	Coordination with the Town of Bourne Conservation Commission
	Vacant Parcel	Bourne Recreation Authority	• Temporary easement of less than 0.01 acre for grading associated with Sandwich Road improvements, representing less than 1% of parcel acreage.	Coordination with Bourne Recreation Authority

[a] Impacts are approximate based only on preliminary design.

Figure 4.18-5. Impacts to Bourne Recreation Authority-owned Article 97 Parcel



Source: Massachusetts Department of Transportation, 2024

4.18.5 Mitigation

As cited in **Section 4.8.5, Property Acquisition, Displacement, and Relocation**, as design progresses, MassDOT will continue to refine temporary and permanent easements and partial acquisitions. All right-of-way acquisitions will be conducted in accordance with the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970. In accordance with MassDOT's Standard Specifications, all temporary easements will be restored to pre-existing conditions upon completion of the Program.

4.18.5.1 Minimization Strategies and Coordination with Owners

MassDOT has developed strategies to minimize impacts to property owners prior to, during, and following construction. Prior to construction start, MassDOT will coordinate with property owners to identify and implement means and methods for maintaining the current uses of the affected parcels during Program construction. During construction, MassDOT's standard specifications require contractors to protect and restore property, including maintaining existing drainage systems and preserving roadside growth.[13] Following construction completion, all land required for temporary easements will be restored to pre-existing conditions.

MassDOT will confirm potential impacts to properties, property boundaries, and the status of open space as design advances and property title searches are conducted. Updates on coordination with property owners and any revised impact assessments resulting from this research will be presented in the Final Environmental Impact Report.

4.18.5.2 Article 97 Land Disposition Authorizations

Due to the permanent impact required on the Bourne Recreation Authority-owned Bourne Scenic Park parcel, MassDOT would be subject to the Article 97 land disposition requirements, including compliance with the PLPA. The PLPA stipulates that applicants are to:

- Notify the public and the Secretary of EEA of the impacts.
- Prepare an alternatives analysis demonstrating that all options to avoid or minimize the use have been applied and no feasible alternative exists.
- Provide replacement land with comparable or greater recreational or natural resource value, acreage, and monetary value.
- Draft legislation and authorization for filing the bill to the Massachusetts legislature.

The USACE conducted a conceptual-level screening of alternatives in the USACE MRER/EA, including a high-level evaluation of environmental impacts, which resulted in the recommendation for an in-kind bridge replacement. Subsequent design work at the 5% to 15% level included detailed assessments of the bridge design elements and interchange approach options, which resulted in the Program

[13] Massachusetts Department of Transportation. 2024. Commonwealth of Massachusetts Department of Transportation Standard Specifications for Highways and Bridges (Edition 1). https://www.mass.gov/doc/2024-standard-specifications-for-highways-and-bridges-division-i-general-requirements-and-covenants/download

Preferred Alternative. As discussed in **Chapter 3**, the Preferred Alternative has been selected because it minimizes impacts to protected open space to the maximum extent practicable while best meeting the Program's need. Both interchange options considered for Bourne North—BN-13.1 and BN-14.4B—would result in relatively similar total impacts to Bourne Scenic Park, with BN-14.4B having a slightly greater impact (14.8 acres) compared to BN-13.1 (14.2 acres).[14] However, MassDOT determined that Option BN-14.b would provide more opportunities to meet the Program's needs than Option BN-13.1, including separating regional and local traffic and geometrically restricting wrong-way driving risk. In particular, Option BN-14.4b rated higher than Option BN-13.1 regarding multimodal accommodations, including providing grade separation over Scenic Highway for pedestrians and bicyclists and meeting the pedestrian and bicycle requirements of MassDOT's Healthy Transportation Directive. Based on this, MassDOT has determined that no feasible alternative exists that would result in fewer open space impacts while providing more opportunities to meet the Program's needs. Furthermore, the impact to the Bourne Recreation Authority-owned parcel is necessary to serve a public purpose, specifically to enable construction of replacement bridges and associated interchange approach networks which will improve cross-canal mobility and accessibility between Cape Cod and mainland Massachusetts for all road users and address the increasing maintenance needs and functional obsolescence of the aging Sagamore and Bourne Bridges.

MassDOT will continue coordination with the Bourne Recreation Authority regarding the proposed permanent easement or partial acquisition on their parcel to identify options to meet the replacement land requirements and/or provide in-lieu funding. The outcome of this coordination will be documented in the Final Environmental Impact Report. The Final Environmental Impact Report will also describe how the Program will comply with the procedures outlined in the PLPA, including whether replacement land or in-lieu funding will be provided; and will address the Program's compliance with the six conditions identified in the Article 97 Land Disposition Policy which determine when "exceptional circumstances" exist such that a disposition of Article 97 land may be allowed.

4.18.5.3 Section 4(f) Reviews: Minimization and Property Enhancement Opportunities

Potential impacts to Section 4(f) protected properties require coordination with Officials with Jurisdiction, the legal representative of the agency or agencies that own or administer the property.

MassDOT is coordinating with the USACE and Bourne Recreation Authority to minimize impacts and maintain the public's use of Bourne Scenic Park during construction and to enhance the park's facilities in the permanent post-construction condition as mitigation for the anticipated construction-period impacts. Similarly, for the Sagamore and Bourne Recreation Areas within the FNP, MassDOT is coordinating with the USACE to relocate temporary uses and provide long-term improvements to these

[14] Note this reflects total impacts to Bourne Scenic Park, which includes the Article 97 Bourne Recreation Authority-owned parcel and non-Article 97 adjacent USACE-owned property. Impacts identified during the preliminary alternatives analysis are based on conceptual through preliminary (up to 15% design) level assessments and are superseded by impacts presented in Chapters 4 and 5, which are based on a more advanced (25%) level of design.

recreational areas. The final measures and written agreement from the Officials with Jurisdiction will be documented in the Final Environmental Impact Report.

It is anticipated that MassDOT's minimal permanent easement requirements could qualify as a Section 4(f) *de minimis* use, because the easements would have no adverse impacts on the activities or features of the field that qualify the property as a Section 4(f) resource.[15] To obtain a *de minimis* use finding, the Officials with Jurisdiction must concur in writing and the public must be provided with an opportunity to comment. MassDOT will continue to coordinate with Officials with Jurisdiction to obtain concurrence that impacts to Section 4(f) resources would be considered *de minimis*. The outcome of this coordination will be documented in the Final Environmental Impact Report.

[15] Title 23, Part 774, Section 774.17: Parks, Recreation Areas, Wildlife and Waterfowl Refuges, and Historic Sites (Section 4(f) (Definitions). https://www.ecfr.gov/current/title-23/chapter-I/subchapter-H/part-774/section-774.17

4 Existing Conditions, Program Impacts, and Mitigation

4.19 Solid and Hazardous Waste Material Management

4.19.1 Introduction

This section assesses the potential construction-related and operational impacts of the No Build Alternative and Build Alternative on solid waste and hazardous materials, including identification of mitigation measures that will be employed to protect public health, construction worker safety, and the environment. **Appendix 4.19, Solid and Hazardous Waste Materials Technical Report**, supplements this section.

The term "solid waste" includes both hazardous and non-hazardous wastes and is defined as any garbage, refuse, sludge from a wastewater treatment plant, water supply treatment plant, or air pollution control facility, and other discarded material, including solid, liquid, semi-solid, or contained gaseous material, resulting from industrial, commercial, mining, and agricultural operations and from community activities.[1] For this assessment, solid waste includes construction debris and excavated soil.

The term "hazardous waste" means a solid waste, or combination of solid wastes, which because of its quantity, concentration, or physical, chemical, or infectious characteristics may (1) cause, or significantly contribute to an increase in mortality or an increase in serious irreversible, or incapacitating reversible, illness; or (2) pose a substantial present or potential hazard to human health or the environment when improperly treated, stored, transported, or disposed of, or otherwise managed.[2]

The term "hazardous materials" collectively refers to hazardous substances and hazardous wastes. Hazardous material means a substance or material that the Secretary of Transportation has determined is capable of posing an unreasonable risk to health, safety, and property when transported in commerce, and has been designated as hazardous.[3] Hazardous materials commonly include petroleum products, pesticides, organic compounds, asbestos, and heavy metals. Hazardous waste may include spent, discarded, spilled, or contaminated products, or wastes from certain industrial processes, as well as material (e.g., soil, water, construction debris, and/or building materials) that exhibit any of the four characteristics of hazardous wastes (ignitability, corrosivity, reactivity, and toxicity).

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[1] The Public Health and Welfare: Solid Waste Disposal, Definitions. 42 United States Code (USC) Section 6903(27). https://uscode.house.gov/view.xhtml?req=granuleid:USC-prelim-title42-section6903&num=0&edition=prelim

[2] The Public Health and Welfare: Solid Waste Disposal, Definitions. 42 USC Section 6903(5). https://uscode.house.gov/view.xhtml?req=granuleid:USC-prelim-title42-section6903&num=0&edition=prelim

[3] Hazardous Materials Safety Regulations. 49 Code of Federal Regulations (CFR) Section 171.8. https://www.ecfr.gov/current/title-49/subtitle-B/chapter-I

4.19.1.1 Regulatory Context

Solid and hazardous waste management is subject to the following regulatory programs:

- Resource Conservation and Recovery Act (42 USC Section 6901 et seq.)[4]
- Massachusetts Solid Waste Management Regulations (310 Code of Massachusetts Regulations (CMR) 19.000)[5]
- Massachusetts Hazardous Waste Regulations (310 CMR 30.000)[6]

The cleanup and assessment of hazardous waste sites is regulated under the following:

- Comprehensive Environmental Response, Compensation and Liability Act (42 USC Section 9601 et seq.)[7]
- Massachusetts Oil and Hazardous Material Release Prevention and Response Act (Massachusetts General Law 21E),[8] which is implemented by Massachusetts Department of Environmental Protection (MassDEP) through the Massachusetts Contingency Plan (310 CMR 40.0000)[9]

Refer to **Appendix 4.19, Solid and Hazardous Waste Material Management Technical Report**, for a comprehensive listing of the regulations and guidance documents that provided framework for this assessment.

4.19.1.2 Methodology and Study Areas

The Massachusetts Department of Transportation (MassDOT) derived information on the presence or likely presence of oil and/or hazardous material (OHM) releases and disposal sites through review of the following data sources:

- Federal and state regulatory database records
- MassDEP Waste Site & Reportable Releases Data Portal
- Historical Sanborn® maps
- Historical U.S. Geologic Survey topographic maps
- Historical aerial photographs
- 2020 U.S. Army Corps of Engineers Cape Cod Canal Highway Bridges Major Rehabilitation Evaluation Report/Environmental Assessment

[4] https://www.epa.gov/laws-regulations/summary-resource-conservation-and-recovery-act
[5] https://www.mass.gov/regulations/310-CMR-1900-solid-waste-management.
[6] https://www.mass.gov/regulations/310-CMR-30000-massachusetts-hazardous-waste-regulations
[7] https://www.epa.gov/enforcement/comprehensive-environmental-response-compensation-and-liability-act-cercla-and-federal#Summary
[8] https://malegislature.gov/Laws/GeneralLaws/PartI/TitleII/Chapter21E
[9] https://www.mass.gov/regulations/310-CMR-400000-massachusetts-contingency-plan

The Study Areas for this assessment encompass a 0.25-mile buffer around the construction limits of disturbance at Sagamore Bridge and Bourne Bridge. MassDOT considered a 0.25-mile buffer zone for this assessment because it is considered highly unlikely for contaminated media to migrate beyond this distance.

4.19.2 Existing Conditions

4.19.2.1 Past and Current Conditions

The Sagamore Bridge and Bourne Bridge Study Areas have a similar land use history that consists mostly of rural, low-density residential and light commercial uses that continued to develop over time. Major land uses within the general vicinity of the Study Areas include a railroad system that runs along the south side of Cape Cod Canal, former and current gasoline service stations, and Joint Base Cape Cod, a 22,000-acre military installation surrounded by the Upper Cape towns of Bourne, Falmouth, Mashpee, and Sandwich. Sanborn Maps for the years 1913 and 1924 depict the Keith Electric Car Company, which manufactured horse-drawn carriages, stagecoaches, prairie schooners for the Gold Rush, and later freight/box cars for the railroad system. The Keith Car Company was along Cape Cod Canal in the vicinity of Sagamore Bridge. The plant was demolished in the 1930s, following the second expansion of Cape Cod Canal.

Based on the historical and current land uses within the Study Areas, OHM could potentially be released into soil and groundwater within the construction limits of disturbance. Historical fill materials placed within the approaches to the bridges may contain contaminants such as metals and polycyclic aromatic hydrocarbons. Prior industrial, commercial and railway uses contribute to residual impacts to soil and groundwater, including metals, coal and ash-containing lead and arsenic, railroad ties treated with chemicals such as creosote, spilled or leaked petroleum products, and other OHM.

According to the U.S. Army Corps of Engineers, the existing paint system on Sagamore Bridge and Bourne Bridge contains residual amounts of lead.[10] Asbestos-containing materials (ACM) may be present in building materials and utilities within the Study Areas. ACMs and polychlorinated biphenyl (PCB)-containing materials may also be present in bridge components within the Study Areas.

4.19.2.2 Sensitive Receptors

Sensitive receptors are human and environmental resources that are more susceptible to the adverse impacts of exposure to hazardous materials, such as elderly people, children, individuals with pre-existing health conditions, as well as threatened or endangered species. As such, sensitive receptors are identified as land uses including but not limited to residential areas, retirement communities, schools, hospitals, daycare facilities, wetlands, and waterbodies.

[10] U.S. Army Corps of Engineers Cape Cod Canal Highway Bridges Major Rehabilitation Evaluation Report/Environmental Assessment, March 2020.

The Study Areas for this assessment feature a variety of sensitive receptors:

- Elderly people (aged 65 and older)
- Children (under age 18)
- Individuals with pre-existing and chronic health conditions
- Residential areas
- Schools
- Endangered species
- Wetlands and waterbodies
- Stormwater critical areas
- U.S. Environmental Protection Agency-designated Sole Source Aquifers

Information on these identified sensitive receptors is presented in other sections of this DEIR:

- **Section 4.6, Land Use, Zoning, and Community Cohesion**
- **Section 4.7, Community Facilities**
- **Section 4.10, Wetlands and Floodplains**
- **Section 4.11, Water Quality and Stormwater**
- **Section 4.12, Threatened, Endangered, and Protected Species and Habitats**
- **Section 4.21, Public Health**

4.19.2.3 Underground Storage Tanks and Solid Waste Landfills

Underground Storage Tanks

An underground storage tank (UST) means any one or combination of tanks (including any connected underground pipes) that is used to contain an accumulation of regulated substances,[11] where at least 10% of its combined volume (tank and connected pipes) is beneath the surface of the ground.[12]

Storage of OHM in USTs occurs at all gasoline service stations and at many large commercial and municipal properties. Modern USTs that are registered and adequately monitored likely do not pose a risk to the environment. However, these storage vessels pose potential sources of contamination that could affect soil and/or groundwater from an unknown or unreported release.

Seven known sites identified within the Sagamore Bridge Study Area either currently or have historically contained USTs:

- 19 Meetinghouse Lane
- 48 Meetinghouse Lane

[11] The term "regulated substance" includes petroleum and petroleum-based substances that comprise a complex blend of hydrocarbons, such as motor fuels, jet fuels, distillate fuel oils, residual fuel oils, lubricants, petroleum solvents, and used oils.

[12] Technical Standards and Corrective Action Requirements for Owners and Operators of Underground Storage Tanks (UST). 40 Code of Federal Regulations Part 280. https://www.epa.gov/sites/default/files/2015-07/documents/regs2015-redline.pdf

- 847 Sandwich Road
- 896 Sandwich Road
- Canal Fuel Company at 70 Cranberry Highway (There is a record of a release from the tank at 70 Cranberry Highway.)
- Stop & Shop at 80 Cranberry Highway
- Sagamore Service Station at 100 Cranberry Highway

Ten known sites identified within the Bourne Bridge Study Area either currently or have historically contained USTs:

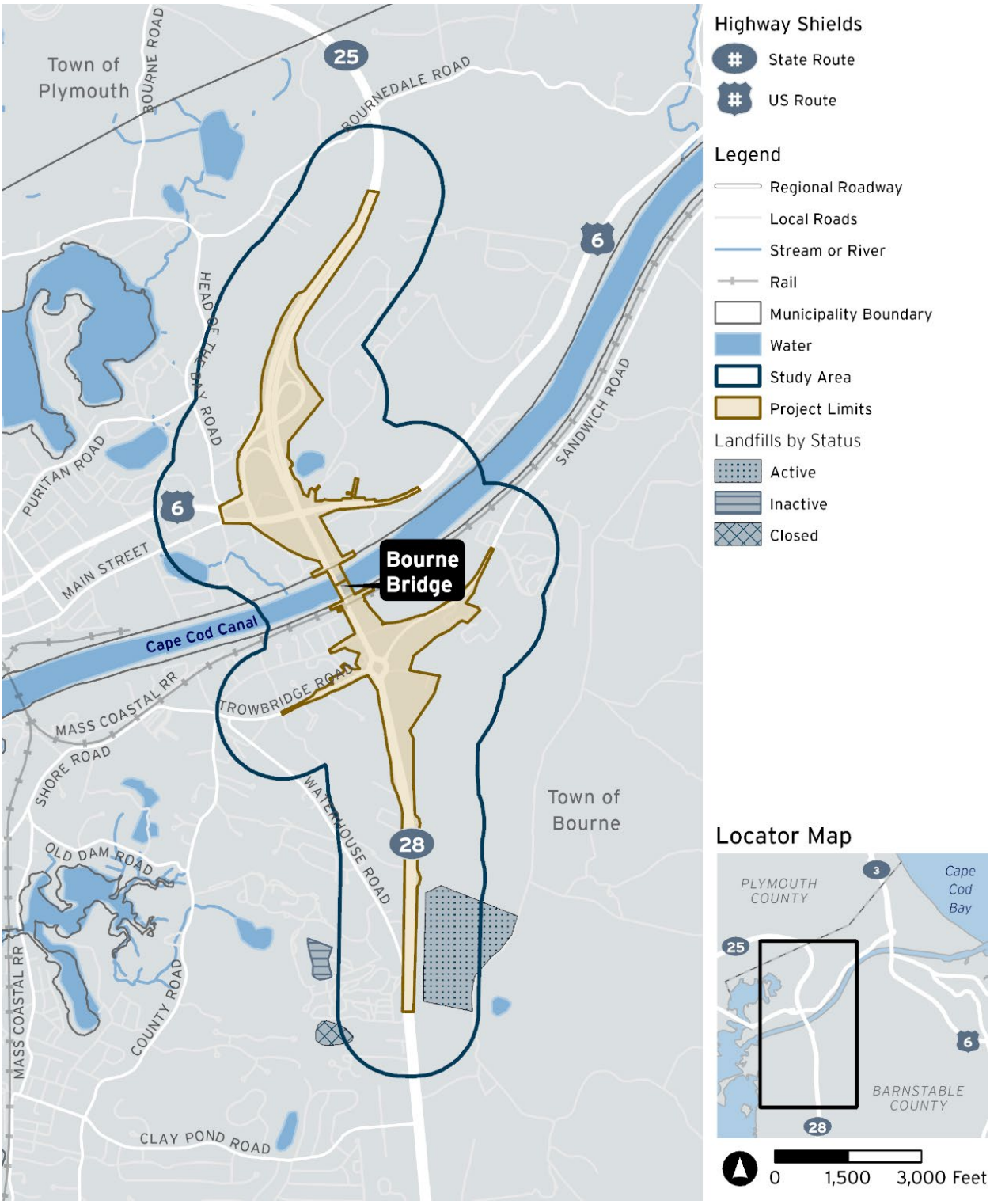
- Bourne Bridge Approach
- 2 Head of the Bay Road
- 343 Scenic Highway
- Canal Road
- 220 Sandwich Road
- Bourne Bridge Rotary
- 4 MacArthur Boulevard
- 48 MacArthur Boulevard
- 50 MacArthur Boulevard
- 60 MacArthur Boulevard

Solid Waste Landfills

A solid waste landfill is a facility or part of a facility established in accordance with a valid site assignment for the disposal of solid waste into or on land.[13] No active or inactive solid waste landfills are within the Sagamore Bridge Study Area. One active solid waste facility, Bourne Landfill, was identified within the Bourne South quadrant. This facility is on Dump Road to the east of State Route 28 (MacArthur Boulevard). MassDOT identified smaller, inactive landfills within the Bourne South quadrant. **Figure 4.19-1** identifies the locations of active and inactive solid waste landfills within the Bourne Bridge Study Area.

[13] Solid Waste Facility Regulations. 310 Code of Massachusetts Regulations 19.000. https://www.mass.gov/regulations/310-CMR-19000-solid-waste-facility-regulations

Figure 4.19-1. Solid Waste Landfills Relative to Bourne Bridge Study Area



Source: Massachusetts Department of Transportation, 2024

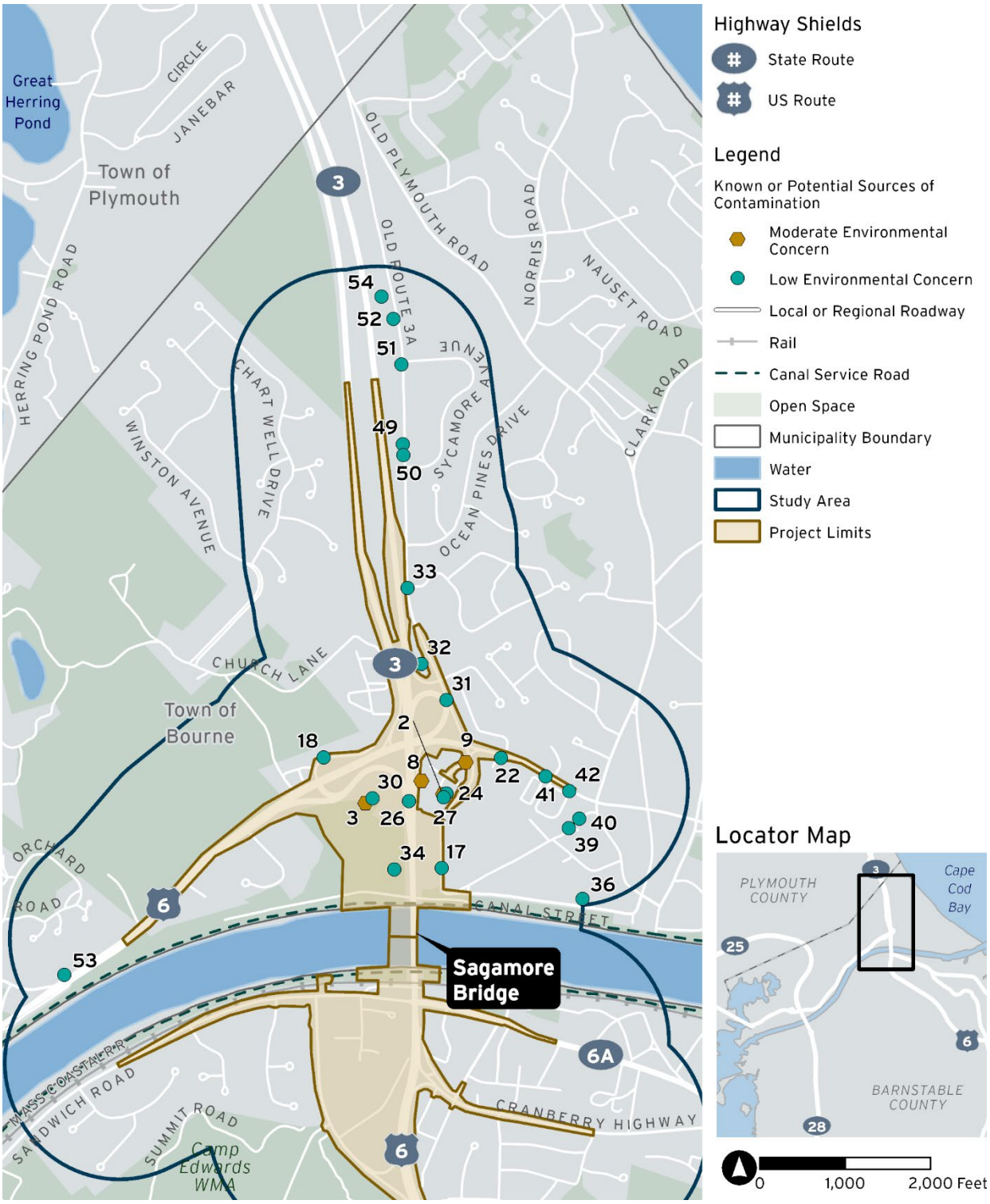
4.19.2.4 Identified Sites of Environmental Concern

Review of federal and state regulatory databases identified 127 sites of concern within the Sagamore Bridge and Bourne Bridge Study Areas that may possibly contain OHM. For this assessment, MassDOT classified these sites as the following:

- **High Environmental Concern** – These sites include locations where OHM impacts are known to exist, or it is highly likely to encounter OHM in environmental media irrespective of regulatory closure status. These sites are most likely associated with soil or groundwater contamination within the construction limits.
- **Moderate Environmental Concern** – These sites include locations within the construction limits where OHM may exist in environmental media, but due the age, type, and the extent of the release, and/or regulatory status as closed, are not expected to present significant contaminant management concerns.
- **Low Environmental Concern** – These sites include locations where no known releases have occurred, or where the databases listings do not indicate potential for environmental impacts (i.e., Resource Conservation and Recovery Act generators, locations that have permitted aboveground storage tanks or USTs, locations where asbestos removal occurred, etc.).

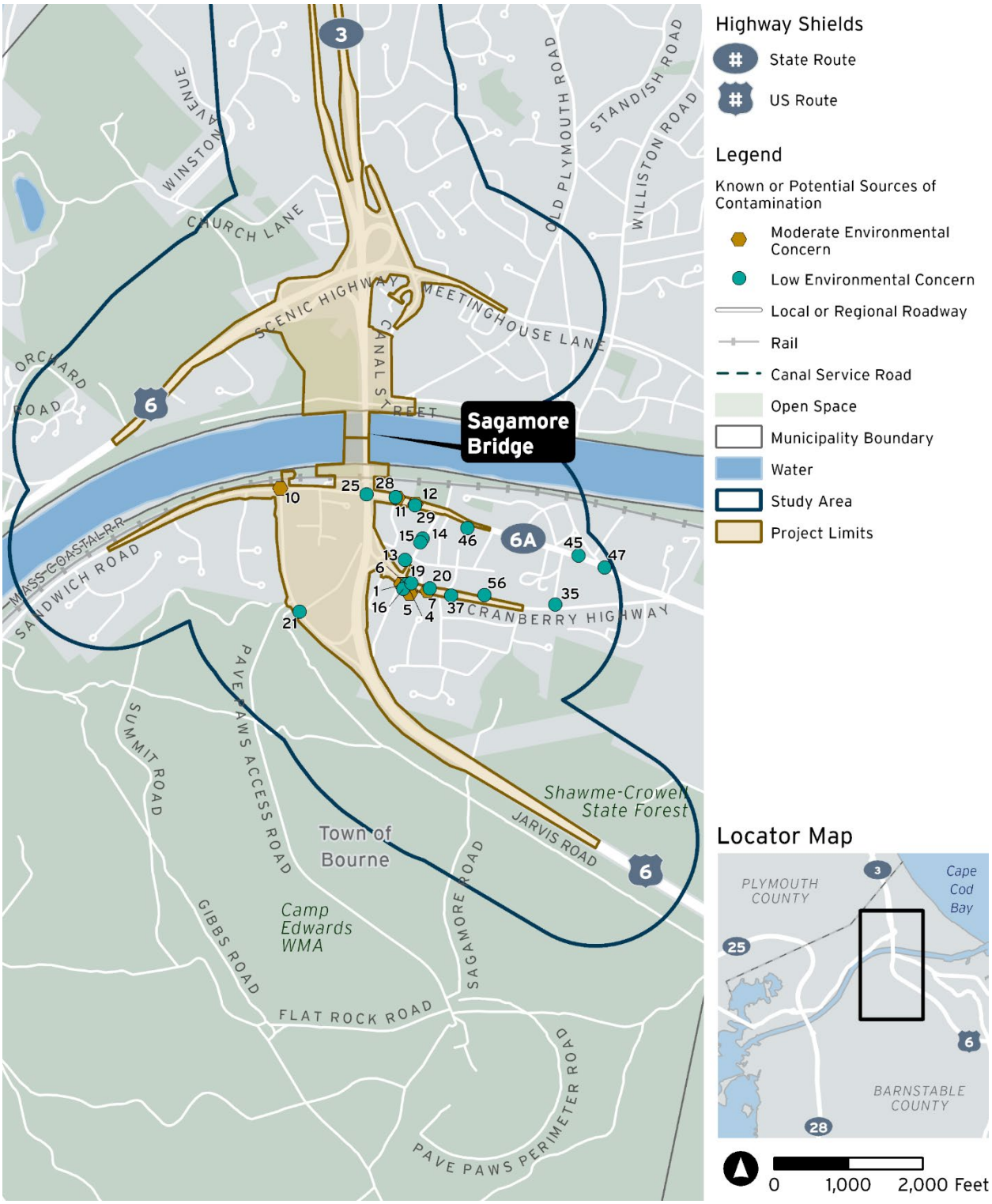
Figure 4.19-2 through Figure 4.19-5 identify the locations of impact and the associated level of environmental concern within the Sagamore North, Sagamore South, Bourne North, and Bourne South quadrants. Refer to **Attachments 1 through 5** in **Appendix 4.19, Solid and Hazardous Waste Material Management Technical Report**, for additional information including figure ID number references, site names, addresses, applicable databases, risk level, contaminant details, and regulatory status.

Figure 4.19-2. Known or Potential Sources of Contamination (Sagamore North Quadrant)



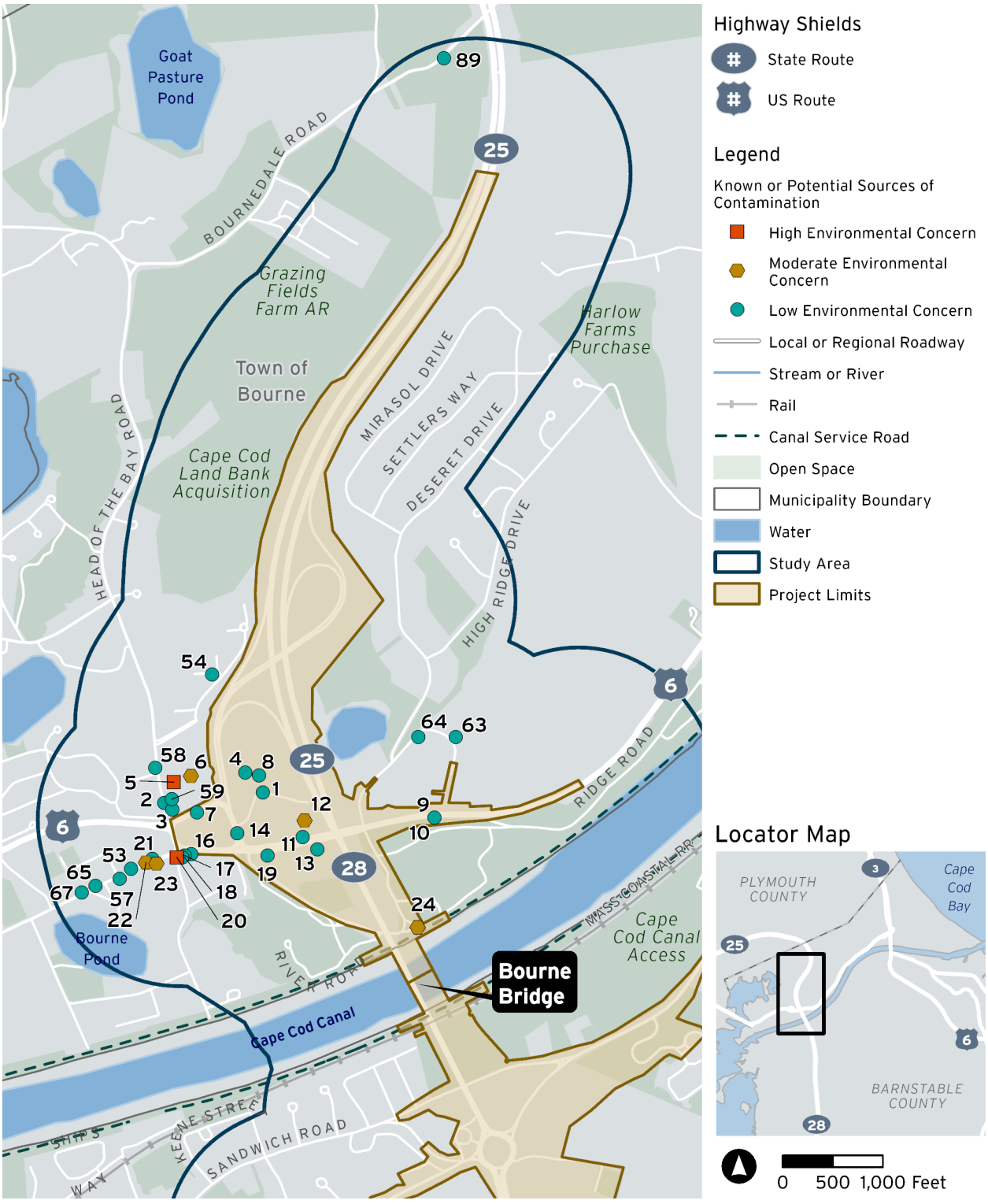
Source: Massachusetts Department of Transportation, 2025

Figure 4.19-3. Known or Potential Sources of Contamination (Sagamore South Quadrant)



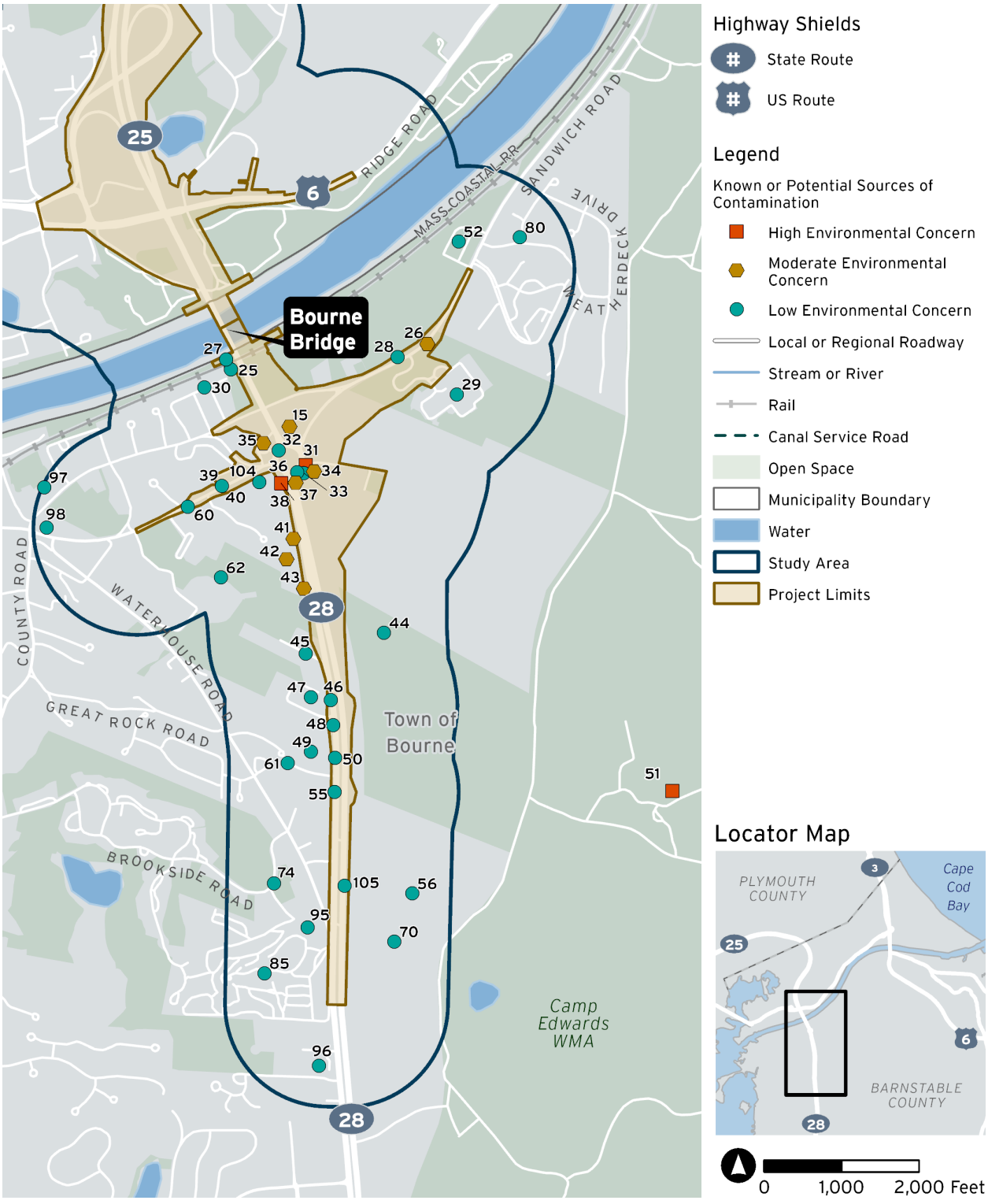
Source: Massachusetts Department of Transportation, 2025

Figure 4.19-4. Known or Potential Sources of Contamination (Bourne North Quadrant)



Source: Massachusetts Department of Transportation, 2025

Figure 4.19-5. Known or Potential Sources of Contamination (Bourne South Quadrant)



Source: Massachusetts Department of Transportation, 2025

Site 12 (moderate environmental concern) identified in the Sagamore South quadrant (refer to **Figure 4.19-3**) was closed with an Activity and Use Limitation (AUL).[14] This site is associated with the Pairpoint Glass Company at 851 Sandwich Road in the town of Bourne. Refer to **Attachment 1** in **Appendix 4.19, Solid and Hazardous Waste Materials Technical Report**, for additional details specific to this identified AUL disposal site.

4.19.3 No Build Alternative

The No Build Alternative would involve the continued operation of Sagamore Bridge and Bourne Bridge with ongoing maintenance by the U.S. Army Corps of Engineers to keep the bridges in a state of good repair. Routine maintenance and emergency repairs would involve the continued removal of historic lead-based paint (LBP) from the bridges. The No Build Alternative also includes near-term projects included in the Cape Cod Region's Federal Fiscal Year 2025-2029 Transportation Improvement Program, which would involve construction activities with potential for encountering OHM.

Any future bridge maintenance repairs and construction of planned projects scheduled for implementation in the Cape Cod Region's Federal Fiscal Year 2025-2029 Transportation Improvement Program would require adherence to applicable federal and state regulations to prevent potential exposures to OHM.

4.19.4 Program Impacts

4.19.4.1 Construction Impacts

The Build Alternative would involve demolishing the existing Sagamore and Bourne Bridges, which contain LBP. The Build Alternative is also expected to encounter contaminated soil and groundwater during soil disturbance within and near OHM-affected sites within the Study Areas. Proposed dredging within Cape Cod Canal for removal of existing bridge pier foundations would involve generating and handling sediments that may be contaminated with OHM.

Construction of the Build Alternative would involve building demolition that could disturb existing hazardous building materials. ACMs are likely to exist in buildings constructed before 1980. ACM poses risks to construction worker safety and the public when disturbed during construction. In addition to the Sagamore and Bourne Bridges, LBP is likely to exist in buildings or structures constructed before 1978. Demolition activities can release harmful lead dust or chips, which pose risks to construction worker safety and public health. In older buildings constructed between the 1950s and 1970s, PCBs may be present in caulking, floor mastic, and fluorescent light ballasts. In addition, buildings with thermostats installed before 2006 may contain mercury that requires proper handling and disposal. The Build Alternative also has potential risk for worker, public, and environmental exposure to

[14] An Activity and Use Limitation is a legal document recorded or registered with the Registry of Deeds that identifies activities and uses that are consistent and inconsistent with, and ongoing obligations and conditions that are necessary to maintain, a level of No Significant Risk at a disposal site where contamination remains after completing assessment and/or cleanup activities. They require oversight and regulatory coordination for any excavation or disturbance within the boundaries of the Activity and Use Limitation area.

hazardous materials due to accidental releases or spills of petroleum products, chemical supplies, and materials during construction.

Construction of the Build Alternative would be managed according to applicable federal and state regulations regarding the use, storage, handling, disposal, and transport of hazardous materials. Compliance with applicable laws and regulations governing the use, storage, transportation, and disposal of hazardous materials would reduce the risk of human and environmental exposure to these materials. **Section 4.19.5.1** provides a discussion of mitigation measures that would be employed to minimize the risk of human and environmental exposure to hazardous materials.

Demolition Waste and Material Management

Table 4.19-1 and **Table 4.19-2** list estimated quantities of demolition waste, and **Table 4.19-3** and **Table 4.19-4** list estimated quantities of excavated and fill material, that would be generated for the Build Alternative. Final quantities will be determined in construction after opportunities for recycling are considered.

Table 4.19-1. Demolition Waste Quantity Estimates (Sagamore Bridge)

Location	Waste Type	Estimated Quantity
Sagamore Bridge Canal Span/Approaches	Steel	4,600 tons
	Rebar (steel)	1,500 tons
	Concrete	63,200 tons
Sagamore North Quadrant, U.S. Route 6 over Scenic Highway	Steel	0 tons
	Rebar (steel)	230 tons
	Concrete	6,300 tons
Total Demolition Waste	—	75,830 tons

Source: Massachusetts Department of Transportation, 2024

Table 4.19-2. Demolition Waste Quantity Estimates (Bourne Bridge)

Location	Waste Type	Estimated Quantity
Bourne Bridge Canal Span/Approaches	Steel	7,750 tons
	Rebar (steel)	2,100 tons
	Concrete	85,300 tons
Bourne North Quadrant, State Route 28 over Scenic Highway	Steel	255 tons
	Rebar (steel)	130 tons
	Concrete	3,600 tons
Bourne North Quadrant, State Route 25 On-/Off-Ramp over State Route 25	Steel	285 tons
	Rebar (steel)	135 tons
	Concrete	3,700 tons
Total Demolition Waste	—	103,255 tons

Source: Massachusetts Department of Transportation, 2024

Table 4.19-3. Material Quantity Estimates (Sagamore Bridge)

Location	Type	Estimated Quantity
Sagamore North Quadrant	Excavated Material	460,000 cubic yards
	Fill Material	215,000 cubic yards
Sagamore South Quadrant	Excavated Material	689,000 cubic yards
	Fill Material	161,000 cubic yards

Source: Massachusetts Department of Transportation, 2025

Table 4.19-4. Material Quantity Estimates (Bourne Bridge)

Location	Type	Estimated Quantity
Bourne North Quadrant	Excavated Material	498,000 cubic yards
	Fill Material	267,000 cubic yards
Bourne South Quadrant	Excavated Material	553,000 cubic yards
	Fill Material	328,000 cubic yards

Source: Massachusetts Department of Transportation, 2025

MassDOT's Contract Specifications will require all demolition waste to be properly segregated and managed based on the nature of the waste and the presence of OHM. Recycling and reuse of concrete, steel and other materials would be implemented as part of the Build Alternative, where possible. On-site reuse of soils and sediments can be maximized based on visual, olfactory, and geotechnical properties. All surplus soils and sediments will undergo laboratory testing prior to transportation with off-site reuse and disposal options dictated by contaminant concentrations. Excess soil and sediment

to be transported off-site for disposal will be managed in accordance with applicable regulatory requirements.

4.19.4.2 Operational Impacts

Operation of the Build Alternative would not have any long-term adverse impacts related to hazardous materials. The Build Alternative would reduce the likelihood of exposure to or potential contamination from hazardous materials and waste through removal of structures (which contain asbestos and LBP), as well as excavation and off-site disposal of contaminated soils. Overall, the Build Alternative would provide long-term benefits by removing and reducing hazardous materials within the Study Areas.

MassDOT will adhere to applicable laws and regulations governing the handling, storage, monitoring, transportation, and disposal of hazardous materials for any future bridge and roadway maintenance activities.

4.19.5 Mitigation

4.19.5.1 Construction Impacts

As discussed in **Section 4.19.4.1**, construction of the Build Alternative would be managed in accordance with applicable federal and state regulations regarding the use, storage, handling, disposal, and transport of hazardous materials. The following mitigation measures will be implemented to protect construction worker safety, prevent public exposure to hazardous materials during construction, and protect the surrounding environment in accordance with applicable regulatory requirements and MassDOT Contract Specifications. With these measures in place, the Build Alternative would not have the potential for significant adverse impacts related to OHM during construction.

MassDOT Responsibilities

- Phase I Environmental Site Assessments will be conducted before acquiring each property to evaluate the potential presence of OHM in building materials in accordance with American Society for Testing and Materials Practices and Standards. Phase II Environmental Site Assessments will be conducted to further evaluate the extent of these contaminants, as warranted by findings of the Phase I Environmental Site Assessments.
- Pre-demolition hazardous building materials surveys will be completed to evaluate the presence of ACM, LBP, PCBs, and other hazardous materials. Based on survey results, abatement will be conducted before demolition. Any building materials, equipment, or utilities containing suspect PCBs, LBP, mercury and/or ACM will be properly contained and disposed of in accordance with the applicable regulatory requirements.
- A Sediment Sampling and Analysis Plan will be prepared and submitted to MassDEP for approval in accordance with the permitting requirements under the 401 Water Quality Certification

regulations.[15] The Sediment Sampling and Analysis Plan will outline procedures for collecting sediment samples from specific locations within Cape Cod Canal, including sampling methods, analysis techniques to be used on those samples, quality assurance measures, and safety protocols. Laboratory sampling analyses will determine the concentration of contaminants present in the sediments and inform the need for special management considerations to ensure the protection of human health, safety, and the environment during construction.

- MassDOT will provide LSP oversight of the contractor and the contractor's Licensed Site Professional (LSP) to ensure hazardous materials are being managed cost effectively and in accordance with all state and federal requirements.

Contractor Responsibilities

- Site-specific Environmental Health and Safety Plans will be developed and implemented to identify, evaluate, and control health and safety hazards resulting from any on-site chemical contamination present in air, soil, water, and sediment during construction and provide for emergency response, as needed. Health and safety procedures will comply with applicable regulations that address employee working conditions and protection of sensitive receptors.
- A Soil and Groundwater Management Plan will be developed and implemented to manage soil, sediment, and groundwater that may be affected by OHM during construction. The Soil and Groundwater Management Plan will detail soil sampling and management techniques that will be performed under the direction of a Licensed Site Professional (LSP), including measures to avoid and/or reuse contaminated media in accordance with applicable regulatory requirements.
- Any work occurring within the boundaries of a known MassDEP release site will be performed under the direction of an LSP to ensure proper management according to the Massachusetts Contingency Plan. Any new areas of contamination encountered during construction will be coordinated with an LSP to determine the appropriate regulatory pathway under the Massachusetts Contingency Plan.
- A Lead Abatement Plan will be developed to specify work practices and procedures to remove LBP during construction. LBP abatement will be performed according to the Occupational Safety and Health Administration's, Lead in Construction Regulations,[16] including containment, worker training, air quality monitoring, collection, and disposal of contaminated debris.

[15] 401 Water Quality Certification. 314 CMR 9.00. https://www.mass.gov/regulations/314-CMR-9-401-water-quality-certification

[16] Safety and Health Regulations for Construction. 29 CFR 1926. https://www.osha.gov/laws-regs/regulations/standardnumber/1926/1926TableofContents

- Asbestos Abatement Work Plans will be developed to specify work practices and procedures related to removing ACM during construction. ACM abatement will be conducted using Massachusetts-licensed professionals according to MassDEP's Asbestos Regulations.[17]
- A Spill Prevention, Containment and Control Plan will be developed to describe planning, prevention, and control measures to minimize impacts resulting from accidental spills or releases of OHM during construction, if on-site storage of oil or oil products exceeds applicable regulatory thresholds.[18]
- If dewatering of affected groundwater is necessary during construction, the contractor will be required to manage and discharge water according to all applicable regulatory requirements. The contractor will perform preliminary testing as required to support any necessary permitting.
- If relocation or removal of an UST is necessary during construction, the contractor will ensure that removal and relocation operations are conducted according to MassDEP's UST regulations.[19]

MassDOT and other regulatory agencies will review and approve the construction management mitigation plans prepared by the contractor, as necessary, before implementation.

[17] Air Pollution Control: Asbestos regulations. 310 CMR 7.15. https://www.mass.gov/doc/310-cmr-715-massdep-asbestos-regulation/download

[18] Overview of the Spill Prevention, Control, and Countermeasure (SPCC) Regulations. 40 CFR 112. https://www.epa.gov/oil-spills-prevention-and-preparedness-regulations/overview-spill-prevention-control-and

[19] Underground Storage Tank (UST) Systems. 310 CMR 80.00. https://www.mass.gov/regulations/310-CMR-8000-underground-storage-tank-ust-systems

4 Existing Conditions, Program Impacts, and Mitigation

4.20 Utilities and Services

4.20.1 Introduction

This section assesses the No Build and Build Alternatives for potential impacts on existing utilities, including water, sewer/septic systems, gas, electrical, and communications. **Section 4.11, Water Quality and Stormwater,** addresses the impacts of the No Build and Build Alternatives on the stormwater drainage system.

4.20.1.1 Methodology and Study Areas

The existing utility locations were identified using a combination of methods. The Massachusetts Department of Transportation (MassDOT) performed aerial Light Detection and Ranging (LiDAR) survey information of the Study Areas to identify aboveground utilities. This information was supplemented with topographic survey and measured pipe inverts within drainage/sewer structures. MassDOT also obtained system maps from the public and private utility owners to provide additional information on underground items. An additional Level B Subsurface Utility Engineering survey was performed on key utility infrastructure components to determine horizontal locations more accurately[1].

MassDOT identified utility impacts by overlaying the preliminary design details to identify areas of conflict with existing infrastructure either horizontally or vertically. These conflict areas were then evaluated to see if they could be minimized prior to determining the final limits of the relocation.

Chapter 3, Proposed Action and Alternatives, defines and **Figure 4.20-1** depicts the Sagamore Bridge and Bourne Bridge Study Areas for this assessment.

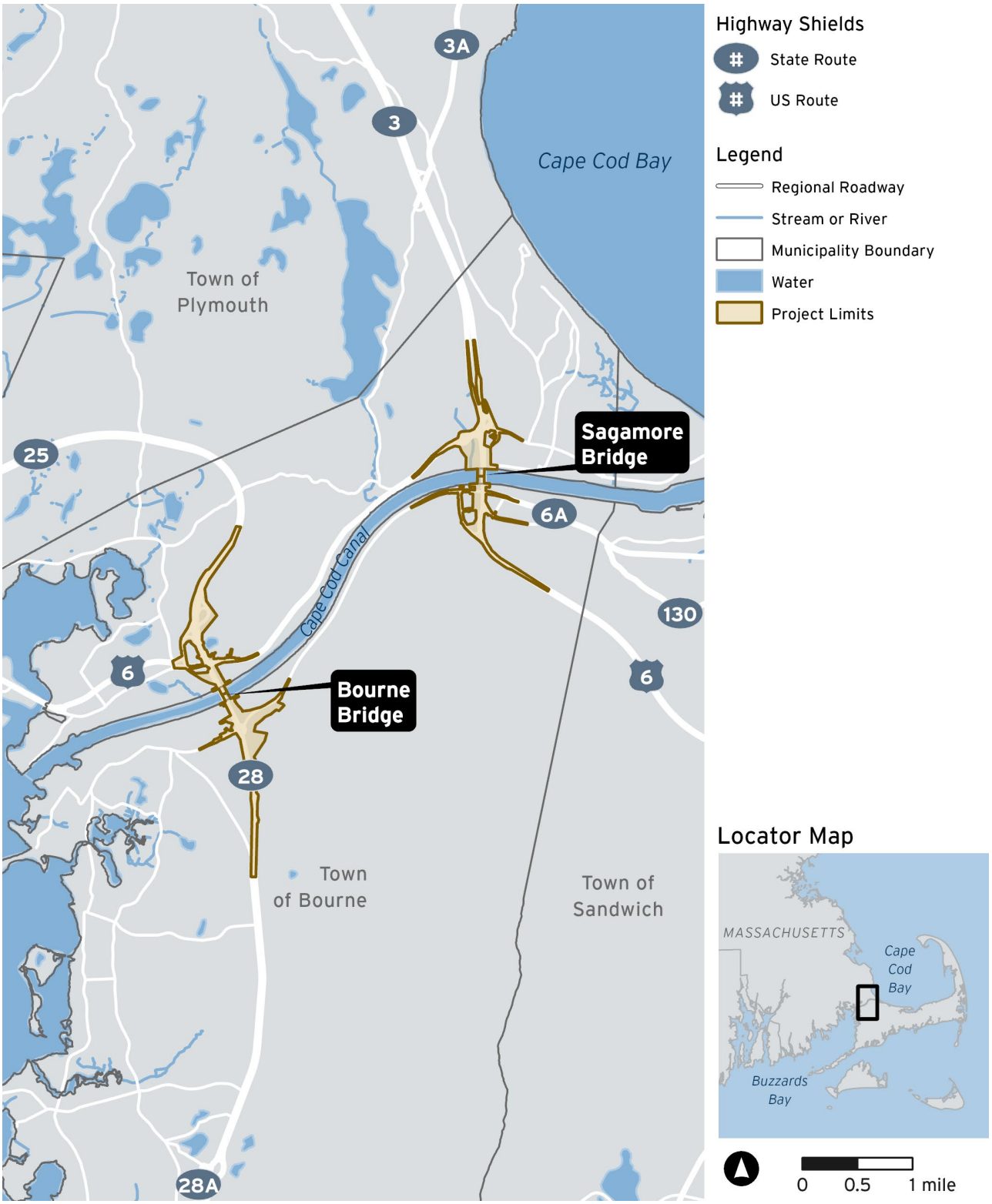
4.20.2 Existing Conditions

The Sagamore and Bourne Bridges each carry utilities across Cape Cod Canal, including natural gas (via National Grid [NGrid]), fiberoptics for telephone and cable (permitted to Verizon New England [Verizon] and leased to others), and electric lines and communications for the U.S. Army Corps of Engineers (USACE). **Figure 4.20-1** does not depict the utilities on the existing bridges and their routing due to safety and security concerns and the sensitive nature of this infrastructure.

The USACE owns and is responsible for maintaining utilities and utility poles along the Canal Service Roads that parallel both sides of the canal and other USACE property in the canal area. Verizon maintains all utility poles in public streets north of the canal, and Eversource Energy (Eversource) maintains the utility poles in public streets south of the canal.

[1] A Level B Subsurface Utility Engineering survey is used to locate and identify underground utilities using surface geophysical methods.

Figure 4.20-1. Public Utilities Study Areas



Source: Massachusetts Department of Transportation, 2024

The remainder of this section further describes the utilities within the Study Areas. The discussion identifies the location of utilities by the following Study Area quadrants:

- Sagamore North
- Sagamore South
- Bourne North
- Bourne South

4.20.2.1 Water Distribution Infrastructure

Three separate water districts serve the Study Area:

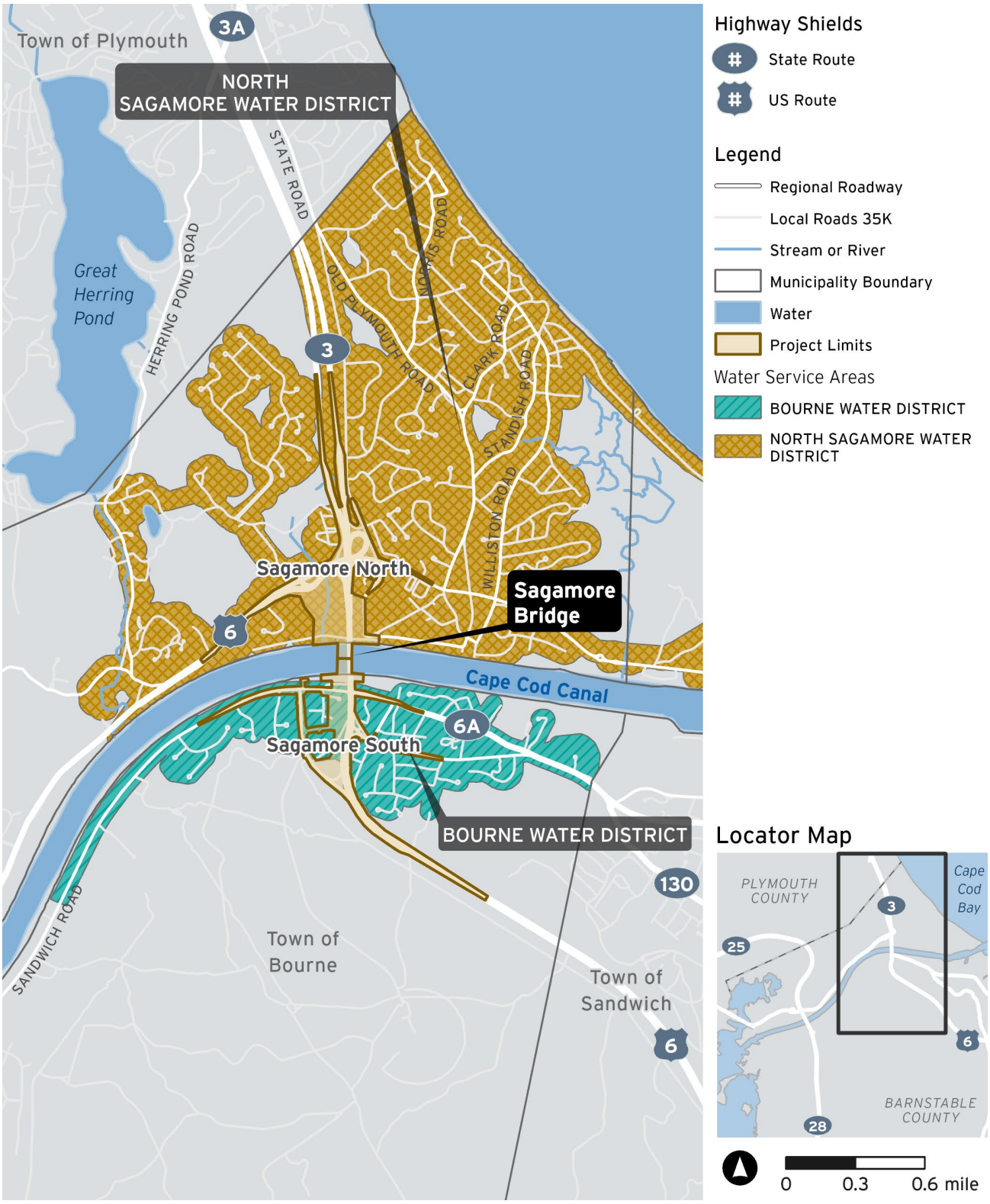
- North Sagamore Water District provides water service north of the canal in the Sagamore North quadrant.
- Buzzards Bay Water District provides service north of the canal in the Bourne North quadrant.
- Bourne Water District provides water service to areas south of the canal, including the Bourne South and Sagamore South quadrants.

Within the Study Areas, waterlines ranging from 2 to 16 inches in diameter run beneath local roadways and connect the distribution system to individual properties. **Figure 4.20-2** and **Figure 4.20-3** illustrate the service areas of the water districts within the Study Areas at Sagamore Bridge and Bourne Bridge, respectively.

4.20.2.2 Sewer/Septic Infrastructure

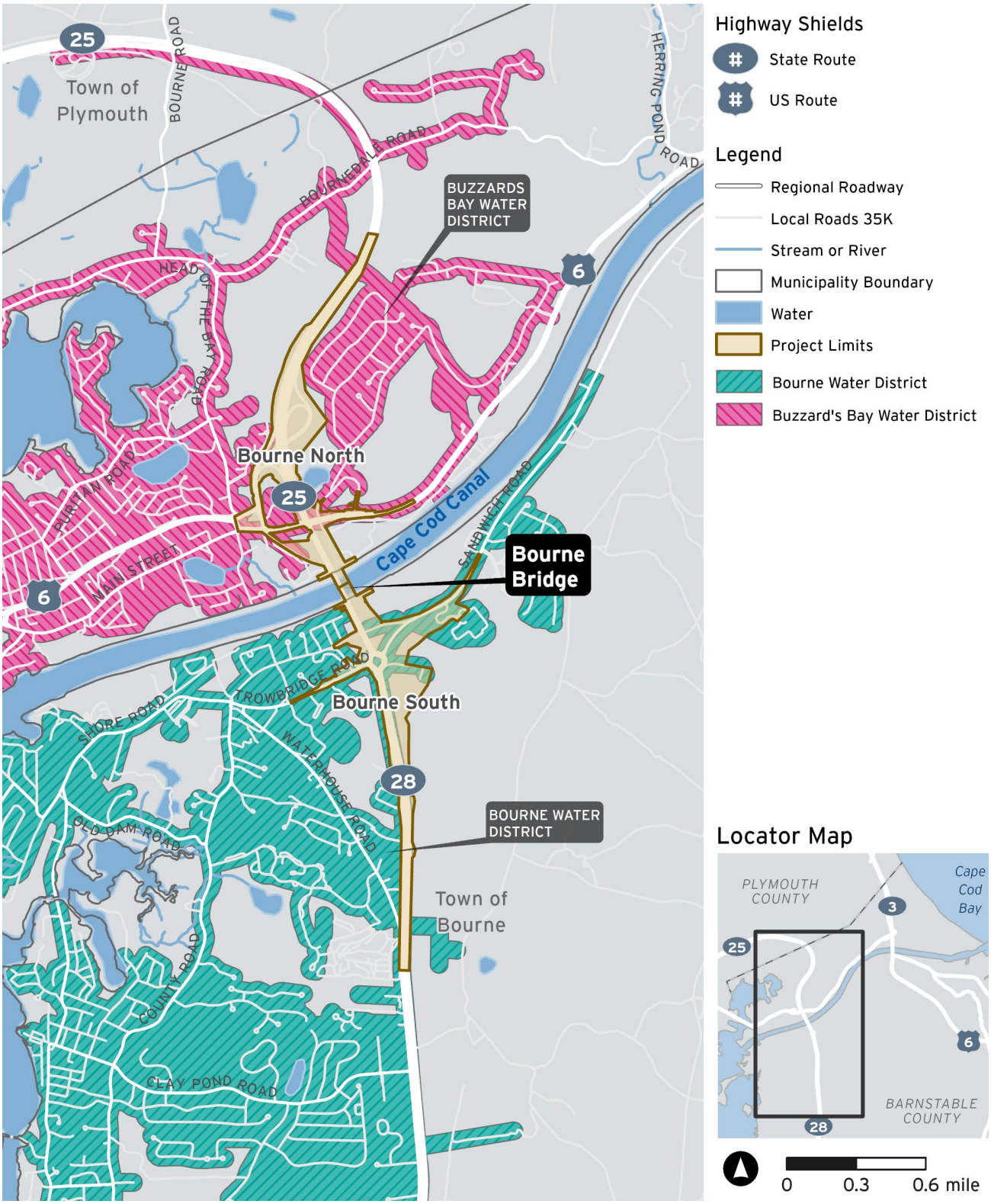
The Bourne Sewer Department operates a sewer system that serves a small portion of the Study Area in the Bourne North quadrant. It provides sewer connections to areas west of the Bourne North quadrant of the Study Area, including the Main Street areas of the town of Bourne. The current system terminates just west of Bourne Bridge beneath U.S. Route 6. The force main for this area runs along U.S. Route 6 to the west, eventually connecting to the Wareham Water Pollution Control Facility. The Bourne Recreation Authority is considering a proposed sewer system within Bourne Scenic Park, to be built in phases, which could be a future connection to this closed system. All other properties within the Study Areas rely on private septic systems for wastewater treatment. **Figure 4.20-4** illustrates the Bourne Sewer Department Service Area.

Figure 4.20-2. Water Service Districts (Sagamore Bridge Study Area)



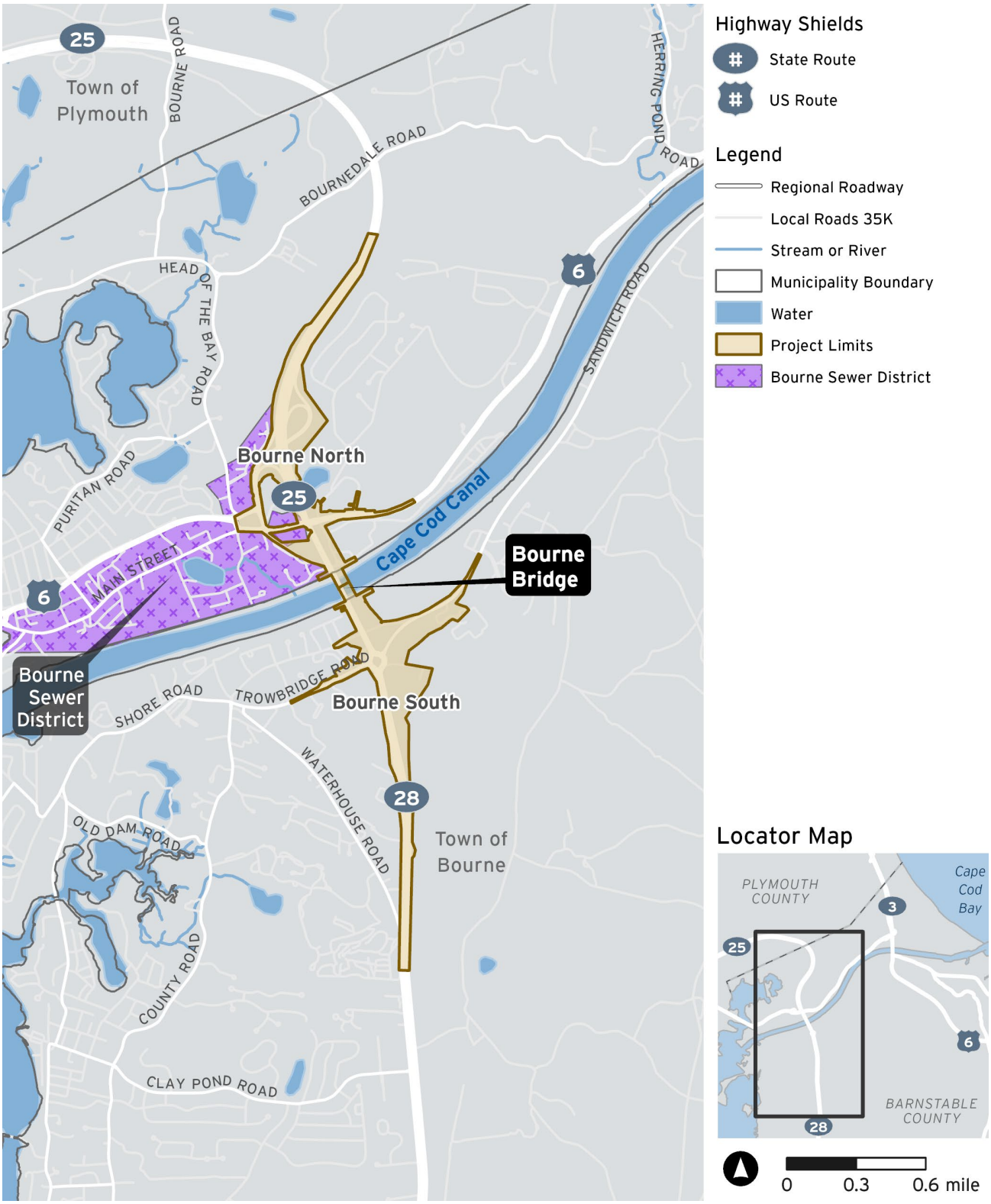
Source: Massachusetts Department of Transportation, 2024

Figure 4.20-3. Water Service Districts (Bourne Bridge Study Area)



Source: Massachusetts Department of Transportation, 2024

Figure 4.20-4. Sewer Department Service Area (Bourne Bridge Study Area)



Source: Massachusetts Department of Transportation, 2024

4.20.2.3 Gas Infrastructure

Enbridge (doing business as Algonquin Gas Transmission) supplies natural gas to the Study Areas through high-pressure interstate transmission pipelines that terminate at two metering and regulating stations located north of Cape Cod Canal in the vicinity of Sagamore and Bourne Bridges. From these stations, NGrid distributes the natural gas throughout the Study Areas. NGrid provides local distribution to customers north of the canal and operates high-pressure transmission mains that cross the canal on Sagamore and Bourne Bridges to serve customers south of the canal. Within the Study Areas, gas lines range from 2 to 12 inches in diameter.

The NGrid gas line on Bourne Bridge ends at a valve station south of the canal, adjacent to the bridge. NGrid's local distribution network provides gas service from this valve station south toward the town of Falmouth and east to serve approximately half of Cape Cod. Similarly, the NGrid gas line on Sagamore Bridge ends at a valve station in the vicinity west of the bridge. NGrid's local distribution network provides gas service from this valve station south and east toward the town of Sandwich and the remainder of Cape Cod. These two systems operate independently south of the canal and are not connected. The gas supply and distribution network are not depicted graphically due to safety concerns and the sensitive nature of this infrastructure.

4.20.2.4 Electrical Infrastructure

High-voltage transmission lines owned by Eversource supply electricity to the Study Areas. **Figure 4.20-5** depicts the location of these transmission lines over U.S. Route 6 in the Sagamore South quadrant and over State Route 25 in the Bourne North quadrant. Eversource provides electrical service to the Study Areas via overhead distribution lines along street utility poles with service drops to residences and businesses.

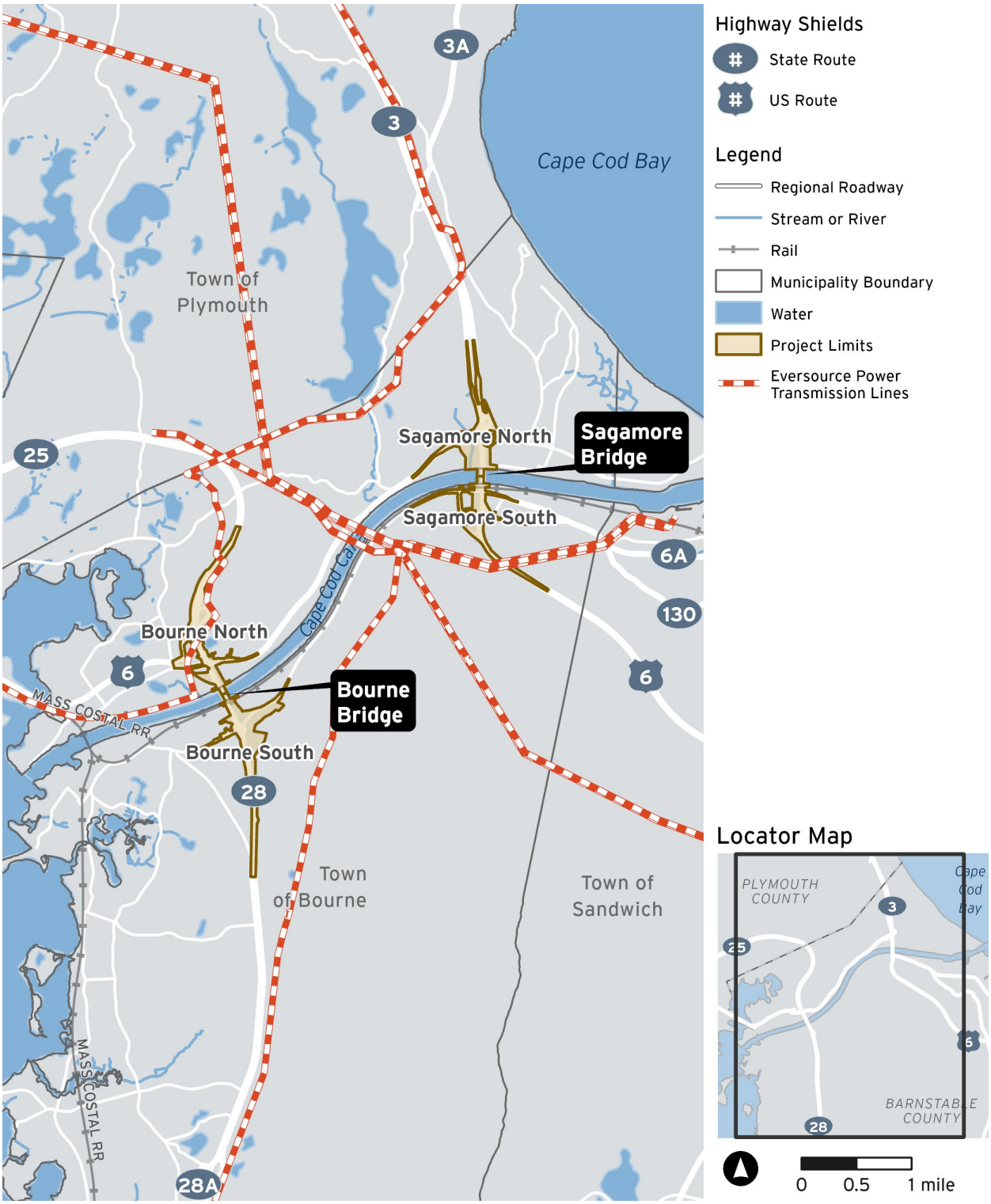
4.20.2.5 Telecommunications

The fiberoptic lines that provide service to all of Cape Cod are carried across the canal on the two bridges. Verizon operates the existing communications conduit on the bridges under a permit from the USACE. Verizon leases this conduit to OpenCape and Comcast. Fiberoptics from the following companies provide cable and internet service within the Study Areas:

- Comcast Cable Communications Management, LLC (Comcast)
- Crown Castle
- Eversource
- OpenCape
- Verizon

Verizon provides telephone service within the Study Areas.

Figure 4.20-5. Eversource Electric Transmission Lines



Source: Massachusetts Department of Transportation, 2024

4.20.2.6 U.S. Army Corps of Engineers Utilities

The bridges carry electric lines for the USACE for street lighting, canal lighting for watercraft navigation, navigation lighting on the bridges, and communications for the radar stations along Cape Cod Canal. The USACE owns and is responsible for maintaining the utilities and utility poles along the Canal Service Roads that parallel both sides of the canal and other USACE property in the canal area.

4.20.3 No Build Alternative

The No Build Alternative would have no long-term or temporary impacts on public utilities or services within the Study Areas. For the No Build Alternative, the utilities would remain in their present locations, and their current owners/service providers would continue to maintain them, except for the gas lines.

Enbridge is proposing the Cape Cod Canal Pipeline Relocation Project, as a result of the USACE's determination that gas line relocation is necessary to address the ongoing maintenance needs of the Sagamore and Bourne Bridges, as concluded in its Major Rehabilitation Evaluation Report and Environmental Assessment (MRER/EA).[2] In the MRER/EA, the USACE determined that that relocation of the gas lines off the existing bridges would be necessary in either a bridge replacement or a bridge rehabilitation scenario.

As described in **Section 4.20.4.3**, Enbridge will be relocating two metering and regulating facilities near the existing Sagamore and Bourne Bridges. The relocation of Enbridge's facilities will undergo a separate environmental evaluation and permitting process. Enbridge will be responsible for installing its new infrastructure and removing the existing infrastructure in accordance with its new permits, obtained through the separate permitting process. Details of Enbridge's design are still being developed; however, a preliminary graphic depicting the general limits of the proposed pipeline relocation is available on the Enbridge website.[3]

4.20.4 Program Impacts

The following sections describe the potential impacts of the Build Alternative on public utilities and services. Potential impacts are discussed according to Study Area quadrant.

4.20.4.1 Water Distribution Infrastructure

Portions of water mains would be relocated in three of the four quadrants: Sagamore North, Sagamore South, and Bourne South. In the Sagamore North quadrant, an existing 12-inch ductile-iron water main in the ramp leading from Scenic Highway to the existing bridge, down to Canal Service Road, and then under the existing bridge to Canal Street would be relocated. In the Sagamore South quadrant, construction would affect the 6-inch water line under U.S. Route 6 from Garfield Avenue to the Market

[2] https://www.nae.usace.army.mil/Portals/74/docs/Topics/Cape%20Cod%20Canal%20Bridges/Reports/MRER-Env-Assessment-March2022-FONSI-FINAL.pdf

[3] https://www.enbridge.com/projects-and-infrastructure/public-awareness/cape-cod-canal-pipeline-relocation-project/project-map

Basket, and it would need to be relocated. In the Bourne South quadrant, a 12-inch asbestos-cement water main would be replaced to allow for the construction of the mainline bridge abutment.

New water connections would be established in the Bourne North quadrant to accommodate the relocation of several buildings within Bourne Scenic Park due to bridge construction.

4.20.4.2 Sewer/Septic Infrastructure

In the Sagamore North quadrant, roadway construction on Canal Street is expected to disturb the leaching fields for septic systems at three to five commercial and residential properties, potentially requiring partial or complete replacement of these leaching fields. In the Sagamore South quadrant, roadway construction is expected to disturb the leaching fields at the Market Basket grocery store site and 20 to 25 other properties along Sandwich Road and Cranberry Highway, potentially requiring the partial or complete replacement of the leaching fields. In the Bourne North quadrant, several buildings within Bourne Scenic Park would need to be relocated during construction, including the restroom facilities on the east side of the bridge. The potential proposed sewer system within the Bourne Scenic Park could have a pumping station that would need to be coordinated with the Build Alternative's construction laydown area to avoid relocation. Additionally, septic system leaching fields along the north side of Scenic Highway and Nightingale Pond Road are anticipated to be disturbed, potentially requiring partial or complete replacement. In the Bourne South quadrant, the restroom facilities (referred to as "comfort stations" by the USACE) at the rail station would be closed during construction and relocated to the permanent rail crossing location. Several trailers, which serve as temporary housing for seasonal USACE employees, would also be relocated during construction. Additionally, roadway construction near the existing Bourne Rotary on Trowbridge Road, Sandwich Road, and Old McArthur Boulevard is anticipated to disturb the leaching fields for septic systems at 6 to 10 commercial and residential properties, potentially requiring their partial or complete replacement.

4.20.4.3 Gas Infrastructure

As discussed in **Section 4.20.3**, in its MRER/EA of the deteriorating Sagamore and Bourne Bridges, the USACE determined that gas line relocation is necessary to address the ongoing maintenance needs of the bridges and would be required in both bridge replacement and bridge rehabilitation scenarios. Further, as directed by MassDOT, gas pipelines would not be permitted on the new bridges due to safety and security considerations.

Both existing Enbridge metering and regulating stations north of the canal, along with the gas pipeline network to these stations, are on USACE property and would be decommissioned and reconstructed in new locations for the new bridges to be constructed. For the Build Alternative, relocating, commissioning, and decommissioning of the gas infrastructure would occur at each crossing prior to major bridge construction activities. Enbridge does not anticipate a service outage as part of its work. Enbridge's relocation work is being reviewed independently of this Build Alternative under the Federal

Energy Regulatory Commission's National Environmental Policy Act[4] and the State's Massachusetts Environmental Policy Act (if applicable) environmental review processes. Following Enbridge's relocation project, new connections by NGrid would be needed to provide service to the existing distribution network from the relocated Enbridge infrastructure within the Study Areas.

4.20.4.4 Electrical Infrastructure

In all four Study Area quadrants, numerous utility poles servicing electrical distribution lines would be relocated and reset. Electrical lines under the existing bridges and along Canal Service Road would be relocated outside of the crane laydown areas. In areas where relocation outside of laydown areas is not feasible, electrical lines would be buried and protected in underground duct banks during construction. Any short-term outages would be minimized through coordination between the property owners, utility companies, contractor, and MassDOT. Eversource would maintain and reset utility poles south of the canal, and Verizon would maintain and reset utility poles north of the canal.

In the Sagamore South quadrant, an electrical duct bank carrying both primary and secondary power would be installed along Sandwich Road, and the overhead distribution lines would be relocated into an underground duct bank to protect the electrical lines. The relocation or raising of the high-tension electric transmission lines crossing U.S. Route 6 near the limit of work should not be required. However, the work near these lines would be coordinated with Eversource.

In the Bourne North quadrant, an electrical duct bank carrying both primary and secondary power would be installed along Scenic Highway and the overhead distribution lines would be relocated into the underground duct bank to protect the electrical lines and eliminate conflicts during construction. The high-tension power transmission lines cross over State Route 25/28 in two locations. The northernmost crossing would not require the relocation or raising of the high-tension power transmission lines crossing as it is near the limit of work. The southern crossing near the bridge would be raised to provide adequate clearance over the raised roadway profile. This would require installation of approximately 10 new utility poles to accommodate the change in elevation on both sides of the roadway. MassDOT would coordinate work near both crossings with Eversource.

In the Bourne South quadrant, an electrical duct bank carrying both primary and secondary power would be installed along Sandwich Road and the overhead distribution lines would be relocated into the duct bank to protect the electrical lines and eliminate conflicts during construction. This would also allow for the existing electrical lines in Trowbridge Road, east of the proposed bridge, to be eliminated, pending concurrence from Eversource.

4.20.4.5 Telecommunications

The fiberoptic lines that carry telephone, internet, and cable across Cape Cod Canal on the two existing bridges would be relocated to the new bridges and fully commissioned prior to the demolition of the existing bridges to preclude any service outages. Any short-term outages would be minimized through

[44] https://www.federalregister.gov/documents/2025/04/09/2025-06071/algonquin-gas-transmission-llc-notice-of-scoping-period-requesting-comments-on-environmental-issues

coordination between the property owners, utility companies, contractor, and MassDOT. In all four Study Area quadrants, utility poles carrying telephone and cable transmission lines would be relocated and reset. Eversource would maintain and reset utility poles south of Cape Cod Canal, and Verizon would maintain and reset utility poles north of Cape Cod Canal.

In the Sagamore North quadrant, a communications duct bank carrying both telephone and cable lines would be installed along the proposed shared-use path to the west of the replacement bridge. This duct bank would replace an existing duct bank in the same area and serve a dual purpose of providing a permanent connection to the replacement bridge as well as a relocated temporary connection to the existing bridge over the canal.

In the Sagamore South quadrant, a communications duct bank for both telephone and cable lines would be installed along Sandwich Road. The existing overhead distribution lines would be relocated into this underground duct bank to protect the communications lines and eliminate conflicts during construction. Similar communications duct banks would be installed along Scenic Highway in the Bourne North quadrant and along Sandwich Road in the Bourne South quadrant and existing overhead telephone and cable wires would be relocated into the underground duct bank to protect the communications lines and avoid conflicts during construction.

4.20.4.6 U.S. Army Corps of Engineers Utilities

USACE infrastructure along Cape Cod Canal would need to be relocated within the construction area where large equipment will be operating during construction, and would include lighting, electrical power, and signals for surveillance and canal navigation systems.

4.20.5 Mitigation

The following sections describe the proposed mitigation for impacts to existing public and private utilities and services.

4.20.5.1 Water Distribution Infrastructure

In all four Study Area quadrants, water systems affected by the Build Alternative will be restored in consultation with the local water authorities. Affected water mains in the Sagamore North, Sagamore South, and Bourne South quadrants will be relocated in consultation with the appropriate water districts. In all cases, service disruptions will be minimized through coordination with the property owners, the water districts, MassDOT, and the contractor.

4.20.5.2 Sewer/Septic Infrastructure

Where leaching fields and/or septic systems would be affected within all four quadrants, MassDOT will coordinate, through the right-of-way process, the development of land damage agreements with individual property owners who would then be responsible for restoring their septic systems. Best management practices will be implemented to effectively manage sewer and other wastewater systems during and after construction activities. The contractor will be responsible for developing emergency response plans that are based on their chosen construction means and methods.

In the Bourne North quadrant, MassDOT will coordinate with the Bourne Sewer Department, the Bourne Recreation Authority, and individual property owners to minimize disruptions in sewer service. It is anticipated that affected facilities within Bourne Scenic Park will be relocated/replaced before the existing facilities are taken out of service.

4.20.5.3 Gas Infrastructure

As noted in **Section 4.20.4.3**, Enbridge must complete its gas infrastructure relocation activities prior to the start of any bridge construction work to prevent service outages. Once the Enbridge relocations are completed, NGrid will relocate its facilities within the Study Areas. Details of the NGrid work are currently under design.

MassDOT will continue to share relevant information with Enbridge to support its efforts in ensuring that all necessary work is completed in advance of the Program.

4.20.5.4 Electrical Infrastructure

Utility pole installation and relocation will be assessed in all four Study Area quadrants during the design process, with new locations being recommended as needed. Electrical lines under the existing bridges and along Canal Service Road will be relocated outside of the crane operation areas. In areas where relocation outside of construction areas is not feasible, electrical lines will be buried and protected in an underground duct bank during construction. All work will be coordinated with Eversource. Any short-term outages will be minimized through coordination between the property owners, utility companies, contractor, and MassDOT.

4.20.5.5 Telecommunications

Existing telecommunication cables will be relocated to the new communications duct banks on the replacement bridges. The new bridges and telecommunications infrastructure will be in place prior to the demolition of the existing bridges to preclude any service outages. Utility pole relocation will be assessed in all four Study Area quadrants during the design process, with new locations being recommended as needed. Communications lines under the existing bridges and along Canal Service Road will be relocated outside of the crane operation areas; in areas where construction areas cannot be avoided, communication lines will be protected in an underground duct bank during construction. No long- or short-term service outages are anticipated.

4.20.5.6 U.S. Army Corps of Engineers Utilities

USACE power, navigation, and signal facilities along Cape Cod Canal will be relocated into underground ducts and protected during construction. Connections to the existing canal bridges will be maintained, and new connections made to the proposed canal bridges will be put in place prior to the demolition of the existing bridges.

4.20.5.7 Other Utility Infrastructure

The USACE has granted the following parties the right to cross over and occupy land owned by the USACE for the purpose of providing utilities or other public services:

- Bourne Recreation Authority
- NGrid
- Algonquin Gas Transmission (Enbridge)
- Verizon
- MassDOT – Highway Division
- North Sagamore Water District
- Comcast Cable Communications Management, LLC
- Canal Sportsmen's Club
- OpenCape

In some cases, through the outgrant, the USACE has notified the grantee that a study for the rehabilitation or replacement of Sagamore Bridge or Bourne Bridge is underway. Utilities that cross the existing bridges under the outgrant with the USACE will need to obtain new agreements with MassDOT – Highway Division to occupy space on the replacement bridges. This will be accomplished by the utilities obtaining a Highway Access Permit from MassDOT.

4 Existing Conditions, Program Impacts, and Mitigation

4.21 Public Health

4.21.1 Introduction

This section assesses the potential short-term (construction) and long-term (operational) impacts of the No Build Alternative and Build Alternative on public health conditions within the 5-mile Designated Geographic Area (DGA). This section also outlines mitigation measures that will be implemented to avoid or minimize the potential for significant adverse impacts to public health during construction or operation of the Build Alternative, as necessary.

Public health conditions are defined in this assessment as chronic diseases, disabilities, and social determinants of health, including a lack of reliable transportation options[1] and social isolation.[2] **Section 4.21.2** provides demographic data on vulnerable populations within the Study Area who are particularly susceptible to adverse health impacts from environmental exposures.

An assessment of the No Build Alternative and Build Alternative relative to vulnerable minority and low-income populations is provided in **Section 4.9, Environmental Justice**.[3] Based on the findings of the Environmental Justice (EJ) analysis presented in this Draft Environmental Impact Report MassDOT determined that the Build Alternative would not materially exacerbate any existing environmental or public health burden on minority and low-income EJ populations.

Conclusions regarding public health are based on the analyses presented in other relevant sections of this Draft Environmental Impact Report including:

- **Section 4.2, Traffic, Transportation, and Safety**
- **Section 4.3, Pedestrian and Bicycle Facilities**
- **Section 4.11, Water Quality and Stormwater**
- **Section 4.14, Air Quality and Greenhouse Gas Emissions**
- **Section 4.15, Noise and Vibration**
- **Section 4.19, Solid and Hazardous Waste Material Management**

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[1] Defined as a lack of reliable transportation in the past 12 months among adults.

[2] Defined as feeling socially isolated among adults.

[3] Massachusetts Executive Office of Energy and Environmental Affairs (EEA). 2022. *Final MEPA Interim Protocol for Analysis of Project Impacts on Environmental Justice Populations.* Accessed December 2024. https://www.mass.gov/doc/final-mepa-interim-protocol-for-analysis-of-project-impacts-on-environmental-justice-populations-effective-date-of-january-1-2022/download.

4.21.1.1 Regulatory Context

The Massachusetts Environmental Policy Act establishes standards and limitations to protect public health and the environment for state agency actions, including permitting, financial assistance or land disposition.[4] Section 57 of the Climate Roadmap Act requires that the Draft Environmental Impact Report describe the potential public health impacts of the Program, as well as measures to avoid, minimize, and mitigate said health impacts.[5]

Many resource-specific regulations are enforced at the federal and state levels to protect public health:

- Clean Air Act[6]
- Clean Water Act[7]
- Resource Conservation and Recovery Act of 1976 (RCRA)[8]
- U.S. Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA)[9]
- Massachusetts Contingency Plan[10]
- Massachusetts Wetlands Protection Act[11]

It is important to consider these laws and their related resource impacts on public health conditions during transportation project planning and development.

4.21.1.2 Study Area and Methodology

The Study Area for this public health assessment encompasses the 5-mile DGA, which includes all or portions of the following 20 census tracts within the towns of Bourne, Falmouth, Mashpee, Plymouth, Sandwich, and Wareham in Barnstable and Plymouth Counties, Massachusetts: 133, 134, 135, 136, 137, 138, 139, 140.02, 141, 143, 144.02, 5306, 5308.01, 5308.02, 5309.02, 5309.03, 5309.04, 5452, 5453, and 5454 (**Figure 4.21-1**). This DGA was defined to evaluate the potential direct and indirect impacts of the Build Alternative on public health conditions. “Direct impacts” are caused by the action and occur at the same time and place, whereas “indirect impacts” are caused by the action and are later in time or farther removed in distance but are still reasonably foreseeable.

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[4] Massachusetts General Law (MGL) Chapter 30, Sections 61 through 62H. https://malegislature.gov/Laws/GeneralLaws/PartI/TitleIII/Chapter30/Section61

[5] Commonwealth of Massachusetts Session Laws Chapter 8, Section 57. https://malegislature.gov/Laws/SessionLaws/Acts/2021/Chapter8

[6] 42 USC Section 7401 et seq. https://19january2021snapshot.epa.gov/laws-regulations/summary-clean-air-act_.html

[7] 33 USC Section 1251 et seq. https://www.epa.gov/laws-regulations/summary-clean-water-act

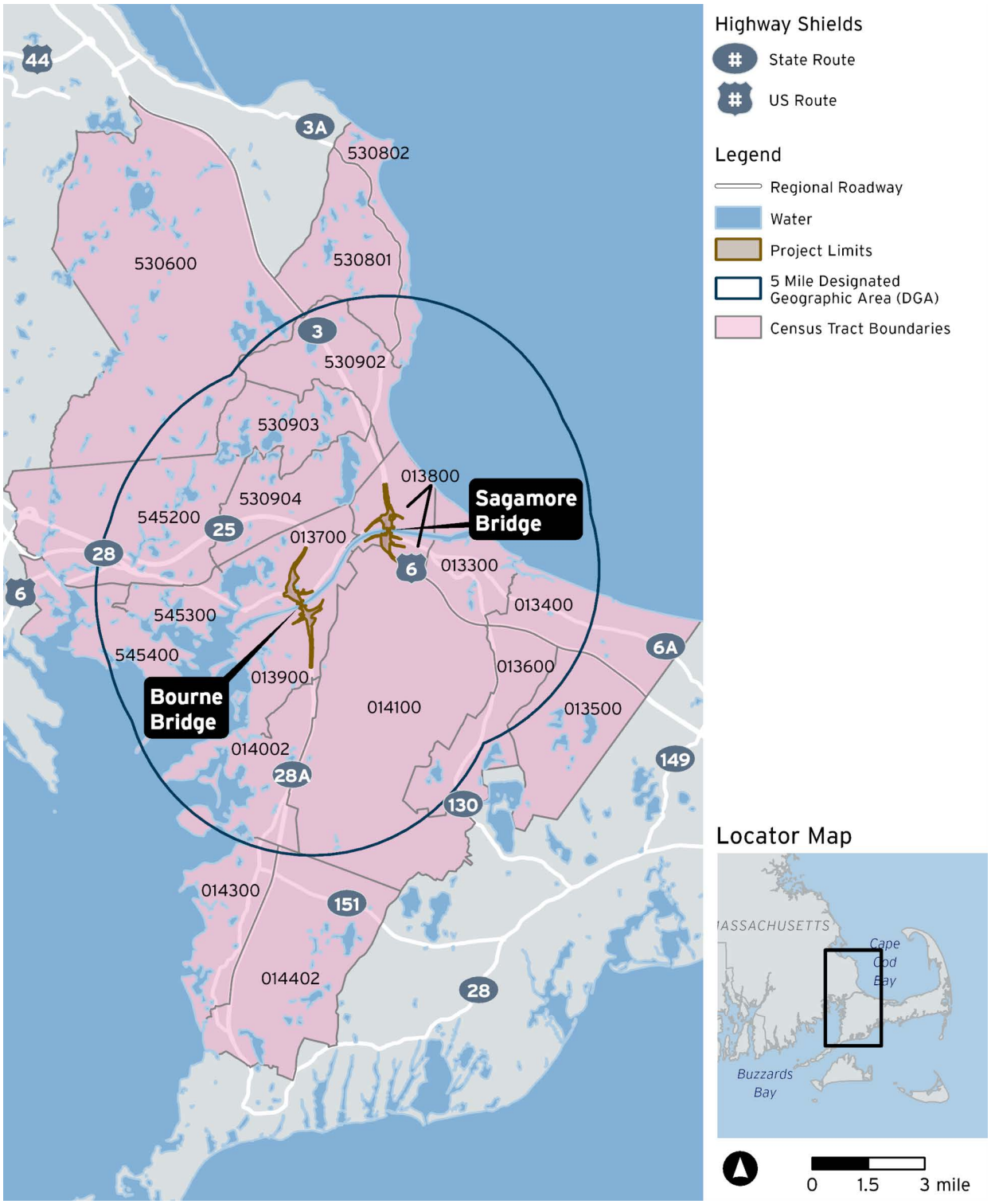
[8] 42 USC Section 6901 et seq. https://www.epa.gov/laws-regulations/summary-resource-conservation-and-recovery-act

[9] 42 USC Section 9601 et seq. https://www.epa.gov/laws-regulations/summary-comprehensive-environmental-response-compensation-and-liability-act

[10] 310 Code of Massachusetts Regulations. 40.0000. https://www.mass.gov/regulations/310-CMR-400000-massachusetts-contingency-plan

[11] MGL Chapter 131, Section 40. https://www.mass.gov/info-details/protecting-wetlands-in-massachusetts

Figure 4.21-1. Public Health Study Area



Source: Massachusetts Department of Transportation, 2024

Section 4.9.4.1 provides an analysis of potential public health impacts to EJ populations within the DGA. This section expands the vulnerable health analysis to include the non-EJ populations within the DGA, which may include other vulnerable populations such as elderly, children, and people with pre-existing health conditions.

To understand baseline conditions for relevant public health conditions in the DGA, MassDOT considered the prevalence of the following chronic illnesses related to air quality and exposure to hazardous materials:

- Heart attack hospitalization
- Childhood asthma
- Childhood blood lead levels
- Low birth weight

MassDOT derived public health data from the Department of Public Health's (DPH) EJ Tool to identify whether any municipality or census tract that includes any of the identified EJ populations exhibits any "Vulnerable Health EJ Criteria".[12]

4.21.2 Existing Conditions

Section 4.9, Environmental Justice,Error! Reference source not found. provides an analysis of potential p ublic health impacts to EJ populations within the DGA. This section expands the vulnerable health analysis to include the non-EJ populations within the DGA, which may include other vulnerable populations such as elderly, children, and people with pre-existing health conditions.

The 5-mile DGA contains 15 census tracts in the towns of Bourne, Falmouth, Plymouth, Sandwich and Wareham, which do not contain EJ populations:

- Bourne: Census Tracts 137 and 138
- Falmouth: Census Tracts 144.02 and 143
- Plymouth: Census Tracts 5308.02, 5308.01, 5309.02, 5309.03, 5309.04, and 5306
- Sandwich: Census Tracts 133, 134, 135, and 136
- Wareham: Census Tract 5454

While there are six municipalities within the DGA (Bourne, Falmouth, Mashpee, Plymouth, Sandwich, and Wareham), only four (Bourne, Mashpee, Sandwich, and Wareham) also contain EJ populations within the 5-mile DGA. As discussed in **Section 4.9.4**, the towns of Bourne, Mashpee, and Wareham meet the vulnerable health criteria at the municipal level for heart attack hospitalization. The town of Wareham also meets the vulnerable health criteria at the municipal level for childhood asthma. No other vulnerable health criteria are met for the towns of Bourne Mashpee, Sandwich, and Wareham at the municipal level.

[12] [12] Description from MA DPH EJ Tool. Accessed May 2025.

Within the DGA, the heart attack hospitalization rate for the town of Falmouth is 36.2 per 10,000 and the rate for the town of Plymouth is 34.2 per 10,000. The prevalence of heart attack hospitalizations in these towns each exceed the 110% statewide rate of 28.0 per 10,000. Due to exceeding the 110% statewide rate, the towns of Falmouth, and Plymouth do meet the vulnerable health criteria for heart attack hospitalization.

The childhood asthma rate for Falmouth is 43.2 per 10,000; the rate for the town of Plymouth is 27.4 per 10,000. Neither of these towns meet or exceed the 110% statewide rate of 65.7 per 10,000 and therefore do not meet the vulnerable health criteria for childhood asthma.

Data on childhood blood lead levels and low birth weight rates are provided in **Table 4.21-1.** The data for the majority of the areas comprising the previously referenced census tracts was suppressed for confidentiality reasons due to reported low case rates. Childhood blood lead level prevalence for Census Tract 133 is 33.6 per 1,000, which exceeds the 110% statewide rate of 17.8 per 1,000; therefore, Census Tract 133 meets the vulnerable health criteria for childhood blood lead levels. Census Tracts 137, 5309.02, and 5454 all have a childhood blood lead level prevalence below 110% of the statewide rate and therefore do not meet the vulnerable health criteria for childhood blood lead levels. Low birth weight rates for Census Tract 5309.04 is 277 per 1,000 and the rate for Census Tract 136 is 254.2. Both census tracts have low birth weight rates that exceed the 110% statewide rate of 238.5 per 1,000 and therefore do meet the vulnerable health criteria for low birth weight. Census Tracts 5309.02 and 134 both have low birth weight rates of 0 per 1,000, which do not exceed the 110% statewide rate and therefore do not meet the vulnerable health criteria for low birth weight.

Table 4.21-1. Childhood Blood Lead Levels and Low Birth Weight Rates Within the DGA

Vulnerable Health Criteria	Municipality or Census Tract	Rate	110% Statewide Rate	Meets Criteria?
Childhood Blood Lead Levels	137	0.0 per 1,000	17.8 per 1,000	No
	138	NS		NA
	144.02	NS		NA
	143	NS		NA
	5308.02	NS		NA
	5308.01	NS		NA
	5309.02	0 per 10,000		No
	5309.03	NS		NA
	5309.04	NS		NA
	5306	NS		NA
	133	33.6 per 1,000		Yes
	134	NS		NA
	135	NS		NA
	136	NS		NA
	5454	12.7 per 1,000		No
Low Birth Weight	137	NS	238.5 per 1,000	NA
	138	NS		NA
	144.02	NS		NA
	143	NS		NA
	5308.02	NS		NA
	5308.01	NS		NA
	5309.02	0 per 1,000		No
	5309.03	NS		NA
	5309.04	277 per 1,000		Yes
	5306	NS		NA
	133	NS		NA
	134	0 per 1,000		No
	135	NS		NA
	136	254.2 per 1,000		Yes
	5454	NS		NA

NS = Not shown due to low sample size to protect privacy.

NA = Not applicable. Exceedance of vulnerable health criteria cannot be determined as rates withheld due to low sample size.

4.21.3 No Build Alternative

For the No Build Alternative, Sagamore and Bourne Bridges—including their highway approach roadway networks north and south of Cape Cod Canal—would retain their current configuration, number of lanes, and alignment. As outlined in **Section 4.2.3.1, Vehicular Traffic Operations,** higher projected average annual daily traffic volumes crossing Sagamore and Bourne Bridges for the 2050 No Build Alternative are expected to increase overall network travel times by 20.1%, compared to 2019 existing conditions.

The 2050 No Build Alternative would have long-term adverse impacts on public health conditions within the Study Area due to increased emergency response times and delays accessing essential healthcare services. According to the Air Quality Analysis described in **Section 4.14, Air Quality and Greenhouse Gas Emissions,** the No Build Alternative would result in greater vehicle miles traveled, vehicle hours traveled, vehicle trips, and traffic congestion when compared to the Build Alternative, which would have long-term adverse impacts on public health conditions within the Study Area due to higher mobile source greenhouse gas emissions. Increased traffic congestion and longer commute times for the 2050 No Build Alternative could also have potential long-term adverse impacts on overall health and quality of life for local communities within the Study Area due to elevated stress levels and anxiety. With no improvements to bicycle and pedestrian accommodations and connectivity in the Study Area for the No Build Alternative, opportunities to encourage active transportation would be precluded.

Routine bridge and roadway maintenance activities for the No Build Alternative could involve handling and disposal of hazardous materials, such as lead-based paint and other potentially harmful substances, which would require implementation of strict procedures to prevent a risk of exposure to workers and the environment.

4.21.4 Program Impacts

4.21.4.1 Construction Impacts

This section discusses the potential construction-period, health-related impacts of the Build Alternative related to air quality and emissions, hazardous material and waste management, noise and vibration, and water quality and stormwater. As described in the relevant analyses of this Draft Environmental Impact Report and summarized in the following sections, the Build Alternative, with implementation of proposed mitigation measures outlined in **Table 4.21-2**, would not have significant adverse impacts on public health conditions during construction.

Air Quality and Greenhouse Gas Emissions

The operation of heavy-duty diesel equipment and trucks would result in short-term elevated mobile source emissions of nitrogen oxides, particulate matter, and carbon monoxide, posing potential respiratory health risks for construction workers and vulnerable populations, such as children, the elderly, and people with pre-existing health conditions. In addition, demolition, cutting, grinding, material handling (loading and unloading) and earthwork (site clearing, excavation, grading, and

compaction) have the potential to generate particulate matter during construction, which can contribute to respiratory health impacts and allergic reactions.

The risks of air quality emissions to public health during construction would be temporary, and can vary depending on construction means and methods, wind patterns, and the proximity of sensitive receptors relative to the construction sites. **Table 4.21-2** outlines measures that MassDOT will implement to mitigate adverse public health impacts related to air quality during construction.

Hazardous Material and Waste Management

The Build Alternative would involve structural demolition activities, dredging, grading, and excavation for utilities and foundations, creating the potential for exposure to contaminated soils, debris, or groundwater during construction. Contaminated materials pose serious health complications to construction workers and the public, if released into the workplace or environment during construction. **Table 4.21-2** outlines industry best management practices that MassDOT will implement to mitigate the release of contaminated materials during construction.

Noise and Vibration

During construction, surrounding noise-sensitive land uses would be exposed to temporarily elevated noise levels that may be a source of annoyance to the public. Construction noise would arise from construction vehicles and construction equipment performing earth work, delivering material, roadway and bridge demolition and construction, building demolition, and vibrations from pile driving. Prolonged exposure to noise pollution can contribute to a variety of public health-related risks, including stress, elevated blood pressure, hearing loss and sleep disruption. During construction, vibration producing activities would be limited to auger drilling hoe ramming, and use of large bulldozers. To mitigate construction-period vibration impacts, MassDOT would include contract specifications that require pre-construction surveys, vibration monitoring, and equipment restrictions. **Table 4.21-2** outlines measures that MassDOT will implement to minimize the adverse impacts of construction noise and vibration on surrounding noise-sensitive land uses.

Water Quality and Stormwater

Sedimentation from earth-disturbing activities and stormwater runoff generated during construction can be substantial sources of pollution for surface waters, groundwater, and drinking water supplies, if stormwater control measures are not in place. The Build Alternative would require a National Pollution Discharge Elimination System permit from the U.S. Environmental Protection Agency to legally discharge stormwater runoff from the construction site. National Pollution Discharge Elimination System permits limit the quantities of pollutants to be discharged and impose monitoring requirements to protect water quality and human health. **Table 4.21-2** outlines measures that MassDOT will implement to prevent adverse impacts to water quality during construction.

4.21.4.2 Operational Impacts

The Build Alternative would replace the existing Sagamore and Bourne Bridges to modern design standards with upgrades to their approach roadway networks, which would yield substantial long-term operational benefits to public health conditions in the DGA due to:

- Improved traffic operations and reduced delays accessing healthcare and other essential services.
- Improved access for emergency vehicles (e.g., ambulances, police cars, fire trucks) crossing Cape Cod Canal.
- Accommodation of an enhanced active transportation (pedestrians and bicycle) network and improved pedestrian and bicycle safety through provision of off-road multiuse facilities on the replacement bridges with connections to new share-used paths along the local roadway network.
- Provision of Americans with Disabilities Act–accessible accommodations for pedestrians (including sidewalks, crosswalks, curb ramps, detectable warnings, and signals).
- Improved community cohesion by enhancing local connectivity from the replacement bridges to neighborhoods, transit services, jobs, schools, recreational facilities, grocery store and other community destinations.
- Improved local and regional air quality through reduced vehicular greenhouse gas emissions.

As discussed in **Section 4.11, Water Quality and Stormwater**, the Build Alternative proposes an increase in impervious surface due to construction of the replacement bridges and reconfiguration of their approaches, which could affect water quality due to resultant runoff volume and/or pollutant load. MassDOT will implement permanent stormwater control measures to reduce, convey, and treat stormwater runoff in accordance with applicable state regulatory requirements.

Based on the Noise and Vibration Analysis results described in **Section 4.15, Noise and Vibration,** noise-sensitive land uses in the Study Area would approach or exceed the Federal Highway Administration Noise Abatement Criteria for noise-sensitive land uses as a result of the Build Alternative. To mitigate operational traffic noise impacts, MassDOT conducted a noise barrier evaluation to identify the feasibility and reasonableness of installing noise barriers. MassDOT identified one location that meets MassDOT's criteria for noise abatement, providing noise reduction benefits for 38 affected residential dwelling units. MassDOT will evaluate the feasibility of noise barriers as the design advances.

As discussed in **Section 4.19, Solid and Hazardous Waste Material Management**, there would be no long-term impacts related to hazardous materials for the Build Alternative. Overall, the Build Alternative would reduce the likelihood of exposure to or potential contamination from hazardous materials and waste through demolition of the aging Sagamore and Bourne Bridges, which contain lead-based paint. The replacement bridges for the Build Alternative would be designed with modern corrosion protection systems to prevent rust and deterioration of their structural steel components.

4.21.5 Permit Standards for Public Health

The Program would require a National Pollutant Discharge Elimination System (NPDES) Construction General Permit because it would disturb 1 acre or more of land and would discharge stormwater into waters of the United States. The NPDES Construction General Permit is intended to minimize pollutant runoff from the site in the receiving waters. The process requires the development and implementation of a Stormwater Pollution Prevention Plan (SWPPP) with appropriate SCMs to minimize discharge of pollutants from the site. Implementation of the SWPPP and associated SCMs will mitigate impacts to the surrounding areas including proximate EJ populations.

4.21.6 Mitigation

Table 4.21-2 outlines mitigation measures that will be implemented to avoid or minimize the construction-period impacts of the Build Alternative relative to air quality, hazardous material and waste management, noise and vibration, and water quality. With implementation of these outlined mitigation measures, the Build Alternative would not result in significant adverse impacts to public health during construction.

Table 4.21-2. Construction-Phase Mitigation Measures

Impact Category	Mitigation Measures
Air Quality	• Install on-site anti-idling signage at various loading and drop-off locations. • Use low-emitting diesel-fueled equipment or retrofitting of heavy-duty diesel-fueled construction equipment to meet applicable emission standards. • Apply dust suppression wetting agents during excavation, grading and other soil disturbing activities. MassDOT would implement Air Monitoring Plans to provide protections for construction workers and surrounding communities from potential airborne releases. • Limit work or activities which may generate substantial airborne dust emissions to less windy days. • Apply secure containment measures for active on-site stockpiles and during transportation of dust-producing materials on public roadways. • Implement a Traffic Management Plan with designated truck routes.
Hazardous Material and Waste Management	• Use a Massachusetts Department of Environmental Protection Licensed Site Professional to oversee work within areas of known or suspected contamination. • Develop a Soil and Groundwater Management Plan and implement by a Contractor to outline procedures for the field screening, classification, and proper handling of excavated soil and groundwater generated during excavation activities. • Develop an Environmental Health and Safety Plan and implement by the Contractor to identify potential hazards associated with planned field activities and outline necessary measures to protect the health and safety of employees, the public, and the environment during construction.

Impact Category	Mitigation Measures
	• Develop Asbestos and Lead Paint Abatement Work Plans and implement by the Contractor to outline procedures for the proper management of asbestos and lead-based materials during construction. • Require that persons performing the functions of Lead and Asbestos workers, supervisors, or contractors during construction have valid licensing and training certifications in accordance with applicable federal and state regulations.
Noise and Vibration	• Develop a Noise Control Plan and implement by the Contractor to identify noise sources, monitor noise levels, and outline noise reduction strategies. • Perform equipment maintenance regularly to minimize noise generation. • Use mufflers and other noise-dampening attachments, where feasible. • Use temporary noise barriers or enclosures, particularly near residences. • Use vibratory pile driving methods instead of traditional impact pile driving. • Schedule noise intensive activities (e.g., pile driving, steel cutting, jackhammering) during daytime hours. • Establish procedures for filing local community noise complaints. • Address construction noise concerns from local residents and work to find solutions.
Water Quality	• Develop a Stormwater Pollution Prevention Plan and implement by the Contractor in conformance with National Pollution Discharge Elimination System requirements to identify potential sources of stormwater pollution from the construction sites and outline control measures to reduce pollutants in stormwater discharges. • Install erosion and sediment control practices prior to the start of earth-disturbing activities. • Maintain and inspect on-site erosion and sedimentation control practices regularly.

As discussed in **Section 4.21.4.2**, replacing the aging Sagamore and Bourne Bridges and configuring their approach roadway networks for the Build Alternative would provide substantial operational benefits in terms of traffic safety and operations, active transportation safety and mobility, reduced mobile source greenhouse gas emissions, and reduced likelihood of exposure to hazardous materials. In addition, new permanent SCMs would be implemented for the Build Alternative in accordance with applicable regulatory requirements to protect and enhance the quality of runoff before it reaches surface waters and drinking water supplies. Furthermore, the noise control plan would minimize nuisance noise conditions and reduce operational noise impacts on public health in the Study Area. These benefits of the Build Alternative would contribute to improved public health outcomes within the Study Area over the long-term.

4.21.7 No Public Health Consequences

Based on the construction impacts and operational impacts listed in **Section 4.21.4.1** and **Section 4.21.4.2**, the Build Alternative is not anticipated to result in any known or foreseeable public

health consequences or impacts. The Build Alternative would provide significant benefits to the surrounding communities in terms of safety, operations, and mobility. The Build Alternative may result in a qualitative decrease in greenhouse gas emissions associated with reduced traffic congestion and improved operations. Additionally, the Program would improve the existing stormwater system and quality of stormwater discharge through the installation of multiple low-impact stormwater control measures, including rain gardens and infiltration basins.

4 Existing Conditions, Program Impacts, and Mitigation

4.22 Climate Change Adaptation and Resiliency

4.22.1 Introduction

This section assesses the potential risks to the No Build Alternative and Build Alternative relative to climate change and extreme weather events for the following existing and future conditions:

- Sea level rise (SLR) and storm surge (SS)
- Extreme precipitation
- Extreme heat
- Winter weather
- Extreme wind

This section evaluates potential risks to the following affected environments referenced in other Draft Environmental Impact Report sections:

- Cape Cod Canal operations
- Bridge infrastructure
- Stormwater control measures
- Land cover
- Highway-traffic operations and safety
- Mobility and accessibility for all road users

In addition to assessing climate risk from the No Build Alternative and Build Alternative, this section also discusses potential mitigation strategies the Massachusetts Department of Transportation(MassDOT) is considering to increase resilience. **Table** 4.22-1 summarizes the affected environments within the Project Limits and Study Areas and the primary climate risks assessed.

4.22.1.1 Regulatory Context

This section was prepared using the following federal and Massachusetts regulatory directives and guidance:

- Establishing a risk management plan under 23 Code of Federal Regulations (CFR) Section 515.7(c)(1) (i.e., risk to bridges on the National Highway System from current and future conditions)
- 33 CFR 207.2: Navigation Regulations, Cape Cod Canal, Massachusetts; Use, Administrative and Navigation
- 23 CFR Part 650(A): Location and Hydraulic Design of Encroachments on Flood Plains

- 23 USC 176: Promoting Resilient Operations for Transformative, Efficient, and Cost-Savings Transportation Program
- Federal Highway Administration Number 25 Highways in the Coastal Environment, Third Edition (2020).
- Federal Highway Administration Hydraulic Engineering Circular Number 18 Evaluating Scour at Bridges, Fifth Edition (2012).
- Massachusetts Environmental Protection Act Interim Protocol on Climate Change Adaptation and Resiliency (2021)
- Certificate of the Secretary of the Office of Energy and Environmental Affairs on the Environmental Notification Form for the Cape Cod Bridges Program (2023).

4.22.1.2 Study Areas

For the purposes of assessing the impacts of climate change adaptation and resiliency, the Study Areas consist of the construction project limit and a 500-foot buffer for Sagamore Bridge and Bourne Bridge (**Figure 4.22-1**).

4.22.1.3 Methodology

The methodology consisted of reviewing published studies, climate data, and future projections and the Resilient Massachusetts Action Team (RMAT) Tool. Refer to **Appendix 4.22, Climate Change Adaptation and Resiliency Technical Report**, for more information and a list of resources referenced.

Use of the Massachusetts Climate Resilience Design Standards Tool

The Cape Cod Bridges Program (Program) Project Limits and associated bridges, roadways, shared-use paths, and stormwater control measures were input to the RMAT Tool. The RMAT Tool identified preliminary high exposure and risk ratings for SLR/ SS, urban/riverine flooding, and extreme heat.[1] The RMAT Tool output reports for Sagamore Bridge and Bourne Bridge are provided as **Attachment 1** and **Attachment 2** to **Appendix 4.22, Climate Change Adaptation and Resiliency Technical Report.** Exposure inherently varies geographically, and exposure outputs do not necessarily apply to the entire Project Limits or all Program elements, or over the entire useful life of Program elements. In reviewing published data with the RMAT Tool outputs for the project sites, MassDOT determined that riverine flooding exposure is erroneous; Cape Cod Canal connects two bays: Cape Cod Bay and Buzzards Bay. The Project Limits include areas within a mapped Federal Emergency Management Agency (FEMA) floodplain, outside of the Massachusetts Coast Flood Risk Model; FEMA floodplains do not distinguish between inland and coastal floodplains, and the extent of the FEMA floodplain within the Project Limits originates from the tidal canal (**Figure 4.22-2** and **Figure 4.22-3**).

[1] Projects that receive a High Exposure score to a climate hazard will always receive a High Risk Rating for that hazard for all building/facility and infrastructure assets based on the relationships underlying the Resilient Massachusetts Action Team (RMAT) Tool.

Table 4.22-1. Climate Change Adaptation and Resiliency Affected Environment

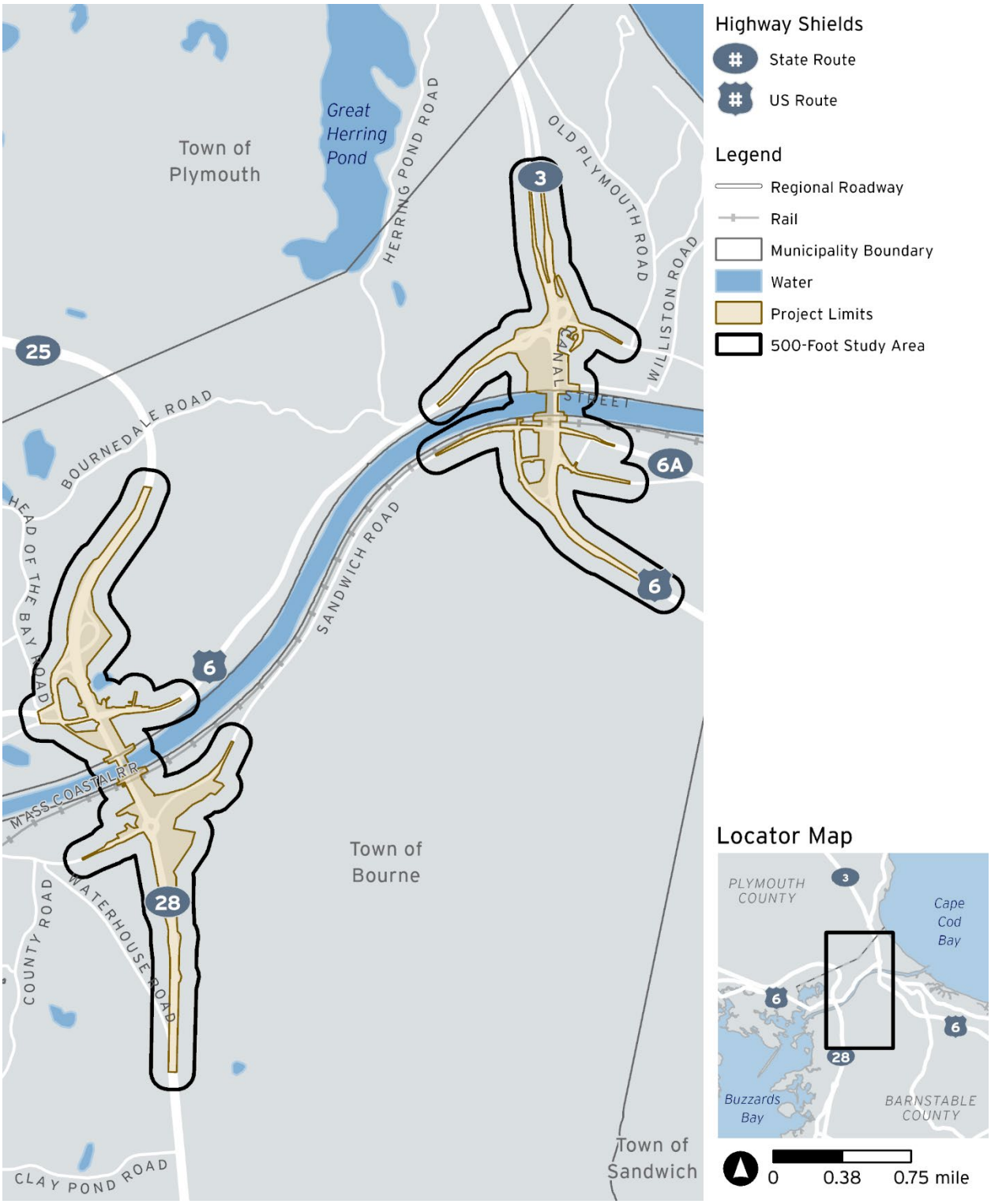
Affected Environment	Related Draft Environmental Impact Report Section	Impacts Assessed				
		Sea Level Rise/ Storm Surge	Extreme Precipitation	Extreme Heat	Winter Weather	Extreme Wind
Canal	Section 4.4, Maritime Transportation, Traffic, and Safety	Navigational Clearance	NA	NA	NA	NA
Bridge	Chapter 3, Proposed Action and Alternatives	Pier Scour	NA	Joint Expansion	Icing on Cables	Design and Aerodynamic Stability
Stormwater Control Measures	Section 4.11, Water Quality and Stormwater	Submerged Outfalls* Infiltration Basin Flooding	Infiltration Basin Performance	NA	NA	NA
Land Cover	Section 4.6, Land Use, Zoning, and Community Cohesion; Section 4.10, Wetlands and Floodplains; Section 4.11, Water Quality and Stormwater	Floodplain Function	Localized Flooding	Surface temperature	NA	NA
Transportation	Section 4.2, Transportation, Traffic, and Safety	Roadways and Evacuation Route Flooding	Localized Flooding	Pavement Performance	Snow and ice on roadways	Vehicle Rollover
Mobility	Section 4.3, Pedestrian and Bicycle Facilities	Shared-use path Flooding	Localized Flooding	Active Transportation Use	NA	NA

Notes:

NA = Not assessed for affected environment.

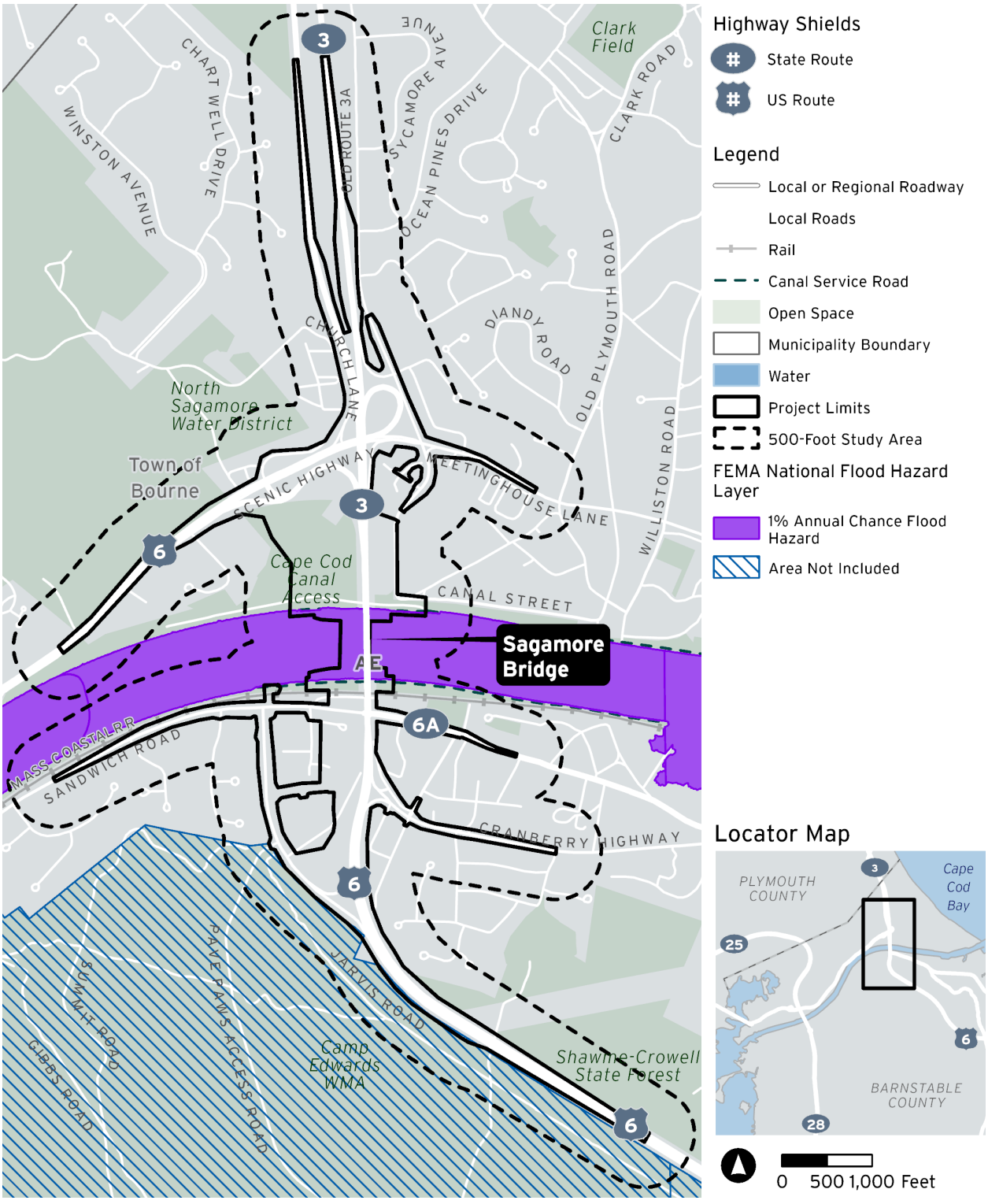
* Outfalls are within the Study Areas, as shown in **Figure 4.22-1**, but they are not part of the Cape Cod Bridges Program; they were assessed due to their impact on stormwater systems (flooding and performance) within the Study Areas.

Figure 4.22-1. Study Areas for Climate Change Adaptation and Resiliency Evaluation



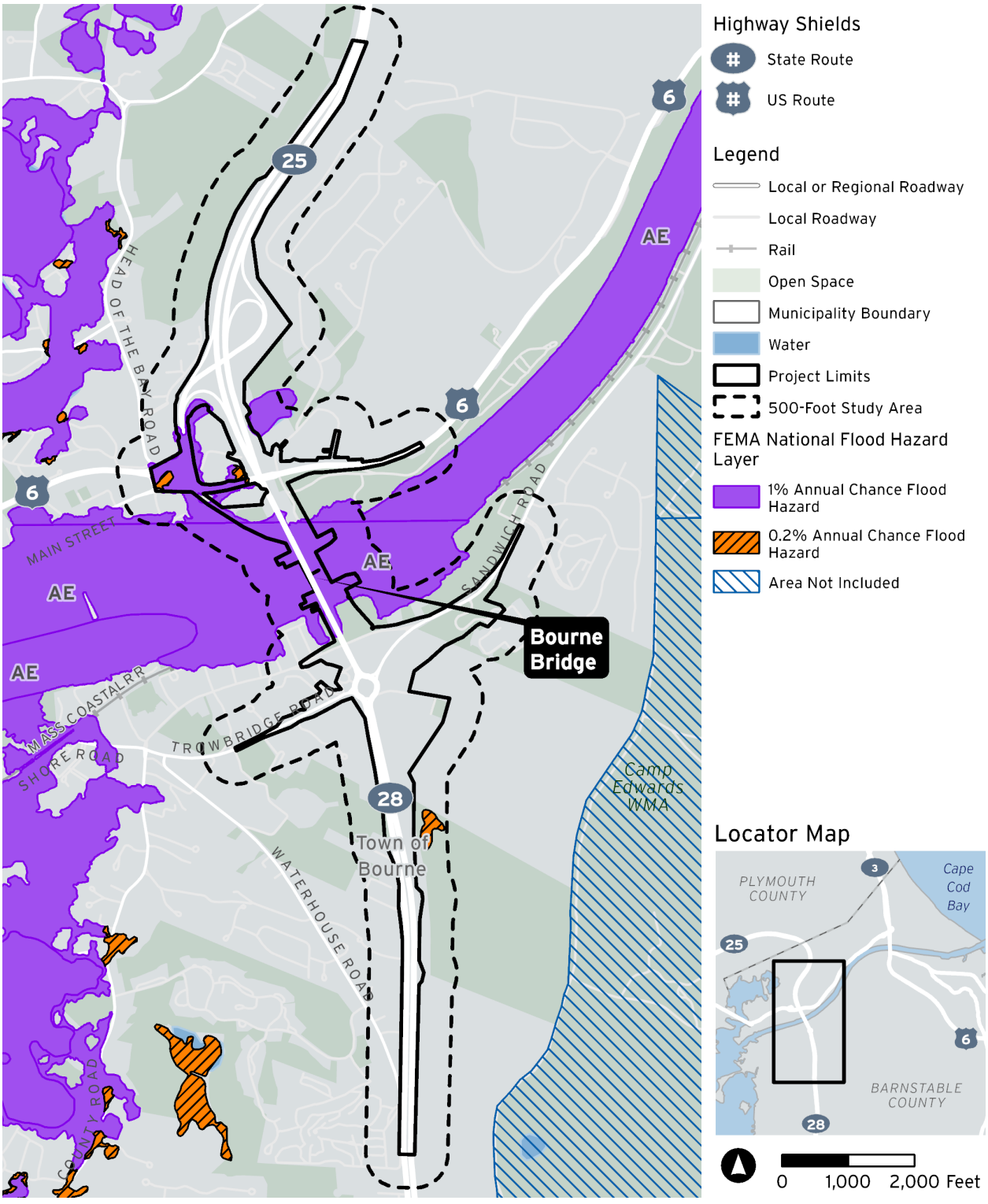
Source: Massachusetts Department of Transportation, 2024

Figure 4.22-2. FEMA Floodplain Limits (Sagamore Bridge Study Area)



Source: Massachusetts Department of Transportation, 2024

Figure 4.22-3. FEMA Floodplain Limits (Bourne Bridge Study Area)



Source: Massachusetts Department of Transportation, 2024

Integration of RMAT Tool Outputs

Table 4.22-2 summarizes what recommendations were taken from the RMAT Tool and integrated into the methodology to assess the No Build Alternative and Build Alternative impacts on the affected environment and to inform mitigation plans.

Table 4.22-2. Impacts Assessed Using RMAT Tool Recommendations

RMAT Tool Output	Recommendation	Affected Environment (Impact)	Useful Life	Assessed
Projected Temperatures	2090, 90th Percentile	Bridge (Expansion Joints)	100 years	Likelihood of temperatures greater than 120° Fahrenheit (F)
Projected Total Precipitation Depth and Peak Intensity for 24-hour Design Storms	2070, 100-year event	Stormwater Control Measures (Infiltration Basins)	50 years	Sizing and performance under recommended event
Projected Total Precipitation Depth and Peak Intensity for 24-hour Design Storms	2070, 100-year event	• Land Cover • Transportation • Mobility	• Not Applicable • 50 years • 30 years	Localized Stormwater Flooding under recommended event
Projected Days Per Year With Maximum Temperature >90°F	2050, 90th Percentile	Transportation (Pavement)	25 years (pavement)	Increased days above 90°F
Projected Days Per Year With Maximum Temperature >90°F	2050, 90th Percentile	Mobility (Active Transportation Use)	30 years	Increased days above 90°F
Projected Days Per Year With Maximum Temperature <32°F	2050, 90th Percentile	Transportation (Snow and Ice on Roadways)	25 years (pavement)	Days below 32°F

RMAT = Resilient Massachusetts Action Team

MassDOT did not ultimately use the projected water surface elevation values from the RMAT Tool to assess impacts due to projections being significantly less conservative than other methods to establish horizontal and vertical floodplain extents at Sagamore Bridge, and the goal of using a consistent methodology across the Program. Projected wave heights and wave action water surface elevation values were ultimately not used to assess impacts due to lack of affected environment in the No Build Alternative and Build Alternative. **Appendix 4.22, Climate Change Adaptation and Resiliency Technical Report**, discusses this in detail.

Environmental Justice Considerations

Refer to **Section 4.9, Environmental Justice**, for identification of Environmental Justice populations and a discussion regarding potential effects to said populations.

Sea Level Rise and Storm Surge Methodology

The methodology included reviewing published relative sea level rise (RSLR) observations and projections, the closest tide gauge (Woods Hole, MA - National Oceanic and Atmospheric Administration Station ID: 8447930), modeled historic and projected SS elevations, FEMA maps and studies, and projected values in the RMAT Tool for water surface elevations, wave heights, and wave action water surface elevations. Projected tidal datums were not available in the RMAT Tool. **Table 4.22-3** and **Table 4.22-4** include summaries of RSLR and SS design criteria used to assess the affected environment, impacts assessed, and methodology. **Appendix 4.22, Climate Change Adaptation and Resiliency Technical Report**, provides more specifics.

Table 4.22-3. Affected Environment and Impacts Assessed: Inundation, Relative Sea Level Rise, and Storm Surge

Design Criteria	Affected Environment	Impact	Relative Sea Level Rise (RSLR) and Inundation Scenario Assessed
Tidal Datums	Canal	Navigational Clearance	• RSLR 3 feet • MHHW
	Stormwater Control Measures	• Submerged or Partially Submerged Outfalls • Infiltration Basin Flooding and Performance	• RSLR 1.1, 2.4, and 4.2 feet • MHHW, MHW, MTL, and MLLW
Storm Surge and Coastal Inundation	Stormwater Control Measures	• Submerged or Partially Submerged Outfalls • Infiltration Basin Flooding	• RSLR NA • 100-year (FEMA) • Category 2 (SLOSH) + 3 feet
	Land Cover	Floodplain Function	• RSLR NA • 100-year (FEMA) • Category 2 (SLOSH) + 3 feet
	Transportation	Roadways and Evacuation Route Flooding	• RSLR NA • 100-year (FEMA) • Category 2 (SLOSH) + 3 feet
	Mobility	Shared-Use Path Flooding	• RSLR NA • 100-year (FEMA) • Category 2 (SLOSH) + 3 feet
Wave Hazards	None	None	None
Scour	Bridge	Pier Scour	• RSLR 7.7 feet • 200-year • 500-year

FEMA = Federal Emergency Management Agency; MHHW = mean higher high water; MHW = mean high water; MLLW = mean lower low water; MTL = mean tide level; NA = not assessed for affected environment; Sea, Lake, and Overland Surges from Hurricanes (SLOSH) model developed by the National Weather Service

Table 4.22-4. Affected Environment and Methodology: Sea Level Rise and Storm Surge

Design Criteria	Affected Environment	Methodology
Tidal Datums[1]	Canal	To evaluate the effect of tidal datums on navigational clearance, the vertical clearance requirement for the existing bridges (135 feet) was subtracted from the existing and proposed replacement bridges' low chord elevation. If the Mean Higher High Water elevation was greater than the resulting elevation, it was assumed to be affected. If affected, additional tidal datums were assessed to estimate the percentage likelihood of being affected over a tide cycle.
	Stormwater Control Measures	To evaluate the effect of tidal datums on outfalls associated with the stormwater control measures, the Massachusetts Department of Transportation (MassDOT) compared tidal datums to outfall invert and crown elevations. If the tidal datum exceeded the outfall invert elevation, MassDOT assumed it to be partially submerged, with potential backflow through the system. If the tidal datum exceeded the outfall crown elevation, MassDOT assumed it to be fully submerged, with potential backflow through the system. MassDOT applied similar comparisons to the infiltration basins, with bottom of basin and top of basin elevations.[2] If the tidal datum exceeded the proposed basin bottom elevation, MassDOT assumed the basin to have reduced infiltration capacity due to groundwater rise. If the tidal datum exceeds the proposed overflow structure's outlet elevation, MassDOT assumed the basin to be partially full to the elevation of the tide. If the tidal datum exceeded the proposed basin top elevation, MassDOT assumed that the tides overtopped the basin and resulted in localized flooding.
Storm Surge and Coastal Inundation	Stormwater Control Measures	To evaluate the effect of storm surge on the stormwater control measures, MassDOT compared storm surge elevations with the elevations of the outfalls and infiltration basins, in a similar fashion to the tidal datum methodology. In addition, the extent of storm surge inundation was overlaid with proposed basins to identify potential for overland flooding.
	Land Cover	To evaluate the impact on land subject to coastal storm flowage, MassDOT overlaid the extent of overland storm surge inundation with existing and proposed grades. Areas with lower elevation were assumed to be where coastal waters flooded first, which informed flood pathways. Grades that exceeded the storm surge elevation were assumed to not be flooded. MassDOT evaluated cross-sections for potential channelization of flow and increased velocities based on grading and land cover surface type.
	Transportation	To evaluate the impact on roadways and active transportation, MassDOT overlaid the extent of overland storm surge inundation with roadways, sidewalks, and shared-use paths. If those routes were within the extent of inundation, MassDOT assumed them to be affected.
	Mobility	

Design Criteria	Affected Environment	Methodology
Scour	Bridge	To evaluate the effect on bridge pier scour, MassDOT analyzed a 2D Hydraulic Model with and without relative sea level rise for the design storm and a more extreme storm (check storm).[3] The maximum scour depth generated should be used to assess impact and design foundations.

[1] Tidal datums were adjusted for relative sea level rise projections from the ResilientMass Maps and Data Center by first converting to an epoch centered on the year 2000 and to a consistent datum of the North American Vertical Datum of 1988 (NAVD88), then adding the relative sea level rise adjustment associated with the planning horizon.

[2] Overflow outlet structure elevations are to be determined and should be assessed once known in accordance with this methodology.

[3] MassDOT is developing the Bourne Bridge 2-D model, which will be updated in the Final Environmental Impact Report.

Extreme Precipitation

The methodology included MassDOT reviewing published National Oceanic and Atmospheric Administration rainfall precipitation frequency estimates, projections from ResilientMass Maps and Data Center (Resilient Mass), and projected values in the RMAT Tool for 24-hour rainfall depths. **Appendix 4.22, Climate Change Adaptation and Resiliency Technical Report**, provides more specifics on the considered rainfall estimates. **Table 4.22-5** summarizes the extreme precipitation design criteria used to assess affected environment and impacts. **Section 4.11, Water Quality and Stormwater,** discusses the methodology used to assess the No Build Alternative and Build Alternative impacts on the affected environment. **Table 4.22-4** provides the methodology for combined impacts with tidal datums.

Table 4.22-5. Affected Environment and Impacts Assessed: Extreme Precipitation

Design Criteria	Affected Environment	Impact	Extreme Precipitation Scenario Assessed
Rainfall Depths	Land Cover, Transportation, Mobility	Localized flooding from capacity of drainage infrastructure	2070, 100-year, 24-hour event
	Stormwater Control Measures	Sizing of infiltration basins	2070, 100-year, 24-hour event
Rainfall Depth and Tidal Datums	Stormwater Control Measures	Performance of storm control measures with submerged or partially submerged outfalls	• 2030 MHW and 100-year, 24-hour • 2050 MLW and 100-year, 24-hour • 2050 MHHW and 100-year, 24-hour • 2070 MHHW and 10-year, 24-hour

MHW = mean high water; MHHW = mean higher high water; MLW = mean low water

Extreme Heat

The methodology included reviewing land cover characteristics, including Land Surface Temperature Indexes and Impervious Surfaces, observed days over 90 Fahrenheit (F), recommended percentiles from the RMAT Tool, and projections on ResilientMass. **Appendix 4.22, Climate Change Adaptation and Resiliency Technical Report**, provides more specifics on extreme heat analyses. Table 4.22-6 and Table 4.22-7 summarize how extreme heat was used to assess the affected environment.

Table 4.22-6. Affected Environment and Impacts Assessed: Extreme Heat

Design Criteria	Affected Environment	Impact	Extreme Heat Scenario Assessed
Max Temperatures	Bridge	Bridge joint expansion	2090, 90th percentile, exceeding 120 Fahrenheit
Days above 90 Fahrenheit	Transportation	Pavement performance	2050, 90th percentile, increase
	Mobility	Active transportation use	2050, 90th percentile, increase
Impervious surface area	Land cover	Surface temperatures	• Percentage area – Less than 10% – Between 10% and 50% – Greater than 50%

Table 4.22-7. Affected Environment and Methodology: Extreme Heat

Design Criteria	Affected Environment	Methodology
Maximum Temperatures	Bridge	To evaluate the effect on the bridge joint expansion, the Massachusetts Department of Transportation (MassDOT) assessed the likelihood of maximum temperatures greater than 120 Fahrenheit (F). The design temperature of steel structures ranges from -30 to 120 F. If the maximum temperature exceeded 120 F, it was assumed to be affected because it is beyond the design range.
Days Above 90 F	Transportation	To evaluate the effect on pavement performance, MassDOT assessed the number of days greater than 90 F. Increases in days over 90 F were assumed to affect pavement performance.
	Mobility	To evaluate the effect of increased temperatures on the use of pedestrian and shared-use paths, MassDOT assessed the number of days greater than 90 F. Increases in days over 90 F were assumed to affect active transportation use.

Design Criteria	Affected Environment	Methodology
Impervious surface area	Land cover	To evaluate the effect on the land surface temperature, MassDOT assessed the percentage of impervious area within the Study Areas in line with the metrics used by the Resilient Massachusetts Action Team (RMAT) Tool for exposure rating. If the percentage was less than 10%, it was assumed to reduce land surface temperature. If the percentage was between 10% to 50%, it was assumed to have a negligible effect on land surface temperatures. If the percentage was greater than 50%, it was assumed to affect land surface temperature and increase heat risk.

Winter Weather

The methodology included reviewing observed days below 32 F, recommended percentiles from the RMAT Tool, projections on ResilientMass, and reviewing results from an extreme value analysis to assess maximum thicknesses for combined snow and ice. **Appendix 4.22, Climate Change Adaptation and Resiliency Technical Report**, provides more specifics on winter analyses. Table 4.22-8 and Table 4.22-9 summarize how MassDOT used winter weather to assess the affected environment.

Table 4.22-8. Affected Environment and Impacts Assessed: Winter Weather

Design Criteria	Affected Environment	Impact	Winter Weather Scenario Assessed
Combined Ice and Wet Snow Thickness	Bridge	Icing on cables and members	500-year (0.2%) thickness (inches)
Freezing temperatures	Transportation	Potential for snow and ice on roadways	2050, 90th percentile, days below 32 Fahrenheit

Table 4.22-9. Affected Environment and Methodology: Winter Weather

Design Criteria	Affected Environment	Methodology
Combined Ice and Wet Snow Thickness	Bridge	To evaluate the effect of icing on bridge members/cables, the Massachusetts Department of Transportation (MassDOT) assessed the maximum thickness of combined ice and wet snow using extreme value analysis and comparing with the values specified in the American Society of Civil Engineers/Structural Engineering Institute (ASCE/SEI) 7-22 for the project location.
Freezing temperatures	Transportation	To evaluate the effect on highway transportation from snow and ice, MassDOT assessed the number of days below 32 Fahrenheit. If there were still days below 32 , it was assumed that snow and ice conditions were possible.

Extreme Wind

The methodology included reviewing wind climate analysis for the replacement bridges' design wind speeds and flutter verification, which included a Monte Carlo simulation of tropical cyclone and hurricane wind speeds. **Appendix 4.22, Climate Change Adaptation and Resiliency Technical Report**, provides more specifics on wind analyses. **Table 4.22-10** and **Table 4.22-11** summarize how extreme winds were used to assess the affected environment.

Table 4.22-10. Affected Environment and Impacts Assessed: Extreme Winds

Design Criteria	Affected Environment	Impact	Extreme Wind Scenario Assessed
1-hour Mean Wind Speed	Bridge	Design	• 97-year (construction) • 1,400-year (completed)
10-minute wind speeds/3 second gusts	Bridge	Aerodynamic Stability	• 1,000-year (construction) • 10,000-year (completed)
3-second wind gusts	Transportation	Vehicle Rollover	Gusts greater than 50 miles per hour

Table 4.22-11. Affected Environment and Methodology: Extreme Winds

Design Criteria	Affected Environment	Methodology[1]
1-hour Mean Wind Speed	Bridge	To evaluate wind loads for bridge design, the Massachusetts Department of Transportation (MassDOT) modeled the mean wind speed at deck level for 1 hour to produce the worst-case loading conditions.
10-minute wind speeds/ 3 second gusts	Bridge	To evaluate aerodynamic stability, MassDOT analyzed extreme wind speeds associated with less-frequent return periods (10-minute mean wind speeds associated with a 1,000-year return period for construction and 10,000-year return period for completed bridge).
3-second wind gusts	Transportation	To evaluate potential vehicle rollover, MassDOT analyzed the likelihood of wind gust speeds greater than 50 miles per hour at deck level.

[1] Methodology aligns with American Association of State Highway and Transportation Officials (AASHTO) Load and Resistance Factor Design Bridge Design Specifications (10th edition) and AASHTO Guide Specifications for Wind Loads on Bridges During Construction (GSWLB-1) return-period recommendations. A specialized wind subconsultant conducted wind tunnel testing of the replacement bridges and a buffeting analysis to determine the wind force impacts on structures.

4.22.2 Existing Conditions

4.22.2.1 Cape Cod Canal

Section 4.4, Maritime Transportation, Traffic, and Safety, identifies the affected environment for navigation.

Sea Level Rise and Storm Surge

Cape Cod Canal is a navigational channel with an existing vertical clearance of 135 feet. The existing and replacement bridges are and would be fixed structures, so SLR/SS affects the ability to maintain the required vertical clearance.

4.22.2.2 Bridge

Chapter 3, Proposed Action and Alternatives, describes the existing and replacement bridges.

Sea Level Rise and Storm Surge

The existing and replacement bridge piers are and would be along the Cape Cod Canal banks and subject to coastal processes, including inundation and scour. SLR/SS affects the coastal processes and may affect water levels, by increasing velocities and flows, while also affecting attack angles related to flow directions that impact scour potential.

Extreme Heat

The existing and replacement bridges' expansion joints are and would be thermally sensitive to extreme temperatures. Temperatures below or exceeding steel design threshold of -30 F to +120 F may affect the performance of the expansion joints.

Winter Weather

Ice accretion affects static loads and wind drag, which may affect aerodynamic stability of the replacement bridges. Icing on bridge structures above the bridge deck (i.e., cables or overhead cross-members) poses a risk to safety, including traffic below, when the accumulated ice or snow sheds off the bridge members and falls down on the bridge deck.[2]

Extreme Wind

Wind causes static loads on a bridge and also results in a special dynamic behavior that affects aerodynamic stability.[3]

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[2] Lubomir, M. and C. T. Georgakis.2022. "A review of ice and snow risk mitigation and control measures for bridge cables," Cold Regions Science and Technology, Volume 193, 103429, ISSN 0165-232X. January. https://doi.org/10.1016/j.coldregions.2021.103429

[3] Federal Highway Administration. 2011. "Framework for Improving Resilience of Bridge Design." Publication No. FHWA-IF-11-016. January. Pg. 56. https://www.fhwa.dot.gov/bridge/pubs/hif11016/hif11016.pdf

4.22.2.3 Stormwater Control Measures

Section 4.11, Water Quality and Stormwater, discusses stormwater control measures.

Sea Level Rise and Storm Surge

Stormwater is ultimately discharged into Cape Cod Canal through outfalls by gravity flow, and SLR/SS affect the ability of the existing outfalls to discharge flow freely (without submerged or partially submerged conditions). **Table 4.22-12** summarizes the outfalls and associated elevations.

Table 4.22-12. Existing Stormwater Outfalls that Discharge into Cape Cod Canal

Outfall Location (quadrant)	Description	Invert Elevation (feet-NAVD88)	Crown Elevation (feet-NAVD88)
Sagamore North	24-inch reinforced concrete pipe	5.15	7.15
Sagamore South – West	36-inch cast iron	4.43	7.43
Sagamore South – East	36-inch cast iron	7.5	10.5
Bourne North*	43-inch by 68-inch concrete	0.46	4.04
Bourne North*	43-inch by 68-inch concrete	0.36	3.94
Bourne South	24-inch reinforced concrete pipe	4.67	6.67

Note: * Twin elliptical culverts

NAVD88 = North American Vertical Datum of 1988

The existing outfalls do not have gates or backflow preventers and modifications to the outfall structures are not proposed as part of the Program. If tides exceed the invert elevations, flow inundates the system and may prevent stormwater from discharging during rain events. This can cause flooding from either SLR/SS or precipitation events. Inundation from SLR/SS also reduces the ability of the infiltration basins to manage stormwater generated by rainfall events.

Extreme Precipitation

Extreme precipitation combined with SLR/SS affects the performance of the overall system—from managing stormwater quality and quantity, to discharging into Cape Cod Canal. Extreme precipitation events also affect the size of the stormwater basin needed to manage rainfall quality and quantity.

4.22.2.4 Land Cover

Land cover is described several sections, including **Section 4.10, Wetlands and Floodplains**; **Section 4.11, Water Quality and Stormwater**; and **Section 4.6, Land Use, Zoning, and Community Cohesion**, which address resource areas, impervious surfaces, and land clearing.

Sea Level Rise and Storm Surge

Figure 4.22-2 and **Figure 4.22-3** show the FEMA floodplain, which is considered a previously developed area within Minimal Wave Action Zone of Land Subject to Coastal Storm Flowage (LSCSF) as described in **Section 4.10, Wetlands and Floodplains**.

LSCSF is presumed to be significant to storm damage prevention and flood control based on its following abilities:

- Dissipate wave energy and decrease the velocity of moving water.
- Receive coastal floodwaters that spread laterally and landward and infiltrate.
- Allow water to flow across the landform without redirecting or channeling the flow or increasing the velocity of flood waters.
- Slow-moving water, thereby reducing erosion.
- Store floodwaters until they can return to the ocean or infiltrate into the ground.

SLR/SS increases the horizontal and vertical extent of LSCSF—even if it does not affect the regulatory boundary.

Extreme Precipitation and Extreme Heat

Impervious surfaces exacerbate localized flooding caused by extreme precipitation and also increase surface temperatures. Vegetative cover improves infiltration and slows moving water.

4.22.2.5 Transportation

Section 4.2, Transportation, Traffic, and Safety, identifies the affected environment for transportation, traffic, and safety, including the Cape Cod Emergency Traffic Plan and Traffic Operations Annex, which identifies traffic control points along major routes to facilitate/expedite off-Cape traffic flow.[4]

Sea Level Rise and Storm Surge

Coastal inundation from SS may affect the likelihood of flooding on formal emergency evacuation routes and roadways. It is not safe to drive into flooded areas; 6 inches of water will reach the bottom of most passenger cars, which can cause loss of control and possible stalling.[5] During flood events, most casualties are caused by vehicles when drivers attempt to drive along flooded roads.[6] Coastal flooding from SS events may result in damage to existing roadways, particularly in areas of channelized flow. SLR/SS increases the horizontal and vertical extent of the inundated area.

Extreme Precipitation

High intensity, short-duration events that exceed design criteria can overwhelm drainage infrastructure and result in localized flooding. The hazard of low-water depths is usually underestimated because it can be perceived as less threatening to drivers.[7] These events can also reduce pavement strength and result in roadway washouts of varying magnitudes.

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[4] Commonwealth of Massachusetts. 2018. Cape Cod Emergency Traffic Plan. July. https://www.mass.gov/doc/cape-cod-emergency-traffic-plan/download

[5] Commonwealth of Massachusetts. n.d. Flood Safety Tips. https://www.mass.gov/info-details/flood-safety-tips

[6] Commonwealth of Massachusetts. n.d. Flood Safety Tips. https://www.mass.gov/info-details/flood-safety-tips

[7] Commonwealth of Massachusetts. n.d. Flood Safety Tips. https://www.mass.gov/info-details/flood-safety-tips

Extreme Heat

Warmer temperatures lead to higher asphalt-concrete pavement temperatures, which affect materials durability distress and fatigue cracking.[8] Extreme heat may reduce material stability, particularly pavement that softens and expands when exposed to extreme heat over long periods of time. This can cause buckling, rutting, and potholes. Combined with heavy precipitation events, this can lead to increased ponding on roadways and/or lead to failures that increase the frequency of repairs and replacements.

Winter Weather

Winter weather (including snow and ice) can cause slower speeds, reduce roadway capacity, increase travel-time delay, and increase crash risk as a result of reduced pavement friction, visibility, and vehicle maneuverability. Average arterial speeds decline by 30% to 40% on snowy or slushy pavement, and highway speeds are reduced by up to 13% in light snow and up to 40% in heavy snow. Winter weather events also increase road maintenance costs, including salt management and costs to repair infrastructure damaged by snow and ice.[9]

Wind

Vehicles are more sensitive to wind while passing over long-span bridges compared to ground-level roads given the higher road elevations, exposure, and possible speed-up impacts.[10]

4.22.2.6 Mobility

Section 4.3, Pedestrian and Bicycle Facilities, identifies the affected environment for pedestrian and bicycles facilities.

Sea Level Rise and Storm Surge

Coastal inundation from SS may affect the likelihood of flooding on shared-use paths and sidewalks. It is not safe for pedestrians or bicyclists to travel into flooded areas; 6 inches of fast-moving water can knock over an adult.[11] Coastal inundation can also reduce pavement strength and result in washouts of varying magnitudes. SLR/SS increases the horizontal and vertical extent of the inundated area.

Extreme Precipitation

High-intensity, short-duration events that exceed design criteria can overwhelm drainage infrastructure and result in localized flooding. It is not safe for pedestrians or bicyclists to travel into

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[8] Federal Highway Administration. 2029. FHWA-HRT-16-084: Impact of Environmental Factors on Pavement Performance in the Absence of Heavy Loads. March. p. 222. https://www.fhwa.dot.gov/publications/research/infrastructure/pavements/16084/16084.pdf

[9] Federal Highway Administration. 2024. n.d. Snow and Ice. September. https://ops.fhwa.dot.gov/weather/weather_events/snow_ice.htm

[10] RWDI. n.d. "Study of vehicle roll-over stability in strong winds," Long Span Bridges. https://rwdi.com/en_ca/projects/vehicle-roll-over-stability-in-strong-winds-on-long-span-bridges/

[11] Commonwealth of Massachusetts. n.d. Flood Safety Tips. https://www.mass.gov/info-details/flood-safety-tips

flooded areas; 6 inches of fast-moving water can knock over an adult.[12] These events can also reduce pavement strength and result in washouts of varying magnitudes.

Extreme Heat

People using alternative modes of transportation (such as bus, bicycle, and walk) are more vulnerable to extreme heat; under extreme heat, the use of shared-use paths and alternative modes of transportation is likely to be lower.[13] Extreme heat may reduce material stability, particularly pavement that softens and expands when exposed to extreme heat over long periods of time. This can cause buckling, rutting, and potholes that affect accessibility of active transportation networks and increase the frequency of maintenance.

4.22.3 No Build Alternative

This section reflects No Build Alternative impacts with current and future conditions based on methodology and affected area described in previous sections. **Table 4.22-13** summarizes the No Build Alternative impacts on the affected environment.

Table 4.22-13. No Build Alternative Impacts

Affected Environment	Sea Level Rise/ Storm Surge	Extreme Precipitation	Extreme Heat	Winter Weather	Extreme Wind
Canal	Navigational clearance	NA	NA	NA	NA
Bridge	NA	NA	No Impact	Icing on Members	Aerodynamic Stability
Stormwater Control Measures	Submerged/partially submerged outfalls[1]	Refer to **Section 4.11, Water Quality and Stormwater**	NA	NA	NA
Land Cover	No impact to floodplain function	NA. Refer to **Section 4.11, Water Quality and Stormwater**	No Impact	NA	NA
Transportation	Roadways and evacuation route flooding	NA. Refer to **Section 4.11, Water Quality and Stormwater**	Pavement performance	Snow and Ice	Vehicle Rollover

[12] Commonwealth of Massachusetts. n.d. Flood Safety Tips. https://www.mass.gov/info-details/flood-safety-tips

[13] Batur, I., V.O. Alhassan, M.V. Chester, S.E. Polzin, C. Chen, C.R. Bhat, R.M. Pendyala. 2024. Understanding how extreme heat impacts human activity-mobility and time use patterns, Transportation Research Part D: Transport and Environment, Volume 136, 2024,104431, ISSN 1361-9209. November. https://doi.org/10.1016/j.trd.2024.104431

Affected Environment	Sea Level Rise/ Storm Surge	Extreme Precipitation	Extreme Heat	Winter Weather	Extreme Wind
Mobility	Shared-use path flooding	NA. Refer to **Section 4.11, Water Quality and Stormwater**	Active Transportation Use	NA	NA

NA = not assessed for affected environment.

[1] Outfalls are within the Study Areas, as shown in **Figure 4.22-1**, but are not part of the Cape Cod Bridges Program; they were assessed due to their impact on stormwater systems (flooding and performance) within the Study Areas.

4.22.3.1 Cape Cod Canal

For the No Build Alternative, Cape Cod Canal and Sagamore and Bourne Bridges would remain as-is, but the navigational clearance would be affected.

Sea Level Rise and Navigational Clearance

For the No Build Alternative, RSLR would affect the ability to maintain the existing 135-foot vertical navigational operational clearance through Cape Cod Canal.[14] The approximate low chord elevations would provide an approximate 137-foot clearance for both structures with existing mean higher high water. If mean higher high water is 3 feet higher, the canal would be unnavigable during high tides.

4.22.3.2 Bridge

For the No Build Alternative, the bridges' decks, superstructures, and substructures would remain as-is.

Sea Level Rise and Bridge Pier Scour

Since reuse of the existing structures is not proposed, a Build Alternative model to assess scour was developed for only the replacement Sagamore Bridge.

Extreme Heat and Bridge Joint Expansion

Design practices and standards for extreme heat have changed since construction of the existing structures, but the steel is likely to have the same sensitivity to heat. There are no projected maximum annual temperatures over 120 F, so the No Build Alternative is unlikely to be affected by extreme heat.

Winter Weather and Icing

Design practices and standards for winter weather have changed since construction of the existing structures, including the link slabs and slab-over-backwall details to reduce risk of winter deicing treatment infiltrating into superstructure and substructure elements. Icing of the cross-members pose a risk to the existing structures as well. Since there are projected days below 32 F in the future, the No Build Alternative is likely to remain vulnerable to winter weather, including snow and ice.

[14] There is a third crossing over Cape Cod Canal, the Railroad Bridge, which is west of Bourne Bridge. The Railroad Bridge crossing has not been evaluated for its impacts to navigational clearance since it is outside the Study Areas and the scope for proposed improvements.

Extreme Wind and Aerodynamic Stability

Design practices and standards for extreme wind have changed since construction of the existing structures. The bridges were designed in the 1930s and are composed of steel trusses forming continuous spans, with spans over Cape Cod Canal that are 616 feet long. Truss bridges tend to be more vulnerable to progressive collapse due to lack of redundancy in design, and generally longer spans (i.e., greater than 300 feet) have issues related to deflections due to wind.[15] The No Build Alternative is vulnerable to extreme wind given the bridges' age and truss structure.

4.22.3.3 Stormwater Control Measures

For the No Build Alternative, the stormwater control measures, including existing infiltration basins, piped infrastructure, and outfalls, would remain as-is.

Sea Level Rise and Submerged and Partially Submerged Outfalls

There are no tide gates or backflow preventers on the outfalls that discharge stormwater to Cape Cod Canal. The No Build Alternative would enable future high tides and SS to back flow through the storm drain system, which may result in localized flooding from tides and/or the inability to convey stormwater runoff to the canal. The outfalls within the Study Areas are vulnerable to rising sea levels, and **Table 4.22-14** summarizes the tidal datums where the inverts and/or crown elevations would be exceeded.

Table 4.22-14. Partially and Fully Submerged Outfalls Based on Tidal Datums with Relative Sea Level Rise

Outfall Location	Invert Elevation Exceeded (Partially Submerged)	Crown Elevation Exceeded (Fully Submerged)
Sagamore North	• 2050 (2.4 feet RSLR) – MHW • 2070 (4.2 feet RSLR) – MHW	• 2070 (4.2 feet RSLR) - MHW
Sagamore South – West	• 2030 (1.2 feet RSLR) – MHHW • 2050 (2.4 feet RSLR) – MHW • 2070 (4.2 feet RSLR) – MHW	• 2070 (4.2 feet RSLR) - MHHW
Sagamore South – East	• 2070 (4.2 feet RSLR) – MHHW	• MLLW would not exceed crown by 2070
Bourne North (twin elliptical culverts)	• 2000 – MHW • 2030 (1.1 feet RSLR) – MTL • 2050 (2.4 feet RSLR) – MTL • 2070 (4.2 feet RSLR) – MLLW	• 2050 (2.4 feet RSLR) – MHW • 2070 (4.2 feet RSLR) – MHW

[15] Federal Highway Administration. 2011. Framework for Improving Resilience of Bridge Design. Publication No. FHWA-IF-11-016. p. 25. January. https://www.fhwa.dot.gov/bridge/pubs/hif11016/hif11016.pdf

Outfall Location	Invert Elevation Exceeded (Partially Submerged)	Crown Elevation Exceeded (Fully Submerged)
Bourne North (twin elliptical culverts)	• 2000 – MHW • 2030 (1.1 feet RSLR) – MTL • 2050 (2.4 feet RSLR) – MTL • 2070 (4.2 feet RSLR) – MLLW	• 2050 (2.4 feet RSLR) – MHW • 2070 (4.2 feet RSLR) – MHW
Bourne South	• 2070 (4.2 feet RSLR) – MHW	• MLLW would not exceed crown by 2070

MHHW = mean higher high water; MHW = mean high water; MLLW = mean lower low water; MTL = mean tide level; RSLR = relative sea level rise

The Bourne North quadrant outfall structure is very vulnerable to RSLR. Current tidal datums restrict flow during high tide with the outfall approximately 50% submerged. With 2.4 feet of RSLR (2050), the Bourne North quadrant outfall would be fully submerged during high tides and free flow only during low tides. With 4.2 feet of RSLR (2070), there would be partial submerged tailwater conditions even at low tide.

Stormwater Control Measure Performance and Extreme Precipitation

Section 4.11, Water Quality and Stormwater, discusses impacts to stormwater control measures from extreme precipitation for the No Build Alternative.

4.22.3.4 Land Cover

For the No Build Alternative, the land cover, including impervious surfaces and land surface temperatures, would remain as-is.

Sea Level Rise/Storm Surge and Land Subject to Coastal Storm Flowage Function

Figure 4.22-4 and **Figure 4.22-5**, respectively, show the extent of overland coastal surge for the No Build Alternative for the Sagamore Bridge and Bourne Bridge Study Areas. **Figure 4.22-6** illustrates the existing flood pathways at the Bourne North quadrant near Belmont Circle. The vertical and horizontal extent of inundations changes slightly between the FEMA 100-year event and a Category 2 Hurricane with 3 feet freeboard. **Section 4.10, Wetlands and Floodplains**, presents additional discussions of impacts to floodplains from the No Build Alternative.

Extreme Precipitation and Localized Stormwater Flooding

Section 4.11, Water Quality and Stormwater, discusses impacts to localized flooding from impervious surfaces and extreme precipitation for the No Build Alternative.

Extreme Heat and Surface Temperatures

For the No Build Alternative, the land cover (impervious surfaces) would remain as-is. **Figure 4.22-7** and **Figure 4.22-8** illustrate the existing impervious surfaces within the Study Areas based on the 2016 land cover dataset hosted on ResilientMass Climate and Hazards Viewer. **Table 4.22-15** summarizes the impervious surface area with the Sagamore Bridge and Bourne Bridge Study Areas.

Table 4.22-15. No Build Alternative: Impervious Area within Sagamore Bridge and Bourne Bridge Study Areas

Study Area	Project Limits (acres)	Roadway Surface Area (acres)[1]	Total Impervious Surface (acres)[2]	No Build Alternative Percentage Impervious
Sagamore Bridge	201.7	42.9	73.5	36.4%
Bourne Bridge	273.7	44.0	80.9	29.5%

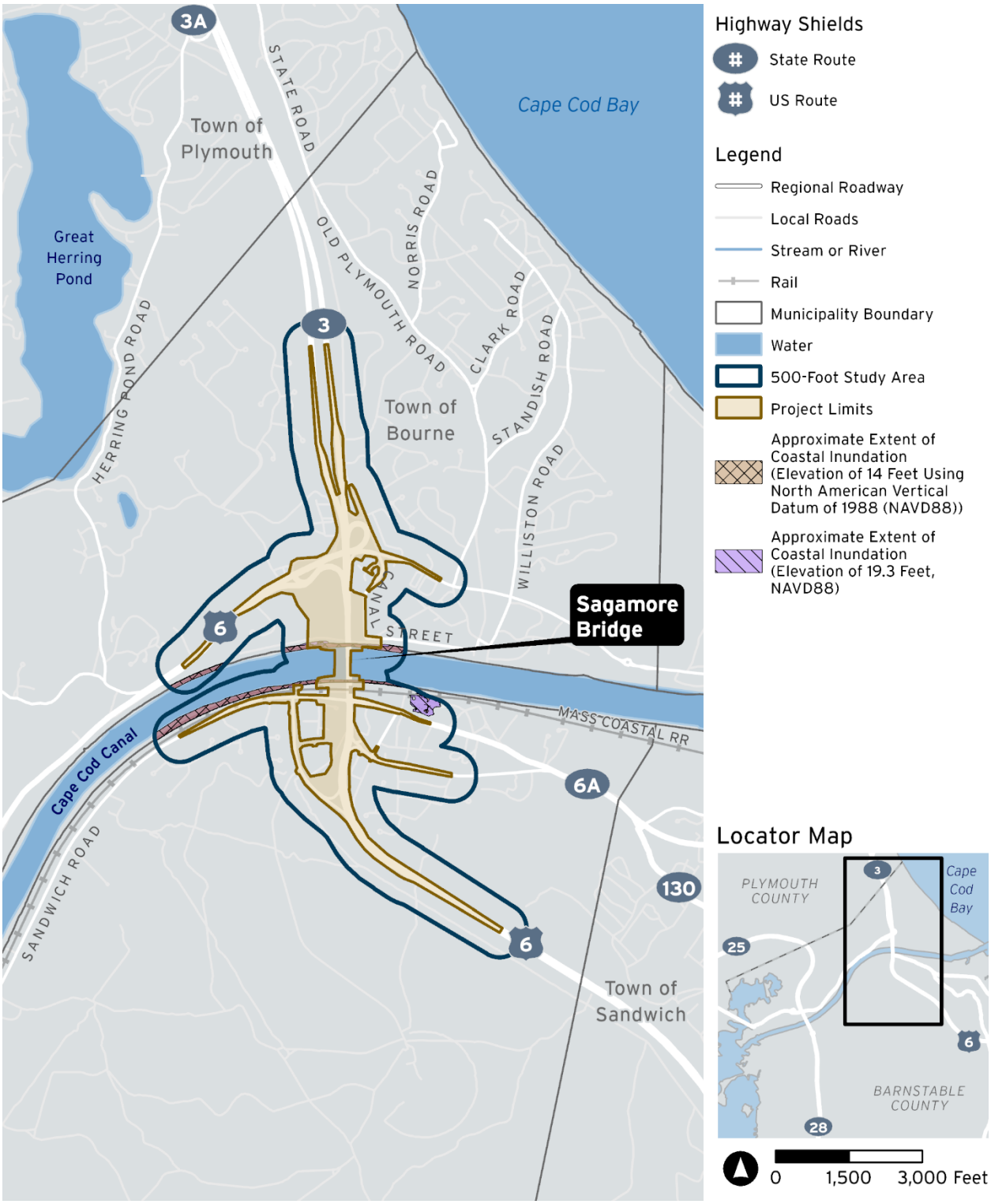
Notes:

[1] The existing roadway surface area based on survey measurements for the north and south quadrants of each Study Area, as presented in **Section 4.11, Water Quality and Stormwater.**

[2] Impervious surface areas are based off Massachusetts Department of Transportation Land Cover Land Use Data, filtered to right-of-way and other impervious surfaces and encompasses more than roadway surfaces.

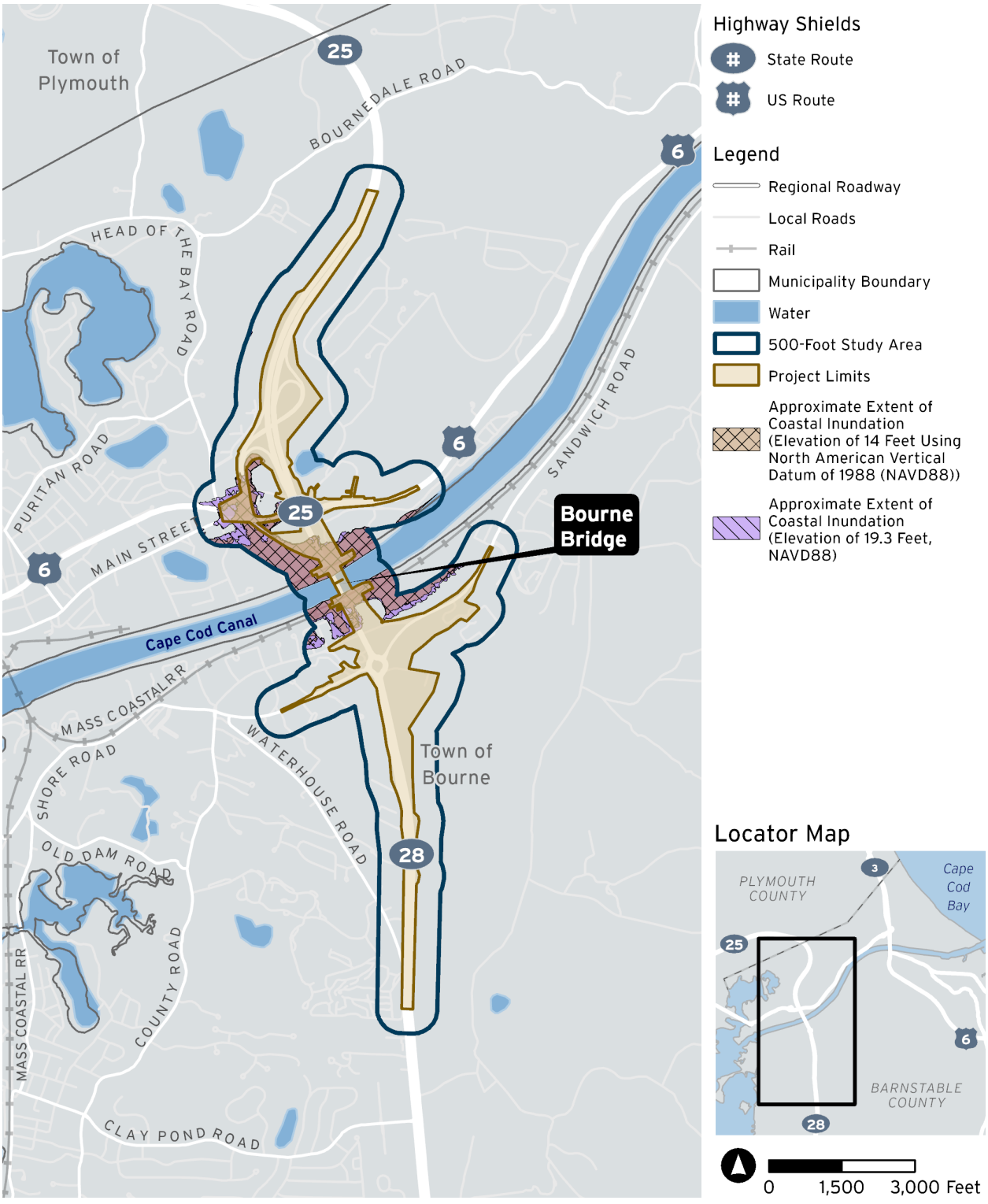
Surface temperature is a function of impervious surfaces, so the No Build Alternative is not assumed to be affected.

Figure 4.22-4. No Build Alternative: Coastal Surge Flood Extents (Sagamore Bridge Study Area)



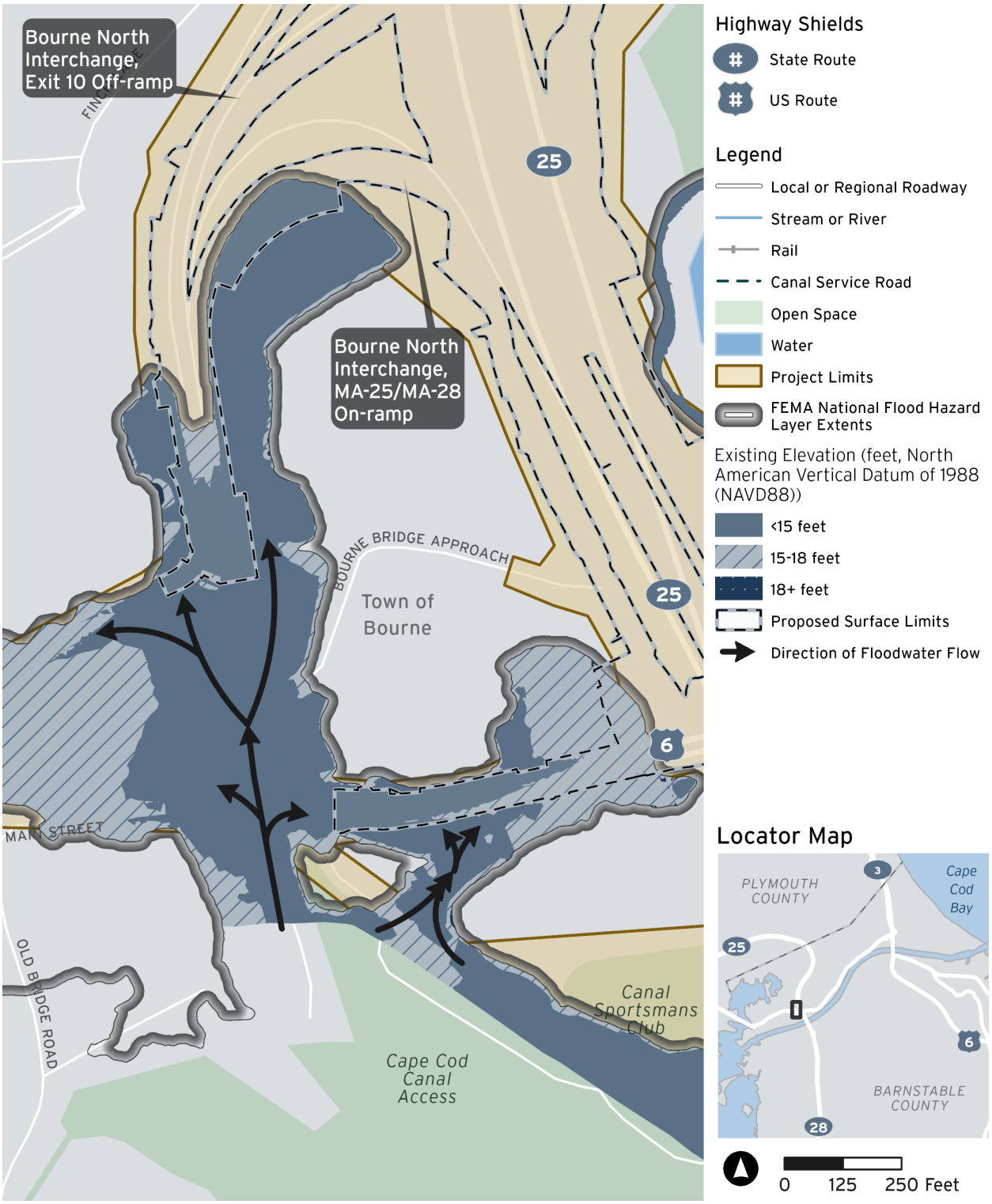
Source: Massachusetts Department of Transportation, 2024

Figure 4.22-5. No Build Alternative: Coastal Surge Flood Extents (Bourne Bridge Study Area)



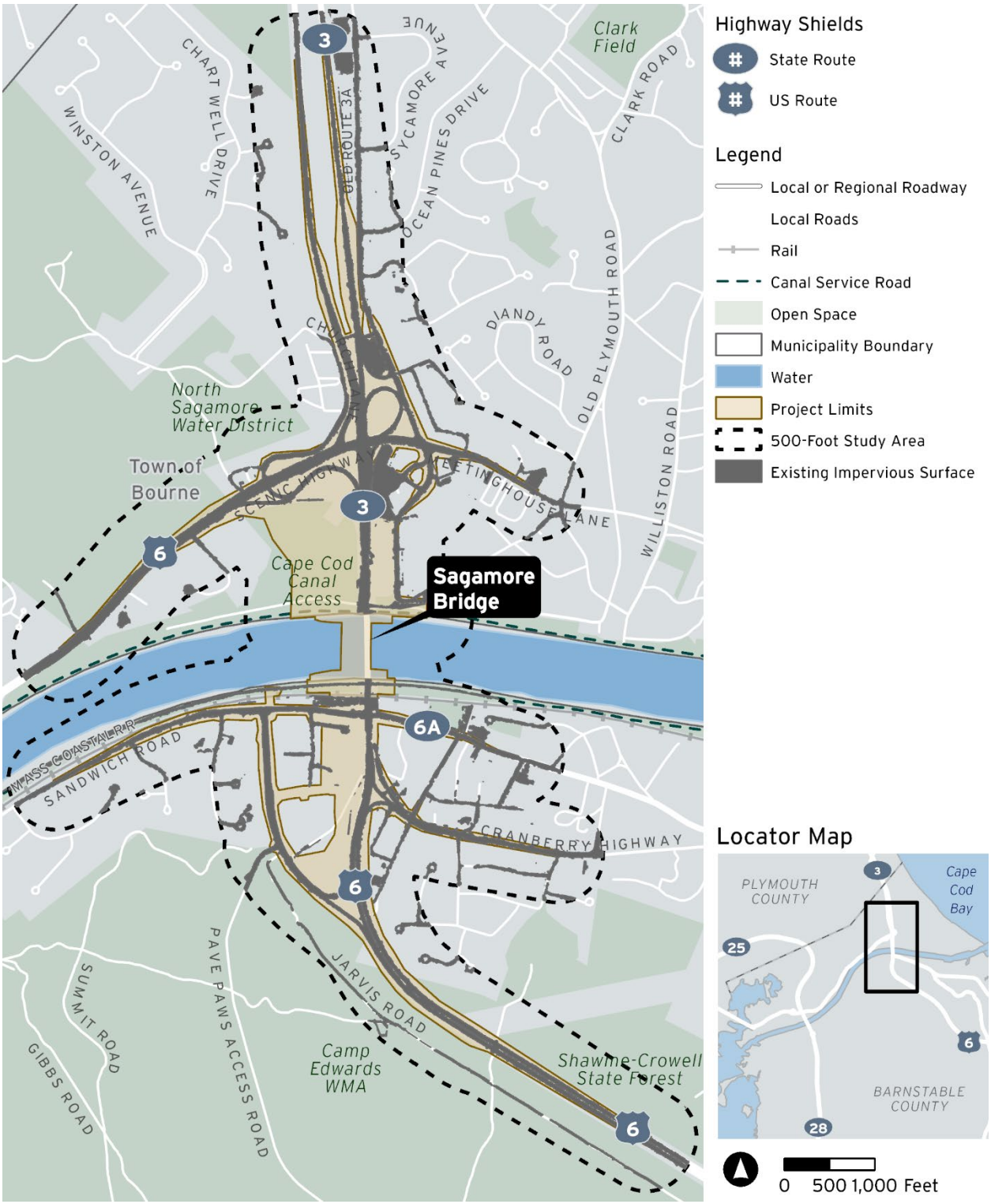
Source: Massachusetts Department of Transportation, 2024

Figure 4.22-6. No Build Alternative: Existing Grading and Flood Pathways (Bourne North Quadrant)



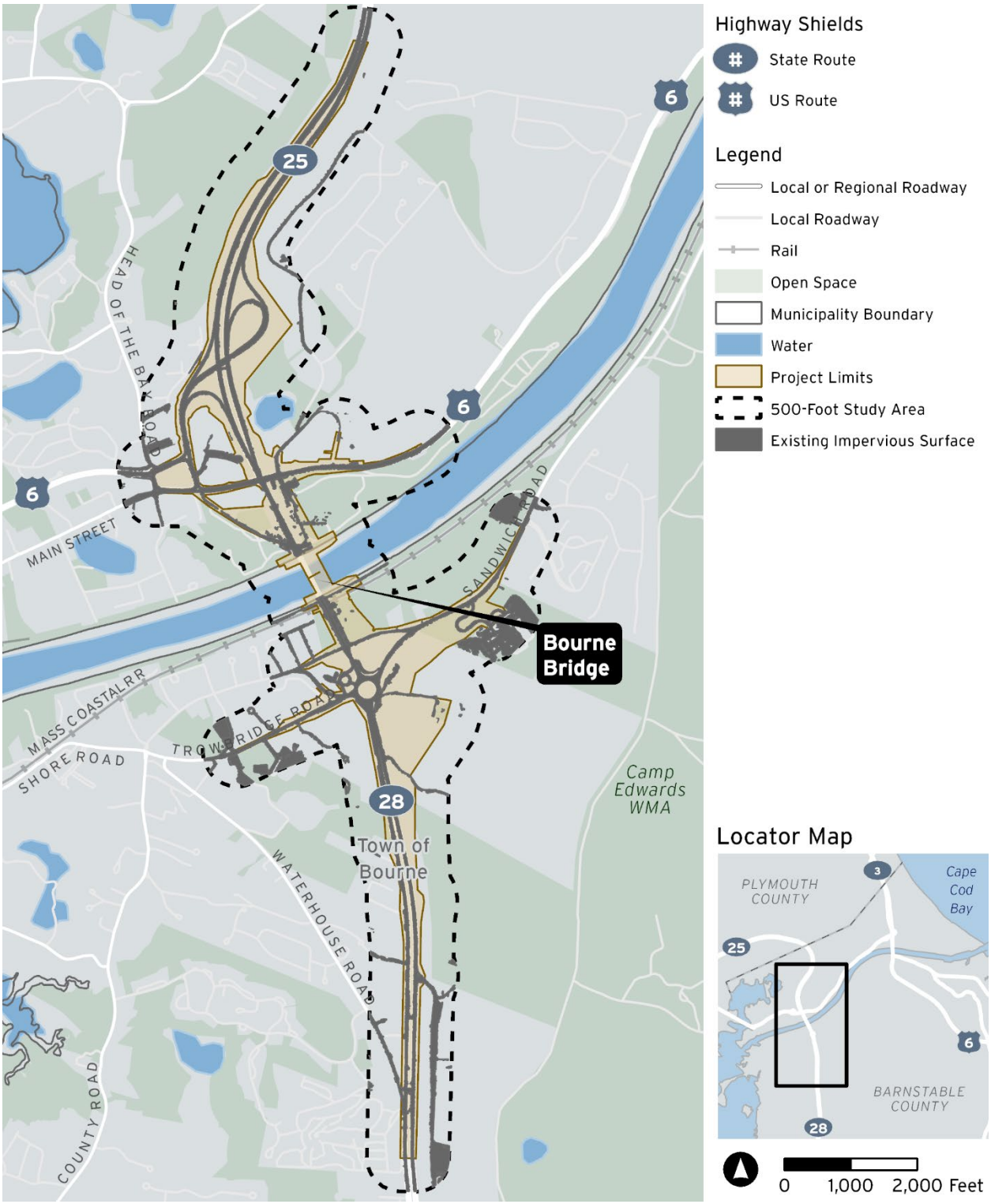
Source: Massachusetts Department of Transportation, 2024

Figure 4.22-7. No Build Alternative: Land Cover – Impervious Surfaces (Sagamore Bridge Study Area)



Source: Massachusetts Department of Transportation, 2024

Figure 4.22-8. No Build Alternative: Land Cover – Impervious Surfaces (Bourne Bridge Study Area)



Source: Massachusetts Department of Transportation, 2024

4.22.3.5 Transportation

For the No Build Alternative, the highway transportation routes would remain as-is.

Sea Level Rise/Storm Surge and Flooded Roadways and Evacuation Routes

The roadways within the Bourne North quadrant, particularly those that travel through Belmont Circle, are vulnerable to coastal inundation; there is at least a 1% annual likelihood (or 1-in-4 chance over the next 30 years) for a coastal flood event. For the No Build Alternative, the likelihood of flooding and existing conditions would remain the same, with heavy traffic volumes exiting to Belmont Circle and merging from the entrance ramp from Belmont Circle. Flooding may cause roadway closures, increase traffic delays, and affect emergency services.

The Cape Cod Emergency Traffic Plan, which facilitates the egress of a high volume of traffic from Cape Cod in the event of a hurricane or other potential or actual hazard, particularly during peak tourist season, includes traffic operations that reduce traffic flow to Belmont Circle, including restricting access to State Routes 28/25 via Scenic Highway and closing Exit 10 (formerly Exit 3) that leads to U.S. Route 6 from State Route 25W.[16] Even with this plan, flooding of Belmont Circle would likely affect traffic plans and operations in emergency recovery and for events that do not trigger plan implementation.

Extreme Precipitation and Localized Stormwater Flooding

Section 4.11, Water Quality and Stormwater, discusses impacts to localized flooding from extreme precipitation for the No Build Alternative.

Extreme Heat and Pavement Performance

For the No Build Alternative, it is likely that the performance of the existing pavement would be affected with increases in days over 90 F, such as increased prevalence of buckling, rutting, and /or potholes.

Winter Weather and Snow and Ice on Roadways

Winter weather conditions that generate snow and ice on roadways are likely to affect the No Build Alternative traffic and safety conditions.

Extreme Wind and Vehicle Rollover Potential

Based on wind climate analysis results, 3-second wind gust speeds that can increase the likelihood of vehicle rollover occur 0.2% of the time (or an average of roughly 20 hours per year) at Sagamore Bridge, and 0.55% of the time (or an average of roughly 50 hours per year) at Bourne Bridge.

[16] Commonwealth of Massachusetts. 2018. Cape Cod Emergency Traffic Plan. July. https://www.mass.gov/doc/cape-cod-emergency-traffic-plan/download

4.22.3.6 Mobility

For the No Build Alternative, the alternative modes of transportation, such as bus, bicycle, and walk, would remain as-is.

Sea Level Rise/Storm Surge and Flooded Shared-Use Paths

Alternative modes of transportation within the Bourne North quadrant, particularly travel through Belmont Circle, are vulnerable to coastal inundation. In the No Build Alternative, existing conditions and likelihood of flooding would remain the same—at least a 1% annual likelihood (or 1-in-4 chance over the next 30 years).

Extreme Precipitation and Localized Stormwater Flooding

Section 4.11, Water Quality and Stormwater, discusses impacts to localized flooding from extreme precipitation for the No Build Alternative.

Extreme Heat and Active Transportation Use

In addition to affected pavement performance, it is likely that extreme heat events will impact the use of alternative modes of travel in the No Build Alternative. There will be more days over 90 F, which may increase the risk of heat stress for pedestrians and bicyclists.

4.22.4 Program Impacts

This section reflects Build Alternative impacts with current and future conditions based on the methodology and the affected area described in previous sections. Refer to **Appendix 4.22, Climate Change Adaptation and Resiliency Technical Report**, for additional information on data, including RSLR, used to analyze impacts. **Table 4.22-16** summarizes the Build Alternative impacts on the affected environment.

Table 4.22-16. Build Alternative Impacts

Affected Environment	Sea Level Rise/ Storm Surge	Extreme Precipitation	Extreme Heat	Winter Weather	Extreme Wind
Canal	No impact	NA	NA	NA	NA
Bridge	No impact*	NA	No impact	Reduced Impact	No impact
Stormwater Control Measures	Submerged/ partially submerged outfalls** Infiltration basin flooding	No impact. Refer to **Section 4.11, Water Quality and Stormwater.**	NA	NA	NA

Affected Environment	Sea Level Rise/ Storm Surge	Extreme Precipitation	Extreme Heat	Winter Weather	Extreme Wind
Land Cover	No impact	No impact. Refer to **Section 4.11, Water Quality and Stormwater**.	Surface temperature	NA	NA
Transportation	Reduced impact	No impact. Refer to **Section 4.11, Water Quality and Stormwater**.	Reduced impact	Reduced impact	Vehicle Rollover
Mobility	Reduced impact	No impact. Refer to **Section 4.11, Water Quality and Stormwater**.	Active Transportation Use	NA	NA

Notes:

NA = not assessed for affected environment. Reduced impact is in comparison to the No Build Alternative.

* Only for Sagamore Bridge at this time.

** Outfalls are within the Study Areas shown in **Figure 4.22-1**, but are not part of the Cape Cod Bridges Program; they were assessed due to their impact on stormwater systems (flooding and performance) within the Study Area.

4.22.4.1 Cape Cod Canal

For the Build Alternative, Cape Cod Canal would remain as-is, but the Sagamore Bridge and Bourne Bridge low chord would be elevated, which reduces the impact on navigational clearance.

Sea Level Rise and Navigational Clearance

The Build Alternative would raise the low chord elevation of the replacement bridges to establish a vertical clearance of 138.3 feet compared to the existing MHHW. This allows the bridges to accommodate an MHHW up to 3 feet higher, so the replacement bridges could maintain the existing 135-foot vertical navigational operational clearance.[17] The replacement bridges would also meet the preliminary vertical clearance determined by the U.S. Coast Guard.[18]

[17] Three feet of relative sea level rise corresponds with the planning horizons between 2050 and 2070 (ResilientMass) and between 2070 and 2125 (U.S. Army Corps of Engineers). **Appendix 4.22, Climate Change Adaptation and Resiliency Technical Report,** provides more details on the relative sea level rise estimates.

[18] The First Coast Guard District issued a Preliminary Navigation Clearance Determination dated March 11, 2025, to the Massachusetts Department of Transportation and U.S. Army Corps of Engineers. The determination stated the replacement Sagamore and Bourne Bridges should provide at least 138.3 feet of vertical clearance and at least 500 feet of horizontal clearance to not unreasonably obstruct the free navigation of the waters over which the bridge is constructed.

4.22.4.2 Bridge

For the Build Alternative, the Sagamore Bridge and Bourne Bridge would be replaced with network tied-arch structures with piers along riprap armored banks. A network tied-arch structure is highly redundant in that it can lose any two cables without compromising stability.

Sea Level Rise and Bridge Pier Scour

MassDOT calculated maximum scour depths for design and check events (200-year and 500-year, respectively, in accordance with Federal Highway Administration Hydraulic Engineering Circular Number 18); the proposed northern canal piers were identified as the maximum scour under current sea level conditions, while RSLR of 7.7 feet leads to the maximum scour depths at the proposed southern canal piers. Refer to **Appendix 4.22, Climate Change Adaptation and Resiliency Technical Report**, for more details on 2-D hydraulic analyses. The foundations of the Build Alternative would be designed to remain stable during the maximum scour design and check events; therefore, the Build Alternative for Sagamore Bridge would unlikely be affected by scour. This assessment of proposed impacts will be updated in the Final Environmental Impact Statement Report (FEIR) once Bourne Bridge is analyzed.

Extreme Heat and Bridge Joint Expansion

Design practices and standards for new bridges include limiting the number of bridge expansion joints and assuming a range of -30 to 120 F. Bridge joints in the Build Alternative are unlikely to be affected by extreme heat.

Winter Weather and Icing

The Build Alternative would be designed for a 1-inch combined ice and wet snow thickness, which corresponds with a 500-year event, using mitigation measures as described in **Section 4.22.5.**

Design practices and standards for new bridges include limiting the number of bridge expansion joints to reduce the risk of winter deicing treatment infiltrating superstructure and substructure elements. While there are projected days below 32 F, the replacement bridges would unlikely be affected by snow and ice events.

Extreme Wind and Aerodynamic Stability

Network tied-arch bridges have better resistance against wind-induced vibrations and deformation. The Build Alternative would be designed to remain stable during the extreme wind conditions identified in the wind climate analysis; as such, extreme wind events would unlikely affect the replacement bridges.

4.22.4.3 Stormwater Control Measures

For the Build Alternative, new infiltration basins are proposed, including piped infrastructure to connect to the existing stormwater system. Existing piped infrastructure and outfalls would remain as-is.

Sea Level Rise and Submerged and Partially Submerged Outfalls

Because there are no tide gates or backflow preventers on the outfalls that discharge stormwater to the canal, the impacts of the Build Alternative would be the same as the No Build Alternative. Refer to **Section 4.22.3.3**.

Sea Level Rise/Storm Surge and Infiltration Basins

The Build Alternative would include 24 new infiltration basins to manage stormwater quality and volumes; five were identified as potentially vulnerable to rising sea levels and SS. **Table 4.22-17** summarizes the Build Alternative infiltration basins where the basin elevations would be exceeded by storm events. Refer to **Section 4.11, Water Quality and Stormwater (Figures 4-11.9 through 4-11.12)** for locations of the infiltration basins.

Without mechanisms to prevent backflow into infiltration basins, coastal inundation may affect the basins when floodwater elevations exceed the overflow structure's outlet elevation, causing the structure to surcharge. Those events would affect the infiltration basins within the extent of coastal inundation with an overflow structure outlet elevation lower than the elevation of the SS.

Table 4.22-17. Build Alternative: Potentially Affected Infiltration Basins

Infiltration Basin ID	Basin Bottom (feet-NAVD88)	Overflow Outlet (feet-NAVD88)	Basin Top (feet-NAVD88)	Potential Inundation Impact
SCM-SS01	13	TBD	21	• FEMA 100-year (Elevation [El.] 14): Exceeds bottom of basin • Top of basin not exceeded
SCM-BN10	12	TBD	18	• FEMA 100-year (El. 16): Exceeds bottom of basin • CAT 2 + 3 feet SLR (El. 19.3): Exceeds top of basin
SCM-BN07	7.5	TBD	17.5	• FEMA 100-year (El. 16): Exceeds bottom of basin • CAT 2 + 3 feet SLR (El. 19.3): Exceeds top of basin
SCM-BN08	13.25	TBD	21	• FEMA 100-year (El. 16): Exceeds bottom of basin • Top of basin not exceeded
SCM-BSO1A	14.5 – 15	TBD	18	• FEMA 100-year (El. 16): Exceeds bottom of basin • CAT 2 + 3 feet SLR (El. 19.3): Exceeds top of basin

CAT 2 = Category 2 Hurricane; FEMA = Federal Emergency Management Agency; NAVD88 = North American Vertical Datum of 1988; TBD = to be determined

Note: The elevations of the proposed overflow outlets are between the bottom and top of the basins and to be determined at a later date.

Extreme Precipitation and Stormwater Control Measure Performance

Stormwater control measures would function as intended with the projected 2070, 100-year 24-hour rainfall event for the Build Alternative as described in **Section 4.11, Water Quality and Stormwater**. The infiltration basins' performance may be altered under scenarios where tidal datums would exceed the outfall invert elevation (refer to **Table 4.22-14**). In these scenarios, a basin's ability to discharge would be reduced, which may result in the infiltration basin temporarily acting as a retention basin. The basins would provide peak flow attenuation and storage until the stormwater captured in the basins is able to infiltrate or discharge through the outfall. As such, the four assessed events (combined extreme rainfall and RSLR) would unlikely affect the proposed stormwater control measures.

4.22.4.4 Land Cover

For the Build Alternative, the land cover, resource areas, and land use would change as described in **Section 4.10, Wetlands and Floodplains,** and **Section 4.6, Land Use, Zoning, and Community Cohesion**.

Sea Level Rise/Storm Surge and Land Subject to Coastal Storm Flowage Function

Figure 4.22-9 and **Figure 4.22-10** show the extent of overland coastal surge for the Build Alternative. These figures also identify areas where changes to site grading and topography are proposed below the associated SS elevations. The extent of overland coastal surge for the Build Alternative for Sagamore Bridge would be the same as the No Build Alternative (**Figure 4.22-4**) because there would be no proposed changes to grading within the flood extents. The extent of overland coastal surge for Bourne Bridge for the Build Alternative (**Figure 4.22-9** and **Figure 4.22-10**) would be the same as the No Build Alternative (**Figure 4.22-5**), with the exception of the Bourne North quadrant, where the proposed grade changes near Belmont Circle would accommodate the higher bridge deck elevation spanning the Cape Cod Canal to maintain navigational clearance and connect to existing grades. **Figure 4.22-11** shows the proposed grade changes and corresponding flood pathways in the Bourne North quadrant. These grade changes would slightly reduce the extent of coastal inundation at the edge of the floodplain, but would not affect the flood pathways compared to the No Build Alternative (**Figure 4.22-6**).

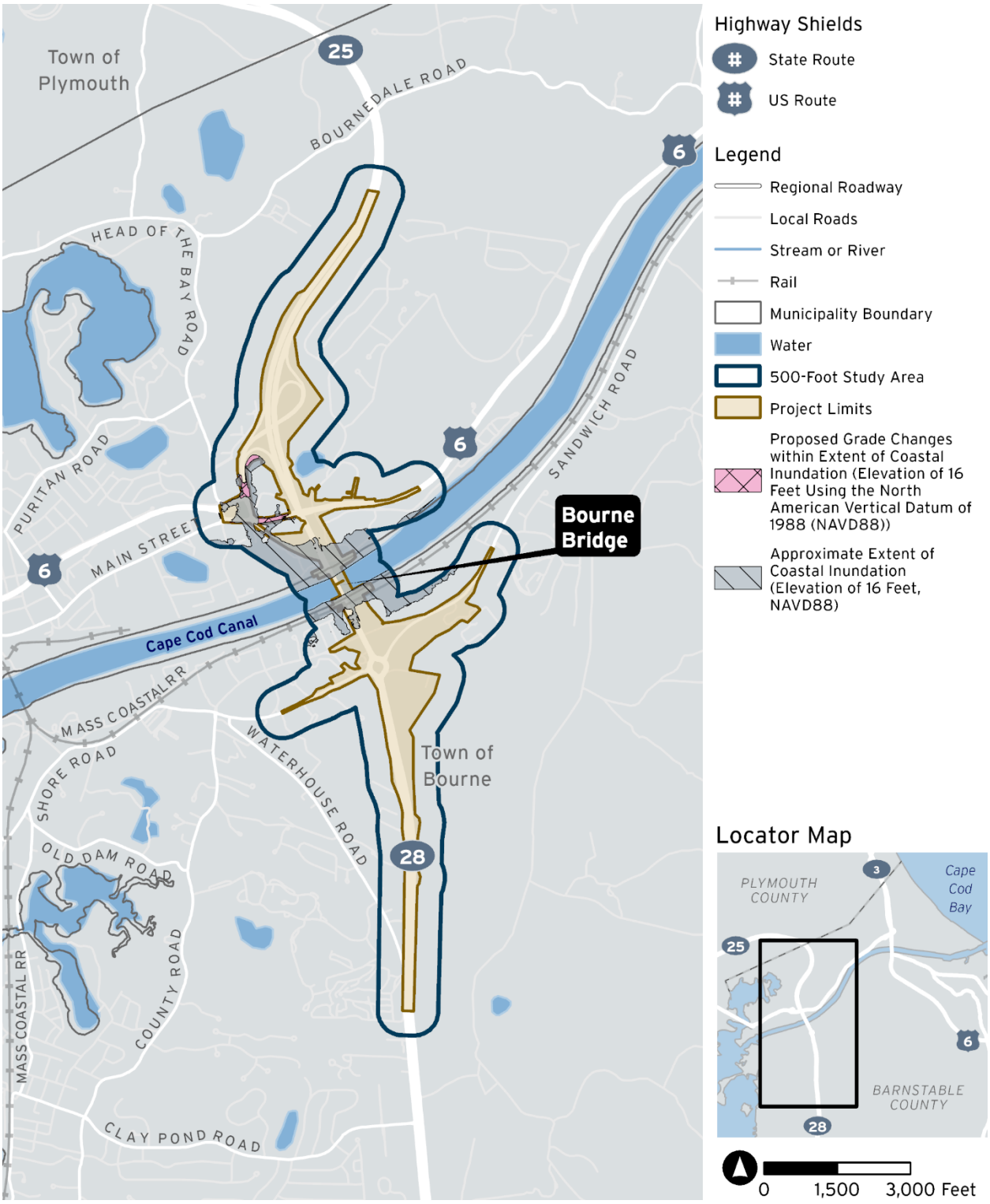
MassDOT took five cross-sections where grade changes are proposed on the ramps and along U.S. Route 6 (**Figure 4.22-12**) to assess potential impediments to flow. **Figure 4.22-13 through Figure 4.22-17** show the cross-sections, which depict the following:

- Existing grade (Dashed Lines - No Build Alternative) and proposed topography (Solid Lines - Build Alternative)
- Proposed roadway surfaces, including shared-use paths and shoulders
- Existing edge of pavement, right-of-way, and driveways to adjacent parcels
- Coastal surge flood elevations (El. 16 FEMA 100-year) and El. 19.3 (Category 2 hurricane + 3 foot freeboard)

The cross-sections on U.S. Route 6 at 701+50 (**Figure 4.22-13**) and 704+50 (**Figure 4.22-14**) are subject to perpendicular and parallel flood pathways; when subject to perpendicular flows, the water travels right to left. The cross-sections on the westbound ramps at 102+50 (**Figure 4.22-15**) and 104+00 (**Figure 4.22-16**) are subject to parallel flood pathways, and the cross-section on the eastbound ramp at 405+00 (**Figure 4.22-17**) is subject to perpendicular flows where the water travels right to left.

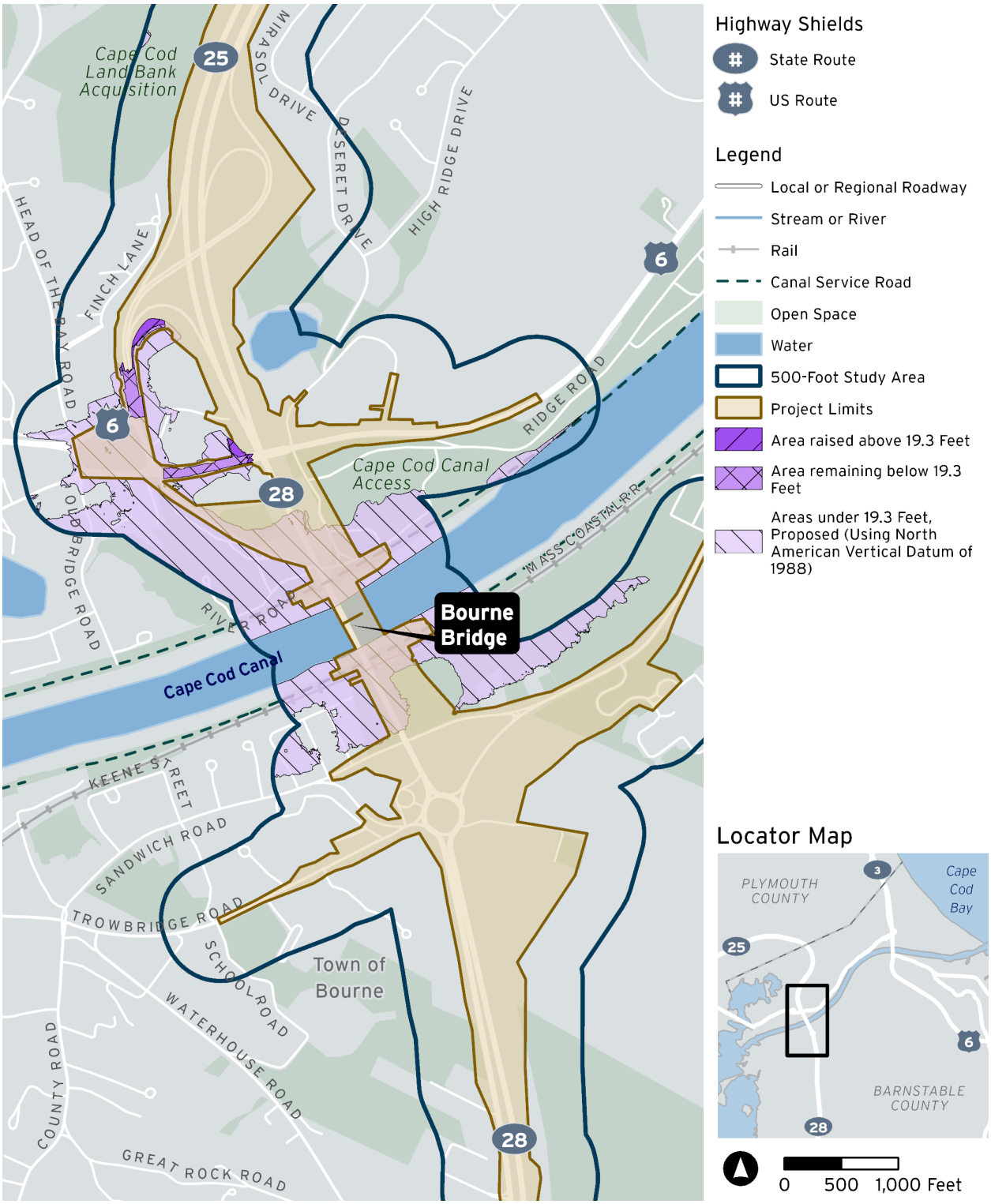
These cross-sections illustrate that the Build Alternative for U.S. Route 6, including changes to landcover and grading, would not likely create channelized flow conditions within the extent of mapped inundation. The proposed changes to the westbound ramps for the Build Alternative would include the installation of retaining walls to increase grades, while reducing the impact on nearby wetlands. These cross-sections would be at the edge of the floodplain and would receive flow from pathways that would have already crossed developed areas with existing impervious surfaces and vertical impediments, such as curbs and structures. The areas farther inland from these cross-sections are low lying wetlands; therefore, the changes to land cover from the westbound ramps are not anticipated to have an impact on the LSCSF functions. The proposed changes to the eastbound ramps for the Build Alternative would include creating an embankment (2H:1V) to raise grades up to 28 feet at the edge of the floodplain, and would receive flow from pathways that would have already crossed developed areas and the existing wetland; therefore, the changes to land cover from the eastbound ramp are not anticipated to have an impact on the LSCSF functions.

Figure 4.22-9. Build Alternative: Coastal Surge Flood Extents – Existing 100-year Floodplain (Bourne Bridge Study Area)



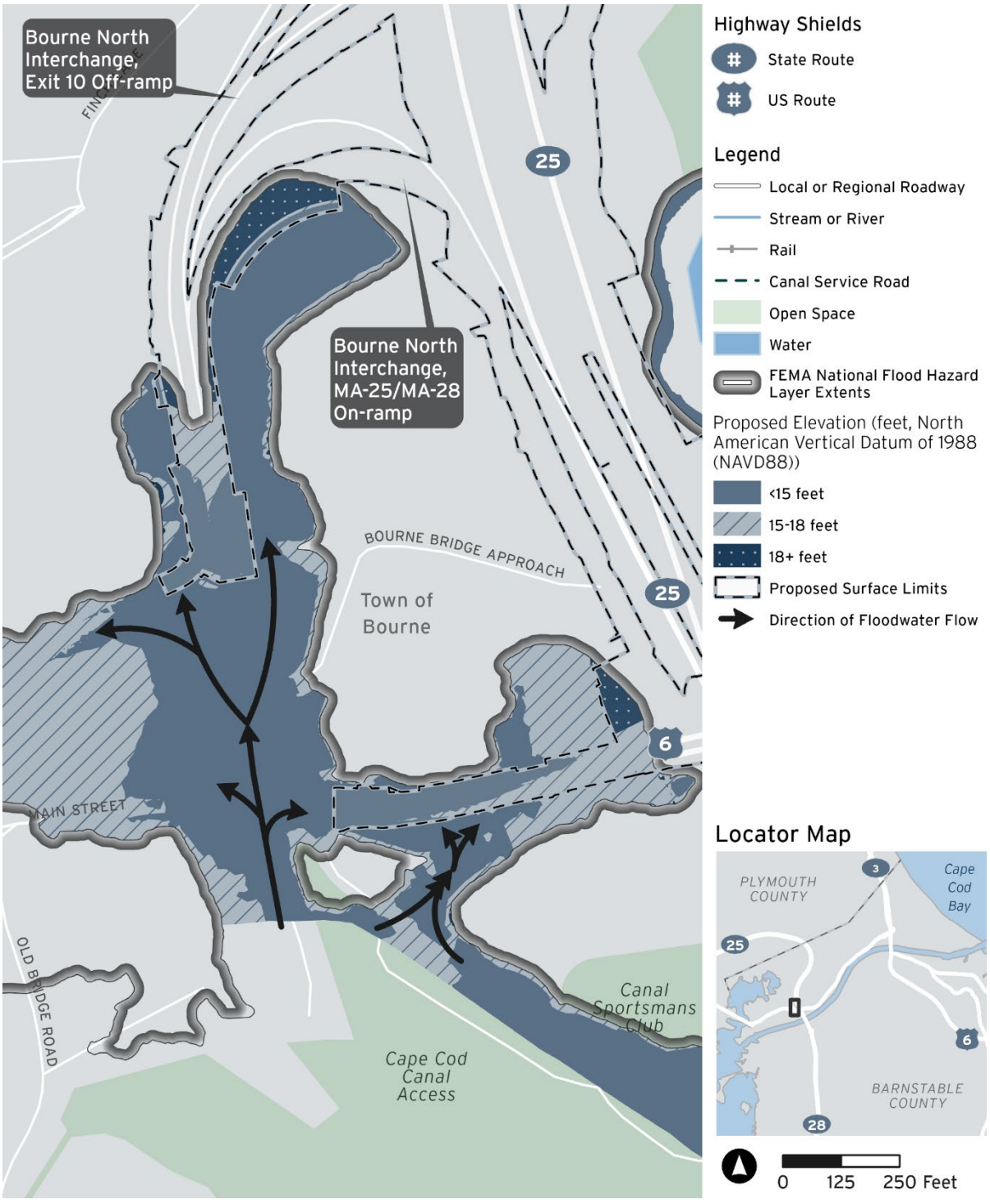
Source: Massachusetts Department of Transportation, 2024

Figure 4.22-10. Build Alternative: Coastal Surge Flood Extents – Category 2 Hurricane + 3 feet Freeboard (Bourne Bridge Study Area)



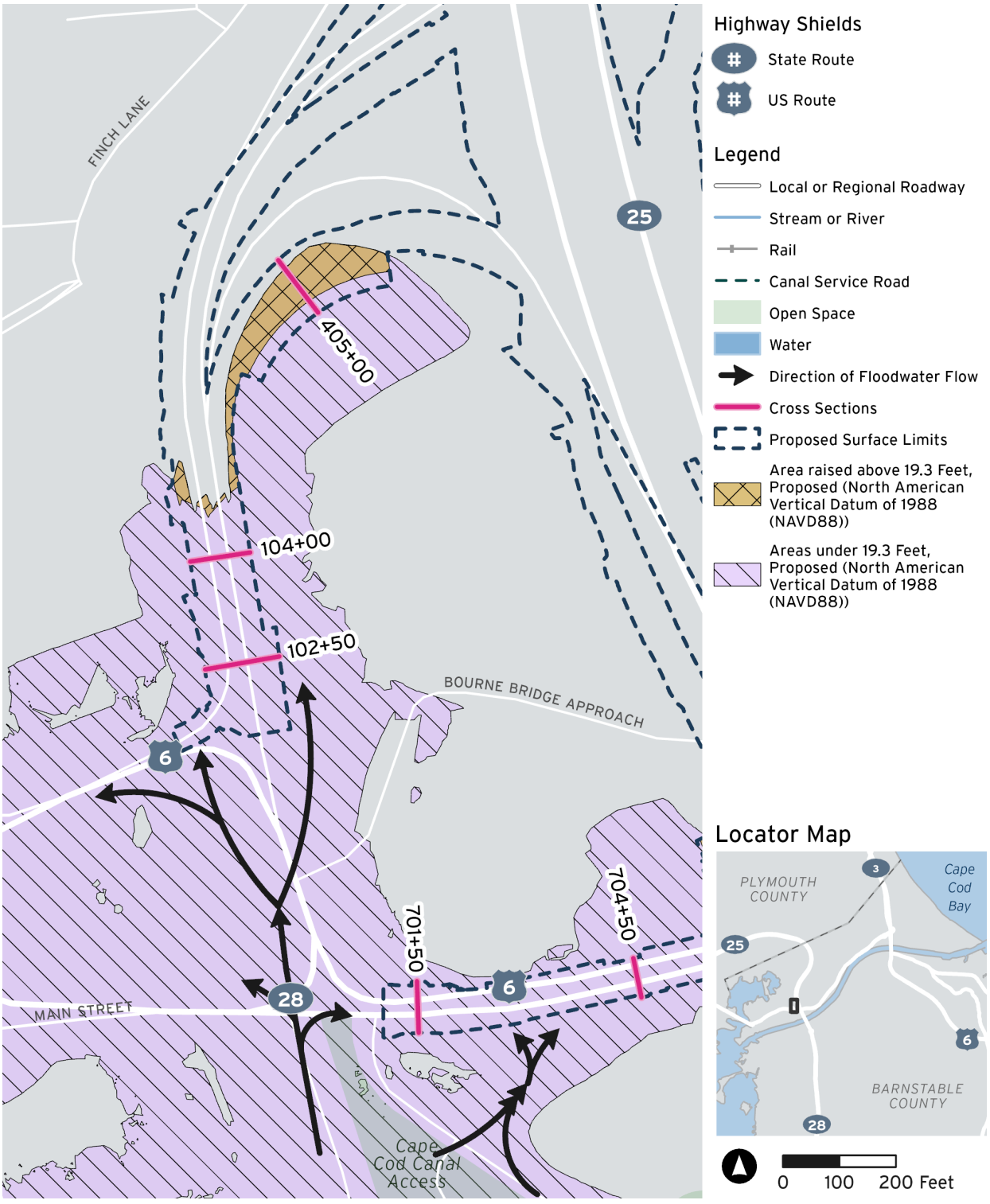
Source: Massachusetts Department of Transportation, 2024

Figure 4.22-11. Build Alternative: Proposed Grading and Flood Pathways (Bourne North Quadrant)



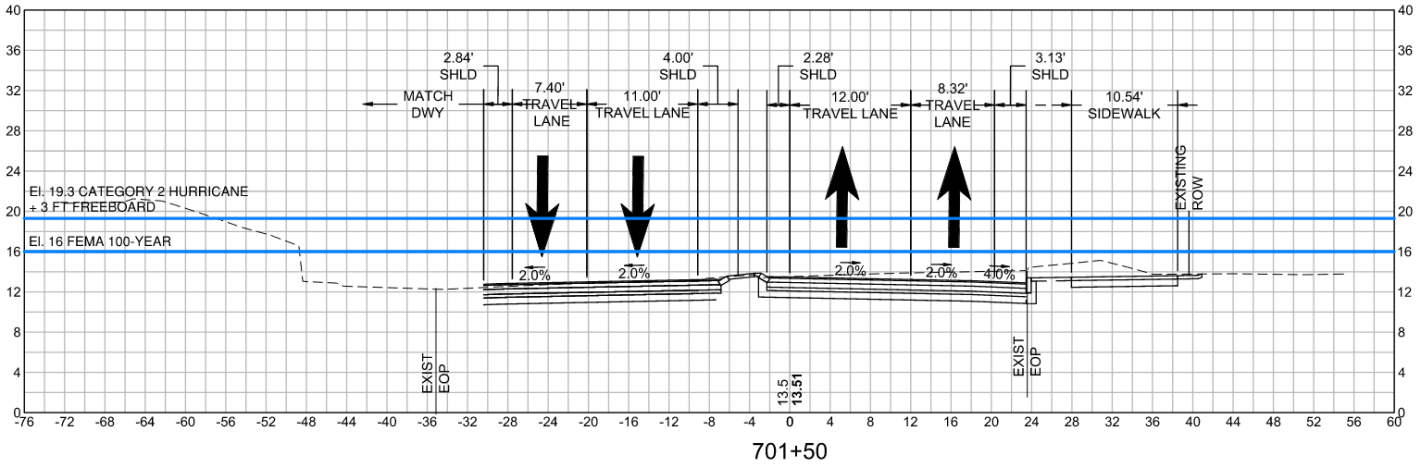
Source: Massachusetts Department of Transportation, 2024

Figure 4.22-12. Build Alternative: Cross-Section Reference for Bourne North Quadrant Grading Plan



Source: Massachusetts Department of Transportation, 2024

Figure 4.22-13. Build Alternative: Cross-Section U.S. Route 6: 701+50, Proposed Grading, Impervious Surfaces, and Coastal Surge Flood Extents (Bourne North Quadrant)

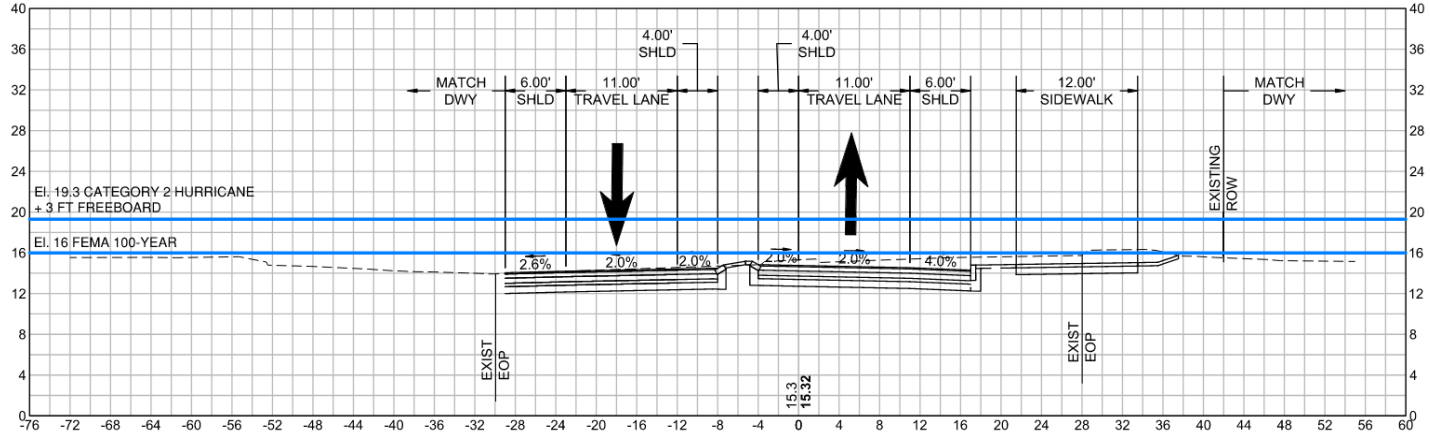


701+50

Source: Massachusetts Department of Transportation, 2024

Note: Cross-section subject to parallel flows. DWY = driveway, EOP = edge of pavement, ROW = right-of-way, SHLD = shoulder

Figure 4.22-14. Build Alternative: Cross-Section U.S. Route 6: 704+50, Proposed Grading, Impervious Surfaces, and Coastal Surge Flood Extents (Bourne North Quadrant)

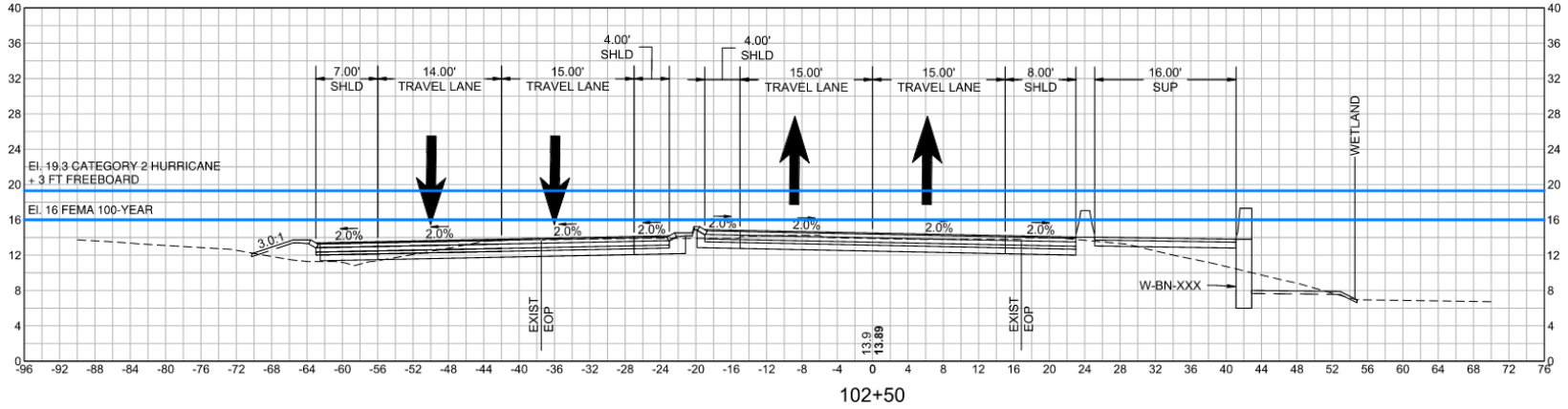


704+50

Source: Massachusetts Department of Transportation, 2024

Note: Cross-section subject to parallel flows. DWY = driveway, EOP = edge of pavement, ROW = right-of-way, SHLD = shoulder

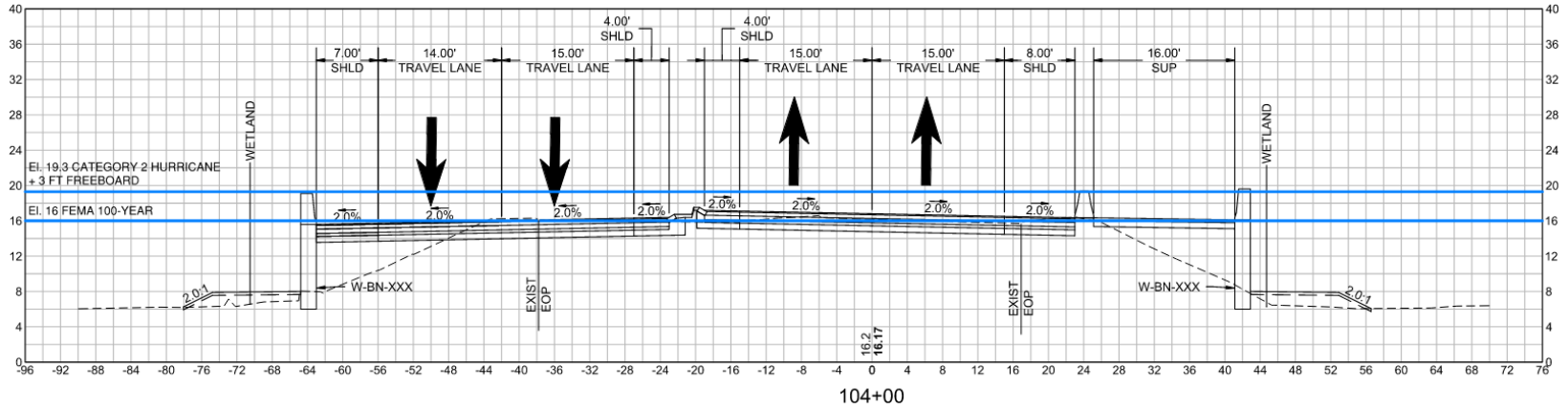
Figure 4.22-15. Build Alternative: Cross-Section Westbound On- and Off-Ramps: 102+50, Proposed Grading, Impervious Surfaces, and Coastal Surge Flood Extents (Bourne North Quadrant)



Source: Massachusetts Department of Transportation, 2024

Note: Cross-section subject to parallel flows. EOP = edge of pavement, SHLD = shoulder, SUP = shared-use path

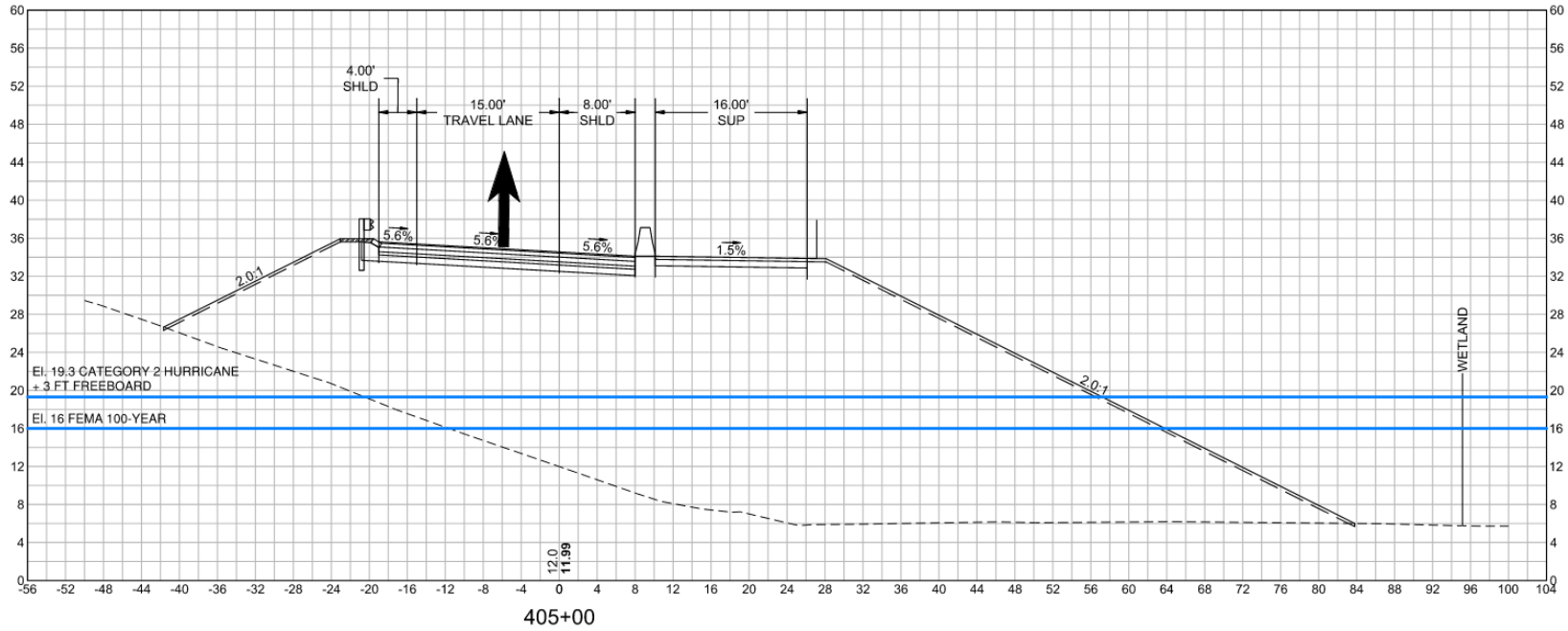
Figure 4.22-16. Build Alternative: Cross-Section Westbound On- and Off-Ramps: 104+00, Proposed Grading, Impervious Surfaces, and Coastal Surge Flood Extents (Bourne North Quadrant)



Source: Massachusetts Department of Transportation, 2024

Note: Cross-section subject to parallel flows. EOP = edge of pavement, SHLD = shoulder, SUP = shared-use path

Figure 4.22-17. Build Alternative: Cross-Section Eastbound On-Ramp: 405+00, Proposed Grading, Impervious Surfaces, and Coastal Surge Flood Extents (Bourne North Quadrant)



Source: Massachusetts Department of Transportation, 2024

Note: Cross-section subject to parallel flows. SHLD = shoulder, SUP = shared-use path

Extreme Precipitation and Localized Stormwater Flooding

MassDOT used rainfall projections to assess stormwater infrastructure as described in **Section 4.11.3**. Stormwater control measures function as intended with the projected 2070, 100-year 24-hour rainfall event for the Build Alternative; as such, localized flooding as a result of impervious surfaces and extreme precipitation will be mitigated through the proposed stormwater control measures presented in **Section 4.11, Water Quality and Stormwater**.

Extreme Heat and Surface Temperatures

The Build Alternative would result in an increase in impervious area (50.9 acres) across the Study Areas, and therefore an increase in level of stormwater treatment required, compared to existing conditions as described in **Section 4.11.6**. The proposed increase in impervious areas would increase the total impervious surface (**Table 4.22-18**); since the final impervious area percentage would be less than 50%, the Build Alternative would not change the exposure rating or rationale in the RMAT Tool. As described in **Section 4.22.5**, MassDOT is developing landscaping plans that may offset the increase in impervious surfaces.

Table 4.22-18. Build Alternative: Impervious Surface Area within Study Areas

Study Areas	Impervious Surface Area Increase (acres)[1]	Percentage Impervious[2]
Sagamore Bridge	+ 25.3	49%
Bourne Bridge	+ 25.6	39%

[1] Increase in impervious surface area based on **Section 4.11.6**.

[2] Increase from No Build Alternative of 36.4% (Sagamore Bridge) and 29.5% (Bourne Bridge).

4.22.4.5 Transportation

As described in **Section 4.2, Transportation, Traffic, and Safety,** the Build Alternative would change the highway transportation routes and traffic.

Sea Level Rise/Storm Surge and Flooded Roadways and Evacuation Routes

In the Build Alternative, the combination of new direct connection ramps between State Route 25 and U.S. Route 6 (Scenic Highway) in the Bourne North quadrant would allow vehicles to bypass Belmont Circle and reduce travel in the existing floodplain and mapped areas of coastal inundation.[19] The Build Alternative would facilitate emergency egress of high traffic volumes from Cape Cod in the event of a hurricane or other potential hazards by replacing Bourne Rotary with a grade-separated diamond interchange and constructing a new flyover ramp connection from Scenic Highway to State Route 25 westbound. Construction of two separate deck structures for the replacement bridges for the Build Alternative would provide additional service redundancy in case of an emergency evacuation or a

[19] Regionally these changes would result in a reduction of 1.7% in vehicle-miles traveled and 8% in vehicle-hours traveled from the No Build Alternative to Build Alternative.

compromising event that would affect a single bridge structure. Cross-canal pedestrian and bicycle lanes would also improve hurricane evacuation ability for all road users.

While flooding of Belmont Circle has at least a 1% annual likelihood (or a 1-in-4 chance of flooding over 30 years), the Build Alternative would increase the adaptive capacity of the network to reduce vulnerability to coastal inundation. Changes to traffic patterns associated with the Build Alternative should be updated for construction phases and completion of the Program within the Cape Cod Emergency Traffic Plan.

Extreme Precipitation and Localized Stormwater Flooding

Stormwater control measures would function as intended with the projected 2070, 100-year 24-hour rainfall event for the Build Alternative; as such, localized flooding as a result of impervious surfaces and extreme precipitation will be mitigated through the proposed stormwater control measures presented in **Section 4.11, Water Quality and Stormwater**.

Extreme Heat and Pavement Performance

MassDOT's Transportation Asset Management Plan includes best practices that have been incorporated into MassDOT standards to increase the resilience of Highway Division assets, including modifying pavement mixtures to provide additional stability in high temperatures and incorporating balanced mixture design methods to reduce mixture cracking and moisture damage. It is likely that extreme heat events for the Build Alternative would still affect the performance of the pavement, but to a lesser degree than the No Build Alternative.

Winter Weather and Snow and Ice on Roadways

The Build Alternative would be designed to meet existing performance standards, which would account for winter weather operational needs, such as plowing and road treatments. Winter weather conditions that generate snow and ice on roadways would still likely affect the Build Alternative traffic and safety conditions, but to a lesser degree than the No Build Alternative.

Extreme Wind and Vehicle Rollover Potential

For the Build Alternative, the impact from extreme wind and vehicle rollover potential would be the same as the No Build Alternative.

4.22.4.6 Mobility

For the Build Alternative, the alternative modes of transportation, such as bus, bicycle, and walk, would change as described in **Section 4.3, Pedestrian and Bicycle Facilities**.

Sea Level Rise/Storm Surge and Flooded Shared-Use Paths

Alternative modes of transportation within the Bourne North quadrant, in particular, those within Belmont Circle, are vulnerable to coastal inundation with a likelihood of flooding of at least a 1% annual likelihood (or 1-in-4 chance over the next 30 years). The Build Alternative would improve mobility within this area but would also significantly improve mobility outside of this area. Cross-canal pedestrian and bicycle lanes proposed in the Build Alternative would improve hurricane evacuation ability for all road users and would reduce travel within the extent of inundation.

Extreme Precipitation and Localized Stormwater Flooding

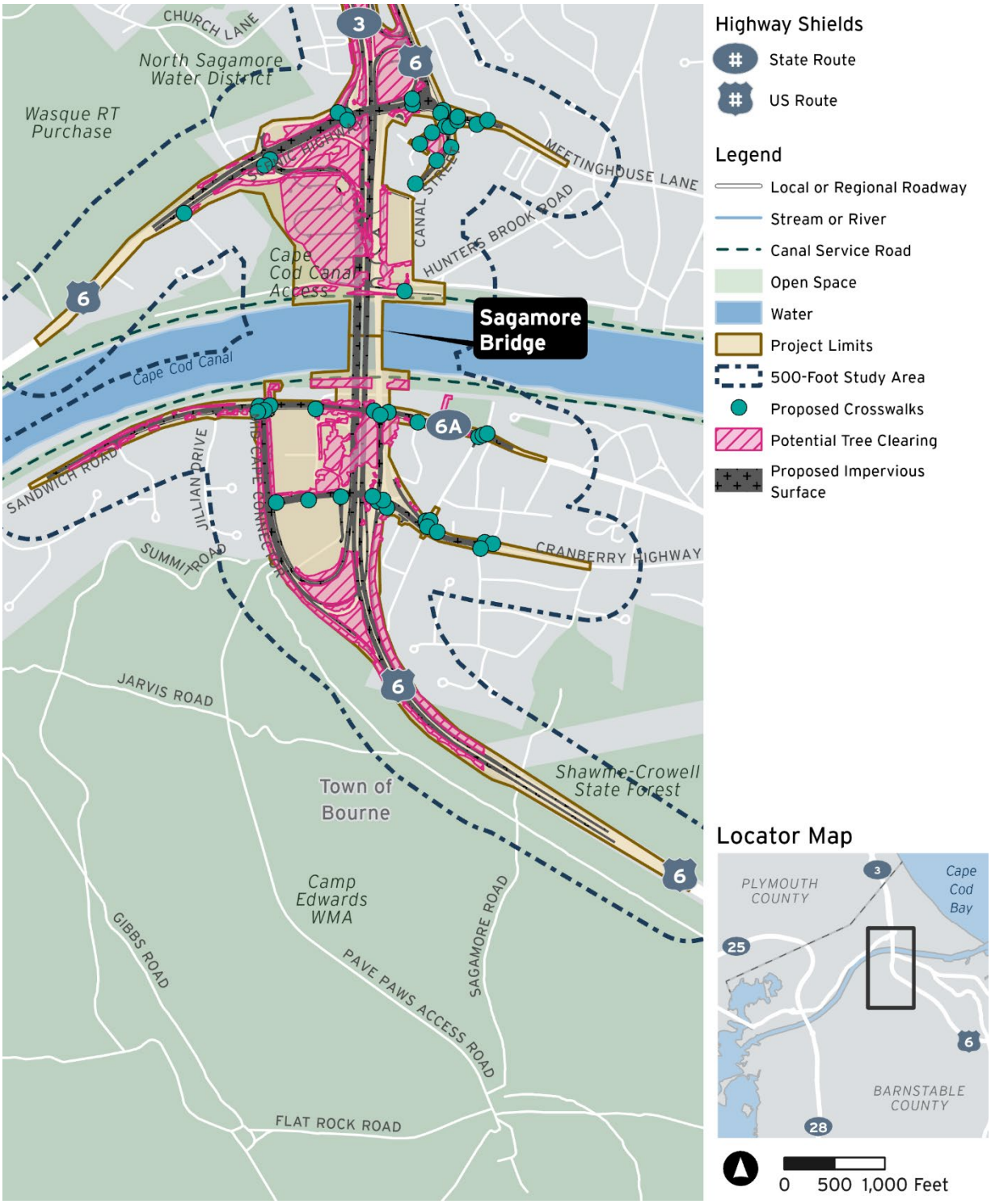
For the Build Alternative, stormwater control measures would function as intended with the projected 2070, 100-year 24-hour rainfall event; as such, localized flooding as a result of impervious surfaces and extreme precipitation will be mitigated through the proposed stormwater control measures presented in **Section 4.11, Water Quality and Stormwater**.

Extreme Heat and Active Transportation Use

Extreme heat events and lack of shade are likely to affect people who use alternative modes of travel proposed in the Build Alternative. These impacts may be more pronounced in areas where tree clearing is required, new impervious surfaces are being proposed, and there are proposed crosswalks where pedestrians are exposed while waiting to cross.

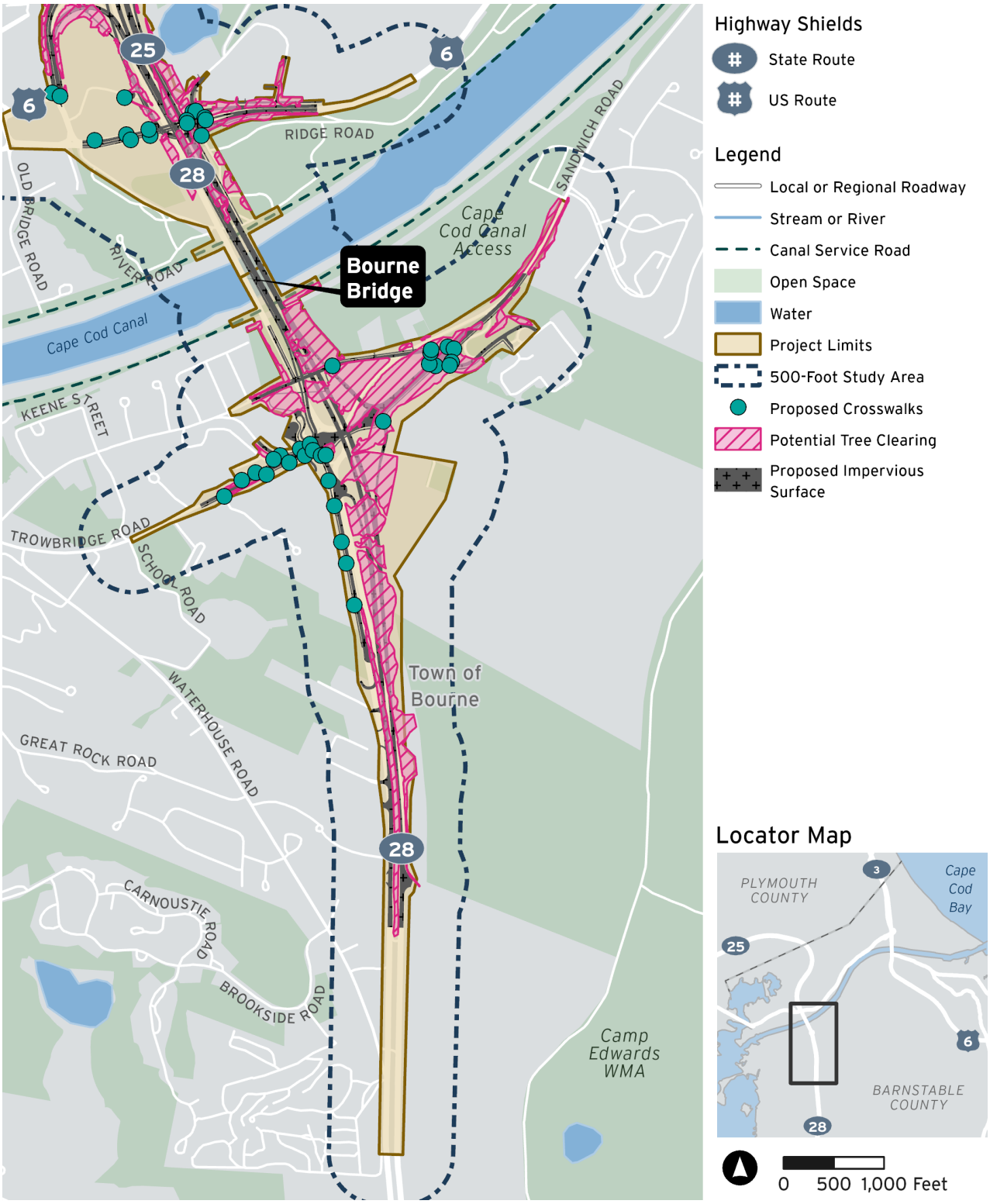
For Sagamore Bridge, these locations would likely include the shared-use path from Scenic Highway to the Canal Service Road, and cross connections from Cranberry Highway, Sandwich Road (State Route 6A) (**Figure 4.22-18**). For Bourne Bridge, these locations would generally be in the area of the replacement Bourne Rotary with a grade-separated diamond interchange and the construction of a new flyover ramp connection from Scenic Highway to State Route 25 westbound (**Figure 4.22-19**).

Figure 4.22-18. Build Alternative: Impervious Surfaces, Tree Clearing, and Crosswalks (Sagamore Bridge Study Area)



Source: Massachusetts Department of Transportation, 2024

Figure 4.22-19. Build Alternative: Impervious Surfaces, Tree Clearing, and Crosswalks (Bourne Bridge Study Area)



Source: Massachusetts Department of Transportation, 2024

4.22.5 Mitigation

This section discusses proposed measures to increase the resilience of the Build Alternative to mitigate impacts on affected environments. Refer to **Appendix 4.22, Climate Change Adaptation and Resiliency Technical Report**, for additional information.

4.22.5.1 Cape Cod Canal

Sea Level Rise and Navigational Clearance

The Build Alternative will be designed to maintain the existing navigational clearance of 135 feet with sea levels 3 feet higher than the existing MHHW.

4.22.5.2 Bridge

Sea Level Rise and Bridge Pier Scour

The Build Alternative for the Sagamore Bridge would be designed to remain stable during the maximum scour design and check events (200-year and 500-year), with and without 7.7 feet of SLR. Mitigation measures will be reassessed for Bourne Bridge pending scour analyses.

Winter Weather and Icing

Deicing measures for bridge cables include a variety of passive mitigation measures, such as modifying the cable surface to reduce size and mass of shed ice fragments or laying heating cables or exchange pipes inside the bridge deck. MassDOT will detail these measures as designs advance, where appropriate, in accordance with best practices.

Extreme Wind and Aerodynamic Stability

The proposed network tied-arch bridges have better resistance against wind-induced vibrations and deformation. The Build Alternative would be designed to remain stable during the extreme wind conditions identified in the wind climate analysis.

4.22.5.3 Stormwater Control Measures

Section 4.11.7 describes the stormwater mitigation measures, which MassDOT based on designing to the projected 2070, 100-year 24-hour rainfall event recommended through the RMAT Tool and the impacts from the four-combination tidal and rainfall events described in the methodology.

Sea Level Rise and Submerged and Partially Submerged Outfalls

Improvements to the existing outfalls are not part of the Build Alternative, but to reduce the risk of backflow into new storm control measures from increased sea levels, backflow preventers or in-pipe tide gates will be considered, where appropriate, to reduce backflow into infiltration basins. MassDOT is developing this mitigation measure and will provide more information in the FEIR.

Sea Level Rise/Storm Surge and Infiltration Basins

The siting and elevations (bottom, overflow, and top) of stormwater infiltration basins proposed for water quality and stormwater mitigation in **Section 4.11.7** will seek to reduce risk of inundation through piped infrastructure and from overland flows.

Extreme Precipitation and Stormwater Control Measure Performance

No mitigation will be required to manage the projected 2070, 100-year 24-hour rainfall event beyond what is proposed in **Section 4.11.7**.

4.22.5.4 Land Cover

Section 4.10, Wetlands and Floodplains, and **Section 4.6, Land Use, Zoning, and Community Cohesion**, describe the land cover mitigation measures.

Sea Level Rise/Storm Surge and Land Subject to Coastal Storm Flowage Function

The Build Alternative would not increase the velocity of moving water or redirect or channelize flow, and it would allow water to spread laterally and landward. The mitigation sections in **Section 4.10, Wetlands and Floodplains,** and **Section 4.11, Water Quality and Stormwater,** describe strategies that will mitigate the impacts of impervious surfaces on infiltration.

Extreme Precipitation and Localized Stormwater Flooding

No mitigation will be required beyond what is proposed in **Section 4.11.7** to manage the projected 2070, 100-year 24-hour rainfall event.

Extreme Heat and Surface Temperatures

Mitigation measures to address potential increases in surface temperature due to increased impervious surfaces and tree clearing will include a comprehensive landscape and vegetation plan. MassDOT is developing the landscape plan and will provide more information in the FEIR.

4.22.5.5 Transportation

Section 4.2, Transportation, Traffic, and Safety, describes the highway transportation, traffic, and safety mitigation measures.

Sea Level Rise/Storm Surge and Flooded Roadways and Evacuation Routes

While the Build Alternative would reduce the impact of flooded roadways and evacuation routes compared to the No Build Alternative, the new traffic patterns should be reviewed and the Cape Cod Emergency Traffic Plan updated as necessary to reflect construction and proposed configurations and flows, as well as remaining flood risk at Belmont Circle. This may include signage and public notices when storms are forecast, as appropriate.

Extreme Precipitation and Localized Stormwater Flooding

No mitigation will be required beyond what is proposed in **Section 4.11.7** to manage the projected 2070, 100-year 24-hour rainfall event.

Extreme Heat and Pavement Performance

MassDOT is considering mitigation measures—such as modifying pavement mixtures to provide additional stability in high temperatures and incorporated balanced mixture design methods to reduce mixture cracking and moisture damage—and will provide more information in the FEIR.

Winter Weather and Snow and Ice on Roadways

MassDOT is considering mitigation measures—such as updated snow and salt management plans for the Program—and will provide more information in the FEIR.

Extreme Wind and Vehicle Rollover Potential

MassDOT is considering mitigation measures—such as installing wind anemometers to measure and report actual wind speeds to Highway Operations, notifying road users of the potential for vehicle rollover, or closing the bridges—will provide more information in the FEIR.

4.22.5.6 Mobility

Section 4.3, Pedestrian and Bicycle Facilities, describes the mitigation measures for pedestrian and bicycle facilities.

Sea Level Rise/Storm Surge and Flooded Shared-Use Paths

While the Build Alternative would reduce the impact of flooded shared use paths and sidewalks compared to the No Build Alternative, MassDOT will communicate the remaining flood risk in the Bourne North quadrant at Belmont Circle to the public. This may include National Weather Service safety signage, such as “Turn around, Don’t drown,” and public notices when storms are forecast, as appropriate.

Extreme Precipitation and Localized Stormwater Flooding

No mitigation will be required beyond what is proposed in **Section 4.11.7** to manage the projected 2070, 100-year 24-hour rainfall event.

Extreme Heat and Active Transportation Use

In addition to identifying opportunities for green infrastructure that will mitigate both extreme precipitation and heat impacts, there may be opportunities to integrate shading features into the bridge fence design that would about the pedestrian path or shaded areas for rest within the approach and arch span cross-sections. Lighter-colored surface materials are recommended to be considered in areas where glare would not affect road user safety. MassDOT is considering these strategies in conjunction with land use mitigation strategies (for example, landscaping plans) and will provide more information in the FEIR.

4 Existing Conditions, Program Impacts, and Mitigation

4.23 Indirect and Cumulative Impacts

4.23.1 Introduction

This section assesses the potential indirect and cumulative impacts of the Build Alternative on the Study Area.

Indirect impacts are those that are caused by an action and are later in time (long-term) or farther removed in distance but are still reasonably foreseeable. These impacts can include inducing changes in patterns of land use, population density or growth rate as well as other related impacts on air, water, and other natural ecosystems, including those that may impact public health. Indirect impacts are considered for environmental resources that exhibit induced changes from project activities.[1] As a result, only indirect impacts from the Build Alternative are considered in this section.

Cumulative impacts are impacts on the environment that result from the Program, in combination with any other projects, and other work or activity in the immediate surroundings and region (301 CMR 11.07(h)).

Past and present activities at Cape Cod Canal include maintenance of the federal navigation channel and routine maintenance of Sagamore and Bourne Bridges. Reasonably foreseeable future actions in the context of the Cape Cod Bridges Program (Program) include the continuation of current maintenance and navigation activities as well as connected bridge approach road work required by the Massachusetts Department of Transportation (MassDOT) to connect new replacement bridges to existing roadways.[2]

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[1] Federal Highway Administration (FHWA). NEPA and Transportation Decisionmaking: Secondary and Cumulative Impact Assessment in the Highway Project Development Process. April 1992. https://www.environment.fhwa.dot.gov/nepa/impact_assessment_highway_dev.aspx

[2] U.S. Army Corps of Engineers. 2022. Environmental Assessment and Finding of No Significant Impact for Major Rehabilitation Evaluation. Cape Cod Canal Highway Bridges, Massachusetts. March. https://www.nae.usace.army.mil/Portals/74/docs/Topics/Cape%20Cod%20Canal%20Bridges/Reports/MRER-Env-Assessment-March2022-FONSI-FINAL.pdf

4.23.1.1 Regulatory Background

Regulatory context and guidance for consideration of potential indirect and cumulative impacts are derived from the following:

- Federal Highway Administration (FHWA). Guidance for Preparing and Processing Environmental and Section 4(f) Documents. Technical Advisory T 6640.8A. October 1987.[3]
- FHWA's Interim Guidance on the Application of Travel and Land Use Forecasting in NEPA, March 2010[4]
- FHWA's Instructions for Reviewing Travel and Land Use Forecasting Analysis in NEPA Documents[5]

Regional and local context informing the assessment of indirect and cumulative impacts is derived from the following:

- Town of Bourne's Local Comprehensive Plan (2019)[6]
- Cape Cod Commission's Regional Policy Plan (2019)[7]
- Cape Cod Regional Transportation Plan[8]
- Cape Cod Climate Action Plan[9]

4.23.1.2 Methodology

Indirect Impacts

The indirect impacts analysis qualitatively assesses the potential indirect impacts of the Build Alternative on the Study Area. The section evaluates the Build Alternative's consistency with local and regional comprehensive plans related to economic development, transportation needs, open space, and land use. The section reviews regional development trends and growth assumptions for Barnstable, Dukes, and Nantucket Counties. Lastly, the indirect impacts analysis discusses the travel time savings and access changes associated with the Build Alternative and assesses the potential for induced regional travel demand and development for the Build Alternative.

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[3] Federal Highway Administration (FHWA). Guidance for Preparing and Processing Environmental and Section 4(f) Documents. Technical Advisory T 6640.8A. October 1987. https://www.environment.fhwa.dot.gov/Legislation/NEPA/guidance_preparing_env_documents.aspx

[4] Federal Highway Administration (FHWA). March 2010. Interim Guidance on the Application of Travel and Land Use Forecasting in NEPA. https://www.environment.fhwa.dot.gov/nepa/Travel_LandUse/travel_landUse_rpt.aspx

[5] Federal Highway Administration (FHWA). February 2018. Instructions for Reviewing Travel and Land Use Forecasting Analysis in NEPA Documents. https://www.environment.fhwa.dot.gov/nepa/Travel_LandUse/forecasting_reviewer_guidance.aspx

[6] Cape Cod Commission. 2019. Town of Bourne Local Comprehensive Plan. https://www.capecodcommission.org/our-work/town-of-bourne-local-comprehensive-plan

[7] Cape Cod Commission. 2019. Regional Policy Plan. https://www.capecodcommission.org/our-work/rpp

[8] Cape Cod Commission. 2024. Cape Cod 2024 Regional Transportation Plan. https://www.capecodcommission.org/our-work/rtp/

[9] Cape Cod Commission. 2021. Cape Cod Climate Action Plan. https://www.capecodcommission.org/our-work/climate-action-plan/

Cumulative Impacts

The cumulative impacts analysis qualitatively assesses the potential cumulative impacts of the Build Alternative on the Study Area in relation to regional transportation plans and initiatives, pedestrian and bicycle improvements, and proximate projects and developments. The analysis identifies current and proposed transportation improvements in collaboration with the Town of Bourne, the Cape Cod Commission, and MassDOT District 5. The analysis reviews the impacts of the Build Alternative in the context of the following:

- Unified Planning Work Program for Fiscal Year 2024
- Cape Cod Commission's Transportation Improvement Program
- Recent and proposed transportation initiatives in the area

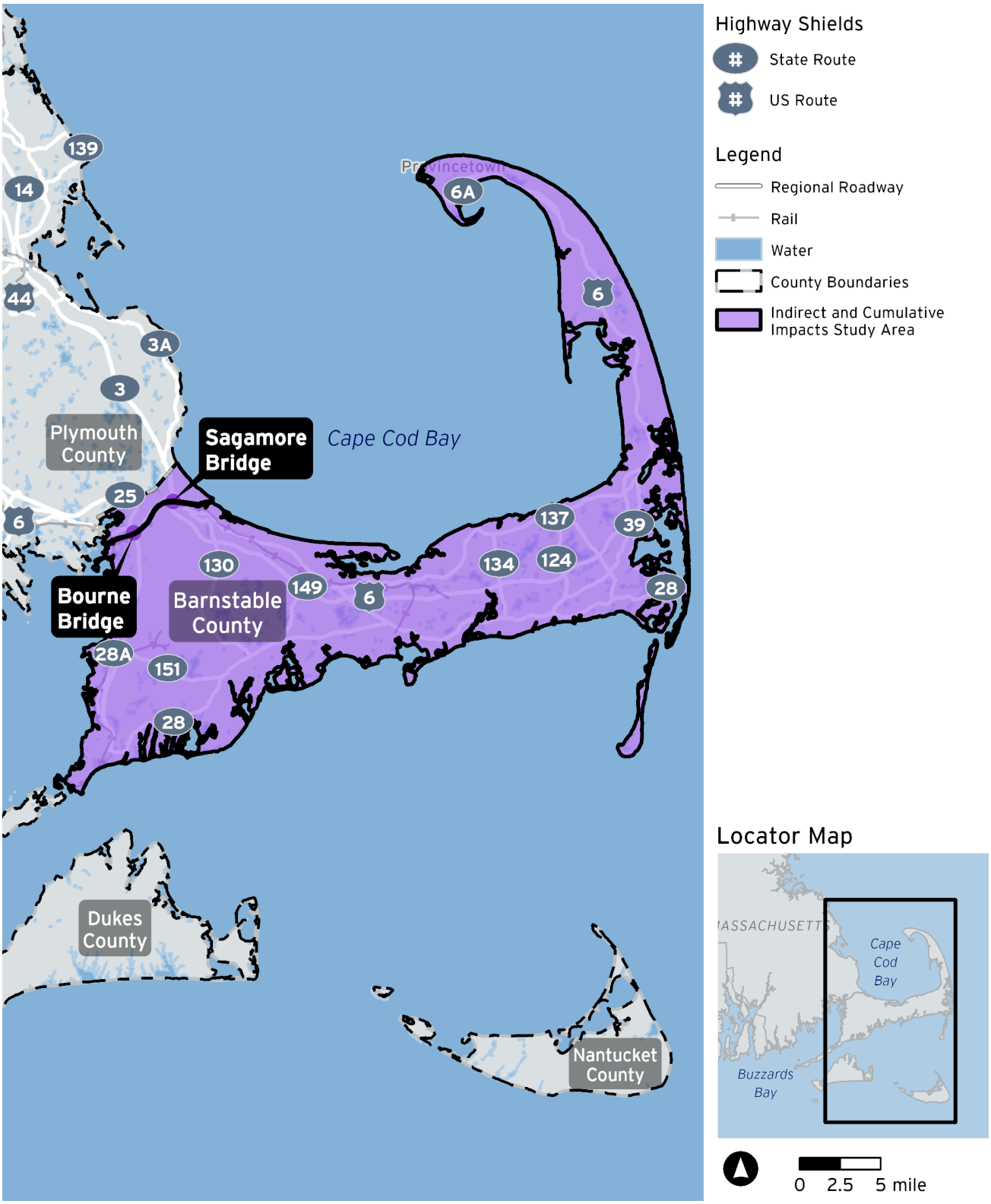
The section assesses how the Build Alternative's pedestrian and bicycle accommodations and connections to the local roadway network align with current and proposed pedestrian and bicycle improvement plans in the town of Bourne, developed in coordination with the Town of Bourne and the Cape Cod Commission. Lastly, the section discusses potential cumulative impacts of the Build Alternative in relation to unrelated, proximate projects and permitted developments in the town of Bourne.

4.23.1.3 Study Area

The Study Area for this indirect and cumulative impacts assessment is Barnstable County (**Figure 4.23-1**). This Study Area was developed to encompass the geographic extent that could be potentially affected by the Build Alternative through indirect and cumulative impacts. The size of the Study Area enables the consideration of impacts that occur later in time, or farther in distance, from the Project Limits, but are still reasonably foreseeable (indirect impacts). The Study Area also considers impacts on the environment resulting from incremental impacts of actions that are aggregated with any other projects and other work or activity in the immediate surroundings and region (cumulative impacts).

Note that for the economic evaluation included in the indirect impact analysis, the Study Area briefly expands to also include Nantucket and Dukes Counties.

Figure 4.23-1. Indirect and Cumulative Impacts Study Area



Source: Massachusetts Department of Transportation, 2024

4.23.2 Indirect Impacts

This section evaluates impacts of the Build Alternative that occur later in time, or farther in distance, from the Project Limits, but are still reasonably foreseeable. Beneficial indirect impacts of the Build Alternative identified in this section include the provision of economic benefits to local and regional economies, the preservation of natural resources on Cape Cod, the creation of reliable mobility opportunities through the implementation of connected and resilient infrastructure, and regional travel time savings resulting in economic and social benefits, including positive impacts on public health. Lastly, this section evaluates the potential for the Build Alternative to create induced travel demand or induced development as a result of the proposed infrastructure improvements.

4.23.2.1 Consistency with Comprehensive Plans

The Build Alternative would be consistent with the Town of Bourne's Local Comprehensive Plan[10] for goals relating to economic development, transportation needs, open space, and land use. **Table 4.23-1** describes this consistency.

Table 4.23-1. Build Alternative: Consistency with the Town of Bourne's Local Comprehensive Plan

Topic	Build Alternative: Consistency with the Local Comprehensive Plan
Economic Development	The Build Alternative's proposed shared-use paths, bike and pedestrian connections would align with the Town of Bourne's vision to support lucrative recreational activities (e.g., boating, golf) and boost the local economy by providing multimodal network connections across the region, and improved access to jobs, schools, and local businesses.[*]
Adequacy of Infrastructure	The Build Alternative would align with the Local Comprehensive Plan's (LCP) goals for infrastructure by improving the flow of through traffic crossing the town of Bourne, replacing the aging canal bridges and the Bourne Bridge Rotary with a conventional highway interchange, by increasing the elevation of the highway bridges by approximately three feet to account for future sea level rise, and by incorporating design features into Program elements to maximize climate resiliency.[*]
Open Space Impacts	The Build Alternative would support the LCP's open space goals by minimizing impacts to open space and enhancing public access through shared-use paths that would provide additional network connections to local roadways. The Build Alternative would also be consistent with the LCP's goal to protect the public rights for fishing, navigation, and recreation, and would maintain and improve navigational passage through Cape Cod Canal.[*]

[10] Cape Cod Commission. 2019. Town of Bourne Local Comprehensive Plan. https://www.capecodcommission.org/our-work/town-of-bourne-local-comprehensive-plan

Topic	Build Alternative: Consistency with the Local Comprehensive Plan
Compatibility with Adjacent Land Uses	Significant alterations to adjacent land uses are not anticipated as a result of the Build Alternative's proposed bridge replacements. Construction impacts would be minimized, which would support the LCP's land use and zoning goals. Additionally, the Build Alternative would support LCP's goals of ensuring that future development respects the town's historic traditions by identifying measures to mitigate the loss of the historic bridges, and by developing the design in coordination with the public.[*]

[*] Massachusetts Department of Transportation. April 2023. Environmental Notification Form. Cape Cod Bridges Program, Bourne, MA.

The Build Alternative would be consistent with the Cape Cod Regional Policy Plan,[11] the Cape Cod Regional Transportation Plan,[12] and the Cape Cod Climate Action Plan[13] for goals relating to economic development, transportation needs, and open space. **Table 4.23-2** describes this consistency.

Table 4.23-2. Build Alternative: Consistency with Regional Plans

Topic	Build Alternative: Consistency with Regional Plans
Economic Development	To improve the efficiency and reliability of freight movement and support economic stability, the Regional Transportation Plan's objectives include reducing delays, improving travel time reliability on the freight network, and minimizing Cape Cod Canal bridge maintenance impacts. By replacing the functionally obsolete bridges, the Build Alternative would address the existing poor traffic operations and the ongoing maintenance needs of the existing bridges while ensuring a stable and robust regional economy.[*]
Adequacy of Infrastructure	The Build Alternative would align with the Regional Policy Plan's goal of developing infrastructure to meet the region's needs while protecting regional resources and promoting long-term sustainability and resiliency. The bridges are being designed to maximize sustainability and resiliency, facilitate more efficient traffic operations to improve travel flow on and off the Cape during emergency events, and to provide for safer and more reliable navigation at the bridge sites.[*] Furthermore, the Build Alternative would enable multimodal transportation options and improve safety for all modes.[*] The Build Alternative would align with the Cape Cod Climate Action Plan's strategies to address vulnerabilities in public infrastructure and manage development in coastal areas by incorporating stormwater improvements, including best management practices and green infrastructure, to provide water quality treatment measures.[*]

[11] Cape Cod Commission. 2019. Regional Policy Plan. https://www.capecodcommission.org/our-work/rpp

[12] Cape Cod Commission. 2024. Cape Cod 2024 Regional Transportation Plan. https://www.capecodcommission.org/our-work/rtp/

[13] Cape Cod Commission. 2021. Cape Cod Climate Action Plan. https://www.capecodcommission.org/our-work/climate-action-plan/

Topic	Build Alternative: Consistency with Regional Plans
Open Space Impacts	The Build Alternative would be consistent with the open space and cultural heritage goals of the Cape Cod Regional Policy Plan. Significant alterations to adjacent land uses, including operational and construction impacts to maritime uses, are not anticipated as a result of the Build Alternative's proposed bridge replacements. The replacement bridges would each have a shared-use path, which would connect residents and visitors to open space recreational areas on both sides of the canal. To address the Regional Policy Plan's cultural heritage goal, the Program would include a Memorandum of Agreement to incorporate measures to mitigate for the demolition of the historic bridges.[*]

[*] Massachusetts Department of Transportation. April 2023. Environmental Notification Form. Cape Cod Bridges Program, Bourne, MA.

4.23.2.2 Regional Development Trends and Growth Assumptions

To evaluate the potential impact of the Build Alternative on future development and growth, this section assesses regional development trends and growth assumptions of Barnstable County (the Indirect and Cumulative Impacts Study Area), Dukes County, and Nantucket County.

According to annual county-based population estimates produced by the U.S. Census Bureau: [14, 15]

- The Barnstable County population decreased by 2% from 2010 to 2019, increased by 12% from 2019 to 2021, and increased by <1% from 2021 to 2024.
- The Dukes County population increased by 5% from 2010 to 2019, increased by 21% from 2019 to 2021, and decreased by approximately 1% annually from 2021 to 2024.
- The Nantucket County population also increased by 11% from 2010 to 2019, increased 27% from 2019 to 2021, and decreased <1% from 2021 to 2024.

The decrease in population growth seen in Barnstable County from 2010 to 2019 can likely be attributed to the historical pattern of retirees moving to Cape Cod, countered by younger adults leaving Cape Cod for work or school. As of 2020, Barnstable County's median age was 55 years, significantly higher than Massachusetts median age of 40 years. Additionally, as of 2023, 34% of the population was aged 65 and over (compared to 18.5% of the Massachusetts population), while only 13.7% were under 18 (compared to 19.2% of the Massachusetts population).[16]

[14] U.S. Census Bureau, Population Division. March 2020. Annual Estimates of the Resident Population for Counties in Massachusetts: April 1, 2010, to July 1, 2019 (CO-EST2019-ANNRES-25). https://www.census.gov/data/datasets/time-series/demo/popest/2010s-counties-total.html

[15] U.S. Census Bureau, Population Division. March 2024. Annual Estimates of the Resident Population for Counties: April 1, 2020, to July 1, 2024 (CO-EST2024-POP25). https://www.census.gov/data/tables/time-series/demo/popest/2020s-counties-total.html

[16] U.S. Census Bureau. QuickFacts: Barnstable County, MA. https://www.census.gov/quickfacts/fact/table/barnstablecountymassachusetts/AGE295221?utm_

Although population grew over 1% in Barnstable County from 2019 to 2021, in all other years from 2000 to 2024, population growth grew at a rate of <1% per year. An average annual growth rate of less than 1% per year is expected to have little to no potential for land use change in the Study Area,[17] and can likely be attributed to limited and seasonal employment opportunities on Cape Cod combined with the high cost of living and housing.

When considering estimated housing growth, a 2012 Cape Cod Commission buildout analysis determined that 27,842 units were available for development in Barnstable County, and a 2017 UMass Donahue Institute housing market analysis estimated potential future demand for 26,000 residential units over a 10-year period. An updated housing market analysis was released in 2023 by the UMass Donahue Institute's analysis which predicted housing unit demand and supply in Barnstable County for 2030, 2040, and 2050. The updated analysis determined that the demand for housing in Barnstable County is projected to exceed housing supply through 2050. Based on a projection of 2020 population figures, the gap between supply and demand for housing units in Barnstable County is estimated at 13,273 units in 2025 and 13,436 in 2030.[18] As a result, residential housing in Barnstable County is expected to be at or above capacity,[19] and any near-term housing growth is expected to consume the remaining supply of developable land regardless of the Program. Residential development in Barnstable County is further stymied by high construction costs,[20] wastewater infrastructure limitations,[21] water supply constraints,[22] and municipal service capacity constraints.

In addition to these housing growth limitations, the existing Barnstable County road network has several bottlenecks that would limit the impact of bridge replacement on future growth and development. According to the 2024-2044 Cape Cod Metropolitan Planning Organization Regional

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17 ECONorthwest & Portland State University. 2001. A Guidebook For Evaluating the Indirect Land Use and Growth Impacts of Highway Improvements: Final Report. April. Prepared for Oregon Department of Transportation. https://www.oregon.gov/odot/Programs/ResearchDocuments/AGuidebookforUsingIndirLand.pdf

18 Cape Cod Commission. Cape Cod Housing Needs. UMass Donahue Institute. 2023. https://capecodcommission.org/resource-library/file/?url=/dept/commission/team/Website_Resources/housing/CC-Housing-Needs-Assessment-2023.pdf&_gl=1*a51bx9*_ga*NzA5NzU0NDAzLjE3Mjk1NDAwMzc.*_ga_LTW77CPM1M*MTc0MTE5NDYwNi4yNC4xLjE3NDExOTYyOTUuMC4wLjA.

19 U.S. Army Corps of Engineers. 2022. Environmental Assessment and Finding of No Significant Impact for Major Rehabilitation Evaluation. Cape Cod Canal Highway Bridges, Massachusetts. March. https://www.nae.usace.army.mil/Portals/74/docs/Topics/Cape%20Cod%20Canal%20Bridges/Reports/MREREnvAssessment.pdf

20 County of Barnstable. 2023. Barnstable County HOME Consortium Program Year 2023 Annual Action Plan. July. https://www.capecod.gov/wp-content/uploads/2022/03/AAP-2023-Approved.pdf

21 Cape Cod Commission. Our Work: Wastewater. Accessed December 2024. https://www.capecodcommission.org/our-work/wastewater/

22 Cape Cod Commission. 2015. Cape Cod Area Wide Water Quality Management Plan Update. June. https://www.capecodcommission.org/resource-library/file/?url=/dept/commission/team/208/208%20Final/Cape_Cod_Area_Wide_Water_Quality_Management_Plan_Update_June_15_2015.pdf

Transportation Plan,[23] and the 2018 Cape Cod Emergency Traffic Plan,[24] there has been a steady increase in traffic throughout Barnstable County, and a proliferation of challenges managing these traffic conditions due to restrictions in route options and capacity. Therefore, despite small, anticipated improvements in travel time, it is unlikely for the Build Alternative to significantly improve access to Barnstable County and increase the number of visitors and development opportunities.[25]

4.23.2.3 Travel Time Savings and Access Changes

According to results of the network-level traffic analysis found in **Section 4.2, Transportation, Traffic, and Safety**, overall network travel time for the Build Alternative is estimated to reduce to 2,240 hours of total travel time compared to the 2,879 hours of total travel time estimated for the No Build Alternative. [26] This indicates that vehicular mobility within the Indirect and Cumulative Impacts Study Area for the 2050 Build Alternative is anticipated to be more efficient than the 2050 No Build Alternative.

The traffic analysis also measured travel time between origin and destination (O-D) points to determine the efficiency of travel along major routes on and near the bridges for the No Build Alternative and Build Alternative. Travel times along all major O-D routes, including cross-canal crossings, are estimated to improve for the 2050 Build Alternative compared to the 2050 No Build Alternative. These estimated reductions in travel times along O-D routes reflect improved accessibility within the Study Area for the Build Alternative.

In addition to vehicular travel time savings and access improvements, the Build Alternative proposes several access improvements for bicyclist and pedestrian travelers, described in detail in **Section 4.3, Pedestrian and Bicycle Facilities.** According to the bicyclist and pedestrian analysis, new bicyclist and pedestrian connections on and near Sagamore Bridge would enable safe and comfortable access for residential neighborhoods to access the Sagamore Park and Ride Lot, the bus depot, and the Canal Service Road for recreational use. On and near Bourne Bridge, new bicyclist and pedestrian connections would provide safe and comfortable access for residents to access local schools, the bus depot, local businesses, and recreational facilities.

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[23] Cape Cod Commission. Cape Cod Regional Transportation Plan 2024-2044. https://www.capecodcommission.org/our-work/rtp

[24] Commonwealth of Massachusetts. 2018. Cape Cod Emergency Traffic Plan. July. https://www.mass.gov/doc/cape-cod-emergency-traffic-plan/download

[25] U.S. Army Corps of Engineers. 2022. Environmental Assessment and Finding of No Significant Impact for Major Rehabilitation Evaluation. Cape Cod Canal Highway Bridges, Massachusetts. March. https://www.nae.usace.army.mil/Portals/74/docs/Topics/Cape%20Cod%20Canal%20Bridges/Reports/MREREnvAssessment.pdf

[26] The network travel times are the summation of the travel times for all vehicles within the network.

4.23.2.4 Induced Travel Demand

This section examines the potential for the Build Alternative to result in induced travel demand due to proposed Program improvements. **Section 4.2, Transportation, Traffic, and Safety,** provides additional detail regarding the estimation of induced travel demand.

As noted in the FHWA's *Interim Guidance on the Application of Travel and Land Use Forecasting in NEPA*,[27] four different components contribute to induced demand, including change in the number of trips, travel routes, mode of travel, and time of travel.

Induced travel demand could occur from new trips due to latent demand or from modifications of existing travel patterns. Trips due to latent demand are identified as new trips that drivers would make if travel conditions improved, such as less congestion or higher design speeds. Socioeconomic factors including changes in households and employment as well as growth in visitor trips can also contribute to latent demand. Based on the most recent 2020 census data, population growth on Cape Cod is expected to remain stagnant and in some areas are expected decline by the year 2050.[28] Factors limiting visitor growth include availability and cost of seasonal rentals, occupancy limits of major attractions, and parking constraints, among others.

In addition, improvements to traffic operations are limited to the bridges and the interchanges directly north and south of the canal. Many visitor trips are long distance in nature, where visitors travel from mainland Massachusetts, New England, and beyond, and involve stays of multiple days. Therefore, changes in travel times are expected to only affect a short portion of a trip. For these reasons, it is not anticipated that there would be a significant increase in the number of trips that would otherwise not travel to Cape Cod due to congestion.

This assessment is supported by the traffic analysis conducted in **Section 4.2, Transportation, Traffic, and Safety,** in which the average annual daily traffic crossing Sagamore and Bourne Bridges for both 2050 No Build Alternative and 2050 Build Alternative conditions is estimated at 129,200 vehicles per day, illustrating that travel time improvements anticipated by this Program are not anticipated to generate additional trips to Cape Cod.

In addition to trips due to latent demand, potential induced travel demand can result from changing travel patterns. The following describes three common causes of induced travel demand that are not due to new travel, but to modifications of existing trip activities:[29]

- Travel routes (route redistribution, where a driver travels across the replacement bridge as a new route instead of using a previous non-bridge-related route) – The bridges provide the only vehicular

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[27] Federal Highway Administration. 2010. Interim Guidance on the Application of Travel and Land Use Forecasting in NEPA. March. https://www.environment.fhwa.dot.gov/nepa/Travel_LandUse/travel_landUse_rpt.aspx

[28] UMass Donahue Institute. 2024. Massachusetts Population Projections 2000-2050. https://donahue.umass.edu/business-groups/economic-public-policy-research/massachusetts-population-estimates-program/population-projections

[29] The Massachusetts Department of Transportation (MassDOT) examined whether these modifications could apply to the replacement Sagamore or Bourne Bridges. MassDOT. 2023. Environmental Notification Form. Cape Cod Bridges Program, Bourne, MA. April.

access across Cape Cod Canal; therefore, it is impossible for there to be induced travel demand resulting from route redistribution.

- Mode of travel (modal shifts from one form of transportation to another, where a transit rider shifts to driving a private vehicle to travel across the bridge) – Improved traffic operations would improve bus travel times and reliability, which may make public transportation a more attractive mode of travel. With improved bicycle and pedestrian facilities, there are also opportunities to convert shorter vehicular trips to alternative modes. However, impacts due to a change in mode of travel are anticipated to be minimal because vehicular traffic would still make up most trips across the canal.
- Time of travel (shifts from off-peak-hour travel to peak-hour travel, where a driver deliberately travels on the bridges during off-peak hours to avoid congestion and then returns to peak-hour travel after the bridge replacement) – Based on traffic modeling conducted for the No Build Alternative and Build Alternative conditions, approximately 25% of the summer Saturday peak-period trip demand could shift to off-peak hours due to added congestion caused by expected seasonal visitor growth. This trip demand could then switch back to peak-hour travel after the bridge completion and travel conditions improve. Based on modeling for the Build Alternative, the travel shifts back to the peak-period traffic would likely occur during the peak summer months and would occur mostly during the Saturday peak. However, the total number of daily vehicle trips are not anticipated to increase.

4.23.2.5 Induced Development

Section 4.5, Socioeconomics, reports and describes the predicted induced economic impacts and associated induced development for the No Build Alternative and Build Alternative for the year 2050. The socioeconomic analysis estimated the creation of 21 jobs on Cape Cod and the Islands (Martha's Vineyard and Nantucket) in 2050 due to operational transportation improvements of the Build Alternative. If this estimated job increase is translated into potential land impacts, at an average of 500 square feet per job,[30] the impact would be approximately 10,500 square feet of new development. In Barnstable County alone there was 26,836,000 square feet of commercial space[31] as of September 2024. Therefore, an additional 10,500 square feet would be an incremental impact of 0.039%, which represents a negligible induced development impact of the Build Alternative. This finding is consistent with the land use and community facility assessments in **Section 4.6, Land Use, Zoning, and Community Cohesion,** and **Section 4.7, Community Facilities**, which illustrate that the Build Alternative would not result in induced development due to direct or indirect impacts.

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[30] Average across all sectors in Cape Cod and the Islands, calculated in **Section 4.5, Socioeconomics**.

[31] Estimated using retail, office, and industrial commercial space estimates in Barnstable County using CoStar Property Information Systems, September 2024. https://www.costar.com

4.23.2.6 Other Indirect Impacts

As discussed in **Section 4.5, Socioeconomics**, the socioeconomic impacts of construction expenditures of the two bridges includes consideration of indirect and induced impacts on business output, household earnings, employment, gross domestic product, and state, local, and federal taxes. Indirect impacts capture the supply chain response, while induced impacts reflect increased household spending from wages earned. Refer to **Table 4.5-18** for the economic and fiscal impacts of the Program, which includes consideration of indirect and induced impacts.

The Build Alternative would not result in indirect impacts to inland wetlands or coastal resource areas that would result in changes to the functions and values in terms of the overall wetland hydrology, cover type, or fragmentation. The Build Alternative impacts would not result in isolated fragments of wetlands or waterways. Potential indirect impacts include the unintended introduction of invasive plant species as discussed in **Section 4.10, Wetlands and Floodplains**.

As discussed in **Section 4.14, Air Quality and Greenhouse Gas Emissions**, the greenhouse gas mesoscale analysis performed for the Program includes indirect emissions from the full life cycle of emissions (i.e., fuel consumption, upstream emissions, etc.). Therefore, indirect greenhouse gas emissions of the Build Alternative are captured in the total projected annual greenhouse gas emissions presented in **Table 4.14-4**.

As discussed in **Section 4.20, Public Health**, the Build Alternative would provide substantial operational benefits that would positively contribute to public health, including traffic safety and operations, active transportation safety and mobility, reduced mobile source greenhouse gas emissions, and reduced likelihood of exposure to hazardous materials, new permanent stormwater control measures, and a reduction in operational noise impacts. These benefits of the Build Alternative would contribute to improved public health outcomes within the Study Area over the long term.

4.23.2.7 Indirect Impacts Summary

This section evaluates the Build Alternative's consistency with comprehensive plans, regional development trends and growth assumptions, anticipated travel time savings and access changes, and the potential for induced travel development demand. While MassDOT considered the Build Alternative's potential to result in reasonably foreseeable indirect impacts to all environmental impact categories considered in the DEIS, MassDOT determined that the reasonably foreseeable indirect impacts of the Build Alternative would include economic, environmental, and transportation benefits, and result in negligible travel and development demand impacts. **Table 4.23-3** summarizes those indirect impacts that would result from the Build Alternative:

Table 4.23-3. Build Alternative: Summary of Indirect Impacts

Section	Summary of Indirect Impacts
Section 4.2, Transportation, Traffic, and Safety	Improves vehicular mobility for 2050 conditions, including reduced network travel time and along major origin-destination routes (refer to **Section 4.23.2.3**). No induced travel demand anticipated (refer to **Section 4.23.2.4**).
Section 4.3, Pedestrian and Bicycle Facilities	New bicyclist and pedestrian connections would promote multimodal access to surrounding facilities and network connections across the region (refer to **Section 4.23.2.3**). Minimal impacts associated with mode shift from vehicles to alternative modes could occur (refer to **Section 4.23.2.4**).
Section 4.5, Socioeconomics	Construction expenditures would contribute to indirect economic impacts associated with supply chain response and increased household spending from wages earned (refer to **Section 4.5.2**). Creates 21 jobs on Cape Cod and the Islands (Martha's Vineyard and Nantucket) by 2050 (refer to **Section 4.23.2.5**).
Section 4.6, Land Use, Zoning, and Community Cohesion	No indirect impacts anticipated. Other factors, such as high cost of living and housing, seasonal employment, and other transportation bottlenecks, would likely constrain visitation and development within Barnstable County regardless of the Build Alternative (refer to **Section 4.23.2.2**).
Section 4.10, Wetlands and Floodplains	Potential unintended introduction of invasive plant species (refer to **Section 4.10.4.2**).
Section 4.14, Air Quality and Greenhouse Gas Emissions	Indirect greenhouse gas emissions, including upstream emissions, associated with the full life-cycle of fuel consumption (refer to **Section 4.14**).
Section 4.21, Public Health	Improves public health outcomes over the long term (refer to **Section 4.21**).

4.23.3 Cumulative Impacts

Cumulative impacts are impacts on the environment that result from the Program in combination with any other projects, and other work or activity in the immediate surroundings and region. This section discusses the Build Alternative's potential cumulative impacts, including impacts relative to regional transportation plans and initiatives, pedestrian and bicycle improvement plans, and proximate projects and developments.

4.23.3.1 Past Transportation Activities

As described in **Section 4.23.1**, past activities at Cape Cod Canal include maintenance of the federal navigation channel and routine maintenance of Sagamore Bridge and Bourne Bridge. Due to the negligible impacts of the routine maintenance, it is not anticipated that these past activities would contribute to cumulative impacts resulting from the Build Alternative.

4.23.3.2 Current and Proposed Transportation Improvements

Table 4.23-4 lists current and proposed transportation improvements in the Program Study Area as indicated in the Federal Fiscal Year (FFY) 2025-2029 Transportation Improvement Program (TIP) for the Cape Cod Metropolitan Planning Organization.[32] These TIP projects are included in the consideration of impacts for the No Build Alternative and Build Alternative.

Table 4.23-4. Transportation Improvement Program Projects Proximate to the Cape Cod Bridges Program

Project Number	Year	Transportation Project	Project Description
606900	2020	Belmont Circle Traffic and Multimodal Improvements	Traffic and multimodal improvements at Belmont Circle at U.S. Route 6 and State Route 25 and State Route 28
608422	2022	Trail Improvements – Sandwich	Shared-use path on Service Road (State Route 130 to Chase Road)
610542	2023	Bourne Rotary Improvements	• Restriping Bourne Rotary to two lanes and adding a channelized right-turn lane from State Route 28 northbound to Sandwich Road eastbound • Adding signs at Bourne Rotary • Installing flashing beacons at the Bourne Rotary approaches
613195	2024	Bridge Systematic Maintenance	Bridge deck replacement of the Quaker Meetinghouse Road Bridge over U.S. Route 6/Mid-Cape Highway as part of an overall bridge preservation strategy
609262	2025	Bourne Rail Trail, Phase 1	First phase of four planned phases of the Bourne Rail Trail connection to the Shining Sea Bikeway to the south in Falmouth and to the Cape Cod Canal path (Canal Service Road) in the town of Bourne; Phase 1 is approximately one-half mile long within the existing right-of-way of the Old Colony Railroad (Woods Hole branch line) from the Canal Service Road to Monument Neck Road.
610673	—	Bourne Rail Trail, Phase 2	Phase 2 of four planned phases of the Bourne Rail Trail connection to Shining Sea Bikeway to the south in Falmouth and to the Cape Cod Canal path (Canal Service Road) in the town of Bourne; Phase 2 is approximately 2 miles long from Monument Neck Road to Monk's Park/ Valley Bars Road.

[32] The TIP was endorsed on May 20, 2024, with subsequent amendments on November 18, 2024; December 16, 2024; February 24, 2025; and an adjustment on March 24, 2025.

Project Number	Year	Transportation Project	Project Description
	—	Bourne Rail Trail, Phase 3 and Phase 4A	Phase 3 and Phase 4A of four planned phases of the Bourne Rail Trail connection to Shining Sea Bikeway to the south in Falmouth
607394/ 611998	—	Bourne Rail Trail, Phase 4B	Phase 4B of four planned phases of the Bourne Rail Trail connection to the Shining Sea Bikeway to the south in Falmouth and to the Cape Cod Canal path (Canal Service Road) in the town of Bourne; Phase 4B is approximately 1 mile long, extending the Shining Sea Bikeway from its current terminus in North Falmouth into the town of Bourne.
606082	2025–2028	U.S. Route 6 Scenic Highway Median Installation [1]	• Resurfacing • Safety improvements, including a raised center median and expanded shoulders to separate eastbound and westbound travel lanes • Drainage improvements • Traffic signal improvements at two intersections • Shared-use path
612053	2025	Bourne/Sandwich, Resurfacing and Related Work on U.S. Route 6	Improvements to pavement serviceability, condition, and roadway safety on U.S. Route 6 from Sagamore Bridge to the Sandwich town line (8.55 miles)
613200	2026	Chase Road over U.S. Route 6 Bridge	Bridge deck replacement of Chase Road over U.S. Route 6 (Mid-Cape Highway) bridge structure in the town of Sandwich
612063	2028	State Route 28 Resurfacing and Related Work	Improvements to pavement serviceability, condition, and roadway safety on MacArthur Boulevard (State Route 28) from Bourne Rotary to Otis Rotary
613199	2028	U.S. Route 6 over State Route 130 Bridge	Bridge deck replacement of U.S. Route 6 (Mid-Cape Highway) bridge structure over State Route 130 in the town of Sandwich
613271	—	Shared-use path, State Route 130 to Canal Service Road	Shared-use path from State Route 130 to Canal Service Road in the town of Sandwich

Note: **Table 4.23-4** includes only those projects in the Study Area that are part of the No Build Alternative. It does not include Project S13144, the replacement of the Sagamore Bridge, which was added to the FFY 2025-2029 TIP as Amendment #2, December 9, 2024.

— No date available.

[1] This project has been reviewed under the Massachusetts Environmental Policy Act (MEPA) as the Median Installation on Route 6 project, EEA #16739. The MEPA filing for this project outlines the anticipated environmental impacts and corresponding mitigation measures that will be implemented as part of this project.

It is anticipated that the TIP projects in **Table 4.23-4** would result in the following benefits:

- Improved traffic flow and reduced congestion due to the restriping and addition of a channelized right-turn lane (Project 610542), and traffic and multimodal improvements (Project 606900).
- Enhanced safety with the installation of flashing beacons and additional signage (Project 610542), the separation of eastbound and westbound travel lanes (Project 606082), and improved road surface condition (Project 612063).
- Promotion of healthier lifestyles and eco-friendly transportation by providing opportunities for active transportation and recreation, and reducing vehicle emissions (Project 608422, 606082, 609262, 610673, 607394/611998).
- Improved multimodal access and connectivity, benefiting pedestrians, cyclists, and public transit users (Project 606900, 608422).
- Creation of a continuous, safe, and scenic route for cyclists and pedestrians (Project 609262, 610673, 607394/611998).
- Enhanced driving experience and reduced vehicle maintenance costs (Project 612063).

In addition to these benefits, the TIP projects could also result in potential short-term traffic disruptions during construction and a potential increase in traffic noise during construction. However, many of these projects will be completed prior to the construction and implementation of the new bridges. Ongoing projects would not worsen temporary construction conditions associated with the Build Alternative due to construction phasing and coordination between design teams.

The benefits described above align with and complement the predicted mobility, accessibility, and safety impacts of the Build Alternative on transportation in the Study Area. The implementation of these TIP projects would support and facilitate the benefits of the Build Alternative before the Build Alternative becomes operational. As a result, it is anticipated that the Build Alternative would result in positive cumulative impacts for the regional transportation system.

4.23.3.3 Impacts Relative to Regional Transportation Plans and Initiatives

In considering cumulative impacts relative to regional transportation planning initiatives, the Build Alternative aligns with and helps to achieve many of the goals of the 2024 Regional Transportation Plan. These goals include the following:[33]

[33] Cape Cod Commission. 2023. Cape Cod Unified Planning Work Program for Federal Fiscal Year 2024. May. https://www.capecodcommission.org/resource-library/file/?url=/dept/commission/team/tr/Transportation%20Plans/UPWP/24UPWP/Report/Final_Cape_Cod_2024_Unified_Planning_Work_Program.pdf

- Providing safe travel options for all users
- Maintaining, protecting, and enhancing the natural environment while strengthening the economy
- Supporting livable communities and village centers that strengthen the long-term sustainability of the region
- Providing a variety of healthy transportation options to all users
- Reducing congestion and improve travel time reliability
- Preserving, maintaining, and modernizing the existing transportation system
- Improving efficiency and reliability of freight movement

The Build Alternative would improve vehicular, pedestrian, and bicyclist safety on and near the bridges, and would provide new shared-use paths on and near the bridges that would provide new, healthy transportation options for users. Congestion and travel time would be reduced because of the Build Alternative, and truck freight reliability would be increased as a result. The Build Alternative aims to safeguard the natural environments of Cape Cod while strengthening the regional economy by providing sustainable connections on and off Cape Cod for locals, commuters, and tourists, alike.

In considering recent and proposed transportation initiatives, the Build Alternative would align with all short- and long-range transportation planning projects identified in the Unified Planning Work Program and would directly support the proposed Transportation Safety/Road Safety Audits and the Sidewalk Connections to Bus Stops & Multifamily Housing projects.[34]

The Build Alternative's interchange and bridge design is based on up-to-date safety and design standards, improving safety outcomes in and around the Study Area. This would reduce the number of dangerous road sections on Cape Cod, which would reduce vehicular crashes and improve the efficiency of the Transportation Safety/Road Safety Audits. As previously described, the Build Alternative's interchange and bridge designs include a new shared-use path across the bridge and much needed sidewalk and bike connections on and off the bridges, which would allow safe navigation around the bridges. The Build Alternative would facilitate improved sidewalk connections to bus stops near the bridges, which would align with the goals of the Sidewalk Connections to Bus Stops & Multifamily Housing projects.

Lastly, the Build Alternative would align with and support development of TIP projects listed in **Table 4.23-4** by providing safe, reliable, and efficient access across the bridges for vehicles, buses, pedestrians, and bicycles.[35] These improvements are anticipated to reduce congestion and improve

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[34] Cape Cod Commission. 2023. Cape Cod Unified Planning Work Program for Federal Fiscal Year 2024. May. https://www.capecodcommission.org/resource-library/file/?url=/dept/commission/team/tr/Transportation%20Plans/UPWP/24UPWP/Report/Final_Cape_Cod_2024_Unified_Planning_Work_Program.pdf

[35] Cape Cod Commission. 2023. Cape Cod Unified Planning Work Program for Federal Fiscal Year 2024. May. https://www.capecodcommission.org/resource-library/file/?url=/dept/commission/team/tr/Transportation%20Plans/UPWP/24UPWP/Report/Final_Cape_Cod_2024_Unified_Planning_Work_Program.pdf

traffic flow, reduce crashes and improve safety, improve drainage systems, create healthy transportation options for travelers crossing the bridges, and improve pedestrian and bicyclist connectivity throughout communities of the Upper Cape.

Considering the alignment of project goals in the 2024 Regional Transportation Plan, Unified Planning Work Program, and TIP with the Build Alternative, and the emphasis on maintaining, protecting, and enhancing the natural environment and creating alternative, active transportation options on and near the bridge, the Build Alternative is not expected to have significant cumulative impacts on the environment relative to regional transportation plans and initiatives.

4.23.3.4 Impacts Relative to Pedestrian and Bicycle Improvement

The Build Alternative's pedestrian and bicycle accommodations include a shared-use path across the bridge, and connections to and from the bridges for pedestrians and bicyclists, linking travelers to sidewalks and the Canal Service Road shared-use paths. These accommodations align with the Town of Bourne and the Cape Cod Commission's current and proposed pedestrian and bicyclist improvement plans.

The Town of Bourne's Open Space and Recreation Plan features a goal of preserving and enhancing both passive and active recreational opportunities for visitors and residents of the town of Bourne, regardless of age or ability. To achieve this goal, the plan cites improving pedestrian and bicyclist access to recreational areas in the town of Bourne and creating additional entry points to the canal.[36]

The Town of Bourne's Local Comprehensive Plan contains the goal of expanding non-vehicular travel options, creating multimodal facilities on the bridge, and improving traffic flow on the bridge to benefit all road users through bridge lane and interchange redesign.[37]

Lastly, the Cape Cod Commission's Complete Streets Prioritization Plan for the town of Bourne prioritizes projects that provide safe and accessible options for all travel modes, for people of all ages and abilities. The Town of Bourne's Complete Streets Prioritization Plan focuses on developing a connected and integrated network that serves all road users.[38]

Each of these current and future plans align with the Build Alternative's proposed pedestrian and bicycle accommodations. Considering the emphasis on improving pedestrian and bicyclist connectivity and reducing vehicular usage, the Build Alternative is not expected to have cumulative impacts on the environment relative to pedestrian and bicyclist improvements.

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[36] Town of Bourne. 2018. Open Space and Recreation Plan. February. https://www.townofbourne.com/sites/g/files/vyhlif12841/f/uploads/open_space_plan_fina_2018.pdf

[37] Cape Cod Commission. 2019. Town of Bourne Local Comprehensive Plan. https://www.capecodcommission.org/our-work/town-of-bourne-local-comprehensive-plan

[38] Cape Cod Commission. 2022. Town of Bourne Complete Streets Prioritization Plan. April. https://www.capecodcommission.org/resource-library/file/?url=/dept/commission/team/tr/Shared%20Documents/TechnicalAssistance/BOURNE/2020%20Bourne%20Bike%20Plan/Report/Final%20PDF/Bourne%20Complete%20Streets%20Report_04_25_2022.pdf

4.23.3.5 Impacts Relative to Proximate Projects and Developments

Separate from the Program, but close in proximity, is the Enbridge Cape Cod Canal Pipeline Relocation Project. A discussion of the Enbridge Cape Cod Canal Pipeline Relocation Project is provided in **Section 4.20, Utilities and Services**.

Also separate from the Program, are several distinct, private permitted developments near Bourne and Sagamore Bridges. While MassDOT has considered these developments as part of its cumulative impacts analysis, they comprise independent undertakings that, in combination with the Program, are not part of a common plan of development. **Table 4.23-5** lists these developments and describes their permit status, according to the Town of Bourne's Planning Department, as of December 16, 2024.[39]

Table 4.23-5. Permitted Developments Proximate to Sagamore and Bourne Bridges

Map and Parcel ID	Address	Permit Status
20.4_006.00	340 and 340R Main Street, Bourne	Special permit and building permit issued
20.3_135.00	328 Main Street, Bourne	Special permit issued
24.0_019.00	6 MacArthur Boulevard, Bourne	Special permit issued
24.0_022.00	4 MacArthur Boulevard, Bourne	Special permit issued
24.0_023.00	2 MacArthur Boulevard, Bourne	Special permit issued
24.0_007.00	2 Bourne Rotary, Bourne	Special permit issued
11.0_027.00	21 Canal Street, Bourne	Special permit issued
07.0_086.00	6 Cape View Way, Bourne	Building permit issued; construction underway
07.0_087.00	8 Cape View Way, Bourne	Building permit issued; construction underway
07.0_088.00	10 Cape View Way, Bourne	Building permit issued; construction underway
07.0_089.00	11 Cape View Way, Bourne	Building permit issued; construction underway
07.0_090.00	12 Cape View Way, Bourne	Building permit issued; construction underway

As described in the indirect impacts section, the Build Alternative is anticipated to have a negligible impact on induced development. The developments listed in **Table 4.23-5** do not interfere with the Build Alternative's construction and staging plans, and once built, the successful operation of the Build Alternative is anticipated to enable more efficient mobility for residents and workers living and working in the new developments.

Due to the proximity of certain developments to the construction extent of the Build Alternative, noise and vibration impacts of the Build Alternative on developments within the Noise Study Area are assessed in **Section 4.15, Noise and Vibration**. Any temporary noise or vibration impacts would be

[39] Based on data provided by the Town of Bourne (August 14, 2024) through the Bourne public data request portal and based on subsequent email and phone correspondences with Jennifer Copeland, Town Planner at the Town of Bourne (last updated December 16, 2024).

mitigated through measures laid out in the Program's Construction Noise Control Plan, which would be implemented in compliance with MassDOT specifications for construction noise control.

4.23.3.6 Cumulative Impacts Summary

This section evaluates the Build Alternative's potential cumulative impacts in combination with regional transportation plans and initiatives, pedestrian and bicycle improvement plans, and proximate projects and developments. MassDOT determined that the cumulative impacts of the Build Alternative would include regional transportation benefits, multimodal safety, connectivity, and accessibility, and improved mobility to new developments proposed in the Study Area. In consideration of these cumulative impacts that would occur from the Build Alternative, **Table 4.23-6** summarizes those impacts relative to each environmental resource.

Table 4.23-6. Build Alternative: Summary of Cumulative Impacts

Section	Summary of Cumulative Impacts
Section 4.2, Transportation, Traffic, and Safety	The Build Alternative, in combination with the other projects identified in the 2025-2029 Transportation Improvement Program (TIP), would result in positive cumulative impacts for the regional transportation system, including improved traffic flow, enhanced safety and driving experiences, and reduced vehicle maintenance costs. Some cumulative impacts during construction, such as traffic disruption, could occur. Design teams would coordinate construction phasing among nearby projects to minimize the potential for cumulative impacts from traffic disruptions.
Section 4.3, Pedestrian and Bicycle Facilities	The Build Alternative, in combination with the other projects identified in the 2025-2029 TIP, would result in positive cumulative impacts for multimodal access and connectivity, benefiting pedestrians and cyclists.
Section 4.4, Maritime Transportation, Traffic, and Safety	MassDOT does not anticipate that other proximate projects and developments would affect maritime transportation, traffic, and safety. Therefore, no cumulative impacts to this resource are anticipated.
Section 4.5, Socioeconomics	The construction of other proximate projects and developments may have similar construction-related socioeconomic impacts as those identified for the Build Alternative, including generating economic output and supporting jobs.
Section 4.6, Land Use, Zoning, and Community Cohesion	The Build Alternative, in combination with other proximate projects and developments, would result in additional land alteration, including tree clearing. However, all proposed projects and developments are reviewed by the respective municipality prior to permit issuance, so any cumulative impacts associated with approved developments would likely be consistent with local land use plans and policies.
Section 4.7, Community Facilities	The Massachusetts Department of Transportation (MassDOT) does not anticipate that other proximate projects and developments would affect community facilities. Therefore, no cumulative impacts to this resource are anticipated.

Section	Summary of Cumulative Impacts
Section 4.8, Property Acquisition, Displacement, and Relocation	MassDOT does not anticipate that other proximate projects and developments would affect property acquisition, displacement, and relocation. Therefore, no cumulative impacts to this resource are anticipated.
Section 4.9, Environmental Justice	Other proximate projects and developments, including transportation projects, would likely provide similar benefits to Environmental Justice populations as those for the Build Alternative, including improved traffic operations and safety, emergency response time, multimodal accommodations, and air quality, resulting in positive cumulative impacts.
Section 4.10, Wetlands and Floodplains	Other proximate projects and developments, including transportation projects, could result in impacts to wetlands and floodplains. However, MassDOT anticipates that those impacts would be similarly mitigated as those proposed for the Build Alternative, so no cumulative impacts are anticipated.
Section 4.11, Water Quality and Stormwater	Other proximate projects and developments, including transportation projects, could result in stormwater generated during construction and operation of those projects. However, MassDOT anticipates that any impacts would be similarly mitigated as those proposed for the Build Alternative, so no cumulative impacts are anticipated.
Section 4.12, Threatened, Endangered, and Protected Species and Habitats	Other proximate projects and developments, including transportation projects, could have potential to affect threatened, endangered, and protected species or their habitats. However, MassDOT anticipates that any potential impacts would be similarly mitigated as those proposed for the Build Alternative, so no cumulative impacts are anticipated.
Section 4.13, Coastal Zone Consistency and Chapter 91 Waterways Review	MassDOT does not anticipate that other proximate projects and developments would affect coastal zone consistency. Therefore, no cumulative impacts to this resource are anticipated.
Section 4.14, Air Quality and Greenhouse Gas Emissions	Other proximate projects and developments, including transportation projects, could result in air emissions during construction. However, MassDOT anticipates that any potential impacts would be similarly mitigated as those proposed for the Build Alternative, so no cumulative impacts are anticipated.
Section 4.15, Noise and Vibration	Other proximate projects and developments, including transportation projects, could result in noise and vibration during construction. However, MassDOT anticipates that any potential impacts would be similarly mitigated as those proposed for the Build Alternative, so no cumulative impacts are anticipated.
Section 4.16, Visual Resources	MassDOT does not anticipate that other proximate projects and developments would affect visual resources. Therefore, no cumulative impacts to this resource are anticipated.

Section	Summary of Cumulative Impacts
Section 4.17, Cultural Resources	Other proximate projects and developments, including transportation projects, could have potential to affect cultural resources. However, MassDOT anticipates that any potential impacts would be similarly mitigated as those proposed for the Build Alternative, so no cumulative impacts are anticipated.
Section 4.18, Public Parks, Recreational Facilities, and Open Space	MassDOT does not anticipate that other proximate projects and developments would affect public parks, recreational facilities, and open space resources. Therefore, no cumulative impacts to this resource are anticipated.
Section 4.19, Solid and Hazardous Waste Material Management	Other proximate projects and developments, including transportation projects, could generate or encounter solid or hazardous waste requiring special handling procedures. However, MassDOT anticipates that any potential impacts would be similarly mitigated as those proposed for the Build Alternative, so no cumulative impacts are anticipated.
Section 4.20, Utilities and Services	Other proximate projects and developments, including transportation projects, could result in temporary impacts to utilities and services if they needed to be relocated as part of construction. However, MassDOT anticipates that any potential impacts would be similarly mitigated as those proposed for the Build Alternative, so no cumulative impacts are anticipated.
Section 4.21, Public Health	The Build Alternative, in combination with the other projects identified in the 2025-2029 TIP relating to active transportation improvements, would result in positive cumulative impacts on public health.
Section 4.22, Climate Change Adaptation and Resiliency	MassDOT does not anticipate that other proximate projects and developments would affect climate change adaptation and resiliency. Therefore, no cumulative impacts to this resource are anticipated.

5 Construction Approach

5.1 Introduction

This chapter describes construction period activities, including sequencing, traffic management, land-based and in-water work, and site maintenance and restoration. Detailed assessments of construction period impacts and mitigation strategies are provided in **Sections 4.1 through 4.23 of Chapter 4, Existing Conditions, Program Impacts, and Mitigation**. As described in the following sections, the Design-Build (D-B) Team may propose alternative construction methods. However, the construction scenarios presented in this chapter and impact analyses presented in **Chapter 4** are based on the preliminary design and were developed in consultation with a construction specialist.

5.2 Overview of Design-Build Construction Method

The Massachusetts Department of Transportation (MassDOT) will be using a "Best Value" (D-B) procurement method for the construction of the Cape Cod Bridges Program, pursuant to Massachusetts General Law Chapter 149A. As described in **Chapter 1, Introduction**, the Cape Cod Bridges Program is planned to be delivered in two phases, with the Sagamore Bridge Replacement Project as Phase 1 Project and the Bourne Replacement Project as Phase 2 Project.

A D-B process is a construction delivery system that combines design services and construction services within a single contract. A "best value" method is one that that provides that highest overall value to MassDOT, considering both cost and quality. Section 15 of Massachusetts General Law Chapter 149A defines quality as the basis on which MassDOT will evaluate the elements of a project that MassDOT has determined are most important to the project, including, for example, quality of design, innovative approach, constructability, life-cycle cost and other long-term maintenance costs, maintenance of traffic, aesthetics, environmental impacts, local impacts, traveler and other user costs, service life, and time to construct.

The D-B method can provide substantial time savings compared to the more traditional Design-Bid-Build approach, which typically involves three sequential project phases consisting of the:

1. Design Phase, in which MassDOT contracts separately with a design firm for project design development, progressing from preliminary to final design, and preparation of construction documents
2. Bid Phase, when the construction documents are available for general contractor review and pricing (bidding)
3. Build or Construction Phase, when the project is built by the selected (the lowest bid) contractor

The sequential nature of the Design-Bid-Build project delivery method can result in project delays as construction cannot begin until the design and procurement phases have been completed.

By awarding one contract under the D-B procurement method, there is no bidding phase, or delay, between the final design and construction phases. In addition to accelerating project delivery by

integrating the design and construction phases, other benefits of the D-B procurement method include:

- Greater cost and schedule control through the use of incentives and disincentives
- Close collaboration between the design and contractor that can promote development of innovative design and construction methodologies to reduce environmental and traffic-related impacts to the maximum extent feasible
- Reduced overall project risk as the D-B entity has responsibility for design and construction under a single contract

The Best Value D-B procurement method is a two-phase selection process, which begins after MassDOT issues public notice of a project and solicits and receives Letters of Interest from proposers. In Phase 1, MassDOT will create a short list of qualified D-B entities (proposers) based on the responses to its Request for Qualifications. In Phase 2, MassDOT will receive technical and price proposals from the short list of proposers based on its Request for Proposals. MassDOT will then award the construction contract to one proposer (a D-B team) based on Best Value, the highest overall value to MassDOT, considering quality and cost. Given the scale of the Cape Cod Bridges Program and the environmental resources within and abutting the Program study areas, MassDOT's evaluation of technical proposals will incentivize environmental mitigation strategies, which may include alternative designs or construction methods that minimize impacts.

Under the D-B procurement method for the Cape Cod Bridges Program (Phase 1 Project), MassDOT's advertised construction contract (Request for Proposals) will provide the Base Technical Concept, defined as approximately 25% level of design, to establish the minimum baseline requirements that must be equaled or exceeded by the D-B team. The awarded D-B team will be required to complete final design and construct the Phase 1 Project in compliance with regulatory permits and approvals, and within the timeframe to be determined the Project schedule, as well as the Project Management Plan, Quality Management Plan, Site Control Plan, Construction Staging Plan, Noise and Dust Control Plans, Health and Safety Plan and all other applicable laws, negotiations, regulations, ordinances, and other requirements, taking into account the right-of-way and other physical constraints affecting the Program. Further, all final Program design and construction components will be reviewed by MassDOT and performed in accordance with MassDOT Design Standards and criteria, specifications, and contract administration practices.

MassDOT will secure all necessary environmental approvals and clearances based on the Program's Base Technical Concept. By selecting D-B procurement methodology for this Program, MassDOT shares responsibility for environmental compliance with the D-B team. Accordingly, the D-B team, in coordination with MassDOT, will be responsible for obtaining any amendments to environmental approvals/clearances necessitated by any proposed deviations from the Base Technical Concept.

5.3 Program Timeline and Durations

Pending the completion of Massachusetts Environmental Policy Act and National Environmental Policy Act environmental reviews and receipt of federal and state permits and approvals, anticipated in spring 2026, MassDOT proposes to initiate the Program's D-B procurement and construction process in fall 2026. Construction activities for the replacement Sagamore Bridge and Bourne Bridge are expected to occur over the course of eight to ten years, respectively. Construction of Sagamore Bridge would begin first, followed by Bourne Bridge once funding is secured. It is currently planned that construction of the replacement Bourne Bridge would commence one year following commencement of replacement Sagamore Bridge construction. However, timing of construction sequencing is dependent upon funding.

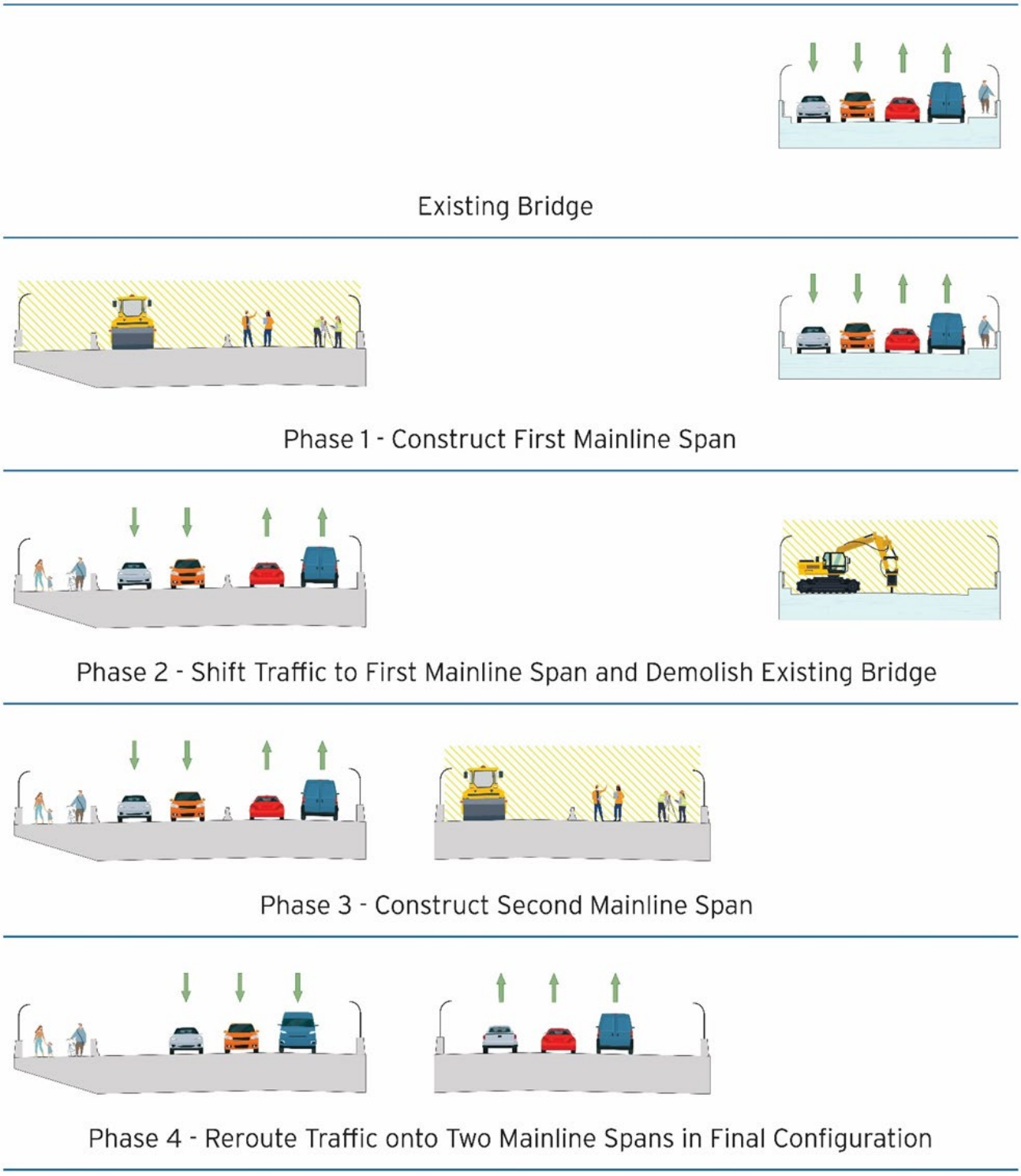
5.4 Program Milestones and Phasing

There are four key milestones for the Program's bridge and interchange network phasing:

- Phase 1 – Construct the first mainline span and approaches, consisting of the eastbound mainline at the Sagamore Bridge crossing and the northbound mainline at the Bourne Bridge crossing.
- Phase 2 – Shift all traffic off the existing bridge and onto the new mainline structure and demolish the existing bridge.
- Phase 3 – Construct the second mainline span and approaches, consisting of the westbound mainline at the Sagamore Bridge crossing and the southbound mainline at the Bourne Bridge crossing.
- Phase 4 – Reroute the traffic onto the two mainline spans in the final configuration and open connections to the shared-use path (SUP) over the canal and supporting path network.

Figure 5-1 presents a simplified schematic of the bridge construction phasing approach. The proposed Sagamore Bridge crossing is shown; the Bourne Bridge crossing would have a similar approach.

Figure 5-1. Proposed Bridge Construction Sequencing Approach



Source: Massachusetts Department of Transportation, 2024

5.5 Early Action/Initial Construction Activities

For each Program quadrant, early action work/initial construction activities would include the following:

- Tree removal
- Right-of-way takings/structure demolition
- Mobilization/establishment of approximate limits of work
- Utility relocations (including electric, sewer, potable water, gas, and telecommunications)
- Construction of temporary SUP connections (where needed), consisting of a minimum 6-foot-wide sidewalk for temporary multimodal access.

This section provides an overview of tree removal, structure demolition, and establishment of project limits. **Section 4.8, Property Acquisition, Displacement, and Relocation,** and **Section 4.20, Utilities and Services** describes the property acquisition process and utility relocations, respectively.

5.5.1 Tree Removal

MassDOT would conduct tree removal as an initial construction activity. Tree removal would be required within designated areas to allow for bridge construction and laydown, roadway and SUP construction, highway and ramp widening, construction of stormwater management basins, and embankment and slope construction.

The total approximate acreage of tree removal would be 132.14 acres, divided among the four Program quadrants as follows:

- Sagamore North quadrant: 38.77 acres
- Sagamore South quadrant: 23.83 acres
- Bourne North quadrant: 23.83 acres
- Bourne South quadrant: 45.71 acres

Refer to **Appendix 4.6, Preliminary Tree Clearing Plans**, which identifies required tree clearing within each Program quadrant based on preliminary design. MassDOT would use its standard specifications to conduct tree removal, which would include clearing and grubbing, tree trimming, tree removal, and stump removal.[1] In preparation for tree removal, an arborist would develop a tree-removal plan. The plan would include inspecting the area of trees to determine the safest option for tree removal, such as identifying where trunks fall and options for lowering trees via rope, crane, or bucket etc., and identifying how tree pieces would be hauled out after cutting to avoid damaging trees that are outside of the designated cut area. When possible, tree removal by climbing is preferred. Tree removal would include removal of all brush, trees, stumps, and roots within the designated area, including dead,

[1] Massachusetts Department of Transportation. 2024 Standard Specifications for Highway and Bridges. Subsections 101 through 105. https://www.mass.gov/doc/2024-standard-specifications-for-highways-and-bridges-division-ii-construction-details/download

dying, and diseased trees, previously fallen trees, branches, uprooted stumps, and other debris. Tree-removal equipment can vary based on the size of the area required to be cleared, the terrain type, ease of access, density of vegetation and timeline; however, the following equipment may be used:

- Versatile equipment (such as excavators, bulldozers, skid steer loaders, tractors, and backhoes) that can clear land
- Specialized equipment (such as stump grinders, brush mowers, and string trimmers)
- Mulchers to clear underbrush, small trees, and leftover fencing (mulching attachments can be used with machines like tractors, skid steers, and excavators).

MassDOT would employ multiple mitigation measures, minimization measures, and best management practices to reduce impacts to federally listed and proposed species with the potential to occur in the Action Area, including implementing time-of-year restrictions on tree clearing. Trees would not be cleared from March 15 through November 30 on the Cape Cod side of Cape Cod Canal and from April 15 through October 31 on the mainland side of Cape Cod Canal. Additional information regarding land alteration and tree clearing is provided in **Section 4.6.4.2, Land Alteration Impacts**.

5.5.2 Individual Structure Removal

To demolish the existing bridges and construct the new bridges, including the realignment of the mainlines, MassDOT would acquire properties and demolish existing structures. Up to 28 structures are anticipated to be demolished within the Project Limits.

Prior to structure demolition, MassDOT would conduct building inspections. The Program would follow Massachusetts Division of Fisheries and Wildlife (MassWildlife) guidance in developing exclusionary measures to ensure that bats are not present in or are removed from structures.[2] Prior to structure demolition, building inspections would be conducted.

Demolition of existing structures on properties acquired by MassDOT could be completed prior to commencement of the Program construction contract(s).

5.5.3 Mobilization and Establishment of Project Limits of Work

MassDOT would establish project limits of work within the four Program quadrants to accommodate bridge and roadway construction, retaining wall construction, installation of stormwater management features, construction access, and equipment laydown and staging areas.

Attachment 1 of Appendix 5, Construction Schematics, provides schematics of the following:

- Approximate bridge and mainline construction limits of work
- Equipment staging concepts for bridge and mainline construction

[2] Massachusetts Division of Fisheries & Wildlife. 2020. Massachusetts Homeowner's Guide to Bats. (7th edition) https://www.mass.gov/doc/massachusetts-homeowners-guide-to-bats/download

Appendix 4.6, Preliminary Tree Clearing Plans, identifies the approximate interchange and SUP limits of work, proposed tree clearing, land alteration, locations of stormwater infiltration basins, and slope limits. **Table 5-1** presents the total acreage of land alteration due to the Program, consisting of the following:

- Tree clearing
- Alteration to existing pavement, such as mill and overlay and roadway reconstruction
- Alteration to previously disturbed areas, such as implementation of stormwater management best management practices

Additional information on land alteration and tree clearing may be found in **Section 4.6.4.2 (Land Alteration)**.

Table 5-1. Program Land Alteration

Program Quadrant	Tree Clearing (acres)	Alterations to Existing Pavement (acres)	Alterations to Previously Disturbed Areas (acres)	Total Land Alteration (acres)
Sagamore North	38.77	18.04	17.98	74.79
Sagamore South	23.83	20.76	17.27	61.87
Bourne North	23.83	21.70	41.20	86.73
Bourne South	45.71	14.27	23.03	82.41
Total	**132.14**	**74.77**	**99.48**	**306.39**

5.6 Construction Sequencing and Traffic Management

5.6.1 Program Goals

The construction sequencing and traffic management goals for each phase of the Program are as follows:

- Remove traffic off the existing bridge as soon as possible.
- Maintain existing roadway and ramp connections throughout the duration of construction.
- Avoid the need for construction detours.
- Reduce or minimize traffic shifts.
- Reduce schedule delays by providing large work zones at the bridge sites.
- Design temporary roadways at 10 miles per hour less than the existing roadway design speed.
- Maintain pedestrian and bicycle connectivity access equal to or better than existing conditions throughout the duration of construction.

5.6.2 Design Standards

MassDOT has established design standards for the following to be maintained throughout construction:

- Mainlines
  - Lane Configuration – 2 lanes minimum in each direction
  - Travel Lane Width – 11-foot minimum
  - Shoulder Width – 0-foot minimum on structure; 2 feet preferred; 1-foot minimum at-grade
  - Vertical Clearance – Maintain existing vertical clearance as a minimum.
- Ramps
  - Travel Lane Width – 11-foot minimum
  - Inside Shoulder Width – 2 feet preferred; 1-foot minimum
  - Outside Shoulder Width – 2 feet preferred; 1-foot minimum
  - Total Ramp Width – 18-foot minimum to accommodate emergency vehicles
  - Entrance/Exit Ramp Design – Taper style ramps preferred; parallel style where necessary.
- Local Roads
  - Travel Lane Width – 10-foot minimum
  - Shoulder width – 2 feet preferred; 1-foot minimum

5.6.3 Summary Description

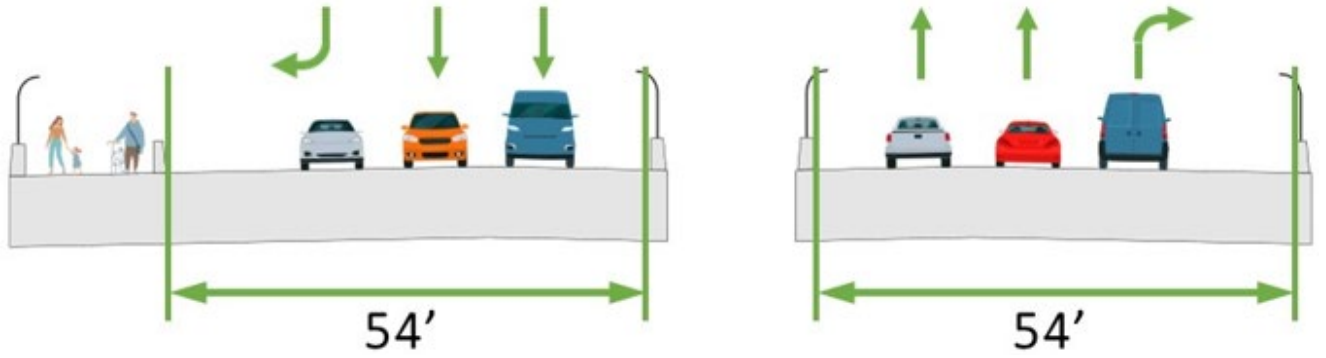
The replacement bridges would be constructed offline (outside of the existing footprint) and a maximum of 250 feet inboard of the existing highway bridges. Sagamore Bridge would be replaced first followed by Bourne Bridge. At each site, the inboard main span (inboard bridge) would be constructed first. At the Sagamore Bridge site, this would be the westernmost bridge, which would ultimately carry traffic onto Cape Cod. For the Bourne Bridge site, this would be the easternmost bridge, which would ultimately carry traffic off Cape Cod. After construction of the first new span, all traffic would be shifted onto it so the existing bridge can be demolished, and the second main span (bridge) can be constructed. **Figure 5-2** presents a highway bridge typical section in the temporary condition; the inboard span would contain all through traffic, leaving the existing bridge without traffic prior to its demolition. **Figure 5-3** presents a typical highway bridge section following construction completion, with both spans operational and traffic rerouted in the final configuration.

Figure 5-2. Highway Bridge Typical Section, Temporary Condition (First Bridge with all Through Traffic)



Source: Massachusetts Department of Transportation, 2024

Figure 5-3. Highway Bridge Typical Section, Completed Construction



Source: Massachusetts Department of Transportation, 2024

5.6.3.1 Bridge Construction

To enable the demolition of the existing Sagamore Bridge and construction of the westbound mainline bridge, all traffic would be shifted onto the proposed eastbound mainline built in the preliminary phases. To do this, while also maintaining two lanes of traffic in the eastbound and westbound directions, a combination of temporary crossovers and pavement widening would be needed. Furthermore, when traffic is on the proposed eastbound mainline structure, the typical section needs to be reduced to two 11-foot lanes in each direction, with two 2-foot shoulders, and separated by temporary median barrier. While all traffic is on this eastbound structure, demolition of the existing bridge and construction of the proposed westbound mainline bridge can occur without conflicts.

To enable the demolition of the existing Bourne Bridge and construction of the southbound mainline bridge, all traffic would be shifted onto the proposed northbound mainline built in the preliminary phases. To do this, while also maintaining two lanes of traffic in the northbound and southbound direction, a combination of temporary crossovers and pavement widening would be needed. Furthermore, when traffic is on the proposed northbound mainline structure, the typical section would be reduced to two 11-foot lanes in each direction, with no shoulder, and separated by temporary barrier. This section would allow the space for four lanes of traffic and the temporary pedestrian path. While all traffic is on this northbound structure, demolition of the existing bridge and construction of the proposed southbound mainline bridge can occur without conflicts.

5.6.3.2 Interchange Approach Construction Phasing

The following provides a general approach to construction phasing for the four quadrants based on preliminary design. Note that there are some activities that cannot occur before previous activities are completed (critical path construction activities); however, there may be an opportunity to construct other activities that do not have critical predecessor tasks. These non-critical-path construction activities could occur earlier than indicated herein. Additionally, as indicated in **Section 5.1**, the D-B team could propose different construction phasing, as well as different means and methods.

Sagamore North Quadrant

Eleven construction phases are proposed for the Sagamore North quadrant. In Phase 1, existing traffic patterns would be maintained, with a potential one-lane traffic and minor lane or shoulder closings at specific locations. Phases 2 through 11 would require revised traffic patterns. Milestone construction points would be reached at the end of Phase 4 and Phase 8. At the end of Phase 4, the U.S. Route 6 eastbound bridge over Cape Cod Canal, including approaches, must be completed. At the end of Phase 8, the U.S. Route 6 westbound bridge over Cape Cod Canal, including approaches, must be completed. Phases 10 and 11 consist of construction closeout and construction completion.

- Phase 1 - Construct the proposed U.S. Route 6 eastbound bridge over the canal, including U.S. Route 6 eastbound approaches and portions of State Route 3 mainline/ramps, while maintaining existing traffic patterns.
- Phase 2 - Continue constructing the mainline and State Route 3 on- and off-ramps with tie-ins at State Road.
- Phase 3 - Phase 3 work would be confined to the Sagamore South quadrant; no work would occur within the Sagamore North quadrant.
- Phase 4 - Construct the embankment and remaining portion of new State Route 3 southbound.
- Phase 5 - Construct portions of the U.S. Route 6 westbound mainline. Shift eastbound traffic to the newly constructed U.S. Route 6 eastbound outside shoulder; maintain westbound traffic on the existing bridge. Construct Sagamore Bridge permanent SUP along the U.S. Route 6 eastbound mainline crossing.
- Phase 6 - Construct the remainder of U.S. Route 6 westbound off-ramp, including completion of the bridge over Scenic Highway, a portion of State Route 3 northbound, remainder of State Route 3 northbound, and State Route 3 northbound on-ramp.
- Phase 7 - Demolish existing bridge structure and remove existing mainline and ramps. Begin construction of new U.S. Route 6 westbound bridge and final structural sections of State Route 3 northbound. The SUP would be fully online at the end of Phase 7.
- Phase 8 - Continue construction of new U.S. Route 6 westbound bridge and approaches.
- Phase 9 - Remove temporary crossovers, construct permanent median barrier, and remove temporary State Route 3 northbound bypass. Construction of SUP would be complete.
- Phase 10 - Begin Project closeout (landscaping, punch list, etc.), including removing temporary widening of State Route 3 southbound off-ramp and installing guardrail.
- Phase 11 - Construction complete.

Sagamore South Quadrant

Eleven construction phases are proposed for the Sagamore South quadrant. In Phase 1, existing traffic patterns would be maintained. Phases 2 through 9 would require revised traffic patterns. Milestone construction points would be reached at the end of Phase 4 and Phase 8. At the end of Phase 4, the

U.S. Route 6 eastbound bridge over Cape Cod Canal including approaches must be completed. At the end of Phase 8, the U.S. Route 6 westbound bridge over Cape Cod Canal, including approaches, must be completed. Phases 10 and 11 consist of construction closeout and construction completion.

- Phase 1 - Construct proposed U.S. Route 6 mainline and ramps eastbound bridge over canal including eastbound approaches and portions of Route while maintaining existing traffic patterns.
- Phase 2 - Construct temporary U.S. Route 6 temporary mainline and ramp crossovers.
- Phase 3 - Construct proposed U.S. Route 6 eastbound and on ramps.
- Phase 4 - Construct remainder of the U.S. Route 6 westbound and on- and off-ramps and temporary cross over from U.S. Route 6 westbound to U.S. Route 6 eastbound.
- Phase 5 - Construct a portion of U.S. Route 6 westbound and westbound on-ramp.
- Phase 6 - Construct permanent U.S. Route 6 westbound off-ramp and Cranberry Highway Extension.
- Phase 7 - Demolish existing bridge structure. Remove existing mainline and ramps. Begin construction of new U.S. Route 6 westbound bridge.
- Phase 8 - Continue construction of new U.S. Route 6 westbound bridge and approaches.
- Phase 9 - Remove existing crossovers and finalize mainline and ramp entrance construction.
- Phase 10 - Begin Project closeout (landscaping, punch list, etc., including installing guardrail).
- Phase 11 - Construction complete.

Bourne North Quadrant

Five construction phases are proposed for the Bourne North quadrant. In Phase 1, existing traffic patterns would be maintained; lane or shoulder closures may be required on some roadways. Phases 2 through 5 would require revised traffic patterns. Milestone construction points would be reached at the end of Phases 3, 4, and 5. At the end of Phase 3, the northbound mainline would be open and the northbound on-ramp from U.S. Route 6 would be open. At the end of Phase 4, the southbound off-ramp to U.S. Route 6 would be open. At the end of Phase 5, the southbound mainline structure would be open with the final traffic patterns.

- Phase 1 - Construct temporary pavement on mainline, including temporary crossover for mainline traffic shifts, temporary widening for mainline traffic shifts, temporary pavement for ramp movements. Begin construction of northbound mainline structure and relocate stormwater interceptor.
- Phase 2
  - Phase 2A - Continue construction of northbound mainline structure, proposed structure over State Routes 25/28, portions of northbound on-ramp from U.S. Route 6, and temporary southbound on-ramp over existing mainline.

  - Phase 2B - Demolish portion of existing northbound mainline and northbound on-ramp. Continue construction of northbound mainline structure and temporary northbound off-ramp.
  - Phase 2C - Demolish remaining portion of existing northbound mainline, northbound off-ramp, and east portion of existing structure over State Routes 25/28. Construct remaining portion of northbound mainline structure, temporary pedestrian path, and northbound on-ramp structure over Nightingale Road.
- Phase 3 - Demolish existing mainline, including structure over U.S. Route 6 and southbound on-ramp. Begin construction of southbound mainline structure, southbound off-ramp to U.S. Route 6 over U.S. Route 6, southbound off-ramp to U.S. Route 6 over Andy Oliva Drive, and SUP connection.
- Phase 4
  - Phase 4A - Demolish west portion of existing structure over State Routes 25/28. Construct portion of southbound mainline and portions of southbound off-ramp to Belmont Circle.
  - Phase 4B - Demolish existing southbound off-ramp. Construct remaining portion of northbound on-ramp from Belmont Circle.
  - Phase 4C - Construct remaining portion of southbound on-ramp.
- Phase 5 - Construct remaining portion of southbound mainline, southbound off-ramp to U.S. Route 6, and portions of the SUP. Begin Project closeout (landscaping, punch list, etc.), including installing guardrail.

Bourne South Quadrant

Seven construction phases are proposed for the Bourne South quadrant. In Phase 1, existing traffic patterns would be maintained; lane or shoulder closures may be required on some roadways. In Phase 2, existing traffic patterns would be maintained, with some exceptions; lane or shoulder closures may be required on some roadways. Phases 3 through 6 would require revised traffic patterns. Milestone construction points would be reached at the end of Phase 3 and Phase 5. At the end of Phase 3, the northbound mainline would be open. At the end of Phase 5, the southbound mainline would be open. Construction would be completed with the final traffic patterns in Phase 7.

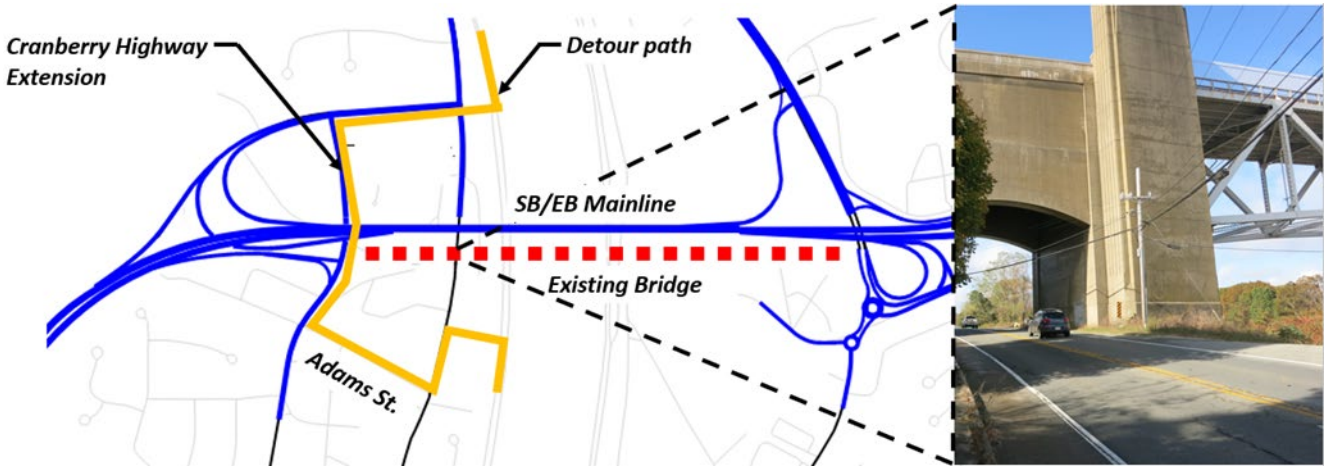
- Phase 1 - Construct proposed northbound mainline, northbound on-ramp bridge, northbound off-ramp, eastern portion of Trowbridge Road, and roundabout at Sandwich Road intersection, and temporary mainline crossover.
- Phase 2 - Construct proposed northbound on-ramp approach roadway, temporary southbound off-ramp U-turn, and Trowbridge Road through existing rotary.
- Phase 3 - Construct portion of proposed southbound mainline. Begin demolition of existing Bourne Bridge.
- Phase 4 - Construct portion of proposed southbound mainline, on-ramp, off-ramp, and portions of the SUP.
- Phase 5 - Complete construction of Trowbridge Road.

- Phase 6 - Construct proposed Frontage Road and complete remaining portions of Trowbridge Road and Sandwich Road. Begin Project closeout (landscaping, punch list, etc.), including installing guardrail.
- Phase 7 - Construction complete.

5.6.3.3 Pedestrian and Bicycle Connections

Maintaining pedestrian and bicycle connectivity during construction would be a priority. The phasing for pedestrian and bicycle connectivity has been sequenced to maintain the existing condition until a time when pedestrian and bicycle traffic can be transferred to the proposed bridge. Temporary connections may be required to maintain the east–west connections between the bridges and Canal Service Roads to allow pedestrians to travel to and from either side of the bridge as they do in the existing condition. The existing bridges would not be demolished until these temporary connections are completed. **Figure 5-4** provides an example of a temporary connection required during demolition of the existing bridge abutment.

Figure 5-4. Example of Temporary Shared-Use Path Connection



Source: Massachusetts Department of Transportation, 2024

EB = eastbound, SB = southbound

5.7 In-Water Construction Activities

5.7.1 Overall Approach and Durations

MassDOT would conduct in-water construction in multiple phases. Work would begin with the temporary installation of supportive structures such as trestles, cofferdams, bulkheads, bollards, docks, and dolphins as well as shoreline riprap removal and dredging to prepare for barge use and construction of the first bridge (main span). This would be followed by construction of the first bridge. After construction of the first bridge, the temporary works enabling demolition would be installed; MassDOT anticipates these to include trestles, containment cells, dolphins, and other items similar to the temporary works for bridge construction. Demolition of the existing bridge and piers would occur

once the enabling temporary works are in place. Following demolition, additional temporary works to support the construction of the second bridge would be installed; these would be similar in nature to those used for construction of the first bridge. Construction of the second bridge would occur once the temporary works that enable it are in place. Lastly, removal of temporary structures, and restoration of intertidal and subtidal fill/riprap would conclude the in-water construction portion of the Program.

For each bridge, in-water work within the north and south quadrants is anticipated to occur concurrently. The estimated durations of Program elements are based on evaluations conducted in coordination with a construction specialist. Durations may vary based on the D-B team's construction means and methods or based on contract packaging.

Construction of the in-water temporary works, drilled shafts, and substructures at the canal delta piers would require approximately two years for each new span. Construction of the delta frames using cranes on work trestles or cranes on land near the shoreline would require approximately one year for each new main span. Erection of the delta frames using cranes on work trestles or cranes on land near the shoreline would require six months for each new main span.

Four canal closures, each lasting approximately three to five days, would be required to allow float-in of the new bridge arches. Demolition of the existing bridge arch spans would require approximately nine months per bridge and demolition of the existing piers would require approximately six months per bridge. Two canal closures, each lasting approximately three to five days, would be required to allow float-out of the existing deconstructed bridge arches.

Attachment 2 of Appendix 5, Construction Schematics, provides schematics of in-water work activities proposed on both sides of the canal at the bridge crossing sites, including conceptual plans for temporary works, general construction layout, and construction vessel layout. Refer to **Section 4.10, Wetlands and Floodplains,** for a discussion of wetland impacts associated with these activities.

5.7.2 Temporary Works

In preparation for bridge construction and demolition, existing shoreline riprap would be removed to allow for installation of sheeting and piles that are needed for the temporary works. The temporary works within each quadrant may include the following:

- Cofferdams constructed of sheeting around the proposed new bridge pier locations
- Containment cells constructed of sheeting around the demolition zone of the existing bridge piers
- Sheeting along the approximate high tide line to create upland work areas, potentially reinforced with tiebacks through the sheeting and into land
- Sheeting below the high tide line to create a bulkhead for contractor use, potentially reinforced with tiebacks through the sheeting and into land
- Docks constructed of sheeting and fill for mooring construction barges
- Pipe pile-supported trestles to support construction and demolition of the new and existing bridge piers, respectively

- Pile-supported dolphins to assist with construction vessel mooring
- Pipe piles in key locations to support the cofferdams surrounding the existing and proposed bridge piers
- Temporary riprap at the base of the construction trestles to protect them from scour during construction

While it is anticipated that most temporary works would not be contained, depending upon the contractor's means and methods, some of the work could be contained within the same containment cell that is used for pier demolition, including the portion of the temporary trestle that overlaps with the existing pier and some of the trestle supporting structure such as driven piles or columns resting on the remaining footings of the existing pier.

5.7.3 Dredging

In-water dredging may be required along the toes of the bulkheads and between the docks to provide sufficient draft for vessels to approach the bulkheads and moor at the docks. Dredging may be conducted using cutterhead suction dredges or clamshell excavation dredges. Temporary fill may be placed between the shoreline and bulkhead sheeting to create the bulkhead and within the dock sheeting to complete the docks. The cofferdams for construction of the new bridge piers are expected be excavated in the wet prior to sealing. The cofferdams would subsequently be dewatered prior to pier construction. Water pumped from the cofferdams would be maintained in settling basins prior to being pumped back into the canal.

5.7.4 New Bridge Construction

The following describes the current preliminary design for the bridge piers. At each bridge site, two new permanent canal-side pier structures would be installed in the intertidal and supratidal riprap zones of each bank, for a total of four piers per site. The foundations of each pier would consist of eight drilled shafts with steel casings filled with reinforced concrete. Construction of the new bridge piers may be conducted from floating shoreline barges moored to the temporary dolphins, from land, or from a temporary trestle over the footing and cofferdam. All work on the pier foundations and footings would be contained within the temporary cofferdams. After pier construction, the steel delta frames would be erected from cranes near land on the work trestle. Once the delta frames are ready to receive them, the main span bridge arches would be floated in and permanently installed over the canal using construction barges over the course of approximately three to five days per bridge. The float-in of the main span arches would require full closure of Cape Cod Canal throughout the duration of the operation and cannot be halted or paused once commenced. After bridge construction is complete, riprap would be placed on the three waterward sides of the pier bases for protection.

Each bridge would have two new permanent canal-side pier structures installed in the terrestrial and intertidal riprap zones of each bank, for a total of four piers per bridge. Steel sheeting would be installed via vibratory or impact hammering to create a cofferdam around the proposed pier locations for soil containment and dredging within the cofferdam.

Pier construction and steel erection may be conducted using floating shoreline barges, which may require temporary dolphins to reduce barge movement in the fast-flowing canal. Pier installation would require dredging in the intertidal zone.

5.7.5 Existing Bridge Demolition

The main spans of the existing bridges are proposed to be cut and lowered onto barges, similar to the float-in process. The lowering and float-out process would occur over the course of approximately three to five days per bridge. The float-out would require full closure of Cape Cod Canal and cannot be halted or paused once commenced.

At each bridge site, the existing two concrete pier columns in the intertidal and/or subtidal zones would be enclosed by a containment cell and demolished into the containment cell. Demolition of the above-water portions of the existing bridge piers may entail cutting or hoe-ramming. Demolition of the bases of the existing concrete bridge piers may include saw-cutting, hoe-ramming, and excavation of the canal bottom to expose the pier base. Demolition would be controlled to minimize debris falling into the canal outside the containment cell. Some demolished materials may be lifted away by crane, and some may be reduced to rubble in the containment cell. Rubble would be removed from the containment cell in the wet. The footprints of the existing piers would be allowed to recover to the surrounding canal bottom habitat.

5.7.6 Construction Vessels

MassDOT estimates that the Program would require as many as four work barges and two delivery barges in each quadrant at any time during daily marine-based construction activities. Each work or delivery barge may require a dedicated tug. Up to four support launch vessels may also be required in each quadrant. Work barges are anticipated to be spud barges with six spuds per barge. **Table 5-2** provides the estimated number and sizes of the types of construction vessels required for day-to-day marine-based construction activities.

Table 5-2. Proposed Vessels Employed in Day-to-Day Marine Operations for the Program

Description Program-wide at Any Time During Construction	Quantity Per Construction Quadrant	Size
Work barges (6 spuds per barge)	4	40 feet x 80 feet
Delivery barges	2	60 feet x 180 feet
Tugs	6	65-foot to 105-foot overall length
Support launches	4	To be determined
Total Vessels per Quadrant	**16**	**40 feet x 80 feet and larger**

Note: This table does not include the work vessels required for arch float-in and float-out operations.

In addition to the estimated 16 construction vessels that would be used daily for in-water construction work, other vessels would be required for the float-in of replacement bridge main spans over three to five days and the float-out for demolition of the existing bridge main spans over three to five days (total of six float-in or float-out operations for the entire Program). These short-duration activities would require a different configuration of barges and support vessels and would be separate from the daily marine-based operations. While the specific size and number of vessels have not yet been determined, MassDOT estimates that each float-in or float-out operation would require two large barges in the canal, with an approximate size of 60 feet by 160 feet each. Up to six tugs of the sizes identified in **Table 5-2** could be required to control the barges during float-in and float-out; up to eight support launches may also be used. Additional work barges of the type identified in **Table 5-2** are expected to be required during float-in and float-out as well. The float-in and float-out operations are exclusive of day-to-day operations.

5.8 Site Maintenance and Restoration

Throughout the duration of construction, MassDOT will incorporate mitigation measures into the Program to minimize adverse effects of in-water-based and land-based disturbance through permits, special provisions, and guidance documents, as well as its Standard Specifications for Highways and Bridges.

5.8.1 Water-Based Restoration

Upon completion of in-water work, all temporary support structures will be removed, and the areas will be restored to preconstruction conditions to the maximum extent practicable. The fill placed against the various temporary works will be excavated, and areas previously excavated will have fill returned to match the preconstruction contours. The temporary riprap at the base of the construction trestles will be removed. All temporary works will be removed or cut off below the mudline, including sheeting used to construct the cofferdams, barge docks, and bulkheads, and the pilings used to construct the mooring dolphins and support the cofferdams. Sheeting and pipe piles may be removed using a vibratory pile driver or by torch cutting below the mudline. Torch cutting the sheeting and pipe piling will require in-water excavation to reach below the mudline. Once all temporary works are removed, the canal bottom will be dredged to prepare the areas for final riprap installation. Riprap initially removed to allow installation of the temporary works will be returned to the quadrants to complete the Program area restoration. The riprap condition upon completion of the Program is anticipated to be similar to the existing riprap condition, except that additional riprap may be added around the new piers for protection. Refer to **Section 4.10, Wetlands and Floodplains,** for additional information regarding measures to avoid, minimize, and mitigate impacts to wetland resource areas.

5.8.2 Site Maintenance and Land-Based Restoration

Throughout the duration of construction, MassDOT would incorporate mitigation measures into the Program to minimize adverse effects of land-based disturbance through permits, special provisions, and guidance documents, as well as its Standard Specifications for Highways and Bridges.

The Program's Construction Stormwater General Permit will contain multiple measures to reduce adverse effects from construction, including, among other control measures, the requirement to stabilize disturbed areas immediately when construction has ceased and will not resume for more than 14 days.

For trees that would not be cleared, MassDOT has issued extensive guidance for tree preservation, including plant protection fencing for public places and staging or other construction activity near desirable vegetation. As applicable, MassDOT will use plant protection fencing to minimize impacts to visual natural resources.

Following completion of the land-based construction activities, acquired areas that are not used for the State Highway Layout will be restored to pre-existing conditions to the maximum extent practicable. There will be instances where site restoration could occur following completion of that specific phase of the Program, such as Trowbridge Road and the new entrance to the Upper Cape Regional Technical High School in the Bourne South quadrant, where the proposed construction would be offline. Refer to **Section 4.6.5** for additional information regarding mitigation measures that will be employed to minimize impacts associated with land alteration and tree clearing.

6 Agency Coordination and Public Involvement

6.1 Introduction

This chapter discusses agency coordination and public involvement conducted by the Federal Highway Administration (FHWA) and Massachusetts Department of Transportation (MassDOT) in the development of this Draft Environmental Impact Report (DEIR).

6.2 Regulatory Framework

The Massachusetts Environmental Policy Act and National Environmental Policy Act processes are occurring concurrently for the Cape Cod Bridges Program; therefore, the public involvement activities required under both federal and state regulations are jointly reflected throughout this chapter. The following provides the regulatory context and guidance for agency coordination and public involvement efforts during development of the Cape Cod Bridges Program (Program).

- Massachusetts Environmental Policy Act (MEPA)[1]
- Efficient Environmental Reviews for Project Decision Making[2]
- Title VI of the Civil Rights Act of 1964[3]
- 36 Code of Federal Regulations Part 800, Protection of Historic Properties
- The Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970 (Uniform Act)

6.3 Agency Coordination

6.3.1 Lead Agencies

The FHWA is the Lead Federal Agency for the Program. As Lead Federal Agency, the FHWA is responsible for managing the Program's environmental review process,[4] including the applicable environmental laws, executive orders, and regulations to be addressed before issuing a final decision on the Program's environmental review and document approval.

As the Project Sponsor and Joint Lead Agency, MassDOT is leading the Program delivery process under MEPA, including the alternatives analysis, environmental review, preparation of the Environmental Impact Report (EIR), public outreach, and permitting pursuant to 301 Code of Massachusetts

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[1] Massachusetts General Law Chapter 30, Sections 61-62I and implementing regulations at 301 CMR 11.00.

[2] 23 United States Code (USC) 139.

[3] 42 USC 2000d(1-7).

[4] Per 23 United States Code (USC) § 139(a)(5), The term "environmental review process" means (1) the process for preparing for a project an environmental impact statement, environmental assessment, categorical exclusion, or other document prepared under the National Environmental Policy Act (NEPA), and (2) the process and schedule, including a timetable for and completion of any environmental permit, approval, review, or study required for a project under any federal law other than NEPA.

Regulations 11.00: MEPA Regulations, under jurisdiction of the Massachusetts Executive Office of Energy and Environmental Affairs (MA EEA).

MassDOT, as Joint Lead Agency, is responsible for providing an opportunity for agency and public involvement in the Program's environmental review process. MassDOT prepared an Agency Coordination Plan to solicit and consider input from other agencies and the public in the environmental review process for the Program. The Program's Agency Coordination Plan is in effect throughout the environmental review process and is regularly updated to reflect ongoing agency involvement, completion of key milestones, and changes to agency contacts and roles, as necessary.

6.3.2 Agency Coordination Plan

As a Lead Agency, MassDOT is responsible for identifying, inviting, and proactively involving agencies to participate in the Program's environmental review process. MassDOT prepared an Agency Coordination Plan to define the process for coordinating agency and public participation, including comments, during the environmental review process. The Agency Coordination Plan provides the framework for communication among the agencies involved in the environmental review process, and it establishes coordination and concurrence points to ensure that workable measures to avoid, minimize, and mitigate adverse impacts to the environment are identified and fully vetted during Program planning. The Agency Coordination Plan is in effect throughout the environmental review process and updated to reflect ongoing agency involvement, completion of key milestones, and changes to agency contacts and roles, as necessary.

6.3.3 Cooperating Agencies

The FHWA invited agencies with jurisdiction by law (via permitting or other regulatory authority) to serve as Cooperating Agencies in the environmental review process for the Program. **Table 6-1** lists the agencies that are serving as Cooperating Agencies in the Program's environmental review process, along with their applicable area(s) of jurisdiction.

Table 6-1. Cooperating Agencies and Areas of Jurisdiction

Cooperating Agency	Review and Authorization Responsibilities
U.S. Army Corps of Engineers (USACE)–New England District	• Issues permits under Section 404 of the Clean Water Act (33 United States Code [USC] 1344), including Section 404(b)(1), and Section 10 of the Rivers and Harbors Act (33 USC 403) for discharges of dredged or fill material into waters of the United States, and for structures in navigable waters of the United States. • Issues Section 408 permission under Section 14 of the Rivers and Harbors Act of 1899 (33 USC 408) for occupation and alteration of a USACE federally authorized Civil Works Project. • Issues a federal permit under the Archaeological Resources Protection Act for archaeological investigation on land within the boundaries of the Cape Cod Canal Federal Navigation Project, pursuant to 43 Code of Federal Regulations (CFR) 7.

Cooperating Agency	Review and Authorization Responsibilities
U.S. Coast Guard – First District	• Issues bridge permits under The General Bridge Act of 1946 (33 USC 525) for construction of new bridges across navigable waters of the United States.
U.S. Environmental Protection Agency – New England Regional Office	• Issues a National Pollutant Discharge Elimination System Construction General Permit for discharge of stormwater from construction sites that disturb 1 acre or more of land under Section 402 of the Clean Water Act (33 USC 1342). • Reviews the Section 404 permit under Section 401 (a)(2) of the Clean Water Act (33 USC 1341(2)(2). • Reviews the Draft and Final Environmental Impact Statements under Section 309 of the Clean Air Act (42 USC 7609).
National Oceanic and Atmospheric Administration National Marine Fisheries Service/ Greater Atlantic Regional Fisheries Office	• Consultation for effects to marine species under Section 7 of the Endangered Species Act (16 USC 1536), the Marine Mammal Protection Act of 1972 (16 USC 1371), and the Fish and Wildlife Coordination Act (16 USC 661). • Consultation for effects to Essential Fish Habitat under the Magnuson-Stevens Fishery Conservation and Management Act (16 USC 1801-1891d).
U.S. Fish and Wildlife Service	• Consultation for effects to terrestrial species under Section 7 of the Endangered Species Act (16 USC 1536) and the Fish and Wildlife Coordination Act (16 USC 661).
Massachusetts Historical Commission (State Historic Preservation Office)	• Consultation under Section 106 of the National Historic Preservation Act (54 USC 306108), including development and execution of a Programmatic Agreement.
Massachusetts Executive Office of Energy and Environmental Affairs	• Issues Secretary Certificates on the Draft and Final Environmental Impact Reports under Massachusetts Environmental Policy Act (301 Code of Massachusetts Regulations [CMR] 11.00).
Massachusetts Department of Fish and Game	• Issues a Conservation and Management Permit under the Massachusetts Endangered Species Act (321 CMR 10.00), if needed.
Massachusetts Department of Environmental Protection	• Issues 401 Water Quality Certification under 314 CMR 9.00.
Massachusetts Office of Coastal Zone Management	• Issues Federal Consistency Determination under the Coastal Zone Management Act (16 USC 1451-1464).

6.3.4 Cooperating Agency Coordination and Concurrence Points

In addition to the review and authorization responsibilities identified in **Table 6-1**, the role of Cooperating Agencies in the Program's environmental review process is to:

- Designate a point of contact to represent the agency in interagency consultations.
- Assist the Lead Agencies in identifying environmental, cultural, or socioeconomic resources of concern.
- Identify as early as practicable any issues that could substantially delay or prevent the granting of a permit or other approval needed for the Program and participate in resolving issues as needed.
- Share information that may be useful to the Lead and Cooperating Agencies.
- Provide timely review and approval of the Program's Purpose and Need Statement, alternatives retained for detailed study in the EIR, impact assessment methodologies for the EIR, and identification of the Preferred Alternative and preliminary mitigation.
- Provide input on the level of detail required on analyses in the Cooperating Agency's areas of expertise, including concurrence with impact analysis methodologies.

6.3.5 Cooperating Agency Meetings and Concurrence Points

The FHWA and MassDOT hosted a series of virtual meetings with Cooperating Agencies to facilitate the exchange of information during Program planning and throughout the environmental review process and to obtain the Cooperating Agencies' concurrence on decision points in the environmental review process. The remainder of this section provides summaries of these Cooperating Agency meetings and concurrence points.

6.3.5.1 Cooperating Agencies Meeting #1

The FHWA and MassDOT hosted the first Program coordination meeting with Cooperating Agencies on June 14, 2023. The purpose of this meeting was to formally initiate Cooperating Agency coordination for the Program. During this meeting, the FHWA and MassDOT presented an overview of the following:

- Prior foundational studies, including the USACE's Major Rehabilitation Evaluation Report (MRER) and the MassDOT Cape Cod Canal Area Transportation Study
- Preliminary Program study areas and existing environmental constraints
- Program public meetings, to date
- Program Purpose and Need
- Background on the Program's MEPA process and intent to align the MEPA and NEPA processes
- Program Design development, to date
- Anticipated environmental permits and approvals

6.3.5.2 Concurrence Point #1 and Cooperating Agencies Meeting #2

FHWA and MassDOT hosted the second Program coordination meeting with Cooperating Agencies on October 17, 2023. The purpose of this meeting was to provide the Cooperating Agencies with an update on the Program. During this meeting, the FHWA and MassDOT presented an overview of the following:

- Roles and responsibilities for Cooperating Agencies in the environmental review process.
- Program Purpose and Need.
- Screening evaluation overview of the USACE's MRER Alternatives, which determined that the replacement of the Sagamore and Bourne Bridges with new bridges built to modern standards is the only reasonable Build Alternative to be advanced for further study in the Program.

During the meeting, the Cooperating Agencies concurred with the Program purpose and need (Concurrence Point #1).

6.3.5.3 Cooperating Agencies Meeting #3

FHWA and MassDOT hosted the third Program coordination meeting with Cooperating Agencies on March 29, 2024. The purpose of this meeting was to solicit feedback on the draft Notice of Intent (NOI), including the Alternatives Analysis Report, and to present the proposed Permitting Timetable.

6.3.5.4 Concurrence Point #2 and Concurrence Point #3

On May 16, 2024, the Cooperating Agencies concurred with the Program's Alternatives Retained for Detailed Study in the DEIR (Concurrence Point #2) as well as the Program Permitting Timetable (Concurrence Point #3).

6.3.5.5 Cooperating Agencies Meeting #4

FHWA and MassDOT hosted the fourth Program coordination meeting with Cooperating Agencies on June 27, 2024. The purpose of this meeting was to review the MEPA/NEPA Assessment Methodologies Report and the Agency Coordination Plan and provide opportunities to agencies to provide comment and feedback. A Program update was also provided at this meeting, with opportunities for discussion.

6.3.5.6 Concurrence Point #4

On July 27, 2024, the Cooperating Agencies concurred with the Program's MEPA/NEPA Assessment Methodologies Report (Concurrence Point #4). FHWA provided the Cooperating Agencies with an updated report on December 2, 2024.

6.3.5.7 Coordination Point #5 and Concurrence Point #5

Prior to publication of the DEIR, the FHWA and MassDOT distributed a preliminary version of the DEIR (Coordination Point #5), including specific sections, and/or technical appendices to Cooperating Agencies for review on March 14, 2025. FHWA and MassDOT identified the Preferred Alternative (including the preferred highway interchange pairings) in the preliminary DEIR submitted for review

and comment by the Cooperating Agencies. Additionally, the DEIR identified preliminary mitigation measures based on coordination with Cooperating Agencies. Comments received from the Cooperating Agencies on the preliminary DEIR on April 14, 2025, constituted approval of the Preferred Alternative and preliminary mitigation measures (Concurrence Point #5).

6.3.5.8 Future Coordination Points and Concurrence Points

Future Coordination Points and Concurrence Points with Cooperating Agencies include the following:

- Coordination Point #6: Issuance of the DEIR and publish notice of availability.
- Coordination Point #7: DEIR public meetings, public review, and close of the DEIR public comment period.
- Coordination Point #8: Preparation of the preliminary draft Final Environmental Impact Report (FEIR).
- Coordination Point #9: Issuance of the FEIR public notice.
- Coordination Point #10: FEIR public review period; issuance of the Secretary's Certificate and completion of MEPA.
- Coordination Point #11: Statutory consultation activities.
- Concurrence Point #6: Issuance of approvals and/or permits post-MEPA and NEPA.

6.4 Public Involvement

6.4.1 Public Involvement Plan

The outreach and engagement process for the Program is guided by a comprehensive Public Involvement Plan (PIP). This robust document details the process of engaging and informing the public and the comprehensive, inclusive, and effective strategies used to solicit feedback from key stakeholders and the local community to successfully implement the Program.

The PIP was first developed at the onset of the Program in January 2021 and has been utilized throughout the duration to benefit the engagement and outreach process. The PIP was shared with stakeholders, including the FHWA and USACE for comments and input to align expectations on public involvement.

The PIP is a living document that is continuously updated to provide the most current information on the public outreach program. It will evolve to respond to community needs as they may change as the Program advances.

The latest available copy of the PIP[5] is posted online on the Program website to promote transparency and provide the public with information on outreach activities and strategies.

[5] https://www.mass.gov/doc/cape-cod-bridges-program-public-involvement-plan/download

Due to the regional importance of access to Cape Cod, the Program necessitates an innovative and collaborative approach to public involvement. The public involvement process must be transparent and inclusive, allowing for two-way communication across all demographics and geographies. Having a robust PIP ensures that MassDOT is utilizing effective communication strategies to achieve consensus amongst diverse populations that help inform Program development. Consistent messaging throughout design and construction is critical to the overall success of the Program. The PIP contains the following goals:

- Continue to effectively inform and engage a broad base of geographically and demographically diverse stakeholders across Cape Cod and the region about this Program.
- Ensure that the public process continues to be inclusive and accessible and provides ample opportunity to engage with MassDOT, provide feedback, ask questions, and attend public meetings for all those who choose to participate.
- Maintain effective online and in-person communication with stakeholders in Cape Cod and across the region.
- Provide the public with opportunities to inform the Program development process.
- Remain responsive to stakeholder comments, inquiries, and needs throughout the entirety of the Program.
- Maintain and update online resources and materials for the public to learn about the status of the Program and ensure materials are accessible for all populations.
- Continuously adapt outreach strategies, messaging, and communication tactics based on public feedback and sentiment.

6.4.2 Communication Tools and Resources

The following tools and resources have been and will continue to be used throughout the Program to inform the public, share information, and gather feedback and input.

6.4.2.1 Program Website

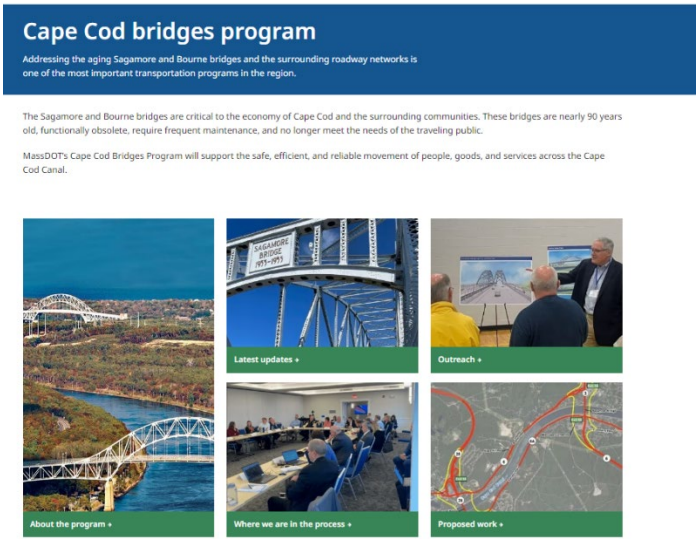
MassDOT developed the Program website[6] to provide a centralized, easily navigable location for the public to access online resources and information on the Program.

[6] https://www.mass.gov/cape-cod-bridges-program

This website contains content and pages regarding the latest updates about the Program, proposed work, Program background, environmental outreach, history of the canal and bridges, and documents and meeting materials. The website also posts upcoming events and contact information.

The website has been heavily used and has seen a high number of visitors. As of May 1, 2025, the website has been visited over 75,000 times by over 50,000 different users. **Exhibit 6-1** shows the website. The website will continue to be available throughout the entirety of the Program.

Exhibit 6-1. Cape Cod Bridges Program Website



6.4.2.2 Stakeholder Database

MassDOT developed a comprehensive stakeholder database to disseminate Program information, including notifications of meetings. The stakeholder database has drawn from previous efforts including the Cape Cod Canal Transportation Study and MRER stakeholder lists.

The stakeholder database has grown throughout the Program as stakeholders who subscribe to updates, submit comments, and attend virtual or in-person meetings have their contact information entered into the Program database. The Program team manages and updates the database through MassDOT's Public Involvement Management Application (PIMA), described in **Section 6.4.2.3**.

As of May 1, 2025, the database included over 5,600 stakeholders, which include, but are not limited to the following:

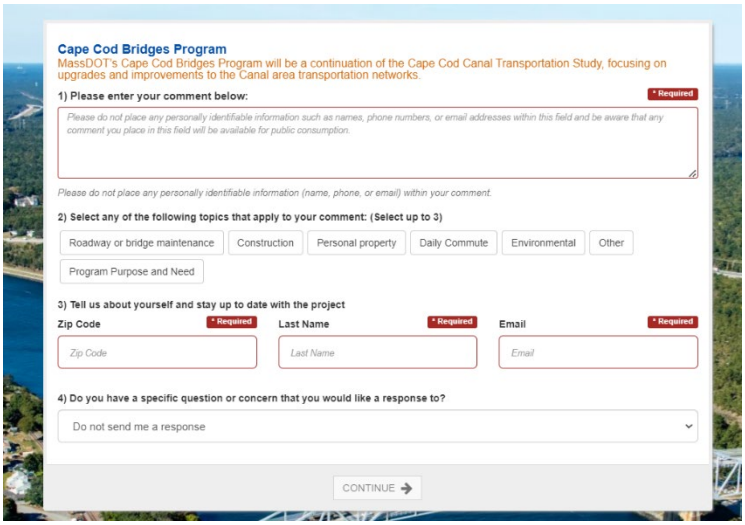
- Abutters
- Bike and pedestrian groups
- Businesses
- Chambers of Commerce
- Churches and faith-based organizations
- Community/advocacy groups
- Council on Aging
- Education institutions
- Emergency services
- Federal, state, and local environmental agencies
- Hospitality groups
- Local, State, and Congressional Officials
- Members of the public
- Neighborhood associations
- Planning Commissions
- Recreation boards
- Residents and local property owners
- Senior Centers
- Tourism sites/groups
- Transit Authorities
- Transportation groups

6.4.2.3 Public Involvement Management Application

Throughout the Program, MassDOT has used its PIMA as a central database of stakeholders and comments to ensure continuous engagement with the public. PIMA contains tools and benefits that help the public more easily comment and provide feedback and allows the Program to manage and track engagement.

PIMA provides an online comment form (**Exhibit 6-2**) that is linked to the Program website and is included on other materials such as emails, flyers, and social media posts. This comment form is customizable and allows the public to provide input and feedback on key topics and priorities, identify areas of concern on a map, rate their opinions of the Program, and subscribe for Program updates.

Exhibit 6-2. PIMA Comment Form



PIMA allows the Program to log all comments and questions regardless of the source. Through PIMA, MassDOT can respond to all comments and questions which creates a seamless process for the public to stay updated on Program developments. Stakeholders receive a confirmation email every time they submit a comment and another notification email when MassDOT has entered a response. As of May 1, 2025, over 1,900 comments and responses have been logged through PIMA. These comments address a variety of topics including right-of-way, construction, bridge design, traffic, and environmental concerns.

PIMA also provides a subscription link, which allows the public to sign up for updates without submitting a comment. The public is prompted to enter basic information, including their name, zip code, and email address to be added to the list. PIMA also serves as a central database of stakeholders and helps ensure continuous engagement of individuals and entities. This database has grown as individuals are added by the Program team, submit a comment or question, or sign up for updates through the subscription link. The subscription link is included in email blasts, social media posts, and other materials to encourage the public to sign up to receive updates.

6.4.2.4 Email Blasts

MassDOT regularly sends email blasts through PIMA to stakeholders and interested parties on a variety of topics and events. These email communications serve to distribute Program updates, public meeting notifications, details on upcoming outreach activities, and other information and content regarding the Program. Email updates are distributed throughout PIMA to the full list of stakeholders and individuals who have signed up to receive materials.

6.4.2.5 Frequently Asked Questions

MassDOT has developed Frequently Asked Questions (FAQ) documents to help convey details and technical information to the public. These documents have included a wide variety of commonly asked questions and concerns, such as questions regarding Program status, schedule, cost, current activities, scope, and benefits. Commonly asked questions were sourced from numerous avenues, including meetings, briefings, and the online comment form. These FAQ documents have been distributed via email to the stakeholder database, shared with stakeholders, and at in-person events.

6.4.2.6 Social Media

MassDOT uses its social media accounts to disseminate messaging relating to the Program milestones, public involvement opportunities, upcoming public meetings, and schedule updates. As of May 1,2025, MassDOT has posted at least 65 separate times on its social media platforms, including Facebook, X (formerly known as Twitter), and Instagram. These social media posts have received nearly 1,700 separate interactions and have been reshared nearly 150 times, helping to further amplify the Program's messages and spread awareness.

6.4.2.7 Flyers

MassDOT uses flyers to disseminate information and solicit information. Flyers are developed for each public meeting and open house, generally two weeks prior to each event, as well as for general updates and information on the Program. These flyers also contain contact information, links to the Program website, and information on how to solicit feedback and questions. Flyers are posted online, distributed in-person at public events, and via email to stakeholders for their own distribution to their organizations and the communities they serve. As a matter of course, flyers are translated to Spanish and Portuguese. Flyers in English, Spanish, and Portuguese have the same distribution process.

6.4.2.8 Press Releases

MassDOT distributes press releases to local, state, and regional outlets to announce details regarding Program updates, milestones, public events, and notable developments. Providing information to the media helps to amplify the Program and further spread information to members of the public and stakeholders.

6.4.2.9 Surveys

MassDOT has developed online surveys to solicit feedback from the public on specific aspects of the Program. For example, MassDOT shared an online survey during the Round 3 public information meetings (described in **Section 6.4.3.4**) to assess the public's preferences for the proposed bridge types. The survey closed on December 16, 2022, and 2,206 submissions were recorded. Surveys also have been used during public meetings to determine usage of interpretation services.

6.4.2.10 Formal Notices

MassDOT issues formal notices to provide official notification to the public of Program events, including all public meetings, open houses, and public hearings. These formal notices are comprehensive documents which provide logistical information, including date, time, location, purpose, and how to seek more information. These documents are posted online on the MassDOT website in an accessible format and included on the MassDOT event page. Additionally, these formal notices are advertised in English and non-English languages in numerous print and digital publications, including the following:

- Cape Cod Times
- Cape Cod Chronicle
- Bourne Enterprise
- El Planeta
- Portuguese Times
- Barnstable Patriot
- Provincetown Independent

These publications have a reported total circulation of nearly 220,000 readers.

6.4.2.11 Phone Calls

MassDOT has received numerous calls throughout the duration of the Program with questions, comments, and feedback. MassDOT has responded to all stakeholder phone call inquiries to be responsive to public concerns and inquiries.

MassDOT has utilized phone calls to coordinate various events, stakeholder meetings, and briefings. Stakeholders are often coordinated via phone as well as using other communication methods to ensure they are aware of events. Coordination calls have also been held with local community organizations and stakeholders as part of the effort to verify demographic data.

6.4.2.12 Public Meeting Recordings

As of May 1, 2025, MassDOT has held 11 virtual public meetings. Each of these meetings were recorded and posted to the Program website page. The recordings are also integrated with PIMA so that users can seamlessly view the recording and submit comments. This allows the public and stakeholders to participate in the meetings when it fits their schedule, have easy access to details regarding the Program, and conveniently provide input and ask questions.

6.4.3 Public Participation Program

6.4.3.1 Advisory Group Meetings

MassDOT has established an Advisory Group to allow for increased engagement with key stakeholders within the Program Study Area and learn of community feedback, needs, and concerns in a focused setting.

This group is intended to provide feedback and input on topics such as design alternatives, community and environmental impacts, and the construction schedule. Feedback, concerns, and questions brought up during Advisory Group discussions are used by the Program team to help make informed decisions throughout Program development.

Advisory Group members represent a variety of stakeholder types, including, but not limited to the following:

- Local and elected officials
- Planning commissions
- Emergency services representatives
- Economic development representatives
- Chambers of commerce

MassDOT plans and hosts each of the Advisory Group meetings. Materials utilized at meetings include presentations, maps, and graphics. In addition to a formal presentation by MassDOT, Advisory Group meetings include opportunities for questions, comments, and discussion. Meetings are held in a hybrid format, to allow for both in-person and virtual participation by Advisory Group members.

Advisory Group meetings are open to the public, and meeting materials, including presentations and meeting notes are made available on the Program website. To date, MassDOT has hosted five Advisory Group meetings—May 2023, September 2023, April 2024, October 2024, and March 2025. **Table 6-2** lists the members of the Advisory Group.

Table 6-2. Advisory Group Members

Federal and State Elected Officials	Other Entities
• Office of U.S. Senator Warren • Office of U.S. Senator Markey • Office of U.S. Representative Keating • Office of U.S. Representative Lynch • Office of Governor Healey • Office of State Senator Fernandes • Office of State Senator Cyr • Office of State Representative Vieira • Office of State Representative Diggs • Office of State Representative Xiarhos • Office of State Representative Moakley • Office of State Representative Luddy	• Association to Preserve Cape Cod • Barnstable County Board of Regional Commissioners • Barnstable County Sheriff • Bourne Commission on Disabilities • Bourne Police Department • Bourne Public Schools • Bourne Recreation Authority • Bourne Selectboard Representatives • Bourne Town Administrator's Advisory Committee on Pedestrian Bicycle Pathway • Cape Cod Canal Region Chamber of Commerce • Cape Cod Chamber of Commerce • Cape Cod Commission • Cape Cod Metropolitan Planning Organization • Cape Cod Regional Transit Authority • Massachusetts Emergency Management Agency • Massachusetts State Police • Town of Bourne • Upper Cape Cod Regional Technical High School • U.S. Army Corps of Engineers

The Advisory Group held its first meeting on May 16, 2023.[7] This event was held at the Upper Cape Cod Regional Technical High School in Bourne and was attended by approximately 56 individuals. This first meeting included a presentation[8] on topics including policies and procedures for the meeting, public involvement, bridges, roadway locations, roadway interchange alternatives, evaluation criteria, the Environmental Notification Form (ENF) filing, and next steps. Following the formal presentation, a question-and-answer session was held. Comments primarily focused on topics including local coordination, construction impacts, funding, regional significance, traffic, and multimodal considerations.

Exhibit 6-3. Advisory Group Meeting (September 23, 2023)



MassDOT held a second meeting of the Advisory Group on September 23, 2023,[9] at the Massachusetts Maritime Academy in the town of Bourne (**Exhibit 6-3**). This event was attended by approximately 45 individuals and included a presentation[10] on topics including grant applications, cost, schedule, an environmental update, Measures of Effectiveness, and multimodal accommodations. Following the formal presentation, a question-and-answer session was held. Comments primarily focused on topics including cost, schedule, multimodal impacts, traffic, and construction. shows this meeting.

The third meeting of the Advisory Group took place on April 9, 2024. This event was held at the Upper Cape Cod Regional Technical High School in Bourne and was attended by approximately 46 individuals (**Exhibit 6-4**). This meeting included a presentation[11] on topics including funding, environmental review, assessment of highway interchange options, schedule, and a bridge update. Following the formal presentation, a question-and-answer session was held. Comments primarily focused on topics including roadway operations, alignment, funding, schedule, and multimodal accommodations.

Exhibit 6-4. Advisory Group Meeting (April 9, 2024)



[7] https://www.mass.gov/doc/cape-cod-bridges-program-advisory-group-summary-4924/download
[8] https://www.mass.gov/doc/cape-cod-bridges-program-advisory-group-presentation-51623/download
[9] https://www.mass.gov/doc/cape-cod-bridges-program-advisory-group-summary-92623/download
[10] https://www.mass.gov/doc/cape-cod-bridges-program-advisory-group-presentation-92623/download
[11] https://www.mass.gov/doc/cape-cod-bridges-program-advisory-group-presentation-492024/download

The fourth meeting of the Advisory Group took place on October 22, 2024. This event was held at the Massachusetts Maritime Academy in the town of Bourne. The event was attended by approximately 40 individuals. The meeting included a presentation[12] on topics including funding, an environmental update, the detailed assessment of highway interchange options, and recommended interchange options. Following the formal presentation, a question-and-answer session was held. Comments primarily focused on funding, construction impacts, traffic, schedule, and roadway operations.

The fifth meeting of the Advisory Group took place on March 13, 2025. This event was held at the Massachusetts Maritime Academy in the town of Bourne. The event was attended by approximately 40 individuals. The fifth meeting's presentation[13] included updates on funding, environmental reviews, roadway interchange options, subsurface exploration, and property acquisitions. Following the formal presentation, a question-and-answer session was held. Comments primarily focused on funding and property acquisitions.

6.4.3.2 Stakeholder Briefings

MassDOT conducts regular briefings with local and regional stakeholders to anticipate priorities of the broader public, address stakeholder needs and concerns, and support a collaborative Program development process.

Stakeholders have been identified according to their mission, regional roles, populations they serve, and involvement in Cape Cod Canal area transportation planning efforts including MassDOT's Cape Cod Canal Transportation Study and the USACE's MRER/EA. The Program is also responsive to stakeholders and entities which request a briefing.

The purpose of meeting with these stakeholders is to help anticipate priorities of the broader public, address stakeholder needs and concerns, and support a collaborative Program development process. These briefings allow meaningful engagement as meetings are discussion-based and focus on specific stakeholder interests and create opportunity for collaborative conversations.

Stakeholder briefings have taken a variety of forms, including virtual online meetings, in-person briefings, and attendance at existing meetings and events. Stakeholders include, but are not limited to the following:

- Town of Bourne
- Boston Region Metropolitan Planning Organization
- Cape Cod Canal Region Chamber of Commerce
- Cape Cod Chamber of Commerce
- Cape Cod Commission
- Cape Cod Regional Transit Authority
- Federal, State, and Local Elected Officials
- Market Basket
- Military-Civilian Community Council for Joint Base Cape Cod
- Nantucket Planning and Economic Development Commission
- Christmas Tree Shops
- Old Colony Planning Council

[12] https://www.mass.gov/doc/cape-cod-bridges-program-advisory-group-presentation-102224/download
[13] https://www.mass.gov/doc/cape-cod-bridges-program-advisory-group-presentation-31325/download

- Sandwich Chamber of Commerce
- Southeastern Regional Transit Authority
- Southeastern Regional Planning & Economic Development Commission
- Steamship Authority

6.4.3.3 Public Meetings

MassDOT regularly holds public meetings—including virtual meetings and open houses—to provide updates and the latest available information, highlight key milestones, and allow the public to provide input and feedback on various aspects of the Program.

MassDOT has an extensive outreach program for each public meeting. Meeting invites and notification materials have been posted and distributed at least two weeks before each meeting and have been translated into Spanish and Portuguese. Notification materials have included formal notices posted online on the MassDOT website and in newspapers, flyers, email blasts, social media posts, press releases, and other email updates.

Spanish, Portuguese, and American Sign Language interpreters have been available at every public meeting, as well as Communication Access Realtime Translation providers. Meeting notification materials also contain information on additional language interpretation and translation services.

Virtual Public Meetings

As of May 1, 2025, MassDOT has held 11 public meetings, which have been attended by a cumulative total of 4,560 individuals. Each of these meetings has been held virtually via Zoom and has consisted of a formal presentation by the Program team followed by an opportunity for public questions and comments.

For each round of meetings, MassDOT posts and distributes meeting invitations and notification materials at least two weeks before each meeting, with translations provided in Spanish and Portuguese. Notification materials have included formal notices posted online on the MassDOT website, flyers, email blasts, newspaper advertisements, social media posts, press releases, and other email updates. A newspaper advertisement was developed in English and translated to Spanish and Portuguese; all three versions were published in online and digital publications. A press release was also distributed to local and regional outlets and MassDOT highlighted these events on social media.

As a matter of course, interpreters are made available at every public meeting. This has included the following:

- Spanish – two interpreters at each meeting
- Portuguese – two interpreters at each meeting
- American Sign Language (ASL) – two interpreters at each meeting
- Communication Access Realtime Translation (CART) – one CART provider at each meeting

Meeting notification materials have also included information on how the public can request additional language interpretation and translation services.

Meeting presentations and summaries are posted on the Program's website in an accessible format. Additionally, the meeting recordings are posted on the Program website and integrated with PIMA, so that users can seamlessly view the recording and submit comments.

Open Houses

As of May 1, 2025, MassDOT has held three open houses and will continue to use these types of events to engage with the public. A total of 1,266 registered individuals attended the three open houses. These events provide increased flexibility and creativity in offering meaningful experiences for stakeholder participation, and an opportunity for stakeholders to interact with each other and MassDOT in an organized and engaging setting. They allow for direct, one-on-one interactions with MassDOT where members of the public can easily ask questions and receive answers.

Each of these events has been held in the town of Bourne, in-person, and in an accessible location. They have taken place during weekdays, in two sessions, over a period of approximately six hours each, to maximize the opportunity for members of the public to attend. Each event has included numerous components—such as graphical displays and pictures, interactive stations, copies of printed materials such as FAQs and relevant documents, videos, and renderings. Additionally, the presentations and graphics used for each meeting have been posted on the Program's website in an accessible format. **Section 6.4.3.4** provides additional details on the open houses.

MassDOT posts and distributes open house invitations and notification materials at least two weeks before each event, with translations provided in Spanish and Portuguese. Notification materials have included formal notices posted on the MassDOT website, flyers, email blasts, newspaper advertisements, social media posts, press releases, and other email updates.

As a matter of course, the following interpreters have been made available at each open house:

- Spanish – one interpreter at each event
- Portuguese – one interpreter at each event
- American Sign Language (ASL) – two interpreters at each event

Notification materials have also included information on how the public can request additional language translation and interpretation services.

Additionally, the presentations and graphics used for each event have been posted on the Program website in an accessible format.

6.4.3.4 Rounds of Public Outreach

To promote effective engagement, MassDOT organized public outreach into rounds. As of May 1, 2025, MassDOT has held seven rounds of public outreach. Each round took place over several weeks or even months, and were intended to share specific information and updates, solicit feedback and questions, and incorporate input into the Program. Each round included events such as virtual public meetings and open houses, and MassDOT posted the recording of each virtual public meeting on its website. This strategy creates a cohesive and coordinated framework for outreach and a standard and predictable process.

Each round afforded the public with opportunities to provide feedback, either through written or verbal opportunities at public meetings or open houses, or through written comments submitted online or at events. All verbal comments were answered in real time, as were written comments submitted at virtual public events. MassDOT provided written responses to all other comments, considered this feedback in Program design, and incorporated this input into FAQs.

It is important to note that public comments and questions are accepted by the Program anytime, not exclusively during rounds of outreach. Additionally, stakeholder engagement has continued throughout the duration of the Program.

As of November 2024, MassDOT has held seven rounds of public outreach, and rounds will continue throughout the duration of the Program. Descriptions and details of each round are as follows.

Round 1 – Spring/Summer 2021

The first round of public outreach for the Program took place in summer 2021. Round 1 consisted of two live, identical virtual public information meetings on June 29 and June 30, 2021 (MassDOT webpage for the June 29, 2021, meeting[14] and the webpage for the June 30, 2021, meeting[15]). Round 1 introduced the Program to the public and provided general information on current activities and next steps. The information conveyed during this round included the history of the Program, the Program team, the need for the Program, the status of Program development, including data collection and analysis, and the public involvement process. A combined total of 686 individuals attended these two public meetings. Approximately 300 comments were submitted verbally or in written form. Comments were responded to, considered by MassDOT in Program design, and logged in PIMA. Comments and questions were primarily related to topics such as personal property and right-of-way impacts, environmental impacts, construction, roadway or bridge maintenance, daily commutes, and the need for the Program.

[14] https://www.mass.gov/event/bourne-cape-cod-canal-area-improvements-virtual-information-meeting-june-29-2021-2021-06-29t190000-0400-2021-06-29t210000-0400

[15] https://www.mass.gov/event/bourne-cape-cod-canal-area-improvements-virtual-information-meeting-june-30-2021-2021-06-30t190000-0400-2021-06-30t210000-0400

Each public meeting was recorded and posted on the MassDOT website (recording of the June 29, 2021, meeting[16] and recording of the June 30, 2021, meeting).[17] **Exhibit 6-5** shows the June 30, 2021, meeting.

Exhibit 6-5. Round 1 Virtual Public Meeting (Spring/Summer 2021)



Source: Massachusetts Department of Transportation, 2024

Round 2 – Fall 2021

The second round of public outreach for the Program took place in fall 2021. Round 2 provided an update on the progress of the Program and solicited input on several components. The information conveyed included details on current activities, existing conditions, Measures of Effectiveness, and input on a Purpose and Need Statement. During the meetings, polls were conducted regarding meeting notifications, travel over the bridges, and priorities for improvements.

This round of outreach consisted of numerous stakeholder briefings and two live, identical virtual public information meetings on November 16, 2021, and November 18, 2021. At each meeting there were opportunities for public comments and questions following the presentations (MassDOT webpage for the November 16, 2021, meeting[18] and the webpage for the November 18, 2021, meeting[19]). A combined total of 565 individuals attended these two public meetings. Approximately 184 comments were submitted verbally or in written form. Comments and questions were primarily related to topics such as bridge conditions, traffic safety, traffic demand and operations, property impacts, construction, and bridge design alternatives. Comments were responded to, considered by MassDOT in Program design, and logged in PIMA.

[16] https://pima.massdotpi.com/public/event-registration/search?project_id=13868&pe_guid=7eb87d91-27ea-4671-a91f-7b70bb35a1f4

[17] https://pima.massdotpi.com/public/event-registration/search?project_id=13868&pe_guid=41a26578-46c2-4a26-900c-4d16ab72e94d

[18] https://www.mass.gov/event/bourne-proposed-cape-cod-canal-area-transportation-improvement-program-111621-2021-11-16t190000-0500-2021-11-16t200000-0500

[19] https://hntb.sharepoint.com/sites/dp_70095_CCBPcollab/Shared%20Documents/1_EIS_Chapters%20and%20Technical%20Reports_InProgress/06._Agency_Coordination_and_Public%20Involvement/CCBP_06_Agency_Coordination_and_Public_Involvement.docx

Each public meeting was recorded and posted on the MassDOT website (recording of the November 16, 2021 meeting[20] and the recording of the November 18, 2021 meeting[21]).

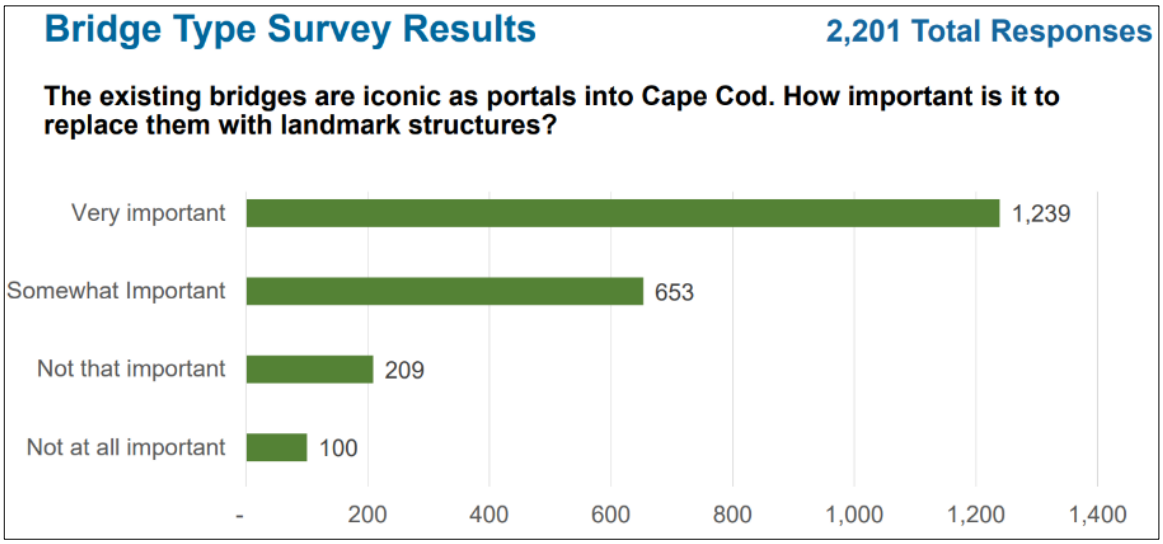
Round 3 – Fall 2022

The third round of public outreach for the Program took place in fall 2022. Round 3 shared information on the status of the Program and attempted to gain public concurrence on key aspects and developments. The information conveyed and shared for public input included the draft Purpose and Need Statement, bridge types, public and stakeholder engagement, funding, and construction staging.

This round of outreach consisted of numerous stakeholder briefings and two live, identical virtual public information meetings on November 15, 2022, and November 17, 2022 (MassDOT webpage for the November 15, 2022, meeting[22] and the webpage for the November 17, 2022, meeting[23]). Additionally, Round 3 included an online survey where the public was asked to rate the proposed bridge types and to rate their views of and preferences for the replacement bridges via two questions:

- How important is it that the new Cape Cod Bridges resemble the current Sagamore and Bourne Bridges?
- How important is it to replace the Cape Cod Bridges with landmark structures? (**Figure 6-1**)

Figure 6-1. Round 3 Bridge Type Survey Results



Source: Massachusetts Department of Transportation, 2024

[20] https://pima.massdotpi.com/public/event-registration/search?project_id=13868&pe_guid=ce4e3615-9583-4fa3-b459-3f472296598d

[21] https://pima.massdotpi.com/public/event-registration/search?project_id=13868&pe_guid=c64ad756-0e66-469c-9fdb-0ffd79503f33

[22] https://www.mass.gov/event/bourne-cape-cod-canal-bridges-program-virtual-public-information-meeting-november-15-2022-2022-11-15t180000-0500-2022-11-15t200000-0500

[23] https://www.mass.gov/event/bourne-cape-cod-canal-bridges-program-virtual-public-information-meeting-november-17-2022-2022-11-17t180000-0500-2022-11-17t200000-0500

A combined total of 1,257 individuals attended these two public meetings. Approximately 367 comments were submitted verbally or in written form. Comments and questions were primarily related to topics such as the Program purpose and need, the environment, construction, daily commute and traffic, bicycles and pedestrians, and bridge design. Comments were responded to, considered by MassDOT in Program design, and logged in PIMA.

Additionally, at the close of the survey, MassDOT recorded 2,215 responses to the survey questions. Nearly 40% of responses indicated that it is very important for the new Cape Cod Bridges to resemble the current bridges, and 56% of responses indicated that it is very important to replace the current bridges with landmark structures. The public also rated the three proposed bridge types, with the arch bridge type receiving an average rating of 4.5 stars, the cable-stayed bridge type receiving an average rating of 2.9 stars, and the concrete box girder bridge type receiving an average rating of 1.7 stars.

Round 4 – Winter 2022/2023

The fourth round of public outreach for the Program took place in winter 2022/2023. Round 4 provided updates on the status of the Program including the Purpose and Need Statement and shared results of public surveys and questions. The information conveyed during this round included review the status of funding, the Program's purpose and need, public feedback on bridge types, proposed lane configurations, and roadway grades and locations.

Round 4 consisted of numerous stakeholder briefings, and two live, identical virtual public information meetings on January 24, 2023, and January 26, 2023 (MassDOT webpage for the January 24, 2023, meeting[24] and the webpage for the January 26, 2023, meeting[25]). A combined total of 991 individuals attended these two public meetings.

At each meeting there were opportunities for public comments and questions following the presentations. A total of approximately 361 comments were submitted verbally or in written form. Comments and questions were primarily related to topics such as public involvement, bridge design, highway design, and bicycles and pedestrians.

Each public meeting was recorded and posted on the MassDOT website (recording of the January 24, 2023 meeting[26] and the recording of the January 26, 2024 meeting[27]).

Round 5 – Spring 2023

The fifth round of public outreach for the Program took place in spring 2023. Round 5 reviewed the proposed interchange approach connections for the Bourne Bridge and the Sagamore Bridge. In

[24] https://www.mass.gov/event/bourne-cape-cod-bridges-program-12423-2023-01-24t180000-0500-2023-01-24t193000-0500

[25] https://www.mass.gov/event/bourne-cape-cod-bridges-program-12623-2023-01-26t180000-0500-2023-01-26t193000-0500

[26] https://pima.massdotpi.com/public/event-registration/search?project_id=13868&pe_guid=2061ae47-d9bf-4f39-bab4-45ec47a593a6

[27] https://pima.massdotpi.com/public/event-registration/search?project_id=13868&pe_guid=8f49eb6d-c8b5-4d2f-9f4d-851abc444cb0

addition to providing updates on the roadway connection options for each bridge, each virtual public meeting consisted of a formal presentation that covered topics such as grant opportunities, a status update, and next steps.

This round of outreach consisted of numerous stakeholder briefings, two live virtual public information meetings, an in-person open house, as well as an Advisory Group meeting (discussed in **Section 6.3.1**). The first public meeting took place on March 22, 2023, and provided an update and information on the Bourne Bridge roadway connection alternatives. The second meeting took place on March 29, 2023, and provided an update and information on the Sagamore Bridge roadway connection alternatives. The content was separated in this manner to ensure the Program could devote adequate time and attention to each bridge and allow the public ample opportunity to learn and ask questions (MassDOT webpage for the March 22, 2023, meeting[28] and the webpage for the March 29, 2023, meeting[29]). A combined total of 694 individuals attended these two public meetings.

At each virtual public meeting there were opportunities for public comments and questions following the presentations. A total of approximately 125 comments were submitted verbally or in written form. Comments and questions were primarily related to topics such as the environment, construction, bridge design, Program schedule, shared-use paths, traffic, safety, and funding.

Each virtual public meeting was recorded and posted on the MassDOT website (recording of the March 22, 2023 meeting[30] and recording of the March 29, 2023, meeting[31]).

The open house took place on May 17, 2023, at the Bourne Veteran's Memorial Community Center, in Bourne. This event provided an update on the status of the Program, project funding and federal grants, the environmental review process, and next steps. This open house consisted of two sessions—an afternoon session from 12 p.m. to 3 p.m., and an evening session from 5 p.m. to 8 p.m. A total of 530 individuals attended this event (MassDOT webpage for open house on May 17, 2023[32]).

[28] https://www.mass.gov/event/cape-bridges-program-bourne-virtual-public-information-meeting-32223-2023-03-22t180000-0400-2023-03-22t200000-0400

[29] https://www.mass.gov/event/cape-bridges-program-sagamore-virtual-public-information-meeting-32923-2023-03-29t180000-0400-2023-03-29t200000-0400

[30] https://pima.massdotpi.com/public/event-registration/search?project_id=13868&pe_guid=89a994e2-ec4a-49f5-8a24-d38b67044193

[31] https://pima.massdotpi.com/public/event-registration/search?project_id=13868&pe_guid=19760912-81f9-45bf-9dbd-4f3ef0415c99

[32] https://www.mass.gov/event/cape-bridges-program-bourne-open-house-51723-2023-05-17t120000-0400-2023-05-17t150000-0400

The open house included displays and graphics regarding roadway approaches, bridge alignments, bridge type, rail trail connections, roadway grades, lane configurations, and construction staging. The event also featured interactive stations, copies of printed materials, a video, and renderings (open house displays on May 17, 2023[33]). The event also served to announce the filing of the ENF with the MEPA Office. Through the open house, approximately 40 comments were submitted to the Program. **Exhibit 6-6** is an image from this open house.

Exhibit 6-6. Open House (May 17, 2023)



Round 6 – Spring 2024

The sixth round of public outreach for the Program took place in spring 2024. Round 6 reviewed MassDOT's assessment of highway interchange options, reviewed the status of Program funding updates, and presented the status of the Program's environmental review.

This round of outreach consisted of numerous stakeholder briefings, a live virtual public information meeting, an in-person open house, as well as an Advisory Group meeting (discussed in **Section 6.3.1**).

The public information meeting took place on April 25, 2024, and was attended by 367 individuals (MassDOT webpage for meeting on April 25, 2024[34]). Following the formal presentation, there were opportunities for public comments and questions following the presentations. Approximately 42 comments were submitted verbally or in written form. Comments and questions were primarily related to topics such as funding, schedule, property impacts, traffic, construction, and roadway operations. The virtual public meeting was recorded and posted on the MassDOT website (Cape Cod Bridges Program - Public Meeting 4/25/24[35]).

The open house took place on May 13, 2024, at the Bourne Veteran's Memorial Community Center, and was attended by 283 individuals (Cape Bridges Program Bourne, Open House 5/13/24). This open house consisted of two sessions—an afternoon session from 12 p.m. to 3 p.m. and an evening session from 5 p.m. to 8 p.m. This event provided an update on the status of the Program, project funding and federal grants, the environmental review process, and next steps.

The open house included displays and graphics regarding interchange options, construction concepts, lane configurations, roadway grade, pedestrian amenities, and bridge type. The event also featured interactive stations, copies of printed materials, a video, and renderings. The May 13, 2024 open house displays can be viewed online. As detailed in **Section 6.4.3.4**, the event also provided additional

[33] https://www.mass.gov/doc/massdot-open-house-document-cape-cod-bridges-program-bourne-51723/download
[34] https://www.mass.gov/event/cape-cod-bridges-program-bourne-virtual-public-information-meeting-42524-04-25-2024
[35] https://pima.massdotpi.com/public/event-registration/search?project_id=13868&pe_guid=28303d0f-e9ab-4ff0-a1ae-3327388368ac

opportunities for public review and comment in advance of submitting the Draft Environmental Impact Report (DEIR). Through the open house, approximately 37 comments were submitted to the Program. **Exhibit 6-7** is an image from this open house.

Exhibit 6-7. Open House (May 13, 2024)



Round 7 – Fall 2024

The seventh round of public outreach for the Program took place in fall 2024. Round 7 provided an update on Program funding, the detailed assessment of interchanges options, recommended interchange options, and subsurface explorations.

Round 7 included an open house event (November 18, 2024, at the Bourne Veteran's Memorial Community Center), which 453 individuals attended. This open house consisted of two sessions – an afternoon session from 12 p.m. to 3 p.m. and an evening session from 5 p.m. to 8 p.m. This event provided an update on the status of the program, the environmental review process, and the detailed assessment of interchange options. The open house included graphics and displays showing interchange options, bridge design, construction concepts, subsurface exploration, and lane configurations.

The event also featured interactive stations, copies of printed materials, and videos of interchange options (Cape Cod Bridge Program Open House Boards 11/18/24). The open house also provided opportunities for public review and comment.

Through this event, approximately 55 comments were submitted to the Program. Comments were responded to, considered by MassDOT in Program design, and logged in PIMA.

6.4.3.5 MassDOT Participation in Community Forums and Local Outreach

In addition to hosting their own open houses and virtual public meetings, MassDOT has attended State Senator Dylan Fernandes' Community Forum on the Program. The Community Forum was held and sponsored by State Senator Dylan Fernandes to provide his constituents with information and updates on the Cape Cod Bridges Program. MassDOT voluntarily attended this public information session to help answer the public's questions and concerns. The forum was held on April 15, 2025, in Admiral's Hall at the Massachusetts Maritime Academy from 5:30 p.m. to 7:00 p.m. Before the opening of the forum, the 400-seat Admiral's Hall was more than half full. The Barnstable and Plymouth County residents were able to hear directly from MassDOT officials in charge of the Program. Senator Dylan Fernandes intends to hold multiple Community Forums in the future as the Program progresses.

Various local organizations have also conducted their own public outreach for the Program. These groups aim to provide the public and their specific stakeholders with information and updates

regarding the Program, often notifying their members and attendees of opportunities to provide comments on the Program.

MassDOT has been invited to and has attended meetings hosted by the following local organizations to provide updates on the Program:

- Sierra Club - Cape Cod & Island Group
- Cape and Island Bridge Committee
- Home Builder and Remodelers Association of Cape Cod
- Bourne Recreation Authority

6.4.4 Environmental Justice Outreach and Engagement

MassDOT has undertaken extensive efforts through the Program to comply with all applicable laws, regulations, and guidance regarding Environmental Justice (EJ) populations, including identifying and engaging EJ populations, and considering, minimizing, and mitigating any potential impacts.

In June 2021, the Commonwealth of Massachusetts' Executive Office of Energy and Environmental Affairs issued an updated Environmental Justice Policy (MA EEA EJ Policy), which was developed to reflect the needs and circumstances specific to EJ populations in Massachusetts.

This MA EEA EJ Policy requires the use of census-block group data to define "EJ populations" in Massachusetts. As defined in the Act and the MA EEA EJ Policy, EJ populations are identified at the census-block group level as a neighborhood where one or more of the following criteria are true:

- The annual median household income is 65% or less of the statewide annual median household income.
- Minorities make up 40% or more of the population.
- 25% or more of households identify as speaking English less than "very well."
- Minorities make up 25% or more of the population and the annual median household income of the municipality in which the neighborhood is located.

6.4.4.1 Environmental Justice Populations Engagement and Accommodations

MassDOT has used numerous tools and measures to ensure that EJ populations, and all individuals wishing to engage with the Program, are afforded that opportunity and represented in the public involvement process. These accommodations include, but are not limited to, the following:

- Providing Spanish and Portuguese translations of Program materials. Translated materials include the Program's comment form, flyers, public notices, and newspaper advertisements.
- Providing Spanish, Portuguese, and American Sign Language (ASL) interpreters at public events.
- Providing interpretation services and translations of specific materials in other languages beyond Spanish and Portuguese upon request.
- Posting Program materials in an accessible format to the Program website to ensure a broad and comprehensive distribution.

- Advertising public events in non-English media publications and distributing press releases to non-English media outlets.
- Posting recordings of public meetings online so that members of the public who are unable to attend or participate when the events are hosted are not excluded from the public involvement process.
- Hosting both in-person and virtual events, which accommodates both individuals who have limited technology capabilities or prefer in-person engagement and individuals who may have limited means to travel to in-person events or prefer engaging at their convenience.
- Scheduling open houses during both daytime and evening hours to maximize attendance and accommodate the schedules of the community.
- Coordinating with community-based organizations, churches, and faith-based organizations. Program information is shared with leaders and their members, and they are provided with opportunities to connect directly with the Program.
- Forming an Advisory Group that comprises members with numerous interests and constituents. Many members represent or serve EJ populations and have valuable insight and relationships with these communities.

6.4.4.2 Environmental Justice Populations Ground Truthing

To further verify data regarding demographics and EJ populations, MassDOT has undertaken a targeted public involvement effort to verify EJ-related data. This effort has included the following:

- Holding coordination calls with community organizations and churches to gauge outreach and engagement methods
- Attending local farmers markets to solicit feedback from the community, including EJ populations
- Using surveys and polls at public meetings to gauge the needs for interpretation services

6.5 Incorporating Feedback

MassDOT has considered public input throughout the Program to promote informed decision-making and ensure the scope, design, and other aspects incorporate community and stakeholder feedback.

Specific examples of components of the Program that have been incorporated into the design based on stakeholder and public engagement include the following:

- Selecting the network tied arch bridge type and identifying areas of interest for bridge design, such as bridge aesthetics and similarity to the existing structures
- Confirming MassDOT's recommended option for each of the four highway interchange quadrants
- Developing the Purpose and Need Evaluation Criteria of separating local and regional traffic

MassDOT will continue to solicit and consider public feedback throughout the design process.

7 Response to Comments

7.1 Introduction

This section provides direct responses to comment letters received during the Massachusetts Environmental Policy Act (MEPA) environmental review process.

7.2 Response to Massachusetts Environmental Policy Act Comment Letters

As specifically required by Certificate issued by the Secretary of the Executive Office of Energy and Environmental Affairs (EEA) on the Cape Cod Bridges Program (EEA# 16695), this chapter provides direct responses to scope items in the Environmental Notification Form (ENF) Certificate and each comment letter submitted during the public review period of the ENF.

The ENF Certificate and all ENF comment letters are included in **Appendix 7, Secretary's Certificate and MEPA Review Comments,** for reference. The ENF Certificate and comment letters have been annotated and individual comments coded in the right-hand margin. Table 7-1 identifies the agencies, organizations, and individuals that provided comments on the ENF and the corresponding table which reiterates the individual comments and provides a direct response.

Table 7-1. Secretary's Certificate and Comment Letters

Commenter	Abbreviation	Table Where Comments are Addressed
Massachusetts Executive Office of Energy and Environmental Affairs Secretary's Certificate on the ENF	MEPA	Table 7-2
Massachusetts Office of Coastal Zone Management	CZM	Table 7-3
Massachusetts Department of Conservation and Recreation	DCR	Table 7-4
Massachusetts Department of Environmental Protection	DEP	Table 7-5
Massachusetts Division of Marine Fisheries	DMF	Table 7-6
Massachusetts Office of Fishing and Boating Access	OFBA	Table 7-7
Massachusetts Historical Commission	MHC	Table 7-8
Natural Heritage and Endangered Species Program	NHESP	Table 7-9
Cape Cod Commission	CCC	Table 7-10
Association to Preserve Cape Cod	APCC	Table 7-11
Art Akeley	AA	Table 7-12
Susan Barlow	SUB	Table 7-13
Stephen Buckley	STB	Table 7-14
Robert Dwyer	RD	Table 7-15
Vanasse & Associates, Inc.	VAI	Table 7-16

7.2.1 Secretary's Environmental Notification Form Certificate

Table 7-2. Secretary's Environmental Notification Form Certificate Comments and Responses

Comment Number	Comment	Response
MEPA 01	The DEIR should describe any changes to the Program since the filing of the ENF. The DEIR should identify, describe, and assess the environmental impacts of any changes to the Program that have occurred between the preparation of the ENF and DEIR.	Since the ENF was submitted, MassDOT selected an interchange option for each quadrant to form the Build Alternative. Refer to **Chapter 3, Proposed Action and Alternatives**, of the DEIR. Additionally, a discipline specific study area was identified and used as the basis to identify the potential effects of the Build Alternative. Refer to **Section 1.6.1** in **Chapter 1, Introduction,** for additional information on changes to the Program since the filing of the ENF.
MEPA 02	The DEIR should also include an updated list of required Permits, Financial Assistance, and other state, local and federal approvals and provide an update on the status of each of these pending actions. The DEIR should include a description and analysis of applicable statutory and regulatory standards and requirements, and a discussion of the Program's consistency with those standards.	Refer to **Section 1.7** in **Chapter 1, Introduction,** of the DEIR, which provides an updated list of required permits and approvals and an update on the status of these pending actions. A discussion of the Program's consistency with applicable regulatory standards and requirements has been included in each resource and/or discipline-specific discussion provided in **Sections 4.2** through **4.23.**
MEPA 03	The DEIR should include updated site plans for existing and proposed conditions at a legible scale that clearly identify all Program components…	Refer to **Appendix 1, Existing Conditions Plans,** and **Appendix 3.2, Proposed Conditions Plans**.

Comment Number	Comment	Response
MEPA 04	The DEIR should expand the discussion presented in the ENF regarding the Program's compliance or consistency with local and regional planning documents.	Refer to **Section 4.6.2.4** of the DEIR for a discussion of relevant goals from the town of Bourne's Local Comprehensive Plan (LCP) and the Cape Cod Commission's Regional Policy Plan (RPP). The Build Alternative aligns with the LCP's open space policy by enhancing public recreation access and establishing green corridors, and it supports the cultural heritage goal by preserving historic and cultural features of the town's landscape. The Build Alternative complies with the goals identified in the RPP by improving access to recreational areas via shared-use paths and preserving cultural heritage through coordination with the Massachusetts Historical Commission (MHC) to mitigate the demolition of the historic bridges. Refer to **Section 4.6.4.1** of the DEIR for additional information.
MEPA 05	The DEIR should provide further documentation to support the preferred bridge design alternatives, including by quantifying and comparing the environmental impacts of the alternatives considered for each project component with respect to land alteration, impervious area, traffic, wetlands, climate resiliency, EJ impacts, and any other impacts to environmental resources. The comparison should be provided in the narrative and in a tabular format.	Refer to **Chapter 3, Proposed Action and Alternatives,** for a high-level comparison of the environmental effects of each of the 10 interchange approach alternatives. A detailed narrative description and a tabular comparison of the environmental impacts of each interchange approach alternative is provided in the following sections of **Chapter 3, Proposed Action and Alternatives**: • Sagamore North: **Section 3.3.3.2, Table 3-9** • Sagamore South: **Section 3.3.3.3, Table 3-12** • Bourne North: **Section 3.3.3.4, Table 3-15** • Bourne South: **Section 3.3.3.5, Table 3-17**

Comment Number	Comment	Response
MEPA 06	The DEIR should discuss what procedures the Proponent will follow in the event future evaluations and reviews, such as federal NEPA and MHC consultations, may result in project changes to accommodate a new or modified alternative other than the ones selected as the Preferred Alternatives for the project.	Any modifications to the Build Alternative will be disclosed in the Final Environmental Impact Report (FEIR). If changes occur after the review of the FEIR, they will be addressed through a MEPA Notice of Project Change (NPC), if necessary.
MEPA 07	The DEIR should provide a detailed comparison of the ten interchange approach alternatives advanced for additional evaluation, including more detailed descriptions and site plans showing the layout of each alternative.	**Section 3.3.3** of the DEIR provides a high-level description of the 10 interchange approach alternatives advanced for further evaluation. Refer to **Section 2.4** of **Appendix 3.1, Attachment 2 Highway Interchange Approaches Detailed Assessment Report,** for a detailed description and conceptual figures showing the layout of each alternative. Refer to the response to MEPA 05 for information regarding a comparison of the impacts of each alternative.
MEPA 08	The DEIR should separately assess alternatives for construction of the shared use path, including more detailed descriptions and plans highlighting the design, width, and interconnection with existing pedestrian/bicycle facilities on either side of the Canal. The DEIR should discuss how these alternatives would be incorporated into each of the ten interchange approach alternatives under consideration.	Each of the 10 interchange approach alternatives summarized in **Section 3.3.3** of the DEIR incorporated a shared-use path (SUP), including connections to the Canal Service Roads. Refer to **Section 2.4** of **Appendix 3.1, Attachment 2, Highway Interchange Approaches Detailed Assessment Report,** for a detailed discussion of the SUPs that were evaluated with each of the 10 interchange approach alternatives. Refer to **Section 4.3** of the DEIR for a discussion of the potential construction and operational effects of the Build Alternative on pedestrian and bicycle infrastructure and associated mitigation measures.
MEPA 09	The DEIR should compare the environmental impacts of each interchange approach and shared use path alternative, with respect to land alteration, impervious area, trip generation, traffic operations, wetlands, GHG emissions, climate resiliency, and any other impacts to environmental resources.	A quantitative tabular comparison of the environmental effects of each interchange approach alternative is provided in **Chapter 3, Proposed Action and Alternatives, Table 3-9** (Sagamore North), **Table 3-12** (Sagamore South)**, Table 3-15** (Bourne North), and **Table 3-17** (Bourne South).

Comment Number	Comment	Response
MEPA 10	The Proponent should consider adding key CBOs and tribes/indigenous organizations as formal members of the Advisory Group.	Please note that the Advisory Group represents a wide range of interests, perspectives, and constituencies in the Cape Cod Canal region. This includes numerous community-based organizations (CBO) within Bourne and the local area such as the Association to Preserve Cape Cod, Cape Cod Commission, Cape Cod Chamber of Commerce, and others. Additionally, tribal representatives have been engaged through the Section 106 review process to identify and mitigate any potential impacts to historical or cultural resources near the project site. Refer to **Section 4.17.2** of the DEIR. Additionally, a comprehensive stakeholder database has been developed to help organize and manage stakeholder information and disseminate information and content. As of September 30, 2024, the database includes over 4,900 stakeholders, which include, but are not limited to the following: • Abutters • Bike and pedestrian groups • Businesses • Chambers of Commerce • Churches and faith-based organizations • Community/advocacy groups • Council on Aging • Education institutions • Emergency services • Federal, state, and local environmental agencies • Hospitality groups • Local, State, and Congressional Officials • Members of the public • Neighborhood associations • Planning Commissions • Recreation boards • Residents and local property owners • Senior Centers • Tourism sites/groups • Transit Authorities • Transportation groups

Comment Number	Comment	Response
MEPA 11	The Proponent should conduct outreach to additional EJ Populations that may be adjacent to the Program Study Areas; specifically, Block Group 1, Census Tract 139 is shown on the EEA EJ Mapper to be very close to the 1-mile radius around the site.	In accordance with the Final MEPA Interim Protocol for Analysis of Project Impacts on Environmental Justice Populations, the Study Area for the EJ assessment encompasses a 5-mile radius from the Program Limits for the Build Alternative at Sagamore and Bourne Bridges. EJ Populations within the Study Area, including Block Group 1, Census Tract 139, are identified within **Table 4.9-1** of **Section 4.9.2** of the DEIR. MassDOT has implemented a range of tools and measures to ensure that these EJ populations, as well as all individuals interested in engaging with the Program, can participate and are well-represented in the public involvement process. MassDOT conducted a targeted effort to validate findings related to EJ populations by attending local events and coordinating with CBOs, churches, and other local stakeholders. These methods aimed to engage with community members, meet people in accessible locations, inform them about the Program, collect input, answer questions, and verify existing conditions to ensure that EJ populations smaller than the Block Group level were accounted for in the analysis.
MEPA 12	The DEIR should include a separate section on "Environmental Justice," and contain a description of measures the Proponent intends to undertake to promote public involvement by EJ Populations during the remainder of the MEPA review process, including any updates to the PIP that the project intends to employ or has employed by the time of the DEIR filing.	The Public Involvement Plan is a living document that is continuously updated to provide the most current information on the public outreach program and evolves to respond to community needs as they may change. The most recent update was published in March 2024 and included updates on Program outreach, the federal and state environmental review processes, and EJ population engagement. The success of the Program and the Public Involvement Plan during each round of public engagement will inform the need for updated outreach strategies. Refer to **Section 6.4.1** of the DEIR for additional information.

Comment Number	Comment	Response
MEPA 13	The Proponent should continue robust outreach and engagement prior to filing the DEIR and should conduct one or more community meetings focused on discussion of remaining project alternatives prior to filing the DEIR.	MassDOT has and will continue to carry out a comprehensive public outreach process throughout the duration of the Program that will allow opportunities for all populations, including EJ populations, to provide feedback on the Build Alternative. This process has included rounds of outreach in Spring 2024 and Fall 2024. Each of these rounds of outreach included an Advisory Group meeting, stakeholder meeting, and an in-person Open House. Refer to **Section 6.4.3** of the DEIR for additional information.
MEPA 14	The DEIR should include a description of the potential sources of pollution within the Program Study Areas, based on mapping layers available through the DPH EJ Tool.	A summary of the potential sources of pollution within the Study Area, including identification of the specific facilities and their enforcement history, is provided in **Section 4.9.4.2** of the DEIR.
MEPA 15	The DEIR should contain a comprehensive discussion of whether any of the impacts from the Program are likely to extend to the identified EJ Populations, and if so, explain how…The DEIR should discuss whether project impacts may materially exacerbate any existing environmental burdens or public health consequences that are assessed as "unfair or inequitable" as compared to the general population.	The Build Alternative would not disproportionately impact EJ populations or worsen existing environmental or public health burdens, while providing benefits such as modern bridges, improved traffic operations, and enhanced bicycle and pedestrian mobility for all users. A detailed analysis of the potential impacts is provided in **Section 4.9.5** of the DEIR.
MEPA 16	The DEIR should discuss whether the project serves to provide "Environmental Benefits" (as defined in 301 CMR 11.02) to the surrounding EJ neighborhoods, including enhanced access to the waterfront, open space or recreational opportunity. The DEIR should evaluate any temporary potential adverse effects to the identified EJ Populations that may result from construction.	The Build Alternative provides "Environmental Benefits" such as better bicycle and pedestrian connectivity to public parks and recreational areas, improved stormwater runoff quality to sole source aquifers, reduced GHG emissions, and decreased exposure to hazardous materials through the removal of existing bridges. Refer to **Section 4.9.5** of the DEIR for a discussion of Program benefits and temporary construction period effects.

Comment Number	Comment	Response
MEPA 17	As part of the Transportation analysis, the DEIR should assess whether impacts to the surrounding roadway network would disproportionately affect EJ populations through intersection delays or other reasons.	The roadway and transportation improvements proposed under the Build Alternative are not located within EJ populations. However, construction of the Build Alternative may result in temporary traffic delays due to increased construction traffic. Refer to **Section 4.9.6** of the DEIR for a discussion of mitigation measures. The Build Alternative is not anticipated to directly result in adverse effects to EJ populations; and the majority of direct effects will occur within non-EJ populations. Additionally, the majority of the project benefits such as improved traffic operations and safety, emergency response time, multi-modal accommodations, and air quality will be experienced regionally. These improvements would provide an overall benefit to the EJ populations within the 5-mile Study Area. Based on this, the Build Alternative would not result in a disproportionate adverse effect or increase the effects of climate change upon EJ populations.
MEPA 18	The DEIR should assess the potential for the project to induce additional demand for vehicular use, and if so, assess whether those impacts will be borne disproportionately by EJ populations…The DEIR should assess the potential secondary growth effects that may result from the project, and whether those effects will be felt disproportionately by EJ populations.	The Build Alternative would not result in induced demand as the improvements focus on geometric upgrades and separation of local and regional traffic near the replacement bridges. No significant changes in travel mode, route, trip length, or number of trips are anticipated as a result of the Build Alternative. Additionally, the Build Alternative is unlikely to cause secondary growth effects because of housing growth limitations and existing roadway capacity and traffic operation challenges. Existing traffic bottlenecks and minimal travel time improvements further reduce the likelihood of significantly enhancing access or increasing development opportunities. Refer to **Section 4.6.4** of the DEIR for additional information.
MEPA 19	The DEIR should include a separate section on "Public Health," and discuss any known or reasonably foreseeable public health consequences that may result from the environmental impacts of the project.	A separate section on "Public Health" is provided as **Section 4.21** of the DEIR. With the implementation of construction-period mitigation measures related to air quality, hazardous material, waste management, noise and vibration, and water quality, the Build Alternative would not result in significant adverse effects to public health. Refer to **Section 4.21.4** of the DEIR for additional information.

Comment Number	Comment	Response
MEPA 20	In particular, the public health effects of increased air emissions, traffic and noise should be assessed.	Refer to **Section 4.21.4** of the DEIR for a discussion of the potential public health effects of increased air emissions, traffic, and noise. Construction of the Build Alternative is not anticipated to result in adverse health impacts related to air emissions, traffic, noise, and vibration due to the implementation of mitigation measures such as anti-idling signage, low-emitting diesel-fueled equipment, dust suppression wetting agents, containment for stockpiles, a Traffic Management Plan, a Noise Control Plan, regular equipment maintenance, mufflers and noise-dampening attachments, temporary noise barriers, vibratory pile driving methods, scheduling noise-intensive activities during daytime hours, and procedures for community noise complaints. The Build Alternative would result in improved traffic operations and reduced delays and an enhanced pedestrian and bicycle networks that will result in improved local and regional air quality through reduced vehicular GHG emissions.
MEPA 21	The Proponent should conduct a noise monitoring program to establish ambient background noise levels within the project area to develop the project criteria noise limits.	A noise measurement program was conducted at 18 sites, consistent with FHWA and MassDOT recommended procedures, to document existing ambient noise levels in noise-sensitive locations in the study area, which consisted of primarily residential areas. Refer to **Section 4.15.3.1** of the DEIR and **Section 4.2.1.4** of **Appendix 4.15, Noise and Vibration Technical Report**.

Comment Number	Comment	Response
MEPA 22	The DEIR should discuss what regulatory requirements, such as MassDEP regulations or policies, apply to noise impacts of construction operations. The DEIR should discuss whether noise impacts are likely to disproportionately affect surrounding EJ neighborhoods or other vulnerable populations…and what mitigation could be considered to minimize the noise impacts of construction operations.	Pursuant to 23 CFR 772.19, all Type I highway projects must consider construction noise effects and mitigation measures. While the Build Alternative is not proposed within identified EJ populations, the Sagamore South interchange improvements would occur adjacent to an EJ population (Block Group 1, Census Tract 141; comprising Joint Base Cape Cod), generating temporary construction noise. However, noise impacts to sensitive receptors are not anticipated, as the area near proposed work activities is undeveloped. MassDOT will require a Noise Control Plan to minimize construction noise. Refer to **Section 4.15.5.2** of the DEIR and **Section 7.2** of **Appendix 4.15, Noise and Vibration Technical Report**.
MEPA 23	The DEIR should provide an updated table which quantifies the land alteration and impervious area associated with each project component in a tabular format. The DEIR should clarify the amount of alteration including the type of vegetation that will be cleared.	Refer to **Table 4.6-4** and **Table 4.6-5** in **Section 4.6.4.3** of the DEIR which quantify the proposed land alteration and impervious area resulting from the Build Alternative. This section also identifies the types of vegetation and tree cover that will be removed as a result of the Build Alternative. Refer to **Appendix 4.6, Preliminary Tree Clearing Plans,** for plans that identify the limits of tree clearing in relation to the proposed work.

Comment Number	Comment	Response
MEPA 24	The DEIR should identify how the project is designed to avoid and minimize land alteration and impervious area. It should provide a comprehensive evaluation of all measures preserve open space and tree cover, to reduce the amount of land alteration, and to convert impervious areas to pervious materials, including reductions in pavement associated with the removal of the existing interchange approaches, and supplemental landscaping or tree planting to mitigate impacts associated with clearing.	Refer to **Section 4.6.4** of the DEIR for details on total land alteration. Approximately 20% of the total clearing would be associated with installation of a SUP to improve public access to and from Cape Cod Canal, as well as to improve multimodal connectivity and safety in the Study Areas. The widths of the proposed sidewalks and SUPs have been minimized as much as possible, while meeting MassDOT's design standards, ensuring the Program's purpose and need are met and providing safe accommodation for vehicles and multi-modal users. The Build Alternative would provide over 200 acres of new landscaping and vegetation, including reforestation, restoration, and street tree plantings. Primarily native plantings will be used to restore and enhance habitat, reinforcing the unique landscape character of the region. Refer to **Section 4.6.5** of the DEIR for additional details. Refer to **Appendix 4.6, Preliminary Tree Clearing Plans,** for plans that identify the limits of tree clearing in relation to the proposed work.
MEPA 25	The DEIR should quantify open space that will remain undisturbed and/or restored upon completion of construction. The DEIR should include site plans that clearly locate and delineate areas proposed for development and those to be left undisturbed.	The Build Alternative would provide over 200 acres of new landscaping and vegetation, including reforestation, restoration, and street tree plantings. Primarily native plantings will be used to restore and enhance habitat, reinforcing the unique landscape character of the region. Refer to **Section 4.6.5** of the DEIR for additional details. Refer to **Appendix 4.6, Preliminary Tree Clearing Plans,** for figures that identify the areas of proposed tree clearing.
MEPA 26	The DEIR should also identify all easements and public utilities on-site and off-site and provide information on the parties to the easements and location and condition of said utility infrastructure. It should describe any constraints on project design or use of the site posed by these conditions.	Existing conditions plans are provided in **Appendix 1, Existing Conditions Plans**. More detailed plans will be developed as the design progresses.

Comment Number	Comment	Response
MEPA 27	Comments provided by MassDEP state that where the addition of the new auxiliary lane will occur, this component of the Program will not be evaluated as redevelopment and the SMS must be fully met.	Stormwater runoff from the new auxiliary lane will fully comply with MassDEP's Stormwater Management Standards (SMS).
MEPA 28	The DEIR should describe how the proposed stormwater management system will fully comply with the SMS.	Refer to **Section 4.11.8** of the DEIR for a discussion of how the Build Alternative would be designed, operated, and maintained in compliance with each of the 10 Stormwater Management Standards.
MEPA 29	The DEIR should identify any infiltration systems that may require registration under MassDEP's Underground Injection Control (UIC) program.	MassDOT will evaluate proposed stormwater control measures to identify those that require registration under MassDEP's UIC program and will register them accordingly.
MEPA 30	The DEIR should also identify all measures that will be employed to protect the water quality of the Cape Cod Sole Source Aquifer.	The Build Alternative is located within two Sole Source aquifers: the Cape Cod Sole Source Aquifer (south of the Cape Cod Canal) and the Plymouth/Carver Sole Source Aquifer (north of the Cape Cod Canal). The Build Alternative includes stormwater control measures (SCMs), including rain gardens, bioretention areas, infiltration basins, sediment forebays, and deep sump catch basins that will improve the treatment and quality of the runoff discharged to these sole source aquifers. Refer to **Section 4.11.7.2** of the DEIR.

Comment Number	Comment	Response
MEPA 31	The DEIR should describe the extent to which the project will preserve existing tree canopies and plant additional trees, including estimates of the number of trees that will be planted.	MassDOT will implement a landscaping plan that will provide new landscaping and vegetation for over 200 acres within the Study Areas to repair, restore, and enhance the landscape flanking the mainline highways, bridges, and local roads and connections to compensate for the disturbance and clearing required as part of the Build Alternative. The landscape plan will include the following landscape types to restore disturbed sites and integrate the new infrastructure into the landscape: landscape restoration and reforestation, street tree planting, lawn, stormwater basins and rain gardens, buffer planting, roundabout planting, special planting, and community open space. Refer to **Section 4.6.5** of the DEIR for additional information. Additional information regarding the proposed landscape plan will be provided in the FEIR.
MEPA 32	The DEIR should quantify and evaluate pre- and post-precipitation depths; peak intensities; groundwater recharge and runoff rates; and changes in water quality.	Refer to **Section 4.11.8** of the DEIR for a discussion regarding the project's compliance with the SMS. **Tables 4.11-5** to **Table 4.11-7** list existing and proposed peak rate discharges. **Table 4.11-8** presents the required and proposed recharge volumes, and **Table 4.11-9** presents the required and proposed water quality volumes and total suspended solids (TSS) removal for the Build Alternative.
MEPA 33	The DEIR should demonstrate the system will be designed to accommodate larger storm events. The DEIR should provide quantitative modeling and analysis to assess the rainfall volumes that will be accommodated by the stormwater design, including under future climate conditions.	The Resilient MA Action Team (RMAT) Tool recommended planning for 100-year, 24-hour event in 2070, which is projected to be 9.8 inches for the Sagamore watersheds and 9.9 inches for the Bourne watersheds. These recommended rainfall depths were used to assess the vulnerability of the stormwater management system and to design more resilient infrastructure. SCMs in the Build Alternative are designed to accommodate the future 2070 100-year, 24-hour event and function as intended. Refer to **Section 4.22.4.3** of the DEIR and **Section 5.3.3** of **Appendix 4.22, Climate Change Adaptation and Resiliency Technical Report**, for additional information.

Comment Number	Comment	Response
MEPA 34	It should include a plan showing the location of BMPs.	Refer to **Figures 4.11-16** to **4.11-19** of the DEIR, which depict the location of proposed SCMs.
MEPA 35	The DEIR should quantify the number of property takings/acquisitions associated with each alternative evaluated, provide a detailed description of the acquisition procedure that will be implemented, and include an update as to the status of any said acquisitions.	A quantitative tabular comparison of the number of property acquisitions and easements associated with each interchange approach alternative is provided in **Table 3-9** (Sagamore North), **Table 3-12** (Sagamore South)**, Table 3-15** (Bourne North), and **Table 3-17** (Bourne South). **Appendix 3.1, Attachment 2, Highway Interchange Approaches Detailed Assessment Report,** provides a more detailed assessment of each interchange approach alternative.
MEPA 36	The DEIR should include graphics that clearly delineate and describe either existing land ownership or acquisitions, easements and associated rights (e.g., rail operations, sewer lines, drainage culverts, etc.) required for project construction, and roadway and intersection jurisdictions. The DEIR should also provide plans at a reasonable scale to discern limits of the existing and proposed roadway rights-of-way and adjacent Article 97 and/or parkland/open space, particularly in the area within and adjacent to the Bourne Scenic Park and the Shawme-Crowell State Forest.	Existing conditions plans are provided in **Appendix 1, Existing Conditions Plans**. Proposed conditions plans are provided in **Appendix 3.2, Proposed Conditions Plans**. More detailed plans will be developed as project design progresses. Property information and a description of the easements required to construct the Build Alternative are provided in **Section 4.8.4** of the DEIR.

Comment Number	Comment	Response
MEPA 37	As evaluation of the selected interchange approach alternatives is advanced, the Proponent should consult with DCR relative to potential impacts to the Shawme-Crowell State Forest. Additionally, consistent with newly enacted St. 2022, c. 274, An Act Preserving Open Space in the Commonwealth (codified as M.G.L. c. 3, § 5A), the Proponent should also consult the EEA land division (at plpa@mass.gov) prior to filing the DEIR to determine whether the Program will result in a disposition or change in use of Article 97 land. The DEIR should provide an update on any such coordination and identify any changes made to the project design in response to this consultation.	The Build Alternative is not anticipated to result in permanent impacts to Shawme-Crowell State Forest. MassDOT will confirm potential effects to properties, property boundaries, and the status of open space as design advances and property title searches are conducted. As needed, MassDOT will coordinate with the EEA land division and other public entities to compensate for impacts, including complying with Article 97 land disposition requirements.
MEPA 38	The DEIR should include a Traffic Impact and Access Study (TIAS) prepared in accordance with EEA/MassDOT Guidelines for EIR/EIS Traffic Impact Assessments…The TIAS should examine existing and future No Build and future Build alternative transportation conditions. The TIAS should discuss existing and proposed traffic volumes and conditions, crash rate data, LOS operations at study area intersections and the surrounding interchanges, and a queuing analysis for all approaches. The DEIR should identify the specific measures to be implemented by the Program that will improve traffic safety.	**Section 4.2.4** of the DEIR and **Appendix 4.2, Traffic Engineering Technical Report**, provides a detailed analysis of the 2050 No Build Alternative and Build Alternative. The analysis addresses existing and proposed traffic volumes, level of service (LOS) operations, queuing at approaches, and safety measures.

Comment Number	Comment	Response
MEPA 39	The DEIR should evaluate the existing and proposed traffic volumes, conditions, and LOS operations for each of the ten interchange approach alternatives advanced for further evaluation. The DEIR should detail how this analysis contributed to the selection of the preferred interchange approach alternatives.	Each of the 10 interchange alternatives were analyzed in a regional traffic operations assessment to evaluate their network performance (number of processed vehicles and average delay per vehicle); total travel time (congestion levels and origin-destination travel times); and queue lengths. A summary of this analysis is provided in **Section 3.2** of the DEIR. A detailed comparison of these metrics is provided for each interchange alternative in **Section 3.3** of **Appendix 3.1, Attachment 2, Highway Interchange Approaches Detailed Assessment Report**. The findings from the regional traffic operations analysis provided MassDOT with valuable insight into the performance of different alternative pairings relative to optimizing network efficiency and mitigating existing congestion and resulted in the elimination of Option BN-6.1 from further evaluation. The remaining nine interchange alternatives were advanced for further evaluation against transportation and contextual performance measures. Refer to **Section 4** of **Appendix 3.1, Attachment 2, Highway Interchange Approaches Detailed Assessment Report,** for additional information.
MEPA 40	The DEIR should also contain a description of existing and proposed bicycle accommodations within the traffic study area including their location, type, width, and routes between key destinations. Supporting graphics depicting proposed roadway cross-sections and routes should be included in the DEIR to facilitate review. The DEIR should explore alternative designs and connections to existing bicycle and pedestrian facilities in conjunction with the evaluation of the interchange approach alternatives.	Refer to **Section 4.3.3** and **Section 4.3.4** of the DEIR for a description of the existing and proposed bicycle and pedestrian facility network, respectively. Graphics depicting the existing and proposed routes, including location, type, and width, are also provided in the above-referenced sections. Each of the 10 interchange approach options summarized in **Section 3.2** of the DEIR incorporated a SUP, including connections to the Canal Service Roads. Refer to **Section 2.4** of **Appendix 3.1, Attachment 2, Highway Interchange Approaches Detailed Assessment Report,** for a detailed discussion of the SUPs that were evaluated with each of the 10 interchange approaches. Refer to **Section 4.3** of the DEIR for a discussion of the potential construction and operational effects of the Build Alternative on pedestrian and bicycle infrastructure and associated mitigation measures.

Comment Number	Comment	Response
MEPA 50	The DEIR should include a traffic management plan that describes measures to avoid, minimize, and mitigate construction period impacts on the surrounding roadway network.	Refer to **Section 5.6** of the DEIR for a conceptual traffic management plan. MassDOT contract specifications for temporary traffic control will require the contractor to develop and implement a detailed Traffic Management Plan that will describe measures to avoid, minimize, and mitigate construction period impacts on the surrounding roadway network.
MEPA 51	The DEIR should describe the process for evaluating the potential for induced demand and discuss in detail the basis for any conclusions reached regarding induced demand including references to published guidance, academic articles, and publicly available research. The DEIR should also evaluate whether any additional trips due to induced demand will have disproportionate adverse impacts to EJ Populations, including Block Group 1, Census Tract 139 identified in the Environmental Justice section above.	The Build Alternative would not result in induced demand as the improvements focus on geometric upgrades and separating local and regional traffic near the replacement bridges, with no significant changes in travel mode, route, trip length, or number of trips anticipated. Travel-time improvements anticipated by this Project are not expected to generate additional trips to Cape Cod. Refer to **Section 4.2.4.6** of the DEIR for additional information on induced demand.
MEPA 52	The DEIR should include a mesoscale air quality analysis using the MOVES model, consistent with the MassDEP Guidelines for Performing Mesoscale Analysis of Indirect Sources, for the study area used for the traffic study performed for the project.	A mesoscale analysis was performed to evaluate the potential regional air quality impact of the Build Alternative from motor vehicle emissions. Mobile source emissions were estimated using the EPA MOVES4 (version 4.0.1). Calculations compared area-wide emissions under existing conditions, the future No Build Alternative, and the Build Alternative. Refer to **Section 4.14.3** of the DEIR and **Section 6.3** of **Appendix 4.14, Air Quality and Greenhouse Gas Emissions Technical Report,** for additional information.

Comment Number	Comment	Response
MEPA 53	The analysis should provide a breakdown of EJ versus non-EJ roadway segments within the study area.	Refer to **Figure 6-2** in **Appendix 4.14, Air Quality and Greenhouse Gas Emissions Technical Report**, which depicts the roadways within the Air Quality Study Areas in relation to identified EJ populations. State Route 130 passes through an EJ population within five miles of the site, as identified using MEPA data. Similarly, State Route 28 and U.S. Route 6 traverse EJ populations located within five miles of the site, as identified using NEPA data. The other state and U.S. routes travel adjacent to, but do not extend through, identified EJ populations.
MEPA 54	The DEIR should estimate the number of construction period truck trips that are anticipated for the project and indicate whether routes of travel will extend through EJ Populations within one mile of the site.	Construction of the Build Alternative is expected to generate 230,368 construction-period truck trips. The origin of these trips will depend on various factors that are currently unknown, such as the locations of suppliers for construction materials, waste disposal sites, staging areas, and the contractor's office or equipment yards. However, it is anticipated that these trips will primarily utilize major interstates and U.S. or State routes, including Interstates 195 and 495, State Routes 3, 130, and 28, and U.S. Routes 6 and 25. State Route 130 passes through an environmental justice (EJ) population within five miles of the site, as identified using MEPA data (refer to **Section 4.9.2** in the DEIR for additional information regarding identification of EJ populations). Similarly, State Route 28 and U.S. Route 6 traverse EJ populations within five miles of the site, as identified using NEPA data. The other State and U.S. Routes travel adjacent to, but do not extend through, identified EJ populations.

Comment Number	Comment	Response
MEPA 55	The DEIR should estimate the extent of new vessel traffic (on daily basis) that would be required by the project based on the anticipated construction needs of the preferred mainline alignment alternative. The DEIR should discuss whether such vessel traffic would pass by any EJ Populations and estimate the increase in air emissions associated with the new vessel traffic.	Up to 64 vessels (16 per quadrant) may be employed in day-to-day operations at one time. Refer to **Section 5.7.6** of **Chapter 5, Construction Approach,** for additional information regarding the number, size, and timing of anticipated vessel trips. Refer to **Section 6.4.3** of **Appendix 4.14, Air Quality and Greenhouse Gas Emissions Technical Report,** for an estimate of air emissions from the construction vessels. The origin of the vessel trips will depend on various factors that are currently unknown, such as the locations of suppliers for construction materials, waste disposal sites, and the location of their home marina or docking facilities. However, regardless of their origin, the vessels will need to enter the canal from either the north or south and pass by an EJ population located adjacent to the southern entrance to the Canal. Furthermore, the emission plume from the vessel stacks will be dispersed and diluted due to meteorological conditions (i.e., wind speed and wind direction) and constant moving nature of the activities, which will help mitigate concentrated ground-level concentrations and exposure as compared to a stationary source.
MEPA 56	The DEIR should provide an updated table which quantifies wetland resource area and buffer zone impacts, both temporary and permanent, associated with each Program component. The DEIR should also demonstrate that the project can be designed and constructed consistent with the WPA Regulations (310 CMR 10.00) and all applicable performance standards, as well as describe all measures proposed to mitigate said impacts.	Tables provided in **Section 4.10.4** of the DEIR quantify the wetland resource impacts associated with the Build Alternative. Refer to **Section 4.10.6.1** of the DEIR for a discussion of the Build Alternative's conformance with the Massachusetts Wetlands Protection Act performance standards.

Comment Number	Comment	Response
MEPA 57	The DEIR should include updated figures that depict and identify all the surveyed vernal pools and their current status (i.e., certified, eligible to be certified, and non-eligible to be certified).	Eight vernal pools were surveyed in the Study Areas as shown on **Figure 4.10-2** through **Figure 4.10-4** and described in **Table 4.10-3** provided in **Section 4.10.2.2** of the DEIR. Two vernal pools are certified through the Natural Heritage and Endangered Species Program (NHESP).
MEPA 58	The DEIR should detail the impacts to said vernal pools and the area within 100 feet of the mean annual high-water boundaries of the pools, if any; the specific measures taken to avoid said impacts; and measures proposed to mitigate any such impacts.	Construction of the Bourne South and Sagamore North interchange approaches would occur within 100 feet of two vernal pools as summarized in **Table 4.10-8** in **Section 4.10.4.1** of the DEIR.
MEPA 59	The DEIR should provide an overview of the potential construction timeline in order for Agencies to assess whether time-of-year (TOY) restrictions may be warranted to protect migratory species using the Canal.	In-water construction activities causing potentially adverse acoustical disturbances or risk for protected species entrapment (i.e., vibratory or impact pile driving, rotary drilling, and dredging) will only occur between September 1 and February 28 each year. Construction support vessel operations, and activities conducted in the dry (i.e., within dewatered cofferdams) or above the High Tide Line (HTL), may occur any time of year. In-water temporary impacts, including turbidity and increased vessel traffic associated, are expected to last approximately six years for each bridge, with potential for acoustic impacts limited to the TOY described above. Refer to **Section 5.7** and **Table 4** in **Appendix 4.12, Attachment 2, Biological Assessment for Marine Species and Agency Coordination**, for additional information.
MEPA 60	…[t]he DEIR should also evaluate the feasibility of reusing demolition materials generated from the removal of the existing bridge foundations to support DMF's underwater reef program.	MassDOT is aware of this program and will continue to consider recycling and reuse of concrete and other materials where possible. Updates on coordination with DMF and material reuse and recycling will be provided in the FEIR.

Comment Number	Comment	Response
MEPA 61	The DEIR should identify any permanent or temporary navigation impacts resulting from implementation of the Program, specifically noting differences in impacts between alternatives considered. The DEIR should also discuss the Program's compliance or consistency with the U.S. Coast Guard's requirements.	The construction approach, and potential impacts on the navigation channel, do not vary between each interchange approach alternative. Refer to **Sections 4.4.4** and **4.4.5** of the DEIR for a discussion of potential navigation impacts and mitigation measures, respectively. MassDOT will apply for bridge permits from the U.S. Coast Guard for the replacement Sagamore and Bourne Bridges. Refer to **Section 4.4.4.3** of the DEIR for additional information.
MEPA 62	To the extent that reuse of the existing bridge piers is determined to be infeasible, the DEIR should identify and evaluate other opportunities to expand recreational access as part of the Program's design. The DEIR should present more than one recreational access alternative, in accordance with the Alternatives Analysis Scope above. The DEIR should also quantify any additional impacts associated with the reuse of the existing bridge piers and each recreational access alternative. The DEIR should also identify any additional permitting required in order to implement such recreational access.	Reuse of the existing bridge piers is not feasible as the USACE requested their removal due to navigational concerns. MassDOT is proposing to construct a walkway and fishing platform at each proposed bridge crossing, positioned at the top of the delta pier footing and at the same elevation as the Canal Service Road. Refer to **Section 4.16.5.1** of the DEIR and **Section 8.3.3** of **Appendix 4.16, Visual Impact Assessment,** for more information. The walkway/fishing platform and connections to the Canal Service Road will require USACE Section 408 review for anticipated temporary and permanent alterations of the waterway and abutting lands of the Federal Navigation Project (FNP). The Build Alternative also includes SUP connections to expand access to existing recreational areas. Specifically, the Build Alternative includes SUP connections between the Bourne Recreational Area and Gallo Ice Arena.
MEPA 63	The DEIR should include a discussion of how the Program complies with the PBD (301 CMR 13.00) criteria. The DEIR should also include information regarding the public benefits associated with the Program.	**Section 4.13.4.2** of the DEIR includes include discussion regarding the Program's compliance with the Public Benefit Determination criteria. **Table 3-18** in **Chapter 3** of the DEIR identifies the operational benefits of the Preferred Alternative for the Program.

Comment Number	Comment	Response
MEPA 64	The DEIR should clarify how each of the proposed project alternatives would avoid or minimize impacts to the Herring River Watershed ACEC and present mitigation proposals for unavoidable impacts. The DEIR should also detail how Program-related activities occurring within the ACEC support the intent and the protections afforded by its designation.	The Build Alternative has minimized impacts to the Herring River Watershed ACEC and Bourne Back River ACEC to the maximum extent practicable. Retaining walls are also proposed in certain areas to minimize impacts to the ACEC. Work within the Herring River Watershed ACEC is limited to pavement widening of approximately 10-ft, which will be located within the existing roadway shoulder. The widening and introduction of pavement within this area is a continuation of the use of an existing transportation corridor and it would not result in direct impacts to the wetlands, the sole source aquifer, or threatened and endangered species habitat. Therefore, it is not expected to adversely affect protected resources associated with the ACEC. No work is proposed within the Bourne Back River ACEC. Refer to **Section 4.10.4.1** of the DEIR for additional information.
MEPA 65	The DEIR should also detail any changes to wildlife habitat and/or hydrology within the ACEC, including any efforts to improve or restore wildlife habitat and natural hydrology within the ACEC.	Work within the Herring River Watershed ACEC is minor, limited to pavement widening of 10 feet within the existing roadway shoulder. Refer to comment MEPA 64.

Comment Number	Comment	Response
MEPA 66	The DEIR should evaluate and quantify all impacts to Priority and Estimated Habitat associated with the interchange alternatives advanced for additional analysis. The DEIR should also provide a discussion on the potential impacts to species utilizing the Canal as habitat and/or to transit between Cape Cod Bay and southern New England during construction period activities. To the extent that the Program will impact rare species or their habitats, the DEIR should identify the BMPs that will be implemented to minimize and/or mitigate such impacts in order to meet state and federal performance standards.	**Section 4.12.4** of the DEIR and **Appendix 4.12, Attachment 1, Biological Assessment for Terrestrial Species and Agency Coordination**, address, evaluate, and quantify potential impacts to NHESP Priority and Estimated Habitats. **Section 4.12.4.2** of the DEIR and **Appendix 4.12, Attachment 2, Biological Assessment for Marine Species and Agency Coordination**, discuss potential impacts to species using the canal as habitat or for transit. **Section 4.12.5** of the DEIR identifies mitigation measures, including BMPs, that would be implemented to minimize and/or mitigate impacts. Protection of terrestrial resources would consist of a time of year (TOY) restriction that prohibits tree clearing during the summer occupancy period for bats and typical nesting season for migratory birds. Protection of marine resources would consist of a TOY restriction for in-water construction activities that may cause acoustic and turbidity effects and for vessel speeds; other BMPs would include using soft starts during pile driving, having a fisheries biologist confirm presence/absence, and use of dolphins and bollards to anchor vessels.
MEPA 67	The Proponent should continue to consult with NHESP, DMF, and other federal agencies to ensure that it evaluates the full extent of potential impacts to rare species and their habitats, and to ensure it assesses all measures to avoid, minimize and or mitigate any impacts. The DEIR should provide an update on any such coordination and identify any changes made to the project design in response to this consultation.	In coordination with FHWA, MassDOT will continue to consult with state and federal agencies through the design phase and receipt of environmental permits and approvals. **Appendix 4.12, Threatened, Endangered, and Protected Species and Habitats Material,** contains the updated agency coordination letters. **Section 4.12.5** of the DEIR identified the avoidance, minimization and mitigation measures that MassDOT will incorporate into Program design and construction methods; these measures, implemented in response to agency consultation, have modified the design, such as using dolphins and bollards to anchor vessels as opposed to barge spudding, and the construction schedule, such as adhering to TOY restrictions for in-water work with potential to cause acoustic and turbidity impacts.

Comment Number	Comment	Response
MEPA 68	Comments from MHC affirm the execution of a PA and acknowledge the need to enter into a revised PA that will include FHWA and future MOAs. The DEIR should include a copy of the amended PA and new MOA.	At the direction of the FHWA Federal Preservation Officer (FPO), a new Programmatic Agreement will be prepared that will commit the Program to mitigate the adverse effects on the NRHP-eligible Sagamore and Bourne Bridges and guide the Program through Section 106 consultation during the Design-Build process. The DEIR includes a draft copy of the Programmatic Agreement (**Appendix 4.17, Draft Programmatic Agreement**). **Section 4.17.6** of the DEIR provides additional details.
MEPA 69	The DEIR should identify the APE to be developed for each bridge crossing and provide an evaluation of potential impacts of the construction and operation of the program on the APE's historic resources. The DEIR should also detail the process for identifying and evaluating archaeological resources, and should identify avoidance, minimization, and/or mitigation measures for the protection and preservation of archaeological resources identified during cultural resource investigations.	**Section 4.17.2** of the DEIR presents the methodology for identifying and evaluating architectural and archaeological resources in the APEs. Architectural and archaeological resources within the Study Area are described in **Section 4.17.2** of the DEIR. **Section 4.17.5** of the DEIR evaluates the effects of the Program alternatives on the APE's historic resources. As indicated in **Section 4.17.3.4,** no significant archaeological resources have been previously recorded or have been identified within the Program's direct APEs. As directed by the Programmatic Agreement, a Special Provision will be included in the Construction Contract for the Discovery of Unanticipated Archaeological and Skeletal Remains.
MEPA 70	The DEIR should include an update on consultations with parties that have been granted consulting party status. To the extent these consultations result in any changes to project design, including bridge type and design and construction methodology, the DEIR should fully describe any such changes and resulting changes to environmental impacts. If any changes are made to any of the preferred alternatives already chosen for certain project components, this should be explained in the DEIR.	**Section 4.17, Cultural Resources,** of the DEIR provides updates on Section 106 consultations. As indicated in **Section 4.17.5** of the DEIR, MassDOT selected the preferred alternative bridge type in part because it has a kinship with the existing historic high-level through truss bridges, would provide a similar monumental gateway experience across the Cape Cod Canal, and would avoid an impact on the Cape Cod Canal Historic District.

Comment Number	Comment	Response
MEPA 71	The DEIR should identify the nature and volume of solid waste to be generated by the project. It should describe handling, reuse, recycling and disposal of solid waste…The DEIR should describe how the project will comply with all applicable requirements.	**Tables 4.19-1** and **4.19-2** in **Section 4.19, Solid and Hazardous Waste Material Management,** of the DEIR identify estimated quantities and types of waste that will be generated under the Build Alternative. Refer to **Section 4.19.5** of the DEIR for a discussion of measures that will be implemented to comply with applicable regulatory requirements.
MEPA 72	The DEIR should include a plan that clearly identifies the location of disposal sites and project elements.	Review of federal and state regulatory databases identified 161 sites of known or potential sources of contamination within or adjacent to the Sagamore Bridge and Bourne Bridge Study Areas that may possibly contain oil and/or hazardous material (OHM). Refer to **Figure 4.19-2** through **Figure 4.19-5** in **Section 4.19.2** of the DEIR for a figure that identifies their locations. Refer to **Section 5.4** and **Section 6.4** of **Appendix 4.19, Solid and Hazardous Waste Material Management Technical Report,** for additional details.
MEPA 73	The DEIR should describe any potential excavation or disturbance in disposal sites and identify any necessary mitigation measures or handling and disposal requirements. The DEIR should also discuss any generation of hazardous waste and/or waste oil and identify potential measures to reduce, recover and reuse hazardous waste.	Several release sites regulated under the Massachusetts Contingency Plan (MCP) are within the Bourne and Sagamore Bridge Study Areas. Most involve small fuel and oil spills that were cleaned up without restrictions. One Activity and Use Limitation (AUL) is near the construction limits in the Sagamore south quadrant. Any disturbance or excavation within these areas must comply with AUL and MCP requirements. Refer to **Section 4.19.5** of the DEIR for a discussion of measures that will be implemented to protect worker safety, prevent public exposure to hazardous materials, and protect the environment in accordance applicable regulatory requirements. Refer to **Appendix 4.19, Solid and Hazardous Waste Material Management Technical Report**, for additional information.

Comment Number	Comment	Response
MEPA 74	The DEIR should describe implementation of a spills contingency plan that addresses prevention and management of potential releases of oil and hazardous materials from pre- and post-construction activities and will be presented to workers at the site and enforced.	MassDOT contract specifications will require the contractor to develop and implement a Spill Prevention, Containment and Control Plan to describe planning, prevention, and control measures to minimize impacts resulting from accidental spills or releases of oil and hazardous materials (OHM) during construction, if on-site storage of oil or oil products exceeds applicable regulatory thresholds.
MEPA 75	Specifically, the DEIR should evaluate how changes to the site's topography will impact coastal storm inundation and local stormwater flooding.	The extent of overland coastal surge for the Build Alternative for Sagamore Bridge is the same as the No Build Alternative, as there are no proposed changes to grading within the flood extents. The extent of overland coastal surge for Bourne Bridge for the Build Alternative is the same as the No Build Alternative, except for Bourne North, where there are proposed grade changes near Belmont Circle. These grade changes slightly reduce the extent of coastal inundation at the edge of the floodplain, but do not impact the flood pathways compared to the No Build Alternative. Refer to **Section 4.22.4.4** of the DEIR and **Section 5.4.1** of **Appendix 4.22, Climate Change Adaptation and Resiliency Technical Report**, for additional information.

Comment Number	Comment	Response
MEPA 76	The DEIR should include a detailed analysis explaining how the appropriate sea level rise factors for the elevation of the bridges as well as for the elevations of the approach roadways was determined.	The methodology included reviewing published relative sea level rise (RSLR) observations and projections, the closest tide gauge (Woods Hole NOAA Gage: 8447930), modeled historic and projected storm surge elevations, FEMA maps and studies, and projected values in the RMAT Tool for water surface elevations, wave heights, and wave action water surface elevations. Projected tidal datums were not available in the RMAT Tool. **Table 4.22-3** and **Table 4.22-4** in **Section 4.22.1.3** of the DEIR include summaries of RSLR and storm surge design criteria used to assess affected environment, impacts assessed, and methodology. The effects of RSLR vary based on the affected environment, and the RSLR rates considered for the Program were determined based on the following: • Useful life or year through which the infrastructure is expected to last • The functional requirements through the infrastructure's useful life • Estimated adaptive capacity at the end of the infrastructure's useful life • Past published USACE assessments of construction costs and impacts Refer to **Section 2.3, Section 5.1.1,** and **Section 5.5.1** of **Appendix 4.22, Climate Change Adaptation and Resiliency Technical Report**, for additional information.
MEPA 77	The DEIR should also include additional information on how the alternative interchange approaches have been designed to avoid increases or changes in velocity, reflection, or channelization of floodwaters by conducting and providing a pre- and post-construction flow path analysis.	The Build Alternative does not increase the velocity of moving water, redirect, or channelize flow, and allows water to spread laterally and landward. Refer to **Section 4.22.4.4** of the DEIR and **Section 5.4.1** of **Appendix 4.22, Climate Change Adaptation and Resiliency Technical Report**, for additional information.

Comment Number	Comment	Response
MEPA 78	The DEIR should compare proposed elevations of the approach roadways and pier foundations to water elevations shown in the MA Resilience Design Tool and discuss how climate data and projections were used to determine the proposed elevations.	Projected Tidal Datums are not available through the RMAT Tool for the Cape Cod Canal. Projected RSLR values from ResilientMass were added to the tidal datums for Sagamore and Bourne Bridge and used for transportation proposed elevations. Refer to **Section 4.22.1.3** of the DEIR and **Section 2.3.2** of **Appendix 4.22, Climate Change Adaptation and Resiliency Technical Report**, for additional information.
MEPA 79	The DEIR should identify the Program Study Areas' vulnerabilities to climate change and potential features incorporated into the design of the project that will increase the resiliency of the Program Study Areas to likely climate change impacts.	Refer to **Section 4.22.2** of the DEIR and **Section 3** of **Appendix 4.22, Climate Change Adaptation and Resiliency Technical Report**, for additional information on the existing conditions within the Program and Study Area and the primary climate risks assessed in the No Build and Build Alternatives. Refer to **Section 4.22.5** of the DEIR and **Section 6** of **Appendix 4.22, Climate Change Adaptation and Resiliency Technical Report**, for additional information on the proposed measures, beyond standard design best practices, to mitigate impacts on affected environments within the Sagamore and Bourne Study Areas
MEPA 80	The DEIR should describe the precipitation data used for the design of the stormwater management system.	The proposed SCMs are designed for the 2070, 24-hour, 100-year storm event. Refer to **Section 4.22.1.3** of the DEIR and **Section 2.2.4** of **Appendix 4.22, Climate Change Adaptation and Resiliency Technical Report**, for additional information.

Comment Number	Comment	Response
MEPA 81	The DEIR should discuss whether the proposed stormwater design will accommodate the recommended 2070 100-year return period (24-hour rainfall volume of 9.8 inches) from the Tool. The DEIR should discuss whether the stormwater management system will attenuate peak flows and meet pollutant loading requirements based on future climate conditions in 2070 and should provide a copy of the Stormwater Report for the project.	The proposed SCMs are designed for the 2070 100-year storm event and are anticipated to attenuate peak flows and meet pollutant loading requirements. Refer to **Section 4.22.1.3** of the DEIR and **Section 2.2.4** of **Appendix 4.22, Climate Change Adaptation and Resiliency Technical Report**, for additional information. A Stormwater Report will be provided to MassDEP and the Bourne Conservation Commission with the Notice of Intent (NOI) application.
MEPA 82	The DEIR should describe mitigation measures implemented as part of the future Build. These measures may include, but should not be limited to, improvements to roadway operations, physical roadway infrastructure upgrades, and use of CO_2 reduction technologies…The Proponent should address this [induced demand] concern in the DEIR. The DEIR should provide a summary of other MassDOT initiatives that seek to reduce the Commonwealth's overall reliance on single-occupant vehicles…	In general, signalized intersections level of service and delays are expected to improve or remain the same for the Build Alternative at most intersections. As described in **Section 4.2.4.6** of the DEIR, the Build Alternative would not result in induced demand as the improvements focus on geometric upgrades and separating local and regional traffic near the replacement bridges, with no significant changes in travel mode, route, trip length, or number of trips anticipated. MassDOT has several initiatives to reduce reliance on single-occupant vehicles, including the Transportation Management Association (TMA) Grant Program and the Beyond Mobility plan. The Complete Streets guidance documents, Safe Routes to School (SRTS) Program, and Statewide Bicycle Transportation and Pedestrian Plans also promote alternative transportation methods like walking, biking, and public transit. These efforts aim to lower greenhouse gas emissions, improve travel reliability, and make biking and walking safe and convenient options for everyday travel.

Comment Number	Comment	Response
MEPA 83	The DEIR should quantify the total areal extent of proposed clearing onsite and off-site, characterized by cover type (i.e., forested, scrub/shrub, grassland, etc.). The DEIR should discuss the measures taken to avoid and/or minimize tree clearing and identify measures that will be implemented to mitigate for the removal of trees.	Refer to **Table 4.6-4** in **Section 4.6.4.2** of the DEIR for details on total land alteration and the types of vegetation and tree cover that will be removed due to the Build Alternative. Approximately 20% of the total clearing would be associated with installation of a SUP to improve public access to and from Cape Cod Canal, as well as to improve multimodal connectivity and safety in the Study Areas. The widths of the proposed sidewalks and SUPs have been minimized as much as possible while still adhering to MassDOT's design standards, ensuring the Program's purpose and need are met and providing safe accommodation for vehicles and multi-modal users. The Build Alternative would provide over 200 acres of new landscaping and vegetation, including reforestation, restoration, and street tree plantings. Primarily native plantings will be used to restore and enhance habitat, reinforcing the unique landscape character of the region. Refer to **Section 4.6.5** of the DEIR for additional details.
MEPA 84	The DEIR should identify how the bridges are anticipated to be constructed, including but not limited to any in-water access, cofferdams, and staging areas. The DEIR should describe the proposed timing and duration of in-water work as well as proposed methodologies. The DEIR should further describe the BMPs that will be implemented to avoid, minimize, and mitigate any potential noise and turbidity impact	Refer to **Section 5.7** of the DEIR for a high-level discussion of in-water work construction activities. **Section 4.12.5.2** of the DEIR identifies measures to protect aquatic resources from noise and turbidity impacts. **Appendix 4.12, Attachment 2, Biological Assessment for Marine Species and Agency Coordination**, provides further details on in-water work and BMPs and TOY restrictions that the Program will incorporate to minimize adverse effects to the waterway.
MEPA 85	The Proponent should coordinate with DCR to ensure that construction-period interruptions to visitor access to the Scusset Beach State Reservation are minimized to the extent feasible. The DEIR should provide an update on said coordination and identify any proposed mitigation measures should visitor access be impacted by the Program.	MassDOT does not anticipate construction-period impacts to visitor access to the Scusset Beach State Reservation.

Comment Number	Comment	Response
MEPA 86	The DEIR should describe how construction activities will be managed in accordance with applicable MassDEP regulations regarding Air Pollution Control (310 CMR 7.01, 7.09-7.10), and Solid Waste Facilities (310 CMR 16.00 and 310 CMR 19.00, including the waste ban provision at 310 CMR 19.017).	Construction and demolition activities will be managed in accordance with the MassDEP regulations regarding Air Pollution Control and Solid Waste Facilities, including the waste ban provision at 310 CMR 19.017.
MEPA 87	The DEIR should describe all construction-period impacts and mitigation relative to wetlands, stormwater, noise, air quality, water quality, and traffic. It should describe truck routes and other mitigation measures that may be implemented to minimize impacts to residential areas by trucks travelling to the site during the construction period.	A discussion of construction period impacts and associated mitigation has been included in each resource and/or discipline specific discussion provided in **Section 4-2 through Section 4-23**. Construction period impacts and mitigation measures are also summarized in **Chapter 8, Mitigation and Draft Section 61 Findings**. Contract specifications will restrict parking and routing of truck traffic through residential neighborhoods and will require the Contractor to develop a Traffic Management Plan that includes designated truck routes, off-peak truck deliveries, employee parking away from residences, electronic message signs for alternate routes, potential traffic signal changes, and police detail for traffic direction.
MEPA 88	The DEIR should provide detailed information regarding the project's generation, handling, recycling, and disposal of construction and demolition debris (C&D) and identify measures to reduce solid waste generated by the project.	MassDOT's Contract Specifications will require all demolition waste to be properly segregated and managed based on the nature of the waste and the presence of Oil and Hazardous Materials (OHM). Recycling and reuse of concrete, steel and other materials would be implemented as part of the Build Alternative, where possible. On-site reuse of soils and sediments can be maximized based on visual, olfactory, and geotechnical properties. All surplus soils and sediments will undergo laboratory testing prior to transportation with off-site reuse and disposal options dictated by contaminant concentrations. Excess soil and sediment to be transported off-site for disposal will be managed in accordance with applicable regulatory requirements.

Comment Number	Comment	Response
MEPA 89	The DEIR should describe stormwater management measures that will be implemented during construction. It should describe potential construction period dewatering activities and associated permitting (i.e., NPDES) and identify mitigation measures.	Dewatering activities are described in **Section 5.7.3** of the DEIR. MassDOT's Contract Specifications will require the Contractor(s) to prepare and implement a Stormwater Pollution Prevention Plan per National Pollutant Discharge Elimination System (NPDES) permitting requirements. Other mitigation measures to avoid or minimize impacts to groundwater, surface water, and stormwater runoff during construction are discussed in **Section 4.11.7.1** of the DEIR. At locations where work may be conducted within the boundaries of a release site, coordination with MassDEP may be required. Locations where dewatering of contaminated groundwater may be conducted require coordination with state and federal agencies for potential dewatering and discharge permits (Dewatering and Remediation General Permit). Refer to **Appendix 4.19, Solid and Hazardous Waste Materials Management Technical Report.**
MEPA 90	The DEIR should include a separate chapter summarizing all proposed mitigation measures including construction-period measures. This chapter should also include a comprehensive list of all commitments made by the Proponent to avoid, minimize and mitigate the environmental and related public health impacts of the project, and should include a separate section outlining mitigation commitments relative to EJ Populations.	Refer to **Chapter 8, Mitigation and Draft Section 61 Findings,** which provides a summary of all mitigation measures, including construction-period measures.

Comment Number	Comment	Response
MEPA 91	The DEIR should contain a copy of this Certificate, and a copy of each comment letter received. In order to ensure that the issues raised by commenters are addressed, the DEIR should include a comprehensive response to comments on the DEIR that specifically address each issue raised in the comment letter; references to a chapter or sections of the DEIR alone are not adequate and should only be used, with reference to specific page numbers, to support a direct response.	A copy of the Certificate with annotations, including all comment letters received, has been included in **Appendix 7, Secretary's Certificate and MEPA Comment Letters.**
MEPA 92	In accordance with 301 CMR 11.16(3), the Proponent should circulate the DEIR to each Person or Agency who commented on the ENF, each Agency from which the project will seek Permits, Land Transfers or Financial Assistance, and to any other Agency or Person identified in the Scope.	The DEIR has been circulated to any person or agency who commented on the ENF, each Agency from which actions are required, and any other parties identified in the DEIR Scope. Specifically, the DEIR was circulated to the updated EJ Reference List obtained on DATE, and a hard copy will be provided to the Bourne Public Library. Pursuant to 23 CFR 771.123(i), the DEIR has been distributed electronically to public officials, interest groups, and members of the public; Cooperating Agencies; and applicable federal and state land management agencies. Refer to **Chapter 9, DEIR Distribution List,** for the circulation list.

7.2.2 Massachusetts Office of Coastal Zone Management

Table 7-3. Massachusetts Office of Coastal Zone Management Comments and Responses

Comment Number	Comment	Response
CZM 01	MassDOT is proposing to increase the vertical clearance of the bridges by 3.18 feet. The downscaled sea level rise projections available on the EEA Climate Clearinghouse website for the Woods Hole Tide gauge indicate that 7.7 to 10.3 feet of sea level rise are projected to occur by 2100. A more detailed analysis explaining how the appropriate sea level rise factors for the elevation of the bridges as well as for the elevations of the approach roadways should be provided in the DEIR.	The methodology included reviewing published relative sea level rise (RSLR) observations and projections, the closest tide gauge (Woods Hole NOAA Gage: 8447930), modeled historic and projected storm surge elevations, FEMA maps and studies, and projected values in the RMAT Tool for water surface elevations, wave heights, and wave action water surface elevations. Projected tidal datums were not available in the RMAT Tool. **Table 4.22-3** and **Table 4.22-4** in **Section 4.22.1.3** of the DEIR include summaries of relative sea level rise (RSLR) and storm surge design criteria used to assess affected environment, impacts assessed, and methodology. The effects of RSLR vary based on the affected environment, and the RSLR rates considered for the Program and associated improvements were determined based on: • Useful life or year through which the infrastructure is expected to last, • The functional requirements through the infrastructure's useful life, • Estimated adaptive capacity at the end of the infrastructure's useful life, and • Past published USACE assessments of construction costs and impacts. Refer to **Section 2.3** and **Section 5.5.1** of **Appendix 4.22, Climate Change Adaptation and Resiliency Technical Report**, for additional information.

Comment Number	Comment	Response
CZM 02	The project should not increase the velocity of flood waters and/or change flow directions on the subject site in a way that may impact the site, adjacent properties, or public or private ways. The DEIR should include additional information on how the alternative approaches have been designed to avoid increasing the impacts described above by conducting and providing a pre- and post-construction flow path analysis.	The Build Alternative does not increase the velocity of moving water, redirect, or channelize flow, and allows water to spread laterally and landward. Refer to **Section 4.22.4.4** of the DEIR and **Section 5.4** of **Appendix 4.22, Climate Change Adaptation and Resiliency Technical Report,** for additional information. Refer to **Section 4.22.4.4** of the DEIR for figures proposed grade changes and corresponding flood pathways.
CZM 03	A narrative comparing the existing to the proposed conditions and expected pathways, noting any potential increases or changes in velocity, reflection, or channelization of floodwaters within the site or onto adjacent parcels.	
CZM 04	A narrative describing how the proposed design of the site avoids, minimizes, or if necessary, mitigates these potential impacts.	The Build Alternative was designed such that it will not increase the velocity of moving water, redirect, or channelize flow, but would allow water to spread laterally and landward. Refer to **Section 4.22.4.4** of the DEIR and **Section 5.4** of **Appendix 4.22, Climate Change Adaptation and Resiliency Technical Report,** for additional information.
CZM 05	The analysis should look at potential impacts for the present using FEMA flood zones and base flood elevations as well as expected conditions over the design life of the project, including the best available data regarding sea level rise for the life of the project.	The methodology included a review of published relative sea level rise (RSLR) observations and projections, the closest tide gauge (Woods Hole NOAA Gage: 8447930), modeled-historic and projected storm surge elevations, FEMA maps and studies, and projected values in the RMAT Tool for water surface elevations, wave heights, and wave action water surface elevations. Refer to **Section 4.22.1.3** of the DEIR and **Section 2.2** and **Section 2.3** of **Appendix 4.22, Climate Change Adaptation and Resiliency Technical Report,** for additional information.

7.2.3 Massachusetts Department of Conservation and Recreation

Table 7-4. Massachusetts Department of Conservation and Recreation Comments and Responses

Comment Number	Comment	Response
DCR 01	DCR review and coordination will be required if there is any anticipated access to or use of state forest land related to construction of the replacement Sagamore bridge. Visitor access to Scusset Beach State Reservation in Sandwich must be taken into consideration related to potential impacts during the Sagamore construction phase.	The Build Alternative is not anticipated to result in permanent impacts to Shawme-Crowell State Forest. MassDOT will confirm potential effects to properties, property boundaries, and the status of open space as design advances and property title searches are conducted. As needed, MassDOT will coordinate with DCR and other public entities to compensate for impacts, including complying with Article 97 land disposition requirements. MassDOT does not anticipate impacts to visitor access to Scusset Beach State Reservation during construction of the Sagamore Bridge replacement.

7.2.4 Massachusetts Department of Environmental Protection

Table 7-5. Massachusetts Department of Environmental Protection Comments and Responses

Comment Number	Comment	Response
DEP 01	Preliminary impact assessments provided in the ENF indicate impacts may only occur to LSCSF, ILSF, and buffer zone. The ENF notes that no 100-foot buffer zone impacts would occur at the Sagamore Bridge crossing. Please note that coastal bank along the Cape Cod Canal would be afforded 100-foot buffer zone under the Massachusetts Wetlands Protection Act. Proposed work within all buffer zones or wetland Resource Areas should be identified in the Draft Environmental Impact Report (DEIR).	The Bourne North and South interchange approaches would occupy approximately 32 acres of the 100-foot buffer zone to state wetlands. The occupation of the buffer zone would include temporary construction work zones, permanent highway ramps, SUPs, landscaping, and mitigation areas.
DEP 02	A copy of the Order of Resource Area Delineation (ANRAD) issued by the Bourne Conservation Commission on May 5, 2022, should be included in the DEIR, including the approved plan.	A copy of the ANRAD is provided as **Appendix 4.10, Abbreviated Notice of Resource Area Delineation**.
DEP 03	The DEIR should also identify how the bridge is anticipated to be constructed, including but not limited to any in-water access, cofferdams, staging areas, etc.	Refer to **Chapter 5, Construction Approach**, for a high-level description of how the bridges would be constructed. Additional construction details for in-water work are provided in **Appendix 4.12, Attachment 2, Biological Assessment for Marine Species and Agency Coordination**.
DEP 04	Figures 5-1 through 5-4 should depict and identify all the surveyed vernal pools and their current status (i.e., certified, eligible to be certified, and non-eligible to be certified) in the DEIR. All efforts should be taken to avoid impacts to these vernal pools and the area within 100 feet of the mean annual high-water boundaries of these pools.	Five vernal pools were surveyed in the Study Areas as shown on **Figure 4.10-2** through **Figure 4.10-4** and described in **Table 4.10-3** in **Section 4.10.2.2** of the DEIR. Two vernal pools are certified through the NHESP. Construction of the Bourne South and Sagamore North interchange approaches would occur within 100 feet of two vernal pools as summarized in **Table 4.10-9** in **Section 4.10.4** of the DEIR.

Comment Number	Comment	Response
DEP 05	Details on the existing and proposed stormwater system should be provided in the DEIR.	The Build Alternative includes SCMs including rain gardens, bioretention areas, infiltration basins, sediment forebays, and deep sump catch basins that will improve the treatment and quality of the runoff that is eventually discharged to these sole source aquifers. Refer to **Section 4.11.7.2** of the DEIR.
DEP 06	The Project description states that 700-foot out-of-water spans are proposed, but the alternatives analysis states both 700-foot and 820-foot out-of-water spans are the preferred options. It appears the 820-foot option would avoid and minimize impacts to coastal resource areas more than the 700-foot option and may avoid permanent impacts entirely. Based on information provided in the ENF, unless otherwise prohibitive, it appears the 820-foot option would be considered the environmentally referred alternative based on the information provided. MassDEP understands that further evaluation of these options will be provided when the alternatives design advances in the DEIR.	As discussed in **Section 3.3.2.3** of the DEIR, MassDOT further evaluated the two main span lengths as part of a detailed bridge fabrication and erection methodology analysis for the bridge type. The detailed assessment included a review of off-site arch fabrication, float-in operations, and arch lifting operations. Based on a detailed constructability assessment, MassDOT identified the 700-foot main span with the bridge piers located within the riprap slope of the canal and above the low tide line as the preferred option
DEP 07	As stated in the ENF, the Project is considered water dependent in accordance with 310 CMR 9.12 and a Chapter 91 Waterways license will be required.	The Cape Cod Canal is a federally controlled waterway for the primary purpose of navigation. As the Cape Cod Canal is not held in trust by the Commonwealth for the benefit of the public, it is not considered subject to state jurisdiction under Chapter 91MassDOT is coordinating with MassDEP to confirm the canal is not subject to State jurisdiction under MGL Chapter 91. Refer to **Section 4.13.4.2** of the DEIR for additional information.
DEP 08	The Proponent is advised that the use of conveyances of stormwater through underground stormwater infiltration structures that qualify as under the jurisdiction of the MassDEP Underground Injection Control (UIC) program…	MassDOT will evaluate proposed stormwater control measures to identify those that require registration under MassDEP's UIC program and will register them accordingly.

Comment Number	Comment	Response
DEP 09	The Project Proponent is advised that if oil and/or hazardous material are identified during the implementation of this project, notification pursuant to the Massachusetts Contingency Plan (310 CMR 40.0000) must be made to MassDEP, if necessary. A Licensed Site Professional (LSP) should be retained to determine if notification is required and, if need be, to render Appropriate opinions.	Any work occurring within the boundaries of a known MassDEP release site will be performed under the direction of an LSP to ensure proper management according to the Massachusetts Contingency Plan. Any new areas of contamination encountered during construction will be coordinated with an LSP to determine the appropriate regulatory pathway under the Massachusetts Contingency Plan. Refer to **Section 4.19.5** of the DEIR for additional information.
DEP 10	A spills contingency plan addressing prevention and management of potential releases of oil and/or hazardous materials from pre- and post-construction activities should be presented to workers at the site and enforced. The plan should include but not be limited to, refueling of machinery, storage of fuels, and potential on-site activity releases.	MassDOT contract specifications will require the contractor to develop and implement a Spill Prevention, Containment and Control Plan to describe planning, prevention, and control measures to minimize impacts resulting from accidental spills or releases of oil and hazardous materials (OHM) during construction, if on-site storage of oil or oil products exceeds applicable regulatory thresholds. Refer to **Section 4.19.5** of the DEIR for additional information.
DEP 11	MassDEP requests that all non-road diesel equipment rated 50 horsepower or greater meet EPA's Tier 4 emission limits, which are the most stringent emission standards currently available for off-road engines. If a piece of equipment is not available in the Tier 4 configuration, then the Proponent should use construction equipment that has been retrofitted with appropriate emissions reduction equipment.	MassDOT Contract Specifications will require the contractor to enforce anti-idling measures consistent with MGL Chapter 90 Section 16A and to certify that all diesel-powered non-road construction equipment and vehicles rated 50 horsepower or greater will have engines that meet either the EPA particulate matter emission standards or emission control technology verified by the EPA or the California Air Resources Board (CARB); or emission control technology certified by manufacturers to meet or exceed emission reductions verified by EPA or CARB. Emission control devices, such as diesel oxidation catalysts or diesel particulate filters, will be installed on the exhaust system side of the diesel combustion engine equipment.

Comment Number	Comment	Response
DEP 12	MassDEP recommends that the Construction and Demolition Waste Management Plan shall include how solid waste/recyclables will be stockpiled, and that erosion controls are provided for the stockpile area of solid waste/recyclables to minimize or prevent runoff impacts.	MassDOT's Contract Specifications will require the contractor prepare a Construction and Demolition Waste Management Plan, which will include stockpile controls. Stockpile controls will also be incorporated into the project Stormwater Pollution Prevention Plan.
DEP 13	MassDEP recommends the Proponent consider source separation or separating different recyclable materials at the job site. Source separation may lead to higher recycling rates and lower recycling costs.	MassDOT's Contract Specifications will require all demolition waste to be properly segregated and managed based on the nature of the waste and the presence of Oil and Hazardous Materials (OHM). Recycling and reuse of concrete, steel and other materials would be implemented as part of the Build Alternative, where possible.
DEP 14	Although the ENF did not indicate that the Proponent intends to reuse of any demolition materials, the Proponent is reminded that reuse of any demolition material requires submittal of MassDEP's BWP SW41 – Beneficial Use Determination – Restricted Applications.	Comment acknowledged. The contractor will be required to submit a Beneficial Use Determination to MassDEP for the reuse of any demolition materials.
DEP 15	Although the ENF did not indicate that tree removal/land clearing will be conducted for the Project, the Proponent is reminded of the MassDEP's requirements for clean wood from land clearing. As defined in 310 CMR 16.02, clean wood means "discarded material consisting of trees, stumps and brush, including but limited to sawdust, chips, shavings, bark, and new or used lumber" …etc. Clean wood does not include wood from commingled construction and demolition waste, engineered wood products, and wood containing or likely to contain asbestos, chemical preservatives, or paints, stains or other coatings, or adhesives. The Proponent should be aware that wood is not allowed to be buried or disposed of at the Site pursuant to 310 CMR 16.00 & 310 CMR 19.000 unless otherwise approved by MassDEP.	Comment acknowledged. The contractor will be required to comply with all applicable regulatory requirements, including MassDEP's requirements for clean wood from land clearing.

Comment Number	Comment	Response
DEP 16	Although the Proponent did not indicate that the project will encounter asbestos containing material, the Project Proponent is advised that demolition activity must comply with both Solid Waste and Air Quality Control regulations. Please note that MassDEP promulgated revised Asbestos Regulations (310 CMR 7.15) that became effective on June 20, 2014. The new regulations contain requirements to conduct a pre-demolition/renovation asbestos survey by a licensed asbestos inspector and post abatement visual inspections by a licensed asbestos project monitor.	Asbestos Abatement Work Plans will be developed to specify work practices and procedures related to removing ACM during construction. ACM abatement will be conducted using Massachusetts-licensed professionals according to MassDEP's Asbestos Regulations. Refer to **Section 4.19.5** of the DEIR for a description of potential asbestos-containing materials that may be disturbed and mitigation measures that will be implemented during construction. Additional information may be found in **Appendix 4.19, Solid and Hazardous Waste Material Management Technical Report**.
DEP 17	Given the location of the Project and Eversource's proposed near-by electric transmission infrastructure investment - driven by anticipated offshore wind energy interconnections on the Cape - MassDEP, in consultation with the Massachusetts Department of Energy Resources, recommends the MassDOT consult with Eversource to evaluate the potential to coordinate and reduce costs for any required energy infrastructure.	MassDOT has been working with Eversource throughout the project development process and will continue to do so.
DEP 18	MassDEP also recommends that the Proponent provide information in the DEIR about the potential and feasibility for the design of the bridges to include drinking water, Wastewater, and telecommunications corridors.	The Build Alternative incorporates communication duct banks. To-date, utility companies have not requested inclusion of additional duct banks. MassDOT will coordination with the USACE regarding their needs for power infrastructure. As directed by MassDOT, gas pipelines would not be permitted on the new bridges due to safety and security considerations.

7.2.5 Massachusetts Division of Marine Fisheries

Table 7-6. Massachusetts Division of Marine Fisheries Comments and Responses

Comment Number	Comment	Response
DMF 01	The DEIR should describe proposed timing and duration of in-water work as well as methodologies. Time-of-year (TOY) restrictions [2] may be warranted to protect migratory species using the Cape Cod Canal depending on the details of the in-water work plan.	**Section 4.12.4** of the DEIR and **Appendix 4.12, Attachment 2, Biological Assessment for Marine Species and Agency Coordination,** discuss potential impact to species using the canal as habitat or for transit. **Section 4.12.5** of the DEIR identifies mitigation measures, including BMPs, that would be implemented to minimize and/or mitigate impacts. In-water construction activities causing potentially adverse acoustical disturbances or risk for protected species entrapment (i.e., vibratory or impact pile driving, rotary drilling, and dredging) will only occur between September 1 and February 28 each year. Construction support vessels operations and activities conducted in the dry (i.e., within dewatered cofferdams), or above the HTL, will occur any time of year. In-water temporary impacts, including turbidity and increased vessel traffic associated with the Program are expected to last approximately six years for each bridge, with potential for acoustic impacts limited to the TOY described above. Refer to **Section 5.8** and **Table 4** of **Appendix 4.12, Attachment 2, Biological Assessment for Marine Species and Agency Coordination**, for additional information.
DMF 02	The DEIR should further describe Best Management Practices to avoid and minimize potential noise and turbidity impacts to existing marine resources associated with removal of old piers and installation of new piers in the Canal.	Refer to response to comment DMF 01.
DMF 03	MA DMF supports recommendations of the MA Office of Fishing and Boating Access to utilize the old bridge abutments to enhance recreational fishing access.	Reuse of the existing bridge piers is not feasible as the USACE requested their removal due to navigational concerns. MassDOT is proposing to construct a walkway and fishing platform at each bridge crossing, positioned at the top of the delta pier footing and at the same elevation as the Canal Service Road. Refer to **Section 4.16.5.1** of the DEIR and **Section 8.3.3** of **Appendix 4.16, Visual Impact Assessment,** for more information.

7.2.6 Massachusetts Office of Fishing and Boating Access

Table 7-7. Massachusetts Office of Fishing and Boating Access Comments and Responses

Comment Number	Comment	Response
OFBA 01	This could be achieved by incorporating fishing pier structures extending seaward from the service road to the new bridge piers proposed to be located within the intertidal zone. An alternative would be to repurpose a portion of the existing bridge piers to support the new fishing structures. This would eliminate the need, cost and potential wetland/waterway resources impacts by eliminating the need to demolish and dispose of the in-water portion of the existing bridge piers.	MassDOT is proposing to construct a walkway and fishing platform at each bridge crossing, positioned at the top of the delta pier footing and at the same elevation as the Canal Service Road. Refer to **Section 4.16.5.1** of the DEIR and **Section 8.3.3** of **Appendix 4.16, Visual Impact Assessment,** for more information. Reuse of the existing bridge piers is not feasible as the USACE requested their removal due to navigational concerns.
OFBA 02	In addition, the Division of Marine Fisheries has a program that develops underwater reefs to provide fish habitat, which also promotes and improves recreational fishing opportunities. Most recently, DMF obtained and deployed granite and concrete salvaged from demolition of portions of the South Coast Rail project. Demolition materials generated from the removal of the existing canal bridge foundations could be utilized for the DMF's underwater reef program's future projects.	MassDOT is aware of this program and will continue to consider recycling and reuse of concrete and other materials where possible. Updates on coordination with DMF and material reuse and recycling will be provided in the FEIR.

7.2.7 Massachusetts Historical Commission

Table 7-8. Massachusetts Historical Commission Comments and Responses

Comment Number	Comment	Response
MHC 01	The MHC signed a Programmatic Agreement (PA) with the Army Corps and MassDOT in 2022, which is included in the ENF. The MHC looks forward to entering into a revised PA that will include the FHWA and future MOAs, as stated on pages 112-113 of the ENF.	At the direction of the FHWA Federal Preservation Officer (FPO), a new Programmatic Agreement will be prepared that will commit the Program to certain stipulations to mitigate the Adverse Effects on the NRHP-eligible Bourne and Sagamore Bridges and guide the Program through Section 106 consultation during the Design/Build process. The DEIR includes a draft copy of the Programmatic Agreement (**Appendix 4.17, Draft Programmatic Agreement**). **Section 4.17.6** of the DEIR provides additional details.

7.2.8 Natural Heritage and Endangered Species Program

Table 7-9. Natural Heritage and Endangered Species Program Comments and Responses

Comment Number	Comment	Response
NHESP 01	The Division requests that the proponent quantify all impacts to Priority Habitat associated with the preferred alternatives in the Environmental Impact Report (EIR) to facilitate further review under MESA. The Division Recommends that the Proponent continue to consult with the Division to ensure that it evaluates the full extent of potential impacts to state-listed species and their habitats, and to ensure it assesses all measures to avoid, minimize and or mitigate any impacts.	**Section 4.12.4.1** of the DEIR and **Appendix 4.12, Attachment 1, Biological Assessment for Terrestrial Species and Agency Coordination**, evaluate and quantify potential impacts to NHESP Priority and Estimated Habitats. **Section 4.12.4.2** of the DEIR and **Appendix 4.12, Attachment 2, Biological Assessment for Marine Species and Agency Coordination,** discuss potential impact to marine species using the canal as habitat or for passage. **Section 4.12.5** of the DEIR identifies mitigation measures, including BMPs, that would be implemented to minimize and/or mitigate impacts.

7.2.9 Cape Cod Commission

Table 7-10. Cape Cod Commission Comments and Responses

Comment Number	Comment	Response
CCC 01	The DEIR should provide more details on proposed pedestrian and path connections to the adjacent roadway and path networks. While state and federal standards, including the MassDOT Healthy Transportation Directive, will ensure new facilities will be built to modern standards, it will require careful planning to ensure that connections maximize safety, convenience, comfort, and usability.	Refer to **Section 4.3.4** of the DEIR for a discussion of proposed bicycle and pedestrian infrastructure and connections to the adjacent roadway and path network.
CCC 02	While the Project is focused on improvements to infrastructure within the study area, it would be beneficial in the DEIR to identify any mitigation actions anticipated to support and enhance public transportation options within and beyond the study area. These mitigation actions ideally would be implemented during construction with the opportunity to become a permanent solution. For example, investment in infrastructure and operations of bus and rail service that would allow for increased frequency could help reduce traffic on the bridges. Traditional barriers, such as the schedule of the Canal Rail Bridge and infrastructure deficiencies identified in the Cape Rail Study, could be addressed to allow for increased rail service to and from Cape Cod. Additionally, investing in bicycle and pedestrian infrastructure within the Upper Cape region could provide for connected modes of transportation to reduce automobile dependence. For example, making meaningful progress on efforts to connect the regional trail network, like building out the Bourne Rail Trail, could improve the options available to travelers in the Canal area. Finally, other measures outside of the study area that may be helpful in reducing vehicle trips, like improvements to or addition of new Park and Ride facilities, should be identified.	MassDOT met with the Cape Cod Commission and Cape Cod Regional Transit Authority in February 2025 to discuss these issues, including the frequency of the Cape Flyer, bus routes and bus stops within the Study Area, and additional park and ride locations. MassDOT will continue to coordinate with the Cape Cod Commission and Cape Cod Regional Transit Authority on these issues as design progresses. MassDOT is advancing Phase I of the Bourne Rail Trail and the Sandwich connection from the Cape Cod Canal to Route 132 and the Cape Cod Rail Trail. These trails will eventually complete a SUP from Woods Hole in Falmouth to the Canal Access Road through the Program Area and eventually heading east to Provincetown. Additionally, MassDOT is advancing the design of a new park and ride at Route 132 in Barnstable, MA, which will provide approximately 120 spaces.

Comment Number	Comment	Response
CCC 03	As detailed in the ENF, ten interchange approach alternatives will be advanced for Phase 2 screening. The DEIR should present detailed analysis of these alternatives to allow for comparisons between alternatives. With respect to the Bourne South Program Study Area, it would be helpful to have more detail on concepts that were considered but dismissed through Phase 1 screening. Where Option BS2.2 identifies that "the single point interchange would reach near capacity in the future build condition" it would be helpful to understand if a similar option was considered with a multi-level ramp system that could provide a free flow movement from Route 28 southbound to Sandwich Road eastbound, one of the heaviest volume movements.	**Table 3-3** and **Table 3-4** in **Section 3.3** of the DEIR, and **Section 2.4** in **Appendix 3.1, Attachment 2, Highway Interchange Approaches Detailed Assessment Report,** provide a high-level description of the 10 interchange approach alternatives advanced for further evaluation. Refer to **Appendix 3.1, Attachment 2, Highway Interchange Approaches Detailed Assessment Report**, for a detailed description and conceptual figures showing the layout of each interchange approach alternative. Refer to the response to MEPA 05 for information regarding a comparison of the impacts of each alternative. Refer to **Section 6** of **Appendix 3.1, Attachment 2, Highway Interchange Approaches Detailed Assessment Report**, for a detailed comparison of interchange option BS-2 and BS-2.2. Option BS-2.2 was dismissed because it offered fewer benefits compared to Option BS-2. While both improved cross canal mobility, BS-2 provided a greater reduction in vehicle-hours traveled, minimized wrong-way driving risks through its geometric design, and offered better multi-modal accommodations with rapid flashing beacons at pedestrian/bicycle crossings. In contrast, BS-2.2 had an inherent risk of wrong-way driving and less favorable signalized crossings for pedestrians and bicyclists.

Comment Number	Comment	Response
CCC 04	Additionally, the DEIR and future documents should provide more detail on additional actions that will be taken to manage the traffic impacts of construction activities. For a project of this scale, we would expect the development of a Traffic Management Plan that considers all modes with involvement of all stakeholders and all agency partners from the outset, development and implementation of specific incident management protocols, a dedicated and proactive informational campaign with updates on construction progress and specific guidance on times to travel and modal options, and utilization of innovative contracting mechanisms to incentive desirable outcomes (ex. maximize safety, minizine delay).	Refer to **Section 5.6** of the DEIR for a conceptual traffic management plan. MassDOT contract specifications for temporary traffic control will require the contractor to develop and implement a detailed Traffic Management Plan.
CCC 05	The Project includes the alteration of up to 168 new acres of land. Clearing of natural forested land is generally discouraged to protect the region's most sensitive resources. An understanding of the existing conditions of any land proposed to be altered would be helpful in assessing impacts to regional resources. The DEIR should provide detail on existing vegetation and any plans to mitigate loss of forested area. The DEIR should also consider and minimize cumulative effects to natural resources of any other non-bridge but associated MassDOT projects (e.g., bike paths, parking, other mitigation projects).	Refer to **Table 4.6-4** in **Section 4.6.4.2** of the DEIR which quantifies the land alteration resulting from the Build Alternative. This section also identifies the types of vegetation and tree cover that will be removed as a result of the Build Alternative. MassDOT will implement a substantial landscaping plan that will provide new landscaping and vegetation for over 200 acres within the Study Area. The landscape plan will include the following landscape types to restore disturbed sites and integrate the new infrastructure into the landscape: landscape restoration and reforestation, street tree planting, lawn, stormwater basins and rain gardens, buffer planting, roundabout planting, special planting, and community open space. Refer to **Section 4.6.5** of the DEIR for additional information. Additional information regarding the proposed landscape plan will be provided in the FEIR.

Comment Number	Comment	Response
CCC 06	Shade tree removal should be avoided to the extent possible. The DEIR should include any updates on shade trees to be removed and plans to replace these within the Town.	MassDOT will minimize shade tree removal to the maximum extent practicable while still meeting the transportation goals outlined in the Program purpose and need. MassDOT will implement a substantial landscaping plan that will provide new landscaping and vegetation for over 200 acres within the Study Areas. The landscape plan will include the following landscape types to restore disturbed sites and integrate the new infrastructure into the landscape: landscape restoration and reforestation, street tree planting, lawn, stormwater basins and rain gardens, buffer planting, roundabout planting, special planting, and community open space. Refer to **Section 4.6.5** of the DEIR for additional information. Additional information regarding the proposed landscape plan will be provided in the FEIR.
CCC 07	While work within protected open space is discouraged, the DEIR should provide documentation of meetings/conversations with open space managers on any plans to use or convert protected open space.	MassDOT will confirm potential effects to properties, property boundaries, and the status of open space as design advances and property title searches are conducted. As needed, MassDOT will coordinate with the open space managers or public entities to compensate for impacts, including complying with Article 97 land disposition requirements.

Comment Number	Comment	Response
CCC 08	Commission staff suggest that the Applicant consider significant wildlife on and around the bridges and the Canal and any actions that may be needed to avoid, minimize, or mitigate impacts.	Refer to **Section 4.12.4** of the DEIR and **Appendix 4.12, Attachment 1, Biological Assessment for Terrestrial Species and Agency Coordination,** and **Attachment 2, Biological Assessment for Marine Species and Agency Coordination**, for information on terrestrial and aquatic species within the Study Area, including measures to avoid, minimize, and mitigate potential impacts associated with the Build Alternative.
CCC 09	MassDOT will refine permanent and temporary impacts to protected wetland resource areas, including the potential to impact Nightingale Pond, as design advances. A detailed analysis of impacts to jurisdictional resource areas, discussion of measures to avoid or minimize impacts, and identification of mitigation measures will be provided in the DEIR.	Refer to **Table 4.10-8** in **Section 4.10.4** of the DEIR for a summary of potential impacts to Nightingale Pond and **Table 4.10-16** in **Section 4.10.5** of the DEIR for a summary of associated mitigation measures. Construction of the westbound ramp from U.S. Route 6 to State Route 25 and auxiliary lane on State Route 25 would result in temporary and permanent impacts to the FEMA floodplain associated with Nightingale Pond. Bank and Land Under Water impacts at Nightingale Pond are associated with fill and grading required to create a 10-ft wide flat area between a proposed retaining wall and the pond to allow for future maintenance and access of the wall. Refer to **Section 4.10.6.1** of the DEIR for additional information regarding mitigation for impacts to Nightingale Pond and compliance with the performance standards of the Massachusetts Wetlands Protection Act.
CCC 10	Details of the improvement dredging mentioned in the ENF should be provided in the DEIR.	Improvement dredging is associated with removal of existing piers and pile. Refer to **Section 4.10.4.1** of the DEIR for additional information.

Comment Number	Comment	Response
CCC 11	To account for future sea level rise and maintain the existing 135-foot vertical clearance, MassDOT proposes to increase the elevation of the bridges by approximately three feet above MHW, for a proposed clearance of 138 feet above MHW. It is not clear that is sufficient for the 100-year design life of the project. Commission staff suggest adding more detail on the Project specific, locally based, hydraulic and stormwater models being developed to inform bridge design and associated project related infrastructure in the DEIR. If, alternatively, the decision is being made that it would be acceptable to have a reduced vertical clearance in the event that future sea level rise exceeds the three feet within the life of the structure, this decision should be identified in the DEIR.	Refer to **Section 2.3** of **Appendix 4.22, Climate Change Adaptation and Resiliency Technical Report,** for a discussion of the sea level rise (SLR) data that was reviewed to inform design. As indicated in **Table 2-6** of **Appendix 4.22, Climate Change Adaptation and Resiliency Technical Report**, Relative Sea Level Rise (SLR) of 3 feet was used to assess effects to navigational clearance. This corresponds with the future 2050 (extreme) or 2070 (intermediate-high) projections from ResilientMass or future 2070 (high) or 2125 (intermediate) projections from the U.S. Army Corps of Engineers study.
CCC 12	In the DEIR, the Applicant should provide more details on proposed LID and BMP elements.	The Build Alternative includes SCMs, including rain gardens, bioretention areas, infiltration basins, sediment forebays, and deep sump catch basins, which will improve the treatment and quality of the runoff that is eventually discharged to these sole source aquifers. Refer to **Section 4.11.7.2** of the DEIR.
CCC 13	Commission staff are pleased that the project, as proposed, will not permanently impact the Upper Cape Water Supply Reserve or other water supply lands. Some work elements for the Bourne North approach overlap with Bourne Water District Wellhead Protection Areas, and potential impacts to this area should also be assessed. While temporary impacts may be reduced through construction phase erosion and sediment control plan and management, additional details on the identified temporary impacts, and the measures planned to minimize those impacts, to the Upper Cape Water Supply Reserve and other water supply areas should be provided in the DEIR.	Refer to **Section 4.11.6** of the DEIR for information regarding work within the Cape Cod Sole Source Aquifer and the Plymouth/Carver Sole Source Aquifer. Mitigation measures are addressed in **Section 4.11.7** of the DEIR.

Comment Number	Comment	Response
CCC 14	Based on the options for the Bourne North approach, Nightingale Pond may be impacted from the Project. Additional details are needed to provide an understanding of the impacts to Nightingale Pond and its surrounding conservation area, including the area's relation to potential roadways and bridges. As approach designs are refined, roadway footprint, elevations, and location of any support structures relative to Nightingale Pond, and possible mitigation strategies, should be provided.	Refer to **Table 4.10-9** in **Section 4.10.4** of the DEIR for a summary of potential impacts to Nightingale Pond and **Table 4.10-16** in **Section 4.10.5** of the DEIR for a summary of associated mitigation measures. Construction of the westbound ramp from U.S. Route 6 to State Route 25 and auxiliary lane on State Route 25 would result in temporary and permanent impacts to the FEMA floodplain associated with Nightingale Pond. Bank and Land Under Water impacts at Nightingale Pond are associated with fill and grading required to create a 10-foot-wide flat area between a proposed retaining wall and the pond to allow for future maintenance and access of the wall. Refer to **Section 4.10.6.1** of the DEIR for additional information regarding mitigation for impacts to Nightingale Pond and compliance with the performance standards of the Massachusetts Wetlands Protection Act.

Comment Number	Comment	Response
CCC 15	The preferred alternative for each element of the Project should be chosen with a goal of having little or no disturbance of significant archaeological resources, and limited adverse impacts to significant historic resources in the Project area.	MassDOT will enter into a Programmatic Agreement with FWHA and the SHPO which will contain certain stipulations to mitigate the adverse effects on the NRHP-eligible Sagamore and Bourne Bridges. Refer to **Section 4.17, Cultural Resources,** of the DEIR for additional information. MassDOT conducted an Archaeological Reconnaissance Survey in 2023 which determined the surveyed landscape has low archaeological sensitivity due to previous construction and development activities. MassDOT subsequently conducted an intensive archaeological survey in five locations with intact soils found no significant archaeological resources. Refer to **Section 4.17.2** of the DEIR for additional information.

7.2.10 Association to Preserve Cape Cod

Table 7-11. Association to Preserve Cape Cod Letter Comments and Responses

Comment Number	Comment	Response
APCC 01	According to the ENF, there are multiple wetland and water resources within the greater project study area in addition to the Cape Cod Canal itself that should be considered in the project planning, including Nightingale Pond in the Bourne Program Study Area, located approximately 100 feet east of Route 25.	Refer to **Section 4.10.2** of the DEIR for a discussion of wetland and water resources within the Study Area, including Nightingale Pond.
APCC 02	The Bourne Program Study Area includes mapped rare species habitat approximately 1,700 feet south of the Bourne Rotary to the east of Route 28. The state's Natural Heritage and Endangered Species Program (NHESP) has identified 13 rare species within the project study area and has indicated that the project has the potential to result in a take of one or more of the identified rare species.	**Figure 4.12-2** in **Section 4.12.2.1** of the DEIR depicts NHESP-mapped Priority Habitat within the Terrestrial Species Study Area. Potential impacts to terrestrial rare species are discussed in **Section 4.12.4.1** of the DEIR.
APCC 03	APCC recommends that the identification of the preferred alternatives in the DEIR be accompanied by a more comprehensive analysis than what was provided in the ENF regarding how these alternatives will affect the wetlands, wetland buffers, and rare species habitats described above. The analysis should include a detailed discussion of how the alternatives will be designed to avoid impacts to environmental resources and how any unavoidable impacts will be minimized and mitigated.	Refer to **Section 4.10, Wetlands and Floodplains,** and **Section 4.12, Threatened, Endangered, and Protected Species and Habitats,** of the DEIR for a detailed analysis regarding impacts to wetlands and rare species and associated mitigation measures. Additional information regarding rare species may be found in **Appendix 4.12, Attachment 1, Biological Assessment for Terrestrial Species and Agency Coordination,** and **Appendix 4.12, Attachment 2, Biological Assessment for Marine Species and Agency Coordination**.

Comment Number	Comment	Response
APCC 04	APCC also recommends that the DEIR provide more detailed analysis of potential impacts to Article 97 lands from project alternatives considered for the Sagamore south crossing interchanges, including Article 97 land associated with the Upper Cape Water Supply Reserve, Shawme-Crowell State Forest and DCR-owned land.	A qualitative comparison of impacts to parks, open space, and recreational facilities associated with each of the 10 interchange approach options is provided in the following Sections of **Appendix 3.1, Attachment 2, Highway Interchange Approaches Detailed Assessment Report**: • Bourne North: **Section 5.6** • Bourne South: **Section 6.6** • Sagamore North: **Section 7.6** • Sagamore South: **Section 8.6** A quantitative tabular comparison of impacts to parks, open space, and recreational facilities associated with each of the ten interchange options is provided in **Table 3-9, Table 3-12, Table 3-15,** and **Table 3-17** in **Section 3.3.3** of the DEIR. A detailed discussion of impacts to Article 97 lands associated with the Build Alternative is provided in **Section 4.18.4** of the DEIR.
APCC 05	APCC strongly encourages the use of green infrastructure to meet stormwater management requirements and recommends that the DEIR provide more detailed information about the stormwater management plan for the project.	The Build Alternative includes stormwater control measures (SCMs), including rain gardens, bioretention areas, infiltration basins, sediment forebays, and deep sump catch basins that will improve the treatment and quality of the runoff that is eventually discharged to these sole source aquifers. Refer to **Section 4.11.7.2** of the DEIR.

Comment Number	Comment	Response
APCC 06	APCC recommends that the DEIR provide more specific information about how the proposed Route 25 northbound onramp connection will impact Nightingale Pond and its wetland buffer and how the shared use path may affect wetlands, particularly with regard to stormwater runoff. APCC is concerned about the potential for stormwater runoff impacts from the very close proximity of the project elements to these wetland resource areas.	Construction of the westbound ramp from U.S. Route 6 to State Route 25 and auxiliary lane on State Route 25 would result in temporary impacts (8,660 square feet) and permanent impacts (2,960 square feet; 2,130 cubic feet) to the floodplains associated with Nightingale Pond. Refer to **Table 4.10-8** in **Section 4.10.4** of the DEIR for a summary of potential impacts to Nightingale Pond and **Table 4.10-16** in **Section 4.10.5** of the DEIR for a summary of associated mitigation measures. Refer to **Section 4.10.6.1** of the DEIR for additional information regarding mitigation for impacts to Nightingale Pond and compliance with the performance standards of the Massachusetts Wetlands Protection Act.
APCC 07	APCC recommends that the DEIR include an analysis of the proposed interchange system preferred alternatives that examines the potential influence these improvements may have on unintended and undesirable secondary development within the region that would ultimately add to, instead of alleviate, traffic congestion.	As described in **Section 4.2.4.6** of the DEIR, the Build Alternative would not result in induced demand as the improvements focus on geometric upgrades and separation of local and regional traffic near the replacement bridges, with no significant changes in travel mode, route, trip length, or number of trips anticipated. Additionally, the Build Alternative is unlikely to cause secondary growth effects because of housing growth limitations and existing roadway capacity and traffic operation challenges. Existing traffic bottlenecks and minimal travel time improvements further reduce the likelihood of significantly enhancing access or increasing development opportunities. Refer to **Section 4.6.2.6** of the DEIR for additional information.

Comment Number	Comment	Response
APCC 08	APCC questions whether MassDOT took into account the potential for the bridge project to encourage an increase in weekend day trips to the Cape from Boston and other short distance locations during the summer months that would result in larger numbers of vehicles crossing the bridges. APCC recommends that MassDOT consider this potential scenario and address it in the DEIR.	**Section 4.2, Transportation, Traffic, and Safety,** of the DEIR outlines the methodology for future traffic volume projections and addresses induced demand concerns. Traffic volumes for No Build Alternative and Build Alternative conditions were developed considering factors like demographic changes, proposed developments, existing and future infrastructure, and visitor growth trends. While peak hour volumes may change due to improved travel times, average daily traffic volumes crossing the canal are expected to remain consistent between 2050 No Build and 2050 Build. Roadway users crossing the canal for discretionary or visitor purposes may choose their travel times based on congestion conditions. Despite improvements included in the Build Alternative, a significant increase in daily trips across the canal is not anticipated. Future peak hour travel time savings across the bridges could be up to 5 minutes in both directions, and diagonal movements across the canal (i.e., Route 25 to Route 6, Route 3 to Route 28, etc.) could see up to 10 minutes of savings when comparing the No Build and Build Alternatives. While these are significant improvements when looking at the limited project area, these travel time savings are not expected to encourage new trips that would otherwise not use the roadways within the project area.
APCC 09	APCC recommends the DEIR provide a discussion of the proposed multi-modal connections that includes an assessment of the number of automobile trips that are anticipated to be replaced by use of the multimodal pathways.	There is not a widely accepted factor for converting vehicle trips to other modes of transportation in the Commonwealth. Automobile trips that will be replaced by the use of multimodal pathways will likely be limited to recreational trips or short-term travel, such as day trips. Other trips that involve alternative modes of travel will likely arrive on the Cape via vehicle and then transfer to other modes of travel.

Comment Number	Comment	Response
APCC 10	It would also be beneficial for the DEIR to include discussion of possible types of investments in electrification of the Cape's transportation system that the Commonwealth can make to offset any potential increases in future traffic coming to Cape Cod, including, but not limited to, additional EV charging stations and investments that support electrification of Cape Cod Regional Transit Authority vehicles.	MassDOT will evaluate incorporating new park and rides with EV charging stations into the Build Alternative. An update on this will be provided in the FEIR.
APCC 11	APCC recommends that the DEIR should describe the infrastructure anticipated for the preferred path alternative that would be necessary to achieve the desired elevation. Will it require elevated ramps and overpasses? If so, how will this alter existing regional visual character? It also appears from conceptual plans in the ENF that the proposed multimodal path's location on the west side of Route 25 is within a DEP-mapped wetland area. The DEIR should further specify the proposed location of the path and its relationship to the wetland area. If the path does impact the wetland or wetland buffer, the DEIR should explain how this impact could be avoided, or if impossible, how it will be appropriately mitigated.	The Bourne North interchange approach network would provide a SUP and a grade-separated crossing for pedestrians and bicyclists via the new flyover ramp over Scenic Highway. Refer to **Section 7.3.4** of **Appendix 4.16, Visual Impact Assessment**, for a detailed description and visualizations of this connection. Refer to **Section 4.10.4** of the DEIR for a graphic and narrative summary of wetland impacts in the Bourne North quadrant. Mitigation measures are discussed in **Section 4.10.5** of the DEIR.
APCC 12	APCC recommends that the DEIR provide ground level visualizations of ramps, bridges, overpasses, etc. for the identified preferred alternatives from various key locations in order to gauge the visual impact of proposed changes to the bridge interchanges.	Refer to **Section 4.16.4** of the DEIR which compares existing and simulated viewsheds and assesses the effects to viewsheds of the highway bridges and interchange networks within the four program quadrants. Additional information is provided in **Appendix 4.16, Visual Impact Assessment**.

7.2.11 Art Akeley

Table 7-12. Art Akeley Comments and Responses

Comment Number	Comment	Response
AA 01	I believe sound abatement measures should be planned along both sides of Route 3 that protects the residents from the increased noise, more traffic, and faster traffic that will obviously occur after this project is completed.	As required by FHWA and MassDOT's highway traffic noise assessment policy, noise barriers were considered for noise-sensitive receivers that were predicted to be impacted by project related traffic noise under the 2050 Build Alternative. Refer to **Section 4.15.5** of the DEIR and **Section 7.1** of **Appendix 4.15, Noise and Vibration Technical Report**, for additional information.

7.2.12 Susan Barlow

Table 7-13. Susan Barlow Comments and Responses

Comment Number	Comment	Response
SUB 01	As a resident of Buzzards Bay, I'd like to comment that if we could get traffic out of Belmont Circle, it would greatly improve the economic development of Bourne's Main Street and downtown area. Bourne residents say they avoid our downtown due to tie-ups at the bridge, but also major backups around Belmont Circle as people must pass through the circle to connect from Scenic Highway to the Bourne Bridge and Rte. 25 to off Cape destinations.	The Build Alternative includes a new flyover ramp connecting Scenic Highway to State Route 25. The flyover ramp will remove westbound traffic to State Route 25 northbound from Belmont Circle and will allow vehicles traveling from State Route 25 eastbound to Scenic Highway eastbound to bypass Belmont Circle. As a result, traffic from Belmont Circle will be removed, reducing congestion on State Route 25 approaching the canal.

7.2.13 Stephen Buckley

Table 7-14. Stephen Buckley Comments and Responses

Comment Number	Comment	Response
STB 01	What MassDOT fails to consider is the other segment of travelers to Cape Cod during that same time, i.e., the people who are "day-trippers" or the "week-enders" who are staying for only a night. For those people, a few hours stuck in traffic (or not) at the #CanalBridges is a much more significant factor in deciding whether to make the trip or not. For Cape Codders, along with the people who are invited to visit them, the threat of "being caught at the Bridges" (in either direction) is common knowledge.	**Section 4.2, Transportation, Traffic, and Safety,** of the DEIR outlines the methodology for future traffic volume projections and addresses Induced Demand concerns. Traffic volumes for No Build and Build conditions were developed considering factors like demographic changes, proposed developments, existing and future infrastructure, and visitor growth trends. While peak hour volumes may change due to improved travel times, average daily traffic volumes crossing the canal are expected to remain consistent between 2050 No Build and 2050 Build. Roadway users crossing the canal for discretionary or visitor purposes may choose their travel times based on congestion conditions as currently occurs. Despite improvements included in the Build Alternative, a significant increase in daily trips across the canal is not anticipated. Future peak hour travel time savings across the bridges could be up to 5 minutes in both directions, and diagonal movements across the canal (i.e., Route 25 to Route 6, Route 3 to Route 28, etc.) could see up to 10 minutes of savings when comparing the No Build and Build Alternatives. While these are significant improvements when looking at the limited project area, these travel time savings are not expected to encourage new trips that would otherwise not use the roadways within the project area.

Comment Number	Comment	Response
STB 02	So, of course, if that threat of being caught in traffic congestion is eliminated, then all those people who are currently deterred from traveling to and from Cape Cod (including additional daily commuters) will be much more inclined to change their driving plans to take advantage of the fact that the "new bridges" will be able to handle much more traffic, perhaps around 50% or more during peak periods. The potential for 50% more people coming over the bridges to Cape Cod during its peak season would not be an insignificant effect on the human environment and the entire infrastructure (e.g., waste-water treatment plants) of the Cape Cod region. As such, the Environmental Impact Report (EIR) should be more curious and thoughtful (than the ENF) in foreseeing what the long-term, regional impact of new bridges will be.	As described in **Section 4.2.4.6** of the DEIR, the Build Alternative would not result in induced demand as the improvements focus on geometric upgrades and separating local and regional traffic near the replacement bridges, with no significant changes in travel mode, route, trip length, or number of trips anticipated. Additionally, the Build Alternative is unlikely to cause secondary growth effects because of housing growth limitations and existing roadway capacity and traffic operation challenges. Existing traffic bottlenecks and minimal travel time improvements further reduce the likelihood of significantly enhancing access or increasing development opportunities. Refer to **Section 4.6.2.6** of the DEIR for additional information.

7.2.14 Robert Dwyer

Table 7-15. Robert Dwyer Comments and Responses

Comment Number	Comment	Response
RD 01	**Bourne North Crossing:** The Directional Interchange Alternative appears to be the best for segregating or separating Through Traffic heading for Rt. 6 from local traffic. I believe it is imperative to keep Through (Rt. 6-bound) Traffic from having to exit and use the Belmont (East) Rotary (or westbound Scenic Highway traffic from needing to enter, and then exit, that rotary to head north on Rt. 25).	The Build Alternative includes a new direct connection ramp from Route 25 southbound to Scenic Highway eastbound and a new ramp from Scenic highway westbound to Route 25 northbound. These movements will not need to use Belmont Circle.
RD 02	**Bourne South Crossing:** …However, they do not alleviate glaring deficiencies of the current interchange around the Bourne Bridge Rotary and south along MacArthur Boulevard/Mass. Rt. 28. They do not segregate Through Traffic from local traffic.	The Build Alternative would separate the Route 28 through traffic from the local traffic at Sandwich Road and Trowbridge Road.
RD 03	However, this separation must be extended much further – all the way to the Otis Rotary. The current northbound lanes would become the new southbound lanes, and new northbound lane should be constructed immediately to the east – on the strip west of the existing power line ROW. Almost all of this land is now State- or Town of Bourne-owned.	The Otis Rotary is located outside of the CCBP Study Area.

Comment Number	Comment	Response
RD 04	Local Bourne traffic needing to access the businesses should be fully segregated from Through Traffic, and only allowed to enter/exit the Through Traffic lanes at the new Interchange (as shown at the north end of "Frontage Road" for your two alternatives, or at the Otis Rotary at the south end. All of the current dangerous and problematic U-turns through the current median should be eliminated. Through Traffic drivers coming south on Rt. 25 can be informed using your standard practice of using blue signs to exit after crossing the bridge onto the extended Frontage Road to access gas stations, restaurants, etc.	The Build Alternative creates a Frontage Road for access to and from the businesses that are impacted by the new interchange. The Otis Rotary is located outside of the CCBP Study Area.
RD 05	I realize that the required extension of the South Approaches further to the south is likely beyond the current Project Area of DOT's design contractor and would certainly be more expensive to construct than either of the two South Approach Alternatives. However, these changes at least must be included in the planning now, because traffic volumes will certainly increase over the 50+ year lifetime of the new bridge.	Comment acknowledged. The Otis Rotary is located outside of the CCBP Study Area.
RD 06	**Providing access to ISWM and the Monument Beach Sportsmens Club - fully separated from Through Traffic:** The current arrangement of access to these facilities is dangerous – traffic from the north must make a median U-Turn, then immediately cross two lanes of northbound traffic. This can be eliminated by constructing a connection road from these facilities east of the relocated lanes of Rt. 28, with a separate, or perhaps combined, intersection with Sandwich Rd. This would move the current residential, and likely increasing truck traffic with demolition debris, household waste, and likely contaminated incinerator bottom and fly ash completely out of Through Traffic lanes.	The design team has been coordinating with the Town of Bourne and the Bourne Integrated Solid Waste Management (ISWM) facility to maintain and provide improvements to access where feasible within the scope of this project.

Comment Number	Comment	Response
RD 07	**Need for providing unimpeded Through Traffic Access to Mid-Cape Highway (Rt. 6) after crossing the new Bourne Bridge:** The design process for the South Approaches Interchange presents a once-in-a generation opportunity to at least plan for dedicated exit/entry connector ramps to facilitate traffic between Rt. 25 and the Mid- Cape Highway (Rt. 6) along the south side of the Canal. This roadway could be a single lane in each direction with limited or no access points between the bridges. It could run along the southeast border of the Upper Cape Tech campus, and the housing developments along Sandwich Road. This route could be routed adjacent to or under existing power line ROWs or could be along the perimeter of the JBCC reservation, which is State-owned property. The east end of this connector would intersect the Mid-Cape Connector near Market Basket, facilitating easy entry to eastbound Rt. 6 (access of traffic returning westbound would require more extensive redesign of the new Sagamore South Approaches…).	The Build Alternative encourages vehicular movements between route 25 and Route 6 to utilize the Scenic Highway. Modifications along the entire length of Sandwich Road is outside the scope of this project. Additionally, Joint Base Cape Cod (JBCC) has concerns about any encroachment onto the base and its potential impact on the base's future use. The northern end of JBCC was transferred to MassWildlife to protect the state-designated Upper Cape Water Supply Reserve. The State Legislature established the Upper Cape Water Supply Commission to ensure the conservation of the Reserve for water supply and wildlife habitat protection, and for compatible military activities. This area is also protected under Article 97 of the Massachusetts Constitution.

7.2.15 Vanasse & Associates, Inc.

Table 7-16. Vanasse & Associates, Inc. Comments and Responses

Comment Number	Comment	Response
VAI 01	DSM requests additional alignment, profile, and cross section information for each alternative to further evaluate and respond to these impacts before an alternative is selected and the design is advanced.	Refer to **Appendix 1, Existing Conditions Plans**, and **Appendix 3.2, Proposed Conditions Plans**. Additional design information will be shared as it becomes available.
VAI 02	DSM requests that traffic analyses of the three Sagamore South Interchange Approach alternatives, with specific reference to the approaches, intersections and access points to the DSM property, be provided for our review before a single interchange alternative is advanced.	An evaluation of the Sagamore South interchange approach alternatives, including summaries of intersection operations, is provided in **Appendix 3.1, Attachment 2, Highway Interchange Approaches Detailed Assessment Report**.
VAI 03	Related to the above displacement issue, DSM is concerned about the ability to accommodate parking demands on its site and needs to understand how any reduction in available parking impacts the highest and best use of the property, specifically including but not limited to the supermarket operation, especially during periods of peak usage.	MassDOT further discussed parking impacts during coordination meetings with DSM on February 27, 2024, and October 9, 2024.
VAI 04	SS-1.1 does not extend the Cranberry Highway to the Mid-Cape Connector and may be a missed opportunity at reducing vehicle travel time and improving network operations.	MassDOT acknowledges this comment.

Comment Number	Comment	Response
VAI 05	With respect to the proposed design alternatives that include a westerly extension of the Cranberry Highway to the Mid-Cape Connector: To properly evaluate and understand this option, and considering how integral the DSM property is to this project, we need to understand traffic and parking lot access impacts and lane usage, and identify other associated property impacts so that they may be mitigated to the greatest extent possible. Related to the above issue, DSM needs to understand intersection operations and the pavement width at the proposed traffic signal at the Mid-Cape Connector. It appears that one alternative would send all interchange traffic through this intersection, and the impacts to access at the DSM property need to be quantified and better understood. For example, if the Cranberry Highway Extension has multiple lanes, long queues, or medians, patrons will have difficulty turning left in and out of DSM's property. Based upon the projected location and width of the Cranberry Highway Extension at its intersection with the Mid-Cape Connector, DSM is concerned about the resulting impacts to the property's truck circulation and access to the loading dock area and parking lot along the north side of the Market Basket building.	Refer to **Appendix 4.2, Attachment 4, 2050 Design Year Build Alternative Conditions** for an analysis of the 2050 Design Year Build Condition. **Attachment 4** includes LOS tables summarizing the 2050 Build Alternative capacity and queue analyses for Fall PM and Summer Saturday Midday at all Study Area intersections (graphical representations of intersection LOS, the LOS and density results of the freeway segments and merging-diverging segments, and VISSIM model predicted vehicle queues in **Section 7.1.4** of **Appendix 4.2, Traffic Engineering Technical Report**. Potential truck site circulation paths were reviewed with DSM during a meeting on October 9, 2024. MassDOT will continue to work with DSM to ensure that truck circulation is accommodated in the final build condition.
VAI 06	DSM requests that MassDOT continue to explore opportunities to shift the replacement bridge and roadways as far to the east as is possible, to help minimize the detrimental impacts on DSM's property.	Comment noted. The mainline alignment has been determined based on required design criteria for the mainline, required clearances from the existing bridge, and staging requirements. As the design progresses, MassDOT will continue to explore opportunities for refinements to minimize impacts on DSM's property.

Comment Number	Comment	Response
VAI 07	DSM requests that MassDOT explore the ability to shift the proposed Route 6 eastbound off-ramp further to the south (whether by adjusting the on/off ramp radii or otherwise), to maximize the remaining land between the DSM property and the Altered State Highway Layout to the south.	Shifting the eastbound off-ramp farther south will necessitate a lower design speed of 20-25 mph, whereas the required design speed is 30 mph. Maintaining a 30-mph design speed while moving the ramp south would encroach on JBCC property. JBCC has concerns about any encroachment onto the base and its potential impact on the base's future use. The northern end of JBCC was transferred to MassWildlife to protect the state-designated Upper Cape Water Supply Reserve. The State Legislature established the Upper Cape Water Supply Commission to ensure the conservation of the Reserve for water supply and wildlife habitat protection, and for compatible military activities. This area is also protected under Article 97 of the Massachusetts Constitution.
VAI 08	The project will have considerable construction impacts on the road network surrounding the DSM property for a lengthy, multi-year construction period. We request that provisions for adequate and uninterrupted site access and parking for DSM's employees, suppliers, and customers, to the greatest extent possible, be included in the project's construction management plan.	Comment noted. Construction staging will be established to minimize impacts and access restrictions. It is also noted that the selected contractor may elect to provide a different staging method than developed by the design team. Additional coordination meetings will be held as the design progresses to support further evaluation of construction staging impacts.

8 Mitigation and Draft Section 61 Findings

8.1 Introduction

The Massachusetts Environmental Policy Act (MEPA) regulations outline mitigation measures to be evaluated and described in the Environmental Impact Report (EIR), including an "assessment of physical, biological, and chemical measures and management techniques designed to limit negative environmental impacts or to cause positive environmental impacts during development and operation of a Project."[1] Massachusetts General Law (MGL) Chapter 30, Section 61 also requires that "any State Agency that takes an Action on a project for which the Secretary [of the Executive Office of Energy and Environmental Affairs] required an EIR shall determine whether the project is likely, directly, or indirectly, to cause damage to the environment and make a finding describing the damage to the environment and confirming that all feasible measures have been taken to avoid or minimize such damage."[2]

The Secretary of the Executive Office of Energy and Environmental Affairs' (EEA) Certificate on the Environmental Notification Form (ENF) for the Cape Cod Bridges Program reiterated these requirements and stated that the Draft EIR (DEIR) should include a separate mitigation chapter that includes the following:

- A summary table of all mitigation commitments
- Draft Section 61 Findings for each State Agency Action to be taken on the Project

Section 8.6 provides a summary table of all mitigation commitments to avoid, minimize, and mitigate potential environmental and public health effects. A draft Section 61 Finding is included as **Section 8.5**.

8.2 Program Description

The Cape Cod Bridges Program (the Program) proposes replacement of Sagamore and Bourne Bridges over Cape Cod Canal in the town of Bourne. The existing bridges would be replaced with parallel, twin tied-arch bridge structures, approximately 10 feet apart, resulting in two bridges at each crossing and four bridges total. The replacement bridge mainline alignment location at both crossings would be offline (outside of the footprint of the existing bridge) and inboard of the existing highway bridges on the side of the canal between the existing Sagamore Bridge and Bourne Bridge. Each main span would provide two through-traffic lanes, one auxiliary lane, and shoulders and barriers in compliance with current Massachusetts Department of Transportation (MassDOT) and Federal Highway Administration (FHWA) standards. Each crossing would also provide one bidirectional pedestrian and bicycle shared-use path (SUP), separated from vehicular traffic by the shoulder and barrier. Additionally, the highway

[1] 301 Code of Massachusetts Regulations 11.07(j)

[2] Determination of impact by agencies; damages to environment; prevention or minimization; foreseeable climate change impacts. https://malegislature.gov/Laws/GeneralLaws/PartI/TitleIII/Chapter30/Section61

interchange approach networks would be reconfigured to align with the replacement bridges on both sides of Cape Cod Canal.

8.3 MEPA History

MassDOT submitted an ENF for the Program to the MEPA Office on April 28, 2023. The ENF was published in the Environmental Monitor on May 10, 2023, which started the public comment period. On July 7, 2023, the Secretary of EEA issued a Certificate on the ENF (EEA #: 16695), which required the submission of a mandatory Environmental Impact Report (EIR) and included a scope of additional analysis for a Draft EIR.

8.4 Anticipated State Agency Actions and Permits

Table 8-1 identifies the state agencies that are expected to take action on a project and therefore must issue Section 61 Findings.

Table 8-1. Anticipated State Agency Actions

Agency Name	Action or Permit
Massachusetts Department of Transportation	Proponent/Funding
Massachusetts Department of Environmental Protection	401 Water Quality Certificate
Natural Heritage and Endangered Species Program	Conservation and Management Permit

8.5 Proposed Draft Section 61 Finding

The language in the following paragraphs is a proposed Draft Section 61 Finding that extends to cover all potential impacts for the Cape Cod Bridge Program and could be adopted by **[AGENCY NAME]**.

- **Project Name:** Cape Cod Bridges Program
- **Project Location:** Bourne, Massachusetts
- **Project Proponent:** Massachusetts Department of Transportation (MassDOT) – Highway Division
- **EEA Number:** 16695

MassDOT has prepared this Section 61 Finding for the Cape Cod Bridges Program (Program) in accordance with the provisions of MGL Chapter 30, Section 61 and 301 CMR 11.07(6)(k). The potential environmental impacts of the Program have been characterized and quantified in the Environmental Notification Form and Draft and Final Environmental Impact Report (EIR), which are incorporated by reference into this Section 61 Finding. Throughout the planning and environmental review process, MassDOT has taken all feasible measures to avoid and/or minimize potential adverse environmental impacts, while meeting the Program's purpose and need. With the mitigation proposed and conducted in cooperation with state agencies, the **[AGENCY NAME]** finds that there are no significant unmitigated impacts.

MassDOT recognizes that the identification of effective mitigation, and implementation of that mitigation throughout the life of the Program, is central to its responsibilities under MEPA. Accordingly, MassDOT has prepared a **Table of Mitigation Commitments** (**Table 8-2**) that provides an overview of the Program's unavoidable environmental impacts and the corresponding measures that will be implemented to mitigate for such impacts. In the **Table of Mitigation Commitments (Table 8-2**), MassDOT provides clear commitments to implement the mitigation measures; identifies the parties responsible for implementation of mitigation measures; and provides a schedule for their implementation.

The **[AGENCY NAME]** has reviewed the MEPA documentation for the Program and finds that the environmental impacts resulting from the Program are those impacts as described in the DEIR, which will be updated as needed in permit applications submitted for compliance with applicable federal and state environmental regulations.

Pursuant to MGL Chapter 30, Section 61, the **[AGENCY NAME]** finds that with the implementation of mitigation measures as identified in **Table 8-2** of the DEIR, all practicable and feasible means and measures will have been taken to avoid or minimize potential damage from the Program to the environment.

Agency: _____

By: _____

Date: _____

8.6 Proposed Mitigation Measures

Table 8-2 summarizes the proposed impact avoidance, minimization, and mitigation measures and forms the basis upon which Section 61 Findings will be made. Refer to the respective chapters in the DEIR for additional details regarding proposed mitigation measures. The costs for the mitigation measures identified in **Table 8-2** have been included in the overall Program costs.

Table 8-2. Mitigation Commitments

Subject Matter	Potential Impact	Mitigation Measure	Responsible Party	Schedule
Transportation, Traffic, and Safety	Relocation of Bourne Station to accommodate construction of the replacement Bourne Bridge	MassDOT will require the contractor to develop a Rail Operations Coordination Plan, including the details of any needed station relocation along the Cape Main Line with the Mass Rail and Transit as well as Federal Highway Administration (FHWA) and the Federal Railroad Administration.	Contractor	During construction
Maritime Transportation, Traffic, and Safety	Vessel encroachment into the 500-foot navigation channel during construction	Coordinate with the U.S. Army Corps of Engineers (USACE) Marine Traffic Controller and maintaining a minimum navigational width of 250 feet for vessel passage.	Contractor	During construction
	Six short-term, full closures of Cape Cod Canal associated with the float-in and float-out activities during construction	• Advise the public of in-water construction work through the Cape Cod Bridge Program (Program) website. • Maintain communications with the Town of Bourne Harbormaster, U.S. Coast Guard, and U.S. Army Corps of Engineers (USACE) about channel closures. • Meet with marinas and marine-related users as needed. • Schedule channel closures to minimize effects on marine transportation, especially recreational users.	MassDOT	During construction
Pedestrian and Bicycle Facilities	Temporary closures of sections of Canal Service Roads	• Provide temporary detours for bicyclists and pedestrians to the maximum extent practicable to ensure safe travel around work zones.	Contractor	During construction

Subject Matter	Potential Impact	Mitigation Measure	Responsible Party	Schedule

Land Use, Zoning, and Community Cohesion	Permanent change in land use to transportation and right-of-way	• Provide clear signage and mapping for alternative routes to reduce confusion, ensuring accessibility for community members during the temporary closure of the Canal Service Roads.
		• Maintain all existing pedestrian and bicycle accommodations and routes.
		• Ensure access to community facilities will be maintained during and after bridge construction.
		• Reduce regional traffic on local roads (e.g., Adams Street, Ben Abbey Road) and improve neighborhood accessibility through the following:
		  ○ Improve access between the neighborhoods on the east side of State Route 6 and Market Basket on the west side of State Route 6.
		  ○ Include the Sandwich Road extension, which would allow drivers to directly access Sandwich Road and avoid the Cranberry Highway Extension and the Market Basket Plaza driveways on Factory Outlet Road.
		  ○ Fully remove mainline State Route 28/25 traffic from the local roadway network.
		• Provide Americans with Disabilities Act-compliant pedestrian and bicycle accommodations to improve community connectivity, provide multimodal travel options to community facilities, and improve the accessibility of existing neighborhoods.
		• Install outlooks and benches along the bridges that will encourage use by bicyclists and pedestrians and serve as informal gathering spaces and/or places for community members to interact and spend time together.
			MassDOT	During design and construction

Subject Matter	Potential Impact	Mitigation Measure	Responsible Party	Schedule

Land Use, Zoning, and Community Cohesion (continued)	Alteration of 281 acres of land, consisting of 107.8 acres of tree clearing, 76 acres of existing pavement, and 98 acres of previously disturbed areas (e.g., grassy areas, stormwater best management practices (BMP).	• Minimize tree clearing to the maximum extent practicable while meeting the Program's goals. Approximately 20% of the total alteration is associated with a new shared-use path to enhance public access, multimodal connectivity, and safety.
		• Provide new landscaping and vegetation for over 200 acres through landscape restoration, reforestation, street tree, buffer, and roundabout planting, lawn re-seeding, and the creation of stormwater basins and rain gardens.
		• The landscape plan will be responsive to site conditions, the unique regional landscape and cultural history, and the needs of the FHWA and USACE and will consider the following, with design elements tailored to specific quadrants:
		  ○ Revegetate all areas disturbed by construction around the new Sagamore and Bourne Bridges, adjacent highways, local roadways, shared-use paths, stormwater and utility infrastructure, and construction staging areas.
		  ○ Develop landscape zones that restore and/or enhance existing habitats and reinforce the unique landscape character of the region.
		  ○ Screen undesirable views for both users of the project area as well as abutters. Improve sight lines and views while mitigating the appearance of undesirable areas within and beyond the bridge sites.
			MassDOT	During design and construction

Subject Matter	Potential Impact	Mitigation Measure	Responsible Party	Schedule
Land Use, Zoning, and Community Cohesion (continued)		○ Provide shade in hardscape areas including along local streetscapes and over the shared-use paths. This will improve the experience for site users while reducing the Urban Heat Island Effect. ○ Stabilize disturbed areas immediately when construction has ceased and resume for no more than 14 days. ○ Implement plant protection fencing for trees that will not be cleared for public places and staging or other construction activity to preserve trees. ○ Utilize plant protection fencing to minimize impacts to visual and natural resources as applicable. ○ Restore acquired areas that are not used for the State Highway Layout to pre-existing conditions to the maximum extent practicable following completion of the Land-based construction activities. ○ Enhance pedestrian zones with planting at trailheads, in medians, and in roundabouts in lieu of impervious surfaces. ○ Integrate stormwater basins with the surrounding restored landscapes so they appear natural and contribute to the creation of habitat as much as possible. ○ Maintain site visibility for safety along highways and roadways and around pedestrian zones and off-road areas for site security.		

Subject Matter	Potential Impact	Mitigation Measure	Responsible Party	Schedule
Land Use, Zoning, and Community Cohesion (continued)		○ Planting: Provide primarily native, site-appropriate planting throughout the Study Area through the following actions: – Use low maintenance planting that is self-sustaining to improve the longevity of the new landscape. – Diversify the plant material to reduce possible mass devastation from future pests. – Propose hardy, coastal tolerant and urban tolerant plant material to survive the site conditions. – Use species attractive to pollinators and wildlife. – Propose drought tolerant plant species for adaptability and suitability for minimally maintained areas of the project site. ○ Account for sun/wind exposure – The availability of sunlight adjacent to and below the bridges will dictate the appropriate plant species at certain locations around the site.		
Property Acquisition, Displacement, and Relocation	Full acquisition of 29 parcels, partial acquisition of 34 parcels, and easements on an additional 114 parcels	• Conduct all relocations in accordance with the Uniform Relocation Assistance and Real Property Acquisition Policies Act, 1971, and Massachusetts General Laws, primarily Chapter 79. • Phase relocations to secure suitable housing for all displaced residents. To the extent feasible, MassDOT will collaborate with local builders to keep relocated families close together, maintaining neighborhood cohesion.	MassDOT	During design and construction

Subject Matter	Potential Impact	Mitigation Measure	Responsible Party	Schedule
Environmental Justice	The Build Alternative would not increase the risk of climate change or exacerbate existing environmental or public health burdens experienced by Environmental Justice (EJ) populations.	• Adequate mitigation measures and coordination will be implemented to ensure that there are no adverse or inequitable impacts to EJ populations during construction, including those related to air quality, noise, or access.	MassDOT	During design and construction
Wetlands and Floodplains	Permanent impacts to the following: • State-regulated Bank (285 linear feet) • Land Under Water (LUW) (1,065 square feet [sf]) • Bordering Land Subject to Flooding (BLSF) (2,960 sf) • Bordering Vegetated Wetlands (BVW/federally regulated Vegetated Wetlands (VW) (2,040 sf)	• Create Bank (at a 1:1.1 ratio) and LUW (at a 1:2.4 ratio) to mitigate impacts to Bank and LUW. • Provide compensatory storage to mitigate impacts to BLSF, creating 4,530 cubic feet (cf) to offset the loss of 2,130 cf. • Provide wetland replication at a 1:1.5 ratio to mitigate impacts to BVW/VW and participation in the Massachusetts Department of Fish and Wildlife's In-Lieu Fee Program.	MassDOT	During design and construction
	Temporary disturbance of vegetated wetlands	• Restore all disturbed areas upon Build Alternative completion. • Photo-document and survey temporary impact areas before disturbance to establish pre-construction baseline conditions and document existing ground elevations.	MassDOT	During design and construction

Subject Matter	Potential Impact	Mitigation Measure	Responsible Party	Schedule
	Permanent impacts to 25,107 sf of Land Under Ocean (LUO) and 108,800 sf of navigable Waters of the United States (WOTUS)	• Remove existing bridge piers to create 6,440 sf of LUO and Navigable WOTUS.	MassDOT	During construction
Wetlands and Floodplains (continued)	Temporary impacts to Coastal Bank, LUO, and Rocky Intertidal Shore	• Mitigate in-kind through either replacement, restoration, or establishment.	MassDOT	During design and construction
Water Quality and Stormwater	Increase of 51 acres of impervious area	• Prioritize the use of low-impact, green infrastructure, such as rain gardens and infiltration basins, in stormwater management design, and achieve compliance with Massachusetts Department of Environmental Protection stormwater standards to the maximum extent practicable. • Minimize new impervious area to the maximum extent practicable while still meeting the Program's purpose and need, with approximately 35% of the new impervious area associated with new sidewalk and shared-use path installation. • Improve the treatment and quality of the runoff that is eventually discharged to Cape Cod Canal and the Plymouth/Carver and Cape Cod sole source aquifers. • Provide new landscaping and vegetation for over 200 acres.	MassDOT	During design and construction

Subject Matter	Potential Impact	Mitigation Measure	Responsible Party	Schedule
Threatened, Endangered, and Protected Species and Habitats	Clearing and construction impacts within priority habitat for state-listed terrestrial species.	• Coordination with the Natural Heritage and Endangered Species Program to identify conservation and management priorities for Massachusetts Endangered Species Act-listed species to achieve the net-benefit mitigation performance standards associated with a Conservation and Management Permit, if such a permit is needed.	MassDOT	During design and construction

Subject Matter	Potential Impact	Mitigation Measure	Responsible Party	Schedule

Threatened, Endangered, and Protected Species and Habitats (continued)	Clearing within suitable habitat for federally listed northern long-eared bats and tricolored bats, the federally proposed monarch butterfly, migratory birds, and Birds of Conservation Concern	• Avoid removing trees within 0.25 mile of known bat hibernacula
		• Avoid removing trees within 0.25 mile of known bat roost trees during the pup season (June 1 through August 15)
		• Comply with time-of-year (TOY) restrictions for tree clearing, avoiding the summer occupancy period for bats and the typical nesting season for migratory birds:
		  ○ March 15 to November 30 on the Cape Cod side of Cape Cod Canal
		  ○ April 15 to October 31 on the mainland side
		• Implement conservation mowing practices on MassDOT rights-of-way consistent with the intent and recommendations outlined in published BMPs for pollinator species such as monarch butterflies, including the following:
		  ○ Restricting mowing to between October 1 and May 1
		  ○ Refraining from mowing entire parcels
		  ○ Mowing only after native plants at sites have completed blooming and dispersing seed
		  ○ Using a minimum cutting height (e.g., 10–12 inches) when mowing, using a flushing bar, and mowing at reduced speeds
		  ○ Mowing parcels only once or twice per year
		• Following construction completion, cleared areas will be revegetated to the maximum extent possible, using native plant species to provide suitable habitat for bat species, pollinators, and other native species.
			MassDOT	During design and construction

Subject Matter	Potential Impact	Mitigation Measure	Responsible Party	Schedule
Threatened, Endangered, and Protected Species and Habitats (continued)	Demolition of existing buildings and bridge abutments that could serve as roosting locations or hibernacula for federally listed northern long-eared bats and tricolored bats during winter months	• Entry points to buildings and bridge abutments will be sealed following Massachusetts Division of Fisheries and Wildlife MassWildlife guidance in the late summer period when juvenile bats typically disperse and before the start of the hibernation period. ○ Building and bridge abutment inspections will be implemented prior to demolition.	MassDOT	During design and construction
	Creation of acoustic impacts that may disrupt roosting of federally listed northern long-eared bats and tricolored bats	• Construction activities with potential to cause acoustic impacts (i.e., impact or vibratory pile driving and rotary drilling) will not occur from March 1 through August 31 of any year.	MassDOT	During design and construction
	Potential for Program vessel collisions with federally listed northern long-eared bats and tricolored bats and the federally proposed monarch butterfly	• Vessels transiting within Cape Cod Canal and between Cape Cod Canal, Buzzards Bay, Cape Cod Bay, and supply ports, will operate at speeds not to exceed 10 knots, thereby reducing the potential for collisions with bats and monarch butterflies traveling over the waterway.	MassDOT	During construction

Subject Matter	Potential Impact	Mitigation Measure	Responsible Party	Schedule
Threatened, Endangered, and Protected Species and Habitats (continued)	Potential for Program vessel collisions with the federally listed fin whale, North Atlantic right whale, sea turtles, Atlantic sturgeon, and shortnose sturgeon	• Vessels transiting within Cape Cod Canal and between Cape Cod Canal, Buzzards Bay, Cape Cod Bay, and supply ports, or within a North Atlantic Right Whales Seasonal Management Area will operate at speeds not to exceed 10 knots unless it is unsafe to do so due to sea conditions. • A protected species observer or marine mammal/sea turtle observer will be present for Program vessel transits through Cape Cod Canal from January 1 through March 15. • Vessel captains or approved species observers will reference NOAA Fisheries information sources to assess potential presence of protected species in vessel traffic areas, avoid harassment or direct impacts to protected species, and report any sightings or interactions with protected species to NOAA Fisheries.	MassDOT	During construction

Subject Matter	Potential Impact	Mitigation Measure	Responsible Party	Schedule
Threatened, Endangered, and Protected Species and Habitats (continued)	Potential for underwater construction noise to cause harassment of federally listed fish, sea turtles, and marine mammals and Essential Fish Habitat (EFH) species	• Comply with TOY restriction of March 1 – August 31 for in-water work with potential to cause acoustic impacts (e.g., pile driving and rotary drilling) to minimize impacts to ESA-protected species and EFH species spawning seasons and early life stages. • A protected species observer or marine mammal/sea turtle observer will be present during in-water construction activities and will have stop-work authority if marine mammals, sea turtles, or sturgeon are observed entering or within the exclusion zones established for protection of marine mammals, sea turtles, and fish from auditory impacts. • Use of equipment ramp-ups and soft starts during pile driving and rotary drilling. • Implement a Marine Mammal and Sea Turtle Monitoring and Mitigation Plan that incorporates design features and operational procedures to minimize impacts on marine mammals and sea turtles.	MassDOT	During construction

Subject Matter	Potential Impact	Mitigation Measure	Responsible Party	Schedule
Threatened, Endangered, and Protected Species and Habitats (continued)	Potential for in-water construction to cause direct disturbance or injury to EFH species and federally listed fish, sea turtles, and marine mammals	• In-water construction activities (excluding vessel traffic) will be confined to the Cape Cod Canal. • Comply with TOY restriction of March 1 – August 31 for dredging and excavation activities. • Use USACE BMPs during dredging and excavation. • Use of cofferdams to allow in-the-dry construction of new bridge piers and demolition of the existing bridge piers. • Completion of visual assessments by a fisheries biologist or protected species observer to confirm protected species will not be entrapped before closure of cofferdams and confirm cofferdams are clear before dewatering. • Maintenance of water pumped from cofferdams in settling basins before discharge back into the canal to minimize potential turbidity impacts to protected species.	MassDOT	During construction

Subject Matter	Potential Impact	Mitigation Measure	Responsible Party	Schedule
Threatened, Endangered, and Protected Species and Habitats (continued)	Potential for EFH habitat disturbance or conversion.	• Completion of shoreline work via shoreline cranes where possible. • Removal of existing pier structure to restore 8,000 sf of natural soft/granular habitat. • Development of a submerged aquatic vegetation (SAV) monitoring plan in coordination with the USACE to include the following: ○ Pre- and post-construction SAV monitoring ○ Compensatory mitigation for an area equivalent to the total potential long-term impacts of the Program to SAV ○ Removal of all temporary works after the completion of construction or cutting of pilings to 2 feet below the mudline, pending review and confirmation by USACE	MassDOT	During design and construction and post-construction
Visual Resources	Loss of Sagamore and Bourne Bridges, the most prominent cultural visual resources	• Select replacement bridge designs that resemble the overall shape of the historic bridge arches and echo the appearance of the existing bridge and inclusion of scenic overlooks and walkway/fishing platforms to provide new vistas of Cape Cod Canal.	MassDOT	During design
	Adverse changes to the visual quality of the Sagamore Bridge and Bourne Bridge Areas of Visual Effect at two locations	• Implement a substantial landscape plan to enhance sight lines and views, screen undesirable areas, and soften the visual impact of new infrastructure to maintain the region's character. • Select wall types for bridge abutments and retaining walls based on visibility and priority, using different materials to enhance Cape Cod's rural character and improve visual quality for travelers and neighbors.	MassDOT	During design and construction

Subject Matter	Potential Impact	Mitigation Measure	Responsible Party	Schedule
Cultural Resources	Demolition of National Register Eligible Sagamore and Bourne Bridges	• Develop a Section 106 Programmatic Agreement with State Historic Preservation Officer and other consulting parties, to specify mitigation measures including: ○ Design bridges with kinship to existing historic bridges. ○ Prepare Historic American Engineering Record documentation of Sagamore Bridge and Bourne Bridge. ○ Install interpretive historic panels. ○ Salvage and reuse original bridge plaques. – Provide updated construction plans for review by MassDOT Archaeologist to determine the need for additional archaeological survey. – Include a Special Provision in the construction contract for the Discovery of Unanticipated Archaeological and Skeletal Remains.	MassDOT	During design and construction

Subject Matter	Potential Impact	Mitigation Measure	Responsible Party	Schedule
Public Parks, Recreational Facilities, and Open Space	Temporary and/or permanent impacts to public park and recreation areas owned by the USACE, Town of Bourne, and the Bourne Recreation Authority	• Coordination with the Bourne Recreation Authority (BRA) and compliance with the requirements set forth in the MA EEA's Article 97 Land Disposition Policy and MGL c.3 § 5A which was established to ensure No Net Loss of Article 97 land. • Coordinate with the BRA and USACE to minimize construction effects on Bourne Scenic Park, maintain public use, relocate uses on a temporary basis to the extent practicable, and enhance park facilities permanently. • Coordinate with USACE to minimize construction effects on Sagamore Recreation Area and Bourne Recreation Area, including (but not limited to) relocating park uses on a temporary basis, maintaining use of the Canal Service Roads to the maximum extent practicable, and enhancing park facilities permanently. • Coordinate with the Town of Bourne for proposed temporary and permanent easements at Keith Field Recreation Area. • Coordinate with the Town of Bourne for temporary easements at Sandwich Road Conservation Area and Wasque RT Purchase parcels (if applicable). • Coordinate with the BRA for a temporary easement at a BRA-owned vacant parcel abutting Sandwich Road.	MassDOT FHWA	During design and construction, and post - construction (operation)

Subject Matter	Potential Impact	Mitigation Measure	Responsible Party	Schedule
Solid and Hazardous Waste Material Management	Potential to encounter hazardous materials in demolition waste and/or contaminated soil, groundwater, and sediment during construction activities	• Prior to finalizing land acquisitions, conduct ASTM Phase I Environmental Site Assessments (ESA), and Phase II ESAs if deemed necessary, to identify potential environmental liabilities associated with each parcel. • Complete pre-demolition hazardous materials surveys to inform the need for abatement. Require any abatement work to be performed by appropriately certified personnel. • Prepare and implement a Sediment Sampling and Analysis Plan to identify the presence of contaminants in anticipated dredge material to inform the need for special management considerations during construction. • Prior to the start of construction, review online databases to identify any new release sites or other new hazardous material related concerns that should be considered. • Develop and implement all relevant construction-period management plans including a Site-Specific Environmental Health and Safety Plan, Soil and Groundwater Management Plan, Lead and Asbestos Abatement Plans, Stormwater Pollution Prevention Plan, and Spill Prevention Plan. • Engage with a Licensed Site Professional prior to handling contaminated soil or groundwater, and prior to performing any work within a regulated release site to ensure compliance with the Massachusetts Contingency Plan (MCP) and other state and federal regulations.	• MassDOT • Contractor	During design and construction

Subject Matter	Potential Impact	Mitigation Measure	Responsible Party	Schedule
Solid and Hazardous Waste Material Management (continued)		• Comply with regulatory requirements for the management of contaminated groundwater under the MCP or U.S. Environmental Protection Agency's (EPA) Dewatering and Remediation General Permit. • Perform underground storage tank relocation/removal during construction in accordance with MassDEP's Underground Storage Tank Program.		
Utilities and Services	Impacts to water, sewer/septic, gas, electrical, and telecommunication facilities	• Coordinate with utility providers to restore impacted water systems and relocate impacted electrical and telecommunications infrastructure to minimize service disruptions. • Continue to coordinate with Enbridge and NGrid regarding relocation of gas infrastructure. • Address impacts to sewer/septic infrastructure through the right-of-way process.	MassDOT	During design and construction
Climate Change Adaptation and Resiliency	Loss or reduction in navigational clearance in the canal with sea level rise (SLR)	• Design replacement Bridges to maintain existing navigational clearance (135 feet) with sea levels 3 feet higher than the existing mean high water.	MassDOT	During design
	Bridge pier scour with SLR/storm surge (SS)	• Adverse changes to the visual quality of the Sagamore Bridge and Bourne Bridge Areas of Visual Effect at two locations.	MassDOT	During design

Subject Matter	Potential Impact	Mitigation Measure	Responsible Party	Schedule
Climate Change Adaptation and Resiliency (continued)	Submerged or partially submerged outfalls and infiltration basin flooding with SLR/SS	• Consider backflow preventers or in-pipe tide gates for outfalls, where appropriate, to reduce backflow into infiltration basins. • Consider the siting and elevation of infiltration basins in conjunction with projected tidal datums and water surface elevations and combination tidal and rainfall events to reduce risk of upstream flooding through piped infrastructure and overland flows to the maximum extent practicable.	MassDOT	During design
	Flooding of roadways, evacuation route, or the shared-use path (SUP) with SLR/SS	• Build Alternative reduces the impact of flooded roadways on evacuation routes as it provides new direct connection ramps between State Route 25 and U.S. Route 6 (Scenic Highway) to allow vehicles to bypass Belmont Circle, which reduces travel in existing floodplain and areas subject to coastal inundation under a Category 2 Hurricane with 3 feet of freeboard. • Cape Cod Emergency Traffic Plan will be updated to reflect construction and proposed configurations and flows, as well as remaining flood risk at Belmont Circle. (This may include signage and public notices when storms are forecast, as appropriate). • Design the Program so that it does not increase the velocity of moving water, redirect, or channelize flow, and allows water to spread laterally and landward.	MassDOT	During design
	Reduced performance of stormwater control measures (SCM) with increased extreme precipitation	• Build alternative SCMs designed for the 2070, 100-year, 24-hour rainfall event, as recommended through the Resilient Massachusetts Action Team (RMAT) Tool.	MassDOT	During design

Subject Matter	Potential Impact	Mitigation Measure	Responsible Party	Schedule
Climate Change Adaptation and Resiliency (continued)	Extreme wind events may increase likelihood of vehicle rollover or unsafe conditions for multimodal users	• Build Alternative includes installing wind anemometers on the bridges to measure and report actual wind speeds to MassDOT-Highway operations and developing procedures to notify road users of the potential for vehicle rollover or close the bridges.	MassDOT	During design and construction
	Extreme wind events may impact bridge aerodynamic stability	• Network tied-arch bridges have better resistance against wind-induced vibrations and deformation. The Build Alternative would be designed to remain stable during the extreme wind conditions identified in the wind climate analysis.	MassDOT	During design
	Changes to land cover (increased impervious areas and tree clearing) may increase surface temperatures with extreme heat events	• Build Alternative will include a landscape and vegetation plan to provide new landscaping and vegetation for over 200 acres through landscape restoration, reforestation, street tree, buffer, and roundabout planting, lawn re-seeding, and the creation of stormwater basins and rain gardens.	MassDOT	During design
	Extreme heat events may impact active transportation use	• Build Alternative will prioritize green infrastructure SCMs that will mitigate both extreme precipitation and heat impacts and consider shading features for pedestrian areas and lighter-colored surface materials (in areas where glare will not impact road user safety). • The landscape plan will consider providing shade in hardscape areas including along local streetscapes and over the SUP. The landscape plan will enhance pedestrian zones with planting at trailheads, in medians, and in roundabouts in lieu of impervious surfaces. This will improve the experience for site users while reducing the Urban Heat Island Effect.	MassDOT	During design

Subject Matter	Potential Impact	Mitigation Measure	Responsible Party	Schedule
Climate Change Adaptation and Resiliency (continued)	Extreme heat events may impact pavement performance	• Build Alternative will consider using pavement mixtures to provide additional stability in high temperatures and incorporate balanced mixture design methods to reduce mixture cracking and moisture damage.	Contractor	During design and construction
	Winter weather may result in icing on bridge cables and members	• Build Alternative will include deicing measures for bridge cables in accordance with best practices.	MassDOT	During design and post-construction (depending on measure selected)
	Winter weather may result in snow and ice on roadways	• Build Alternative will include updated snow and salt management plans for the Program.	MassDOT	During construction and post-construction
Construction Period	Traffic delays due to increased construction traffic.	• Implement construction staging and sequencing to minimize impacts to the traveling public. • Develop and implement a Traffic Management Plan that includes designated truck routes, off-peak truck deliveries, employee parking away from residences, electronic message signs for alternate routes, potential traffic signal changes, and police detail for traffic direction.	Contractor	During design and construction

Subject Matter	Potential Impact	Mitigation Measure	Responsible Party	Schedule
Construction Period (continued)	Construction equipment and vehicle exhaust	• Require the contractor to enforce anti-idling provisions at Massachusetts General Law Chapter 90 Section 16A and certify that all diesel-powered non-road equipment (50+ horsepower) meet EPA or California Air Resources Board emission standards, with emission control devices installed on exhaust systems. • Use ultra-low sulfur diesel fuel in construction equipment. • Use alternative-fueled or electric equipment where feasible. • Maintain construction equipment in proper working order.	Contractor	During construction
	Potential for erosion and sedimentation during construction	• Implement a Stormwater Pollution Prevention Plan detailing all controls, applicable BMPs, and mitigation measures, with timelines for each construction phase involving major soil-disturbing activities.	Contractor	During construction

Subject Matter	Potential Impact	Mitigation Measure	Responsible Party	Schedule
Construction Period (continued)	Temporary increase in noise levels generated by construction vehicles and construction equipment	• Require contractors to submit a Noise Control Plan (NCP) for approval, developed by an Acoustical Engineer. • Conduct noise monitoring to document compliance with recommended construction noise limits outlined in NCP. Measured noise levels that exceed or approach limits will require implementation of corrective action. • Use noise control measures such as temporary noise barriers/curtain systems and portable enclosures for small equipment (i.e., jackhammers and concrete saws), where feasible. • Implement a public outreach program to coordinate activities and schedules, and work with local communities to address concerns.	Contractor	During construction
	Temporary construction-induced vibration annoyance	• Require contractor to develop a Vibration Control and Mitigation Plan for approval, developed by an Acoustical Engineer or vibration specialist. The Plan will outline procedures for predicting vibration levels, include a pre-construction buildings survey to identify structures of concern, specify vibration reduction measures to prevent structural damage and minimize annoyance, and provide a third-party compliance monitoring plan. • Establish construction vibration structural damage response action and stop-work levels. • Sequence operations to reduce total vibration levels by separating significant vibration-inducing activities. Limit vibration-inducing activities to daytime hours, where feasible.	Contractor	During construction

Subject Matter	Potential Impact	Mitigation Measure	Responsible Party	Schedule
Construction Period (continued)	Temporary closures of portions of the railroad during construction.	• Develop a Rail Operations Coordination Plan to minimize and mitigate construction-period impacts to rail operations.	Contractor	During construction

9 DEIR Distribution List

9.1 Introduction

State regulations governing the preparation of Environmental Impact Reports (EIR) under the Massachusetts Environmental Policy Act (MEPA) require distribution to the MEPA Office and to those who provided comments on the prior Environmental Notification Form (ENF).[1] MEPA also requires distribution to an "Environmental Justice (EJ) Reference List" comprising certain indigenous organizations and community-based organizations based on the Cape Cod Bridges Program's proximity to EJ populations.

In accordance with these requirements, the DEIR has been distributed to the agencies and individuals outlined in **Table 9-1 through Table 9-3**. A hard copy of the DEIR is available at Bourne Public Library (19 Sandwich Road, Bourne MA).

9.2 Federal Agencies

The DEIR has been electronically distributed to the federal agencies listed in **Table 9-1**.

Table 9-1. Federal Agencies

Agency	Address
Federal Highway Administration	joi.singh@dot.gov
U.S. Army Corps of Engineers	Craig.A.Martin@usace.army.mil

9.3 Commenters on the Environmental Notification Form

The DEIR has been distributed to the MEPA Office and to the commenters on the Environmental Notification Form listed in **Table 9-2**.

[1] 301 Code of Massachusetts Regulations 11.16(3)

Table 9-2. Commenters on the MEPA Environmental Notification Form

Commenters	Address
Massachusetts Environmental Policy Act Office	Tori.Kim@mass.gov nicholas.moreno@mass.gov MEPA-EJ@mass.gov
Massachusetts Office of Coastal Zone Management	Lisa.Engler@mass.gov Sean.duffey@mass.gov Patrice.bordonaro@mass.gov
Massachusetts Department of Conservation and Recreation	Brian.Arrigo@mass.gov Andy.backman@mass.gov
Massachusetts Department of Environmental Protection – Southeastern Regional Office	George.Zoto@mass.gov Jonathan.Hobill@mass.gov
Massachusetts Department of Fish and Game – Division of Marine Fisheries	dan.mckiernan@mass.gov
Massachusetts Department of Fish and Game – Natural Heritage and Endangered Species Program	Timothy.mcguire2@mass.gov Eve.schluter@mass.gov Melany.cheeseman@mass.gov Emily.holt@mass.gov
Massachusetts Historical Commission	The MA Archives Building 220 Morrissey Boulevard Boston, MA 02125
Massachusetts Office of Fishing and Boating Access	terrance.smith@mass.gov
Cape Cod Commission	ksenatori@capecodcommission.org
Association to Preserve Cape Cod	info@apcc.org Attn: Andrew Gottlieb, Executive Director
Art Akeley	aaakeley@comcast.net
Susan Barlow	efgsue@gmail.com
Stephen Buckley	Sbuckley714@gmail.com
Robert L. Dwyer	Rdwyerrhg@gmail.com
Vanasse & Associates, Inc.	jdirk@rdva.com JCarmody@rdva.com

9.4 Environmental Justice Reference List

The DEIR has been distributed to the community-based organizations (CBO), tribes, and indigenous organizations listed in **Table 9-3**.

Table 9-3. Environmental Justice Reference List

Name	Title	E-mail	Affiliation	Contact Type
Claire B.W. Muller	Movement Building Director	claire@uumassaction.org	Unitarian Universalist Mass Action Network	Statewide Community-Based Organizations (CBO)
Julia Blatt	Executive Director	juliablatt@massriversalliance.org	Massachusetts Rivers Alliance – River Protection	Statewide CBO
Jodi Valenta	Massachusetts State Director	Jodi.Valenta@tpl.org	The Trust for Public Land	Statewide CBO
Kerry Bowie	Board President	kerry@msaadapartners.com	Browning the GreenSpace	Statewide CBO
Sylvia Broude	Executive Director	sylvia@communityactionworks.org	Community Action Works	Statewide CBO
Britteny Jenkins	Vice President	Bjenkins@clf.org	Conservation Law Foundation	Statewide CBO
Alex St. Pierre	Director of Communities & Toxics	aestpierre@clf.org	Conservation Law Foundation	Statewide CBO
Paulina Muratore	Director of Transportation Justice and Infrastructure	pmuratore@clf.org	Conservation Law Foundation	Statewide CBO
Breanne Frank	Associate Attorney	bfrank@clf.org	Conservation Law Foundation	Statewide CBO
Amy Boyd Rabin	Vice President of Policy	aboydrabin@environmentalleague.org	Environmental League of Massachusetts	Statewide CBO
Zahra Saifee	Policy & Advocacy Coordinator	zsaifee@environmentalleague.org	Environmental League of Massachusetts	Statewide CBO
Ben Hellerstein	MA State Director	ben@environmentmassachusetts.org	Environment Massachusetts	Statewide CBO
Robb Johnson	Executive Director	robb@massland.org	Mass Land Trust Coalition	Statewide CBO
Cindy Luppi	New England Director	cluppi@cleanwater.org	Clean Water Action	Statewide CBO
Dálida Rocha	Executive Director	dalida@n2nma.org	Neighbor to Neighbor Mass.	Statewide CBO
Lena Entin	Director of Individual Giving	Lena@N2NMa.org	Neighbor to Neighbor Mass.	Statewide CBO
Miles Gresham	Campaign Director	Miles@N2NMa.org	Neighbor to Neighbor Mass	Statewide CBO
Rob Moir	Executive Director	rob@oceanriver.org	Ocean River Institute	Statewide CBO

Name	Title	E-mail	Affiliation	Contact Type
Vickash Mohanka	Director, MA Chapter	vick.mohanka@sierraclub.org	Sierra Club MA	Statewide CBO
Heidi Ricci	Director of Policy	hricci@massaudubon.org	Mass Audubon	Statewide CBO
Alma Gordon	President	tribalcouncil@chappaquiddickwampanoag.org	Chappaquiddick Tribe of the Wampanoag Nation	Indigenous Organization
Cheryll Toney Holley	Chair	crwritings@aol.com	Nipmuc Nation (Hassanamisco Nipmucs)	Indigenous Organization
John Peters, Jr.	Executive Director	john.peters@mass.gov	Massachusetts Commission on Indian Affairs (MCIA)	Indigenous Organization
Melissa Ferretti	Chair	melissa@herringpondtribe.org	Herring Pond Wampanoag Tribe	Indigenous Organization
Patricia D. Rocker	Council Chair	rockerpatriciad@verizon.net	Chappaquiddick Tribe of the Wampanoag Nation, Whale Clan	Indigenous Organization
Raquel Halsey	Executive Director	rhalsey@naicob.org	North American Indian Center of Boston	Indigenous Organization
Cora Pierce	Not Provided	Coradot@yahoo.com	Pocassett Wampanoag Tribe	Indigenous Organization
Elizabeth Solomon	Not Provided	Solomon.Elizabeth@gmail.com	Massachusett Tribe at Ponkapoag	Indigenous Organization
Bettina Washington	Tribal Historic Preservation Officer	thpo@wampanoagtribe-nsn.gov	Wampanoag Tribe of Gay Head (Aquinnah)	Federal Tribe
Brian Weeden	Chair	Brian.Weeden@mwtribe-nsn.gov	Mashpee Wampanoag Tribe	Federal Tribe
Shared E-mail Address	Not Provided	106Review@mwtribe-nsn.gov	Mashpee Wampanoag Tribe	Federal Tribe
David Weeden	Tribal Historic Preservation Officer/Director	David.Weeden@mwtribe-nsn.gov	Mashpee Wampanoag Tribe	Federal Tribe
Nakia Hendricks Jr	Office Manager	engagefalmouth@gmail.com	Engage Falmouth	Local CBO
Michael Digiano	Executive Director	MDiGiano@falmouthedic.org	Falmouth Economic Development & Industrial Corporation	Local CBO
Reverend Bob Murphy	Retired Minister	murphydalzell@aol.com	Unitarian Universalist Congregation of Falmouth	Local CBO
Kit O'Connor	Office Administrator	admin@uuffm.org	Unitarian Universalist Congregation of Falmouth	Local CBO
Mireille Bejjani	Energy Justice Director	mbejjani8@gmail.com	Community Action Works	Local CBO

Name	Title	E-mail	Affiliation	Contact Type
Barry Margolin	Chair, Policy & Program Committee	info@capecodclimate.org	Cape Cod Climate Change Collaborative	Local CBO
Kristina Dower	Executive Director	info@cacci.cc	Community Action Committee of Cape Cod & Islands	Local CBO
Maura Valdez	Executive Director	MValdez@groundworksouthcoast.org	Groundwork Southcoast	Local CBO
Hauke Kite-Powell	Chair	hauke@whoi.edu	Woods Hole Diversity Advisory Committee	Local CBO