STORMWATER MANAGEMENT REPORT

Standish Way - Yarmouth, MA

August 2024

Yarmouth Stormwater Design and Implementation Project

Partner: Association to Preserve Cape Cod

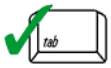
Owner/Operator: Town of Yarmouth

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.

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[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

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): Porous Pavement, Public Education Signage

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.

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[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

STANDISH WAY
YARMOUTH STORMWATER DESIGN AND IMPLEMENTATION PROJECT
YARMOUTH, MA

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EXECUTIVE SUMMARY

The purpose of this report is to describe existing and proposed drainage conditions of the Standish Way site (MC-3) in Yarmouth, as well as proposed green stormwater infrastructure (GSI) structures and management strategies to reduce stormwater impacts. This project is part of efforts to improve water quality in the Town of Yarmouth by reducing pollutant loads in stormwater runoff, specifically nitrogen, bacteria, and sediment. The Standish Way site was identified as a priority stormwater retrofit in a CZM-funded assessment focused on green infrastructure Stormwater Control Measures (SCMs) and low impact design.

The main goal for this site is to capture, manage and treat stormwater runoff from Standish Way prior to entering the existing SCM within the Colonial Acres Beach parking lot and ultimately discharging to Mill Creek and Lewis Bay.

There are existing SCMs within and surrounding the Colonial Acres Beach parking lot, including an infiltration trench, porous pavement, and an underground gravel wetland. These systems currently treat the runoff from Windemere Road and Standish Way that is discharging to Mill Creek via the Colonial Acres Beach parking lot. Due to site constraints, the underground gravel wetland system is only able to treat the 1/2 inch storm event from the Standish Way drainage area.

This project involves the development of new green stormwater infrastructure (GSI) systems along Standish Way to reduce the drainage area of the undersized gravel wetland/porous pavement system and ultimately treat the full 1 inch of runoff of the area draining to Mill Creek via the beach parking lot with the combination of the existing and proposed GSI systems.

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

- Tree Trench to provide filtration of pollutants and infiltration
- Bioretention to filter pollutants from stormwater through a soil media
- Porous pavement sidewalk to reduce impervious cover and provide infiltration
- Public Educational Signage to inform the public

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). In addition to the MASMS, the project aimed to meet the NRCS Stormwater Runoff Control Code 570 standards (NRCS 2011).

As shown in **Table 1,** the proposed project meets or exceeds each standard**,** except the recharge and water quality standards, which are met to the MEP. Each of the proposed treatment SCMs (tree trench and bioretention) are designed to capture and treat the full one inch of runoff of their contributing drainage areas. By diverting runoff from Standish Way to the two proposed SCMs, the existing underground gravel wetland is then able to treat the full one inch of runoff from the remainder of the Standish Way drainage area. Overall, this project will significantly improve conditions along Standish Way and reduce on-going impacts to Mill Creek and Lewis Bay, while also providing public education benefits.

Table 1. Project MASMS Compliance Summary

	Minimum Standard	Type	Compliance	Report Reference(s)
1	**New Stormwater Conveyances**	Narrative	Yes	Section 3.3
2	**Water Quantity**	Calculation	Yes	Section 4.3/Table 6/Appendix B
3	**Recharge**	Calculation	Yes	Section 4.2/Table 5/Appendix B
4	**Water Quality**	Calculation	Yes	Section 4.1/Table 3/Table 4/Appendix B
5	**Land Uses with Higher Potential Pollutant Loading**	Narrative	Not Applicable	Section 2.0
6	**Critical Areas**	Narrative	Yes	Section 4.1
7	**Redevelopment**	Narrative	Yes	Section 4.0
8	**Erosion Control**	Narrative	Yes	Section 4.4/Appendix F
9	**Operation and Maintenance**	Narrative	Yes	Section 4.5/Appendix D
10	**Illicit Discharges**	Narrative	Yes	Section 4.6

1.0 INTRODUCTION

This report provides a summary of the stormwater management systems proposed for Standish Way in Yarmouth, MA. The Yarmouth Department of Public Works is proposing this project in collaboration with the Association to Preserve Cape Cod (APCC) as a part of a town effort (Yarmouth Stormwater Design and Implementation Project) to improve water quality in the Town of Yarmouth. 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 Management Standards (MASMS) to the maximum extent practicable.

In addition, this site is identified as a priority under the Cape Cod Water Resources Restoration Project (CCWRRP) conducted by Natural Resources Conservation Science (NRCS) and the Cape Cod Conservation District (CCCD). Therefore, this project was also designed to meet the NRCS Stormwater Runoff Control Code 570 (NRCS Code 570) (NRCS 2011). NRCS Code 570 is consistent with the MASMS standards with the exception of the below standards which include more stringent requirements.

- Pretreatment to remove oil, grease, and sediments. - Refer to Section 4.1
- There is no Maximum Extent Practicable option for the recharge and water quality volume treatment required. - Refer Section 4.1 & 4.2

1.1 Background

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.

As part of a Coastal Zone Management (CZM) Coastal Habitat and Water Quality Grant, the Town of Yarmouth Department of Public Works (DPW), APCC and Horsley Witten Group (HW) completed a comprehensive assessment and stormwater management plan identifying and prioritizing stormwater retrofit sites on the south shore of Yarmouth. Concept designs 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 support from a second Coastal Habitat and Water Quality Grant, 25% designs were developed for five high-ranking priority sites, and two sites were chosen to advance to 75% designs and permitting, including this one on

Standish Way. Funding is available to further advance the two priority sites through 100% design and construction. In addition, this project on Standish Way was designed with intent to be submitted for construction sponsorship under the Cape Cod Water Resources Restoration Project, a joint initiative by the USDA Natural Resources Conservation Service (NRCS) and the Cape Cod Conservation District (CCCD).

1.2 Project Goals

The purpose of this project is to improve water quality in Mill Creek and Lewis Bay by reducing or eliminating pollutant loads from stormwater runoff at the end of Standish Way 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.

The existing SCMs within the Colonial Acres Beach parking lot provide some treatment of the runoff from Standish Way; however, due to site constraints, were not able to be sized to treat the full one-inch storm. This project specifically aims to propose SCMs along Standish Way to reduce the amount of untreated runoff flowing to the undersized SCMs (porous pavement/gravel wetland) and thus provide treatment of the full one-inch storm of the Standish Way drainage area with the combination of the existing and proposed GSI systems.

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 and alternatives analysis 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; and
- 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 are shellfish growing areas, have water quality impairments and are subject to TMDLs, the SCMs were chosen to maximize not only total suspended solids (TSS) removal, but total nitrogen (TN), total phosphorus (TP) and bacteria load reductions as well. MASMS was used as a reference for TSS

removal estimates for bioretentions and infiltration trenches, 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 Natural Resources 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) as well as larger storm events, including the 2-, 10-, 25- and 100-year 24-hour Type III storm events. The rainfall depths used for each storm event are the NOAA+ values (NOAA Atlas 14 90% Upper Confidence value multiplied by 0.9) (NOAA NWS, 2017). Rainfall values are included in **Appendix A**.

2.0 Existing Conditions

The Standish Way site (MC-3) is located along the southern end of Standish Way, at the north-central side of Lewis Bay, with project elements proposed within the Standish Way ROW between Windemere Road and Sagamore Road. The Standish Way ROW is primarily bordered by residential properties in the vicinity of the proposed project with the exception of the Colonial Acres Resort located on the east side of Standish Way. Southwest of the intersection between Standish Way and Windemere Road is a public parking area providing access to Mill Creek and Colonial Acres Beach on Lewis Bay. The site's land use is not classified as a land use with higher potential pollutant loads (LUHPPL) and thus, is not subject to MASMS **Standard 5**.

There are several existing SCMs within and surrounding the Colonial Acres Beach parking lot, including an infiltration trench, porous pavement, and an underground gravel wetland. The infiltration trench is located at the end of Standish Way within the Right of Way (ROW). Two catch basin located at the intersection of Windemere Road and Standish Way connect into the Infiltration Trench. These catch basins capture runoff from Windemere Road, and it is assumed the Infiltration Trench was sized to treat the 1-inch storm event. Within recent years, the Town installed porous pavement in the Colonial Acres Beach parking lot with an underground gravel wetland. This system receives runoff from Standish Way in addition to the runoff from the parking lot itself. Due to site constraints, this system is only able to treat the ½-inch storm event. Additionally, there are two existing leaching catch basins at the intersection of Sagamore Road and Standish Way that capture runoff from the west side of Standish Way upgradient from the proposed site.

2.1 Receiving Water and Watershed

Standish Way runoff ultimately discharges into Mill Creek, which flows into Lewis Bay, a bay opens into Nantucket Sound. Mill Creek provides habitat for shellfish growing areas. However, it is listed as

[1] It is important to note that these curves have a crosswalk to help users determine which specific curve to reference: for infiltrating trenches, the appropriate curve is the Infiltration Trench (Soil infiltration rate = 8.27 in/hr) Performance Curve, for infiltrating bioretentions (no liners/underdrains), the appropriate curve is the Surface Infiltration (Soil infiltration rate = 2.41 in/hr) Performance Curve, and for subsurface gravel wetlands, the appropriate curve is the Gravel Wetland Performance Curve.

impaired for total nitrogen and fecal coliform by the most recent Massachusetts DEP 303(d) – 2022 Integrated list of Waters.

Mill Creek is located in the Lewis Bay Watershed, for which total maximum daily load documents (TMDLs) has been developed for nitrogen. Lewis Bay itself requires a TMDL, as it falls under Category 5. The full list of impairments for this portion of the watershed is listed below, and a map showing these resources is included in **NOI Narrative Figure 7**:

- Lewis Bay (MA96-36) Yarmouth, Lewis Bay Watershed – Impaired for total nitrogen, estuarine bioassessments, fecal coliform, and nutrient/eutrophication biological indicators; Category 5 (TMDL required) of the 2022 Integrated List of Waters.
- Mill Creek (MA96-80) Yarmouth, Lewis Bay Watershed – Impaired for total nitrogen and fecal coliform; Category 4a (TMDL completed) of the 2022 Integrated List of Waters.

2.2 Drainage Area

Two existing drainage area maps were created including the overall drainage area map and the existing project drainage area map. The overall drainage area map includes the drainage areas flowing to Mill Creek via the Colonial Acres Beach parking lot (SP1). The total area draining to SP1 is approximately 2.74 acres, with 1.30 acres of that being impervious area, and is comprised of three drainage areas: DA1, DA2, and DA3. DA1 is the project drainage area, which includes runoff from Standish Way flowing toward the Colonial Acres Beach parking lot. DA2 is the beach parking lot area itself that flows to the existing underground gravel wetland via porous pavement. DA3 is the Windemere Road drainage area that flows to the existing infiltration trench. See the overall drainage area map (to Mill Creek) and a detailed breakdown of land cover in **Appendix A**.

This project specifically aims to provide treatment opportunities along Standish Way to reduce the amount of untreated runoff entering the undersized gravel wetland (SP1A) and therefore, the HydroCAD modelling focuses on DA1. This area is approximately 1.46 acres with 0.63 acres of that being impervious area. It consists of residential properties, lawn areas, and road pavement. See the existing drainage area map (Project MC-3) 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 November 2023. A full description of these resource areas is included in **NOI Narrative**, and their locations and associated buffers are shown on the plans in **Appendix F**. The only wetland resource areas identified at the site are the 200-ft Buffer to Riverfront Area and the 100-year FEMA flood zone (**NOI Narrative Figure 3**). Since the site discharges near a public beach, shellfish growing area, and within soils with a high infiltration rate, 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 area are composed of Carver coarse sand, at 3-8% slopes. Carver coarse sand is hydrologic soil group A (HSG) and hydrologic soil group B (HSG), as shown in **NOI Narrative Figure 5**.

One test pit (TP) was conducted at the site on January 3, 2024 near the intersection of Standish Way and Windemere Road. The test pit aimed to evaluate subsurface conditions and estimate seasonal high groundwater (ESHGW) based on evidence of mottling or redox. Since no mottling or redox was observed, the ESHGW was based on the Mean High Water (MHW) of the nearby stream. The MHW elevation was determined to be 2.31' using LiDAR elevation data from MassGIS in combination with hydrographic survey data from a nearby NOAA tidal station located in Chatham, MA (Station ID - 8447435). Similar results were found based on adjusting the observed groundwater elevation with the Frimpter Method (USGS, 2022; Cape Cod Commission, 2006; Cape Cod Commission, 2024)[2]. The test pit was witnessed and logged by a HW Massachusetts Title 5 Approved Soil Evaluator, with the results shown in **Table 2** below. See **Appendix C** for soil test pit logs.

The parent material of the native soil unit, Carver Coarse Sand is sandy glaciofluvial, comprising mostly outwash terraces, plains, and delta landforms. Based on the depth of the proposed tree trench, a design infiltration rate (Rawls) of 8.27 in/hr is used for coarse sand. See **Appendix C** for soil test pit logs.

Table 2. Test Pit (TP) Results

Test Pit ID	Surface Elevation at TP (ft)	Pit Bottom Elevation (ft)	Observed GW Elevation (ft)	ESHGW Elevation (ft)	Soil Texture(s) at SCM	Design Infiltration Rate (in/hr)
TP-1	4.5	1.2	1.2	2.3	Coarse sand	8.27

3.0 Proposed Conditions

The proposed project consists of the following stormwater and related site development improvements: GSI including a tree trench and a bioretention; and

- Porous pavement sidewalk to reduce overall impervious cover and meet ADA requirements.

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

- Capture, treat, and infiltrate to the maximum extent practicable the first one inch of runoff (Water Quality Volume (WQV)); and
- Engage the community with interpretive signage.

[2] Index Well Mashpee 29 (MIW-29) Zone A adjustment factor in January 2024 of 1.3 feet was used to adjust the observed groundwater to develop the ESHGW of 2.5 feet.

3.1 SCM Selection Process

Multiple types of SCMs and locations were analyzed and considered during the design process of this site that resulted in the proposed design of one bioretention area and one tree trench proposed on the east side of Standish Way. The focus for alternatives considered was vegetated GSI practices that maximized pollutant removal, including nutrients and bacteria. Alternative options considered are described below.

Option 1: Option 1 included proposing a bioretention area along the east grass shoulder of Standish Way that extended from Sagamore Road to Windemere Road. This design included several inlets along Standish Way diverting runoff to the practice and an overflow at the lower end of the practice that directed runoff back onto Standish Way. Several constraints were identified once survey was complete that did not make this design feasible including the steepness of the grass shoulder up to the 114 Standish Way property line and the limited width of the grass shoulder. During the initial site visit, the fence line along the 124 Standish Way property was assumed to be the approximate property line/ROW line. Survey, however, determined the property line was roughly 4-5' closer to Standish Way than the fence line, leaving limited space for a sidewalk, bioretention area, and grading.

Option 2: Infiltration trenches were considered at several locations along the length of the Standish Way drainage area. During the initial site visit, an opportunity for a tree trench in front of 102 Standish Way was identified; however, survey identified a water service line in the location of the proposed infiltration trench. Infiltration/tree trenches were also considered in front of 127 Stanish and in front of 124 Standish Way due to the limited width of the grass shoulder. However, the soil analysis conducted along the grass shoulder identified groundwater at Elevation 2.5, which did not provide a 2' vertical separation between the bottom of the trench and groundwater at either location.

Option 3, the Selected option: The chosen design includes components of both Option 1 and 2. A bioretention area is proposed in the flatter area along 114 and 124 Standish Way with a shorter length than Option 1 resulting in less grading to the existing surface. The sidewalk is proposed to curve around the bioretention area eliminating the need for runoff to cross the sidewalk to reach the bioretention area. A tree trench is proposed at the upper end of the 114 Standish Way property line where the elevations are higher and the tree trench design can meet the groundwater separation requirements. Once both SCMs reach capacity, runoff will bypass the inlets and continue down the existing flow path of Standish Way. This provides a safe, non-erosive bypass for runoff as well as avoiding installation of a new outlet location. The bottom of the bioretention area is approximately one foot below the sidewalk elevation and is designed to pond 6 inches before runoff bypasses the system. This minor depth change and ponding depth poses minimal risk to the safety of humans and animals and therefore, does not include any type of barrier.

3.2 Drainage Areas

The contributing drainage area from Standish Way to the existing SCMs (SP1A) under proposed conditions is the same as existing, with a total of approximately 1.46 acres. However, the proposed project is reducing impervious cover by roughly 1,100 square feet by replacing the paved sidewalk with a

porous one. The existing drainage area (DA1) was subdivided for the proposed conditions in order to model flows to the proposed SCMs, including: DA1A (northeast Standish), DA1B (southeast Standish), and DA1C (southwest Standish). The proposed SCMs were added as "ponds" in the HydroCAD model. The proposed porous asphalt was modeled with a reduced curve number (CN = 40) per the Rhode Island Stormwater Design and Installation Standards Manual (2015). DA1A and DA1B flow to the proposed GSI systems while DA1C continues to SP1A untreated. The area of untreated impervious area contributing runoff from Standish Way to the existing SCMs is reduced from approximately 0.63 acres to 0.25 acres. See the proposed drainage area map (Project MC-3) and a detailed breakdown of land cover in **Appendix A,** as well as the proposed HydroCAD model report in **Appendix B.**

3.3 Structural Stormwater Control Measures (SCMs)

The proposed stormwater management includes a GSI approach to capture, detain, treat, and infiltrate runoff. 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.

There are three stormwater GSI practices proposed– a bioretention area, a tree trench, and porous pavement. Pretreatment will be provided with sediment forebays and water quality units. Flow from large storm events will bypass the GSI practices and continue to flow down Standish Way. These SCMs are described in more detail below.

Pretreatment

A porous sediment forebay is 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 area. A proprietary water quality unit (WQU) will provide pretreatment of the runoff prior to conveyance into the tree trench.

Bioretention Areas

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, and 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.). Some BIOs located in areas with poor drainage or high groundwater are lined and/or have underdrains, while others located greater than 2 feet above ESHGW and in sandy soils can just infiltrate the treated runoff.

One BIO is proposed along the shoulder of Standish Way within the ROW. Runoff from the road enters the BIO through a paved flume. The runoff then flows through the sediment forebay and overflows into the BIO area. This BIO is not designed with an overflow structure; once the BIO reaches capacity, runoff will continue down Standish Way. This BIO captures, treats, and infiltrates the first inch of runoff from the contributing drainage area. The BIO has greater than 2-feet separation from bottom of bed to

ESHGW as required and will be planted with low-maintenance, native plants tolerant of the periods of inundation and dry conditions.

Tree Trench

A tree trench is an underground practice that detains, treats, and infiltrates runoff. There is one tree trench proposed in the right of way, upgradient of the BIO. The system consists of pretreatment via a WQU with a grate, a perforated inflow pipe, the stone storage reservoir, planting soil, and two trees. Once the trench reaches capacity, runoff will bypass the catch basin grate and continue down Standish Way. The tree trench has greater than 2-feet separation from the bottom of stone to the ESHGW as required.

Porous Pavement

Porous pavement is designed to capture and infiltrate runoff while providing the stability of traditional pavement. The system consists of a porous asphalt layer over a crushed stone reservoir. For small storms, the runoff falling directly on the porous pavement will completely infiltrate the pavement. For larger, intense storms, rainfall rate can exceed the infiltration rate of the porous pavement surface. Once this occurs, runoff will flow across the surface to the low point/drainage structure. Porous pavement should be placed to minimize “run-on” from adjacent traditional impervious pavement, as this can lead to premature clogging.

Porous pavement is proposed for the sidewalk within the project site. During those larger, intense storm events, runoff from the porous pavement sidewalk will flow into the bioretention area and/or roadway.

3.4 Non-structural SCMs

The non-structural SCMs proposed at the site include pavement reduction and public education. Removing the existing paved sidewalk and replacing with porous pavement reduces total volume of stormwater from the site. The proposed signage at the site will help educate the public on watershed issues, green stormwater infrastructure, and what they can do at their own homes to reduce stormwater pollutants from their lawns and driveways.

4.0 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 within soils with a rapid infiltration rate (greater than 2.4 inches per hour) 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 SCMs were sized to treat the full one-inch water quality volume (WQv) for their contributing drainage areas (DA1A and DA1B). As a result less runoff is flowing to the existing underground gravel wetland and is therefore able to treat the full one-inch of its contributing drainage area (DA1C and DA2). The proposed HydroCAD model results showing treatment of the water quality volume are included in **Appendix B** and summarized below in **Table 3**.

Table 3. Compliance with Water Quality Volume (WQV) Requirements

DA ID	SCM ID	IA* (ac)	WQv Goal (ac-ft)	WQv Provided (ac-ft)**	% WQv Provided	Meets Requirement?	Notes
DA1A	TT1	0.26	0.022	0.022	100%	Y	Tree trench treats 1-inch runoff
DA1B	BIO1	0.10	0.008	0.008	100%	Y	Bioretention treats 1-inch runoff
DA1C	Existing SCMs	0.25	0.021	0.021***	0%	Y	Portion of porous sidewalk; remaining runoff from DA continues to downgradient existing GSI for treatment
TOTAL SITE:		**0.61**	**0.163**	**0.163**	**100%**	**Y**	**Combination of proposed and existing SCM**

**Impervious Area*

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

****Assumed treatment by downstream existing SCM designed by others.*

Pollutant Load Reductions

The proposed bioretention area and tree trench exceed the MASMS requirements for TSS removal and maximize removals of the other pollutants of concern. Estimated TSS, phosphorus (TP), nitrogen (TN), and bacteria removals for the proposed project are provided in **Table 4.** The proposed O&M Guide in **Appendix D** 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. While DA1C runoff is not managed within the proposed SCMs, it is fully treated by the existing SCMs (porous pavement/underground gravel wetland) downgradient.

Table 4. 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	TT1	0.26	0.022	1.0	80%	98%	100%	98%	Y
DA1B	BIO1	0.10	0.008	1.0	90%	98%	100%	100%	Y
DA1C	EX SCMs	0.25	0.021*****	1.0	80%	61%	68%	77%	*Presumed; not part of proposed project*
TOTAL SITE:		**0.61**	**0.051**	**1.0**	**82%**	**83%**	**87%**	**90%**	**Y**

**From HydroCAD results – see Appendix B for volume "discarded" for WQv Event*
***From MASMS*
****From MS4 NPDES Permit Appendix F Attachment 3 (USEPA 2021)*
*****From Paradigm Environmental (2019)*
******Assumed treatment by downstream existing SCM designed by others.*

In addition, since the site is located in a critical area (near a public beach, shellfishing area, and the site has soils with a rapid infiltration rate) and must meet MASMS **Standard 6**, pretreatment practices before infiltration should remove 44% TSS or more. For the tree trench (TT1) shown above in **Table 4, CDS** water quality units are proposed for pretreatment prior to infiltration into the underlying soil, providing 80% TSS removal (**Appendix C of the O&M Guide**) and fully meeting **Standard 6**. In addition, BIO1 provides 90% treatment prior to infiltrating into the underlying soils, also fully meeting **Standard 6**.
In addition to the MASMS standards NRCS Code 570 requires pretreatment to remove oil, grease, and sediments. As the project site is on a residential road low amounts of oil and grease are expected in the drainage area. The water quality unit and sediment forebay are expected to capture the levels of oil and grease expected in the runoff.

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 D**.

4.2 Recharge

Infiltrating treated runoff into the underlying native sands is a goal of this project. 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 by the MASMS 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 do meet the required recharge volume by **Standard 3**, as well as, the NRCS Code 570 recharge requirement. TT1 and BIO1 provide the required recharge amount for the full

drainage area (DA1A, DA1B, and DA1C), however there is no actual recharge provided for DA1C in the proposed SCMs. Additionally, approximately 1,220 sf of porous pavement has been proposed to provide infiltration and reduce runoff.

Another requirement of **Standard 3** is that infiltrating SCMs must fully drain in 72 hours. The proposed HydroCAD model results showing nearly full recharge of the first inch of runoff by the bioretention and tree trench, and the drawdown times (from full basins to empty) are included in **Appendix B** and summarized below in **Table 5.**

Table 5. 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	TT1	0.26	A	0.6	0.013	0.022	167%	16	Y	
DA1B	BIO1	0.10	A	0.6	0.005	0.008	167%	16	Y	
DA1C	N/A	0.25	A	0.6	0.012	0.000	0%	NA	Y	DA continues to existing GSI
TOTAL SITE:		**0.61**			**0.030**	**0.030**	**100%**		**Y**	

**From HydroCAD results – see Appendix B for volume "discarded" for WQv Event*
***From HydroCAD results – see Appendix B for hydrograph showing time from peak elevation to fully drained basins (WQv Event or 25-yr storm for Chambers)*

4.3 Water Quantity

The main focus of this project is to improve water quality and habitat, but reducing water quantity impacts during large storm events was also considered. The proposed bioretention area, tree trench, and porous pavement will reduce peak flows and runoff volumes for the 2-, 10-, 25- and 100-year storms. The existing and proposed HydroCAD model results for these larger storm events are included in **Appendix B,** and the resulting peak flows and runoff volumes are summarized below in **Table 6** for both existing (EX) and proposed (PR) conditions. These results show that the proposed improvements will reduce peak flows and runoff volumes for all evaluated storms, and thus, fully meet the requirements of **Standard 2** of the MASMS.

Table 6. Summary of Existing and Proposed Condition Peak Flow Rates and Runoff Volumes

Study Point		Peak Flow, cfs				Runoff Volume, acre-ft			
		2-yr	10-yr	25-yr	100-yr	2-yr	10-yr	25-yr	100-yr
SP1	EX	1.20	3.06	4.69	7.55	0.098	0.225	0.337	0.537
	PR	0.53	1.96	4.11	7.10	0.046	0.130	0.237	0.432
Reduction	**%**	***56%***	***36%***	***12%***	***6%***	***53%***	***42%***	***30%***	***20%***

**From HydroCAD results – see Appendix B*

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 NPDES Construction General Permit Stormwater Pollution Plan (SWPPP) is not required. However, planning for effective erosion and sediment controls (ESCs) was important to this project's design, and so an ESC Plan is included in the design plans (**Appendix F**), along with a detailed sequence of construction activities and ESC notes. Silt socks are proposed along the downgradient edges of the area of disturbance. Additionally, inlet protection (silt sacks) is proposed in downgradient catch basins. Regular street sweeping is to be provided along Standish Way to minimize tracking of sediment. Since there is no construction entrance/exit proposed at this site, extra care should be taken in monitoring sediment tracking and sweeping the road. Areas for other sediment traps/basins should be provided on an as-needed basis. 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 guide is also included in **Appendix E** 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 D and F**).

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 D**) includes measures to prevent future illicit discharges.

5.0 REFERENCES

Association to Preserve Cape Cod. 2022. State of the Waters: Cape Cod Report.

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

Massachusetts Department of Environmental Protection (MADEP). 2008. Massachusetts Stormwater Standards Manual.

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

MassGIS (Massachusetts Office of Geographic and Environmental Information). 2023. See their homepage at: http://www.mass.gov/mgis/.

National Oceanic and Atmospheric Administration (NOAA) - National Weather Service (NWS). 2017. Point Precipitation Frequency Estimates: MA. NOAA Atlas 14, Volume 10, Version 3. https://hdsc.nws.noaa.gov/hdsc/pfds/pfds_map_cont.html?bkmrk=ma

National Oceanic and Atmospheric Administration (NOAA) – Tides & Currents. 2024. Water Levels. https://tidesandcurrents.noaa.gov/waterlevels.html?id=8447435

Natural Resources Conservation Service (NRCS). 2011. Stormwater Runoff Control Code 570.

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.

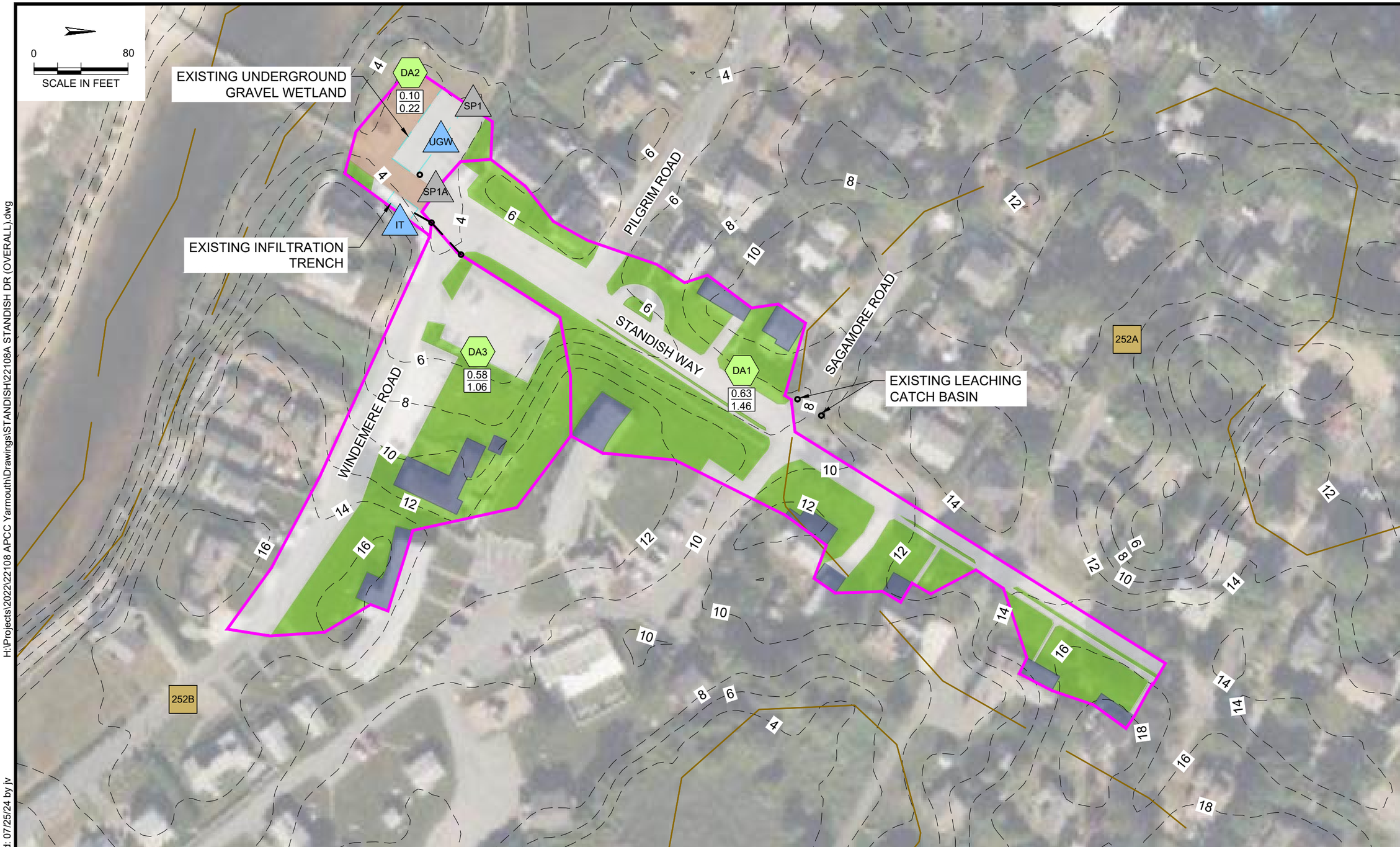
USEPA (United States Environmental Protection Agency). 2019. National Pollutant Discharge Elimination System (NPDES). See their homepage at: http://cfpub.epa.gov/NPDES/.

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

U.S. Geological Survey (USGS). 2022. Determining High Groundwater Levels in Massachusetts. https://www.usgs.gov/centers/new-england-water-science-center/science/updating-a-method-estimate-probable-high#web-tools.

APPENDIX A – Drainage Areas

- Existing and Proposed Drainage Areas Maps
- Land Coverage Summaries



LEGEND

DRAINAGE AREA BOUNDARY

WOODS
WATER
ROOFTOP
GRASS
POROUS PAVEMENT
PAVEMENT

IMP. AREA
TOTAL AREA
(ACRES)
1.00
5.00

DA1 DRAINAGE AREA
SP1 STUDY POINT
P1 POND

SOIL BOUNDARY
TIME OF CONCENTRATION FLOW PATH
2' MINOR CONTOUR
DRAINAGE INFRASTRUCTURE

SOIL TYPES

252A CARVER COARSE SAND (HSG A) 0 TO 3 PERCENT SLOPES

252B CARVER COARSE SAND (HSG B) 3 TO 8 PERCENT SLOPES

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Date: JULY 2024
Design By: JLV
Drawn By: JLV
Checked By: MW

Plan Set:

SITE MC-3: STANDISH WAY
STORMWATER RETROFIT DESIGN AND
IMPLEMENTATION PROJECT - 75% DESIGN
YARMOUTH, MASSACHUSETTS

Plan Title:
OVERALL DRAINAGE AREA MAP (TO MILL CREEK) (PROJECT T-194)

Prepared For:
Town of Yarmouth DPW
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Phone: (508) 398-2231 ext. 1250

Project Number:
22108A

Sheet Number:
1 of 3

H:\Projects\2022\22108 APCC Yarmouth\Drawings\STANDISH\22108A STANDISH DR (OVERALL).dwg

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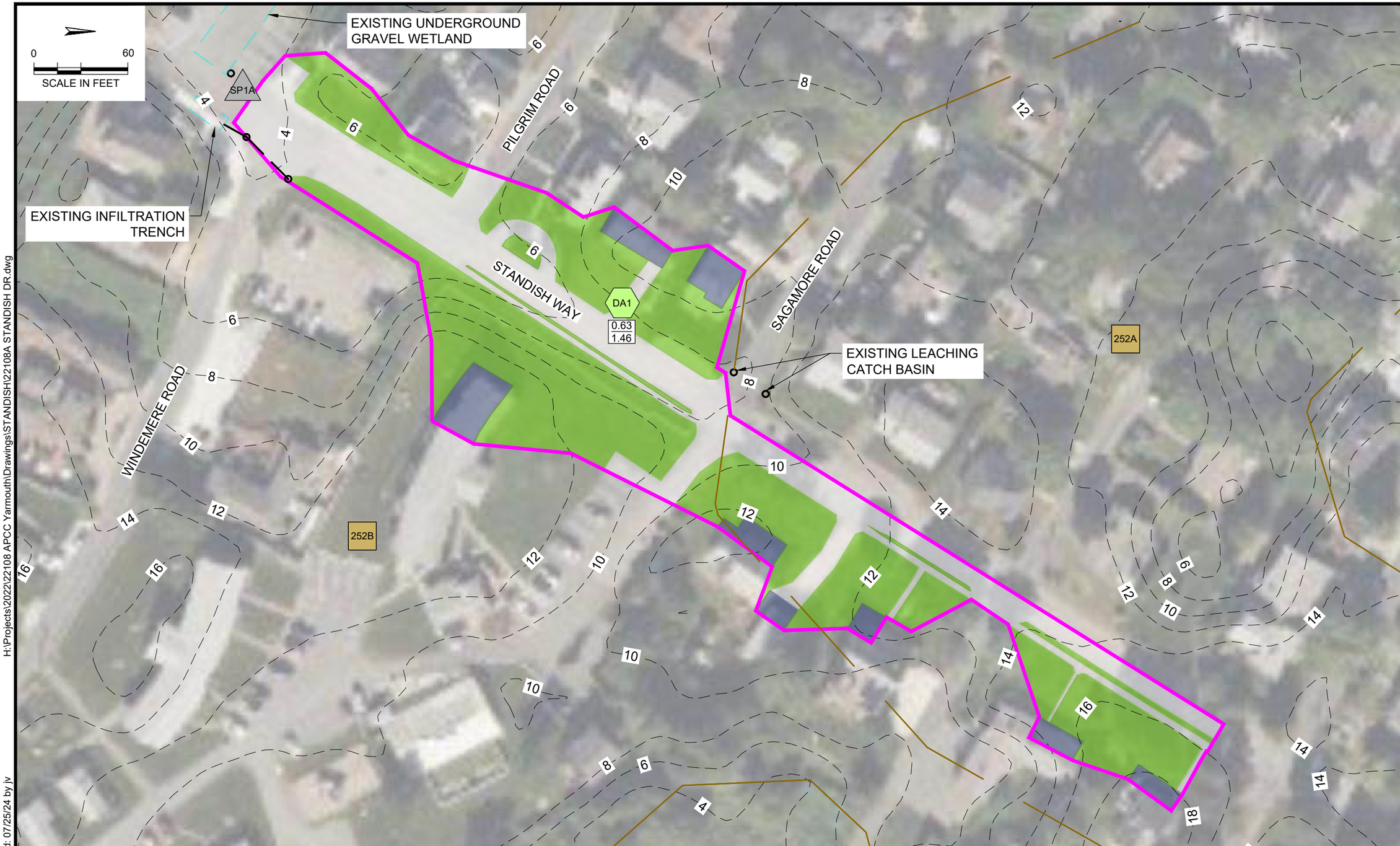

LEGEND

DRAINAGE AREA BOUNDARY

WOODS
WATER
ROOFTOP
GRASS
PAVEMENT

IMP. AREA
TOTAL AREA
(ACRES)
1.00
5.00

DA1 DRAINAGE AREA

SP1 STUDY POINT

P1 POND

SOIL BOUNDARY

TIME OF CONCENTRATION FLOW PATH

2' MINOR CONTOUR

DRAINAGE INFRASTRUCTURE

SOIL TYPES

252A CARVER COARSE SAND (HSG A)
0 TO 3 PERCENT SLOPES

252B CARVER COARSE SAND (HSG B)
3 TO 8 PERCENT SLOPES

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Checked By: MW
Drawn By: JLV
Design By: JLV
Date: JULY 2024

Plan Set:
SITE MC-3: STANDISH WAY
STORMWATER RETROFIT DESIGN AND
IMPLEMENTATION PROJECT - 75% DESIGN
YARMOUTH, MASSACHUSETTS

Plan Title:
EXISTING DRAINAGE AREA MAP (PROJECT MC-3)

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Project Number:
22108A

Sheet Number:
2 of 3

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LEGEND

DRAINAGE AREA BOUNDARY

WOODS
WATER
ROOFTOP
GRASS
PAVEMENT

IMP. AREA / TOTAL AREA (ACRES): 1.00 / 5.00

DA1 DRAINAGE AREA

SP1 STUDY POINT

P1 POND

SOIL BOUNDARY

TIME OF CONCENTRATION FLOW PATH

2' MINOR CONTOUR

DRAINAGE INFRASTRUCTURE

SOIL TYPES

252A CARVER COARSE SAND (HSG A) 0 TO 3 PERCENT SLOPES

252B CARVER COARSE SAND (HSG B) 3 TO 8 PERCENT SLOPES

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Date: JULY 2024
Design By: JLV
Drawn By: JLV
Checked By: MW

Plan Set: SITE MC-3: STANDISH WAY STORMWATER RETROFIT DESIGN AND IMPLEMENTATION PROJECT - 75% DESIGN YARMOUTH, MASSACHUSETTS

Plan Title: PROPOSED DRAINAGE AREA MAP (PROJECT MC-3)

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Project Number: 22108A

Sheet Number: 3 of 3

H:\Projects\2022\22108 APCC Yarmouth\Drawings\STANDISH\22108A STANDISH DR.dwg
last modified: 07/25/24 printed: 07/25/24 by jv

STANDISH SW RETROFIT YARMOUTH, MA	Calc'd by:	JLV
	Checked by:	MW
Existing Drainage Conditions	Date:	7/25/2024

DRAINAGE AREAS	
DA1	**STANDISH**
DA2	**PARKING LOT**
DA3	**WINDEMERE**

NOAA 14+ 24-hr Type III (inches)	
WQv	1.21
1-yr	3.05
2-yr	3.61
5-yr	4.52
10-yr	5.29
25-yr	6.57
100-yr	8.64
500-yr	0.00

DA1	**STANDISH**					
Cover type	Area, ft^2	Area, *ac*	Note			
Paved	22,564	0.518				
Permeable		0.000				
Roof	5,025	0.115				
Water	0	0.000				
Woods		0.000		**Impervious**		
Grass	35,923	0.825		Area, ft^2	Area, *ac*	Percent
TOTAL	63,512	1.458		27,589	0.633	43

DA2	**PARKING LOT**					
Cover type	Area, ft^2	Area, *ac*	Note			
Paved	4,205	0.097				
Permeable	4,415	0.101				
Roof	0	0.000				
Water	0	0.000				
Woods	0	0.000		**Impervious**		
Grass	874	0.020		Area, ft^2	Area, *ac*	Percent
TOTAL	9,494	0.218		4,205	0.097	44

DA3	WINDEMERE					
Cover type	Area, ft^2	Area, *ac*	Note			
Paved	21,469	0.493				
Permeable	0	0.000				
Roof	3,621	0.083				
Water	0	0.000				
Woods	0	0.000		**Impervious**		
Grass	21,132	0.485		Area, ft^2	Area, *ac*	Percent
TOTAL	46,222	1.061		25,090	0.576	54

ALL	***ALL EX AREAS COMBINED***					
Cover type	Area, ft^2	Area, *ac*	Note			
Paved	48,238	1.107				
Permeable	4,415	0.101				
Roof	8,646	0.115				
Water	0	0.000				
Woods	0	0.000		**Impervious**		
Grass	57,929	0.845		Area, ft^2	Area, *ac*	Percent
TOTAL	119,228	2.737		56,884	1.306	48

STANDISH SW RETROFIT YARMOUTH, MA	Calc'd by:	JLV
	Checked by:	MW
Proposed Drainage Conditions (FOR DA1 ONLY)	Date:	7/25/2024

DRAINAGE AREAS	
DA1A	**NORTHEAST STANDISH**
DA1B	**SOUTHEAST STANDISH**
DA1C	**SOUTHWEST STANDISH**

NOAA 14+ 24-hr Type III (inches)	
WQv	1.21
1-yr	3.05
2-yr	3.61
5-yr	4.52
10-yr	5.29
25-yr	6.57
100-yr	8.64
500-yr	0.00

DA1A	**NORTHEAST STANDISH**					
Cover type	Area, ft^2	Area, *ac*	Note			
Paved	9,276	0.213				
Permeable	23	0.001				
Roof	2,179	0.050				
Water		0.000				
Woods		0.000		**Impervious**		
Grass	14,034	0.322		Area, ft^2	Area, *ac*	Percent
TOTAL	25,512	0.586		11,455	0.263	45

DA1B	**SOUTHEAST STANDISH**					
Cover type	Area, ft^2	Area, *ac*	Note			
Paved	2,811	0.065				
Permeable	969	0.022				
Roof	1,355	0.031				
Water	276	0.006				
Woods		0.000		**Impervious**		
Grass	10,401	0.239		Area, ft^2	Area, *ac*	Percent
TOTAL	15,812	0.363		4,166	0.096	26

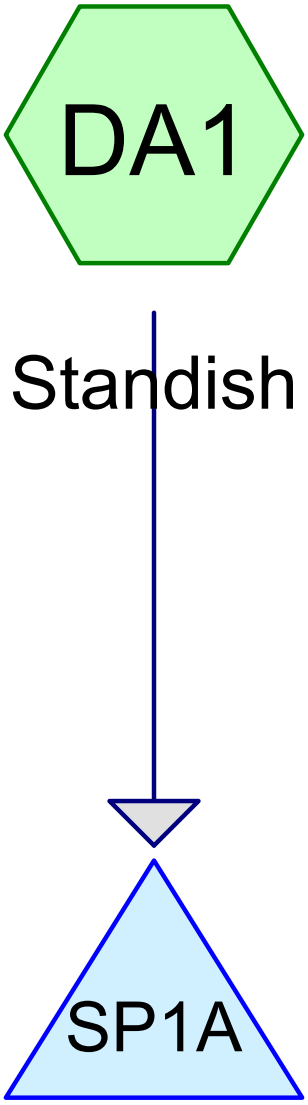
DA1C	SOUTHWEST STANDISH					
Cover type	Area, ft^2	Area, *ac*	Note			
Paved	9,357	0.215				
Permeable	198	0.005				
Roof	1,490	0.034				
Water	0	0.000				
Woods	0	0.000		**Impervious**		
Grass	11,143	0.256		Area, ft^2	Area, *ac*	Percent
TOTAL	22,188	0.509		10,847	0.249	49

ALL	***ALL PR AREAS COMBINED***					
Cover type	Area, ft^2	Area, *ac*	Note			
Paved	21,444	0.492				
Permeable	1,190	0.027				
Roof	5,024	0.115				
Water	276	0.006				
Woods	0	0.000		**Impervious**		
Grass	35,578	0.817		Area, ft^2	Area, *ac*	Percent
TOTAL	63,512	1.458		26,468	0.608	42

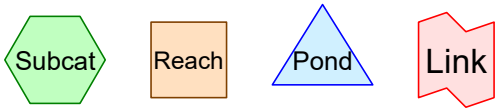
APPENDIX B – Hydrologic/Hydraulic Model Results

HydroCAD® Results

- Existing
- Proposed



Study Point 1A



Routing Diagram for 22108 STANDISH EX
Prepared by Horsley Witten Inc, Printed 7/25/2024
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Rainfall Events Listing (selected events)

Event#	Event Name	Storm Type	Curve	Mode	Duration (hours)	B/B	Depth (inches)	AMC
1	2yr	Type III 24-hr		Default	24.00	1	3.61	2
2	10yr	Type III 24-hr		Default	24.00	1	5.29	2
3	25yr	Type III 24-hr		Default	24.00	1	6.57	2
4	100yr	Type III 24-hr		Default	24.00	1	8.64	2

Area Listing (all nodes)

Area (acres)	CN	Description (subcatchment-numbers)
0.825	39	>75% Grass cover, Good, HSG A (DA1)
0.518	98	Paved parking, HSG A (DA1)
0.115	98	Roofs, HSG A (DA1)
1.458	**65**	**TOTAL AREA**

Time span=1.00-72.00 hrs, dt=0.05 hrs, 1421 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

SubcatchmentDA1: Standish Runoff Area=63,512 sf 43.44% Impervious Runoff Depth=0.81"
Tc=5.0 min CN=65 Runoff=1.20 cfs 0.098 af

Pond SP1A: Study Point 1A Inflow=1.20 cfs 0.098 af
Primary=1.20 cfs 0.098 af

Total Runoff Area = 1.458 ac Runoff Volume = 0.098 af Average Runoff Depth = 0.81"
56.56% Pervious = 0.825 ac 43.44% Impervious = 0.633 ac

Summary for Subcatchment DA1: Standish

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

Runoff = 1.20 cfs @ 12.10 hrs, Volume= 0.098 af, Depth= 0.81"
Routed to Pond SP1A : Study Point 1A

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr 2yr Rainfall=3.61"

Area (sf)	CN	Description
22,564	98	Paved parking, HSG A
5,025	98	Roofs, HSG A
35,923	39	>75% Grass cover, Good, HSG A
63,512	65	Weighted Average
35,923		56.56% Pervious Area
27,589		43.44% Impervious Area

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

Summary for Pond SP1A: Study Point 1A

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

Inflow Area = 1.458 ac, 43.44% Impervious, Inflow Depth = 0.81" for 2yr event
Inflow = 1.20 cfs @ 12.10 hrs, Volume= 0.098 af
Primary = 1.20 cfs @ 12.10 hrs, Volume= 0.098 af, Atten= 0%, Lag= 0.0 min

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

Time span=1.00-72.00 hrs, dt=0.05 hrs, 1421 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

SubcatchmentDA1: Standish Runoff Area=63,512 sf 43.44% Impervious Runoff Depth=1.85"
Tc=5.0 min CN=65 Runoff=3.06 cfs 0.225 af

Pond SP1A: Study Point 1A Inflow=3.06 cfs 0.225 af
Primary=3.06 cfs 0.225 af

Total Runoff Area = 1.458 ac Runoff Volume = 0.225 af Average Runoff Depth = 1.85"
56.56% Pervious = 0.825 ac 43.44% Impervious = 0.633 ac

Summary for Subcatchment DA1: Standish

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

Runoff = 3.06 cfs @ 12.09 hrs, Volume= 0.225 af, Depth= 1.85"
Routed to Pond SP1A : Study Point 1A

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr 10yr Rainfall=5.29"

Area (sf)	CN	Description
22,564	98	Paved parking, HSG A
5,025	98	Roofs, HSG A
35,923	39	>75% Grass cover, Good, HSG A
63,512	65	Weighted Average
35,923		56.56% Pervious Area
27,589		43.44% Impervious Area

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

Summary for Pond SP1A: Study Point 1A

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

Inflow Area = 1.458 ac, 43.44% Impervious, Inflow Depth = 1.85" for 10yr event
Inflow = 3.06 cfs @ 12.09 hrs, Volume= 0.225 af
Primary = 3.06 cfs @ 12.09 hrs, Volume= 0.225 af, Atten= 0%, Lag= 0.0 min

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

Time span=1.00-72.00 hrs, dt=0.05 hrs, 1421 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

SubcatchmentDA1: Standish Runoff Area=63,512 sf 43.44% Impervious Runoff Depth=2.77"
Tc=5.0 min CN=65 Runoff=4.69 cfs 0.337 af

Pond SP1A: Study Point 1A Inflow=4.69 cfs 0.337 af
Primary=4.69 cfs 0.337 af

Total Runoff Area = 1.458 ac Runoff Volume = 0.337 af Average Runoff Depth = 2.77"
56.56% Pervious = 0.825 ac 43.44% Impervious = 0.633 ac

Summary for Subcatchment DA1: Standish

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

Runoff = 4.69 cfs @ 12.08 hrs, Volume= 0.337 af, Depth= 2.77"
Routed to Pond SP1A : Study Point 1A

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr 25yr Rainfall=6.57"

Area (sf)	CN	Description
22,564	98	Paved parking, HSG A
5,025	98	Roofs, HSG A
35,923	39	>75% Grass cover, Good, HSG A
63,512	65	Weighted Average
35,923		56.56% Pervious Area
27,589		43.44% Impervious Area

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

Summary for Pond SP1A: Study Point 1A

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

Inflow Area = 1.458 ac, 43.44% Impervious, Inflow Depth = 2.77" for 25yr event
Inflow = 4.69 cfs @ 12.08 hrs, Volume= 0.337 af
Primary = 4.69 cfs @ 12.08 hrs, Volume= 0.337 af, Atten= 0%, Lag= 0.0 min

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

Time span=1.00-72.00 hrs, dt=0.05 hrs, 1421 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

SubcatchmentDA1: Standish Runoff Area=63,512 sf 43.44% Impervious Runoff Depth=4.42"
Tc=5.0 min CN=65 Runoff=7.55 cfs 0.537 af

Pond SP1A: Study Point 1A Inflow=7.55 cfs 0.537 af
Primary=7.55 cfs 0.537 af

Total Runoff Area = 1.458 ac Runoff Volume = 0.537 af Average Runoff Depth = 4.42"
56.56% Pervious = 0.825 ac 43.44% Impervious = 0.633 ac

Summary for Subcatchment DA1: Standish

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

Runoff = 7.55 cfs @ 12.08 hrs, Volume= 0.537 af, Depth= 4.42"
Routed to Pond SP1A : Study Point 1A

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr 100yr Rainfall=8.64"

Area (sf)	CN	Description
22,564	98	Paved parking, HSG A
5,025	98	Roofs, HSG A
35,923	39	>75% Grass cover, Good, HSG A
63,512	65	Weighted Average
35,923		56.56% Pervious Area
27,589		43.44% Impervious Area

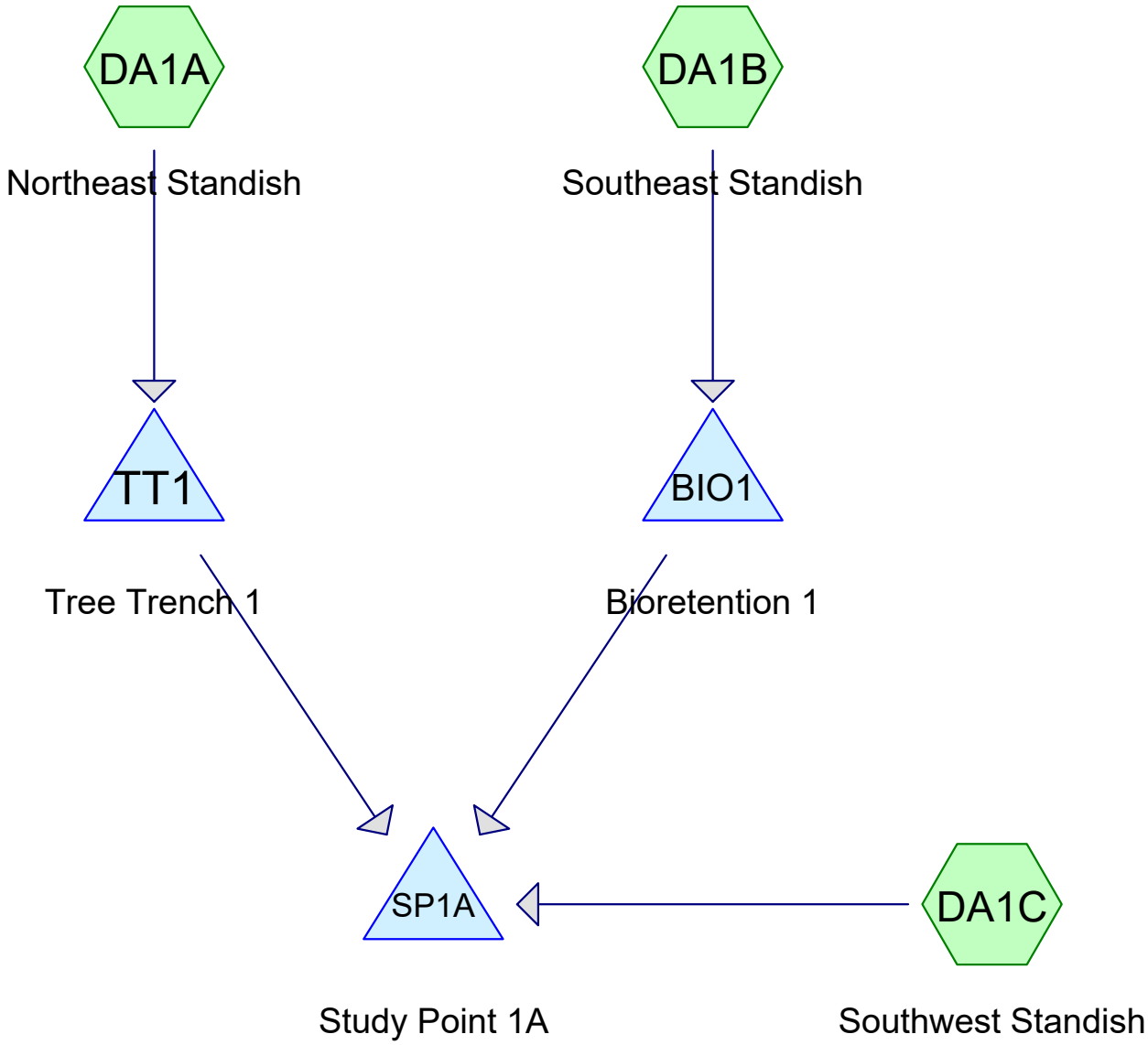
Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

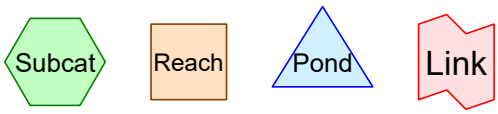
Summary for Pond SP1A: Study Point 1A

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

Inflow Area = 1.458 ac, 43.44% Impervious, Inflow Depth = 4.42" for 100yr event
Inflow = 7.55 cfs @ 12.08 hrs, Volume= 0.537 af
Primary = 7.55 cfs @ 12.08 hrs, Volume= 0.537 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 22108 STANDISH PR
Prepared by Horsley Witten Inc, Printed 8/6/2024
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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	1.21	2

Area Listing (all nodes)

Area (acres)	CN	Description (subcatchment-numbers)
0.817	39	>75% Grass cover, Good, HSG A (DA1A, DA1B, DA1C)
0.492	98	Paved parking, HSG A (DA1A, DA1B, DA1C)
0.027	40	Permeable Pavement, HSG A (DA1A, DA1B, DA1C)
0.115	98	Roofs, HSG A (DA1A, DA1B, DA1C)
0.006	98	Water Surface, HSG A (DA1B)
1.458	**64**	**TOTAL AREA**

Summary for Subcatchment DA1A: Northeast Standish

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

Runoff = 0.29 cfs @ 12.07 hrs, Volume= 0.022 af, Depth= 0.45"
Routed to Pond TT1 : Tree 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=1.21"

	Area (sf)	CN	Description
	9,276	98	Paved parking, HSG A
	2,179	98	Roofs, HSG A
	14,034	39	>75% Grass cover, Good, HSG A
*	23	40	Permeable Pavement, HSG A
	25,512	65	Weighted Average
	14,057	39	55.10% Pervious Area
	11,455	98	44.90% Impervious Area

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

Summary for Subcatchment DA1B: Southeast Standish

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

Runoff = 0.11 cfs @ 12.07 hrs, Volume= 0.008 af, Depth= 0.28"
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=1.21"

	Area (sf)	CN	Description
	2,811	98	Paved parking, HSG A
	1,355	98	Roofs, HSG A
	10,401	39	>75% Grass cover, Good, HSG A
	276	98	Water Surface, HSG A
*	969	40	Permeable Pavement, HSG A
	15,812	56	Weighted Average
	11,370	39	71.91% Pervious Area
	4,442	98	28.09% Impervious Area

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

Summary for Subcatchment DA1C: Southwest Standish

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

Runoff = 0.28 cfs @ 12.07 hrs, Volume= 0.021 af, Depth= 0.49"
Routed to Pond SP1A : Study Point 1A

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=1.21"

	Area (sf)	CN	Description
	9,357	98	Paved parking, HSG A
	1,490	98	Roofs, HSG A
*	11,143	39	>75% Grass cover, Good, HSG A
*	198	40	Permeable Pavement, HSG A
	22,188	68	Weighted Average
	11,341	39	51.11% Pervious Area
	10,847	98	48.89% Impervious Area

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

Summary for Pond BIO1: Bioretention 1

Inflow Area = 0.363 ac, 28.09% Impervious, Inflow Depth = 0.28" for WQv event
Inflow = 0.11 cfs @ 12.07 hrs, Volume= 0.008 af
Outflow = 0.02 cfs @ 12.49 hrs, Volume= 0.008 af, Atten= 79%, Lag= 24.8 min
Discarded = 0.02 cfs @ 12.49 hrs, Volume= 0.008 af
Primary = 0.00 cfs @ 1.00 hrs, Volume= 0.000 af
Routed to Pond SP1A : Study Point 1A

Routing by Stor-Ind method, Time Span= 1.00-72.00 hrs, dt= 0.05 hrs
Peak Elev= 4.80' @ 12.49 hrs Surf.Area= 427 sf Storage= 100 cf

Plug-Flow detention time= 28.2 min calculated for 0.008 af (100% of inflow)
Center-of-Mass det. time= 28.2 min (809.0 - 780.8)

Volume	Invert	Avail.Storage	Storage Description
#1	4.50'	588 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
4.50	250	0	0
5.00	550	200	200
5.50	1,000	388	588

Device	Routing	Invert	Outlet Devices
#1	Primary	5.00'	**4.0' 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 4.50' **2.410 in/hr Exfiltration over Surface area** Phase-In= 0.01'

Discarded OutFlow Max=0.02 cfs @ 12.49 hrs HW=4.80' (Free Discharge)
└─**2=Exfiltration** (Exfiltration Controls 0.02 cfs)

Primary OutFlow Max=0.00 cfs @ 1.00 hrs HW=4.50' (Free Discharge)
└─**1=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Summary for Pond SP1A: Study Point 1A

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

Inflow Area = 1.458 ac, 42.11% Impervious, Inflow Depth = 0.17" for WQv event
Inflow = 0.28 cfs @ 12.07 hrs, Volume= 0.021 af
Primary = 0.28 cfs @ 12.07 hrs, Volume= 0.021 af, Atten= 0%, Lag= 0.0 min

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

Summary for Pond TT1: Tree Trench 1

Inflow Area = 0.586 ac, 44.90% Impervious, Inflow Depth = 0.45" for WQv event
Inflow = 0.29 cfs @ 12.07 hrs, Volume= 0.022 af
Outflow = 0.03 cfs @ 12.40 hrs, Volume= 0.022 af, Atten= 88%, Lag= 19.7 min
Discarded = 0.03 cfs @ 12.40 hrs, Volume= 0.022 af
Primary = 0.00 cfs @ 1.00 hrs, Volume= 0.000 af
Routed to Pond SP1A : Study Point 1A

Routing by Stor-Ind method, Time Span= 1.00-72.00 hrs, dt= 0.05 hrs / 2
Peak Elev= 7.00' @ 12.67 hrs Surf.Area= 620 sf Storage= 315 cf

Plug-Flow detention time= 64.3 min calculated for 0.022 af (100% of inflow)
Center-of-Mass det. time= 64.2 min (845.0 - 780.8)

Volume	Invert	Avail.Storage	Storage Description
#1	4.51'	295 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc) 894 cf Overall x 33.0% Voids
#2	6.00'	45 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)
		340 cf	Total Available Storage

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
4.51	600	0	0
6.00	600	894	894

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
6.00	20	0	0
7.75	20	35	35
8.00	20	5	40
8.01	1,000	5	45

Device	Routing	Invert	Outlet Devices
#1	Discarded	4.51'	**2.410 in/hr Exfiltration over Surface area** Phase-In= 0.01'
#2	Primary	7.75'	**20.0' long x 0.5' breadth free overflow down road**
			Head (feet) 0.20 0.40 0.60 0.80 1.00
			Coef. (English) 2.80 2.92 3.08 3.30 3.32

Discarded OutFlow Max=0.03 cfs @ 12.40 hrs HW=6.12' (Free Discharge)
└─**1=Exfiltration** (Exfiltration Controls 0.03 cfs)

Primary OutFlow Max=0.00 cfs @ 1.00 hrs HW=4.51' (Free Discharge)
└─**2=free overflow down road** (Controls 0.00 cfs)

Rainfall Events Listing (selected events)

Event#	Event Name	Storm Type	Curve	Mode	Duration (hours)	B/B	Depth (inches)	AMC
1	2yr	Type III 24-hr		Default	24.00	1	3.61	2
2	10yr	Type III 24-hr		Default	24.00	1	5.29	2
3	25yr	Type III 24-hr		Default	24.00	1	6.57	2
4	100yr	Type III 24-hr		Default	24.00	1	8.64	2

Summary for Subcatchment DA1A: Northeast Standish

Runoff = 0.48 cfs @ 12.10 hrs, Volume= 0.040 af, Depth= 0.81"
Routed to Pond TT1 : Tree Trench 1

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr 2yr Rainfall=3.61"

	Area (sf)	CN	Description
	9,276	98	Paved parking, HSG A
	2,179	98	Roofs, HSG A
	14,034	39	>75% Grass cover, Good, HSG A
*	23	40	Permeable Pavement, HSG A
	25,512	65	Weighted Average
	14,057	39	55.10% Pervious Area
	11,455	98	44.90% Impervious Area

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

Summary for Subcatchment DA1B: Southeast Standish

Runoff = 0.10 cfs @ 12.12 hrs, Volume= 0.013 af, Depth= 0.42"
Routed to Pond BIO1 : Bioretention 1

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr 2yr Rainfall=3.61"

	Area (sf)	CN	Description
	2,811	98	Paved parking, HSG A
	1,355	98	Roofs, HSG A
	10,401	39	>75% Grass cover, Good, HSG A
	276	98	Water Surface, HSG A
*	969	40	Permeable Pavement, HSG A
	15,812	56	Weighted Average
	11,370	39	71.91% Pervious Area
	4,442	98	28.09% Impervious Area

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

Summary for Subcatchment DA1C: Southwest Standish

Runoff = 0.53 cfs @ 12.09 hrs, Volume= 0.041 af, Depth= 0.97"
Routed to Pond SP1A : Study Point 1A

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr 2yr Rainfall=3.61"

	Area (sf)	CN	Description
	9,357	98	Paved parking, HSG A
	1,490	98	Roofs, HSG A
*	11,143	39	>75% Grass cover, Good, HSG A
*	198	40	Permeable Pavement, HSG A
	22,188	68	Weighted Average
	11,341	39	51.11% Pervious Area
	10,847	98	48.89% Impervious Area

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

Summary for Pond BIO1: Bioretention 1

Inflow Area = 0.363 ac, 28.09% Impervious, Inflow Depth = 0.42" for 2yr event
Inflow = 0.10 cfs @ 12.12 hrs, Volume= 0.013 af
Outflow = 0.02 cfs @ 13.02 hrs, Volume= 0.013 af, Atten= 75%, Lag= 53.6 min
Discarded = 0.02 cfs @ 13.02 hrs, Volume= 0.013 af
Primary = 0.00 cfs @ 1.00 hrs, Volume= 0.000 af
Routed to Pond SP1A : Study Point 1A

Routing by Stor-Ind method, Time Span= 1.00-72.00 hrs, dt= 0.05 hrs
Peak Elev= 4.81' @ 13.02 hrs Surf.Area= 435 sf Storage= 105 cf

Plug-Flow detention time= 39.9 min calculated for 0.013 af (100% of inflow)
Center-of-Mass det. time= 39.9 min (965.6 - 925.8)

Volume	Invert	Avail.Storage	Storage Description
#1	4.50'	588 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
4.50	250	0	0
5.00	550	200	200
5.50	1,000	388	588

Device	Routing	Invert	Outlet Devices
#1	Primary	5.00'	**4.0' 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	4.50'	**2.410 in/hr Exfiltration over Surface area** Phase-In= 0.01'

Discarded OutFlow Max=0.02 cfs @ 13.02 hrs HW=4.81' (Free Discharge)
└─**2=Exfiltration** (Exfiltration Controls 0.02 cfs)

Primary OutFlow Max=0.00 cfs @ 1.00 hrs HW=4.50' (Free Discharge)
└─**1=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Summary for Pond SP1A: Study Point 1A

Inflow Area = 1.458 ac, 42.11% Impervious, Inflow Depth = 0.38" for 2yr event
Inflow = 0.53 cfs @ 12.09 hrs, Volume= 0.046 af
Primary = 0.53 cfs @ 12.09 hrs, Volume= 0.046 af, Atten= 0%, Lag= 0.0 min

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

Summary for Pond TT1: Tree Trench 1

Inflow Area = 0.586 ac, 44.90% Impervious, Inflow Depth = 0.81" for 2yr event
Inflow = 0.48 cfs @ 12.10 hrs, Volume= 0.040 af
Outflow = 0.15 cfs @ 12.32 hrs, Volume= 0.036 af, Atten= 69%, Lag= 13.6 min
Discarded = 0.03 cfs @ 12.25 hrs, Volume= 0.031 af
Primary = 0.11 cfs @ 12.32 hrs, Volume= 0.005 af
Routed to Pond SP1A : Study Point 1A

Routing by Stor-Ind method, Time Span= 1.00-72.00 hrs, dt= 0.05 hrs / 2
Peak Elev= 7.76' @ 12.30 hrs Surf.Area= 620 sf Storage= 370 cf

Plug-Flow detention time= 164.8 min calculated for 0.036 af (90% of inflow)
Center-of-Mass det. time= 118.0 min (1,001.4 - 883.4)

Volume	Invert	Avail.Storage	Storage Description
#1	4.31'	335 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc) 1,014 cf Overall x 33.0% Voids
#2	6.00'	45 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)
		380 cf	Total Available Storage

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
4.31	600	0	0
6.00	600	1,014	1,014

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
6.00	20	0	0
7.75	20	35	35
8.00	20	5	40
8.01	1,000	5	45

Device	Routing	Invert	Outlet Devices
#1	Discarded	4.31'	**2.410 in/hr Exfiltration over Surface area** Phase-In= 0.01'
#2	Primary	7.75'	**20.0' long x 0.5' breadth free overflow down road** Head (feet) 0.20 0.40 0.60 0.80 1.00 Coef. (English) 2.80 2.92 3.08 3.30 3.32

Discarded OutFlow Max=0.03 cfs @ 12.25 hrs HW=7.52' (Free Discharge)
└─**1=Exfiltration** (Exfiltration Controls 0.03 cfs)

Primary OutFlow Max=0.05 cfs @ 12.32 hrs HW=7.76' (Free Discharge)
└─**2=free overflow down road** (Weir Controls 0.05 cfs @ 0.28 fps)

Summary for Subcatchment DA1A: Northeast Standish

Runoff = 1.23 cfs @ 12.09 hrs, Volume= 0.090 af, Depth= 1.85"
Routed to Pond TT1 : Tree Trench 1

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr 10yr Rainfall=5.29"

	Area (sf)	CN	Description
	9,276	98	Paved parking, HSG A
	2,179	98	Roofs, HSG A
	14,034	39	>75% Grass cover, Good, HSG A
*	23	40	Permeable Pavement, HSG A
	25,512	65	Weighted Average
	14,057	39	55.10% Pervious Area
	11,455	98	44.90% Impervious Area

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

Summary for Subcatchment DA1B: Southeast Standish

Runoff = 0.44 cfs @ 12.10 hrs, Volume= 0.036 af, Depth= 1.19"
Routed to Pond BIO1 : Bioretention 1

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr 10yr Rainfall=5.29"

	Area (sf)	CN	Description
	2,811	98	Paved parking, HSG A
	1,355	98	Roofs, HSG A
	10,401	39	>75% Grass cover, Good, HSG A
	276	98	Water Surface, HSG A
*	969	40	Permeable Pavement, HSG A
	15,812	56	Weighted Average
	11,370	39	71.91% Pervious Area
	4,442	98	28.09% Impervious Area

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

Summary for Subcatchment DA1C: Southwest Standish

Runoff = 1.23 cfs @ 12.08 hrs, Volume= 0.089 af, Depth= 2.09"
Routed to Pond SP1A : Study Point 1A

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr 10yr Rainfall=5.29"

	Area (sf)	CN	Description
	9,357	98	Paved parking, HSG A
	1,490	98	Roofs, HSG A
*	11,143	39	>75% Grass cover, Good, HSG A
*	198	40	Permeable Pavement, HSG A
	22,188	68	Weighted Average
	11,341	39	51.11% Pervious Area
	10,847	98	48.89% Impervious Area

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

Summary for Pond BIO1: Bioretention 1

Inflow Area = 0.363 ac, 28.09% Impervious, Inflow Depth = 1.19" for 10yr event
Inflow = 0.44 cfs @ 12.10 hrs, Volume= 0.036 af
Outflow = 0.30 cfs @ 12.22 hrs, Volume= 0.036 af, Atten= 31%, Lag= 7.2 min
Discarded = 0.03 cfs @ 12.22 hrs, Volume= 0.025 af
Primary = 0.27 cfs @ 12.22 hrs, Volume= 0.011 af
Routed to Pond SP1A : Study Point 1A

Routing by Stor-Ind method, Time Span= 1.00-72.00 hrs, dt= 0.05 hrs
Peak Elev= 5.08' @ 12.22 hrs Surf.Area= 625 sf Storage= 249 cf

Plug-Flow detention time= 56.3 min calculated for 0.036 af (100% of inflow)
Center-of-Mass det. time= 56.3 min (939.3 - 883.0)

Volume	Invert	Avail.Storage	Storage Description
#1	4.50'	588 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
4.50	250	0	0
5.00	550	200	200
5.50	1,000	388	588

Device	Routing	Invert	Outlet Devices
#1	Primary	5.00'	**4.0' 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	4.50'	**2.410 in/hr Exfiltration over Surface area** Phase-In= 0.01'

Discarded OutFlow Max=0.03 cfs @ 12.22 hrs HW=5.08' (Free Discharge)
└─**2=Exfiltration** (Exfiltration Controls 0.03 cfs)

Primary OutFlow Max=0.26 cfs @ 12.22 hrs HW=5.08' (Free Discharge)
└─**1=Broad-Crested Rectangular Weir** (Weir Controls 0.26 cfs @ 0.80 fps)

Summary for Pond SP1A: Study Point 1A

Inflow Area = 1.458 ac, 42.11% Impervious, Inflow Depth = 1.07" for 10yr event
Inflow = 1.96 cfs @ 12.09 hrs, Volume= 0.130 af
Primary = 1.96 cfs @ 12.09 hrs, Volume= 0.130 af, Atten= 0%, Lag= 0.0 min

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

Summary for Pond TT1: Tree Trench 1

Inflow Area = 0.586 ac, 44.90% Impervious, Inflow Depth = 1.85" for 10yr event
Inflow = 1.23 cfs @ 12.09 hrs, Volume= 0.090 af
Outflow = 0.78 cfs @ 12.09 hrs, Volume= 0.071 af, Atten= 36%, Lag= 0.3 min
Discarded = 0.03 cfs @ 12.00 hrs, Volume= 0.041 af
Primary = 0.75 cfs @ 12.09 hrs, Volume= 0.030 af
Routed to Pond SP1A : Study Point 1A

Routing by Stor-Ind method, Time Span= 1.00-72.00 hrs, dt= 0.05 hrs / 2
Peak Elev= 7.80' @ 12.09 hrs Surf.Area= 620 sf Storage= 371 cf

Plug-Flow detention time= 194.9 min calculated for 0.071 af (79% of inflow)
Center-of-Mass det. time= 111.8 min (968.3 - 856.5)

Volume	Invert	Avail.Storage	Storage Description
#1	4.31'	335 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc) 1,014 cf Overall x 33.0% Voids
#2	6.00'	45 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)
		380 cf	Total Available Storage

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
4.31	600	0	0
6.00	600	1,014	1,014

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
6.00	20	0	0
7.75	20	35	35
8.00	20	5	40
8.01	1,000	5	45

Device	Routing	Invert	Outlet Devices
#1	Discarded	4.31'	**2.410 in/hr Exfiltration over Surface area** Phase-In= 0.01'
#2	Primary	7.75'	**20.0' long x 0.5' breadth free overflow down road** Head (feet) 0.20 0.40 0.60 0.80 1.00 Coef. (English) 2.80 2.92 3.08 3.30 3.32

Discarded OutFlow Max=0.03 cfs @ 12.00 hrs HW=7.37' (Free Discharge)
└─**1=Exfiltration** (Exfiltration Controls 0.03 cfs)

Primary OutFlow Max=0.69 cfs @ 12.09 hrs HW=7.80' (Free Discharge)
└─**2=free overflow down road** (Weir Controls 0.69 cfs @ 0.65 fps)

Summary for Subcatchment DA1A: Northeast Standish

Runoff = 1.88 cfs @ 12.08 hrs, Volume= 0.135 af, Depth= 2.77"
Routed to Pond TT1 : Tree Trench 1

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr 25yr Rainfall=6.57"

	Area (sf)	CN	Description
	9,276	98	Paved parking, HSG A
	2,179	98	Roofs, HSG A
	14,034	39	>75% Grass cover, Good, HSG A
*	23	40	Permeable Pavement, HSG A
	25,512	65	Weighted Average
	14,057	39	55.10% Pervious Area
	11,455	98	44.90% Impervious Area

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

Summary for Subcatchment DA1B: Southeast Standish

Runoff = 0.77 cfs @ 12.09 hrs, Volume= 0.059 af, Depth= 1.94"
Routed to Pond BIO1 : Bioretention 1

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr 25yr Rainfall=6.57"

	Area (sf)	CN	Description
	2,811	98	Paved parking, HSG A
	1,355	98	Roofs, HSG A
	10,401	39	>75% Grass cover, Good, HSG A
	276	98	Water Surface, HSG A
*	969	40	Permeable Pavement, HSG A
	15,812	56	Weighted Average
	11,370	39	71.91% Pervious Area
	4,442	98	28.09% Impervious Area

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

Summary for Subcatchment DA1C: Southwest Standish

Runoff = 1.82 cfs @ 12.08 hrs, Volume= 0.130 af, Depth= 3.07"
Routed to Pond SP1A : Study Point 1A

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr 25yr Rainfall=6.57"

	Area (sf)	CN	Description
	9,357	98	Paved parking, HSG A
	1,490	98	Roofs, HSG A
*	11,143	39	>75% Grass cover, Good, HSG A
*	198	40	Permeable Pavement, HSG A
	22,188	68	Weighted Average
	11,341	39	51.11% Pervious Area
	10,847	98	48.89% Impervious Area

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

Summary for Pond BIO1: Bioretention 1

Inflow Area = 0.363 ac, 28.09% Impervious, Inflow Depth = 1.94" for 25yr event
Inflow = 0.77 cfs @ 12.09 hrs, Volume= 0.059 af
Outflow = 0.74 cfs @ 12.12 hrs, Volume= 0.059 af, Atten= 5%, Lag= 2.1 min
Discarded = 0.04 cfs @ 12.12 hrs, Volume= 0.030 af
Primary = 0.70 cfs @ 12.12 hrs, Volume= 0.029 af
Routed to Pond SP1A : Study Point 1A

Routing by Stor-Ind method, Time Span= 1.00-72.00 hrs, dt= 0.05 hrs
Peak Elev= 5.16' @ 12.12 hrs Surf.Area= 692 sf Storage= 298 cf

Plug-Flow detention time= 46.6 min calculated for 0.059 af (100% of inflow)
Center-of-Mass det. time= 46.6 min (913.4 - 866.7)

Volume	Invert	Avail.Storage	Storage Description
#1	4.50'	588 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
4.50	250	0	0
5.00	550	200	200
5.50	1,000	388	588

Device	Routing	Invert	Outlet Devices
#1	Primary	5.00'	**4.0' 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	4.50'	**2.410 in/hr Exfiltration over Surface area** Phase-In= 0.01'

Discarded OutFlow Max=0.04 cfs @ 12.12 hrs HW=5.15' (Free Discharge)
└**2=Exfiltration** (Exfiltration Controls 0.04 cfs)

Primary OutFlow Max=0.66 cfs @ 12.12 hrs HW=5.15' (Free Discharge)
└**1=Broad-Crested Rectangular Weir** (Weir Controls 0.66 cfs @ 1.09 fps)

Summary for Pond SP1A: Study Point 1A

Inflow Area = 1.458 ac, 42.11% Impervious, Inflow Depth = 1.95" for 25yr event
Inflow = 4.11 cfs @ 12.09 hrs, Volume= 0.237 af
Primary = 4.11 cfs @ 12.09 hrs, Volume= 0.237 af, Atten= 0%, Lag= 0.0 min

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

Summary for Pond TT1: Tree Trench 1

Inflow Area = 0.586 ac, 44.90% Impervious, Inflow Depth = 2.77" for 25yr event
Inflow = 1.88 cfs @ 12.08 hrs, Volume= 0.135 af
Outflow = 1.71 cfs @ 12.08 hrs, Volume= 0.124 af, Atten= 9%, Lag= 0.1 min
Discarded = 0.03 cfs @ 11.85 hrs, Volume= 0.047 af
Primary = 1.67 cfs @ 12.08 hrs, Volume= 0.078 af
Routed to Pond SP1A : Study Point 1A

Routing by Stor-Ind method, Time Span= 1.00-72.00 hrs, dt= 0.05 hrs / 2
Peak Elev= 7.85' @ 12.08 hrs Surf.Area= 620 sf Storage= 372 cf

Plug-Flow detention time= 106.5 min calculated for 0.124 af (92% of inflow)
Center-of-Mass det. time= 65.0 min (909.3 - 844.3)

Volume	Invert	Avail.Storage	Storage Description
#1	4.31'	335 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc) 1,014 cf Overall x 33.0% Voids
#2	6.00'	45 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)
		380 cf	Total Available Storage

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
4.31	600	0	0
6.00	600	1,014	1,014

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
6.00	20	0	0
7.75	20	35	35
8.00	20	5	40
8.01	1,000	5	45

Device	Routing	Invert	Outlet Devices
#1	Discarded	4.31'	**2.410 in/hr Exfiltration over Surface area** Phase-In= 0.01'
#2	Primary	7.75'	**20.0' long x 0.5' breadth free overflow down road** Head (feet) 0.20 0.40 0.60 0.80 1.00 Coef. (English) 2.80 2.92 3.08 3.30 3.32

Discarded OutFlow Max=0.03 cfs @ 11.85 hrs HW=7.34' (Free Discharge)
└─**1=Exfiltration** (Exfiltration Controls 0.03 cfs)

Primary OutFlow Max=1.59 cfs @ 12.08 hrs HW=7.84' (Free Discharge)
└─**2=free overflow down road** (Weir Controls 1.59 cfs @ 0.85 fps)

Summary for Subcatchment DA1A: Northeast Standish

Runoff = 3.03 cfs @ 12.08 hrs, Volume= 0.216 af, Depth= 4.42"
Routed to Pond TT1 : Tree Trench 1

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr 100yr Rainfall=8.64"

	Area (sf)	CN	Description
	9,276	98	Paved parking, HSG A
	2,179	98	Roofs, HSG A
	14,034	39	>75% Grass cover, Good, HSG A
*	23	40	Permeable Pavement, HSG A
	25,512	65	Weighted Average
	14,057	39	55.10% Pervious Area
	11,455	98	44.90% Impervious Area

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

Summary for Subcatchment DA1B: Southeast Standish

Runoff = 1.40 cfs @ 12.08 hrs, Volume= 0.101 af, Depth= 3.35"
Routed to Pond BIO1 : Bioretention 1

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr 100yr Rainfall=8.64"

	Area (sf)	CN	Description
	2,811	98	Paved parking, HSG A
	1,355	98	Roofs, HSG A
	10,401	39	>75% Grass cover, Good, HSG A
	276	98	Water Surface, HSG A
*	969	40	Permeable Pavement, HSG A
	15,812	56	Weighted Average
	11,370	39	71.91% Pervious Area
	4,442	98	28.09% Impervious Area

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

Summary for Subcatchment DA1C: Southwest Standish

Runoff = 2.86 cfs @ 12.08 hrs, Volume= 0.203 af, Depth= 4.78"
Routed to Pond SP1A : Study Point 1A

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr 100yr Rainfall=8.64"

	Area (sf)	CN	Description
	9,357	98	Paved parking, HSG A
	1,490	98	Roofs, HSG A
*	11,143	39	>75% Grass cover, Good, HSG A
*	198	40	Permeable Pavement, HSG A
	22,188	68	Weighted Average
	11,341	39	51.11% Pervious Area
	10,847	98	48.89% Impervious Area

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

Summary for Pond BIO1: Bioretention 1

Inflow Area = 0.363 ac, 28.09% Impervious, Inflow Depth = 3.35" for 100yr event
Inflow = 1.40 cfs @ 12.08 hrs, Volume= 0.101 af
Outflow = 1.35 cfs @ 12.11 hrs, Volume= 0.101 af, Atten= 3%, Lag= 1.6 min
Discarded = 0.04 cfs @ 12.11 hrs, Volume= 0.037 af
Primary = 1.31 cfs @ 12.11 hrs, Volume= 0.064 af
Routed to Pond SP1A : Study Point 1A

Routing by Stor-Ind method, Time Span= 1.00-72.00 hrs, dt= 0.05 hrs
Peak Elev= 5.24' @ 12.11 hrs Surf.Area= 764 sf Storage= 356 cf

Plug-Flow detention time= 36.1 min calculated for 0.101 af (100% of inflow)
Center-of-Mass det. time= 36.1 min (886.1 - 850.0)

Volume	Invert	Avail.Storage	Storage Description
#1	4.50'	588 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
4.50	250	0	0
5.00	550	200	200
5.50	1,000	388	588

Device	Routing	Invert	Outlet Devices
#1	Primary	5.00'	**4.0' 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	4.50'	**2.410 in/hr Exfiltration over Surface area** Phase-In= 0.01'

Discarded OutFlow Max=0.04 cfs @ 12.11 hrs HW=5.23' (Free Discharge)
└─**2=Exfiltration** (Exfiltration Controls 0.04 cfs)

Primary OutFlow Max=1.27 cfs @ 12.11 hrs HW=5.23' (Free Discharge)
└─**1=Broad-Crested Rectangular Weir** (Weir Controls 1.27 cfs @ 1.36 fps)

Summary for Pond SP1A: Study Point 1A

Inflow Area = 1.458 ac, 42.11% Impervious, Inflow Depth = 3.56" for 100yr event
Inflow = 7.10 cfs @ 12.08 hrs, Volume= 0.432 af
Primary = 7.10 cfs @ 12.08 hrs, Volume= 0.432 af, Atten= 0%, Lag= 0.0 min

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

Summary for Pond TT1: Tree Trench 1

Inflow Area = 0.586 ac, 44.90% Impervious, Inflow Depth = 4.42" for 100yr event
Inflow = 3.03 cfs @ 12.08 hrs, Volume= 0.216 af
Outflow = 3.03 cfs @ 12.08 hrs, Volume= 0.215 af, Atten= 0%, Lag= 0.0 min
Discarded = 0.03 cfs @ 11.50 hrs, Volume= 0.051 af
Primary = 3.00 cfs @ 12.08 hrs, Volume= 0.165 af
Routed to Pond SP1A : Study Point 1A

Routing by Stor-Ind method, Time Span= 1.00-72.00 hrs, dt= 0.05 hrs / 2
Peak Elev= 7.89' @ 12.08 hrs Surf.Area= 620 sf Storage= 372 cf

Plug-Flow detention time= 35.4 min calculated for 0.215 af (100% of inflow)
Center-of-Mass det. time= 34.7 min (865.4 - 830.8)

Volume	Invert	Avail.Storage	Storage Description
#1	4.31'	335 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc) 1,014 cf Overall x 33.0% Voids
#2	6.00'	45 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)
		380 cf	Total Available Storage

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
4.31	600	0	0
6.00	600	1,014	1,014

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
6.00	20	0	0
7.75	20	35	35
8.00	20	5	40
8.01	1,000	5	45

Device	Routing	Invert	Outlet Devices
#1	Discarded	4.31'	**2.410 in/hr Exfiltration over Surface area** Phase-In= 0.01'
#2	Primary	7.75'	**20.0' long x 0.5' breadth free overflow down road** Head (feet) 0.20 0.40 0.60 0.80 1.00 Coef. (English) 2.80 2.92 3.08 3.30 3.32

Discarded OutFlow Max=0.03 cfs @ 11.50 hrs HW=7.37' (Free Discharge)
└─**1=Exfiltration** (Exfiltration Controls 0.03 cfs)

Primary OutFlow Max=2.89 cfs @ 12.08 hrs HW=7.89' (Free Discharge)
└─**2=free overflow down road** (Weir Controls 2.89 cfs @ 1.04 fps)

APPENDIX C – Soil Test Pit Logs

Commonwealth of Massachusetts

City/Town of Yarmouth

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

C. On-Site Review

Deep Observation Hole Number: 1 (Hole #) | 1/4/24 (Date) | 1000A (Time) | 30F Cloud (Weather) | 41º38'49.10"N (Latitude) | 70º15'21.98"W (Longitude)

1. Land Use: ROW (e.g. woodland, agricultural field, vacant lot, etc.) | Grass (Vegetation) | No (Surface Stones (e.g. cobbles, stones, boulders, etc.)) | 0-3 (Slope (%))

Description of Location: SE corner, intersection of Windermere Rd and Standish Way | 6.7 (Surface elevation)

2. Soil Parent Material: Sandy glaciofluvial deposits | Moraines, outwash plains (Landform) | (Position on Landscape (SU, SH, BS, FS, TS))

3. Distances From:

Open Water Body	175	feet	Drainage Way		feet	Wetlands	175	feet
Property Line	5	feet	Drinking Water Well		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: 39" 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			
0-24	A	LS	10YR 2/2				-	-	M	Fi	
24-27	B	LS	10YR 4/6				5	-	M	Fi	
27-39	C	CS	10YR 5/6				10	-	M	Fi	

Additional Notes: _____

APPENDIX D – Operation and Maintenance Guide

Stormwater Operations & Maintenance Guide

Standish Way Stormwater Retrofit Project

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1. INTRODUCTION

This document provides a general description along with the operation and maintenance requirements for the Standish Way Stormwater Retrofit project within the Standish Way Right of Way between the intersections of Windemere Road and Sagamore Road. 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

Standish Way is a Town-owned and operated road. 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)
- **Tree Trench (1):** **$1,000**
  ($1,000/trench)
- **Drainage Structures (WQU 100)** **$500**
  ($500/structure)
- **Porous Pavement:** **$1,000**
  ($500/cleaning)

Owner contact information is provided below:

Owner: **Town of Yarmouth**
Contact: **Department of Public Works**
Amanda Lima, Town Engineer
74 Town Brook Road
West Yarmouth, MA 02673
508-398-2231

Contact: **Town of Yarmouth**
Department of Public Works
Nathan Whetten, Senior Project Manager
74 Town Brook Road
West Yarmouth, MA 02673
508-398-2231

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

c. Porous Pavement: Porous pavements are designed to capture and infiltrate runoff. The areas of porous pavement have been placed to ensure they do not collect runoff from the traditional impervious pavement, as this can clog the pervious pavement. Regular maintenance is critical to the success of this practice.

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 AREA

Structural Components

1. ***Collect***: Stormwater runoff is directed to paved flume inlet where stormwater enters the sediment forebay.

2. ***Capture Sediment***: Sand and debris settle out within sediment forebays.

3. ***Move Water:*** The stormwater discharges directly to the bioretention area via a check dam weir.

4. ***Treat and Manage***: Stormwater overtops the forebay check dam and flows through the planted bioretention area. 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 rain events, the water level will rise and once the bioretention area reaches capacity runoff will bypass the paved flume and continue down the road.

MAINTENANCE SCHEDULE: BIORETENTION AREA

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.

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

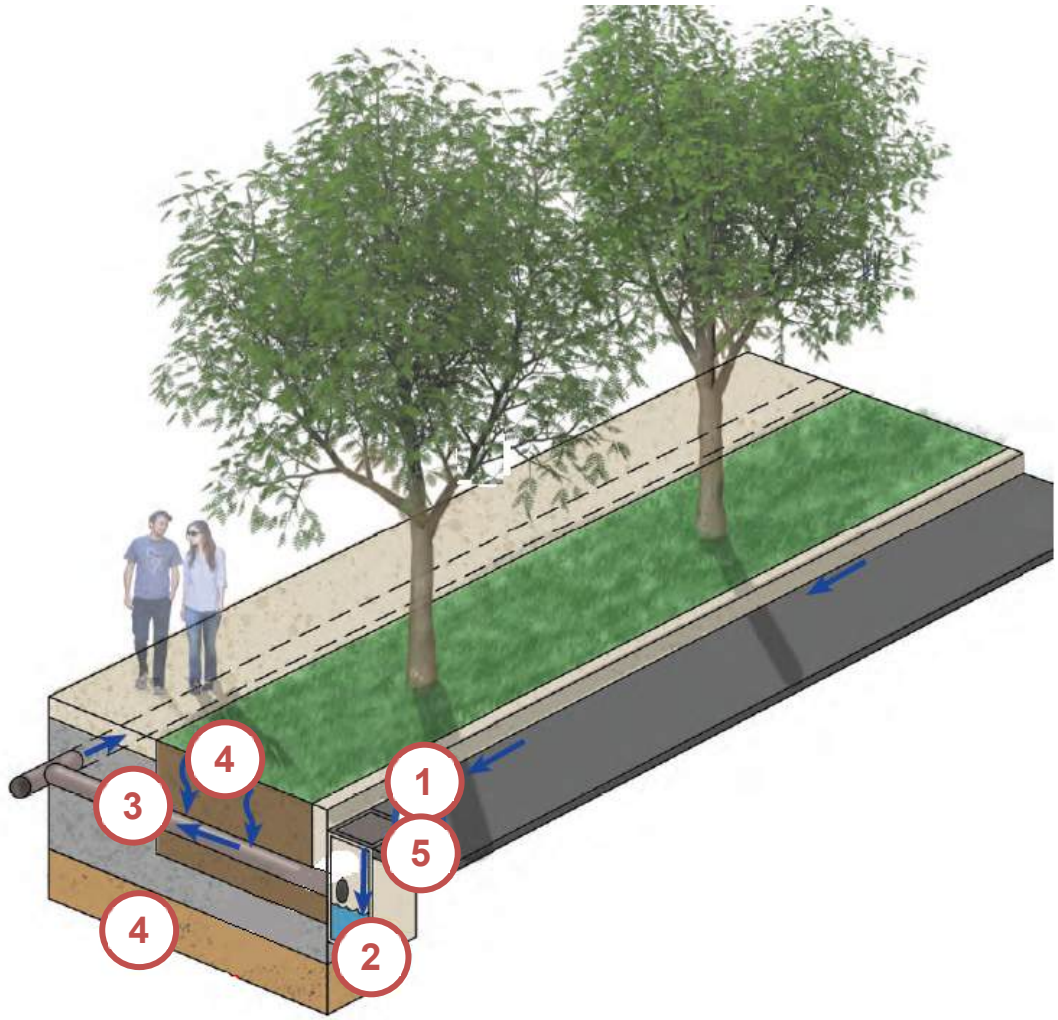
X required inspection

x as needed

- When removing trash and debris during monthly inspections look for:
  - If sediment is > 3" in paver lined sediment forebays. Ensure sediment does not cause blockage of inlet weirs. If it is, remove sediment.
  - 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: TREE 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 road.

MAINTENANCE SCHEDULE: TREE TRENCH

A site inspection of the tree 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.

Tree 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. STRUCTURAL COMPONENTS: POROUS PAVEMENT

Structural Components

1. ***Collect***: Stormwater runoff is absorbed directly into the pervious surface when it rains.
2. ***Capture Sediment***: Porous pavements are designed for minimal run-on from permeable surfaces (like lawn areas) and no runoff from impervious pavement, so sediment should be minimal. Sediment will filter into the porous pavement and will eventually clog.
3. ***Move Water:*** The stormwater filters through the surface material and choker courses.
4. ***Treat and Manage***: The stormwater is treated as it flows through the filter course into the underlying native soils.
5. ***Overflow***: During larger rain events, once the porous pavement and gravel below are saturated, additional runoff will flow downgradient to the bioretention or road.

MAINTENANCE SCHEDULE: POROUS PAVEMENT

A site inspection of the porous pavement shall be conducted at least twice a year in the Spring and Fall, and after major storm events (2” of rain or greater). See the calendar below.

Pervious Pavement and Pavers 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	x	x	**X**	x

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

X required inspection

x as needed

Frequent cleaning and maintenance is critical to prevent clogging of porous surfaces. To keep the surface clean, sweep the porous pavement using vacuum sweepers at least twice a year.

No sanding or de-icing is permitted. Full porous pavement replacement will be conducted every 10-20 years or as determined necessary due to field conditions.

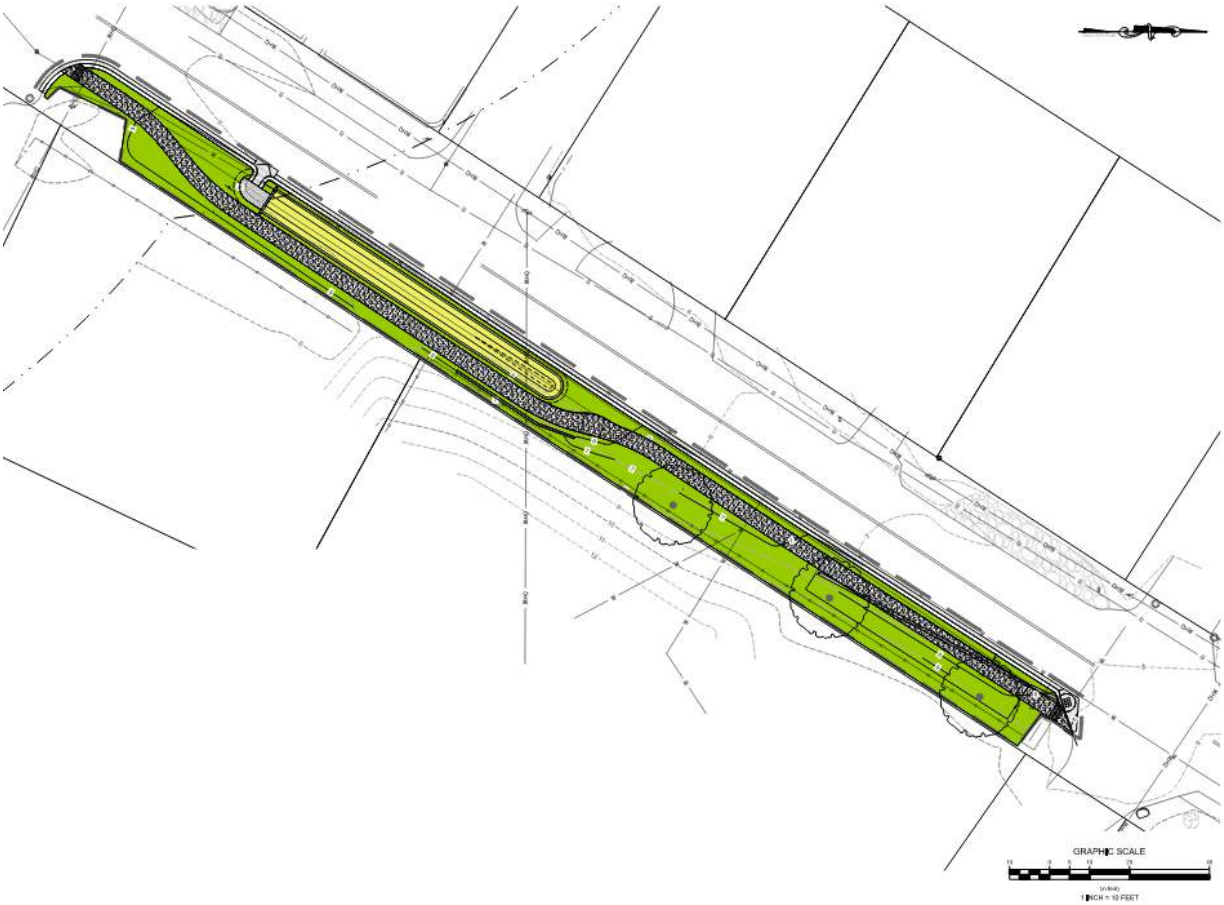
7. PLANTINGS

7.1. Plantings

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

“Mow” Areas

No “Mow” Area



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: 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	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*)

8. 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. Porous pavement should be swept using a vacuum sweeper at least twice a year.

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 or porous pavement.

9. 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
- Tree Trench
- Porous Pavement
- Landscaping

Operation and Maintenance Checklist
Standish Way Stormwater Retrofit Project

Date:

Time:

Inspector:

Maintenance Item	Description	Maintenance (Y/N)
1, 2 & 3. Inlet Flume, Sediment Forebay, Water Quality Unit, and Check Dam Weir		
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**.*	
Erosion	Check for areas of erosion (gullies, animal burrowing, or overtopping), particularly near check dam weirs, perimeter, and guard rail posts. Repair as necessary and return to design grades.	
Actions to be taken:		
4 & 5. Bioretention Area, Tree 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 sediment accumulation and/or standing water that indicates clogging in the tree trench. If sediment or standing water is observed in the trench for more than 48 hours after a storm event, clean out tree trench.	
Actions to be taken:		

Operation and Maintenance Checklist
Standish Way Stormwater Retrofit Project

Maintenance Item	Description	Maintenance (Y/N)
Porous Pavement		
Debris Removal	Remove trash from paved and perimeter areas. Sweep surface.	
Vacuum	Vacuum surface to clean pores of debris and sediment with a commercial vacuum system.	
Structure	Repair cracking or other structural issues as found during inspection.	
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
Standish Way Stormwater Retrofit Project

Location:

Date:

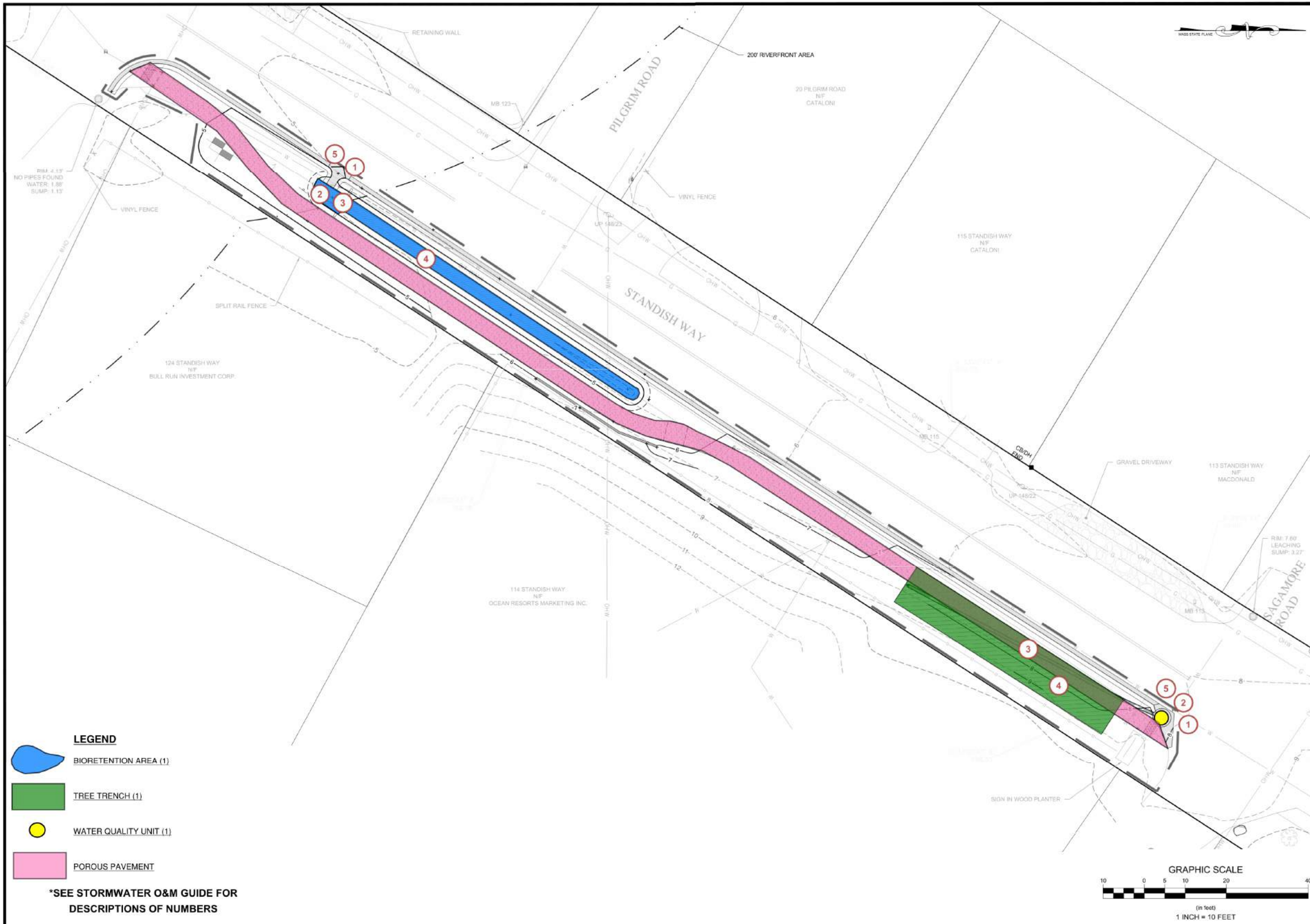
Inspector:

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 or nearby site include Asian bittersweet and common reed (Phragmites australis).

“Mowed” Areas
No “Mow” Areas (Bioretention Areas)
All areas

APPENDIX B – Overall SCM Locations



Revisions

Rev.	Date	By	Appr.	Description

Horsley Witten Group, Inc.
Sustainable Environmental Solutions
www.horsleywitten.com
90 Route 6A
Sandwich, MA 02563
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Date: AUGUST 2024 | Designed By: JLV | Drawn By: JLV | Checked By: MW

Plan Set:
SITE MC-3: STANDISH WAY
STORMWATER RETROFIT DESIGN AND
IMPLEMENTATION PROJECT - 75% DESIGN
YARMOUTH, MASSACHUSETTS

Plan Title:
OVERALL SCM LOCATIONS

Prepared For:
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DPW
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Survey Provided By:
Horsley Witten Group, Inc.
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Fax: 508-833-3150
Dated: December 1, 2023

Registration:

Project Number: 22108A

Sheet: 1 of 1

Sheet Number: C - 4

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.

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The product(s) described may be protected by one or more of the following US patents: 5,322,629; 5,624,576; 5,707,527; 5,759,415; 5,788,848; 5,985,157; 6,027,639; 6,350,374; 6,406,218; 6,641,720; 6,511,595; 6,649,048; 6,991,114; 6,998,038; 7,186,058; 7,296,692; 7,297,266; 7,517,450 related foreign patents or other patents pending.

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CDS Inspection & Maintenance Log

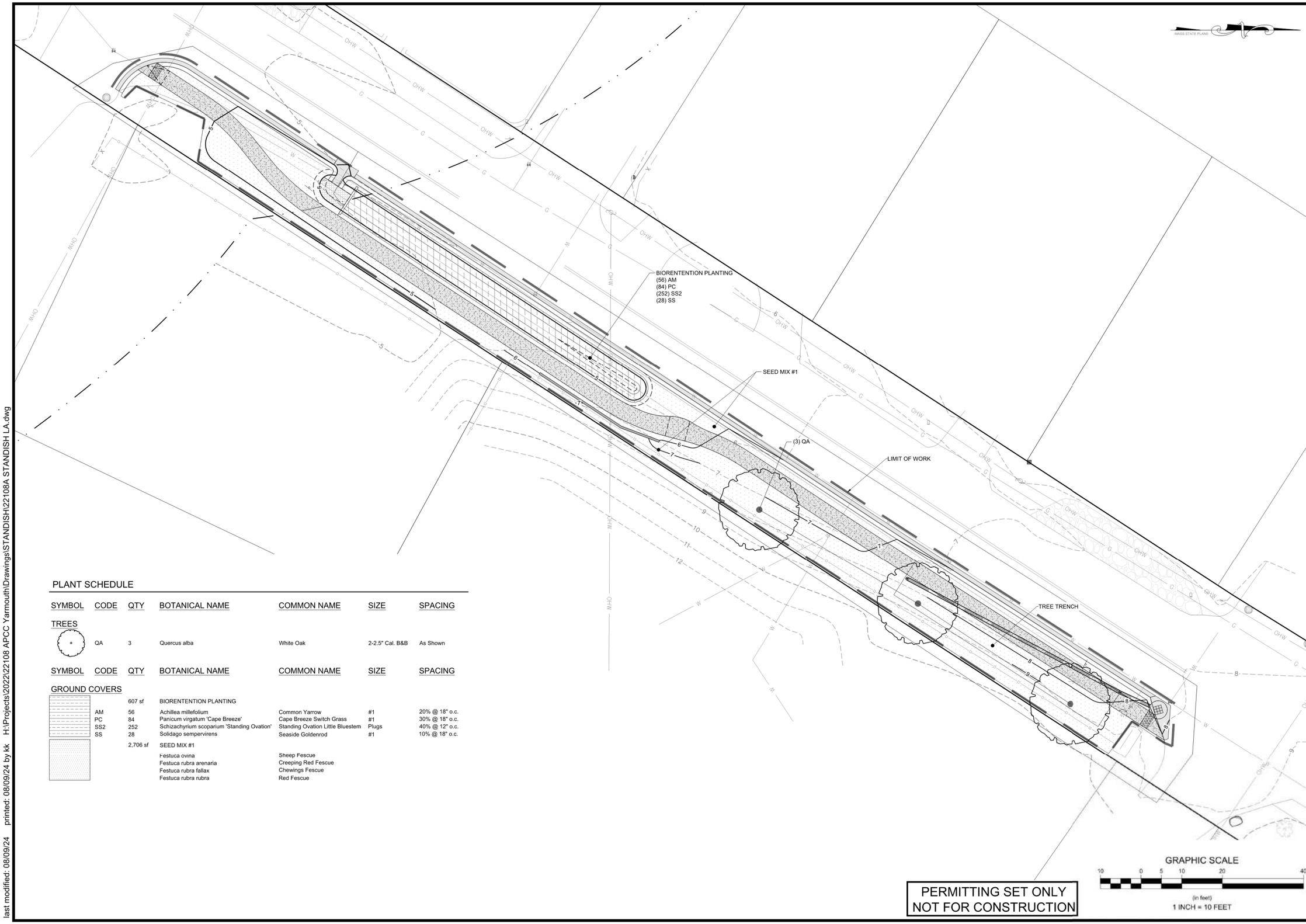
CDS Model: _____ Location: _____

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



PERMITTING SET ONLY
NOT FOR CONSTRUCTION

PLANT SCHEDULE

SYMBOL	CODE	QTY	BOTANICAL NAME	COMMON NAME	SIZE	SPACING
TREES						
	QA	3	Quercus alba	White Oak	2-2.5" Cal. B&B	As Shown

SYMBOL	CODE	QTY	BOTANICAL NAME	COMMON NAME	SIZE	SPACING
GROUND COVERS						
		607 sf	BIORENTENTION PLANTING			
	AM	56	Achillea millefolium	Common Yarrow	#1	20% @ 18" o.c.
	PC	84	Panicum virgatum 'Cape Breeze'	Cape Breeze Switch Grass	#1	30% @ 18" o.c.
	SS2	252	Schizachyrium scoparium 'Standing Ovation'	Standing Ovation Little Bluestem	Plugs	40% @ 12" o.c.
	SS	28	Solidago sempervirens	Seaside Goldenrod	#1	10% @ 18" o.c.
		2,706 sf	SEED MIX #1			
			Festuca ovina	Sheep Fescue		
			Festuca rubra arenaria	Creeping Red Fescue		
			Festuca rubra fallax	Chewings Fescue		
			Festuca rubra rubra	Red Fescue		

Revisions

Rev.	Date	By	Appr.	Description

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Date: AUGUST 2024 | Designed By: KJK | Drawn By: KJK | Checked By: MBE

Plan Set: SITE MC-3: STANDISH WAY STORMWATER RETROFIT DESIGN AND IMPLEMENTATION PROJECT - 75% DESIGN YARMOUTH, MASSACHUSETTS

Plan Title: PLANTING PLAN

Prepared For
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USDA United States Department of Agriculture
Natural Resources Conservation Service

Survey Provided By:
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Dated: December 1, 2023

Registration:
DRAFT
NOT FOR CONSTRUCTION

Project Number: 22108A | Sheet: 6 of 7

Sheet Number: L - 1

APPENDIX E – 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.

- Sediment Silt Sock Barrier will be installed prior to commencement of construction. 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.

- Temporary Sediment Traps/Basins should be installed 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.

- Slope Stabilization will occur immediately upon obtaining final grades as shown on the project site plans. Runoff should be blocked from entering the paved flume/bioretention area until final stabilization has been achieved. 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.

The entire stormwater management system including pipes, structures, bioretention area, and tree 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. Bioretention area is to remain offline, blocked from road runoff at inflow, until permanent planting is established.

- 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 F – Site Plans