Stormwater Management Report

HARWICH ROAD SUBDIVISION

Off Wareham Street
Carver, Massachusetts

Prepared for:
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Carver, MA, 02571

Prepared by:

BEALS + THOMAS

April 6, 2022

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REGISTERED
PROFESSIONAL ENGINEER

4/6/22

Matthew Cote, PE

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LIST OF ATTACHMENTS

1.0 INTRODUCTION

The proposed project includes a stormwater management system designed to mitigate potential impacts the proposed project could have on the existing watershed. Stormwater controls have been proposed to control peak runoff rates, provide water quality, promote groundwater recharge and sediment removal. The proposed system has been designed to comply with:

- The 2008 Massachusetts Department of Environmental Protection (DEP) Stormwater Management Handbook,
- The Massachusetts Wetland Protection Act (310 CMR 10.00), and
- The Town of Carver Wetlands Protection Bylaws

The pre- and post-development hydrologic conditions were modeled using HydroCAD™ version 10.10 to demonstrate that post-development stormwater runoff rates will be less than or equal to the pre-development rates. Watershed maps with soil types as well as detailed analysis of the model results are also included. The following tables summarize the peak runoff rates and volumes for the pre- and post-development conditions.

Table 1: Pre- & Post-development Peak Runoff Rate Comparison, units are in cubic feet per second (cfs).

Storm Event	2 Year		10 Year		25 Year		100 Year	
	Pre	Post	*Pre*	Post	*Pre*	Post	*Pre*	Post
Design Point 1	*0.00*	0.00	*0.00*	0.00	*0.02*	0.01	*0.05*	0.04
Design Point 2	*0.00*	0.00	*0.00*	0.00	*0.01*	0.01	*0.03*	0.02

Table 2: Pre- & Post-development Runoff Volume Comparison, units are in acre-feet.

Storm Event	2 Year		10 Year		25 Year		100 Year	
	Pre	Post	*Pre*	Post	*Pre*	Post	*Pre*	Post
Design Point 1	*0.00*	0.00	*0.00*	0.00	*0.01*	0.01	*0.02*	0.02
Design Point 2	*0.00*	0.00	*0.00*	0.00	*0.01*	0.01	*0.01*	0.01

2.0 PRE-DEVELOPMENT CONDITIONS

2.1 Site Conditions

The site is currently undeveloped and wooded. There are no existing stormwater controls on-site.

Runoff from the site currently drains to two primary locations: Wareham Street at the western portion of the site and the wooded area at the eastern portion of the site. The Wareham Street side of the site has been named Design Point 1 (DP-1) and the western side of the site has been named Design Point 2 (DP-2) in the hydrologic analyses.

The site does not contain, nor is it tributary to any Critical Areas.

The site is not within a watershed with a TMDL or draft TMDL.

2.2 Soil Description

The Natural Resources Conservation Service (NRCS) lists the on-site soils as Carver coarse sand, an excessively drained soil consisting of 80% Carver coarse sand, and 20% minor components. Generally, this soil is located in areas of moraines and outwash plains, and has an organic soil layer extending down 3-inches below the surface followed by a coarse sand layer. NRCS classifies this type of soil as hydrologic class A soil.

A Certified Soil Evaluator (Mark Mooney, EIT, SE 14347) conducted a site visit on 03/30/2022 to verify the NRCS classification. Inspection of the site determined that the onsite soils have not been disturbed, filled or otherwise altered. The soils observed were consistent with NRCS soil mapping. Soil Textures consisted of loamy sand underlain by sand. No groundwater or redoximorphic features were observed. A percolation test was also conducted in the area of the proposed subsurface infiltration chambers. The test pits and percolation test were witnessed by the Carver Board of Health agent. A summary of the test pits and soil logs are included in Attachment 1.

2.3 Hydrologic Analysis

Sub-catchment areas were delineated based on existing runoff patterns and topographic information. This information is shown on the *Pre-Development Conditions Hydrologic Areas Map* included in Attachment 2. Summaries of each area with respect to Curve Number and Time of Concentration calculations can be found in the model results also in Attachment 2.

3.0 POST-DEVELOPMENT CONDITIONS

3.1 Design Strategy

During the design phase of the site layout, consideration was given to conserving environmentally sensitive features and minimizing impact on the existing hydrology. To achieve this, extensive grading was avoided and the site was designed to match the existing terrain where feasible. Minimizing earthwork helps to maintain the existing drainage patterns to the maximum extent practicable under post-development conditions. On-site resource areas were excluded from the development envelope and will not be altered by the proposed project.

A stormwater management system has been designed to provide treatment for stormwater runoff associated with the proposed impervious surfaces on site. All stormwater BMPs were designed to treat a minimum of the first 1.0 inch of runoff generated by the on-site impervious areas. Proprietary stormwater treatment systems were designed to treat the runoff rate associated with the water quality volume in accordance with the requirements of the DEP Stormwater Handbook. Stormwater BMP sizing worksheets and water quality sizing calculations are included in Attachment 5 of this report.

To mitigate increased stormwater flow rates associated with the proposed impervious area, a subsurface infiltration system has been proposed. Based on the data presented in the soil logs the infiltration chambers have been proposed in the southwest corner of the site, where estimated seasonal high groundwater and bedrock are over 9-feet below the existing grade.

3.2 Hydrologic Analysis

The established design points used in the pre-development conditions analysis were used in the post-development analysis for direct comparison. The tributary areas and flow paths were modified to reflect post-development conditions. See Attachment 3 for the *Post- Development Conditions Hydrologic Areas Map*. Summaries of each area with respect to Curve Number and Time of Concentration calculations can be found in the model results in Attachment 3.

3.3 Stormwater Management Controls Sizing

Infiltration Chamber

The proposed stormwater infiltration system consists of Stormtech SC-740 chambers with a stone base. The infiltration system was sized using the Simple Dynamic Method, as described in Chapter 3 of the Massachusetts Stormwater Handbook, using a Rawl’s exfiltration rate of 2.41 inches per hour. The system has been designed to meet the required recharge volume, and will fully dewater within 72 hours.

A mounding analysis was performed to ensure that the potential rise in groundwater elevation would not interfere with the system fully dewatering within 72 hours.

3.4 Hydraulic Calculations

The proposed storm drain system was analyzed based on the 50-year storm event using the Rational Formula. A watershed map and detailed hydraulic analysis are provided in Attachment 4.

3.5 Compliance with DEP Stormwater Management Standards

The proposed stormwater management system was designed in compliance with the ten (10) DEP Stormwater Management Standards. The following summary provides key information related to the proposed stormwater management system, its design elements, and mitigation measures for potential impacts.

STANDARD 1: No new stormwater conveyance (e.g. outfalls) may discharge untreated stormwater directly to or cause erosion in wetlands or waters of the Commonwealth.

There will be no direct discharge of untreated stormwater to nearby wetlands or waters of the Commonwealth. Runoff from all impervious areas of the site will be conveyed to stormwater management controls for infiltration, water quality treatment, and runoff rate attenuation prior to discharge to adjacent wetlands.

STANDARD 2: Stormwater management systems shall be designed so that post-development peak discharge rates do not exceed pre-development peak discharge rates.

The stormwater management design will control post-development peak discharge rates for the 2-, 10-, and 100-year, 24-hour storms so as to maintain pre-development peak discharge rates. Refer to Section 1.0 Introduction for a summary of the peak runoff rates.

STANDARD 3: Loss of annual recharge to groundwater shall be eliminated or minimized through the use of environmentally sensitive site design, low impact development techniques, stormwater management practices and good operation and maintenance. At a minimum, the annual recharge from the post-development site shall approximate the annual recharge from pre-development conditions based on soil types. This Standard is met when the stormwater management system is designed to infiltrate the required recharge volume as determined in accordance with the Massachusetts Stormwater Handbook.

The stormwater management system includes a subsurface infiltration area that will effectively recharge groundwater on-site. Infiltration BMPs were sized using the simple dynamic method based on the required recharge volume for the post-development site. As a result, annual recharge from the post-development site will approximate the annual recharge from the site under pre-development conditions. See Attachment 5 for stormwater BMP design worksheets and Groundwater Recharge Calculation.

STANDARD 4: Stormwater management systems shall be designed to remove 80% of the average annual post-construction load of Total Suspended Solids (TSS).

The proposed project will meet the water quality requirements of Standard 4 using several on-site treatment trains that achieve 80% TSS removal. Refer to Attachment 5 for the TSS removal worksheets. Structural BMPs designed for water quality treatment, including the deep sump hooded catch basins, and Stormceptor® water quality treatment systems, were sized to capture and treat the flow rate associated with the first 1.0-inch of runoff from proposed impervious surfaces. All proposed stormwater management BMPs will be operated and maintained to ensure continued water quality treatment of runoff. The Site Owner's Manual complies with the Long-Term Pollution Prevention Plan (Standard 4) and the Long-Term Operation and Maintenance Plan (Standard 9) requirements of the 2008 Massachusetts Department of Environmental Protection (MassDEP) Stormwater Management Standards. The Manual outlines source control and pollution prevention measures and maintenance requirements of stormwater best management practices (BMPs) associated with the proposed development.

STANDARD 5: For land uses with higher potential pollutant loads (LUHPPLs), source control and pollution prevention shall be implemented in accordance with the Massachusetts Stormwater Handbook to eliminate or reduce the discharge of stormwater runoff from such land uses to the maximum extent practicable.

The proposed project is not associated with stormwater discharges from land uses with higher potential pollutant loads.

STANDARD 6: Stormwater discharges to critical areas must utilize certain stormwater management BMPs approved for critical areas. Critical areas are Outstanding Resource Waters, shellfish beds, swimming beaches, coldwater fisheries and recharge areas for public water supplies.

There are no stormwater discharges to critical areas associated with this project.

STANDARD 7: **Redevelopment of previously developed sites must meet the Stormwater Management Standards to the maximum extent practicable. However, if it is not practicable to meet all the Standards, new (retrofitted or expanded) stormwater management systems must be designed to improve existing conditions.**

The proposed project is new development, and therefore this standard does not apply.

STANDARD 8: **A plan to control construction-related impacts during erosion, sedimentation and other pollutant sources during construction and land disturbance activities (construction period erosion, sedimentation, and pollution prevention plan) shall be developed and implemented.**

A Stormwater Pollution Prevention Plan (SWPPP) will be developed prior to construction to comply with Section 3 of the NPDES Construction General Permit for Stormwater Discharges; therefore, the requirements of Standard 8 are fulfilled.

STANDARD 9: **A Long-Term Operation and Maintenance (O&M) Plan shall be developed and implemented to ensure that stormwater management systems function as designed.**

The Site Owner's Manual complies with the Long-Term Pollution Prevention Plan (Standard 4) and the Long-Term Operation and Maintenance Plan (Standard 9) requirements of the 2008 Massachusetts Department of Environmental Protection (MassDEP) Stormwater Management Standards. The Manual outlines source control and pollution prevention measures and maintenance requirements of the stormwater best management practices (BMPs) associated with the proposed development.

STANDARD 10: **All illicit discharges to the stormwater management system are prohibited.**

There will be no illicit discharges to the proposed stormwater management system associated with the proposed project. An Illicit Discharge Compliance Statement is provided on the following page.

3.6 Illicit Discharge Compliance Statement

An illicit discharge is any discharge to a stormwater management system that is not comprised entirely of stormwater, discharges from fire-fighting activities, and certain non-designated non-stormwater discharges.

To the best of my knowledge, no detectable illicit discharge exists on site. The site plans included with this report detail the storm sewers that convey stormwater on the site and demonstrate that these systems do not include the entry of an illicit discharge. A Site Owner's Manual is also included, which contains the Long Term Pollution Plan that outlines measures to prevent future illicit discharges. As the Site Owner, I will ultimately be responsible for implementing the Long Term Pollution Prevention Plan.

Signature: ______________________

Owner's Name

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

Checklist for Stormwater Report

A. Introduction

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

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

The Stormwater Report must include:

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

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

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

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

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

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

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

Checklist for Stormwater Report

B. Stormwater Checklist and Certification

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

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

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

Registered Professional Engineer's Certification

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

Registered Professional Engineer Block and Signature

COMMONWEALTH OF MASSACHUSETTS
MATTHEW COTE
CIVIL
No. 46829
REGISTERED
PROFESSIONAL ENGINEER
4/6/22

4/6/22
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): ______________________

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 (continued)

Standard 2: Peak Rate Attenuation

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

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

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

Standard 3: Recharge

☒ Soil Analysis provided.

☒ Required Recharge Volume calculation provided.

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

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

☐ Static ☒ Simple Dynamic ☐ Dynamic Field[1]

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

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

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

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

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

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

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

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

Checklist (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 (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 (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.

Attachment 1
Soil Data

Soil Map—Plymouth County, Massachusetts

70° 45' 2" W
70° 43' 37" W

354700 354900 355100 355300 355500 355700 355900 356100 356300 356500

41° 48' 55" N
41° 48' 55" N

4630700 4630500 4630300 4630100 4629900 4629700 4629500

354700 354900 355100 355300 355500 355700 355900 356100 356300 356500

41° 48' 14" N
41° 48' 14" N

70° 45' 2" W
70° 43' 37" W

Map Scale: 1:8,950 if printed on A landscape (11" x 8.5") sheet.

N

Meters: 0 100 200 400 600

Feet: 0 400 800 1600 2400

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 19N WGS84

MAP LEGEND

Area of Interest (AOI)

Area of Interest (AOI)

Soils

Soil Map Unit Polygons

Soil Map Unit Lines

Soil Map Unit Points

Special Point Features

Blowout

Borrow Pit

Clay Spot

Closed Depression

Gravel Pit

Gravelly Spot

Landfill

Lava Flow

Marsh or swamp

Mine or Quarry

Miscellaneous Water

Perennial Water

Rock Outcrop

Saline Spot

Sandy Spot

Severely Eroded Spot

Sinkhole

Slide or Slip

Sodic Spot

Spoil Area

Stony Spot

Very Stony Spot

Wet Spot

Other

Special Line Features

Water Features

Streams and Canals

Transportation

Rails

Interstate Highways

US Routes

Major Roads

Local Roads

Background

Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:12,000.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Plymouth County, Massachusetts
Survey Area Data: Version 14, Sep 2, 2021

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Sep 25, 2020—Oct 9, 2020

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Map Unit Legend

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
1	Water	28.9	7.5%
7A	Rainberry coarse sand, 0 to 3 percent slopes, sanded surface	6.6	1.7%
11A	Rainberry coarse sand, 0 to 3 percent slopes	4.8	1.3%
23A	Tihonet coarse sand, 0 to 3 percent slopes	0.8	0.2%
37A	Massasoit - Mashpee complex, 0 to 3 percent slopes	6.9	1.8%
52A	Freetown muck, 0 to 1 percent slopes	2.5	0.6%
53A	Freetown muck, ponded, 0 to 1 percent slopes	14.7	3.8%
55A	Freetown coarse sand, 0 to 3 percent slopes, sanded surface	53.5	13.9%
60A	Swansea coarse sand, 0 to 2 percent slopes	16.7	4.3%
252A	Carver coarse sand, 0 to 3 percent slopes	6.5	1.7%
252B	Carver coarse sand, 3 to 8 percent slopes	128.0	33.2%
252C	Carver coarse sand, 8 to 15 percent slopes	9.9	2.6%
256A	Deerfield loamy fine sand, 0 to 3 percent slopes	1.3	0.3%
256B	Deerfield loamy fine sand, 3 to 8 percent slopes	23.4	6.1%
259B	Carver loamy coarse sand, 3 to 8 percent slopes	2.5	0.7%
259C	Carver loamy coarse sand, 8 to 15 percent slopes	7.8	2.0%
262C	Quonset sandy loam, 8 to 15 percent slopes	1.2	0.3%
435B	Plymouth loamy coarse sand, 3 to 8 percent slopes	2.6	0.7%
435C	Plymouth loamy coarse sand, 8 to 15 percent slopes	2.8	0.7%
437C	Plymouth loamy coarse sand, 8 to 15 percent slopes, bouldery	2.6	0.7%
438C	Plymouth loamy coarse sand, 8 to 15 percent slopes, extremely bouldery	4.6	1.2%

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
480C	Plymouth - Carver complex, 8 to 15 percent slopes	11.7	3.0%
665B	Udipsamments, 0 to 8 percent slopes	37.8	9.8%
700A	Udipsamments, wet substratum, 0 to 3 percent slopes	4.3	1.1%
702C	Udipsamments, 8 to 15 percent slopes	3.3	0.8%
Totals for Area of Interest		**385.7**	**100.0%**

Plymouth County, Massachusetts

252B—Carver coarse sand, 3 to 8 percent slopes

Map Unit Setting

National map unit symbol: 2y07x
Elevation: 0 to 240 feet
Mean annual precipitation: 36 to 71 inches
Mean annual air temperature: 39 to 55 degrees F
Frost-free period: 140 to 240 days
Farmland classification: Not prime farmland

Map Unit Composition

Carver, coarse sand, and similar soils: 80 percent
Minor components: 20 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Carver, Coarse Sand

Setting

Landform: Moraines, outwash plains
Landform position (two-dimensional): Summit, shoulder, backslope, footslope, toeslope
Landform position (three-dimensional): Crest, head slope, nose slope, side slope, tread
Down-slope shape: Convex, linear
Across-slope shape: Linear
Parent material: Sandy glaciofluvial deposits

Typical profile

Oi - 0 to 2 inches: slightly decomposed plant material
Oe - 2 to 3 inches: moderately decomposed plant material
A - 3 to 7 inches: coarse sand
E - 7 to 10 inches: coarse sand
Bw1 - 10 to 15 inches: coarse sand
Bw2 - 15 to 28 inches: coarse sand
BC - 28 to 32 inches: coarse sand
C - 32 to 67 inches: coarse sand

Properties and qualities

Slope: 3 to 8 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Excessively drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to very high (1.42 to 14.17 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Maximum salinity: Nonsaline (0.0 to 1.9 mmhos/cm)
Available water supply, 0 to 60 inches: Low (about 4.3 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 3s
Hydrologic Soil Group: A
Ecological site: F149BY005MA - Dry Outwash
Hydric soil rating: No

Minor Components

Deerfield

Percent of map unit: 10 percent
Landform: Outwash terraces, outwash plains, kame terraces, outwash deltas
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Concave
Hydric soil rating: No

Hinckley

Percent of map unit: 5 percent
Landform: Eskers, kames, outwash deltas, outwash terraces, outwash plains, kame terraces, moraines
Landform position (two-dimensional): Footslope, shoulder, backslope, summit, toeslope
Landform position (three-dimensional): Nose slope, side slope, crest, head slope, riser, tread
Down-slope shape: Convex
Across-slope shape: Convex
Hydric soil rating: No

Merrimac

Percent of map unit: 3 percent
Landform: Kame terraces, outwash deltas, outwash terraces
Landform position (three-dimensional): Tread, riser
Down-slope shape: Linear
Across-slope shape: Linear
Hydric soil rating: No

Mashpee

Percent of map unit: 2 percent
Landform: Depressions, drainageways, terraces
Landform position (three-dimensional): Tread
Down-slope shape: Concave
Across-slope shape: Concave
Hydric soil rating: Yes

Data Source Information

Soil Survey Area: Plymouth County, Massachusetts
Survey Area Data: Version 14, Sep 2, 2021

B E A L S + T H O M A S
Soil Test Pit Log

1833.120- Carver, MA
3/30/2022

Deep Observation Hole Number: TP - 1

Depth (in.)	Soil Horizon/ Layer	Soil Matrix: Color-Moist (Munsell)	Redoximorphic Features			Soil Texture (USDA)	Coarse Fragments % by Volume		Soil Structure	Soil Consistence (Moist)	Other
			Depth	Color	Percent		Gravel	Cobbles & Stones			
0-6	A	10YR 2/2				Loamy Sand	0 - 5	0 - 5	Granular	Friable	
6-24	Bw	10YR 6/6				Loamy Sand	0-5	0-5	Massive	Friable	
24-100	C	10YR 7/3				Sand	0-5	0-5	Single Grain	Loose	

Additional Notes:
No water or redox observed

BEALS + THOMAS
Soil Test Pit Log

1833.120- Carver, MA
3/30/2022

Deep Observation Hole Number: TP - 2

Depth (in.)	Soil Horizon/ Layer	Soil Matrix: Color-Moist (Munsell)	Redoximorphic Features			Soil Texture (USDA)	Coarse Fragments % by Volume		Soil Structure	Soil Consistence (Moist)	Other
			Depth	Color	Percent		Gravel	Cobbles & Stones			
0-6	A	10YR 2/2				Loamy Sand	0 - 5	0 - 5	Granular	Friable	
6-24	Bw	10YR 6/6				Loamy Sand	0-5	0-5	Massive	Friable	
24-100	C	10YR 7/3				Sand	0-5	0-5	Single Grain	Loose	

Additional Notes:
No water or redox observed

BEALS + THOMAS
Soil Test Pit Log

1833.120- Carver, MA
3/30/2022

Deep Observation Hole Number: TP - 3

Depth (in.)	Soil Horizon/ Layer	Soil Matrix: Color-Moist (Munsell)	Redoximorphic Features			Soil Texture (USDA)	Coarse Fragments % by Volume		Soil Structure	Soil Consistence (Moist)	Other
			Depth	Color	Percent		Gravel	Cobbles & Stones			
0-8	A	10YR 2/2				Loamy Sand	0 - 5	0 - 5	Granular	Friable	
8-20	Bw	10YR 6/6				Loamy Sand	0-5	0-5	Massive	Friable	
24-90	C	10YR 7/3				Sand	0-5	0-5	Single Grain	Loose	

Additional Notes:
No water or redox observed

BEALS + THOMAS
Soil Test Pit Log

1833.120- Carver, MA
3/30/2022

Deep Observation Hole Number: TP - 4

Depth (in.)	Soil Horizon/ Layer	Soil Matrix: Color-Moist (Munsell)	Redoximorphic Features			Soil Texture (USDA)	Coarse Fragments % by Volume		Soil Structure	Soil Consistence (Moist)	Other
			Depth	Color	Percent		Gravel	Cobbles & Stones			
0-4	A	10YR 2/2				Loamy Sand	0 - 5	0 - 5	Granular	Friable	
4-28	Bw	10YR 6/6				Loamy Sand	0-5	0-5	Massive	Friable	
28-94	C	10YR 7/3				Sand	0-5	0-5	Single Grain	Loose	

Additional Notes:
No water or redox observed

Commonwealth of Massachusetts
City/Town of Carver
Percolation Test
Form 12

Percolation test results must be submitted with the Soil Suitability Assessment for On-site Sewage Disposal. DEP has provided this form for use by local Boards of Health. Other forms may be used, but the information must be substantially the same as that provided here. Before using this form, check with the local Board of Health to determine the form they use.

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

[redacted]

A. Site Information

Owner Name

Off Wareham Street
Street Address or Lot #

Carver	MA	02330
City/Town	State	Zip Code

Contact Person (if different from Owner)

Telephone Number

B. Test Results

	3/30/22	10:53 AM		
	Date	Time	Date	Time
Observation Hole #	Perc A			
Depth of Perc	54"			
Start Pre-Soak	10:53 A.M.			
End Pre-Soak	Did Not Pre-Soak			
Time at 12”				
Time at 9”				
Time at 6”				
Time (9”-6”)				
Rate (Min./Inch)	<2min/in			
	Test Passed: ☒		Test Passed: ☐	
	Test Failed: ☐		Test Failed: ☐	

Mark Mooney SE#14347
Test Performed By:

Kevin Forgue
Board of Health Witness

Comments:

Attachment 2
Pre-Development Hydrologic Analysis

EXISTING CONDITIONS HYDROLOGY CALCULATION SUMMARY

OBJECTIVE

To determine pre-development peak rates and volumes of runoff from the site for the 2, 10, & 100-year storm events at the design points.

CONCLUSION(S)

Peak Runoff Rates (CFS):

Storm Event	DP-1	DP-2
2-Year	0.00	0.00
10-Year	0.00	0.00
25-Year	0.02	0.01
100-Year	0.05	0.03

Total Runoff Volumes (Ac-Ft):

Storm Event	DP-1	DP-2
2-Year	0.00	0.00
10-Year	0.00	0.00
25-Year	0.01	0.01
100-Year	0.02	0.01

CALCULATION METHODS

1. Runoff curve numbers (CN), time-of-concentration (Tc), and runoff rates were calculated based on TR-55 methodology.
2. AutoCAD 2019 computer program was utilized for digitizing ground cover areas.
3. Peak runoff rates were computed using HydroCAD version 10.10.

ASSUMPTIONS

1. The ground cover types were determined using aerial imagery. Hydrologic soil groups based on United States Department of Agriculture, NRCS Soil Survey map information.

SOURCES OF DATA/ EQUATIONS

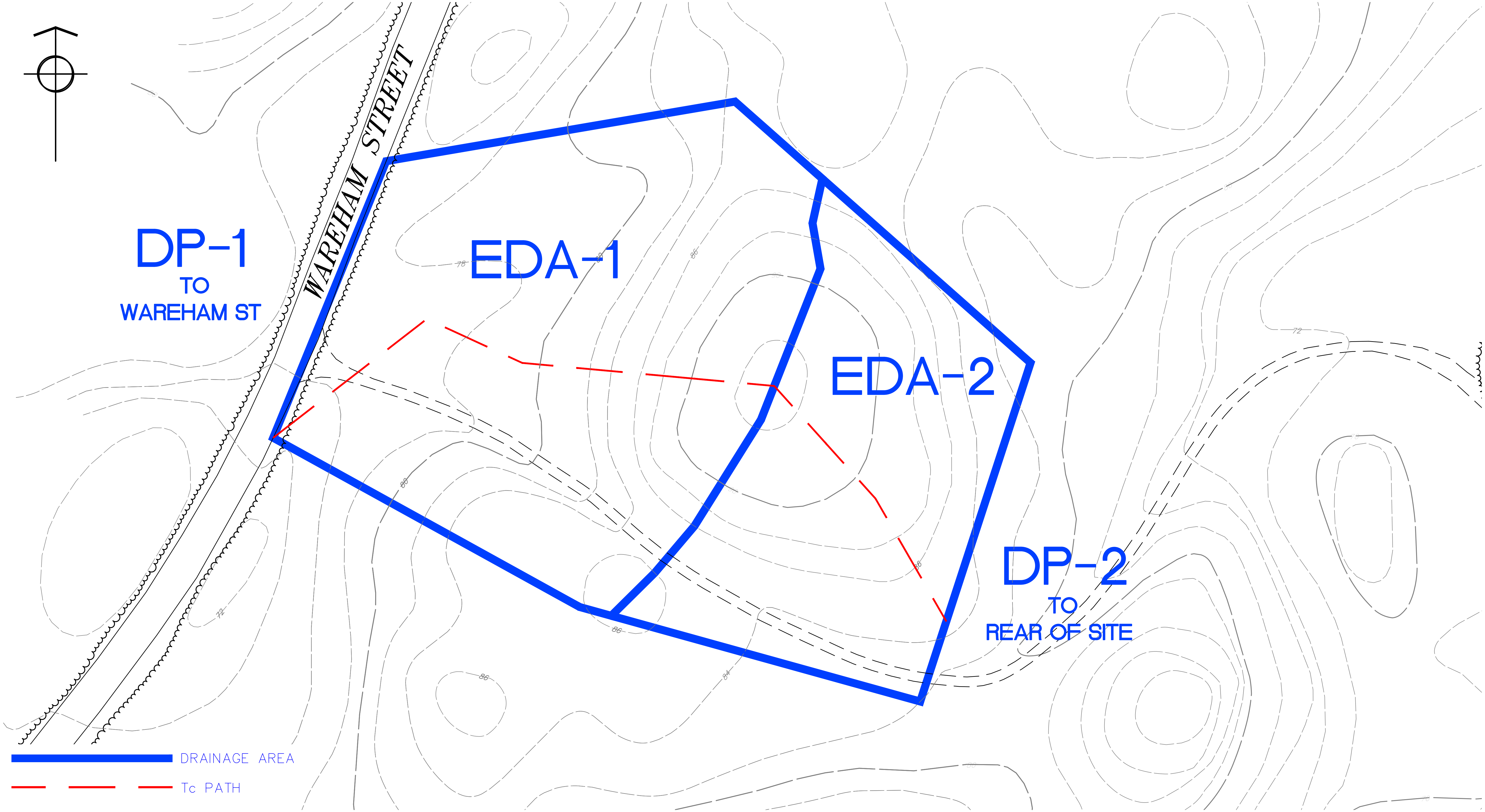
1. Existing Conditions Watershed Map prepared by Beals and Thomas, Inc. File No. 1833120P651A-001
2. NRCS Soil Survey for Plymouth County, hydrologic soil group report, downloaded from Web Soil Survey on 3/22/2022.
3. Massachusetts DEP Stormwater Management Handbook, February 2008.

REV	CALC. BY	DATE	CHECKED BY	DATE	APPROVED BY	DATE
0	MPM	3/30/22	NPS	3/31/22	MC	4/5/22

1833120CS001A

Fox Run Subdivision

Carver, MA



METERS 0 10 25 50
0 30 60 120 180 FEET

BEALS + THOMAS

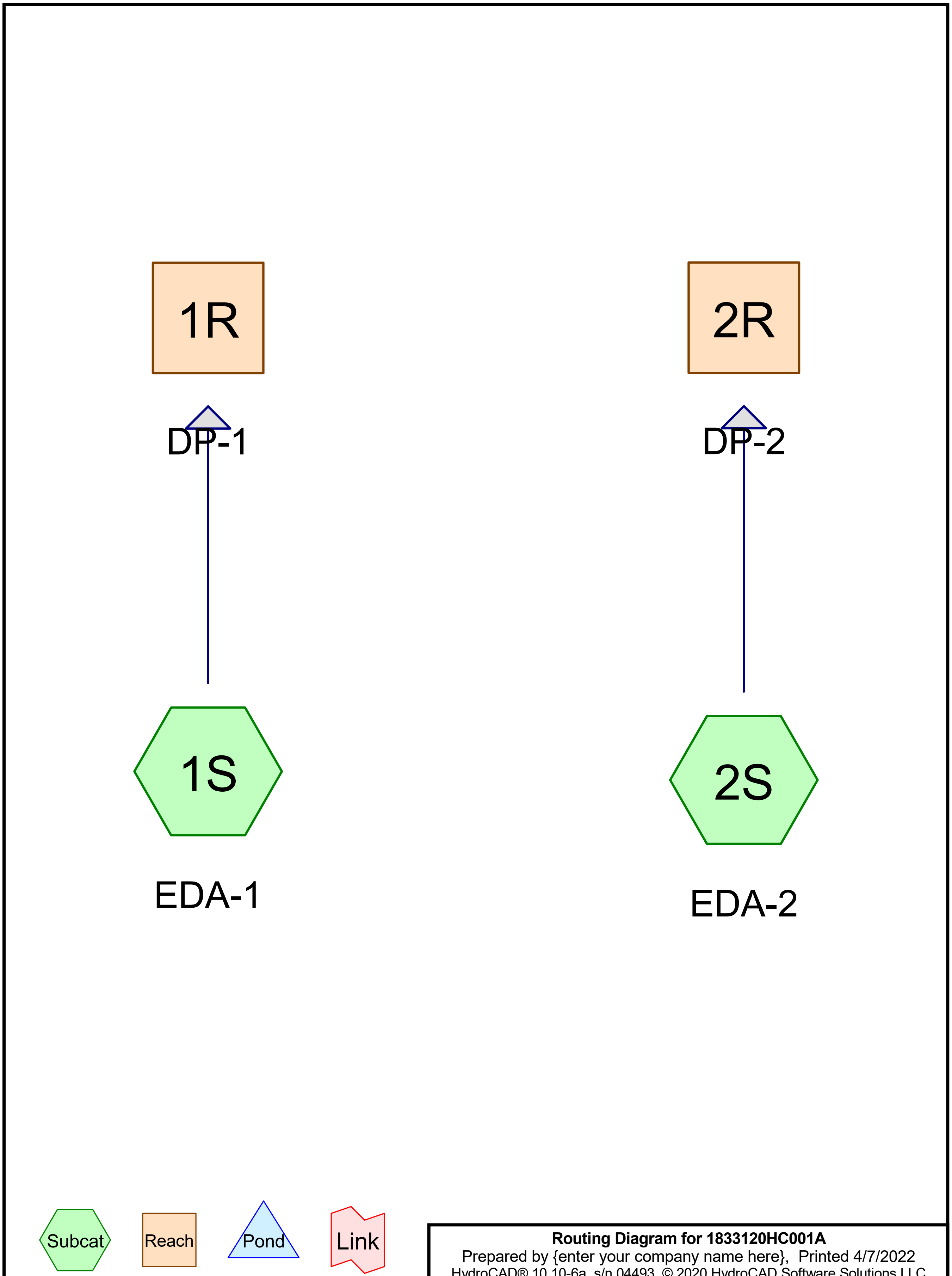
B+T Drawing No. 1833120P651A-001 Date: 3/31/2022 Scale: 1" = 60'

Existing Conditions

Watershed Map

Figure

1



Routing Diagram for 1833120HC001A
Prepared by {enter your company name here}, Printed 4/7/2022
HydroCAD® 10.10-6a s/n 04493 © 2020 HydroCAD Software Solutions LLC

Rainfall Events Listing (selected events)

Event#	Event Name	Storm Type	Curve	Mode	Duration (hours)	B/B	Depth (inches)	AMC
1	Plymouth-002yr	Type III 24-hr		Default	24.00	1	3.40	2
2	Plymouth-010yr	Type III 24-hr		Default	24.00	1	5.08	2
3	Plymouth-025yr	Type III 24-hr		Default	24.00	1	6.22	2
4	Plymouth-100yr	Type III 24-hr		Default	24.00	1	7.00	2

Area Listing (all nodes)

Area (acres)	CN	Description (subcatchment-numbers)
2.81	30	Woods, Good, HSG A (1S, 2S)
2.81	**30**	**TOTAL AREA**

Time span=5.00-20.00 hrs, dt=0.05 hrs, 301 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 1S: EDA-1 Runoff Area=1.79 ac 0.00% Impervious Runoff Depth=0.00"
Flow Length=356' Tc=13.6 min CN=30 Runoff=0.00 cfs 0.000 af

Subcatchment 2S: EDA-2 Runoff Area=1.02 ac 0.00% Impervious Runoff Depth=0.00"
Flow Length=189' Tc=12.7 min CN=30 Runoff=0.00 cfs 0.000 af

Reach 1R: DP-1 Inflow=0.00 cfs 0.000 af
Outflow=0.00 cfs 0.000 af

Reach 2R: DP-2 Inflow=0.00 cfs 0.000 af
Outflow=0.00 cfs 0.000 af

Total Runoff Area = 2.81 ac Runoff Volume = 0.000 af Average Runoff Depth = 0.00"
100.00% Pervious = 2.81 ac 0.00% Impervious = 0.00 ac

Summary for Subcatchment 1S: EDA-1

Runoff = 0.00 cfs @ 5.00 hrs, Volume= 0.000 af, Depth= 0.00"
Routed to Reach 1R : DP-1

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr Plymouth-002yr Rainfall=3.40"

Area (ac)	CN	Description
1.79	30	Woods, Good, HSG A
1.79		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
9.0	50	0.0600	0.09		**Sheet Flow, Sheet** Woods: Light underbrush n= 0.400 P2= 2.50"
4.6	306	0.0500	1.12		**Shallow Concentrated Flow, Woods** Woodland Kv= 5.0 fps
13.6	356	Total			

Summary for Subcatchment 2S: EDA-2

Runoff = 0.00 cfs @ 5.00 hrs, Volume= 0.000 af, Depth= 0.00"
Routed to Reach 2R : DP-2

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr Plymouth-002yr Rainfall=3.40"

Area (ac)	CN	Description
1.02	30	Woods, Good, HSG A
1.02		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.6	50	0.0400	0.08		**Sheet Flow, Sheet** Woods: Light underbrush n= 0.400 P2= 2.50"
2.1	139	0.0500	1.12		**Shallow Concentrated Flow, Woods** Woodland Kv= 5.0 fps
12.7	189	Total			

Summary for Reach 1R: DP-1

Inflow Area = 1.79 ac, 0.00% Impervious, Inflow Depth = 0.00" for Plymouth-002yr event
Inflow = 0.00 cfs @ 5.00 hrs, Volume= 0.000 af
Outflow = 0.00 cfs @ 5.00 hrs, Volume= 0.000 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs

Summary for Reach 2R: DP-2

Inflow Area = 1.02 ac, 0.00% Impervious, Inflow Depth = 0.00" for Plymouth-002yr event
Inflow = 0.00 cfs @ 5.00 hrs, Volume= 0.000 af
Outflow = 0.00 cfs @ 5.00 hrs, Volume= 0.000 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs

Time span=5.00-20.00 hrs, dt=0.05 hrs, 301 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 1S: EDA-1 Runoff Area=1.79 ac 0.00% Impervious Runoff Depth>0.00"
Flow Length=356' Tc=13.6 min CN=30 Runoff=0.00 cfs 0.000 af

Subcatchment 2S: EDA-2 Runoff Area=1.02 ac 0.00% Impervious Runoff Depth>0.00"
Flow Length=189' Tc=12.7 min CN=30 Runoff=0.00 cfs 0.000 af

Reach 1R: DP-1 Inflow=0.00 cfs 0.000 af
Outflow=0.00 cfs 0.000 af

Reach 2R: DP-2 Inflow=0.00 cfs 0.000 af
Outflow=0.00 cfs 0.000 af

Total Runoff Area = 2.81 ac Runoff Volume = 0.000 af Average Runoff Depth = 0.00"
100.00% Pervious = 2.81 ac 0.00% Impervious = 0.00 ac

Summary for Subcatchment 1S: EDA-1

Runoff = 0.00 cfs @ 20.00 hrs, Volume= 0.000 af, Depth> 0.00"
Routed to Reach 1R : DP-1

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr Plymouth-010yr Rainfall=5.08"

Area (ac)	CN	Description
1.79	30	Woods, Good, HSG A
1.79		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
9.0	50	0.0600	0.09		**Sheet Flow, Sheet** Woods: Light underbrush n= 0.400 P2= 2.50"
4.6	306	0.0500	1.12		**Shallow Concentrated Flow, Woods** Woodland Kv= 5.0 fps
13.6	356	Total			

Summary for Subcatchment 2S: EDA-2

Runoff = 0.00 cfs @ 20.00 hrs, Volume= 0.000 af, Depth> 0.00"
Routed to Reach 2R : DP-2

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr Plymouth-010yr Rainfall=5.08"

Area (ac)	CN	Description
1.02	30	Woods, Good, HSG A
1.02		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.6	50	0.0400	0.08		**Sheet Flow, Sheet** Woods: Light underbrush n= 0.400 P2= 2.50"
2.1	139	0.0500	1.12		**Shallow Concentrated Flow, Woods** Woodland Kv= 5.0 fps
12.7	189	Total			

Summary for Reach 1R: DP-1

Inflow Area = 1.79 ac, 0.00% Impervious, Inflow Depth > 0.00" for Plymouth-010yr event
Inflow = 0.00 cfs @ 20.00 hrs, Volume= 0.000 af
Outflow = 0.00 cfs @ 20.00 hrs, Volume= 0.000 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs

Summary for Reach 2R: DP-2

Inflow Area = 1.02 ac, 0.00% Impervious, Inflow Depth > 0.00" for Plymouth-010yr event
Inflow = 0.00 cfs @ 20.00 hrs, Volume= 0.000 af
Outflow = 0.00 cfs @ 20.00 hrs, Volume= 0.000 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs

Time span=5.00-20.00 hrs, dt=0.05 hrs, 301 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 1S: EDA-1 Runoff Area=1.79 ac 0.00% Impervious Runoff Depth>0.07"
Flow Length=356' Tc=13.6 min CN=30 Runoff=0.02 cfs 0.010 af

Subcatchment 2S: EDA-2 Runoff Area=1.02 ac 0.00% Impervious Runoff Depth>0.07"
Flow Length=189' Tc=12.7 min CN=30 Runoff=0.01 cfs 0.006 af

Reach 1R: DP-1 Inflow=0.02 cfs 0.010 af
Outflow=0.02 cfs 0.010 af

Reach 2R: DP-2 Inflow=0.01 cfs 0.006 af
Outflow=0.01 cfs 0.006 af

Total Runoff Area = 2.81 ac Runoff Volume = 0.015 af Average Runoff Depth = 0.07"
100.00% Pervious = 2.81 ac 0.00% Impervious = 0.00 ac

Summary for Subcatchment 1S: EDA-1

Runoff = 0.02 cfs @ 15.34 hrs, Volume= 0.010 af, Depth> 0.07"
Routed to Reach 1R : DP-1

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr Plymouth-025yr Rainfall=6.22"

Area (ac)	CN	Description
1.79	30	Woods, Good, HSG A
1.79		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
9.0	50	0.0600	0.09		**Sheet Flow, Sheet** Woods: Light underbrush n= 0.400 P2= 2.50"
4.6	306	0.0500	1.12		**Shallow Concentrated Flow, Woods** Woodland Kv= 5.0 fps
13.6	356	Total			

Summary for Subcatchment 2S: EDA-2

Runoff = 0.01 cfs @ 15.32 hrs, Volume= 0.006 af, Depth> 0.07"
Routed to Reach 2R : DP-2

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr Plymouth-025yr Rainfall=6.22"

Area (ac)	CN	Description
1.02	30	Woods, Good, HSG A
1.02		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.6	50	0.0400	0.08		**Sheet Flow, Sheet** Woods: Light underbrush n= 0.400 P2= 2.50"
2.1	139	0.0500	1.12		**Shallow Concentrated Flow, Woods** Woodland Kv= 5.0 fps
12.7	189	Total			

Summary for Reach 1R: DP-1

Inflow Area = 1.79 ac, 0.00% Impervious, Inflow Depth > 0.07" for Plymouth-025yr event
Inflow = 0.02 cfs @ 15.34 hrs, Volume= 0.010 af
Outflow = 0.02 cfs @ 15.34 hrs, Volume= 0.010 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs

Summary for Reach 2R: DP-2

Inflow Area = 1.02 ac, 0.00% Impervious, Inflow Depth > 0.07" for Plymouth-025yr event
Inflow = 0.01 cfs @ 15.32 hrs, Volume= 0.006 af
Outflow = 0.01 cfs @ 15.32 hrs, Volume= 0.006 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs

Time span=5.00-20.00 hrs, dt=0.05 hrs, 301 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 1S: EDA-1 Runoff Area=1.79 ac 0.00% Impervious Runoff Depth>0.16"
Flow Length=356' Tc=13.6 min CN=30 Runoff=0.05 cfs 0.024 af

Subcatchment 2S: EDA-2 Runoff Area=1.02 ac 0.00% Impervious Runoff Depth>0.16"
Flow Length=189' Tc=12.7 min CN=30 Runoff=0.03 cfs 0.014 af

Reach 1R: DP-1 Inflow=0.05 cfs 0.024 af
Outflow=0.05 cfs 0.024 af

Reach 2R: DP-2 Inflow=0.03 cfs 0.014 af
Outflow=0.03 cfs 0.014 af

Total Runoff Area = 2.81 ac Runoff Volume = 0.038 af Average Runoff Depth = 0.16"
100.00% Pervious = 2.81 ac 0.00% Impervious = 0.00 ac

Summary for Subcatchment 1S: EDA-1

Runoff = 0.05 cfs @ 13.89 hrs, Volume= 0.024 af, Depth> 0.16"
Routed to Reach 1R : DP-1

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr Plymouth-100yr Rainfall=7.00"

Area (ac)	CN	Description
1.79	30	Woods, Good, HSG A
1.79		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
9.0	50	0.0600	0.09		**Sheet Flow, Sheet** Woods: Light underbrush n= 0.400 P2= 2.50"
4.6	306	0.0500	1.12		**Shallow Concentrated Flow, Woods** Woodland Kv= 5.0 fps
13.6	356	Total			

Summary for Subcatchment 2S: EDA-2

Runoff = 0.03 cfs @ 13.87 hrs, Volume= 0.014 af, Depth> 0.16"
Routed to Reach 2R : DP-2

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr Plymouth-100yr Rainfall=7.00"

Area (ac)	CN	Description
1.02	30	Woods, Good, HSG A
1.02		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.6	50	0.0400	0.08		**Sheet Flow, Sheet** Woods: Light underbrush n= 0.400 P2= 2.50"
2.1	139	0.0500	1.12		**Shallow Concentrated Flow, Woods** Woodland Kv= 5.0 fps
12.7	189	Total			

Summary for Reach 1R: DP-1

Inflow Area = 1.79 ac, 0.00% Impervious, Inflow Depth > 0.16" for Plymouth-100yr event
Inflow = 0.05 cfs @ 13.89 hrs, Volume= 0.024 af
Outflow = 0.05 cfs @ 13.89 hrs, Volume= 0.024 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs

Summary for Reach 2R: DP-2

Inflow Area = 1.02 ac, 0.00% Impervious, Inflow Depth > 0.16" for Plymouth-100yr event
Inflow = 0.03 cfs @ 13.87 hrs, Volume= 0.014 af
Outflow = 0.03 cfs @ 13.87 hrs, Volume= 0.014 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs

Attachment 3
Post-Development Hydrologic Analysis

PROPOSED CONDITIONS HYDROLOGY CALCULATION SUMMARY

OBJECTIVE

To determine post-development peak rates and volumes of runoff from the site for the 2, 10, & 100-year storm events at the design points.

CONCLUSION(S)

Peak Runoff Rates (CFS):

Storm Event	DP-1	DP-2
2-Year	0.00	0.00
10-Year	0.00	0.00
25-Year	0.01	0.01
100-Year	0.04	0.02

Total Runoff Volumes (Ac-Ft):

Storm Event	DP-1	DP-2
2-Year	0.00	0.00
10-Year	0.00	0.00
25-Year	0.01	0.01
100-Year	0.02	0.01

CALCULATION METHODS

1. Runoff curve numbers (CN), time-of-concentration (Tc), and runoff rates were calculated based on TR-55 methodology.
2. AutoCAD 2019 computer program was utilized for digitizing ground cover areas.
3. Peak runoff rates were computed using HydroCAD version 10.10.

ASSUMPTIONS

1. The ground cover types were determined using aerial imagery. Hydrologic soil groups based on United States Department of Agriculture, NRCS Soil Survey map information.

SOURCES OF DATA/ EQUATIONS

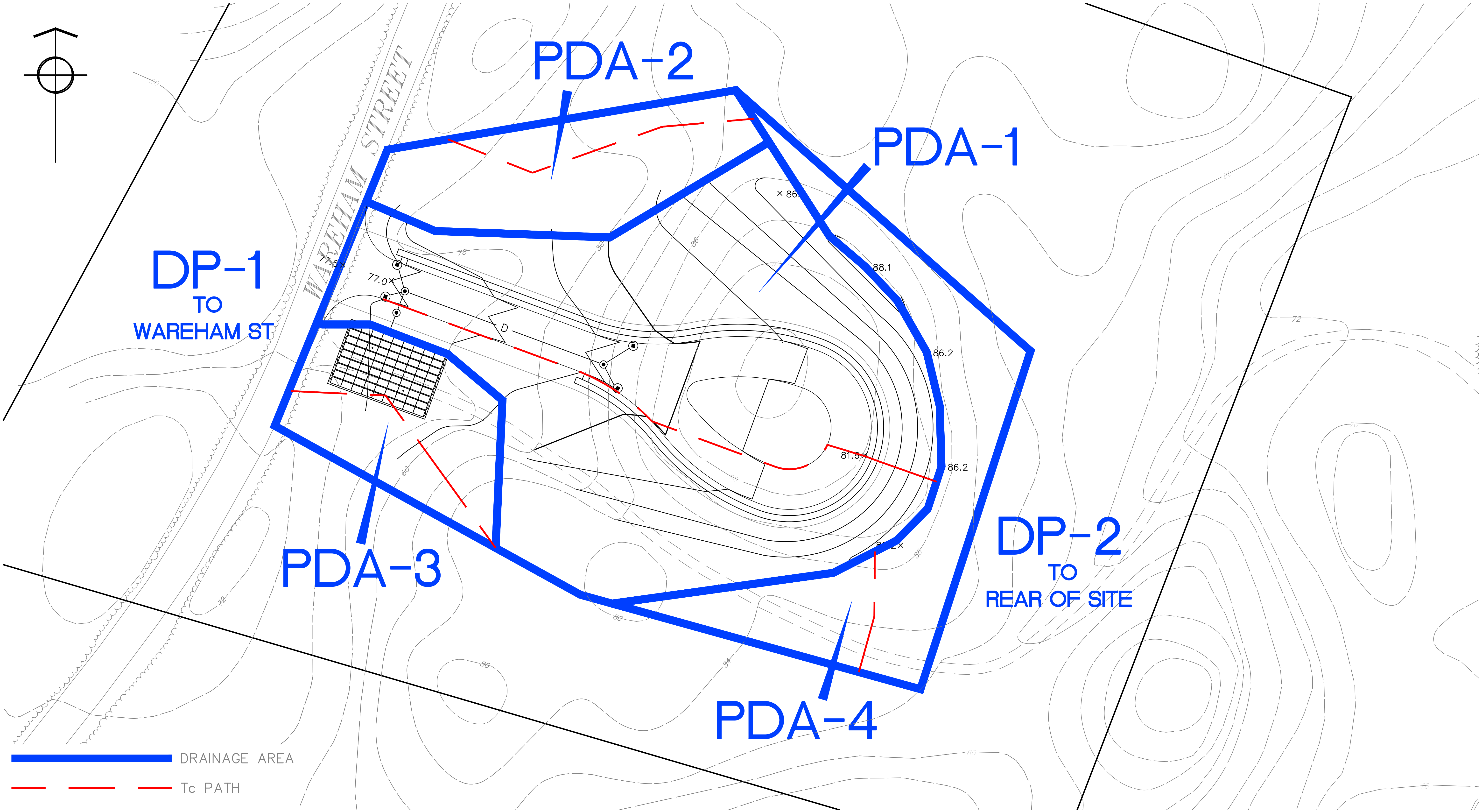
1. Proposed Conditions Watershed Map prepared by Beals and Thomas, Inc. File No. 1833120P651A-002
2. NRCS Soil Survey for Plymouth County, hydrologic soil group report, downloaded from Web Soil Survey on 3/22/2022.
3. Massachusetts DEP Stormwater Management Handbook, February 2008.

REV	CALC. BY	DATE	CHECKED BY	DATE	APPROVED BY	DATE
0	MPM	3/30/22	NPS	3/31/22	MC	4/5/22

1833120CS002A

Fox Run Subdivision

Carver, MA



BEALS + THOMAS

B+T Drawing No. 1833120P651A-002 Date: 3/31/2022 Scale: 1" = 60'

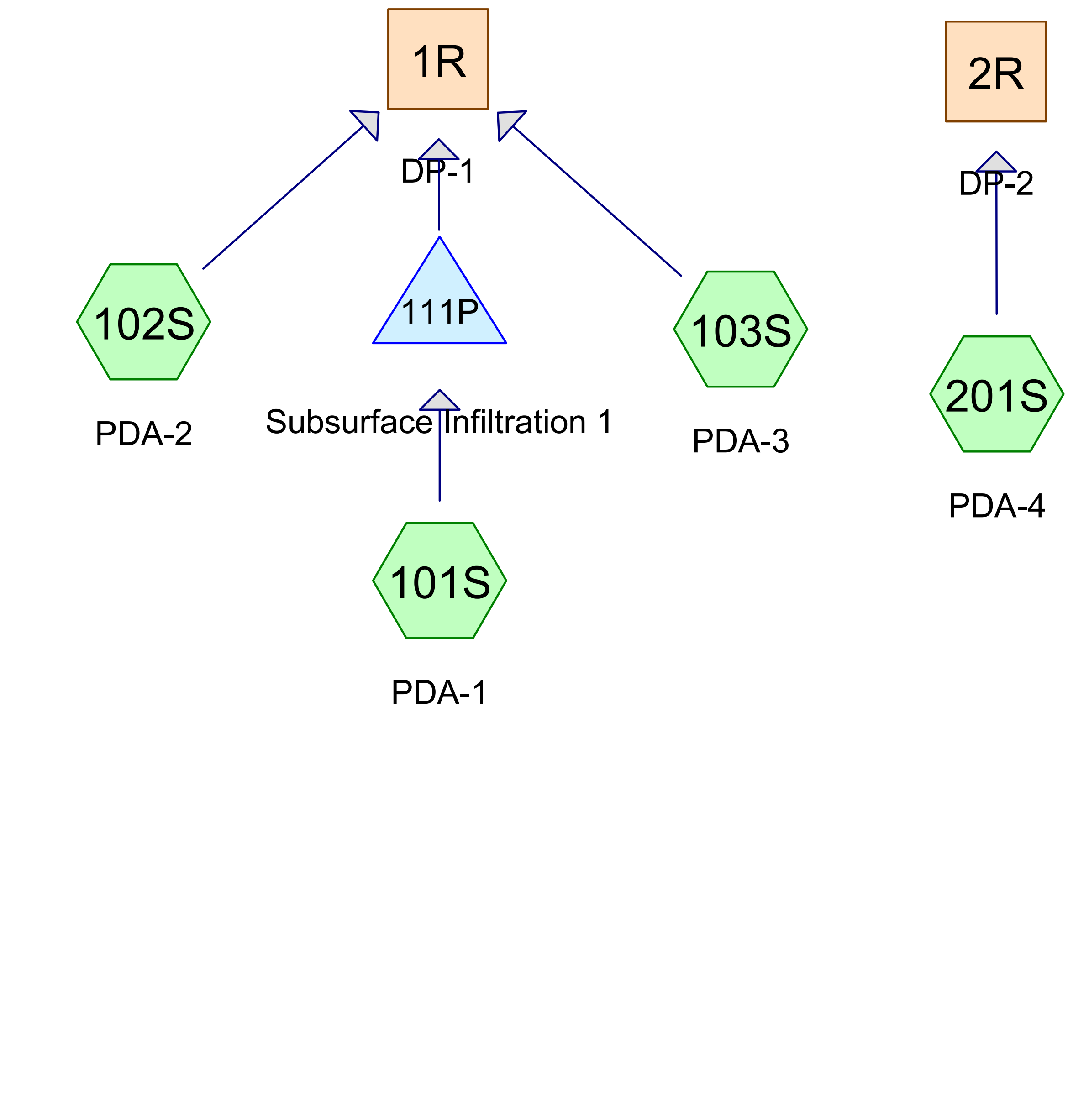
METERS 0 10 25 50
0 30 60 120 180 FEET

Proposed Conditions

Watershed Map

Figure

2



Routing Diagram for 1833120HC002A
Prepared by {enter your company name here}, Printed 4/7/2022
HydroCAD® 10.10-6a s/n 04493 © 2020 HydroCAD Software Solutions LLC

Rainfall Events Listing (selected events)

Event#	Event Name	Storm Type	Curve	Mode	Duration (hours)	B/B	Depth (inches)	AMC
1	Plymouth-002yr	Type III 24-hr		Default	24.00	1	3.40	2
2	Plymouth-010yr	Type III 24-hr		Default	24.00	1	4.70	2
3	Plymouth-025yr	Type III 24-hr		Default	24.00	1	6.22	2
4	Plymouth-100yr	Type III 24-hr		Default	24.00	1	7.00	2

Area Listing (all nodes)

Area (acres)	CN	Description (subcatchment-numbers)
1.24	39	>75% Grass cover, Good, HSG A (101S, 102S, 103S, 201S)
0.40	98	Paved roads w/curbs & sewers, HSG A (101S)
1.17	30	Woods, Good, HSG A (101S, 102S, 103S, 201S)
2.81	**44**	**TOTAL AREA**

Time span=5.00-30.00 hrs, dt=0.05 hrs, 501 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 101S: PDA-1 Runoff Area=1.66 ac 24.03% Impervious Runoff Depth=0.22"
Tc=6.0 min CN=52 Runoff=0.13 cfs 0.031 af

Subcatchment 102S: PDA-2 Runoff Area=0.35 ac 0.00% Impervious Runoff Depth=0.00"
Flow Length=183' Tc=12.4 min CN=31 Runoff=0.00 cfs 0.000 af

Subcatchment 103S: PDA-3 Runoff Area=0.30 ac 0.00% Impervious Runoff Depth=0.00"
Flow Length=208' Tc=10.1 min CN=33 Runoff=0.00 cfs 0.000 af

Subcatchment 201S: PDA-4 Runoff Area=0.50 ac 0.00% Impervious Runoff Depth=0.00"
Flow Length=79' Slope=0.0400 '/' Tc=11.1 min CN=31 Runoff=0.00 cfs 0.000 af

Reach 1R: DP-1 Inflow=0.00 cfs 0.000 af
Outflow=0.00 cfs 0.000 af

Reach 2R: DP-2 Inflow=0.00 cfs 0.000 af
Outflow=0.00 cfs 0.000 af

Pond 111P: Subsurface Infiltration 1 Peak Elev=70.43' Storage=0.001 af Inflow=0.13 cfs 0.031 af
Outflow=0.13 cfs 0.031 af

Total Runoff Area = 2.81 ac Runoff Volume = 0.031 af Average Runoff Depth = 0.13"
85.77% Pervious = 2.41 ac 14.23% Impervious = 0.40 ac

Summary for Subcatchment 101S: PDA-1

Runoff = 0.13 cfs @ 12.37 hrs, Volume= 0.031 af, Depth= 0.22"
Routed to Pond 111P : Subsurface Infiltration 1

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-30.00 hrs, dt= 0.05 hrs
Type III 24-hr Plymouth-002yr Rainfall=3.40"

	Area (ac)	CN	Description
*	0.00	0	, HSG A
	0.20	30	Woods, Good, HSG A
	1.07	39	>75% Grass cover, Good, HSG A
	0.40	98	Paved roads w/curbs & sewers, HSG A
	1.66	52	Weighted Average
	1.26		75.97% Pervious Area
	0.40		24.03% Impervious Area

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

Summary for Subcatchment 102S: PDA-2

Runoff = 0.00 cfs @ 5.00 hrs, Volume= 0.000 af, Depth= 0.00"
Routed to Reach 1R : DP-1

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-30.00 hrs, dt= 0.05 hrs
Type III 24-hr Plymouth-002yr Rainfall=3.40"

Area (ac)	CN	Description
0.32	30	Woods, Good, HSG A
0.03	39	>75% Grass cover, Good, HSG A
0.35	31	Weighted Average
0.35		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.6	50	0.0400	0.08		**Sheet Flow, Sheet** Woods: Light underbrush n= 0.400 P2= 2.50"
1.8	133	0.0600	1.22		**Shallow Concentrated Flow, Woods** Woodland Kv= 5.0 fps
12.4	183	Total			

Summary for Subcatchment 103S: PDA-3

Runoff = 0.00 cfs @ 5.00 hrs, Volume= 0.000 af, Depth= 0.00"
Routed to Reach 1R : DP-1

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-30.00 hrs, dt= 0.05 hrs
Type III 24-hr Plymouth-002yr Rainfall=3.40"

Area (ac)	CN	Description
0.10	39	>75% Grass cover, Good, HSG A
0.20	30	Woods, Good, HSG A
0.30	33	Weighted Average
0.30		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.3	50	0.1000	0.11		**Sheet Flow, Sheet** Woods: Light underbrush n= 0.400 P2= 2.50"
2.8	158	0.0350	0.94		**Shallow Concentrated Flow, Woods** Woodland Kv= 5.0 fps
10.1	208	Total			

Summary for Subcatchment 201S: PDA-4

Runoff = 0.00 cfs @ 5.00 hrs, Volume= 0.000 af, Depth= 0.00"
Routed to Reach 2R : DP-2

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-30.00 hrs, dt= 0.05 hrs
Type III 24-hr Plymouth-002yr Rainfall=3.40"

Area (ac)	CN	Description
0.05	39	>75% Grass cover, Good, HSG A
0.45	30	Woods, Good, HSG A
0.50	31	Weighted Average
0.50		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.6	50	0.0400	0.08		**Sheet Flow, Sheet** Woods: Light underbrush n= 0.400 P2= 2.50"
0.5	29	0.0400	1.00		**Shallow Concentrated Flow, Woods** Woodland Kv= 5.0 fps
11.1	79	Total			

Summary for Reach 1R: DP-1

Inflow Area =	2.31 ac,	17.29% Impervious,	Inflow Depth = 0.00"	for Plymouth-002yr event	
Inflow =	0.00 cfs @	5.00 hrs,	Volume=	0.000 af	
Outflow =	0.00 cfs @	5.00 hrs,	Volume=	0.000 af,	Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 5.00-30.00 hrs, dt= 0.05 hrs

Summary for Reach 2R: DP-2

Inflow Area =	0.50 ac,	0.00% Impervious,	Inflow Depth = 0.00"	for Plymouth-002yr event	
Inflow =	0.00 cfs @	5.00 hrs,	Volume=	0.000 af	
Outflow =	0.00 cfs @	5.00 hrs,	Volume=	0.000 af,	Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 5.00-30.00 hrs, dt= 0.05 hrs

Summary for Pond 111P: Subsurface Infiltration 1

Inflow Area = 1.66 ac, 24.03% Impervious, Inflow Depth = 0.22" for Plymouth-002yr event
Inflow = 0.13 cfs @ 12.37 hrs, Volume= 0.031 af
Outflow = 0.13 cfs @ 12.44 hrs, Volume= 0.031 af, Atten= 6%, Lag= 4.4 min
Discarded = 0.13 cfs @ 12.44 hrs, Volume= 0.031 af

Routing by Stor-Ind method, Time Span= 5.00-30.00 hrs, dt= 0.05 hrs
Peak Elev= 70.43' @ 12.44 hrs Surf.Area= 0.07 ac Storage= 0.001 af

Plug-Flow detention time= 4.2 min calculated for 0.031 af (100% of inflow)
Center-of-Mass det. time= 4.2 min (973.1 - 968.9)

Volume	Invert	Avail.Storage	Storage Description
#1A	70.40'	0.062 af	**44.25'W x 67.70'L x 3.50'H Field A** 0.241 af Overall - 0.085 af Embedded = 0.155 af x 40.0% Voids
#2A	70.90'	0.085 af	**ADS_StormTech SC-740 +Cap** x 81 Inside #1 Effective Size= 44.6"W x 30.0"H => 6.45 sf x 7.12'L = 45.9 cf Overall Size= 51.0"W x 30.0"H x 7.56'L with 0.44' Overlap 81 Chambers in 9 Rows
		0.148 af	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Discarded	70.40'	**2.410 in/hr Exfiltration over Surface area**

Discarded OutFlow Max=0.17 cfs @ 12.44 hrs HW=70.43' (Free Discharge)
└─**1=Exfiltration** (Exfiltration Controls 0.17 cfs)

Pond 111P: Subsurface Infiltration 1 - Chamber Wizard Field A

Chamber Model = ADS_StormTech SC-740 +Cap (ADS StormTech® SC-740 with cap length)
Effective Size= 44.6"W x 30.0"H => 6.45 sf x 7.12'L = 45.9 cf
Overall Size= 51.0"W x 30.0"H x 7.56'L with 0.44' Overlap

51.0" Wide + 6.0" Spacing = 57.0" C-C Row Spacing

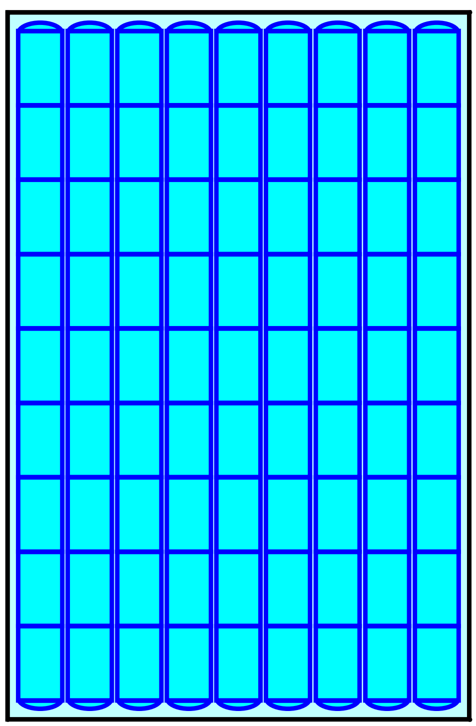
9 Chambers/Row x 7.12' Long +0.81' Cap Length x 2 = 65.70' Row Length +12.0" End Stone x 2 = 67.70' Base Length
9 Rows x 51.0" Wide + 6.0" Spacing x 8 + 12.0" Side Stone x 2 = 44.25' Base Width
6.0" Stone Base + 30.0" Chamber Height + 6.0" Stone Cover = 3.50' Field Height

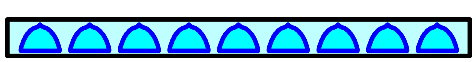
81 Chambers x 45.9 cf = 3,721.1 cf Chamber Storage

10,484.5 cf Field - 3,721.1 cf Chambers = 6,763.4 cf Stone x 40.0% Voids = 2,705.4 cf Stone Storage

Chamber Storage + Stone Storage = 6,426.5 cf = 0.148 af
Overall Storage Efficiency = 61.3%
Overall System Size = 67.70' x 44.25' x 3.50'

81 Chambers
388.3 cy Field
250.5 cy Stone





Time span=5.00-30.00 hrs, dt=0.05 hrs, 501 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 101S: PDA-1 Runoff Area=1.66 ac 24.03% Impervious Runoff Depth=0.67"
Tc=6.0 min CN=52 Runoff=0.84 cfs 0.093 af

Subcatchment 102S: PDA-2 Runoff Area=0.35 ac 0.00% Impervious Runoff Depth=0.00"
Flow Length=183' Tc=12.4 min CN=31 Runoff=0.00 cfs 0.000 af

Subcatchment 103S: PDA-3 Runoff Area=0.30 ac 0.00% Impervious Runoff Depth=0.02"
Flow Length=208' Tc=10.1 min CN=33 Runoff=0.00 cfs 0.000 af

Subcatchment 201S: PDA-4 Runoff Area=0.50 ac 0.00% Impervious Runoff Depth=0.00"
Flow Length=79' Slope=0.0400 '/' Tc=11.1 min CN=31 Runoff=0.00 cfs 0.000 af

Reach 1R: DP-1 Inflow=0.00 cfs 0.001 af
Outflow=0.00 cfs 0.001 af

Reach 2R: DP-2 Inflow=0.00 cfs 0.000 af
Outflow=0.00 cfs 0.000 af

Pond 111P: Subsurface Infiltration 1 Peak Elev=71.02' Storage=0.021 af Inflow=0.84 cfs 0.093 af
Outflow=0.17 cfs 0.093 af

Total Runoff Area = 2.81 ac Runoff Volume = 0.094 af Average Runoff Depth = 0.40"
85.77% Pervious = 2.41 ac 14.23% Impervious = 0.40 ac

Summary for Subcatchment 101S: PDA-1

Runoff = 0.84 cfs @ 12.12 hrs, Volume= 0.093 af, Depth= 0.67"
Routed to Pond 111P : Subsurface Infiltration 1

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-30.00 hrs, dt= 0.05 hrs
Type III 24-hr Plymouth-010yr Rainfall=4.70"

	Area (ac)	CN	Description
*	0.00	0	, HSG A
	0.20	30	Woods, Good, HSG A
	1.07	39	>75% Grass cover, Good, HSG A
	0.40	98	Paved roads w/curbs & sewers, HSG A
	1.66	52	Weighted Average
	1.26		75.97% Pervious Area
	0.40		24.03% Impervious Area

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

Summary for Subcatchment 102S: PDA-2

Runoff = 0.00 cfs @ 24.00 hrs, Volume= 0.000 af, Depth= 0.00"
Routed to Reach 1R : DP-1

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-30.00 hrs, dt= 0.05 hrs
Type III 24-hr Plymouth-010yr Rainfall=4.70"

Area (ac)	CN	Description
0.32	30	Woods, Good, HSG A
0.03	39	>75% Grass cover, Good, HSG A
0.35	31	Weighted Average
0.35		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.6	50	0.0400	0.08		**Sheet Flow, Sheet** Woods: Light underbrush n= 0.400 P2= 2.50"
1.8	133	0.0600	1.22		**Shallow Concentrated Flow, Woods** Woodland Kv= 5.0 fps
12.4	183	Total			

Summary for Subcatchment 103S: PDA-3

Runoff = 0.00 cfs @ 21.62 hrs, Volume= 0.000 af, Depth= 0.02"
Routed to Reach 1R : DP-1

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-30.00 hrs, dt= 0.05 hrs
Type III 24-hr Plymouth-010yr Rainfall=4.70"

Area (ac)	CN	Description
0.10	39	>75% Grass cover, Good, HSG A
0.20	30	Woods, Good, HSG A
0.30	33	Weighted Average
0.30		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.3	50	0.1000	0.11		**Sheet Flow, Sheet** Woods: Light underbrush n= 0.400 P2= 2.50"
2.8	158	0.0350	0.94		**Shallow Concentrated Flow, Woods** Woodland Kv= 5.0 fps
10.1	208	Total			

Summary for Subcatchment 201S: PDA-4

Runoff = 0.00 cfs @ 24.00 hrs, Volume= 0.000 af, Depth= 0.00"
Routed to Reach 2R : DP-2

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-30.00 hrs, dt= 0.05 hrs
Type III 24-hr Plymouth-010yr Rainfall=4.70"

Area (ac)	CN	Description
0.05	39	>75% Grass cover, Good, HSG A
0.45	30	Woods, Good, HSG A
0.50	31	Weighted Average
0.50		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.6	50	0.0400	0.08		**Sheet Flow, Sheet**
					Woods: Light underbrush n= 0.400 P2= 2.50"
0.5	29	0.0400	1.00		**Shallow Concentrated Flow, Woods**
					Woodland Kv= 5.0 fps
11.1	79	Total			

Summary for Reach 1R: DP-1

Inflow Area = 2.31 ac, 17.29% Impervious, Inflow Depth = 0.00" for Plymouth-010yr event
Inflow = 0.00 cfs @ 23.10 hrs, Volume= 0.001 af
Outflow = 0.00 cfs @ 23.10 hrs, Volume= 0.001 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 5.00-30.00 hrs, dt= 0.05 hrs

Summary for Reach 2R: DP-2

Inflow Area = 0.50 ac, 0.00% Impervious, Inflow Depth = 0.00" for Plymouth-010yr event
Inflow = 0.00 cfs @ 24.00 hrs, Volume= 0.000 af
Outflow = 0.00 cfs @ 24.00 hrs, Volume= 0.000 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 5.00-30.00 hrs, dt= 0.05 hrs

Summary for Pond 111P: Subsurface Infiltration 1

Inflow Area = 1.66 ac, 24.03% Impervious, Inflow Depth = 0.67" for Plymouth-010yr event
Inflow = 0.84 cfs @ 12.12 hrs, Volume= 0.093 af
Outflow = 0.17 cfs @ 12.05 hrs, Volume= 0.093 af, Atten= 80%, Lag= 0.0 min
Discarded = 0.17 cfs @ 12.05 hrs, Volume= 0.093 af

Routing by Stor-Ind method, Time Span= 5.00-30.00 hrs, dt= 0.05 hrs
Peak Elev= 71.02' @ 13.09 hrs Surf.Area= 0.07 ac Storage= 0.021 af

Plug-Flow detention time= 45.6 min calculated for 0.093 af (100% of inflow)
Center-of-Mass det. time= 45.5 min (958.1 - 912.6)

Volume	Invert	Avail.Storage	Storage Description
#1A	70.40'	0.062 af	**44.25'W x 67.70'L x 3.50'H Field A** 0.241 af Overall - 0.085 af Embedded = 0.155 af x 40.0% Voids
#2A	70.90'	0.085 af	**ADS_StormTech SC-740 +Cap** x 81 Inside #1 Effective Size= 44.6"W x 30.0"H => 6.45 sf x 7.12'L = 45.9 cf Overall Size= 51.0"W x 30.0"H x 7.56'L with 0.44' Overlap 81 Chambers in 9 Rows
		0.148 af	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Discarded	70.40'	**2.410 in/hr Exfiltration over Surface area**

Discarded OutFlow Max=0.17 cfs @ 12.05 hrs HW=70.45' (Free Discharge)
└─**1=Exfiltration** (Exfiltration Controls 0.17 cfs)

Pond 111P: Subsurface Infiltration 1 - Chamber Wizard Field A

Chamber Model = ADS_StormTech SC-740 +Cap (ADS StormTech® SC-740 with cap length)
Effective Size= 44.6"W x 30.0"H => 6.45 sf x 7.12'L = 45.9 cf
Overall Size= 51.0"W x 30.0"H x 7.56'L with 0.44' Overlap

51.0" Wide + 6.0" Spacing = 57.0" C-C Row Spacing

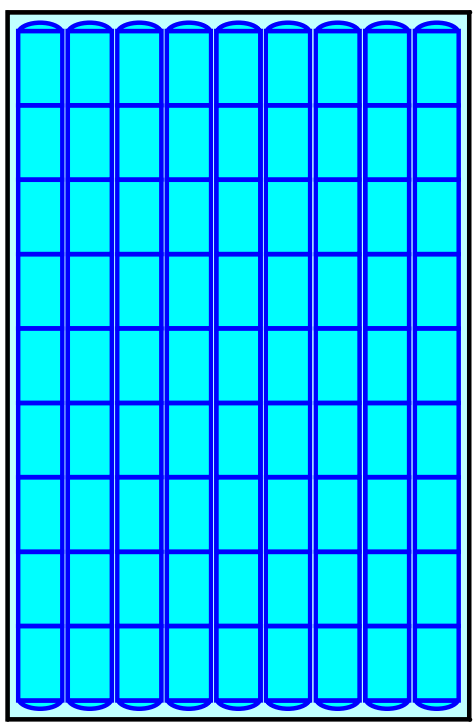
9 Chambers/Row x 7.12' Long +0.81' Cap Length x 2 = 65.70' Row Length +12.0" End Stone x 2 = 67.70' Base Length
9 Rows x 51.0" Wide + 6.0" Spacing x 8 + 12.0" Side Stone x 2 = 44.25' Base Width
6.0" Stone Base + 30.0" Chamber Height + 6.0" Stone Cover = 3.50' Field Height

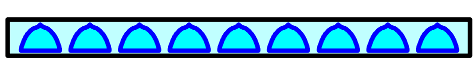
81 Chambers x 45.9 cf = 3,721.1 cf Chamber Storage

10,484.5 cf Field - 3,721.1 cf Chambers = 6,763.4 cf Stone x 40.0% Voids = 2,705.4 cf Stone Storage

Chamber Storage + Stone Storage = 6,426.5 cf = 0.148 af
Overall Storage Efficiency = 61.3%
Overall System Size = 67.70' x 44.25' x 3.50'

81 Chambers
388.3 cy Field
250.5 cy Stone





Time span=5.00-30.00 hrs, dt=0.05 hrs, 501 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 101S: PDA-1 Runoff Area=1.66 ac 24.03% Impervious Runoff Depth=1.41"
Tc=6.0 min CN=52 Runoff=2.31 cfs 0.195 af

Subcatchment 102S: PDA-2 Runoff Area=0.35 ac 0.00% Impervious Runoff Depth=0.13"
Flow Length=183' Tc=12.4 min CN=31 Runoff=0.01 cfs 0.004 af

Subcatchment 103S: PDA-3 Runoff Area=0.30 ac 0.00% Impervious Runoff Depth=0.21"
Flow Length=208' Tc=10.1 min CN=33 Runoff=0.01 cfs 0.005 af

Subcatchment 201S: PDA-4 Runoff Area=0.50 ac 0.00% Impervious Runoff Depth=0.13"
Flow Length=79' Slope=0.0400 '/' Tc=11.1 min CN=31 Runoff=0.01 cfs 0.005 af

Reach 1R: DP-1 Inflow=0.01 cfs 0.009 af
Outflow=0.01 cfs 0.009 af

Reach 2R: DP-2 Inflow=0.01 cfs 0.005 af
Outflow=0.01 cfs 0.005 af

Pond 111P: Subsurface Infiltration 1 Peak Elev=72.22' Storage=0.085 af Inflow=2.31 cfs 0.195 af
Outflow=0.17 cfs 0.195 af

Total Runoff Area = 2.81 ac Runoff Volume = 0.209 af Average Runoff Depth = 0.89"
85.77% Pervious = 2.41 ac 14.23% Impervious = 0.40 ac

Summary for Subcatchment 101S: PDA-1

Runoff = 2.31 cfs @ 12.11 hrs, Volume= 0.195 af, Depth= 1.41"
Routed to Pond 111P : Subsurface Infiltration 1

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-30.00 hrs, dt= 0.05 hrs
Type III 24-hr Plymouth-025yr Rainfall=6.22"

	Area (ac)	CN	Description
*	0.00	0	, HSG A
	0.20	30	Woods, Good, HSG A
	1.07	39	>75% Grass cover, Good, HSG A
	0.40	98	Paved roads w/curbs & sewers, HSG A
	1.66	52	Weighted Average
	1.26		75.97% Pervious Area
	0.40		24.03% Impervious Area

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

Summary for Subcatchment 102S: PDA-2

Runoff = 0.01 cfs @ 14.99 hrs, Volume= 0.004 af, Depth= 0.13"
Routed to Reach 1R : DP-1

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-30.00 hrs, dt= 0.05 hrs
Type III 24-hr Plymouth-025yr Rainfall=6.22"

Area (ac)	CN	Description
0.32	30	Woods, Good, HSG A
0.03	39	>75% Grass cover, Good, HSG A
0.35	31	Weighted Average
0.35		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.6	50	0.0400	0.08		**Sheet Flow, Sheet** Woods: Light underbrush n= 0.400 P2= 2.50"
1.8	133	0.0600	1.22		**Shallow Concentrated Flow, Woods** Woodland Kv= 5.0 fps
12.4	183	Total			

Summary for Subcatchment 103S: PDA-3

Runoff = 0.01 cfs @ 13.74 hrs, Volume= 0.005 af, Depth= 0.21"
Routed to Reach 1R : DP-1

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-30.00 hrs, dt= 0.05 hrs
Type III 24-hr Plymouth-025yr Rainfall=6.22"

Area (ac)	CN	Description
0.10	39	>75% Grass cover, Good, HSG A
0.20	30	Woods, Good, HSG A
0.30	33	Weighted Average
0.30		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.3	50	0.1000	0.11		**Sheet Flow, Sheet** Woods: Light underbrush n= 0.400 P2= 2.50"
2.8	158	0.0350	0.94		**Shallow Concentrated Flow, Woods** Woodland Kv= 5.0 fps
10.1	208	Total			

Summary for Subcatchment 201S: PDA-4

Runoff = 0.01 cfs @ 14.97 hrs, Volume= 0.005 af, Depth= 0.13"
Routed to Reach 2R : DP-2

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-30.00 hrs, dt= 0.05 hrs
Type III 24-hr Plymouth-025yr Rainfall=6.22"

Area (ac)	CN	Description
0.05	39	>75% Grass cover, Good, HSG A
0.45	30	Woods, Good, HSG A
0.50	31	Weighted Average
0.50		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.6	50	0.0400	0.08		**Sheet Flow, Sheet** Woods: Light underbrush n= 0.400 P2= 2.50"
0.5	29	0.0400	1.00		**Shallow Concentrated Flow, Woods** Woodland Kv= 5.0 fps
11.1	79	Total			

Summary for Reach 1R: DP-1

Inflow Area =	2.31 ac,	17.29% Impervious,	Inflow Depth = 0.05"	for Plymouth-025yr event	
Inflow =	0.01 cfs @	14.71 hrs,	Volume=	0.009 af	
Outflow =	0.01 cfs @	14.71 hrs,	Volume=	0.009 af,	Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 5.00-30.00 hrs, dt= 0.05 hrs

Summary for Reach 2R: DP-2

Inflow Area = 0.50 ac, 0.00% Impervious, Inflow Depth = 0.13" for Plymouth-025yr event
Inflow = 0.01 cfs @ 14.97 hrs, Volume= 0.005 af
Outflow = 0.01 cfs @ 14.97 hrs, Volume= 0.005 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 5.00-30.00 hrs, dt= 0.05 hrs

Summary for Pond 111P: Subsurface Infiltration 1

Inflow Area = 1.66 ac, 24.03% Impervious, Inflow Depth = 1.41" for Plymouth-025yr event
Inflow = 2.31 cfs @ 12.11 hrs, Volume= 0.195 af
Outflow = 0.17 cfs @ 11.85 hrs, Volume= 0.195 af, Atten= 93%, Lag= 0.0 min
Discarded = 0.17 cfs @ 11.85 hrs, Volume= 0.195 af

Routing by Stor-Ind method, Time Span= 5.00-30.00 hrs, dt= 0.05 hrs
Peak Elev= 72.22' @ 15.44 hrs Surf.Area= 0.07 ac Storage= 0.085 af

Plug-Flow detention time= 245.5 min calculated for 0.195 af (100% of inflow)
Center-of-Mass det. time= 245.2 min (1,129.1 - 883.9)

Volume	Invert	Avail.Storage	Storage Description
#1A	70.40'	0.062 af	**44.25'W x 67.70'L x 3.50'H Field A** 0.241 af Overall - 0.085 af Embedded = 0.155 af x 40.0% Voids
#2A	70.90'	0.085 af	**ADS_StormTech SC-740 +Cap** x 81 Inside #1 Effective Size= 44.6"W x 30.0"H => 6.45 sf x 7.12'L = 45.9 cf Overall Size= 51.0"W x 30.0"H x 7.56'L with 0.44' Overlap 81 Chambers in 9 Rows
		0.148 af	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Discarded	70.40'	**2.410 in/hr Exfiltration over Surface area**

Discarded OutFlow Max=0.17 cfs @ 11.85 hrs HW=70.44' (Free Discharge)
└─**1=Exfiltration** (Exfiltration Controls 0.17 cfs)

Pond 111P: Subsurface Infiltration 1 - Chamber Wizard Field A

Chamber Model = ADS_StormTech SC-740 +Cap (ADS StormTech® SC-740 with cap length)
Effective Size= 44.6"W x 30.0"H => 6.45 sf x 7.12'L = 45.9 cf
Overall Size= 51.0"W x 30.0"H x 7.56'L with 0.44' Overlap

51.0" Wide + 6.0" Spacing = 57.0" C-C Row Spacing

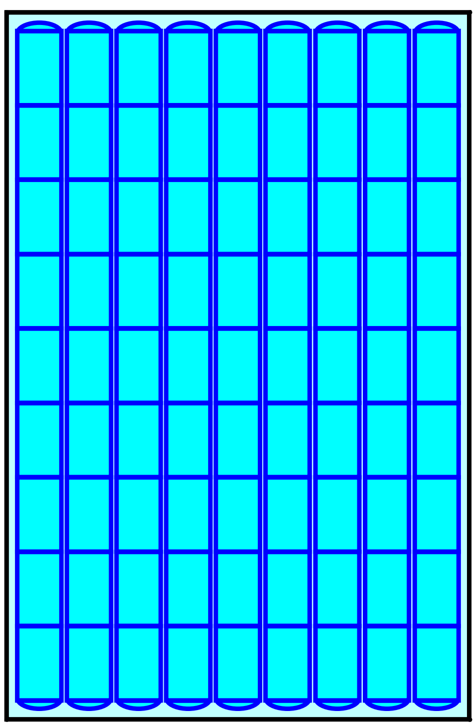
9 Chambers/Row x 7.12' Long +0.81' Cap Length x 2 = 65.70' Row Length +12.0" End Stone x 2 = 67.70' Base Length
9 Rows x 51.0" Wide + 6.0" Spacing x 8 + 12.0" Side Stone x 2 = 44.25' Base Width
6.0" Stone Base + 30.0" Chamber Height + 6.0" Stone Cover = 3.50' Field Height

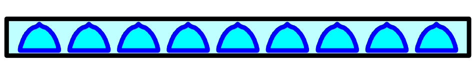
81 Chambers x 45.9 cf = 3,721.1 cf Chamber Storage

10,484.5 cf Field - 3,721.1 cf Chambers = 6,763.4 cf Stone x 40.0% Voids = 2,705.4 cf Stone Storage

Chamber Storage + Stone Storage = 6,426.5 cf = 0.148 af
Overall Storage Efficiency = 61.3%
Overall System Size = 67.70' x 44.25' x 3.50'

81 Chambers
388.3 cy Field
250.5 cy Stone





Time span=5.00-30.00 hrs, dt=0.05 hrs, 501 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 101S: PDA-1 Runoff Area=1.66 ac 24.03% Impervious Runoff Depth=1.85"
Tc=6.0 min CN=52 Runoff=3.20 cfs 0.256 af

Subcatchment 102S: PDA-2 Runoff Area=0.35 ac 0.00% Impervious Runoff Depth=0.26"
Flow Length=183' Tc=12.4 min CN=31 Runoff=0.01 cfs 0.008 af

Subcatchment 103S: PDA-3 Runoff Area=0.30 ac 0.00% Impervious Runoff Depth=0.37"
Flow Length=208' Tc=10.1 min CN=33 Runoff=0.03 cfs 0.009 af

Subcatchment 201S: PDA-4 Runoff Area=0.50 ac 0.00% Impervious Runoff Depth=0.26"
Flow Length=79' Slope=0.0400 '/' Tc=11.1 min CN=31 Runoff=0.02 cfs 0.011 af

Reach 1R: DP-1 Inflow=0.04 cfs 0.017 af
Outflow=0.04 cfs 0.017 af

Reach 2R: DP-2 Inflow=0.02 cfs 0.011 af
Outflow=0.02 cfs 0.011 af

Pond 111P: Subsurface Infiltration 1 Peak Elev=73.33' Storage=0.132 af Inflow=3.20 cfs 0.256 af
Outflow=0.17 cfs 0.254 af

Total Runoff Area = 2.81 ac Runoff Volume = 0.284 af Average Runoff Depth = 1.21"
85.77% Pervious = 2.41 ac 14.23% Impervious = 0.40 ac

Summary for Subcatchment 101S: PDA-1

Runoff = 3.20 cfs @ 12.10 hrs, Volume= 0.256 af, Depth= 1.85"
Routed to Pond 111P : Subsurface Infiltration 1

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-30.00 hrs, dt= 0.05 hrs
Type III 24-hr Plymouth-100yr Rainfall=7.00"

	Area (ac)	CN	Description
*	0.00	0	, HSG A
	0.20	30	Woods, Good, HSG A
	1.07	39	>75% Grass cover, Good, HSG A
	0.40	98	Paved roads w/curbs & sewers, HSG A
	1.66	52	Weighted Average
	1.26		75.97% Pervious Area
	0.40		24.03% Impervious Area

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

Summary for Subcatchment 102S: PDA-2

Runoff = 0.01 cfs @ 12.94 hrs, Volume= 0.008 af, Depth= 0.26"
Routed to Reach 1R : DP-1

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-30.00 hrs, dt= 0.05 hrs
Type III 24-hr Plymouth-100yr Rainfall=7.00"

Area (ac)	CN	Description
0.32	30	Woods, Good, HSG A
0.03	39	>75% Grass cover, Good, HSG A
0.35	31	Weighted Average
0.35		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.6	50	0.0400	0.08		**Sheet Flow, Sheet** Woods: Light underbrush n= 0.400 P2= 2.50"
1.8	133	0.0600	1.22		**Shallow Concentrated Flow, Woods** Woodland Kv= 5.0 fps
12.4	183	Total			

Summary for Subcatchment 103S: PDA-3

Runoff = 0.03 cfs @ 12.48 hrs, Volume= 0.009 af, Depth= 0.37"
Routed to Reach 1R : DP-1

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-30.00 hrs, dt= 0.05 hrs
Type III 24-hr Plymouth-100yr Rainfall=7.00"

Area (ac)	CN	Description
0.10	39	>75% Grass cover, Good, HSG A
0.20	30	Woods, Good, HSG A
0.30	33	Weighted Average
0.30		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.3	50	0.1000	0.11		**Sheet Flow, Sheet** Woods: Light underbrush n= 0.400 P2= 2.50"
2.8	158	0.0350	0.94		**Shallow Concentrated Flow, Woods** Woodland Kv= 5.0 fps
10.1	208	Total			

Summary for Subcatchment 201S: PDA-4

Runoff = 0.02 cfs @ 12.59 hrs, Volume= 0.011 af, Depth= 0.26"
Routed to Reach 2R : DP-2

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-30.00 hrs, dt= 0.05 hrs
Type III 24-hr Plymouth-100yr Rainfall=7.00"

Area (ac)	CN	Description
0.05	39	>75% Grass cover, Good, HSG A
0.45	30	Woods, Good, HSG A
0.50	31	Weighted Average
0.50		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.6	50	0.0400	0.08		**Sheet Flow, Sheet** Woods: Light underbrush n= 0.400 P2= 2.50"
0.5	29	0.0400	1.00		**Shallow Concentrated Flow, Woods** Woodland Kv= 5.0 fps
11.1	79	Total			

Summary for Reach 1R: DP-1

Inflow Area =	2.31 ac,	17.29% Impervious, Inflow Depth = 0.09"	for Plymouth-100yr event	
Inflow =	0.04 cfs @	12.52 hrs, Volume=	0.017 af	
Outflow =	0.04 cfs @	12.52 hrs, Volume=	0.017 af,	Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 5.00-30.00 hrs, dt= 0.05 hrs

Summary for Reach 2R: DP-2

Inflow Area = 0.50 ac, 0.00% Impervious, Inflow Depth = 0.26" for Plymouth-100yr event
Inflow = 0.02 cfs @ 12.59 hrs, Volume= 0.011 af
Outflow = 0.02 cfs @ 12.59 hrs, Volume= 0.011 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 5.00-30.00 hrs, dt= 0.05 hrs

Summary for Pond 111P: Subsurface Infiltration 1

Inflow Area = 1.66 ac, 24.03% Impervious, Inflow Depth = 1.85" for Plymouth-100yr event
Inflow = 3.20 cfs @ 12.10 hrs, Volume= 0.256 af
Outflow = 0.17 cfs @ 11.75 hrs, Volume= 0.254 af, Atten= 95%, Lag= 0.0 min
Discarded = 0.17 cfs @ 11.75 hrs, Volume= 0.254 af

Routing by Stor-Ind method, Time Span= 5.00-30.00 hrs, dt= 0.05 hrs
Peak Elev= 73.33' @ 16.06 hrs Surf.Area= 0.07 ac Storage= 0.132 af

Plug-Flow detention time= 378.1 min calculated for 0.254 af (99% of inflow)
Center-of-Mass det. time= 374.4 min (1,249.0 - 874.6)

Volume	Invert	Avail.Storage	Storage Description
#1A	70.40'	0.062 af	**44.25'W x 67.70'L x 3.50'H Field A** 0.241 af Overall - 0.085 af Embedded = 0.155 af x 40.0% Voids
#2A	70.90'	0.085 af	**ADS_StormTech SC-740 +Cap** x 81 Inside #1 Effective Size= 44.6"W x 30.0"H => 6.45 sf x 7.12'L = 45.9 cf Overall Size= 51.0"W x 30.0"H x 7.56'L with 0.44' Overlap 81 Chambers in 9 Rows
		0.148 af	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Discarded	70.40'	**2.410 in/hr Exfiltration over Surface area**

Discarded OutFlow Max=0.17 cfs @ 11.75 hrs HW=70.44' (Free Discharge)
└─**1=Exfiltration** (Exfiltration Controls 0.17 cfs)

Pond 111P: Subsurface Infiltration 1 - Chamber Wizard Field A

Chamber Model = ADS_StormTech SC-740 +Cap (ADS StormTech® SC-740 with cap length)
Effective Size= 44.6"W x 30.0"H => 6.45 sf x 7.12'L = 45.9 cf
Overall Size= 51.0"W x 30.0"H x 7.56'L with 0.44' Overlap

51.0" Wide + 6.0" Spacing = 57.0" C-C Row Spacing

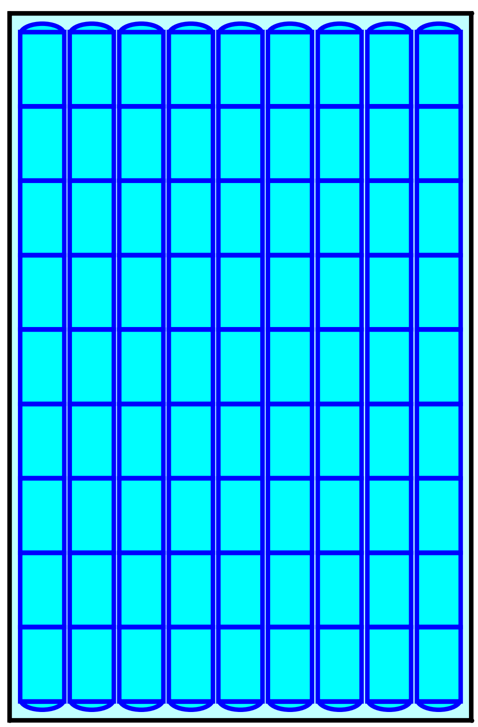
9 Chambers/Row x 7.12' Long +0.81' Cap Length x 2 = 65.70' Row Length +12.0" End Stone x 2 = 67.70' Base Length
9 Rows x 51.0" Wide + 6.0" Spacing x 8 + 12.0" Side Stone x 2 = 44.25' Base Width
6.0" Stone Base + 30.0" Chamber Height + 6.0" Stone Cover = 3.50' Field Height

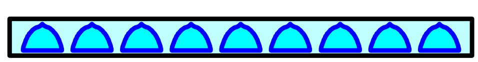
81 Chambers x 45.9 cf = 3,721.1 cf Chamber Storage

10,484.5 cf Field - 3,721.1 cf Chambers = 6,763.4 cf Stone x 40.0% Voids = 2,705.4 cf Stone Storage

Chamber Storage + Stone Storage = 6,426.5 cf = 0.148 af
Overall Storage Efficiency = 61.3%
Overall System Size = 67.70' x 44.25' x 3.50'

81 Chambers
388.3 cy Field
250.5 cy Stone





Attachment 4
Hydraulic Calculations

HYDRAULICS CALCULATION SUMMARY

OBJECTIVE

- To design a stormwater collection system to capture and convey runoff to proposed stormwater management BMPs.
- To design a stormwater management system to meet the design standards of the Massachusetts DEP Stormwater Management Handbook for erosion and scour protection.

CONCLUSION(S)

- The proposed stormwater collection system will adequately collect and convey the peak runoff rates from the 50-year storm.
- The proposed stormwater management design has been reviewed for compliance with the stormwater management standards described in the DEP's Stormwater Management Handbook, dated February 2008.

CALCULATION METHODS

1. Drainage structures and drainpipes are designed using the Rational Formula and based on a 50-year storm frequency.

ASSUMPTIONS

1. Runoff coefficient C=0.3 for pervious areas.
2. Runoff coefficient C=0.9 for impervious areas.
3. Manning's n=0.013 for HDPE pipes.
4. The time of concentration for contributing subcatchments is 6 minutes for all CBs.
5. The minimum full-flow (scour) velocity is 3 feet per second.
6. The maximum full-flow (scour) velocity is 10 feet per second.

SOURCES OF DATA/ EQUATIONS

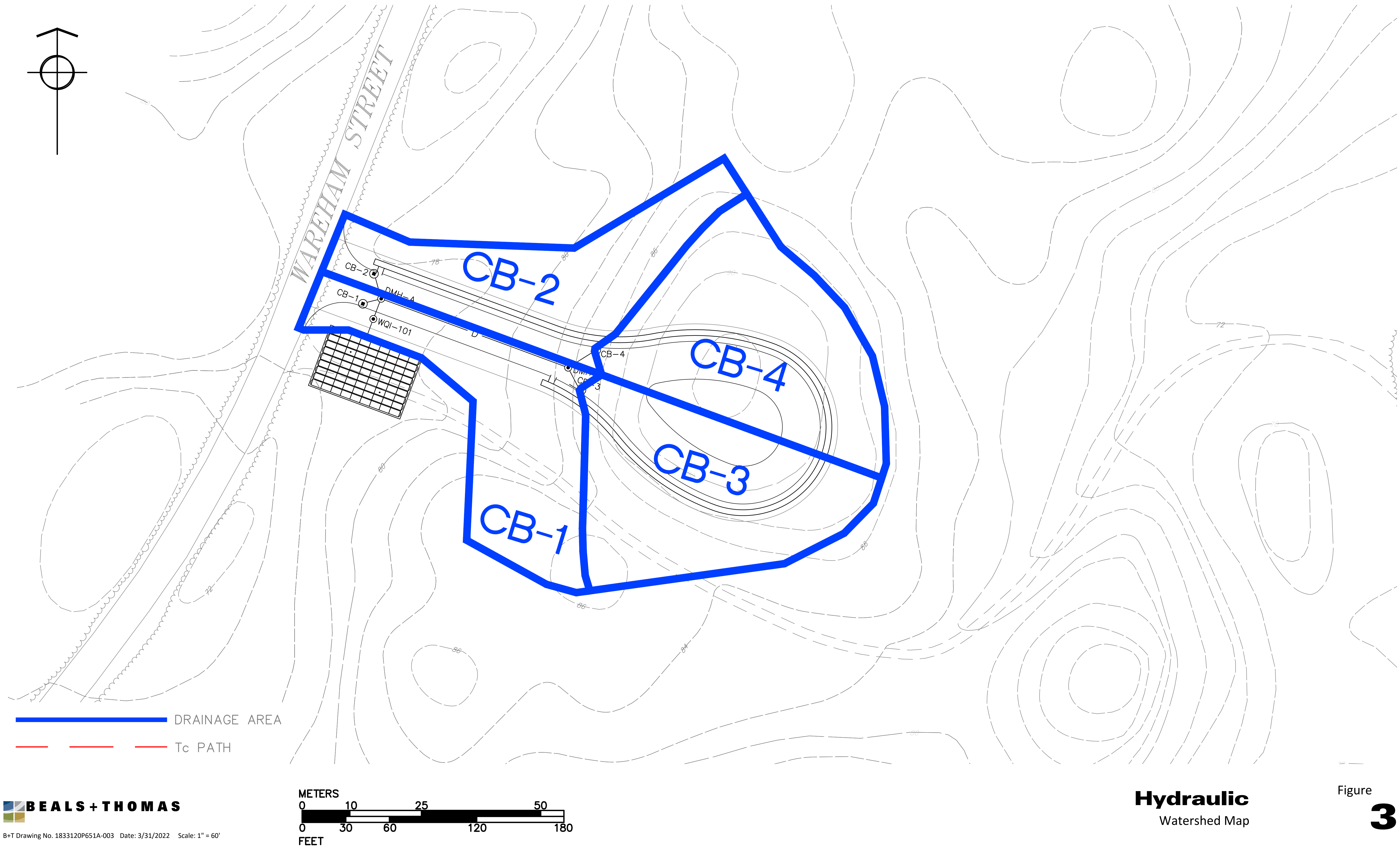
1. Proposed Hydraulic Areas Map, prepared by Beals and Thomas, Inc., File No. 1833120P003A-003.
2. Rational Method (Q=CiA) was used to calculate peak runoff rates,
3. Manning's Formula was used to determine pipe capacities.
4. 50-year storm intensity determined from Barnstable Storm Intensity, Duration and Frequency Curves.
5. Massachusetts DEP Stormwater Management Handbook.

REV	CALC. BY	DATE	CHECKED BY	DATE	APPROVED BY	DATE
0	MPM	3/30/22	NPS	3/31/22	MC	4/5/22

1833120CS003A

Fox Run Subdivision

Carver, MA



BEALS + THOMAS

B+T Drawing No. 1833120P651A-003 Date: 3/31/2022 Scale: 1" = 60'

Hydraulic

Watershed Map

Figure

3

BEALS + THOMAS

Hydraulic Drainage Areas & Corresponding Rational Method Flows

Using the Rational Method:

$$Q = CIA$$

Where:

Q = flow (cfs)

C = Runoff Coefficient (0.9 for impervious areas)

I = Rainfall Intensity, 50-year storm (in/hr) (from Barnstable IDF curve, see attached)

A = Contributing Area (acres)

Assumptions: - Coefficient of runoff for Imperivious Surfaces = 0.9

- Coefficient of runoff for Pervious Surfaces = 0.3

Inlet	Contributing Area (Acres)	Weighted Average Rational Coefficients	Rainfall Intensity for Barnstable (in/hr) (Tc 6 min, see IDF Curve)	Contributing Flow (cfs)
CB-1	0.374	0.41	6.60	1.02
CB-2	0.364	0.44	6.60	1.07
CB-3	0.452	0.46	6.60	1.38
CB-4	0.474	0.46	6.60	1.45
DMH-B	0.926	0.46	6.60	2.83
DMH-A	1.664	0.44	6.60	4.87
WQI-1	1.664	0.44	6.60	4.87

JOB NO. 1833.120 COMPUTED BY MPM CHECKED BY NPS

FILE 1833120SWM001A DATE 3/30/2022 DATE 3/31/2022

BEALS + THOMAS
Hydraulic Pipe Sizing Calculations

Using the Manning Equation to Verify Pipe Capacities Versus Pipe Flows:

$$Q = \frac{1.49}{n} A R^{\frac{2}{3}} S^{\frac{1}{2}}$$

Where:

Q = flow (cfs)
n = Manning's roughness coefficient
A = Cross Sectional Area (sf)
R = Hydraulic Radius (ft)
S = Pipe Slope

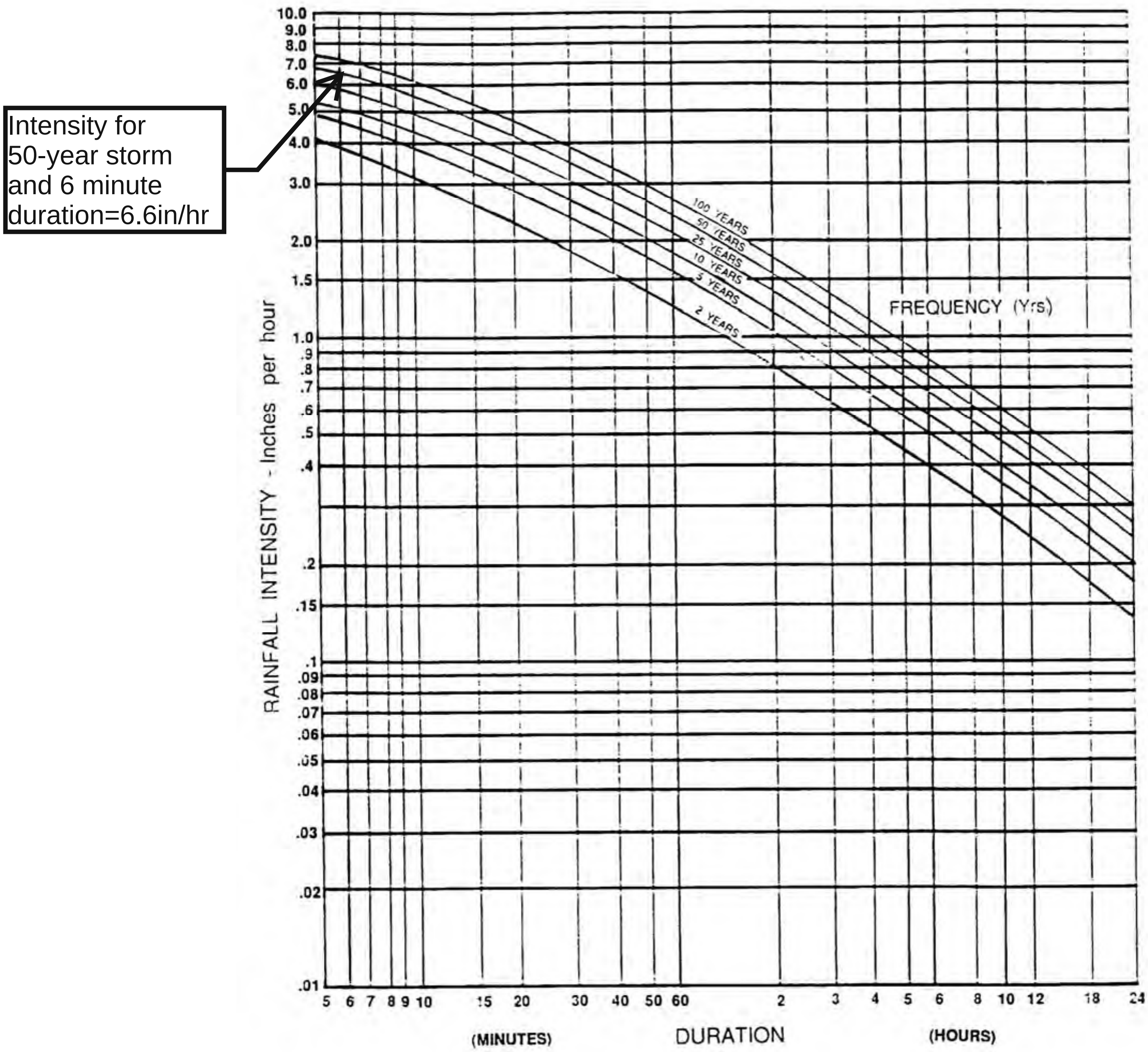
Assumptions: Pipe velocity shall be between 3.0 ft/sec and 10 ft/sec

Pipe Connection	Contributing Flow-50 Year Storm(cfs)	Proposed Pipe Size and Material	Proposed Pipe Slope (rise/run)	Full-Flow Capacity of Pipe from Manning Equation (cfs)	Adequate	Velocity (ft/sec)
CB-3 to DMH-B	1.38	12" HDPE	0.016	4.5	OK	5.8
CB-4 to DMH-B	1.45	12" HDPE	0.012	3.9	OK	5.0
CB-1 to DMH-A	1.02	12" HDPE	0.026	5.8	OK	7.3
CB-2 to DMH-A	1.07	12" HDPE	0.016	4.5	OK	5.8
DMH-B to DMH-A	2.83	12" HDPE	0.018	4.8	OK	6.1
DMH-A to WQI-101	4.87	18" HDPE	0.018	14.1	OK	8.0

JOB NO. 1833.120 COMPUTED BY MPM CHECKED BY NPS
FILE 1833120SWM001A DATE 3/30/2022 DATE 3/31/2022

Exhibit 8-13

Intensity – Duration – Frequency Curve for Barnstable, MA



Source: TR55 - Urban Hydrology for Small Wetlands, NRCS

Attachment 5
Groundwater Mounding, TSS Removal, Water Quality Volume, and Groundwater Recharge Calculations

BEALS+THOMAS

GROUNDWATER MOUNDING CALCULATION SUMMARY

OBJECTIVE

To determine the maximum groundwater mounding height beneath Subsurface Infiltration System #1.

CONCLUSION(S)

The mounding analysis indicates that the groundwater elevation would rise approximately 1.66-feet to infiltrate the required volume. Therefore, it can be concluded that the rise in groundwater elevation will not prohibit the subsurface system from dewatering within 72 hours.

CALCULATION METHODS

1. Estimated maximum groundwater mounding height calculated using Hantush equation.

ASSUMPTIONS

1. Vertical hydraulic conductivity [R] (unsaturated zone) is equal to the infiltration rate of the proposed infiltration system = 2.41 in/hr = 4.82 ft/day.
2. Specific yield [Sy] is 0.26 based on data provided in GSWS Paper 1662-D for Medium Sand.
3. Horizontal hydraulic conductivity [K] (saturated zone) is 200 ft/day based on data provided in USGS Report 86-4053A for mixed sand and gravel.
4. ½ the length of basin (in x direction) [x] = 33.85 ft.
5. ½ the width of basin (in y direction) [y] = 22.13 ft.
6. Subsurface Infiltration System #1 takes approximately 10.68 hours (t=0.45 days) to dewater.
7. Estimated saturated thickness [hi(0)] is 10.00 ft based upon field conditions.

SOURCES OF DATA/ EQUATIONS

1. Hantush equation spreadsheet published by the USGS.
2. Page 2 of USGS Report 86-4053A, Yield and Quality of Ground Water from Stratified-Drift Aquifers, Taunton River Basin, Massachusetts: Executive Summary, 1989.
3. Page D1 of GWSWS Paper 1662-D, Specific Yield – Compilation of Specific Yields for Various Materials, 1967.
4. Massachusetts Stormwater Handbook, 2008

REV	CALC. BY	DATE	CHECKED BY	DATE	APPROVED BY	DATE
0	MPM	3/30/22	NPS	3/31/22	MC	4/5/22

1833120CS004A

This spreadsheet will calculate the height of a groundwater mound beneath a stormwater infiltration basin. More information can be found in the U.S. Geological Survey Scientific Investigations Report 2010-5102 "Simulation of groundwater mounding beneath hypothetical stormwater infiltration basins".

The user must specify infiltration rate (R), specific yield (Sy), horizontal hydraulic conductivity (Kh), basin dimensions (x, y), duration of infiltration period (t), and the initial thickness of the saturated zone (hi(0), height of the water table if the bottom of the aquifer is the datum). For a square basin the half width equals the half length (x = y). For a rectangular basin, if the user wants the water-table changes perpendicular to the long side, specify x as the short dimension and y as the long dimension. Conversely, if the user wants the values perpendicular to the short side, specify y as the short dimension, x as the long dimension. All distances are from the center of the basin. Users can change the distances from the center of the basin at which water-table aquifer thickness are calculated.
Cells highlighted in yellow are values that can be changed by the user. Cells highlighted in red are output values based on user-specified inputs. The user MUST click the blue "Re-Calculate Now" button each time ANY of the user-specified inputs are changed otherwise necessary iterations to converge on the correct solution will not be done and values shown will be incorrect. Use consistent units for all input values (for example, feet and days)

use consistent units (e.g. feet & days **or** inches & hours)

Input Values

4.8200	***R***	**Recharge (infiltration) rate (feet/day)**
0.260	**Sy**	**Specific yield, Sy (dimensionless, between 0 and 1)**
200.00	**K**	**Horizontal hydraulic conductivity, Kh (feet/day)***
33.850	**x**	**1/2 length of basin (x direction, in feet)**
22.125	**y**	**1/2 width of basin (y direction, in feet)**
0.445	**t**	**duration of infiltration period (days)**
10.000	**hi(0)**	**initial thickness of saturated zone (feet)**

Conversion Table

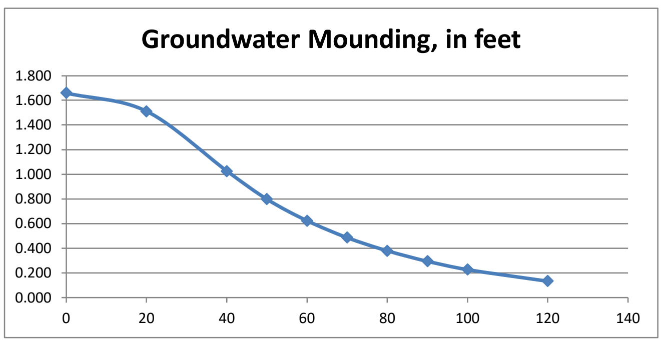
inch/hour	**feet/day**
0.67	1.33
2.00	4.00
hours	**days**
36	1.50

In the report accompanying this spreadsheet (USGS SIR 2010-5102), vertical soil permeability (ft/d) is assumed to be one-tenth horizontal hydraulic conductivity (ft/d).

11.660	**h(max)**	**maximum thickness of saturated zone (beneath center of basin at end of infiltration period)**
1.660	**Δh(max)**	**maximum groundwater mounding (beneath center of basin at end of infiltration period)**

Ground-water Mounding, in feet	**Distance from center of basin in x direction, in feet**
1.660	**0**
1.511	**20**
1.026	**40**
0.798	**50**
0.623	**60**
0.487	**70**
0.380	**80**
0.295	**90**
0.227	**100**
0.133	**120**

Re-Calculate Now



Disclaimer

This spreadsheet solving the Hantush (1967) equation for ground-water mounding beneath an infiltration basin is made available to the general public as a convenience for those wishing to replicate values documented in the USGS Scientific Investigations Report 2010-5102 "Groundwater mounding beneath hypothetical stormwater infiltration basins" or to calculate values based on user-specified site conditions. Any changes made to the spreadsheet (other than values identified as user-specified) after transmission from the USGS could have unintended, undesirable consequences. These consequences could include, but may not be limited to: erroneous output, numerical instabilities, and violations of underlying assumptions that are inherent in results presented in the accompanying USGS published report. The USGS assumes no responsibility for the consequences of any changes made to the spreadsheet. If changes are made to the spreadsheet, the user is responsible for documenting the changes and justifying the results and conclusions.

YIELD AND QUALITY OF GROUND WATER FROM STRATIFIED-DRIFT AQUIFERS, TAUNTON RIVER BASIN, MASSACHUSETTS: EXECUTIVE SUMMARY

By Wayne W. Lapham and Julio C. Olimpio

U.S. GEOLOGICAL SURVEY

Water-Resources Investigations Report 86-4053A

Prepared in cooperation with

COMMONWEALTH OF MASSACHUSETTS
DEPARTMENT OF ENVIRONMENTAL MANAGEMENT
DIVISION OF WATER RESOURCES

Boston, Massachusetts
1989

PHYSICAL SETTING AND HYDROGEOLOGY OF THE BASIN

The Taunton River basin covers 530 mi^2 (square miles) of Bristol, Norfolk, and Plymouth Counties in southeastern Massachusetts. All or parts of the cities of Attleboro, Brockton, Fall River, New Bedford, and Taunton, and 36 towns are in the basin (fig. 1). The basin is drained by the Matfield, Town, and Taunton Rivers.

Tributary streams include the Canoe, Nemasket, Wading, Threemile, and Winnetuxet Rivers. Surface-water drainage is generally southward toward Mount Hope Bay, a part of Narragansett Bay at Fall River.

Stratified-drift deposits cover about 62 percent of the basin. These deposits are primarily ice-contact, outwash, and lake-bottom sediments, which were deposited in preglacial bedrock valleys and in water-filled depressions in the till and bedrock surface during retreat of the last glacier. The sediments are composed of sand, gravel, cobbles, silt, and clay. The drift ranges in thickness from zero to about 200 ft (feet) in some of the deep preglacial bedrock valleys. The thickest deposits are lake-bottom deposits composed of fine sand interbedded with silt and clay. Stratified-drift deposits are more abundant in the central and southern parts of the basin than in the northern part of the basin. In the northern one-third of the basin, stratified drift fills narrow, north-south trending valleys, which are bordered by till and bedrock uplands.

Yields of wells in the fine-grained stratified-drift deposits are usually no more than a few gallons per minute (gal/min) whereas yields of wells in the coarse-grained stratified drift may exceed 300 gal/min. The coarse-grained parts of the stratified-drift deposits form the major aquifers in the basin. In the northern part of the basin, these aquifers are long, narrow, and thin, and have saturated thicknesses that range from about 20 ft to somewhat more than 100 ft. The widths of the stratified-drift aquifers generally range from 0.1 to 1.5 mi (miles), and their lengths generally range from 1 to 5 mi.

Twenty-six stratified-drift aquifers in the northern half of the basin were studied in detail (fig. 2). These aquifers were selected because current and projected 1990 water-supply deficits are greatest in the northern half of the basin, affecting 14 of 19 municipalities. In contrast, only one of nine municipalities in the southern half of the basin is projected to have a deficit (Richard Thibedeau, Massachusetts Division of Water Resources, written commun.,1984). The 26 aquifers also were selected because the use of ground water as the sole source of supply is greatest in the northern half of the basin. Fifteen of 19 municipalities in the northern half of the basin use ground water as compared to 4 of 9 municipalities in the southern half of the basin.

The 26 stratified-drift aquifers were identified as areas of stratified drift that have a transmissivity equal to or greater than 1,337 ft^2/d (square feet per day), which is equivalent to 10,000 gallons per day per foot. The aquifers underlie or are near major rivers or tributaries. The aquifers are composed mostly of layers of sand and gravel but include some interbedded layers of silt and clay. John R. Williams (U.S. Geological Survey, written commun., 1982) determined that the hydraulic conductivity of fine-to-coarse gravel ranges from about 150 to 500 ft/d (feet per day), mixed sand and gravel averages about 200 ft/d, and fine-to-coarse sand ranges from about 25 to 150 ft/d. The transmissivity of the stratified drift is equal to the product of its hydraulic conductivity and saturated thickness. Therefore, equal transmissivities at different locations in an aquifer may be the result of thin deposits of high-conductivity drift or thick deposits of low-conductivity drift. Transmissivity exceeds 4,000 ft^2/d in small areas in nearly all 26 aquifers. In a few areas, where the stratified drift is thick or has a high hydraulic conductivity, transmissivity exceeds 10,000 ft^2/d.

AQUIFER YIELDS

Estimates from Model Simulations

During severe drought, ground-water discharge from aquifers to streams is reduced or ceases, streamflow is at a minimum, and only small amounts of surface water are stored in wetlands and ponds. Consequently, water pumped from most aquifers in New England during severe drought is derived largely from storage in the aquifers. During normal climatic conditions, water pumped from an aquifer is derived from storage, intercepted ground-water discharge, and induced infiltration of surface water. To account for drought and normal conditions, two sets of aquifer-yield estimates were made for each of the 26 stratified-drift aquifers using simple ground-water flow models. "Short-term" aquifer yields during drought conditions were determined by considering only water from storage and are expressed as single values for several selected pumping periods. "Long-term" aquifer yields during normal

Specific Yield--Compilation of Specific Yields for Various Materials

GEOLOGICAL SURVEY WATER SUPPLY PAPER 1662-D

Prepared in cooperation with the California Department of Water Resources

SPECIFIC YIELD—COMPILATION OF SPECIFIC YIELDS FOR VARIOUS MATERIALS

By A. I. Johnson

ABSTRACT

Specific yield is defined as the ratio of (1) the volume of water that a saturated rock or soil will yield by gravity to (2) the total volume of the rock or soil. Specific yield is usually expressed as a percentage. The value is not definitive, because the quantity of water that will drain by gravity depends on variables such as duration of drainage, temperature, mineral composition of the water, and various physical characteristics of the rock or soil under consideration. Values of specific yield, nevertheless, offer a convenient means by which hydrologists can estimate the water-yielding capacities of earth materials and, as such, are very useful in hydrologic studies.

The present report consists mostly of direct or modified quotations from many selected reports that present and evaluate methods for determining specific yield, limitations of those methods, and results of the determinations made on a wide variety of rock and soil materials. Although no particular values are recommended in this report, a table summarizes values of specific yield, and their averages, determined for 10 rock textures. The following is an abstract of the table:

Specific yields, in percent, of various materials

[Rounded to nearest whole percent]

Material	Number of determinations	Specific yield: Maximum	Minimum	Average
Clay	15	5	0	2
Silt	16	19	3	8
Sandy clay	12	12	3	7
Fine sand	17	28	10	21
Medium sand	17	32	15	26
Coarse sand	17	35	20	27
Gravelly sand	15	35	20	25
Fine gravel	17	35	21	25
Medium gravel	14	26	13	23
Coarse gravel	14	26	12	22

INTRODUCTION

PURPOSE AND SCOPE

The purpose of this report is to assist hydrologists in estimating the quantity of water in storage in ground-water reservoirs by providing

B E A L S + T H O M A S

Standard 3: Drawdown

$$\textbf{Drawdown Time} = \frac{\textbf{Rv}}{\textbf{(K) (Bottom Area)}}$$

where:

Rv = Storage Volume Below Outlet [Ac-ft]

K= Infiltration Rate [in/hr]

Bottom Area= Bottom Area of Recharge System [Ac]

Infiltration System

Rv =	0.148	Ac-ft	
K =	2.410	in/hr	
Bottom Area =	0.069	Acres	
Drawdown Time =	**10.680**	**Hours**	*< 72 Hours, Design is in compliance with the standard.*

Note:

1. The infiltration BMPs have been designed to fully drain within 72 hours, therefore the proposed stormwater management design is in compliance with Standard 3 .

2. Infiltration Rate based on Volume 3, Chapter 1, Table 2.3.3 *Rawls Rates* from the 2008 MA DEP Stormwater Management Handbook.

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FILE:	1833120SWM001A	DATE:	03/30/22	DATE:	3/31/2022

INSTRUCTIONS:

Non-automated: Mar. 4, 2008

1. Sheet is nonautomated. Print sheet and complete using hand calculations. Column A and B: See MassDEP Structural BMP Table
2. The calculations must be completed using the Column Headings specified in Chart and Not the Excel Column Headings
3. To complete Chart Column D, multiple Column B value within Row x Column C value within Row
4. To complete Chart Column E value, subtract Column D value within Row from Column C within Row
5. Total TSS Removal = Sum All Values in Column D

Location: Carver, MA

TSS Removal Calculation Worksheet

A BMP[1]	B TSS Removal Rate[1]	C Starting TSS Load*	D Amount Removed (B*C)	E Remaining Load (C-D)
Deep Sump and Hooded Catch Basin	0.25	1.00	0.25	0.75
Proprietary BMP	0.90	0.75	0.67	0.08

Total TSS Removal = 92%

Separate Form Needs to be Completed for Each Outlet or BMP Train

Project: 1833.120

Prepared By: MPM

Date: 4/1/22

*Equals remaining load from previous BMP (E) which enters the BMP

Non-automated TSS Calculation Sheet must be used if Proprietary BMP Proposed

1. From MassDEP Stormwater Handbook Vol. 1

Mass. Dept. of Environmental Protection

Project:	**Harwich Road Subdivision**
Location:	**Carver, MA**
Prepared For:	**Beals & Thomas**

Purpose: To calculate the water quality flow rate (WQF) over a given site area. In this situation the WQF is derived from the first 1" of runoff from the contributing impervious surface.

Reference: Massachusetts Dept. of Environmental Protection Wetlands Program / United States Department of Agriculture Natural Resources Conservation Service TR-55 Manual

Procedure: Determine unit peak discharge using Figure 1 or 2. Figure 2 is in tabular form so is preferred. Using the tc, read the unit peak discharge (qu) from Figure 1 or Table in Figure 2. qu is expressed in the following units: cfs/mi^2/watershed inches (csm/in).

Compute Q Rate using the following equation:

Q = (qu) (A) (WQV)

where:

Q = flow rate associated with first 1" of runoff
qu = the unit peak discharge, in csm/in.
A = impervious surface drainage area (in square miles)
WQV = water quality volume in watershed inches (1" in this case)

Structure Name	Impv. (acres)	A (miles^2)	t_c (min)	t_c (hr)	WQV (in)	qu (csm/in.)	Q (cfs)
WQU 101	0.40	0.0006250	6.0	0.100	1.00	774.00	0.48

The WQf sizing calculation selects the minimum size CDS/Cascade/StormCeptor model capable of operating at the computed WQf peak flowrate prior to bypassing. It assumes free discharge of the WQf through the unit and ignores the routing effect of any upstream storm drain piping. As with all hydrodynamic separators, there will be some impact to the Hydraulic Gradient of the corresponding drainage system, and evaluation of this impact should be considered in the design.

CONTECH ENGINEERED SOLUTIONS

CDS TECHNOLOGIES

CDS ESTIMATED NET ANNUAL SOLIDS LOAD REDUCTION BASED ON THE RATIONAL RAINFALL METHOD

HARWICH ROAD SUBDIVISION
CARVER, MA

Area	**0.40 ac**	Unit Site Designation	**WQU 101**
Weighted C	**0.9**	Rainfall Station #	**66**
t_c	**6 min**		
CDS Model	**1515-3**	CDS Treatment Capacity	**1.0 cfs**

Rainfall Intensity[1] (in/hr)	Percent Rainfall Volume[1]	Cumulative Rainfall Volume	Total Flowrate (cfs)	Treated Flowrate (cfs)	Incremental Removal (%)
0.08	35.3%	35.3%	0.03	0.03	33.6
0.16	23.8%	59.1%	0.06	0.06	22.2
0.24	12.9%	72.0%	0.09	0.09	11.8
0.32	7.8%	79.8%	0.12	0.12	7.0
0.40	4.9%	84.7%	0.14	0.14	4.3
0.48	3.5%	88.3%	0.17	0.17	3.0
0.56	1.7%	90.0%	0.20	0.20	1.4
0.64	1.8%	91.8%	0.23	0.23	1.5
0.72	1.9%	93.7%	0.26	0.26	1.5
0.80	0.9%	94.6%	0.29	0.29	0.7
1.00	2.3%	96.9%	0.36	0.36	1.7
2.00	2.9%	99.8%	0.72	0.72	1.4
3.00	0.2%	100.0%	1.08	1.00	0.1
0.00	0.0%	100.0%	0.00	0.00	0.0
0.00	0.0%	100.0%	0.00	0.00	0.0
0.00	0.0%	100.0%	0.00	0.00	0.0
0.00	0.0%	100.0%	0.00	0.00	0.0
0.00	0.0%	100.0%	0.00	0.00	0.0
0.00	0.0%	100.0%	0.00	0.00	0.0
0.00	0.0%	100.0%	0.00	0.00	0.0
0.00	0.0%	100.0%	0.00	0.00	0.0
					90.1

Removal Efficiency Adjustment[2] =	0.0%
Predicted % Annual Rainfall Treated =	100.0%
Predicted Net Annual Load Removal Efficiency =	**90.1%**

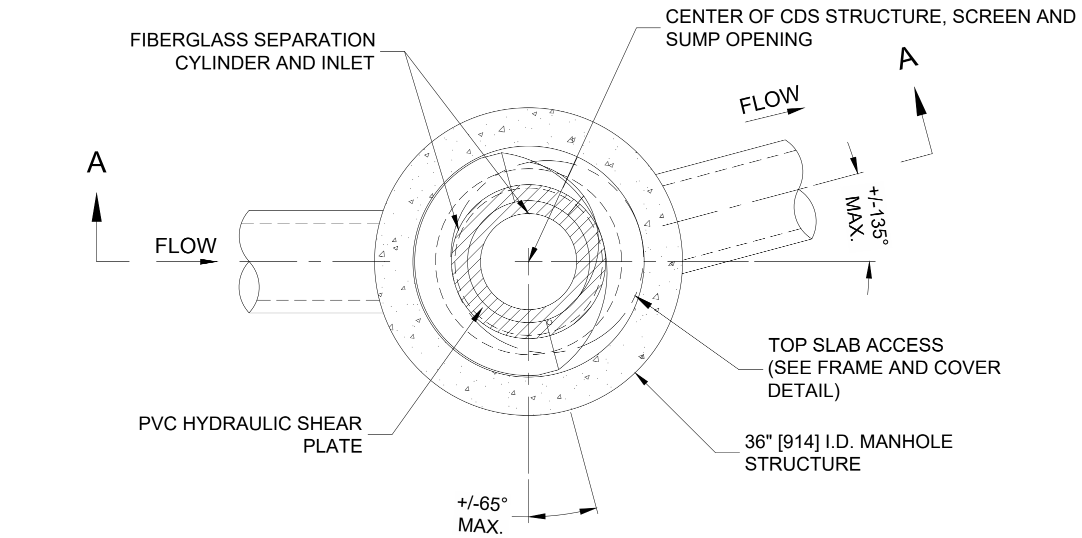
1 - Based on 14 years of 15 minute precipitation data from NCDC station 3821, Hyannis, in Barnstable County, MA

2 - Reduction due to use of 60-minute data for a site that has a time of concentration less than 30-minutes.

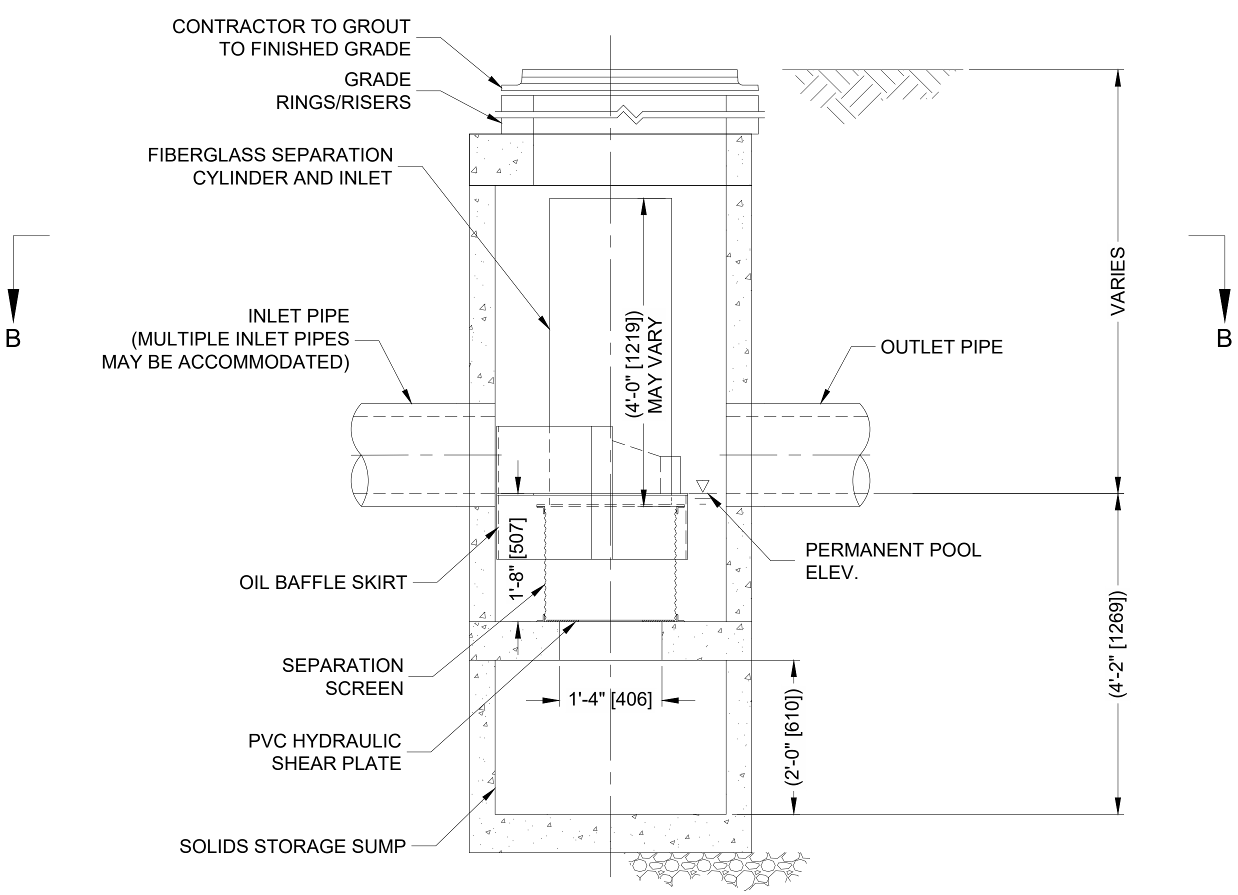
CDS1515-3-C DESIGN NOTES

CDS1515-3-C RATED TREATMENT CAPACITY IS 1.0 CFS, OR PER LOCAL REGULATIONS.

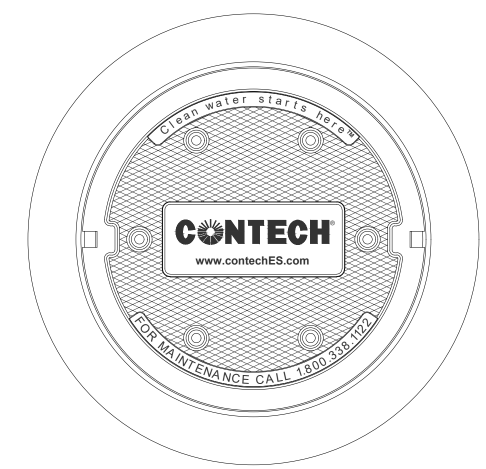
THE STANDARD CDS1515-3-C CONFIGURATION IS SHOWN.



PLAN VIEW B-B
N.T.S.



ELEVATION A-A
N.T.S.



FRAME AND COVER
(DIAMETER VARIES)
N.T.S.

SITE SPECIFIC DATA REQUIREMENTS

STRUCTURE ID			
WATER QUALITY FLOW RATE (CFS OR L/s)			*
PEAK FLOW RATE (CFS OR L/s)			*
RETURN PERIOD OF PEAK FLOW (YRS)			*
SCREEN APERTURE (2400 OR 4700)			*
PIPE DATA:	I.E.	MATERIAL	DIAMETER
INLET PIPE 1	*	*	*
INLET PIPE 2	*	*	*
OUTLET PIPE	*	*	*
RIM ELEVATION			*
ANTI-FLOTATION BALLAST		WIDTH	HEIGHT
		*	*
NOTES/SPECIAL REQUIREMENTS:			
* PER ENGINEER OF RECORD			

GENERAL NOTES
1. CONTECH TO PROVIDE ALL MATERIALS UNLESS NOTED OTHERWISE.
2. FOR SITE SPECIFIC DRAWINGS WITH DETAILED STRUCTURE DIMENSIONS AND WEIGHT, PLEASE CONTACT YOUR CONTECH ENGINEERED SOLUTIONS LLC REPRESENTATIVE. www.ContechES.com
3. CDS WATER QUALITY STRUCTURE SHALL BE IN ACCORDANCE WITH ALL DESIGN DATA AND INFORMATION CONTAINED IN THIS DRAWING. CONTRACTOR TO CONFIRM STRUCTURE MEETS REQUIREMENTS OF PROJECT.
4. STRUCTURE SHALL MEET AASHTO HS20 LOAD RATING, ASSUMING EARTH COVER OF 0' - 2', AND GROUNDWATER ELEVATION AT, OR BELOW, THE OUTLET PIPE INVERT ELEVATION. ENGINEER OF RECORD TO CONFIRM ACTUAL GROUNDWATER ELEVATION. CASTINGS SHALL MEET AASHTO M306 AND BE CAST WITH THE CONTECH LOGO..
5. IF REQUIRED, PVC HYDRAULIC SHEAR PLATE IS PLACED ON SHELF AT BOTTOM OF SCREEN CYLINDER. REMOVE AND REPLACE AS NECESSARY DURING MAINTENANCE CLEANING.
6. CDS STRUCTURE SHALL BE PRECAST CONCRETE CONFORMING TO ASTM C-478 AND AASHTO LOAD FACTOR DESIGN METHOD.

INSTALLATION NOTES
A. ANY SUB-BASE, BACKFILL DEPTH, AND/OR ANTI-FLOTATION PROVISIONS ARE SITE-SPECIFIC DESIGN CONSIDERATIONS AND SHALL BE SPECIFIED BY ENGINEER OF RECORD.
B. CONTRACTOR TO PROVIDE EQUIPMENT WITH SUFFICIENT LIFTING AND REACH CAPACITY TO LIFT AND SET THE CDS MANHOLE STRUCTURE.
C. CONTRACTOR TO INSTALL JOINT SEALANT BETWEEN ALL STRUCTURE SECTIONS AND ASSEMBLE STRUCTURE.
D. CONTRACTOR TO PROVIDE, INSTALL, AND GROUT INLET AND OUTLET PIPE(S). MATCH PIPE INVERTS WITH ELEVATIONS SHOWN. ALL PIPE CENTERLINES TO MATCH PIPE OPENING CENTERLINES.
E. CONTRACTOR TO TAKE APPROPRIATE MEASURES TO ASSURE UNIT IS WATER TIGHT, HOLDING WATER TO FLOWLINE INVERT MINIMUM. IT IS SUGGESTED THAT ALL JOINTS BELOW PIPE INVERTS ARE GROUTED.

THIS PRODUCT MAY BE PROTECTED BY ONE OR MORE OF THE FOLLOWING U.S. PATENTS: 5,788,848; 6,641,720; 6,511,595; 6,581,783; RELATED FOREIGN PATENTS, OR OTHER PATENTS PENDING.

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CDS1515-3-C
ONLINE CDS
STANDARD DETAIL

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B E A L S + T H O M A S

Standard 4: Water Quality Volume Summary

$$V_{WQ} = (D_{WQ} / 12 \text{ in/ft}) \times (A_{IMP} \times 43{,}560 \text{ SF/Ac}) \text{ where:}$$

V_{WQ} = Required Water Quality Volume [CF]

D_{WQ} = Water Quality Depth : 1-inch for discharges within a Zone II or Interim Wellhead Protection Area, to or near critical areas, runoff from LUHPPL, or exfiltration to soil with infiltration rate 2.4 in/hr or greater; ½-inch for discharges to other areas.

A_{IMP} = Post-development Impervious Area; may exclude roof top areas [Ac]

Required Water Quality Volume:

Drainage Area/ Treatment Train	A_{IMP} [Ac]	D_{WQ} [in]	V_{WQ} Required [CF]	
PDA-1	0.400	1	1,452	
Total Required Water Quality Volume:			1,452	Cubic Feet

Provided Water Quality Volume:

Drainage Area/ Treatment Train	BMP	Water Quality Volume Provided [CF]	
PDA-1	Infiltration System	6,446	
PDA-1	CDS Unit	1,452	
Total Provided Water Quality Volume:		7,898	Cubic Feet

WATER QUALITY VOLUME PROVIDED IS GREATER THAN OR EQUAL TO THE REQUIRED WATER QUALITY VOLUME, THEREFORE PROPOSED STORMWATER MANAGEMENT DESIGN IS IN COMPLIANCE WITH STANDARD 4.

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B E A L S + T H O M A S
Proprietary Water Quality Inlet Sizing

Step 1: Define Minimum Flow Rate per Water Quality Inlet to Treat Desired Water Quality Volume

Water quality inlets are sized based on flow rate; therefore expressing Water Quality Volume as a flow rate based on the percentage of cumulative average volume captured ensures systems are sized to achieve the desired Water Quality treatment level.

$Q = (q_u)(A)(WQV)$ where:

Q = peak flow rate associated with first 1.0-inch of runoff [CFS]

q_u = The Peak Discharge [CFS/mi^2/in] Massachusetts DEP Standard Method to Convert Required Water Quality Volume to a Discharge Rate for Sizing Flow Based Manufactured Proprietary Stormwater Treatment Practices

A = Contributing Drainage Area, Impervious Surface Only [Ac]

WQV = The Water Quality Treatment Depth [In]

WQI No.	A (Ac)	Tc (Min)	WQV (in)	q_u (csm/in)	Q (cfs)
WQS-101	0.40	6.0	1.0	774	0.48
Total	0.40	Acres			

Step 2: Size Water Quality Inlet as recommended by Manufacturer

See attached Sizing Report(s) for recommended model(s).

Step 3: Water Quality Volume Provided by WQI unit(s)

Total Impervious Area Treated by WQI unit(s):	0.40	Acres
	17,424	SF
Treated Water Quality Depth : (accounted for by Average Water Quality Flow Rate)	1.0	inches
Total Water Quality Volume provided by Water Quality Inlets	**1,452**	**CF**

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Standard 3: Groundwater Recharge

Groundwater Recharge Volume Required:

Rv = F x Impervious Area, where:

Rv = Required Recharge Volume [Ac-ft]

F = Target Depth Factor associated with each Hydrologic Soil Group (HSG) [in]

Impervious Area = Total Pavement and Rooftop Area under Post-development Conditions [Ac]

			Impervious Area [Acres]	Required Recharge Volume [Ac-ft]	
HSG "A", use F =	0.6	in	0.400	0.020	
Total Required Recharge Volume (Rv) =				**0.020**	**Ac-ft**

Capture Area Adjustment: (Ref: DEP Handbook V.3 Ch.1 P.27-28)

Total Site Impervious Area (Total)=	0.4	Acres
Impervious Area Draining to Infiltrative BMPs (infil) =	0.40	Acres (PDA-01B Impervious Area)
Percent Imp. Area Draining to Infiltrative BMPs =	100.0%	
Capture Area Adjustment Factor = (Total)/(Infil) = Ca =	1.00	
Adjusted Required Recharge Volume = Ca x Rv	**0.020**	**Ac-ft**

Groundwater Recharge Volume Provided :

BMP	Provided Recharge Volume [Ac-ft]	
Infiltration System	0.148	
Total Provided Recharge Volume =	**0.148**	**Ac-ft**

PROVIDED GROUNDWATER RECHARGE VOLUME IS GREATER THAN OR EQUAL TO THE REQUIRED RECHARGE VOLUME, THEREFORE PROPOSED STORMWATER MANAGEMENT DESIGN IS IN COMPLIANCE WITH STANDARD 3.

JOB NO.	1833.120	COMPUTED BY:	MPM	CHECKED BY:	NPS
FILE:	1833120SWM001A	DATE:	03/30/22	DATE:	3/31/2022

Attachment 6
Site Owner's Manual

Site Owner’s Manual

HARWICH ROAD SUBDIVISION

Off Wareham Street
Carver, Massachusetts

Prepared for:
A.D. Makepeace
158 Tihonet Road
Carver, MA 02571

Prepared by:

BEALS + THOMAS

April 6, 2022

1833120RP002A

TABLE OF CONTENTS

FIGURES

APPENDICES

1.0 INTRODUCTION

The Site Owner's Manual complies with the Long-Term Pollution Prevention Plan (Standard 4) and the Long-Term Operation and Maintenance Plan (Standard 9) requirements of the 2008 Massachusetts Department of Environmental Protection (DEP) Stormwater Handbook. The Manual outlines source control and pollution prevention measures and maintenance requirements of stormwater best management practices (BMPs) associated with the proposed development.

2.0 SITE OWNER'S AGREEMENT

2.1 Operation and Maintenance Compliance Statement

Site Owner: A.D. Makepeace Company
158 Tihonet Road
Carver, MA 02571

Responsible Party: A.D. Makepeace Company

A.D. Makepeace Company or their successors shall maintain ownership of the on-site stormwater management system as well as the responsibility for operation and maintenance during the post-development stages of the project. The site has been inspected for erosion and appropriate measures have been taken to permanently stabilize any eroded areas. All aspects of stormwater best management practices (BMPs) have been inspected for damage, wear and malfunction, and appropriate steps have been taken to repair or replace the system or portions of the system so that the stormwater at the site may be managed in accordance with the Stormwater Management Standards. Future responsible parties shall be notified of their continuing legal responsibility to operate and maintain the BMPs. The operation and maintenance plan for the stormwater BMPs is being implemented.

Responsible Party Signature

4·7·22
Date

2.2 Stormwater Maintenance Easements

There are no off-site areas utilized for stormwater control, therefore no stormwater management easements are required. The Site Owner will have access to all stormwater practices for inspection and maintenance, including direct maintenance access by heavy equipment to structures requiring regular maintenance.

2.3 Record Keeping

The Site Owner shall maintain a rolling log in which all inspections and maintenance activities for the past three years shall be recorded. The Operation and Maintenance Log includes information pertaining to inspections, repairs, and disposal relevant to the project's stormwater management system. The Log is located in Appendix A.

The Operation and Maintenance Log shall be made available to the Conservation Commission and the DEP upon request. The Conservation Commission and the DEP shall be allowed to enter and inspect the premises to evaluate and ensure that the responsible party complies with the maintenance requirements for each BMP.

2.4 Training

Employees involved in grounds maintenance and emergency response will be educated on the general concepts of stormwater management and groundwater protection. The Site Owner's Manual will be reviewed with the maintenance staff. The staff will be trained on the proper course of action for specific events expected to be incurred during routine maintenance or emergency situations.

3.0 LONG-TERM POLLUTION PREVENTION PLAN

In compliance with Standard 4 of the 2008 DEP Stormwater Management Handbook, this section outlines source control and pollution prevention measures to be employed on-site after construction.

3.1 Storage of Materials and Waste

The site shall be kept clear of trash and debris at all times. Certain materials and waste products shall be stored inside or outside upon an impervious surface and covered, as required by local and state regulations.

3.2 Vehicle Washing

No commercial vehicle washing shall take place on site.

3.3 Routine Inspections and Maintenance of Stormwater BMPs

See Section 4.0 Long-Term Operation and Maintenance Plan, for routine inspection and maintenance requirements for all proposed stormwater BMPs.

3.4 Spill Prevention and Response

A contingency plan shall be implemented to address the spill or release of petroleum products and hazardous materials and will include the following measures:

1. Equipment necessary to quickly attend to inadvertent spills or leaks shall be stored on-site in a secure but accessible location. Such equipment shall include but not be limited to the following: safety goggles, chemically resistant gloves and overshoe boots, water and chemical fire extinguishers, sand and shovels, suitable absorbent materials, storage containers and first aid equipment (i.e. Indian Valley Industries, Inc. 55-gallon Spill Containment kit or approved equivalent).

2. Spills or leaks shall be treated properly according to material type, volume of spillage and location of spill. Mitigation shall include preventing further spillage, containing the spilled material in the smallest practical area, removing spilled material in a safe and environmentally-friendly manner, and remediation of any damage to the environment.

3. For large spills, Massachusetts DEP Hazardous Waste Incident Response Group shall be notified immediately at 888-304-1133 and an emergency response contractor shall be consulted.

3.5 Maintenance of Lawns, Gardens, and other Landscaped Areas

Lawns, gardens, and other landscaped areas shall be maintained regularly by the site owner.

3.6 Storage and Use of Fertilizers, Herbicides, and Pesticides

All fertilizers, herbicides, and pesticides shall be stored in accordance with local, state, and federal regulations. The application rate and use of fertilizers, herbicides, and pesticides on the site shall at no time exceed local, state, or federal specifications.

3.7 Pet Waste Management

Pet owners shall be required to pick up after their animals and dispose of waste in the trash.

3.8 Operation and Management of Septic Systems

The proposed development will be serviced by individual septic system to treat wastewater. The septic systems shall be operated and maintained in accordance with local and state regulations.

3.9 Snow and Deicing Chemical Management

Snow removal and use of deicing chemicals at the proposed development shall comply with the following requirements:

- Plowed snow shall be placed in the areas outside of wetland boundaries and stormwater best management practices. The following maintenance measures shall be undertaken at all snow disposal sites:
    - Debris shall be cleared from an area prior to using it for snow disposal.
    - Debris and accumulated sediments shall be cleared from the site and properly disposed of at the end of the snow season and no later than May 15.
- In accordance with the Massachusetts General Laws, Chapter 85, Section 7A, salt and other de-icing chemicals will be stored at an indoor location. Salt and other deicing chemicals shall be stored in accordance with Massachusetts General Law.
- Sand piles shall be contained and stabilized to prevent the discharge of sand to wetlands or water bodies, and, where feasible, covered.
- Salt storage piles shall be located outside of the 100-year floodplain.
- The application of salt on the proposed parking areas and driveway shall at no time exceed state or local requirements.

4.0 LONG-TERM OPERATION AND MAINTENANCE PLAN

This section outlines the stormwater best management practices (BMPs) associated with the proposed stormwater management system and identifies the long-term inspection and maintenance requirements for each BMP.

4.1 Stormwater Management System Components

The following table outlines the type and quantity of the BMPs and their general location. Please reference the site plan(s) provided in the Figures section for exact location. All BMPs are accessible for maintenance from the development roadway.

BMP Type	Quantity	Location
Catch Basins	4	Throughout roadway
Drain Manholes	2	Throughout roadway
Water Quality Unit	1	Near southwest side of roadway
Infiltration Chambers	1	Near southwest side of roadway

4.2 Inspection and Maintenance Schedules

4.2.1 Deep Sump and Hooded Catch Basins & Drain Manholes

Catch basins shall be inspected four times per year, including after the foliage season. Other inspection and maintenance requirements include:

- Units shall be cleaned (organic material, sediment and hydrocarbons removed) four times per year or whenever the depth of deposits is greater than or equal to one half the depth from the bottom of the invert of the lowest pipe in the basin.
    - Cleanout shall always occur after street sweeping.
- If any evidence of hydrocarbons is found during inspection, the material shall be immediately removed using absorbent pads or other suitable measures and disposed of legally.
- Remove other accumulated debris as necessary.
- Transport and disposal of accumulated sediment off-site shall be in accordance with applicable local, state and federal guidelines and regulations.

4.2.2 Proprietary Separators

Maintenance of proprietary separators shall be performed according the recommendations set forth by the manufacturer (see Appendix C. Proprietary Separator Technical Manual for complete installation, operation and maintenance procedures). Inspection and maintenance procedures for proprietary devices are provided below:

- Units shall be inspected post-construction, prior to being put into service.
- Units shall be inspected not less than twice per year following installation and no less than once per year thereafter.
- Units shall be inspected immediately after any oil, fuel or chemical spill.
- All inspections shall include checking the oil level and sediment depth in the unit.
- Removal of sediments/oils shall occur per manufacturer recommendations.
- A licensed waste management company shall remove captured petroleum waste products from any oil, chemical or fuel spills and dispose.
- OSHA confined space entry protocols shall be followed if entry into the unit is required.

4.2.3 Subsurface Infiltration Structures

Subsurface infiltration structures shall be inspected twice per year. The inlets shall be inspected, and all debris that may clog the system shall be removed.

4.3 Estimated Operation and Maintenance Budget

An operations and maintenance budget was prepared to approximate the annual cost of the inspections required in compliance with the DEP Stormwater Management Policy. The table below estimates the annual cost to inspect and maintain each proposed BMP, based on the requirements in Section 4.2.

BMP Type	# of BMPS	Annual O&M Cost (per BMP)[1]	Total Cost
Catch Basins & Drain Manholes	6	\$200-\$400	\$1,200-\$2,400
Stormceptor®	1	\$100-\$300	\$100-\$300
Subsurface Infiltration Structures	1	\$200-\$400	\$200-\$400
		Total	**\$1,500-\$3,100**

[1] Annual maintenance cost is based on estimate of the cost to complete all inspection and maintenance measures outlined in Section 4.2. For BMPs that require sediment removal at regular intervals (i.e. every 5 or 10 years), the annual cost includes the annual percentage of that cost.

Figures

Figure 1: Site Plan

I HEREBY CERTIFY THAT THIS PLAN HAS BEEN PREPARED IN CONFORMITY WITH THE RULES AND REGULATIONS OF THE REGISTERS OF DEEDS OF THE COMMONWEALTH OF MASSACHUSETTS.

DATE

KENNETH CONTE, PLS No. 38033

I, CLERK OF THE TOWN OF CARVER, HEREBY CERTIFY THAT THE NOTICE OF APPROVAL OF THIS PLAN BY THE PLANNING BOARD HAS BEEN RECEIVED AND RECORDED AT THIS OFFICE ON ____________, AND NO APPEAL WAS RECEIVED DURING THE NEXT TWENTY DAYS AFTER RECEIPT AND RECORDING OF SAID NOTICE.

DATE TOWN CLERK

APPROVAL UNDER SUBDIVISION CONTROL LAW REQUIRED CARVER PLANNING BOARD:

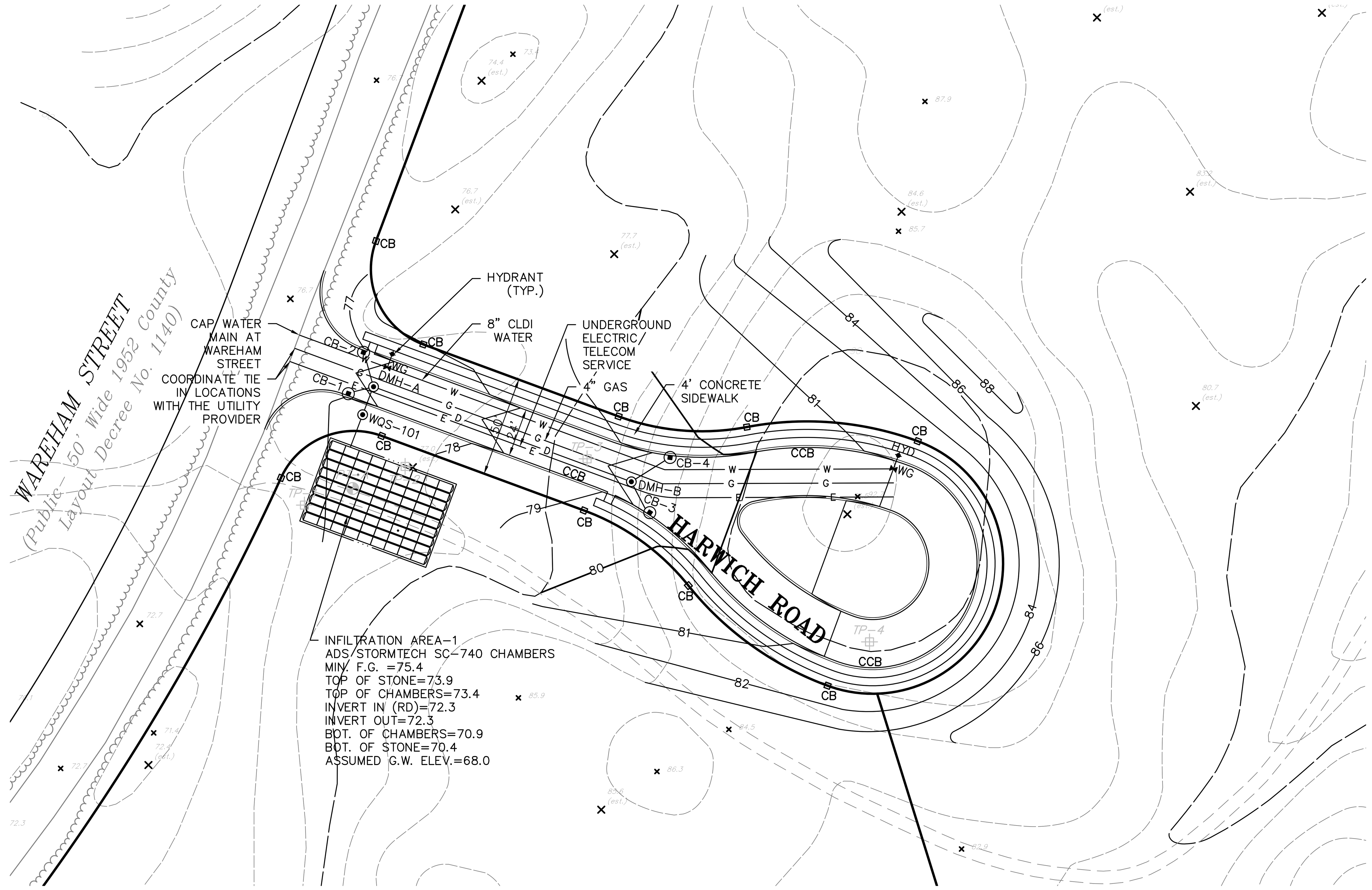
DATE

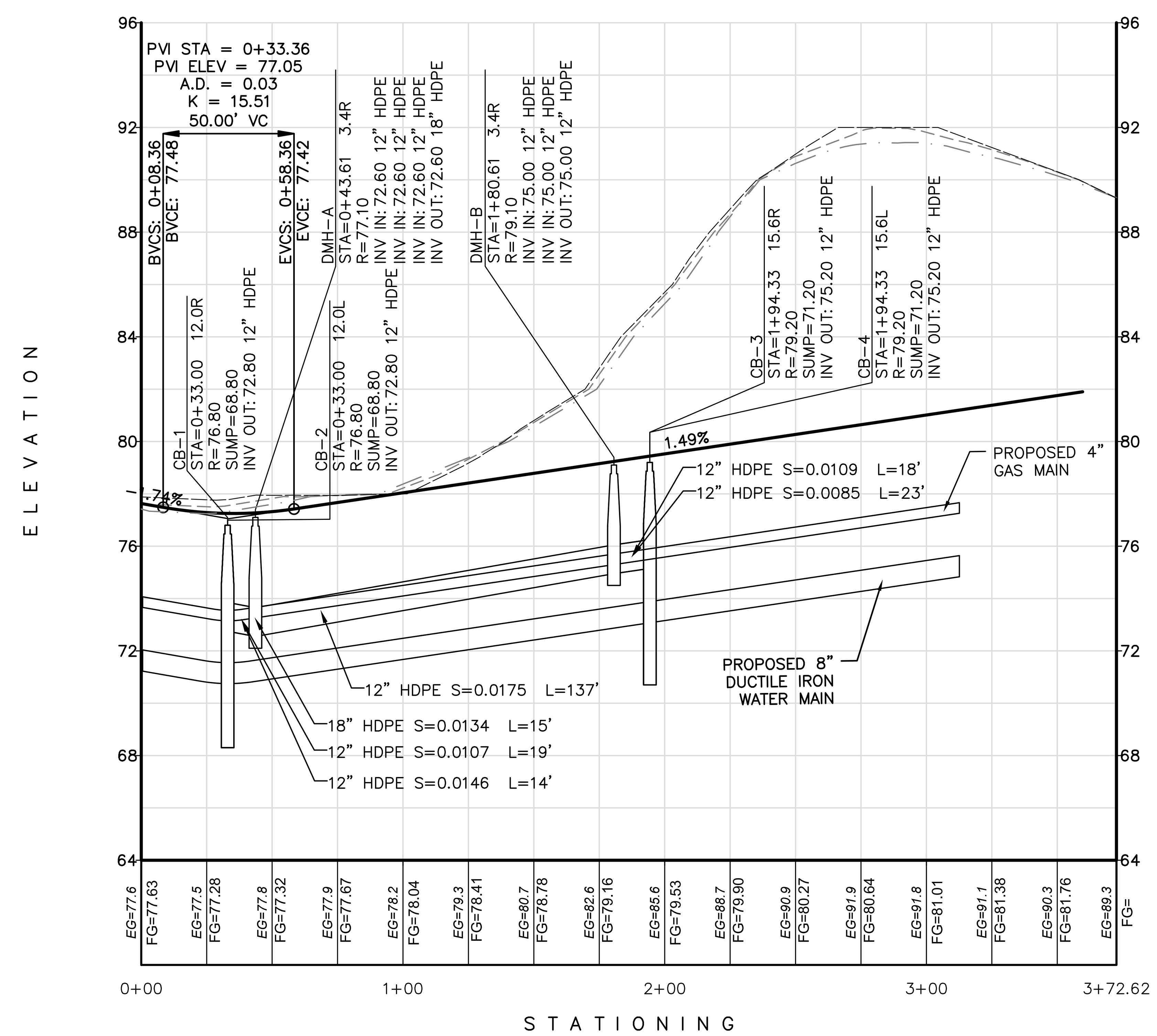
MASSACHUSETTS STATE PLANE COORDINATE SYSTEM–NAD83

N

RIM AND INVERT SCHEDULE

STRUCTURE	RIM		INVERT		DIAMETER	PIPE		STRUCTURE
CB-1	R=	76.8	I=	72.8	12	HDPE	TO	DMH-A
CB-2	R=	76.8	I=	72.8	12	HDPE	TO	DMH-A
CB-3	R=	79.2	I=	75.2	12	HDPE	TO	DMH-B
CB-4	R=	79.2	I=	75.2	12	HDPE	TO	DMH-B
DMH-A	R=	77.1	I=	72.6	12	HDPE	FROM	CB-1
			I=	72.6	12	HDPE	FROM	CB-2
			I=	72.6	12	HDPE	FROM	DMH-B
			I=	72.6	15	HDPE	TO	WQI-101
DMH-B	R=	79.1	I=	75.0	12	HDPE	FROM	CB-3
			I=	75.0	12	HDPE	FROM	CB-4
			I=	75.0	12	HDPE	TO	DMH-A
WQS-101	R=	77.2	I=	72.4	18	HDPE	FROM	DMH-A
			I=	72.4	18	HDPE	TO	INF-1





Harwich Road PROFILE

SCALE: 1"=40' (HOR.) 1"=4' (VER.)

LEGEND

- PROPOSED CENTERLINE GRADE
- EXISTING CENTERLINE GRADE
- EXISTING RIGHT SIDELINE GRADE
- EXISTING LEFT SIDELINE GRADE

THIS PLAN HAS BEEN PREPARED IN CONFORMITY WITH THE RULES AND REGULATIONS OF THE REGISTERS OF DEEDS OF THE COMMONWEALTH OF MASSACHUSETTS.

FOR REGISTRY USE

PREPARED FOR:

A.D. MAKEPEACE COMPANY
158 TIHONET ROAD
WAREHAM, MASSACHUSETTS

OWNER OF RECORD:

A.D. MAKEPEACE COMPANY
158 TIHONET ROAD
WAREHAM, MASSACHUSETTS

DEED BOOK 1828 PG. 468
ASSESSOR'S MAP 134
PARCELS 4–1,4–2B & 4–3

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PREPARED BY:

BEALS+THOMAS
Civil Engineers + Landscape Architects + Land Surveyors + Planners + Environmental Specialists

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	ISSUE DATE	DESCRIPTION

MPM	MPM	MC	MC
DES	DWN	CHK'D	APP'D

DEFINITIVE SUBDIVISION PLAN OF

HARWICH ROAD SUBDIVISION
CARVER, MASSACHUSETTS
(PLYMOUTH COUNTY)

SCALE: 1" = 40' DATE: MONTH DAY, 2022

METERS 0 5 10 25
FEET 0 20 40 80 120

LAYOUT PLAN AND PROFILE

B+T JOB NO.1833.120

B+T PLAN NO. 1833120P647A–001

C5.1

Appendices

Appendix A

Operation and Maintenance Log

OPERATION AND MAINTENANCE LOG

This template is intended to comply with the operation and maintenance log requirements of the 2008 DEP Stormwater Management Handbook. Copies of this log should be made for all inspections and kept on file for three years from the inspection date.

Name/Company of Inspector:
Date/Time of Inspection:
Weather Conditions: (Note current weather and any recent precipitation events)

Stormwater BMP	Inspection Observations	Actions Required

Appendix B

List of Emergency Contacts

List of Emergency Contacts

Massachusetts DEP Hazardous Waste Incident Response Group
(617) 792-7653

Town of Carver Fire Department
Emergencies: Dial 911
99 Main Street
Carver, MA 02330
Tel: (508) 866-3440
Fire Chief: Craig Weston

Town of Carver Police Department
Emergencies: Dial 911
3 Center Street
Carver, MA 02330
Tel: (508)-866-2000
Police Chief: Marc Duphily

Appendix C

Proprietary Separator Technical Manual & Subsurface Infiltration System Manuals

CONTECH®
ENGINEERED SOLUTIONS

CDS Guide
Operation, Design, Performance and Maintenance

CDS®

Using patented continuous deflective separation technology, the CDS system screens, separates and traps debris, sediment, and oil and grease from stormwater runoff. The indirect screening capability of the system allows for 100% removal of floatables and neutrally buoyant material without blinding. Flow and screening controls physically separate captured solids, and minimize the re-suspension and release of previously trapped pollutants. Inline units can treat up to 6 cfs, and internally bypass flows in excess of 50 cfs (1416 L/s). Available precast or cast-in-place, offline units can treat flows from 1 to 300 cfs (28.3 to 8495 L/s). The pollutant removal capacity of the CDS system has been proven in lab and field testing.

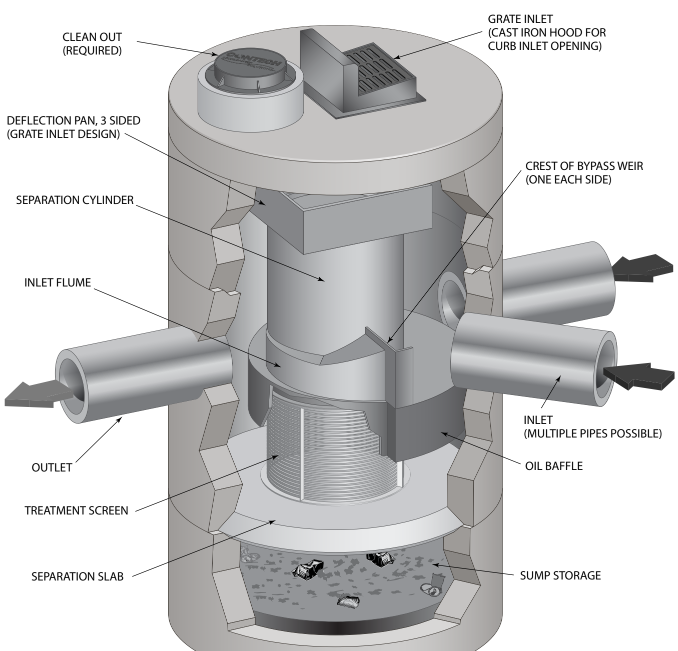
Operation Overview

Stormwater enters the diversion chamber where the diversion weir guides the flow into the unit's separation chamber and pollutants are removed from the flow. All flows up to the system's treatment design capacity enter the separation chamber and are treated.

Swirl concentration and screen deflection force floatables and solids to the center of the separation chamber where 100% of floatables and neutrally buoyant debris larger than the screen apertures are trapped.

Stormwater then moves through the separation screen, under the oil baffle and exits the system. The separation screen remains clog free due to continuous deflection.

During the flow events exceeding the treatment design capacity, the diversion weir bypasses excessive flows around the separation chamber, so captured pollutants are retained in the separation cylinder.



Design Basics

There are three primary methods of sizing a CDS system. The Water Quality Flow Rate Method determines which model size provides the desired removal efficiency at a given flow rate for a defined particle size. The Rational Rainfall Method™ or the and Probabilistic Method is used when a specific removal efficiency of the net annual sediment load is required.

Typically in the Unites States, CDS systems are designed to achieve an 80% annual solids load reduction based on lab generated performance curves for a gradation with an average particle size (d50) of 125 microns (μm). For some regulatory environments, CDS systems can also be designed to achieve an 80% annual solids load reduction based on an average particle size (d50) of 75 microns (μm) or 50 microns (μm).

Water Quality Flow Rate Method

In some cases, regulations require that a specific treatment rate, often referred to as the water quality design flow (WQQ), be treated. This WQQ represents the peak flow rate from either an event with a specific recurrence interval, e.g. the six-month storm, or a water quality depth, e.g. 1/2-inch (13 mm) of rainfall.

The CDS is designed to treat all flows up to the WQQ. At influent rates higher than the WQQ, the diversion weir will direct most flow exceeding the WQQ around the separation chamber. This allows removal efficiency to remain relatively constant in the separation chamber and eliminates the risk of washout during bypass flows regardless of influent flow rates.

Treatment flow rates are defined as the rate at which the CDS will remove a specific gradation of sediment at a specific removal efficiency. Therefore the treatment flow rate is variable, based on the gradation and removal efficiency specified by the design engineer.

Rational Rainfall Method™

Differences in local climate, topography and scale make every site hydraulically unique. It is important to take these factors into consideration when estimating the long-term performance of any stormwater treatment system. The Rational Rainfall Method combines site-specific information with laboratory generated performance data, and local historical precipitation records to estimate removal efficiencies as accurately as possible.

Short duration rain gauge records from across the United States and Canada were analyzed to determine the percent of the total annual rainfall that fell at a range of intensities. US stations' depths were totaled every 15 minutes, or hourly, and recorded in 0.01-inch increments. Depths were recorded hourly with 1-mm resolution at Canadian stations. One trend was consistent at all sites; the vast majority of precipitation fell at low intensities and high intensity storms contributed relatively little to the total annual depth.

These intensities, along with the total drainage area and runoff coefficient for each specific site, are translated into flow rates using the Rational Rainfall Method. Since most sites are relatively small and highly impervious, the Rational Rainfall Method is appropriate. Based on the runoff flow rates calculated for each intensity, operating rates within a proposed CDS system are determined. Performance efficiency curve determined from full scale laboratory tests on defined sediment PSDs is applied to calculate solids removal efficiency. The relative removal efficiency at each operating rate is added to produce a net annual pollutant removal efficiency estimate.

Probabilistic Rational Method

The Probabilistic Rational Method is a sizing program Contech developed to estimate a net annual sediment load reduction for a particular CDS model based on site size, site runoff coefficient, regional rainfall intensity distribution, and anticipated pollutant characteristics.

The Probabilistic Method is an extension of the Rational Method used to estimate peak discharge rates generated by storm events of varying statistical return frequencies (e.g. 2-year storm event). Under the Rational Method, an adjustment factor is used to adjust the runoff coefficient estimated for the 10-year event, correlating a known hydrologic parameter with the target storm event. The rainfall intensities vary depending on the return frequency of the storm event under consideration. In general, these two frequency dependent parameters (rainfall intensity and runoff coefficient) increase as the return frequency increases while the drainage area remains constant.

These intensities, along with the total drainage area and runoff coefficient for each specific site, are translated into flow rates using the Rational Method. Since most sites are relatively small and highly impervious, the Rational Method is appropriate. Based on the runoff flow rates calculated for each intensity, operating rates within a proposed CDS are determined. Performance efficiency curve on defined sediment PSDs is applied to calculate solids removal efficiency. The relative removal efficiency at each operating rate is added to produce a net annual pollutant removal efficiency estimate.

Treatment Flow Rate

The inlet throat area is sized to ensure that the WQQ passes through the separation chamber at a water surface elevation equal to the crest of the diversion weir. The diversion weir bypasses excessive flows around the separation chamber, thus preventing re-suspension or re-entrainment of previously captured particles.

Hydraulic Capacity

The hydraulic capacity of a CDS system is determined by the length and height of the diversion weir and by the maximum allowable head in the system. Typical configurations allow hydraulic capacities of up to ten times the treatment flow rate. The crest of the diversion weir may be lowered and the inlet throat may be widened to increase the capacity of the system at a given water surface elevation. The unit is designed to meet project specific hydraulic requirements.

Performance

Full-Scale Laboratory Test Results

A full-scale CDS system (Model CDS2020-5B) was tested at the facility of University of Florida, Gainesville, FL. This CDS unit was evaluated under controlled laboratory conditions of influent flow rate and addition of sediment.

Two different gradations of silica sand material (UF Sediment & OK-110) were used in the CDS performance evaluation. The particle size distributions (PSDs) of the test materials were analyzed using standard method "Gradation ASTM D-422 "Standard Test Method for Particle-Size Analysis of Soils" by a certified laboratory.

UF Sediment is a mixture of three different products produced by the U.S. Silica Company: "Sil-Co-Sil 106", "#1 DRY" and "20/40 Oil Frac". Particle size distribution analysis shows that the UF Sediment has a very fine gradation (d50 = 20 to 30 μm) covering a wide size range (Coefficient of Uniformity, C averaged at 10.6). In comparison with the hypothetical TSS gradation specified in the NJDEP (New Jersey Department of Environmental Protection) and NJCAT (New Jersey Corporation for Advanced Technology) protocol for lab testing, the UF Sediment covers a similar range of particle size but with a finer d50 (d50 for NJDEP is approximately 50 μm) (NJDEP, 2003).

The OK-110 silica sand is a commercial product of U.S. Silica Sand. The particle size distribution analysis of this material, also included in Figure 1, shows that 99.9% of the OK-110 sand is finer than 250 microns, with a mean particle size (d50) of 106 microns. The PSDs for the test material are shown in Figure 1.

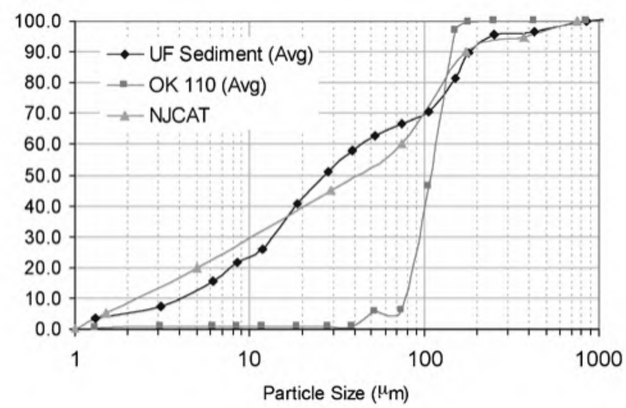


Figure 1. Particle size distributions

Tests were conducted to quantify the performance of a specific CDS unit (1.1 cfs (31.3-L/s) design capacity) at various flow rates, ranging from 1% up to 125% of the treatment design capacity of the unit, using the 2400 micron screen. All tests were conducted with controlled influent concentrations of approximately 200 mg/L. Effluent samples were taken at equal time intervals across the entire duration of each test run. These samples were then processed with a Dekaport Cone sample splitter to obtain representative sub-samples for Suspended Sediment Concentration (SSC) testing using ASTM D3977-97 "Standard Test Methods for Determining Sediment Concentration in Water Samples", and particle size distribution analysis.

Results and Modeling

Based on the data from the University of Florida, a performance model was developed for the CDS system. A regression analysis was used to develop a fitting curve representative of the scattered data points at various design flow rates. This model, which demonstrated good agreement with the laboratory data, can then be used to predict CDS system performance with respect to SSC removal for any particle size gradation, assuming the particles are inorganic sandy-silt. Figure 2 shows CDS predictive performance for two typical particle size gradations (NJCAT gradation and OK-110 sand) as a function of operating rate.

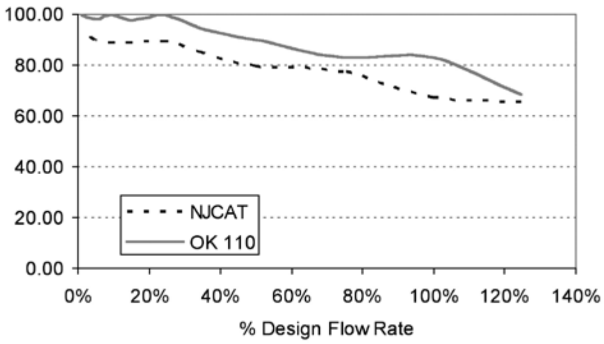


Figure 2. CDS stormwater treatment predictive performance for various particle gradations as a function of operating rate.

Many regulatory jurisdictions set a performance standard for hydrodynamic devices by stating that the devices shall be capable of achieving an 80% removal efficiency for particles having a mean particle size (d50) of 125 microns (e.g. Washington State Department of Ecology — WASDOE - 2008). The model can be used to calculate the expected performance of such a PSD (shown in Figure 3). The model indicates (Figure 4) that the CDS system with 2400 micron screen achieves approximately 80% removal at the design (100%) flow rate, for this particle size distribution (d50 = 125 μm).

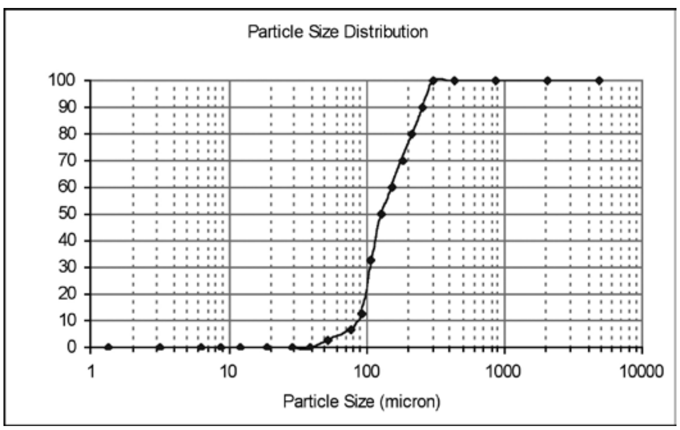


Figure 3. WASDOE PSD

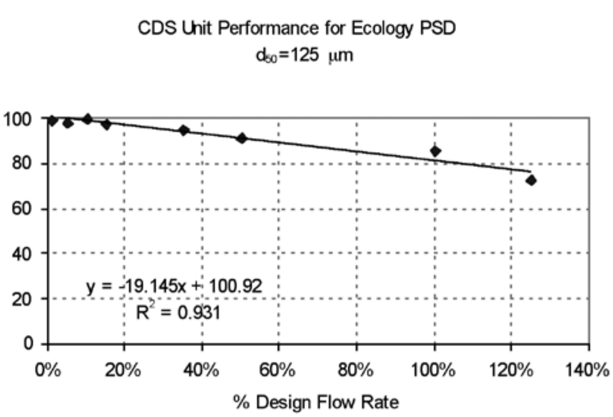


Figure 4. Modeled performance for WASDOE PSD.

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.

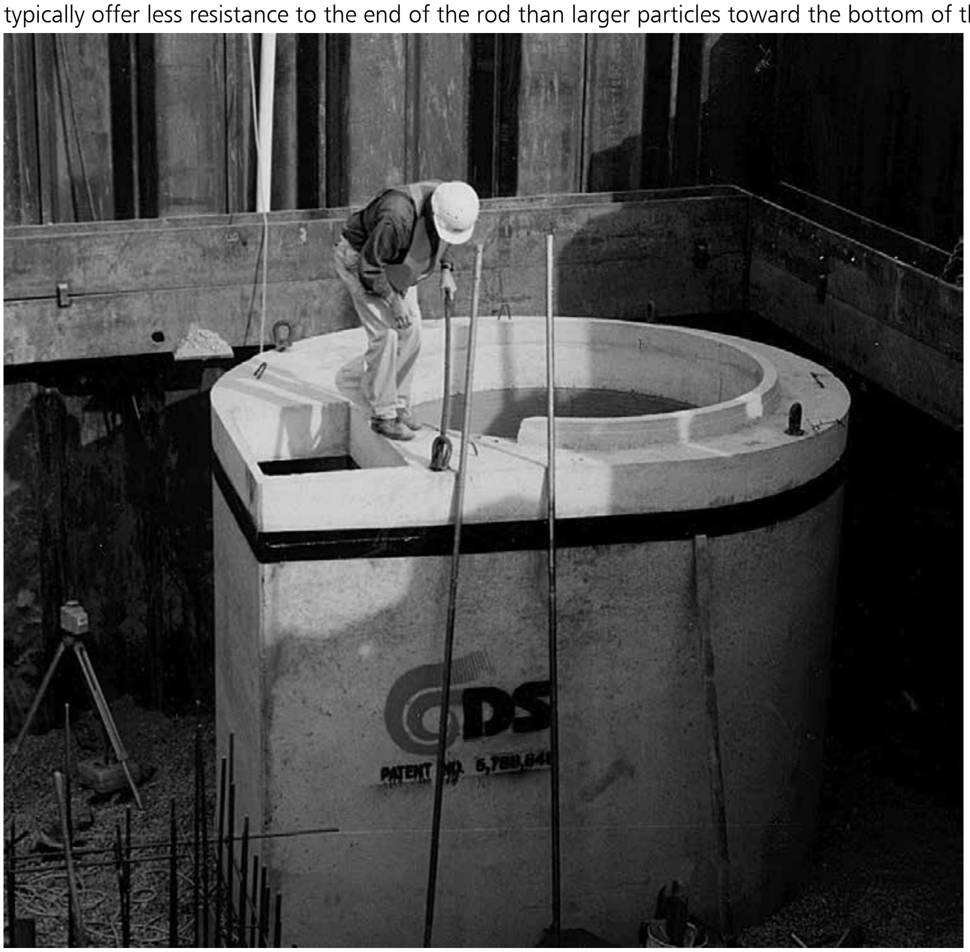
In installations where the risk of petroleum spills is small, liquid contaminants may not accumulate as quickly as sediment. However, the system should be cleaned out immediately in the event of an oil or gasoline spill. Motor oil and other hydrocarbons that accumulate on a more routine basis should 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 cleaned 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. Check your local regulations for specific requirements on disposal.

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	1.5	3.0	0.9	1.3	1.0
CDS2020	5	1.5	3.5	1.1	1.3	1.0
CDS2025	5	1.5	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

Note: To avoid underestimating the volume of sediment in the chamber, carefully lower the measuring device to the top of the sediment pile. Finer silty particles at the top of the pile may be more difficult to feel with a measuring stick. These finer particles typically offer less resistance to the end of the rod than larger particles toward the bottom of the pile.



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.

SUPPORT

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

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cds_manual 3/17 PDF

RECYCLED PAPER

ADS StormTech® Installation Guide
SC-310/SC-740/DC-780

StormTech
Installation Video

Required Materials and Equipment List

- Acceptable fill materials per Table 1
- ADS Plus and non-woven geotextile fabrics
- StormTech solid end caps and pre-cored end caps
- StormTech chambers
- StormTech manifolds and fittings

Important Notes:

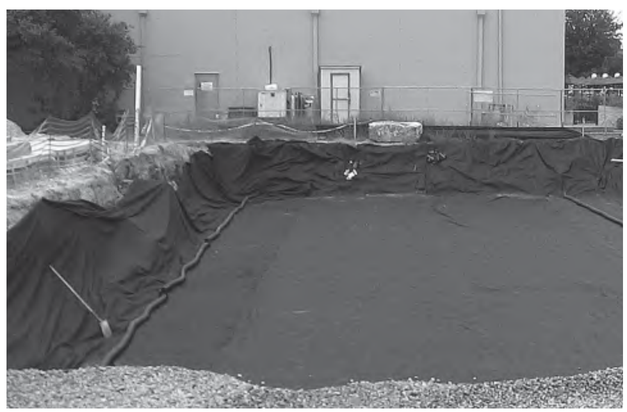
A. This installation guide provides the minimum requirements for proper installation of chambers. Non-adherence to this guide may result in damage to chambers during installation. Replacement of damaged chambers during or after backfilling is costly and very time consuming. It is recommended that all installers are familiar with this guide, and that the contractor inspects the chambers for distortion, damage and joint integrity as work progresses.

B. Use of a dozer to push embedment stone between the rows of chambers may cause damage to chambers and is not an acceptable backfill method. Any chambers damaged by using the “dump and push” method are not covered under the StormTech standard warranty.

C. Care should be taken in the handling of chambers and end caps. Avoid dropping, prying or excessive force on chambers during removal from pallet and initial placement.

Requirements for System Installation

Excavate bed and prepare subgrade per engineer’s plans.



Place non-woven geotextile over prepared soils and up excavation walls. Install underdrains if required.

Place clean, crushed, angular stone foundation 6” (150 mm) min. Compact to achieve a flat surface.

Manifold, Scour Fabric and Chamber Assembly

Install manifolds and lay out ADS Plus fabric at inlet rows (min. 12.5 ft (3.8 m)) at each inlet end cap. Place a continuous piece along entire length of Isolator® Plus Row(s).

Align the first chamber and end cap of each row with inlet pipes. Contractor may choose to postpone stone placement around end chambers and leave ends of rows open for easy inspection of chambers during the backfill process.

Continue installing chambers by overlapping chamber end corrugations. Chamber joints are labeled "Lower Joint – Overlap Here" and "Build this direction – Upper Joint" Be sure that the chamber placement does not exceed the reach of the construction equipment used to place the stone. Maintain minimum 6" (150 mm) spacing between rows.

Attaching the End Caps

Lift the end of the chamber a few inches off the ground. With the curved face of the end cap facing outward, place the end cap into the chamber's end corrugation.

Prefabricated End Caps

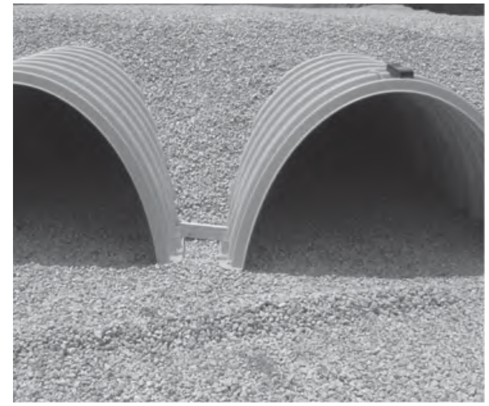
24" (600 mm) inlets are the maximum size that can fit into a SC-740/DC-780 end cap and must be prefabricated with a 24" (600 mm) pipe stub. SC-310 chambers with a 12" (300 mm) inlet pipe must use a prefabricated end cap with a 12" (300 mm) pipe stub. When used on an Isolator Row Plus, these end caps will contain a welded FLAMP (flared end ramp) that will lay on top of the ADS Plus fabric (shown above)

Isolator Row Plus

Place a continuous layer of ADS Plus fabric between the foundation stone and the Isolator Row Plus chambers, making sure the fabric lays flat and extends the entire width of the chamber feet. Drape a strip of ADS non-woven geotextile over the row of chambers (not required over DC-780). This is the same type of non-woven geotextile used as a separation layer around the angular stone of the StormTech system.

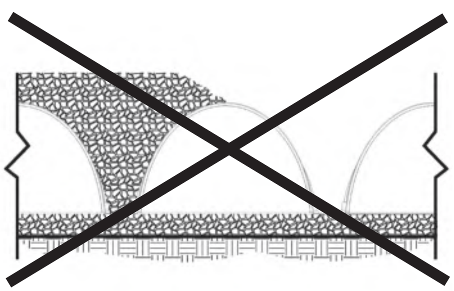
Initial Anchoring of Chambers – Embedment Stone


Initial embedment shall be spotted along the centerline of the chamber evenly anchoring the lower portion of the chamber. This is best accomplished with a stone conveyor or excavator reaching along the row.

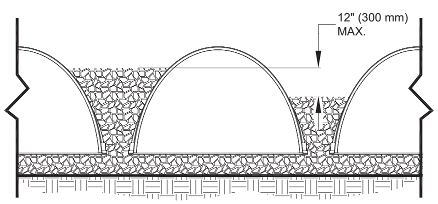



No equipment shall be operated on the bed at this stage of the installation. Excavators must be located off the bed. Dump trucks shall not dump stone directly on to the bed. Dozers or loaders are not allowed on the bed at this time.

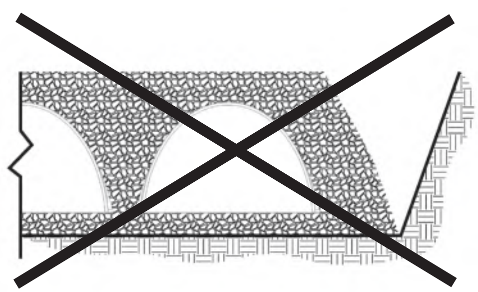
Backfill of Chambers – Embedment Stone



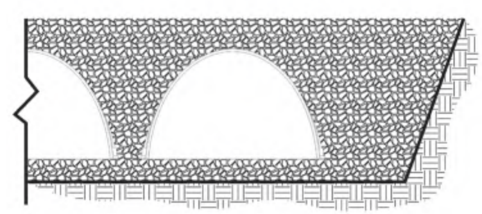
Uneven Backfill



Even Backfill



Perimeter Not Backfilled



Perimeter Fully Backfilled

Backfill chambers evenly. Stone column height should never differ by more than 12” (300 mm) between adjacent chamber rows or between chamber rows and perimeter.

Perimeter stone must be brought up evenly with chamber rows. Perimeter must be fully backfilled, with stone extended horizontally to the excavation wall.

Backfill - Embedment Stone & Cover Stone

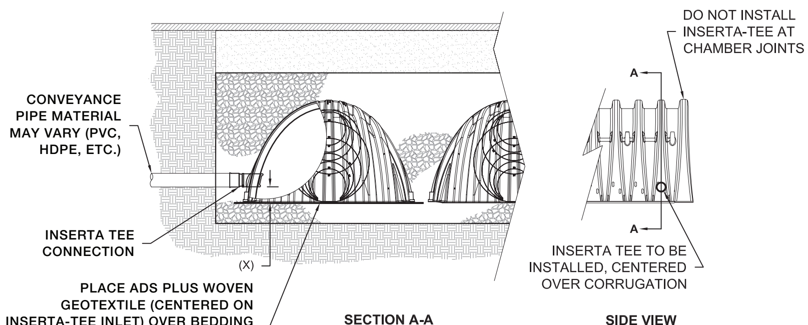
Continue evenly backfilling between rows and around perimeter until embedment stone reaches tops of chambers. Perimeter stone must extend horizontally to the excavation wall for both straight or sloped sidewalls. **Only after chambers have been backfilled to top of chamber and with a minimum 6" (150 mm) of cover stone on top of chambers can small dozers be used over the chambers for backfilling remaining cover stone.**

Small dozers and skid loaders may be used to finish grading stone backfill in accordance with ground pressure limits in Table 2. They must push material parallel to rows only. Never push perpendicular to rows. StormTech recommends that the contractor inspect chambers before placing final backfill. Any chambers damaged by construction shall be removed and replaced.

Final Backfill of Chambers – Fill Material

Install non-woven geotextile over stone. Geotextile must overlap 24" (600 mm) min. where edges meet. Compact each lift of backfill as specified in the site design engineer's drawings. Roller travel parallel with rows.

Inserta Tee Detail



NOTE:
PART NUMBERS WILL VARY BASED ON INLET PIPE MATERIALS. CONTACT STORMTECH FOR MORE INFORMATION.

CHAMBER	MAX DIAMETER OF INSERTA TEE	HEIGHT FROM BASE OF CHAMBER (X)
SC-310	6" (150 mm)	4" (100 mm)
SC-740	10" (250 mm)	4" (100 mm)
DC-780	10" (250 mm)	4" (100 mm)
INSERTA TEE FITTINGS AVAILABLE FOR SDR 26, SDR 36, SCH 40 IPS GASKETED & SOLVENT WELD, N-12, HP STORM, C-900 OR DUCTILE IRON.		

StormTech Isolator Row Plus Detail

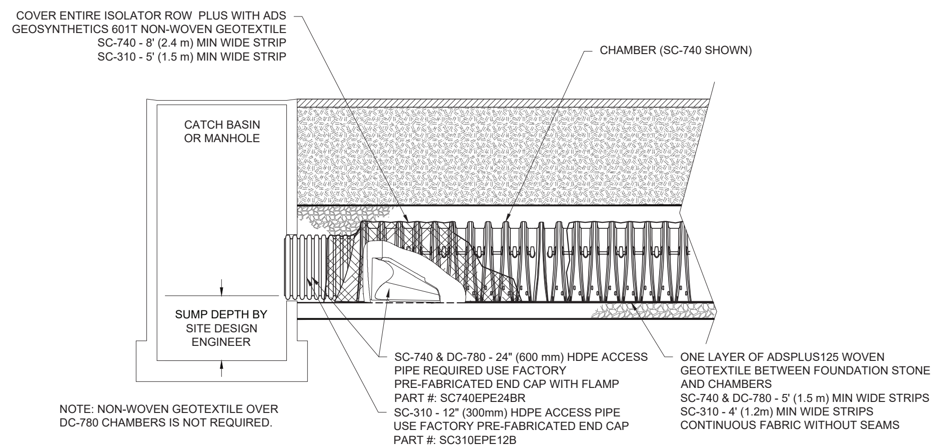


Table 1- Acceptable Fill Materials

Material Location	Description	AASHTO M43 Designation[1]	Compaction/Density Requirement
(D) **Final Fill:** Fill Material for layer 'D' starts from the top of the 'C' layer to the bottom of flexible pavement or unpaved finished grade above. Note that the pavement subbase may be part of the 'D' layer.	Any soil/rock materials, native soils or per engineer's plans. Check plans for pavement subgrade requirements.	N/A	Prepare per site design engineer's plans. Paved installations may have stringent material and preparation requirements.
(C) **Initial Fill:** Fill Material for layer 'C' starts from the top of the embedment stone ('B' layer) to 18" (450 mm) above the top of the chamber. Note that pavement subbase may be part of the 'C' layer.	Granular well-graded soil/aggregate mixtures, <35% fines or processed aggregate. Most pavement subbase materials can be used in lieu of this layer.	AASHTO M45 A-1, A-2-4, A-3 or AASHTO M43[1] 3, 357, 4, 467, 5, 56, 57, 6, 67, 68, 7, 78, 8, 89, 9, 10	Begin compaction after min. 12" (300 mm) of material over the chambers is reached. Compact additional layers in 6" (150 mm) max. lifts to a min. 95% Proctor density for well-graded material and 95% relative density for processed aggregate materials. Roller gross vehicle weight not to exceed 12,000 lbs (53 kN). Dynamic force not to exceed 20,000 lbs (89 kN)
(B) **Embedment Stone:** Embedment Stone surrounding chambers from the foundation stone to the 'C' layer above.	Clean, crushed, angular stone	AASHTO M43[1] 3, 357, 4, 467, 5, 56, 57	No compaction required.
(A) **Foundation Stone:** Foundation Stone below the chambers from the subgrade up to the foot (bottom) of the chamber.	Clean, crushed, angular stone,	AASHTO M43[1] 3, 357, 4, 467, 5, 56, 57	Place and compact in 6" (150 mm) lifts using two full coverages with a vibratory compactor.[2, 3]

Please Note:

1. The listed AASHTO designations are for gradations only. The stone must also be clean, crushed, angular. For example, a specification for #4 stone would state: "clean, crushed, angular no. 4 (AASHTO M43) stone".
2. StormTech compaction requirements are met for 'A' location materials when placed and compacted in 6" (150 mm) (max) lifts using two full coverages with a vibratory compactor.
3. Where infiltration surfaces may be comprised by compaction, for standard installations and standard design load conditions, a flat surface may be achieved by raking or dragging without compaction equipment. For special load designs, contact StormTech for compaction requirements.

Figure 1- Inspection Port Detail

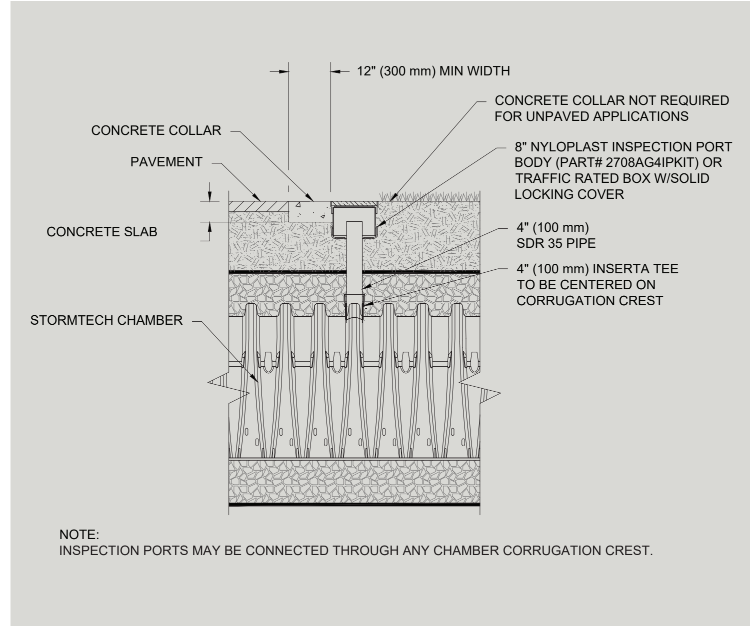
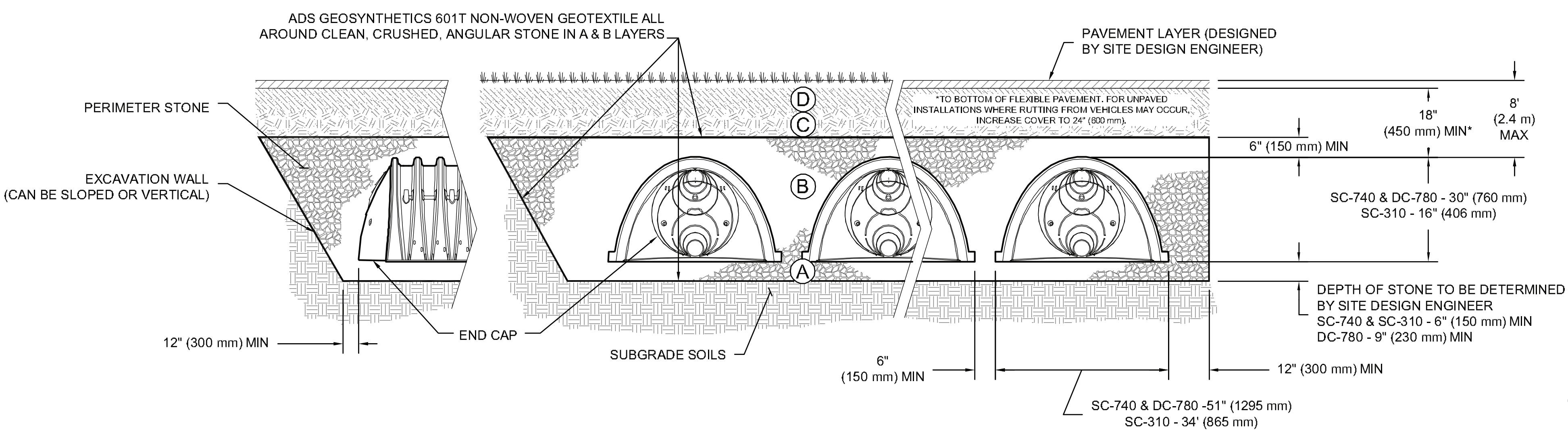


Figure 2 - Fill Material Locations



Notes:

1. 36" (900 mm) of stabilized cover materials over the chambers is recommended during the construction phase if general construction activities, such as full dump truck travel and dumping, are to occur over the bed.

2. During paving operations, dump truck axle loads on 18" (450 mm) of cover may be necessary. Precautions should be taken to avoid rutting of the road base layer, to ensure that compaction requirements have been met, and that a minimum of 18" (450 mm) of cover exists over the chambers. Contact StormTech for additional guidance on allowable axle loads during paving.

3. Ground pressure for track dozers is the vehicle operating weight divided by total ground contact area for both tracks. Excavators will exert higher ground pressures based on loaded bucket weight and boom extension.

4. Mini-excavators (< 8,000lbs/3,628 kg) can be used with at least 12" (300 mm) of stone over the chambers and are limited by the maximum ground pressures in Table 2 based on a full bucket at maximum boom extension.

5. Storage of materials such as construction materials, equipment, spoils, etc. should not be located over the StormTech system. The use of equipment over the StormTech system not covered in Table 2 (ex. soil mixing equipment, cranes, etc) is limited. Please contact StormTech for more information.

6. Allowable track loads based on vehicle travel only. Excavators shall not operate on chamber beds until the total backfill reaches 3 feet (900 mm) over the entire bed.

Table 2 - Maximum Allowable Construction Vehicle Loads[6]

Material Location	Fill Depth over Chambers in. (mm)	Maximum Allowable Wheel Loads		Maximum Allowable Track Loads[6]		Maximum Allowable Roller Loads
		Max Axle Load for Trucks lbs (kN)	Max Wheel Load for Loaders lbs (kN)	Track Width in. (mm)	Max Ground Pressure psf (kPa)	Max Drum Weight or Dynamic Force lbs (kN)
Ⓓ Final Fill Material	36" (900) Compacted	32,000 (142)	16,000 (71)	12" (305) 18" (457) 24" (610) 30" (762) 36" (914)	3880 (186) 2640 (126) 2040 (97) 1690 (81) 1470 (70)	38,000 (169)
Ⓒ Initial Fill Material	24" (600) Compacted	32,000 (142)	16,000 (71)	12" (305) 18" (457) 24" (610) 30" (762) 36" (914)	2690 (128) 1880 (90) 1490 (71) 1280 (61) 1150 (55)	20,000 (89)
	24" (600) Loose/ Dumped	32,000 (142)	16,000 (71)	12" (305) 18" (457) 24" (610) 30" (762) 36" (914)	2390 (114) 1700 (81) 1370 (65) 1190 (57) 1080 (51)	20,000 (89) Roller gross vehicle weight not toexceed 12,000 lbs. (53 kN)
	18" (450)	32,000 (142)	16,000 (71)	12" (305) 18" (457) 24" (610) 30" (762) 36" (914)	2110 (101) 1510 (72) 1250 (59) 1100 (52) 1020 (48)	20,000 (89) Roller gross vehicle weight not to exceed 12,000 lbs. (53 kN)
Ⓑ Embedment Stone	12" (300)	16,000 (71)	NOT ALLOWED	12" (305) 18" (457) 24" (610) 30" (762) 36" (914)	1540 (74) 1190 (57) 1010 (48) 910 (43) 840 (40)	20,000 (89) Roller gross vehicle weight not to exceed 12,000 lbs. (53 kN)
	6" (150)	8,000 (35)	NOT ALLOWED	12" (305) 18" (457) 24" (610) 30" (762) 36" (914)	1070 (51) 900 (43) 800 (38) 760 (36) 720 (34)	NOT ALLOWED

Table 3 - Placement Methods and Descriptions

Material Location	Placement Methods/ Restrictions	Wheel Load Restrictions	Track Load Restrictions	Roller Load Restrictions
		See Table 2 for Maximum Construction Loads		
Ⓓ Final Fill Material	A variety of placement methods may be used. All construction loads must not exceed the maximum limits in Table 2.	36" (900 mm) minimum cover required for dump trucks to dump over chambers.	Dozers to push parallel to rows until 36" (900mm) compacted cover is reached.[4]	Roller travel parallel to rows only until 36" (900 mm) compacted cover is reached.
Ⓒ Initial Fill Material	Excavator positioned off bed recommended. Small excavator allowed over chambers. Small dozer allowed.	Asphalt can be dumped into paver when compacted pavement subbase reaches 18" (450 mm) above top of chambers.	Small LGP track dozers & skid loaders allowed to grade cover stone with at least 6" (150 mm) stone under tracks at all times. Equipment must push parallel to rows at all times.	Use dynamic force of roller only after compacted fill depth reaches 12" (300 mm) over chambers. Roller travel parallel to chamber rows only.
Ⓑ Embedment Stone	No equipment allowed on bare chambers. Use excavator or stone conveyor positioned off bed or on foundation stone to evenly fill around all chambers to at least the top of chambers.	No wheel loads allowed. Material must be placed outside the limits of the chamber bed.	No tracked equipment is allowed on chambers until a min. 6" (150 mm) cover stone is in place.	No rollers allowed.
Ⓐ Foundation Stone	No StormTech restrictions. Contractor responsible for any conditions or requirements by others relative to subgrade bearing capacity, dewatering or protection of subgrade.			

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Isolator® Row
O&M Manual

The Isolator® Row

Introduction

An important component of any Stormwater Pollution Prevention Plan is inspection and maintenance. The StormTech Isolator Row is a technique to inexpensively enhance Total Suspended Solids (TSS) and Total Phosphorus (TP) removal with easy access for inspection and maintenance.

The Isolator Row

The Isolator Row is a row of StormTech chambers, either SC-160, SC-310, SC-310-3, SC-740, DC-780, MC-3500 or MC-7200 models, that is surrounded with filter fabric and connected to a closely located manhole for easy access. The fabric-wrapped chambers provide for sediment settling and filtration as stormwater rises in the Isolator Row and passes through the filter fabric. The open bottom chambers and perforated sidewalls (SC-310, SC- 310-3 and SC-740 models) allow stormwater to flow both vertically and horizontally out of the chambers. Sediments are captured in the Isolator Row protecting the adjacent stone and chambers storage areas from sediment accumulation.

ADS geotextile fabric is placed between the stone and the Isolator Row chambers. The woven geotextile provides a media for stormwater filtration, a durable surface for maintenance, prevents scour of the underlying stone and remains intact during high pressure jetting. A non-woven fabric is placed over the chambers to provide a filter media for flows passing through the chamber's sidewall. The non-woven fabric is not required over the SC-160, DC-780, MC-3500 or MC-7200 models as these chambers do not have perforated side walls.

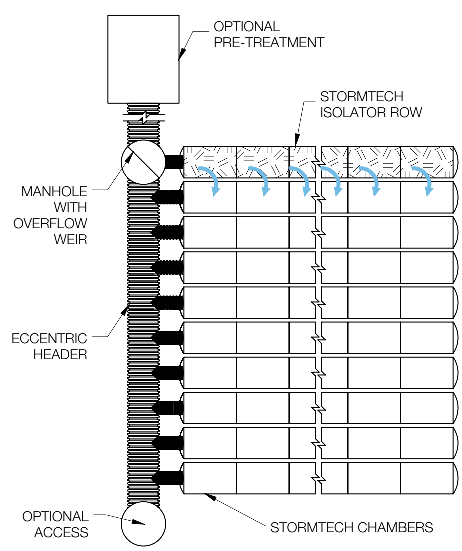
The Isolator Row is designed to capture the "first flush" runoff and offers the versatility to be sized on a volume basis or a flow-rate basis. An upstream manhole provides access to the Isolator Row and includes a high/low concept such that stormwater flow rates or volumes that exceed the capacity of the Isolator Row bypass through a manifold to the other chambers. This is achieved with an elevated bypass manifold or a high-flow weir. This creates a differential between the Isolator Row row of chambers and the manifold to the rest of the system, thus allowing for settlement time in the Isolator Row. After Stormwater flows through the Isolator Row and into the rest of the chamber system it is either exfiltrated into the soils below or passed at a controlled rate through an outlet manifold and outlet control structure.

The Isolator Row may be part of a treatment train system. The treatment train design and pretreatment device selection by the design engineer is often driven by regulatory requirements. Whether pretreatment is used or not, StormTech recommend using the Isolator Row to minimize maintenance requirements and maintenance costs.

Note: *See the StormTech Design Manual for detailed information on designing inlets for a StormTech system, including the Isolator Row.*

Looking down the Isolator Row from the manhole opening, woven geotextile Fabric is shown between the chamber and stone base.

StormTech Isolator Row with Overflow Spillway (*not to scale*)



Isolator Row Inspection/Maintenance

Inspection

The frequency of inspection and maintenance varies by location. A routine inspection schedule needs to be established for each individual location based upon site specific variables. The type of land use (i.e. industrial, commercial, residential), anticipated pollutant load, percent imperviousness, climate, etc. all play a critical role in determining the **actual frequency of inspection and maintenance practices.**

At a minimum, StormTech recommends annual inspections. Initially, the Isolator Row should be inspected every 6 months for the first year of operation. For subsequent years, the inspection should be adjusted based upon previous observation of sediment deposition.

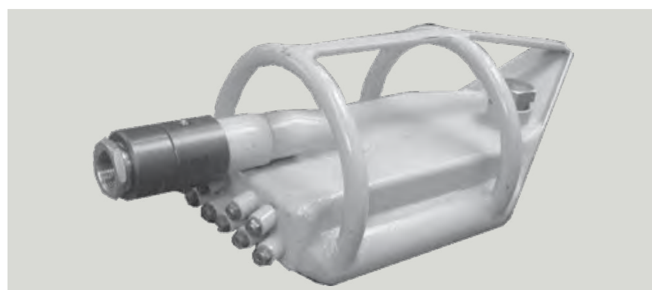
The Isolator Row incorporates a combination of standard manhole(s) and strategically located inspection ports (as needed). The inspection ports allow for easy access to the system from the surface, eliminating the need to perform a confined space entry for inspection purposes.

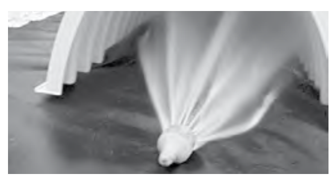
If upon visual inspection it is found that sediment has accumulated, a stadia rod should be inserted to determine the depth of sediment. When the average depth of sediment exceeds 3 inches throughout the length of the Isolator Row, clean-out should be performed.

Maintenance

The Isolator Row was designed to reduce the cost of periodic maintenance. By “isolating” sediments to just one row, costs are dramatically reduced by eliminating the need to clean out each row of the entire storage bed. If inspection indicates the potential need for maintenance, access is provided via a manhole(s) located on the end(s) of the row for cleanout. If entry into the manhole is required, please follow local and OSHA rules for a confined space entries.

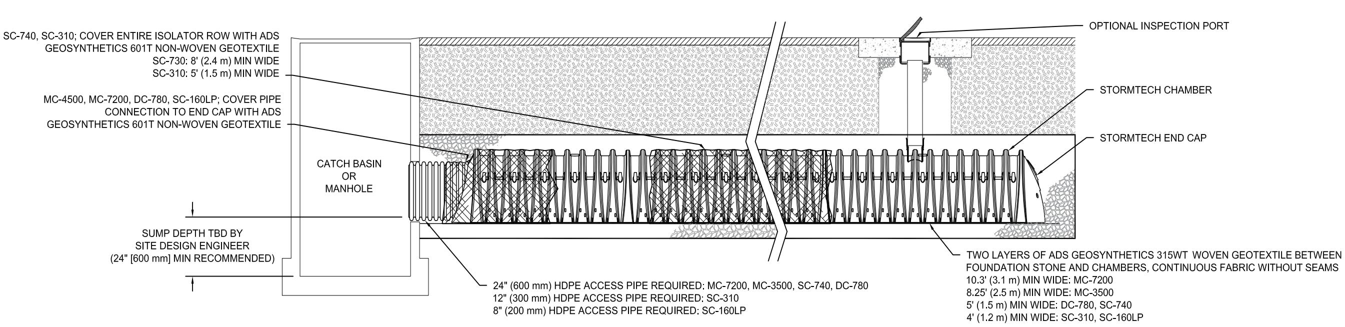
Maintenance is accomplished with the JetVac process. The JetVac process utilizes a high pressure water nozzle to propel itself down the Isolator Row while scouring and suspending sediments. As the nozzle is retrieved, the captured pollutants are flushed back into the manhole for vacuuming. Most sewer and pipe maintenance companies have vacuum/JetVac combination vehicles. Selection of an appropriate JetVac nozzle will improve maintenance efficiency. Fixed nozzles designed for culverts or large diameter pipe cleaning are preferable. Rear facing jets with an effective spread of at least 45” are best. JetVac reels can vary in length. For ease of maintenance, ADS recommends Isolator Row lengths up to 200" (61 m). **The JetVac process shall only be performed on StormTech Isolator Rows that have AASHTO class 1 woven geotextile (as specified by StormTech) over their angular base stone.**





StormTech Isolator Row (not to scale)

Note: *Non-woven fabric is only required over the inlet pipe connection into the end cap for SC-160LP, DC-780, MC-3500 and MC-7200 chamber models and is not required over the entire Isolator Row.*



Isolator Row Step By Step Maintenance Procedures

Step 1

Inspect Isolator Row for sediment.
  A) Inspection ports (if present)
    i. Remove lid from floor box frame
    ii. Remove cap from inspection riser
    iii. Using a flashlight and stadia rod,measure depth of sediment and record results on maintenance log.
    iv. If sediment is at or above 3 inch depth, proceed to Step 2. If not, proceed to Step 3.
  B) All Isolator Row
    i. Remove cover from manhole at upstream end of Isolator Row
    ii. Using a flashlight, inspect down Isolator Row through outlet pipe
      1. Mirrors on poles or cameras may be used to avoid a confined space entry
      2. Follow OSHA regulations for confined space entry if entering manhole
    iii. If sediment is at or above the lower row of sidewall holes (approximately 3 inches), proceed to Step 2. If not, proceed to Step 3.

Step 2

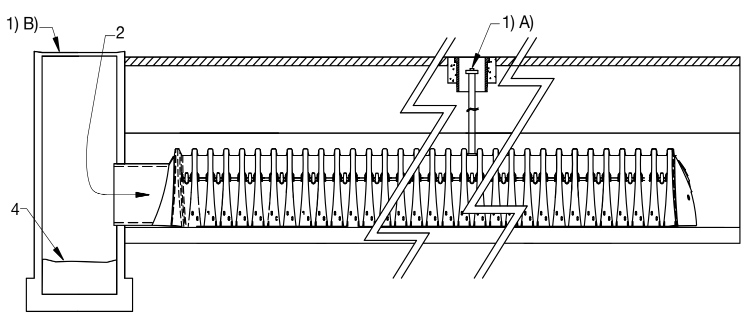
Clean out Isolator Row using the JetVac process.
  A) A fixed floor cleaning nozzle with rear facing nozzle spread of 45 inches or more is preferable
  B) Apply multiple passes of JetVac until backflush water is clean
  C) Vacuum manhole sump as required

Step 3

Replace all caps, lids and covers, record observations and actions.

Step 4

Inspect & clean catch basins and manholes upstream of the StormTech system.



Sample Maintenance Log

Date	Stadia Rod Readings		Sedi-ment Depth (1)–(2)	Observations/Actions	Inspector
	Fixed point to chamber bottom (1)	Fixed point to top of sediment (2)			
3/15/11	6.3 ft	none		New installation. Fixed point is CI frame at grade	DJM
9/24/11		6.2	0.1 ft	Some grit felt	SM
6/20/13		5.8	0.5 ft	Mucky feel, debris visible in manhole and in Isolator Row, maintenance due	NV
7/7/13	6.3 ft		0	System jetted and vacuumed	DJM

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