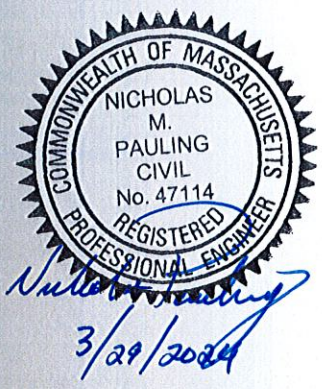
Stormwater Management Permit Application & Stormwater Management Report

91 Groton-Harvard Road
Ayer, MA

March 2024

Submitted to:
Town of Ayer
Planning Board
1 Main Street
Ayer, MA 01432



Submitted by:
North Atlantic Concrete
270 Ayer Rd, Unit 1
Harvard, MA 01451

Prepared by:
Goldsmith, Prest & Ringwall, Inc.
39 Main Street, Suite 301
Ayer, MA 01432

Project No:
231083

GPR Engineering Solutions for Land & Structures

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Attachments

Section 1

Permit Application and DEP Stormwater Management Report Checklist

Ayer Planning Board
Stormwater Management Permit Application

1. LOCATION OF PROPERTY

Street Address 91 Groton-Harvard Road

Registry Middlesex South Book 66861 Page 280

Assessor's Map 13 Parcel 8

Zoning District (including Overlay if applicable):

R-A1

2. OWNER INFORMATION

Name North Atlantic Concrete

Address 270 Ayer Road, Unit 1, Harvard, MA

Telephone 978-660-8441

3. ENGINEER INFORMATION

Name Goldsmith, Prest & Ringwall, Inc.

Address 39 Main Street, Ayer, MA

Email kiek@gpr-inc.com

Telephone 978-772-1590

4. PROJECT TYPE (CHECK ALL THAT APPLY)

☐ **Minor Project:**

- ☐ Land disturbance of an area greater than 20,000 sq. ft. but less than 40,000 sq. ft.
- ☐ Land disturbance of a volume of earth greater than 1,500 cubic yards but less than 2,200 cubic yards
- ☐ Land disturbance of an area of land 1,000 sq. ft. to 10,000 sq. ft.
  - ☐ If the slope is 15% or greater; or
  - ☐ If the soil cut or filled exceeds four (4) feet in vertical depth at its deepest point as measured from the natural ground level. This requirement may be waived for septic system installation
- ☐ Land disturbance that meets or exceeds 2,000 square feet of area and is less than 5,000 square feet of area within a Critical Area or where stormwater discharge is directly or indirectly to an Impaired Waterbody or its tributaries

☒ **Major Project:**

- ☒ Land disturbance of an area of greater than 40,000 sq. ft.
- ☒ Land disturbance of a volume of earth resulting in a total quantity greater than 2,200 cubic yards
- ☒ Land disturbance of an area of land greater than 10,000 sq. ft.
  - ☐ If the slope is 15% or greater; or
  - ☒ If the soil cut or filled exceeds four (4) feet in vertical depth at its deepest point as measured from the natural ground level.
- ☐ Land disturbance that meets or exceeds 5,000 square feet of area within a Critical Area or where stormwater discharge is directly or indirectly to an Impaired Waterbody or its tributaries
- ☐ Land disturbance resulting in a net increase of 30% or more of impervious area on a parcel of land having more than 5,000 square feet of existing impervious area

☐ **Modification of Permit # _____** ☐ **Extension of Permit # _____**

5. Other Jurisdiction

Conservation Commission

Board of Health

Building Permit

Other:_____

6. REQUIRED SUBMITTALS

- **Completed Stormwater Management Permit Application**
- **Written Authorization Signed by the Owner(s), if submitted by another individual**
- **Stormwater Management Erosion and Sedimentation Control Plan ("Stormwater Plan")**
- **Operation and Maintenance Plan ("O&M Plan")**
- **Certified List of Abutters (300 Feet) (Major Projects Only)**
- **Application Fee $150.00**
- **Engineering or Consultant Review Fee (if applicable)**
    - **DPW Review Fee**
        - **Minor Project = $100.00**
        - **Major Project = $200 plus $0.005 per square foot of land area that will be disturbed by activities authorized by the Stormwater Management Permit**
    - **Outside Consultant Review Fee**
        - **Minor and Major Project = To Be Determined by Planning Board as obtained from its consultant**
- **Advertising Fee (cost to be determined and borne by the applicant)**

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.

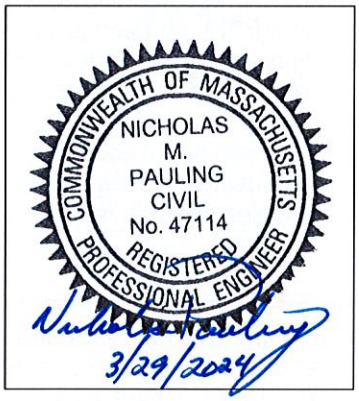
Note: Because stormwater requirements vary from project to project, it is possible that a complete Stormwater Report may not include information on some of the subjects specified in the Checklist. If it is determined that a specific item does not apply to the project under review, please note that the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



Nicholas Pauling 3/29/2024
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): Infilitration Chambers & Direct Roof Recharge, Focalpoint Biofiltration

Standard 1: No New Untreated Discharges

☒ No new untreated discharges

☒ Outlets have been designed so there is no erosion or scour to wetlands and waters of the Commonwealth

☒ Supporting calculations specified in Volume 3 of the Massachusetts Stormwater Handbook included.

Checklist for Stormwater Report

Checklist (continued)

Standard 2: Peak Rate Attenuation

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

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

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

Standard 3: Recharge

☒ Soil Analysis provided.

☒ Required Recharge Volume calculation provided.

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

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

☒ Static ☐ Simple Dynamic ☐ Dynamic Field[1]

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

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

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

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

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

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

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

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

Checklist for Stormwater Report

Checklist (continued)

Standard 3: Recharge (continued)

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

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

Standard 4: Water Quality

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

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

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

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

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

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

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

Checklist for Stormwater Report

Checklist (continued)

Standard 4: Water Quality (continued)

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

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

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

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

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

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

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

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

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

☐ All exposure has been eliminated.

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

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

Standard 6: Critical Areas

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

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

Checklist for Stormwater Report

Checklist (continued)

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

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

☐ Limited Project

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

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

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

☐ Bike Path and/or Foot Path

☒ Redevelopment Project

☐ Redevelopment portion of mix of new and redevelopment.

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

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

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

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

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

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

Checklist for Stormwater Report

Checklist (continued)

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

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

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

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

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

Standard 9: Operation and Maintenance Plan

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

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

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

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

Standard 10: Prohibition of Illicit Discharges

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

☐ An Illicit Discharge Compliance Statement is attached;

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

Section 2

Introduction and Methodology & Stormwater Management Waiver Request

Introduction and Methodology

This Stormwater Management Report is intended to accompany plans for the proposed commercial redevelopment applying for a Site Plan Review & Stormwater Management Permit application for the subject site, located along Groton-Harvard Road, between Oak Ridge Drive and Washington Street. Included in this report are calculations that support a final engineering design as required by the Massachusetts Stormwater Handbook and the Town of Ayer Stormwater Regulations. Site specific information is presented under two scenarios, “pre-development” and “post-development” conditions, so that potential impacts due to the project can be identified, quantified and, as necessary, mitigated.

The final design intent seeks to meet the following interrelated goals:

1. Limit stormwater runoff rates for the 2-, 10-, 25- and 100-year storm events to existing (pre-development) levels;

2. Address each of the Massachusetts Stormwater Management Standards as a commercial redevelopment project.

3. Prevent appreciable sediment and other suspended solids and contaminants transport by trapping them on site via Best Management Practices;

4. Provide adequate drainage for new surfaces;

5. Maintain existing drainage patterns while providing a cost-effective engineering solution that addresses regulatory as well as real-world constraints.

6. Combination of storage and design release rate to not result in a storage duration of greater than seventy-two hours.

Site Description

The proposed project is a commercial redevelopment at 91 Groton-Harvard Road located between Oak Ridge Drive and Washington Street in Ayer, MA. The project site parcel is designated as Map 13, Parcel 8 by the Town of Ayer Assessors department. The project site is a parcel consisting of 4.2± Ac. of land area. Approximately 2/3 of the subject site on the western portion is an existing developed area with general commercial mixed uses, while the remaining 1/3 is undisturbed wooded area on the eastern portion of the subject site. The subject site is located south of the abutting the Ayer Transfer Station, west of the abutting a large network of wetland area surrounding the Upper Flannegan Pond, and north of the abutting wooded conservation land. The disturbed portion of the project site is generally surrounded by trees, acting as natural screening to the surrounding area, and is approximately 300 FT away from the existing network of wetland area east of the subject site.

There is an existing commercial building located approximately 75 FT away from the Groton-Harvard Road street line and surrounded by a large paved/gravel footprint that is currently being used for general commercial access and exterior storage. There are two existing driveway accesses located north and south of the existing building on site. The limit of the proposed work on site shall remain solely within the existing disturbed limit of the subject site, while maintaining approximately 300 FT away from the existing wetland area.

The existing grade and drainage pattern on the project site is generally dictated by an existing ridge located on the northern portion of the site. The existing ridge acts as a high point dividing the stormwater westerly towards Groton-Harvard Road and easterly towards the wooded area. The general slope within the existing developed portion of the site varies around 3-10%, while the slope at the eastern wooded area is generally steep, which can vary from 15-25%, heading down towards the limit of wetland area.

Available NRCS soils mapping for the project and surrounding areas shows diverse soils, ranging from Hydrologic Soil Group (HSG) B & D. NRCS indicate that the subject site can be divided into two types of soil, Udorthents – Loamy on the western portion of the site, and Hollis-Rock outcrop-Charlton complex on the eastern portion of the site.

NRCS does not provide a HSG for Udorthents – Loamy, but this portion of the site shall be deemed as HGS B for the purpose of analysis and following the HSG designation for Loamy Sand in accordance with the Massachusetts Stormwater Handbook. Hollis-Rock outcrop-Charlton complex is typically considered as HSG D and shall be designated as such for the purpose of analysis. The divide between the two soil groups appears to be nearly matching the limit of the existing disturbed/developed and the undisturbed portion of the subject site.

Onsite soil evaluations were performed by this office. These soil classifications, along with other listed characteristics in the logs reveal that the mapping is typically consistent with the field evaluation.

Under the pre-development scenario, the watershed map consists of 4.2± Ac which is the whole project site area. The watershed area associated with the project site can be interpreted as two subcatchment areas. As shown on the plan entitled “WATERSHED MAP – PRE-DEVELOPMENT”, included within the attached Appendix, the subcatchment area is shown as SC1.0 and SC2.0. SC1.0 and SC2.0 are being used to quantify peak flows to two different Analysis Points, shown as AP-1 and AP-2 respectively. AP-1 summarizes the flow from the subcatchment areas to onto the street (Groton-Harvard Road) while AP-2 summarizes the flow from the subcatchment areas towards the wetland area southeast of the project area.

Project Description

The project proposes to demolish the existing commercial building and construct a 12,000± SF while maintaining the existing commercial mixed uses. The proposed project will also provide 16 paved parking spaces, an onsite subsurface sewage disposal system, and utility connections. The proposed development will maintain its existing onsite exterior storage areas. The existing driveway accesses shall be paved and adjusted/shifted as needed to accommodate the proposed

building and parking areas. The project as a whole decreases the total post-construction impervious cover on site, improving upon an existing non-conforming open space area on site and providing more natural groundwater recharge.

In order to further improve upon general drainage conditions on site, various stormwater Best Management Practices (BMP) are proposed. Onsite stormwater BMPs are designed to capture and treat stormwater, provide groundwater recharge, reduce stormwater runoff than existing conditions to the maximum practicable as a commercial redevelopment project.

Under the post-development scenario, the project has been divided into a total of 5 subcatchment (SC) areas, shown on the plan entitled “WATERSHED MAP – DEVELOPED CONDITIONS”, and included in the attached Appendix, outlining runoff to the development Analysis Points, AP-1 and AP-2.

Subcatchment SC1.1 outlines stormwater runoff from the western portion of the project site that is not able to be collected and generally sheet flows to AP-1.

Subcatchment SC1.2 outlines stormwater runoff from the proposed paved parking area north of the proposed building. Stormwater within said subcatchment area shall be collected and treated with a proprietary system called Rain Guardian Turret and Focalpoint Biofiltration, located adjacent to the north driveway access. The treatment system will treat the stormwater runoff and allow stormwater to infiltrate through the soil media. Once said treatment system is inundated, stormwater will be able to continue downgradient onto AP-1.

Subcatchment SC2.1 outlines stormwater runoff from the proposed paved parking area south of the proposed building, to be collected via a proposed catch basin located adjacent to the south driveway access. The deep sump hooded catch basin will provide some debris/sediment removal prior to continuing down the treatment train towards the proposed infiltration chambers for further treatment and groundwater recharge.

Proposed infiltration chambers are designed to have an isolator row to provide additional treatment to the system, as well as a drain manhole access to allow for cleaning and removal of sediment contained within the isolator row. An overflow outlet is also provided for the proposed infiltration chambers to allow stormwater to continue onto AP-2.

Subcatchment SC2.2 outlines the stormwater over the roof of the proposed building. Stormwater shall be collected via gutters and roof drain manifold and directly discharge into proposed infiltration chambers, similar to SC2.1.

Subcatchment SC2.3 outlines the stormwater runoff from the remaining portion of the subject site that is not controlled, just as it was for the existing conditions. Said portion will sheet flow across the existing gravel portion of the lot and continue towards AP-2 as it does currently.

The proposed BMP’s have been designed in accordance with the Massachusetts Stormwater Standards and the Town of Ayer Stormwater Regulations to attenuate peak flows, treat runoff from impervious surfaces and maintain groundwater recharge to improve upon the existing site

conditions to the maximum extent practicable.
Hydrologic and Hydraulic Computation Methodology

Runoff rates were computed using the rainfall events as published by the National Oceanic and Atmospheric Administration (NOAA) as the latest published rainfall data as recommended by HydroCAD's most recent program update HydroCAD-10.2.4b. The following 24-hour rainfall events were analyzed:

Frequency (years): 2, 10, 25 and 100

As outlined above, runoff from the site has been analyzed at AP-1 and AP-2 under the pre-development and post-development conditions.

Massachusetts Stormwater Management Redevelopment Checklist (Standard 7)

Standard 1: (Untreated discharges)
No new stormwater conveyances (e.g., outfalls) may discharge untreated stormwater directly to or cause erosion in wetlands or waters of the Commonwealth. (Full compliance with Standard 1 is required for new outfalls.)

New outfalls are treating stormwater to meet the minimum 80% TSS removal, therefore the project is in full compliance with Standard 1.

Standard 2: (Peak rate control and flood prevention)
Stormwater management systems must be designed so that post-development peak discharge rates do not exceed pre-development peak discharge rates. This Standard may be waived for land subject to coastal storm flowage. (Standard 2 compliance to the Maximum Extent Practicable as Redevelopment.)

Stormwater management systems are designed so that the post-development peak discharge rates do not exceed pre-development peak discharge rates (See Hydrology Summary for 24-hour Storm), therefore the project is in full compliance with Standard 2.

Standard 3: (Recharge to Ground water)
Loss of annual recharge to ground water shall be eliminated or minimized through the use of infiltration measures, including environmentally sensitive site design, low impact development techniques, best management practices, and good operation and maintenance. At a minimum, the annual recharge from the post-development site shall approximate the annual recharge from the pre-development conditions based on soil type. This Standard is met when the stormwater management system is designed to infiltrate the required recharge volume as determined in accordance with the Massachusetts's Stormwater Handbook. (Standard 3 compliance to the Maximum Extent Practicable as Redevelopment.)

As the project proposes to reduce overall site impervious cover, therefore there is no loss of annual recharge to groundwater. However, Stormwater management systems have been designed to treat water quality volume in accordance with the Ayer Stormwater Management

Regulations to the maximum extent practicable through the use of infiltration chambers, and calculations are provided to show required stormwater recharge volume will drawdown within 72 hours (See Groundwater Recharge & Drawdown Time), therefore the project is in full compliance with Standard 3.

Standard 4: (80% TSS Removal)

Stormwater management systems must be designed to remove 80% of the average annual post-construction load of Total Suspended Solids (TSS). This standard is met when:

a) Suitable practices for source control and pollution prevention are identified in a long-term pollution prevention plan and thereafter are implemented and maintained;
b) Stormwater BMPs are sized to capture the required water quality volume determined in accordance with the Massachusetts Stormwater Handbook; and
c) Pretreatment is provided in accordance with the Massachusetts Stormwater Handbook.

(Standard 4 compliance to the Maximum Extent Practicable as Redevelopment.)

a) Proposed BMPs are suitable to remove 80% TSS removal in accordance with the Massachusetts Stormwater Handbook and A Long-Term Pollution Prevent and Stormwater System Operation and Maintenance Plan has been provided.
b) Stormwater BMPs are sized to capture the required water quality volume in accordance wit the Massachusetts Stormwater Handbook (See Water Quality Retention Volume).
c) Pretreatment has been provided for the proposed BMP in the form of deep sump hooded catch basin and Isolator Row with drain manhole access.

The project is in full compliance with Standard 4.

Standard 5 (Higher Potential Pollutant Loads (HPPL)

For land uses with higher potential pollutant loads, 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. If through source control and/or pollution prevention, all land uses with higher potential pollutant loads cannot be completely protected from exposure to rain, snow, snow melt and stormwater runoff, the proponent shall use the specific stormwater BMPs determined by the Department to be suitable for such use as provided in the Massachusetts Stormwater Handbook. Stormwater discharges from land uses with higher potential pollutant loads shall also comply with the requirements of the Massachusetts Clean Waters Act, M.G.L. c. 21, §§ 26-53, and the regulations promulgated thereunder at 314 CMR 3.00, 314 CMR 4.00 and 314 CMR 5.00. (Full compliance with Standard 5 is required for new and redevelopment.)

Land uses are not associated with higher potential pollutant loads, therefore the project is in full compliance with Standard 5.

Standard 6 (Critical Areas)

Stormwater discharges to a Zone II or Interim Wellhead Protection Area of a public water supply and stormwater discharges near or any other critical area require the use of the specific source control and pollution prevention measures and the specific stormwater best management practices determined by the Department to be suitable for managing discharges to such area, as provided in the Massachusetts Stormwater Handbook. A discharge is near a critical area if there is a strong

likelihood of a significant impact occurring to said area, taking into account site-specific factors. Stormwater discharges to Outstanding Resource Waters or Special Resource Waters shall be set back from the receiving water and receive the highest and best practical method of treatment. A "stormwater discharge," as defined in 314 CMR 3.04(2)(a)1. or (b), to an Outstanding Resource Water or Special Resource Water shall comply with 314 CMR 3.00 and 314 CMR 4.00. Stormwater discharges to a Zone I or Zone A are prohibited unless essential to the operation of the public water supply. (Full compliance with Standard 6 is required for new and redevelopment.)

Stormwater discharges are not within or near critical resource areas, therefore the project is in full compliance with Standard 6.

Standard 8: (Erosion, Sediment Control)

A plan to control construction-related impacts, including erosion sedimentation and other pollutant sources during construction and land disturbance activities (construction period erosion, sedimentation, and pollution prevention plan), must be developed and implemented. (Full compliance with Standard 8 is required for new and redevelopment.)

Erosion control plan and notes provided within Site Plan set, a SWPPP will be submitted before land disturbance can begin, therefore the project is in full compliance with Standard 8.

Standard 9: (Operation and Maintenance)

A long-term operation and maintenance plan must be developed and implemented to ensure that stormwater management systems function as designed. (Full compliance with Standard 9 is required for new and redevelopment.)

Long-Term Pollution Prevent and Stormwater System Operation and Maintenance Plan has been provided, therefore the project is in full compliance with Standard 9.

Standard 10 (Illicit Discharges)

All illicit discharges to the stormwater management system are prohibited.

There are no known or suspected illicit discharges to the stormwater management at the redevelopment project site and an Illicit Discharge Compliance Statement has been provided, therefore the project is in full compliance with Standard 10.

Ayer Redevelopment Stormwater Management Performance and Design Standards

Stormwater Management Systems on Redevelopment Sites shall meet the following Standards to the maximum extent practicable:

a) *Massachusetts Stormwater Policy Standards 1, 2, and 3, the pretreatment and structural best management practices requirements Massachusetts Stormwater Policy Standards 5 and 6.*

   The proposed project is in full compliance with the Massachusetts Stormwater

Management Standards 1, 2, 3, 5 and 6.

b) *Stormwater management systems on Redevelopment sites shall also improve existing conditions by requiring that stormwater management systems be designed to:*
    1) *Retain the volume of runoff equivalent to, or greater than, 0.80 inch multiplied by the total post-construction impervious surface area on the site and/or*
    2) *Remove 80% of the average annual post-construction load of Total Suspended Solids (TSS) generated from the total post-construction impervious area on the site and 50% of the average annual load of Total Phosphorus (TP) generated from the total postconstruction impervious surface area on the site.*

    1) The required stormwater retention volume as required (0.8-inch x total post-construction impervious surface) is 6,450 CF. The proposed BMP has been designed to retain 2,306 CF of water quality volume due to site constraints. The project proposes to capture the redevelopment portion (31,306 SF) of the impervious area and retain 0.8-inch of said redevelopment (2,087 CF). (See Water Quality Retention Volume and Stormwater Management Waiver Request Letter).
    2) Stormwater systems are designed to provided removal of TSS and TP generated from redevelopment portion of the post-construction site. (See Water Quality Retention Volume and Stormwater Management Waiver Request Letter).

c) *Redevelopment activities that are exclusively limited to maintenance and improvement of existing roadways …*

    Not applicable to the project.

d) *Stormwater management systems on redevelopment sites may utilize offsite mitigation within the same USGS HUC12 as the redevelopment site to meet the equivalent retention or pollutant removal requirements.*

    Project does not intend to utilize offsite mitigation method.

Summary of Results

Peak discharge rates and volumes of the calculated runoff for both conditions analyzed are displayed in the HYDROLOGY SUMMARY that follows. As shown within the summary, the peak discharge rates for all analyzed storm events are less than or equal to those under pre-development conditions. As required for any redevelopment project, the project nearly meets all of the Massachusetts Stormwater Standards, while providing drainage improvements to the maximum extent practicable to meet the Ayer's Stormwater Regulations for a redevelopment project. The redevelopment project as a whole improves upon the general drainage conditions for existing site, as the project proposes to reduce total site impervious area and provides groundwater recharge and pollutant removal for the redevelopment portion of the total site. See Appendix for computed solids quantities / removal process trains, and water quality runoff volumes.

GPR
Civil Engineering • Land Planning • Land Surveying
Engineering Solutions
for Land & Structures

March 19, 2024

Town of Ayer Planning Board
1 Main Street
Ayer, MA 01432

Subject: **Stormwater Management Waiver Request Letter**
91 Groton-Harvard Road
Ayer, MA 01432

Dear Board Members:

On behalf of our client, North Atlantic Concrete, we respectfully request the following waivers from the Town of Ayer Stormwater Management Application:

2.8.D.b- Redevelopment Stormwater Management Performance and Design Standards:

Required: Stormwater management systems on redevelopment sites shall also improve existing conditions by requiring that stormwater management systems be designed to:

1) Retain the volume of runoff equivalent to, or greater than, 0.80 inch multiplied by the total post-construction impervious surface area on the site and/or
2) Remove 80% of the average annual post-construction load of Total Suspended Solids (TSS) generated from the total post-construction impervious area on the site and 50% of the average annual load of Total Phosphorus (TP) generated from the total postconstruction impervious surface area on the site.

Requested: Allow water quality retention volume and pollutant removal (TSS and TP) to be provided to only the redevelopment portion of the project site.

Reason: Through onsite soil testing for locating suitable area for subsurface sewage disposal system and drainage system, it was discovered that the site surface condition is filled with ledge. For most of the test pit locations that were possible to dig down, we discovered fill materials that are unsuitable for locating drainage system. After multiple days of digging, we were able to locate an area south of the existing building to allow for subsurface infiltration chambers, therefore a drainage system was designed for the site based on this area.

Section 3

Hydrology Summary for 24-hour Storm

HYDROLOGY SUMMARY FOR 24-HOUR STORM

91 Groton-Harvard Road, Ayer, MA
Project No. 231083

PEAK DISCHARGE RATE

Pre-Development (cfs)

Analysis Point	2-YR	10-YR	25-YR	100-YR
AP-1	1.6	3.0	4.0	5.4
AP-2	6.6	12.8	16.8	22.9

Development (cfs)

Analysis Point	2-YR	10-YR	25-YR	100-YR
AP-1	0.7	1.5	2.0	2.8
AP-2	5.7	12.2	16.8	22.8

Pre-Development vs. Developed (cfs)

Analysis Point	2-YR	10-YR	25-YR	100-YR
AP-1	**-0.9**	**-1.5**	**-2.0**	**-2.6**
AP-2	**-0.9**	**-0.6**	**0.0**	**-0.1**

Section 4

Appendix

Map Scale: 1:3,360 if printed on A landscape (11" x 8.5") sheet.

N

Meters
0 45 90 180 270

Feet
0 150 300 600 900

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 1:24,000.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

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: Middlesex County, Massachusetts
Survey Area Data: Version 23, Sep 12, 2023

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

Date(s) aerial images were photographed: May 22, 2022—Jun 5, 2022

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	4.5	10.0%
53A	Freetown muck, ponded, 0 to 1 percent slopes	0.1	0.2%
103C	Charlton-Hollis-Rock outcrop complex, 8 to 15 percent slopes	0.5	1.2%
104D	Hollis-Rock outcrop-Charlton complex, 15 to 25 percent slopes	17.3	38.9%
105E	Rock outcrop-Hollis complex, 3 to 35 percent slopes	0.3	0.8%
424D	Canton fine sandy loam, 15 to 25 percent slopes, extremely bouldery	5.6	12.6%
652	Udorthents, refuse substratum	5.3	11.9%
654	Udorthents, loamy	10.9	24.5%
Totals for Area of Interest		**44.6**	**100.0%**

FORM 11 - SOIL EVALUATOR FORM

No. 231083 Date: 2/2/24

Commonwealth of Massachusetts
Ayer, Massachusetts

Soil Suitability Assessment for Stormwater Design

Performed by: Bruce Ringwall, GPR Inc Date: 1/30/24
Witnessed by: Not Witnessed

Location Address: or Lot No. 91 Groton-Harvard Road Ayer, MA 01432	Owner's Name: North Atlantic Concrete Address: 270 Ayer Rd, Unit 1 Harvard, MA 01451 Telephone No.

New Construction ☐ Upgrade ☐ Repair ☐

Office Review

Published Soil Survey Available: No ☑ Yes ☐

Year Published Internet Publication Scale na Soil Map Unit 654
Soil Name Udorthents, loamy Soil Limitations Previously disturbed, Unrecognizable
Soil Name -- Soil Limitations --
Soil Name -- Soil Limitations --

Surficial Geologic Report Available: No ☑ Yes ☐

Year Published MASS GIS Publication Scale --
Geologic Material(Map Unit) Compact Glacial Till
Landform Ground Morraine

Flood Insurance Rate Map: 25017C0204E

Above 500 Year Flood Boundary No ☐ Yes ☑
Within 500 Year Flood Boundary No ☑ Yes ☐
Within 100 Year Flood Boundary No ☑ Yes ☐
Within Velocity Zone No ☑ Yes ☐

Wetland Area:

National Wetlands Inventory Map (map unit) N/A
Wetlands Conservancy Program Map (map unit) N/A

Current Water Resource Conditions (USGS): Month January

Range: Above Normal ☐ Normal ☐ Below Normal ☑
Other Reference Reviewed USGS

FORM 11 - SOIL EVALUATOR FORM

Location Address or Lot #: 91 Groton-Harvard Road
Ayer, MA 01432

On-Site Review

Deep Hole #: 124-1 Date: 01/30/24 Time: 10:00 AM Weather: Overcast 27°
Location (identify on site plan) See Attached Sketch
Land Use Gravel Slope (%) 1% Surfaces Stones few
(eg woodland, agricultural field, vacant lot etc…)
Vegatation gravel lot
Landform Ground Morraine
Position on landscape See attached Sketch
Distances from:

Open Water Body	>100 feet	Drainage Way	>100 feet
Possible Wet Area	>100 feet	Property Line	84± feet
Drinking Water Well	>100 feet	Other:	
			feet

Deep Observation Hole Log

Hole # 124-1 NB 25 Suface El. 307.8

Depth from Surface (inches)	Soil Horizon	Soil Texture (USDA)	Soil Color (MUNSELL)	Soil Mottling	Other (Stucture, Stones, Boulders, Consistency, % Gravel)
0-78	Fill	--	--	--	--
78-104	BB	SL	10YR 6/6	--	--
104-140	C	S	2.5Y 6/3	--	--

Parent Material (geologic) Compact Glacial Till Depth to Bedrock: > 140"
Depth to Groundwater: Standing Water in the Hole None Weeping from Pit Face: None
Estimated Seasonal High Groundwater in the Hole > 140"
Aditional Notes

FORM 11 - SOIL EVALUATOR FORM

Location Address or Lot #: 91 Groton-Harvard Road
Ayer, MA 01432

On-Site Review

Deep Hole #: 124-2 Date: 01/30/24 Time: 10:30 AM Weather: Overcast 27°
Location (identify on site plan) See Attached Sketch
Land Use Gravel Slope (%) 2% Surfaces Stones few
(eg woodland, agricultural field, vacant lot etc…)
Vegatation gravel lot
Landform Ground Morraine
Position on landscape See attached Sketch
Distances from:

Open Water Body	>100 feet	Drainage Way	>100 feet
Possible Wet Area	>100 feet	Property Line	95± feet
Drinking Water Well	>100 feet	Other:	
			feet

Deep Observation Hole Log

Hole # 124-2 NB 25 Suface El. 307.4

Depth from Surface (inches)	Soil Horizon	Soil Texture (USDA)	Soil Color (MUNSELL)	Soil Mottling	Other (Stucture, Stones, Boulders, Consistency, % Gravel)
0-108	Fill	--	--	--	--
108-114	C	LS	2.5Y 6/3	--	--

Parent Material (geologic) Compact Glacial Till Depth to Bedrock: > 114"
Depth to Groundwater: Standing Water in the Hole None Weeping from Pit Face: None
Estimated Seasonal High Groundwater in the Hole > 114"
Aditional Notes

FORM 11 - SOIL EVALUATOR FORM

Location Address or Lot #: 91 Groton-Harvard Road
Ayer, MA 01432

On-Site Review

Deep Hole #: 124-3 Date: 01/30/24 Time: 11:00 AM Weather: Overcast 27°
Location (identify on site plan) See Attached Sketch
Land Use Gravel Slope (%) 2% Surfaces Stones few
(eg woodland, agricultural field, vacant lot etc…)
Vegatation gravel lot
Landform Ground Morraine
Position on landscape See attached Sketch
Distances from:

Open Water Body	>100 feet	Drainage Way	>100 feet
Possible Wet Area	>100 feet	Property Line	55± feet
Drinking Water Well	>100 feet	Other:	
			feet

Deep Observation Hole Log

Hole # 124-3 NB 25 Suface El. 307.1

Depth from Surface (inches)	Soil Horizon	Soil Texture (USDA)	Soil Color (MUNSELL)	Soil Mottling	Other (Stucture, Stones, Boulders, Consistency, % Gravel)
0-144	Fill	--	--	--	--

*MINIMUM OF 2 HOLES REQUIRED AT EVERY PROPOSED DISPOSAL AREA

Parent Material (geologic) Compact Glacial Till Depth to Bedrock: > 144"
Depth to Groundwater: Standing Water in the Hole None Weeping from Pit Face: None
Estimated Seasonal High Groundwater in the Hole > 144"
Aditional Notes

FORM 11 - SOIL EVALUATOR FORM

Location Address or Lot #: 91 Groton-Harvard Road
Ayer, MA 01432

On-Site Review

Deep Hole #: 124-4 Date: 01/30/24 Time: 11:30 AM Weather: Overcast 27°
Location (identify on site plan) See Attached Sketch
Land Use Gravel Slope (%) 2% Surfaces Stones few
(eg woodland, agricultural field, vacant lot etc…)
Vegatation gravel lot
Landform Ground Morraine
Position on landscape See attached Sketch
Distances from:

Open Water Body	>100 feet	Drainage Way	>100 feet
Possible Wet Area	>100 feet	Property Line	78± feet
Drinking Water Well	>100 feet	Other:	
			feet

Deep Observation Hole Log

Hole # 124-4 NB 25 Suface El. 308.2

Depth from Surface (inches)	Soil Horizon	Soil Texture (USDA)	Soil Color (MUNSELL)	Soil Mottling	Other (Stucture, Stones, Boulders, Consistency, % Gravel)
0-58	Fill	--	--	--	--
58-65	BB	--	--	--	--

Parent Material (geologic) Compact Glacial Till Depth to Bedrock: 65"
Depth to Groundwater: Standing Water in the Hole None Weeping from Pit Face: None
Estimated Seasonal High Groundwater in the Hole > 65"
Aditional Notes

FORM 11 - SOIL EVALUATOR FORM

Location Address or Lot #: 91 Groton-Harvard Road
Ayer, MA 01432

On-Site Review

Deep Hole #: 124-5 Date: 01/30/24 Time: 12:00 PM Weather: Overcast 27°
Location (identify on site plan) See Attached Sketch
Land Use Gravel Slope (%) 2% Surfaces Stones few
(eg woodland, agricultural field, vacant lot etc…)
Vegatation gravel lot
Landform Ground Morraine
Position on landscape See attached Sketch
Distances from:

Open Water Body	>100 feet	Drainage Way	>100 feet
Possible Wet Area	>100 feet	Property Line	108± feet
Drinking Water Well	>100 feet	Other:	
			feet

Deep Observation Hole Log

Hole # 124-5 NB 25 Suface El. 308.5

Depth from Surface (inches)	Soil Horizon	Soil Texture (USDA)	Soil Color (MUNSELL)	Soil Mottling	Other (Stucture, Stones, Boulders, Consistency, % Gravel)
0-54	Fill	--	--	--	--
54-62	BA	--	--	--	--
62-72	BB	SL	2.5Y 6/6	--	--
72-98	C	SL	2.5Y 6/3	--	--

Parent Material (geologic) Compact Glacial Till Depth to Bedrock: > 98"
Depth to Groundwater: Standing Water in the Hole None Weeping from Pit Face: None
Estimated Seasonal High Groundwater in the Hole > 98"
Aditional Notes

FORM 11 - SOIL EVALUATOR FORM

Location Address or Lot#: 91 Groton-Harvard Road
Ayer, MA 01432

Determination for Seasonal High Water Table

Method Used:

- ☐ Depth observed standing in observation hole _____ inches _____
- ☐ Depth weeping from side of observation hole _____ inches _____
- ☑ Depth to soil mottles * inches See individual Reports
- ☐ Ground water adjustment _____ feet _____

Index Well Number _____ Reading Date _____ Index Well Level _____

Adjustment Factor _____ Adjusted Ground Water Level _____

Depth of Naturally Occuring Pervious Material

Does at least four feet of naturally occuring pervious material exist in all areas observed throughout the area proposed for the soil absorption system? N/A

If not, what is the depth of naturally occuring pervious material? -- Feet

Certification

I certify that I am currently approved by the Department of Environmental Protection pursuant to 310 CMR 15.017 to conduct soil evaluations and that the above analysis has been performed by me consistent with the training, expertise and experience described in 310 CMR 15.017. I further certify that the results of my soil evaluation, as indicated, on the attached soil evaluation form, are accurate and in accordance with 310 CMR 15.100 through 15.107.

Signature _____ Date 2/2/2024

Notes: _____

Signature

N/F
TOWN OF AYER
19532/329

SC1.0

654
SOIL "B"

104D
SOIL "D"

SC2.0

AP-1

AP-2

N/F
TOWN OF AYER
13628/588

N
W
E
S

LEGEND:

- SUBCATCHMENT LIMIT
- SC-1 — SUBCATCHMENT LABEL
- TIME OF CONCENTRATION
- HYDROLOGIC SOIL GROUP
- AP-1 — DRAINAGE ANALYSIS POINT

GRAPHIC SCALE

60 0 30 60 120

(IN FEET)
1 INCH = 60 FEET

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www.gpr-inc.com

PREPARED FOR:

NORTH ATLANTIC CONCRETE
270 AYER RD, UNIT 1
HARVARD, MA 01451

DES'D BY: KI | CHK'D BY: NMP

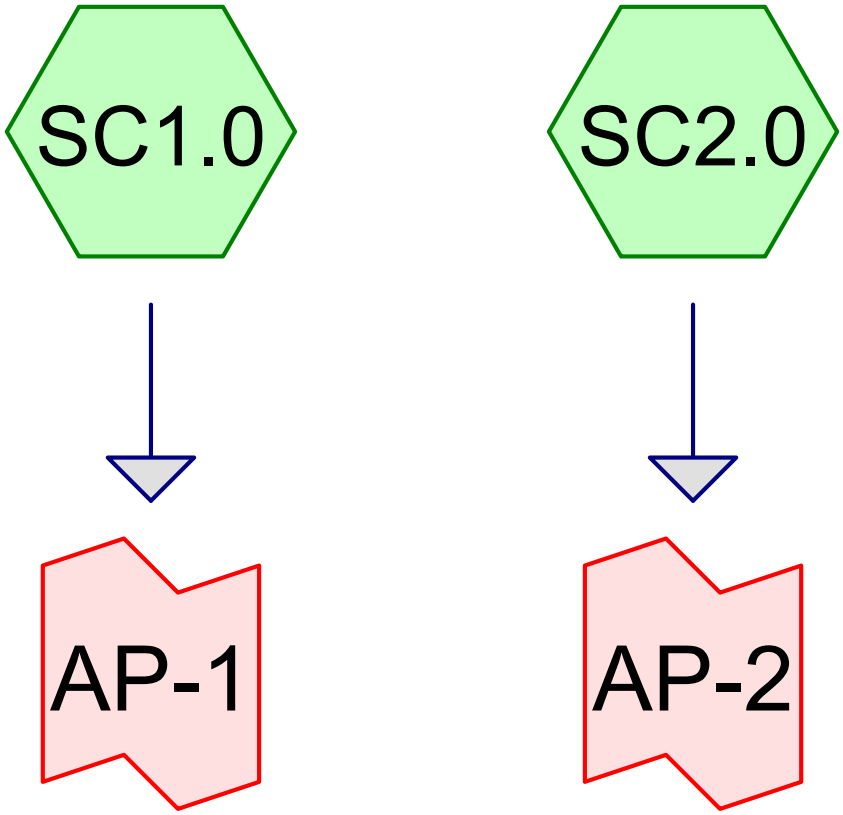
DATE: MARCH 2024

PRE-DEVELOPMENT WATERSHED MAP

NORTH ATLANTIC CONCRETE
91 GROTON-HARVARD ROAD
AYER, MA

PROJECT: 231083 | 1 OF 1

P:\23---\231083\DWG\PERMIT\SITE PLAN.DWG 03-20-24 5:14:38 PM - LAYOUT PRE



Subcat Reach Pond Link

Routing Diagram for PRE

Prepared by Goldsmith, Prest & Ringwall, Inc, Printed 3/28/2024

Area Listing (all nodes)

Area (sq-ft)	CN	Description (subcatchment-numbers)
14,684	61	>75% Grass cover, Good, HSG B (SC1.0, SC2.0)
25,550	80	>75% Grass cover, Good, HSG D (SC2.0)
55,566	85	Gravel, HSG B (SC1.0, SC2.0)
23,673	91	Gravel, HSG D (SC2.0)
16,727	98	Paved parking, HSG B (SC1.0, SC2.0)
2,522	98	Roofs, HSG B (SC1.0, SC2.0)
44,862	77	Woods, Good, HSG D (SC2.0)
183,584	**83**	**TOTAL AREA**

Time span=0.00-24.00 hrs, dt=0.06 hrs, 401 points x 2
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment SC1.0: Runoff Area=35,215 sf 47.42% Impervious Runoff Depth>1.62"
Flow Length=265' Tc=6.0 min CN=83 Runoff=1.6 cfs 4,740 cf

Subcatchment SC2.0: Runoff Area=148,369 sf 1.72% Impervious Runoff Depth>1.62"
Flow Length=429' Tc=6.0 min CN=83 Runoff=6.6 cfs 19,973 cf

Link AP-1: Inflow=1.6 cfs 4,740 cf
Primary=1.6 cfs 4,740 cf

Link AP-2: Inflow=6.6 cfs 19,973 cf
Primary=6.6 cfs 19,973 cf

Total Runoff Area = 183,584 sf Runoff Volume = 24,713 cf Average Runoff Depth = 1.62"
89.51% Pervious = 164,335 sf 10.49% Impervious = 19,249 sf

Summary for Subcatchment SC1.0:

Runoff = 1.6 cfs @ 12.13 hrs, Volume= 4,740 cf, Depth> 1.62"
Routed to Link AP-1 :

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.06 hrs
NOAA10 24-hr D 2-Year Rainfall=3.21"

	Area (sf)	CN	Description
	935	98	Roofs, HSG B
*	5,838	85	Gravel, HSG B
	12,679	61	>75% Grass cover, Good, HSG B
	15,763	98	Paved parking, HSG B
	35,215	83	Weighted Average
	18,517		52.58% Pervious Area
	16,698		47.42% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.9	50	0.0100	0.91		**Sheet Flow, Gravel** Smooth surfaces n= 0.011 P2= 3.21"
0.1	5	0.0100	1.61		**Shallow Concentrated Flow, Gravel** Unpaved Kv= 16.1 fps
1.3	210	0.0190	2.80		**Shallow Concentrated Flow, Pavement** Paved Kv= 20.3 fps
2.3	265	Total, Increased to minimum Tc = 6.0 min			

Summary for Subcatchment SC2.0:

Runoff = 6.6 cfs @ 12.13 hrs, Volume= 19,973 cf, Depth> 1.62"
Routed to Link AP-2 :

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.06 hrs
NOAA10 24-hr D 2-Year Rainfall=3.21"

	Area (sf)	CN	Description
	44,862	77	Woods, Good, HSG D
	25,550	80	>75% Grass cover, Good, HSG D
*	23,673	91	Gravel, HSG D
	1,587	98	Roofs, HSG B
*	49,728	85	Gravel, HSG B
	2,005	61	>75% Grass cover, Good, HSG B
	964	98	Paved parking, HSG B
	148,369	83	Weighted Average
	145,818		98.28% Pervious Area
	2,551		1.72% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.7	50	0.0200	1.20		**Sheet Flow, Gravel** Smooth surfaces n= 0.011 P2= 3.21"
1.1	206	0.0360	3.05		**Shallow Concentrated Flow, Gravel** Unpaved Kv= 16.1 fps
0.1	47	0.6710	5.73		**Shallow Concentrated Flow, Grass** Short Grass Pasture Kv= 7.0 fps
1.1	126	0.1570	1.98		**Shallow Concentrated Flow, Woodlands** Woodland Kv= 5.0 fps
3.0	429	Total, Increased to minimum Tc = 6.0 min			

Summary for Link AP-1:

Inflow Area = 35,215 sf, 47.42% Impervious, Inflow Depth > 1.62" for 2-Year event
Inflow = 1.6 cfs @ 12.13 hrs, Volume= 4,740 cf
Primary = 1.6 cfs @ 12.13 hrs, Volume= 4,740 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.06 hrs

Summary for Link AP-2:

Inflow Area = 148,369 sf, 1.72% Impervious, Inflow Depth > 1.62" for 2-Year event
Inflow = 6.6 cfs @ 12.13 hrs, Volume= 19,973 cf
Primary = 6.6 cfs @ 12.13 hrs, Volume= 19,973 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.06 hrs

Time span=0.00-24.00 hrs, dt=0.06 hrs, 401 points x 2
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment SC1.0: Runoff Area=35,215 sf 47.42% Impervious Runoff Depth>3.18"
Flow Length=265' Tc=6.0 min CN=83 Runoff=3.0 cfs 9,331 cf

Subcatchment SC2.0: Runoff Area=148,369 sf 1.72% Impervious Runoff Depth>3.18"
Flow Length=429' Tc=6.0 min CN=83 Runoff=12.8 cfs 39,314 cf

Link AP-1: Inflow=3.0 cfs 9,331 cf
Primary=3.0 cfs 9,331 cf

Link AP-2: Inflow=12.8 cfs 39,314 cf
Primary=12.8 cfs 39,314 cf

Total Runoff Area = 183,584 sf Runoff Volume = 48,645 cf Average Runoff Depth = 3.18"
89.51% Pervious = 164,335 sf 10.49% Impervious = 19,249 sf

Summary for Subcatchment SC1.0:

Runoff = 3.0 cfs @ 12.12 hrs, Volume= 9,331 cf, Depth> 3.18"
Routed to Link AP-1 :

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.06 hrs
NOAA10 24-hr D 10-Year Rainfall=5.01"

	Area (sf)	CN	Description
	935	98	Roofs, HSG B
*	5,838	85	Gravel, HSG B
	12,679	61	>75% Grass cover, Good, HSG B
	15,763	98	Paved parking, HSG B
	35,215	83	Weighted Average
	18,517		52.58% Pervious Area
	16,698		47.42% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.9	50	0.0100	0.91		**Sheet Flow, Gravel** Smooth surfaces n= 0.011 P2= 3.21"
0.1	5	0.0100	1.61		**Shallow Concentrated Flow, Gravel** Unpaved Kv= 16.1 fps
1.3	210	0.0190	2.80		**Shallow Concentrated Flow, Pavement** Paved Kv= 20.3 fps
2.3	265	Total, Increased to minimum Tc = 6.0 min			

Summary for Subcatchment SC2.0:

Runoff = 12.8 cfs @ 12.12 hrs, Volume= 39,314 cf, Depth> 3.18"
Routed to Link AP-2 :

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.06 hrs
NOAA10 24-hr D 10-Year Rainfall=5.01"

	Area (sf)	CN	Description
	44,862	77	Woods, Good, HSG D
	25,550	80	>75% Grass cover, Good, HSG D
*	23,673	91	Gravel, HSG D
	1,587	98	Roofs, HSG B
*	49,728	85	Gravel, HSG B
	2,005	61	>75% Grass cover, Good, HSG B
	964	98	Paved parking, HSG B
	148,369	83	Weighted Average
	145,818		98.28% Pervious Area
	2,551		1.72% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.7	50	0.0200	1.20		**Sheet Flow, Gravel**
					Smooth surfaces n= 0.011 P2= 3.21"
1.1	206	0.0360	3.05		**Shallow Concentrated Flow, Gravel**
					Unpaved Kv= 16.1 fps
0.1	47	0.6710	5.73		**Shallow Concentrated Flow, Grass**
					Short Grass Pasture Kv= 7.0 fps
1.1	126	0.1570	1.98		**Shallow Concentrated Flow, Woodlands**
					Woodland Kv= 5.0 fps
3.0	429	Total, Increased to minimum Tc = 6.0 min			

Summary for Link AP-1:

Inflow Area = 35,215 sf, 47.42% Impervious, Inflow Depth > 3.18" for 10-Year event
Inflow = 3.0 cfs @ 12.12 hrs, Volume= 9,331 cf
Primary = 3.0 cfs @ 12.12 hrs, Volume= 9,331 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.06 hrs

Summary for Link AP-2:

Inflow Area = 148,369 sf, 1.72% Impervious, Inflow Depth > 3.18" for 10-Year event
Inflow = 12.8 cfs @ 12.12 hrs, Volume= 39,314 cf
Primary = 12.8 cfs @ 12.12 hrs, Volume= 39,314 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.06 hrs

Time span=0.00-24.00 hrs, dt=0.06 hrs, 401 points x 2
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment SC1.0: Runoff Area=35,215 sf 47.42% Impervious Runoff Depth>4.21"
Flow Length=265' Tc=6.0 min CN=83 Runoff=4.0 cfs 12,348 cf

Subcatchment SC2.0: Runoff Area=148,369 sf 1.72% Impervious Runoff Depth>4.21"
Flow Length=429' Tc=6.0 min CN=83 Runoff=16.8 cfs 52,026 cf

Link AP-1: Inflow=4.0 cfs 12,348 cf
Primary=4.0 cfs 12,348 cf

Link AP-2: Inflow=16.8 cfs 52,026 cf
Primary=16.8 cfs 52,026 cf

Total Runoff Area = 183,584 sf Runoff Volume = 64,374 cf Average Runoff Depth = 4.21"
89.51% Pervious = 164,335 sf 10.49% Impervious = 19,249 sf

Summary for Subcatchment SC1.0:

Runoff = 4.0 cfs @ 12.12 hrs, Volume= 12,348 cf, Depth> 4.21"
Routed to Link AP-1 :

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.06 hrs
NOAA10 24-hr D 25-Year Rainfall=6.13"

	Area (sf)	CN	Description
	935	98	Roofs, HSG B
*	5,838	85	Gravel, HSG B
	12,679	61	>75% Grass cover, Good, HSG B
	15,763	98	Paved parking, HSG B
	35,215	83	Weighted Average
	18,517		52.58% Pervious Area
	16,698		47.42% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.9	50	0.0100	0.91		**Sheet Flow, Gravel** Smooth surfaces n= 0.011 P2= 3.21"
0.1	5	0.0100	1.61		**Shallow Concentrated Flow, Gravel** Unpaved Kv= 16.1 fps
1.3	210	0.0190	2.80		**Shallow Concentrated Flow, Pavement** Paved Kv= 20.3 fps
2.3	265	Total, Increased to minimum Tc = 6.0 min			

Summary for Subcatchment SC2.0:

Runoff = 16.8 cfs @ 12.12 hrs, Volume= 52,026 cf, Depth> 4.21"
Routed to Link AP-2 :

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.06 hrs
NOAA10 24-hr D 25-Year Rainfall=6.13"

	Area (sf)	CN	Description
	44,862	77	Woods, Good, HSG D
	25,550	80	>75% Grass cover, Good, HSG D
*	23,673	91	Gravel, HSG D
	1,587	98	Roofs, HSG B
*	49,728	85	Gravel, HSG B
	2,005	61	>75% Grass cover, Good, HSG B
	964	98	Paved parking, HSG B
	148,369	83	Weighted Average
	145,818		98.28% Pervious Area
	2,551		1.72% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.7	50	0.0200	1.20		**Sheet Flow, Gravel**
					Smooth surfaces n= 0.011 P2= 3.21"
1.1	206	0.0360	3.05		**Shallow Concentrated Flow, Gravel**
					Unpaved Kv= 16.1 fps
0.1	47	0.6710	5.73		**Shallow Concentrated Flow, Grass**
					Short Grass Pasture Kv= 7.0 fps
1.1	126	0.1570	1.98		**Shallow Concentrated Flow, Woodlands**
					Woodland Kv= 5.0 fps
3.0	429	Total, Increased to minimum Tc = 6.0 min			

Summary for Link AP-1:

Inflow Area = 35,215 sf, 47.42% Impervious, Inflow Depth > 4.21" for 25-Year event
Inflow = 4.0 cfs @ 12.12 hrs, Volume= 12,348 cf
Primary = 4.0 cfs @ 12.12 hrs, Volume= 12,348 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.06 hrs

Summary for Link AP-2:

Inflow Area = 148,369 sf, 1.72% Impervious, Inflow Depth > 4.21" for 25-Year event
Inflow = 16.8 cfs @ 12.12 hrs, Volume= 52,026 cf
Primary = 16.8 cfs @ 12.12 hrs, Volume= 52,026 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.06 hrs

Time span=0.00-24.00 hrs, dt=0.06 hrs, 401 points x 2
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment SC1.0: Runoff Area=35,215 sf 47.42% Impervious Runoff Depth>5.84"
Flow Length=265' Tc=6.0 min CN=83 Runoff=5.4 cfs 17,132 cf

Subcatchment SC2.0: Runoff Area=148,369 sf 1.72% Impervious Runoff Depth>5.84"
Flow Length=429' Tc=6.0 min CN=83 Runoff=22.9 cfs 72,183 cf

Link AP-1: Inflow=5.4 cfs 17,132 cf
Primary=5.4 cfs 17,132 cf

Link AP-2: Inflow=22.9 cfs 72,183 cf
Primary=22.9 cfs 72,183 cf

Total Runoff Area = 183,584 sf Runoff Volume = 89,315 cf Average Runoff Depth = 5.84"
89.51% Pervious = 164,335 sf 10.49% Impervious = 19,249 sf

Summary for Subcatchment SC1.0:

Runoff = 5.4 cfs @ 12.12 hrs, Volume= 17,132 cf, Depth> 5.84"
Routed to Link AP-1 :

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.06 hrs
NOAA10 24-hr D 100-Year Rainfall=7.86"

	Area (sf)	CN	Description
	935	98	Roofs, HSG B
*	5,838	85	Gravel, HSG B
	12,679	61	>75% Grass cover, Good, HSG B
	15,763	98	Paved parking, HSG B
	35,215	83	Weighted Average
	18,517		52.58% Pervious Area
	16,698		47.42% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.9	50	0.0100	0.91		**Sheet Flow, Gravel** Smooth surfaces n= 0.011 P2= 3.21"
0.1	5	0.0100	1.61		**Shallow Concentrated Flow, Gravel** Unpaved Kv= 16.1 fps
1.3	210	0.0190	2.80		**Shallow Concentrated Flow, Pavement** Paved Kv= 20.3 fps
2.3	265	Total, Increased to minimum Tc = 6.0 min			

Summary for Subcatchment SC2.0:

Runoff = 22.9 cfs @ 12.12 hrs, Volume= 72,183 cf, Depth> 5.84"
Routed to Link AP-2 :

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.06 hrs
NOAA10 24-hr D 100-Year Rainfall=7.86"

	Area (sf)	CN	Description
	44,862	77	Woods, Good, HSG D
	25,550	80	>75% Grass cover, Good, HSG D
*	23,673	91	Gravel, HSG D
	1,587	98	Roofs, HSG B
*	49,728	85	Gravel, HSG B
	2,005	61	>75% Grass cover, Good, HSG B
	964	98	Paved parking, HSG B
	148,369	83	Weighted Average
	145,818		98.28% Pervious Area
	2,551		1.72% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.7	50	0.0200	1.20		**Sheet Flow, Gravel**
					Smooth surfaces n= 0.011 P2= 3.21"
1.1	206	0.0360	3.05		**Shallow Concentrated Flow, Gravel**
					Unpaved Kv= 16.1 fps
0.1	47	0.6710	5.73		**Shallow Concentrated Flow, Grass**
					Short Grass Pasture Kv= 7.0 fps
1.1	126	0.1570	1.98		**Shallow Concentrated Flow, Woodlands**
					Woodland Kv= 5.0 fps
3.0	429	Total, Increased to minimum Tc = 6.0 min			

Summary for Link AP-1:

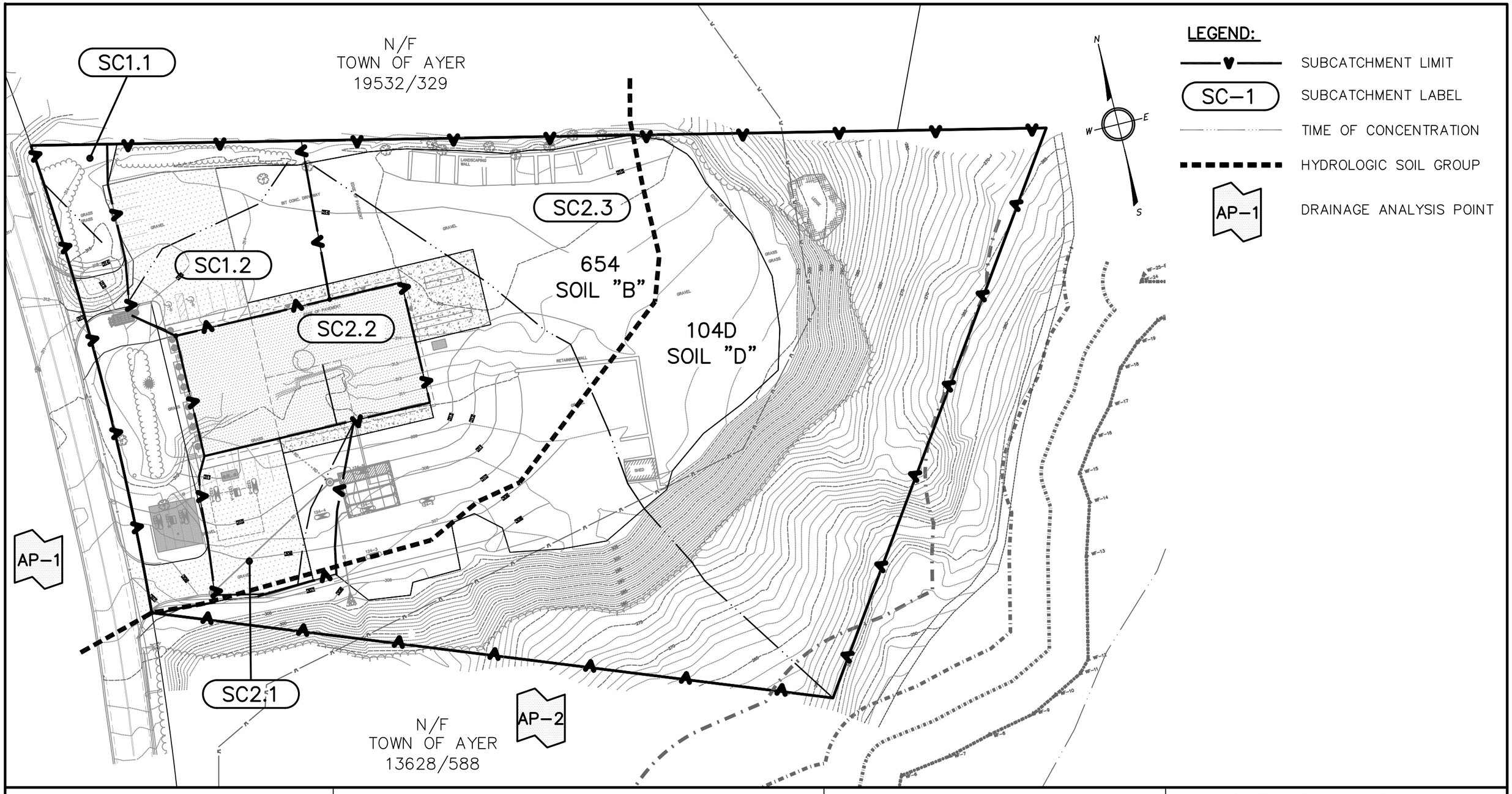
Inflow Area = 35,215 sf, 47.42% Impervious, Inflow Depth > 5.84" for 100-Year event
Inflow = 5.4 cfs @ 12.12 hrs, Volume= 17,132 cf
Primary = 5.4 cfs @ 12.12 hrs, Volume= 17,132 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.06 hrs

Summary for Link AP-2:

Inflow Area = 148,369 sf, 1.72% Impervious, Inflow Depth > 5.84" for 100-Year event
Inflow = 22.9 cfs @ 12.12 hrs, Volume= 72,183 cf
Primary = 22.9 cfs @ 12.12 hrs, Volume= 72,183 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.06 hrs



GRAPHIC SCALE

60 0 30 60 120

(IN FEET)

1 INCH = 60 FEET

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PREPARED FOR:

NORTH ATLANTIC CONCRETE
270 AYER RD, UNIT 1
HARVARD, MA 01451

DES'D BY: KI | CHK'D BY: NMP

DATE: MARCH 2024

POST-DEVELOPMENT WATERSHED MAP

NORTH ATLANTIC CONCRETE
91 GROTON-HARVARD ROAD
AYER, MA

PROJECT: 231083 | 1 OF 1

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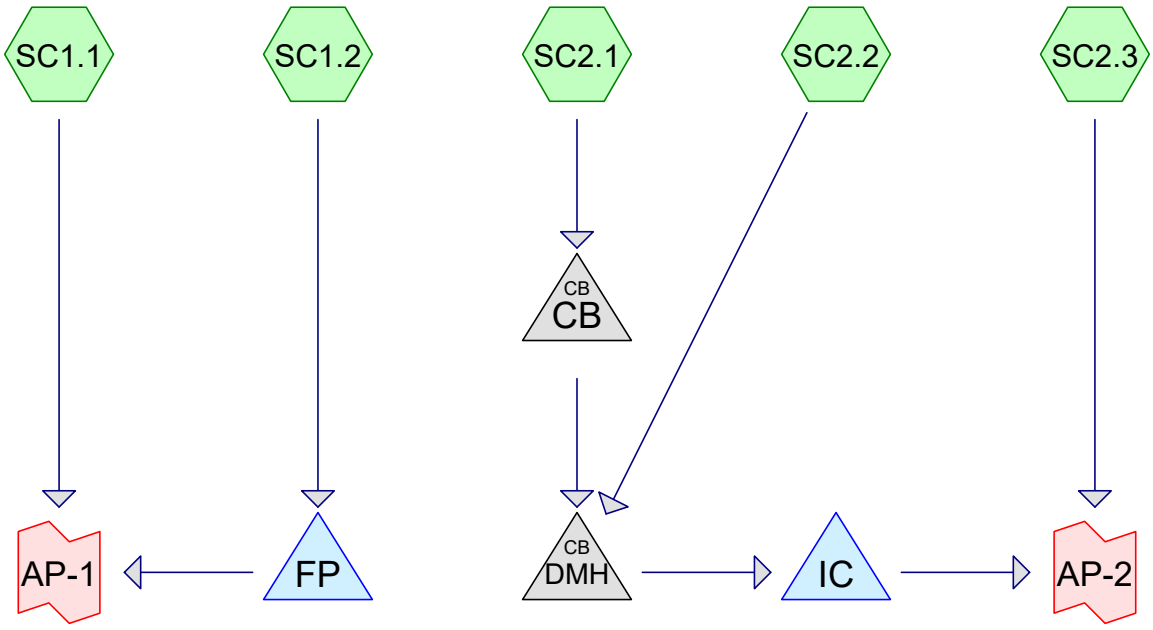


Subcat Reach Pond Link

Routing Diagram for POST

Prepared by Goldsmith, Prest & Ringwall, Inc, Printed 3/28/2024

Area Listing (all nodes)

Area (sq-ft)	CN	Description (subcatchment-numbers)
16,373	61	>75% Grass cover, Good, HSG B (SC1.1, SC1.2, SC2.1, SC2.3)
25,594	80	>75% Grass cover, Good, HSG D (SC2.3)
42,818	85	Gravel, HSG B (SC1.2, SC2.1, SC2.3)
22,944	91	Gravel, HSG D (SC2.3)
18,308	98	Paved parking, HSG B (SC1.1, SC1.2, SC2.1, SC2.3)
295	98	Paved parking, HSG D (SC2.1)
12,000	98	Roofs, HSG B (SC2.2)
390	98	Roofs, HSG D (SC2.3)
44,862	77	Woods, Good, HSG D (SC2.3)
183,584	**83**	**TOTAL AREA**

Time span=0.00-24.00 hrs, dt=0.06 hrs, 401 points x 2
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment SC1.1: Runoff Area=13,665 sf 20.50% Impervious Runoff Depth>0.78"
Flow Length=53' Tc=6.0 min CN=69 Runoff=0.3 cfs 893 cf

Subcatchment SC1.2: Runoff Area=14,644 sf 44.80% Impervious Runoff Depth>1.76"
Flow Length=140' Tc=6.0 min CN=85 Runoff=0.7 cfs 2,153 cf

Subcatchment SC2.1: Runoff Area=8,503 sf 67.51% Impervious Runoff Depth>2.45"
Flow Length=179' Tc=6.0 min CN=93 Runoff=0.5 cfs 1,738 cf

Subcatchment SC2.2: Runoff Area=12,000 sf 100.00% Impervious Runoff Depth>2.98"
Flow Length=42' Tc=6.0 min CN=98 Runoff=0.9 cfs 2,975 cf

Subcatchment SC2.3: Runoff Area=134,772 sf 2.89% Impervious Runoff Depth>1.54"
Flow Length=493' Tc=6.0 min CN=82 Runoff=5.7 cfs 17,343 cf

Pond CB: Peak Elev=305.83' Inflow=0.5 cfs 1,738 cf
12.0" Round Culvert n=0.013 L=100.0' S=0.0100 '/' Outflow=0.5 cfs 1,738 cf

Pond DMH: Peak Elev=305.83' Inflow=1.4 cfs 4,713 cf
24.0" Round Culvert n=0.013 L=5.0' S=0.0200 '/' Outflow=1.4 cfs 4,714 cf

Pond FP: Peak Elev=311.81' Storage=411 cf Inflow=0.7 cfs 2,153 cf
Outflow=0.5 cfs 1,940 cf

Pond IC: Peak Elev=305.83' Storage=2,392 cf Inflow=1.4 cfs 4,714 cf
Discarded=0.0 cfs 1,792 cf Primary=0.0 cfs 624 cf Outflow=0.1 cfs 2,416 cf

Link AP-1: Inflow=0.7 cfs 2,833 cf
Primary=0.7 cfs 2,833 cf

Link AP-2: Inflow=5.7 cfs 17,966 cf
Primary=5.7 cfs 17,966 cf

Total Runoff Area = 183,584 sf Runoff Volume = 25,101 cf Average Runoff Depth = 1.64"
83.12% Pervious = 152,591 sf 16.88% Impervious = 30,993 sf

Summary for Subcatchment SC1.1:

Runoff = 0.3 cfs @ 12.13 hrs, Volume= 893 cf, Depth> 0.78"
Routed to Link AP-1 :

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.06 hrs
NOAA10 24-hr D 2-Year Rainfall=3.21"

Area (sf)	CN	Description
0	98	Paved parking, HSG D
0	80	>75% Grass cover, Good, HSG D
2,802	98	Paved parking, HSG B
10,863	61	>75% Grass cover, Good, HSG B
13,665	69	Weighted Average
10,863		79.50% Pervious Area
2,802		20.50% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
4.6	50	0.0332	0.18		**Sheet Flow, Grass** Grass: Short n= 0.150 P2= 3.21"
0.0	3	0.0470	1.52		**Shallow Concentrated Flow, Grass** Short Grass Pasture Kv= 7.0 fps
4.6	53	Total, Increased to minimum Tc = 6.0 min			

Summary for Subcatchment SC1.2:

Runoff = 0.7 cfs @ 12.13 hrs, Volume= 2,153 cf, Depth> 1.76"
Routed to Pond FP :

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.06 hrs
NOAA10 24-hr D 2-Year Rainfall=3.21"

	Area (sf)	CN	Description
	3,424	61	>75% Grass cover, Good, HSG B
	6,560	98	Paved parking, HSG B
*	4,660	85	Gravel, HSG B
	14,644	85	Weighted Average
	8,084		55.20% Pervious Area
	6,560		44.80% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.9	50	0.0100	0.91		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 3.21"
0.5	90	0.0200	2.87		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
1.4	140	Total, Increased to minimum Tc = 6.0 min			

Summary for Subcatchment SC2.1:

Runoff = 0.5 cfs @ 12.12 hrs, Volume= 1,738 cf, Depth> 2.45"
Routed to Pond CB :

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.06 hrs
NOAA10 24-hr D 2-Year Rainfall=3.21"

	Area (sf)	CN	Description
	295	98	Paved parking, HSG D
	5,445	98	Paved parking, HSG B
*	2,346	85	Gravel, HSG B
	417	61	>75% Grass cover, Good, HSG B
	8,503	93	Weighted Average
	2,763		32.49% Pervious Area
	5,740		67.51% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.7	50	0.0200	1.20		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 3.21"
0.7	129	0.0233	3.10		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
1.4	179	Total, Increased to minimum Tc = 6.0 min			

Summary for Subcatchment SC2.2:

Runoff = 0.9 cfs @ 12.12 hrs, Volume= 2,975 cf, Depth> 2.98"
Routed to Pond DMH :

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.06 hrs
NOAA10 24-hr D 2-Year Rainfall=3.21"

Area (sf)	CN	Description
12,000	98	Roofs, HSG B
12,000		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0	42		0.12		**Direct Entry, Roof**

Summary for Subcatchment SC2.3:

Runoff = 5.7 cfs @ 12.13 hrs, Volume= 17,343 cf, Depth> 1.54"
Routed to Link AP-2 :

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.06 hrs
NOAA10 24-hr D 2-Year Rainfall=3.21"

	Area (sf)	CN	Description
	25,594	80	>75% Grass cover, Good, HSG D
	0	98	Paved parking, HSG D
	44,862	77	Woods, Good, HSG D
*	22,944	91	Gravel, HSG D
	1,669	61	>75% Grass cover, Good, HSG B
	3,501	98	Paved parking, HSG B
*	35,812	85	Gravel, HSG B
	0	55	Woods, Good, HSG B
	390	98	Roofs, HSG D
	134,772	82	Weighted Average
	130,881		97.11% Pervious Area
	3,891		2.89% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.9	50	0.0100	0.91		**Sheet Flow, Gravel** Smooth surfaces n= 0.011 P2= 3.21"
1.5	270	0.0360	3.05		**Shallow Concentrated Flow, Gravel** Unpaved Kv= 16.1 fps
0.1	47	0.6710	5.73		**Shallow Concentrated Flow, Grass** Short Grass Pasture Kv= 7.0 fps
1.1	126	0.1570	1.98		**Shallow Concentrated Flow, Woodlands** Woodland Kv= 5.0 fps
3.6	493	Total, Increased to minimum Tc = 6.0 min			

Summary for Pond CB:

Inflow Area = 8,503 sf, 67.51% Impervious, Inflow Depth > 2.45" for 2-Year event
Inflow = 0.5 cfs @ 12.12 hrs, Volume= 1,738 cf
Outflow = 0.5 cfs @ 12.12 hrs, Volume= 1,738 cf, Atten= 0%, Lag= 0.0 min
Primary = 0.5 cfs @ 12.12 hrs, Volume= 1,738 cf
Routed to Pond DMH :

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.06 hrs / 2
Peak Elev= 305.83' @ 13.80 hrs
Flood Elev= 308.20'

Device	Routing	Invert	Outlet Devices
#1	Primary	305.25'	**12.0" Round Culvert** L= 100.0' CPP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 305.25' / 304.25' S= 0.0100 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.79 sf

Primary OutFlow Max=0.5 cfs @ 12.12 hrs HW=305.67' TW=304.48' (Dynamic Tailwater)
1=Culvert (Inlet Controls 0.5 cfs @ 1.74 fps)

Summary for Pond DMH:

Inflow Area = 20,503 sf, 86.52% Impervious, Inflow Depth > 2.76" for 2-Year event
Inflow = 1.4 cfs @ 12.12 hrs, Volume= 4,713 cf
Outflow = 1.4 cfs @ 12.12 hrs, Volume= 4,714 cf, Atten= 0%, Lag= 0.0 min
Primary = 1.4 cfs @ 12.12 hrs, Volume= 4,714 cf
Routed to Pond IC :

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.06 hrs / 2
Peak Elev= 305.83' @ 13.66 hrs
Flood Elev= 309.90'

Device	Routing	Invert	Outlet Devices
#1	Primary	303.25'	**24.0" Round Culvert** L= 5.0' CPP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 303.25' / 303.15' S= 0.0200 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 3.14 sf

Primary OutFlow Max=1.4 cfs @ 12.12 hrs HW=304.48' TW=304.45' (Dynamic Tailwater)
1=Culvert (Inlet Controls 1.4 cfs @ 0.69 fps)

Summary for Pond FP:

Inflow Area = 14,644 sf, 44.80% Impervious, Inflow Depth > 1.76" for 2-Year event
Inflow = 0.7 cfs @ 12.13 hrs, Volume= 2,153 cf
Outflow = 0.5 cfs @ 12.20 hrs, Volume= 1,940 cf, Atten= 33%, Lag= 4.6 min
Primary = 0.5 cfs @ 12.20 hrs, Volume= 1,940 cf
Routed to Link AP-1 :

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.06 hrs / 2
Peak Elev= 311.81' @ 12.20 hrs Surf.Area= 3,820 sf Storage= 411 cf

Plug-Flow detention time= 82.1 min calculated for 1,940 cf (90% of inflow)
Center-of-Mass det. time= 31.9 min (885.1 - 853.2)

Volume	Invert	Avail.Storage	Storage Description
#1	311.20'	1,552 cf	**Ponding over system (Prismatic)**Listed below (Recalc)
#2	308.95'	36 cf	**FocalPoint Soil Media (Prismatic)**Listed below (Recalc) 180 cf Overall x 20.0% Voids
#3A	306.75'	50 cf	**8.56'W x 11.38'L x 2.19'H Field A** 214 cf Overall - 89 cf Embedded = 125 cf x 40.0% Voids
#4A	307.00'	84 cf	**Ferguson R-Tank HD 1** x 20 Inside #3 Inside= 15.7"W x 17.3"H => 1.80 sf x 2.35'L = 4.2 cf Outside= 15.7"W x 17.3"H => 1.89 sf x 2.35'L = 4.4 cf 20 Chambers in 5 Rows
		1,722 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
311.20	80	0	0
311.70	80	40	40
312.00	10,000	1,512	1,552

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
308.95	80	0	0
309.00	80	4	4
311.00	80	160	164
311.20	80	16	180

Device	Routing	Invert	Outlet Devices
#1	Primary	311.70'	**5.3' long x 2.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 3.50 Coef. (English) 2.54 2.61 2.61 2.60 2.66 2.70 2.77 2.89 2.88 2.85 3.07 3.20 3.32

Primary OutFlow Max=0.5 cfs @ 12.20 hrs HW=311.81' TW=0.00' (Dynamic Tailwater)
↑—**1=Broad-Crested Rectangular Weir** (Weir Controls 0.5 cfs @ 0.83 fps)

Summary for Pond IC:

Inflow Area = 20,503 sf, 86.52% Impervious, Inflow Depth > 2.76" for 2-Year event
Inflow = 1.4 cfs @ 12.12 hrs, Volume= 4,714 cf
Outflow = 0.1 cfs @ 13.69 hrs, Volume= 2,416 cf, Atten= 95%, Lag= 93.9 min
Discarded = 0.0 cfs @ 7.56 hrs, Volume= 1,792 cf
Primary = 0.0 cfs @ 13.69 hrs, Volume= 624 cf
Routed to Link AP-2 :

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.06 hrs / 2
Peak Elev= 305.83' @ 13.69 hrs Surf.Area= 1,029 sf Storage= 2,392 cf

Plug-Flow detention time= 243.4 min calculated for 2,416 cf (51% of inflow)
Center-of-Mass det. time= 83.3 min (860.3 - 777.0)

Volume	Invert	Avail.Storage	Storage Description
#1A	302.40'	1,511 cf	**29.92'W x 34.38'L x 5.50'H Field A** 5,657 cf Overall - 1,878 cf Embedded = 3,779 cf x 40.0% Voids
#2A	303.15'	1,878 cf	**ADS_StormTech MC-3500 d +Cap** x 16 Inside #1 Effective Size= 70.4"W x 45.0"H => 15.33 sf x 7.17'L = 110.0 cf Overall Size= 77.0"W x 45.0"H x 7.50'L with 0.33' Overlap 16 Chambers in 4 Rows Cap Storage= 14.9 cf x 2 x 4 rows = 119.2 cf
		3,390 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Primary	305.70'	**10.0" Round Culvert** L= 60.0' CPP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 305.70' / 305.10' S= 0.0100 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.55 sf
#2	Discarded	302.40'	**1.020 in/hr Exfiltration over Surface area**

Discarded OutFlow Max=0.0 cfs @ 7.56 hrs HW=302.46' (Free Discharge)
↑—**2=Exfiltration** (Exfiltration Controls 0.0 cfs)

Primary OutFlow Max=0.0 cfs @ 13.69 hrs HW=305.83' TW=0.00' (Dynamic Tailwater)
↑—**1=Culvert** (Inlet Controls 0.0 cfs @ 0.96 fps)

Summary for Link AP-1:

Inflow Area = 28,309 sf, 33.07% Impervious, Inflow Depth > 1.20" for 2-Year event
Inflow = 0.7 cfs @ 12.17 hrs, Volume= 2,833 cf
Primary = 0.7 cfs @ 12.17 hrs, Volume= 2,833 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.06 hrs

Summary for Link AP-2:

Inflow Area = 155,275 sf, 13.93% Impervious, Inflow Depth > 1.39" for 2-Year event
Inflow = 5.7 cfs @ 12.13 hrs, Volume= 17,966 cf
Primary = 5.7 cfs @ 12.13 hrs, Volume= 17,966 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.06 hrs

Time span=0.00-24.00 hrs, dt=0.06 hrs, 401 points x 2
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment SC1.1: Runoff Area=13,665 sf 20.50% Impervious Runoff Depth>1.96"
Flow Length=53' Tc=6.0 min CN=69 Runoff=0.7 cfs 2,234 cf

Subcatchment SC1.2: Runoff Area=14,644 sf 44.80% Impervious Runoff Depth>3.37"
Flow Length=140' Tc=6.0 min CN=85 Runoff=1.3 cfs 4,117 cf

Subcatchment SC2.1: Runoff Area=8,503 sf 67.51% Impervious Runoff Depth>4.20"
Flow Length=179' Tc=6.0 min CN=93 Runoff=0.9 cfs 2,979 cf

Subcatchment SC2.2: Runoff Area=12,000 sf 100.00% Impervious Runoff Depth>4.77"
Flow Length=42' Tc=6.0 min CN=98 Runoff=1.4 cfs 4,769 cf

Subcatchment SC2.3: Runoff Area=134,772 sf 2.89% Impervious Runoff Depth>3.08"
Flow Length=493' Tc=6.0 min CN=82 Runoff=11.3 cfs 34,643 cf

Pond CB: Peak Elev=306.63' Inflow=0.9 cfs 2,979 cf
12.0" Round Culvert n=0.013 L=100.0' S=0.0100 '/' Outflow=0.9 cfs 2,979 cf

Pond DMH: Peak Elev=306.63' Inflow=2.3 cfs 7,748 cf
24.0" Round Culvert n=0.013 L=5.0' S=0.0200 '/' Outflow=2.3 cfs 7,752 cf

Pond FP: Peak Elev=311.86' Storage=635 cf Inflow=1.3 cfs 4,117 cf
Outflow=0.8 cfs 3,903 cf

Pond IC: Peak Elev=306.62' Storage=2,856 cf Inflow=2.3 cfs 7,752 cf
Discarded=0.0 cfs 1,926 cf Primary=1.5 cfs 3,486 cf Outflow=1.5 cfs 5,411 cf

Link AP-1: Inflow=1.5 cfs 6,137 cf
Primary=1.5 cfs 6,137 cf

Link AP-2: Inflow=12.2 cfs 38,129 cf
Primary=12.2 cfs 38,129 cf

Total Runoff Area = 183,584 sf Runoff Volume = 48,743 cf Average Runoff Depth = 3.19"
83.12% Pervious = 152,591 sf 16.88% Impervious = 30,993 sf

Summary for Subcatchment SC1.1:

Runoff = 0.7 cfs @ 12.13 hrs, Volume= 2,234 cf, Depth> 1.96"
Routed to Link AP-1 :

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.06 hrs
NOAA10 24-hr D 10-Year Rainfall=5.01"

Area (sf)	CN	Description
0	98	Paved parking, HSG D
0	80	>75% Grass cover, Good, HSG D
2,802	98	Paved parking, HSG B
10,863	61	>75% Grass cover, Good, HSG B
13,665	69	Weighted Average
10,863		79.50% Pervious Area
2,802		20.50% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
4.6	50	0.0332	0.18		**Sheet Flow, Grass** Grass: Short n= 0.150 P2= 3.21"
0.0	3	0.0470	1.52		**Shallow Concentrated Flow, Grass** Short Grass Pasture Kv= 7.0 fps
4.6	53	Total, Increased to minimum Tc = 6.0 min			

Summary for Subcatchment SC1.2:

Runoff = 1.3 cfs @ 12.12 hrs, Volume= 4,117 cf, Depth> 3.37"
Routed to Pond FP :

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.06 hrs
NOAA10 24-hr D 10-Year Rainfall=5.01"

	Area (sf)	CN	Description
	3,424	61	>75% Grass cover, Good, HSG B
	6,560	98	Paved parking, HSG B
*	4,660	85	Gravel, HSG B
	14,644	85	Weighted Average
	8,084		55.20% Pervious Area
	6,560		44.80% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.9	50	0.0100	0.91		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 3.21"
0.5	90	0.0200	2.87		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
1.4	140	Total, Increased to minimum Tc = 6.0 min			

Summary for Subcatchment SC2.1:

Runoff = 0.9 cfs @ 12.12 hrs, Volume= 2,979 cf, Depth> 4.20"
Routed to Pond CB :

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.06 hrs
NOAA10 24-hr D 10-Year Rainfall=5.01"

	Area (sf)	CN	Description
	295	98	Paved parking, HSG D
	5,445	98	Paved parking, HSG B
*	2,346	85	Gravel, HSG B
	417	61	>75% Grass cover, Good, HSG B
	8,503	93	Weighted Average
	2,763		32.49% Pervious Area
	5,740		67.51% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.7	50	0.0200	1.20		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 3.21"
0.7	129	0.0233	3.10		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
1.4	179	Total, Increased to minimum Tc = 6.0 min			

Summary for Subcatchment SC2.2:

Runoff = 1.4 cfs @ 12.12 hrs, Volume= 4,769 cf, Depth> 4.77"
Routed to Pond DMH :

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.06 hrs
NOAA10 24-hr D 10-Year Rainfall=5.01"

Area (sf)	CN	Description
12,000	98	Roofs, HSG B
12,000		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0	42		0.12		**Direct Entry, Roof**

Summary for Subcatchment SC2.3:

Runoff = 11.3 cfs @ 12.12 hrs, Volume= 34,643 cf, Depth> 3.08"
Routed to Link AP-2 :

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.06 hrs
NOAA10 24-hr D 10-Year Rainfall=5.01"

	Area (sf)	CN	Description
	25,594	80	>75% Grass cover, Good, HSG D
	0	98	Paved parking, HSG D
	44,862	77	Woods, Good, HSG D
*	22,944	91	Gravel, HSG D
	1,669	61	>75% Grass cover, Good, HSG B
	3,501	98	Paved parking, HSG B
*	35,812	85	Gravel, HSG B
	0	55	Woods, Good, HSG B
	390	98	Roofs, HSG D
	134,772	82	Weighted Average
	130,881		97.11% Pervious Area
	3,891		2.89% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.9	50	0.0100	0.91		**Sheet Flow, Gravel** Smooth surfaces n= 0.011 P2= 3.21"
1.5	270	0.0360	3.05		**Shallow Concentrated Flow, Gravel** Unpaved Kv= 16.1 fps
0.1	47	0.6710	5.73		**Shallow Concentrated Flow, Grass** Short Grass Pasture Kv= 7.0 fps
1.1	126	0.1570	1.98		**Shallow Concentrated Flow, Woodlands** Woodland Kv= 5.0 fps
3.6	493	Total, Increased to minimum Tc = 6.0 min			

Summary for Pond CB:

Inflow Area = 8,503 sf, 67.51% Impervious, Inflow Depth > 4.20" for 10-Year event
Inflow = 0.9 cfs @ 12.12 hrs, Volume= 2,979 cf
Outflow = 0.9 cfs @ 12.12 hrs, Volume= 2,979 cf, Atten= 0%, Lag= 0.0 min
Primary = 0.9 cfs @ 12.12 hrs, Volume= 2,979 cf
Routed to Pond DMH :

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.06 hrs / 2
Peak Elev= 306.63' @ 12.26 hrs
Flood Elev= 308.20'

Device	Routing	Invert	Outlet Devices
#1	Primary	305.25'	**12.0" Round Culvert** L= 100.0' CPP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 305.25' / 304.25' S= 0.0100 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.79 sf

Primary OutFlow Max=0.0 cfs @ 12.12 hrs HW=306.04' TW=306.29' (Dynamic Tailwater)
↑—**1=Culvert** (Controls 0.0 cfs)

Summary for Pond DMH:

Inflow Area = 20,503 sf, 86.52% Impervious, Inflow Depth > 4.53" for 10-Year event
Inflow = 2.3 cfs @ 12.12 hrs, Volume= 7,748 cf
Outflow = 2.3 cfs @ 12.12 hrs, Volume= 7,752 cf, Atten= 0%, Lag= 0.0 min
Primary = 2.3 cfs @ 12.12 hrs, Volume= 7,752 cf
Routed to Pond IC :

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.06 hrs / 2
Peak Elev= 306.63' @ 12.20 hrs
Flood Elev= 309.90'

Device	Routing	Invert	Outlet Devices
#1	Primary	303.25'	**24.0" Round Culvert** L= 5.0' CPP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 303.25' / 303.15' S= 0.0200 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 3.14 sf

Primary OutFlow Max=2.2 cfs @ 12.12 hrs HW=306.29' TW=306.25' (Dynamic Tailwater)
1=Culvert (Inlet Controls 2.2 cfs @ 0.71 fps)

Summary for Pond FP:

Inflow Area = 14,644 sf, 44.80% Impervious, Inflow Depth > 3.37" for 10-Year event
Inflow = 1.3 cfs @ 12.12 hrs, Volume= 4,117 cf
Outflow = 0.8 cfs @ 12.21 hrs, Volume= 3,903 cf, Atten= 37%, Lag= 4.9 min
Primary = 0.8 cfs @ 12.21 hrs, Volume= 3,903 cf
Routed to Link AP-1 :

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.06 hrs / 2
Peak Elev= 311.86' @ 12.21 hrs Surf.Area= 5,480 sf Storage= 635 cf

Plug-Flow detention time= 53.6 min calculated for 3,903 cf (95% of inflow)
Center-of-Mass det. time= 24.7 min (852.3 - 827.6)

Volume	Invert	Avail.Storage	Storage Description
#1	311.20'	1,552 cf	**Ponding over system (Prismatic)**Listed below (Recalc)
#2	308.95'	36 cf	**FocalPoint Soil Media (Prismatic)**Listed below (Recalc) 180 cf Overall x 20.0% Voids
#3A	306.75'	50 cf	**8.56'W x 11.38'L x 2.19'H Field A** 214 cf Overall - 89 cf Embedded = 125 cf x 40.0% Voids
#4A	307.00'	84 cf	**Ferguson R-Tank HD 1** x 20 Inside #3 Inside= 15.7"W x 17.3"H => 1.80 sf x 2.35'L = 4.2 cf Outside= 15.7"W x 17.3"H => 1.89 sf x 2.35'L = 4.4 cf 20 Chambers in 5 Rows
		1,722 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
311.20	80	0	0
311.70	80	40	40
312.00	10,000	1,512	1,552

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
308.95	80	0	0
309.00	80	4	4
311.00	80	160	164
311.20	80	16	180

Device	Routing	Invert	Outlet Devices
#1	Primary	311.70'	**5.3' long x 2.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 3.50 Coef. (English) 2.54 2.61 2.61 2.60 2.66 2.70 2.77 2.89 2.88 2.85 3.07 3.20 3.32

Primary OutFlow Max=0.8 cfs @ 12.21 hrs HW=311.86' TW=0.00' (Dynamic Tailwater)
└**1=Broad-Crested Rectangular Weir** (Weir Controls 0.8 cfs @ 1.00 fps)

Summary for Pond IC:

Inflow Area = 20,503 sf, 86.52% Impervious, Inflow Depth > 4.54" for 10-Year event
Inflow = 2.3 cfs @ 12.12 hrs, Volume= 7,752 cf
Outflow = 1.5 cfs @ 12.20 hrs, Volume= 5,411 cf, Atten= 33%, Lag= 4.9 min
Discarded = 0.0 cfs @ 4.56 hrs, Volume= 1,926 cf
Primary = 1.5 cfs @ 12.20 hrs, Volume= 3,486 cf
Routed to Link AP-2 :

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.06 hrs / 2
Peak Elev= 306.62' @ 12.20 hrs Surf.Area= 1,029 sf Storage= 2,856 cf

Plug-Flow detention time= 190.4 min calculated for 5,398 cf (70% of inflow)
Center-of-Mass det. time= 67.2 min (832.0 - 764.8)

Volume	Invert	Avail.Storage	Storage Description
#1A	302.40'	1,511 cf	**29.92'W x 34.38'L x 5.50'H Field A** 5,657 cf Overall - 1,878 cf Embedded = 3,779 cf x 40.0% Voids
#2A	303.15'	1,878 cf	**ADS_StormTech MC-3500 d +Cap** x 16 Inside #1 Effective Size= 70.4"W x 45.0"H => 15.33 sf x 7.17'L = 110.0 cf Overall Size= 77.0"W x 45.0"H x 7.50'L with 0.33' Overlap 16 Chambers in 4 Rows Cap Storage= 14.9 cf x 2 x 4 rows = 119.2 cf
		3,390 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Primary	305.70'	**10.0" Round Culvert** L= 60.0' CPP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 305.70' / 305.10' S= 0.0100 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.55 sf
#2	Discarded	302.40'	**1.020 in/hr Exfiltration over Surface area**

Discarded OutFlow Max=0.0 cfs @ 4.56 hrs HW=302.46' (Free Discharge)
↑—**2=Exfiltration** (Exfiltration Controls 0.0 cfs)

Primary OutFlow Max=1.4 cfs @ 12.20 hrs HW=306.57' TW=0.00' (Dynamic Tailwater)
↑—**1=Culvert** (Inlet Controls 1.4 cfs @ 2.56 fps)

Summary for Link AP-1:

Inflow Area = 28,309 sf, 33.07% Impervious, Inflow Depth > 2.60" for 10-Year event
Inflow = 1.5 cfs @ 12.15 hrs, Volume= 6,137 cf
Primary = 1.5 cfs @ 12.15 hrs, Volume= 6,137 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.06 hrs

Summary for Link AP-2:

Inflow Area = 155,275 sf, 13.93% Impervious, Inflow Depth > 2.95" for 10-Year event
Inflow = 12.2 cfs @ 12.13 hrs, Volume= 38,129 cf
Primary = 12.2 cfs @ 12.13 hrs, Volume= 38,129 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.06 hrs

Time span=0.00-24.00 hrs, dt=0.06 hrs, 401 points x 2
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment SC1.1: Runoff Area=13,665 sf 20.50% Impervious Runoff Depth>2.81"
Flow Length=53' Tc=6.0 min CN=69 Runoff=1.1 cfs 3,201 cf

Subcatchment SC1.2: Runoff Area=14,644 sf 44.80% Impervious Runoff Depth>4.42"
Flow Length=140' Tc=6.0 min CN=85 Runoff=1.7 cfs 5,395 cf

Subcatchment SC2.1: Runoff Area=8,503 sf 67.51% Impervious Runoff Depth>5.31"
Flow Length=179' Tc=6.0 min CN=93 Runoff=1.1 cfs 3,760 cf

Subcatchment SC2.2: Runoff Area=12,000 sf 100.00% Impervious Runoff Depth>5.89"
Flow Length=42' Tc=6.0 min CN=98 Runoff=1.7 cfs 5,887 cf

Subcatchment SC2.3: Runoff Area=134,772 sf 2.89% Impervious Runoff Depth>4.10"
Flow Length=493' Tc=6.0 min CN=82 Runoff=14.9 cfs 46,076 cf

Pond CB: Peak Elev=307.16' Inflow=1.1 cfs 3,760 cf
12.0" Round Culvert n=0.013 L=100.0' S=0.0100 '/' Outflow=1.1 cfs 3,760 cf

Pond DMH: Peak Elev=307.15' Inflow=2.8 cfs 9,647 cf
24.0" Round Culvert n=0.013 L=5.0' S=0.0200 '/' Outflow=2.8 cfs 9,646 cf

Pond FP: Peak Elev=311.88' Storage=788 cf Inflow=1.7 cfs 5,395 cf
Outflow=1.1 cfs 5,180 cf

Pond IC: Peak Elev=307.12' Storage=3,070 cf Inflow=2.8 cfs 9,646 cf
Discarded=0.0 cfs 1,967 cf Primary=2.1 cfs 5,328 cf Outflow=2.1 cfs 7,295 cf

Link AP-1: Inflow=2.0 cfs 8,381 cf
Primary=2.0 cfs 8,381 cf

Link AP-2: Inflow=16.8 cfs 51,404 cf
Primary=16.8 cfs 51,404 cf

Total Runoff Area = 183,584 sf Runoff Volume = 64,319 cf Average Runoff Depth = 4.20"
83.12% Pervious = 152,591 sf 16.88% Impervious = 30,993 sf

Summary for Subcatchment SC1.1:

Runoff = 1.1 cfs @ 12.13 hrs, Volume= 3,201 cf, Depth> 2.81"
Routed to Link AP-1 :

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.06 hrs
NOAA10 24-hr D 25-Year Rainfall=6.13"

Area (sf)	CN	Description
0	98	Paved parking, HSG D
0	80	>75% Grass cover, Good, HSG D
2,802	98	Paved parking, HSG B
10,863	61	>75% Grass cover, Good, HSG B
13,665	69	Weighted Average
10,863		79.50% Pervious Area
2,802		20.50% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
4.6	50	0.0332	0.18		**Sheet Flow, Grass** Grass: Short n= 0.150 P2= 3.21"
0.0	3	0.0470	1.52		**Shallow Concentrated Flow, Grass** Short Grass Pasture Kv= 7.0 fps
4.6	53	Total, Increased to minimum Tc = 6.0 min			

Summary for Subcatchment SC1.2:

Runoff = 1.7 cfs @ 12.12 hrs, Volume= 5,395 cf, Depth> 4.42"
Routed to Pond FP :

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.06 hrs
NOAA10 24-hr D 25-Year Rainfall=6.13"

	Area (sf)	CN	Description
	3,424	61	>75% Grass cover, Good, HSG B
	6,560	98	Paved parking, HSG B
*	4,660	85	Gravel, HSG B
	14,644	85	Weighted Average
	8,084		55.20% Pervious Area
	6,560		44.80% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.9	50	0.0100	0.91		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 3.21"
0.5	90	0.0200	2.87		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
1.4	140	Total, Increased to minimum Tc = 6.0 min			

Summary for Subcatchment SC2.1:

Runoff = 1.1 cfs @ 12.12 hrs, Volume= 3,760 cf, Depth> 5.31"
Routed to Pond CB :

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.06 hrs
NOAA10 24-hr D 25-Year Rainfall=6.13"

	Area (sf)	CN	Description
	295	98	Paved parking, HSG D
	5,445	98	Paved parking, HSG B
*	2,346	85	Gravel, HSG B
	417	61	>75% Grass cover, Good, HSG B
	8,503	93	Weighted Average
	2,763		32.49% Pervious Area
	5,740		67.51% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.7	50	0.0200	1.20		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 3.21"
0.7	129	0.0233	3.10		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
1.4	179	Total, Increased to minimum Tc = 6.0 min			

Summary for Subcatchment SC2.2:

Runoff = 1.7 cfs @ 12.12 hrs, Volume= 5,887 cf, Depth> 5.89"
Routed to Pond DMH :

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.06 hrs
NOAA10 24-hr D 25-Year Rainfall=6.13"

Area (sf)	CN	Description
12,000	98	Roofs, HSG B
12,000		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0	42		0.12		**Direct Entry, Roof**

Summary for Subcatchment SC2.3:

Runoff = 14.9 cfs @ 12.12 hrs, Volume= 46,076 cf, Depth> 4.10"
Routed to Link AP-2 :

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.06 hrs
NOAA10 24-hr D 25-Year Rainfall=6.13"

	Area (sf)	CN	Description
	25,594	80	>75% Grass cover, Good, HSG D
	0	98	Paved parking, HSG D
	44,862	77	Woods, Good, HSG D
*	22,944	91	Gravel, HSG D
	1,669	61	>75% Grass cover, Good, HSG B
	3,501	98	Paved parking, HSG B
*	35,812	85	Gravel, HSG B
	0	55	Woods, Good, HSG B
	390	98	Roofs, HSG D
	134,772	82	Weighted Average
	130,881		97.11% Pervious Area
	3,891		2.89% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.9	50	0.0100	0.91		**Sheet Flow, Gravel** Smooth surfaces n= 0.011 P2= 3.21"
1.5	270	0.0360	3.05		**Shallow Concentrated Flow, Gravel** Unpaved Kv= 16.1 fps
0.1	47	0.6710	5.73		**Shallow Concentrated Flow, Grass** Short Grass Pasture Kv= 7.0 fps
1.1	126	0.1570	1.98		**Shallow Concentrated Flow, Woodlands** Woodland Kv= 5.0 fps
3.6	493	Total, Increased to minimum Tc = 6.0 min			

Summary for Pond CB:

Inflow Area = 8,503 sf, 67.51% Impervious, Inflow Depth > 5.31" for 25-Year event
Inflow = 1.1 cfs @ 12.12 hrs, Volume= 3,760 cf
Outflow = 1.1 cfs @ 12.12 hrs, Volume= 3,760 cf, Atten= 0%, Lag= 0.0 min
Primary = 1.1 cfs @ 12.12 hrs, Volume= 3,760 cf
Routed to Pond DMH :

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.06 hrs / 2
Peak Elev= 307.16' @ 12.24 hrs
Flood Elev= 308.20'

Device	Routing	Invert	Outlet Devices
#1	Primary	305.25'	**12.0" Round Culvert** L= 100.0' CPP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 305.25' / 304.25' S= 0.0100 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.79 sf

Primary OutFlow Max=0.0 cfs @ 12.12 hrs HW=306.71' TW=306.94' (Dynamic Tailwater)
1=Culvert (Controls 0.0 cfs)

Summary for Pond DMH:

Inflow Area = 20,503 sf, 86.52% Impervious, Inflow Depth > 5.65" for 25-Year event
Inflow = 2.8 cfs @ 12.12 hrs, Volume= 9,647 cf
Outflow = 2.8 cfs @ 12.12 hrs, Volume= 9,646 cf, Atten= 0%, Lag= 0.0 min
Primary = 2.8 cfs @ 12.12 hrs, Volume= 9,646 cf
Routed to Pond IC :

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.06 hrs / 2
Peak Elev= 307.15' @ 12.18 hrs
Flood Elev= 309.90'

Device	Routing	Invert	Outlet Devices
#1	Primary	303.25'	**24.0" Round Culvert** L= 5.0' CPP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 303.25' / 303.15' S= 0.0200 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 3.14 sf

Primary OutFlow Max=2.8 cfs @ 12.12 hrs HW=306.93' TW=306.88' (Dynamic Tailwater)
1=Culvert (Inlet Controls 2.8 cfs @ 0.88 fps)

Summary for Pond FP:

Inflow Area = 14,644 sf, 44.80% Impervious, Inflow Depth > 4.42" for 25-Year event
Inflow = 1.7 cfs @ 12.12 hrs, Volume= 5,395 cf
Outflow = 1.1 cfs @ 12.21 hrs, Volume= 5,180 cf, Atten= 38%, Lag= 5.1 min
Primary = 1.1 cfs @ 12.21 hrs, Volume= 5,180 cf
Routed to Link AP-1 :

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.06 hrs / 2
Peak Elev= 311.88' @ 12.21 hrs Surf.Area= 6,357 sf Storage= 788 cf

Plug-Flow detention time= 45.0 min calculated for 5,180 cf (96% of inflow)
Center-of-Mass det. time= 22.1 min (839.3 - 817.1)

Volume	Invert	Avail.Storage	Storage Description
#1	311.20'	1,552 cf	**Ponding over system (Prismatic)**Listed below (Recalc)
#2	308.95'	36 cf	**FocalPoint Soil Media (Prismatic)**Listed below (Recalc) 180 cf Overall x 20.0% Voids
#3A	306.75'	50 cf	**8.56'W x 11.38'L x 2.19'H Field A** 214 cf Overall - 89 cf Embedded = 125 cf x 40.0% Voids
#4A	307.00'	84 cf	**Ferguson R-Tank HD 1** x 20 Inside #3 Inside= 15.7"W x 17.3"H => 1.80 sf x 2.35'L = 4.2 cf Outside= 15.7"W x 17.3"H => 1.89 sf x 2.35'L = 4.4 cf 20 Chambers in 5 Rows
		1,722 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
311.20	80	0	0
311.70	80	40	40
312.00	10,000	1,512	1,552

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
308.95	80	0	0
309.00	80	4	4
311.00	80	160	164
311.20	80	16	180

Device	Routing	Invert	Outlet Devices
#1	Primary	311.70'	**5.3' long x 2.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 3.50 Coef. (English) 2.54 2.61 2.61 2.60 2.66 2.70 2.77 2.89 2.88 2.85 3.07 3.20 3.32

Primary OutFlow Max=1.0 cfs @ 12.21 hrs HW=311.88' TW=0.00' (Dynamic Tailwater)
↑—**1=Broad-Crested Rectangular Weir** (Weir Controls 1.0 cfs @ 1.08 fps)

Summary for Pond IC:

Inflow Area = 20,503 sf, 86.52% Impervious, Inflow Depth > 5.65" for 25-Year event
Inflow = 2.8 cfs @ 12.12 hrs, Volume= 9,646 cf
Outflow = 2.1 cfs @ 12.18 hrs, Volume= 7,295 cf, Atten= 24%, Lag= 3.7 min
Discarded = 0.0 cfs @ 3.60 hrs, Volume= 1,967 cf
Primary = 2.1 cfs @ 12.18 hrs, Volume= 5,328 cf
Routed to Link AP-2 :

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.06 hrs / 2
Peak Elev= 307.12' @ 12.18 hrs Surf.Area= 1,029 sf Storage= 3,070 cf

Plug-Flow detention time= 176.7 min calculated for 7,295 cf (76% of inflow)
Center-of-Mass det. time= 66.7 min (826.3 - 759.6)

Volume	Invert	Avail.Storage	Storage Description
#1A	302.40'	1,511 cf	**29.92'W x 34.38'L x 5.50'H Field A** 5,657 cf Overall - 1,878 cf Embedded = 3,779 cf x 40.0% Voids
#2A	303.15'	1,878 cf	**ADS_StormTech MC-3500 d +Cap** x 16 Inside #1 Effective Size= 70.4"W x 45.0"H => 15.33 sf x 7.17'L = 110.0 cf Overall Size= 77.0"W x 45.0"H x 7.50'L with 0.33' Overlap 16 Chambers in 4 Rows Cap Storage= 14.9 cf x 2 x 4 rows = 119.2 cf
		3,390 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Primary	305.70'	**10.0" Round Culvert** L= 60.0' CPP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 305.70' / 305.10' S= 0.0100 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.55 sf
#2	Discarded	302.40'	**1.020 in/hr Exfiltration over Surface area**

Discarded OutFlow Max=0.0 cfs @ 3.60 hrs HW=302.46' (Free Discharge)
↑—**2=Exfiltration** (Exfiltration Controls 0.0 cfs)

Primary OutFlow Max=2.1 cfs @ 12.18 hrs HW=307.11' TW=0.00' (Dynamic Tailwater)
↑—**1=Culvert** (Inlet Controls 2.1 cfs @ 3.79 fps)

Summary for Link AP-1:

Inflow Area = 28,309 sf, 33.07% Impervious, Inflow Depth > 3.55" for 25-Year event
Inflow = 2.0 cfs @ 12.15 hrs, Volume= 8,381 cf
Primary = 2.0 cfs @ 12.15 hrs, Volume= 8,381 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.06 hrs

Summary for Link AP-2:

Inflow Area = 155,275 sf, 13.93% Impervious, Inflow Depth > 3.97" for 25-Year event
Inflow = 16.8 cfs @ 12.13 hrs, Volume= 51,404 cf
Primary = 16.8 cfs @ 12.13 hrs, Volume= 51,404 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.06 hrs

Time span=0.00-24.00 hrs, dt=0.06 hrs, 401 points x 2
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment SC1.1: Runoff Area=13,665 sf 20.50% Impervious Runoff Depth>4.23"
Flow Length=53' Tc=6.0 min CN=69 Runoff=1.6 cfs 4,812 cf

Subcatchment SC1.2: Runoff Area=14,644 sf 44.80% Impervious Runoff Depth>6.07"
Flow Length=140' Tc=6.0 min CN=85 Runoff=2.3 cfs 7,410 cf

Subcatchment SC2.1: Runoff Area=8,503 sf 67.51% Impervious Runoff Depth>7.02"
Flow Length=179' Tc=6.0 min CN=93 Runoff=1.5 cfs 4,973 cf

Subcatchment SC2.2: Runoff Area=12,000 sf 100.00% Impervious Runoff Depth>7.61"
Flow Length=42' Tc=6.0 min CN=98 Runoff=2.1 cfs 7,614 cf

Subcatchment SC2.3: Runoff Area=134,772 sf 2.89% Impervious Runoff Depth>5.72"
Flow Length=493' Tc=6.0 min CN=82 Runoff=20.5 cfs 64,256 cf

Pond CB: Peak Elev=307.75' Inflow=1.5 cfs 4,973 cf
12.0" Round Culvert n=0.013 L=100.0' S=0.0100 '/' Outflow=1.5 cfs 4,973 cf

Pond DMH: Peak Elev=307.74' Inflow=3.6 cfs 12,587 cf
24.0" Round Culvert n=0.013 L=5.0' S=0.0200 '/' Outflow=3.6 cfs 12,577 cf

Pond FP: Peak Elev=311.92' Storage=1,025 cf Inflow=2.3 cfs 7,410 cf
Outflow=1.4 cfs 7,193 cf

Pond IC: Peak Elev=307.69' Storage=3,305 cf Inflow=3.6 cfs 12,577 cf
Discarded=0.0 cfs 2,005 cf Primary=2.6 cfs 8,212 cf Outflow=2.6 cfs 10,217 cf

Link AP-1: Inflow=2.8 cfs 12,006 cf
Primary=2.8 cfs 12,006 cf

Link AP-2: Inflow=22.8 cfs 72,468 cf
Primary=22.8 cfs 72,468 cf

Total Runoff Area = 183,584 sf Runoff Volume = 89,065 cf Average Runoff Depth = 5.82"
83.12% Pervious = 152,591 sf 16.88% Impervious = 30,993 sf

Summary for Subcatchment SC1.1:

Runoff = 1.6 cfs @ 12.13 hrs, Volume= 4,812 cf, Depth> 4.23"
Routed to Link AP-1 :

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.06 hrs
NOAA10 24-hr D 100-Year Rainfall=7.86"

Area (sf)	CN	Description
0	98	Paved parking, HSG D
0	80	>75% Grass cover, Good, HSG D
2,802	98	Paved parking, HSG B
10,863	61	>75% Grass cover, Good, HSG B
13,665	69	Weighted Average
10,863		79.50% Pervious Area
2,802		20.50% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
4.6	50	0.0332	0.18		**Sheet Flow, Grass** Grass: Short n= 0.150 P2= 3.21"
0.0	3	0.0470	1.52		**Shallow Concentrated Flow, Grass** Short Grass Pasture Kv= 7.0 fps
4.6	53	Total, Increased to minimum Tc = 6.0 min			

Summary for Subcatchment SC1.2:

Runoff = 2.3 cfs @ 12.12 hrs, Volume= 7,410 cf, Depth> 6.07"
Routed to Pond FP :

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.06 hrs
NOAA10 24-hr D 100-Year Rainfall=7.86"

	Area (sf)	CN	Description
	3,424	61	>75% Grass cover, Good, HSG B
	6,560	98	Paved parking, HSG B
*	4,660	85	Gravel, HSG B
	14,644	85	Weighted Average
	8,084		55.20% Pervious Area
	6,560		44.80% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.9	50	0.0100	0.91		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 3.21"
0.5	90	0.0200	2.87		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
1.4	140	Total, Increased to minimum Tc = 6.0 min			

Summary for Subcatchment SC2.1:

Runoff = 1.5 cfs @ 12.12 hrs, Volume= 4,973 cf, Depth> 7.02"
Routed to Pond CB :

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.06 hrs
NOAA10 24-hr D 100-Year Rainfall=7.86"

	Area (sf)	CN	Description
	295	98	Paved parking, HSG D
	5,445	98	Paved parking, HSG B
*	2,346	85	Gravel, HSG B
	417	61	>75% Grass cover, Good, HSG B
	8,503	93	Weighted Average
	2,763		32.49% Pervious Area
	5,740		67.51% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.7	50	0.0200	1.20		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 3.21"
0.7	129	0.0233	3.10		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
1.4	179	Total, Increased to minimum Tc = 6.0 min			

Summary for Subcatchment SC2.2:

Runoff = 2.1 cfs @ 12.12 hrs, Volume= 7,614 cf, Depth> 7.61"
Routed to Pond DMH :

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.06 hrs
NOAA10 24-hr D 100-Year Rainfall=7.86"

Area (sf)	CN	Description
12,000	98	Roofs, HSG B
12,000		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0	42		0.12		**Direct Entry, Roof**

Summary for Subcatchment SC2.3:

Runoff = 20.5 cfs @ 12.12 hrs, Volume= 64,256 cf, Depth> 5.72"
Routed to Link AP-2 :

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.06 hrs
NOAA10 24-hr D 100-Year Rainfall=7.86"

	Area (sf)	CN	Description
	25,594	80	>75% Grass cover, Good, HSG D
	0	98	Paved parking, HSG D
	44,862	77	Woods, Good, HSG D
*	22,944	91	Gravel, HSG D
	1,669	61	>75% Grass cover, Good, HSG B
	3,501	98	Paved parking, HSG B
*	35,812	85	Gravel, HSG B
	0	55	Woods, Good, HSG B
	390	98	Roofs, HSG D
	134,772	82	Weighted Average
	130,881		97.11% Pervious Area
	3,891		2.89% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.9	50	0.0100	0.91		**Sheet Flow, Gravel** Smooth surfaces n= 0.011 P2= 3.21"
1.5	270	0.0360	3.05		**Shallow Concentrated Flow, Gravel** Unpaved Kv= 16.1 fps
0.1	47	0.6710	5.73		**Shallow Concentrated Flow, Grass** Short Grass Pasture Kv= 7.0 fps
1.1	126	0.1570	1.98		**Shallow Concentrated Flow, Woodlands** Woodland Kv= 5.0 fps
3.6	493	Total, Increased to minimum Tc = 6.0 min			

Summary for Pond CB:

Inflow Area = 8,503 sf, 67.51% Impervious, Inflow Depth > 7.02" for 100-Year event
Inflow = 1.5 cfs @ 12.12 hrs, Volume= 4,973 cf
Outflow = 1.5 cfs @ 12.12 hrs, Volume= 4,973 cf, Atten= 0%, Lag= 0.0 min
Primary = 1.5 cfs @ 12.12 hrs, Volume= 4,973 cf
Routed to Pond DMH :

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.06 hrs / 2
Peak Elev= 307.75' @ 12.24 hrs
Flood Elev= 308.20'

Device	Routing	Invert	Outlet Devices
#1	Primary	305.25'	**12.0" Round Culvert** L= 100.0' CPP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 305.25' / 304.25' S= 0.0100 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.79 sf

Primary OutFlow Max=0.0 cfs @ 12.12 hrs HW=307.15' TW=307.43' (Dynamic Tailwater)
↑—**1=Culvert** (Controls 0.0 cfs)

Summary for Pond DMH:

Inflow Area = 20,503 sf, 86.52% Impervious, Inflow Depth > 7.37" for 100-Year event
Inflow = 3.6 cfs @ 12.12 hrs, Volume= 12,587 cf
Outflow = 3.6 cfs @ 12.12 hrs, Volume= 12,577 cf, Atten= 0%, Lag= 0.0 min
Primary = 3.6 cfs @ 12.12 hrs, Volume= 12,577 cf
Routed to Pond IC :

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.06 hrs / 2
Peak Elev= 307.74' @ 12.18 hrs
Flood Elev= 309.90'

Device	Routing	Invert	Outlet Devices
#1	Primary	303.25'	**24.0" Round Culvert** L= 5.0' CPP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 303.25' / 303.15' S= 0.0200 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 3.14 sf

Primary OutFlow Max=3.6 cfs @ 12.12 hrs HW=307.43' TW=307.34' (Dynamic Tailwater)
1=Culvert (Inlet Controls 3.6 cfs @ 1.14 fps)

Summary for Pond FP:

Inflow Area = 14,644 sf, 44.80% Impervious, Inflow Depth > 6.07" for 100-Year event
Inflow = 2.3 cfs @ 12.12 hrs, Volume= 7,410 cf
Outflow = 1.4 cfs @ 12.21 hrs, Volume= 7,193 cf, Atten= 40%, Lag= 5.2 min
Primary = 1.4 cfs @ 12.21 hrs, Volume= 7,193 cf
Routed to Link AP-1 :

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.06 hrs / 2
Peak Elev= 311.92' @ 12.21 hrs Surf.Area= 7,516 sf Storage= 1,025 cf

Plug-Flow detention time= 36.5 min calculated for 7,176 cf (97% of inflow)
Center-of-Mass det. time= 19.3 min (824.5 - 805.2)

Volume	Invert	Avail.Storage	Storage Description
#1	311.20'	1,552 cf	**Ponding over system (Prismatic)**Listed below (Recalc)
#2	308.95'	36 cf	**FocalPoint Soil Media (Prismatic)**Listed below (Recalc) 180 cf Overall x 20.0% Voids
#3A	306.75'	50 cf	**8.56'W x 11.38'L x 2.19'H Field A** 214 cf Overall - 89 cf Embedded = 125 cf x 40.0% Voids
#4A	307.00'	84 cf	**Ferguson R-Tank HD 1** x 20 Inside #3 Inside= 15.7"W x 17.3"H => 1.80 sf x 2.35'L = 4.2 cf Outside= 15.7"W x 17.3"H => 1.89 sf x 2.35'L = 4.4 cf 20 Chambers in 5 Rows
		1,722 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
311.20	80	0	0
311.70	80	40	40
312.00	10,000	1,512	1,552

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
308.95	80	0	0
309.00	80	4	4
311.00	80	160	164
311.20	80	16	180

Device	Routing	Invert	Outlet Devices
#1	Primary	311.70'	**5.3' long x 2.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 3.50 Coef. (English) 2.54 2.61 2.61 2.60 2.66 2.70 2.77 2.89 2.88 2.85 3.07 3.20 3.32

Primary OutFlow Max=1.4 cfs @ 12.21 hrs HW=311.92' TW=0.00' (Dynamic Tailwater)
↑**1=Broad-Crested Rectangular Weir** (Weir Controls 1.4 cfs @ 1.19 fps)

Summary for Pond IC:

Inflow Area = 20,503 sf, 86.52% Impervious, Inflow Depth > 7.36" for 100-Year event
Inflow = 3.6 cfs @ 12.12 hrs, Volume= 12,577 cf
Outflow = 2.6 cfs @ 12.19 hrs, Volume= 10,217 cf, Atten= 27%, Lag= 3.9 min
Discarded = 0.0 cfs @ 2.64 hrs, Volume= 2,005 cf
Primary = 2.6 cfs @ 12.19 hrs, Volume= 8,212 cf
Routed to Link AP-2 :

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.06 hrs / 2
Peak Elev= 307.69' @ 12.19 hrs Surf.Area= 1,029 sf Storage= 3,305 cf

Plug-Flow detention time= 159.7 min calculated for 10,217 cf (81% of inflow)
Center-of-Mass det. time= 66.8 min (820.5 - 753.6)

Volume	Invert	Avail.Storage	Storage Description
#1A	302.40'	1,511 cf	**29.92'W x 34.38'L x 5.50'H Field A** 5,657 cf Overall - 1,878 cf Embedded = 3,779 cf x 40.0% Voids
#2A	303.15'	1,878 cf	**ADS_StormTech MC-3500 d +Cap** x 16 Inside #1 Effective Size= 70.4"W x 45.0"H => 15.33 sf x 7.17'L = 110.0 cf Overall Size= 77.0"W x 45.0"H x 7.50'L with 0.33' Overlap 16 Chambers in 4 Rows Cap Storage= 14.9 cf x 2 x 4 rows = 119.2 cf
		3,390 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Primary	305.70'	**10.0" Round Culvert** L= 60.0' CPP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 305.70' / 305.10' S= 0.0100 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.55 sf
#2	Discarded	302.40'	**1.020 in/hr Exfiltration over Surface area**

Discarded OutFlow Max=0.0 cfs @ 2.64 hrs HW=302.46' (Free Discharge)
↑—**2=Exfiltration** (Exfiltration Controls 0.0 cfs)

Primary OutFlow Max=2.6 cfs @ 12.19 hrs HW=307.66' TW=0.00' (Dynamic Tailwater)
↑—**1=Culvert** (Inlet Controls 2.6 cfs @ 4.73 fps)

Summary for Link AP-1:

Inflow Area = 28,309 sf, 33.07% Impervious, Inflow Depth > 5.09" for 100-Year event
Inflow = 2.8 cfs @ 12.14 hrs, Volume= 12,006 cf
Primary = 2.8 cfs @ 12.14 hrs, Volume= 12,006 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.06 hrs

Summary for Link AP-2:

Inflow Area = 155,275 sf, 13.93% Impervious, Inflow Depth > 5.60" for 100-Year event
Inflow = 22.8 cfs @ 12.13 hrs, Volume= 72,468 cf
Primary = 22.8 cfs @ 12.13 hrs, Volume= 72,468 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.06 hrs

Stormwater Management Standard 3
GROUNDWATER RECHARGE

Pre-Development Conditions

91 Groton-Harvard Road, Ayer, MA
Project No. 231083

		Area (sf)	Area (Ac)
Total Subcatchment Areas		183,584	4.2
Total Subcatchment Areas On-Site		183,584	4.2
Total Area of Hydrolic Soil Groups On-Site		183,584	4.2
	A	0	0.0
	B	89,499	2.1
	C	0	0.0
	D	94,085	2.2

Surface Type Areas (On-Site)

Woods		44,862	1.0
	B	0	0.0
	D	44,862	1.0
Grass		40,234	0.9
	B	14,684	0.3
	D	25,550	0.6
Pavement		16,727	0.4
	B	16,727	0.4
	D	0	0.0
Gravel		79,239	1.8
	B	55,566	1.3
	D	23,673	0.5
Roofs		2,522	0.1
	B	2,522	0.1
	D	0	0.0
Total Impervious Area On-Site		98,488	2.3

Infiltration Volume

Inches of Recharge per Storm Event	A	0.60
	B	0.35
	C	0.25
	D	0.10

Infiltration Volume = ∑ {[(Total Subcatchment Area within HSG) - (Total Impervious Area within HSG)]
x (inches of Recharge Per Storm)}

Infiltration Volume **1,015 CF**

Stormwater Management Standard 3
GROUNDWATER RECHARGE

Post Development Conditions

91 Groton-Harvard Road, Ayer, MA
Project No. 231083

		Area (sf)	Area (Ac)
Total Subcatchment Areas		183,584	4.2
Total Subcatchment Areas On-Site		183,584	4.2
Total Area of Hydrolic Soil Groups On-Site		183,584	4.2
	A	0	0.0
	B	89,499	2.1
	C	0	0.0
	D	94,085	2.2
Surface Type Areas (On-Site)			
Woods		44,862	1.0
	B	0	0.0
	D	44,862	1.0
Grass		41,967	1.0
	B	16,373	0.4
	D	25,594	0.6
Pavement		18,603	0.4
	B	18,308	0.4
	D	295	0.0
Roofs		12,390	0.3
	B	12,000	0.3
	D	390	0.0
Gravel		65,762	1.5
	B	42,818	1.0
	D	22,944	0.5
Total Impervious Area On-Site		96,755	2.2

Infiltration Volume

Inches of Recharge per Storm Event	A	0.60
	B	0.35
	C	0.25
	D	0.10

Infiltration Volume = ∑ {[(Total Subcatchment Area within HSG) - (Total Impervious Area within HSG)] x (inches of Recharge Per Storm)}

Natural Infiltration Volume	1,065	CF	
Pre-Development Infiltration Volume	1,015	CF	
Offset Infiltration Volume	-50	CF	
Impervious Area Captured by BMP	20,503	SF	See SC2.1 & SC2.2 in HydroCAD Report
Capture Area Adjustment Factor	N/A		Total Imp. Area / Imp. Area Captured
Required Inilfiltration Volume	**-50**	**CF**	Offset Infil. Vol. x Capture Area Adjustment Factor

Provided Infiltration Volume

Infiltration Chambers (IC)	2,306	CF	Volume below 305.70' Orifice
Total Provided Inilfiltration Volume	**2,306**	**CF**	

Stormwater Management Standard 3
GROUNDWATER RECHARGE

Infiltration Area Requirements

91 Groton-Harvard Road, Ayer, MA
Project No. 231083

Drawdown Time

(Per Massachusetts Stormwater regulations, infiltration areas must completely drain within 72 hours)

		Infiltration Chambers (IC)
Infiltration Area Storage Volume	cf	2,306
Design infiltration Rate	in/hr	1.02
Infiltration Bottom Area	sf	1,030

Drawdown Time = Infiltration Area Storage Volume / [Design Infiltration Rate x Infiltration Area Bottom Area]

Drawdown Time (Hrs)	**26.3**

Mounding Analysis

Per the Massachusetts Stormwater Handbook, mounding analysis is required when ".. The vertical separation from the bottom of an exfiltration system to seasonal high groundwater is less than four (4) feet and the recharge system is proposed to attenuate the peak discharge from a 10-year or higher 24-hour storm." The mounding analysis "... must show that the REQUIRED RECHARGE VOLUME is fully dewatered within 72 hours..."

		Infiltration Chambers (IC)
Hydraulic Conductivity	ft/day	16 Standard Value for "Medium Sand" material
Specific Yield		0.28 Standard Value for "Medium Sand" material
Initial Saturated Thickness	ft	10 Depth to bedrock
Design Recharge Rate	ft/day	2.04 infiltration rate
Time	days	3 Minimum 72 hr evaluation period
Bottom Infiltrating Area	sf	1,030
Length of Infiltration Area	ft	34.4
Width of Infiltration Area	ft	29.9
Time when Infiltration Stops	days	1.10 Calculated Drawdown Time (see Above)
Maximum Water table rise at 72 hours[1]	**ft** **in**	**0.46** **5 1/2**

- Resulting mound will not interfere with the full draining of the infiltration area in accordance with Mass Stormwater Standards -

[1] - mounding analysis calculated by MOUNDSOLV v4.0. (www.aqesolv.com) Copyright 2019-2021 HydroSOLVE, Inc.

Stormwater Management Standard 4
WATER QUALITY RETENTION VOLUME

91 Groton-Harvard Road, Ayer, MA
Project No. 231083

Parameter	Unit	Quantity	Remarks
Watershed area	sf	183,584	
Predevelopment impervious area	sf	98,488	
Total impervious area added	sf	-1,733	
Total impervious area	sf	96,755	
Total impervious area required for retention	sf	96,755	
Runoff depth over impervious area	IN	0.5	
Required Water Quality Volume	**CF**	**-72**	Per Massachusetts Stormwater Handbook
Required Stormwater Retention (Ayer)	CF	6,450	0.80 x Total Post-Construction Imp. Area
Imp. area captured in redevelopment	CF	31,306	See SC1.2, SC2.1 & SC2.2 in HydroCAD
Requested Waiver Stormwater Retention (See Stormwater Management Waiver)	**CF**	**2,087**	0.80 x Imp. area captured in redevelopment
Provided Water Quality Volume			
Infiltration Chambers (IC)	CF	2,306	Volume below 305.70' Orifice
DESIGN VOLUME PROVIDED	**CF**	**2,306**	

Stormwater Management Standard 4
TSS REMOVAL

91 Groton-Harvard Road, Ayer, MA
Project No. 231083

Process Train No.	Stormwater BMP	TP Removal Rate	TSS Removal Rate	TSS Remaining at Discharge	TSS Removed at Discharge
AP-1	FP	66% [1]	91.2% [1]	8.8%	**91.2%**
AP-2	CB	--	25%	75.0%	25%
	IC	92% [2]	100% [2]	0%	**100%**

[1] MA DEP Proprietary Technology Compliance - FocalPoint High Performance Modular Biofiltration System.
[2] EPA Region 1's Stormwater Best Management Practices Performance Analysis. Revised March 2010.

ABBREVIATIONS:
TSS=total suspended solids; SF=square feet; SC=subcatchment; DC=drainage channel; BMP=best management practices; CB=deep sump hooded catch basin; FB = Sediment Forebay; INF=infiltration basin; WB=wet basin; SP=Silt Prison Catch Basin FP=FocalPoint; IC=infiltration chambers

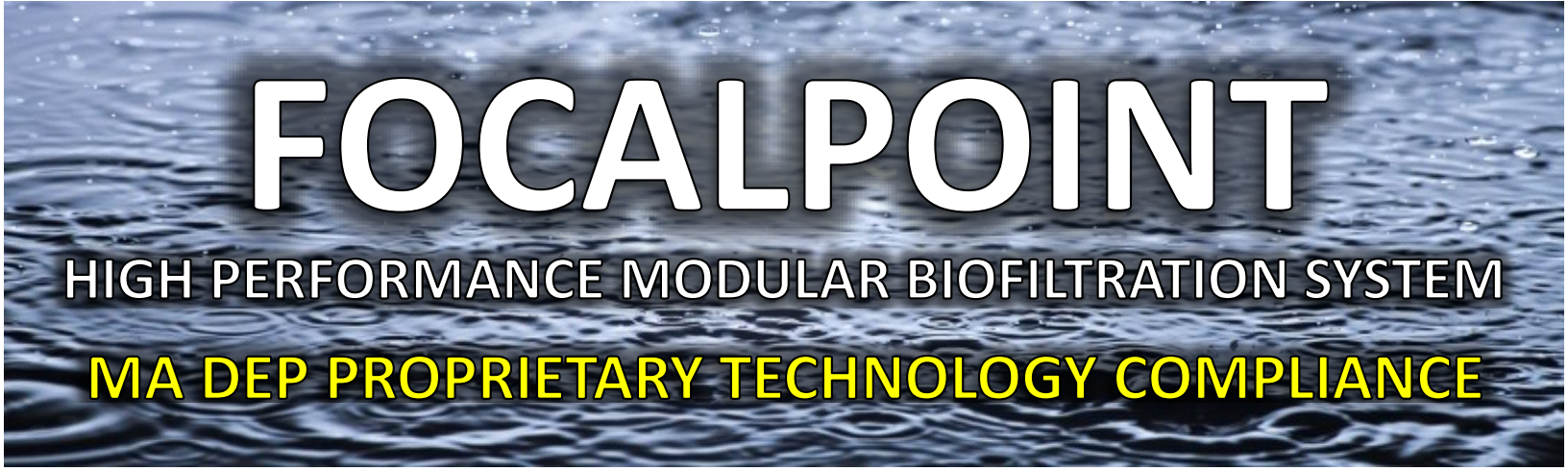
Drainage Pipe Performance Summary

91 Groton-Harvard Road, Ayer, MA
Project No. 231083

FROM			TO																
Structure	Rim	Invert	Structure	Invert	Pipe Size (in)	Pipe Type	Length (ft)	Slope (ft/ft)	Slope (%)	Manning's n	Pipe Area (sf)	Hydraulic Radius (ft)	Q_{full} (cfs)	V_{full} (ft/s)	Q_{25}	Q_{25} / Q_{full}	Propotional Flow d/D	V_{25} / V_{full}	V_{25}
RD	--	306.70	DMH	305.90	12	HDPE	40.0	0.020	2.0%	0.013	0.785	0.250	5.1	6.4	1.7	0.34	0.47	0.95	6.1
CB	308.20	305.25	DMH	304.25	12	HDPE	100.0	0.010	1.0%	0.013	0.785	0.250	3.6	4.5	1.1	0.31	0.38	0.88	4.0
DMH	309.90	303.25	IC	303.15	24	HDPE	5.0	0.020	2.0%	0.013	3.142	0.500	32.1	10.2	2.8	0.09	0.21	0.64	6.5
IC	--	305.70	FES	305.10	10	HDPE	60.0	0.010	1.0%	0.013	0.545	0.208	2.2	4.0	2.1	0.96	0.77	1.14	4.6

Note: Drainage pipes shall be designed to accommodate the 25-year storm event, maintain velocities between 2.5 and 10 feet per second per Ayer Stormwater Regulations.

Abbreviations:
CB - Catch Basin; DCB - Double Grate Catch Basin; DMH - Drain Manhole; FES - Flared End Section; RD - Roof Drain; IC - Infiltration Chambers



ACF Environmental has prepared this guidance document for engineers designing projects in Massachusetts with the FocalPoint high performance modular biofiltration system. This information is based on the guidance provide in Chapter 4 of the Massachusetts Stormwater Handbook titled "Process to Approve or Deny the Use of Proprietary Stormwater Technology". Each evaluation criteria is provided below followed by a response from ACF in **bold face blue** text to address the criteria. It is anticipated that this document would be provided as an attachment to a permit application with local MA conservation commission groups and local reviewing authorities.

Process To Approve or Deny the Use of Proprietary Stormwater Technology

There are only two ways to evaluate a proposed use of a proprietary BMP in Massachusetts:

1. The Commonwealth has evaluated the performance of the technology and assigned a TSS removal efficiency.

This does not apply to FocalPoint-HPMBS, please proceed to Item 2.

2. The issuing authority has evaluated the proposed use of a particular proprietary BMP at a specific site and assigned a TSS removal efficiency based upon its own case-by-case review of the effectiveness and intended use of the proprietary BMP.

MassDEP strongly recommends that the issuing authority evaluate proposed BMPs using studies reviewed by the University of Massachusetts and posted on its stormwater database website (www.mastep.net). That database includes information on the relative quality of the studies, and should be used as the basis for a local agency's evaluation of the effectiveness of a proprietary system. Based on this information, the issuing authority may decide to approve or deny the use of any proprietary technology. The issuing authority may not unreasonably deny the use of a proposed technology.

Per the MassDEP The Massachusetts Strategic Envirotechnology Partnership (MassSTEP) was defunded by the Commonwealth and thereafter sunset by the Massachusetts Executive Office of Energy and Environmental Affairs (MassEEA) on January 11, 2011. As such, it is not effective for regulatory purposes pursuant to the Massachusetts Wetlands Protection (310 CMR 10.00) or any other regulations of the Commonwealth. Similarly, the Massachusetts Stormwater Technology Evaluation Project (MASTEP) is no longer funded by the Massachusetts Department of Environmental Protection (MassDEP) and is not effective for regulatory purposes pursuant to the Massachusetts Wetlands Protection (310 CMR 10.00) or any other regulations of the Commonwealth.

In regards to the Technology and Reciprocity Partnership (TARP), MassDEP has not granted written reciprocity to any of the reviews conducted by the New Jersey Corporation for Advanced Technology (NJCAT) through the New Jersey DEP. As such, any documents represented as being TARP compliant verifications are not effective for regulatory purposes pursuant to the Massachusetts Wetlands Protection (310 CMR 10.00) or any other regulations of the Commonwealth.

If the operating parameters and performance claims of a proprietary technology have not been fully verified by STEP or TARP and a MassDEP removal efficiency rating has not been assigned, the technology vendor must submit evaluative information to the local agency regarding the technology's effectiveness.

On October 28, 2014, ACF Environmental of East Norriton, Pennsylvania authorized Civil & Environmental Consultants, Inc. (CEC) to perform a 3rd party, full-scale test to assess the water quality performance of the FocalPoint High Performance Modular Biofiltration System (HPMBS). The field-based assessment was performed in accordance with a protocol which produces the same quality and quantity of data as the protocols established by the University of New Hampshire Stormwater Center, the Technology Acceptance and Reciprocity Partnership, or the Washington State Department of Ecology Technology Assessment Protocol (TAPE). Specifically, TAPE protocols were followed for this study and are indicated in the Table 1. Table 2 provides a summary of removal efficiencies based on even mean concentrations. A full technical evaluation report that includes a complete breakdown of individual event data, statistical analysis, analytical sheets and conclusions is available upon request.

Table 1. TAPE versus TARP Protocols

STANDARD	TAPE	TARP
Number of test sites	1	None
Number of Storms	12-35	15-20
Storm Depth (inches)	≥ 0.15	≥ 0.10
Antecedent Dry Period (hrs)	6 with less than 0.04 inches	6
Storm Duration (hr)	1	None
Average Storm Intensity	None	None
Sampling Methods	Automated	Automated
Type of Samples	Flow weighted composite	Flow weighted composite
Minimum # of Aliquots	10	10

Volume Coverage (covering X% of each storms total runoff volume)	75	70
Pollutant Analyzed	TSS pH Metals (Zn, Cu, Cd) Oils and Grease TPH TP TKN (none) SSC (optional)	TSS
Performance Criteria for all three protocols	Influent Range 20-100 mg/L TSS, 100-200 mg/L TSS ≥ 200 mg/L TSS	Effluent Criteria ≤ 20 mg/L 80% removal 80% removal

Table 2. Summary of removal efficiencies for primary constituents of concern – Suspended Sediment (TSS), Total Phosphorus (TP), Total Nitrogen (TN)

Study Method	Constituents	% Removal Concentration Based, for the event mean [A]	% Removal Mass Based, for the event mean	Bootstrap 95% CI for mean [LCL, UCL], Concentration Based	Bootstrap 95% CI for mean [LCL, UCL] Mass Based	% Removal, Lab Based Column Study [B]
TAPE	Suspended Sediment (TSS)	84.4 (n=20)	91.4 (n=19)	[76.4, 91.4]	[87.5, 94.7]	91.2
TAPE	Total Phosphorus (TP)	52 (n=20)	72.5 (n=19)	[37.3, 67.6]	[63.9, 80.6]	66
TAPE	Total Nitrogen (TN) [C]	58.7 (n=16)	77.9 (n=15)	[45.4, 72]	[72.5, 83.2]	48.5

[A] Automated flow-weighted composites were collected and composite sample concentrations are defined as the volume weighted average of all the individual samples. Therefore, the event mean concentration (EMC) for the flow-weighted sample is the concentration of the composite.

[B] CEC Assessment of suspended solids and nutrient attenuation by the Virginia mixture of FocalPoint Biofiltration System via column testing, October 2014.

[C] For this study period there were no measureable removals of nitrates. The reduction in TN is derived from the attenuation of the Kjeldahl Nitrogen portion of the influent concentrations.

As indicated in the table above, the TAPE minimum 12 qualified rainfall\runoff events have been met. All 20 events are classified as qualifying storm events, as defined by TAPE for this research (i.e., qualifying storm event of 0.15-inch or greater rainfall total).

Relative to TSS, the influent concentrations measured from the test site range from 4.9 to 1,560 mg/L.

For the 20-100 mg/L influent range, the measured effluent TSS does meet the TAPE-required upper 95% confidence limit about the mean effluent concentration of less than or equal to 20 mg/L (data calculations from the study produced a 16.8 mg/L upper confidence limit concentration via bootstrapping; 14.5 mg/L upper confidence limit for the median from Q-Q plots).

For influent TSS in the range of 100-200 mg/L, the TAPE minimum 80% removal efficiency requirement is met.

For influent TSS greater than 200 mg/L, the TAPE minimum 80% removal efficiency requirement is met.

Please note that Proprietary BMPs are NOT required to be evaluated by MassDEP to be used in Massachusetts. Only a small number of proprietary BMPs have been evaluated by the Commonwealth, and those evaluations are limited to the specific conditions that were reviewed. In most case in Massachusetts, a proposed use of a particular proprietary BMP at a specific site will be reviewed by the local agency on a case–by-case basis.

FocalPoint HPMBS will be reviewed by the local agency on a case-by-case basis.

How to Evaluate the Effectiveness of Proprietary BMPs that Do Not Have a MassDEP TSS Removal Efficiency Rating: MassDEP recognizes that the process of reviewing a proposed use of a particular proprietary BMP at a specific site may be daunting. MassDEP has prepared guidance for conducting this review.

Step One: Information that should be submitted as part of the Wetlands NOI.

As more fully set out below, issuing authorities require sufficient information to evaluate proposed uses of proprietary BMPs. If sufficient information is not submitted with the NOI, the Conservation Commission should request additional information as part of the review process. Specific information that a Conservation Commission may want to request prior to a hearing include:

A complete description of the proprietary technology or product including a discussion of the advantages of the technology when compared to conventional stormwater treatment systems and LID practices, including:

FocalPoint HPMBS is a modular, high performance biofiltration system that often works in tandem with other integrated management practices (IMP). Contaminated stormwater runoff enters the biofiltration bed through a conveyance swale, planter box, or directly through a curb cut or false inlet. Energy is dissipated by a rock or vegetative dissipation device and is absorbed by a 3-inch layer of aged, double shredded hardwood mulch, with fines removed, on the surface of the biofiltration media.

The FocalPoint HPMBS design describes a mostly permeable profile or boxless system that is identical to that of a traditional bioretention system (i.e., 2-3 inches of mulch layer, 18-24 inch media depth, ≥ 6" underdrain and 24 to 48 hr for complete drain down time) and substitutes high performance, high-flow rate engineered media for traditional slow-flow rate media and incorporates a matching high performance, highly permeable, modular underdrain for typical perforated pipe. The performance difference between these two systems is dramatic in terms of their ability to receive water. The modular underdrain also may be expanded to include integrated subsurface storage options for extended detention, infiltration, and/or reuse. These options are integral to the FocalPoint HPMBS design and they are almost infinitely scalable in length width and depth. Outfall from these underdrain structures may be restricted to meet any design need, either by pipe, pump (for harvesting) or subsurface infiltration.

As the water passes through the mulch layer, most of the larger sediment particles and heavy metals are removed through sedimentation and chemical reactions with the organic material in the mulch. Water passes through the biofiltration media where the finer particles are removed and numerous chemical reactions take place to immobilize and capture pollutants in the soil media.

The cleansed water passes into the underdrain/storage system and remaining flows are directed to a stormwater conveyance system or other appropriate discharge point. Once the pollutants are in the media, bacteria begin to break down and metabolize the materials and the plants begin to uptake and metabolize the pollutants. Some pollutants such as heavy metals, which are chemically bound to organic particles in the mulch, are released over time as the organic matter decomposes to release the metals to the feeder roots of the plants and the cells of the bacteria in the media where they remain and are recycled. Other pollutants such as phosphorus are chemically bound to the soil particles and released slowly back to the plants and bacteria and used in their metabolic processes. Nitrogen goes through a variety of very complex biochemical processes where it can ultimately end up in the plant/bacteria biomass, turned to nitrogen gas or dissolves back into the water column as nitrates depending on soil temperature, pH and the availability of oxygen. The pollutants ultimately are retained in the mulch, media and biomass with some passing out of the system into the air or back into the water.

The System is comprised of the following elements and depicted in Figure 1.

Open Cell Underdrain: **A modular, high infiltration rate 'flat pipe' underdrain/storage system which is designed to directly infiltrate or exfiltrate water through its surface. The modular underdrain overcomes the limited collection capacity of traditional stone and pipe underdrains. A 90% open surface area collects water significantly faster and can be extended below for additional volume.**

Separation Layer: **A wide aperture mesh layer is utilized to prevent bridging stone from entering the underdrain system. The separation layer utilizes the concept of 'bridging' to separate the biofiltration media from the underdrain without the use of geotextile fabrics. The use of geotextile fabrics within an infiltration device can lead to clogging; by eliminating the need for a geotextile fabric, the potential for clogging is greatly reduced.**

High Flow Media: The advanced high flow rate engineered media utilizes physical, chemical and biological mechanisms of the soil, plant and microbe complex to remove pollutants found in stormwater runoff. Infiltration rates at 100 inches per hour overcome the challenges of clogging and flooding while minimizing space requirements.

Mulch: Shredded hardwood mulch acts as a pre-treatment mechanism by preventing trash, sediments and particles from entering the system. Removal and replacement of mulch is necessary only every 6-12 months and is the only maintenance requirement for the entire system. Maintenance cycles may be extended with the implementation of upstream pretreatment.

Plants: Native Plants are best suited as they adjust well to periodic droughts and temperature extremes. The media contains 10% by volume peat moss. Over the years the decaying mulch, roots, fungi, bacteria and organic inputs from stormwater runoff add to the organic mix as it evolves as more natural soil strata. Soil moisture is maintained through the use of peat moss and mulch.

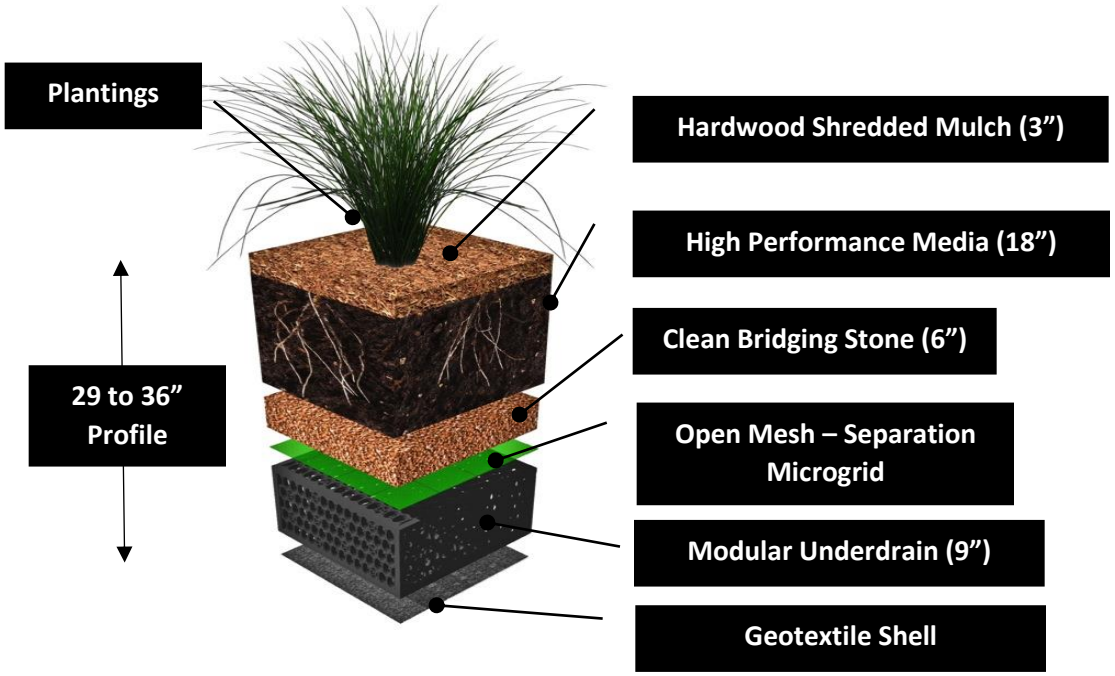


Figure 1. Cross section of a FocalPoint-HPMBS

While the most remarkable effect of the high-flow media in a FocalPoint HPMBS design is that it allows for a dramatically smaller footprint of the biofilter media bed, the surface storage option inherent in a conventional bioretention remains a design option. In this case the smaller biofilter bed is located within a simple, vegetated recession or swale without necessity for excavation, underdrain, special plantings or special maintenance beyond the small biofilter. Although the infiltration flow rate of the media bed is 100 inches per hour, the time frame associated with draining the surface pond, if this approach is utilized, is dependent not on the infiltration rate of subsurface soils as it would be with a conventional system, but on the size of the FocalPoint HPMBS biofilter, which can be adjusted according to allowable drain down time and factor of safety. These characteristics are the key to the economics,

maintainability and design flexibility of FocalPoint HPMBS and are not likely accomplished if the media is enclosed in a precast shell.

- Size: What volume is it designed to hold and/or treat? How is the system sized to meet the performance standards in order to handle the required water quality volume, rate of runoff, and types of storms? Standard 4 requires treatment for a required water quality volume, not for a specified design flow rate.
    - **The FocalPoint HPMBS is sized to treat the water quality volume (WQv) as determined by a qualified project engineer or local jurisdiction.**
    - **FocalPoint HPMBS sizing is iterative and site specific based on the available space above the unit for temporary storage of the water quality volume prior to overflow. For example, on a site with little available space for the water quality volume above the unit, the FocalPoint HPMBS may need to be increased in size to utilize the 100 inch/hr. infiltration rate to ensure the entire water quality volume passes through the unit. On the other hand, if a great wealth of space was available for the water quality volume to temporarily pond over the unit, the FocalPoint HPMBS could be incrementally reduced in size. A key design parameter is having the system draw down within 24-48 hours from the commencement of the storm.**
    - **ACF Environmental has developed a sizing calculator/tool (*ACF FP and RT Calculator)* to assist engineers and designers with the optimal sizing of the unit in all configurations and locations. The tool is a dynamic model that distributes the water quality volume and design storm with an SCS 24-hour rainfall event. The tool demonstrates how much volume is treated by the FocalPoint HPMBS and at what point in the storm the overflow device is activated. The system size can also be modeled and verified in a program such as HydroCAD or other model.**
    - **At a minimum, the filter bed area to impervious runoff area should be 0.40% (44 sq. ft of filter bed area to 10,890 s.q ft of impervious area) and the ponding volume above the practice equal to 20% of the WQV.**

- Technical description, schematic and process flow diagram: How does it work? What are the technical configurations of the unit? Are there any pretreatment requirements? How does it fit in combination with other treatment systems?
    - **Figure 1 below provides schematic and process flow diagram.**
    - **The system works according to the fundamentals of media bed\infitration bed design and is best described by the Darcy Equation which the area of the filter bed as a function of (WQv, filter bed depth, coefficient of permeability, average height of the water above the filter bed and drain down time of the filter bed).**
    - **The configuration is typically square or rectangular in shape. The minimum size FocalPoint HPMBS from a constructability standpoint is 20 SF and the minimum width should be 2 ft.**
    - **The system has a vertical profile of 3 ft (typical) from top of mulch to bottom of underdrain.**
    - **The ponding zone above the mulch can take on many different geometric shapes, the most common being trapezoidal bowl with a ponding depth of 6 to 18 inches.**

- **Pretreatment of runoff entering a FocalPoint HPMBS is recommended to trap coarse sediment particles before they reach and prematurely close the filter bed. Pretreatment measures must be designed to dissipate velocities and spread water out over a 2 to 4 ft width. Many pretreatment options are available and include manufactured systems like the Rain Guardian or non-propriety systems like stone aprons\diaphragms, grass filter stripes and level lip spreaders.**
- **The system integrates into Low Impact Development objectives and seeks to decentralize the management of stormwater. Conversely, and may also be used in a more centralized or end of pipe application if site condition dictate.**
- **The system can be configured either off-line or on-line and be used in combination with other treatment systems if required to meet the project specific treatment goals.**

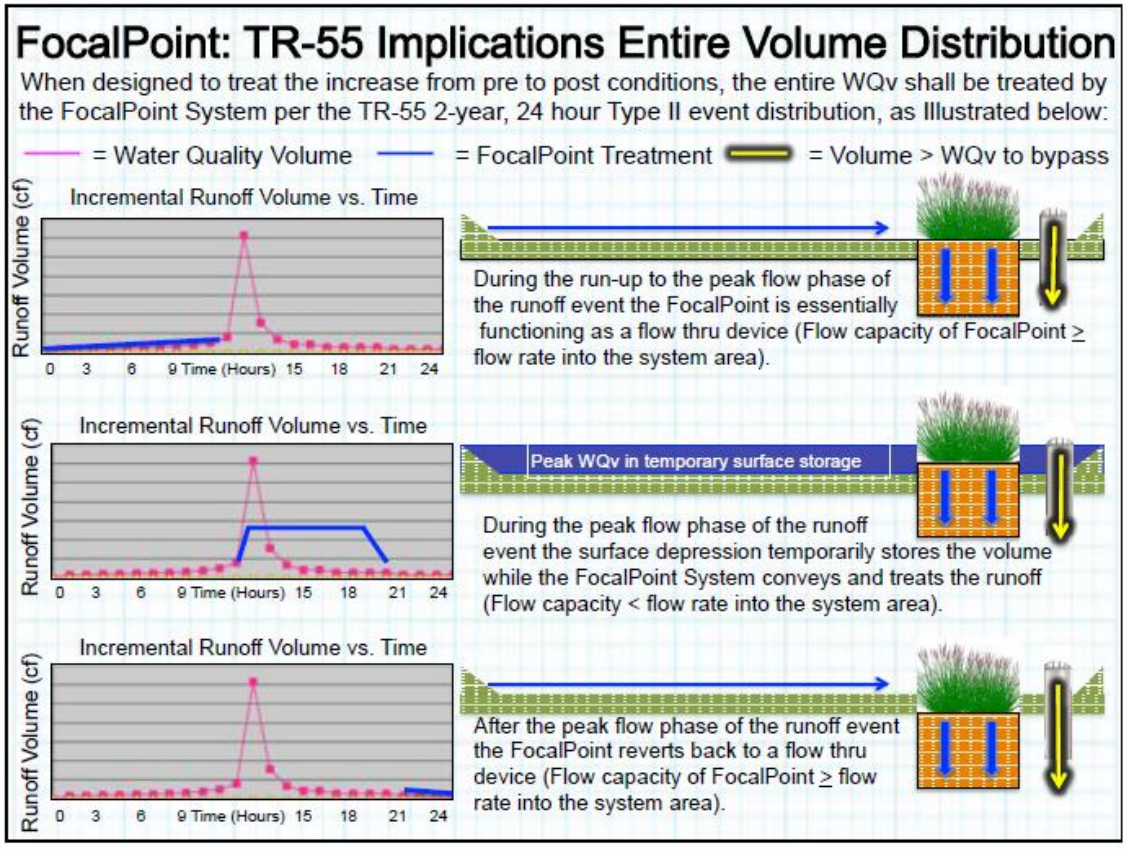


Figure 2. Cross section of a FocalPoint-HPMBS

- Capital costs and installation process and costs: What does this size system cost? Are there any consumable materials that need to be replaced and if so, how often and how much do they cost? How will the system be installed and who will supervise the installation to ensure that it is done properly? What mistakes can happen during installation? Is any special handling, installation techniques or equipment required?
  - **Capital costs are market driven and typically range from $125 to $185/SF of filter bed area. Installation cost range from $30 to $60/SF of filter bed area.**
  - **The system is installed with common utility\landscape equipment and labor.**

- **A jobsite superintendent or foreman is qualified to supervise installation as this is not different than a planter bed, bioretention or landscape feature.**
- **ACF Environmental has certified installers and is qualified to site supervise. We offer these services as part of our contract with the customer.**
- **No special handling is required.**
- **No special equipment is required**

- Potential disadvantages at this site: Any physical constraints? Weight or buoyancy issues? Durability issues? Energy requirements?
  - **The system should be separated from the water table to ensure that groundwater does not inundate the filter bed. A separation distance of 2 feet is recommended between bottom of excavated FocalPoint HPMBS area and the seasonally high ground water table.**

- Operation and maintenance (O&M) requirements and costs: New technologies will not have long-term data on O&M requirements, so it is particularly important that an applicant provide all available information for evaluation.
  - **We have installed over 1,000 systems across the United States and sufficient experience with O&M to feel confident our recommendation on maintenance frequency are sound.**
  - **All stormwater treatment systems require maintenance for effective operation. This necessity is often incorporated in your property's permitting process as a legally binding operation and maintenance agreement. Other reasons for maintenance include:**
    - **Avoid legal challenges from your jurisdiction's maintenance enforcement program.**
    - **Prolong the lifespan of your FocalPoint HPMBS.**
    - **Avoid costly repairs.**
    - **Help reduce pollutant loads leaving your property.**
  - **Simple maintenance of the FocalPoint HPMBS is required to continue effective pollutant removal from stormwater runoff before any discharge into downstream waters. This procedure will also extend the longevity of the living biofiltration system. The unit will recycle and accumulate pollutants within the biomass, but may also be subjected to other materials entering the surface of the system. This may include trash, silt and leaves etc. which will be contained above the mulch and/or biofiltration media layer. Too much silt may inhibit the FocalPoint's HPMBS flowrate, which is a primary reason for system maintenance. Removal of accumulated silt/sediment and/or replacement of the mulch layer (when specified), is an important activity that prevents over accumulation of such silt/sediment.**
  - **Convergent Water Technologies and/or its Value-Added Reseller (VAR) include a 1-year maintenance plan with each system purchased. Annual included maintenance consists of two (2) scheduled maintenance visits. Additional maintenance may be necessary depending on sediment and trash loading (by Owner or at additional cost). The start of the maintenance plan begins when the system is activated for full operation. Full operation is defined as when the**

site is appropriately stabilized, the unit is installed and activated (by VAR), i.e., when mulch (if specified) and plantings are added.

- **Activation should be avoided until the site is fully stabilized (full landscaping, grass cover, final paving and street sweeping completed). Maintenance visits are scheduled seasonally; the spring visit aims to clean up after winter loads including salts and sands. The fall visit helps the system by removing excessive leaf litter.**
- **It has been found that in regions which receive between 30-50 inches of annual rainfall, (2) two visits are generally required. Regions with less rainfall often only require (1) one visit per annum. Varying land uses can affect maintenance frequency.**
- **Some sites may be subjected to extreme sediment or trash loads, requiring more frequent maintenance visits. This is the reason for detailed notes of maintenance actions per unit, helping the VAR/Maintenance contractor and Owner predict future maintenance frequencies, reflecting individual site conditions. Owners must promptly notify the VAR/Maintenance contractor of any damage to the plant(s), which constitute(s) an integral part of the biofiltration technology. Owners should also advise other landscape or maintenance contractors to leave all maintenance of the FocalPoint HPMBS to the VAR/Maintenance contractor (i.e. no pruning or fertilizing).**

B. Data on how well the alternative technology works:

- Flow proportional sampling from laboratory testing and full-scale operations that is representative of the potential range of rainfall events (for example, a sufficient number of storms is generally at least 15) and located at sites similar to the conditions of the installation under review.
  - **A full scale FocalPoint HPMBS has been field monitoring to TAPE protocols as described Table 1 above and include flow weighted composite sample.**
  - **The system was installed in July of 2015 and has experienced 57 days with measurable precipitation. The total rainfall depth for the study period to date is 18.24 inches. Of the 57 wet weather events, there have been 12 qualified events as defined by TAPE.**

- Calculation of TSS removal rate should be presented. If there is a removal rating for a similar technology and use posted at http://www.mass.gov/dep/, and the proponent makes a claim for a higher TSS removal rate than for the similar system posted, the applicant must provide sufficient data to support the claim. Removal rates should show removal of various particle sizes across the full range of operating conditions including maximum, minimum and optimal conditions for reliable performance.
  - **Removal rates from the TAPE level field study are based in event mean concentrations, which characterize the operating rate conditions, influent\effluent TSS concentrations and particle sizes from the start to the end of the rainfall event.**
  - **Total Suspended Solids (TSS) removal of 86% as defined as the change in average event mean concentration (EMC) between the influent runoff and effluent runoff was observed. TSS influent EMCs ranges from 4.9 to 238 mg/L from the field test site. Hydraulic operating conditions for each storm event**

ranged from 7 to 157% of design capacity; thereby demonstrating performance across the full range of operating conditions.

- **Per TAPE protocol, particle size distribution (PSD) shall be determined by Method ASTM D3977. We have run this method for two events and determined the majority of material in the runoff are clays and silts (Method B) with the remainder being fine to coarse sand (below 250 microns). The corresponding influent TSS concentration for the 9/30/15 event was 26.6 mg/L and the portion associated with silts and clays (Method B) measured at 16 mg/L or mg/kg, for a percentage of 60%. The influent TSS concentration for the 10/9/15 event was 197 mg/L and the portion associated with silts and clays (Method B) was 161 mg/L or mg/kg, for a percentage of 82%.**

- **The MassSDEP requires 80% TSS removal for most permitted projects and the results from the TAPE field study confirm the we are able to meet and exceed this removal rate.**

- A copy of the site's operation and maintenance plan including operational details on any full-scale installations: e.g., locations, length of time in operation, maintenance logs (logs should record the dates of inspections and cleaning, actions performed, quantities of solids removed, and time required for work).
  - **Not applicable at this time.**

- Information on any system failures, what those failures were, and how were they corrected.
  - **The mechanisms of failure inherent with bioswales, bioretention, rain gardens are the same for FocalPoint.**
  - **The system includes a 1-yr guarantee on media infiltration rate along with the first year of maintenance as part of the upfront capital cost.**

- Copies of any articles from peer-reviewed, scientific or engineering journals.
  - ***Land and Water Magazine, Jan\Feb 2016 Issue, Lessons Learned from LID Based Roadway, Anthony Kendrick, Env SP.***

- Any approvals or permits from other authorities. **(See below)**

RECENT REGUALATORY APPROVALS:

New Hampshire Department of Environmental Protection (NHDES) Alteration of Terrain Bureau (AOT) has approved the FocalPoint\HPMBS system for stand-alone 80% treatment on the basis of our TAPE field testing data.

Maine Department of Environmental Protection (MEDEP) has approved the FocalPoint\HPMBS system for stand-alone treatment of TSS and Phosphorus.

VA DEQ – BMP Clearinghouse Approval for 50% Phosphorus (maximum allowable removal)

Virginia Department of Transportation (VDOT) Tree Box Filter Specification

- **The filtration media shall achieve a flow rate equal to a minimum of 100 inches per hour and verified via a third part report**

- **The unit shall remove 80% TSS using Sil-Co-Sill 106 typical particle size distribution in the laboratory. Field results should show at least 80% TSS removal following either TAPE or TARP testing protocols.**
- **The unit shall belocated to esnnure that high flow events shall bypass the filter media preventing erosion and resuspension of pollutants.**

Florida Department of Environmental Protection (FLDEP) included on the Accepted Technology List

Pennsylvania Department of Environmental Protection – approved as a stand alone treatment BMP for TP, TSS and TN.

District of Columbia – Department of Energy and Enviroment (DDOEE) - approved as a stand-alone bioretention practice consistent with Chapter 3.5 BMP Manual.

Missouri Department of Transportation – approved as an acceptable bioretention practice

Harris County, TX - Office of Public Infrastructure – approved as a stand alone BMP and is acceptabke fir LID method for green roadway, green street and green infrastructure. Generic FocalPoint-HPMBS details and specicaitons are available for download at the Harris County

- References along with contact information from other installations.

Town of Falmouth
Department of Public Works
271 Falmouth Rd
Falmouth, ME 04105
Mr. Jay Reynolds
207-699-5374

Harris County Government
Engineering Department
1001 Preston, 7th Floor
Houston, TX 77002
Mr. John Blount, P.E.
713-755-6888

City of Houston
Engineering Services Section
611 Walker St
Houston, TX 77002
Ms. Kathlie Jeng-Bullock, P.E.
832-395-2511

Sebago Technics
City of South Portland Engineer
75 John Roberts Rd, Suite 1A
South Portland, ME 04106
Mr. Dan Riley, P.E.
207-200-2100

Town of Kittery
Code Enforcement
200 Rogers Road
Kittery, ME 03904
Jessa Kellogg
207-475-1321

C. Operation and Maintenance (O&M) Plan:

- To ensure that the system will function as designed, all stormwater management systems must have a written operation and maintenance plan in accordance with Stormwater

Management Standard 9. MassDEP stresses the importance of routine maintenance for all stormwater control technologies. A number of alternative technologies perform very well, but only if they are installed and maintained as specified by the manufacturer. For example, some alternative wet vaults may be able to achieve a high TSS removal rate, but only if they are cleaned often enough to prevent re-entrainment of previously trapped sediment.

The O & M Plan shall **(see attached)**

1. Identify access points to all components of the stormwater system;

2. Specify equipment, personnel, and training needed to inspect and maintain system;

3. Include a list of any safety equipment and safety training required for personnel;

4. Set forth a suggested frequency of inspection and cleaning; and

5. Provide a sample inspection checklist and maintenance log.

Please refer to Standard 9 in the Stormwater Technical Handbook (Volume 1, Chapter 1 and Volume 2, Chapter 1) for further guidance about O&M.

BMP Performance Table

BMP Name: Infiltration Trench

Soil Infiltration Rate: 1.02 in/hr

Land Use	Pollutant	Depth of Runoff Treated (inches)							
		0.1	0.2	0.4	0.6	0.8	1.0	1.5	2.0
Commercial	TSS	44%	70%	93%	99%	100%	100%	100%	100%
	TP	26%	46%	72%	85%	92%	96%	99%	100%
	Zn	72%	94%	99%	100%	100%	100%	100%	100%
Industrial	TSS	45%	71%	94%	99%	100%	100%	100%	100%
	TP	27%	47%	73%	86%	92%	96%	99%	100%
	Zn	46%	76%	98%	99%	100%	100%	100%	100%
High-Density Residential	TSS	46%	72%	94%	99%	100%	100%	100%	100%
	TP	27%	47%	73%	86%	92%	96%	99%	100%
	Zn	54%	84%	98%	99%	100%	100%	100%	100%
Medium-Density Residential	TSS	55%	80%	97%	99%	100%	100%	100%	100%
	TP	27%	47%	72%	85%	91%	95%	98%	99%
	Zn	21%	40%	69%	86%	95%	99%	100%	100%
Low-Density Residential	TSS	51%	74%	93%	98%	99%	100%	100%	100%
	TP	28%	47%	71%	84%	90%	94%	98%	99%
	Zn	15%	32%	60%	79%	90%	96%	99%	100%
Runoff Volume Reduction		26%	45%	68%	81%	88%	92%	97%	98%

Annual Pollutant Loading Rates

Land use	Pollutant load (lbs/acre-year)		
	TSS	TP	Zn
Commercial	1117.77	1.66	2.33
Industrial	745.22	1.43	0.45
High-Density Residential	465.08	1.10	0.79
Medium-Density Residential	274.63	0.55	0.11
Low-Density Residential	72.11	0.042	0.043

**Page extracted from the Stormwater Best Management Practices (BMP) Performance Analysis. Revised March 2010.

Massachusetts Stormwater Standards

Standard 10 - Illicit Discharge Compliance Statement

Site Address:	91 Groton-Harvard Road, Ayer, MA
Owner:	North Atlantic Concrete
Applicant, if different:	Same as Owner
Plan Reference:	Commercial Development – 91 Groton-Havrard Road by Goldsmith, Prest & Ringwall, Inc. Dated March 2024.
DEP File Number:	N/A

As required by Standard 10 of the Massachusetts Stormwater Standards, I, the undersigned, being the Owner of the subject property do hereby certify that the stormwater system, as shown on the referenced plan, does not permit any illicit discharges to enter the stormwater management system. I also certify that the existing use of the property does not permit any illicit discharges.

Illicit discharges are discharges not associated with the following: stormwater; water from fire fighting; water line flushing or street washing; landscape watering and irrigation; uncontaminated groundwater; potable water; foundation or footing drains; air conditioning condensate; residential vehicle washing; residential non-detergent building cleaning water, de-chlorinated water from swimming pools; flows from riparian habitats or wetlands.

Further, I certify that the stormwater management system shown on the referenced plan will be maintained in accordance with the Operations and Maintenance Manual submitted with the Notice of Intent and approved by the Conservation Commission.

Signed: Limhuot Tiv

Print: Limhuot Tiv, GPR, Agent of Applicant — 3/19/2024

Owner or Authorized Applicant — Date

231083 - NAC

Fee Calculation

		Remarks
Site Plan Review		
Major Site Plan	$4,100.00	1,001-20,000 GSF: $3,000 + $100 for every additional 1,000 GSF over 1,000 [12,000SF]
Total	$4,100.00	Made Payable to Town of Ayer

Stormwater Review	$150.00	
Major Project	$625.00	$200 + ($0.005 per disturbed area) [85,000SF]
Total	$775.00	Made Payable to Town of Ayer