## **PROJECT DESCRIPTION**

# Nahant Thicket Wildlife Sanctuary Ecological Restoration, Visitor Services, and Hydrology Improvements

# **Project Description**

The proposed project involves ecological restoration, hydrological, and visitor service improvements at the Massachusetts Audubon Society's (Mass Audubon) Nahant Thicket Wildlife Sanctuary. The proposed work is intended to improve the habitat value of the property for birds and other wildlife, improve visitor access and experience, and improve hydrological conditions that have deteriorated over the years and have resulted in increased flooding.

Nahant Thicket Wildlife Sanctuary is an approximately 4.0-acre property located at 50 Wharf Street, Nahant, Massachusetts. The property location is shown on Plan 1. The sanctuary provides important habitat for birds, especially during spring migration, and it is part of the Nahant Bay Important Bird Area. Currently there is an unimproved parking area for two vehicles located on Furbush Road and the property is transected by a walking trail.

When acquired by Mass Audubon in 1949, the property was primarily a wooded swamp. However, since that time, increased rainfall, development of the surrounding watershed, and the establishment of non-native invasive plant species have resulted in changes in vegetation and degraded the habitat values. Changes in hydrology have also raised concerns from neighbors regarding flooding and have occasionally flooded the walking trail.

To address and evaluate these issues and identify remedial measures, a detailed study of the property was conducted by Mass Audubon's Ecological Extension Service and a hydrology investigation was conducted by Inter-Fluve of Cambridge Massachusetts. These studies included close coordination with the Town of Nahant, and two public meetings were held to identify concerns and receive comments from residents of Nahant living near the property. The results of these studies and consultations are the basis for the proposed ecological restoration, visitor services, and hydrology improvements.

The proposed project has the following goals:

- 1. Improve habitat values to benefit birds and other wildlife.
- 2. Improve the existing trail system to provide better access during wet weather and reduce impacts of foot traffic by replacing the existing dirt path with a raised boardwalk.
- 3. Improve access for visitors by improving the existing parking area by regrading and installing a visitor information kiosk.
- 4. Hydrological modifications to improve water flow, benefiting habitat and the visitor experience.

These project elements are described in detail below.

# Habitat Restoration

Proposed habitat restoration at Nahant Thicket will consist of the removal of non-native invasive plant species with the selective planting and seeding of native plants to replace them (Figure 8). Since much of the sanctuary land is currently invaded to a greater or lesser degree by non-native invasive plant species such as common reed (*Phragmites australis ssp. australis*), Japanese knotweed (*Fallopia japonica*), oriental bittersweet (*Celastrus orbiculata*), and multiflora rose (*Rosa multiflora*), removal of these plants will be phased in over time to minimize disturbance. When invasive plants are removed in an area, the area will be revegetated with native plant species before additional areas are treated. Initial invasive plant removal and replanting with native species will focus on areas disturbed for boardwalk construction and hydrological improvements. The invasive plant species to be targeted for removal are all species identified as invasive in Massachusetts by the Massachusetts Invasive Plant Advisory Group and are banned for importation, growing, or sale in Massachusetts by the Massachusetts by the Massachusetts Department of Agricultural Resources.

Invasive plant control will include a combination of manual, mechanical, and chemical methods. Manual control, such as hand pulling or cutting with hand tools will be performed by Mass Audubon staff and volunteers, mechanical control, such as the use of motorized saws and mowing machines, will be performed by Mass Audubon staff or qualified contractors. Chemical control will be performed by Mass Audubon staff or qualified contractors experienced in ecological restoration and licensed for herbicide use by the Massachusetts Department of Agricultural Resources. The herbicides that will be used for invasive plant control at Nahant Thicket are formulations approved for use in wetlands by the Massachusetts Department of Agricultural Resources.

The resulting restoration will result in improved aesthetics for residents and visitors as well as more diverse and improved habitat conditions for wildlife as areas now dominated by non-native invasive plants will be restored to a combination of wet meadow, pollinator meadow, shrub thickets, and red maple swamp dominated by native plant species. Details of the proposed restoration areas are shown on Figure 4.

## **Trail Relocation and Improvements**

Currently Nahant Thicket Wildlife Sanctuary has an approximately 650 foot long walking trail that runs on a north/south axis between Furbush Road and Wharf Street. Figure 5 shows the location of the existing trail and parking area. The closest access to the trail is located approximately 450 feet from the parking area, thus requiring visitors to the sanctuary arriving by car to walk along Furbush Road to reach the trail. The trail includes approximately 200 feet of 28-inch wide boardwalk raised about a foot above the ground that traverses the wettest areas and a wooden bridge that crosses a 20 to 25 foot wide mosquito control ditch that flows from the northwest to the southeast across the property. The remainder of the trail is a dirt path that varies from 3 to 4 feet wide that is frequently muddy and during times of high water, is largely impassable due to flooding. Images of the existing trail, boardwalk, and bridge are presented in Figure 1.

The proposed trail improvements include the creation of a boardwalk trail that will be accessible from the existing entry points on Furbush Road and Wharf Street, and also connected to the existing parking area on Furbush Road (Figure 4). The total length of the new trail will be approximately 1,001 feet. Portions of the existing trail that will not be included in the proposed trail will be abandoned and revegetated.

The proposed trail will consist entirely of a 4-foot wide boardwalk standing roughly one foot above the ground. The replacement of the existing trail with boardwalk will eliminate the soil impacts of foot traffic while providing access to the property even during periods of high water. The proposed boardwalk design will utilize helical piers for support to minimize soil disturbance (Figure 2). Mass Audubon's Ecological Extension Service recently used this construction method in partnership with the U. S. Fish & Wildlife Service at the Great Meadows National Wildlife Refuge in Sudbury, Massachusetts. Images of this boardwalk are presented in Figure 6. The proposed new boardwalk at Nahant Thicket will be built by a contractor experienced in the design and construction of boardwalks using helical pier supports.

Vegetation removal and temporary disturbance of the area will be necessary for a distance of approximately 3 feet on each side of the proposed boardwalk during construction. However, due to the use of helical piers for boardwalk support, soil disturbance will be minimal and disturbed areas along the boardwalk edges should quickly re-vegetate. Our experience with similar boardwalk designs at other locations has indicated that portions of the area beneath the boardwalk edges will receive sufficient light to support revegetation after construction is complete. This, combined with the revegetation of the abandoned portions of the existing dirt trail and boardwalks, should result in a minimal loss of vegetative cover on the property.

# Visitor Access

The existing two car capacity parking space, which is located in uplands at the wetland edge along Furbush Road (location shown on Figure 5) will be improved by regrading. The dimensions of the existing parking area are approximately 21 feet wide by 19 feet deep and the surface consists of compacted earth.

A signage kiosk providing information about Nahant Thicket Wildlife Sanctuary will be installed to provide visitor information and shrub plantings will be made to screen the parking area from nearby houses. Figure 7 shows an example of a new, scaled back version of a Mass Audubon visitor informational sign. The dimensions of the sign for Nahant Thicket will be on the order of approximately 18 x 24 inches.

The connector trail from the proposed new loop trail to the parking lot will eliminate the current need for sanctuary visitors to walk along Furbush Road to reach the existing trail entrance.

## **Hydrology**

Chronic flooding of portions of Nahant Thicket Wildlife Sanctuary has been a problem for years and to better understand this problem and develop solutions, Mass Audubon hired the consulting firm Inter-Fluve to evaluate the hydrology of the site and propose solutions. This work included close coordination with the Town of Nahant. The results of this study are presented in Figure 3, *Inter-fluve Technical Memorandum - Basis of Design Memo for the Nahant Thicket, Nahant, MA, October 1, 2018.* 

Nahant Thicket Wildlife Sanctuary lies in a shallow valley surrounded by higher land to the north, west, and east. The lands draining to Nahant Thicket are largely covered with low to medium density residential development. All water flowing into Nahant Thicket ultimately drains to the ocean via a storm sewer beneath Furbush Road. Increased rainfall in recent decades, combined with occasional obstructions of the storm sewer outlet have resulted in periodic flooding of Nahant Thicket, particularly during high tides when the flap gate in the storm sewer closes to prevent seawater from flowing back into the sanctuary or when the gate becomes blocked by debris.

A main hydrological feature of the property is a large drainage ditch, approximately 20 to 25 feet wide by 290 feet long that drains much of Nahant Thicket and ultimately discharges flow to the storm sewer beneath Furbush Road. This ditch is periodically maintained by the Northeast Massachusetts Mosquito & Wetland Management District.

The proposed channel design includes a new sinuous channel flowing from the Wharf Road stormwater outflow pipe to the existing large ditch. This large ditch will be redesigned to be narrower to limit the volume of standing water. At the confluence of the two channels, the water will flow east and enter the stormwater pipe that eventually goes under Furbush Road. An additional new channel is proposed to go south from the existing large ditch to the existing stormwater pipe at the downstream end of the site. This sinuous channel will only be activated if the capacity of the channels in the upstream portions of the site is exceeded. No decrease in flood storage capacity will result from the proposed improvements. However, if the stormwater infrastructure is maintained, water should flow from the site during lower-magnitude storms at low tide. Details and drawings of the proposed hydrological improvements are presented in the attached Plan 2.

The proposed hydrological improvements at Nahant Thicket have been reviewed by and are supported by the Northeast Massachusetts Mosquito & Wetland Management District. The District, which has performed regular maintenance on the main ditch at Nahant Thicket, will serve as the contractor for the proposed hydrological improvements if staff time is available. If the District is unable to undertake this work due to other work commitments, an experienced contractor will be hired.

In addition to reducing flooding and improving water flow through the sanctuary, the proposed hydrological improvements are intended to improve wildlife habitat conditions and visitor experience by restoring the main ditch to a more natural physical and ecological condition.

## Wetland Resource Area Impacts of the Project

Most wetland resource area impacts of the proposed project will be temporary in nature. We anticipate the following impacts on wetland resource areas from the various project elements:

<u>Invasive Plant Control</u>: Due to the widespread nature of invasive plants on the property, we anticipate that nearly the entire property, approximately 160,000 square feet of Bordering Vegetated Wetland, will be temporarily impacted at some time during the duration of the Order of Conditions. However, since the invasive plant control will be conducted over several years, and replanting with native plant species will occur where dense stands of invasive plants will be removed, no wetland resources values are expected to be impacted and the long term result will be an improvement in wildlife habitat value.

<u>Trail Relocation/Boardwalk Construction</u>: The proposed boardwalk construction will involve the temporary clearing of a path 10 feet wide by 1,001 feet long. The boardwalk itself will be 4 feet wide by 1,001 feet long, with 3 feet of clearing on each side of the proposed boardwalk during construction. The three feet of vegetation cleared on each side of the boardwalk will be revegetated following construction. In areas where invasive plants are removed the area will be replanted with native plant species. The total area beneath the new boardwalk will be 4,003 square feet of Bordering Vegetated Wetland. Portions of this area along the edges of the boardwalk should receive sufficient light to revegetate. Based on this we estimate that about 2,001 square feet of Bordering Vegetated Wetland will be permanently impacted by boardwalk construction. However, the exiting 660-foot long trail and boardwalk will be abandoned, with the existing boardwalk removed, and the area allowed to revegetate. We estimate that this will result in the revegetation of approximately 1,617 square feet of Bordering Vegetated Wetland. The construction of the new boardwalk and the removal of the old trail/boardwalk will thus result in permanent impacts on 18 square feet of Bordering Vegetated Wetland.

<u>Hydrology Improvements</u>: The projected impacts to wetland resource areas associated with the proposed hydrological improvements are as follows:

Bank: 543 linear feet of temporary disturbance, permanent reduction of less than 16 linear feet.

Bordering Vegetated Wetland: 25,561 square feet of disturbance, permanent increase of 2,680 square feet.

Land Subject to Coastal Flowage: 31,136 square feet of temporary disturbance, no permanent disturbance.

#### \*\*\*\*\*

# List of associated attachments and figures referenced in the project description: and to be appended to the NOI:

Plan 1: Location of Nahant Thicket Wildlife Sanctuary.

Plan 2: Nahant Thicket Wildlife Sanctuary, March 31, 2018. A set of six plans and details presenting design for proposed hydrology improvements.

Figure 1: Existing Conditions at Nahant Thicket Wildlife Sanctuary.

Figure 2: Boardwalk Framing Plan and General Notes, Room & Guarracino LLC, Structural Engineers, Somerville, MA.

Figure 3: Inter-Fluve Technical Memorandum - Basis of Design Memo for the Nahant Thicket, Nahant, MA, October 1, 2018.

Figure 4: Proposed Conditions at Nahant Thicket Wildlife Sanctuary.

Figure 5: Existing Trail and Parking Locations, Nahant Thicket Wildlife Sanctuary.

Figure 6: Raised Boardwalk at Great Meadows National Wildlife Refuge, Sudbury, Massachusetts.

Figure 7: Example of Mass Audubon Standard Visitor Services Kiosk.

Figure 8: Nahant Thicket Wildlife Sanctuary Vegetation Plan





# MassAudubon NAHANT THICKET WILDLIFE SANCTUARY March 31, 2018

SITE MAP SCALE: 1" = 300'

Wharf Ri





COVER, LOCATION AND SHEET INDEX

SHEET

1 OF 6



SURVEY	CONTROL

OUNTION					
POINT NUMBER	EASTING	NORTHING	ELEVATION	DESCRIPTION	
101	814223.23	2979317.97	5.23	cp101	
103	814419.83	2979536.06	7.51	cp103	
106	814555.24	2979362.11	4.83	106magnail	
107	814046.11	2979103.49	8.81	cp107	
1082	814277.29	2979402.75	3.84	cp102	
1272	814075.20	2979439.08	3.25	parkhustCP	
10108	814289.00	2979578.59	7.64	magnail	
10109	814192.02	2979609.54	8.27	magnail	
10111	814131.01	2979393.52	4.47	cp111	

#### NOTES:

- 1. TOPOGRAPHIC SURVEY FOR THE NAHANT THICKET SITE WAS PERFORMED BY INTERFLUVE, NOV DEC 2017 .
- 2. FOR SURROUNDING TOPOGRAPHY, 1 FT CONTOURS ARE FROM THE 2013-2014 SANDY LIDAR DATASET SPONSORED BY USGS AND COLLECTED BETWEEN NOVEMBER 2013 AND DECEMBER 2014. THE DATESET IS AVAILABLE AND WAS OBTAINED FROM MassGIS.
- 4. PARCEL DATA WAS OBTAINED FROM LEVEL 3 PARCELS (M196) COORDINATED AND MAINTAINED BY MassGIS.
- 5. THE HORIZONTAL COORDINATE SYSTEM IS THE NORTH AMERICAN DATUM OF 1983, MASSACHUSETTS STATE PLANE, MAINLAND ZONE, US FEET.
- 6. THE VERTICAL DATUM IS THE NORTH AMERICAN VERTICAL DATUM OF 1988.

#### **LEGEND**

4	<u>A</u>	CONTROL POINT		
		LIMITS OF DISTURBANCE		
		CONSTRUCTION ACCESS AND STAGING	AREA	
		TEMPORARY SILT FENCE		
—		5' MAJOR CONTOURS		
		1' MINOR CONTOURS		
		PARCEL BOUNDARY		
	— W ——	WATER LINE		
	OE	OVERHEAD POWER LINES		
	— — SD —	STORM DRAINAGE		
	Ø	STORM MANHOLE		
	⊞	STORM CATCH BASIN		
	V	FIRE HYDRANT		
	J.	UTILITY POLE		
oor	E	XISTING CONDITIONS,		
		SURVEY & SEDIMENT	2	OF 6
		CONTROL PLAN	~	0









EXISTING RESOURCE AREA IMPACTS					
RESOURCE AREAS	MAXIMUM PROJECT DISTURBANCE TO EXISTING RESOURCE	PERMANENT CHANGES			
BANK	551 LF	LESS 16 LF			
BORDERING VEGETATED WETLAND	26,108 SF	ADD 2,853 SF			
LAND SUBJECT TO COASTAL FLOWAGE	31,136 SF	NO CHANGE			



NOTE: THE APPROXIMATE COASTAL FLOWAGE EXTENTS SHOWN ARE BASED ON REGULATORY FLOODPLAIN MAPPING COMPLETED UNDER THE JURISDICTION AND DIRECTION OF THE FEDERAL EMERGENCY MANAGEMENT AGENCY (FEMA)

#### **LEGEND**

//

EXISTING MAJOR 5' CONTOURS

- EXISTING MINOR 1' CONTOURS
  - PROPOSED CONTOURS
- PARCEL BOUNDARIES
- LIMITS OF DISTURBANCE
  - VEGETATED WETLANDS (EXISTING CONDITIONS)

VEGETATED WETLANDS (PROPOSED CONDITIONS)

COASTAL FLOOD AREA

SL SW MB NN IK M	N 4 A
DRAWN     DRAWN     DESIGNED     CHECKED       DRAWN     DESIGNED     CHECKED     NAHANT THICK       NO.     BY     DATE     REVISION DESCRIPTION     DATE     PROJECT	CKET WILD ant, Massa



Figure 1



Parking on the North side of Furbush Road



Current entrance sign

Figure 1



Existing trail conditions for the main trail.



Bridge over central ditch.

# GENERAL

- 1. Structural work shall conform to the requirements of "The Massachusetts State Building Code"-9 th Edition; "The International Building Code"-IBC 2015; and ASCE 7-10. 2. Verify and coordinate dimensions related to this project.
- 3. Typical details and notes shown on structural drawings shall be applicable to all parts of
- the structural work except where specifically required otherwise by contract documents. 4. Details not specifically shown shall be similar to those shown for the most nearly similar
- condition as determined by the engineer. 5. The contractor shall submit complete shop drawings for all parts of the work. No performance of the work shall commence without review of the shop drawings by the engineer.

# FOUNDATIONS

- 1. Foundations for this project consist of steel pipes with augers.
- 2. No responsibility is assumed by the structural engineer for the validity of the subsurface conditions described on the drawings.
- 3. Foundation units shall be centered under supported structural members, unless noted otherwise on the drawings.
- 4. Exterior construction shall be carried down below finished exterior grade to a minimum depth of 4'-0", unless noted otherwise.

# STRUCTURAL TIMBER CONSTRUCTION

- 1. Timber construction shall conform to Part II "Design" as published in the "Timber Construction Manual" (AITC 6<sup>th</sup> Edition) and to "National Design Specification for Wood Construction" (NF.PA, 2010 Edition).
- 2. New timber for structural use shall have a moisture content as specified in the "National
- Design Specification for Wood Construction (NF.PA, 2010 Edition). 3. Timber construction shall conform to Article 23, "Wood" of the Mass. Code, latest edition
- 4. Material properties for timber shall conform to the following:
  - (A) For pressure-treated members with nominal 2" thickness, Southern Pine #1 or better (19% max MC) (ACQ Pressure Treated).
    - Allowable bending stress Fb = 1300 PSI
    - Allowable shear stress Fv = 90 PSI
  - Compression parallel to grain = 1550 PSI
  - Compression perpendicular to grain = 565 PSI





- masonry or weather).
- (A) 2x6; 2x8
- (B) 2-2x6; 2-2x8 (C) 3-2x6; 3-2x8

- architect.
- has been installed.
- straight-grained.

- galvanized.

# STRUCTURAL DESIGN LOADS

- 1. Dead loads
- 2. Live loads
  - (A) Walkways 60 PSF
- from snow or rain.
- 10'-0" MAX.

5. "PT" indicates pressure-treated lumber (to be used when in contact with concrete,

6. Joist support by nailing is forbidden unless used with an approved hanger. Unless noted otherwise on plans, all flush framed joists and beams shall be framed with Simpson hangers as follows (or approved equals):

,	Type 'U26'	
	Type 'U26-2'	
	Type 'U26-3'	
11501	timber shall be	1

7. Anchor bolts and bolts for structural timber shall be ASTM A 307 (Galvanized). Standard cut washers shall be provided between wood and bolt head, and between wood and bolt nut unless steel plates or plate washers are used.

8. No joist shall be noted or drilled with holes without the specific approval of the architect. 9. No joist shall be repaired or reinforced in any way without the specific approval of the

10. Beams built up of timbers shall be firmly nailed or bolted together.

11. Temporary erection bracing shall be provided to hold structural timber securely in position as described on the drawings. It shall not be removed until permanent bracing

12. Timber shall be generally knot-free, with only small tight knots permitted and generally

13. Structural timber shall be identified by the grade mark of or certificate of inspection issued by a grading or inspection bureau or agency recognized as being competent.

14. Structural timber shall be visually stress-graded lumber in accordance with the provisions of ASTM designation D245-74, "Methods for Establishing Structural Grades and Related Allowable Properties for Visually Graded Lumber".

15. Timber shall be so handled and covered as to prevent marring and moisture absorption

16. Steel plates and angles shall be new steel conforming to ASTM A36, and be hot dipped

(A) Weight of building components



# Inter-Fluve Technical Memorandum



Amber Carr, Jeff Collins - Mass Audubon
Nick Nelson - Inter-Fluve
October 1, 2018
Basis of Design Memo for the Nahant Thicket, Nahant, MA

Inter-Fluve was contracted by Mass Audubon to provide channel designs to improve flow conveyance at their Nahant Thicket property in Nahant, MA. Preliminary project opportunities and recommendations were described in the Summary Findings of the Nahant Thicket Technical Memorandum (Inter-Fluve, 2017). The goal of the selected preferred alternative was to create a sinuous channel to collect and direct flow of water through the Thicket, while improving habitat quality for wildlife, particularly migratory birds. While a small property, it contains valuable migratory bird habitat with a short walking trail for wildlife observation. Mass Audubon's goals for this site are to improve the bird habitat and improve the visitor experience. The purpose of this technical memorandum is to describe the design elements and the analyses that were completed to guide the designs. This memo will accompany the designs through the permitting process to provide additional information not conveyed on the design planset.

# Introduction

The Nahant Thicket is a 4.5-acre wildlife sanctuary within the Nahant Bay Important Bird Area (IBA). It is a low-lying area that is important for migratory birds in the spring and fall. Nahant Preservation Trust, a partner of Mass Audubon, has purchased a nearby parcel where ecological and recreational improvements are planned. Mass Audubon is interested in restoring Nahant Thicket to provide visitors with an enhanced experience and migratory birds with sufficient habitat and food resources. To better understand restoration opportunities, Mass Audubon requested that Inter-Fluve investigate the hydrology of the site and provide design recommendations to support the following Mass Audubon goals:

- Control the invasive plants and increase the native plants while enhancing the habitat for migratory birds
- Improve visitor access and recreation
- Improve site hydrology specifically, reduce mosquito habitat and reduce duration of standing water.

# **Site Understanding**

The contributing watershed of the Nahant Thicket is approximately 24 acres. Much of the runoff from the impervious surfaces within the watershed flows overland or enters storm drains that flow in and around the Thicket. The northern portion of the site is currently mapped by MassDEP as deciduous wooded swamp and the southern portion as shallow marsh meadow or fen. The soils are mapped as Freetown Muck, and probing of the soils on the site confirmed 2-3 feet of this muck on top of more consolidated substrate.

The Nahant Thicket was historically a tidally-influenced salt-marsh or wetland. An 1829 map depicted the entire area as a wetland, while a photograph from 1876 shows a tidal connection under a bridge on piers where Willow Road crosses over the outlet of the stream (Inter-Fluve 2017). The reconstruction of the road and installation of a small stormwater pipe with a flap gate has altered the hydrology and ecology of the Thicket. Tidal flows no longer enter the site unless the flap gate is stuck open during moderate or high tides. In addition, inland stormwater flows moving through the Thicket cannot exit the site until low tide when the flap gate can open. This results in standing water during certain portions of the tidal cycle following rain events. It has also altered the ecology, moving from salt-marsh dominated vegetation to mostly freshwater wetland vegetation species, which attract many of the migratory birds currently found within the Thicket.

## Site Survey

Topographic data used in the designs was obtained from an RTK-GPS survey of the site that Inter-Fluve completed in 2017. This data was connected to existing LiDAR data to create a topographic map sufficient for designs. All data is in Massachusetts State Plane, Mainland Zone, US feet horizontal coordinate system and the vertical datum is NAVD88.

#### **Existing Drainage Network**

Under existing conditions, Nahant Thicket has three primary channels that convey water through the site:

1) At the northeastern end of the Thicket, stormwater outfalls from Wharf Street and Walton Road discharge stormwater into a small ditch, approximately 8 feet wide and 1-2 feet deep. This ditch flows southwest for approximately 80 feet and then turns southeast for another 80 feet before entering a pipe under Furbush Road that connects with the main stormwater line under Furbush Road.

2) In the middle of the Thicket, an overwidened ditch managed for mosquito control flows northwest to southeast before entering the same stormwater pipe under Furbush Road. At the downstream end of this ditch is a trash grate at the pipe inlet. This trash grate becomes clogged with debris and backs up water into the ditch.

3) At the southwestern end of the site, water flows overland and through small swales before entering a broken pipe that we believe connects with the main stormwater pipe under Furbush Road.

The pipe under Furbush Road continues under Willow Road and outlets to the ocean. A flap gate within a manhole on the seaward side of Willow Road is designed to prevent ocean water from entering the pipe system and to allow stormwater to exit into the ocean. The outlet of this pipe is on the beach and is exposed during low tide. It is an 18-inch pipe that is partially filled with sand and gravel, limiting the opening of the pipe to less than one foot. High tide markings indicate that if the beach were not artificially built to be higher in elevation, the high tides would flow over the road and inundate the Thicket. This artificial berm, and the flap gate in the stormwater pipe, limit the salt water entering the Thicket, but also make it difficult for freshwater to leave the project site. Furthermore, if the existing flap gate is wedged open or not functioning properly due to debris, ocean water is capable of inundating the property through the stormwater infrastructure by back-flowing through the system.

# Hydrology and Hydraulic Analysis

Inter-Fluve used the methods described in the Natural Resources Conservation Service (NRCS) Technical Report 55, "Hydrology for Small Urban Watersheds" to estimate runoff rates to the Thicket for a suite of design events. Inter-Fluve delineated the contributing area to the Thicket in a GIS environment using high resolution topographic data available from MassGIS<sup>1</sup> and the Nahant municipal stormwater drainage plan. Inter-Fluve used the contributing area delineation, the 2005 Landuse/Land Cover data, available from MassGIS,<sup>2</sup> and soils data, available from the NRCS,<sup>3</sup> to calculate a composite curve number for each of four subwatersheds in the study area (Figure 1, Table 1).

Inter-Fluve used the high-resolution topographic data, the municipal stormwater drainage plan, and the 2005 MassGIS Landuse/Landcover data to estimate the time of concentration for each subwatershed.

• 0	•		
	Area Cu		Time of
	(acres)	Number	Concentration
Subcatchment			(minutes)
1: Mosquito Trench	5.2	71	26
2: Pipe by stairway	1.8	81	6
3: Area 3	11.0	78	13
4: The Thicket	5.9	75	70

Table 1. Hydrologic Properties of Subwatersheds in the Study Area

The contributing area to the Thicket is approximately 24 acres. Approximately 69% of the land within the watershed is occupied by low-density to medium-density residential developments. The remaining land is forest, wetland, or open space. Approximately 90% of the contributing area is composed of soils classified as Hydrologic Soil Group C or D (Figure 1). These soils are not well drained.

<sup>&</sup>lt;sup>1</sup> 2013-2014 Sandy LiDAR Data available via MassGIS. <u>https://docs.digital.mass.gov/dataset/massgis-data-lidar-terrain-data</u>

<sup>&</sup>lt;sup>2</sup> 2005 Landuse/Landcover Data available viaMassGIS. <u>https://docs.digital.mass.gov/dataset/massgis-data-land-use-2005</u>

<sup>&</sup>lt;sup>3</sup> 2018 Query of the SSURGO WSS via the NRCS. <u>https://websoilsurvey.sc.egov.usda.gov/App/HomePage.htm</u>

Inter-Fluve used NOAA Atlas 14 to define the precipitation depths for design events for a range of recurrence intervals (Table 2). Inter-Fluve used a composite 14-point distribution to define precipitation distribution for each of the design events.

Average Return Precipitation		
Period (years)	Depth (inches)	
1	2.6	
2	3.2	
5	4.2	
10	5.0	
25	6.2	
50	7.1	
100	7.9	

 Table 2. 24-hour Precipitation Depths by Average Return Period

Inter-Fluve used HydroCAD software to simulate runoff hydrographs for the contributing subwatersheds. Figure 1 illustrates the hydrologic assumptions including the subwatershed boundaries, the time of concentration flow paths, the land use data, and the hydrologic soil group data.

Subwatershed 1 contributes overland flow into the existing "mosquito" ditch. Subwatershed 2 contributes to a pipe outlet in the north central portion of the Thicket. Discharge from this area flows southwest through the middle of the Thicket parcel and is intercepted by the "mosquito" ditch. Subwatershed 3 contributes to a pipe outlet in the northeast corner of the Thicket. Discharge from this pipe enters the parcel, takes a sharp turn to the east, and leaves the parcel via stormwater outlet to Furbush Road. Subwatershed 4 is the Thicket itself.



Figure 1. Hydrologic Summary of the Study Area

Inter-Fluve used the hydrologic model to estimate peak stormwater runoff volumes and peak runoff rates for the 1-, 2-, 5-, 10-, 25-, 50-, and 100-year design events. Table 3 presents the peak runoff rates for the 2-year design event. The 2-year recurrence interval was chosen to be the design storm event as this can be conveyed by the stormwater infrastructure during low tide with the flap gates open. The stormwater infrastructure is not able to pass larger storm events, so water would begin to back up into the Thicket site, resulting in standing water. Standing water occurs under existing conditions when the high tide forces the flap gate shut, or when too much water is trying to enter the stormwater infrastructure. Under proposed conditions, rain events during high tide or storms larger than the 2-year recurrence interval will still result in flooded conditions, but once the flap gate opens, the proposed channels are designed to convey the water out of the site without substantial standing water remaining in the channels. This project does not include changes to the stormwater outlet pipe, which results in the flap gate being closed during all but the low tides. Therefore, this project does not change the flooding potential of the Thicket, but attempts to improve the drainage and flow of water once the flap gate is open.

Subcatchment	Peak Runoff Rate (cfs)		
1: Mosquito Trench	2.8		
2: Pipe by stairway	3.0		
3: Area 3	12.7		
4: The Thicket	2.2		

 Table 3. HydroCAD 2-year Storm Event Peak Runoff Rates (based on NOAA's Atlas 14

 Precipitation Depths during 24-hr Storm) for flows entering the Thicket property.

Note that Area 3 Subcatchment discharge is not included in channel sizing estimates, as flows that enter here feed into the NE corner ditch and quickly out into the Furbush Road stormwater infrastructure, which will remain undisturbed under proposed conditions.

# **Proposed Design**

The Nahant Thicket is at the downgradient end of a small, but heavily developed watershed that discharges stormwater into the Thicket. The ground surface within the Thicket is close to the elevation of the groundwater in the area and the soils are not conducive to infiltration, so on-site water storage is not effective or efficient. The elevation of the Thicket is also low compared to the tidal fluctuations in the nearby cove, resulting in the inability of the system to drain stormwater for large periods of each day.

A preliminary study and hydrologic investigation provided three restoration alternatives, described in detail in the Summary Findings Technical Memorandum (Inter-Fluve 2017). The first option was to minimize modification to the site but provide more regular maintenance to stormwater infrastructure at the Thicket. This low-cost option would likely have improved some, but not all, of the unwanted flooding at the site. A second option was to construct stormwater storage units under the roadways adjacent to the site, which would provide substantial flood reduction but require considerable coordination and collaboration with the Town and surrounding community and a require a high capital cost. The third option detailed in the Memorandum was to re-activate the tidal fluctuations within the Thicket by connecting the site to the ocean through an opening under or through Willow Road, requiring little long-term maintenance but higher costs and similar to Option 2, considerable coordination and collaboration with the Town and surrounding community. Further discussions with stakeholders indicated an additional option: create a more sinuous, meandering channel through the Thicket which would collect and concentrate flows to move through the site rather than remaining ponded, and which would provide a more natural habitat for the wildlife sanctuary. Mass Audubon has been in discussions with the Town of Nahant about flushing out the stormwater system more regularly and looking into possible repairs as needed. This will help flow conveyance through the stormwater infrastructure. The following section describes the proposed channel design within the Thicket.

# **Proposed Design Elements** Channel Alignment

Three proposed channels generally follow the flow paths shown in Figure 1 under current conditions. The proposed primary channel in the upper northwest half of the Thicket will be a sinuous, 420-foot long channel that extends from the Wharf Road storm pipe inlet southwest to the existing mosquito ditch in the center of the parcel. From there, flows will continue east to the existing stormwater infrastructure under Furbush Road. At the upstream end of the proposed primary channel, a riprap apron will transition flow from the storm water pipe to the channel.

The existing mosquito ditch is an over-widened channel with standing water due to the debris caught in the trash grate of the stormwater pipe. Under proposed conditions, this ditch will be partially filled in, with a narrower stream channel constructed to convey stormwater from the pipe in the western part of the site and connect with the new proposed channel coming from the northern portion of the site. The water will continue to flow to the existing stormwater infrastructure under Furbush Road.

In the event that too much water is flowing into the Thicket to be conveyed adequately out to Furbush Road, an overflow channel will provide additional storm water conveyance in the lower portion of the Thicket property via a meandering channel that flows southerly to an existing storm pipe. The upstream end of the overflow channel ties into the former mosquito ditch at an elevation of 1.9 feet, approximately 1.5 feet higher in elevation than the bed of the primary channel.

## **Proposed Channel Dimensions**

The proposed channels will have all have the same channel geometry: a bottom width of 1.5 feet and banks graded at a 2:1 angle until meeting with the existing ground. The channel has been designed to fit the 2-year event flows of 8 cfs from the West and North storm water inlets. No changes to the pipes conveying storm water into or out of the Thicket are proposed at this time. The channel banks and all disturbed areas will be seeded and planted following construction with native seed mixes.

# References

Inter-Fluve. 2017. Summary of findings for the Nahant Thicket, Nahant MA Technical Memorandum. Prepared for Mass Audubon.



"This map is for planning purposes only. Boundaries are approximate. THIS MAP IS NOT A SURVEY. "



"This map is for planning purposes only. Boundaries are approximate. THIS MAP IS NOT A SURVEY. "

Figure 2: Existing Trail and Parking Locations, Nahant Thicket Wildlife Sanctuary









# Welcome to Straitsmouth Island

The operation of Straitsmouth Island is a joint venture of Mass Audubon, the Town of Rockport, and the Thacher Island Association. The Town owns 1.8 acres including the lighthouse (since 2010). Mass Audubon owns the remaining 28 acres maintaining the entire island as a wildlife sanctuary. Thacher Island Association member volunteers supply the funding and thousands of work hours to restore and maintain the facilities for the benefit of the public. Keepers are stationed here from June until September. The island is closed to the public from September 1 until June 1 or when the Keepers are not in attendance.



Please be gentle on this historic and environmentally-sensitive site while enjoying this island.

Island is open to the public between June 1 and September 1 only when resident Keepers are on site. Posted hours of island operation are sunrise to sunset or at the discretion of the Keeper.

For your safety and to avoid conflicts with wildlife, we ask that you please:

- Sign in with the island Keeper.
- Do not camp, use open fires, or bring pets onto the island.
- Leave everything as you find it do not disturb wildlife or remove vegetation, buoys, or lobster traps.
- Leave no litter. Visitors are responsible for taking their trash back to the mainland.
- Do not smoke.
- Do not swim off the ramp or elsewhere on the island.
- Enjoy and maintain the tranquility of the island.

Footbridge Walkway
Boat Launch Ramp (Gap Cove)
Oil House
Maintenance Barn
Main Trail (Manton Trail)
Kubota Beach & Trail
Auxiliary Boat Landing
Old Derrick site (1901-1970)
Farm & Grazing Fields
Seal Sunning Location
Public Compost Toilet

(12)



LIMITS OF DISTURBANCE         Image: Description of Disturbance <t< th=""><th></th></t<>	
LINTS OF DISTURBANCE     HOPORARY SILT FENCE     PROPOSED 1 FT. CONTOURS     SALT-TOLERANT ZONE     PROSENUATER ZONE     PROSENUATER ZONE     PROSENUATER ZONE     PROSENUATER SPECIES     PROSENUATER SPECIES     PROSENUE ZONE     PROSENUE ZON	
ELMITS OF DISTORBARCE     FREPORARY SULT FENCE     FROPOSED 1 FI. CONTOURS     SALT-TOLERANT ZONE     FRESHWATER ZONE     FRESHWATER ZONE     PHRAGMITES REMOVAL ZONE + PLANT     WHATER SEMEOVAL ZONE + PLANT     SHOWY EVENING PRIMADSE     DEALCOM WIGDLUM     ATLANTC COASTAL PANIC GRASS     PRACEL BOUNDARY     WHATER LINE     SHOWY EVENING PRIMADSE     DEALCOM WIGDLUM     SHOWY EVENING PRIMADSE     DEALCOM WIGDLUM     SAND LOVEGRASS     Fragrestis trichodes     SAND DIOVEGRASS     Fragrestis trichodes     SAND DIOVEGRASS     Fragrestis trichodes     SAND DIOVEGRASS     FRAGMETER SPECIES     SAND BLOPSEED     Sporobolus cryptandrus     SHOWY EVENING PRIMADSE     DEALCOM 2'-3' 20     DISTURBANCE     PRACELBOUNDARY     TREES     Gray birch     Acer rubrum     15' bare root 2'-3' 20     DISTURBANCE     PRACEMITES REMOVAL     SONK nigra     15' bare root 2'-3' 20     DISTURBANCE     PRACEMITES REMOVAL     SONK nigra     15' bare root 2'-3' 30     DIAGMETER SPECIES     Single fully polylifilia     15' bare root 2'-3' 30     DIAGMETER     PLANT WITH FRESHWATER SPECIES     SING BIAR MORE     SONK nigra     15' bare root 2'-3' 30     DIAGMETER     DIAGMETER     DIAGMETER     DIAGMETER     DIAGMETER     DIAGMETER     DIAGMETER     DIAGMETER	
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swallip rose Rosa plustris 6' bare root 1'-2' 240	
American cranberry bush     Viburnum trilobum     6'     bare root     1'-2'     200	
SHRUBS     shrubby cinquefoil     Dasiphora fruticosa     6'     bare root     1'-2'     90	
Winterberry     Ilex verticillata     6'     bare root     1'-2'     100	i Y
Red chokeberry     Aronia arbutifolia     6'     bare root     1'-2'     160       PHRAGMITES REMOVAL ZONE +     PHRAGMITES REMOVAL ZONE +	
SALT-TOLERANT SPECIES	
EASTERN COTTONWOOD Populus deltoides 15' bare root 3' 20	X
WHITE OAK Quercus alba 15' bare root 3' 10	X
IREES     RIVER BIRCH     Beluid nigra     15     bare root     3'     15       PLACK CUEDDY     Drum construct     AFL     bare not     3'     15	
BLACK CHERKY Prunus serolina 15 bare root 3 20	
SPICEBISH Lindera benzoin 6' 10 cu3 plug 2' 80	
SOUTHERN ARROWHEAD Viburnum dentatum 6' 10 cu3 plug 2' 75	
SHRUBS BUTTONBUSH Cephalanthus occidentalis 6' 10 cu3 plug 2' 30	
COMMON SERVICEBERRY Amelanchier arborea 6' 10 cu3 plug 2' 80	
RED CHOKEBERRY     Aronia arbutifolia     6'     10 cu3 plug     2'     40	

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MassAudubon NAHANT THICKET WILDLIFE SANCTUARY Nahant, Massachusetts



