STORMWATER MANAGEMENT REPORT

Electric Avenue Boat Ramp - Bourne, MA

November 2023

Cape Cod Boat Ramp Stormwater Retrofit Project

Partner: Association to Preserve Cape Cod
Owner/Operator: Town of Bourne

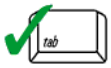
Horsley Witten Group

Massachusetts Department of Environmental Protection
Bureau of Resource Protection - Wetlands Program

Checklist for Stormwater Report

A. Introduction

Important: When filling out forms on the computer, use only the tab key to move your cursor - do not use the return key.



A Stormwater Report must be submitted with the Notice of Intent permit application to document compliance with the Stormwater Management Standards. The following checklist is NOT a substitute for the Stormwater Report (which should provide more substantive and detailed information) but is offered here as a tool to help the applicant organize their Stormwater Management documentation for their Report and for the reviewer to assess this information in a consistent format. As noted in the Checklist, the Stormwater Report must contain the engineering computations and supporting information set forth in Volume 3 of the Massachusetts Stormwater Handbook. The Stormwater Report must be prepared and certified by a Registered Professional Engineer (RPE) licensed in the Commonwealth.

The Stormwater Report must include:

- The Stormwater Checklist completed and stamped by a Registered Professional Engineer (see page 2) that certifies that the Stormwater Report contains all required submittals.[1] This Checklist is to be used as the cover for the completed Stormwater Report.
- Applicant/Project Name
- Project Address
- Name of Firm and Registered Professional Engineer that prepared the Report
- Long-Term Pollution Prevention Plan required by Standards 4-6
- Construction Period Pollution Prevention and Erosion and Sedimentation Control Plan required by Standard 8[2]
- Operation and Maintenance Plan required by Standard 9

In addition to all plans and supporting information, the Stormwater Report must include a brief narrative describing stormwater management practices, including environmentally sensitive site design and LID techniques, along with a diagram depicting runoff through the proposed BMP treatment train. Plans are required to show existing and proposed conditions, identify all wetland resource areas, NRCS soil types, critical areas, Land Uses with Higher Potential Pollutant Loads (LUHPPL), and any areas on the site where infiltration rate is greater than 2.4 inches per hour. The Plans shall identify the drainage areas for both existing and proposed conditions at a scale that enables verification of supporting calculations.

As noted in the Checklist, the Stormwater Management Report shall document compliance with each of the Stormwater Management Standards as provided in the Massachusetts Stormwater Handbook. The soils evaluation and calculations shall be done using the methodologies set forth in Volume 3 of the Massachusetts Stormwater Handbook.

To ensure that the Stormwater Report is complete, applicants are required to fill in the Stormwater Report Checklist by checking the box to indicate that the specified information has been included in the Stormwater Report. If any of the information specified in the checklist has not been submitted, the applicant must provide an explanation. The completed Stormwater Report Checklist and Certification must be submitted with the Stormwater Report.

[1] The Stormwater Report may also include the Illicit Discharge Compliance Statement required by Standard 10. If not included in the Stormwater Report, the Illicit Discharge Compliance Statement must be submitted prior to the discharge of stormwater runoff to the post-construction best management practices.

[2] For some complex projects, it may not be possible to include the Construction Period Erosion and Sedimentation Control Plan in the Stormwater Report. In that event, the issuing authority has the discretion to issue an Order of Conditions that approves the project and includes a condition requiring the proponent to submit the Construction Period Erosion and Sedimentation Control Plan before commencing any land disturbance activity on the site.

Massachusetts Department of Environmental Protection
Bureau of Resource Protection - Wetlands Program

Checklist for Stormwater Report

B. Stormwater Checklist and Certification

The following checklist is intended to serve as a guide for applicants as to the elements that ordinarily need to be addressed in a complete Stormwater Report. The checklist is also intended to provide conservation commissions and other reviewing authorities with a summary of the components necessary for a comprehensive Stormwater Report that addresses the ten Stormwater Standards.

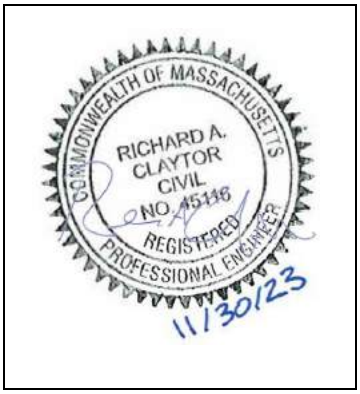
Note: Because stormwater requirements vary from project to project, it is possible that a complete Stormwater Report may not include information on some of the subjects specified in the Checklist. If it is determined that a specific item does not apply to the project under review, please note that the item is not applicable (N.A.) and provide the reasons for that determination.

A complete checklist must include the Certification set forth below signed by the Registered Professional Engineer who prepared the Stormwater Report.

Registered Professional Engineer's Certification

I have reviewed the Stormwater Report, including the soil evaluation, computations, Long-term Pollution Prevention Plan, the Construction Period Erosion and Sedimentation Control Plan (if included), the Long-term Post-Construction Operation and Maintenance Plan, the Illicit Discharge Compliance Statement (if included) and the plans showing the stormwater management system, and have determined that they have been prepared in accordance with the requirements of the Stormwater Management Standards as further elaborated by the Massachusetts Stormwater Handbook. I have also determined that the information presented in the Stormwater Checklist is accurate and that the information presented in the Stormwater Report accurately reflects conditions at the site as of the date of this permit application.

Registered Professional Engineer Block and Signature



11/30/2023

Signature and Date

Checklist

Project Type: Is the application for new development, redevelopment, or a mix of new and redevelopment?

☐ New development

☒ Redevelopment

☐ Mix of New Development and Redevelopment

Checklist for Stormwater Report

Checklist (continued)

LID Measures: Stormwater Standards require LID measures to be considered. Document what environmentally sensitive design and LID Techniques were considered during the planning and design of the project:

- ☐ No disturbance to any Wetland Resource Areas
- ☐ Site Design Practices (e.g. clustered development, reduced frontage setbacks)
- ☒ Reduced Impervious Area (Redevelopment Only)
- ☒ Minimizing disturbance to existing trees and shrubs
- ☐ LID Site Design Credit Requested:
  - ☐ Credit 1
  - ☐ Credit 2
  - ☐ Credit 3
- ☐ Use of "country drainage" versus curb and gutter conveyance and pipe
- ☒ Bioretention Cells (includes Rain Gardens)
- ☐ Constructed Stormwater Wetlands (includes Gravel Wetlands designs)
- ☒ Treebox Filter
- ☐ Water Quality Swale
- ☐ Grass Channel
- ☐ Green Roof
- ☒ Other (describe): Coastal Bank Stabilization with Native Plants

Standard 1: No New Untreated Discharges

- ☒ No new untreated discharges
- ☒ Outlets have been designed so there is no erosion or scour to wetlands and waters of the Commonwealth
- ☐ Supporting calculations specified in Volume 3 of the Massachusetts Stormwater Handbook included.

Checklist for Stormwater Report

Checklist (continued)

Standard 2: Peak Rate Attenuation

☒ Standard 2 waiver requested because the project is located in land subject to coastal storm flowage and stormwater discharge is to a wetland subject to coastal flooding.

☐ Evaluation provided to determine whether off-site flooding increases during the 100-year 24-hour storm.

☒ Calculations provided to show that post-development peak discharge rates do not exceed pre-development rates for the 2-year and 10-year 24-hour storms. If evaluation shows that off-site flooding increases during the 100-year 24-hour storm, calculations are also provided to show that post-development peak discharge rates do not exceed pre-development rates for the 100-year 24-hour storm.

Standard 3: Recharge

☒ Soil Analysis provided.

☒ Required Recharge Volume calculation provided.

☐ Required Recharge volume reduced through use of the LID site Design Credits.

☒ Sizing the infiltration, BMPs is based on the following method: Check the method used.

☐ Static ☒ Simple Dynamic ☐ Dynamic Field[1]

☐ Runoff from all impervious areas at the site discharging to the infiltration BMP.

☒ Runoff from all impervious areas at the site is *not* discharging to the infiltration BMP and calculations are provided showing that the drainage area contributing runoff to the infiltration BMPs is sufficient to generate the required recharge volume.

☒ Recharge BMPs have been sized to infiltrate the Required Recharge Volume.

☐ Recharge BMPs have been sized to infiltrate the Required Recharge Volume *only* to the maximum extent practicable for the following reason:

- ☐ Site is comprised solely of C and D soils and/or bedrock at the land surface
- ☐ M.G.L. c. 21E sites pursuant to 310 CMR 40.0000
- ☐ Solid Waste Landfill pursuant to 310 CMR 19.000
- ☐ Project is otherwise subject to Stormwater Management Standards only to the maximum extent practicable.

☒ Calculations showing that the infiltration BMPs will drain in 72 hours are provided.

☐ Property includes a M.G.L. c. 21E site or a solid waste landfill and a mounding analysis is included.

[1] 80% TSS removal is required prior to discharge to infiltration BMP if Dynamic Field method is used.

Checklist for Stormwater Report

Checklist (continued)

Standard 3: Recharge (continued)

☐ The infiltration BMP is used to attenuate peak flows during storms greater than or equal to the 10-year 24-hour storm and separation to seasonal high groundwater is less than 4 feet and a mounding analysis is provided.

☐ Documentation is provided showing that infiltration BMPs do not adversely impact nearby wetland resource areas.

Standard 4: Water Quality

The Long-Term Pollution Prevention Plan typically includes the following:

- Good housekeeping practices;
- Provisions for storing materials and waste products inside or under cover;
- Vehicle washing controls;
- Requirements for routine inspections and maintenance of stormwater BMPs;
- Spill prevention and response plans;
- Provisions for maintenance of lawns, gardens, and other landscaped areas;
- Requirements for storage and use of fertilizers, herbicides, and pesticides;
- Pet waste management provisions;
- Provisions for operation and management of septic systems;
- Provisions for solid waste management;
- Snow disposal and plowing plans relative to Wetland Resource Areas;
- Winter Road Salt and/or Sand Use and Storage restrictions;
- Street sweeping schedules;
- Provisions for prevention of illicit discharges to the stormwater management system;
- Documentation that Stormwater BMPs are designed to provide for shutdown and containment in the event of a spill or discharges to or near critical areas or from LUHPPL;
- Training for staff or personnel involved with implementing Long-Term Pollution Prevention Plan;
- List of Emergency contacts for implementing Long-Term Pollution Prevention Plan.

☒ A Long-Term Pollution Prevention Plan is attached to Stormwater Report and is included as an attachment to the Wetlands Notice of Intent.

☒ Treatment BMPs subject to the 44% TSS removal pretreatment requirement and the one inch rule for calculating the water quality volume are included, and discharge:

- ☐ is within the Zone II or Interim Wellhead Protection Area
- ☒ is near or to other critical areas
- ☒ is within soils with a rapid infiltration rate (greater than 2.4 inches per hour)
- ☐ involves runoff from land uses with higher potential pollutant loads.

☐ The Required Water Quality Volume is reduced through use of the LID site Design Credits.

☒ Calculations documenting that the treatment train meets the 80% TSS removal requirement and, if applicable, the 44% TSS removal pretreatment requirement, are provided.

Checklist for Stormwater Report

Checklist (continued)

Standard 4: Water Quality (continued)

☒ The BMP is sized (and calculations provided) based on:

- ☒ The ½" or 1" Water Quality Volume or
- ☐ The equivalent flow rate associated with the Water Quality Volume and documentation is provided showing that the BMP treats the required water quality volume.

☐ The applicant proposes to use proprietary BMPs, and documentation supporting use of proprietary BMP and proposed TSS removal rate is provided. This documentation may be in the form of the propriety BMP checklist found in Volume 2, Chapter 4 of the Massachusetts Stormwater Handbook and submitting copies of the TARP Report, STEP Report, and/or other third party studies verifying performance of the proprietary BMPs.

☒ A TMDL exists that indicates a need to reduce pollutants other than TSS and documentation showing that the BMPs selected are consistent with the TMDL is provided.

Standard 5: Land Uses With Higher Potential Pollutant Loads (LUHPPLs)

☐ The NPDES Multi-Sector General Permit covers the land use and the Stormwater Pollution Prevention Plan (SWPPP) has been included with the Stormwater Report.

☐ The NPDES Multi-Sector General Permit covers the land use and the SWPPP will be submitted ***prior to*** the discharge of stormwater to the post-construction stormwater BMPs.

☐ The NPDES Multi-Sector General Permit does ***not*** cover the land use.

☐ LUHPPLs are located at the site and industry specific source control and pollution prevention measures have been proposed to reduce or eliminate the exposure of LUHPPLs to rain, snow, snow melt and runoff, and been included in the long term Pollution Prevention Plan.

☐ All exposure has been eliminated.

☐ All exposure has ***not*** been eliminated and all BMPs selected are on MassDEP LUHPPL list.

☐ The LUHPPL has the potential to generate runoff with moderate to higher concentrations of oil and grease (e.g. all parking lots with >1000 vehicle trips per day) and the treatment train includes an oil grit separator, a filtering bioretention area, a sand filter or equivalent.

Standard 6: Critical Areas

☒ The discharge is near or to a critical area and the treatment train includes only BMPs that MassDEP has approved for stormwater discharges to or near that particular class of critical area.

☒ Critical areas and BMPs are identified in the Stormwater Report.

Checklist for Stormwater Report

Checklist (continued)

Standard 7: Redevelopments and Other Projects Subject to the Standards only to the maximum extent practicable

☒ The project is subject to the Stormwater Management Standards only to the maximum Extent Practicable as a:

☐ Limited Project

☐ Small Residential Projects: 5-9 single family houses or 5-9 units in a multi-family development provided there is no discharge that may potentially affect a critical area.

☐ Small Residential Projects: 2-4 single family houses or 2-4 units in a multi-family development with a discharge to a critical area

☐ Marina and/or boatyard provided the hull painting, service and maintenance areas are protected from exposure to rain, snow, snow melt and runoff

☐ Bike Path and/or Foot Path

☒ Redevelopment Project

☐ Redevelopment portion of mix of new and redevelopment.

☒ Certain standards are not fully met (Standard No. 1, 8, 9, and 10 must always be fully met) and an explanation of why these standards are not met is contained in the Stormwater Report.

☒ The project involves redevelopment and a description of all measures that have been taken to improve existing conditions is provided in the Stormwater Report. The redevelopment checklist found in Volume 2 Chapter 3 of the Massachusetts Stormwater Handbook may be used to document that the proposed stormwater management system (a) complies with Standards 2, 3 and the pretreatment and structural BMP requirements of Standards 4-6 to the maximum extent practicable and (b) improves existing conditions.

Standard 8: Construction Period Pollution Prevention and Erosion and Sedimentation Control

A Construction Period Pollution Prevention and Erosion and Sedimentation Control Plan must include the following information:

- Narrative;
- Construction Period Operation and Maintenance Plan;
- Names of Persons or Entity Responsible for Plan Compliance;
- Construction Period Pollution Prevention Measures;
- Erosion and Sedimentation Control Plan Drawings;
- Detail drawings and specifications for erosion control BMPs, including sizing calculations;
- Vegetation Planning;
- Site Development Plan;
- Construction Sequencing Plan;
- Sequencing of Erosion and Sedimentation Controls;
- Operation and Maintenance of Erosion and Sedimentation Controls;
- Inspection Schedule;
- Maintenance Schedule;
- Inspection and Maintenance Log Form.

☒ A Construction Period Pollution Prevention and Erosion and Sedimentation Control Plan containing the information set forth above has been included in the Stormwater Report.

Checklist for Stormwater Report

Checklist (continued)

Standard 8: Construction Period Pollution Prevention and Erosion and Sedimentation Control (continued)

☐ The project is highly complex and information is included in the Stormwater Report that explains why it is not possible to submit the Construction Period Pollution Prevention and Erosion and Sedimentation Control Plan with the application. A Construction Period Pollution Prevention and Erosion and Sedimentation Control has ***not*** been included in the Stormwater Report but will be submitted ***before*** land disturbance begins.

☒ The project is ***not*** covered by a NPDES Construction General Permit.

☐ The project is covered by a NPDES Construction General Permit and a copy of the SWPPP is in the Stormwater Report.

☐ The project is covered by a NPDES Construction General Permit but no SWPPP been submitted. The SWPPP will be submitted BEFORE land disturbance begins.

Standard 9: Operation and Maintenance Plan

☒ The Post Construction Operation and Maintenance Plan is included in the Stormwater Report and includes the following information:

- ☒ Name of the stormwater management system owners;
- ☒ Party responsible for operation and maintenance;
- ☒ Schedule for implementation of routine and non-routine maintenance tasks;
- ☒ Plan showing the location of all stormwater BMPs maintenance access areas;
- ☒ Description and delineation of public safety features;
- ☒ Estimated operation and maintenance budget; and
- ☒ Operation and Maintenance Log Form.

☐ The responsible party is ***not*** the owner of the parcel where the BMP is located and the Stormwater Report includes the following submissions:

- ☐ A copy of the legal instrument (deed, homeowner's association, utility trust or other legal entity) that establishes the terms of and legal responsibility for the operation and maintenance of the project site stormwater BMPs;
- ☐ A plan and easement deed that allows site access for the legal entity to operate and maintain BMP functions.

Standard 10: Prohibition of Illicit Discharges

☒ The Long-Term Pollution Prevention Plan includes measures to prevent illicit discharges;

☐ An Illicit Discharge Compliance Statement is attached;

☐ NO Illicit Discharge Compliance Statement is attached but will be submitted ***prior to*** the discharge of any stormwater to post-construction BMPs.

STORMWATER MANAGEMENT REPORT

ELECTRIC AVENUE BOAT RAMP
CAPE COD BOAT RAMP STORMWATER RETROFIT PROJECT
BOURNE, MA

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EXECUTIVE SUMMARY

The purpose of this report is to describe existing and proposed site drainage conditions at the Electric Avenue Boat Ramp, as well as measures to prevent stormwater pollution during and after construction. This project is part of a regional effort led by the Association to Preserve Cape Cod (APCC) to improve water quality at public boat ramps on Cape Cod by implementing green stormwater infrastructure (GSI) retrofits. The main goals for this site are to improve water quality and habitat by better managing and treating stormwater runoff from the boat ramp access road prior to entering Buttermilk Bay. The project also aims to provide public outreach on the benefits of GSI and overarching watershed issues using interpretive signage.

The project includes the following structural and non-structural stormwater control measures (SCMs):

- Bioretention Area and Infiltration Trench for Treatment
- Pavement Reduction
- Stabilization of the Coastal Bank
- Public Educational Signage

Since the proposed stormwater management system is a retrofit project undertaken solely to improve water quality at the site, it falls under the redevelopment category in accordance with the Massachusetts Stormwater Management Standards (MASMS 2008), as described in Massachusetts Stormwater Handbook, Volume 1 Chapter 1. As a redevelopment project, the design is required to meet the MASMS standards to the maximum extent practicable (MEP).

As shown in **Table 1,** the proposed project meets or exceeds each standard**,** except the water quality standard, which is met to the MEP. In addition, a waiver for the water quantity standard will be requested as the site is within the 100-year coastal flood plain. While each of the proposed SCMs are designed to capture and treat the full one inch of runoff of their contributing drainage areas, a portion of the boat ramp could not be captured due to site constraints. Overall, this project will significantly improve water quality conditions at the Electric Avenue Boat Ramp and reduce on-going impacts to Buttermilk Bay, while also providing additional habitat, coastal resiliency, and public education benefits.

Table 1. Project MASMS Compliance Summary

	Minimum Standard	Type	Compliance	Report Reference(s)
1	**New Stormwater Conveyances**	Narrative	Yes	Section 3.2
2	**Water Quantity**	Calculation	Waived	Section 4.3/Appendix B
3	**Recharge**	Calculation	Yes	Section 4.2/Table 6/Appendix B
4	**Water Quality**	Calculation	MEP	Section 4.1/Table 4/Table 5/Appendix B
5	**Land Uses with Higher Potential Pollutant Loading**	Narrative	Not Applicable	Section 0
6	**Critical Areas**	Narrative	Yes	Section 4.1
7	**Redevelopment**	Narrative	Yes	Section 0
8	**Erosion Control**	Narrative	Yes	Section 4.4/Appendix G
9	**Operation and Maintenance**	Narrative	Yes	Section 4.5/Appendix E
10	**Illicit Discharges**	Narrative	Yes	Section 4.6

INTRODUCTION

This report provides a summary of the stormwater management systems proposed for the Electric Avenue Boat Ramp in Bourne, MA, a Town-owned and operated boat ramp (**Figure 1**). The Bourne Engineering, Conservation, and Natural Resources Departments are proposing this project in collaboration with the Association to Preserve Cape Cod (APCC) as a part of a regional effort (Cape Cod Boat Ramp Stormwater Retrofit Project) to improve water quality at public boat ramps across Cape Cod. The proposed project has been designed to retrofit existing impervious areas for water quality improvements and improving overall site conditions. This report describes the existing and proposed site conditions and the practices to be implemented to reduce stormwater discharges and pollutants during and after construction. As required for retrofit projects, the stormwater system for the project has been designed to conform to the requirements of the Massachusetts Stormwater Standards (MASMS) to the maximum extent practicable (MEP).

1.1 Background

Freshwater ponds and coastal embayments across Cape Cod are significantly degraded by nutrient and bacteria impairment. Land uses, including stormwater runoff and fertilizer use, contribute on average 20% of the controllable nitrogen load within our coastal watersheds (Cape Cod Commission 208 Plan, 2015) and bacterial contamination, including cyanobacteria, regularly causes closures of beaches. In report (APCC's 2022 State of the Waters), 90% of the coastal embayments and 39% of the freshwater ponds assessed received unacceptable water quality scores. These high nutrient loads are of concern for the environment, our coastal economy, and public health as they negatively impact habitat for fish and shellfish and can result in unsafe conditions for swimming, fishing and boating. Public boats ramps are a common source of pollution in areas of high recreational use. As such, these locations have been targeted by APCC's regional project.

As part of an EPA Southeast New England Program (SNEP) Watershed Grant, APCC and partners first identified 20 public boat ramps across 10 Cape Cod towns in need of improved stormwater management. Concept designs for each of these twenty sites were ranked based on various criteria including potential pollutant removal (i.e., load and drainage area), water quality status of the associated waterbody, construction cost and feasibility, and additional human use and resource benefits (restored shellfish and anadromous fish habitat, proximity to environmental justice communities, improved climate resiliency, opportunity for public education, etc.). With additional funding from a CZM FY23 Coastal Habitat and Water Quality Grant, 25% and 75% designs were developed for seven high-ranking priority sites, including this one at Electric Avenue/Buttermilk Bay, which has a direct connection to Buzzards Bay.

1.2 Project Goals

The purpose of this project is to improve water quality in Buttermilk Bay by reducing or eliminating pollutant loads from stormwater runoff at the public boat ramp using green stormwater infrastructure (GSI) stormwater control measures (SCMs). Specifically, the project aims to maximize pollutant removal (% bacteria, nitrogen and phosphorus) and water quality volume treated. Over time, we hope this work

leads to a reduction in the frequency and/or length of beach closures and shellfish bed closures related to bacteria contamination; and reduction in nutrients and associated algal blooms in the Bay.

1.3 Design Methodology

The design was completed by the following tasks:

- Preliminary field assessment of the site and contributing drainage area to identify usage, physical and environmental constraints and opportunities, and long-term operation and maintenance concerns
- Determination of drainage areas and land coverage within the project area
- Selection of structural and non-structural SCMs best suited to site conditions and project goals
- Structural SCM sizing and performance estimates (described further below)
- Hydrologic/Hydraulic Modeling (described further below)
- Grading and layout of site plan
- Erosion control plan development
- Operation and maintenance (O&M) plan development

SCM Performance Estimates

The proposed SCMs were selected and sized to maximize pollutant load removals. Since the waterbodies this site drains to have water quality impairments and are subject to TMDLs, the SCMs were chosen to maximize not only total suspended solids (TSS) removal, but total phosphorus (TP), total nitrogen (TN), and bacteria load reductions as well. MASMS was used as a reference for TSS removal estimates, but the more recently developed pollutant load removal curves (USEPA 2021 & Paradigm Environmental 2019) were used for TP, TN, and bacteria.[1]

Hydrologic/Hydraulic Modeling

Existing and proposed conditions for the project area were modeled using HydroCAD software, which combines USDA Soil Conservation Service hydrology and hydraulic techniques (commonly known as SCS TR-55 and TR-20) to generate hydrographs. Conditions were evaluated for the water quality event (storm that produces 1 inch of runoff, or a roughly 1.2-inch rain event).

Existing Conditions

The Electric Avenue Boat Ramp is a popular water access point on the south end of Buttermilk Bay, adjacent to a public beach, and accessed by Electric Avenue. The site is located within a mile of a mapped income environmental justice population (**Figure 3**). This land use is not classified as a land use with higher potential pollutant loads (LUHPPL) and thus, is not subject to MASMS **Standard 5**.

[1] It is important to note that these curves have a crosswalk to help users determine which specific curve to reference: for infiltrating bioretentions (no liners/underdrains), the appropriate curve is the Surface Infiltration (Soil infiltration rate = 2.41 in/hr) Performance Curve.

The project site includes an access drive down to a paved boat ramp, on-street trailer parking, a pier, a paved kayak storage area, and various signage (**Figure 2**). The existing pavement at the site is aging, with visible cracks. Additionally, there is excess pavement on the north side of the boat ramp that is not used for parking. A trench drain at the top of the boat ramp is intended to direct stormwater runoff into an oil and grit separator and a dry well. However, the trench drain is frequently clogged, allowing stormwater to bypass this system. Also, the dry well could not be located on site; therefore, the current condition of the dry well is unknown.

2.1 Receiving Water and Watershed

Electric Avenue Boat Ramp discharges stormwater into Buttermilk Bay, an estuarine embayment connected to Buzzards Bay. Buttermilk Bay is a shellfishing area, and the boat ramp is adjacent to a public beach. However, Buttermilk Bay (MA95-01) is listed as impaired for Estuarine Bioassessments, Fecal Coliform, and Nutrient/Eutrophication Biological Indicators (Category 5 – TMDL required) by the most recent Massachusetts DEP 303(d) – 2018/2020 Integrated list of Waters, and APCC's State of the Waters Report lists it as unacceptable for nutrient loading. In addition, the site is located in the Buzzards Bay Watershed, for which a total maximum daily load document (TMDL) has been developed for pathogens. The map showing these resources is included in **Figure 4**.

2.2 Drainage Area

The boat ramp's existing contributing drainage area is approximately 2 acres. This area is comprised of residential roads and properties, with roughly half the drainage area consisting of impervious cover. Based on existing topography and flow paths, the total drainage area was divided into two separate drainage areas: DA1 (Boat Ramp) and DA2 (Beach). DA1 is the area that flows down the boat ramp into the bay, modelled as SP1. DA2 is the area adjacent to the boat ramp that flows down the beach to SP1. See the existing conditions drainage area map and a detailed breakdown of land cover in **Appendix A,** as well as the existing HydroCAD model report in **Appendix B.**

2.3 Resource Areas

HW wetland biologists delineated several resource areas at the site in December 2022. A full description of these resource areas is included in **Appendix C**, and their locations and associated buffers are shown on the plans in **Appendix G**. The wetland resource areas include Coastal Beach; Coastal Bank; Land Subject to Coastal Storm Flowage (LSCSF); and the 50-foot and 100-foot Buffer Zones to Coastal Beach and Coastal Bank. Additional resource areas present adjacent to the site include Land Under the Ocean; Banks of or Land Under the Ocean, Ponds, Streams, Rivers, Lakes, or Creeks that Underlie an Anadromous/Catadromous Fish Run ("Fish Run"); and Land Containing Shellfish. Invasive or Likely Invasive species (as defined by the Massachusetts Invasive Plant Advisory Group) were present at the site as part of the Coastal Bank plant communities, and include spotted knapweed, Asiatic bittersweet, shrub honeysuckle, and border privet.

According to the most recent version of the Massachusetts Natural Heritage Atlas (15th Edition, August 1, 2021), the project site lies adjacent to Estimated Habitat of Rare Wildlife and Certified Vernal Pools

(EH 398) and/or Priority Habitat of Rare Species (PH 452) as designated by the Massachusetts Natural Heritage and Endangered Species Program (NHESP) (Figure 3). Since the site discharges near a public beach area and shellfishing area, it is considered a critical area and subject to MASMS **Standard 6**.

2.4 Soils

Soils data from the Natural Resources Conservation Service (NRCS) indicate that the soils within the drainage areas to the site are composed of Carver loamy coarse sand, 3-8% and beaches, coarse sand. The beaches, coarse sand area was classified as an unranked hydrologic soil group (HSG). Due to the classification of the soil texture and the proximity beach the beach, coarse sand soil type was assumed to be HSG A. The distribution of HSGs of those soils within the contributing drainage areas are outlined in **Table 2** and shown in **Figure 5**.

Table 2. NRCS Soils Data for Drainage Areas

Soil Type	HSG	Acres in Total Drainage Area (% of Total)
Carver loamy coarse sand	A	1.65 (81%)
Beach, sand	A	0.39 (9%)
	TOTAL	***2.04 (100%)***

One test pit was conducted at the site on December 20, 2022 to evaluate subsurface conditions and estimated seasonal high groundwater (ESHGW) based on evidence of mottling or redox. The test pit was excavated and witnessed by the Town's DPW staff and logged by an HW certified Massachusetts Soil Evaluator. Results are shown in **Table 3** below.

The test pit was conducted just off pavement, on the south side of the ramp in the "Beaches, sand" soil unit with parent material of beach sand; immediately adjacent up-gradient, the unit "Carver loamy coarse sand" has a parent material of sandy glaciofluvial deposits. The soil underlying the site was found to be a shallow layer of loamy sand overlaying medium sand. See **Appendix D** for test pit soil log. No mottling or groundwater seepage was observed, so the ESHGW is conservatively assumed at pit bottom. The test pit could not be excavated beyond a depth of 96" due to the sandy material caving in.

Table 3. Test Pit (TP) Results

Test Pit ID	Surface Elevation at TP (ft)	Pit Bottom Elevation (ft)	ESHGW Elevation (ft)	Soil Texture(s)	Design Infiltration Rate (in/hr)	Notes
TP-1	9.3	1.3	1.3	Medium Sand	8.27	ESHGW placed at pit bottom

Proposed Conditions

The proposed project consists of the following stormwater and related site development improvements:

- Resurfaced boat ramp access road to better direct runoff;
- Formal sidewalk to improve pedestrian access to boat ramp dock;
- GSI including a bioretention area and underground infiltration trench;
- Coastal bank planting for stabilization and resiliency; and
- Reduction in overall impervious cover.

The proposed GSI system is designed to meet the following major objectives:

- Capture, treat, and infiltrate at least the first one inch of runoff;
- Reduce peak flows and runoff volumes from the site; and
- Engage the community with interpretive signage.

3.1 Drainage Areas

The boat ramp's contributing drainage area under proposed conditions is the same as existing, with a total of approximately 2 acres. However, the proposed project is reducing impervious cover by roughly 10%, dropping the total impervious cover to 42%. DA1 (Boat Ramp) and DA2 were subdivided for the proposed conditions in order to model flows to the proposed SCMs. The proposed DA1 drainage areas are DA1A (Boat Ramp), DA1B (Electric North), DA1C (Electric South). The proposed DA2 drainage areas are DA2A (Park Area) and DA2B (Beach). The proposed SCMs were added as "ponds" in the HydroCAD model. All site runoff will discharge to Study Point 1 (SP1).

See the proposed conditions drainage area map and a detailed breakdown of land cover in **Appendix A,** as well as the proposed HydroCAD model report in **Appendix B.**

3.2 Structural Stormwater Control Measures (SCMs)

The proposed stormwater management includes a GSI approach to capture, treat, infiltrate, and detain runoff by using the following SCMs. There are two stormwater GSI practices throughout the site, including a bioretention area and an infiltration trench. Pretreatment will be provided with proprietary water quality units, and overflows from extreme events are designed to bypass catch basin grates and flow down the boat ramp. The stormwater management systems were designed to meet **Standard 1**, so that no new untreated stormwater runoff will be directed to any off-site areas or resource areas. Runoff from contributing impervious areas will be treated by the proposed practices.

Water Quality Units (WQU)

Water Quality Units are provided for pretreatment of the runoff from the paved surfaces to allow for sediment and other debris to settle out prior to conveyance into the bioretention areas. They are proprietary underground structures that are used in place of sediment forebays when space is limited.

Bioretention Area (BIO)

A bioretention area (BIO) is a shallow depression used to treat stormwater runoff using a specific planting soil and plants to filter runoff. The method combines physical filtering and adsorption with bio-geochemical processes to remove pollutants. The system consists of an inflow component, a pretreatment element, a shallow ponding area planted with appropriate native plant species (tolerant to both wet and dry periods as well as other site conditions such as wind, salt, shade, etc.), and an overflow weir. Some BIOs located in areas with poor drainage or high groundwater are lined and/or have underdrains, while others located in sandy soils greater than 2 feet above ESHGW can just infiltrate the treated runoff.

One BIO is proposed on the town-owned property adjacent to the boat ramp. This BIO captures, treats, and infiltrates the first inch of runoff from the contributing drainage areas. Runoff from larger storm events is designed to bypass the bioretention area and flow down the boat ramp. An overflow weir is also provided to help safely direct flows once the bioretention area reaches capacity. The BIO has greater than 2-feet separation to ESHGW as required. The BIO will be planted with low-maintenance, native plants tolerant of the salty and windy site conditions.

Infiltration Trench

An infiltration trench is an underground practice that detains, treats, and infiltrates runoff. There is one infiltration trench proposed in the right of way, adjacent to the boat ramp. The system consists of pretreatment via a WQU with a grate, a perforated inflow pipe, the stone storage reservoir, and native plantings. Once the trench reaches capacity runoff will bypass the catch basin grate and continue down the boat ramp. The infiltration trench has greater than 2-feet separation to ESHGW as required.

3.3 Non-structural SCMs

The non-structural SCMs proposed at the site include stabilizing the coastal bank, pavement reduction (~2,100 sf) and public educational signage. Excess pavement and concrete were reduced with the proposed design, reducing overall runoff volume. In addition, an interpretive sign is proposed overlooking the bioretention area along the pedestrian path leading from the road to the dock. This sign will explain the GSI at the site as a part of the larger watershed issues discussed above and encourage GSI actions at home.

Stormwater Design Components

The proposed SCMs were designed to meet a variety of goals and regulatory requirements as discussed above. As a retrofit project for managing existing impervious cover, this design must specifically comply with the redevelopment standard (MASMS **Standard 7)** by meeting all standards to the maximum extent practicable. The project fully meets this standard, as described in detail below.

4.1 Water Quality

The main purpose of this retrofit project is to improve water quality. This section describes the treatment volumes and pollutant load reductions achieved by the proposed design and how they compare to the MASMS standards.

Treatment Volume

Per **Standard 4** of MASMS, the stormwater management system for a new development site discharging to a critical area must be sized to treat the first one inch of runoff and remove 80% or more of the annual post-construction load of total suspended solids (TSS). As a retrofit (falls under **Standard 7** - Redevelopment), the project is only required to meet this to the maximum extent practicable. However, the proposed bioretention area and infiltration trench was sized to treat the full one-inch water quality volume for their contributing drainage areas, and only a small portion of the site could not be captured and treated (DA1A-Boat Ramp). The proposed HydroCAD model results showing treatment of the full water quality volume are included in **Appendix B** and summarized below in **Table 4**.

Table 4. Compliance with Water Quality Volume Requirements

DA ID	SCM ID	IA* (ac)	WQv Goal (ac-ft)	WQv Provided (ac-ft)**	% WQv Provided	Meets Requirement?	Notes
DA1A	NA	0.07	0.006	0.000	0%	N	Boat ramp not captured for this retrofit project given space and land use
DA1B	IT1	0.21	0.018	0.018	100%	Y	Infiltration Trench treats full 1-inch runoff
DA1C	BIO1	0.56	0.048	0.048	100%	Y	Bioretention treats just under the full 1-inch runoff
DA2A	BIO1	0.000	0.000	0.000	0%	Y	Drainage Area does not include any impervious area
DA2B	NA	0.000	0.000	0.000	0%	Y	Drainage Area does not include any impervious area
TOTAL SITE:		**0.85**	**0.072**	**0.066**	**91.7%**	**MEP**	**MEP for Retrofit Projects**

**Impervious Area (IA)*

***From HydroCAD results – see Attachment B for volume "discarded" for WQv Event*

Pollutant Load Reductions

The bioretention and infiltration trench exceed the MASMS requirements for TSS removal and maximize removals of the other pollutants of concern. Estimated TSS, phosphorus, nitrogen, and bacteria removals for the proposed project are provided in **Table 5.** The proposed O&M Guide in **Appendix E** was developed to ensure that the stormwater system continues to function as it was designed into the future to maintain these levels of pollutant removal.

Table 5. Compliance with Water Quality Pollutant Load Reduction Requirements

DA ID	SCM ID	IA* (ac)	WQv Provided (ac-ft)**	Runoff Depth Treated (in)	TSS Removal (%)***	TP Removal (%)****	TN Removal (%)****	Bacteria Removal (%)*****	Meets Reqt?
DA1A	NA	0.07	0.000	0.0	0%	0%	0%	0%	N
DA1B	IT1	0.21	0.018	1.0	90%	98%	100%	98%	Y
DA1C	BIO1	0.56	0.048	1.0	90%	98%	100%	100%	Y
DA2A	BIO1	0	0	0.0	NA	NA	NA	NA	Y
DA2B	NA	0	0	0.0	NA	NA	NA	NA	Y
TOTAL SITE:		**0.85**	**0.066**	**0.9**	**82%**	**90%**	**92%**	**91%**	**MEP**

**Impervious Area (IA)*
***From HydroCAD results – see Attachment B for volume "discarded" for WQv Event*
****From MASMS*
*****From MS4 NPDES Permit Appendix F Attachment 3 (USEPA 2021)*
******From Paradigm Environmental (2019)*

In addition, since the site is located in a critical area (near a public beach and shellfishing area) and must meet MASMS **Standard 6**, pretreatment practices before infiltration should remove 44% TSS or more. As shown above in **Table 5,** water quality units are provided for pretreatment prior to infiltration into the underlying soil, providing greater than 44% TSS removal and fully meeting **Standard 6**.

Long-term Pollution Prevention Plan

Source control is important to ensure long-term functionality of the proposed SCMs and protect downstream resources and habitat. A long-term pollution prevention plan specific to this site is provided as a part of the O&M Guide in **Appendix E**.

4.2 Recharge

Infiltrating treated runoff into the underlying native sands contributes to the goal of this project of improving water quality in Buttermilk Bay. For new development projects, the MASMS requires a specific annual "recharge" volume (Rev) based on the HSG of the soil covered by new impervious surfaces, with a higher volume required for sandy soils (HSG A) and lower for silty, clayey soils (HSG D). This project is only required to provide infiltration or recharge to the maximum extent practicable as a redevelopment project, as there is already pavement at the site.

However, the proposed SCMs actually provide more than required by **Standard 3**. A majority of stormwater runoff at the site is being directed to infiltrating SCMs in comparison to the existing conditions where runoff is mostly directly draining to the pond. Another requirement of **Standard 3** is that infiltrating SCMs must fully drain in 72 hours. The proposed HydroCAD model results showing full recharge of the first inch of runoff by the SCMs and the drawdown times (from full basins to empty) are included in **Appendix B** and summarized below in **Table 6.**

Table 6. Compliance with Recharge Requirements

DA ID	SCM ID	IA* (ac)	Soil HSG	Required Recharge Depth (in)	Rev Goal (ac-ft)	Rev Provided (ac-ft)**	% Rev Provided	Draw-down Time (hrs)***	Meets Reqt?	Notes
DA1A	NA	0.07	A	0.6	0.004	0.000	0%	NA	N	Boat ramp not captured for this retrofit project given space and land use
DA1B	IT1	0.21	A	0.6	0.011	0.018	171%	12	Y	Infiltration Trench recharges full 1-inch runoff
DA1C	BIO1	0.56	A	0.6	0.028	0.048	171%	12	Y	Bioretention recharges full 1-inch runoff
DA2A	BIO1	0.00	A	0.6	0.000	0.000	0%	NA	Y	DA does not include any impervious area
DA2B	NA	0.00	A	0.6	0.000	0.000	0%	NA	Y	DA does not include any impervious area
TOTAL SITE:		**0.85**			**0.042**	**0.065**	**153%**		**Y**	**Exceeds Requirement for Site**

**Impervious Area (IA)*
***From HydroCAD results – see Attachment B for volume "discarded" for WQv Event*
****From HydroCAD results – see Attachment B for hydrograph showing time from peak elevation to fully drained basins (WQv Event)*

4.3 Water Quantity

The main goal of this project is to improve water quality. Since the site is located within the 100-year floodplain and designated as land subject to coastal storm flowage, the requirements of **Standard 2** of the MASMS may be waived as stormwater model results are not meaningful during large storms when the site will be underwater.

4.4 Erosion Control

Controlling erosion and sedimentation from the construction site is important to meet the overall water quality goals of this retrofit project, as well as to meet MASMS **Standard 8**. Given this site's size (< 1 acre of disturbance), a full NPDES Construction General Permit Stormwater Pollution Plan (SWPPP) is not required. Regardless, planning for effective erosion and sediment controls (ESCs) is important to this project's design, and an ESC Plan is included in the design plans (**Appendix G**), along with a detailed

sequence of construction activities and ESC notes. Visibility fence and/or silt socks are proposed at the limit of work to protect off-site areas and trees; silt socks are proposed along the downgradient edges of the area of disturbance. A construction entrance will be installed to minimize tracking onto Electric Avenue. Areas for sediment traps/basins have been identified for when the pavement is removed from the boat ramp, exposing a large area of soil. A turbidity curtain is proposed at the bottom of the boat ramp to minimize sediment entering the bay during high tides. Disturbed areas will be stabilized as soon as possible to minimize erosion and sedimentation with pavement, seeding and/or erosion control blankets, if necessary. A Pollutant Controls During Construction plan is also included in **Appendix F** that discusses these controls in more detail. With these layered ESCs implemented throughout the site, discharge of sediment-laden runoff during construction should be minimized to the maximum extent practicable.

The contractor will be required to establish these erosion controls prior to beginning any other project-related work. The ESC Plan will also establish the limit of work, beyond which the contractor will not be allowed to perform any work. It is the contractor's responsibility to monitor and correct erosion control practices throughout the duration of the project. Erosion control measures will not be removed until the project reaches completion as directed by the project engineer or landscape architect.

4.5 Operation and Maintenance

Ongoing maintenance is vital for long-term success at the site. All SCMs were designed to be low-maintenance in nature. These SCMs will be operated and maintained appropriately during construction and post-construction as required on the construction drawings and O&M Guide per MASMS **Standard 9** (**Appendix E and G**).

4.6 Illicit Discharges

There will be no illicit discharges to the existing system by the proposed project per MASMS **Standard 10**. The Long-Term Pollution Prevention Plan in the O&M Guide (**Appendix E**) includes measures to prevent future illicit discharges.

REFERENCES

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Cape Cod Commission. 2015. 208 Plan – Cape Cod's Area Wide Water Quality Management Plan Updated.

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MADEP. 2019. See their homepage at www.state.ma.gov/dep.

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Paradigm Environmental. 2019. USEPA Memo. Tisbury MA Impervious Cover Disconnection (ICD) Project: An Integrated Stormwater Management Approach for Promoting Urban Community Sustainability and Resilience - Task 4D. Develop Planning Level GI SCM Performance Curves for Estimating Cumulative Reductions in SW-Related Indicator Bacteria.

USEPA (United States Environmental Protection Agency). 2019. National Pollutant Discharge Elimination System (NPDES). See their homepage at: http://cfpub.epa.gov/NPDES/.

USEPA. 2021. National Pollutant Discharge Elimination System (NPDES)-General Permits for Stormwater Discharges from Small Municipal Separate Storm Sewer Systems in Massachusetts (as modified).

FIGURES

Horsley Witten Group
Sustainable Environmental Solutions

Path: H:\Projects\2022\22032 CC Boat Ramp SW Retrofits\GIS\Maps\ReportFigureMaps\ElectricAve\Locus.mxd

Date: 9/26/2023
Data Sources: Bureau of Geographic Information (MassGIS), ESRI

This map is for informational purposes and may not be suitable for legal, engineering, or surveying purposes.

● Electric Ave Boat Ramp

ELECTRIC AVE Boat Ramp
Cape Cod Boat Ramp Stormwater Retrofit Project
Bourne, MA

Figure 1
Locus Map

Horsley Witten Group
Sustainable Environmental Solutions

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Date: 8/28/2023
Data Sources: Bureau of Geographic Information (MassGIS), ESRI

This map is for informational purposes and may not be suitable for legal, engineering, or surveying purposes.

Electric Ave Boat Ramp
Town Parcels

ELECTRIC AVE Boat Ramp
Cape Cod Boat Ramp Stormwater Retrofit Project
Bourne, MA

Figure 2
Aerial

Horsley Witten Group
Sustainable Environmental Solutions

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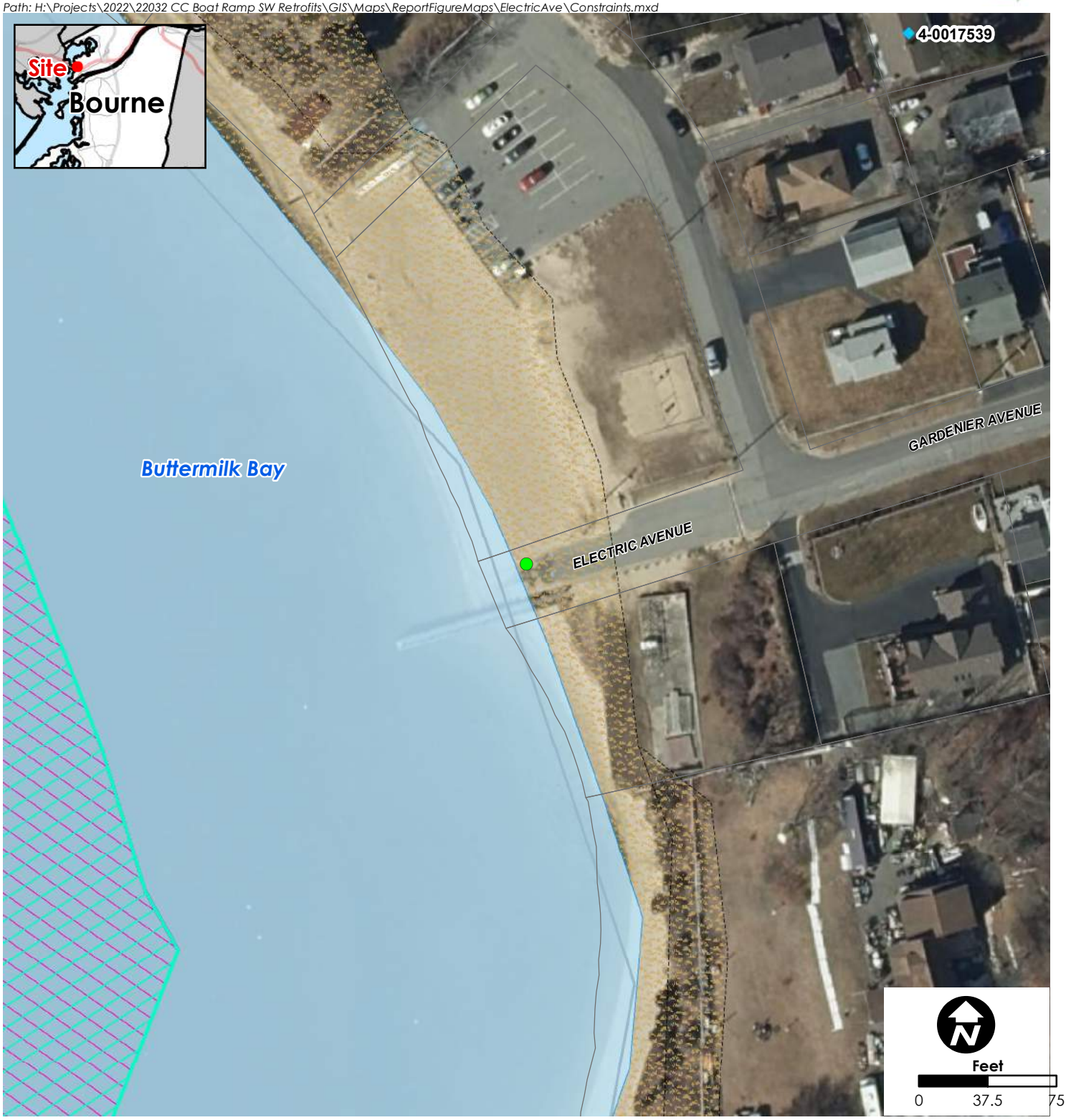


Date: 9/26/2023
Data Sources: Bureau of Geographic Information (MassGIS), ESRI

This map is for informational purposes and may not be suitable for legal, engineering, or surveying purposes.

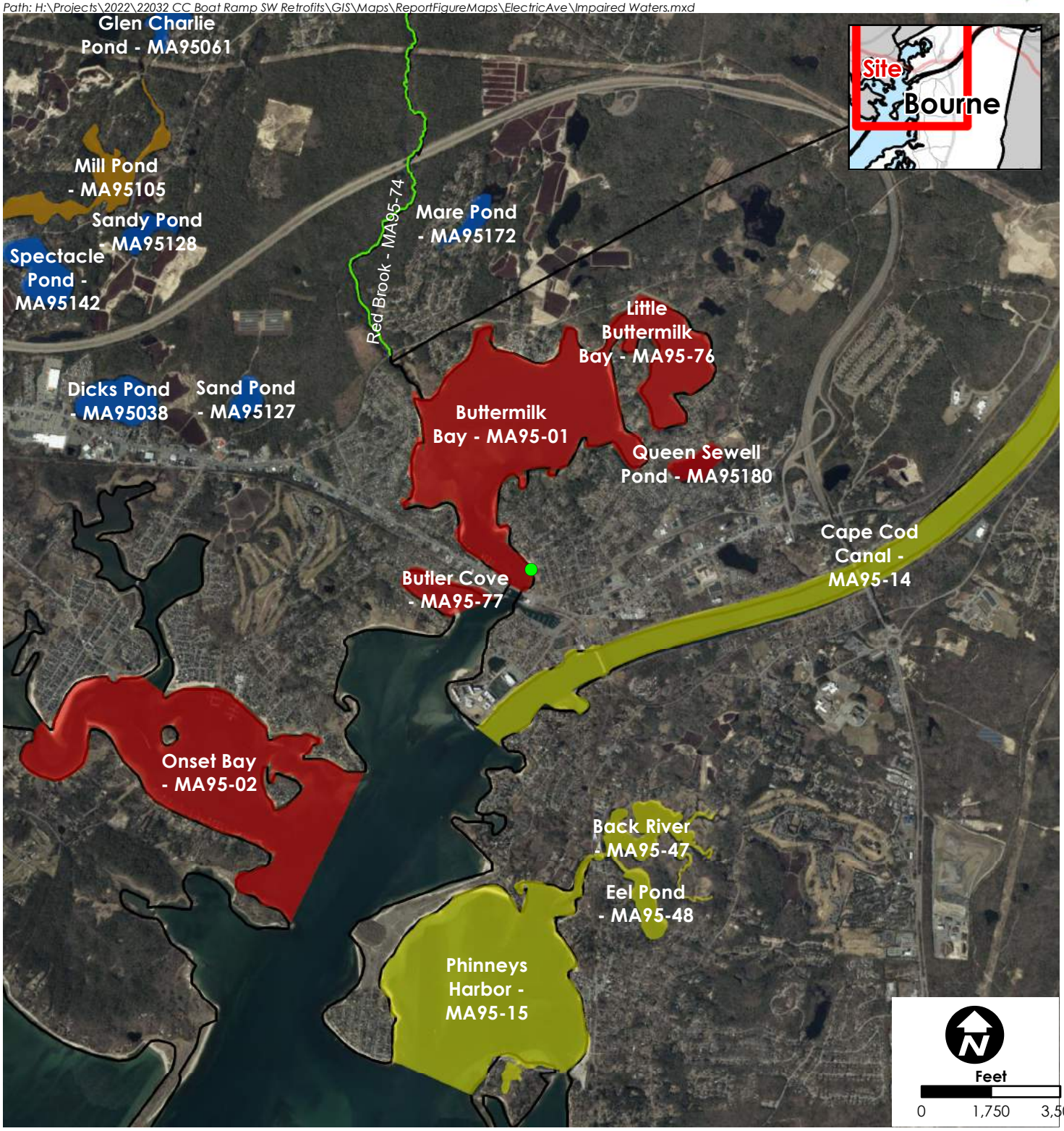
- Electric Ave Boat Ramp
- Town Parcels
- Chapter 21E - TIER1D
- NHESP Priority Habitats of Rare Species
- NHESP Estimated Habitats of Rare Wildlife
- Shoreline
- Closure Line
- Open Water
- Beach/Dune

ELECTRIC AVE Boat Ramp
Cape Cod Boat Ramp Stormwater Retrofit Project
Bourne, MA

Figure 3
Constraints

Horsley Witten Group
Sustainable Environmental Solutions

Path: H:\Projects\2022\22032 CC Boat Ramp SW Retrofits\GIS\Maps\ReportFigureMaps\ElectricAve\Impaired Waters.mxd



Date: 9/26/2023
Data Sources: Bureau of Geographic Information (MassGIS), ESRI

This map is for informational purposes and may not be suitable for legal, engineering, or surveying purposes.

Electric Ave Boat Ramp

2018/2020 Integrated List Data

2) Attaining some uses; other uses not assessed

3 - No uses assessed
4A - Impaired - TMDL is completed
4C - Impairment not caused by a pollutant
5 - Impaired - TMDL required

ELECTRIC AVE Boat Ramp
Cape Cod Boat Ramp Stormwater Retrofit Project
Bourne, MA

Figure 4
Impaired Waters

Horsley Witten Group
Sustainable Environmental Solutions

Path: H:\Projects\2022\22032 CC Boat Ramp SW Retrofits\GIS\Maps\ReportFigureMaps\ElectricAve\Soils.mxd

Date: 9/27/2023
Data Sources: Bureau of Geographic Information (MassGIS), ESRI

This map is for informational purposes and may not be suitable for legal, engineering, or surveying purposes.

Electric Ave Boat Ramp
Town Parcels

Hydrologic Soil Group

<Null>
A

ELECTRIC AVE Boat Ramp
Cape Cod Boat Ramp Stormwater Retrofit Project
Bourne, MA

Figure 5
Soils

APPENDIX A – Drainage Areas

- Existing and Proposed Drainage Areas Maps
- Land Coverage Summaries

Horsley Witten Group, Inc.
Sustainable Environmental Solutions
90 Route 6A Sandwich, MA 02563
horsleywittengroup.com

Date: 05/30/2023
Design By: JLV
Drawn By: JLV
Checked By: MW

Plan Set:
ELECTRIC AVENUE
CAPE COD BOAT RAMP STORMWATER
RETROFIT PROJECT- PERMITTING PLANS
BOURNE, MASSCHUSETTS

Plan Title:
EXISTING DRAINAGE AREA MAP

Prepared For:
Town of Bourne
24 Perry Ave
Bourne, MA
Phone: (508) 759-0600

Project Number:
22032

Sheet Number:
1 of 2

Horsley Witten Group, Inc.
Sustainable Environmental Solutions
90 Route 6A Sandwich, MA 02563
horsleywittengroup.com

Date: 11/13/2023
Design By: JLV
Drawn By: JLV
Checked By: MW

Plan Set:
ELECTRIC AVENUE
CAPE COD BOAT RAMP STORMWATER
RETROFIT PROJECT- PERMITTING PLANS
BOURNE, MASSACHUSETTS

Plan Title:
PROPOSED DRAINAGE AREA MAP

Prepared For:
Town of Bourne
24 Perry Ave
Bourne, MA
Phone: (508) 759-0600

Project Number:
22032

Sheet Number:
2 of 2

CAPE COD BOAT RAMPS- ELECTRIC AVE BOURNE, MA	Calc'd by:	JV
	Checked by:	MW
Existing Drainage Conditions	Date:	9/29/2023

DRAINAGE AREAS	
DA1	**BOAT RAMP**
DA2	**BEACH**

NOAA 14+ 24-hr Type III (inches)	
WQv	1.21
1-yr	3.09
2-yr	3.65
5-yr	4.58
10-yr	5.36
25-yr	6.61
100-yr	8.60
500-yr	11.34

DA1	**BOAT RAMP**		
Cover type	Area, ft^2	Area, *ac*	Note
Paved	29,633	0.680	
Sand	2,046	0.047	
Roof	6,917	0.159	
Water	0	0.000	
Woods	0	0.000	
Grass	32,710	0.751	
TOTAL	71,306	1.637	

Impervious		
Area, ft^2	Area, *ac*	Percent
36,550	0.839	51

DA2	**BEACH**		
Cover type	Area, ft^2	Area, *ac*	Note
Paved	2,752	0.063	
Sand	3,880	0.089	
Roof	0	0.000	
Water	0	0.000	
Woods	3,225	0.074	
Grass	7,757	0.178	
TOTAL	17,614	0.404	

Impervious		
Area, ft^2	Area, *ac*	Percent
2,752	0.063	16

ALL	***ALL EXISTING AREAS COMBINED***					
Cover type	Area, ft^2	Area, *ac*	Note			
Paved	32,385	0.743				
Permeable	5,926	0.136				
Roof	6,917	0.159				
Water	0	0.000				
Woods	3,225	0.074		**Impervious**		
Grass	40,467	0.929		Area, ft^2	Area, *ac*	Percent
TOTAL	88,920	2.041		39,302	0.902	44

CAPE COD BOAT RAMPS- ELECTRIC AVE BOURNE, MA	Calc'd by:	JV
	Checked by:	MW
Proposed Drainage Conditions	Date:	9/29/2023

DRAINAGE AREAS	
DA1A	BOAT RAMP
DA1B	ELECTRIC NORTH
DA1C	ELECTRIC SOUTH
DA2A	PARK AREA
DA2B	BEACH

NOAA 14+ 24-hr Type III (inches)	
WQv	1.21
1-yr	3.09
2-yr	3.65
5-yr	4.58
10-yr	5.36
25-yr	6.61
100-yr	8.60
500-yr	11.34

DA1A	BOAT RAMP		
Cover type	Area, ft^2	Area, *ac*	Note
Paved	3,361	0.077	
Sand	1,983	0.046	
Roof	0	0.000	
Water	0	0.000	
Woods	0	0.000	
Grass	3,180	0.073	
TOTAL	8,524	0.196	

Impervious		
Area, ft^2	Area, *ac*	Percent
3,361	0.077	39

DA1B	ELECTRIC NORTH		
Cover type	Area, ft^2	Area, *ac*	Note
Paved	7,615	0.175	
Sand	0	0.000	
Roof	1,560	0.036	
Water	0	0.000	
Woods	0	0.000	
Grass	9,340	0.214	
TOTAL	18,515	0.425	

Impervious		
Area, ft^2	Area, *ac*	Percent
9,175	0.211	50

DA1C	ELECTRIC SOUTH					
Cover type	Area, ft^2	Area, *ac*	Note			
Paved	19,117	0.439				
Sand	0	0.000				
Roof	5,357	0.123				
Water	0	0.000				
Woods	0	0.000		**Impervious**		
Grass	20,116	0.462		Area, ft^2	Area, *ac*	Percent
TOTAL	44,590	1.024		24,474	0.562	55

DA2A	PARK AREA					
Cover type	Area, ft^2	Area, *ac*	Note			
Paved	0	0.000				
Sand	0	0.000				
Roof	0	0.000				
Water	1,071	0.025				
Woods	2,891	0.066		**Impervious**		
Grass	7,050	0.162		Area, ft^2	Area, *ac*	Percent
TOTAL	11,012	0.253		0	0.000	0

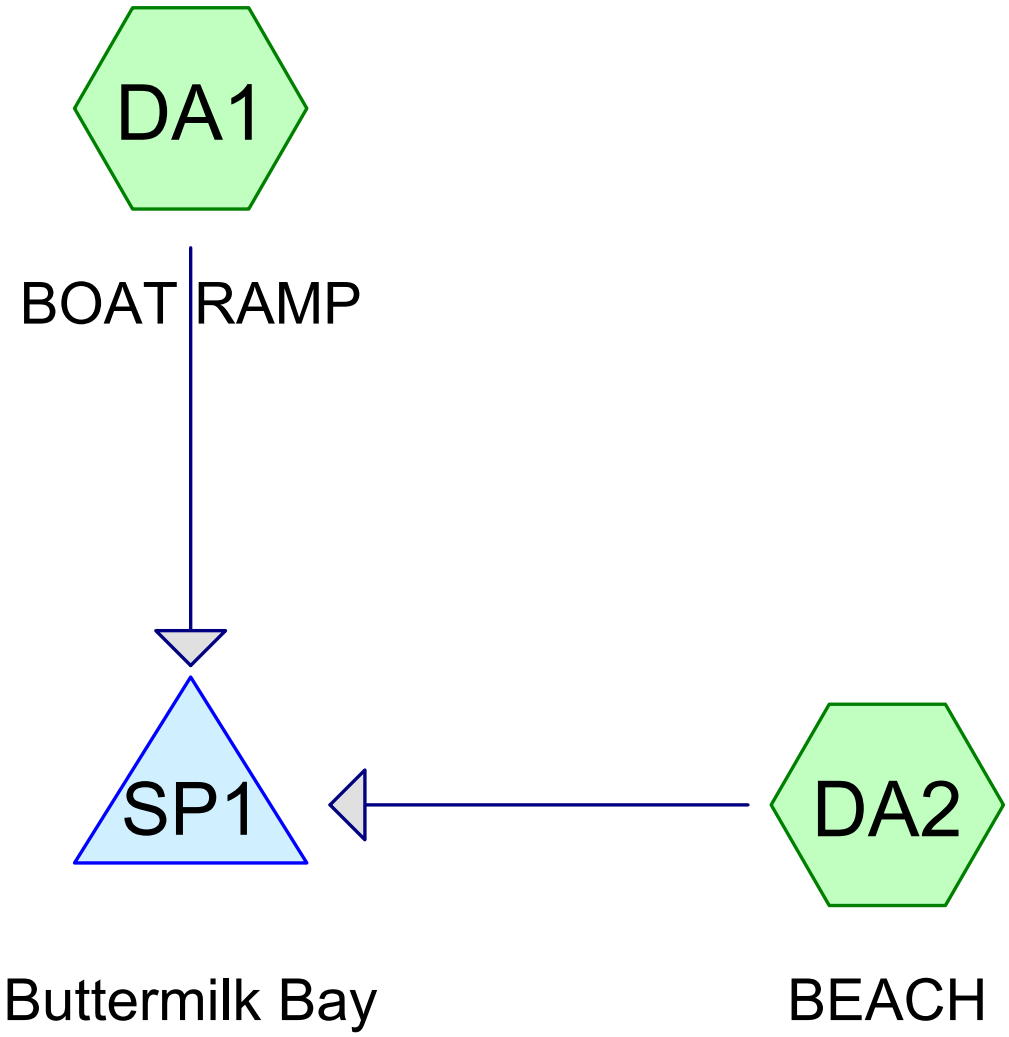
DA2B	BEACH					
Cover type	Area, ft^2	Area, *ac*	Note			
Paved	0	0.000				
Sand	3,873	0.089				
Roof	0	0.000				
Water	0	0.000				
Woods	0	0.000		**Impervious**		
Grass	2,407	0.055		Area, ft^2	Area, *ac*	Percent
TOTAL	6,280	0.144		0	0.000	0

ALL	***ALL PROPOSED AREAS COMBINED***					
Cover type	Area, ft^2	Area, *ac*	Note			
Paved	30,093	0.691				
Sand	5,856	0.134				
Roof	6,917	0.159				
Water	1,071	0.025				
Woods	2,891	0.066		**Impervious**		
Grass	42,093	0.966		Area, ft^2	Area, *ac*	Percent
TOTAL	88,921	2.041		37,010	0.850	42

APPENDIX B – Hydrologic/Hydraulic Model Results

HydroCAD® Results

- Existing
- Proposed



Subcat Reach Pond Link

Routing Diagram for 22032 Electric EX
Prepared by Horsley Witten Inc, Printed 10/5/2023

Rainfall Events Listing (selected events)

Event#	Event Name	Storm Type	Curve	Mode	Duration (hours)	B/B	Depth (inches)	AMC
1	WQV	Type III 24-hr		Default	24.00	1	1.27	2

Area Listing (all nodes)

Area (acres)	CN	Description (subcatchment-numbers)
0.929	39	>75% Grass cover, Good, HSG A (DA1, DA2)
0.743	98	Paved parking, HSG A (DA1, DA2)
0.159	98	Roofs, HSG A (DA1)
0.136	63	Sand (DA1, DA2)
0.074	30	Woods, Good, HSG A (DA2)
2.041	**66**	**TOTAL AREA**

Ground Covers (all nodes)

HSG-A (acres)	HSG-B (acres)	HSG-C (acres)	HSG-D (acres)	Other (acres)	Total (acres)	Ground Cover	Subcatchment Numbers
0.929	0.000	0.000	0.000	0.000	0.929	>75% Grass cover, Good	DA1, DA2
0.743	0.000	0.000	0.000	0.000	0.743	Paved parking	DA1, DA2
0.159	0.000	0.000	0.000	0.000	0.159	Roofs	DA1
0.000	0.000	0.000	0.000	0.136	0.136	Sand	DA1, DA2
0.074	0.000	0.000	0.000	0.000	0.074	Woods, Good	DA2
1.905	**0.000**	**0.000**	**0.000**	**0.136**	**2.041**	**TOTAL AREA**	

Time span=1.00-72.00 hrs, dt=0.05 hrs, 1421 points
Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv.
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment DA1: BOAT RAMP Runoff Area=71,306 sf 51.26% Impervious Runoff Depth=0.54"
Tc=5.0 min CN=40/98 Runoff=0.99 cfs 0.074 af

Subcatchment DA2: BEACH Runoff Area=17,614 sf 15.62% Impervious Runoff Depth=0.16"
Tc=5.0 min CN=43/98 Runoff=0.07 cfs 0.006 af

Pond SP1: Buttermilk Bay Inflow=1.06 cfs 0.079 af
Primary=1.06 cfs 0.079 af

Total Runoff Area = 2.041 ac Runoff Volume = 0.079 af Average Runoff Depth = 0.47"
55.80% Pervious = 1.139 ac 44.20% Impervious = 0.902 ac

Summary for Subcatchment DA1: BOAT RAMP

[49] Hint: Tc<2dt may require smaller dt

Runoff = 0.99 cfs @ 12.07 hrs, Volume= 0.074 af, Depth= 0.54"
Routed to Pond SP1 : Buttermilk Bay

Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv., Time Span= 1.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr WQV Rainfall=1.27"

	Area (sf)	CN	Description
	29,633	98	Paved parking, HSG A
	6,917	98	Roofs, HSG A
	32,710	39	>75% Grass cover, Good, HSG A
*	2,046	63	Sand
	71,306	70	Weighted Average
	34,756	40	48.74% Pervious Area
	36,550	98	51.26% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Summary for Subcatchment DA2: BEACH

[49] Hint: Tc<2dt may require smaller dt

Runoff = 0.07 cfs @ 12.07 hrs, Volume= 0.006 af, Depth= 0.16"
Routed to Pond SP1 : Buttermilk Bay

Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv., Time Span= 1.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr WQV Rainfall=1.27"

	Area (sf)	CN	Description
	2,752	98	Paved parking, HSG A
	7,757	39	>75% Grass cover, Good, HSG A
*	3,880	63	Sand
	3,225	30	Woods, Good, HSG A
	17,614	52	Weighted Average
	14,862	43	84.38% Pervious Area
	2,752	98	15.62% Impervious Area

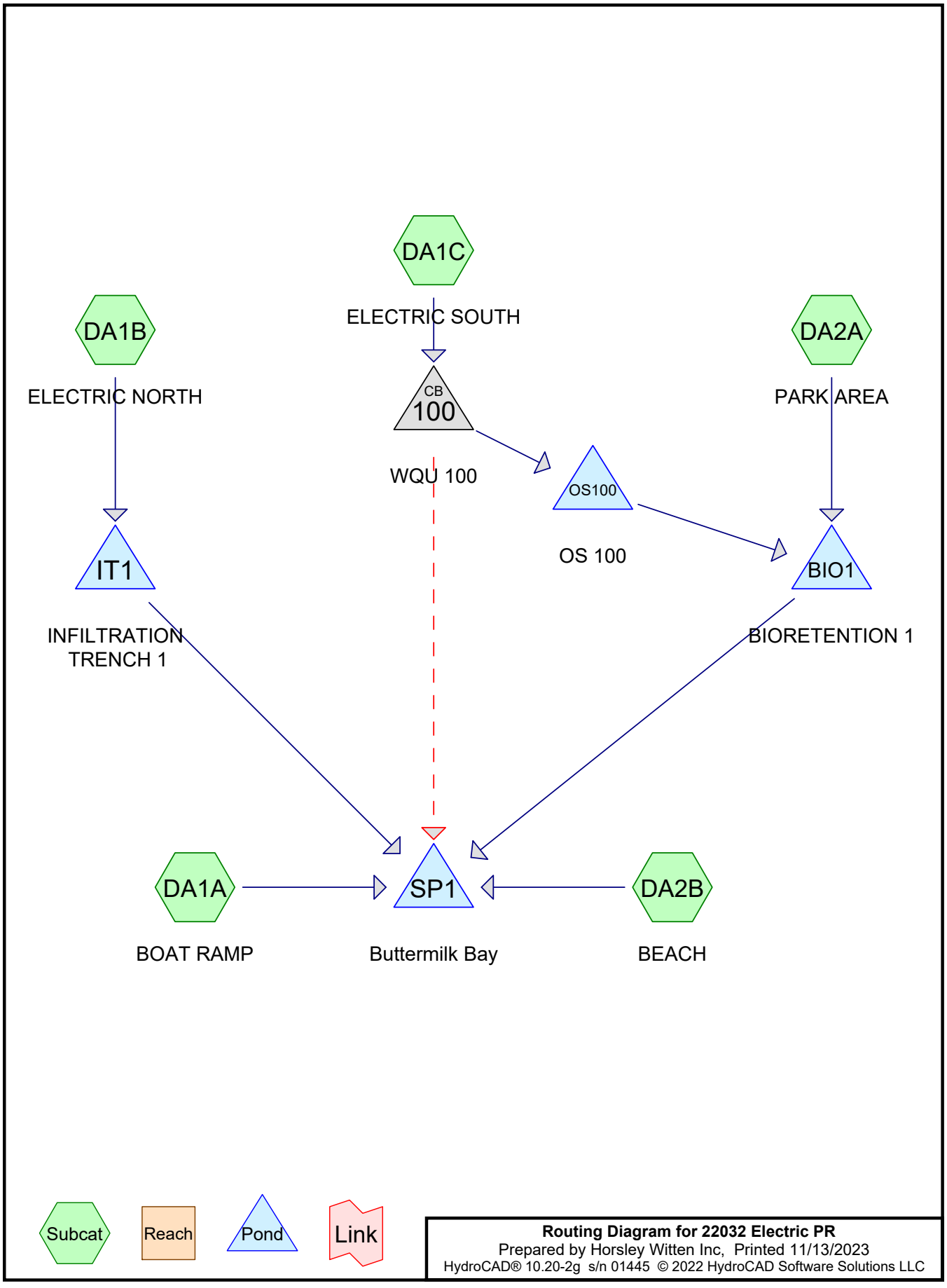
Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Summary for Pond SP1: Buttermilk Bay

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 2.041 ac, 44.20% Impervious, Inflow Depth = 0.47" for WQV event
Inflow = 1.06 cfs @ 12.07 hrs, Volume= 0.079 af
Primary = 1.06 cfs @ 12.07 hrs, Volume= 0.079 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind method, Time Span= 1.00-72.00 hrs, dt= 0.05 hrs



Routing Diagram for 22032 Electric PR
Prepared by Horsley Witten Inc, Printed 11/13/2023

Rainfall Events Listing (selected events)

Event#	Event Name	Storm Type	Curve	Mode	Duration (hours)	B/B	Depth (inches)	AMC
1	WQV	Type III 24-hr		Default	24.00	1	1.22	2

Area Listing (all nodes)

Area (acres)	CN	Description (subcatchment-numbers)
0.966	39	>75% Grass cover, Good, HSG A (DA1A, DA1B, DA1C, DA2A, DA2B)
0.691	98	Paved parking, HSG A (DA1A, DA1B, DA1C)
0.159	98	Roofs, HSG A (DA1B, DA1C)
0.134	63	Sand (DA1A, DA2B)
0.025	98	Water Surface, HSG A (DA2A)
0.066	30	Woods, Good, HSG A (DA2A)
2.041	**66**	**TOTAL AREA**

Ground Covers (all nodes)

HSG-A (acres)	HSG-B (acres)	HSG-C (acres)	HSG-D (acres)	Other (acres)	Total (acres)	Ground Cover	Subcatchment Numbers
0.966	0.000	0.000	0.000	0.000	0.966	>75% Grass cover, Good	DA1A, DA1B, DA1C, DA2A, DA2B
0.691	0.000	0.000	0.000	0.000	0.691	Paved parking	DA1A, DA1B, DA1C
0.159	0.000	0.000	0.000	0.000	0.159	Roofs	DA1B, DA1C
0.000	0.000	0.000	0.000	0.134	0.134	Sand	DA1A, DA2B
0.025	0.000	0.000	0.000	0.000	0.025	Water Surface	DA2A
0.066	0.000	0.000	0.000	0.000	0.066	Woods, Good	DA2A
1.907	**0.000**	**0.000**	**0.000**	**0.134**	**2.041**	**TOTAL AREA**	

Time span=1.00-72.00 hrs, dt=0.05 hrs, 1421 points
Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv.
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment DA1A: BOAT RAMP Runoff Area=8,524 sf 39.43% Impervious Runoff Depth=0.40"
Tc=5.0 min CN=48/98 Runoff=0.09 cfs 0.006 af

Subcatchment DA1B: ELECTRIC NORTH Runoff Area=18,515 sf 49.55% Impervious Runoff Depth=0.50"
Tc=5.0 min CN=39/98 Runoff=0.24 cfs 0.018 af

Subcatchment DA1C: ELECTRIC SOUTH Runoff Area=44,590 sf 54.89% Impervious Runoff Depth=0.55"
Tc=5.0 min CN=39/98 Runoff=0.63 cfs 0.047 af

Subcatchment DA2A: PARK AREA Runoff Area=11,012 sf 9.73% Impervious Runoff Depth=0.10"
Tc=5.0 min CN=36/98 Runoff=0.03 cfs 0.002 af

Subcatchment DA2B: BEACH Runoff Area=6,280 sf 0.00% Impervious Runoff Depth=0.00"
Tc=5.0 min CN=54/0 Runoff=0.00 cfs 0.000 af

Pond 100: WQU 100 Peak Elev=6.96' Inflow=0.63 cfs 0.047 af
Primary=0.63 cfs 0.047 af Secondary=0.00 cfs 0.000 af Outflow=0.63 cfs 0.047 af

Pond BIO1: BIORETENTION 1 Peak Elev=7.46' Storage=784 cf Inflow=0.66 cfs 0.048 af
Discarded=0.08 cfs 0.048 af Primary=0.00 cfs 0.000 af Outflow=0.08 cfs 0.048 af

Pond IT1: INFILTRATION TRENCH 1 Peak Elev=9.63' Storage=351 cf Inflow=0.24 cfs 0.018 af
Discarded=0.02 cfs 0.011 af Primary=0.16 cfs 0.004 af Outflow=0.16 cfs 0.016 af

Pond OS100: OS 100 Peak Elev=7.10' Storage=0.000 af Inflow=0.63 cfs 0.047 af
Discarded=0.00 cfs 0.001 af Primary=0.63 cfs 0.046 af Outflow=0.63 cfs 0.047 af

Pond SP1: Buttermilk Bay Inflow=0.19 cfs 0.011 af
Primary=0.19 cfs 0.011 af

Total Runoff Area = 2.041 ac Runoff Volume = 0.073 af Average Runoff Depth = 0.43"
57.17% Pervious = 1.167 ac 42.83% Impervious = 0.874 ac

Summary for Subcatchment DA1A: BOAT RAMP

[49] Hint: Tc<2dt may require smaller dt

Runoff = 0.09 cfs @ 12.07 hrs, Volume= 0.006 af, Depth= 0.40"
Routed to Pond SP1 : Buttermilk Bay

Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv., Time Span= 1.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr WQV Rainfall=1.22"

	Area (sf)	CN	Description
	3,361	98	Paved parking, HSG A
	3,180	39	>75% Grass cover, Good, HSG A
*	1,983	63	Sand
	8,524	68	Weighted Average
	5,163	48	60.57% Pervious Area
	3,361	98	39.43% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Summary for Subcatchment DA1B: ELECTRIC NORTH

[49] Hint: Tc<2dt may require smaller dt

Runoff = 0.24 cfs @ 12.07 hrs, Volume= 0.018 af, Depth= 0.50"
Routed to Pond IT1 : INFILTRATION TRENCH 1

Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv., Time Span= 1.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr WQV Rainfall=1.22"

	Area (sf)	CN	Description
	7,615	98	Paved parking, HSG A
	9,340	39	>75% Grass cover, Good, HSG A
	1,560	98	Roofs, HSG A
	18,515	68	Weighted Average
	9,340	39	50.45% Pervious Area
	9,175	98	49.55% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Summary for Subcatchment DA1C: ELECTRIC SOUTH

[49] Hint: Tc<2dt may require smaller dt

Runoff = 0.63 cfs @ 12.07 hrs, Volume= 0.047 af, Depth= 0.55"
Routed to Pond 100 : WQU 100

Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv., Time Span= 1.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr WQV Rainfall=1.22"

Area (sf)	CN	Description
19,117	98	Paved parking, HSG A
20,116	39	>75% Grass cover, Good, HSG A
0	30	Woods, Good, HSG A
0	98	Water Surface, HSG A
5,357	98	Roofs, HSG A
44,590	71	Weighted Average
20,116	39	45.11% Pervious Area
24,474	98	54.89% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Summary for Subcatchment DA2A: PARK AREA

[49] Hint: Tc<2dt may require smaller dt

Runoff = 0.03 cfs @ 12.07 hrs, Volume= 0.002 af, Depth= 0.10"
Routed to Pond BIO1 : BIORETENTION 1

Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv., Time Span= 1.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr WQV Rainfall=1.22"

Area (sf)	CN	Description
7,050	39	>75% Grass cover, Good, HSG A
2,891	30	Woods, Good, HSG A
1,071	98	Water Surface, HSG A
11,012	42	Weighted Average
9,941	36	90.27% Pervious Area
1,071	98	9.73% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Summary for Subcatchment DA2B: BEACH

[49] Hint: Tc<2dt may require smaller dt
[45] Hint: Runoff=Zero

Runoff = 0.00 cfs @ 1.00 hrs, Volume= 0.000 af, Depth= 0.00"
Routed to Pond SP1 : Buttermilk Bay

Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv., Time Span= 1.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr WQV Rainfall=1.22"

	Area (sf)	CN	Description
	2,407	39	>75% Grass cover, Good, HSG A
*	3,873	63	Sand
	6,280	54	Weighted Average
	6,280	54	100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Summary for Pond 100: WQU 100

[57] Hint: Peaked at 6.96' (Flood elevation advised)

Inflow Area = 1.024 ac, 54.89% Impervious, Inflow Depth = 0.55" for WQV event
Inflow = 0.63 cfs @ 12.07 hrs, Volume= 0.047 af
Outflow = 0.63 cfs @ 12.07 hrs, Volume= 0.047 af, Atten= 0%, Lag= 0.0 min
Primary = 0.63 cfs @ 12.07 hrs, Volume= 0.047 af
Routed to Pond OS100 : OS 100
Secondary = 0.00 cfs @ 1.00 hrs, Volume= 0.000 af
Routed to Pond SP1 : Buttermilk Bay

Routing by Stor-Ind method, Time Span= 1.00-72.00 hrs, dt= 0.05 hrs
Peak Elev= 6.96' @ 12.07 hrs

Device	Routing	Invert	Outlet Devices
#1	Primary	6.00'	**6.0" Round Pipe to Bio** L= 36.0' CMP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 6.00' / 5.50' S= 0.0139 '/' Cc= 0.900 n= 0.013 Concrete pipe, bends & connections, Flow Area= 0.20 sf
#2	Secondary	10.20'	**10.0' long x 0.5' breadth free overflow down ramp** Head (feet) 0.20 0.40 0.60 0.80 1.00 Coef. (English) 2.80 2.92 3.08 3.30 3.32

Primary OutFlow Max=0.61 cfs @ 12.07 hrs HW=6.91' (Free Discharge)
↑—**1=Pipe to Bio** (Inlet Controls 0.61 cfs @ 3.09 fps)

Secondary OutFlow Max=0.00 cfs @ 1.00 hrs HW=6.00' (Free Discharge)
↑—**2=free overflow down ramp** (Controls 0.00 cfs)

Summary for Pond BIO1: BIORETENTION 1

[81] Warning: Exceeded Pond OS100 by 0.43' @ 12.70 hrs

Inflow Area = 1.276 ac, 45.94% Impervious, Inflow Depth = 0.45" for WQV event
Inflow = 0.66 cfs @ 12.07 hrs, Volume= 0.048 af
Outflow = 0.08 cfs @ 12.62 hrs, Volume= 0.048 af, Atten= 87%, Lag= 33.0 min
Discarded = 0.08 cfs @ 12.62 hrs, Volume= 0.048 af
Primary = 0.00 cfs @ 1.00 hrs, Volume= 0.000 af
Routed to Pond SP1 : Buttermilk Bay

Routing by Stor-Ind method, Time Span= 1.00-72.00 hrs, dt= 0.05 hrs
Peak Elev= 7.46' @ 12.62 hrs Surf.Area= 1,473 sf Storage= 784 cf

Plug-Flow detention time= 78.3 min calculated for 0.048 af (100% of inflow)
Center-of-Mass det. time= 78.2 min (859.7 - 781.5)

Volume	Invert	Avail.Storage	Storage Description
#1	6.75'	2,088 cf	**Custom Stage Data (Prismatic)**Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
6.75	200	0	0
7.00	1,200	175	175
7.50	1,500	675	850
7.75	1,700	400	1,250
8.00	5,000	838	2,088

Device	Routing	Invert	Outlet Devices
#1	Primary	7.50'	**12.0' long x 0.5' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 Coef. (English) 2.80 2.92 3.08 3.30 3.32
#2	Discarded	6.75'	**2.410 in/hr Exfiltration over Surface area**

Discarded OutFlow Max=0.08 cfs @ 12.62 hrs HW=7.46' (Free Discharge)
2=Exfiltration (Exfiltration Controls 0.08 cfs)

Primary OutFlow Max=0.00 cfs @ 1.00 hrs HW=6.75' (Free Discharge)
1=Broad-Crested Rectangular Weir (Controls 0.00 cfs)

Summary for Pond IT1: INFILTRATION TRENCH 1

[85] Warning: Oscillations may require smaller dt or Finer Routing (severity=87)

Inflow Area = 0.425 ac, 49.55% Impervious, Inflow Depth = 0.50" for WQV event
Inflow = 0.24 cfs @ 12.07 hrs, Volume= 0.018 af
Outflow = 0.16 cfs @ 12.35 hrs, Volume= 0.016 af, Atten= 32%, Lag= 16.7 min
Discarded = 0.02 cfs @ 11.30 hrs, Volume= 0.011 af
Primary = 0.16 cfs @ 12.35 hrs, Volume= 0.004 af
Routed to Pond SP1 : Buttermilk Bay

Routing by Stor-Ind method, Time Span= 1.00-72.00 hrs, dt= 0.05 hrs
Peak Elev= 9.63' @ 12.35 hrs Surf.Area= 20 sf Storage= 351 cf

Plug-Flow detention time= 434.7 min calculated for 0.016 af (88% of inflow)
Center-of-Mass det. time= 380.8 min (1,161.3 - 780.6)

Volume	Invert	Avail.Storage	Storage Description
#1	5.50'	357 cf	**Custom Stage Data (Prismatic)**Listed below (Recalc) 1,081 cf Overall x 33.0% Voids

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
5.50	300	0	0
9.00	300	1,050	1,050
9.01	20	2	1,052
10.50	20	30	1,081

Device	Routing	Invert	Outlet Devices
#1	Discarded	5.50'	**2.410 in/hr Exfiltration over Surface area**
#2	Primary	9.60'	**10.0' long x 0.5' breadth free overflow down ramp**
			Head (feet) 0.20 0.40 0.60 0.80 1.00
			Coef. (English) 2.80 2.92 3.08 3.30 3.32
#3	Device 1	6.40'	**8.0" Vert. Pipe to Trench** C= 0.600
			Limited to weir flow at low heads

Discarded OutFlow Max=0.02 cfs @ 11.30 hrs HW=6.50' (Free Discharge)
↑**1=Exfiltration** (Exfiltration Controls 0.02 cfs)
↑**3=Pipe to Trench** (Passes 0.02 cfs of 0.04 cfs potential flow)

Primary OutFlow Max=0.11 cfs @ 12.35 hrs HW=9.63' (Free Discharge)
↑**2=free overflow down ramp** (Weir Controls 0.11 cfs @ 0.45 fps)

Summary for Pond OS100: OS 100

[81] Warning: Exceeded Pond 100 by 0.99' @ 24.15 hrs

Inflow Area = 1.024 ac, 54.89% Impervious, Inflow Depth = 0.55" for WQV event
Inflow = 0.63 cfs @ 12.07 hrs, Volume= 0.047 af
Outflow = 0.63 cfs @ 12.07 hrs, Volume= 0.047 af, Atten= 0%, Lag= 0.0 min
Discarded = 0.00 cfs @ 4.40 hrs, Volume= 0.001 af
Primary = 0.63 cfs @ 12.07 hrs, Volume= 0.046 af
Routed to Pond BIO1 : BIORETENTION 1

Routing by Stor-Ind method, Time Span= 1.00-72.00 hrs, dt= 0.05 hrs
Peak Elev= 7.10' @ 12.07 hrs Surf.Area= 0.000 ac Storage= 0.000 af

Plug-Flow detention time= 6.8 min calculated for 0.047 af (100% of inflow)
Center-of-Mass det. time= 6.3 min (786.8 - 780.6)

Volume	Invert	Avail.Storage	Storage Description
#1	5.00'	0.000 af	**4.00'D x 3.00'H Vertical Cone/Cylinder**
			0.001 af Overall - 0.000 af Embedded = 0.001 af x 33.0% Voids
#2	5.50'	0.000 af	**2.00'D x 1.50'H Vertical Cone/Cylinder** Inside #1
		0.000 af	Total Available Storage

Device	Routing	Invert	Outlet Devices
#1	Primary	7.00'	**24.0" Horiz. Bio Bubbler** C= 0.600
			Limited to weir flow at low heads
#2	Device 3	5.50'	**1.0" Vert. Weep holes X 4.00** C= 0.600
			Limited to weir flow at low heads
#3	Discarded	5.00'	**2.410 in/hr Exfiltration over Surface area**

Discarded OutFlow Max=0.00 cfs @ 4.40 hrs HW=5.55' (Free Discharge)
└**3=Exfiltration** (Exfiltration Controls 0.00 cfs)
└**2=Weep holes** (Passes 0.00 cfs of 0.01 cfs potential flow)

Primary OutFlow Max=0.60 cfs @ 12.07 hrs HW=7.10' (Free Discharge)
└**1=Bio Bubbler** (Weir Controls 0.60 cfs @ 1.01 fps)

Summary for Pond SP1: Buttermilk Bay

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 2.041 ac, 42.83% Impervious, Inflow Depth = 0.06" for WQV event
Inflow = 0.19 cfs @ 12.35 hrs, Volume= 0.011 af
Primary = 0.19 cfs @ 12.35 hrs, Volume= 0.011 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind method, Time Span= 1.00-72.00 hrs, dt= 0.05 hrs

APPENDIX C – Wetland Resources Summary Memo

Horsley Witten Group
Sustainable Environmental Solutions
90 Route 6A • Unit 1 • Sandwich, MA 02563
508-833-6600 • horsleywitten.com

MEMORANDUM

To: Jordan Mora, APCC

From: Ben Wollman, Wetland Scientist

Date: January 19, 2023

Re: Wetland Resources – Electric Avenue Boat Ramp Stormwater Retrofit Site, Bourne, MA

HW has prepared the following memo and site figures to document the wetland resource areas at the referenced site and to provide regulatory context for future work.

General Site Description

The site is located at the western end of Electric Avenue in Bourne, MA, adjacent to the Cohasset Narrows at the southern end of Buttermilk Bay, which is at the northeastern extent of Buzzards Bay. The site is located just north of Route 6, which crosses the Cohasset Narrows via the Dalton Memorial Bridge.

This site consists of a paved boat ramp next to a pier and paved kayak storage (with concrete retaining wall), on-street trailer parking, and a large parking lot for public beach separated from the ramp by a playground on top of a steeper section of slope next to the beach area.

FEMA Designation

According to the FEMA National Flood Hazard Map (Community Panel No. 25001C0313K, effective July 6, 2021), the majority of the site is located within a Special Flood Hazard Area, Zones AE (1% annual chance of flooding, with base flood elevation of 16 feet) (**Figure 1**).

State-listed Rare Species Habitat and Open Space

According to the most recent version of the *Massachusetts Natural Heritage Atlas* (15th Edition, August 1, 2021), the project site lies adjacent to *Estimated Habitat of Rare Wildlife and Certified Vernal Pools* (EH 398) and/or *Priority Habitat of Rare Species* (PH 452) as designated by the Massachusetts Natural Heritage and Endangered Species Program (NHESP)(**Figure 2**).

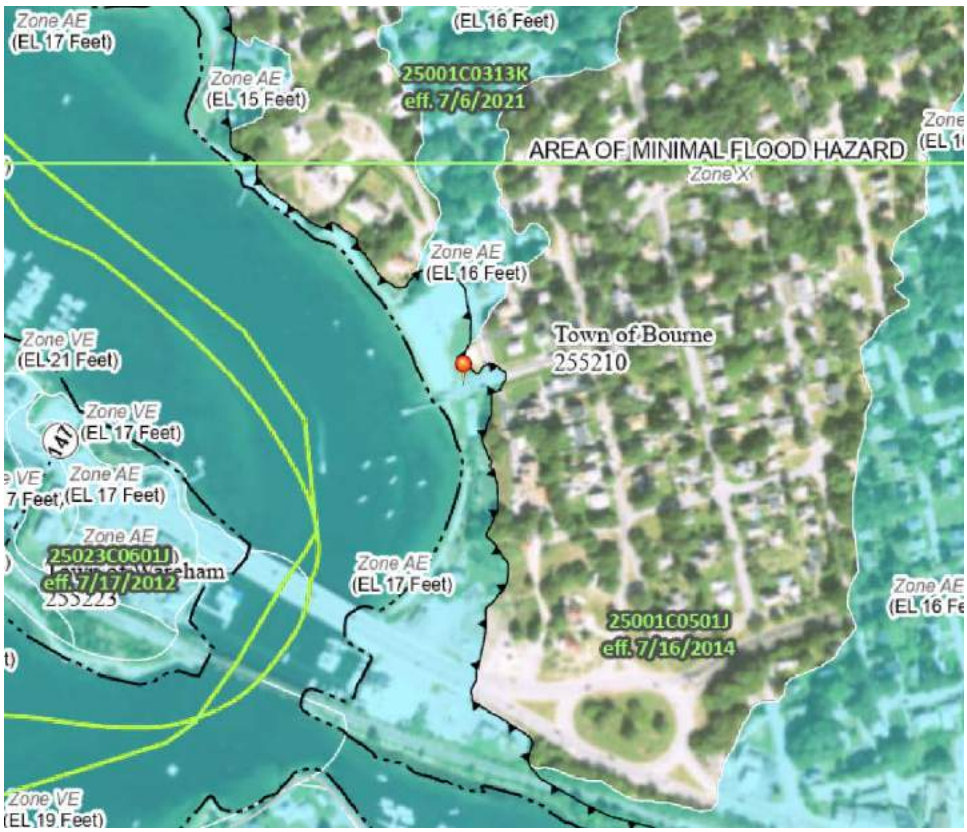


Figure 1. Excerpt from Federal Emergency Management Agency (FEMA) FIRMette for the subject site.

Figure 2. Rare species habitat (Source: MassMapper 2022).

Wetland Resource Areas

The site supports coastal wetland resource areas, as defined under the Massachusetts *Wetlands Protection Act* (M.G.L. Ch. 131 § 40) and the Town of Bourne Wetlands Protection Bylaw (Chapter 3, Article 3.7) and their respective regulations. Horsley Witten Group, Inc. (HW) wetland biologists identified and delineated these resource areas during a site visit on December 2, 2022. Jurisdictional areas identified on or adjacent to the site include Coastal Beach; Coastal Bank; Land Subject to Coastal Storm Flowage (LSCSF); and the 50-foot and 100-foot Buffer Zones to Coastal Beach and Coastal Bank. Additional resource areas present adjacent to the site include Land Under the Ocean; Banks of or Land Under the Ocean, Ponds, Streams, Rivers, Lakes, or Creeks that Underlie an Anadromous/Catadromous Fish Run ("Fish Run"); and Land Containing Shellfish.

HW followed wetland resource area identification and on-site delineation procedure guidelines described in the Massachusetts *Wetlands Protection Act* (M.G.L. Ch. 131 § 40), and its implementing Regulations (310 CMR 10.00), and the Town of Bourne *Wetlands Protection By-law* (Chapter 3, Article 3.7) and associated *Bourne Wetlands Regulations*. Coastal Bank determinations were made following the DEP Program Policy 92-1: Coastal Banks (March 1992).

Prior to conducting field delineations, HW reviewed existing source data, including USGS Geological Survey 7.5 minute topographic maps, Massachusetts Department of Environmental Protection (MassDEP) wetlands source data available through the Massachusetts Geographic Information System (MassGIS), USDA Natural Resources Conservation Service (NRCS) soils survey, U.S. Fish and Wildlife Service National Wetland Inventory (NWI) maps, and other source data to identify the presence of jurisdictional wetlands and waters of the United States within the site. This information was used to compile base mapping to assist in the understanding of the hydrologic variables, soils conditions, and vegetation communities (where applicable).

A brief description of the regulatory definitions and the observed resources areas is provided below.

Coastal Beach

Coastal Beach is defined at 310 CMR 10.27(2) as "*unconsolidated sediment subject to wave, tidal and coastal storm action which forms the gently sloping shore of a body of salt water and includes tidal flats. Coastal beaches extend from the mean low water line landward to the dune line, coastal bankline or the seaward edge of existing man-made structures, when these structures replace one of the above lines, whichever is closest to the ocean."*

Coastal Beach is located at this project site, both north and south of Electric Ave (**Photos 1 & 2**). This beach is bound by Coastal Bank to the east, which is briefly interrupted by a section of pavement where Electric Avenue abuts directly with the beach. The substrate of this beach is comprised of unconsolidated sands, with a scattered mix of pebbles, cobbles, and boulders. Wrack lines were observed along the most recent high tide line at the time of the site visit. The landward boundary of the Coastal Beach occurs where the Coastal Bank beings and the slope becomes greater than 10:1.

Photo 1. Coastal Beach present north of the Electric Ave.

Photo 2. Coastal Beach present south of Electric Ave.

Coastal Bank

Coastal Bank is defined at 310 CMR 10.30(2) as "*the seaward face or side of any elevated landform, other than a coastal dune, which lies at the landward edge of a coastal beach, land subject to tidal action, or other wetland.*"

Coastal Bank is present to the north and south of Electric Avenue at the site. There are multiple Coastal Banks located south of Electric Avenue, which conform to figure 5 of the DEP's Wetland Program Policy 92-1, where the banks are separated by Land Subject to Coastal Storm Flowage, and the top boundary of the landward-most Coastal Bank occurs along the 100-year FEMA flood elevation (16') (**Photo 3)**. There are also multiple Coastal Bank located north of Electric Avenue, one of which is accurately represented by figure 3, where the top boundary occurs along the 100-year FEMA flood elevation (16') (**Photo 4**). The other Coastal Bank present north of Electric Avenue is best represented by figure 4 of the DEP Wetland Program Policy 92-1, where the top boundary of the Coastal Bank occurs along the top of the parking lot retaining wall and conforms to figure 4 of the DEP Wetland Program Policy 92-1 (**Photo 5)**. The bank varies in cover composition, with naturally vegetated portions north and south of the site and just seaward of the playground area, as well as areas of barren sand on the lower sections of the bank north of the boat ramp where the Town maintains beach access for the public. Commonly observed plant species growing on the vegetated sections of the Coastal Bank consist of a mix of native and non-native species that include black oak (*Quercus velutina*), eastern red cedar (*Juniperus virginiana*), shrub honeysuckle (*Lonicera sp.*), Asiatic bittersweet (*Celastrus orbiculatus*), tick quack grass (*Thinopyrum pycnanthum*), privet (*Ligustrum sp.*), spotted knapweed (*Centaurea stoebe*), little bluestem (*Schizachyrium scoparium*). The vegetation on the steeper upper sections of the centrally located Coastal Bank (between the boat ramp and parking area retaining wall) and the section just south of the boat ramp are comprised mostly of the herbaceous species listed above. Although the lower, less steep section of the Coastal Bank located north of the boat ramp is comprised of unvegetated open sand of coarse to medium grain size, the soils below the surface transition to unsorted, loamy sand material mixed with consolidated fragments fines (silt and clay), indicating Coastal Bank rather than Coastal Dune. The area is historically significantly manipulated from its natural state as an established and maintained by the Town as a recreational beach/boat access area, and therefore may contain features that are atypical of a natural Coastal Bank area (e.g., open sandy section of the lower bank); however, HW believes the proper designation and delineation of the area is as Coastal Bank.

To determine the regulatory limits of the Coastal Bank, HW established three transects (TA, TB, & TC) along the face of the Coastal Bank in accordance with the DEP Program Policy (92-1) to determine the top of the Coastal Bank.

Photo 3. Multiple Coastal Banks present at the site, south of Electric Avenue.

Photo 4. Coastal Bank section present just north of Electric Ave.

Photo 5. Coastal Bank occurs where the retaining wall is located between the beach and parking area.

Land Subject to Coastal Storm Flowage

Land Subject to Coastal Storm Flowage is defined at 310 CMR 10.04 as "*land subject to any inundation caused by coastal storms up to and including that caused by the 100-year storm, surge of record or storm of record, which ever is greater.*"

The majority of the site is located within the 1% annual chance flood hazard area (Zone AE – EL 16 feet) (see **Figure 1** above).

Invasive Species

Invasive or Likely Invasive species (as defined by the Massachusetts Invasive Plant Advisory Group) were present at the site as part of the Coastal Bank plant communities, and include spotted knapweed, Asiatic bittersweet, shrub honeysuckle, and border privet. The Massachusetts Invasive Plant Advisory Group identifies invasive plant species as "non-native species that have spread into native or minimally managed plant systems in Massachusetts," and which "cause economic or environmental harm by developing self-sustaining populations and becoming dominant and/or disruptive to those systems." For future planning purposes, the Town may wish to develop a management plan for reducing or eliminating these plants at this site to allow for the establishment of naturally vegetated protective buffers to the wetland resource areas.

If you have any questions regarding our findings, or if HW may be of further assistance, please do not hesitate to contact me directly at bwollman@horsleywitten.com or at (508) 833-6600.

APPENDIX D – Soil Test Pit Logs

Commonwealth of Massachusetts

City/Town of Bourne

Form 11 - Soil Suitability Assessment for On-Site Sewage Disposal

C. On-Site Review

Deep Observation Hole Number: 1 (Hole #) | 12/20/22 (Date) | 745A (Time) | 35F Cloudy (Weather) | 41º44'54.17"N (Latitude) | 70º37'10.22"W (Longitude)

1. Land Use: Parking lot and boat ramp (e.g. woodland, agricultural field, vacant lot, etc.) | Grass (Vegetation) | No (Surface Stones (e.g. cobbles, stones, boulders, etc.)) | 20% (Slope (%))

Description of Location: Off south edge of Electric Ave

2. Soil Parent Material: Sandy glaciofluvial | Outwash plains, moraines (Landform) | Toeslope (Position on Landscape (SU, SH, BS, FS, TS))

3. Distances From: Open Water Body 50 feet | Property Line 5 feet | Drainage Way feet | Drinking Water Well feet | Wetlands feet | Other feet

4. Unsuitable Materials Present: ☐ Yes ☐ No If Yes: ☑ Disturbed Soil ☐ Fill Material ☐ Weathered/Fractured Rock ☐ Bedrock

5. Groundwater Observed: ☐ Yes ☑ No If Yes: _____ Depth weeping from pit _____ Depth standing water in hole

Soil Log

Depth (in)	Soil Horizon/ Layer	Soil Texture (USDA)	Soil Matrix: Color-Moist (Munsell)	Redoximorphic Features			Coarse Fragments % by Volume		Soil Structure	Soil Consistence (Moist)	Other
				Depth	Color	Percent	Gravel	Cobbles/Stones			
0-10	FILL	FSL	10YR 4/3						M	Fr	
10-13	Ab	LS	10YR 2/1						SG	Fr	
13-16	Bw	LS	10YR 4/6						SG	Fr	
16-96	C1	MS	10YR 6/4						SG	Fr	

Additional Notes: Side walls cave-in at 96"

APPENDIX E – Operation and Maintenance Guide

Stormwater Operations & Maintenance Guide

Electric Avenue Boat Ramp

Table of Contents

APPENDICES

1. INTRODUCTION

This document provides a general description along with the operation and maintenance requirements for the Electric Avenue Boat Ramp Stormwater Retrofit project at 0 Electric Avenue. The responsible parties are required to inspect and maintain all measures as outlined in this maintenance guide throughout the year. Site maintenance is divided into three categories as outlined below.

1. Green Stormwater Infrastructure
    - Structural Components
    - Structural Maintenance Schedule
    - Planting
    - Landscape Maintenance Schedule
    - Weed Guide

2. General Site Maintenance
    - Trash & Debris
    - Pet Waste
    - Pavement Sweeping
    - Contributing Drainage Areas
    - Snow Removal
    - De-icing

3. Long-Term Pollution Prevention Measures

2. RESPONSIBLE PARTIES AND BUDGET

The Electric Avenue Boat Ramp is a Town-owned and operated boat ramp. The Town will provide staff, volunteers as possible, and funding for the long-term O&M at the site. The estimated average annual O&M budget for the proposed system is shown below:

- **Bioretentions (1):** **$2,000**
  ($2,000/Bio)
- **Infiltration Trench (1):** **$1,000**
  ($1,000/trench)
- **Drainage Structures (WQU 100, WQU 101)** **$1,000**
  ($500/structure)

Owner contact information is provided below:

Owner: **Town of Bourne**

Contact: **Department of Public Works**
DPW Director
24 Perry Avenue
Bourne, MA 02532
508-759-0600

Contact: **Department of Natural Resources**
Christopher Southwood, Director
24 Perry Avenue
Bourne, MA 02532
csouthwood@townofbourne.com
508-759-0600

Owner - Signature:_____ Date:_____

Owner - Signature:_____ Date:_____

3. GREEN STORMWATER INFRASTRUCTURE

3.1. How Does Green Infrastructure Work?

Green Stormwater Infrastructure (GSI) is a nature-based approach to stormwater treatment and management. These stormwater practices or "treatment areas" are designed to mimic nature and use the natural filtration properties of soil and plants to remove pollutants from stormwater runoff prior to discharging to the municipal drainage system or waterbodies.

GSI relies on the following basic steps to function properly. Structural components of the practices facilitate the functioning of the steps. If one of these steps, or components, does not work properly, the entire system can be compromised and the GSI practice itself could be contributing to maintenance problems. This can lead to landscape nuisances, more frequent maintenance, and costly repairs/improvement. The steps are:

1. ***Collect*** (Inlets)
2. ***Move Water*** (Conveyance) if needed, can come after capturing sediment
3. ***Capture Sediment*** (Pretreatment)
4. ***Treat and Manage*** (Filter, Infiltrate or Store)
5. ***Overflow*** (Structures and Spillways)

3.2. What is required for Maintenance?

As these are nature-based systems that rely on plant upkeep, the maintenance for GSI typically falls under landscape and general site maintenance services. Proper operation and maintenance (O&M) are vital to its long-term viability. Regularly scheduled maintenance can prevent system failures due to sediment build-up, damage, or deterioration. The maintenance requirements outlined in this guide are critical to ensure proper treatment, maintain storage capacity and preserve the visual integrity.

General maintenance includes the following:

1. Removing sediment from the pretreatment practices used to capture sediment.
2. Maintaining the proper drainage function and pollutant removal capacity of the systems.
3. Maintaining healthy native trees, plants, and vegetative cover as well as the removal of unwanted weeds and invasive species.

It is recommended that all practices be maintained regularly as part of the routine landscape maintenance or at a minimum four times per year and after major rain events:

- **Early Spring**: during spring cleanup
- **Summer:** during lawn mowing and other routine site maintenance
- **Early Fall:** when leaves begin to fall
- **Late Fall/Early Winter:** after all the leaves have fallen during leaf removal
- **After major storm events**: 2" of rain or greater.

The following sections describe the general function and landscape maintenance of each practice on the site. Included in the appendices is a specific Inspection Report for the site (**Appendix A**) along with a plan showing the location of the items to be inspected and maintained (**Appendix B**).

3.3. What practices are used at this site?

The following practices are present at this site:

a. Bioretention Area: A bioretention area is a stormwater management practice to manage and treat stormwater runoff using a conditioned planting soil bed or "filter" media and plants to filter runoff captured in a shallow depression. The method combines physical filtering and adsorption with bio-geochemical processes to remove pollutants.

b. Infiltration Trench: Infiltration Trenches are used for temporary underground storage of stormwater in a stone reservoir, allowing it to infiltrate into the underlying native soil.

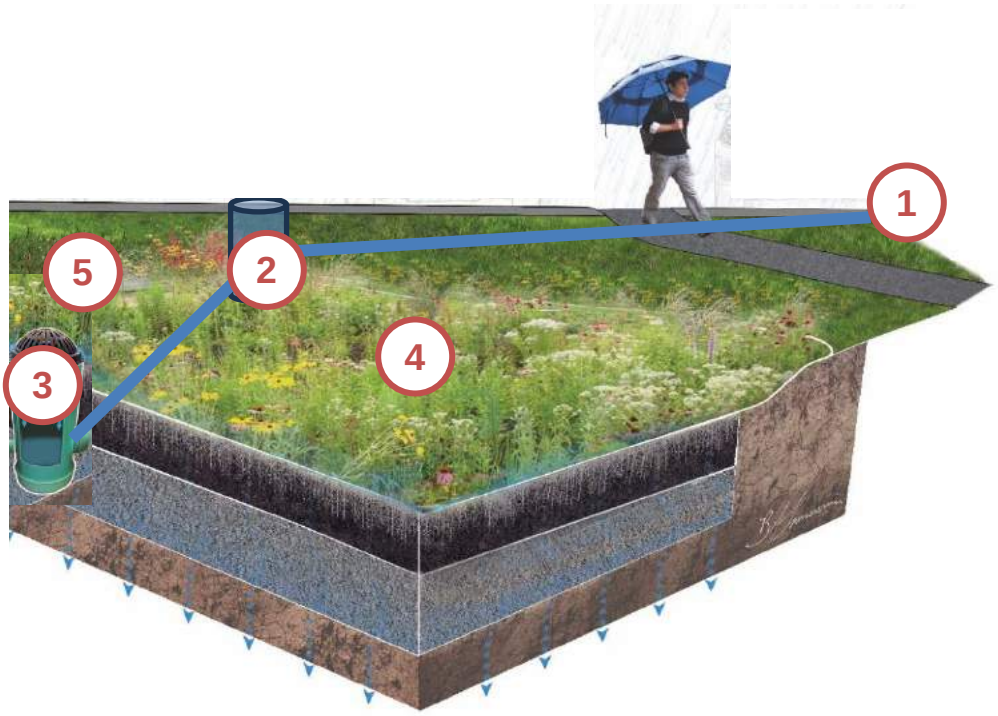
The maintenance for the green infrastructure is divided into two categories:

a. The **Structural Components** that make up the basic steps of a functioning system.

b. The **Plantings** that are the landscape and filtration element.

Each category is further described in the sections below.

4. STRUCTURAL COMPONENTS: BIORETENTION AREAS



Structural Components

1. ***Collect***: Stormwater runoff is directed to a water quality unit inlet along the road.
2. ***Capture Sediment***: The water quality unit captures sediment, trash, and debris.
3. ***Move Water:*** Runoff from small storm events discharges to the bioretention area via a "bubbler" structure.
4. ***Treat and Manage***: Plants slow the water down, and the soil media and plant roots filter the runoff, removing nutrients and bacteria. The treated water then infiltrates into the soil below or overflows as described below.
5. ***Overflow***: During larger storm events, runoff will fill up the water quality unit and then continue down the boat ramp. No large storm flows are designed to enter the Bioretention area, however there is an emergency spillway in the bioretention area, for any flow greater than the water quality volume to be directed back to the boat ramp.

MAINTENANCE SCHEDULE: BIORETENTION AREAS

A site inspection of the bioretention components shall be conducted at least twice a year in the Spring and Fall, and after major storm events (2" of rain or greater). Debris and trash should be removed monthly (between April and November) and sediment removal should occur during the two site inspections and during the monthly debris and trash inspections as needed. See the calendar below and the Inspection Report in **Appendix A** for more information. See the CDS Inspection and Maintenance Guide in **Appendix C** for maintenance guidance on the water quality unit.

Bioretention General Maintenance Schedule												
	Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**July**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Task	**Frequency & Time of the Year**											
Site Inspection				**X**							**X**	
Debris & Trash Removal				**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	
Sediment Removal				**X**	x	x	x	x	x	x	**X**	

should **also** be completed after major storm events

X required inspection

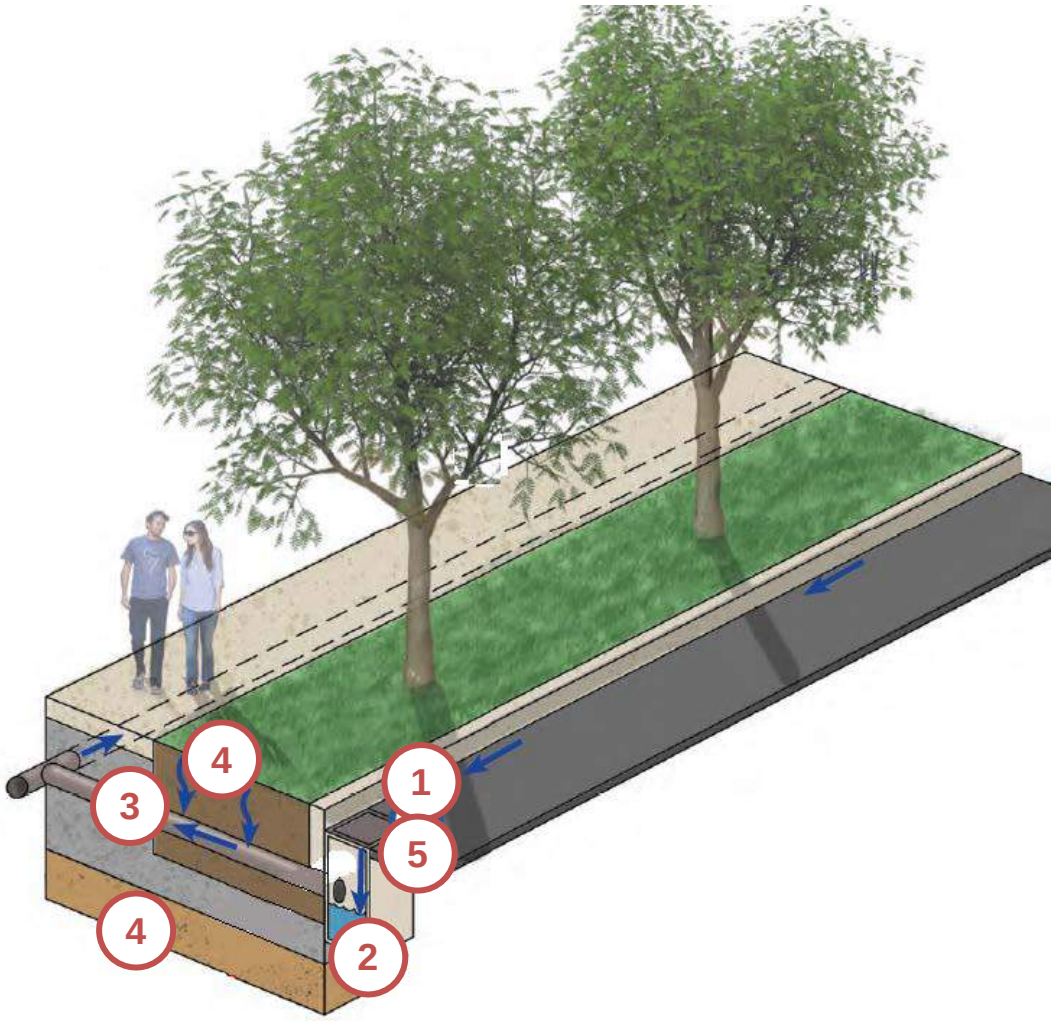
x as needed

- When removing trash and debris during monthly inspections look for:
  - If standing water does not drain after 48 hours. See Inspection Report for action items.

- After rain event look for:
  - If standing water does not drain after 48 hours. See Inspection Report for action items.

See Plantings section for information on plantings maintenance of the bioretention area. Use the plantings maintenance calendar to combine maintenance efforts.

5. STRUCTURAL COMPONENTS: INFILTRATION TRENCH



1. ***Collect***: Stormwater runoff is collected along the road gutter via overland flow through a water quality unit inlet.

2. ***Capture Sediment***: The water quality unit with catch basin grate captures sediment, trash, and debris.

3. ***Move Water:*** Stormwater runoff flows through the 8" perforated underdrain pipe which discharges to the stone reservoir.

4. ***Infiltrate***: Stormwater is infiltrated into the subsoils.

5. ***Overflow***: During larger rain events, once the stone reservoir and water quality unit have reached capacity, runoff will continue down the boat ramp.

MAINTENANCE SCHEDULE: INFILTRATION TRENCH

A site inspection of the infiltration trench components shall be conducted at least twice a year in the Spring and Fall, and after major storm events (2" of rain or greater). Debris and trash should be removed monthly (between April and November) and sediment removal should occur during the two site inspections and during the monthly debris and trash inspections as needed. See the calendar below and the Inspection Report in **Appendix A** for more information. See the CDS Inspection and Maintenance Guide in **Appendix C** for maintenance guidance on the water quality unit.

Infiltration Trench General Maintenance Schedule												
	Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**July**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Task	**Frequency & Time of the Year**											
Site Inspection				**X**							**X**	
Debris & Trash Removal				**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	
Sediment Removal				**X**	x	x	x	x	x	x	**X**	

should **also** be completed after major storm events

X required inspection

x as needed

- After rain event look for:
  - If standing water does not drain after 48 hours. See Inspection Report for action items.

See Plantings section for information on plantings maintenance of the infiltration basin. Use the plantings maintenance calendar to combine maintenance efforts.

6. PLANTINGS

6.1. Plantings

The planting design for the site consists of three landscape maintenance areas. The “mow” area which consists of turf, the “no mow” areas, and the natural buffer. The plantings maintenance checklist is included in **Appendix A**, and the full planting plan is available in **Appendix D**.

“Mow” Areas

No “Mow” Area

Natural Buffer

PLANTINGS: "MOW" AREAS MAINTENANCE

There is an area of the site that is allowed to be maintained as "mowed" lawn as necessary. Landscape maintenance of "mowed" lawn areas includes the following:

Seeding

Loam and reseed bare spots with a seed mix that matches existing species.

Mowing/Weed Whacking

Cut only 1/3 of vegetation. Do not mow during drought periods or when excessively wet. Depending on height of grasses and the time of year, grass cuttings/stalks may need to be raked and removed from site.

Watering

Allowing the lawn areas to "brown" is desired. Water only during drought conditions or during reseeding establishment period.

Fertilizing

No fertilizer shall be used.

Weeding

Weeding should be limited to invasive and weedy species (see section 3.6 Weed Identification below and the Weed Guide at https://web.uri.edu/riss/files/In-the-Weeds.pdf). Non-chemical methods (hand pulling and hoeing) are required; chemical herbicides should be avoided. Properly remove and dispose of all invasive species off site as to prevent colonization elsewhere, this includes disposal on land beyond the project area.

Monitoring

During the establishment period, walk the mow areas monthly during the first year to look for invasive species, bare spots and identify potential pest or disease problems. Properly remove and dispose of all invasive species as to prevent colonization elsewhere, this includes disposal on land beyond the project area.

Debris & Trash

Remove and properly dispose litter from all areas prior to mowing.

PLANTINGS: NO "MOW" AREA MAINTENANCE (BIORETENTION AREAS)

By design, plants in bioretention areas are meant to flourish throughout the growing season leaving dry standing stalks during the dormant months. Plants do not require fertilizers or watering (except during drought or establishment period). This area, as well as the area surrounding the forebay, is designated as "no mow." Frequent mowing would eliminate selected meadow species, may promote the growth of undesirable plants, and require additional maintenance and watering. It is recommended this area be cut back no more than one time per year and only as necessary. Remove and replace vegetation as necessary, using the appropriate species as shown on the Planting Plan. The best time to plant is in early to mid-fall or early to mid-spring. Specific maintenance activities of the "no mow" area include:

Seeding

Loam and reseed bare spots with the specified seed mix as shown on the Planting Plan.

Cutting Back

Recommend cutting with shears a maximum of once a year in early spring. Otherwise, allow areas to grow to their natural heights (12" to 36") to maintain a meadow appearance. Do NOT cut area lower than 6" – maintain sporadic wooden stakes on site at 6" height to provide visual cues during cutting. Depending on height of grasses and the time of year, grass cuttings/stalks may need to be raked and removed from site so as not to clog the bioretention. Use a leaf blower as needed to assist in clean-up.

Pruning

Prune trees and shrubs to remove deadwood and low hanging branches.

Watering

Water only during drought conditions or during reseeding establishment period.

Fertilizing

No fertilizer shall be used.

Weeding

Weeding should be limited to invasive and weedy species (see section on Weed Identification below and the Weed Guide at https://web.uri.edu/riss/files/In-the-Weeds.pdf). Non-chemical methods (hand pulling and hoeing) are required; chemical herbicides should be avoided. Properly remove and dispose off site all invasive species as to prevent colonization elsewhere; this includes disposal on land beyond the project area.

Monitoring

During the establishment period, walk the "no mow" areas monthly without the intent to cut, but to look for invasive species, bare spots and identify potential pest or disease problems.

Debris & Trash

Remove and properly dispose of litter from all areas.

PLANTINGS: NATURAL BUFFER AREAS MAINTENANCE

This area is intended to increase the natural buffer to the adjacent pond and is not to be disturbed. Maintenance of natural buffer areas includes the following:

Monitoring

Walk the buffers to look for potential invasive species and identify potential disease.

Weeding

Weeding should be limited to invasive and weedy species (see section 3.6 Weed Identification below and the Weed Guide at https://web.uri.edu/riss/files/In-the-Weeds.pdf). Non-chemical methods (hand pulling and hoeing) are required; chemical herbicides should be avoided. Properly remove and dispose of all invasive species as to prevent colonization elsewhere; this includes disposal on land beyond the project area.

Watering

Water only during drought conditions or during the plant establishment period.

Debris & Trash

Remove and properly dispose litter from all natural areas.

PLANTINGS: REPLACEMENTS

The plants that thrive in bioretention areas are typically quite drought tolerant due to the filter profile having a top layer of planting soil and sandy soil media below. They need to be able to withstand periods of inundation after storm events; however, when it doesn't rain, there will be less water held naturally in the sand than in other soil types for the plants to use, so they need to tolerate dry periods as well.

Specifying plants native to the area increases the ecosystem benefits by helping to support native wildlife like pollinators.

If replacements are needed, use the planting plan as a guide (see **Appendix D**). However, if all the plants of a certain species have not done well in the bioretention area or other locations on the site, do not replace with that same species. Rather, replant with one or more of the other species that has thrived under the conditions or have a plant professional choose a different species based on current photos of the site.

Site specific considerations for plants in bioretention areas should be:

- Preferably native and pollinator-friendly
- Drought tolerant
- Tolerant of inundation for 24 hours
- Size constraints:
    - taller perennials at the bottom of the bioretention
    - shorter perennials on the side slopes
- Salt and wind tolerant
- A mix of different types of plants that will create a resilient plant community: cold & warm season grasses, perennials, groundcovers in all areas.

PLANTINGS: MAINTENANCE SCHEDULE

By design, plants in the bioretention area are meant to help filter the stormwater as it passes through and flourish throughout the growing season. The plants do not require fertilizers or mulch, and, after establishment, only need water during periods of drought. Remove and replace vegetation as necessary, using the appropriate species as discussed in the no-mow section above. Weeding and monitoring for invasive species should occur quarterly during the growing season. An annual spring "clean up" includes cutting last season's growth of the perennials and pruning as needed. See the calendar below, the Plantings Maintenance Checklist in **Appendix A**, the Weed Identification section, and the Weed Identification Guide at https://web.uri.edu/riss/files/In-the-Weeds.pdf for more information.

Bioretention Landscape Maintenance Schedule												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Task	**Frequency & Time of the Year**											
Cutting				**X**								
Mowing				x	**X**	x	x	x	x	x		
Weeding				**X**		**X**			**X**		**X**	
Monitoring				**X**		**X**			**X**		**X**	
Watering						x	x	x	x			
Seeding				x	x				x	x		
Plant Replacement				x	x				x	x		

"Mow" Areas
No "Mow" Areas
All areas

X required
x as needed

- Trash and debris are removed during monthly structural component inspections but can also be completed during landscape maintenance visits for weeding and monitoring.

Yellow Toadflax *(Linaris vulgaris)*

Redroot Pigweed- (*Amaranthus retroflexus)*

Smartweed *(Polygonum lapathifolium)*

Dandelion *(Taraxacum officinale)*

Fireweed *(Erechtites hieracifolia)*

Spotted Spurge (Euphorbia maculata)

Crabgrass *(Digitaria ischaemum)*

Crabgrass with seedheads

Ragweed (*Ambrosia artemisiifolia*)

Japanese Knotweed (Polygonum cuspidatum)

Ragweed (*Ambrosia artemisiifolia*)

Oriental Bittersweet (*Celastrus orbiculatus*)

Green Foxtail (Setaria viridis)

Norway Maple Tree Seedling (Acer platanoides)

Catalpa Tree Seedling (Catalpa speciosa)

Purple Loosestrife (*Lythrum salicaria*)

Field Bindweed (*Convolvulus arvensis*)

Black Swallow-wort (*Cynanchum louisea*)

7. GENERAL SITE MAINTENANCE

General site maintenance includes the following requirements:

Trash & Debris

Remove and properly dispose of all trash and debris.

Pet Waste

Visitors to the site are encouraged to pick up after their pets. Remove and properly dispose of all pet waste left behind. Pet waste should be picked up and disposed of properly to reduce bacteria and nutrient levels in stormwater.

Pavement Sweeping

Paved roadways should be mechanically swept, at a minimum of once per year in early spring, to remove accumulated sand and sediment debris.

Snow Removal

Due to the potential for plant damage, snow piling and or removal is NOT recommended in the bioretention areas.

De-Icing

When de-icing compounds are necessary for areas draining to the green stormwater infrastructure, the least harmful chemicals should be used. Excessive salting should be avoided. Use of large amounts of sand should also be avoided, since it may obstruct the conveyance system. Ice removal is NOT permitted in the bioretention area.

8. LONG-TERM POLLUTION PREVENTION MEASURES

Long-term pollution prevention measures implemented at the site reduce pollutants in stormwater discharges. The following precautions will be employed on an on-going basis.

Spill Prevention & Control Measures

To minimize the risk of spills or other accidental exposure of materials and substances to stormwater runoff, the following material management is to be used when working on site.

- Any materials stored on-site will be stored in a neat, orderly manner in their appropriate containers.
- Products will be kept in their original containers with the original manufacturer's label.
- Substances will not be mixed with one another unless recommended by the manufacturer.
- Manufacturers' recommendations for proper use and disposal will be followed.
- The contractor's supervisor will be issued this Guide to ensure proper use and disposal of materials.

Materials or substances listed below may be present on-site for maintenance and care should be taken to avoid spills:

- Petroleum Based Products

The following product-specific measures will be followed on-site:

- *Petroleum Products* - All on-site vehicles will be monitored for leaks and receive preventative maintenance to reduce the chance of leakage.
- *Grass Clipping, Leaf Litter and Plant Debris* – are to be removed from the property and not disposed on site.

APPENDIX A – Maintenance Checklists

- Bioretention Area
- Infiltration Trench
- Landscaping

Operation and Maintenance Checklist
Electric Avenue Boat Ramp

Date:

Time:

Inspector:

Maintenance Item	Description	Maintenance (Y/N)
1, 2 & 3. Catch Basin, Overflow Structure and Water Quality Unit		
Debris Cleanout	Remove all trash, leaf litter and debris from the inlet and water quality unit.	
Sediment/Organic Debris Removal	Check for clogging and sediment accumulation that impacts inflow and outflow. Remove and properly dispose of sediment when the catch basin sump is 50% full. Remove/cut any vegetation that sprouts through voids in grates, covers, or pavement. Inspect and clean out water quality units per manufacturer's instructions in **Appendix C**.*	
Actions to be taken:		
4 & 5. Bioretention Area, Infiltration Trench		
Debris Cleanout	Remove trash and debris from the surface.	
Erosion	Signs of erosion gullies, animal burrowing, or overtopping are observed. Repair as necessary.	
Sediment/Organic Debris Removal	Remove sediment accumulation and properly dispose when accumulation is greater than or equal to 3 inches.*	
Water Draining properly	If standing water is observed in bioretention area for more than 48 hours after a storm event, rototill or aerate the bottom 6 inches to break up any hard-packed sediment, and re-plant as needed. Check for leaf litter, debris, and sediment accumulation in overflow structures that impact inflow to underground infiltration features. If accumulation present, schedule cleaning. Check for sediment accumulation and/or standing water that indicates clogging in the infiltration trench. If sediment or standing water is observed in the trench for more than 48 hours after a storm event, clean out infiltration trench.	

Operation and Maintenance Checklist
Electric Avenue Boat Ramp

Maintenance Item	Description	Maintenance (Y/N)
Actions to be taken:		
General Site Maintenance		
Debris Removal	Remove trash from perimeter areas.	
Pet Waste Removal	Remove any pet waste from perimeter areas.	
Pavement Sweeping	Sweep road minimum once a year after spring thaw.	
Contributing drainage area	Confirm that contributing drainage area stabilized – stabilize as necessary.	
Snow Removal	Ensure snow piles do no block inlet structures and are not placed in the bioretention area.	
De-Icing	Do not remove ice in the bioretention areas. If needed on road, use de-icing compounds with the least harmful chemicals. Avoid excessive salting or large amounts of sand.	
Actions to be taken:		

*Sediment shall be disposed of offsite in a pre-approved location.

Plantings Maintenance Checklist
Electric Avenue Boat Ramp

Location:

Date:

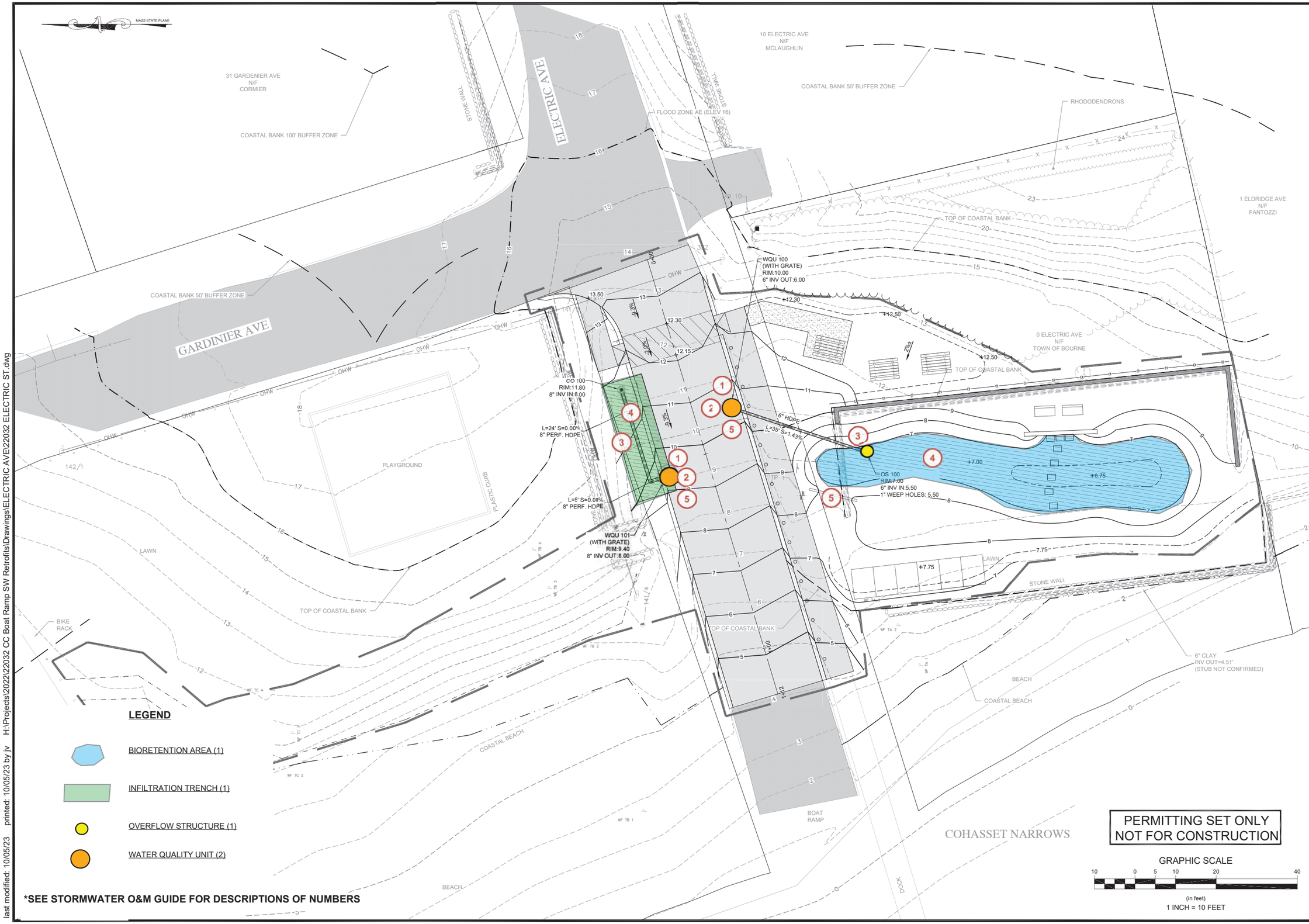
Inspector:

Task	Description	Complete (Y/N)
Cutting	• Cut with shears once a year in the early spring. • Do not cut lower than 6". • Blow out leaves and cuttings for easy removal. • Remove cuttings so the bioretention area does not clog.	
Mowing	• Mow twice a year or more frequently as needed with a mulching mower or weed whacker depending on the frequency of cutting. • Bag clippings as needed and dispose of off site. • Maintain a cutting height of 3" or greater. • Leave the grass taller in the warmer months. • Trim edges when necessary.	
Weeding	• Weeding should be limited to invasive and exotic species, which can overwhelm the desired plant community.* • Non-chemical methods including hand pulling and hoeing are recommended. • Chemical herbicides are not allowed.	
Monitoring	• Look for potential invasive species and identify potential disease. Remove and dispose of all invasive species.* (see weeding)	
Watering	• During establishment or drought conditions, plants should be watered a minimum of once every seven to ten days.	
Seeding	• Loam and re-seed bare spots with the specified seed mix as shown on the Planting Plan.	
Plant Replacement	• Replace/replant diseases, unhealthy or dead plans to maintain a healthy plant community	
Fertilizing	NONE	
Mulch	NONE	
Actions to be taken:		

*Invasive species shall be disposed of offsite in a pre-approved location. Species observed on site include spotted knapweed (*Centaurea stoebe)*, Asiatic bittersweet (*Celastrus orbiculatus*), shrub honeysuckle (*Lonicera sp.*), and border privet (*Ligustrum obtusifolium*).

"Mowed" Areas
No "Mow" Areas (Bioretention Areas)
All areas

APPENDIX B – Overall SCM Locations



LEGEND

- BIORETENTION AREA (1)
- INFILTRATION TRENCH (1)
- OVERFLOW STRUCTURE (1)
- WATER QUALITY UNIT (2)

***SEE STORMWATER O&M GUIDE FOR DESCRIPTIONS OF NUMBERS**

PERMITTING SET ONLY
NOT FOR CONSTRUCTION

GRAPHIC SCALE

10 0 5 10 20 40

(in feet)

1 INCH = 10 FEET

Revisions

Rev.	Date	By	Appr.	Description
1				
2				
3				
4				
5				
6				
7				

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Date: OCTOBER 2023

Plan Set:
ELECTRIC AVENUE
CAPE COD BOAT RAMP STORMWATER
RETROFIT PROJECT- PERMITTING PLANS
BOURNE, MASSACHUSETTS

Plan Title:
SITE & GRADING PLAN

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DRAFT
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Project Number: 22032
Sheet: 4 of 8

Sheet Number: C - 4

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APPENDIX C – CDS Inspection and Maintenance Guide

CONTECH®
ENGINEERED SOLUTIONS

CDS® Inspection and Maintenance Guide

CDS TECHNOLOGIES

Maintenance

The CDS system should be inspected at regular intervals and maintained when necessary to ensure optimum performance. The rate at which the system collects pollutants will depend more heavily on site activities than the size of the unit. For example, unstable soils or heavy winter sanding will cause the grit chamber to fill more quickly but regular sweeping of paved surfaces will slow accumulation.

Inspection

Inspection is the key to effective maintenance and is easily performed. Pollutant transport and deposition may vary from year to year and regular inspections will help ensure that the system is cleaned out at the appropriate time. At a minimum, inspections should be performed twice per year (e.g. spring and fall) however more frequent inspections may be necessary in climates where winter sanding operations may lead to rapid accumulations, or in equipment washdown areas. Installations should also be inspected more frequently where excessive amounts of trash are expected.

The visual inspection should ascertain that the system components are in working order and that there are no blockages or obstructions in the inlet and separation screen. The inspection should also quantify the accumulation of hydrocarbons, trash, and sediment in the system. Measuring pollutant accumulation can be done with a calibrated dipstick, tape measure or other measuring instrument. If absorbent material is used for enhanced removal of hydrocarbons, the level of discoloration of the sorbent material should also be identified during inspection. It is useful and often required as part of an operating permit to keep a record of each inspection. A simple form for doing so is provided.

Access to the CDS unit is typically achieved through two manhole access covers. One opening allows for inspection and cleanout of the separation chamber (cylinder and screen) and isolated sump. The other allows for inspection and cleanout of sediment captured and retained outside the screen. For deep units, a single manhole access point would allows both sump cleanout and access outside the screen.

The CDS system should be cleaned when the level of sediment has reached 75% of capacity in the isolated sump or when an appreciable level of hydrocarbons and trash has accumulated. If absorbent material is used, it should be replaced when significant discoloration has occurred. Performance will not be impacted until 100% of the sump capacity is exceeded however it is recommended that the system be cleaned prior to that for easier removal of sediment. The level of sediment is easily determined by measuring from finished grade down to the top of the sediment pile. To avoid underestimating the level of sediment in the chamber, the measuring device must be lowered to the top of the sediment pile carefully. Particles at the top of the pile typically offer less resistance to the end of the rod than consolidated particles toward the bottom of the pile. Once this measurement is recorded, it should be compared to the as-built drawing for the unit to determine weather the height of the sediment pile off the bottom of the sump floor exceeds 75% of the total height of isolated sump.

Cleaning

Cleaning of a CDS systems should be done during dry weather conditions when no flow is entering the system. The use of a vacuum truck is generally the most effective and convenient method of removing pollutants from the system. Simply remove the manhole covers and insert the vacuum hose into the sump. The system should be completely drained down and the sump fully evacuated of sediment. The area outside the screen should also be cleaned out if pollutant build-up exists in this area.

In installations where the risk of petroleum spills is small, liquid contaminants may not accumulate as quickly as sediment. However, the system should be cleaned out immediately in the event of an oil or gasoline spill should be cleaned out immediately. Motor oil and other hydrocarbons that accumulate on a more routine basis should be removed when an appreciable layer has been captured. To remove these pollutants, it may be preferable to use absorbent pads since they are usually less expensive to dispose than the oil/water emulsion that may be created by vacuuming the oily layer. Trash and debris can be netted out to separate it from the other pollutants. The screen should be power washed to ensure it is free of trash and debris.

Manhole covers should be securely seated following cleaning activities to prevent leakage of runoff into the system from above and also to ensure that proper safety precautions have been followed. Confined space entry procedures need to be followed if physical access is required. Disposal of all material removed from the CDS system should be done in accordance with local regulations. In many jurisdictions, disposal of the sediments may be handled in the same manner as the disposal of sediments removed from catch basins or deep sump manholes.

CDS Model	Diameter		Distance from Water Surface to Top of Sediment Pile		Sediment Storage Capacity	
	ft	m	ft	m	y^3	m^3
CDS1515	3	0.9	3.0	0.9	0.5	0.4
CDS2015	4	1.2	3.0	0.9	0.9	0.7
CDS2015	5	1.3	3.0	0.9	1.3	1.0
CDS2020	5	1.3	3.5	1.1	1.3	1.0
CDS2025	5	1.3	4.0	1.2	1.3	1.0
CDS3020	6	1.8	4.0	1.2	2.1	1.6
CDS3025	6	1.8	4.0	1.2	2.1	1.6
CDS3030	6	1.8	4.6	1.4	2.1	1.6
CDS3035	6	1.8	5.0	1.5	2.1	1.6
CDS4030	8	2.4	4.6	1.4	5.6	4.3
CDS4040	8	2.4	5.7	1.7	5.6	4.3
CDS4045	8	2.4	6.2	1.9	5.6	4.3
CDS5640	10	3.0	6.3	1.9	8.7	6.7
CDS5653	10	3.0	7.7	2.3	8.7	6.7
CDS5668	10	3.0	9.3	2.8	8.7	6.7
CDS5678	10	3.0	10.3	3.1	8.7	6.7

Table 1: CDS Maintenance Indicators and Sediment Storage Capacities

Support

- Drawings and specifications are available at www.contechstormwater.com.
- Site-specific design support is available from our engineers.

Contech Engineered Solutions LLC provides site solutions for the civil engineering industry. Contech's portfolio includes bridges, drainage, sanitary sewer, stormwater, earth stabilization and wastewater treament products. For information, visit www.ContechES.com or call 800.338.1122

CONTECH ENGINEERED SOLUTIONS

800.925.5240
www.ContechES.com

CDS Inspection & Maintenance Log

CDS Model: _____ Location: _____

Date	Water depth to sediment[1]	Floatable Layer Thickness[2]	Describe Maintenance Performed	Maintenance Personnel	Comments

1. The water depth to sediment is determined by taking two measurements with a stadia rod: one measurement from the manhole opening to the top of the sediment pile and the other from the manhole opening to the water surface. If the difference between these measurements is less than the values listed in table 1 the system should be cleaned out. **Note: to avoid underestimating the volume of sediment in the chamber, the measuring device must be carefully lowered to the top of the sediment pile.**

2. For optimum performance, the system should be cleaned out when the floating hydrocarbon layer accumulates to an appreciable thickness. In the event of an oil spill, the system should be cleaned immediately.

APPENDIX D – Planting Plan

KEY

EVERGREEN TREE

LARGE SHRUB

SHRUB

SEED MIX #1

SEED MIX #2

SEED MIX #1 OVERSEEDING PERENNIALS

Master Plant List

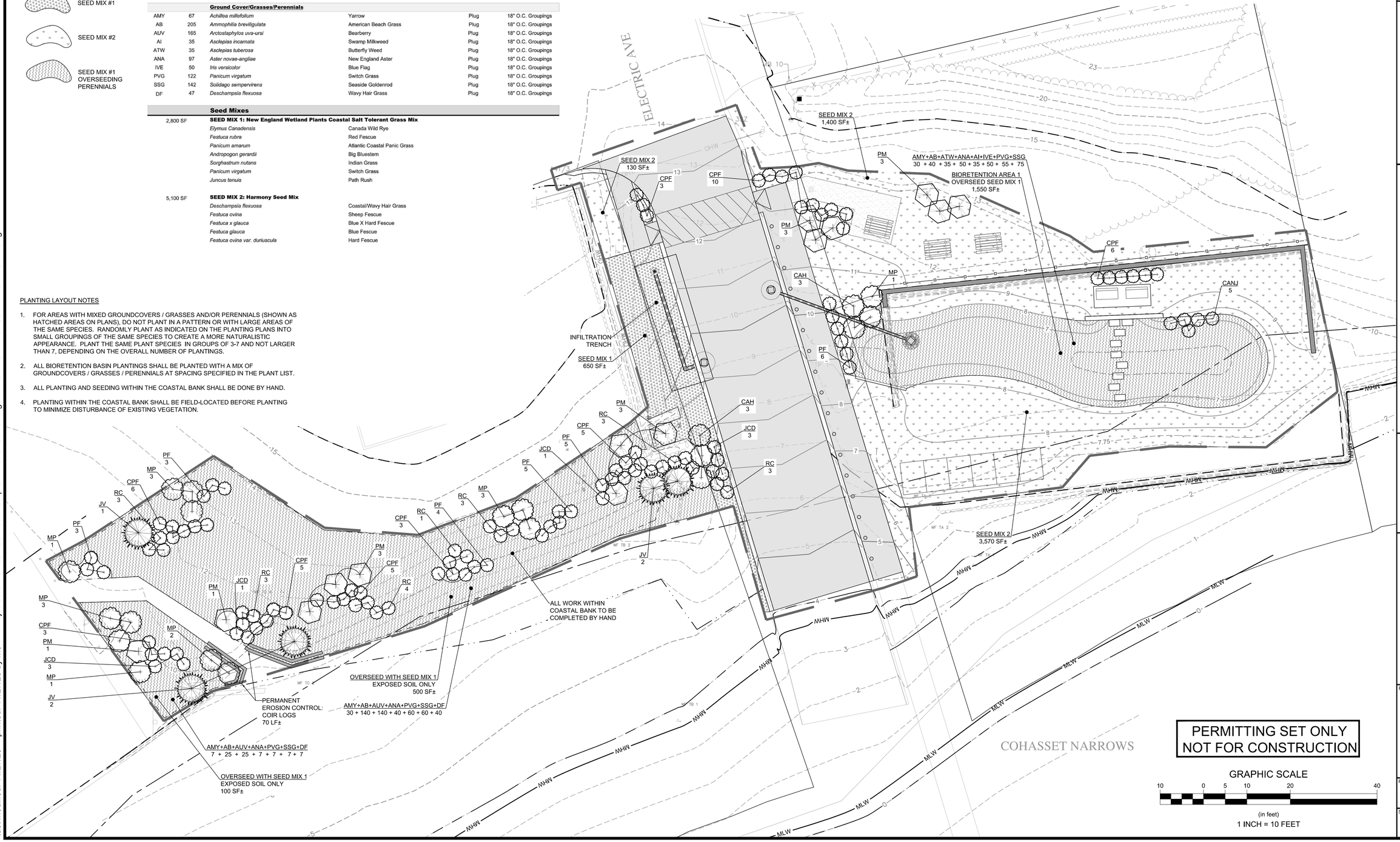
Key	#	Botanical Name	Common Name	Size	Spacing
		Trees			
JV	5	*Juniperus virginiana*	Eastern Red Cedar	8' - 10' h.	As Shown
		Shrubs			
CANJ	5	*Ceanothus americanus*	New Jersey Tea	#3	As Shown
CAH	6	*Clethra alnifolia*	Summer Sweet	#3	As Shown
CPF	46	*Comptonia peregrina*	Sweet Fern	#1	As Shown
JCD	8	*Juniperus communis 'Depressa'*	Common Field Juniper	#1	As Shown
MP	14	*Morella pensylvanica*	Northern Bayberry	#5	As Shown
PF	26	*Potentilla fruticosa*	Potentilla/ Shrubby cinquefoil	#3	As Shown
PM	14	*Prunus maritima*	Beach Plum	#5	As Shown
RC	20	*Rosa carolina*	Carolina rose	#2	As Shown
		Ground Cover/Grasses/Perennials			
AMY	67	*Achillea millefolium*	Yarrow	Plug	18" O.C. Groupings
AB	205	*Ammophilia breviligulata*	American Beach Grass	Plug	18" O.C. Groupings
AUV	165	*Arctostaphylos uva-ursi*	Bearberry	Plug	18" O.C. Groupings
AI	35	*Asclepias incarnata*	Swamp Milkweed	Plug	18" O.C. Groupings
ATW	35	*Asclepias tuberosa*	Butterfly Weed	Plug	18" O.C. Groupings
ANA	97	*Aster novae-angliae*	New England Aster	Plug	18" O.C. Groupings
IVE	50	*Iris versicolor*	Blue Flag	Plug	18" O.C. Groupings
PVG	122	*Panicum virgatum*	Switch Grass	Plug	18" O.C. Groupings
SSG	142	*Solidago sempervirens*	Seaside Goldenrod	Plug	18" O.C. Groupings
DF	47	*Deschampsia flexuosa*	Wavy Hair Grass	Plug	18" O.C. Groupings

Seed Mixes

2,800 SF	**SEED MIX 1: New England Wetland Plants Coastal Salt Tolerant Grass Mix**	
	Elymus Canadensis	Canada Wild Rye
	Festuca rubra	Red Fescue
	Panicum amarum	Atlantic Coastal Panic Grass
	Andropogon gerardii	Big Bluestem
	Sorghastrum nutans	Indian Grass
	Panicum virgatum	Switch Grass
	Juncus tenuis	Path Rush
5,100 SF	**SEED MIX 2: Harmony Seed Mix**	
	Deschampsia flexuosa	Coastal/Wavy Hair Grass
	Festuca ovina	Sheep Fescue
	Festuca x glauca	Blue X Hard Fescue
	Festuca glauca	Blue Fescue
	Festuca ovina var. duriuscula	Hard Fescue

PLANTING LAYOUT NOTES

1. FOR AREAS WITH MIXED GROUNDCOVERS / GRASSES AND/OR PERENNIALS (SHOWN AS HATCHED AREAS ON PLANS), DO NOT PLANT IN A PATTERN OR WITH LARGE AREAS OF THE SAME SPECIES. RANDOMLY PLANT AS INDICATED ON THE PLANTING PLANS INTO SMALL GROUPINGS OF THE SAME SPECIES TO CREATE A MORE NATURALISTIC APPEARANCE. PLANT THE SAME PLANT SPECIES IN GROUPS OF 3-7 AND NOT LARGER THAN 7, DEPENDING ON THE OVERALL NUMBER OF PLANTINGS.
2. ALL BIORETENTION BASIN PLANTINGS SHALL BE PLANTED WITH A MIX OF GROUNDCOVERS / GRASSES / PERENNIALS AT SPACING SPECIFIED IN THE PLANT LIST.
3. ALL PLANTING AND SEEDING WITHIN THE COASTAL BANK SHALL BE DONE BY HAND.
4. PLANTING WITHIN THE COASTAL BANK SHALL BE FIELD-LOCATED BEFORE PLANTING TO MINIMIZE DISTURBANCE OF EXISTING VEGETATION.



PERMITTING SET ONLY
NOT FOR CONSTRUCTION

GRAPHIC SCALE

10 0 5 10 20 40

(in feet)

1 INCH = 10 FEET

Revisions

Rev.	Date	By	Appr.	Description

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Date: NOVEMBER 17, 2023

ELECTRIC AVENUE
CAPE COD BOAT RAMP STORMWATER
RETROFIT PROJECT- PERMITTING PLANS
BOURNE, MASSACHUSETTS

PLANTING PLAN

Plan Set:

Plan Title:

Prepared For:
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Dated: December 28, 2022

Registration:

Project Number: 22032

Sheet : 7 of 8

Sheet Number: C - 7

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APPENDIX F – Pollutant Controls During Construction

POLLUTANT CONTROLS DURING CONSTRUCTION

1.1 Structural Practices

The following are the structural practices that will be implemented as part of the construction activity.

- Visibility Fence/Sediment Silt Sock Barrier will be installed prior to commencement of construction. The visibility fence will keep construction equipment within the limit of work, and the silt sock will be used on the downgradient portions of the limit of work to allow water to flow through it while keeping sediment on site. The Town will be informed upon their installation so that they may inspect these barriers prior to construction. Portions of these barriers will be replaced and/or repaired as necessary. Barriers will be installed parallel to land slope at the perimeter of the work site, as shown on the Plans. Details are provided in the Plans.

- Silt Sacks (or approved equivalent) will be installed at catch basins and following construction of the proposed overflow structures to prevent sedimentation during construction. The silt sack will be emptied/replaced and disposed of off-site if damage is observed.

- Sediment Traps/Basins. The bioretention area will be graded to within one foot of design elevations until site is fully stabilized to capture sediment during construction. Heavy equipment will not be allowed to operate on the surface location where the system is planned because soil compaction can adversely impact the long-term performance. Light earth-moving equipment will be used for excavation and construction of the system. All excavated materials from the area will be removed and disposed of in an approved location. Additional sediment traps should be installed as shown on the plans and in additional locations as needed during construction. All sediment traps/basins will be inspected at least once every seven calendar days and immediately after storm events by the Construction Manager.

- Construction Entrance will be installed following pavement removal. All construction vehicles must use this access point to ensure sediment is not tracked off site.

- Slope Stabilization will occur immediately upon obtaining final grades as shown on the project site plans. Areas that fail to stabilize will be re-graded to final grade and stabilized as necessary. The amount of land disturbed will be minimized to reduce potential for erosion and sedimentation. Stabilization measures shall be initiated within 14 days following the end of construction at each portion of the site and as soon as practicable.

- Turbidity Curtains are floating barriers, typically used in marine construction to contain the dispersion of silt and sediment in the water. The turbidity curtain is proposed to be installed at the edge of the sediment trap at the bottom of the boat ramp. This area is likely to fill with water during high tides and/or storm events, therefore, a floating sediment barrier is recommended to contain the sediment and protect the bay.

The entire stormwater management system including pipes, structures, bioretention area, and infiltration trench, will be inspected upon completion of construction. Sediment will be removed from all elements of the stormwater management system. All control measures must be installed and maintained in accordance with manufacturer's specifications, good engineering practices, and in accordance with this report (every seven calendar days and after storm events). If inspections show that a control has failed or been installed incorrectly, the Operator must replace or modify it within 24 hours.

1.2 Stabilization Practices

The amount of land disturbed during construction will be minimized to reduce the potential for erosion and sedimentation. Prompt surface stabilization will be provided to control erosion in areas where disturbances cannot be avoided during construction. Stabilization measures shall be initiated within 14 days following the end of construction at each portion of the site. Exceptions to this requirement are allowable when snow cover prevents the initiation of stabilization within 14 days, in which case such measures shall be undertaken as soon as possible.

Stabilization measures that will be, or may be, used during construction are described below:

- Temporary Seeding – Temporary seeding of disturbed surfaces with fast-growing grasses (annual rye) to provide greater resistance to stormwater runoff and/or wind erosion for areas where construction has temporarily ceased.
- Permanent Seeding – Permanent seeding of surfaces with vegetation, including but not limited to grass, trees, bushes, and shrubs, to stabilize the soil. Establishing a permanent and sustainable ground cover at a site stabilizes the soil while reducing the sediment content in runoff.
- Permanent Planting –establish all planting as required at the completion of the project.
- Erosion Control Blankets - install erosion control blankets along all slopes greater than 3:1.
- Mulching – materials, including but not limited to hay, grass, woodchips, straw, and gravel will be placed on the soil surface to cover and hold in place disturbed soils.

Temporary seeding or other soil stabilization measures will be provided where construction activities have ceased at the site. Topsoil stockpiles will be temporarily seeded or covered to prevent erosion and will be surrounded with silt fence or silt sock. When the site's final grade has been established, permanent vegetation will be planted on the disturbed areas. The vegetation will consist of grass, shrubs, bushes, and trees in the locations indicated on the plans.

1.3 Other Types of Controls

Additional controls/practices will be undertaken to reduce pollution in stormwater runoff flows which include, but are not limited to, control of off-site mud tracking from construction site, dust suppression, proper sanitary waste disposal, earthwork procedures timed and conducted in manners aimed to minimize erosion and sedimentation, snow removal plans, proper management of waste materials, proper management of hazardous waste, proper material stockpiling, and spill prevention and control measures.

- Dust Suppression – Water sprays shall be used to control dust during extended dry periods during construction.

- Earthwork – The exposure of disturbed surfaces to stormwater and potential stormwater erosion will be minimized by well-organized earthwork procedures. Stabilization procedures shall be undertaken in accordance with this report. Grubbing during wet seasons will be avoided if feasible.

- Snow Removal Plan – Plowed snow collected from the roadway and parking areas will be deposited onto free draining, pervious surfaces, away from the sites drainage conveyance structures to maximize infiltration.

- Waste Materials – Dumpsters rented from a licensed solid waste management company will be used to store solid waste and debris that cannot be recycled, reused or salvaged. The dumpsters will meet all local and state solid waste management regulations. Dumpsters will be covered when refuse is not being directly deposited or withdrawn from them. Potentially hazardous wastes will be separated from normal wastes, including segregation of storage areas and proper labeling of containers. Removal of all waste from the site will be performed by licensed contractors in accordance with applicable regulatory requirements and disposed of at either local or regional approved facilities. Waste materials will not be buried on-site. All site personnel will be instructed regarding the correct procedures for waste disposal. Notices stating these procedures will be posted at the site. Solvents and flushing materials used during construction and pre-operational cleaning will be provided, handled, managed, and removed by the contractor for appropriate off-site disposal.

- Hazardous Waste Materials – Any disposal of hazardous materials will be completed using the required paperwork. Copies will be provided to the Engineer and to the city.

- Spill Prevention and Control Measures – To minimize the risk of spills or other accidental exposure of materials and substances to stormwater runoff, the following material management practices will be used throughout the project:

    - An effort will be made to store only enough products required to do the job.

- All materials stored on-site will be stored in a neat, orderly manner in their appropriate containers and, if possible, under a roof or other enclosure.
- Products will be kept in their original containers with the original manufacturer's label.
- Substances will not be mixed with one another unless recommended by the manufacturer.
- Whenever possible, the maximum amount of a product will be used before disposing of the container.
- Manufacturers' recommendations for proper use and disposal will be followed.
- The site superintendent will conduct daily inspections to ensure proper use and disposal of materials.

To reduce the risk associated with hazardous materials used on the site, the following practices will be used:

- Products will be kept in original containers unless they are not resealable.
- Original labels and material safety data sheets will be retained and kept on-site; they contain important product information.
- If surplus product must be disposed of, manufacturers' or local and state recommended methods for proper disposal will be followed.

- Materials List - Materials or substances listed below are expected to be present on-site during construction:

- Concrete	- Fertilizers
- Asphalt	- Petroleum Based Products
- Paints (enamel and latex)	- Cleaning Solvents
- Metal Studs	- Wood
- Concrete	- Tar
- Sealants	- Adhesives

The following product-specific practices will be followed on-site:

Petroleum Products - All on-site vehicles will be monitored for leaks and receive preventative maintenance to reduce the chance of leakage. Petroleum products will be stored in tightly sealed containers which area clearly labeled. Any asphalt substances used on-site will be applied according to the manufacturers' recommendations.

Paints – All containers will be tightly sealed and stored indoors when not required for use. Excess paint will not be discharged to the storm sewer system but will be properly disposed of according to the manufacturers' instructions or state and local regulations.

Concrete Trucks – Concrete trucks will not be allowed to wash out or discharge surplus concrete or drum wash water on the site.

In addition to the good housekeeping and material management practices discussed in the previous sections of this plan, the following practices will be followed for spill prevention and cleanup:

- Manufacturers' recommended methods for spill cleanup will be clearly posted, and site personnel will be made aware of the procedures and location of the information and cleanup supplies.
- Materials and equipment necessary for spill cleanup will be kept in the material storage area on-site. Equipment and materials will include, but not be limited to, brooms, dust pans, mops, rags, gloves, goggles, speedi-dry, sand, sawdust, and plastic and metal trash containers specifically for this purpose.
- All spills will be cleaned up immediately after discovery. Spills large enough to reach the storm water system will be reported to the National Response Center at 1-800-424-8802.
- The spill area will be kept well ventilated and personnel will wear appropriate protective clothing to prevent injury from contact with a hazardous substance.
- Spills of toxic or hazardous material will be reported to the appropriate state or local government agency, regardless of the size.
- The site superintendent responsible for the day-to-day site operations will be the spill prevention and clean-up coordinator. He will designate at least three other site personnel who will receive spill prevention and cleanup training. These individuals will each become responsible for a particular phase of prevention and cleanup. The names of responsible spill personnel will be posted in the material storage area and in the on-site office trailer.

APPENDIX G – Site Plans