HERRING RIVER RESTORATION PROJECT

DEVELOPMENT OF REGIONAL IMPACT APPLICATION

--December 2019--

APPLICANT:
TOWN OF WELLFLEET

TOWN OF WELLFLEET
1620
INCORPORATED 1763

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List of Figures and Tables

Frequently Used Terms

Adaptive Management Plan—The plan under which adaptive management decision-making for continued project implementation will be based on system response to incremental increases in tidal exchange. See Section 5 of this application for a thorough discussion on Adaptive Management

Berm—A mound or bank of earth, used especially as a barrier.

Biota—The combined flora and fauna of a region.

Brackish water—Water containing a mixture of seawater and fresh water; contains dissolved materials in amounts that exceed normally acceptable standards for municipal, domestic, and irrigation uses.

Brackish—A mixture of fresh and saltwater typically found in estuarine areas; of intermediate salinity.

Buffer zone—In general, a barrier between sensitive wildlife habitat and land uses such as agriculture or urban development. A transitional zone intended to provide for compatibility of nearby dissimilar uses. In regulatory context includes the 100-foot buffer zone regulated under the Massachusetts Wetlands Protection Act as well as the 50-foot filter strip regulated under the Wellfleet Environmental Protection Regulations.

Datum—A base elevation used as a reference from which to reckon heights or depths.

Ebb tide—The tide defined when the movement of the tidal current is away from the shore or down a tidal river or estuary.

Ecosystem—A basic functional unit of nature comprising both organisms and their nonliving environment, intimately linked by a variety of biological, chemical, and physical processes.

Ecological restoration—The return of an ecosystem to a close approximation of its condition prior to disturbance. Used specifically herein to refer to Ecological Restoration Limited Projects pursuant to 310 CMR 10.11.

Estuarine— Of, relating to, or found in an estuary.

Estuary—The wide part of a river where it nears the sea; where fresh and salt water mix in a semi enclosed body of water.

Fauna—Animals, especially the animals of a particular region or period, considered as a group.

Floodplain—An area adjacent to a lake, stream, ocean or other body of water lying outside the ordinary banks of the water body and periodically filled by flood flows. Often referred to as the area likely to be filled by the 100-year flood (base flood).

Flora—Plants considered as a group, especially the plants of a particular country, region, or time.

Freshwater wetlands—In context of WEPR, defined per 2.03(2) and including isolated wetlands and vernal pools

Groundwater—Water that penetrates the earth's surface from precipitation and from infiltration from streams; water present below ground from ponds and lakes; water that flows or ponds underground.

Halophyte—Salt-tolerant vegetation.

Hydraulic—Of or involving a fluid, especially water, under pressure.

Hydrodynamic modeling—The modeling of the flow field, circulation, and water surface elevations within a water body driven by external conditions, including tides, winds, inflows, outflows.

Hydrology—The scientific study of the properties, distribution, and effects of water on the earth's surface, in the soil and underlying rocks, and in the atmosphere.

Intertidal habitat—The tidal area between the mean lower low water (MLLW) and mean higher high water (MHHW) which is alternately exposed and covered by water twice daily.

Invasive species—A species that is a non-native (exotic) to the ecosystem under consideration and whose introduction causes or is likely to cause economic or environmental harm or harm to human health.

Jurisdictional wetlands—Wetland resource areas under the jurisdiction of local, state or federal regulatory programs.

Marsh—A common term applied to describe treeless wetlands characterized by shallow water and abundant emergent, floating, and submerged wetland flora. Typically found in shallow basins, on lake margins, along low gradient rivers, and in calm tidal areas. Marshes may be fresh, brackish or saline, depending on their water source(s).

Mean sea level—The arithmetic mean of hourly heights observed over the National Tidal Datum Epoch.

MHHW— Mean Higher High Water, the average of the higher high water height of each tidal day observed over the National Tidal Datum Epoch or other specified shorter series.

MHW—Mean High Water, the average height of all the high tides.

MHWS—Mean High Water Spring, the average height throughout the year of two successive high waters during those periods of 24 hours when the range of the tide is at its greatest.

MLLW—Mean Lower Low Water, the average of the lower low water height of each tidal day observed over the National Tidal Datum Epoch or other specified shorter series.

MLW—Mean Low Water, the average height of all low water heights.

North American Vertical Datum (NAVD)—All elevations presented in this project are based on the NAVD88. NAVD88 replaced National Geodetic Vertical Datum of 1929 (NGVD 29) as a result of greater accuracy and the ability to account for differences in gravitational forces in different areas based on satellite systems. Within the project area, NAVD88 is 0.86 feet lower in elevation than NGVD 29.

Regulatory Oversight Group—A successor to the TWG established by MEPA, to continue the participation from representatives of regulatory authorities having jurisdiction over project activities under the Special Review Procedure after Class 1 infrastructure construction is commenced and the project begins the adaptive management phase.

Restoration—See Ecological Restoration

Saline—Of, relating to, or containing salt; salty.

Salinity—A measure of the salt concentration of water; higher salinity means more dissolved salts.

Salt marsh—A coastal habitat consisting of salt-resistant plants residing in an organic-rich sediment.

Sedimentation—The deposition or accumulation of sediment.

Species of concern (federal definition)—An informal term that refers to those species which USFWS believes might be in need of concentrated conservation actions (formerly known as Category 1 or 2 Candidate).

Spring tides—The tides resulting when the gravitational forces exerted on the Earth by the sun and moon are acting in the same direction.

Submerged aquatic vegetation (SAV)—Aquatic vegetation that cannot tolerate dry conditions and because of this, live with their leaves at or below the water surface.

Subsidence—The motion of a surface (usually, the Earth's surface) as it shifts downward relative to a datum such as sea level.

Subtidal habitat—Areas below mean lower low water MLLW that are covered by water most of the time.

Swamp—A seasonally flooded bottomland with more woody plants than a marsh and better drainage than a bog.

Threatened species (federal definition)—Any species which is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range.

Tidal flushing—The action of saltwater entering an estuary during high tides. It renews the salinity and nutrients to the estuary and removes artificially introduced toxins in the environment.

Tidal marsh—Wetlands with fresh water, brackish water, or salt water along tidal shores.

Tidal prism—The volume of water that flows into and out of a marsh.

Topography—The general configuration of a land surface, including its relief and the position of its natural and man-made features.

Turbidity—The relative clarity of water, which depends in part on the material in suspension in the water.

Wetlands—Pursuant to the U.S. Army Corps of Engineers (Federal Register, 1982) and the Environmental Protection Agency (Federal Register, 1980) jointly define wetlands as: Those areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs, and similar areas. Wetlands are also defined under applicable local and state regulatory programs.

Acronyms and Abbreviations

ACEC	Areas of Critical Environmental Concern
ADA-compliant	Americans with Disabilities Act compliant
APE	Area of Potential Effect
BMP	Best Management Practice
BVW	Bordering Vegetation Wetlands
CCC	Cape Cod Commission
CCNS	Cape Cod National Seashore
CES	Coastal Engineering Structure
CWA	Clean Water Act
CNR	Chequessett Neck Road
CYCC	Chequessett Yacht and Country Club
CZM	Massachusetts Office of Coastal Zone Management
DER	Massachusetts Division of Ecological Restoration
DRI	Development of Regional Impact
EFDC	Environmental Fluid Dynamics Code
EFH	Essential fish habitat
EIR	Environmental Impact Report
EIS	Environmental Impact Statement

EIS/EIR	Environmental Impact Statement / Environmental Impact Report
FEMA	Federal Emergency Management Agency
FHR	Friends of Herring River
GHG	Greenhouse gas
GIS	Geographic Information System
HREC	Herring River Executive Council
HRRP	Herring River Restoration Project
HRSG	Herring River Stakeholders Group
HRTT	Herring River Technical Team
MassDEP	Massachusetts Department of Environmental Protection
MassDOT	Massachusetts Department of Transportation
MEPA	Massachusetts Environmental Policy Act
MESA	Massachusetts Endangered Species Act
MHW	Mean High Water (see definition above)
MHHW	Mean Higher High Water (see definition above)
MHWS	Mean High Water Spring (see definition above)
MLW	Mean Low Water (see definition above)
MLLW	Mean Low Lower Water (see definition above)
MOU	Memorandum of Understanding
National Register	National Register of Historic Places
NEPA	National Environmental Policy Act
NHESP	Natural Heritage and Endangered Species Program
NHPA	National Historic Preservation Act of 1966
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NOI	Notice of Intent
NPS	National Park Service
NRCS	Natural Resources Conservation Service
ROD	Record of Decision
SDM	Structured Decision-Making
SLAMM	Sea Level Affecting Marshes Model
SRP	Special Review Procedure

THPO	Tribal Historic Preservation Officer
TWG	Technical Working Group
USACE	U.S. Army Corps of Engineers
USEPA	U.S. Environmental Protection Agency
USFWS	U.S. Fish and Wildlife Service
WEPR	Wellfleet Environmental Protection Regulations
WPA	Massachusetts Wetland Protection Act

1. Required Documents

1.A. Application cover sheet

(See following page. The original signed form is provided with the application package.)

CAPE COD COMMISSION

Application Cover Sheet

Cape Cod Commission
3225 Main Street, PO Box 226
Barnstable, MA 02630
Tel: (508) 362-3828 • Fax: (508) 362-3136

For Commission Use Only
Date Received:
Fee ($):
Check No:
File No:

A Type of Application (check all that apply)

- [x] Development of Regional Impact (DRI)
- [ ] DRI Scoping
- [ ] DRI Exemption
- [ ] Hardship Exemption
- [ ] Jurisdictional Determination
- [ ] Request for Joint MEPA/DRI Review
- [ ] Decision Extension
- [ ] Decision Modification

B Project Information

Project Name: Herring River Restoration Project
Total Site Acreage:
Project/Property Location: Wellfleet and Truro, MA
Zoning: National Seashore Park and Residential 1

Brief Project Description:
Include total square footage of proposed and existing development, gross floor area, number of lots existing or to be created, specific uses, description of existing conditions, as applicable (attach additional sheets if necessary).
The Project consists of the following elements necessary to allow restoration of tidal flow and restore 570 acres of coastal wetlands under Phase 1 of the Proejct: 1) removal of a portion of the Chequessett Neck Road dike and replacement with a bridge and tide gates; 2) installation of a water control structure with tide gates at Pole Dike Road where it crosses the entrance channel to Upper Pole Dike Creek; and 3) removal of a portion of High Toss Road where it crosses the marsh.

C Owner(s) of Record

List the following information for all involved parcels. Provide copies of each Deed and Purchase and Sale Agreement and/or evidence of leasehold interest, if applicable, for all involved parcels. Proof of ownership/legal rights for Applicant(s) to proceed with the proposed development must be documented prior to the Commission deeming any application complete. List the local, state, or federal agencies from which permits or other actions have been/will be filed (attach additional sheets if necessary).

Map/Parcel	Owner's Name	Lot & Plan	Land Court Certificate of Title #	Registry of Deeds Book/Page #

There ARE / **ARE NOT** (circle one) court claims, pending or completed, involving this property (if yes, please attach relevant information).

Is there an existing CCC Decision for the Property? [ ] yes [x] no (if so, recording information for decision, please attach relevant information).

D Certification

I hereby certify that all information provided on this application form and in the required attachments is true and accurate to the best of my knowledge. I agree to notify the Cape Cod Commission of any changes on the information provided in this application, in writing, as soon as is practicable. I understand failure to provide the required information and any fees may result in a procedural denial of my project.
NOTE: For wireless communication facilities, a licensed carrier should be either an applicant or a co-applicant.

APPLICANT
Applicant(s) Name: Town of Wellfleet Tel: 508-349-0300 Fax: 508-349-0305
Address: 300 Main Street, Wellfleet, MA 02667
Signature: Daniel R. Hoort Date: 12-11-19

CO-APPLICANT
Co-Applicant(s) Name: Tel: Fax:
Address:
Signature: Date:

CONTACT
Contact: Daniel R. Hoort, Town Administrator Tel: 508-349-0300 Fax: 508-349-0305
Address: 300 Main Street, Wellfleet, MA 02667
Signature: Daniel R. Hoort Date: 12-11-19

PROPERTY OWNER
Property Owner: Town of Wellfleet and Cape Cod National Seashore Tel: Fax:
Address:
Signature: See attached letter from Cape Cod National Seashore Superintendent Date:
Text

BILLABLE ENTITY
Name: Town of Wellfleet Tel: 508-349-0300 Fax: 508-349-0305
Address: 300 Main Street, Wellfleet, MA 02667

1.B. Letter from CCNS

United States Department of the Interior

NATIONAL PARK SERVICE
Cape Cod National Seashore
99 Marconi Site Road
Wellfleet, MA 02667
508.771.2144
508.349.9052 Fax

IN REPLY REFER TO:
N2219

December 9, 2019

Kristy Senatori
Executive Director
Cape Cod Commission
PO Box 226
Barnstable, MA 02630

Re: Town of Wellfleet, Development of Regional Impact Application for Herring River Restoration Project, Phase 1

Dear Ms. Senatori:

The proposed restoration of the Herring River estuary is a project of unique significance to the region, and of vital importance to the Cape Cod National Seashore.

Prior to 1909, the Herring River estuary included roughly 1,000 acres of salt marsh, intertidal flats and open-water habitats. Construction of a dike at the mouth of the river has since severely limited tidal exchange between the estuary and Wellfleet Harbor, resulting in loss of wetland resource function, degradation of water quality and loss of habitat. Herring River today is designated as an Impaired Water under the Federal Clean Water Act, and the dike is a state-designated point source for bacterial contamination responsible for the closure of hundreds of acres of once-harvestable downstream shellfish beds. This degraded system is located in the towns of Wellfleet and Truro, and eighty percent of the flood plain is within the boundary of the Cape Cod National Seashore.

The Cape Cod National Seashore is working in partnership with the Town of Wellfleet, and state and federal partners, to implement a plan to restore Herring River. The plan is the result of more than two decades of scientific study led by National Park Service (NPS) scientists and extensive stakeholder engagement. The formal process began in 2005, when the seashore and Town of Wellfleet entered into a Memorandum of Agreement (MOU) to study whether restoration of Herring River is feasible. The resulting *Herring River Conceptual Restoration Plan* was accepted by the Town and NPS, and provided the basis for developing a detailed restoration plan. The detailed restoration plan successfully completed state and federal environmental impact reviews in 2016. Recently, the Town and NPS entered into a new MOU (MOU IV) to implement the restoration plan.

In furtherance of MOU IV, the Project is seeking environmental permits for authorization to implement Phase 1 of the restoration. Phase 1 will restore 570 acres of tidal wetlands. Within the Phase 1 area, 540 acres or 95% is owned by the United States and managed by NPS. The success of this project will have a profound effect on resource health, habitat and recreational opportunities in the Cape Cod National Seashore.

The DRI application submitted by the Town of Wellfleet includes descriptions of work that will take place on land within the Congressionally-authorized NPS boundary. The Cape Cod National Seashore grants permission for this work to be described in the DRI application, and we pledge our continued support, coordination and cooperation in the implementation of the proposed restoration activities. Two structures described in the application, the Mill Creek Water Control Structure and the tide barrier to protect Way 672, are to be built on federal land by the federal government and, therefore, are not subject to Cape Cod Commission review. The NPS will seek all applicable permits for those activities.

Please let me know if the Commission needs additional information about the seashore's role in this important project.

Sincerely,

Brian Carlstrom, Superintendent
Cape Cod National Seashore

1.C. USGS Quadrangle Figures

(See following pages)

Path: J:\F451-003 Friends of Herring River - Cape Cod Commission DRI_2016-0125\04 GRAPHICS\MXD\DRI\F451_003_Fig01_ProjectArea.mxd
Drawing Date: 2019/12/10

ESS group
environmental consulting & engineering services

0 1,250 2,500 Feet

Herring River Restoration Project
Wellfleet and Truro, Massachusetts

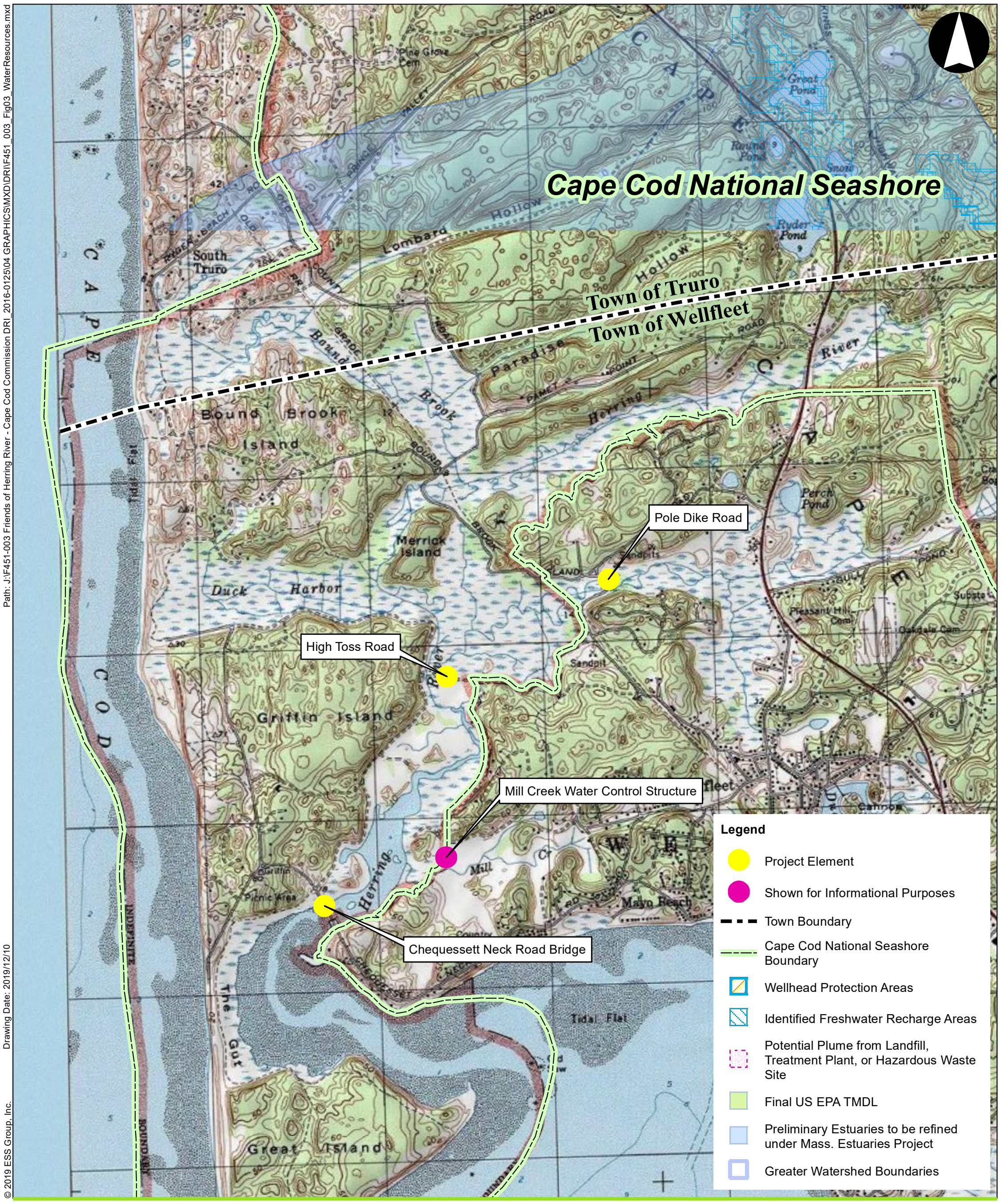
USGS Locus

Source: 1) ESRI, USA Topo Map, 2017
2) National Park Service, Basin and Park Boundaries, 2017

- Project Element
- Shown for Informational Purposes
- Town Boundary
- Cape Cod National Seashore Boundary

Figure 1-1 USGS Locus

Figure 1-2 Significant Natural Resource Areas



ESS group environmental consulting & engineering services

0 1,250 2,500 Feet

Herring River Restoration Project
Wellfleet and Truro, Massachusetts

Cape Cod Commission
Water Resources

Source: 1) ESRI, USA Topo Map, 2017
2) National Park Service, Basin and Park Boundaries, 2017
3) Cape Cod Commission, Wetlands 2018

Figure 1-3 Water Resources

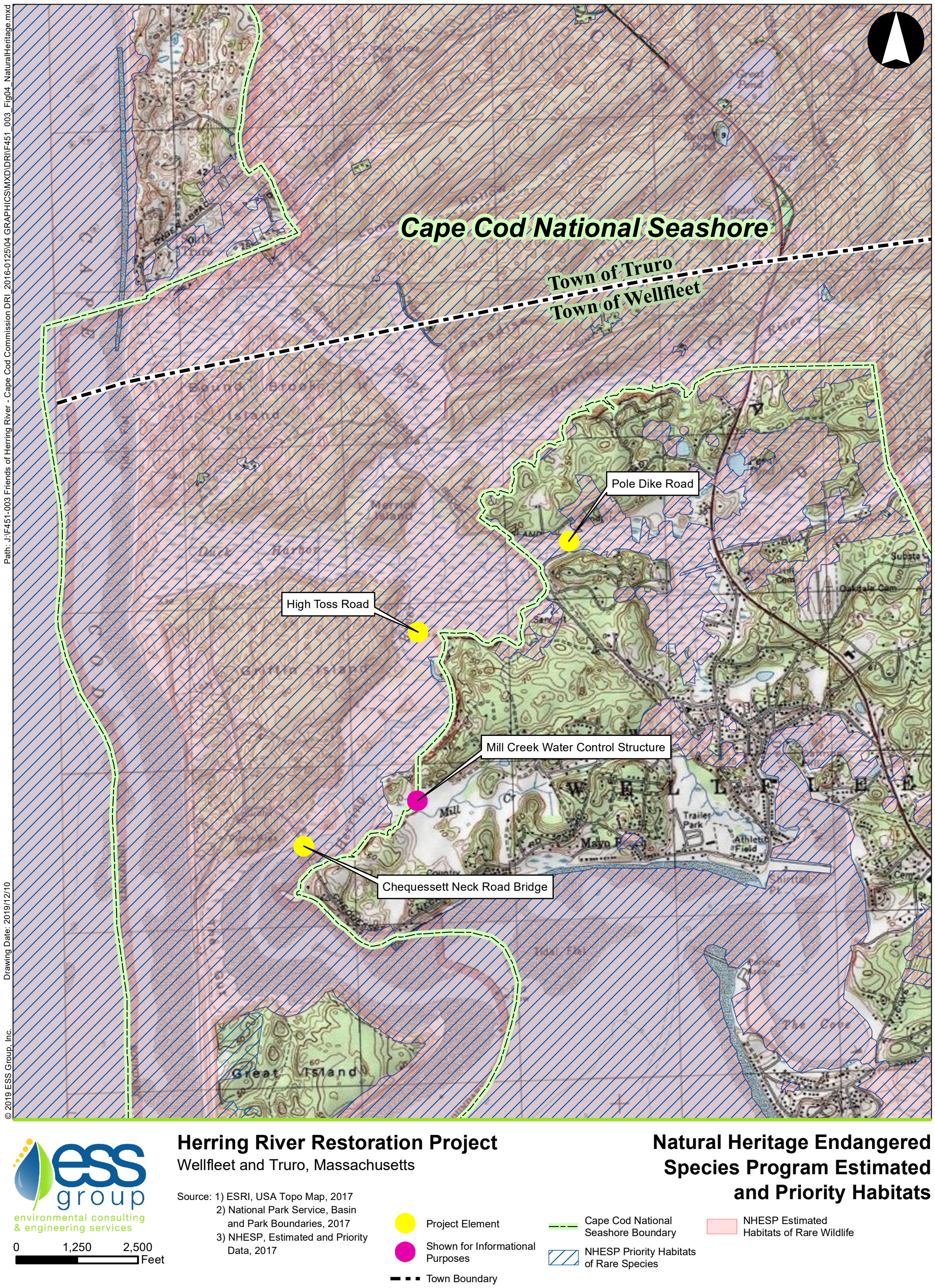


Figure 1-4. NHESP Estimated and Priority Habitats

1.D Certified Abutters List

Abutters were identified as owners of parcels within 300 feet of the project water control elements: Chequessett Neck Road Bridge (including the adjacent construction staging area), Pole Dike Road water control structure, and High Toss Road removal. Parcels were identified as abutting if they were within:

a) 300 feet of the property line where the limit of disturbance (LOD) extends beyond the Town-owned right-of-way (ROW); or

(b) 300 feet of the edge of the ROW where the LOD does not extend beyond the ROW.

The abutting non-federal parcels are shown on Figure 1-5.

A corresponding list of abutters was compiled and certified by the Town of Wellfleet Assessor. Three sets of labels from the certified list of abutters are enclosed with the application. The list of abutters is provided on the following pages.

At the time the Cape Cod Commission mails the notice of the public hearing to the list of abutters, the Town will send a courtesy notice of the public hearing to other parcel owners in the Herring River flood plain.

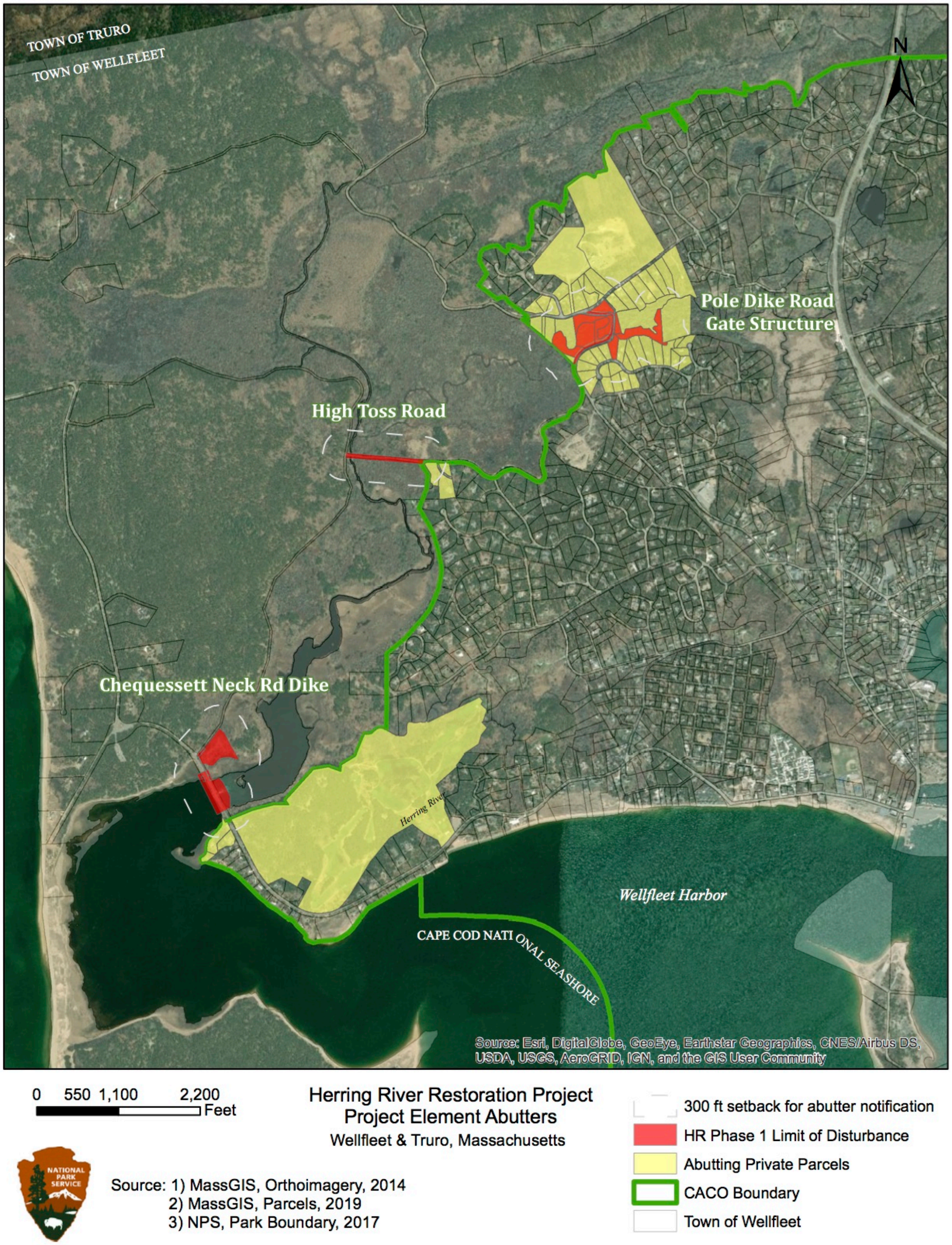


Figure 1-5. Abutting Non-federal Parcels, Phase 1

TOWN OF WELLFLEET
300 MAIN STREET WELLFLEET MASSACHUSETTS 02667
Tel (508) 349-0304 Fax (508) 349-0317
www.wellfleetma.org

BOARD OF ASSESSORS

MEMORANDUM

TO: Hillary Lemos, Health & Conservation Agent

FROM: Nancy Vail, Assessor NV

DATE: 9/5/19

RE: DRI Abutters List sent 9/3/19

Please be advised that the above referenced abutters list emailed to you on September 3, 2019 was generated by me and is therefore, by definition, certified by me.

HEALTH DEPARTMENT
TOWN OF WELLFLEET
SEP 09 2019
RECEIVED BY:

Herring River Restoration Project | 300-foot Abutters | Certified 23 Aug 2019

MAP	PARCEL	EXTN	NAME	MAILING STREET	CITY	STATE	ZIP	LOCAL	
7	24	0	TOWN OF WELLFLEET TRANSFER STATION	300 MAIN ST	WELLFLEET	MA	02667	266	COLES NECK RD
7	25	0	WELLER LISA A	320 COLES NECK RD	WELLFLEET	MA	02667	320	COLES NECK RD
7	25	1	PECHUKAS ROLF	PO BOX 978	WELLFLEET	MA	02667	330	COLES NECK RD
7	26	0	BESWICK SCOTT & VERMEHREN TRUDY	340 COLES NECK RD	WELLFLEET	MA	02667	340	COLES NECK RD
7	27	0	AYOTTE STEPHEN R & THERESA A	74 WESTLEIGH DR	HARWINTON	CT	06791	360	COLES NECK RD
7	28	0	TOWN OF WELLFLEET TRANSFER STATION	300 MAIN STREET	WELLFLEET	MA	02667	370	COLES NECK RD
7	29	0	WEBSTER HELEN E	10 PHEASANT RUN	WELLFLEET	MA	02667	10	PHEASANT RUN
7	30	0	VANDERSCHMIDT GEORGE F	BOX 972	WELLFLEET	MA	02667	30	PHEASANT RUN
7	44	0	GIESE BENJAMIN S & BRAMSON RACHEL	1014 MADERA CIRCLE	COLLEGE STATION	TX	77840	49	PHEASANT RUN
7	45	0	GOLDMAN ISABEL P & NABATI LIDA	28 ESSEX ST APT 2	CAMBRIDGE	MA	02139	45	PHEASANT RUN
7	46	0	GREENE DIANE M & AXELROD NAOMI G	15 PHEASANT RUN	WELLFLEET	MA	02667	15	PHEASANT RUN
7	48	0	WELLFLEET CONSERVATION TRUST	PO BOX 84	WELLFLEET	MA	02667	0	COLES NECK RD
7	49	0	WELLFLEET CONSERVATION TRUST	PO BOX 84	WELLFLEET	MA	02667	0	BOUND BROOK ISLAND
7	50	0	TOWN OF WELLFLEET	300 MAIN ST	WELLFLEET	MA	02667	0	BOUND BROOK ISLAND
7	51	0	WELLFLEET CONSERVATION TRUST	PO BOX 84	WELLFLEET	MA	02667	0	BOUND BROOK ISLAND
7	51	1	WELLFLEET CONSERVATION TRUST	PO BOX 84	WELLFLEET	MA	02667	0	COLES NECK RD
7	52	0	WELLFLEET CONSERVATION TRUST	PO BOX 84	WELLFLEET	MA	02667	0	BOUND BROOK ISLAND
7	53	0	WELLFLEET CONSERVATION TRUST	PO BOX 84	WELLFLEET	MA	02667	0	BOUND BROOK ISLAND
7	54	0	WELLFLEET CONSERVATION TRUST	PO BOX 84	WELLFLEET	MA	02667	0	POLE DIKE RD
7	55	0	WELLFLEET CONSERVATION TRUST	PO BOX 84	WELLFLEET	MA	02667	0	POLE DIKE RD
7	56	0	VANDERSCHMIDT HANNELORE F	225 COLES NECK RD	WELLFLEET	MA	02667	239	COLES NECK RD
7	56	1	SAMUELSON MARNIE CRAWFORD C/O IN BALANCE	PO BOX 45	CHATHAM	MA	02633	339	COLES NECK RD
7	56	2	FAWKES ASHLEY E	319 COLES NECK RD	WELLFLEET	MA	02667	319	COLES NECK RD
7	56	3	SELDIN ABBE L & SCHNEIDER FARNY	BOX 842	WELLFLEET	MA	02667	299	COLES NECK RD
7	56	4	BERRY MARY C	BOX 95	S WELLFLEET	MA	02663	287	COLES NECK RD
7	56	5	CUMING JOYCE A TRUSTEE	100 RTE 6A	ORLEANS	MA	02653	275	COLES NECK RD
7	56	6	ADELSON KERIN B & GRODBERG DAVID M	77 EDGEHILL RD	NEW HAVEN	CT	06511	263	COLES NECK RD
7	56	7	CHARLTON ALDONA & ZIMILICKI ALAN	195 ERIE ST	CAMBRIDGE	MA	02139	251	COLES NECK RD
7	64	0	TOWN OF WELLFLEET	300 MAIN ST	WELLFLEET	MA	02667	0	POLE DIKE RD
7	65	0	TOWN OF WELLFLEET	300 MAIN ST	WELLFLEET	MA	02667	0	POLE DIKE RD
7	66	0	TOSCANINI ELAINE LIFE ESTATE C/O LIANA TOSCANINI	1553 HARTSVILLE-N MARLBORO RD	NEW MARLBOROUGH	MA	01230	1160	BROWNS NECK RD
7	67	0	JACOBSON SCOTT & SCHWAB HILLARY	3 GIBBS ST	BROOKLINE	MA	02446	1150	BROWNS NECK RD
7	68	0	WADSWORTH PAUL K & LISY JANE E	2906 KINGSLEY RD	CLEVELAND	OH	44122	1142	BROWNS NECK RD

Herring River Restoration Project | 300-foot Abutters | Certified 23 Aug 2019

MAP	PARCEL	EXTN	NAME	MAILING STREET	CITY	STATE	ZIP	LOCAL	
7	69	0	LARSEN P REED	161 CLINTON RD	BROOKLINE	MA	02446	1136	BROWNS NECK RD
7	70	0	KERBER JORDAN E & MORAN MARY H	19 WEST PLEASANT ST	HAMILTON	NY	13346	1130	BROWNS NECK RD
7	71	0	WOOD DARROW	75 HENRY ST #6K	BROOKLYN	NY	11201	1116	BROWNS NECK RD
7	72	0	THEILMAN WARD & THEILMAN MARYLOU E, TRUSTEES	40 VALLEY VIEW DR	AMHERST	MA	01002	1100	BROWNS NECK RD
7	73	0	ICKLAN WILLIAM & JOAN F C/O ICKLAN JOHN E & SAMUEL K	209 W 13TH ST APT 9	NEW YORK	NY	10011	1090	BROWNS NECK RD
7	74	0	PALINO CHRISTIAN & MARINI MICHELA, TRUSTEES	2936 MADELINE ST	OAKLAND	CA	94602	1080	BROWNS NECK RD
7	75	0	GOLDBERG MANUEL & HELEN A	514 LUMINARY BLVD	OSPREY	FL	34229	1070	BROWNS NECK RD
7	76	0	WELLFLEET CONSERVATION TRUST	PO BOX 84	WELLFLEET	MA	02667	0	POLE DIKE RD
8	220	0	VANDERSCHMIDT HANNELORE F & GEORGE F	225 COLES NECK RD	WELLFLEET	MA	02667	225	COLES NECK RD
8	266	0	FODASKI ELIZABETH & KATE & BAKER RICHARD & LUBOW GENE & JACOBSON LAWRENCE & JACOBS LIN	115 WILLOW ST APT 2C	BROOKLYN	NY	11201	55	MARSH END
8	267	0	JACOBS LINDA & BARBARA & LUBOW GENE J	24 5TH AVE #1612a	NEW YORK	NY	10011	45	MARSH END
8	268	0	CARBONI BARBARA	122 ALBEMARLE RD	NEWTON	MA	02460	1060	BROWNS NECK RD
8	270	0	TOWN OF WELLFLEET CONSERVATION COMMISSION	300 MAIN STREET	WELLFLEET	MA	02667	0	COLES NECK RD OFF
8	310	0	CARIANI KAREN	629 WATERTOWN ST UNIT B	NEWTON	MA	02460	1050	BROWNS NECK RD
8	311	0	PALLEY MARIAN L & PALLEY HOWARD A, TRUSTEES	11 NORTH TOWNVIEW LANE	NEWARK	DE	19711	33	MARSH END
8	319	0	WELLFLEET CONSERVATION TRUST	PO BOX 84	WELLFLEET	MA	02667	0	BROWNS NECK RD OFF
12	231	0	MURRAY-BROWN ANDREW	10 MAST HILL RD	HINGHAM	MA	02043	245	HIGH TOSS RD
12	234	0	BESSETTE RODOLPHE G JR& JEAN C	BOX 141	WELLFLEET	MA	02667	255	HIGH TOSS RD
12	235	0	HIRSCH JONATHAN H & MEEK ROBERT P	72 WARREN AVE UNIT 202	BOSTON	MA	02116	25	WAY #672
12	252	0	ROSENKRANTZ LOUISE, TURITZ EUGENE & ROSENKRANTZ DEBORAH TRUSTEES	2124 DERBY ST	BERKELEY	CA	94705	1107	BROWNS NECK RD
12	253	0	KELLEY EVELYN S	1115 BROWNS NECK RD	WELLFLEET	MA	02667	1115	BROWNS NECK RD
12	254	0	LANGTON CHRISTINE & SPIELBERG IVAN	365 W 25TH ST APT 16J	NEW YORK	NY	10001	39	BROWNS NECK RD
12	255	0	MORRILL RICHARD C & FISH LESLIE ANN, TRUSTEES	BOX 413	WELLFLEET	MA	02667	1175	BROWNS NECK RD
12	266	0	BIRENBAUM HELEN B TRUSTEE	108 WILLOW ST	BROOKLYN	NY	11201	1162	BROWNS NECK RD
12	267	0	MITCHELL PAULA A TRUSTEE C/O INVESTORS SECURITY TRUST	5246 RED CEDAR DR STE 101	FT MEYERS	FL	33907	1170	BROWNS NECK RD
12	268	0	HOPKINS GRACE	1172 BROWN'S NECK RD	WELLFLEET	MA	02667	1172	BROWNS NECK RD
12	269	0	FORIST MELINDA D	1155 BROWN'S NECK RD	WELLFLEET	MA	02667	1155	BROWNS NECK RD
12	270	0	SPIELBERG IVAN & LANGTON CHRISTINE	365 W 25TH ST #16J	NEW YORK	NY	10001	1135	BROWNS NECK RD
18	5	0	HALLORAN KATHERINE H	9 COACH RD	LEXINGTON	MA	02420	1360	CHEQUESSETT NECK RD
19	81	0	CHEQ YACHT & COUNTRY CLUB	PO BOX 779	WELLFLEET	MA	02667	680	CHEQUESSETT NECK RD
19	91	0	EURICH DONALD A & LAZARUS JILL	7 WALNUT ST	NEWTONVILLE	MA	02460	1065	CHEQUESSETT NECK RD
19	92	0	CURRIER CHARLES B & LUCY A	1045 CHEQUESSETT NECK RD	WELLFLEET	MA	02667	1045	CHEQUESSETT NECK RD

1.E. List of Required Permits

Agency/Regulatory Authority	Permit/Approval	Status
Federal		
U.S. Department of the Interior – National Park Service	NEPA Review	Complete (Record of Decision published June 21, 2016)
U.S. Environmental Protection Agency	U.S. Clean Waters Act - NPDES Construction General Permit	To be filed
U.S. Army Corps of Engineers	Individual Permit pursuant to Section 404 of Clean Water Act and Section 10 of Rivers and Harbors Act	To be filed
U.S Department of the Interior - National Park Service	Review under Section 106 of the National Historic Preservation Act	Complete
U.S. Fish and Wildlife Service	Review under Section 7 of the Federal Endangered Species Act	To be completed
NOAA Fisheries	Essential Fish Habitat Review -Magnuson-Stevens Fishery Conservation and Management Act	To be completed
Federal Consistency Review (through MA Coastal Zone Management)	Review under Coastal Zone Management Act of 1972	To be reviewed
U.S. Coast Guard	Bridge Permit	Determination of Non-Applicability to be requested.
U.S. EPA	National Pollution Discharge Elimination System (NPDES) Permit	To be filed
State		
Executive Office of Energy and Environmental Affairs	Massachusetts Environmental Policy Act (MEPA) (MGL C. 30, s 61-62H) Review	Complete (MEPA Certificate issued July 15, 2016)
Massachusetts Department of Environmental Protection - Wetlands and Waterways	Section 401 Water Quality Certification (314 CMR 9.00)	To be filed
Massachusetts Department of Environmental Protection - Wetlands and Waterways	Chapter 91 Waterways Licensing and Permitting (310 CMR 9.00)	To be filed
Massachusetts Department of Environmental Protection - Wetlands and Waterways	Massachusetts Wetlands Protection Act (MGL C 131, s 40 and 40A) – Orders of Conditions from Wellfleet and Truro Conservation Commissions	To be filed with local Conservation Commissions
Massachusetts Historical Commission	State Historic Register Review	PNF has been filed. Programmatic Agreement in place.

Massachusetts Department of Transportation	Bridge Permit for Chequessett Neck Road Bridge	To be filed
Massachusetts Natural Heritage and Endangered Species Program	Habitat Management and Monitoring Plan	MEPA Certificate notes NHESP comments that it appears that the Project qualifies for MESA Habitat Management Exemption. A Draft Habitat Management and Monitoring Plan will be submitted and reviewed by NHESP pursuant to 321 CMR 10.14(15)
Regional		
Cape Cod Commission	Development of Regional Impact Review: Scoping Determination	Scoping decision issued March 7, 2019
Cape Cod Commission	Development of Regional Impact Review	To be filed
Local - Wellfleet		
Wellfleet Conservation Commission	Order of Conditions – Massachusetts Wetlands Protection Act and Local Bylaws	To be filed
Local - Truro		
Truro Conservation Commission	Order of Conditions – Massachusetts Wetlands Protection Act and Local Bylaws	To be filed

2. Executive Summary

The Herring River system is a 1,100-acre tidally-restricted estuary located in the Towns of Wellfleet and Truro, in Barnstable County, Massachusetts. Prolonged tidal restriction caused by the Chequessett Neck Road dike in Wellfleet has resulted in severe habitat degradation and nearly complete loss of native tidal wetland habitat. As a consequence, Herring River is listed as an "Impaired Water" in violation of several Clean Water Act standards; and the Chequessett Neck Road Bridge is a state-designated point source for bacterial contamination responsible for closure of downstream shellfish areas. The Town of Wellfleet and the National Park Service (NPS) have entered into a Memorandum of Understanding to implement the Herring River Restoration Project ("Project") to re-establish tidal exchange to the Herring River estuary and thereby remediate degraded conditions and restore native wetland habitats. The Project represents an unmatched opportunity to restore the environment of Cape Cod and revive the ecological and economic benefits provided by a healthy natural coastal river and tidal wetland system. Most of the area of proposed restoration is in the Cape Cod National Seashore (CCNS), and owned by the NPS.

The Project is the result of more than a decade of scientific study, extensive stakeholder involvement, federal, state and local collaboration and public discussions with local leadership. The Project design has been strengthened by the input of community and regional stakeholders. The Project team includes national experts in estuarine science, civil engineering and environmental resource management.

The Town of Wellfleet and CCNS are seeking environmental permits necessary to implement Phase 1 and restore approximately 570 acres of native tidal wetlands. All Phase 1 area is currently under wetlands jurisdiction, 95 percent (540 acres) is owned by the NPS, and two percent involves any private residential property. For purposes of this Development of Regional Impact (DRI) Application, the Town of Wellfleet is the sole applicant for the Project. The NPS will separately pursue all required permits for the Mill Creek water control structure, and a tide barrier structure, which are proposed on land owned by the NPS. While not a subject of this Application, the Mill Creek water control structure and Way 672 tide barrier structure are described in this Application for purposes of completeness.

The Project will re-establish tidal flow to the estuary incrementally using a carefully calibrated adaptive management approach that will balance ecological goals with water level control measures to allow the highest tide range practicable while protecting potentially vulnerable structures on public and private properties, including roads and homes. Tidal flow will be facilitated through (1) replacement of a portion of the existing earthen dike and tidal control structure at Chequessett Neck Road with a new bridge and tide gate system; (2) construction or alteration of other tidal control structures at the entrances to the Mill Creek and Upper Pole Dike Creek sub-basins; (3) removal of a portion of High Toss Road where it crosses the marsh between the Lower Herring River and Lower Pole Dike Creek sub-basins; (4) vegetation and marsh management; and (5) measures to prevent water intrusion impacts to structures on public and private properties. Project implementation will be governed by a locally-appointed decision-making council of Town and CCNS officials, and informed by extensive modeling, monitoring and analysis so that unexpected and/or undesirable responses can be detected early on and addressed with appropriate response actions. The Project will result in significant improvements in water quality, rare species habitat, fisheries, and recreational opportunities throughout the Herring River floodplain while improving its resiliency and ability to adapt to the effects of climate change. Restored tidal wetlands will significantly reduce greenhouse gas emissions by reclaiming lost carbon storage and reducing methane emissions.

The Project has been developed over several years in partnership with the Town of Wellfleet, NPS, and members of the community. At each stage of project development, the Project team has worked closely with federal, state and local entities to account for their interests and potential concerns. The Project has completed review under the Massachusetts Environmental Policy Act (MEPA), and received its Certificate of Compliance on July 15, 2016 (EEA # 14272). Phasing of the Project is contemplated in the Final Environmental Impact Report (EIR), and the impacts of Phase 1 are within the scope of impacts identified in the Final EIR.

Because the Project was required to prepare an EIR under MEPA, the Project requires review before the Commission as a DRI. As the Commission stated in its comment letter (July 8, 2016) to the MEPA Office on the Project's Final EIR, "[t]he project's outcomes anticipated and desired by the proponents will bring broad ecological benefits to the Herring River system in Wellfleet and Truro, and as a result will likely benefit human health and the local and regional economy. However, the proposed changes associated with the project, including to the existing man-made structures within the estuary such as the Chequessett Neck Road (CNR) dike, and upstream dikes, culverts, and roadways, are not without impacts to natural resources." The Commission's MEPA comment letter also noted, "[t]his large-scale ecological restoration project does not fit neatly into the Cape Cod Commission's regulatory framework." Many of the issues typically applicable to DRI projects are not applicable to this Project. Accordingly, the Town applied for a Limited Scope Development of Regional Impact review on January 2, 2019. On March 7, 2019, the Commission issued a Development of Regional Impact Scoping Decision "establishing the goals and objectives from Section 6 of the 2019 RPP [Regional Policy Plan] that will be considered by the Commission during DRI review in determining the Project's consistency with the 2019 RPP."

The Project represents a unique opportunity to restore significant ecological resources and ecosystem services (including social and economic benefits to the community) provided by a healthy estuary. This Application demonstrates that the Project is consistent with the 2019 Regional Policy Plan (RPP).

This Application describes the Project in eight numbered sections. Section 1.0 provides required documentation. Section 2.0 consists of this summary. Section 3.0 provides a description of the Project, including phasing, tide control elements, mitigation, and governance. Section 4.0 contains an analysis of the Project's consistency with the RPP goals and objectives identified in the Commission's scoping decision. Section 5.0 provides a description of the Adaptive Management Plan that will guide implementation of tidal restoration. Section 6.0 provides information on Project budgeting and funding. Section 7.0 provides a complete list of references used in the development of the application. Section 8.0 contains documents referred to throughout the application including a Programmatic Agreement between the NPS and State Historic Preservation Office, Herring River Adaptive Management Plan, project chronology, letters of support, and design plans for tide control elements and mitigation.

3. Detailed Project Description

3.A Overview

The Herring River system is one of the largest tidally-restricted estuaries in the Northeast. The Herring River estuary encompasses a nearly 1,100-acre floodplain and more than 11 miles of waterways. Historically, the river supported a vibrant tidal river ecosystem and one of the largest nurseries for commercial and recreational fish and shellfish on Cape Cod. The 1909 construction of a 900-foot earthen dike and tide control structure across the main entrance to Herring River created the tidal restriction and ensuing environmental degradation. The Town of Wellfleet, Barnstable County, Massachusetts, and the National Park Service (NPS) propose to restore natural tidal wetland habitats to large portions of the Herring River estuary in and adjacent to Cape Cod National Seashore (CCNS), by re-establishing tidal exchange to the river and its connected sub-basins.

Due to a more than a century of tidal restriction, approximately 10 acres out of the original 1,100 acres of salt marsh remain. The Herring River Restoration Project (Project) represents a unique opportunity to restore a significant native tidal marsh system and the many ecological and community benefits a healthy estuary provides to surrounding communities and the region.

The Project will reconnect Herring River with Cape Cod Bay and the Gulf of Maine, thereby restoring the natural coastal food web that numerous fish, shellfish, birds and other wildlife depend on for their survival. Restoring the estuary is an important step to increase fish populations and enhance the region’s commercial and recreational fisheries and shellfisheries. The Project is based on leading-edge estuarine science and will serve as a model for restoring other estuaries in Massachusetts and along America’s coasts.

Increased tidal exchange will be achieved by replacing a portion of the Chequessett Neck Road dike with a new water control structure with tide gates to reconnect the Herring River estuary to Wellfleet Harbor and Cape Cod Bay. Additionally, new water control structures with tide gates will be constructed to control tides in the Mill Creek and Upper Pole Dike Creek sub-basins (See Figure 3-1). Tidal exchange will be increased incrementally over time, using an adaptive management process (See Section 5 and Section 8.B.) Marsh management (e.g., channel clearing to improve drainage and sediment supplementation to elevate substrate) and vegetation management activities also are proposed to enhance restoration.

3.A.1 History of Degradation

Historically, the Herring River was the largest tidal estuary complex on the Outer Cape and included about 1,100 acres of salt marsh, intertidal flats, and open-water habitats (HRTC 2007). The Herring River system was dramatically altered in 1909 when the Town of Wellfleet constructed the Chequessett Neck Road dike at the mouth of the Herring River with the goal of reducing the presence of salt marsh mosquitoes. The dike restricted tides in the Herring River and reduced the tide range from approximately 10 feet on the downstream harbor side to about two feet upstream of the dike. By restricting the flow of ocean tides and salt water, the dike had immediate and devastating effects on the tidal system and the community benefits provided by the river and its associated estuarine wetlands.

By the mid-1930s, the Herring River, now artificially altered from a saltwater to mostly a freshwater system, was channelized and straightened. Between 1929 and 1933, the Chequessett Yacht and Country Club (CYCC) constructed a nine-hole golf course in the adjoining Mill Creek floodplain. Several homes were also built at low elevations in the former Herring River floodplain.

By the 1960s, the dike's original tide gates had rusted (frozen) in an open position, increasing tidal range and salinity in the lower Herring River. This caused periodic inundation of CYCC golf course and other private properties. In 1973, the Town of Wellfleet required that the dike be repaired to accommodate anadromous fish passage. As a result, the Massachusetts Department of Public Works rebuilt the dike in 1974 (HRTC 2007). Following reconstruction, tide height monitoring by the CCNS showed that the new tide gate opening was too small to achieve the tide heights required by the Order of Conditions issued by the Wellfleet Conservation Commission. In 1977, the Massachusetts Attorney General issued an injunction requiring the Town to cede control of the dike to the Massachusetts Department of Environmental Quality Engineering (now the Department of Environmental Protection [MassDEP]) so that increased tidal flow could be attained to the level mandated by the Order of Condition (HRTC 2007).

In 1980, a large die-off of American eels (*Anguilla rostrata*) and other fish drew attention to the poor water quality in the Herring River. The Massachusetts Division of Marine Fisheries (DMF) and NPS identified the cause of the fish kill as high acidity and aluminum toxicity resulting from diking and marsh drainage (Soukup and Portnoy 1986). The sluice gate opening was increased to 20 inches in 1983. That year, CCNS scientists documented summertime dissolved oxygen depletions and river herring (*Alosa* spp.) kills for the first time (Portnoy 1991). The NPS then implemented measures to protect river herring by blocking their emigration from upstream ponds to prevent the fish from entering anoxic waters (HRTC 2007).

Concerns about flooding of private properties and increased mosquito populations prevented the Town from opening the tide gate further. NPS mosquito breeding research conducted from 1981 to 1984 found that mosquitoes, (*Ochlerotatus cantator* and *O. canadensis)*, were breeding abundantly in the Herring River. However, estuarine fish, important mosquito predators, could not access breeding areas because of low tidal range, low salinity, and high acidity (Portnoy 1984). In 1984, the Town increased the sluice gate opening to 24 inches, where it has since remained (HRTC 2007).

In 1985, the DMF classified shellfish beds in the river mouth as "prohibited" due to fecal coliform contamination. In 2003, water quality problems caused MassDEP to list Herring River as "impaired" under the federal Clean Water Act Section 303(d) for low pH, high metal concentrations, and pathogens. More recently, NPS researchers identified bacterial contamination as another result of restricted tidal flow and reduced salinity (Portnoy and Allen 2006).

3.A.2 Cumulative Effects of Tidal Restriction

Herring River's wetland resources and natural ecosystem functions have been severely altered and damaged by more than 100 years of tidal restriction and salt marsh drainage caused by the existing CNR dike. A range of water quality and other ecological problems will continue until the Project reconnects the river and wetlands with the marine environment. The evidence of these problems include:

- Massachusetts DEP has designated Herring River as an "Impaired Water" in violation of Clean Water Act standards for high aluminum, low pH, high fecal coliform bacteria and a fish passage barrier.
- Water quality in the river is impaired year-round. Data measured by the US Geological Survey over multiple years show that dissolved oxygen in river water regularly falls below established thresholds for causing stress and mortality for fish and other aquatic life.
- The Massachusetts DMF has designated the CNR dike as a point source of bacterial contamination, resulting in the closure of once harvestable shellfish beds upstream and downstream of the dike due to poor water quality.
- Tidal restriction, along with stream channelization and ditch drainage, has lowered water levels above the dike causing the marsh plain to sink 2-3 feet. Because tidal restrictions radically affect the processes of sedimentation on the salt marsh surface and the accumulation of belowground organic material (peat), much of the diked Herring River floodplain has subsided up to three feet relative to current mean sea level (Portnoy and Giblin 1997). Coastal marshes must increase in elevation at a rate equal to or greater than the rate of sea-level rise to persist. This increase in elevation (accretion) must occur to promote the growth of salt marsh vegetation and gradually increase the elevation of the marsh surface. Diking has effectively blocked sediment from reaching the Herring River floodplain and prevented necessary accretion. In addition, drainage has increased the rate of organic peat decomposition by aerating the sediment and caused sediment pore spaces to collapse. These processes have contributed to the severe historic and continuing subsidence in the Herring River's diked wetlands.
- Prolonged exposure of drained salt marsh peat to air causes it to decompose and release sulfuric acid into surrounding soils and receiving waters. Acid sulfate soils are a major problem covering hundreds of acres of original Herring River marshes. Absent regular saturation by salt water, these soils leach toxic acidity and aluminum into remaining surface water, killing aquatic animals.
- Coastal resiliency has been diminished due to alteration of natural sediment processes and salt marsh surface subsidence.
- Elimination of tidal flooding and salinity has resulted in a loss of salt marsh and other forms of estuarine habitat. As noted above, approximately 10 acres out of an original 1,100 acres of salt marsh remain.
- Lower salinity and loss of estuarine vegetation has allowed non-native *Phragmites* to invade the salt marsh above the dike, and upland shrubs and trees to invade above High Toss Road, where water levels rarely reach the original marsh surface.
- Changes in marsh vegetation have led to an increase in methane-emitting ponded freshwater wetlands and a reduction in carbon-storing tidal wetlands, contributing to a net warming effect on the climate.

- River herring and other anadromous fish species that once thrived in the river have been depleted due to poor water quality and obstructions to migratory passage.

Fortunately, the damaging environmental effects of disconnecting the river from the marine environment can be reversed over time with the return of tidal flow. As described below, the Town of Wellfleet and the CCNS have developed a restoration plan to reverse the degraded conditions in the Herring River system.

3.A.3 Local Project Governance

A local project governance structure has been established to oversee Phase 1 restoration and ensure compliance with regulatory requirements and permit conditions, including adherence to maximum water levels. The Town of Wellfleet and CCNS recently entered into a new Memorandum of Understanding (MOU IV in 2019) to provide the management framework for implementation.[1]

MOU IV sets forth the structure and decision-making process for the Project. MOU IV establishes a Herring River Executive Council (HREC) consisting of three members from Wellfleet and two from CCNS to be responsible for approving all major Project implementation decisions and activities. The HREC's responsibilities include, but are not limited to, establishing and providing policy direction; reviewing and approving the Project's Adaptive Management Plan; monitoring Project progress; modifying or altering Project infrastructure water control structure openings (after receiving technical input from the members of the Herring River Technical Team (HRTT)), and ensuring that the Project complies with applicable regulations and laws. The HREC members have been appointed, and will continue to meet as needed during the permitting and construction phases.

The HREC is the entity responsible for implementation decision-making during Phase 1 restoration. The HREC may seek input from various sources, including, but not limited to, the HRTT. Current participants in the HRTT include the Town of Wellfleet, National Park Service, U.S. Fish and Wildlife Service, National Oceanic and Atmospheric Administration, USDA/Natural Resources Conservation Service, and Massachusetts Department of Fish and Game - Division of Ecological Restoration. MOU IV also identifies the Herring River Stakeholder Group (HRSG) as a source for advisory input on Project implementation issues. HREC meetings are also open to the public and the HREC will consider public comment in its decision-making.

Among its responsibilities, the HREC will adopt a tide gate management policy to achieve Phase 1 restoration, after receiving technical input from the members of the HRTT. The tide gate management

[1] The Towns of Wellfleet and Truro and the Cape Cod National Seashore (CCNS) entered into successive memoranda of understanding (MOUs) to study the feasibility of restoration (MOU I in 2005), develop a conceptual restoration plan (MOU II in 2007) and agree to implement the restoration plan (MOU III in 2016). Truro is not a party to the superseding MOU IV and has adopted a new role as an interested municipal stakeholder fully supporting the ecological restoration objectives of the Project.

policy will include protocols for ongoing restoration activity and for assessing possible responses during emergency storm events. The policy will set forth proposed tide gate configurations and other management actions and identify the parties responsible for each action. The policy will ensure adherence to environmental permit conditions and the operation and maintenance requirements for each structure. It is envisioned that an initial tide gate management policy of sufficient detail will be included in wetlands permit applications.

Once the HREC has approved a tide gate management policy, it will designate the parties responsible for: (1) coordinating with the NPS and Town to carry out authorized actions and (2) analyzing, compiling, and summarizing monitoring data, modeling output, field observations, and other information. During this process, members of the HRTT will provide ongoing advisory technical input to the HREC. Third-party organizations may be engaged to implement approved management actions, field monitoring, data analysis, and public outreach activities.

MOU IV also confirms that CCNS and the Town of Wellfleet, respectively, will continue to own the infrastructure they own today or to be built on land they each own. For example, Mill Creek water control structure and Way 672 tide barrier will be built on CCNS property and owned by NPS. The Chequessett Neck Road and Pole Dike Road water control structures, and the elevated road segments and culverts in Wellfleet will be owned by the Town of Wellfleet. Owners will have long-term responsibility for infrastructure maintenance. In accordance with MOU IV, the owners of the different elements of Project infrastructure may engage the services of third-party entities to construct, operate and maintain Project infrastructure, or perform these functions themselves. The owners also agree to work cooperatively to ensure compliance with all permit conditions, noticing requirements and other environmental compliance obligations.

3.A.4 Extensive Project Benefits

The Herring River Restoration Project is the result of rigorous scientific study, extensive stakeholder involvement and public discussions with local leadership. A strong commitment to local engagement has marked the decade-long journey from idea to concept, and from concept to design. Project planning and evaluation began in 2005 and has included more than 50 community meetings and presentations, 100 one-on-one meetings with property owners, 125 technical meetings with project technical team members and consultants, and Town and NPS staff. A chronology of events in the community-based restoration effort is presented in Section 8.F. This outreach has helped to build strong, broad based support for the Project, evidenced by the support letters also found in Section 8.G.

The community commitment and broad-based support of the Project stem from the extensive ecological and community benefits that the return of tidal flow to the Herring River system will generate including, but not limited to:

- Reconnecting the Herring River estuary to Cape Cod Bay and the Gulf of Maine to recover the estuary's functions as: (1) a nursery for marine animals, and; (2) a source of organic matter for export to near-shore waters.

- Restoring the natural coastal food web to support numerous fish and bird species and other wildlife that depend on healthy coastal marsh habitats and processes for their migration and survival.
- Reopening waterways to improve migration and spawning for a variety of fish species including River Herring, American Eel, Striped Bass and Winter Flounder, as well as Diamond-back Terrapin.
- Enhancing habitat to increase local fish production; and remove physical impediments to migratory fish passage to restore once-abundant river herring and eel runs.
- Protecting and enhancing harvestable shellfish resources both within the estuary and in receiving waters of Wellfleet Harbor. Re-opening and expanding shellfish beds will benefit the local economy; in 2018 the shellfish harvest in Wellfleet was valued at $7.2 million. Shellfish habitat restoration will also help to sustain local shellfishing jobs, which are estimated to number 400-450.[2]
- Enhancing coastal resiliency by restoring normal sediment deposition needed to allow the marsh to gain elevation and mitigate impacts of sea level rise, and by constructing state-of-the-art tidal control infrastructure to protect low-lying roads and other structures.
- Re-establishing the estuarine gradient of native salt, brackish, and freshwater marsh habitats in place of the invasive non-native and upland plants that have colonized most parts of the degraded floodplain.
- Enhancing opportunities for canoeing, kayaking, and wildlife viewing over a diversity of restored wetland and open-water habitats including 6 miles of waterways for recreation and tourism. Tourism accounts for nearly $11 million annually to the local community and supports jobs.
- Generating approximately $624 million in local and regional economic benefits over the life of the project based on economic studies of other coastal restoration projects.
- Combating climate change by returning lost carbon storage volume and reducing methane emissions from deteriorated salt marsh. A preliminary estimate indicates that, since the CNR dike was built in 1909, the Herring River has emitted 730,000 metric tons of CO^2 equivalents, comparable to emissions from 155,000 US autos operating for one year.[3]
- Re-establishing the natural control of nuisance mosquitoes by restoring tidal range and flushing to conditions that are not conducive to mosquito habitat, and by increasing access for fish that prey on mosquito larvae. Another unfortunate consequence of the 1909 diking of Herring River has been to increase freshwater swamp habitat suitable for the mosquito species more likely to carry viruses. Restoration of tides and salty water will replace much of this habitat that is conducive to virus-bearing freshwater mosquitoes with healthy salt marshes throughout much of the estuary.

3.A.5 Science-based Plan Presented for DRI Approval

The Project is the result of more than three decades of scientific study including more than 230 technical

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[2] Civetta, Nancy. Wellfleet Shellfish Department. Presentation to Herring River Stakeholder Group. November 6, 2019.

[3] Kroeger, KD, Gonneea, ME, et al. 2019. Climatic impacts of tidal restriction and restoration: Full carbon and greenhouse gas budgets, with radiative forcing calculations. Society of Wetland Scientists Annual Meeting, Baltimore, MD.

studies, peer-reviewed scientific articles, and other data sources, which are listed on twenty-two pages contained in the Final Environmental Impact Report (FEIR), and a decade of stakeholder engagement. Strong technical direction and technical input from dozens of national experts in environmental management and estuarine science have shaped the Project.

Hydrodynamic modeling studies by the consulting firm Woods Hole Group form the basis of design requirements for the overall restoration program, including the need for infrastructure modifications and additions to protect existing infrastructure and structures from increased water levels. The primary flood protection objective is to prevent adverse flooding impacts to the built environment from increased water levels throughout the Project area, including during storm events. All flood protection mitigation measures have been designed to prevent impacts up to the modeled storm-of-record tidal surge with appropriate freeboard.[4] This storm surge has only been sustained through multiple tide cycles once, during the blizzard of 1978, and thus is a very conservative flood protection design standard.

In 2016, the Project obtained federal and state approvals of its FEIR developed in accordance with the National Environmental Policy Act (NEPA); NPS Director's Order 12; and the Massachusetts Environmental Policy Act (MEPA). The FEIR selected a preferred alternative for the Herring River Restoration Project. The selected alternative is supported by extensive assessment of existing conditions as well as modeling and predictions for restored ecological conditions. The scientific basis for the FEIR was largely drawn from a series of studies conducted by NPS researchers and others, beginning in the 1980s and summarized in the Herring River Conceptual Restoration Plan in 2007. A two-dimensional hydrodynamic model was developed that established the feasibility of tidal restoration and analyzed the effects of restoring tidal flow to different parts of the estuary. This included three different scenarios for sea level rise over the next 50 years and analysis of numerous combined storm events. The model was also used to develop and analyze alternatives for the FEIR based on balancing degrees of tidal restoration with necessary measures to prevent inundation of structures. Since the completion of the FEIR, the Town, CCNS and others have engaged additional input from stakeholders, abutters, and technical experts, which has helped to refine Project plans.

Because the Project was required to prepare an EIR under MEPA, the Project requires review before the Cape Cod Commission as a DRI.

The Town now seeks DRI authorization to implement all Phase 1 project elements and associated mitigation as described in this application. On March 7, 2019, the Commission issued a Development of Regional Impact Scoping Decision "establishing the goals and objectives from Section 6 of the 2019 RPP

[4] The storm-of-record refers to a model simulation of the significant coastal flooding event in February 1978 (Woods Hole Group (WHG), 2012). It should be noted that the storm-of-record has no correlation to the FEMA Flood Insurance Rate Map 100-year event (1% annual probability of occurrence). FEMA-predicted flood levels during the 100-year storm event are at elevations ten feet to 13 feet throughout the Project Area. The current CNR dike is not a FEMA-designated flood control structure and the redesigned structure will likewise not be a FEMA-designated flood control structure. For these reasons, the Project will have no effect on the FEMA-predicted 100-year flood elevations or the extent of the 100-year FIRM flood plain within the Herring River basin. See Section 4.2.E for more discussion.

[Regional Policy Plan] that will be considered by the Commission during DRI review in determining the Project's consistency with the 2019 RPP." The application responds to the scope of review set forth in the Commission's March 7, 2019 decision.

Since the Commission began its review of the Project during the MEPA process, the Project has evolved in ways that provide greater protection of floodplain properties and structures. The scope of the Project has been further defined, detailed plans have been developed for measures to protect public and private structures, and further discussions and agreements with property owners have taken place.

3.A.6 On-going Monitoring and Adaptive Management

The proposed adaptive management plan is a rigorous science-based process of predicting system responses to restoration actions; monitoring system conditions before, during and after management actions are implemented; comparing the predicted and observed system responses to update the understanding of the system response to management actions; and using the results to inform and refine management actions. Information obtained from monitoring improves the ability to predict future outcomes and make better 'adaptive' decisions regarding the selection of appropriate management actions throughout the course of implementation.

Extensive monitoring is underway or is being planned to document baseline conditions and, once implementation begins, measure ongoing system responses to restoration of tidal flow. Table 8B-1 found in Section 8.B of this application provides a summary of the performance measures, prediction tools and monitoring methods that will be employed for each restoration objective and sub-objective.

By way of example to demonstrate how achievement of a particular restoration goal will be monitored, shellfish issues are described below.[5] Restoration objectives include maximizing habitat quality for native estuarine animals, including shellfish, and also minimizing adverse impacts to shellfish beds in Wellfleet Harbor. Extensive monitoring will occur during implementation to measure enhancements to shellfish resources and to protect against unanticipated impacts to shellfish resources. Monitoring activities have been presented in multiple public forums co-sponsored by FHR and the Wellfleet Shellfish Advisory Board.[6]

Recent and ongoing monitoring efforts to address shellfish habitat objectives are described below. Each of these, along with additional work that is still under consideration, will continue or will be repeated at the appropriate stage after the restoration project begins.

- National Seashore Monthly Water Quality Monitoring: Since 2005, scientists from the National Seashore have sampled water quality at 6 - 11 stations from Route 6 to Wellfleet Harbor each month. Variables analyzed include dissolved oxygen, pH (acidity), nitrogen, phosphorus, silica, iron,

[5] Monitoring efforts for other restoration objectives and sub-objectives are summarized in Table 8B-1 of the Herring River Adaptive Management Plan, found in Attachment 8.B.
[6] Video recordings of these meetings can be seen at http://www.friendsofherringriver.org/Videos.

chlorophyll, and suspend sediment. The data provide a long-term trend of water quality throughout the Herring River floodplain.

- Continuous Real-Time Water Level and Water Quality Network: In 2017 Friends of Herring River installed 5 stations (4 in Herring River, 1 in Wellfleet Harbor) equipped with instruments that measure water level, salinity, temperature, dissolved oxygen, and pH at 15-minute intervals. The data provide both long-term trends (months to years) and short-term changes (hours to days) at each location. Data can be viewed on a public website to allow anyone to track changes as the Project is implemented. (https://v2.wqdatalive.com/public/820)

- 2013-2015 Water Quality and Estuarine Habitat Assessment from High Toss to the Harbor: The National Seashore conducted two studies between 2013 and 2015; one to assess movement of nutrients, carbon, and sediment in the downstream and upstream reaches of the river, and the other to study baseline inventories of benthic invertebrates and food webs. These studies provide information on nutrient status and particle movement from the river to the harbor and will be repeated as the restoration project is implemented. A NPS publication documenting this work is under review.

- USGS Water Quality Monitoring: The U.S. Geological Survey collected data at the Chequessett Neck Road dike from 2015 into 2018. Data collection will be reinitiated in 2020. This study uses an automated device to sample water passing through the dike during ebb and flood tides to separately analyze water moving in and out of the river and during varied tidal events. Samples are analyzed for nutrients and suspended sediment. A USGS report covering data collected so far is currently under review and will be released in 2020.

- Surficial Sediment Samples in Aquaculture Areas: Samples of the top 2-3 inches of sediment were taken at multiple sites near Mayo Beach, Egg Island, and Powers Landing by National Seashore scientists in 2006, 2010, and 2017. The samples analyzed the percent of organic material and the amounts of fine and coarse sediment. Describing these baseline sediment characteristics of Wellfleet Harbor is key to understanding current sedimentation trends to inform how the system may respond to reconnection with the Herring River.

- Harbor Sediment and Bathymetric Mapping: In 2019 the National Seashore, Friends of Herring River, and Center for Coastal Studies began a multi-parameter study to describe the sediment characteristics and seafloor elevation in aquaculture areas close to the river. This study involves high resolution and highly accurate data obtained by GPS-based ground survey, drone-based aerial photography, and boat-based side-scan sonar. The data product will be a detailed map of the area depicting bottom elevations, channel dimensions, tidal shoals, and flats that will show how Wellfleet Harbor changes from season-to-season and as the restoration project is implemented.

- Characterization of Herring River Sediment: Similar to the harbor mapping project, the National Seashore is examining sediment from the river and floodplain upstream of Chequessett Neck Road and is surveying elevations across the marsh to understand the pre-restoration conditions and assess how sediment may migrate throughout the system when the restoration project is underway.

- Fecal Coliform: National Seashore and cooperating scientists collected data that were published in 2009 that documented how the restoration project would improve water quality in shellfishing areas that are now closed to harvest due to bacterial contamination. The sampling conducted for this research will be repeated at least once prior to the beginning of the restoration project and will be repeated again throughout the implementation period to quantify and confirm the conclusions cited in the publication (Portnoy and Allen 2009).

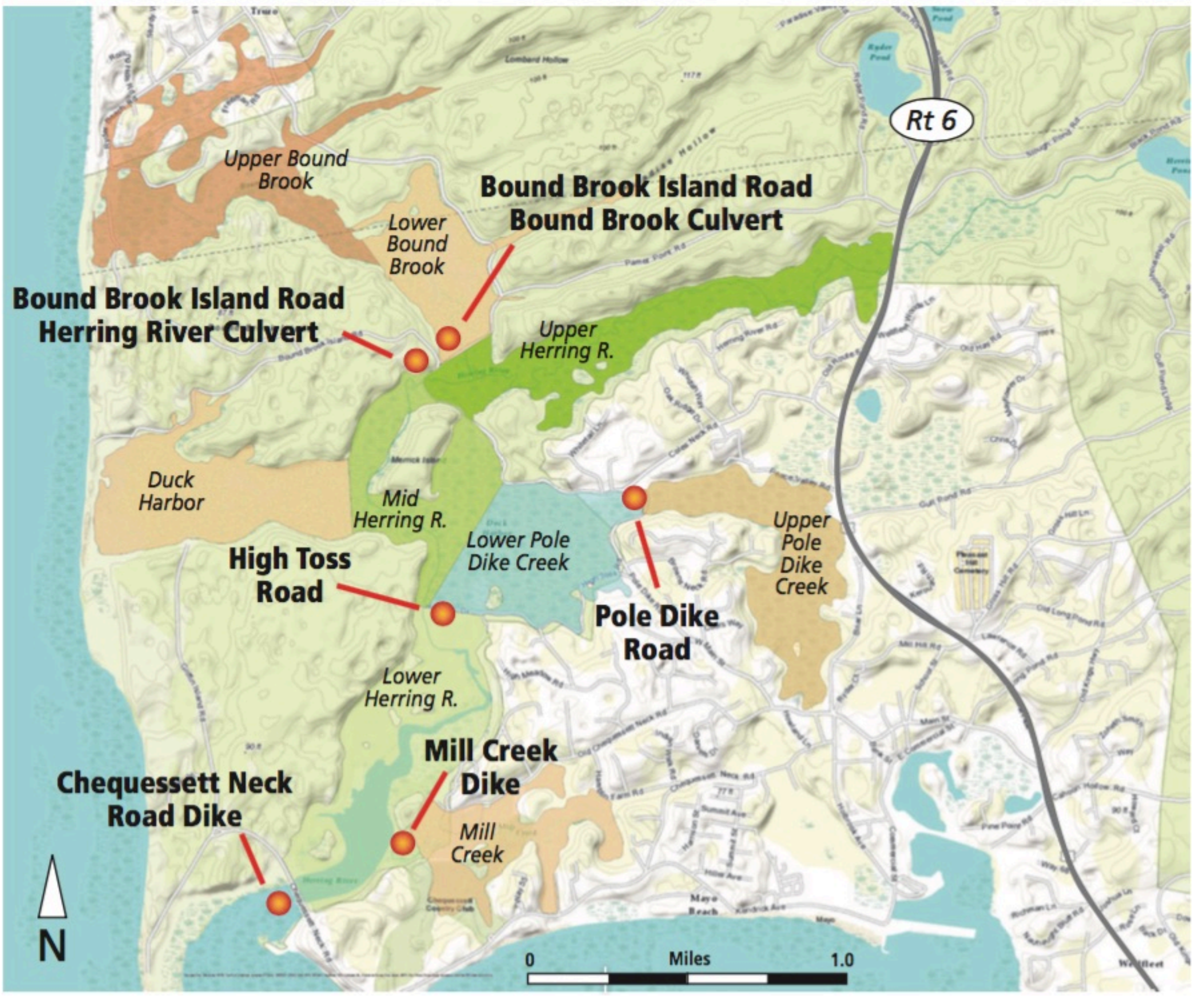

Figure 3-1. Project Features and Herring River Sub-basins

Chequessett Neck Road and Pole Dike Road water control structures are to be owned by Town of Wellfleet. Road/culvert work is on roads owned by either Town of Wellfleet or Town of Truro. Mill Creek Water Control Structure is to be owned by NPS.

3.B Project Elements and Phasing

The Town of Wellfleet is seeking a DRI permit to implement Phase 1 of the restoration: 1) **tide control elements** to construct or retrofit water control structures or remove restrictions in order to incrementally restore and control tidal exchange; 2) **mitigation measures** to prevent impacts to public or private structures resulting from restored tidal flow, and 3) **vegetation and marsh management measures** implemented within the Project area to maximize the benefits of restored tidal flow and enhance estuarine habitats. This section starts with a discussion of project phasing, and then describes the three types of elements necessary to proceed with Phase 1.

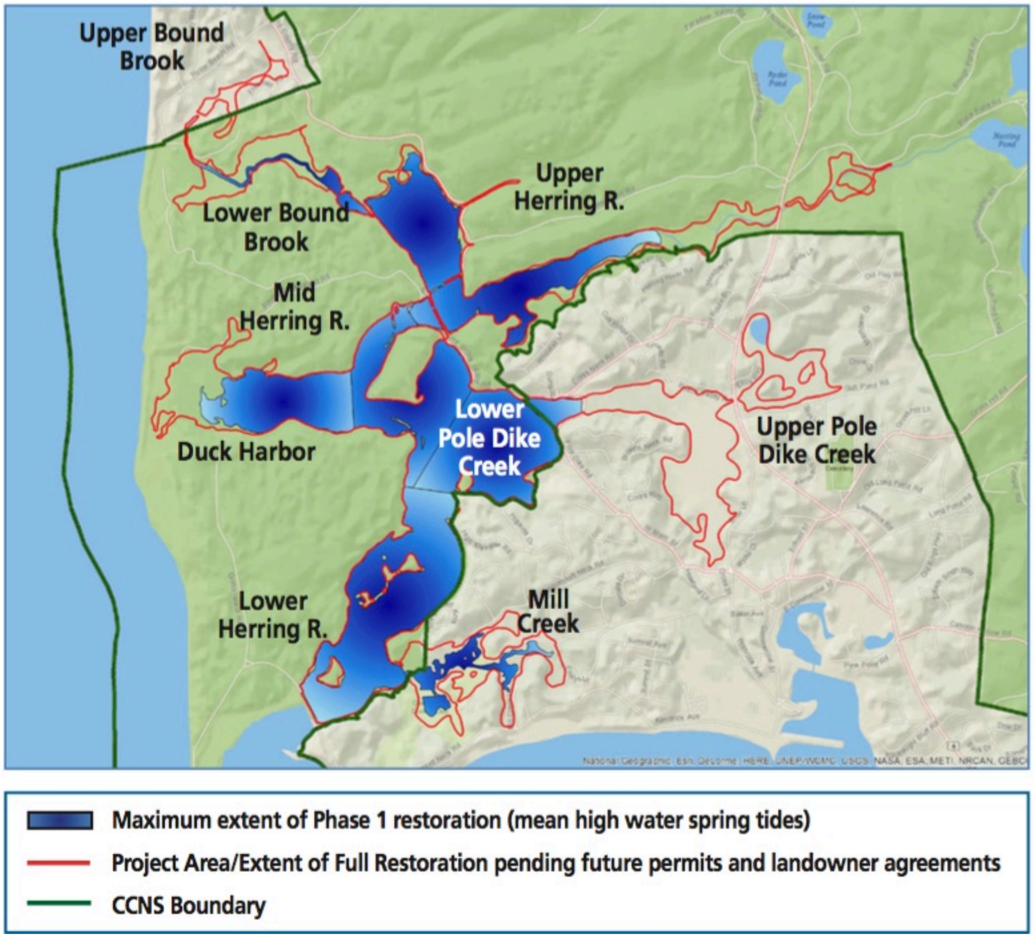

Figure 3-2. Extent of Herring River Restoration Project, Phase 1

3.B.1 Phasing

The Project's MEPA certificate contemplates that the Project restoration will occur in phases. The environmental permit applications presently being developed seek approval to implement Phase 1 of the Project. Any proposed future increases in water levels beyond those approved in permits for Phase 1 would require permit amendments or new permits—with full regulatory review and opportunities for public input—as well as agreements with property owners for any necessary measures to protect structures from the effects of tidal restoration.

3.B.1.1 Phase 1

Phase 1 of the Project proposes to restore up to approximately 570 acres of tidal wetlands (Figure 3-2). During Phase 1, the new Chequessett Neck Road Bridge and tide gates and the Mill Creek water control structure will eventually be configured to allow partial tidal flow into Herring River and Mill Creek up to a maximum water level specified for each respective basin. Thus, Phase 1 includes partial restoration of tides in the Mill Creek sub-basin following implementation of mitigation measures designed to prevent tidal water intrusion impacts to the CYCC golf course resulting from the Project. Tidal flow in Mill Creek will be managed by tide gate settings at the Mill Creek water control structure so that water levels will not impact any private structures. Phase 1 will exclude tides from the Upper Pole Dike Creek sub-basin to protect several low-lying private properties that would require mitigation measures to prevent tidal flow impacts. The Pole Dike Creek crossing will be equipped with tide gates that allow unidirectional flow (drainage only) while preventing any tidal flow from entering Upper Pole Dike Creek basin as a result of Phase 1 restoration. Maximum water levels in all areas of the estuary affected by Phase 1 tidal restoration will be kept below elevations that could impact any structures that are not protected by Phase 1 flood protection measures. As noted above, water levels will be continuously monitored throughout the system using an established Continuous Real-Time Water Level and Water Quality Network. If data show that water levels are higher than anticipated levels during early stages of restoration, this could be addressed by slowing the pace or reducing the size of tide gate openings, or closing gates entirely. Such actions would reduce the tide range as management alternatives are evaluated.

Predicted mean water surface elevations in each sub-basin at the end point of Phase 1 are presented in Table 3-1 below. These water surface levels were established using multiple hydrodynamic modeling scenarios to determine the maximum Phase 1 area of restoration that can be achieved while preventing impacts to unprotected structures. The overall Phase 1 restoration objectives will be achieved by the following actions:

- Opening tide gates (i.e., number of gates opened and size of openings) on the new Chequessett Neck Road Bridge. Under Phase 1, mean high water will be increased to a maximum level of 3.6 feet NAVD88 in the Lower Herring River, which will restore approximately 570 acres. The tide gates will be opened incrementally over a number of years while careful monitoring of ecosystem responses is undertaken, and may be closed at any time if conditions warrant.

  The mean high water (MHW) value of 3.6 feet NAVD88 was based on the current 19-year tidal epoch and determined using the hydrodynamic model (Woods Hole Group, 2012) for a specific gate configuration representing the Phase 1 endpoint. This predicted value of MHW represents the condition at the endpoint of Phase 1. It is expected that there would be numerous other restoration steps in the adaptive management process with MHW values less than 3.6 feet NAVD88. The water levels in Lower Herring River will be continuously monitored throughout the restoration project and short-term tidal benchmarks will be computed and updated for each month for a given gate configuration. As noted above, monitoring equipment used to measure water levels in the lower river and Mill Creek is already in place and data can be viewed in real-time.[7]

- Restoring approximately 21 acres (included in the 570 acres noted above) in the Mill Creek sub-basin with a water level of 2.5 feet during Mean High Water Spring (MHWS).[8] Hydrodynamic

[7] Ibid.
[8] Mean High Water Spring is a defined tidal datum that is the average of the successive pair of highest tides during spring tide range. This value was determined using the hydrodynamic model (Woods Hole Group, 2012) for the

modeling projections indicate that for normal tides concurrent with a 100-year rainfall event, the peak water surface elevation would be 3.1 feet, and for a 10-year storm surge concurrent with a 100-year rainfall event, the peak water surface elevation would be 3.7 feet. This theoretical peak water surface elevation of 3.7 feet for a combined 10-year storm surge/100 year rainfall event has never been recorded. Even if it were to occur, this water surface elevation would not adversely affect any structures in the Mill Creek sub basin.[9]

- Drainage will be significantly improved during Phase 1 by clearing channels to remove accumulated sediment in Mill Creek and by other measures that decrease low tides in the main river basin.
- No tidal restoration is proposed for the Upper Pole Dike Creek sub-basin under current permit applications for Phase 1. Hydrodynamic models show that Phase 1 Project implementation will not cause an increase in peak water levels over existing conditions during combined tidal surge and precipitation storm events. At full Phase 1 tidal flow, the peak water level during a combination 10-year storm and 100-year precipitation event is 2.9 feet in Upper Pole Dike Creek, which is the same as existing conditions for a 100-year precipitation event (storm surge would not reach Upper Pole Dike Creek under existing conditions.) Drainage data collected from Upper Pole Dike Creek indicated that the peak of the surge and the precipitation would not occur at the same time. This information was incorporated into the model to produce the water surface elevations for the combined events. The tide control at Pole Dike Road and improved drainage in Lower Pole Dike Creek will lower the mean water surface elevation before the storm to a lower starting point, providing more volume of water storage in Upper Pole Dike Creek than is presently available.
- Maximum water levels (including under storm conditions) during Phase 1 will be kept below the elevation of the lowest-lying unprotected structure. Once implementation begins, hydrodynamic models will be updated based on continuous monitoring of water levels as the tide gates at the Chequessett Neck Road Bridge are opened incrementally. This will allow ongoing hydrodynamic model refinement during the early stages of tidal restoration to verify that the permitted maximum Phase 1 water levels for the main Herring River basin correspond with observed conditions.

If, during the early stages[10] of Phase 1 tidal restoration, refined modeling indicates that the permitted maximum Phase 1 water levels for the main Herring River basin could cause water levels anywhere in the Project area to exceed elevations of the lowest low-lying structures, proactive adaptive management actions will be implemented to prevent impacts. Adaptive management actions could include reducing the permitted maximum Phase 1 water levels allowed in the main Herring River basin by closing tide gates, drainage improvements within sub-basins, and/or additional on-site mitigation for low-lying structures (such as raising structures or constructing berms). Refined modeling results and

current 19-year tidal epoch.

[9] The combination of precipitation and surge conditions used in this analysis have never occurred in the observed historic record. This indicates the extreme nature of the conditions being considered and the overall conservative nature of the assessment. It is likely that these combination conditions may never occur. (Woods Hole Group, 2017)

[10] The duration of the first stage of Phase 1 restoration depends on multiple variables related to system response to restoration and adaptive management decisions made during implementation.

adaptive management actions will be determined and implemented (if necessary) during the early stages of Phase 1 tidal restoration, well before water levels have any potential to impact low-lying structures.

Table 3-1. Average Water Elevations under Maximum Phase 1 Restoration Conditions by Sub-basin

Sub-Basin	Phase I		Full Restoration		
	Mean High Water Spring		Mean High Water Spring		Storm-of-Record
	Average Water Elevation (feet)	Area (acres)	Average Water Elevation (feet)	Area (acres)	Area (acres)
Lower Herring River	4.2	147	5.6	156	165
Mid Herring River	3.4	84	4.5	87	73
Lower Pole Dike Creek	3.8	103	4.8	106	146
Upper Pole Dike Creek	N/A	0	4.1	92	120
Mill Creek	2.5	21	4.7	71	80
Duck Harbor	3.5	68	4.3	108	119
Upper Herring River	3.0	68	3.4	103	132
Lower Bound Brook	2.5	63	4.2	71	86
Upper Bound Brook	2.4	12	2.9	56	148

This application and other local, state and federal permit applications being developed for the Project seek authorization to implement Phase 1 of the restoration. Any increase in tide levels beyond the levels specified in Phase 1 permits would require permit amendments or new permits, and would be subject to agreements with landowners for any measures necessary to protect structures from the effects of tidal restoration.

3.B.1.2 Potential Future Phases

Future phases may propose to increase water levels above the maximum water level authorized in Phase 1 and may include increasing/initiating tidal restoration in the Mill Creek and Upper Pole Dike Creek sub-basins. Any future proposals to increase water levels above the maximum water level authorized in Phase 1 will require permit amendments or new permits as well as consent of property owners for site-based mitigation of potential structural impacts.

3.B.2 Tide Control Elements

Phase 1 of the Project will involve construction of all major water control infrastructure and allow tidal restoration to nearly two-thirds (570 acres) of the full restoration area (890 acres), while minimizing effects on private land. The extent of Phase 1 restoration is shown in Figure 3-2. Approximately 540 acres or 95% of the Phase 1 restoration area is within the CCNS and owned by the NPS.

For the purposes of this DRI application, the project site consists of the parcels within the limits of disturbance for the construction of three water control elements:

- The existing Chequessett Neck Road water control structure (replacing a portion of the dike with a new bridge and tide gates);
- High Toss Road (removing the portion that crosses the estuary and blocks tidal flow; and
- Pole Dike Creek water control structure where it crosses Pole Dike Road (installing a tide gate).

These three water control elements are described in further detail below. Plans showing existing conditions and proposed limits of disturbance for the project elements are provided in Section 8.H.

A fourth water control measure, the Mill Creek water control structure, is not subject to Cape Cod Commission Act review because construction of the water control structure by NPS on federal land constitutes a purely federal activity. Moreover, the federal government will retain ownership of the structure once built. Pursuant to fundamental principles of federal supremacy and sovereign immunity, such federal activities are not governed by state or local regulations absent an explicit waiver by Congress of sovereign immunity. Accordingly, NPS will pursue all permits for this structure that are applicable. However, to provide a full picture of the restoration project, the Mill Creek water control structure is described herein.[11] The Mill Creek, Chequessett Neck Road and Pole Dike Road water control structures will be constructed and operable when restoration commences.

The limits of disturbance include the footprint of the respective water control element and any ancillary area necessary during construction (i.e., staging areas). The limits of disturbance for the Chequessett Neck Road Bridge and High Toss Road tide control elements consist entirely of land owned by either the Town of Wellfleet or National Park Service. The Pole Dike Creek element will have impacts beyond the Right-of-Way that will require temporary and permanent easements; the need for easements has been discussed with owners of the affected properties, each of whom has provided written consent to show work on their property on permit applications. The limits of disturbance are distinguished from areas of mitigation activity adjacent to or in the vicinity of the water control elements, which include measures such as road elevation/culvert enlargement work, or marsh/channel work, necessary to enhance the restoration process and protect public and private structures from damage resulting from the return of

[11] Other aspects of the Project on federal land or involving NPS are subject to Cape Cod Commission Act review because either: (1) Principles of federal supremacy do not govern because the action is not a purely federal activity on federal land, but rather an activity undertaken by a non-federal entity to improve a non-federally owned structure (e.g., Chequessett Neck Road bridge) or right-of-way (e.g., road elevation work on town roads), even where the structure or right of way is otherwise on federal land or (2) a purely federal activity on federal land must nevertheless comply with state or local requirements because Congress has explicitly waived sovereign immunity with respect to the particular type of regulation or activity (e.g., under the Clean Water Act, Congress has waived sovereign immunity with respect to regulations addressing solely water quality; accordingly, some federal activities such as vegetation management or channel clearing are subject to state and local laws that regulate water quality).

tidal flow. The Commission's review may encompass tide control elements, mitigation activities, and the broad regional benefits associated with the Phase 1 570-acre wetland restoration.

Additional details concerning construction sequencing and resource impacts and benefits associated with the tide control elements are addressed in Section 4.0 of this application.

3.B.2.1 Chequessett Neck Road (CNR) Bridge and Water Access Facility

The primary tide control element is the Chequessett Neck Road Bridge and tide gates. The Project will remove a portion of the existing earthen dike and three-bay culvert structure at Chequessett Neck Road, and install a 165-foot wide bridge with adjustable tide gates. The new bridge and tide gates will allow for the gradual transition from the presently restricted tidal flushing regime to conditions more closely resembling the River's natural flow prior to construction of the Chequessett Neck Road dike. The bridge and tide gate design was selected following an analysis of possible structural alternatives to replace the existing dike and tide gates and to determine which would be best suited to achieve the restoration objectives.[12]

Based on this analysis, a new pre-cast box beam bridge structure equipped with adjustable and removable tide gates was selected as the preferred design concept. This proposed structure is comprised of two outer spans of approximately 49.5 feet and one center span of approximately 66 feet, for a total hydraulic opening potential of approximately 165 feet. There would be 4-foot wide piers at both ends of the bridge separating the inner and outer spans. The number of spans and their respective lengths were determined based on relative span length ratios required by the Massachusetts Department of Transportation (MassDOT) LRFD Bridge Manual. The design includes adequately-sized stone armor embankment slope protection and channel bottom scour protection designed to resist scour and wave action. Plans for the innovative bridge/tide control structure are found in Section 8.H.

The tide control structure consists of multiple elements including: slide gates, combination flap/slide gates, and removable concrete panels. Per the management and governance principles set forth in the MEPA Certificate on the FEIS/FEIR, restoration will be achieved through incremental removal/manipulation of these gates and panels would be opened incrementally according to in the decision analysis process reflected in the Project's Adaptive Management Plan (See Sections 5 and 8.B.)

Several alternative gate types/configurations and operating scenarios were evaluated to determine the optimal number/type of gates to be constructed with the proposed structure (WHG 2013). Numerous gate types and configurations were also analyzed, each offering varied features, and functionality, and requiring varying levels of operation and maintenance. Based on the evaluation, it was determined that the preferred gate type, configuration, and operation would include:

- A total of two combination slide/flap gates (shown by the green areas in Figure 3-3). The combination gates would be six feet wide and ten feet in height (at maximum hydraulic opening) and positioned in the center span. These gates would be mounted on removable pre-cast concrete

[12] An evaluation of design options, geotechnical analyses and scour/wave analyses can be found in Appendix K of the FEIR (25% Engineering Design Report Herring River Tidal Restoration Project).

panels. The combination gates provide increased control of the low water, mean tide level, and tidal range within the Herring River system. The combination gates allow for additional flow out of the system, providing the ability for non-linear exchange of water flux that can shift the mean tide level and allow for increased drainage capacity if desired. Additionally, the two combination flap/slide gates will allow the new bridge structure to approximate existing conditions at the current dike, which consist of a single slide gate and two timber flap gates.

- A total of seven slide gates (shown by the yellow areas in Figure 3-3). The slide gates would also be six feet wide and ten feet in height (maximum hydraulic opening) and mounted on removable pre-cast concrete panels. Five of these gates would be positioned in the center span, while one gate would be contained in each of the outer spans. Although only six gates would be required, a seventh gate would be added for redundancy and in case of operation failure of one of the other primary gates. This additional gate would also allow for continued operation of a damaged or compromised gate structure that is scheduled for, or undergoing, repair or maintenance.

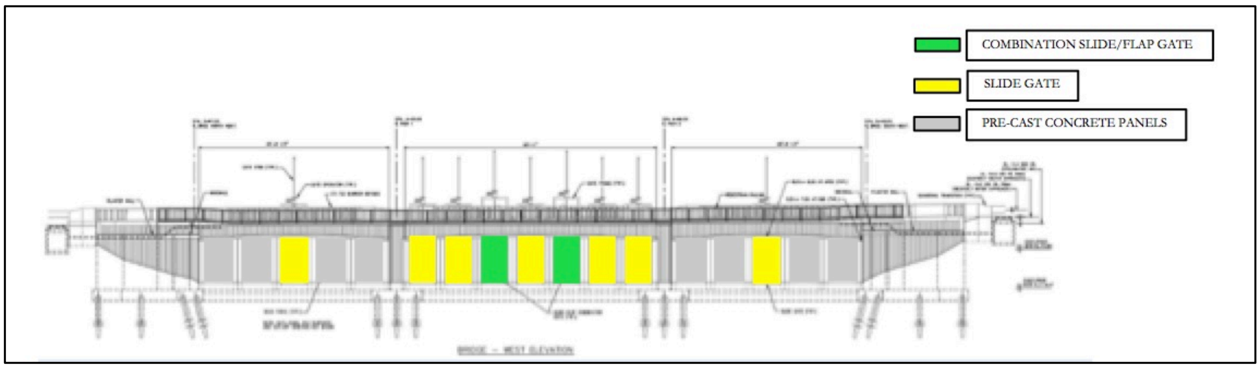

Figure 3-3. Box Beam Bridge Layout with Tide Control Structures

- A total of eight removable pre-cast concrete panels (shown by the gray areas in Figure 3-3). Each of these panels would be approximately 12.5 feet wide. There would be 4 panels in each of the outer spans.

This proposed configuration was developed by identifying the maximum and minimum water levels attainable within the Herring River system given the forcing tidal levels in Wellfleet Harbor using tidal control. The flexibility of this design model allows for any feasible water level to be attainable through the range of adjustable gate openings and/or removed panels enabled by the proposed design configuration. An Operations and Maintenance (O&M) Plan will be developed as part of final design and will be submitted in conjunction with the Notice of Intent, as required by Wetlands Protection Act regulations. An initial tide gate management policy will be submitted with the Notice of Intent, and the subsequent selection of tide gate openings will be guided by the Project's Adaptive Management Plan (see Section 5).

The new bridge will also include enhanced parking, pedestrian access, and viewing/fishing platforms, improved stormwater management, and improved aesthetics from burial of overhead utilities (See Figure 3-4 and as described in Section 4.0 of this application.)

In addition to the structural alternatives analysis that led to selection of the box beam bridge structure (FAO 2013), other aspects of bridge design evolved through an assessment of alternatives conducted with input from CCNS and Wellfleet officials and local citizens. Preliminary bridge designs were presented and discussed at public annual meetings of the Friends of Herring River in 2014 and 2015. A series of alternatives for water access and portage design elements were evaluated in light of multiple design objectives including cost, ADA accessibility, resource area impacts and visual impacts (FAO 2015). The water access and portage design alternatives were reviewed in a 2015 meeting with town Police, Fire and Public Works Departments, Selectboard members and CCNS officials for comment and selection of a preferred approach. The input from this meeting provided the project team with direction on bridge design, materials and aesthetics.

Like the existing CNR dike, the new design is not proposed to serve as a designated FEMA flood control structure (See Section 4.2.E for more discussion). The new bridge will have a final surface elevation similar to the existing dike (sloped between 11.7 and 12.6 feet, compared to the present 11.3 feet). According to the Flood Insurance Rate Maps (FIRM) released by FEMA, during 100-year storm event tides when the current CNR dike would be overtopped, floodwater also would enter the Herring River floodplain at other locations along Cape Cod Bay. Therefore, increasing the height of the Chequessett Neck Road structure would not prevent flooding in the estuary during a storm surge. Retaining the existing elevation of the roadway and structure will also preserve rural character, which was a community design objective.

Figure 3-4.Visualization of Chequessett Neck Road Bridge, looking southwest (Fuss & O'Neill)

The proposed bridge /tide gate structure has been reviewed by MassDOT and is designed to comply with the requirements of the MassDOT Load and Resistance Factor Design (LRFD) Bridge Manual and the American Association of State Highway and Transportation Officials (AASHTO) LRFD Bridge Design as well as the following design criteria:

- To serve a 75-year design life with proper maintenance;
- To minimize temporary and long term environmental impacts;
- To provide a safe and secure mechanism for adjusting and controlling flow into the Herring River;
- To allow for the reconfiguration of the bridge/gate structure to provide a maximum hydraulic opening measuring 10 feet in height by 165 feet in width;
- To provide a stream bed invert elevation of -4.0 feet;
- To provide a structure that can withstand, at a minimum, a potential sea level rise of up to 2.1 feet (the predicted maximum sea level rise over 50 years);
- To provide a structure capable of providing similar or enhanced public access;
- To provide a structure requiring minimal maintenance and low future costs; and
- To design the bridge and gate structures to withstand significant lateral loads from tidal fluctuations, storm surge events (such as the 100-year and 500-year frequency flood events), and to withstand a saltwater environment with wave action.

3.B.2.2 Removal of High Toss Road Causeway

The Herring River passes under High Toss Road, the second road that crosses the river, approximately one mile upstream from Chequessett Neck Road (Figure 3-1). The western portion of the road is an earthen berm causeway that was built across the salt marsh in the 19th century. It is unpaved and infrequently traveled by vehicles. The River passes under High Toss Road through a five-foot-diameter concrete culvert. Hydrodynamic modeling has shown that the culvert will cause a major restriction when tidal flow is increased at Chequessett Neck Road. The causeway would be overtopped daily by seawater under any restoration scenario, and would impede ebb tide drainage.

Complete removal of the earthen causeway and culvert crossing of Herring River at High Toss Road is a tide control component of the Project. A natural channel will be restored to its prior width of approximately 30 feet for tidal water conveyance.

Project proponents considered several alternatives to protect the portion of the road over the marsh surface from tidal flow. These alternatives ranged from elevating the road above the level of the predicted high tides to removing it entirely. The alternatives considered were ultimately not supported by the Wellfleet Board of Selectmen for a combination of reasons, most notably that as compared to the Project Proposal, the alternatives could not provide access for emergency response personnel, would conflict with overall restoration goals and additional environmental impacts associated with elevating the roadway, and involved increased long-term maintenance and replacement costs. The Board of Selectmen voted to abandon and not replace the earthen causeway and culvert crossing of Herring River (MOTION 216-592, May 24, 2016). Accordingly, roadbed fill and the Herring River culvert will be removed and the channel will be restored to match the natural channel width and depth above and below the roadway crossing. Further channel modifications, as may be necessary to achieve Project goals, will be carried out under the Adaptive Management Plan. Work along High Toss Road will then progress from west to east, with the fill within the floodplain of Herring River removed and stockpiled elsewhere within the work area. Fill removal will only extend to a point where the final grade matches the adjacent wetland plain. No other excavation or soil amendments are proposed within the footprint of the earthen causeway. Upon reaching the proposed final grade, all disturbed areas will be seeded with a native wetland seed mixture.

As noted above, to maintain access to existing properties located on Way #672, a portion of High Toss Road from Way #672 to Pole Dike Road (travelway) will be elevated above the modeled storm-of-record. High Toss Road will be elevated to a minimum of 6-inches above the predicted water surface during the modeled storm event (6 inches above 7.0 feet.)

3.B.2.3 Water Control Structure at Pole Dike Road

After consultation with potentially affected property owners within the Upper Pole Dike Creek sub-basin, a water control structure was included at the Pole Dike Road crossing to prevent potential impacts to private structures in the Upper Pole Dike Creek sub-basin. Based on hydrodynamic assessment of post-restoration conditions using adaptive management simulations (Wood Hole Group, 2015), it was determined that by raising the road and increasing the culvert opening as described below, a tide gate structure should be installed at the culvert to restrict flow into Upper Pole Dike Creek. Accordingly, the Pole Dike Road culvert has been designed to have a hydraulic gate structure to restrict upstream flow. Therefore, Pole Dike Road will function similarly to a coastal levee during storm events up to the storm-of-record.

The proposed design at Pole Dike Road is to raise the roadway from 4.7 to 8.8 feet NAVD 88 and to increase the size of the culvert from a 36-inch circular culvert to an eight-foot high by seven-foot wide box culvert with a combination flap/slide gate (Section 13). The proposed freeboard for this roadway segment is two feet. The combination flap/slide gate will be able to regulate tidal flow to the Upper Pole Dike sub-basin, thereby avoiding or limiting water elevations. An Operations and Maintenance (O&M) Plan will be developed as part of final design and will be submitted in conjunction with the Notice of Intent, as required by Wetlands Protection Act regulations. Again, this flow control structure will only protect against flooding when water elevations are less than or equal to the storm-of-record.

No tidal restoration is proposed for the Upper Pole Dike Creek sub-basin as part of Phase 1. Hydrodynamic models show that water levels (including under storm conditions) during Phase 1 will not affect the lowest-lying unprotected structure. Based on modeling, at full Phase 1 tidal flow, the peak water level during a combination 10-year storm and 100-year precipitation event is lower than existing conditions for the same event.

3.B.2.4 Mill Creek Water Control Structure
A secondary water control structure equipped with tide gates across Mill Creek will allow a partial, controlled re-introduction of tidal exchange in the Mill Creek sub-basin to restore 21 acres of tidal wetlands in Phase 1 while protecting structures on private properties. The Mill Creek water control structure will be located entirely on property owned by the NPS. Therefore, the NPS will prepare the final design, pursue all necessary permitting and will secure funding to construct the water control structure with tide gates. The Mill Creek structure is not the subject of this permit request, and is described herein for informational purposes.

The design of the structure and tide gates was selected following an analysis of several design alternatives. Each alternative was evaluated based on environmental, constructability, aesthetic, sustainability, and cost factors. After evaluation of costs and benefits, a single sheet pile wall was selected. Design plans depicting the layout, dimension, tide gate structure (capable of allowing controlled, bi-directional tidal exchange between the Herring River and Mill Creek), and access road are found in Section 8.H. The design was revised so that the layout for the structure is contained within the CCNS boundary.

The new Mill Creek water control structure will be constructed with a crest height of 9.5 feet. This is based on a maximum, storm-of-record high tide on the downstream side of 7.5 feet, thereby providing two feet of freeboard against an extreme storm event. The structure design contains five culverts or openings, each five feet wide, for a 25-foot wide opening in total, and with adjustable combination flap-slide gates, as described below. The tide gates can be completely closed to inflowing tidal water if warranted based on predicted severe storm conditions. In such a case, freshwater would still be able to drain out of Mill Creek.

Heavy-gauge steel sheet piles are proposed, which is the most common material used for sheet pile walls due to its inherent strength which increases service life, and availability and familiarity to local contractors, which reduces costs. Since a steel sheet pile wall at this location would be subject to potential corrosion, the wall will be specified to use weathering steel or ASTM A-690 high-nickel steel with a sacrificial thickness. Sacrificial thickness is an accepted engineering method for providing corrosion protection in a marine environment. The sacrificial thickness will allow the wall to be subject to corrosive action over the life of the wall and not result in a structural failure of the sheet pile construction. This approach was selected to minimize future maintenance, operating efforts and costs.

A cantilevered steel walkway platform will be attached to the upstream side of the structure to provide a safe means for staff completing inspections, maintenance or other operating functions. This platform will be secured from access by unauthorized users and be designed to comply with relevant OSHA requirements.

Scour protection in the form of soil-filled, vegetated stone armor will be installed immediately upstream and downstream of the structure and its hydraulic opening, and soil-filled, vegetated articulated concrete block matting will provide a stable surface along the sheeting for equipment to access the hydraulic opening to remove debris and complete other required maintenance. These Project elements are critical to protect the foundation and stability of the structure, and to assure that maintenance staff can safely complete required activities to maintain unobstructed flow through the structure's hydraulic opening.

The structure's tidal control mechanism will consist of five electrically-operated, rising stem combination slide/flap gates, each opening measuring approximately five feet in width by six feet in height. The gates will be mounted to a cast-in-place concrete structure, which will be structurally integrated into the steel sheet structure. This concrete structure will be supported by a foundation of timber piles and will be configured with a narrow (less than three-feet wide) concrete apron forming an invert where channel flow transits across the footprint of the structure, to avoid scour and other potential damage. Functional benefits provided by the tide gates include a safe and secure mechanism for adjusting and controlling flow into and out of the Mill Creek sub-basin; and mechanisms that are easily operated, allowing persons of varying technical background and physical ability to operating the gates.

Slide-flap gates are structures that combine the features of a slide gate with the functionality of flap gate by allowing the sliding leaf to rotate about a horizontal transverse axis at the top of the gate opening. This functionality is typically provided to allow storm flow drainage from a tidal estuary, while limiting tidal surge or high tides into an estuary that could otherwise result in damage to the built environment. For example, when the gate is partially open, the open area below the gate leaf allows for bi-directional flow, while the upper portion of the gate opening (where the leaf is located) restricts flow in one direction to a greater degree. As the gate moves to a more fully closed position, the open area (and bidirectional flow) decreases, resulting in the flow becoming predominately or entirely one-directional due to the function of the flap gate. Each gate will offer options to be locked in a closed or open position for security.

Access to the water control structure will be provided by a 12-foot wide drive that will extend approximately 1,200 feet from Old Chequessett Neck Road to a location near the north end of the structure, where a turn-around area will be constructed to allow adequate room for operation/maintenance vehicle maneuvers. A security gate will be provided at the access drive's entrance to prevent access by unauthorized vehicles.

Proposed Project elements have been designed to meet the following objectives:

- Provide a 75-year design life with proper maintenance;
- Minimize temporary and long-term environmental impacts;
- Accommodate modifications to withstand potential future overtopping;
- Facilitate ease of operation and maintenance, and;
- Minimize future maintenance costs.

Ancillary work includes grading and stabilization of the tidal channel immediately adjacent to the structure, dredging of accumulated sediment within existing tidal channels upstream and downstream of the structure, and removal of an earthen dike remnant on the north side of the channel upstream of the proposed structure.

Tidal channels upstream and downstream of the structure will be excavated to remove accumulated sediment; channels will not be widened as part of this activity. The channel dredging is expected to improve freshwater drainage out of Mill Creek. Removed sediment will be side-cast, dispersed onto the adjacent marsh areas or, alternately hauled from the site to be beneficially reused within the Herring River basin, consistent with environmental permits.

3.B.3. Mitigation Measures

This section describes the mitigation measures associated with Phase 1 tidal restoration. All mitigation measures are designed to protect the subject structures under full tidal restoration conditions. For the purposes of DRI review, the mitigation activities are not within the project site area, which consists of the parcels within the limits of disturbance for the construction of the primary water control measures needed to restore tidal flow in the estuary.

3.B.3.1 Chequessett Yacht and Country Club

CYCC is a semi-private club with a nine-hole golf course located in the Mill Creek sub-basin of the Herring River. Currently, portions of the CYCC golf course experience occasional flooding by groundwater and surface water in the area of Mill Creek. Hydrodynamic modeling also shows that under certain conditions and absent mitigation measures, portions of the CYCC golf course would be affected by the increased water levels in the Mill Creek sub-basin as currently proposed in Phase 1. To address this, for a number of years, representatives of the project team and CYCC have engaged in dialogue to develop a detailed plan to: (1) see the restoration project succeed, and; (2) protect the CYCC golf course from potential adverse impact.

A key element of this multi-year effort is a plan to elevate low golf course holes. This plan includes:

- Raising and renovating portions of the five lower fairways, tees, greens, roughs, sand traps and cartpaths (Holes #s 1, 6, 7, 8 & 9) to mitigate against water levels up to the elevation 6.4 feet NAVD 88. This 6.36-foot elevation represents the maximum water level that would occur under storm-of-record conditions with tide gates in the Mill Creek water control structure open 3 feet high and the tide gates in the Chequessett Neck Road water control structure open 10 feet high, and full Project restoration (beyond Phase 1) has occurred;

- Excavation and then reconstruction of one upland CYCC golf course hole (Hole #2) which will provide a portion of fill needed for the Project (approximately 180,000 cubic yards), to be used in raising the five lower holes of the golf course. Approximately 73,000 cubic yards of fill will be used for other Project-related needs outside of the CYCC Property. The total amount of fill removed from hole #2 and other areas totals approximately 253,000 cubic yards;

- Installation of new irrigation on Holes #s 1, 2, 6, 7, 8 & 9 and relocation of the practice area to an upland portion of the CYCC Property; and
- Clearing channels and managing natural vegetation on the course and in the Mill Creek sub basin as may be needed to improve drainage and augment restoration (some channels will be identified and cleared mechanically to improve drainage, and others will be cleared naturally as restoration proceeds).

In addition, the plan includes improvements on holes #3, 4 and 5, which are not impacted by inundation, to make them compatible with other re-constructed holes. Plans for the golf course work are contained in Section 8.H.

CYCC and Project representatives have jointly acknowledged that the regulatory approvals and funding to implement the golf course work are dependent on actions beyond the control of either party. Accordingly, this work and other potential aspects of mitigation, including but not limited to contingency measures that may be employed and would be necessary if permits and funding for the golf course work described above are not secured, remain under discussion between CYCC, the Town and CCNS.

3.B.3.2 Low-Lying Road Crossings and Culverts (Pole Dike, Bound Brook Island and Old County Roads)
The Project area consists of several low-lying roadways (LLR) that are vulnerable to high tide water levels under the proposed Project. The primary design objective of this mitigation measure is to elevate the roadways to prevent overtopping during the storm-of-record. The road segments are to be elevated to a minimum of 6 inches above the predicted water surface during the modeled storm event. Current design plans are presented in Section 8.H.

To prevent over-topping, the road surfaces and culverts need to be elevated. Approximately 24,500 linear feet of roadway are included in the Project area. Of this, approximately 10,850 linear feet of road will be raised. Elevating these roads also requires widening the road bases and replacing six existing culverts and installing the Pole Dike Road water control structure with tide gate. The 10,850 linear feet (approximately two miles) of roadway is not continuous and is made of smaller road segments. While impacts to wetlands will be necessary to widen road bases, the impacts are far outweighed by the overall wetlands benefits of the Project. Additionally, a traffic management plan will be implemented to minimize disruption to residents and businesses. These issues are addressed in Section 4.0 of this application.

A geotechnical investigation of existing low-lying road segments and associated culverts was conducted to assist in the development of construction plans for the Project site, including the cut and fill operations. The existing road surface at low-lying areas ranges from 2.3 to 5.2 feet, which will be elevated to 4.25 to 7.5 feet. The goal is to elevate the existing roadway segments above the storm-of-record within the Project area (3.72 to 6.88 feet) including freeboard. Freeboard of 0.5 feet above the storm-of-record was selected to elevate these roadway segments. The actual increase in elevation varies throughout the Project area. About 0 to 4.5 feet of fill is required over existing ground elevations to achieve the final site grading. As part of the re-grading, existing culverts will be replaced with upgraded pipes and box culvert structures.

To accommodate the increase in road elevation, a side slope treatment of 3:1 (horizontal to vertical) ratio was selected to blend the side slopes into existing grades, and avoid abrupt, steep transitions between the road and adjacent land for the safety of pedestrians, cyclists, and equestrians. A 3:1 side slope provides a slope that can be stabilized with natural vegetation without concerns to slope stability, and requires only limited scour protection. The Bound Brook Island Road culvert at Herring River is the only location where 3:1 side slope ratio was not attainable. Gabion basket walls are to be included at this location on each side of the road, on the side of the culvert where the wingwalls are set close to the edge of the road.

Design of the replacement culverts include a headwall and wing walls at the three box culverts. The wing walls are necessary due to the height of the culvert opening and slope down from the road toward the water surface. Construction of the replacement culverts will require open cuts through the existing roadway to install the replacement culvert at the stream crossings. The box culverts will be installed over a layer of geotextile fabric and 12 inches of crushed stone within common borrow and will be covered by 12 inches of select gravel and flexible pavement. The 24-inch reinforced concrete pipes will also be installed over geotextile fabric and 12 inches of crushed stone and will be overlaid with 24-inches of select gravel and flexible pavement.

A temporary bypass for water flow will be required at each stream crossing during culvert installation. The hydraulic capacity of the bypass culverts will meet or exceed the capacity of the existing culverts. Dredging requirements to install the Project's culverts, associated wing walls, gabion basket walls, riprap apron, and foundation support for each of these components include removal of existing material beneath the structure and riprap locations.

Construction will be performed in stages to manage traffic flow during construction. A Maintenance Protection of Traffic Plans was developed in accordance with the Federal Highway Manual Uniform Traffic Control Devices. The Detour Plans and MPOT, which show all required road closures and detours, are contained in Section 8.H.

Compliance with state stormwater regulations is required to the maximum extent practicable for redevelopment projects. Generally, an alternative is practicable if it can be implemented within the site being redeveloped, taking into consideration cost, land area requirements, soils, and other site constraints. The primary constraints for this Project are the limited right-of-way, elevated groundwater and adjacent resource areas. Practices that will require either additional resource area impacts or impacts to private property will be defined as not practicable for the purposes of stormwater compliance.

The stormwater treatment shown on the plans consists of the inclusion of vegetated swales along the constructed road sections, taking into account the transverse pitch of the road, land available along the roadside, and other physical features. Swales will be designed to meet Stormwater Management Standards to the maximum extent practicable. Due to high elevation of groundwater, the swales will be conveyance swales, not bio-infiltration swales. The Project will fully comply with the provisions of the Stormwater Management Standards requiring the development and implementation of a construction-period erosion and sedimentation control plan, a pollution prevention plan, an operation and maintenance plan, and the prohibition of illicit discharges.

The criteria used to size the seven proposed replacement culverts were based upon recommendations established by Woods Hole Group (WHG) in its "Herring River Hydrodynamic Modeling Model Report" (2012). The proposed culverts are based upon the specific recommendations from WHG, included in a January 23, 2015 letter report, except for the Driveway culvert. Data on the existing and proposed culverts are presented in Table 3-2. Unlike the other six culverts, the Pole Dike Road culvert has been designed to have a hydraulic gate structure.

Table 3-2. Existing and Proposed Low Lying Roads and Culvert Size and Elevation

Location	Existing Culvert	Existing Invert Elevation (ft)	Existing Road Elevation (ft)	Proposed Road Elevation (ft)	Proposed Culvert Height by Width (ft)	Proposed Invert Elevation (ft)	Proposed Crown Elevation (ft)	Annual High Water (ft)	Storm-of-Record (ft)
Pole Dike Road	36-inch	-1.3	4.7	8.82	8 by 7	-1.2	6.8	4.94	6.82
Bound Brook Island Road at Herring River	54-inch	-3.5	4.0	7.7	8 by 6	-2.7	5.3	4.73	6.44
Bound Brook Island Road at Bound Brook	24-inch	-2.3	2.4	6.4	6 by 6	-2.2	3.8	4.11	5.53
Old County Road Paradise Hollow	12-inch	0.3	3.5	6.53	24-inch	0.3	2.3	4.13	5.75
Old County Road Lombard Hollow (S)	Unknow n	1.05	4.4	5.89	24-inch	1.0	3.0	2.85	3.72
Old County Rd Lombard Hollow (N)	Not Found	Not Found	4.9	5.44	24-inch	1.1	3.1	2.85	3.72
Bound Brook Island Road Private Driveway	Not found	Not found	4.2	7.2	24-inch	0.0	2.0		6.70

3.B.3.3 Elevation of High Toss Road

High Toss Road, in its current condition, is approximately two feet above the surrounding grade, and given its elevation, will be overtopped at high tides greater than approximately three feet. In order to maintain access to existing properties located on High Toss Road or Way #672 (also known as Rainbow Lane and Snake Creek Road), the portion of High Toss Road from approximately Way #672 to Pole Dike Road will be elevated to a minimum of 6 inches above the predicted water surface during the modeled storm event (6 inches above 7.0 feet).

The proposed work at High Toss Road has three primary objectives to:

- Restore Herring River and its floodplain to a naturalized and unrestricted state in the vicinity of High Toss Road through the removal of the culvert on Herring River and the fill associated with the causeway within the floodplain.
- Elevate the alignment of High Toss Road between Pole Dike Road and Way #672 water control structure to elevation 7.5 feet to prevent overtopping of the roadway. This includes 0.5 feet of freeboard above the elevation of the modeled storm-of-record of 7.0 ft. Current design plans are presented in Section 8.H.
- Replace an existing culvert located approximately 460 feet west of Pole Dike Road with a larger diameter culvert to promote hydraulic connection of wetlands on both sides of High Toss Road at this location.

3.B.3.4 Mitigation Work on Other Private Property

Mitigation measures to protect structures on three private properties from potential impacts of tidal restoration are described below. Letters of consent to describe this work in permit applications have been obtained from each property owner.

<u>Bound Brook Island Road</u>

A private property located off of Bound Brook Island Road is a low-lying property with a structure vulnerable to tidal inundation under Phase 1 restoration. The Project has reached agreement with the property owners to provide measures to fully protect the structure.

The property has two dwellings with individual gravel driveways; proposed mitigation measures include relocating and elevating the existing driveway serving the lower of the two dwellings. A bench-wall barrier will be installed around a patio area of said dwelling to protect the lower entrance. Following construction and site restoration, the property will be very similar to existing conditions. No detrimental effects on use of the property are anticipated and the beneficial effects of reduced potential for water intrusion are permanent.

The property is accessed via a gravel road off of Bound Brook Island Road. As part of the LLR roadwork described above, a portion of Bound Brook Island Road in the vicinity of the subject property will be elevated, as will the gravel access road to the dwellings; and a culvert near the beginning of the gravel access road will be replaced. Construction on the property will likely not occur in phases. The driveway and patio may be constructed simultaneously.

Mill Creek Sub-basin

Private wells serving properties at 70 and 80 Mill Creek Lane, respectively, could be overtopped by tidal water during Phase 1 restoration. Consistent with agreements reached with the subject property owners, each of the two wells will be relocated to a site above maximum water levels under both Phase 1 and also for full restoration.

3.B.3.5 Tide Barrier to Protect Way #672

Way #672 (a portion of which is also known as Rainbow Lane or Snake Creek Road) is located adjacent to the Herring River, approximately one mile upstream of Chequessett Neck Road. The following section addresses the evaluation, selection, and design of alternative structural configurations to protect Way #672 from impacts related to restoration of tidal flow.

A structure is being proposed to protect the road and residential properties along Way #672 from restored tidal flow, while minimizing wetland impacts, construction costs, and operation/maintenance requirements. Like the Mill Creek water control structure, this structure is entirely on land owned by the NPS, and is not subject to Cape Cod Commission Act review because construction of the structure by NPS on federal land constitutes a purely federal activity. NPS will pursue all permits for the structure that are applicable. A description of the structure is provided herein for informational purposes.

The assessment of potential impacts to low-lying structures indicated that tidal flow could temporarily reach two private driveways off of Way #672, a private low-lying well and both High Toss Road and Way #672, during larger coastal storm events under Phase 1 restoration. Several conceptual design alternatives were evaluated for a tide barrier to be located on CCNS property to protect the above-mentioned structures from tidal flow under all Phase 1 conditions.

The following five potential structural configurations were evaluated: earthen dike, precast concrete wall, cast-in-place concrete wall, steel sheeting wall, and timber barrier wall. Based on seven selection criteria that encompassed physical site conditions, natural resource impacts, constructability, cost, maintenance requirements and site compatibility, two of the five alternatives (steel sheeting wall and timber barrier wall) were selected for further evaluation, as well as a third "hybrid" wall utilizing a combination of a steel sheeting (below grade) and timber barrier wall (above grade). The three alternatives are all single walls and therefore will have similar a footprint and layout. Based on the assessment, the NPS selected the hybrid steel/timber alternative.

The proposed structure will be designed to satisfy the following specific criteria that serve as minimum standards for design and construction:

- Minimize temporary and long-term environmental impacts;
- Top of dike set at elevation 7.5 feet;
- Minimize future maintenance costs;

- Maximize the structure's ability to adapt to future conditions (e.g., ease and cost of future alterations);
- Allow for positive upland drainage, as determined necessary subsequent design phases;
- Provide seepage cutoff, as and if determined necessary in future phases of design, and;
- Withstand lateral loads and salt water environment.

3.B.4 Secondary Vegetation and Marsh Management Actions

This permit application also encompasses potential secondary management actions on the marsh plain that are needed to enhance ecosystem function in concert with tidal restoration. Proposed actions include additional drainage improvements (e.g., vegetation removal and channel excavation to remove accumulated sediments), vegetation management, and sediment supplementation to increase marsh elevation. At the time of permit submittals, the precise locations, methods and timing of these activities are unknown as they depend in part on system responses to the return of tidal flow. Uncertainties about the implementation details of these actions will be resolved as tidal restoration progresses and the response of the system is evaluated in accordance with the Adaptive Management Plan described in Section 5.0 and contained in full in Section 8.B.

3.B.4.1 Vegetation Management

Vegetation management is a class of project activities, along with incremental tidal restoration and facilitating the recovery of natural tidal marsh channel networks and elevation that are being pursued as part of the adaptive management plan. This section provides a general description of activities, methods, and effects. A more detailed draft Vegetation Management plan is found in Appendix F. This information will be supplemented and refined during project implementation and presented by the HRRC when appropriate in detailed, site-specific Vegetation Treatment Plans (VTPs) for review and comment by the Regulatory Oversight Group and Herring River Stakeholder Group (HRSG), and approval by the HREC.

As Phase 1 is implemented, salt water will cause decline and mortality to much of the herbaceous and woody freshwater-dependent and upland vegetation that has colonized the floodplain. If left standing, dying and dead trees and larger shrubs could hamper the re-colonization of native salt marsh plant communities. In some areas currently dominated by herbaceous, freshwater-dependent emergent plant species, the non-native, invasive common reed (*Phragmites australis*) could expand which would have a number of deleterious ecological and socioeconomic effects, including displacement of native vegetation and a reduction in habitat quality for fish and wildlife. The specific goal for managing vegetation as part of the Herring River Restoration Project is to support the long-term, sustainable re-colonization of native estuarine vegetation as tidal range, salinity and sediment transport processes are restored.

Vegetated areas that will be affected at each stage of tidal restoration were identified by comparing NPS vegetation cover type data with spatial data output from the EFDC hydrodynamic model. Active removal and management of vegetation will be limited to the emergent marsh areas with existing occurrences of common reed, as well as shrub-lands and woodlands. Within the area of the Herring River floodplain affected by regular tidal inundation up to the Phase 1 project limit, approximately 43 acres is currently dominated by common reed, most of which occurs within the Lower Herring River sub-basin. Shrub-lands comprise about 179 acres and are scattered throughout all of the Herring River sub-basins with the exception of Bound Brook. The largest contiguous stands of shrub-land currently occur in portions of Duck Harbor, Lower Pole Dike Creek, and the Upper Herring River sub-basins. Woodlands currently make up approximately 126 acres of the Phase 1 project area, with most stands occurring in the Lower Herring River, Mid-Herring River and Lower Pole Dike Creek sub-basins. In total, up to approximately 348 acres within the Herring River floodplain could require some form of vegetation management as part of Phase One of the project.

Vegetation management will be conducted incrementally. It will be closely coordinated with Chequesett Neck Road tide gate management and the resulting increases in water surface elevations, tidal range, and salinity. Generally, vegetation management operations would be conducted before tidal flows are reintroduced to a given area before the ground surface is affected by salt or brackish water. Inundation with saltwater that promptly follows vegetation removal is expected to be highly effective for preventing or limiting regrowth of undesirable species and is expected to foster re-colonization of native estuarine plant communities.

3.B.4.2 Marsh Management

Restoration of natural stream channel connectivity and marsh surface elevation is a major component of the Herring River Restoration Project. Marsh management is a class of project activities, along with incremental tidal restoration and vegetation management, that will be pursued as part of the coordinated adaptive management program.

These activities cannot be described in detail at a site-specific level prior to commencing the restoration and adaptive management program. Many of the locations where this work could potentially be necessary are remote and currently either covered in dense, shrubby vegetation or under water. The work is also dependent on specific vegetation, micro-topography, and tidal flow characteristics. Attempting to evaluate potential treatment sites and design future marsh surface restoration actions based on existing conditions is a fruitless exercise, since these conditions will change after tidal exchange is restored. Conditions will also vary greatly among different locations and at different stages of the restoration process. Therefore, this broad summary is based on the best information available and current projections of how restored tidal flow will generally affect the project area as well as the types of interventions that are expected to be necessary for restoring natural stream networks and marsh elevation.

4. Regional Policy Plan Analysis

The following section discusses each of the RPP Goals and Objectives identified in the March 2019 DRI Scoping Decision issued for this Project. The RPP goals and objectives are addressed in the order in which they are listed in the Scoping Decision. For each category of RPP topics, the narrative describes existing conditions, post restoration conditions, and the ways in which restoration responds to and satisfies specific RPP Goals and Objectives.

4.A Water Resources (WR)

This section reviews the existing condition of water resources in the Herring River system and demonstrates how post restoration conditions meet the RPP Water Resources (WR) goal and applicable WR objectives.

4.A.1 Existing Conditions

4.A.1.1 Salinity of Surface Waters

The existing Chequessett Neck Road dike has limited the upstream mean tide range in Herring River to only 2.2 feet compared to 10.3 feet in Wellfleet Harbor. In Wellfleet Harbor, salinity typically ranges between 30 and 32 parts per thousand (ppt) (NPS data, as presented in WHG 2009). Under current conditions, saline water from Wellfleet Harbor only reaches upstream to approximately High Toss Road, approximately 1.2 miles upstream of the dike (Figure 3-1 in the FEIS). Based on the analysis of roots and rhizomes from peat cores, salinity penetration supported smooth cordgrass (*Spartina alterniflora*) throughout the historic floodplain (Orson and Roman in Roman 1987). CCNS monitoring data confirm that waters within the upper estuary are now consistently fresh as a result of tidal restriction. Downstream of the Chequessett Neck Road dike, waters are brackish to marine with monthly mean salinities of 15 to 27 ppt during low tide. Section 3.2 of the FEIS provides a more detailed discussion on existing surface water salinity in the Herring River floodplain (HRRC 2016).

4.A.1.2 Water and Sediment Quality

The Massachusetts Surface Water Quality Standards have designated the lower portion of the Herring River up to High Toss Road as Class SA waters (314 CMR 4.05). These standards reflect the status of water quality needed to support designated uses of the waters. Class SA waters are required to have excellent habitat for aquatic life and conditions for recreational use. In addition, the Herring River estuary is designated by the Commonwealth as Outstanding Resource Waters (314 CMR 4.04). The Herring River reach from High Toss Road to the outlet of Herring Pond has been designated as Class B water. Class B waters are designated as habitat for fish, wildlife, and other aquatic life, including for their reproduction, growth and other critical functions, migration, and primary and secondary contact recreation. In some cases, where designated, Class B waters are a suitable source of public water supply with the appropriate treatment. Outstanding Resource Waters include waters designated for protection based on their high socio-economic, recreational, ecological, and aesthetic values.

Plainly none of these standards are satisfied in current conditions. The Herring River estuary currently does not meet the targeted designation criteria because of degraded water quality conditions. Over the last 100 years, surface water quality in the Herring River estuary has declined because of the severely restricted tidal flushing of the estuary, as well as drainage of marsh soils and sediments. Restricted tidal influence and marsh drainage have resulted in low pH, increased mobilization of aluminum and iron, sustained periods of low dissolved oxygen, and high levels of fecal coliform bacteria. Water quality concerns, including high aluminum, low pH, and high fecal coliform bacteria, have also resulted in the listing of the Herring River on the 303(d) list of impaired waters under the federal Clean Water Act (CWA). A more detailed discussion on dissolved oxygen, pH and sulfate, nutrients, and fecal coliform within the Project area can be found in section 3.3.5 of the FEIS (HRRC 2016). The following bulleted section provides a brief summary of current conditions for water quality.

- **Dissolved oxygen**: Anoxic and near-anoxic conditions exist regularly along the main stem of the river (Portnoy 1991). Dissolved oxygen levels collected at the Chequessett Neck Road dike by the USGS in 2016-17 show that concentrations frequently fall below the 6.0 mg/l standard for Class SA waters (314 CMR 4.05). Dissolved oxygen levels vary with the tides and at nearly every low tide during the summer, dissolved oxygen levels are highly stressful to fish and other aquatic animals. Low dissolved oxygen results from the combination of high oxygen demand and greatly reduced tidal flushing. Restored tidal conditions would import copious volumes of oxygen-saturated seawater.
- **pH and Sulfate:** Salt marsh soils in the Herring River estuary are naturally rich in sulfur because salt marsh microbes use sulfate as an oxidizing agent to decompose organic matter in anoxic marsh sediments. The process produces dissolved sulfide, a large fraction of which is sequestered as iron-sulfide. The mineral is not stable in the current aerobic environment created by diking and drainage of the salt marsh. As a result, the sulfide has reacted with oxygen to form sulfuric acid which has acidified the soil to pH levels less than 3 (roughly the same acidity as a lemon), compared with the range of 6.5 to 8.5 stipulated for Class SA waters (314 CMR 4.05). Acidic water can result in a loss of aquatic vegetation, as well as the killing of fish and other organisms.
- **Fecal Coliform:** The Herring River is listed as impaired for fecal coliform in a 0.39 square mile area between Griffin Island and Wellfleet Harbor (MassDEP et al. 2009). MassDEP has designated the Chequessett Neck Road dike as a point source for bacterial contamination. In 2005, fecal coliform concentrations at nine stations between High Toss Road and Egg Island were found to be elevated, reaching up to 1,000 colonies per 100 ml during an outgoing tide (Portnoy & Allen 2006). For reference, shellfish harvesting is prohibited if fecal coliform concentrations exceed 14 colonies per 100 ml of water. High fecal coliform concentrations have kept the Herring River downstream of the Chequessett Neck Road dike permanently closed to shellfishing in some areas and only conditionally approved in other areas (FEIS 3.3.6) Given the low development density fecal coliform bacteria probably originate from wildlife in the estuary and watershed rather than from humans.

- **Nutrients:** Although there is no documentation of specific anthropogenic or natural inputs, potential sources of excessive nutrients within the Herring River watershed include animal waste and atmospheric deposition. Watershed loading from septic systems and run-off is believed to play a smaller role in Herring River compared with other more developed estuarine watersheds. Nutrients have accumulated in the Herring River marsh soils due to the lack of tidal flushing. Re-flooding sediments may release ammonium-nitrogen and phosphorus (Portnoy & Gilbin 1997) so monitoring of ammonium-nitrogen levels is planned during restoration

Sediment testing for metals and pesticides was conducted in 2007 and 2014, and this information is characterized in the FEIS. To more comprehensively depict existing conditions, additional sampling of sediment chemical characteristics is currently underway in consultation with MassDEP and US Army Corps of Engineers. These data will be incorporated in Sediment Management Plans submitted for review and approval by MassDEP and US Army Corps of Engineers under Section 401 Section 404 Water Quality Certification permit regulations.

4.A.2 Post Restoration Conditions

4.A.2.1 Salinity of Surface Waters

The return of tidal flow to Herring River will begin to re-establish the salinity gradient necessary for a healthy estuary. Impacts on surface water salinity resulting from Project activities are based primarily on a hydrodynamic model that was developed for the Herring River floodplain (WHG 2012). The model includes a simulation of water surface elevations, salinities, and flow velocities throughout the Herring River. See section 4.2.1 of the FEIR for a detailed description of hydrodynamic modeling methods used to predict future salinities throughout the estuary. Model results are summarized in table 4-3 of the FEIR and reported in detail in the FEIR (Appendix B). Under the proposed conditions, the Herring River floodplain upstream of High Toss Road will change from a freshwater system to a tidally influenced, saline environment, increasing the areal extent of tidal exchange by an order of magnitude in comparison to current conditions. However, because of the lack of a salinity gradient throughout the system under existing conditions, calibration and validation of the modeled salinities for the mixing, transport, and diffusion processes have a degree of uncertainty. As restoration progresses, increasing the size of opening at the Chequessett Neck Road water control structure may also result in greater salt penetration than predicted by the model because of natural erosion (deepening) of the tidal channels, intentional channel improvements undertaken as marsh management actions, and improved low tide drainage, all effectively increasing the rate of tidal flushing. With each incremental tide gate opening and associated monitoring of water elevations and salinity, the model can be further validated and the level of uncertainty reduced for future incremental openings. Specific uncertainties, hypotheses, monitoring strategies, and potential management actions aimed at addressing impacts associated with changes in salinity will be addressed in the Project's adaptive management plan.

4.A.2.2 Water and Sediment Quality

Tidal restoration will substantially improve water and sediment quality by increasing the range of seawater flows, thereby creating higher tides and enhancing low tide drainage. In addition, the proposed conditions will substantially decrease residence times of flows from the Herring River floodplain to Wellfleet Harbor by at least a factor of 25, which is expected to maintain dissolved oxygen concentration above state water quality standards at all times. Water and sediment quality improvements are major objectives of the Project and are integral for the restoration of habitat conditions required for the re-establishment of native fish, shellfish and other estuarine animal populations. Improved dissolved oxygen concentrations will benefit migratory diadromous fish as well as resident fish and invertebrates. The impact analysis for this section has been based on published studies of the Herring River and other estuaries, unpublished water quality and sediment data collected by CCNS and USGS, and hydrodynamic modeling (WHG 2012). The following bulleted section provides a brief summary of water and sediment quality. A more detailed discussion on impacts to water and sediment quality proposed by the Project, including individual discussions on soil chemistry, nutrients, pesticides, and fecal coliform within the Project area, can be found in section 4.3 of the FEIR.

- **Soil Chemistry:** Restored tidal flushing is expected to reduce acidification within the mid-portion of the Herring River estuary where saline water will again saturate drained peat. The rate of aerobic decomposition and acid production within the soil will decrease substantially, and the pH of porewater and surface water will increase (Portnoy and Giblin 1997). With restored salinities, aluminum and iron will no longer be leached from the soil to receiving waters in concentrations that stress aquatic life. Decreased decomposition and increased saturation of soil pore spaces with water will also prevent further subsidence of the marsh surface.
- **Fecal Coliform:** Regular tidal flushing will substantially decrease fecal coliform concentrations in the Herring River due to increased flushing rates, lower water temperature, and higher salinity and dissolved oxygen. (Portnoy and Allen, 2006) The reduction of bacteria concentrations will result from the dilution of cleaner inflowing water into the system, as well as the significantly reduced life span of bacteria in more saline waters. Greatly reduced fecal coliform concentrations within Herring River and Wellfleet Harbor are expected to eventually allow for removal of the river from the 303(d) list for impairment by pathogens and lead to the reopening of once productive areas for shellfish harvesting.
- **Nutrients:** Concentrations of nitrogen in the wetland sediments of Herring River have remained high. Renewed tidal flushing of acid sulfate soils will allow ammonium-nitrogen to be released into receiving waters over the short term (Portnoy and Giblin 1997). However, with the increased volume of tidal flushing, nutrients will be diluted and removed from the system with each tide cycle. Overall, released nutrients will benefit growth of salt marsh vegetation in the restored marsh.
- **Pesticides and other Organic Compounds**: The project proponents are not seeking authorization to use any pesticides including herbicides.

4.A.3 Response to RPP Water Resources Goal and Objectives

The RPP Water Resources goal is "to maintain a sustainable supply of high quality untreated drinking water and protect preserve or restore the ecological integrity of fresh and marine surface waters."

The Commission's scoping decision identifies this goal, in addition to WR1, WR2 and WR3 as applicable to this Project. The Scoping Decision also identifies WR4 as applicable, but limited to the stormwater management associated with the Project's proposed water control structures and low-lying roadway segments. The stormwater management is proposed in the context of redevelopment to improve stormwater management over existing conditions, rather than as part of a new development. Stormwater management design for engineered stormwater structures is described in Section 8.D.

Objective WR1 – Protect, preserve and restore groundwater quality

This objective seeks to ensure that the project protects, preserves and restores groundwater quality. The Project meets the objective to protect, preserve and restore groundwater quality, as described below.

The Project is not in a Wellhead Protection Area, or Potential Public Water Supply Area as identified on the RPP Data Viewer. Therefore, the methods of demonstrating compliance with objective WR1 for projects within such areas do not apply.

The Project is not proposing a private wastewater system or wastewater treatment facility. Therefore, the methods for demonstrating compliance with objective WR1 for projects that contain a private wastewater system or wastewater treatment facility do not apply.

The Project will not result in the generation of wastewater; and the site-wide nitrogen loading concentration will not exceed 5 ppm. In fact, the Project will overall benefit nitrogen loading. The Wellfleet Local Comprehensive Plan Committee estimates a reduction in nitrogen load in Wellfleet Harbor as a result of implementing the Herring River restoration project. (Cape Cod Commission Watershed Report: Wellfleet Harbor, 2017)

Nitrogen loading from runoff associated with project elements will not increase due to enhanced stormwater management (see WR4). Stormwater management measures included in the bridge design will improve treatment of runoff. Elevated low-lying roadways will reduce uncontrolled run-off into wetlands and improve conveyance. All construction contracts will include appropriate stormwater Best Management Practices. (see WR4).

The Project complies with objective WR1 in that it will protect and preserve groundwater quality, and otherwise have no adverse impact to down-gradient existing or proposed drinking water wells. This conclusion is based on the following information.

WR1 Response 1. The Project protects all private wells. The Project has studied the potential impact of restoration on private wells under Phase 1 and full restoration conditions. (Martin et al, 2019, See Section 8.C). The study incorporates recent investigations for Herring River which correctly evaluated the effect of tidal restoration on groundwater beneath and adjacent to an intermittently flooded intertidal estuary. These studies found that tidal restoration is expected to increase the mean water level in the river and streams, resulting in a slight increase of the water table elevation and consequent increase in thickness of the freshwater zone in the aquifer. These investigative findings support the conclusion that only wells exposed to salt water inundation at the ground surface around the casing are likely to experience water quality impacts resulting from tidal restoration at Herring River.

Based on this understanding of impact risk, a total of seven wells were identified with the potential for saltwater inundation at the ground surface resulting from full tidal restoration of the Herring River Estuary. Two of the seven wells will be plugged and abandoned. Two other of the seven wells would not be affected under Phase 1 restoration. Mitigation actions have been identified to fully protect the remaining three wells potentially affected under Phase 1 restoration. Owners of two of the three wells have consented to relocation of their wells. The third well will be protected from intermittent saltwater inundation by a tide control barrier location on Cape Cod National Seashore property.

WR1 Response 2. The RPP Water Resources I Data Viewer identifies a "potential plume" emanating from the capped Wellfleet town landfill located on Coles Neck Road as an impaired area. This plume is not located within the project area. In its comment letter on the FEIS the Cape Cod Commission requested "more analysis about the relationship between higher water levels and tidal exchange in the Herring River, and potential effect on any remaining contaminants with the Town of Wellfleet's closed landfill site on Cole's Neck Road.

Analysis of the 2018 Biennial Post-Closure Monitoring Report for the Wellfleet Municipal Landfill (The Johnson Company, 2019, See Section 8.C) concluded that based on current data there does not appear to be a contaminated groundwater plume associated with the landfill. The 2005 landfill closure was successful and that landfill leachate has been reduced and/or stopped. The vast majority of organic and inorganic data was either non-detect or significantly below the drinking water criteria. The only constituents that exceed any type of standard are pH, iron, manganese, and 1,4-dioxane. In general, it appears that the up-gradient wells have similar levels of contamination to wells that are down-gradient of the landfill. The restoration of the Herring River into a saltwater marsh will have some effect on the tidal cycle in the vicinity of the landfill. However, tidal restoration will bring surface water no closer to the landfill than it is today, >500 feet; and groundwater levels and flow direction at the landfill will not change as a result of the tidal restoration.

WR1 Response 3. The Project does not use, treat, generate, handle, store or dispose of Hazardous Materials or Hazardous Wastes. Phase 1 permits for the Project will not include use of irrigation, chemical fertilizers, or pesticides. During construction, all contractors will be required to comply with federal and state statutes and best management practices for treatment, handling, storage or reporting of any hazardous materials or hazardous wastes as applicable.

Objective WR2 – Protect, preserve and restore freshwater resources

This objective seeks to ensure that the Project protects, preserves and restores freshwater resources. The Project is not within a Freshwater Recharge Area as identified on the RPP Data Viewer. Therefore, the methods for demonstrating compliance with WR2 for projects in such areas do not apply.

However, the Project will enhance and improve naturally occurring freshwater resource conditions in the upper reaches of the Herring River system and therefore complies with WR2. This conclusion is based on the following information.

WR2 Response 1. The Project will restore the natural salinity gradient to the Herring River system, and will improve naturally-occurring freshwater resources in the upper reaches of the Herring River system. The return of tidal flow to Herring River will begin to re-establish the salinity gradient necessary for a healthy estuary. Impacts on surface water salinity resulting from Project activities are based primarily on a hydrodynamic model that was developed for the Herring River floodplain (WHG 2012). The model includes a simulation of water surface elevations, salinities, and flow velocities throughout the Herring River. See section 4.2.1 of the FEIR for a detailed description of hydrodynamic modeling methods used to predict future salinities throughout the estuary. Model results are summarized in table 4-3 of the FEIR and reported in detail in the FEIR (Appendix B). Under the proposed conditions, the Herring River floodplain upstream of High Toss Road will change from a freshwater system to a tidally influenced, saline environment, increasing the areal extent of tidal exchange by an order of magnitude in comparison to current conditions. However, because of the lack of a salinity gradient throughout the system under existing conditions, calibration and validation of the modeled salinities for the mixing, transport, and diffusion processes have a degree of uncertainty. As restoration progresses, increasing the size of opening at the Chequessett Neck Road water control structure may also result in greater salt penetration than predicted by the model because of natural erosion (deepening) of the tidal channels, intentional channel improvements undertaken as marsh management actions, and improved low tide drainage, all effectively increasing the rate of tidal flushing. With each incremental tide gate opening and associated monitoring of water elevations and salinity, the model can be further validated and the level of uncertainty reduced for future incremental openings. Specific uncertainties, hypotheses, monitoring strategies, and potential management actions aimed at addressing impacts associated with changes in salinity will be addressed in the Project's Adaptive Management Plan (Section 5).

Tidal restoration will substantially improve water and sediment quality by increasing the range of seawater flows, thereby creating higher tides and enhancing low tide drainage. In addition, the proposed conditions will substantially decrease residence times of flows from the Herring River floodplain to Wellfleet Harbor by at least a factor of 25, which is expected to maintain dissolved oxygen concentration above state water quality standards at all times. Even in the upper reaches of the estuary where significant change in the salinity gradient is not anticipated, the increase in tidal influence will improve dissolved oxygen. Water and sediment quality improvements are major objectives of the Project and are integral for the restoration of habitat conditions required for the re-establishment of native fish, shellfish and other estuarine animal populations. Improved dissolved oxygen concentrations will benefit migratory diadromous fish as well as resident fish and invertebrates. The impact analysis for this section has been based on published studies of the Herring River and other estuaries, unpublished water quality and sediment data collected by CCNS and USGS, and hydrodynamic modeling (WHG 2012).

Objective WR 3 – Protect, preserve and restore marine water resources

As described above, Herring River is designated by the Commonwealth as Outstanding Resource Waters. However, under existing conditions, Herring River is included on the 303(d) list of impaired waters under the federal Clean Water Act (CWA), and the existing Chequessett Neck Road dike is a designated point source for bacterial contamination of shellfish beds in Wellfleet Harbor. Marine water quality is severely degraded based on several measures, including persistent anoxic conditions, high acidity, metals, bacterial contamination, and accumulated nutrients due to lack of tidal flushing.

This objective seeks to ensure that the Project protects, preserves and restores marine water resources. The Project meets this objective in that the resulting restoration of near natural tidal flow will result in significant improvements in the health and sustainability of marine water resources. This conclusion is based on the following information.

WR3 Response 1. The return of tidal flow to Herring River will begin to re-establish the salinity gradient necessary for a healthy estuary. (see WR-2, finding 1 above)

WR3 Response 2. Tidal restoration will substantially decrease residence times of flows from the Herring River floodplain to Wellfleet Harbor by at least a factor of 25, which is expected to maintain dissolved oxygen concentration above state water quality standards at all times.

WR3 Response 3. Restored tidal flushing is expected to reduce acidification within the mid-portion of the Herring River estuary where saline water will again saturate drained peat. With restored salinities, aluminum and iron will no longer be leached from the soil to receiving waters in concentrations that stress aquatic life.

WR3 Response 4. Regular tidal flushing will substantially decrease fecal coliform concentrations in the Herring River due to increased flushing rates, lower water temperature, and higher salinity and dissolved oxygen.

WR3 Response 5. There will be little change in nutrient flux, and dependent phytoplankton, on the seaward side with tidal restoration. In greenhouse microcosm experiments NPS did observe that re-salination of acid sulfate soils, typical of the drained wetlands above High Toss Road, mobilized ammonium-nitrogen; however, this should be a short-term phenomenon. (Portnoy and Giblin 1997). The ammonium is presently adsorbed to clay particles. To the extent that seawater reaches these sediments, ammonium will desorb and will be available as a nitrogen source to primary producers, both phytoplankton and wetland vascular plants. However, with an incremental and slow restoration of tidal exchange, any increases in ammonium will be gradual, i.e. not a large pulse. However, with the increased volume of tidal flushing, nutrients will be diluted and removed from the system with each tide cycle. Overall, released nutrients will benefit growth of salt marsh vegetation in the restored marsh. Also, with the high flushing rate in Wellfleet Harbor proper, this nitrogen is not expected to cause excess algae blooms. (Draft CWMP, 2014)

WR3 Response 6. Coastal resource restoration (i.e., restoration of salt marsh) is non-traditional method of nutrient removal. The project will restore 570 acres of salt marsh and other estuarine wetlands. The Cape Cod Commission Watershed Report for Wellfleet Harbor cites that the Wellfleet Local Comprehensive Plan Committee estimates a reduction in nitrogen load in Wellfleet Harbor as a result of implementing the Herring River and Mayo Creek restoration projects.

Objective WR4[13] – Manage and treat stormwater to protect and preserve water quality

This objective seeks to ensure that the project protects, preserves and restores groundwater quality. The project elements and associated roadway elevation work necessary to protect roadways from impacts resulting from tidal restoration meet the state's definition for redevelopment with respect to stormwater management under this objective, as described below. Thus, the applicable standard for stormwater management for redevelopment is to improve stormwater management over existing conditions. The project meets this standard by incorporating upgraded stormwater management in the design of the CNR bridge, and by enhancing stormwater management in the design of elevated segments of low-lying roads. This conclusion is based on the following information:

WR4 Response 1. The Project improves site conditions to enhance stormwater retention, water quality treatment and recharge compared with existing conditions. The improvements in stormwater management are described below:

- The Chequessett Neck Road bridge will be designed to improve stormwater management and treatment over current conditions.
- Under current conditions, stormwater runoff generated by the roadway approaches to the Chequessett Neck Road dike drains to the River/Harbor with little to no pretreatment. The proposed stormwater management system for the CNR bridge will consist of a "treatment train" approach that will remove 80% TSS prior to discharge to the River/Harbor. In the "treatment train," runoff generated by the proposed approaches (as well as the new bridge) will be captured by proprietary vortex separator inlet units that will function as the first level of pretreatment prior to discharging to stormwater planter/filter areas. These pretreatment units will remove sediment/total suspended solids (TSS), floating trash/debris, oils, and hydrocarbons from the stormwater runoff without washing out previously captured pollutants. Treated flow from these BMPs will then be conveyed by new drain piping to stormwater planters/filters located on each side

[13] The Limited Scoping Decision (March 7, 2019) states that review of this objective "is limited to the stormwater management associated with proposed water control structures and low-lying roadways."

of the bridge that will function as a secondary level of pretreatment. Runoff discharged to these planters will be filtered by approximately 24 inches of soil media prior to percolating into the underlying soils.

- Treated stormwater beyond the infiltrative capacity of the underlying soils and weep holes will be captured by under-drain systems and conveyed to the Herring River and Wellfleet Harbor. It should be noted that the surface area of the planters, depths of filter media, and depths of ponding above the surface of the media were designed to fully contain runoff generated by contributing drainage areas during storm events up to, and including, the water quality storm event (without overtopping the walls of the planters).

- Existing low-lying roads to be elevated currently have no stormwater management measures in place. In proposed plans, vegetated swales have been added to sections of the roadway along the marsh wherever possible to provide for non-erosive conveyance and minimize runoff directly into the adjacent vegetated wetlands. Drainage improvements on Hopkins Drive at the intersection with High Toss Road will include the installation of 4 deep-sump catch basins connected via manifold to underground infiltration chambers; this system, combined with a pair of dry wells to be installed further up the hill, will capture and infiltrate existing runoff from Hopkins Drive before it reaches High Toss Road.

- Proposed elevation of low roadways would meet the definition of a Redevelopment Project as defined in the MassDEP Stormwater Handbook and regulated per SW Management Standard 7 in the WPA and 401 WQC permitting processes. Stormwater management plans for roadway elevation projects will attempt to meet each of the state stormwater management standards to the maximum extent practicable. As required by Wetland Protection Act regulations, a stormwater report will be submitted with the Notice of Intent to demonstrate that all reasonable efforts to meet the stormwater management standards have been made, including a complete evaluation of possible stormwater management measures to comply with all standards, adequately document standards that could be met only to the maximum extent practicable, and be designed at a minimum to improve existing conditions.

- Pretreatment of stormwater will be provided to the extent practicable along low-lying roads given the adjacency of wetlands and high groundwater.

- Strict adherence to all stormwater management standards would impose a hardship on the Project by significantly increasing costs and construction timelines, and would result in additional impacts to wetland resources.

4.B Wetland Resources (WT)

4.B.1 Existing Wetland Resources Conditions

4.B.1.1 Sediment Transport and Soils

The geomorphology surrounding the Herring River has been primarily determined by relatively recent glacial processes and associated sea-level fluctuations, which caused the deposition of marine sands, silts and clays. As sea level rise slowed about 4,000 years ago, salt marsh plants were able to colonize and accumulate peat, which provided the base for salt marshes to develop (Roman 1987). Material derived from decaying salt marsh plants, diurnal tidal exchange, and coastal storm surges eventually resulted in the accumulation of approximately 10 feet of peat in the Herring River estuary. When the Herring River was diked more than 100 years ago, these processes were interrupted and both the salt marsh and the underlying peat began to subside. The dike's blockage of tidal currents has also reduced the dimensions of the Herring River channel. The restricted tidal exchange at the Chequessett Neck Road dike has degraded the ecological functions of the Herring River estuary that are dependent on and linked to the river's proximity and connections to Cape Cod Bay and Wellfleet Harbor as sources of sediment.

There are two sediment-related issues relevant for this restoration project. First, restoring tidal exchange at the dike will mobilize sediment that has accumulated within the existing channels as a natural tidal channel system begins to be re-established. Second, because the tidal restriction has caused subsidence of the former marsh surface during the last 100 years, future changes in the tidal water surface elevations in the Herring River will need to be managed to assure a successful transition back to a healthy salt marsh community. The following bulleted section provides a brief summary of sediment transport and soils. A more detailed discussion on tidal channels, marsh surface elevations, and soils within the Project area can be found in Section 3.4 of the FEIS (HRRC 2016).

- **Tidal channels:** Because the volume of water flowing through the estuary was greatly reduced by the construction of the Chequessett Neck Road dike, the tidal creeks in the Herring River estuary that existed prior to the construction of the dike have completely or partially filled with sediment. Sediment transport analyses of the existing system found that current tidal flow velocities are sufficient to re-suspend sediment, but only near the dike.
- **Marsh surface elevations:** Coastal marsh elevations must increase at a pace equal to or greater than the rate of sea level rise to promote the growth of salt marsh grasses. In the Herring River estuary, the 1909 dike construction greatly reduced the upstream transport of inorganic marine sediment from reaching the salt marshes within the basin. Additionally, marsh drainage increased the rate of organic peat decomposition by aerating and drying the peat which has caused soil pore spaces to collapse and marsh elevations to subside. Much of the former salt marsh surface is approximately one to three feet lower than the mean high-water elevation of 4.8 feet in Wellfleet Harbor (Portnoy and Giblin 1997). Ultimately, to restore a healthy salt marsh in the Herring River, the process of marsh surface accretion needs to be restored in conjunction with restored tide levels.

- **Methane emissions**: The tidally restricted Herring River is contributing large volumes of methane (a greenhouse gas) into the atmosphere. Unlike healthy salt marshes, which produce little methane, microbial decomposition in freshwater wetland sediment releases copious methane. It is estimated that the Herring River is currently emitting 184 metric tons of methane each year (Walker 2015). Methane is estimated to be twenty times more potent as a greenhouse gas than carbon dioxide (FEIR, 3.4.4).

4.B.1.2 Wetland Habitats and Vegetation

Over the last century, reductions in tidal exchange caused by the Chequessett Neck Road dike have dramatically changed the vegetation of the Herring River floodplain, primarily resulting in the conversion of salt marsh to less salt-tolerant, upland woodland plant communities and freshwater emergent marsh and shrub wetlands. The former extensive tidal marsh is currently comprised of palustrine (freshwater) wetlands with a smaller amount of remnant salt marsh in the Lower Herring River sub-basin. Estuarine systems are those in which salinities during the period of average annual low flow exceed 0.5 ppt (Cowardin et al. 1979). Re-establishing estuarine wetlands to replace native and non-native and vegetation that has colonized the Herring River will help restore the estuary’s functions as a nursery and feeding ground for marine and estuarine animals.

The Project has developed a suite of ecosystem models that could integrate with the Herring River hydrodynamic model (WHG 2012) and provide predictions of expected future state conditions for the adaptive management plan (see Section 5, Adaptive Management). As part of that effort, Woods Hole Group (WHG) was contracted to apply the Sea Level Affecting Marshes Model (SLAMM, Warren Pinnacle 2012) to the Herring River project area. SLAMM was designed and is typically used to estimate expected changes to regional coastal wetland types resulting from predicted long-term sea level rise (e.g., 50-100 years). Its use for the Herring River project is a unique application of SLAMM. For the Herring River, potential wetland changes, driven by increased tidal range caused by tide gate management, are simulated over a 5 to 25 year time frame for a relatively small spatial area. The process for adapting SLAMM and preparing input files for this purpose is described in detail in a final report prepared by WHG (WHG 2018).

To set-up SLAMM, an input file representing existing wetland cover types was required. For the Herring River SLAMM application, two wetland data sources were used: recent vegetation map data developed by CCNS and the National Wetland Inventory (NWI) wetland maps. These data were supplemented with additional analyses using LiDAR elevation data for ground elevation and canopy height, as well as tidal datums to differentiate between regularly- and irregularly-flooded marsh. The final resulting wetland input layer is shown in Figure 4-3 below. Existing wetland cover type categories are described below and summarized in Table 4-1 below. Figure 4-4 shows sub-basin locations.

Marine Sub-Tidal: The SLAMM input data identifies 33 acres of open water within the Lower Herring River subbasin which supports an extensive bed of submerged aquatic vegetation including widgeon grass (Portnoy, Phipps, and Samora 1987; Snow 1975).

Low and High Salt marsh: The previously extensive areas of salt marsh within the approximately 1,100-acre floodplain have nearly all developed into freshwater herbaceous and wooded habitats. Currently only 70 acres of salt marsh persist upstream of the dike, mostly within the Lower Herring River sub-basin. In New England, salt marshes support salt-tolerant vegetation such as smooth cordgrass (*Spartina alterniflora*), salt marsh hay (*Spartina patens*), glasswort (*Salacornia virginica*), spikegrass (*Distichlis spicata*), black grass (*Juncus gerardii*), marsh elder (*Iva frutescens*), and groundsel bush (*Baccharis halimifolia*) (Niering and Warren 1980; Tiner 1987). Much of the Herring River salt mash area is dominated by invasive common reed (*Phragmites australis*). Of the 70 acres classified as salt marsh for SLAMM, approximately 59 acres are low marsh and 11 acres are high marsh.

Brackish marsh: Twelve acres of brackish marsh occur within the Project area, mostly within the Lower Herring River sub-basin. The remaining smaller areas lie within the Mill Creek, Bound Brook, and Pole Dike Creek sub-basins. In the Herring River, brackish marsh consists of dense stands of invasive common reed (*Phragmites australis*) with common three-square (*Schoenoplectus pungens*).

Freshwater Sub-Tidal: Thirty-six acres of freshwater aquatic habitat occurs upstream of High Toss. Although water column salinity is undetectable in these areas, bi-directional flow influenced by tidal forcing is apparent.

Fresh Emergent Marsh: There are 334 acres of freshwater marsh/meadow occurring within the Project area. Freshwater marsh habitats within the Project area are typically dominated by narrowleaf cattail (*Typha angustifolia*) with the following common associates: wool grass (*Scirpus cyperinus*), bluejoint (*Calamagrostis canadensis*), rushes (*Juncus* spp.), and American bur-reed (*Sparganium americana*). About 222 acres of fresh emergent marsh would be impacted in Phase 1 of the project.

Shrub-Scrub Freshwater Wetlands: There are 149 acres of shrubland habitat in the Project area. Common woody species within this cover type include highbush blueberry (*Vaccinium corymbosum*), sweet pepperbush (*Clethra alnifolia*), swamp azalea (*Rhododendron viscosum*), water-willow (*Decodon verticillatus*), buttonbush (*Cephalanthus occidentalis*), alder (*Alnus* spp.), and leatherleaf *(Chamaedaphne calyculata*). Common woody species within the dry shrubland habitat include northern bayberry (*Morella pensylvanica*), black oak saplings (*Quercus velutina*), and shadbush (*Amelanchier* spp.). About 102 acres of shrub-scrub wetlands would be impacted in Phase 1 of the project.

Non-Tidal Wooded Swamp: A total of 302 acres of woodland habitat currently occurs in the Project area. Woodland habitat within the Herring River floodplain represents a combination of several forested cover types dominated by black cherry (*Prunus serotina*), red maple (*Acer rubrum*), shadbush, northern arrowwood. (*Viburnum recognitum*) sweet pepperbush. and swamp azalea. About 245 acres of non-tidal wooded swamp wetlands would be impacted in Phase 1 of the project.

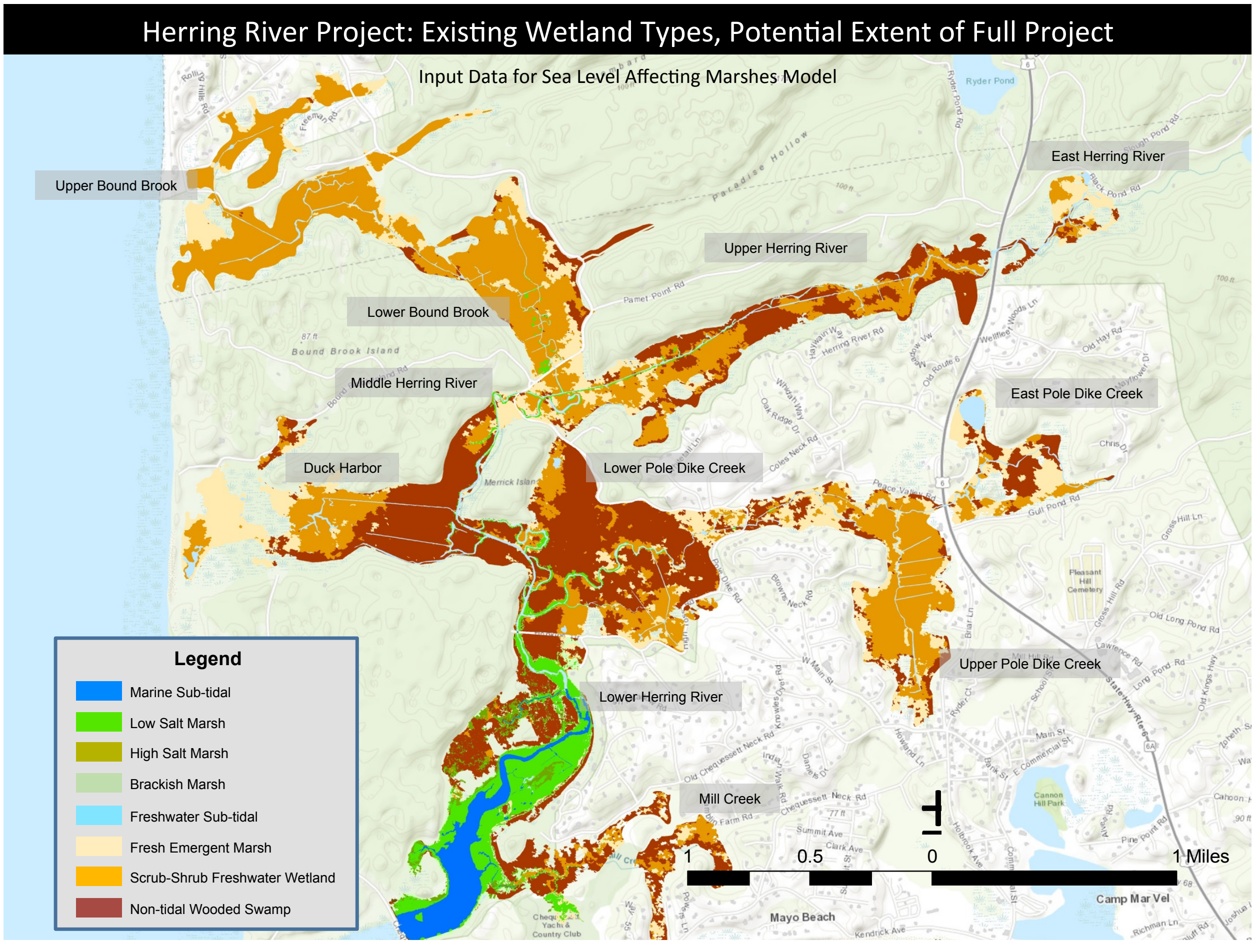

Figure 4-1. Existing Wetland Types, Potential Extent of Full Project

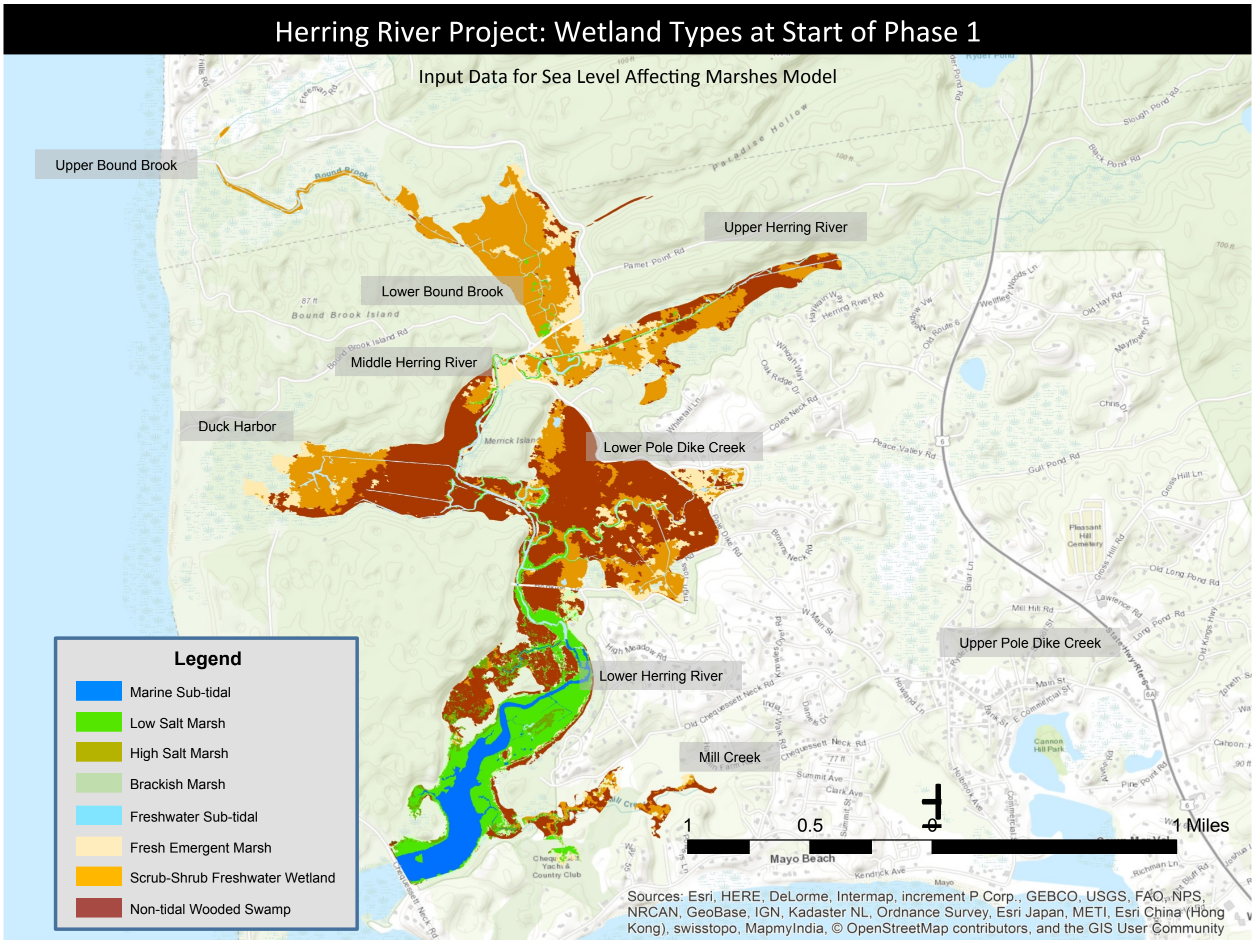

Figure 4-2. Wetland Types at Start of Phase 1

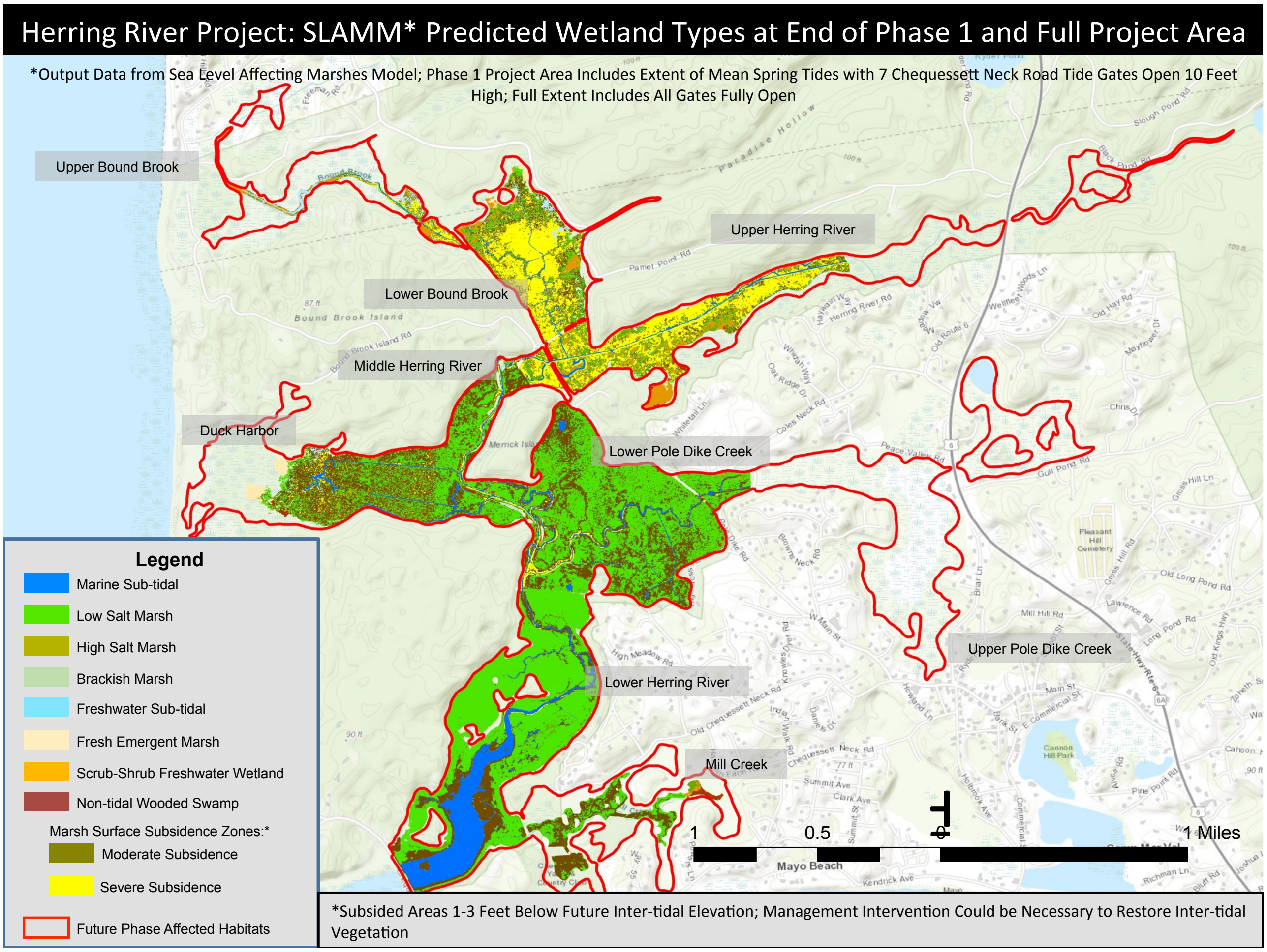

Figure 4-3. Wetland Types at End of Phase 1 and Full Project Area

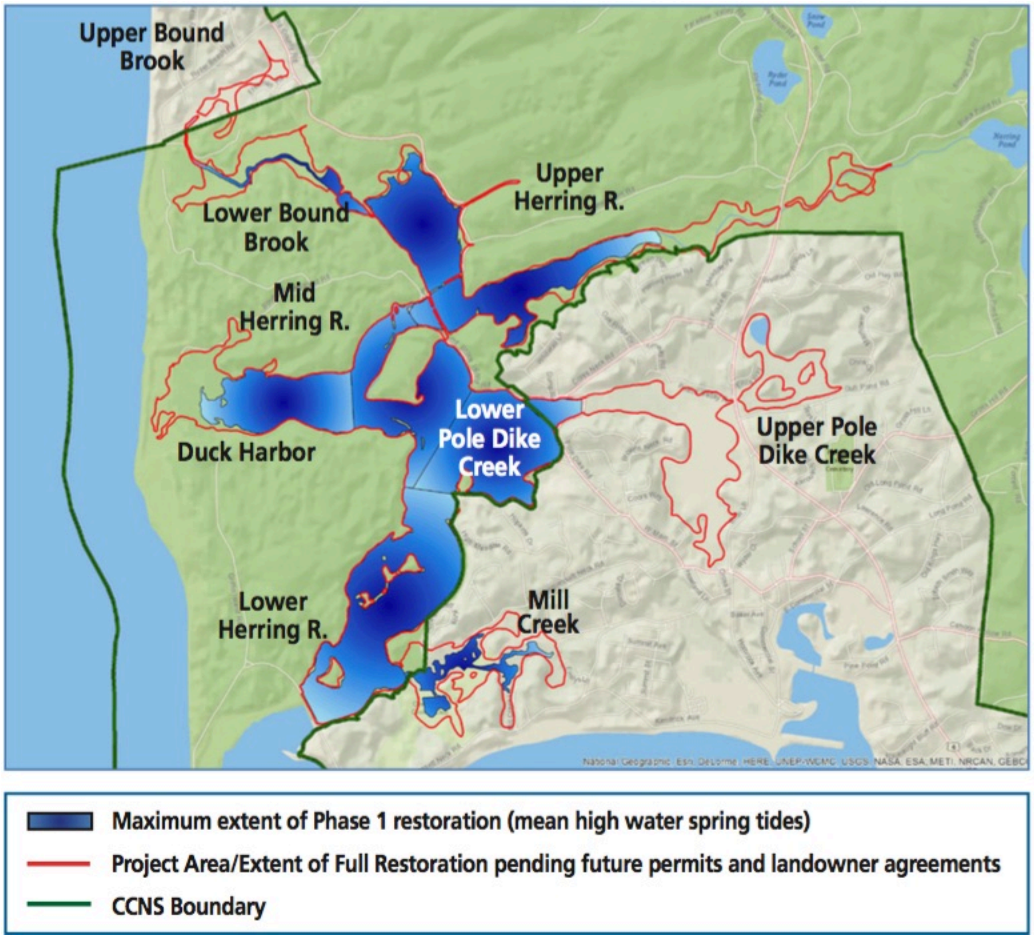

Figure 4-4. Extent of Herring River Restoration Project, Phase 1

Table 4-1. Existing and Proposed Wetland Habitat Types, Phase 1 Proposed Conditions (Acres)

	Marine Subtidal			Low Salt Marsh			High Salt Marsh			Brackish Marsh			Fresh Emergent Marsh			Scrub-Shrub Freshwater Wetland			Nontidal Wooded Swamp			Freshwater Subtidal			Subsided Areas Requiring Marsh Surface Management During Phase 1*	
	Ext.	Ph.1		Ext.	Ph.1		Ext.	Ph.1		Ext.	Ph.1		Ext.	Ph.1		Ext.	Ph.1		Ext.	Ph1		Ext.	Ph.1			
	Full Proj.	Start	End	Full Proj.	Start	End	Full Proj.	Start	End	Full Proj.	Start	End	Full Proj.	Start	End	Full Proj.	Start	End	Full Proj.	Start	End	Full Proj.	Start	End	Moderate Subsidence	Severe Subsidence
Lower Herring River	32.5	32.5	29.3	46.9	46.9	93.7	10.2	10.2	1.6	10.1	10.1	<0.1	1.8	1.8	<0.1	1.8	1.8	0.0	37.1	37.1	0.4	1.3	1.3	0.0	20.6	0.9
Mid Herring River	<0.1	<0.1	4.6	3.9	3.9	31.5	0.0	0.0	0.3	0.2	0.2	0.0	5.8	5.8	0.3	5.0	5.0	<0.1	45.1	45.1	3.5	6.4	6.4	<0.1	19.7	4.6
Upper Herring River	0.0	0.0	3.3	1.9	1.9	7.6	0.0	0.0	3.2	0.0	0.0	0.5	50.0	32.9	8.4	14.4	11.9	0.2	46.4	16.7	1.9	5.6	3.4	0.3	8.8	33.1
Mill Creek	0.0	0.0	0.0	2.4	1.8	8.5	0.4	0.2	0.4	1.2	0.6	0.0	9.7	4.6	0.4	6.4	2.4	0.0	25.1	7.7	0.8	0.0	0.0	0.0	11.3	0.0
Duck Harbor	0.0	0.0	1.8	0.0	0.0	15.8	0.0	0.0	<0.1	0.0	0.0	0.2	26.3	21.1	0.7	28.3	7.5	3.1	23.6	20.4	2.6	3.2	1.9	0.5	24.4	3.7
Lower Pole Dike Creek	0.0	0.0	3.4	2.4	2.4	84.7	0.0	0.0	0.6	<0.1	<0.1	<0.1	31.7	31.7	0.6	15.0	15.0	<0.1	82.3	82.3	2.4	3.8	3.8	<0.1	39.4	1.8
Upper Pole Dike Creek	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	56.6	56.6	56.6	24.5	24.5	24.5	14.8	14.8	14.8	3.6	3.6	3.6	0.0	0.0
Lower Bound Brook	0.0	0.0	1.4	1.0	1.0	8.7	0.0	0.0	0.6	0.0	0.0	0.5	54.0	47.1	4.3	12.3	9.1	1.1	8.8	3.7	1.2	1.6	1.6	1.5	13.5	29.7
Upper Bound Brook	0.0	0.0	0.7	0.0	0.0	1.1	0.0	0.0	<0.1	0.0	0.0	0.2	86.7	8.9	2.9	18.4	1.4	0.3	1.3	0.2	<0.1	3.4	1.6	2.7	1.5	2.4
East Pole Dike	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	7.8	7.8	7.8	15.3	15.3	15.3	13.1	13.1	13.1	5.5	5.5	5.5	0.0	0.0
East Herring River	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.7	3.7	3.7	7.7	7.7	7.7	4.1	4.1	4.1	2.0	2.0	2.0	0.0	0.0
Total	**32.5**	**32.5**	**44.5**	**58.5**	**57.9**	**251.6**	**10.6**	**10.4**	**6.7**	**11.5**	**10.9**	**1.4**	**334.1**	**222.0**	**85.7**	**149.1**	**101.6**	**52.2**	**301.7**	**245.2**	**17.2**	**36.4**	**31.1**	**16.1**	**139.2**	**76.2**

*Subsided areas 1-3 feet below future inter-tidal elevation; management intervention could be necessary to restore inter-tidal vegetation

Source: National Park Service

4.B.2 Post Restoration Wetland Resource Conditions

4.B.2.1 Sediment Transport and Soils

Restoration of sediment transport processes is a critical aspect of the Project because it will foster processes needed to rebuild subsided marsh plains and restore the dimension (width and depth) and pattern of tidal channels. In addition, the mobilization of suspended load fine materials will help to revitalize ecological processes and resources in Herring River and Wellfleet Harbor. Sediment deposition on the marsh plain and a concurrent increase in elevation to the subsided salt marsh surface is critical for the re-establishment and long-term sustainability of marsh habitat. In addition, restored sediment transport processes will concurrently result in the return of natural geomorphology of tidal channels within the Project area. This impact analysis is based primarily on findings from a quantitative sediment transport study of the Herring River system (see Appendix B in the FEIS). The bulleted section below summarizes general impacts to sediment transport and soil. Section 4.4 of the FEIS analyzes the potential impact of mobilized sediments to the former Herring River salt marsh and tidal channel system in additional detail, including changes to tidal channels, marsh surface elevation, organic and inorganic matter, upland sediment sources, and blue carbon.

- **Impacts on Sediment Transport:** In response to increased tidal flow, the fine sediments that have accumulated in the tidal channels upstream and downstream of the new water control structure will be mobilized as suspended load and suspended fines. This process is expected to be temporary and will diminish considerably once the hydrologic system reaches equilibrium with restored tidal conditions. Over a longer period, bank and bed erosion is expected to increase the dimensions of the restored tidal channels. Much of this sediment movement will take place as bedload and suspended load, and the duration of this process will largely depend on the rate at which tides are incrementally restored, as well as the size and configuration of the final Chequessett Neck Road tide gate opening. In addition, the increased size of the Chequessett Neck Road tide gate opening will alter the long-term sediment transport patterns in the marsh. Because the system is flood-dominated, the restoration of sediment transport processes will provide a source of marine sediment to the marsh surface and will be crucial to the establishment of a sustainable tidal marsh system.
- **Blue Carbon:** Changes to sediment transport and associated accretion of marsh surface elevations will also affect carbon cycling dynamics within the Herring River. Re-establishing tidal exchange will substantially increase the volume of carbon stored within the Herring River marshes. This process involves the storage of carbon from outside of the system (sequestration) and the uptake of carbon dioxide from the atmosphere through primary production within restored tidal habitats and burial in the salt marsh peat soils. It is estimated that at full restoration, several hundred metric tons of carbon would be buried beneath the floodplain each year, which is equivalent to the eliminating the emissions of several hundred cars. As noted above, the restoration will result in a substantial reduction of methane emissions, which is an even more potent greenhouse gas.

- **Impacts on Soils:** Anticipated physical and chemical changes in the soil will interact with the vegetation and wildlife that will grow on and in the soil to re-establish the complex marsh ecosystem. There will be physical changes such as when pore space redevelops as the dried soil responds to being saturated again by the tides. There will be chemical changes such as the increase in the soil pH as seawater returns to the area; this will be especially important for the highly acid Maybid Variant Silty Clay Loam soil type. There will also be changes in soil texture as the surface either loses or gains sand, silt, or clay depending on whether tidal sedimentation processes erode or deposit those materials. The organic content of the soil is likely to increase as fresh and/or salt marsh peats once again are created. While some of the characteristics used to classify the soil into named types may rapidly or slowly change, a number of characteristics will not change because they are based on the soil's parent material. Overall, there may not ultimately be enough difference to rename a soil, but the changes are of great importance to the restoration.

4.B.2.2 Wetland Habitats and Vegetation

Re-introduction of tidal flows to the Herring River floodplain will result in the widespread restoration of degraded coastal wetlands to estuarine sub-tidal and intertidal habitats. Based on hydrodynamic modeling (Appendix B in the FEIS), salinity within restored intertidal habitat will range from near full-strength seawater (approximately 30 ppt) in the lower portions closer to Wellfleet Harbor to freshwater (<5 ppt) in the upper reaches. Mid-range salinities (5 to18 ppt) will occur predominantly in the middle portions of the floodplain. High salinity (generally 18 ppt and higher) will kill salt-intolerant plants that have become established on the former salt marsh floodplain and support the re-colonization of native salt marsh plants. In areas further upstream where low to mid-range salinities will be present, a mix of brackish and freshwater hydrophytes is expected to persist (FEIR, Section 4.5). The uppermost reaches of the floodplain will likely show little to no change in the existing plant community.

Increased tidal exchange resulting from the implementation of Phase 1 of the Project will have a profound effect on the Herring River ecosystem. The majority of the floodplain is comprised of former tidally-dependent salt marshes that are now dominated by invasive common reed (*Phragmites australis*), emergent freshwater plants, and upland tree and shrub species. Restoring tidal flow to the floodplain will largely displace these plant communities with the polyhaline inter-tidal habitats that naturally occurred prior to construction of the Chequessett Neck Road dike in 1909.

SLAMM Modeling of Habitat Changes: The primary purpose for setting up and running SLAMM for the Herring River project is to develop predictions of wetland habitat change under each of the seven tide gate management policies incorporated into the adaptive management plan at several time steps over project implementation time spans ranging from 5 to 25 years (see Section 5). The resulting model outputs can also inform a detailed analysis of expected habitat types at the end of the Phase 1 implementation period.

However, because SLAMM is a relatively simple model, several ecosystem processes that are critical for restoration of inter-tidal habitats within the Herring River project area cannot be directly simulated. For example, SLAMM does not provide the ability to predict future inter-tidal habitats influenced by an estuarine salinity gradient. To overcome this for the Herring River application, direct output from SLAMM was filtered by output from the salinity module of the Environmental Fluid Dynamics Code (EFDC) hydrodynamic model (WHG 2012) to create subclasses of potential future habitat types influenced by fresh, brackish, and marine salinity ranges (WHG 2018). The SLAMM outputs depicted in Figures 4-2 and 4-3 above reflect this filtering process.

The Herring River SLAMM application predicts future habitat types using future tidal range and salinity levels without changes to the present marsh surface elevations. Since areas of the Herring River floodplain have subsided by up to three feet due to tidal restrictions and marsh ditching, SLAMM outputs are biased toward lower elevation habitats. This includes prominent areas of sub-tidal and inter-tidal mudflat habitats.

The Herring River SLAMM application outputs are not precise projections of future wetland habitat types. While marsh accretion will certainly occur as the restoration project is implemented, the rate of acretion is not known and cannot feasibly be modeled due to the inherent uncertainties associated with multiple variables that will affect accretion rates in the Herring River system. Marsh surfaces will increase in elevation as salt marsh vegetation recolonizes the floodplain and below ground biological activity in the root zone contributes to marsh elevation. The tide gate management policy to maintain artificially low tide ranges for two or more growing seasons as plants become established (i.e., “policy 2G”, described in Section 11(D)(2)) is intended to hasten this process. In addition, the areas with the greatest degree of subsidence are expected to function as sediment “sinks”, receiving higher levels of natural sediment deposition as tide range is increased and thereby accreting at faster rates than other zones. Similar to the “2G” tide gate management policy, the “Sediment” tide gate policy (see Section 11(D)(2)) is also designed to favor increased sediment deposition and retention in subsided areas.

In summary, the specific habitat conditions predicted by SLAMM are not the precise desired or expected habitat outcomes for the project because they don’t account for marsh accretion during restoration. Nonetheless, the SLAMM outputs are useful for illustrating general habitat changes (i.e., from non-tidal to tidal marsh) and for targeting zones for enhanced monitoring and potential implementation of secondary management actions. The most subsided areas are expected to receive the greatest degree of sediment deposition as tidal flow is increased. If supported by hydrodynamic (i.e., tide range, hydroperiod) and sediment (i.e., total suspended sediment, soil bulk density, accretion and surface elevation) monitoring data, tide gate policies and secondary management actions (such as supplementation of the sediment budget) will be implemented to favor increased marsh elevations. The objectives for management of subsided area is to establish marsh elevations that support as much inter-tidal vegetated habitat as possible.

Summary of Habitat Changes: Existing wetland habitat types are shown in Figure 4-1 for the full project area and in Figure 4-2 for the Phase 1 project area. Potential future habitat types at the end of Phase 1 are shown in Figure 4-3. Figure 4-3 also depicts areas of moderate and severe subsidence which were projected by SLAMM to be tidal flat and sub-tidal habitats, respectively. In general, moderately subsided areas are located in the Duck Harbor, Middle Herring River, and Lower Pole Dike Creek sub-basins. These areas, shown in brown on Figure 4-3, are approximately 1-2 feet below the expected inter-tidal zone where salt marsh vegetation can grow. Through natural accretion associated with restored tidal flow and potential management intervention, these areas are expected to eventually develop into inter-tidal salt marsh. Severely subsided areas, show in yellow on Figure 4-3, located primarily in the Lower Bound Brook sub-basin, are 2-3 feet below future inter-tidal elevations and will take longer and likely a greater degree of management to recover sufficient elevation.

Coverage of existing and potential future habitat types projected by SLAMM are compared for each sub-basin in Table 4-1. In addition to the moderate and severely subsided areas shown on Figure 4-3, elevations are expected to generally increase on marsh surfaces and decrease in marsh channels throughout the floodplain. The SLAMM outputs are biased toward lower elevation estuarine wetland types and should be considered approximate, relative projections of future wetland habitats. SLAMM analyses and other methods of predicting future conditions will improve as the project is implemented and data from the actual response of the system are collected and assessed.

Restoration will lead to significant transitions in habitat types system-wide. These include a 12-acre increase in marine sub-tidal habitat and a 193.7-acre (330%) increase in low salt marsh. Virtually all other habitat types will decrease system-wide, including a 3.7-acre decrease in high salt marsh, a 9.5-acre decrease in brackish marsh, a 136.3-acre decrease in fresh emergent marsh, a 49.5-acre decrease in scrub shrub, and a 228 acre decrease in non-tidal wooded swamp. The relative degree of change in water level and salinity influences the particular habitat changes in each sub-basin.

- **Lower Herring River:** Closest to the tidal opening at Chequessett Neck Road, low salt marsh will increase 46.8 acres (100%) and marine sub-tidal habitat will increase 3.2 acres. A comparable amount of decreased acreage will occur in the categories of scrub-shrub freshwater (1.8 acres), non-tidal wooded swamp (36.7 acres), and freshwater sub-tidal swamp (1.3 acres). There is no change in fresh emergent marsh.
- **Mid Herring River:** The effects of increased salinity will also be apparent in Mid Herring River, with a 4.5-acre increase in marine sub-tidal where less than one-tenth of an acre currently exists; a 27.6 acres increase of low salt marsh; and a slight 0.3-acre increase in high salt marsh. Corresponding decreases in the following habitat types will occur: brackish marsh (0.2 acre), Fresh emergent marsh (5.5 acres), scrub-shrub freshwater (5 acres), freshwater sub-tidal (6.4 acres; and non-tidal wooded swamp (41.6 acres).
- **Upper Herring River:** In Upper Herring River, marine sub-tidal habitat will increase 3.3 acres and brackish marsh will increase .5 acres, where currently none of these habitat types exists. There also will be a 5.7-acre increase in low salt marsh and a 3.2-acre increase in high salt marsh. These habitat gains correspond to a 24.5-acre decrease in fresh emergent marsh; an 11.8-acre decrease in scrub-shrub freshwater wetland; a 14.8-acre decrease in non-tidal wooded swamp and 3-acre decrease in freshwater sub-tidal marsh.

- **Mill Creek:** Limited restoration in Mill Creek will result in less dramatic changes in habitat types. A 6.9-acre decrease in non-tidal wooded swamp and a 2.4-acre decrease in scrub-shrub freshwater wetland will be offset by a 6.7-acre gain in low salt marsh and a .2-acre gain in high salt marsh.
- **Duck Harbor:** In Duck Harbor marine sub-tidal (1.8-acres) and low salt marsh (15.8-acres) will appear where none previously existed. These gains offset decreases in fresh emergent marsh (20.4-acres), scrub-shrub freshwater wetland (4.4-acres) and non-tidal wooded swamp (17.8-acres).
- **Lower Pole Dike Creek:** Lower Pole Dike Creek will see a 3.4-acre increase in marine subtidal habitat and an 82.3-acre increase in low salt marsh where less than three acres currently exists. These gains offset decreases in less salt-tolerant habitat types, including losses of freshwater emergent marsh (31.1 acres), scrub-shrub marsh (15 acres) and non-tidal wooded swamp (79.9 acres)
- **Upper Pole Dike Creek:** Tidal restoration will be prevented from entering Upper Pole Dike Creek. As a result, habitat changes will be very limited in that sub-basin, and mainly attributable to improved drainage.

4.B.2.3 Wetland Impacts Associated with Tidal Control Elements and Mitigation

In addition to the restoration-driven changes in wetland vegetation described above, there will be permanent and temporary (construction-related) impacts to wetland resource areas associated with the tide control elements and mitigation measures. These impacts are necessary to achieve the benefits of restoring 570 acres of tidal wetland resources. The designs of tide control measures and elevated tide protection mitigation actions are based on a careful alternatives assessment to select measures capable of supporting restoration objectives while avoiding or minimizing impacts to wetland resources. Table 4-2 provides a summary of wetland resource alteration associated with tide control project elements, and Table 4-3 provides a summary of wetland resource alteration associated with elevated tide protection mitigation measures. Table 4-4 provides a summary of tide control and mitigation impacts. Supporting tables providing wetland resource alterations for each project element and mitigation measure are provided following the discussion of wetland resource objectives.

Table 4-2. Summary of Wetland Protection Act Resource Area Impacts for Tide Control Elements[1]

	Resource Area	Units	CNR Bridge		Mill Creek Water Control Structure		High Toss Road Causeway		Pole Dike Rd Water Control Structure		Total Impact	
			Impact		Impact		Impact		Impact			
			P	T	P	T	P	T	P	T	P	T
Coastal	Land Under Ocean	SF	15,066	6,274	491	8,958	N/A	N/A	N/A	N/A	**15,557**	**15,232**
	Salt Marsh	SF	12,909	4,393	4,274	23,115	N/A	N/A	N/A	N/A	**17,183**	**27,508**
	Coastal Beach (Tidal Flats)	SF	7,971	1,078	N/A	N/A	N/A	N/A	N/A	N/A	**7,971**	**1,078**
	Land Containing Shellfish[2]	SF	36,713	11,060	N/C	N/C	N/A	N/A	N/A	N/A	**36,713**	**11,060**
	Land Subject to Coastal Storm Flowage[3]	SF	88,128	103,089	60,586	59,730	N/C	N/C	N/C	N/C	**148,714**	**162,819**
Inland	Bordering Vegetated Wetlands	SF	948	2,419	16,614	7,862	N/A	5,250	15,348	14,183	**32,910**	**29,714**
	Land Under Water	SF	N/A	N/A	N/A	N/A	N/A	120	618	85	**618**	**205**
	Inland Bank	LF	N/A	N/A	N/A	N/A	N/A0	100	99	12	**99**	**112**
	Riverfront Area[4]	SF	50,444	45,832	39,064	29,967	N/A	8,170	N/C	N/C	**89,508**	**83,969**

N/A = Not applicable

N/C = Not calculated at this time

[1]Summary table does not include resource area impacts associated with habitat conversion project-wide. Impacts to Buffer Zones and Coastal Bank are not available at this time. Impacts to Fish Run will be included in Coastal Bank, Land Under Ocean, inland Bank and/or Land Under Water, as appropriate.

[2] Land Containing Shellfish refers to the total project site area within the boundaries of the mean higher high water (MHHW) levels upstream and downstream of the CNR dike.

[3] Land Subject to Coastal Storm Flowage refers to the total project site area within the boundaries of the FEMA Flood Insurance Rate Map 100-year flood zone.

Note: Land Subject to Coastal Storm Flowage (LSCSF) and Riverfront Area overlap with each other and with other resource areas; therefore, any given square-foot of impacted area might be counted in more than one table row, i.e., impact to Bordering Vegetated Wetland (BVW) for the High Toss Road causeway removal is also impact to LSCSF and may be impact to Riverfront Area depending on the location.

[4] Riverfront Area refers to the total project site area within 200-feet of the mean high water (MHW) line of perennial streams (for tidal rivers) or within 200-feet of the mean annual high water (MAHW) line of perennial streams (for inland rivers

Table 4-3. Summary of Wetland Protection Act Resource Area Impacts for Mitigation Elements[1]

Resource Area		Units	Drainage Associated with Mill Creek WCS		CYCC		High Toss Road Elevation		Low Lying Road Elevations		Way #672 Tide Barrier		Total Impact	
			Impact		Impact		Impact		Impact		Impact			
			P	T	P	T	P	T	P	T	P	T	P	T
Coastal	Land Under Ocean	SF	N/A	575	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	**N/A**	**575**
Coastal	Salt Marsh	SF	N/A	2,530	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	**N/A**	**2,530**
Coastal	Coastal Beach (Tidal Flats)	SF	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	**N/A**	**N/A**
Coastal	Land Containing Shellfish[2]	SF	N/A	N/C	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	**N/A**	**N/C**
Coastal	Land Subject to Coastal Storm Flowage[3]	SF	N/A	49,530	888,900	N/C	178,848	N/C	N/C	N/C	N/C	N/C	**1,067,748**	**49,530**
Inland	Bordering Vegetated Wetlands	N/A	N/A	37,140	12,000	N/C	11,000	18,930	98,685	33,370	9,050	1,110	**130,735**	**90,550**
Inland	Land Under Water	N/A	N/A	9,285	600	N/C	0	160	618	3,043	485	N/A	**1,703**	**12,488**
Inland	Inland Bank	N/A	N/A	N/A	400	N/C	20	20	99	227	77	N/A	**596**	**247**
Inland	Riverfront Area[4]	N/A	N/A	39,670	N/A	145,736	16,390	1,150	N/C	N/C	N/C	N/C	**16,390**	**186,556**

N/A = Not applicable

N/C = Not calculated at this time

[1]Summary table does not include resource area impacts associated habitat conversion project-wide. Impacts to Buffer Zones and Coastal Bank are not available at this time. Impacts to Fish Run will be included in Coastal Bank, Land Under Ocean, Inland Bank and/or Land Under Water, as appropriate.

[2] Land Containing Shellfish refers to the total project site area within the boundaries of the mean higher high water (MHHW) levels upstream and downstream of the CNR dike.

[3] Land Subject to Coastal Storm Flowage refers to the total project site area within the boundaries of the FEMA Flood Insurance Rate Map 100-year flood zone.

[4] Riverfront Area refers to the total project site area within 200-feet of the mean high water (MHW) line of perennial streams (for tidal rivers) or within 200-feet of the mean annual high water (MAHW) line of perennial streams (for inland rivers).

[5] Mitigation at CYCC will permanently impact 476,100 SF of Isolated Vegetated Wetland (IVW) regulated under the local WPA bylaw and at the state level through the Water Quality Certification program.

Table 4-4. Summary of Combined Wetland Resource Area Impacts Associated with Tide Control and Mitigation Elements[1]

Resource Area		Units	Total Impact	
			P	T
Coastal	Land Under Ocean	SF	**15,557**	**15,807**
	Salt Marsh	SF	**17,183**	**30,038**
	Coastal Beach (Tidal Flats)	SF	**7,971**	**1,078**
	Land Containing Shellfish[2]	SF	**36,713**	**11,060**
	Land Subject to Coastal Storm Flowage[3]	SF	**1,216,462**	**212,349**
Inland	Bordering Vegetated Wetlands	N/A	**163,645**	**120,664**
	Land Under Water	N/A	**4,261**	**10,135**
	Bank	N/A	**746**	**209**
	Riverfront Area[4]	N/A	**105,898**	**270,525**

N/A = Not applicable

N/C = Not calculated at this time

1 Summary table does not include resource area impacts associated with habitat conversion project-wide. Impacts to Buffer Zones and Coastal Bank are not available at this time. Impacts to Fish Run will be included in Coastal Bank, Land Under Ocean, Inland Bank and/or Land Under Water, as appropriate.

2 Land Containing Shellfish refers to the total project site area within the boundaries of the mean higher high water (MHHW) levels upstream and downstream of the CNR dike.

3 Land Subject to Coastal Storm Flowage refers to the total project site area within the boundaries of the FEMA Flood Insurance Rate Map 100-year flood zone.

4 Riverfront Area refers to the total project site area within 200-feet of the mean high water (MHW) line of perennial streams (for tidal rivers) or within 200-feet of the mean annual high water (MAHW) line of perennial streams (for inland rivers).

4.B.3 Response to Wetland Resources Objectives

The Wetlands Resources goal of the RPP is to protect, preserve, or restore the natural values and functions of inland and coastal wetlands and their buffers. The Project meets this goal by restoring the health and functioning of coastal wetland resources in the Herring River floodplain. Restoration will be accomplished by returning tidal flow to the system incrementally and in accordance with an adaptive management program. The restoration of tidal flow and reconnection of the estuary to Cape Cod Bay will repair the substantial damage to natural wetland functions and ecology caused by the construction of artificial tide control structures throughout the floodplain (See section 3.A of this Application.) The existing structures were expressly designed to prevent tidal flow and undermine the natural functioning and health of coastal wetlands resources. Phase 1 of the restoration, which is the subject of this Application, would restore the health and natural functioning of 570 acres of degraded tidal wetlands, including elevation of more than 200 acres of severely subsided marsh plain. All water control measures and mitigation measures have been designed to avoid or minimize temporary and permanent impacts to inland and coastal wetland resources, which are necessary to achieve the expansive benefits of tidal wetlands restoration. It is noted that Phase 1 encompasses all tide control infrastructure necessary for full tidal restoration of 890 acres of degraded tidal wetlands pending additional permits, permit amendments and agreements with property owners for any mitigation measures necessary to protect vulnerable structures from potential impacts under full restoration conditions.

Objective WT 1 – Protect wetlands and their buffers from vegetation and grade changes

Wetlands and their buffers must not be altered except in the limited circumstances set forth in the Commission's Wetland Resources Technical Bulletin, and where the applicant can show that there is a public benefit, that there is no feasible alternative, and the impacts from the alteration have been mitigated. The limited circumstances outlined in the Commissions bulletin include water dependent structures and uses "designed to achieve a public benefit such as water quality improvement." For such projects, "[w]here alterations cannot be avoided, a public benefit should be demonstrated, development impacts should be minimized, and applicant (sic) must show there is not feasible alternative."

The Restoration Project meets objective WT 1 as shown by the following information:

WT1 Response 1. The tide control structures and mitigation measures that are the subject of this permit application are water dependent structures and/or uses. Each of the tide control structures is necessary to implement the restoration of tidal flow incrementally while avoiding harm to resource areas and private and public structures. Similarly, the mitigation measures are needed to protect public and private structures from potential adverse impacts associated with the return of tidal flow. The role each tide control structure and mitigation measure plays in the restoration project is described in Section 3.B.

WT1 Response 2. Proposed water dependent structures and uses are necessary to achieve a substantial public benefit. The broad public benefits associated with the restoration facilitated by the tide control structures and protective mitigation measures includes: improved marine water quality; restoration of 570 acres of wetlands and associated aquatic and avian habitat; increased carbon storage and substantially reduced methane emissions; restoration of shellfish habitat, reconnection of estuarine wetlands and habitat with the marine environment; elevation of subsided marsh and elimination of acid sulfate soils; and increased waterways access and recreational opportunities.

WT1 Response 3. The design of water dependent structures is based on extensive analysis of alternatives (see Section 3.B). The design approaches selected reflect the designs deemed most effective at achieving restoration goals while avoiding or minimizing adverse impacts, including avoidance and minimization of alteration to wetland resource areas and buffers. Selected designs have been further modified to avoid or minimize alteration of wetland impacts to the maximum extent possible.

WT1 Response 4. Development activity proximate to wetlands that is necessary to accomplish the restoration of tidal wetlands will result in minor changes in vegetation, grade, or sun exposure or nutrient inputs to wetland or buffer areas, as described below. The development activity is necessary to achieve the broader public benefits associated with restoration of 570 acres of tidal wetlands: Each project element has been design to achieve the benefits of restoration and avoid or minimize negative impacts to wetland resources to the maximum extent practicable.

- Sun exposure may be altered by the Mill Creek water control structure, where no structure currently exists; and at the new Chequessett Neck Road bridge, which will include a larger platform area. Sun exposure will not be altered for any wetland resource or buffer proximate to construction of High Toss Road, Pole Dike Creek water control structure, or low road elevation work.

- Grades adjacent to elevated roadways will be increased slightly, to 3:1. The increase in grade is necessary to accommodate the elevation and provide safe passage for autos, equestrians, bicycles and pedestrians, while minimizing the increase in road surface area and associated impact to wetland resource or buffer area (see Section 3.B).

- Areas adjacent to elevated roadways and tide control structures will be re-graded and re-vegetated with indigenous species, subject to Orders of Condition issued by the Conservation Commissions of the Towns of Wellfleet and Truro, respectively (see Section 3.B).

- The CNR bridge will incorporate enhanced stormwater management measures which capture and treat stormwater run-off and reduce nutrient inputs to wetland resource areas and buffers (see WR-4, finding 1, above)

Objective WT 2 – Protect wetlands from changes in hydrology

The Project will restore historic hydrology, which had been altered by the introduction of tidal obstructions. The Restoration Project meets this objective based on the following information:

WT2 Response 1. This Project does not propose water withdrawals greater than 20,000 gpd in proximity to wetlands. Therefore, the methods for demonstrating compliance with WT 2 for such projects do not apply.

WT2 Response 2. The Project will improve stormwater management over existing conditions. As described in WR-4, finding 1, the project meets the definition of redevelopment under the state stormwater regulations. The standard for stormwater management for redevelopment projects is improvement over existing conditions. As described in Section 3.B and WR-4, finding 1, the project will substantially improve stormwater management over existing conditions, resulting in greater infiltration and reduced potential for inputs in adjacent wetland resources and buffer areas.

WT2 Response 3. Restoration of tidal flow will restore wetland hydrology in a manner that serves a public purpose by restoring estuarine wetland habitat and improving water quality in a Commonwealth designated Outstanding Resource Water. The current tidally restricted environment of the Herring River is an artificial condition created by the installation of the Chequessett Neck Road dike. The Project is seeking permits under the MA Wetlands Protection Act (WPA) regulations. These and other applicable regulations protect wetlands and the important public interests they serve, including clean water, protection from storm damage, and provision of fisheries, shellfish, and wildlife habitat. For example, the WPA Ecological Restoration Limited Project provisions explicitly allow approval of tidal restoration projects while also ensuring that the "built environment", including structures and infrastructure, is not impacted by significant increases in water levels and storm damage. In the case of the Herring River, where the estuary and the public interests it supports have become so severely degraded over the past century, the WPA allows regulators to approve the return of tidal flow to revive the damaged river and its wetlands, so long as the proposed work complies with applicable WPA provisions.

Objective WT 3[14] – Protect wetlands from stormwater discharges

The Restoration Project meets this objective based on the following information:

WT3 Response 1. The Project will improve stormwater management over existing conditions. As described in WR-4, finding 1, the Project meets the definition of redevelopment under the state stormwater best management practices. The standard for stormwater management for redevelopment projects is improvement over existing conditions. As described in Section 3.B and WR-4, finding 1, the Project will substantially improve stormwater management over existing conditions, resulting in greater infiltration and reduced potential for inputs in adjacent wetland resources and buffer areas.

WT3 Response 2. The CNR bridge design includes stormwater best management practices that will capture and treat runoff from the bridge and also from Griffin Island that currently flows directly into Salt Marsh and the Herring River. Drainage improvements at the intersection of High Toss Road and Hopkins Drive will also capture and treat existing runoff from beyond the Project footprint, much of which currently flows untreated into BVW. The elevation of low-lying roadways is designed to direct the majority of runoff to swales instead of allowing it to continue flowing directly into adjacent wetlands.

Objective WT 4 – Promote the restoration of degraded wetland resource areas

According to the Wetland Resources Technical Bulletin, the Regional Policy Plan "encourages the restoration of degraded natural habitats and natural communities…Measures to restore altered or degraded inland or coastal wetlands, including…. restoration of tidal flushing are encouraged." Phase 1 of the Herring River Restoration Project is the largest coastal wetland restoration project on Cape Cod. The Restoration Project meets this objective based on the following information:

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[14] The Limited Scoping Decision (March 7, 2019) states that review of this objective "is limited to the stormwater management associated with proposed water control structures and low-lying roadways."

WT4 Response 1. The Project will restore degraded wetlands and improve natural wetland functions, restore native vegetation, enhance natural coastal processes, function and sediment movement. By restoring native tidal wetland habitat to large portions of the Herring River estuary, the Project will:

- To the extent practicable, given adjacent infrastructure and other social constraints, re-establish the natural tidal range, salinity distribution, and sedimentation patterns of the former 1,100-acre estuary;
- Improve estuarine water quality for resident estuarine and migratory animals including fish, shellfish, and waterbirds;
- Protect and enhance harvestable shellfish resources both within the estuary and in receiving waters of Wellfleet Harbor;
- Restore the connection between the estuary and the larger marine environment to recover the estuary's functions as (1) a nursery for marine animals and (2) a source of organic matter for export to near-shore waters;
- Remove physical impediments to migratory fish passage to restore once-abundant river herring and eel runs;
- Re-establish the estuarine gradient of native salt, brackish, and freshwater marsh habitats in place of the invasive non-native and upland plants that have colonized most parts of the degraded floodplain;
- Restore normal sediment accumulation on the wetland surface and the accumulation of below ground organic material (peat) to counter subsidence of the former saltmarsh and to allow the Herring River marshes to accrete in the face of sea-level rise;
- Re-establish the natural control of nuisance mosquitoes by restoring tidal range and flushing, water quality, and predatory fish access;
- Restore the expansive marshes and tidal waters that were once a principal maritime focus of both Native Americans and European settlers of outer Cape Cod in a manner that preserves the area's important cultural resources;
- Minimize adverse impacts to cultural resources during project construction and adaptive management phases;
- Minimize adverse impacts to surrounding land uses, such as domestic residences, low-lying roads, wells, septic systems, commercial properties, and private property, including CYCC;
- Educate visitors and the general public by demonstrating the connection between productive estuaries and salt marshes and a natural tidal regime;
- Improve finfishing and shellfishing opportunities; and
- Enhance opportunities for canoeing, kayaking, and wildlife viewing over a diversity of restored wetland and open-water habitats.

WT4 Response 2. The Project will remove structures currently located in the flood hazard area. The structures to be removed include a portion of High Toss Road that crosses the floodplain. The removal of this segment of dirt roadway will eliminate an impediment to tidal flow. In addition, two residential structures currently located in the flood hazard area will be removed. These structures are within the boundary of CCNS in the Lower Herring River basin and would be innundated by restoring tidal flow to the main river basin. These properties are at very low elevations and would be affected early on in the restoration process. Unlike potentially affected structures elsewhere in the floodplain, there are no tide control structures that can minimize or prevent impacts. In light of the importance of these parcels for achieving the goals of the restoration, and the lack of options for protecting the structures, the CCNS negotiated with the private owners and acquired the two properties. The structures and onsite wastewater treatment systems on each property will be removed prior to tidal restoration.

WT4 Response 3. The Project will remove invasive species from wetland resource areas where it will improve the natural functions of the wetland. The roughly 1,100-acre Herring River floodplain currently contains approximately 45 acres of common reed. Restoration of tidal exchange will increase water column salinity in the Lower Herring River sub-basin to 20 ppt and higher. This rapid increase in salinity and the higher water levels are expected to quickly stress common reed and lead to die-off and eventual re-colonization of native salt marsh species. Consequently, in the Lower Herring River sub-basin, the restoration of tidal flow will be the primary means of common reed control. However, cutting and removal of material prior to the return of tidal flow will also be considered. (See Section 5., Adaptive Management, subsection on vegetation management for information on the proposed treatment and monitoring of common reed.)

4.C Wildlife and Plant Habitat (WPH)

4.C.1 Existing Conditions

4.C.1.1 Aquatic Species

In terms of the number and diversity of species, estuaries rank along with coral reefs and tropical rain forests as the most productive ecosystems on earth. They serve as a nursery for forage species and help support the food chain for a sustainable fishery. However, the loss of tidal flow and resulting changes in salinity have profoundly influenced the diversity of estuarine species in Herring River. In general, the area immediately downstream of the Chequessett Neck Road dike is characterized by estuarine species that are dependent on marine conditions. The abrupt change in salinity and tidal flushing in the Lower Herring River basin between the dike and High Toss Road results in a dramatic change in species richness and abundance, with species more tolerant of lower salinities becoming more dominant as one moves landward. Upstream of High Toss Road only freshwater-dependent or migratory anadromous/catadromous species are found (HRRC 2016).

Section 3.6 of the FEIS includes inventories and observations of aquatic fauna that currently exist within the Herring River estuary and the receiving waters of Wellfleet Harbor (HRRC 2016). Estuarine fish, macroinvertebrates, anadromous/catadromous fish, and shellfish are briefly summarized below.

- **Estuarine fish:** Compared to conditions prior to the construction of the Chequessett Neck Road dike, existing conditions in the Herring River estuary provide greatly reduced habitats for spawning, nursery, and feeding for many young and adult fish and shellfish species. Common estuarine fish that currently use the lower Herring River include Atlantic menhaden (*Brevoortia tyrannus*), four-spine stickleback (*Apeltis quadracus*) and mummichog (*Fundulus heteroclitus*) (Gwilliam 2005 unpublished data in Roman and James-Pirri 2011).

- **Shellfish and Other Macroinvertebrates:** Oysters (*Crassostrea virginica*), quahogs (*Mercenaria mercenaria*), and softshell clams (*Mya arenaria*) constitute the most common shellfish in Wellfleet Harbor and Herring River downstream of the dike, with oyster and quahog being the two most abundant and economically important species. No softshell clams were found in Herring River upstream of the Chequessett Neck Road dike in a 1984 survey. Other species, including blue mussels, razor clams, surf clams, and bay scallops are found downstream of the Chequessett Neck Road dike (Town of Wellfleet 1995). Due to degraded habitat conditions, harvesting of shellfish in Herring River is prohibited. DMF has designated the Chequessett Neck Road dike as a point source for bacterial contamination and closed shellfish beds downstream of the Chequessett Neck Road dike to harvesting due to high bacteria concentrations in the water. A study conducted by CCNS between 2013 and 2015 showed that the benthic community composition differed among three sections of the river, with the freshwater Upper Herring River having a completely different community composition than the saltier Lower Herring River and Downstream sections which were quite similar. Amphipods dominated the salty estuarine sections with significant co-occurrence of gastropods, polychaetes, and bivalves. In the benthos of the fresh, upstream section, larval insects dominated with significant co-occurrence of isopods and bivalves (Fox et. al. 2017).

- **Anadromous/catadromous fish:** Six migratory fish including five anadromous species – alewife (*Alosa pseudoharengus*), blueback herring (*Alosa aestivalis*), hickory shad (*Alosa mediocris*), white perch (*Morone americana*), and striped bass (*Morone saxatilis*), along with one catadromous species – American eel (*Anguilla rostrata*) – are found in the Herring River.

Historically, the Herring River was home to a robust river herring fishery. Town records report the annual river herring harvest to be 200,000-240,000 fish (the total run would have been much larger) (Wellfleet Town Reports, 1889, 1890). More recently, annual herring counters using Massachusetts DMF sample-census methodology have estimated the river herring run to be 17,035 (2009), 12,523 (2010), 12,523 (2011), and 8,044 (2017) (Association to Preserve Cape Cod). The headwater ponds of the Herring River provide approximately 157 acres of spawning habitat for river herring. However, the current two-foot by six-foot sluice gate opening at the Chequessett Neck Road dike is undersized, making it more difficult for fish to reach spawning areas. While other factors, such as offshore fishing and abundance of predators, have likely contributed to some of the decrease in river herring runs in Herring River and other areas throughout the northeast United States, construction of the dike has been a major factor in the decrease in river herring within the Herring River system (Curley et al. 1972).

4.C.1.2 Rare, Threatened, and Endangered Species

As part of the permitting process, the project proponents will complete consultations required under the Federal and Massachusetts Endangered Species Acts. The HRRP will require completion of a Biological Evaluation under Section 7 of the Endangered Species Act, which will be completed in consultation with the USFWS. Additionally, the HRRP will develop a Habitat Management Plan for state-listed species in coordination with the Massachusetts Natural Heritage and Endangered Species Program (NHESP).

To date, two federally threatened species have been identified as potentially utilizing portions of the Project area, including the rufa red knot (*Calidris canutus rufa*) and the northern long-eared bat (*Myotis septentrionalis*).

- **Rufa red knot:** The rufa red knot is a medium-sized shorebird which has been recorded as a spring migrant on Cape Cod, but is more commonly present as a mid-summer to early fall migrant (Harrington et al. 2010a; Harrington et al. 2010b).
- **Northern long-eared bat:** The northern long-eared bat is a widespread species found from Maine to North Carolina on the US Atlantic Coast. During the summer, northern long-eared bats roost in forested habitat underneath bark. During the evening, northern long-eared bats can be found foraging in a variety of forested and non-forested habitats. During winter, northern long-eared bats hibernate in caves and mines. The northern long-eared bat is one of the species of bats most impacted by the disease white-nose syndrome, which was the primary reason behind the species' listing in 2015.

Currently, six state-listed wildlife species occur within the Herring River Project area: three birds, American bittern (*Botaurus lentiginosus*), least bittern (*Ixobrychus exilis*), and northern harrier (*Circus cyaneus*); two reptiles, diamondback terrapin (*Malaclemys terrapin*) and eastern box turtle (*Terrapene c. carolina*); and one invertebrate, water-willow stem borer (*Papaipema sulphurata*).

- **American bittern:** The American bittern is a medium-sized bird that spends most of its time hidden among marshland vegetation. Despite the presence of potential nesting habitat and call-playback survey results that have previously indicated the presence of American bitterns (Erwin, Conway, and Hadden 2002), there is no documentation of nesting activity of this species within the Herring River Project area.
- **Least bittern:** The least bittern is the smallest member of the heron family. Suitable habitats include fresh and brackish water marshes (Gibbs et al. 2009). Although call-playback survey results indicate the presence of least bitterns (Erwin, Conway, and Hadden 2002), there is no documentation of nesting activity within the Herring River Project area. However, more recent sightings of the least bittern in the Herring River floodplain during the breeding season may indicate that the species could be nest in some years (Broker n.d.; unpublished data).
- **Northern harrier:** Northern harriers, a slim, long-legged accipiter, are uncommon summer residents or migrants in Massachusetts. Field surveys from 2004 to 2006 indicated a relatively small breeding population at CCNS and one to two nesting locations within the Bound Brook sub-basins (Bowen 2006).
- **Diamondback terrapin:** The diamondback terrapin, a marine turtle, uses brackish marsh habitats for foraging and sandy shoreline habitats for nesting. The brackish marshes along the periphery of Wellfleet Harbor support the northernmost population on the East Coast. Terrapin populations were decimated in the 19th century by overharvesting for food. They recovered by the mid-20th century, but now face renewed pressures from loss or degradation of nesting habitats to development, increased nest predation by raccoons and skunks, and increased adult mortality from road kills (Cook 2008a).
- **Eastern box turtle:** Although listed as a Species of Special Concern under the Massachusetts Endangered Species Act (MESA), eastern box turtles are relatively common terrestrial reptiles on Cape Cod that use dry and moist woodland and freshwater marsh habitats (R. Cook pers. comm. 2011, as reported in HRRC 2016). Pine barrens and oak thickets present in areas adjacent to the Herring River estuary are optimal habitat types for this species.
- **Water-willow stem borer:** The water-willow stem borer is a globally rare, noctuid moth found only on the coastal plain of southeastern Massachusetts and Cape Cod. Water-willow stem borer larvae feed almost exclusively on water-willow (*Decodon verticillatus*), a freshwater wetland plant widely distributed throughout New England. Numerous stands of water-willow support the stem borer along the margins of the Herring River and its tributaries.

Section 3.7 of the FEIS describe the protected species and their current status within the Herring River estuary in greater detail (HRRC 2016).

4.C.1.3 Terrestrial Wildlife

Over 450 species of amphibians, reptiles, fish, birds, and mammals are known to inhabit the diverse array of upland, wetland, and coastal ecosystems found in CCNS and the Herring River floodplain. The Project area provides year-round habitat for many of these species, and for others provides seasonal nesting, migration, and/or over-wintering habitat. Information on the birds, mammals, and reptiles and amphibians present in the Project area are briefly described below. Section 3.8 of the FEIS provides a more detailed discussion on the occurrence of terrestrial wildlife, marine mammals and sea turtles, waterbirds, and other species that inhabit Seashore woodlands, heathlands, grasslands, swamps, marshes, and vernal pools (HRRC 2016).

- **Birds:** CCNS provides a wide diversity of freshwater, marine, and upland habitats for roughly 370 species of birds. About 80 of these bird species nest on CCNS during the spring and summer months, with the remainder using CCNS for migratory stopovers or to overwinter. Freshwater marsh birds, upland birds, and salt marsh birds are found in the Herring River estuary. The most commonly detected freshwater marsh birds during a 1999 and 2000 survey of the area were sora (*Porzana carolina*), pied-billed grebe (*Podilymbus podiceps*), and Virginia rail (*Rallus limicola*) (Erwin, Conway, and Hadden 2002).
- **Mammals:** Small mammals, such as mice, voles, and shrews are very abundant in marsh grasses around Herring River. Small mammals play a major role in trophic dynamics, consuming plant material and invertebrates, and in turn serving as prey for snakes, raptorial birds, and small to mid-sized carnivorous mammals. The most common group of mammals found in coastal marsh habitats in the New England region are rodents, which are an important prey species for raptors. Common mammals of coastal marshes include the meadow vole (*Microtus pennsylvanicus*), red fox (*Vulpes vulpes*), opossum (*Didelphis virginiana*), chipmunk (*Tamias* spp.), and muskrat (*Ondatra zibethicus*) (Smith 1997).
- **Reptiles and amphibians:** In addition to its importance to the five species of migratory marine turtles foraging the offshore waters of Cape Cod, there are 23 species of reptiles and amphibians living their entire life at CCNS within the Herring River project vicinity. Turtles present on CCNS include the diamondback terrapin, eastern box turtle, freshwater painted turtle (*Chrysemys picta*); snapping turtle (*Chelydra serpentina*); the less common musk turtle, (*Sternotherus odoratus*); and spotted turtle (*Clemmys guttata*) (Cook 2008b). Frogs, snakes, and salamanders, including green frog (*Rana clamitans melanota*), Fowler's toad (*Bufo woodhousii fowleri*), eastern spadefoot (*Scaphiopus holbrooki*), eastern garter snake (*Thamnophis s. sirtalis*), northern water snake (*Nerodia s. sipedon*), and the four-toed salamander (*Hemidactylium scutatum*), use coastal marsh habitats similar to those found at the Herring River estuary.

4.C.2 Post Restoration Conditions

4.C.2.1 Aquatic Species

Potential impacts to aquatic species were evaluated based on available literature concerning life histories and habitat requirements. Additional information concerning past and present occurrence of estuarine fish and macroinvertebrates, anadromous and catadromous fish, shellfish in the Herring River estuary and Wellfleet Harbor also was obtained from CCNS, and Wellfleet town officials based on field work. The analysis also integrated the findings of the hydrodynamic modeling of the estuary, using the predicted mean high spring tide as the best approximation of the extent of tidal influence and the areal extent of estuarine habitat. Based on this analysis, under full restoration the proposed areal extent of estuarine habitat will increase approximately 12 to 13 times over the current extent. Additionally, the fully restored habitat will include approximately 11.5 miles of mainstem tidal creek for use by resident, as well as, migratory and anadromous species, providing access to 160 acres of pond habitat for spawning.

The design of the new Chequessett Neck Road bridge will dramatically improve passage for species such as river herring (alewives and blueback herring), hickory shad, white perch, American eels, and possibly sea run brook trout. Several species of shellfish that rely on saline conditions will be able to recolonize tidal creek habitat upstream of the new bridge and tide gate structure. The restoration of tidal exchange to the Herring River system will result in permanent increases (when compared to existing conditions) in spawning and nursery habitat for fish species and estuarine macroinvertebrates. Consequently, the HRRP is expected to lead to corresponding increases in abundance and will constitute a significant beneficial impact for those aquatic species. For shellfish and resident estuarine fish these beneficial impacts will be local and limited to the estuary. For diadromous fish, the benefits will be regional. In accordance with the Magnuson-Stevens Fisheries Conservation and Management Act, an Essential Fish Habitat Assessment has been completed and can be found in the FEIS (Appendix F). An impact analysis on aquatic species is briefly summarized in the bulleted section below and can be found in more detail in section 4.6 of the FEIS (HRRC 2016).

- **Estuarine fish and macroinvertebrates:** The restored estuarine waters and salt marsh will provide substantially more spawning and nursery habitats for both resident and transient fish species as well as for estuarine macroinvertebrates, thereby greatly increasing their abundance. The HRRP will also improve access to 160 acres of pond habitat for diadromous fish at full restoration. The new breidge and tide gates at Chequessett Neck Road will provide better fish passage (11.5 miles of tidal creek channels at full restoration) for all fish including anadromous and catadromous species. This, combined with improved water quality and access to the headwaters of the river, will likely enhance the size of the run of river herring and allow for the possible reintroduction of sea-run brook trout into the Herring River estuary.
- **Shellfish:** Re-introduction of tidal flow will vastly improve shellfish habitat. By greatly increasing the flow of clean saline water from Cape Cod Bay into the Herring River, the restoration is expected to reduce bacterial concentrations, which cause the current closure of the shellfishery, to levels that

are safe for shellfish harvesting. The reduction of bacteria concentrations will result from dilution with clean marine water, as well as significantly reducing the life span of bacteria in the more saline and better-oxygenated waters. Restored tidal range and salinity upstream of the CNR bridge and tide gates will also allow shellfish to spread into areas of the estuary where they are currently not found. Ultimately, the restoration is expected to improve water quality in Wellfleet Harbor by reducing bacterial concentrations, and likely will increase the area in the Harbor where shellfish could be harvested. The restoration of hundreds of acres of productive tidal marsh will also greatly increase the flow of nutrients which should benefit shellfish growth in Wellfleet Harbor.

There is currently no evidence that sedimentation of shellfish beds and grants will occur. Studies and modeling conducted by researchers from Boston University, University of Rhode Island and the Woods Hole Group have consistently demonstrated that the net direction of sediment movement following the restoration will be upstream into Herring River. Any fine silts that may travel on outgoing and incoming tides are expected to remain suspended during tidal exchange such that they would take weeks or months to settle and by then would either flow back into Herring River or be transported out of the system into Cape Cod Bay. The predominant upstream movement of sediments will contribute to deposition on, and restoration of the salt marsh, which will contribute nutrients and provide habitat for the wild shellfishery. Channel bathymetry and bottom elevations of areas near the Wellfleet Harbor aquaculture beds will be monitored for sediment deposition throughout the restoration. Adaptive Management measures will be implemented, if necessary, to avoid or minimize adverse impacts.

4.C.2.2 Rare, Threatened, and Endangered Species

The degraded conditions of the Herring River floodplain support several species listed as rare, threatened or endangered by the Massachusetts Natural Heritage and Endangered Species Program (NHESP) or the USFWS that are dependent on freshwater and upland habitats and probably did not occur on a regular basis in the Herring River before construction of the Chequessett Neck Road dike in 1909. Federal and state-listed species were identified through informal consultation with the USFWS and NHESP and formally through comments submitted to MEPA by the NHESP in 2008. The Project is continuing to work in coordination with NHESP on the development of a Habitat Management Plan for the state-listed species, which will be integrated with the Adaptive Management Plan and described in subsequent permit applications. A draft Habitat Management Plan outline that has been developed in consultation with NHESP is provided in Attachment 8.H.

Based on consultations with USFWS and NHESP and the refined vegetation change analysis discussed previously in Section 4.B, projected habitat changes resulting from the proposed conditions are described on a species-by-species basis briefly in the bulleted section below. Additional detail is provided in sections 4.6 and 4.7 of the FEIS.

- **American bittern/least bittern:** Although both American and least bitterns primarily use freshwater marsh habitats, both species also use brackish marsh habitats. Overall, the Project will have minimal impact on the quantity and quality of bittern nesting habitat and will substantially increase salt marsh habitat used by these birds for foraging, nesting, and other non-breeding behaviors. Nesting activity by American Bitterns (State endangered) and Least Bitterns (State Endangered) has not been detected recently; nonetheless nesting habitat is expected to slightly decrease in the lower parts of the floodplain and shift upriver as wet shrublands become wetter and develop into emergent marshes. In the Lower Herring River, Mill Creek, Middle Herring River, Lower Pole Dike Creek sub-basins, existing cat-tail and other freshwater emergent plant species will be replaced by salt marsh vegetation. In the upper sub-basins, existing freshwater marsh habitat should persist. Additionally, tidal freshwater and low salinity brackish marsh are anticipated to expand as the existing shrubland and woodland habitats become wetter and are replaced by herbaceous emergent vegetation.

- **Northern harrier:** Historically, several pairs of Northern harriers have been recorded as nesting within the Bound Brook sub-basin (Bowen 2006). Small habitat changes within Bound Brook sub-basin due to tidal restoration are not expected to hinder future nesting activity. Northern harrier nesting sites in the Upper Bound Brook sub-basin are anticipated to remain unchanged in Phase 1. Other plant community changes throughout the Herring River Project area likely will restore and enhance harrier foraging habitat as existing forest is replaced by herbaceous tidal fresh, brackish, and salt marsh wetlands.
- **Diamondback terrapin:** Full restoration will expand habitat by more than 750 acres for Diamondback Terrapins (State Threatened). Terrapins use the river and fringing marshes for foraging, breeding and nesting**.** In the short term, the small amount of salt marsh habitat occurring upstream of the Chequessett Neck Road dike, which has recently been used by nesting terrapins, (unpublished MA Audubon data) will likely be impacted as tidal range increases. In addition, terrapin passage upstream may be impeded while the bridge is being constructed and could be affected by construction noise, vibrations, and other activities. However, over the long term, tidal restoration is expected to restore hundreds of acres of nesting, nursery, wintering, and foraging habitat, allowing diamondback terrapins to almost fully reoccupy their historic distribution within the Herring River floodplain.
- **Eastern box turtle:** Increased salinities and higher water levels are expected to alter portions of the degraded floodplain that serves as habitat for Eastern Box Turtle (State Special Concern). However, these areas are adjacent to other suitable Eastern Box Turtle habitat, including 3,500 acres protected by CCNS. Restoration of tidal conditions throughout the Herring River floodplain are expected to affect eastern box turtles by restoring more saline and/or wetter conditions in areas that have dried out in response to diking of the river and drainage of salt marsh soils. Restored tidal influence may also limit the ability of box turtles to access freshwater for thermoregulation and hydration. During periods of high storm-driven tides, it is possible that groups of turtles that occur on Griffin, Bound Brook, and Merrick Islands may be restricted to those islands. However, during normal tidal conditions, eastern box turtles are expected to be able to move among the islands and the mainland along the upper boundaries of the floodplain where areas are expected to remain as freshwater and periodically dry. The Project team and NHESP are currently working closely to

monitor Box Turtle movements under existing conditions and are developing a Monitoring Plan to track movement of turtles during restoration.

- **Water-willow stem borer:** Assessment of impacts to water-willow (*Decodon)* serves as a proxy for direct impacts to the water-willow stem borer. *Decodon* has low tolerance to frequent inundation by salt water; therefore, any long-term exposure to salt water influence is likely to adversely affect its distribution. However, increased water levels and subsequent change from forested to palustrine shrub- and emergent-dominated habitats is expected to increase the occurrence of *Decodon* in the upstream areas where salinity of tidally influenced water is expected to remain low.
- **Rufa red knot:** There are no records confirming the presence of red knot in the Herring River Project area, but because they have been observed on Cape Cod, they are assumed to be present. In general, the habitat changes associated with restoration will benefit red knot.
- **Northern long-eared bat:** Habitat changes associated with restoration will reduce the acreage in the Project area that is suitable for northern long-eared bats feeding and roosting. However, the wooded habitat types that will be restored to other estuarine habitats will occur slowly, over many years, are currently degraded and are common in other parts of Cape Cod. If northern long-eared bats are present in the Project area, it is unlikely that loss of a limited number of acres of degraded woodlands will have a detectable effect on individuals or population of bats.

4.C.2.3 Terrestrial Wildlife

Even in its degraded state, the Herring River floodplain supports diverse habitats for a wide array of invertebrate, reptile, amphibian, bird, and mammal species. Tidal restoration will initiate changes to many of these habitats that could potentially affect certain wildlife populations. Mammals, reptiles, and amphibians are expected to gradually relocate to suitable habitat as the estuary undergoes the expected transition from a degraded freshwater wetland to a functioning estuarine wetland. Because of the gradual pace of environmental change and the animals' mobility, no significant adverse impacts on regional populations are anticipated. For birds, there will be a substantial change in the diversity of species using the estuary. Species dependent on estuarine wetlands will become more abundant, while species dependent on woodland, shrubland, or heathland will become less abundant. This estuary-wide, permanent change in species composition, in the context of restoring a now-rare and ecologically critical estuarine wetland ecosystem, is considered to be a significant beneficial impact.

Due to the lack of data regarding the local status of most wildlife species and their specific use of the Herring River floodplain, this impact analysis is necessarily based on a broad view of general wildlife habitat changes predicted to result from tidal restoration, including the previously discussed analyses on wetland habitats and vegetation and on hydrodynamic modeling of the estuary (WHG 2011). A brief discussion on impacts to birds, mammals, reptiles, and amphibians resulting from increased tidal range and varying salinity levels throughout the Project area can be found in the bulleted section below, and in additional detail in section 4.8 of the FEIS (HRRC 2016).

- **Birds:** Shifts in avian community structure following tidal restoration and increases in open-water habitat generally include an overall increase in avian abundance and an accompanying transition from a community dominated by generalists and passerines to one dominated by waterfowl, shorebirds, and wading birds (Seigel et al. 2005). Several high priority salt marsh- and tidal creek-dependent species such as salt marsh sparrows (*Ammodramus caudacutus*), willets (*Tringa semipalmata*), great egrets (*Ardea alba*), snowy egrets (*Egretta thula*), osprey (*Pandion haliaetus*), and common terns (*Sterna hirundo*) are expected to benefit directly through restoration of nesting and/or foraging opportunities in the Herring River. Tidal restoration will also restore wetland and open-water habitats for resident and migratory waterfowl such as black ducks (*Anas rubripes*), common mergansers (*Mergus merganser*), and bufflehead (*Bucephala albeola*), as well as for shorebirds such as willets, greater yellowlegs (*Tringa melanoleuca*), and lesser yellowlegs (*Tringa flavipes*).
- **Mammals:** Adequate habitat for foraging, cover and breeding sites would remain for most species following restoration. The gradual restoration of tidal flow would allow these animals to adjust or shift their local range within the River and floodplain, if needed shift to the abundant upland habitat adjacent to the project area. Small animals like mice and rabbits, and larger species such as deer and coyotes, will persist on marsh hummocks and edges, and are expected to use the marsh habitats during low tides. Salt meadow cord grass, for example, is a valuable forage plant for white-tailed deer and provides habitat for meadow voles, which then are an important food source for northern harriers and other raptors.

  Initial restoration will result in gradual return of tidal flow to habitat and affect movements of meadow voles, white-footed mice and other small rodents, but eventually preferred habitats will be restored and expanded. In the short term, medium and large mammal species such as raccoon (*Procyon lotor*), striped skunk (*Mephitis mephitis*), muskrat (*Ondatra zibethicus*), river otter (*Lontra canadensis*), and white-tailed deer (*Odocoileus virginianus*) may be displaced from currently occupied habitat. However, increased tidal range and salinity, restored salt, brackish, and freshwater marsh habitats are anticipated to provide long-term benefits with improved water quality, more abundant and diverse prey species, and a more open, expansive habitat structure.
- **Reptiles and amphibians:** Snapping turtles (*Chelydra serpentine*), spotted turtles (*Clemmys guttate*), and northern water snake (*Nerodia sipedon*) inhabit the freshwater areas upstream of High Toss Road, but can survive in brackish water and salt marsh habitats. Amphibians are not present within high salinity portions of coastal environments. Increases in tidal range associated with restoration may, in the short term, limit and disrupt reptile and amphibian breeding, foraging, and nesting in the lower areas of the floodplain. However, these areas are less likely to be occupied initially and restoration is planned to proceed at a gradual pace, allowing any affected populations to relocate to suitable habitat. In the long term, reptile and amphibian populations are anticipated to shift and adjust their ranges, but no significant declines in species diversity or abundance is expected.

4.C.3 Response to Wildlife and Plant Habitat Objectives

The Wildlife and Plant Habitat goal of the Regional Policy Plan is to protect, preserve, or restore wildlife and plant habitat to maintain the region's natural diversity. The Project achieves this goal by significantly improving habitat for a wide variety of terrestrial, avian and aquatic wildlife. Restoration of up to 570 acres of inter-tidal marsh in Phase 1 will expand habitat for species that thrive in salt and brackish marsh environments. Salt marshes are among the most productive ecosystems on the planet and provide food, shelter, nesting sites, and migratory habitat for many species of birds, mammals, and reptiles. Restoring tides to the Herring River will enhance the quality and quantity of these resources and improve their resiliency in the face of increased threats by sea level rise and land-based pollution and encroachment.

The Project's Environmental Impact Statement/Report contains an inventory of wildlife and plant habitats, and includes projections of potential changes in habitat related to the restoration. The FEIS/FEIR is augmented by additional information contained in this application. As described below, the HRTT is working closely with Massachusetts Natural Heritage and Endangered Species Program (NHESP) and other experts to estimate changes to habitats of state-listed rare wildlife species, and to develop a Habitat Management Plan. Importantly, the Project has been designed to ensure that any changes in tidal flow occur slowly and incrementally so that aquatic, avian and land-based wildlife have the ability to relocate to appropriate nearby habitat. Expected changes to habitat are limited in the upstream portions of the Project area because salinity levels there will remain low and will experience no or a relatively small tidal range. Additionally, tidal flow will not be restored in the Upper Pole Dike Creek sub-basin during the Project's first phase.

The tide control structure and mitigation activities are within the Wellfleet Harbor Area of Critical Environmental Concern (ACEC). Therefore, the Project has been designed to avoid or minimize impacts to important resources. The restoration process will be guided by the Project's permit conditions and Adaptive Management Plan and has included rigorous monitoring of existing conditions (many of which are degraded) and the future conditions that will occur during the restoration process. The overall objective of the adaptive management process is to balance the outcomes of the many project objectives which then will guide management decisions.

Objective WPH 1 – Maintain existing plant and wildlife populations and species diversity

The restoration of tidal flow will alter wetland plant habitat as described in table 4-1 and figures 4-1, 4-2 and 4-3 (Section 4.B.3) in order to achieve the overarching goal of restoring 570 acres of native tidal wetland habitats and improving the resiliency of the Herring River floodplain. As set forth in the FEIS (Section 3.5), wetland habitats and vegetation cover within the Herring River floodplain have changed dramatically since European settlement and the construction of structures have restricted tidal exchange throughout the system, most notably the building of the Chequessett Neck Road dike in 1909. Historically, salt marsh once extended east of present day Route 6. Due to tidal restriction, this once-extensive tidal marsh (previously dominated by cord grasses), has been displaced by woody vegetation, invasive species and emergent freshwater plants, particularly in the upper portion of the floodplain.

The Project meets this objective based on the following information:

WPH1 Response 1. As noted in response to the Wetland Resources goals and objectives above, increased tidal exchange resulting from the implementation of Phase 1 of the Project will have a profound effect on the Herring River ecosystem. The majority of the floodplain is comprised of former tidally-dependent salt marshes that are now dominated by invasive common reed (*Phragmites australis*), emergent freshwater plants, and upland tree and shrub species. Restoring tidal flow to the floodplain will largely displace these plant communities with the polyhaline inter-tidal habitats that naturally occurred prior to construction of the Chequessett Neck Road dike in 1909.

WPH1 Response 2. Clearing of invasive common reed and extensive woody vegetation will be undertaken to achieve restoration objectives. As Phase 1 is implemented, salt water will cause decline and mortality of much of the herbaceous and woody freshwater dependent and upland vegetation that has colonized the floodplain. If left standing, dying and dead trees and larger shrubs could hamper the re-colonization of native salt marsh plant communities. In some areas currently dominated by herbaceous, freshwater-dependent emergent plant species, non-native, invasive common reed could expand, which would have a number of deleterious ecological and socioeconomic effects, including displacement of native vegetation and a reduction in habitat quality for fish and wildlife. The distribution of common reed will be closely monitored and integrated management actions will be undertaken to prevent colonization elsewhere in the project area.

WPH1 Response 3. Vegetation management will be conducted in accordance with a Vegetation Management Plan. The specific goal for managing vegetation as part of the Herring River Restoration Project is to support the long-term, sustainable re-colonization of native estuarine vegetation as tidal range, salinity and sediment transport processes are restored.

WPH1 Response 4. There are no known specimen tress in the Phase 1 restoration area. Much of the second-growth forest in the upper reaches of the Phase 1 restoration area as well as areas immediately adjacent will be unaffected.

WPH1 Response 5. Marsh management activities will be undertaken to augment tidal restoration and reverse other previous direct and indirect alterations of the system's topography, bathymetry, and drainage capacity. Marsh management will be undertaken in a three-step process to minimize disturbance: passive management that allows natural tidal flow to transport and deposit sediment on the salt marsh surface; tide gate manipulation to augment natural tidal flows; and active marsh management (See Sections 5.0 and 8.B). The primary issues to be addressed with marsh management include:

- Loss/subsidence of the former salt marsh surface elevation
- Sediment entrained in marsh channels, channel blockages
- Historic grid ditching, channelization, water logged soils

- Spoil piles adjacent to ditches and channelized reaches of the Herring River

WPH1 Response 5. The Project will re-grade and replant areas disturbed during construction with native vegetation as needed to enhance or restore wildlife habitat.

WPH1 Response 6. As described above and summarized below, the Project will enhance wildlife habitat and maintain or enhance opportunities for wildlife passage. The Project will not erect fencing or other barriers to wildlife passage, or result in fragmentation of wildlife and plant habitat.

Fish:

- Phase 1 of the Project will remove barriers for all fish including anadromous and catadromous species at Chequessett Neck Road dike and High Toss Road and, and at full restoration will result in the restoration of 11.5 miles of tidal creek channels. At full restoration there will be substantially more spawning and nursery habitat (enhanced access to 160 acres of coastal pond at full restoration) for both resident and transient fish species as well as for estuarine macroinvertebrates, greatly increasing their abundance.

Shorebirds and Migratory Birds:

- Tidal restoration and an increase in open water habitat is expected to lead to an overall shift in the composition of bird species from generalists that thrive in many habitats, to waterfowl, shorebird and wading bird species that rely on salt marshes. According to the Massachusetts Division of Fisheries and Wildlife, the American black duck, in particular, should benefit from salt marsh restoration at Herring River.
- The upper reaches of Herring River is currently freshwater marsh, in which habitat for birds that are dependent on emergent salt marsh has been severely degraded Restoration will benefit nesting and foraging habitat for several high priority salt-marsh and tidal-creek dependent species such as willets, salt marsh sparrows, great and snowy Egrets, osprey and Common terns, as well as migratory waterfowl.
- Freshwater and brackish marsh used for nesting areas by northern harriers (State Threatened), American bitterns (state endangered) and least bitterns (State Endangered status) will slightly decrease in the lower parts of the floodplain and shift upriver as wet shrublands become wetter and develop into emergent marshes. Overall, the Project will have minimal impact on the quantity and quality of bittern nesting habitat, and will substantially increase salt marsh habitat used by these birds for foraging, nesting and other non-breeding behaviors.
- Restoration of high salt marsh (dominated by *Spartina patens*), which is declining throughout Wellfleet Harbor and other parts of Cape Cod, will provide critical nesting habitat for the saltmarsh sparrow, a declining species completely reliant on this habitat for breeding.
- If no action is taken, continued forest and shrub growth and expansion of non-native, invasive *Phragmites* will displace the more open, herbaceous habitats in the upper part of the system that are relied upon by harriers and bitterns for nesting.

Reptiles:

- The full restoration of Herring River will expand habitat by more than 750 acres for diamondback terrapins (State Threatened). Terrapins use the river and fringing marshes for foraging, breeding and nesting.
- Increased salinities and higher water levels are expected to alter portions of the degraded floodplain that serves as habitat for Eastern Box Turtle (State Special Concern). However, these areas are adjacent to other suitable Eastern Box Turtle habitat, including 3,500 acres protected by the Cape Cod National Seashore. The Project team and NHESP are working closely to develop a Habitat Management Plan and for state listed species that will include monitoring movements of Eastern Box Turtles.

Mammals:

- Adequate habitat for foraging, cover and den sites would remain for most species following restoration. The gradual restoration of tidal flow would allow these animals to adjust or shift their local range within the River, floodplain, and the abundant upland habitat adjacent to the project area. Small animals like mice and rabbits, and larger species such as deer and coyotes, will persist on marsh hummocks and edges, and will use the restored marsh during low tides. Salt meadow cord grass, for example, is a valuable forage plant for white-tailed deer and provides habitat for meadow voles, which in turn are an important food source for harriers and other raptors.

WPH1 Response 7. The Project will not alter large, contiguous un-fragmented areas, and there will be no new development proposed for Key Sites as defined in the State Wildlife Action Plan, and BioMap2 Core Habitat and Critical Natural Landscapes as defined by the Massachusetts Natural Heritage and Endangered Species Program.

Objective WPH 2 – Restore degraded habitats through use of native plant communities

The Project meets this objective based on the following information:

WPH2 Response 1. As has been described above, the Project will return tidal flow to the Herring River floodplain incrementally, and this will result in the restoration of 570 acres of native tidal marsh at the end of Phase 1. Concurrently, management actions will be implemented that will result in the elimination or removal of degraded habitat, including acid sulfate soils; degraded water quality; and invasive species of vegetation that has displaced salt marsh.

WPH2 Response 2. Transitions in wetland habitat types have been analyzed and demonstrated to result in beneficial wildlife and plant habitat changes as detailed in section 4.B.3, Table 4-1 and Figures 4-1 and 4-2, and 4-3, and in responses one through three to Wetland Resources (WT) objective 4 (WT4).

WPH2 Response 3. Restoration objectives and management actions will be guided by permitting conditions and facilitated by an adaptive management plan that includes monitoring, modeling, and evaluation of vegetation management and marsh management activities.

WPH2 Response 4. The Project will remove two residential structures currently located in the flood hazard area. These structures are within the boundary of CCNS in the Lower Herring River basin and would be inundated by restoring tidal flow to the main river basin. These properties are at very low elevations and would be affected early in the restoration process. Unlike potentially affected structures elsewhere in the floodplain, there are no tide control structures that can minimize or prevent these impacts. In light of the importance of these parcels for achieving the goals of the restoration, and the lack of options for protecting the structures, the CCNS negotiated with the private owners and acquired the two properties. The structures and onsite wastewater treatment systems on each property will be removed prior to tidal restoration. (See WT 4, Finding 2)

Objective WPH 3 – Protect and preserve rare species habitat, vernal pools, 350-foot buffers to vernal pools

The Project meets this objective based on the following information:

WPH3 Response 1. The Project will not result in a take under the Massachusetts Endangered Species Act (MESA). The Project's MEPA Certificate notes that according to NHESP the Project qualifies for a MESA Habitat Management Exemption. Accordingly, HRTT is working collaboratively with NHESP on the development of a Habitat Management Plan for state-listed species, which will be submitted and reviewed by NHESP pursuant to 321 CMR 10.14(15). The Project also will complete reviews under Section 7 of the Federal Endangered Species Act, and Essential Fish Habitat Review under the Magnuson-Stevens Fishery Conservation and Management Act.

WPH3 Response 2. Increased salinity following restoration will eliminate some stands of water willow, which is the host plant for the water-willow stem borer, a State-threatened moth, endemic to southeastern Massachusetts. However, this habitat loss will be limited in upstream areas, where salinity levels will remain low, and because tidal flow will not be restored in the 174-acre Upper Pole Dike Creek during the Project's first phase. In addition, stands where water willow is common are found along the edges of ponds and vernal pools near the project area, so large areas of habitat are available for the moth to colonize. The HRTT, National Seashore and NHESP are working closely to develop a Habitat Management Plan that will monitor changes in water willow habitat and implement collaboratively developed management measures that will ensure the long-term viability of the species within the area.

WPH3 Response 3. There are no know vernal pools or buffers to vernal pools in the Project area or adjacent to areas of mitigation activities.

Objective WPH 4 – Manage Invasive species

The Project meets this objective based on the following information:

WPH4 Response 1. The Project will remove invasive species from wetland resource areas where it will improve the natural functions of the wetland. The roughly 1,100-acre Herring River floodplain currently contains approximately 48 acres of common reed, most of which occurs in the Lower Herring River sub-basin. Restoration of tidal exchange will increase water column salinity in this sub-basin to 20 ppt and higher. This increase in salinity and the higher water levels are expected to quickly stress common reed and lead to die-off and eventual re-colonization of native salt marsh species. Consequently, in the Lower Herring River sub-basin, the restoration of tidal flow will be the primary means of common reed control. However, cutting and removal of material prior to the return of tidal flow will also be considered. (See Section 5., Adaptive Management, subsection on vegetation management for information on the proposed treatment and monitoring of common reed.)

WPH4 Response 2. The Project will re-establish the estuarine gradient of native salt, brackish, and freshwater marsh habitats in place of the invasive non-native and upland plants that have colonized most parts of the degraded flood plain upstream of the Project Site.

Pursuant to 310 CMR 10.12(1)(f), the Notice of Intent will include a plan for invasive species prevention and control. Invasive vegetation includes any plant species recognized by the Massachusetts Invasive Plant Advisory Group (MIPAG) as invasive, likely invasive, or potentially invasive in The Evaluation of Non-Native Plant Species for Invasiveness in Massachusetts (MIPAG, 2005).

Specific management measures that will be instituted during construction include:

- To minimize the potential for introduction of invasive species to the project area, contractor vehicles, equipment, and materials will be inspected and cleaned of any visible soil, vegetation, insects, and debris before bringing them to the project site. Cleaning methods will include, but not be limited to, brushing, scraping, and/or the use of compressed air to remove visible soils and vegetation.
- Contractors will be instructed to minimize ground disturbance and vegetation removal as much as possible, and to remain within designated access ways and work areas.
- All disturbed soils will be stabilized and seeded with a native seed mix immediately following completion of work in that area. All seed mixes shall be free of invasive, non-native plant species.
- Plant and seed materials will be of regional, southern New England genotype stock.
- Any invasive vegetation disturbed during construction will be stockpiled within the work area and removed from the site following completion of work in a given area to prevent spread of invasive species from one portion of the work area to another.

Management of invasive species following construction and throughout the restoration and adaptive management periods will be addressed in the Vegetation Management Plan and Adaptive Management Plan developed for the Project.

Objective WPH 5 – Promote best management practices to protect wildlife and plant habitat from the adverse impacts of development

The Project meets this objective based on the following information:

WPH5 Response 1. Road elevation sites will be restored to existing conditions following construction. Existing signage will be restored as necessary. Seeding and soil stabilization measures will be installed along roadways in accordance with planting plan, details and specifications. Project soil stabilization and plantings include use of salt tolerant seed mix along the roadways, as well as low marsh plantings (*Spartina alterniflora* plugs) and high marsh plantings (*Spartina patens* and *Distichlis spicata* plugs) at specific wetland elevations disturbed within the vicinity of the three box culverts openings. Staging areas will be restored to original conditions. Final pavement restoration will be conducted, and all remaining disturbed areas will be restored.

WPH5 Response 2. Bid documents will require contractors to employ erosion control and other best practices, avoid unnecessary disturbance of sensitive habitat, and adhere to all permit requirements and conditions to ensure the protection of wetland resources, habitat, and wildlife.

4.D Community Design (CD)

4.D.1 Existing Conditions

Currently, there are approximately 700 acres of woodlands and shrublands in the Herring River floodplain, while open water and salt and brackish marsh account for 88 acres primarily located in the Lower Herring River sub-basin. Freshwater marsh and meadows account for approximately 433 acres within the floodplain. The existing landscape character differs markedly between the upper and lower portions of the floodplain, with vegetation changing dramatically from north to south.

An abundance of highly visible dying trees in the Lower Pole Dike Creek and mid-Herring River sub-basins is a good example of how a salt marsh that becomes artificially isolated behind a dike results in vegetation changes that do not support a stable and productive ecosystem.

The dead trees are mostly black cherry, an upland species that cannot tolerate water-saturated soils. The species has invaded the floodplain between Bound Brook Island and Pole Dike Roads to the north, and High Toss Road to the south. The trees took root following diking and intense mosquito-control drainage activities that effectively de-watered the wetland. Around 1984, the Cape Cod Mosquito Control Project voluntarily stopped the drainage activities

Figure 4-5. Acres of dead trees visible from Pole Dike Road

There has been no further dredging of the river or its tributaries since then. Over time, shoaling and plant growth in the river and other waterways has slowed drainage and allowed the wetland to again become wet. The re-wetting of soils would in turn cause plants like black cherry, which require an unsaturated root zone, to die. A closer look may show that other upland plants are dying too.

Note that all the dead trees are at low floodplain elevations, while the same species at higher elevations along Pole Dike Road look fine. This supports the idea that the mortality is caused by root-zone flooding and not disease or insect infestation, although these latter two could be secondary stresses on already flood-stressed trees.

4.D.2 Post Restoration Conditions

Based on Project modeling of expected changes to vegetation and hydrology, and the observed effects of other coastal habitat restoration projects in the region and nationally, the Project is expected to result in long-term viewscape benefits. These benefits include the ability to observe broad expanses of open water (at high tide), salt marsh, and salt meadows. To reduce aesthetic effects during the temporary marsh transition period, the Project will remove woody vegetation on public lands (and with prior permission on private lands) before trees and shrubs are killed by salt water. This work will be done in stages corresponding the planned increments of tidal restoration.

The restoration of tidal flow resulting from the Project will likely improve the value of properties abutting the floodplain, while generating significant ecological, social, and economic benefits for the communities and region. Evidence supports enhancement —not devaluing—of property values. Other coastal locations in Wellfleet provide many examples of residential and commercial properties in close proximity to intertidal landforms, from mud flat, to open water, to intertidal salt marsh. None of these properties are adversely affected by their close proximity to intertidal areas. To the contrary, the value and rental income potential of properties abutting intertidal areas are typically higher than comparable properties that are not in close proximity to intertidal areas. Short-term aesthetic effects during the marsh transition period will be mitigated by the removal of woody vegetation which will hasten the growth of salt-tolerant vegetation and accelerate the appearance of marsh and river vistas.

4.D.3 Response to Community Design Objective

Objective CD3 – Avoid adverse visual impacts from infrastructure and scenic resources

The Project meets this objective based on the following information:

CD3 Response 1. The Project will result in an overall increase in scenic views of tidal marsh and open water available to the public from the Chequessett Neck Road Bridge, Old County Road, High Toss Road and Pole Dike Road. The Project also will result in the removal of hundreds of acres of currently dead woody vegetation, which is currently visible from these local roads. None of the proposed tidal control or mitigation activities will interfere with an existing viewscape.

CD3 Response 2. The Project will co-locate infrastructure with existing infrastructure and utilize previously developed impervious areas:

- The Chequessett Neck Road Bridge will be built on the site of the existing Chequessett Neck Road dike. Any increase in footprint and impervious surface area is necessary to accommodate public access viewing, kayak portage and stormwater management.

- The Pole Dike Road water control structure will be built under the existing Pole Dike Road surface, with minimal increase in footprint.
- All roadway elevations provided for mitigation will retain the same road profile and curvature. (See T1, findings)

CD3 Response 3. The Project will relocate electrical and telephone utilities underground and under the bridge deck of the Chequessett Neck Road Bridge. The utilities currently are strung on polls that cross the Chequessett Neck Road dike.

CD3 Response 4. Aesthetics were taken in to consideration in the design of all project elements with the objective of minimizing visual intrusion and blending into the rural environment. The CNR bridge/tide control structure is designed to incorporate the necessary components for tide control, safe pedestrian/vehicular access, public viewing while reflecting the rural character of Chequessett Neck Road. The width and curvature of roadways was retained to the extent practicable.

4.E Coastal Resiliency (CR)

4.E.1 Existing Conditions

Measurements indicate that, relative to sea level, much of the diked Herring River floodplain is up to 3 feet below its pre-dike elevation, and likewise below the current elevation of salt marsh seaward of the dike. Coastal marshes must increase in elevation at a pace equal to, or greater than, the rate of sea-level rise in order to persist. Man-made artificial tidal restriction has blocked the important process of sedimentation on the salt marsh. Additionally, marsh drainage has increased the rate of organic peat decomposition by aerating the sediment and caused sediment pore spaces to collapse. All of these processes have contributed to severe historic and continuing subsidence in the Herring River diked wetlands.

The subsidence and degradation of the salt marsh resulting from decreased tidal flow has created large, low-lying areas vulnerable to sea level rise and associated storm surge. FEMA has designated the estuary as a "Special Flood Hazard Area." The Cape Cod Commission has created a mapping tool to assess risk and vulnerability, as well as visualizations that show potential impacts of hurricanes and sea level rise. Building on that information, and in view of concerns over severe winter storms and coastal flooding in 2018, the towns of Wellfleet and Truro and the Cape Cod Commission held a Municipal Vulnerability Preparedness stakeholder workshop in March 2019. The workshop considered major environmental and infrastructure threats to the region due to sea level rise, severe weather and associated storm surge. Workshop participants, including local officials, community stakeholders and regional resiliency planners, found that "Addressing climate change impacts is an urgent matter for these neighboring Outer Cape communities . . . the towns are vulnerable to storm surges, coastal erosion, and sea level rise that threatens the built environment, drinking water aquifer, biodiversity and natural resources." The workshop designated restoration of salt marsh and replacement of culverts as the top recommendation to improve community resilience.

4.E.2 Post Restoration Conditions

The replacement of degraded, outdated infrastructure, including the existing Chequessett Neck Road dike and tide gates, as well as undersized culverts, will improve ecosystem and community resiliency to climate change and rising sea levels. Since the dike was constructed in 1909, the upstream salt marsh has subsided significantly and sea level has increased resulting in an effective increase in water height upstream of the existing dike. A primary objective of the project is to restore natural sedimentation processes upstream, allowing the marsh to once again accrete and keep up with rising sea level. The restored marsh will act as a natural buffer to storms and wave action. It will also displace the existing methane-emitting freshwater wetlands and serve as a carbon sink that reduces greenhouse gases currently contributing to climate change. Tidal restoration will also allow floodwaters from coastal storms to recede more quickly. The following project outcomes are directly related to resilience:

- Restoration of 570 acres salt marsh and tidal wetlands during Phase 1 will enhance natural storm attenuation and flood storage.
- Measurable increases in the elevation of the now-subsided marsh plain through natural accretion of sediments and possibly thin layer deposition.
- Replacement of undersized culverts at Chequessett Neck Road, Pole Dike Road, and other low-lying roads.
- Pole Dike Creek tide gates will be closed to allow drainage only, and will improve drainage following storm events.
- Chequessett Neck Road and Mill Creek tide gates will also allow for quicker drainage of sub-basins following heavy precipitation and storm events.
- Improved storm water management will be built into the Chequessett Neck Road bridge and road improvements, to improve storm drainage and avoid negative impacts to wetlands and water quality.

The Project will also result in the removal of three structures from the floodplain. Two single-family residences on Way 672 have been acquired by CCNS. The structures, including sub-surface septic systems, will be removed from the properties. In addition, the portion of High Toss Road constructed across the marsh plain will be removed to restore tidal flow.

Below is a description of the hydrodynamic modeling parameters used to design project elements and mitigation, and of the Project's relationship to FEMA 100-year floodplain and to sea level rise.

4.E.2.1 Hydrodynamic Modeling Parameters

Hydrodynamic modeling undertaken by Woods Hole Group is the core analysis used to predict water level changes and potential for structural impacts due to restoration of tidal flows. This modeling provides the basis for the predicted tidal water level datums in Table 3-2 and described throughout the document. This section summarizes the parameters used in the modeling, and its relationship to FEMA floodplain maps and predictions of sea level rise.

Hydrodynamic modeling for the Project considers the following model variables:

- **Normal tidal conditions:** Cases that utilize normal tidal conditions represent average tides occurring within the Herring River system based on normal forcing tides occurring in Wellfleet Harbor. Data utilized to develop the normal tidal conditions were collected in 2007 and 2010. These conditions correspond to the same normal tidal conditions utilized in modeling efforts (Woods Hole Group, 2012). The normal tidal conditions included assessment of tidal benchmarks based on the National Tidal Datum Epoch of 1983 through 2001 using tidal constituents only. Therefore, these simulations represent an average condition that would occur under normal circumstances. These cases do not represent every specific tidal variation that could occur.
- **Storm surge conditions**: Two distinct storm surge conditions were used to specify the peak water surface elevation corresponding to coastal storm surge events in Wellfleet Harbor. The events

correspond to the 10-year return period storm surge (8.3 feet) and the storm of record for the region (9.3 feet, Blizzard of 1978)(USACE). These storm events were specified in Wellfleet Harbor and represent a reasonable expected range of storm surges that may affect the Herring River system. More specific details on the development of these boundary conditions are presented in detail in Woods Hole Group (2012).

- **Precipitation conditions:** In addition to the storm surge scenarios, return period precipitation-based events were developed. Rainfall conditions were based on the extreme precipitation tables developed by Cornell University (http://precip.eas.cornell.edu/) for a 10-year (moderate) and 100-year (extreme) return period precipitation over a 24-hour period. Average values for the 24-hour total precipitation amount for the area were estimated from these data and values of 5 inches and 8 inches were used for the 10-year and 100-year return period precipitation amounts, respectively. Precipitation is added to the model in two modes: (1) direct input over the model surface, which accounts for rain that falls directly in the model area, and (2) discharge of freshwater from the greater watershed of each sub-basin. These discharge conditions are different for Mill Creek and Upper Pole Dike Creek based on the watershed of each sub-basin.
- **Combination precipitation and storm surge conditions:** Combined coastal storm surge and precipitation conditions were also modeled. Combinations included: a) the storm of record return period surge with a 10-year return period precipitation event and b) a 10-year return period surge with a 100-year return period precipitation event. These combinations were selected based on ongoing studies evaluating the joint probability between precipitation amounts and storm surge levels (Douglas, 2015). These studies have evaluated daily and accumulated 2-day and 3-day precipitation amounts in correlation with observed surge water levels in Boston Harbor. The highest rainfalls are generally associated with water levels within the interquartile range of the distribution (between 75th percentile and 25th percentile), which means that the largest precipitation events don't occur in concert with the largest storm surge events. Outliers and extreme outliers (storm surge events) in water levels are associated with rainfall of approximately 50 to 100 mm (or approximately 2 to 4 in, which is approximately a 2 to 10-year precipitation return period). These data support the co-occurrence of a storm of record surge with a 10-yr precipitation event as a conservative analysis. Additionally, these combination conditions have never occurred in Boston or Provincetown over approximately the last 100 years. This illustrates the extreme (and highly conservative) nature of the conditions being considered.

4.E.2.2 Relationship to FEMA 100-Year Flood Plain

The Project does not affect the FEMA Flood Insurance Rate Maps (FIRMs) 100-year Base Flood Elevation (i.e., "A zone"). The latest FEMA Flood Insurance Study (FIS) and FIRMs for Wellfleet approved by the Town in 2014 indicate that changes to tidal hydrology resulting from the Project will have no effect on FEMA's regulatory 100-year floodplain and will not alter FEMA flood insurance requirements. The reasons for this are (1) FEMA does not recognize the existing Chequessett Neck Road dike as a flood control structure and (2) their most recent FIS predicts the 100-year coastal storm surge entering the Herring River by over-topping the dike, breaching barrier dunes at Ryder Beach and Duck Harbor (Secret Beach), and overwashing a low segment of Chequessett Neck Road near Powers Landing. Therefore, the

FEMA-predicted flood levels in the Herring River basin are governed by water flowing over low points around the edge of the floodplain (i.e. Chequessett Neck Road dike, Ryder Beach, Duck Harbor, and Powers Landing), not the amount of water flowing through the Chequessett Neck Road dike. The current Chequessett Neck Road dike is not a FEMA-designated flood control structure and the redesigned structure will likewise not be a FEMA-designated flood control structure. For these reasons, the Project will have no effect on the FEMA-predicted 100-year flood elevations or the extent of the 100-year FIRM floodplain within the Herring River basin. Since it is not practical to construct flood protection that could be certified by FEMA at Ryder Beach, Duck Harbor, and Powers Landing, it is similarly not practicable or cost-effective to construct the new Chequessett Neck Road bridge and tide gates for FEMA certification. Therefore the new Chequessett Neck Road bridge will be rebuilt to a similar crest height as the existing dike.

4.E.2.3 Relationship to Sea Level Rise

With respect to Sea Level Rise, The Woods Hole Group hydrodynamic model also applied guidance provided by the U.S. Army Corps of Engineers (USACE; 2009, 2011) to account for the effects of various rates of sea level rise over the next 50 years specifically for the Wellfleet Harbor area. The upstream sub-basins (e.g., Pole Dike Creek, Bound Brook, Duck Harbor, Upper Herring River) that are currently non-tidal remain relatively unaffected by the sea level rise increase. Although over the long-term it may be theorized that the mean water surface elevation would increase uniformly throughout the system, the broad, flat marsh plains of the Herring River system create hypsometry that does not produce uniform water level increases in the system. This analysis, combined with the extreme coastal storm modeling described previously, indicates that the freeboard incorporated into the Project's infrastructure designs will prevent surface water impacts to structures and infrastructure for at least the next 50 years under the most severe sea level rise scenario analyzed. Additionally, the Chequessett Neck Road bridge and tide gates has been designed as a water control structures that can be managed as necessary in response to future sea level rise to keep maximum water levels below elevations that could impact structures. For example, through gate management the Project has the ability to manage (lower) future mean high water and maximum water levels in the Lower Herring River and other sub-basins.

The longer-term effects of sea level rise beyond 50 years, are more uncertain and difficult, if not impossible, to analyze with precision. As sea level changes, managers and stakeholders for the Herring River will need to revise the tide gate operations, management plans, and potential mitigation measures. Dikes, tide gates, and other project elements will require maintenance and possibly replacement or modification. At that time, planners will need to assess the condition of the estuary, the tidal conditions in Wellfleet Harbor and Cape Cod Bay, and other related factors and plan for a course of action that continues to support the ecological health and function of the Herring River while also protecting vulnerable private property and public infrastructure.

It is important to note that potential increases in sea level to the extent suggested by the MA CZM report and others would have effects that greatly alter the entire Cape Cod groundwater and surface water system independent of the physical status of dikes, bridges, and water control structures in the Herring River. These effects are outside the influence and scope of the restoration project and include a higher groundwater table, increased surficial freshwater discharge into the river, and the potential for overwash of storm surges at several points including the Chequessett Neck Road dike, Duck Harbor, Bound Brook and Powers Landing.

4.E.3 Response to Coastal Resiliency Objectives

The Community Resiliency goal of the RPP is to prevent or minimize human suffering and loss of life and property or environmental damage resulting from storms, flooding, erosion, and relative sea level rise. The Project meets this goal by restoring the vitality of coastal resources and the beneficial functions they provide for protection from storm surge and sea level rise; by designing water dependent structures to be resilient to storm surge and relative sea level rise; and by avoiding non-water dependent development in the floodplain.

Objective CR2 - Plan for sea level rise, erosion and floods

The Project meets this objective based on the following information:

CR2 Response 1. The Project restores natural coastal resources to function and provide the natural beneficial functions of resilience and storm surge protection. A primary objective of the Project is to restore natural sedimentation processes upstream, allowing the marsh to accrete and maintain elevation with rising sea level. The restored salt marsh will, in turn, enhance coastal resilience as a natural buffer to storms and wave action to reduce erosion. Tidal restoration will also allow floodwaters from coastal storms to recede more quickly. This will help to protect roadways, wells, and other infrastructure.

CR2 Response 2. All Project tide control elements and mitigation measures have been designed to accommodate sea level rise. As described above, hydrodynamic modeling studies form the basis of design requirements for the overall restoration program, including the need for infrastructure modifications and additions to protect existing infrastructure and structures from increased water levels. The freeboard incorporated into the Project's infrastructure designs will prevent surface water impacts to structures and infrastructure for at least the next 50 years under the most severe sea level rise scenario analyzed. All measures intended to protect structures from the potential effects of tidal restoration are designed to protect the subject structures under full tidal restoration conditions. Additional infrastructure protection will occur with undergrounding of utilities in designated areas.

CR2 Response 3. The Project contributes to the reduction of greenhouse gas emissions that contribute to climate change. Blue carbon refers to the carbon naturally stored in coastal wetlands and seagrass beds that would otherwise contribute to atmospheric carbon dioxide loading and global climate change. Historically, the Herring River salt marshes absorbed large volumes of carbon in peat soils, which accumulated year after year as sea level slowly increased. However, decades of artificial tidal restriction have led to massive release of carbon by altering sediment deposition and tidal circulation patterns.

Blockage of tidal flow, and accompanying carbon-laden sediment, has allowed carbon to remain suspended in the water column where portions of it are released to the atmosphere as carbon dioxide. In addition, conversion of hundreds of acres of salt marsh to freshwater marsh has likely increased methane emissions, adding further to greenhouse gas emissions associated with the degraded Herring River floodplain. Over a forty-year period, the restoration of the entire Herring River floodplain could result in greenhouse gas emissions reductions of 300,00 metric tons of CO^2 equivalent. For Phase 1 restoration, the greenhouse gas emissions reduction benefit is 150,000 metric tons of CO^2 equivalent.[15]

Objective CR3 - Reduce vulnerability of built environment to coastal hazards

The Project meets this objective based on the following information:

CR3 Response 1. As described above, the Project will enhance coastal resiliency by restoring normal sediment deposition needed to allow the marsh plain to gain elevation and mitigate impacts of sea level rise, and by constructing state-of-the-art tidal control infrastructure to protect low-lying roads and other public and private structures. The resilient design of tide control structures is described in Section 3.B.2 of this application.

CR3 Response 2. The Project does not site non-water dependent development in a coastal resource area. Two existing non-water dependent residential dwellings in the floodplain within the CCNS boundary have been acquired by the NPS. The structures and associated sub-surface septic systems located on Way 672 (aka Rainbow Lane or Snake Creek Road) will be removed prior to restoration. In addition, a segment of High Toss Road (referred to herein as High Toss Road causeway) where it crosses the Herring River marsh plain will be excavated and removed. The existing causeway and blocks tidal flow and its removal will restore tidal flow between Lower Herring River (currently downstream of the causeway) and Mid-Herring River and Lower Pole Dike Creek (currently upstream of the causeway).

CR3 Response 3. Project mitigation measures include elevation of segments of low-lying roads within the Herring River floodplain that may be susceptible to inundation after tidal exchange is restored. In combination these segments constitute approximately two miles of roadway. These are public roads that cross the river and various tributary streams and link upland areas that surround the estuary. They range from infrequently traveled fire roads to moderately busy paved roads. The major low-lying roads identified as affected by the Project are portions of High Toss Road, Old County Road, Bound Brook Island Road, Pole Dike Road, Old Chequessett Neck Road, Duck Harbor Road, and Ryder Hollow Road. All of the roads are low volume roads. With respect to the road segment elevations, the Commission's FEIR comment letter notes that "the proposed alterations are necessary and appropriate." Low-lying road designs are described in Section 3.B.3 of this application, and plans are provided in Section 8.H.

In addition, as described in section 3.B.3, mitigation measures to protect against water intrusion will be installed at CYCC and on three other private properties. These measures have been designed with the

[15] Herring River Carbon Project Feasibility Study. TerraCarbon. Version 1.4. August 2019

support and consent of property owners, and have been designed using the modeling parameters above and will be designed to protect against impacts under full tidal restoration conditions. These measures are described in section 3.B.3 of this application. Plans for proposed work on CYCC property are provided in section 8.H of this application.

4.F Transportation (TR)

4.F.1 Existing Conditions

Chequessett Neck Road and Pole Dike Road, where new tide control elements are proposed, are existing paved town roads. High Toss Road is an unpaved sand berm used primarily as a fire road, and it also provides access to a small number of private properties on adjacent unpaved ways, and recreational access to Griffin Island.

In addition, several segments of low-lying roads occur within the Herring River floodplain and may be susceptible to inundation after tidal exchange is restored. In combination these segments constitute approximately two miles of roadway. These are public roads that cross the river and various tributary streams and link upland areas that surround the estuary. They range from infrequently traveled fire roads to moderately busy paved roads. The major low-lying roads identified as affected by the Project are portions of High Toss Road, Old County Road, Bound Brook Island Road, Pole Dike Road, Old Chequessett Neck Road, Duck Harbor Road, and Ryder Beach Road.

4.F.2 Post Restoration Conditions

Construction of the Project's primary tide control element involves the removal of approximately 165 feet of the existing earthen dike and tide control elements currently installed under Chequessett Neck Road, and constructing a new bridge equipped with tide gates. Additional tide control elements and mitigation actions will require the elevation of existing low-lying roadways. The construction of tide control elements and mitigation will be managed to ensure public safety and minimize disruption of automobile, bicycle and pedestrian traffic during all phases of construction, as described below.

4.F.2.1 Chequessett Neck Road Bridge

The Chequessett Neck Road Bridge Replacement Project will be constructed in the following five stages[16]:

- **Stage 1A:** This stage will include the preparation necessary for installation of the temporary bypass/ traffic diversion roadway. Erosion controls will be installed along with temporary steel sheeting required to construct the approach embankments for the temporary bypass bridge and water control cofferdams. Stone channel bottom scour protection will also be installed on the eastern side of the temporary sheeting at the bridge opening/exit area. This stage of construction is expected to last 4-6 weeks.
- **Stage 1B:** This stage will consist of the installation of the temporary bypass/traffic diversion bridge and the completion of its approach embankments (within the limits of temporary sheeting). Overhead electrical utilities will be temporarily diverted during this stage along the temporary

[16] Sheet CS-120 – Construction Sequence & Water Control Plan of the Project Plans

bypass route. At the end of this stage of construction, traffic flow will be diverted from Chequessett Neck Road onto the bypass bridge. This stage of construction is expected to last 4-6 weeks.

- **Stage 2:** This stage will consist primarily of the installation of temporary steel sheeting along the harbor side of the dike; the construction of the proposed southern bridge pier, abutment, and wingwalls; the installation of stone channel bottom scour protection within the bridge's southern span as well as the bridges western entrance/exit approach area; the installation of stone armor embankment protection along both sides of the bridge's southern approach; and the installation of the concrete stairway on the eastern side of the roadway embankment. Additionally, temporary tide gates will be installed on the harbor side of the southern bridge span to control flow for Stage 3. This stage of construction is expected to last 8-10 weeks.
- **Stage 3:** This stage will consist primarily of the installation of the construction of the proposed northern bridge pier, abutment, and wingwalls; the installation of stone channel bottom scour protection within the bridge's northern and centers spans; the installation and stone armor embankment protection along both sides of the bridge's northern approach; the removal of temporary sheeting on the western side of the embankment; and the installation of the access stairway on the western side of the roadway embankment and the upper portion of the access stairway on the eastern side of the roadway embankment. This stage of construction is expected to last 10-12 weeks.
- **Stage 4**: This stage will consist primarily of the installation of the bridge's superstructure, approach slabs, and recreational/viewing platforms; the removal of any remaining temporary cofferdams that were installed for diverting tidal flows; the construction of the new roadway (including roadway base course), its associated improvements, and guardrail system; the installation of new electric and telecommunication utilities; the installation of tide gates/panels; and the installation of the project's new stormwater management system including pre-treatment catch basins and stormwater planters. This stage of construction is expected to last 14-16 weeks.
- **Stage 5:** This stage will consist primarily of the removal of temporary utilities along the temporary bypass route; the redirection of traffic onto the new bridge and the removal of temporary signal; the installation of the lower portion of the access stairway on the eastern side of the roadway embankment and portion of the boardwalk within the limits of sheeting; the removal of the temporary bridge structure; and the restoration of the Project Site. This stage of construction is expected to last 6-8 weeks.

Construction staging: The Chequessett Neck Road Bridge project's primary staging area on property owned by the NPS will be located within the Project's limits of disturbance on the northern side of the Herring River. The majority of this area consists of upland wooded area. The preferred staging area is also within the vicinity of eastern box turtle habitat mapped by NHESP, as well as areas of potential cultural resource and archaeological sensitivity (Herbster and Heitert 2011). A Phase 1B Cultural Resources Assessment was conducted in spring of 2015 with the goal of identifying the most appropriate construction staging and laydown areas during the construction of the new bridge. Project staging will work around any archaeologically or ecologically sensitive areas and avoid impacts to these resources.

Other off-site staging areas to the north of the Project site are deemed provisional and subject to revision or exclusion pending initiation and completion of discussions with the Town of Wellfleet and/or NPS (as to the extent, type, and seasonality of potential staging/storage activities associated with the Project). In addition to the specific locations shown within the Project plans, additional off-site staging areas may be utilized, subject to discussion and agreement with respective property owners, the Town of Wellfleet, and the NPS. These include a public parking area at the end of Duck Harbor Road, a former borrow pit on Pole Dike Road (currently owned by the Town of Wellfleet), and a parking area on Griffin Island Road (also owned by the Town of Wellfleet).

Barges will be mobilized to the site for additional staging of materials (e.g., steel sheeting, pipe piles) and to provide operating platforms for crane equipment at various stages of construction. It is expected that the majority of barges, if not all barges, will be located on the harbor-side of the embankment; however, one or more barges may be deployed on the river-side of the embankment, subject to the engineer's review and acceptance of the contractor's proposed access plan submittal prior to construction. Any barges mobilized to the site will be required to be cleaned immediately prior to transport, be equipped with spuds to secure the barge from waves, currents, and tidal fluctuations, and be provided with a site-specific fueling protocol, spill control and countermeasure plan and appropriate spill containment/cleanup materials.

Pedestrian/Canoe/kayak access: The Chequessett Neck Road Bridge project will enhance the ease and safety of public pedestrian and canoe/kayak access to the river. Design features to improve pedestrian access include:

- ADA-compliant viewing platforms on both sides of the bridge structure along with multiple stairways that will provide recreational users (i.e. canoers and kayakers) with access to the Harbor and River at varying tide levels.
- 10-foot wide level bench areas on both sides of the embankment that can serve as viewing/fishing areas at the full tidal range.
- A new permeable gravel parking lot (adjacent to the intersection of Chequessett Neck Road and Duck Harbor Road) with a permeable gravel pathway and boardwalk that will provide full accessibility for recreational users on the riverside of the bridge.
- A wider roadway embankment crest that will accommodate (2) 11’-0” travel lanes that will tie into existing lane widths at the limits of construction (refer to Sheet CS-121 of the Project Plans); an 8’-0” wide parking lane and adjacent 5’-0” wide sidewalk that will be constructed on the western side of the bridge structure; a 5’-0” wide sidewalk will be constructed on the eastern side of the bridge structure; and multiple cross walks to provide safe pedestrian access to both sides of the bridge.

Public water access facilities are incorporated as part of the overall project, providing safe portage of hand carried recreational watercraft between Wellfleet Harbor and Herring River. Provisions for a parking area on the inland side, north of the bridge (along Duck Harbor Road) with access to the Herring River is included as part of the CNR bridge construction. Adding public water access facilities at the proposed CNR bridge site is intended to improve safety of recreational watercraft users. The following considerations were taken into account during the development of the proposed portage route alternatives to account for safe access and maneuverability while portaging:

- Avoiding sharp turns;
- Avoiding egress near parked cars;
- Providing a path that is a minimum of five feet width that is easily traversed by a single person utilizing a wheeled cart to help maneuver his/her craft;
- Minimizing longitudinal slopes to 8.33% or less (as steeper slopes exceeding 15% will make transition from land to water difficult);
- Providing an accessible launch between 9-inches and 2-feet from the highest expected tidal water level; and
- Providing handrails or other support structures including step-down designs or ropes.

Portage routes between Wellfleet Harbor and Herring River were narrowed down to two primary locations: (1) from the harbor side of the roadway embankment to the river side via the installation of ramp and/or step structures (adjacent to the north end of the proposed bridge); and (2) from the planned unpaved parking area near the temporary staging area to a new landing/launch structure on the upstream side of the embankment. It was noted that recreational access to Wellfleet Harbor (on the harbor side of the dike) is currently provided at the gravel access area that exists to the west of the Chequessett Neck Road and Duck Harbor Road intersection. In addition, the new CNR bridge includes a new canoe/kayak portage and access area on the Griffin Island side of the new structure.

Traffic control during construction: Traffic and pedestrian flow across the CNR dike will be provided throughout the construction period. Two major alternatives were evaluated to bypass traffic on CNR during the period of construction: (1) the construction of a temporary bridge crossing over Herring River (parallel to the existing dike) and (2) the closure of Chequessett Neck Road bridge and the diversion of traffic to Duck Harbor and High Toss Roads following substantial improvements to accommodate diverted traffic.

Temporary bridge crossing over the Herring River*:* Installing a temporary bridge adjacent to CNR which would cross the Herring River and connect traffic on both sides of the existing dike would result in less of a temporary impact to on-site wetland areas as compared to the non-preferred alternative. The other major advantage to this approach is that traffic is moved to the side, outside of the proposed structure's footprint, allowing the contractor greater flexibility during construction. This would result in a shorter duration of construction as compared to a phased construction approach that utilized one lane (per phase) of the existing dike to pass traffic throughout the construction period. A shorter duration of construction would result in less of a temporary impact to on-site wetland resource areas.

In order to minimize the Project's limit of disturbance to on-site wetland resource areas as a result of this method of traffic management, the temporary by-pass bridge layout was designed to just meet the minimum radius requirements to safely accommodate the turning movements of a WB-62 (truck) vehicle while staying within the limits of scour protection recommended by WHG. This approach safely accommodates emergency vehicles and school buses. To further minimize impacts to on-site wetland resources, the temporary bridge system has been designed with a temporary bridge superstructure system that will span above a significant section of the river. To achieve this, substructure elements consisting of piers/pile bents will be used to elevate a significant portion of the superstructure while earthen abutments encompassed by steel sheeting will be used to create the temporary approaches.

While the preferred approach will require the rental of a temporary bridge system and construction of temporary piers/pile bents to support the superstructure, this on-site alternative to traffic management was selected as the preferred alternative (in comparison to the off-site Duck Harbor/High Toss Road approach) as it will result in less of an impact on wetland resources compared to the off-site alternative of making improvements to Duck Harbor Road and High Toss Road to accommodate diverted traffic.

4.F.2.2 Mill Creek Water Control Structure – Construction Staging and Traffic Management

The Mill Creek structure is not a subject of this application, but is described below for informational purposes.

The Project's primary staging area is on property owned by the NPS and will be located within the Project's limits of disturbance on the north of the proposed access road, approximately 400 feet north of the new structures. This area consists of an upland wooded area. Construction associated with the Mill Creek water control structure is expected to last between six to eight months, subject to applicable Time of Year restrictions and weather conditions. Because the proposed work would occur off of public roads, no traffic management is proposed.

4.F.2.3 High Toss Road – Construction Staging and Traffic Management

All construction vehicles and personnel will access the work area via Pole Dike Road, on the eastern end of High Toss Road. Work will begin on the western end of High Toss Road. Traditional construction equipment including excavators and bulldozers will be used to remove the roadbed fill and the Herring River culvert. Work along High Toss Road will then progress from west to east, with the fill within the floodplain of Herring River removed and stockpiled elsewhere within the work area. After the removal of roadbed fill within the floodplain has been completed and final design grades have been achieved, the elevating of High Toss Road will begin in areas as shown on the Project plans. Construction equipment will be used to transport fill material to be added to the road surface in areas that are currently below the minimum target elevation until the entire remaining road surface is above elevation 7.5 feet. The culvert on the unnamed stream on the eastern end of High Toss Road will be removed and replaced with a new culvert. The proposed culvert opening at High Toss Road is 18 inches in diameter to allow for increased hydraulic capacity and ease of maintenance. Based on the size of the existing wetland south of the roadway at this location, this size should be adequate to support future tidal exchange.

Following the completion of construction work, all disturbed areas will be graded and stabilized. All construction vehicles, equipment, and materials, including erosion controls, will be removed from the site, and these areas will be restored to pre-construction conditions.

The first phase of construction will involve the installation of erosion controls in the work areas as shown on the drawings. At the Herring River culvert removal location, a silt curtain will be placed across the Herring River. At locations uphill of cut slopes, straw wattles, erosion control measures, or similar will be placed to divert runoff around the cut slope until it is stabilized. The installed erosion controls will be inspected and maintained in accordance with NPDES Construction General Permit and other permit approvals until the construction area is stabilized.

Based on the results of the geotechnical analysis, it is envisioned that most material removed from the floodplain will be used for the elevating the travelway of High Toss Road. While the selected contractor will determine the means and methods of construction, it is assumed the likely filling operation for the travelway will proceed from west to east to minimize the haul distance for the material that is removed from the floodplain. The fill material will be stockpiled at a location to be determined and then used on the travelway. Work in the floodplain and travelway are likely to proceed simultaneously once sufficient material has been removed from the floodplain to start work on the travelway.

Once the floodplain work and the filling operation for the travelway are complete, the road will be brought to final grade and stabilized with gravel material. After the area is stabilized, erosion controls will be removed, and construction will be complete. It is assumed all aspects associated with the High Toss Road will be completed in a single construction season.

High Toss Road is a very low volume road; therefore; large-scale traffic management measures are not anticipated to be required. Appropriate construction signage and barriers will be implemented and maintained by the selected contractor and limited police details or flagmen will be used as directed by the Town. Since High Toss Road provides access to residents on and near Way #672, the ability to travel over High Toss Road will be maintained to the maximum extent possible throughout construction. Any limitations on work hours for construction will be determined by the Town.

4.F.2.4 Pole Dike Road Water Control Structure and Other Low-lying Road Work

The proposed roadway alignments maintain the existing horizontal geometry with minor adjustments in vertical alignment to accommodate the increased elevation and culvert crossings. The centerline of the proposed road segments matches the centerline of the existing roads. The elevated roadway segments are designed to transition back into existing geometric alignments. Horizontal and vertical alignment of the elevated road segments follows published standards by the MassDOT, American Association of State

Highway and Transportation Officials (AASHTO) Green Book (2011), and the Federal Highway Administration.

The proposed design maintains a consistent cross-section design for the elevated roads: two 11-foot travel ways and two three-foot unpaved shoulders. The MassDOT design criteria (2006) recommend a travel lane width of ten- to twelve feet. The existing roadway has an average width of 10.5 feet. For safety purposes, the proposed travel lane width was increased to 11 feet. The proposed alignment is based upon two 11-foot paved travel ways and two 3-foot unpaved shoulders.

The existing roadways have limited guardrails along the alignment. The existing roadways are unposted and are located in an uncongested area. Based on input received from the local police departments, the existing speed limit is 40 MPH. It is recommended that the elevated roadways have a posted speed limit of 35 MPH. Per MassDOT Highway Design Manual, Section 3.6.5, the design speed will be 5 MPH over posted speed to limit which accounts for traffic volumes and anticipated driver characteristics.

To comply with MassDOT standards, the proposed design includes installation of guardrails along the edge of the roadway in the areas where the road will be filled to raise alignment above the storm-of-record elevation. MassDOT standards require that for a roadway with a design speed of less than 40 mph guardrails are necessary if the clear zone is less than 7-feet wide. Since the clear zone is defined as an area with traversable, recoverable slope (4H:1V or flatter), it is necessary to put up guardrails along nearly the entire southbound section of proposed elevated roadway and some portions of the northbound proposed elevated lanes. The design includes approximately 11,900 linear feet of guardrail, comprised of approximately 7,500 linear feet of guardrail on the southbound side and 4,400 linear feet on the northbound lanes.

Construction will be performed in stages to manage traffic flow during construction. A Maintenance Protection of Traffic Plans (MPOT) was developed in accordance with the Federal Highway Manual Uniform Traffic Control Devices (MUTCD). The Detour Plans and MPOT, which show all required road closures and detours, are contained in Section 8.H.

4.F.3 Response to Transportation Objective

The transportation goal of the RPP is to provide and promote a safe, reliable, and multi-modal transportation system. The Project advances this goal by incorporating auto, pedestrian and bicycle safety into the design of the Chequessett Neck Road Bridge and road elevation measures. As a coastal restoration project, the Herring River Restoration Project will not generate new traffic trips or impose any additional burden on the local or regional roadway network.

The Project will enhance transportation safety and efficiency by providing significant improvements to existing road infrastructure, including the new CNR Bridge and approaches, removal of a portion of High Toss Road and (by mitigation) elevation and culvert replacements along of segments of low roads. The Commission's FEIR comment letter states that "[i]impacts of this project on the roadway network should continue to be detailed in subsequent work and submissions to the Cape Cod Commission under DRI review. Where paved roadways are significantly altered, accommodation for non-motorists should be maintained and, to the extent feasible, improved. In addition to permanent impacts, temporary construction impacts on the roadway network should be addressed in subsequent analysis and submissions to the Commission."

A description of this work and related traffic management during construction is provided above and is further detailed on plans for the bridge and all roadway elevation work proposed as mitigation (see Section 13). In all cases, stormwater management and safety are improved, and accommodation of non-motorists is maintained. The roadway design plans maintain existing road dimensions in order to maintain the rural character of local roads and to minimize impacts to adjacent wetlands. Traffic management plans developed to maintain safe vehicular and non-motorist access during road construction are described below and are provided in Section 8.H.

Objective TR1 – Improve safety and eliminate hazards for all users of Cape Cod's transportation system

The Project meets this objective based on the following information:

TR1 Response 1. The Restoration Project will not generate new traffic trips and therefore preparation of a Traffic Impact Assessment (TIA) is not warranted. According to the Commission's Transportation Technical Bulletin, "[t]he scope of a TIA is largely informed by the scale of the potential impact to the transportation system as approximated by the anticipated new peak hour trips generated by the project." The Project is not anticipated to generate 50 or more new peak hour trips, and therefore is not required to present a detailed analysis of off-site safety impacts of the development at Study Area locations and implement appropriate safety improvements.

TR1 Response 2. Road designs incorporate all required MassDOT and FHA standards for safety:

- The proposed bridge /tide gate structure has been reviewed by MassDOT and is designed to comply with the requirements of the MassDOT LRFD Bridge Manual and the American Association of State Highway and Transportation Officials (AASHTO) LRFD Bridge Design (See section 3.B.2 of this Application):
- To design the bridge and gate structures to withstand significant lateral loads from tidal fluctuations, storm surge events (such as the 100-year and 500-year frequency flood events), and to withstand a saltwater environment with wave action.
- Horizontal and vertical alignment of the elevated road segments follows published standards by the MassDOT, American Association of State Highway and Transportation Officials (AASHTO) Green Book (2011), and the Federal Highway Administration.

- In accordance with MassDOT standards, design low road elevations includes installation of guardrails along the edge of the roadway in the areas where the road will be filled to raise alignment above the storm-of-record elevation

TR1 Response 3. The Project has developed traffic management plans for all roadway construction that maintain safe vehicular, pedestrian and bicycle access during all stages of construction. All properties that rely on these roadways for access will have safe access during all stages of construction.

- A temporary bypass/traffic diversion bridge will provide vehicular, pedestrian and bicycle traffic over the portion of Chequessett Neck Road that crosses Herring River during all stages of construction.

- For all low-lying roadwork, a Maintenance Protection of Traffic Plans (MPOT) was developed in accordance with the Federal Highway Manual Uniform Traffic Control Devices (MUTCD).

- High Toss Road is a very low volume road; therefore; large-scale traffic management measures are not anticipated to be required. Appropriate construction signage and barriers will be implemented and maintained by the selected contractor and limited police details or flagmen will be used as directed by the Town.

TR1 Response 4. Roadway profiles will be retained to the maximum extent possible to maintain the rural character of the roads.

- Where public roads or access roads to private property are elevated, the design of these measures has maintained clear lines of sight and avoided creating sight distance obstructions.

- The proposed design maintains a consistent cross-section design for the elevated roads: two 11-foot travel ways and two three-foot unpaved shoulders. The MassDOT design criteria (2006) recommend a travel lane width of ten- to twelve feet. The existing roadway has an average width of 10.5 feet. For safety purposes, the proposed travel lane width was increased to 11 feet.

4.G Cultural Heritage (CH)

4.G.1 Existing Conditions

Identification and preservation of cultural resources within the Project area are highly important components of the Project. To initiate consultation with the Massachusetts Historical Commission (MHC), a Project Notification Form (PNF) was completed by the CCNS and filed in 2008. Based on recommendations from the MHC, cultural resources within the Project Area were assessed through a Phase 1A archaeological background research and cultural resources sensitivity assessment that was completed for the Project area in 2011. This resulted in a Programmatic Agreement between the MHC and NPS (see Section 8.0 of this application) that established the Area of Project Effect (APE)[17] and the identification of archaeological resources and resolution of any potential impacts resulting from the Project. Section 3.9 of the FEIS includes a detailed discussion of the unique stewardship role of the NPS for cultural resources, guiding regulations and policies, and the two categories of cultural resources that were retained for analysis: archaeological resources and historic structures. Topics covered in detail in the FEIS are briefly summarized below.

- **Guiding regulations and policies:** The National Historic Preservation Act (NHPA) (1966, as amended) is the principal legislative authority for managing cultural resources associated with National Park Service projects. Generally, Section 106 of the act requires all federal agencies to consider the effects of their actions on cultural resources listed on or determined eligible for listing in the National Register of Historic Places (National Register). Other important laws or Executive Orders designed to protect cultural resources include the NPS Organic Act, American Indian Religious Freedom Act, Archaeological Resources Protection Act, National Environmental Policy Act (NEPA), Executive Order 11593 (Protection and Enhancement of the Cultural Environment), and Executive Order 13007 (Indian Sacred Sites).
- **Archeological resources:** Archeological resources in the Project area have been assessed using a combination of archival research, site file research, and walkover surveys. These were used to document known archeological resources within the Herring River restoration area and to identify areas where unknown archeological resources may exist. This information, in combination with predictive models developed for archeological resources elsewhere in the region, was then used to plot areas of archeological sensitivity. Steps to identify, evaluate, and mitigate any adverse effects on significant properties are defined in the final Programmatic Agreement developed among the consulting parties (See Section 8.A of this application).
- **Historic structures:** Although there are no historic structures listed in the National Register in the Herring River estuary, a dike apparently spanned Mill Creek near its confluence with the Herring River. The Colonial period Atwood-Higgins House and other buildings associated with the house lie

[17] The APE is defined as the areas in the estuary below the 10-foot contour elevation, and certain upland areas where project impacts may occur, such as areas around CYCC, Chequessett Neck Road dike, and several low-lying roads including High Toss Road, Bound Brook Island Road and Pole Dike Road. Source: FEIR Section 3.9.2

within 100 meters of the Area of Project Effect (APE) of the restoration project near the confluence of Bound Brook and the Herring River on the eastern tip of Bound Brook Island (Herbster and Heitert 2011). Recent work has defined an Atwood-Higgins Historic District, which has been nominated for the National Register. Other historic structures may be identified and evaluated as the extent of project effects are finalized; steps necessary to identify and evaluate historic structures in the area of potential effect are defined in the final Programmatic Agreement (See Section 8.A of this application).

4.G.2 Post Restoration Conditions

The CCNS submitted a Project Notification Form (PNF) for the Project to the MHC in 2008. Subsequently in 2014, the CCNS and MHC executed a Programmatic Agreement to identify and resolve effects on archaeological resources resulting from the Project (See Section 8.A of this application).

In 2011, the Public Archaeology Laboratory (PAL) completed a Phase IA Archeological Background Research and Sensitivity Assessment report (Herbster and Heitert 2011) within the Area of Potential Effect (APE) to determine the potential for impact on cultural resources resulting from full tidal restoration. The results of the Phase IA survey determined that several previously known archeological sites have been identified adjacent to proposed project impact areas. Portions of the proposed project impact areas are therefore considered sensitive for the presence of pre-Contact Native American and post-Contact (Historic Period) archeological resources. Effects to cultural resources will be resolved in accordance with the stipulations described in the Programmatic Agreement in compliance with Section 106 of the National Historic Preservation Act of 1966 (NHPA). The section below briefly summarizes expected impacts to cultural resources and the project's approach to protecting sensitive cultural resources from potential impacts. Section 4.9 of the FEIS contains a more complete discussion on the effects of increased tidal elevations and tidal flows, changes to the Chequessett Neck Road dike, impacts of adaptive management actions, and potential impacts that will be avoided, minimized, or mitigated (HRRC 2016).

Increased tidal elevations and tidal flow: Modeled erosional patterns expected to occur because of increased tidal flows do not overlap with any archaeologically sensitive areas or known sites along the margins of the APE, and only resources which cross the existing channels are likely to be affected. Considering the greatest level of erosion potential as it relates to archeological resources, the only archeological resources that could potentially be impacted by increased erosion are along High Toss Road, and at the intersection of Bound Brook Island Road and the former Cape Cod Railroad alignment. No areas of pre-contact sensitivity fall within modeled erosional zones under any of the modeling scenarios.

Chequessett Neck Road dike: The dike and roadway are not considered historic resources. An archaeological survey of the surrounding areas where staging or stockpiling may occur identified low-density archaeological deposits that are deeply buried and would not be affected by surface activities associated with the construction (Herbster et al 2016).

Impacts of management actions: The only management actions that could potentially affect archaeological resources are those actions which will necessitate ground disturbance that will primarily occur within existing and former transportation corridors through the modification of roadway elevations or the replacement of culverts beneath these roadways.

Potential adverse impacts to be avoided, minimized, or mitigated: To minimize potential impacts, any archaeologically sensitive areas or sites will be avoided. If avoidance is not possible, then additional archeological assessment and/or survey will be conducted where ground-disturbing activities are to be conducted. This will include construction footprints and any ancillary areas associated with construction, if these areas correspond to archeological sites or sensitive areas. Archaeological monitoring will also be conducted during construction in some potentially sensitive areas. If significant archeological sites are identified, then in accordance with the Programmatic Agreement, actions to mitigate impacts will need to be developed for these specific resources.

In 2015, PAL completed Phase IB archeological investigations within portions of the project area at the privately-owned CYCC property and two CCNS parcels on the north side of the Chequessett Neck Road dike (Herbster et al 2016). One potentially significant pre-contact archeological site was identified on the CYCC property. Proposed improvements in the CCNS impact area were found not to affect significant cultural resources and no additional archaeological investigations were recommended.

In 2016, PAL completed an Addendum Phase IB archeological survey within a proposed work area on federally-owned property on the north side of the river from CYCC that will provide access to the Mill Creek area. No archeological resources or cultural deposits were identified within the project area, and no additional archeological investigations were recommended (Herbster 2016).

In 2018, PAL completed a second Addendum Phase IB archeological survey within additional areas of CYCC property where work may be proposed (Herbster and Lüttge 2018) that identified a potentially significant site. To the extent possible, any future ground disturbance will avoid impacts to either of the two CYCC sites. If avoidance is not possible and in accordance with the Programmatic Agreement, additional archeological testing will be completed to fully delineate the boundaries of the site.

4.G.3 Response to Cultural Heritage Objectives

The Cultural Heritage goal of the RPP is to protect and preserve the significant cultural, historic, and archaeological values and resources of Cape Cod. The Project responds to this goal by restoring a native ecosystem and the environmental and community benefits supported by the ecosystem. Traditionally the ecosystem supported commercial and recreational shellfishing, finfishing, and numerous recreational pursuits that are important to residents and regional tourism. Moreover, every element of the Project has been designed to retain and reflect the rural character of the roadways and surrounding area.

Objective CH2 – Protect and preserve archeological resources and assets from alteration and relocation

The Project meets this objective based on the following information:

CH2 Response 1. The Project's activities related to archaeological sites and historic structures are dictated by a Programmatic Agreement executed between the Department of Interior and Massachusetts Historical Commission, found in Section 8.A. In accordance with the Programmatic Agreement, all construction activity and disturbance will be directed away from significant archaeological sites so they are not disturbed. Any potential impacts will be avoided, minimized and mitigated as described above and in accordance with the Programmatic Agreement.

CH2 Response 2. Major construction activity for tide control and elevated tide mitigation is proposed to occur primarily in and adjacent to existing travelways and areas of previous disturbance (Chequessett Neck Road, Pole Dike Road, High Toss Road, Old County Road, Bound Brook Island Road). Additional activity proposed to occur on property owned by the existing golf course at CYCC, including excavation of fill for elevating portions of the golf course and low roads, has proceeded subject to cultural assessments undertaken by PAL in accordance with the Programmatic Agreement.

CH2 Response 3. Significant archaeological sites will be protected from development. Approximately 540 of the 570 acres restored in Phase 1 are within the CCNS owned by the NPS, and any significant archaeological sits on that land will be protected from development. Wellfleet Conservation Trust owns an additional 9 acres and any significant archaeological sites on that land also will be protected from development. Any significant archaeological sites on approximately 10 acres owned by CYCC will be protected from development in accordance with the Programmatic Agreement. There are no significant cultural resources identified on the remaining 17 acres of privately owned land.

Objective CH3 – Preserve and enhance public access and rights to and along the shore

The Project meets this objective based on the following information:

CH3 Response 1. Currently, there is no waterway access into Herring River, and no safe portage for members of the public to access Herring River for canoeing or kayaking. The bridge will restore historic public waterway access to Herring River, which existing prior to installation of the dike in 1909. As detailed in Section 3.B.2, the new CNR bridge will enhance the ease and safety of public pedestrian and canoe/kayak access to the Herring River. The bridge will also provide a safe pedestrian platform area for fish casting, which is a popular activity on the existing dike.

CH3 Response 2. The removal of High Toss Road will restore historic waterway access between Lower Herring River and Lower Pole Dike Creek. Recreational access over the High Toss Road causeway to Griffin Island will be redirected to Chequessett Neck Road. The new bridge is designed with added features to accommodate recreational access to Herring River.

CH3 Response 3. Portions of low roads to be elevated are designed to maintain the same width and curvature to the maximum extent possible, in order to retain the rural character of the roads while ensuring vehicular and pedestrian access and minimizing impacts to adjacent natural resources.

CH4 Response 4. The Project will restore scenic historic landscapes.

- Restoration of tidal flow will lead to the removal of fresh water and invasive species that are not salt tolerant. Herbaceous and woody vegetation will be removed in accordance with a Vegetation Management Plan. As these species are removed and tidal flow is increased, salt tolerant wetland vegetation species will colonize. By the end of Phase 1 of the restoration, 570 acres of scenic tidal marsh will be restored or in transition.

- The underground and under bridge relocation of electrical and telephone wires currently strung on poles across Chequessett Neck Road will help to restore the historic scenic character of Chequessett Neck Road. The undevelopment of two residential structures in Lower Herring River will also reopen a portion of historic landscape.

CH4 Response 5. The Project will apply for Chapter 91 Waterways licenses or permits for structures, fill or dredging in Commonwealth tidelands, and will adhere to all applicable requirements for public access to and along the shore.

Objective CH4 – Protect and preserve traditional agriculture and maritime development and uses

The Project meets this objective based on the following information:

CH4 Response 1. The Project maintains and restores a traditional industry that contributes to economic diversity and preserves historical traditions in the region. Shellfising is annually a $5 million industry in the Town of Wellfleet, and an important element of the community's quality of life and visitor appeal. Current conditions have resulted in documented damage to shellfishing in the community. Currently, water flowing out through the dike into Wellfleet Harbor at low ebb tide contains very high concentrations of Fecal Coliform bacteria, and the Chequessett Neck Road dike is a designated point source for this pollutant. These high bacterial concentrations negatively impact shellfish beds and grants, and have led the Massachusetts Division of Marine Fisheries to close hundreds of acres of once-harvestable beds seaward of the dike over the past decades. The restoration will result in a 13-fold increase in the volume of tidal water entering Herring River. By introducing clean saline water from Cape Cod Bay into the Herring River, the restoration will reduce bacterial concentrations that account for current shellfish closures to limits that are safe for shellfish harvesting. The reduction of bacteria concentrations will result from the dilution of cleaner inflowing water into the system, as well as the significantly reduced life span of bacteria in more saline waters.   Restored tidal flow will also allow shellfish to spread into areas of the estuary where they are currently not found, forming new shellfish beds. Ultimately the restoration will improve water quality in Wellfleet Harbor by reducing bacterial concentrations, and may increase the area in the Harbor where shellfish may be harvested. Over time and in accordance with procedures set forth by MassDMF, it is anticipated that these resources may be reopened to public recreational shellfishing.

CH4 Response 2. The Project will not interfere with any existing maritime activity, and will restore and enhance historic public access to Herring River. The proposed design of the CNR bridge incudes a pedestrian platform and portage areas to enhance recreational maritime activities such as canoeing, kayaking and fishing. Currently there is no safe public access to launch a canoe or kayak in Herring River.

CH4 Response 3. There are no known farmlands noted in historic or cultural landscape inventories or listed in the National Register of Historic Places.

CH4 Response 4. No existing maritime industrial structures or maritime industrial buildings are located in the Phase 1 restoration area.

5. Overview of Adaptive Management

This Project proposes to use a rigorous form of adaptive management to guide the restoration of tidal flow in the Herring River system. Adaptive management is a valuable and versatile approach for many environmental restoration projects implemented over a long timeframe. For example, in order for a nutrient management plan to be considered consistent with the Cape Cod Area Wide Water Quality Management Plan Update, the Commission requires that plans incorporate an adaptive management approach, "to be responsive to changes in environmental quality, relative effectiveness of implemented approaches, identification of new technology, and unforeseen community needs."[18]

Adaptive management provides the framework within which alternative management actions can be systematically evaluated during consideration of multiple project objectives, thereby allowing for informed local management decisions. Following adaptive management guidelines, the Project will restore tidal flow incrementally while water quality, vegetation, tide levels, salinity, sediment movement and many other environmental factors are monitored and compared with pre-restoration conditions and expected changes. The rate of tidal restoration can be slowed, reversed, or increased based on the system response as indicated by monitoring data.

The Herring River Adaptive Management Plan (HRAMP) is contained in Section 8.B. This section is intended to provide an overview of the HRAMP and serve as a guide to the more detailed document.

5.A What is Adaptive Management?

Adaptive management is an iterative process of (1) making predictions regarding outcomes of management actions, (2) monitoring system responses once management actions are implemented, (3) comparing predicted outcomes to observed outcomes of management actions, and (4) using the result to update our understanding of system responses to guide future management actions. Information obtained from post-implementation monitoring improves our ability to predict future outcomes and make better decisions regarding the selection of appropriate future management actions.

Adaptive management differs from a 'trial and error' and other reactive processes by comparing predicted outcomes to observed system responses in order to improve our understanding of system behavior through collection of data used to update predictive models, rather than simply rejecting an action that failed to elicit the desired outcome. Thus, adaptive management is a process for decision making under evolving conditions that promotes flexibility by adjusting decisions as outcomes from management actions and other events become better understood. Characteristics of the Herring River Restoration Project provide the conditions appropriate for using an adaptive management approach. These include a broad range of potential system responses to management that make it difficult to

[18] Cape Cod Commission, Guidance on Section 208 Plan Update. Obtaining a Consistency Determination, April 2018.

determine the best restoration policy and a series of water-control decisions repeated over time. Therefore, an adaptive management framework is the most productive method to address restoration decisions related to managing tidal exchange within the Herring River estuary.

5.B Structure of the HRAMP

The HRAMP was developed by the project team in collaboration with the US Geological Survey (USGS). The HRAMP establishes the framework for decision making on how to operate adjustable tide gates at a new CNR bridge to maximize the ecological benefits of restoring tides to the Herring River estuary while minimizing adverse impacts.

The HRAMP consists of two phases: the setup phase and the implementation or iterative phase. The setup phase consists of several steps that must be taken prior to implementation of any management action:

1. Define the problem to be addressed by the Project;
2. Identify specific objectives to be achieved by the Project;
3. Select potential policies or management actions capable of achieving objectives;
4. Identify predicted outcomes or consequences of each potential action with respect to the stated restoration objectives, based on extensive baseline monitoring and modeling;
5. Develop a method for assessing trade-offs among competing objectives and identifying the policy, decision, or action that is most likely to achieve the objectives; and
6. Develop and implement a monitoring program to track outcomes of selected management activities and compare outcomes with predictions.

The balance of this section summarizes each of these six steps, and describes additional detail contained in the HRAMP Plan found in Section 8.B.

5.C Define the Problem

An effective adaptive management plan requires a clear definition of the problem, or problems, to be addressed in order to identify why the decision needs to be made, and the individuals who can make the decision. Individuals or groups that have an interest in the resources affected and a willingness to work with others on the problem (i.e., stakeholders) should be identified.

The Project has evolved over more than three decades of scientific study and more than a decade of stakeholder engagement led by the Town of Wellfleet and CCNS. The responsive and transparent community planning process has helped to clarify the ecological and socio-economic problems that have developed under current tidally restricted conditions, and are to be addressed by the Project. These issues are described in detail in the FEIS/FEIR and are summarized in Section 3.A of this Application. The community planning process also has identified issues of concern associated with restoration (e.g., visual changes, property impacts, traffic management during construction) that need to be taken into consideration in Project design and implementation.

As described in the HRAMP contained in Section 8.B, the decision-making process (Section 5.H) enables local decisions to be made in based on best available science and information, and in consideration of stakeholder input.

5.D Identify Objectives, Performance Measures and Management Outcomes

Defining project objectives starts with considering what you care about: what is to be achieved and what to avoid. The focus is on achieving ecological and socio-economic objectives using quantifiable metrics to evaluate progress towards achievement of well-defined restoration goals. Clearly defined objectives are the foundation of any decision process. In adaptive management, predicting the consequences of available actions in terms of measurable objectives provides a clear path for identifying the best performing strategy. Thus, the analysis starts with defining the objectives.

The fundamental objectives of the Herring River Restoration Project are shown in Figure 5-1. The fundamental objectives are derived, in part, from NPS management policies as articulated in the current General Management Plan for the CCNS, which states that the objective for managing coastal wetlands is to “Restore the natural hydrography and ecology of estuaries in consultation with affected municipalities” (NPS 1998). This broad policy has been applied to the Herring River project more explicitly through the HRAMP, with development of a set of overarching fundamental objectives to restore the ecosystem.

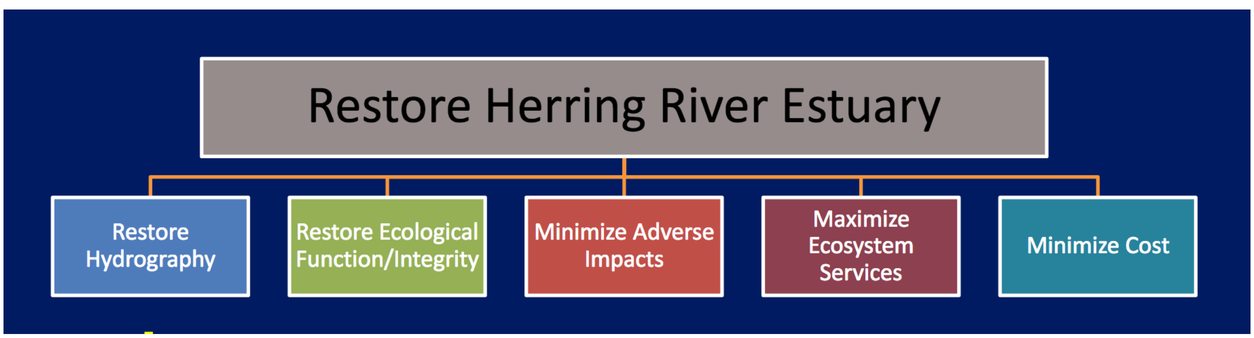

Figure 5-1. Fundamental objectives of the Herring River Restoration Project

The fundamental objectives of the HRAMP are compatible with RPP goals and objectives. This suggests that Project implementation in accordance with the HRAM will further the goals and objectives of the RPP. Table 5-1 lists the fundamental objectives with corresponding RPP objectives.

Fundamental Objective of Herring River Adaptive Management Plan	**Corresponding Regional Policy Plan Objectives**
Restore natural hydrography, including tide range and topography/bathymetry	WR3: Protect, preserve and restore marine water resources WT4: Promote the restoration of degraded wetland resources
Restore ecological function and integrity, including salinity, water quality, and aquatic habitat	WT4: Promote the restoration of degraded wetland resources WP2: Restore degraded habitats through use of native plant communities WP4: Manage invasive species
Minimize adverse impacts to ecological, cultural, and socio-economic resources; Minimize the costs of restoration	TR1: Improve safety and eliminate hazards for all users of Cape Cod's transportation system CD3: Avoid adverse visual impacts from infrastructure and scenic resources CH2: Protect and preserve archaeological resources and assets from alteration or relocation CH4: Protect and preserve traditional agricultural and maritime development and uses
Maximize eco-system services (i.e., benefits people receive from the estuary)	CR2: Plan for sea level rise, erosion and floods CR3: Reduce vulnerability of built environment to floods CH3: Preserve and enhance public access and rights to and along the shore
Maximize understanding of the project effects to federal- and state-listed rate, threatened, and endangered species	WP1: Maintain and protect existing plant and wildlife populations and species diversity WP3: Protect and preserve rare species habitat, vernal pools, 350-foot buffers to vernal pools WP5: Promote best management practices to protect wildlife and plant habitat from the adverse impacts of development

Table 5-1. Comparison of Adaptive Management Plan and Regional Policy Plan Objectives

For each fundamental objective, a series of sub-objectives has been identified. Sub-objectives are intended to provide further definition of fundamental objectives. As an example, to illustrate the relationship of fundamental objectives and sub-objectives, Figure 5-2 shows the sub-objectives identified for the fundamental objective of Restoring Hydrography.

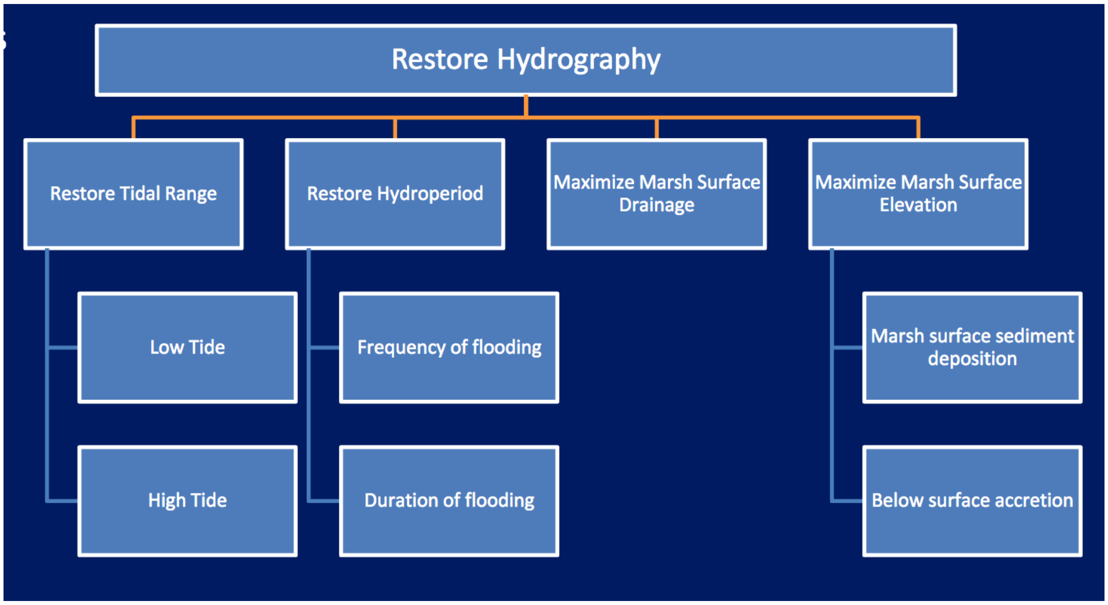

Figure 5-2. Sub-objectives and performance measures for fundamental objective: Restore Hydrography

Performance measures are then identified to measure performance of the fundamental objectives and sub-objectives directly. Performance measures must serve two purposes: 1) to predict how well a management strategy is expected to meet each of the objectives (i.e., models are used to make predictions), and 2) to provide metrics useful for monitoring; i.e., to determine how the system is responding to implementation of a management action and to evaluate progress towards achieving stated objectives. The monitoring needs for adaptive management will be matched to on-going and planned monitoring programs to identify gaps and avoid duplication. An example of performance measures for the fundamental objective of restoring hydrography is provided in Table 5-2.
A complete list of fundamental objectives, sub-objectives and performance measures is contained in Attachment 8.B.

Fundamental Objective #1: Restore Hydrography					
Sub-Objectives	*Performance Measures*	*Desired direction*	*Spatial scale*	*Predictions*	*Monitoring*
Restore Tidal Range					
Restore Low Tide	Minimum water surface elevations (ft) averaged for sub-basins and at key locations	Minimize	Sub-basin	EFDC Hydrodynamic Model	Electronic water level data loggers for sub-basins and at key locations
Restore High Tide	Maximum water surface elevations (ft) averaged for sub-basins and at key locations	Maximize	Sub-basin	EFDC Hydrodynamic Model	Electronic water level data loggers for sub-basins and at key locations
Restore Hydroperiod					
Flooding extent	Marsh area inundated by tides (%)	Maximize	Sub-basin	EFDC Hydrodynamic Model	Electronic water level data loggers for sub-basins and at key locations
Duration of flooding	Duration (h) of inundation of marsh surface at key locations	Maximize	Sub-basin	EFDC Hydrodynamic Model	Electronic water level data loggers for sub-basins and at key locations
Maximize Marsh Surface Drainage	Extent of ponded water at low tide (%)	Minimize	Sub-basin	EFDC Hydrodynamic Model	Electronic water level data loggers in areas of predicted ponding

Table 5-2. Illustrative performance measures, predictive methods and monitoring approach for sub-objectives

5.E Select Management Actions and Policies

The Project has identified management actions designed to achieve the full range of restoration objectives (Section 8.B). These management actions consist of 1) tide gate management, 2) vegetation management, and 3) marsh management. Tide gate management is considered the primary management action. Vegetation and marsh management are considered secondary actions that will be undertaken as necessary to enhance restoration and achieve specific Project objectives.

Tide Gate Management

The primary management actions under consideration involve decisions regarding the volume of tidal flow permitted through of a series of newly constructed tide gates at the three different locations; these actions involve decisions regarding the number, location, magnitude of opening, and flow direction at the individual tide gate openings at any given time. Timing and frequency of gate operations can be periodic or episodic, coincident with extreme predicted high tides and coastal storm events. At each decision point, one or more gates can be raised or lowered or not changed.

To investigate a range of plausible gate management strategies, the USGS and representatives of partner agencies developed a series of seven potential restoration trajectory scenarios, referred to as "platform policies", that encompass a representative range of restoration timelines, frequency and size of gate adjustments, and management priorities. Figure 5-3 below shows a comparison of the Mean High Water (MHW) Levels for the Full Herring River Restoration Project in the Lower Herring River Sub-basin Among Different Platform Policies. It is important to note that certain water surface elevations have specific ecological significance. For example, 1) only after MHW reaches an elevation of 1.8 feet[19] will water rise above the Herring River channel banks and flow out over the existing marsh surface; 2) a MHW elevation of 2.6 feet is approximately the highest MHW elevation that would not require

[19] All tidal metrics are expressed relative to NAVD 88.

mitigation of low-lying roadways or properties; and 3) at a MHW elevation of 3.6 feet, most of the Lower Herring River marsh would be flooded during spring tides.

It should be noted that the HRAMP has been designed to meet the project needs for full restoration. However, during Phase 1, the selected tide gate policy would not allow water levels to exceed levels allowed under permits. To achieve water levels above those permitted for Phase 1 restoration would require new permits or permit amendments.

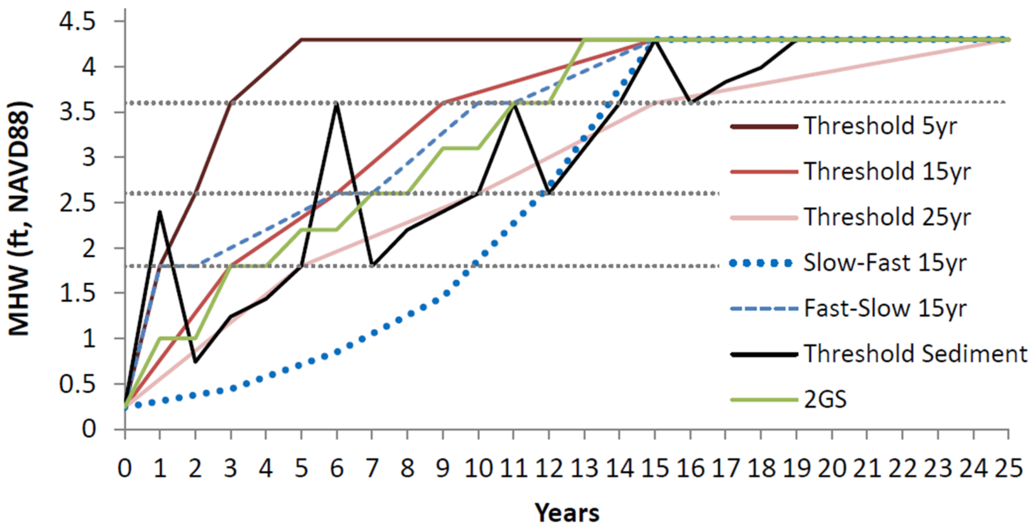

Figure 5-3. Comparison of the Mean High Water (MHW) Levels for the Full Herring River Restoration Project in the Lower Herring River Sub-basin Among Different Platform Policies (Maximum MHW elevations would be adjusted to 3.6 feet (NAVD88) for Phase 1 of the Project)

Tide gate management strategies are referred to as "platform" policies because they provide the baseline conditions for analysis of project impacts to which secondary management activities can be added to improve performance with respect to specific project objectives. Secondary management actions, described below, are those other than changes to tide gate configuration and include direct management of vegetation and sediment, connectivity of tidal channels and pools, and mitigation of potentially adverse project impacts. Secondary actions would be implemented in addition to tide gate management to improve overall policy performance. The purpose of the decision analysis process is to identify the best performing tide-gate management approach and incorporate secondary actions to improve performance, and to select the overall policy (tide-gate management plus secondary actions) that provides the best outcomes across the objectives. The location, timing, and other details of secondary actions cannot be anticipated in most cases until an initial policy is implemented and some degree of tidal exchange is restored. The ability to direct secondary actions in reaction to system responses to the implemented tide gate policy is one way of learning from and adapting management as restoration progresses.

The HRAMP found in Section 8.B contains a detailed description of the full range of potential tide gate management policies and the process by which a selected tide gate management policy will be selected. The varied effects of fully opening the tide gates using different management policies that encompass time spans ranging from 5 to 25 years are being analyzed to identify the most advantageous policy for tide gate management. Decision support software has been developed for use by the Project team to compare policy options by evaluating trade-offs and risk as represented by Project objectives. Although development and testing of the decision framework has been completed, improving predictions for the full suite of ecological and socio-economic objectives and conducting trade-off, and risk and sensitivity analyses using the improved predictions is required before a fully operational adaptive management process can be implemented. This process is ongoing and will continue through 2020.

It should be noted that decisions about tidal gate adjustments will be legally mandated and subject to regulatory oversight under the US Clean Water Act, the Coastal Zone Management Act, the MA Wetlands Protection Act and Waterways regulations, the Towns of Wellfleet and Truro wetland by-laws, and the MA Endangered Species Act. Tide gate management decisions will be constrained by actions deemed necessary to protect public and private structures within the Project area; e.g., at the end of the permitted Phase 1 of the project, the maximum mean daily high tide elevations would be limited to 3.6 feet in the Lower Herring River and 2.5 feet within the Mill Creek sub-basin while no tidal flow would be allowed into Upper Pole Dike Creek.

Secondary Vegetation and Marsh Management Actions

As noted above, the restoration outcomes of tide gate management policies will be augmented by the selection of secondary management actions. Secondary management actions are designed to accelerate or maximize the recovery of estuarine habitats, enhance the benefits of tidal restoration, and avoid or reduce potential adverse ecological and socioeconomic impacts of restored tidal flow. Secondary actions include management of floodplain vegetation, modification of marsh surface elevations through management of sediment supply and distribution, and restoration of connectivity and natural sinuosity of tidal creeks to enhance the circulation of salt water through the system. Decisions regarding secondary actions will involve where and when to implement management measures, what techniques to use, and how to best coordinate the actions with the tide gate management. Specific details for most of these measures cannot be known until some degree of tidal flow is restored and monitoring information is gathered about how the Herring River system is responding.

The HRAMP found in Section 8.B provides detail on the range vegetation management and marsh management activities, how they will be selected, and how they will be undertaken. The HRAMP also discusses the potential interaction between secondary management actions with tide gate management policies.

5.F Predict Outcomes and Consequences

Decision making is future oriented – decisions are made after considering “what will happen if an action or an alternate action is taken?” Thus, predicting consequences is an essential part of any decision, with the type or complexity of the prediction dependent on the significance of the outcomes. Performance, or the response of a measurable attribute for each Project objective, is predicted under each tide gate platform policy. Comparing predicted performance across all objectives provides the basis for selecting a policy. Recall that each objective has a performance metric (measurable attribute), including a unit of measure, desired direction of response, and spatial and temporal scales. For each objective, a method of prediction is needed as well as a method for monitoring to determine what actually happens after implementing the policy in order to assess, learn, and adapt.

In the development of methods of prediction and monitoring for the Herring River, a tiered approach was used. Tier 1 predictions are best professional judgments developed the HRRC. Tier 2 predictions are those provided through formal elicitation methods by subject matter experts and, where appropriate, community stakeholders. Tier 3 predictions are generated by quantitative models. For the Herring River, Tier 1 predictions have already been compiled, but are only being used to assess and develop future decision analyses. Tier 2 and 3 predictions will be used for the actual adaptive management plan and functional decision analysis. Tier 3 predictions can only be applied when a cost-effective quantitative model exists for a given objective. As shown in Table 5-3 shown above, Tier 3 predictions exist or are planned for about two-thirds of the Herring River objectives. Where no quantitative model is available, Tier 2 predictions will be elicited from technical subject matter experts and community stakeholders through formal elicitation processes. This process is under and will continue through 2020.

More detail on predicted outcomes for objectives and sub-objectives, and the numerical models used, is found in the HRAMP contained in Section 8.B.

5.G Evaluate Predicted Outcomes Considering Tradeoffs and Risks

Tradeoff analysis is the process of evaluating which of several potential courses of action (i.e., Herring River platform policies) offers the best possible outcome. The process of this evaluation can also offer insight into where information deficiencies exist – or what actions must be taken to improve resource outcomes. Tradeoff analysis is typically performed before any action is taken, and it therefore depends on predictions of how a given action will affect one or more objectives. Accurate predictions are therefore a foundation of quantitative decision analysis, and among the goals of a tradeoff analysis is to base decisions on the best available information.

Trade-off analysis software will be used to evaluate the expected performance and trade-offs of various management strategies. The trade-off analysis will help identify which platform policies are most advantageous for achieving the objectives based on weighted preferences and attitudes toward risk taking. The software produces numeric scoring of “preferred” management strategies, but it will be up to the Project technical team to evaluate the results, along with input from stakeholders, permitting agencies and other sources to make informed and transparent decisions about the most appropriate actions at any given point in the project implementation timeline.

More information about the trade-off analysis decision-tool and other factors that will be weighed in trade-off analyses is provided in the HRAMP found in Section 8.B.

5.H Decision-making During Implementation

The governance and administrative structure for implementing the HRAMP is described in a memorandum of understanding (MOU-IV) between CCNS and the Town of Wellfleet. MOU IV explicitly acknowledges the responsibility of the Town and CCNS by establishing the HREC as the formal, decision-making authority for the Project. The HREC is comprised of two Selectboard members and the Town Administrator from Wellfleet, the CCNS Superintendent, and one additional CCNS representative. MOU IV identifies the HRTT as an informal, intergovernmental staff technical working group formed for the purpose of providing technical input for project-related decisions as necessary or appropriate. In September 2017, the HREC established a formal Herring River Stakeholder Group (HRSG), a 19-member body representing a broad range of local and regional interests. The purpose of the HRSG is to communicate with stakeholders within the community to ensure that their respective interests and views are well represented and considered by the HREC and to provide advisory input to the HREC on key implementation issues.

A Regulatory Oversight Group will assist in the preparation and review of the HRAMP and will review implementation progress on an ongoing basis. The Regulatory Oversight Group is called for under the Secretary's MEPA Certificate to include, at a minimum, representative(s) from the following agencies:

- Federal: NPS, USFWS, NOAA, NRCS, EPA, USACE;
- State: MEPA, DER, DMF, NHESP, MassDEP, CZM, State Historic Preservation Officer (SHPO);
- Regional: Cape Cod Commission;
- Local: Town of Wellfleet, Town of Truro: and
- Tribal: Mashpee Wampanoag Tribe

The decision-making process is grounded on the collection and evaluation of monitoring data intended to measure performance of the specific objectives formulated for the adaptive management plan. The approach for monitoring and data collection is discussed in the following section. Scientists at CCNS will be primarily responsible for guiding data collection. Members of the project team will review monitoring data as the basis for providing technical support to the HREC. As management actions are implemented by the HREC and the response of the system is monitored, the members of the project team will continue to assess the performance of models and other predictive tools by comparing those outputs to actual, observed outcomes. These results will be summarized in written reports by CCNS and others, and will be shared with the HREC to inform the selection of management actions to be implemented during the subsequent time period. Written reports to the HREC will describe previous management actions, data analysis, and recommendations for future management actions. The HREC will either approve the recommendations or request additional data collection and/or analysis for further review and possible reconsideration of recommended management actions.

More detail on the content of management recommendation to the HREC is contained in the HRAMP found in Section 8.B.

5.I Design and Implement Targeted Monitoring Program

The collection, analysis, and application of credible monitoring data to compare with predictions from modeling is the primary means in adaptive management to assess progress towards meeting project objectives. Equally important is the ability to predict the variation of expected outcomes across a range of alternative management actions that are under consideration. As previously described, in adaptive management output data from models and other predictive methods are used to conduct trade-off analyses so that predictions of how management actions influence objectives can be compared. After management actions are implemented, monitoring data are used to determine real outcomes, evaluate how models performed, and refine model predictions about the outcomes of future actions.

Detail on the monitoring plan that has been undertaken to establish baseline conditions for each objective, and the future monitoring that will be undertaken to track responses to management actions for each objective is contained in the HRAMP found in Section 8.B.

6. Project Budgeting and Funding Information

In its comment letter concerning the FEIR, the Commission asked the Project applicant to provide further detail concerning project budgeting and funding. In particular, the Commission requested detail about funding sources and timelines, a breakdown of costs, including costs of mitigation necessary to protect structures, and a phasing/funding plan that would allow the project to commence prior to full implementation. In response to this request, the following preliminary estimates are provided based on best available information at the time of this application, and are subject to change.

6.A Breakdown of Costs

The preliminary estimated cost to construct and implement Phase 1 of the restoration is $47 million over five years. The cost per acre of area restored is on par with other restoration projects in the Commonwealth. All estimated costs are subject to change as Project plans evolve.

Phase 1 includes all major infrastructure elements necessary for tidal restoration: the Chequessett Neck Road bridge and tide gates, Mill Creek water control structure, Pole Dike Road water control structure, road segment elevation work, removal of a portion of High Toss Road, vegetation management, protection for structures on low properties and adaptive management (including ongoing monitoring and modeling).

The largest single cost element is the Chequessett Neck Road bridge and tide gates at an estimated cost of $15M. By contrast, the Mitchell River Bridge in Chatham was $14M; and the Muddy Creek Bridge, a much less sophisticated structure, was $6M. Table 10-1 shows a breakdown of major costs elements.

Table 6-1. Breakdown of Costs for Phase 1

Chequessett Neck Road Bridge	$15 M (33%)
Mill Creek Water Control Structure	$3 M (6%)
CYCC	$5.5 M (12%)
Pole Dike Road WCS and Low Road Work	$8 M (17%)
High Toss Road	$1 M (2%)
Low Property Mitigation	$1.1M (2%)
Cultural/Archeological	$0.5 M (1%)
Contingency	$2 M (4%)
Adaptive Management 5 years	$7.5 M (16%)
Project Management	$2.5 M (5%)
Total	**$47 M (100%)**

6.B Mitigation

All work necessary to protect structures on public or private property from the effects of tidal restoration during Phase 1 is included in the Phase 1 implementation budget. This includes $8 million in low road elevation and culvert work on town roadways accounting for 17% of the implementation budget; $5.5 million in mitigation work on CYCC accounting for 12% of the implementation budget; and $1.1 million in prevention for low properties, including the construction of the Way #672 protection structure, accounting for 2% of the implementation budget.

6.C Phasing and Funding

Although Phase 1 will be permitted for partial restoration, all infrastructure elements are needed to control tide levels. Therefore, for the implementation budget for Phase 1 includes all major infrastructure elements needed for full restoration.

The Project already has a jumpstart on construction and implementation funding. The Commonwealth of Massachusetts has included $11 million for construction as part of the state capital investment plan, which accounts for roughly 25% of Phase 1 cost. The Cape Cod National Seashore is seeking funding to cover the cost of constructing the Mill Creek water control structure, which is located on property owned by the NPS. The NPS is not eligible to fund infrastructure that is not located on land it owns. However, the NPS will continue to provide technical and adaptive management support. Most of the remaining funding for Phase 1 implementation is expected to come from a combination of federal sources, potentially augmented by private grant sources. The NPS/CCNS is helping to coordinate discussions with other federal agency partners about how the Project meets shared agency and program-specific objectives. Through these discussions, existing and potential funding opportunities are being explored.

The USDA Small Watersheds Program has previously provided technical assistance funding for design and permitting, and has been identified as a potential source of significant implementation funding. USDA Small Watersheds Program officials have visited the site and confirmed that implementation of the Project is eligible and would be consistent with funding goals of the program. Conversations with the USDA Small Watersheds Program will continue as the Project moves further into permitting.

Through the USFWS, the National Coastal Wetlands Conservation Program, and the North American Wetlands Conservation Act have been identified as potential sources. The Project may be able to apply for multiyear funding under these programs.

The NOAA Coastal Resiliency and NOAA Restoration programs which have already invested in the design and permitting of the Project, also will be pursued for implementation funding potential.

The Project also is in communications with the National Parks Foundation, Ducks Unlimited, National Fisheries and Wildlife Foundation, The Nature Conservancy and other non-governmental and private entities to explore funding strategies and opportunities.

Based on the progress to date, the Project is on track for the remaining funding to be in place for a construction start in calendar year 2022. The Project team has an established and successful track record working with federal and state partners and non-governmental organizations, having raised funds for environmental assessments, monitoring, modeling, engineering design and permitting.

7. References

Abdul-Aziz, O. and Ishtiag, K. 2015. A User-friendly Model for Predicting Greenhouse Gas Fluxes and Carbon Storage in Tidal Wetlands. Bringing Wetlands to Market Project Fact Sheet, accessed 12/23/2015.

Ashworth, M. J. 1982. Feedback Design of Systems with Significant Uncertainty. Research Studies Press, Chichester, UK.

Bowen, R.V. 2006. Status and Habitat use of Breeding Northern Harriers at Cape Cod National Seashore. Final report to National Park Service. 27 p.

Buchman, M.F. 2008. NOAA Screening Quick Reference Tables, NOAA OR&R Report 08-1, Seattle, WA, Office of Response and Restoration Division, National Oceanographic and Atmospheric Administration, 34p.

Cape Cod Commission, Guidance on Section 208 Plan Update. Obtaining a Consistency Determination, April 2018.

Cape Cod National Seashore and the Herring River Restoration Committee (HRRC). 2016. Herring River Restoration Project Final Environmental Impact Statement/Environmental Impact Report, May 2016.

Cook, R.P. 2008a. Report on Reptiles and Amphibians at Cape Cod National Seashore. http://www.nps.gov/caco/naturescience/upload/AMPHIBIANS_AND_REPTILES_OF_CAPE_COD_NATIONAL_SEASHORE_2008-2.pdf.

Cook, R.P. 2008b. Illustrated Guide to Turtles at Cape Cod National Seashore. Accessed on January 1, 2011 at: http://www.nps.gov/caco/naturescience/upload/turtlepage-2.pdf.

Cowardin, L.M., Carter, V., Fancis, C.G., and E.T. LaRoe. 1979. Classification of Wetlands and Deepwater Habitats of the United States. U.S. Department of the Interior, Fish and Wildlife Service, Office of Biological Services, Washington, D.C.

Cumbler, J.T.. 2014. Cape Cod: An Environmental History of a Fragile Ecosystem.

Curley, J.R., Lawton, R.P., Whittaker, D.K., and J.M. Hickey. 1972. A Study of the Marine Resources of Wellfleet Harbor. Division of Marine Fisheries, Department of Natural Resources, the Commonwealth of Massachusetts, Monograph series number 12. 37 p.

Erwin, R.M., Conway, C.J., and S.W. Hadden. 2002. Species Occurrence of Marsh Birds at Cape Cod National Seashore, Massachusetts. *Northeastern Naturalist* 9(1): 1-12.

Fox, S.E., A. Mittermayr, M.A. Adams, K. Medeiros, T. Smith, S, Smith, and K.L. Vaughan. The Ecological Evaluation of Herring River: A pre-restoration characterization of water quality, benthic community structure and food webs, and vegetation. National Park Service, Cape Cod

National Seashore. Unpublished report, 2017.

Fuss and O'Neill. 2013. Technical Memorandum – Dike and Control Structure Alternatives Analysis Herring River Salt Marsh Restoration, Prepared for Herring River Restoration Committee.

Gibbs, J.P., Melvin, S., Reid, F.A., Lowther, P., and A.F. Poole. 2009. Least Bittern (*Ixobrychus exilis*), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/017.

Gwilliam, E. 2005. Nekton Sampling in Herring River. Unpublished raw data.
Hamrick, J.M. 1996. User's manual for the environmental fluid dynamic computer code. The College of William and Mary, Virginia Institute of Marine Science, Special Report 328, 224 pp.

Harrington B.A, Hill, N.P., and B. Nikula. 2010a. Changing Use of Migration Staging Areas by Red Knots: An Historical Perspective from Massachusetts. 2010. *Waterbirds* 33(2): 188-192.

Harrington, B.A., Koch, S., Niles, L.K., and K. Kalasz. 2010b. Red Knots with Different Winter Destinations: Differential use of an Autumn Stopover Area. *Waterbirds* 33:3, 357-363.

Hazelton ELG, Mozdzer TJ, Burdick DM, Kettenring KM, Whigham DF. 2014. *Phragmites australis* management in the United States: 40 years of methods and outcomes. AoB PLANTS 6: plu001; doi:10.1093/aobpla/plu001

Herbster, H. and K. Heitert. 2011. *Phase IA Archaeological Background Research and Sensitivity Assessment Herring River Tidal Restoration Project Cape Cod National Seashore, Towns of Wellfleet and Truro, Barnstable County, Massachusetts.* The Public Archaeology Laboratory, Inc. Pawtucket, Rhode Island.

Herbster, H., S. Lüttge and J. Horn. 2016. Phase IB Intensive (Locational) Archeological Survey, Herring River Tidal Restoration Project, Wellfleet, Massachusetts, NRAP Project Number CACO 2014 A, ARPA Permit Number 2015.CACO.01. PAL report no. 2480.02. Submitted to Friends of the Herring River, Wellfleet, MA. 146 pages.

Herbster, H. 2016. Addendum Phase IB (Locational) Phase IB Intensive (Locational) Archeological Survey, Herring River Tidal Restoration Project, Wellfleet, Massachusetts NRAP Project Number CACO 2014 A, ARPA Permit Number 2016.CACO.01. PAL report no. 2480.02. Submitted to Friends of the Herring River, Wellfleet, MA.

Herbster, H. and S. Lüttge. 2018. Addendum Phase IB Intensive (Locational) Archeological Survey, Herring River Tidal Restoration Project, Chequessett Yacht and Country Club Reconstruction Areas, Wellfleet, Massachusetts. PAL report no. 2480.03. Submitted to Friends of the Herring River, Wellfleet, MA.

Herring River Technical Committee (HRTC). 2007 Herring River Tidal Restoration Project, Conceptual Restoration Plan. October 2007. Prepared by: Herring River Technical Committee

and ENSR for Towns of Wellfleet and Truro and the Cape Cod National Seashore.
Hyland J.L. and H. Costa. 1995. Examining Linkages between Contaminant Inputs and their Impacts on Living Marine Resources of the Massachusetts Bay Ecosystem through Application of the Sediment Quality Triad Method. Massachusetts Bays Program, MBP-95-03. Prepared by Arthur D. Little.

Kroeger, KD, Gonneea, ME, et al. 2019. Climatic impacts of tidal restriction and restoration: Full carbon and greenhouse gas budgets, with radiative forcing calculations. Society of Wetland Scientists Annual Meeting, Baltimore, MD.

Martin, Larry. Evaluation of the Potential for Private, Domestic Wells to be Affected by Restoration of Tidal Flow in the Herring River Basin, Cape Cod, Massachusetts. December 2018.

Massachusetts Department of Environmental Protection (MassDEP). MCP Method 1: Soil Category S-2 Standards, http://www.mass.gov/dep/cleanup/laws/0975_6b.htm. (Accessed June 6, 2011).

Massachusetts Department of Environmental Protection (MassDEP), U.S. Environmental Protection Agency (USEPA), and ENSR. 2009. Final Pathogen TMDL for the Cape Cod Watershed.
McCarthy, M.A., and H.P. Possingham. 2007. Active adaptive management for conservation. *Conservation Biology*: The Journal of the Society for Conservation Biology 21:956–63.

National Park Service, U.S. Department of the Interior (NPS). 1998. Cape Cod General Management Plan. Retrieved from: http://www.nps.gov/caco/parkmgmt/general-management-plan.htm.

Nichols, J.D., and B.K. Williams. 2006. Monitoring for conservation. *Trends in Ecology & Evolution.* 21:668–673.
Nichols, J.D., Runge, M.C., Johnson, F.A., and B.K. Williams. 2006. Adaptive harvest management of North American waterfowl populations – recent successes and future prospects. *Journal of Ornithology* 147:28.

Nichols, J.D., Johnson, F.A., Williams, B.K., and G.S. Boomer. 2015. On formally integrating science and policy: walking the walk. *Journal of Applied Ecology.* 52:539-543.

Niering W.A. and R.S. Warren. 1980. Vegetation Patterns and Processes of New England Salt Marshes. *Bioscience.* 30:301-307.

Orson, R.A and C.T. Roman. 1987. Herring River Estuary: Historic Vegetation Development *in* An Evaluation of Alternatives for Estuarine Restoration Management: The Herring River Ecosystem (Cape Cod National Seashore). Technical Report, National Park Service Cooperative Research Unit, Rutgers University, New Brunswick, New Jersey.

Parkhurst, D.L., Kipp, K.L., Engesgaard, Peter, and Charlton, S.R., 2004, PHAST: Program for simulating ground-water flow, solute transport, and multicomponent geochemical reactions: U.S. Geological Survey Techniques and Methods 68, 154 p

Portnoy, J.W. 1984. Saltmarsh diking and nuisance mosquito production on Cape Cod, Massachusetts. *Journal of the American Mosquito Control Association*. 44:560–564.

Portnoy, J.W. 1991. Summer Oxygen Depletion in a Diked New England Estuary. Estuaries. 14(2):122–129.Portnoy, J.W. and J. Allen. 2006. Effects of Tidal Restrictions and Potential Benefits of Tidal Restoration on Fecal Coliform and Shellfish-water Quality. *Journal of Shellfish Research*. 25(2):609–617.

Portnoy, J.W. and A.E. Giblin. 1997. Effects of Historic Tidal Restrictions on Saltmarsh Sediment Chemistry. *Biogeochemistry*. 36:275–303.
Portnoy, J.W., Phipps, C., and B.A. Samora. 1987. Mitigating the effects of oxygen depletion on Cape Cod anadromous fish. *Park Science*. 8:12–13.

Portnoy, J.W. and Allen, Jenny R. 2006. Effects of Tidal Restrictions and Potential Benefits of Tidal Restoration on Fecal Coliform and Shellfish-Water Quality. *Journal of Shellfish Research*, Volume 25, Number 2, pp. 609-617.

Quinn, J.G., Cairns, R.W., Hartman, P.C., and J.W. King. 2001 Study of organic contaminants in coastal ponds and marshes, Cape Cod National Seashore. Long-term Coastal Ecosystem Monitoring Program, Cape Cod National Seashore, Wellfleet Massachusetts.

Roman, C.T. 1987. An Evaluation of Alternatives for Estuarine Restoration Management: The Herring River Ecosystem (Cape Cod National Seashore). Technical Report, National Park Service Cooperative Research Unit, Rutgers University, New Brunswick, New Jersey.

Roman, C. and M.J. James-Pirri. 2011. Pre-restoration Nekton Data Analysis and Summary, Herring River, Cape Cod. National Seashore: Preliminary Analysis. November 16, 2011.

Seigel, A., Hatfield C., and J.M. Hartman. 2005. Avian Response to Restoration of Urban Tidal Marshes in the Hackensack Meadowlands, New Jersey. Urban Habitats, Volume 3, Number 1. pgs 1541-7115. http://www.urbanhabitats.org.

Settelmyer, S., Swails, E., Eaton, J. 2019. Herring River Carbon Project Feasibility Study. TerraCarbon version 1.4

Smith, H.R. 1997. Mammals of West River Memorial Park. In Restoration of an Urban Salt Marsh: An Interdisciplinary Approach (D. G. Casagrande, ed.) pp. 237–252. Bulletin Number 100, Yale School of Forestry and Environmental Studies, Yale University, New Haven, CT.

Smith, S.M. 2005. Manual control of *Phragmites australis* on pondshores of Cape Cod National Seashore, Massachusetts, USA. Journal of Aquatic Plant Management 43:50–53.

Snow. 1975. Recolonization of salt marsh species at the Herring River marsh, Wellfleet, Massachusetts. 1975. 46 p.

Soukup, M.A. and J.W. Portnoy. 1986. Impacts from Mosquito Control-induced Sulfur Mobilization in a Cape Cod Estuary. *Environmental Conservation*. 13(1):47–50.

Tiner, R.W. 1987. A Field Guide to Coastal Wetland Plants of the Northeastern United States. University of Massachusetts Press, Amherst, MA. 285 pp.

Town of Wellfleet. 2011. Shellfishing Maps. Wellfleet Harbor: Recreational Shellfishing Areas. www.wellfleetma.org/Public_Documents/WellfleetMA_Departments/shellfish_dept/shellfish_maps

Walters, C.J. and R. Hilborn. 1978. "Ecological optimization and adaptive management." Annual Review of Ecology and Systematics 9, 157e188

Warren Pinacle Consulting, Inc. 2012. SLAMM 6.2 Technical Documentation, Warren Pinnacle Consulting, Inc. Accessed online at: http://warrenpinnacle.com/prof/SLAMM/index.html.
Williams, B.K., Szaro, R.C., and C.D. Shapiro. 2007. Adaptive management: the U.S. Department of the Interior technical guide. Page 84. Adaptive Management Working Group, U.S. Department of the Interior, Washington, DC.

Williams, B.K. and F.A. Johnson. 1995. "Adaptive management and the regulation of waterfowl harvests." Wildlife Society Bulletin 23, 430-436.

Williams, B.K., R.C. Szaro, and C.D. Shapiro. 2009. Adaptive Management: The U.S. Department of the Interior Technical Guide. Adaptive Management Working Group, U.S. Department of the Interior, Washington, DC.

Williams, B.K. and E.D. Brown. 2012. Adaptive Management: The U.S. Department of the Interior Applications Guide. Adaptive Management Working Group, U.S. Department of the Interior, Washington, DC.

Woods Hole Group (WHG). 2009. Herring River Hydrodynamic Modeling. Draft Modeling Report. Prepared for the Town of Wellfleet (June 2009).

Woods Hole Group (WHG). 2011. *Hydrodynamic Modeling Data for Herring River Restoration Plan*. Prepared for the Cape Cod National Seashore.

Woods Hole Group (WHG). 2012 Herring River Hydrodynamic Modeling Final Comprehensive Report to HRRC and NPS, Cape Cod National Seashore, Wellfleet, MA. 208 pp.

Woods Hole Group (WHG). 2012. *Herring River Hydrodynamic Modeling for Estuarine Habitat Restoration, Wellfleet, Massachusetts*. Final Report, Prepared for Herring River Restoration Committee.

Woods Hole Group (WHG). 2013 Herring River Restoration Project: Final Dike Control Structure Hydrodynamic Modeling Final Comprehensive Report to HRRC and NPS, Cape Cod National Seashore, Wellfleet, MA. 22 pp.

Woods Hole Group (WHG). 2016. Herring River Restoration Project: Mill Creek Groundwater Model: Technical Memorandum to HRRC, with Third Party Review Memo by Sanborn-Head, Inc.

Woods Hole Group (WHG). 2017. Hydraulic Summary of Mill Creek and Upper Pole Dike Creek. Technical Memorandum to Friends of Herring River, June 30 2017.

Woods Hole Group (WHG). 2018. Analysis and Results for Additional Modeling of Upper Pole Dike Creek and Mill Creek. Submitted to Friends of Herring River, June 29, 2018.

8. Attachments

8.A Project Management Form and Programmatic Agreement

(See following pages)

8.B Herring River Adaptive Management Plan

(See following pages)

8.C Groundwater Studies

Technical Memorandum on Wellfleet Landfill Leachate

The Johnson Company. May 21, 2019.

Evaluation of the Potential for Private, Domestic Wells to be Affected by Restoration of Tidal Flow in the Herring River Basin, Cape Cod, Massachusetts

Martin, Larry. December 2018

(See following pages)

8.D Stormwater Calculations for Engineered Stormwater Management Structures

(See following pages)

Stormwater Management Design Information for Chequessett Neck Road Bridge
Fuss & O'Neill

Stormwater Operation & Maintenance Plan, High Toss Road and Hopkins Drive
ESS Group

8.E NHESP Correspondence and Draft Habitat Management Plan Outline

(See following pages)

8.F Project Chronology

(See following pages)

8.G Support Letters

(See following pages)

Hon. Julian Cyr, Senator and Hon. Sarah Peake, Representative

Wellfleet Shellfish Advisory Board

Wellfleet Open Space Committee

Wellfleet Natural Resources Advisory Board

Dennis O'Connell, Wellfleet Conservation Trust

Andrew Gottlieb, Association to Preserve Cape Cod

John J. Clarke, Massachusetts Audubon

Richard Delaney, Center for Coastal Studies

Wayne Klockner, The Nature Conservancy

Great Pastures Homeowners Association, Wellfleet

Gail Ferguson, Wellfleet

The Cumblers, Wellfleet

8.H Design Plans

8.H.1 Project Elements

Chequessett Neck Road Bridge:
Herring River Restoration Project Chequessett Neck Road Bridge and Water Access Facility Construction. Permitting Drawing Set. June 2018; Revised November 12, 2019. Prepared by Fuss & O'Neill, Inc.

Pole Dike Road and other low-lying roads:
Herring River Restoration Project. Engineering Design to Elevate Low-Lying Roadways and Replace Associated Culverts. Permit Plans – Not for Construction. May 2019. Prepared by Louis Berger U.S. Inc.

High Toss Road Removal:
Herring River Restoration Project. High Toss Road Permit-Level Design Plans. June 30, 2017; Revised June 28, 2018. Prepared by ESS Group, Inc.

8.H.2 Mitigation

Herring River Restoration Project. Permit Plans for Low-Lying Property Impact Prevention. Miller-Frederiksen Property (695 Bound Brook Island Road). Permit Plans – Not For Construction. April 2018. Prepared by Louis Berger U.S. Inc.

Herring River Restoration Project. Chequessett Yacht and Country Club Reconfiguration Permit-Level Design Plans. DRAFT. September 13, 2019. Prepared by ESS Group, Inc.
(Note: An updated stamped plan set will be provided shortly to reflect a new haul road location)

8.H.3 Federal Structures on Federal Land

Mill Creek Water Control Structure:
Herring River Restoration Project Mill Creek Water Control Structure. Construction Project Permitting Drawing Set. June 2018. Prepared by Fuss & O'Neill, Inc.

Way 672 Tide Barrier:
Herring River Restoration Project. Way #672 Tidal Barrier Alternatives Assessment. Existing and Proposed Conditions. June 2019. Prepared by Fuss & O'Neill, Inc.
(Note: An updated plan set will be provided shortly for informational purposes)