STORMWATER REPORT

HAGGETTS POND RAIL TRAIL
ANDOVER, MASSACHUSETTS

NOVEMBER 7, 2023

Applicant:

Town of Andover
36 Bartlet Street
Andover, Massachusetts, 01810

BSC Job Number: 8-9985.01

Prepared by:

BSC GROUP

300 Brickstone Square
Andover, MA 01810

TABLE OF CONTENTS

SECTION 1.0

Project Narrative

1.01 PROJECT DESCRIPTION

The Town of Andover, the "Applicant", is proposing to improve and provide accessibility to approximately 1.18 miles of existing rail trail between Lowell Street and High Plain Road in the Town of Andover. Additionally, the Town wishes to add a small accessible boardwalk spur for a look out over Haggetts Pond (the "Project"). The Project will include improvements to the existing parking areas on the south side of Haggetts Pond Road, and the creation of additional parking on the north side of Haggetts Pond Road as well as at High Plain Road. The proposed trail will comprise an 8-ft wide asphalt surface with a 3-ft wide stone dust walking shoulder on one side and 1-ft wide gravel shoulder on the other.

The proposed stormwater management system has been designed to comply with MassDEP's stormwater management standards that were incorporated into the Regulations on January 2, 2008 (see *310 CMR 10.05(6)(k)*). For footpaths, bike paths and other paths for pedestrian and/or nonmotorized vehicle access, the proposed activities are required to meet the stormwater management standards to the maximum extent practicable (*310 CMR 10.05(6)(m)6*.). The parking lot areas have been designed in full compliance with the Town of Andover and MassDEP Stormwater Standards.

1.02 PRE-DEVELOPMENT DRAINAGE CONDITIONS

The Haggetts Pond Rail Trail is proposed within the footprint of an abandoned railbed, existing parking areas, upland area, and existing paved roadways within the Town of Andover. As such, new impacts to adjacent resource areas will be minimal. Land use adjacent to the trail includes areas of residential development, and areas of mixed forest. The railbed transects several soil types from northeast to southwest, primarily including areas of Freetown muck, Hinckley loamy sand, Canton fine sandy loam, and Windsor loamy sand.

Along its route, the existing trail passes near a number of wetland resources. These include areas of Bordering Vegetated Wetland (BVW), intermittent streams, hydrologic connections, and Haggetts Pond. All stream and hydrologic connection crossings are via existing culverts and/or overland flow.

1.03 POST-DEVELOPMENT DRAINAGE CONDITIONS

The stormwater management system has been designed in accordance with the DEP Stormwater Handbook and the Town of Andover Stormwater Management & Erosion Control Bylaws as follows:

High Plain Road Runoff – Existing runoff from High Plain Road in the vicinity of the trail is collected in a catch basin on the north side of High Plain Road and discharges, untreated, via a 12" RCP culvert to the woodland adjacent to the onsite wetlands. The south side of High Plain Road sheet flows to the Project area untreated.

The Project proposes to collect this existing runoff and provide treatment per the Mass Stormwater Handbook to improve water quality associated with this runoff. The existing catch basin is proposed to discharge to a rip-rap forebay and bio-retention area prior to flowing overland to the adjacent wetlands. Additionally, the existing overland runoff flow will be captured in the same forebay and bio-retention area, or in two other bio-retention areas to be constructed. The proposed forebay and bio-retention areas will provide a minimum of 80% TSS removal for these existing offsite runoff flows to the Project area.

High Plain Road Parking Lot Runoff - The proposed High Plain Road Parking Lot is located just outside the Zone A Surface Drinking Water Zone and will be constructed as porous pavement per the MassDEP Stormwater

Standards providing a minimum of 80% TSS removal, reducing post-development peak stormwater runoff rates and providing groundwater recharge of the collected runoff.

Haggetts Pond Road Runoff – Existing runoff from Haggetts Pond Road in the vicinity of the trail is currently collected in a catch basin on the south side of Haggetts Pond Road and discharges, untreated, via a 12" RCP culvert to a drainage swale which leads directly to Haggetts Pond.

The Project proposes to collect the existing runoff and provide treatment per the Mass Stormwater Handbook to improve water quality associated with this runoff. The existing catch basin will be fitted with an outlet hood if one is not present, and will be inspected to verify a deep (4' minimum) sump is present. The structure is proposed to discharge to a rip-rap forebay and bio-retention area prior to flowing to Haggetts Pond. An up-to-date catch basin and properly sized forebay will provide the required 44% TSS removal pretreatment as this area is within the Zone A of Haggetts Pond. With adequate pretreatment, the proposed bio-retention area will provide a minimum of 80% TSS removal for runoff collected in the existing catch basin along Haggetts Pond Road.

Haggetts Pond North Parking Lot Runoff – The Haggetts Pond North Parking Lot (Pond side) is located in the Zone A Surface Drinking Water Zone and, per the Mass Stormwater Handbook, is not suitable for porous pavement. Stormwater will instead be collected in a proprietary water quality unit and discharged to a bio-retention pond. A minimum of 80% TSS removal will be achieved while reducing post-development peak stormwater runoff rates and providing groundwater recharge of the collected runoff.

Haggetts Pond South Parking Lot Runoff – The Haggetts Pond South Parking Lot is also located in the Zone A Surface Drinking Water Zone and, per the Mass Stormwater Handbook, is not suitable for porous pavement. Stormwater will be collected in a water quality unit and discharged to subsurface infiltration/ detention chambers under the parking area. The system has been designed to achieve a minimum of 80% TSS removal, reduce post-development peak stormwater runoff rates and provide groundwater recharge of the collected runoff.

Haggetts Pond Rail Trail Runoff – The proposed paved, gravel, and stone dust Shared-Use Path along the Rail Trail will overlay the existing impervious gravel railroad bed within the rail ROW. Stormwater will be managed from the rail trail by sheet-flow to the trail shoulders away from Haggetts Pond. The 1- and 3-ft wide stone shoulders will trap sediment and aid in infiltration, directing the water flow through the vegetative buffers for infiltration. The new surface is overlaid on the site of an existing compacted stabilized soil and gravel rail bed. Post development stormwater discharge from the trail will follow existing drainage conveyance patterns. The trail is designed to shed runoff to the trail shoulder and as such, is neither designed nor anticipated to shed significant runoff into any roads, wetlands, or Haggetts Pond directly.

The Project is not anticipated to increase pollutant loads. The rail trail will be used by pedestrians and bicyclists, which will not contribute contaminants to the path surface. Trash and dog waste stations will be provided at all parking lot locations. Other than emergency situations, motor vehicle access along the path will be limited to maintenance. In addition, the rail trail will not be plowed and/or treated in the winter. Therefore, there will be little to no contaminants on the path surface to be washed off by storm water runoff.

Once construction is complete, the site will be fully stabilized and, to the extent possible, revegetated with native vegetation.

Specifics of the proposed site stormwater management are as follows:

Standard 1 - New Stormwater Conveyances

Per Massachusetts Stormwater Management Standard #1, no new outfalls may discharge untreated stormwater directly to or cause erosion in wetlands or waters of the Commonwealth. Treatment is accomplished using appropriately sized forebays and bioretention areas, or properly designed porous pavement at all areas generating untreated stormwater. Riprap protection is provided at all discharge points, minimizing any erosion.

Standard 2 - Stormwater Runoff Rates

Watershed modeling was performed using HydroCAD Stormwater Modeling Software version 10.20, a computer aided design program that combines SCS runoff methodology with standard hydraulic calculations. A model of the site's hydrology was developed for both pre- and post-development conditions to assess the effects of the proposed improvements, and analyzed across the 2-yr, 10-yr, 25-yr, and 100-yr 24-hr storm events as provided in National Oceanic and Atmospheric Administration (NOAA) – National Weather Service "NOAA Atlas 14" and using curve number (CN) values as provided in Table 1 of the Andover Stormwater Management and Erosion Control Regulations.

The stormwater management system has been designed such that the post-development conditions for the parking lots result in a decrease in the peak offsite runoff rates for these paved areas subject to vehicular travel. Peak flow rates from each of the parking lot areas are tabularized below. Peak flow rates from the trail itself are allowed to meet this standard only to the maximum extent practicable. In an effort to limit disturbance to the sensitive resource areas that follow the trail closely, stormwater management and subsequent grading and clearing for trail runoff was omitted from the designs and model.

Table 1.1 – Peak Flow Rates Summary to 1R: Offsite East at High Plain Road

	Existing Conditions (cfs)	Proposed Improvements (cfs)	Peak Runoff Decrease (cfs)
2-year Peak Runoff	0.5	0.0	-0.5
10-year Peak Runoff	1.3	0.3	-1.0
25-year Peak Runoff	1.9	0.6	-1.3
100-year Peak Runoff	2.8	1.1	-1.7

Table 1.2 – Peak Flow Rates Summary to 1R: Offsite East at Haggetts Pond Road

	Existing Conditions (cfs)	Proposed Improvements (cfs)	Peak Runoff Decrease (cfs)
2-year Peak Runoff	0.0	0.0	0.0
10-year Peak Runoff	0.1	0.0	-0.1
25-year Peak Runoff	0.2	0.0	-0.2
100-year Peak Runoff	0.5	0.5	0.0

Standard 3 - Groundwater Recharge

The existing ground water recharge is estimated based on the Massachusetts Stormwater Management Standards #3, as follows:

Rv = F x impervious area

Rv = *Required Recharge Volume*, expressed in Ft^3, cubic yards, or acre-feet
F = Target Depth Factor associated with each Hydrologic Soil Group
Impervious Area = pavement

NRCS HYDROLOGIC SOIL GROUP	APPROX. SOIL TEXTURE	TARGET DEPTH FACTOR (F)
A	sand	**0.6-inch**
B	loam	**0.35-inch**
C	silty loam	**0.25-inch**
D	clay	**0.1-inch**

Table: Recharge Target Depth by Hydrologic Soil Group (HSG)

The Natural Resources Conservation Service (NRCS) classified the majority of the Project site as HSG-A soils with small pockets of B-type and C-type soils, as shown in the attached soil report included in the Appendix. A Certified DEP (Department of Environmental Protection) Soil Evaluator performed six deep-hole test pits on September 26, 2023, confirming these NRCS classifications largely as in-situ fine sand and determining depths to seasonal high groundwater (see Appendix).

Based on the above, the following table summarizes the prescribed stormwater runoff volume required to be recharged to the groundwater based on the existing site soil conditions determined from current soils maps of

the area along with onsite soil evaluations performed by a Certified Massachusetts Soil Evaluator for the site;

Hydrologic Group	Proposed Impervious Area	Recharge Required	Total Prescribed Stormwater Runoff Volume to Recharge
A	0.311 ac; 13,544 sf	0.60 inches	0.016 acre-feet; 677 cubic feet
B	0 acres	0.35 inches	0 acre-feet
C	0.345 acres; 15,040 sf	0.25 inches	0.007 acre-feet; 313 cubic feet
D	0 acres	0.10 inches	0 acre-feet
Totals	**0.656 acres; 28,584 sf**	**-**	**0.023 acre-feet, 990 cubic feet**

Roughly 93% (26,631 s.f.) of the total impervious area onsite (28,584 s.f.) is discharging to the proposed infiltration BMPs. This ratio satisfies the 65% minimum requirement of this standard and is used to adjust the required recharge volume accordingly.

Recharge Volume Required (Adjusted)
= 990 c.f. * $\frac{28,584 \text{ s.f.}}{26,631 \text{ s.f.}}$
= **1,063 c.f**.

To meet/exceed the prescribed stormwater runoff volume to be recharged to the groundwater, the Project proposes the construction of a new porous pavement parking lot and new bio-retention areas treating all vehicular traveled ways prior to infiltration. These have been sized per the *Static* Method as outlined in the Massachusetts Stormwater Handbook, using the storage volumes of each system below their lowest inverts out. See Section 5 of this Report for HydroCAD printouts of these systems' storge tables.

Static Method – Total proposed storage (recharge) volume below lowest outlets:

Infiltration BMP	Recharge Volume	(Lowest outlet elevation)
- Pond 1P:	666 c.f.	(EL.131.65)
- Pond 3P:	8,275 c.f.	(EL.135.33)
- Pond 4P:	833 c.f.	(EL.125.00)
- Pond 6P:	1,313 c.f.	(EL.130.00)
	11,087 c.f.	

Total Recharge Volume Provided: **11,087 c.f.** (>1,063 c.f. required)

Draw Down Calculation

$$Time_{drawdown} = \frac{Rv}{(K)(Bottom\ Area)}$$

Where:
Rv = Storage Volume
K = Saturated Hydraulic Conductivity For "Static" and "Simple Dynamic" Methods, use Rawls Rate (see Table 2.3.3)(converted to ft/hr)
Bottom Area = Bottom Area of Recharge Structure

Table 2.3.3: 1982 Rawls Rates (Rawls, Brakensiek and Saxton, 1982_

Texture Class	NRCS Hydrologic Soil Group (HSG)	Infiltration Rate Inches/Hour
Sand	A	8.27
Loamy Sand	**A**	**2.41**
Sandy Loam	B	1.02
Loam	B	0.52
Silt Loam	C	0.27
Sandy Clay Loam	C	0.17
Clay Loam	D	0.09
Silty Clay Loam	D	0.06
Sandy Clay	D	0.05
Silty Clay	D	0.04
Clay	D	0.02

Draw Down Times (per infiltration BMP)

Infiltration BMP	Recharge Volume R_v	Sat. Hydraulic Conductivity K	System Bottom Area	Draw Down Time (72hrs max.)
Pond 1P	666 c.f.	2.41 in/hr (0.20 ft/hr)	174 s.f.	**19.1 hr.**
Pond 3P	8,275 c.f.	2.41 in/hr (0.20 ft/hr)	10,344 s.f.	**4.0 hr.**
Pond 4P	833 c.f.	2.41 in/hr (0.20 ft/hr)	643 s.f.	**6.5 hr.**
Pond 6P	1,313 c.f.	2.41 in/hr (0.20 ft/hr)	2,313 s.f.	**2.8 hr.**

Standard 4 - Water Quality

The proposed stormwater management system has been designed to provide treatment for stormwater runoff from all new paved vehicular areas, as well as any existing paved vehicular areas shedding onto the Project site. Treatment is achieved by bioretention areas and porous pavement where applicable, with pretreatment being provided by deep sump hooded catch basins, sediment forebays, and proprietary water quality units wherever BMPs are within applicable sensitive resource areas. These BMPs will satisfy the removal of a minimum 80% total suspended solids (TSS) to meet the Massachusetts Stormwater Handbook Standard #4, and the more stringent 90% minimum TSS removal as required by the Andover Stormwater Management and Erosion Control Regulations.

Water Quality Units (WQU) are one of the proposed treatment BMPs, and sizing calculations are included in Sections 6.02 and 6.03 of this report. These sizing calculations were performed using the Water Quality flow rate as outlined in the *2013 MA DEP Standard Method to Convert Required Water Quality Volume to a Discharge Rate for Sizing Flow Based Manufactured Proprietary Stormwater Treatment Systems* (2013 MADEP Q Rate).

To calculate the water quality flow rate, a water quality volume must first be calculated.

WQV = (WQD/12 inches/foot) * (A_{IMP})

WQV = *Required Water Quality Volume* (in cubic feet)
WQD = Water Quality Depth: **1-inch**. (Requirement of the Town stormwater regulations)
A_{IMP} = Impervious Area (in square feet)

WQU-1 at 4S – Haggetts Pond North Parking:

WQV = (1.0 in. / 12 inches/ft) * (2,020 s.f.)

= **168 c.f.**

WQU-2 at 6S – Haggetts Pond South Parking:

WQV = (1.0 in. / 12 inches/ft) * (5,197 s.f.)

= **433 c.f.**

Water Quality Flow Rates for the corresponding WQUs are then calculated using the equation below. Complete sizing calculations can be found in Section 6.2 and 6.3 of this Report, with full TSS removal tables at each distinct treatment train found in Section 6.4.

$WQF = (q_u)(A)(WQD)$

WQF = Water Quality Flow Rate for first 1.0-inch of runoff (in cubic feet per second)
q_u = unit peak discharge (in csm/in*, see 2013 MADEP Q Rate for T_c=0.1 hours)
A = Impervious Area (in square miles)
WQD = Water Quality Depth: **1.0** inches

*csm/in: cubic feet per second per square mile per watershed inch

The Town Stormwater Regulations also require proposed drainage systems' ability to remove 60% of the phosphorus load from the total post-construction impervious area on the site. The Massachusetts MS4 General Permit, Attachment 3 to Appendix F, contains tables and figures displaying the predicted long-term phosphorus load reduction of a given various common stormwater infiltration BMP's and given soil infiltration rates. These tables were used in calculating the expected phosphorus load removal performance of the proposed drainage system.

The two methods for stormwater infiltration in the Project are through porous pavement and through bio-retention areas. The MA MS4 General Permit lists porous pavement (with subsurface infiltration) as a type of "infiltration trench" and bio-retention areas (no underdrains) as a type of "infiltration basin." Soil types shown in the included Soil Test Pit Logs are predominantly sand in the areas of infiltration, which have an allowable infiltration rate of 2.41 in/hr per the Stormwater Management Handbook. The MA MS4 General Permit Tables 3-8 and 3-14 included with this Report lists cumulative phosphorus load reduction percentages as a function of treated runoff depth from impervious areas given the Project BMP (infiltration trench or basin, respectively) and infiltration rate (2.41 in/hr). A weighted average of treated runoff depth across the entire Project's impervious area is calculated below.

Total proposed impervious area:		**28,584 s.f.**
-	Infiltrated impervious area:	26,631 s.f.
-	Other impervious area:	1,953 s.f.
Total proposed infiltration (recharge) volume:		**11,087 c.f.** (volume below lowest outlet)

Treated depth: **11,087 c.f. / 26,631 s.f.** **= 0.416 ft.** **= 5.0 in.**

Untreated depth: **0 c.f. / 1,953 s.f.** **= 0 ft.** **= 0 in.**

Weighted average depth: $\frac{(26{,}631 * 5.0) + (1{,}953 * 0)}{28{,}584}$ = **4.66 in.**

A treated runoff depth of 4.66 inches, given the applicable BMPs and infiltration rates, yields an expected cumulative phosphorus load reduction of 100% under both BMP conditions, satisfying the Town requirement of 60%.

The proposed stormwater management system has been designed to meet the Massachusetts Stormwater Handbook Standard #4 and the Town stormwater regulations for the removal of Total Suspended Solids (TSS) and phosphorus. Refer to Section 6 and the Appendix of this Report for supporting calculations.

Standard 5 – Land Uses With Higher Potential Pollutant Loads (LUHPPL)

The Project is not considered a land use with higher potential pollutant loads.

Standard 6 – Stormwater Discharges to a Critical Area

The Project is within a Zone A Outstanding Resource Water (ORW) and is subject to Standard 6. In order to satisfy the source control requirements of this Standard, the Long Term Pollution Prevention & Operation and Maintenance Plan found in Section 4 of this Report outlines constraints on the storage and use of road salts and deicing chemicals within the Project. To satisfy the pollution prevention requirements of this Standard, all existing paved vehicular areas within the ORW shedding to the Project site will be pretreated with water quality units or deep sump hooded catch basins and sediment forebays in order to achieve at least 44% TSS removal prior to discharging to an exfiltrating bioretention area.

Standard 7 – Redevelopment Projects

This project is not classified as a redevelopment project and all standards are met fully.

Standard 8 – Sedimentation and Erosion Control Plan

Erosion & Sediment Control Plans are included within the plan set as Sheets ESC-100 – ESC-101 along with a narrative in Section 3.0 of this Report.

Standard 9 – Long Term Operation and Maintenance Plan

A long-term operation and maintenance plan is included in Section 4.0 of this Report

Standard 10 –Illicit Discharges to the Stormwater Management System are Prohibited

There are no known illicit discharges to the proposed Stormwater Management System, and none are proposed.

Conclusions

The Project has been designed to meet, and in some cases exceed, the applicable provisions of the State and Town Stormwater Management Standards. With the provisions of deep sump hooded catch basins, sediment forebays and infiltrating bioretention areas, and porous pavement, along with nonstructural BMPs such as road salt/deicing chemical controls and snow storage requirements, the proposed Project has been designed to reduce the impacts to the surrounding Resource Areas and properties.

SECTION 2.0

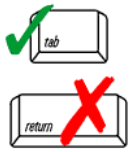
MASSACHUSETTS DEPARTMENT OF ENVIRONMENTAL PROTECTION CHECKLIST FOR STORMWATER REPORT

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

Checklist for Stormwater Report

A. Introduction

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



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

The Stormwater Report must include:

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

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

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

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

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

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

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

Checklist for Stormwater Report

B. Stormwater Checklist and Certification

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

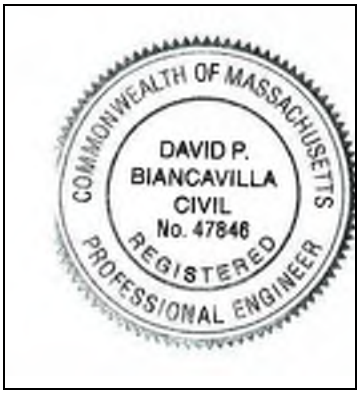
Note: Because stormwater requirements vary from project to project, it is possible that a complete Stormwater Report may not include information on some of the subjects specified in the Checklist. If it is determined that a specific item does not apply to the project under review, please note that the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

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

Registered Professional Engineer's Certification

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

Registered Professional Engineer Block and Signature



11/07/2023
Signature and Date

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

Checklist for Stormwater Report

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

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): _____

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

Checklist for Stormwater Report

Checklist **(continued)**

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.

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]

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

☐ 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

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

Checklist for Stormwater Report

Checklist **(continued)**

Standard 3: Recharge (continued)

- ☐ 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.

☐ 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)

Checklist for Stormwater Report

Checklist (continued)

Standard 4: Water Quality (continued)

☐ 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.

☐ 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.

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

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.

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

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 3.0

CONSTRUCTION PERIOD POLLUTION PREVENTION AND EROSION AND SEDIMENTATION CONTROL PLAN (STORM WATER POLLUTION PREVENTION PLAN - SWPPP)

CONSTRUCTION PERIOD POLLUTION PREVENTION AND EROSION AND SEDIMENTATION CONTROL PLAN
(STORM WATER POLLUTION PREVENTION PLAN - SWPPP)

This Section specifies requirements and suggestions for implementation of a Storm Water Pollution Prevention Plan (SWPPP) for the Project in Andover, Massachusetts.

The storm water pollution prevention measures contained in this SWPPP shall be at least the minimum required by Local Regulations. While filing of a Notice of Intent for protection under the National Pollution Discharge Elimination System (NPDES) for this Construction ais not required, the Contractor shall provide additional measures to prevent pollution from stormwater discharges in compliance with the NPDES Phase II permit requirements and all other local, state and federal requirements. A NPDES for the Industrial activities is active for the site use and shall be maintained and followed as part of this project. A copy can be provided upon request.

The Contractor shall NOT begin construction without submitting evidence that a NPDES Notice of Intent (NOI) governing the discharge of storm water from the construction site for the entire construction period has been filed at least seven days prior to construction. It is the Contractor's responsibility to complete and file the NOI.

The cost of any fines, construction delays and remedial actions resulting from the Contractor's failure to comply with all provisions of local regulations and Federal NPDES permit requirements shall be paid for by the Contractor at no additional cost to the Owner.

As a requirement of the EPA's NPDES permitting program, each Contractor and Subcontractor responsible for implementing and maintaining stormwater Best Management Practices shall execute a Contractor's Certification form.

The SWPPP shall include provisions for, but not be limited to, the following:

1. Construction Trailers
2. Lay-down Areas
3. Equipment Storage Areas
4. Stockpile Areas
5. Disturbed Areas

1.0 Erosion and Sedimentation Control

The Contractor shall be solely responsible for erosion and sedimentation control at the site. The Contractor shall utilize a system of operations and all necessary erosion and sedimentation control measures, even if not specified herein or elsewhere, to minimize erosion damage at the site to prevent the migration of sediment into environmentally sensitive areas. Environmentally sensitive areas include all wetland resource areas within, and downstream of, the site, and those areas of the site that are not being altered.

Erosion and sedimentation control shall be in accordance with this Section, the design drawings, and the following:

- "Storm Water Management for Construction Activities, Developing Pollution Prevention Plans and Best Management Practices" (EPA 832-R92-005, Sept. 1992).
- "Storm Water Management for Construction Activities, Developing Pollution Prevention Plans and Best Management Practices – Summary Guidance" (EPA 833-R92-001, Oct. 1992).
- Massachusetts Stormwater Management Policy Handbook (Volume I) and Technical Handbook (Volume II) issued by the Massachusetts Department of Environmental Protection, March 1997.
- Massachusetts Erosion and Sediment Control Guidelines for Urban and Suburban Areas, A Guide for Planners, Designers and Municipal Officials, March 1997.

The BMP's presented herein should be used as a guide for erosion and sedimentation control and are not intended to

be considered specifications for construction. The most important BMP is maintaining a rapid construction process, resulting in prompt stabilization of surfaces, thereby reducing erosion potential. Given the primacy of rapid construction, these guidelines have been designed to allow construction to progress with essentially no hindrance by the erosion control methods prescribed. These guidelines have also been designed with sufficient flexibility to allow the contractor to modify the suggested methods as required to suit seasonal, atmospheric, and site-specific physical constraints.

Another important BMP is the prevention of concentrated water flow. Sheet flow does not have the erosive potential of a concentrated rivulet. These guidelines recommend construction methods that allow localized erosion control and a system of construction, which inhibits the development of shallow concentrated flow. These BMP's shall be maintained throughout the construction process.

2.0 CONTACT INFORMATION AND RESPONSIBLE PARTIES

The following is a list of all project-associated parties:

Owner/Applicant
Town of Andover
Andover, Massachusetts, 01810
Phone: TBD

Contact: To Be Determined During Construction

Contractor
To Be Determined

Environmental Consultant
BSC Group
300 Brickstone Square
Andover, MA 01810

Contact: David Biancavilla, PE
Phone: (617) 896 – 4347
Email: dbiancavilla@bscgroup.com

3.0 Procedural Conditions of the Construction General Permit (CGP)

The following list outlines the Storm Water responsibilities for all construction operators working on the Project. The operators below agree through a cooperative agreement to abide by the following conditions throughout the duration of the construction project, effective the date of signature of the required SWPPP. These conditions apply to all operators on the project site.

4.0 Project Description and Intended Construction Sequence

The applicant is planning to make parking and trail improvements to the proposed project site.

Soil disturbing activities will include site demolition, installing stabilized construction exits, installation of erosion and sedimentation controls, grading, storm drain inlets, construction of trailways and parking lots and preparation for final seeding, mulching and landscaping. Please refer to Table 1 for the projects anticipated construction timetable. A description of BMP's associated with project timetable and construction-phasing elements is provided in section 4.2 of this SWPPP.

Table 1 – Anticipated Construction Timetable

Construction Phasing Activity	Anticipated Timetable
Demolition, Grubbing and Stripping of Limits of Construction Phase	To be determined
Rough Site Grading and Site Utilities	To be determined
Trail	To be determined
Parking	To be determined
Landscaping	To be determined
Final Clean-up	To be determined

5.0 Potential Sources of Pollution

Any project site activities that have the potential to add pollutants to runoff are subject to the requirements of this sample SWPPP. Listed below is a description of potential sources of pollution from both sedimentation to Storm Water runoff, and pollutants from sources other than sedimentation.

Table 2 – Potential Sources of Sediment to Storm Water Runoff

Potential Source	Activities/Comments
Construction Site Entrance and Site Vehicles	Vehicles leaving the site can track soils onto public roadways. Site Vehicles can readily transport exposed soils throughout the site and off-site areas.
Grading Operations	Exposed soils have the potential for erosion and discharge of sediment to off-site areas.
Material Excavation, Relocation, and Stockpiling	Stockpiling of materials during excavation and relocation of soils can contribute to erosion and sedimentation. In addition, fugitive dust from stockpiled material, vehicle transport and site grading can be deposited in wetlands and waterway.
Landscaping Operations	Landscaping operations specifically associated with exposed soils can contribute to erosion and sedimentation. Hydroseeding if not properly applied can runoff to adjacent wetlands and waterways.

Table 4 – Potential Pollutants and Sources, other than Sediment to** Storm Water **Runoff

Potential Source	Activities/Comments
Staging Areas and Construction Vehicles	Vehicle refueling, minor equipment maintenance, sanitary facilities and hazardous waste storage
Materials Storage Area	General building materials, solvents, adhesives, paving materials, paints, aggregates, trash, etc.
Construction Activities	Construction, paving, curb/gutter installation, concrete pouring/mortar/stucco

6.0 Erosion and Sedimentation Control Best Management Practices

The project site is characterized by primarily impervious surface. All construction activities will implement Best Management Practices (BMP's) in order to minimize overall site disturbance and impacts to the sites natural features. Please refer to the following sections for a detailed description of site-specific BMP's. In addition, an Erosion and Sedimentation Control Plan is provided in the Site Plans.

7.0 Timetable and Construction Phasing

This section provides the Owner and Contractor with a suggested order of construction that shall minimize erosion and the transport of sediments. The individual objectives of the construction techniques described herein shall be considered an integral component of the project design intent of each project phase. The construction sequence is not

intended to prescribe definitive construction methods and should not be interpreted as a construction specification document. However, the Contractor shall follow the general construction phase principles provided below:

- Protect and maintain existing vegetation wherever possible.
- Minimize the area of disturbance.
- To the extent possible, route unpolluted flows around disturbed areas.
- Install mitigation devices as early as possible.
- Minimize the time disturbed areas are left unstabilized.
- Maintain siltation control devices in proper condition.
- The contractor should use the suggested sequence and techniques as a general guide and modify the suggested methods and procedures as required to best suit seasonal, atmospheric, and site-specific physical constraints for the purpose of minimizing the environmental impact of construction.

Demolition, Grubbing and Stripping of Limits of Construction Phase

- Install TEC devices as required to prevent sediment transport into resource areas.
- Place a ring of silt socks and/or hay bales around stockpiles.
- Stabilize all exposed surfaces that will not be under immediate construction.
- Store and/or dispose all pavement and building demolition debris as indicated in accordance with all applicable local, state, and federal regulations.

Parking/Trail Areas Sub-base Construction

- Install temporary culverts and diversion ditches and additional TEC devices as required by individual construction area constraints to direct potential runoff toward detention areas designated for the current construction phase.
- Compact gravel as work progresses to control erosion potential.
- Apply water to control air suspension of dust.
- Avoid creating an erosive condition due to over-watering.
- Install piped utility systems as required as work progresses, keeping all inlets sealed until all downstream drainage system components are functional.

Binder Construction

- Fine grade gravel base and install processed gravel to the design grades.
- Compact pavement base as work progresses.
- Install pavement binder coat starting from the downhill end of the site and work toward the top.

Finish Paving

- Repair and stabilize damaged side slopes.
- Clean inverts of drainage structures.
- Install final top coat of pavement.

Final Clean-up

- Clean inverts of culverts and catch basins.
- Remove sediment and debris form rip-rap outlet areas.
- Remove TEC devices only after permanent vegetation and erosion control has been fully established.

8.0 Site Stabilization

Grubbing Stripping and Grading

- Erosion control devices shall be in place as shown on the design plans before grading commences.

- Stripping shall be done in a manner, which will not concentrate runoff. If precipitation is expected, earthen berms shall be constructed around the area being stripped, with a silt sock, silt fence or hay bale dike situated in an arc at the low point of the berm.
- If intense precipitation is anticipated, silt socks, hay bales, dikes and /or silt fences shall be used as required to prevent erosion and sediment transport. The materials required shall be stored on site at all time.
- If water is required for soil compaction, it shall be added in a uniform manner that does not allow excess water to flow off the area being compacted.
- Dust shall be held at a minimum by sprinkling exposed soil with an appropriate amount of water.

Maintenance of Disturbed Surfaces

- Runoff shall be diverted from disturbed side slopes in both cut and fill.
- Mulching may be used for temporary stabilization.
- Silt sock, hay bale or silt fences shall be set where required to trap products of erosion and shall be maintained on a continuing basis during the construction process.

Loaming and Seeding

- Loam shall not be placed unless it is to be seeded directly thereafter.
- All disturbed areas shall have a minimum of 4" of loam placed before seeded and mulched.
- Consideration shall be given to hydro-mulching, especially on slopes in excess of 3 to 1.
- Loamed and seeded slopes shall be protected from washout by mulching or other acceptable slope protection until vegetation begins to grow.

Storm Water Collection System Installation

- The Storm Water drainage system shall be installed from the downstream end up and in a manner which will not allow runoff from disturbed areas to enter pipes.
- Excavation for the drainage system shall not be left open when rainfall is expected overnight. If left open under other circumstances, pipe ends shall be closed by a staked board or by an equivalent method.
- All catch basin openings shall be covered by a silt bag between the grate and the frame or protected from sediment by silt fence surrounding the catch basin grate.

Completion of Paved Areas

- During the placement of sub-base and pavement, the entrance to the Storm Water drainage systems shall be sealed when rain is expected. When these entrances are closed, consideration must be given to the direction of run-off and measures shall be undertaken to minimize erosion and to provide for the collection of sediment.
- In some situations it may be necessary to keep catch basins open.
- Appropriate arrangements shall be made downstream to remove all sediment deposition.

Stabilization of Surfaces

- Stabilization of surfaces includes the placement of pavement, rip-rap, wood bark mulch and the establishment of vegetated surfaces.
- Upon completion of construction, all surfaces shall be stabilized even though it is apparent that future construction efforts will cause their disturbance.
- Vegetated cover shall be established during the proper growing season and shall be enhanced by soil adjustment for proper pH, nutrients and moisture content.
- Surfaces that are disturbed by erosion processes or vandalism shall be stabilized as soon as possible.
- Areas where construction activities have permanently or temporarily ceased shall be stabilized within 14 days from the last construction activity, except when construction activity will resume within 21 days (e.g., the total time period that construction activity is temporarily ceased is less than 21 days).

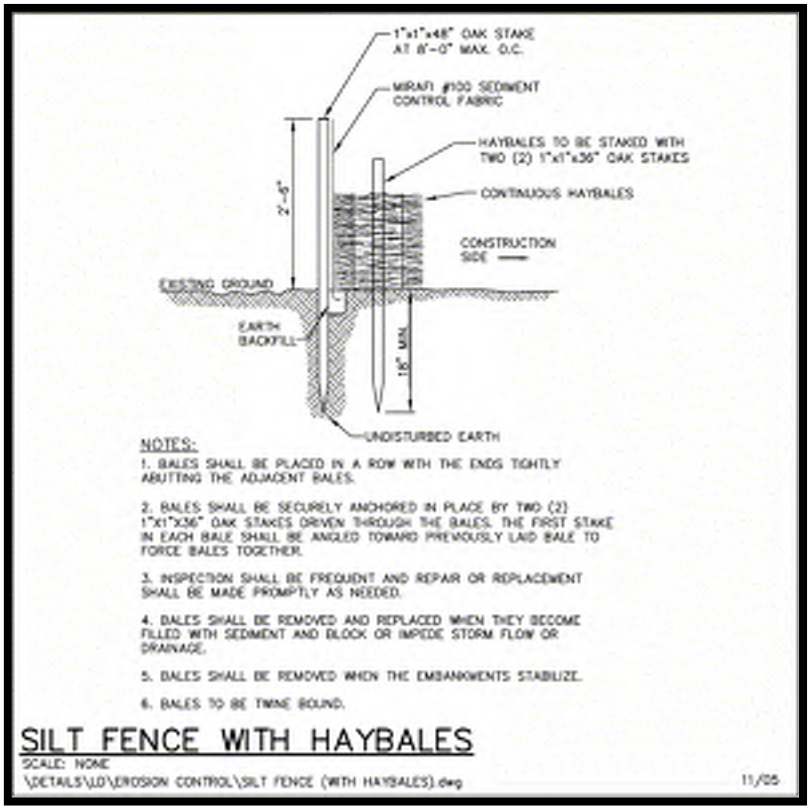
- Hydro-mulching of grass surfaces is recommended, especially if seeding of the surfaces is required outside the normal growing season.
- Hay mulch is an effective method of temporarily stabilizing surfaces, but only if it is properly secured by branches, weighted snow fences or weighted chicken wire.

9.0 Temporary Structural Erosion Control Measures

Temporary erosion control measures serve to minimize construction-associated impacts to wetland resource and undisturbed areas. Please refer to the following sections for a description of temporary erosion control measures implemented as part of the project and this sample SWPPP.

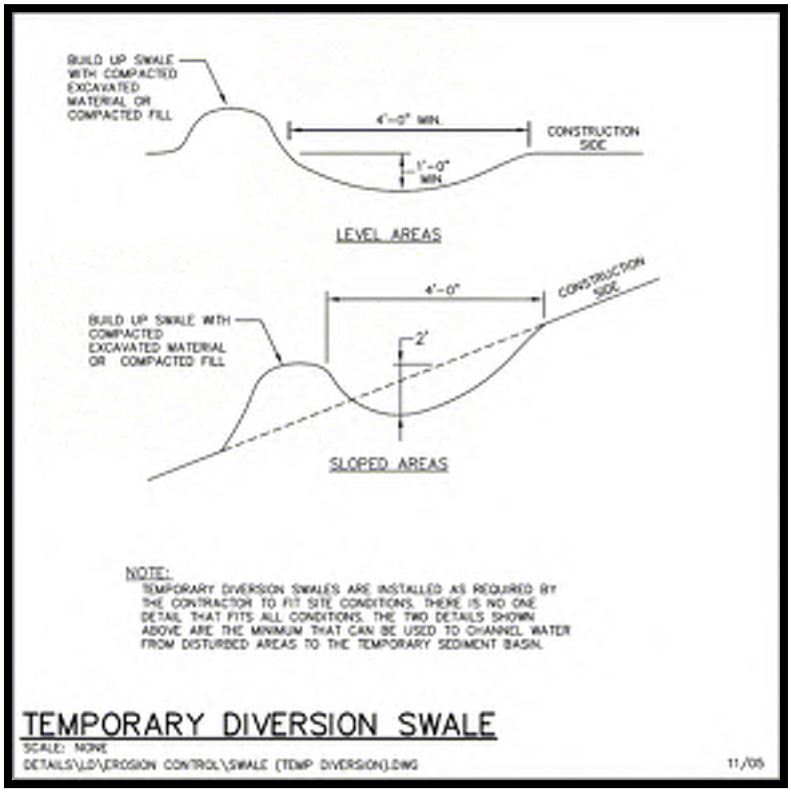
9.01 Silt Socks, Haybales, and Silt Fencing

Siltation barriers composed of silt socks and double-staked hay bales and trenched silt fence will be installed within the 100-foot buffer zone along the upland side of delineated wetland resources. The siltation barriers will demarcate the limit of work, form a work envelope and provide additional assurance that construction equipment will not enter the adjacent wetlands or undisturbed portions of the site. All barriers will remain in place until disturbed areas are stabilized.



9.02 Temporary Storm Water Diversion Swale

A temporary diversion swale is an effective practice for temporarily diverting Storm Water flows and to reduce Storm Water runoff velocities during storm events. The swale channel can be installed before infrastructure construction begins at the site, or as needed throughout the construction process. The diversion swale should be routinely compacted or seeded to minimize the amount of exposed soil.



9.03 Material Stockpiling Locations

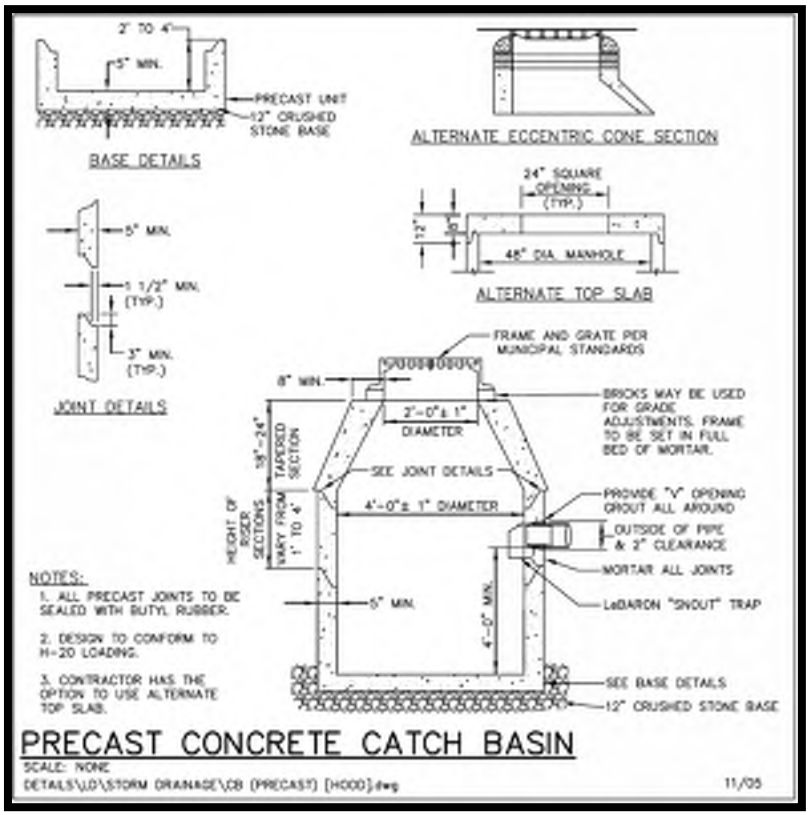
There will be no storage of soil, gravel or construction debris within the 100-foot buffer zone to wetland resource areas. It is anticipated that all excavated material will be placed in a dump truck and stockpiled outside the 100-foot buffer zone during construction activities. Piping and trench excavate associated with the subsurface utility work will be contained with a single row of silt socks and/or hay bales.

10.0 Permanent Structural Erosion Control Measures

Permanent erosion control measures serve to minimize post-construction impacts to wetland resource areas and undisturbed areas. Please refer to the following sections for a description of permanent erosion control measures implemented as part of the project and this SWPPP.

10.01 Catch Basins and Trench Drains with Deep Sumps and Hooded Traps

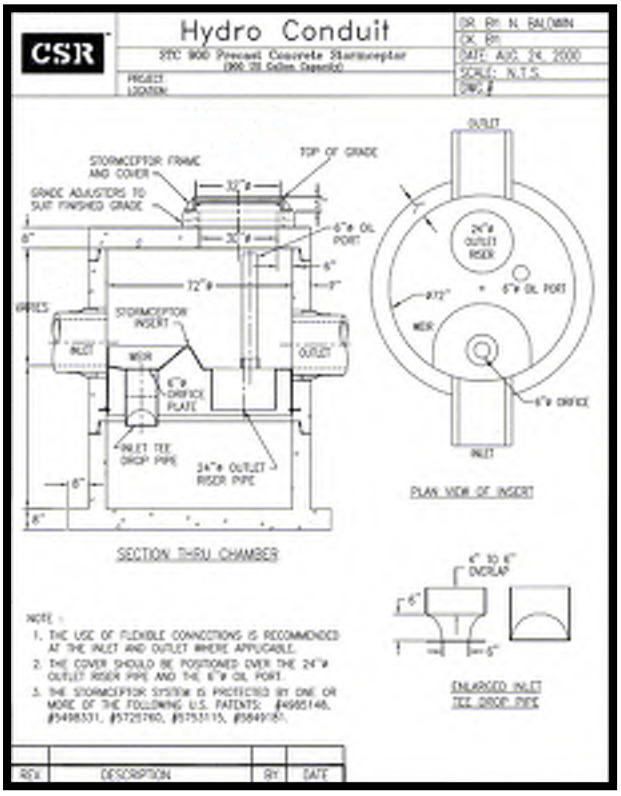
Parking lots will be bermed (or curbed) and provided with catch basins to collect runoff. The entire drainage system for each respective project phase will be installed during the initial phases of construction. The collection system will be installed from the downstream end up, and in a manner which will not allow runoff from disturbed areas to enter the pipes.
The catch basins will be inspected and cleaned as necessary (sediment depth of 12") at least two times per year. The optimum time for cleaning is during the period just after the snowmelt of late winter and prior to the onset of heavy spring precipitation. All sediments and hydrocarbons will be properly handled and disposed of in accordance with local state and federal guidelines and regulations.



10.02 Stormceptor® Water Quality Units

The Stormceptor water quality structure will require periodic inspection and cleaning to maintain operation and function. Owners should have these units inspected on a quarterly basis and after periods of intense precipitation. Inspection of the Stormceptor unit can be done by using a clear Plexiglas tube (sludge judge) to extract a water column sample. When sediment depth exceeds 12 inches then cleaning of the unit is required. These water quality structures will be checked and cleaned after petroleum spills. The appropriate regulatory agencies (Department of Environmental Protection, and the Environmental Protection Agency) should immediately be contacted following a petroleum spill.

Maintenance of Stormceptor units should be done by a vacuum truck that will remove water, sediment, debris, floating hydrocarbons and other materials in the unit. The proper cleaning and disposal of the removed materials and liquid must be followed. Inlet and outlet pipes must also be checked for any obstructions. Structural parts of the Stormceptor units shall be repaired as necessary.



11.0 Good Housekeeping Best Management Practices

11.01 Material Handling and Waste Management

Solid waste generation during the construction period will be primarily construction debris. The debris will include scrap lumber (used forming and shoring pallets and other shipping containers), waste packaging materials (plastic sheeting and cardboard), scrap cable and wire, roll-off containers (or dumpsters) and will be removed by a contract hauler to a properly licensed landfill. The roll-off containers will be covered with a properly secured tarp before the hauler exists the site. In addition to construction debris, the construction work force will generate some amount of household-type wastes (food packing, soft drink containers, and other paper). Trash containers for these wastes will be located around the site and will be emptied regularly so as to prevent wind-blown litter. This waste will also be removed by a contract hauler.

All hazardous waste material such as oil filters, petroleum products, paint and equipment maintenance fluids will be stored in structurally sound and sealed shipping containers in the hazardous-materials storage area and segregated from other non-waste materials. Secondary containment will be provided for all materials in the hazardous materials storage area and will consist of commercially available spill pallets. Additionally, all hazardous materials will be disposed of in accordance with federal, state and municipal regulations.

Two temporary sanitary facilities (portable toilets) will be provided at the site in the combined staging area. The toilets will be away from a concentrated flow path and traffic flow and will have collection pans underneath as secondary treatment. All sanitary waste will be collected from an approved party at a minimum of three times per week.

11.02 Building Material Staging Areas

Construction equipment and maintenance materials will be stored at the combined staging area and materials storage areas. Silt fence will be installed around the perimeter to designate the staging and materials storage area. A watertight shipping container will be used to store hand tools, small parts and other construction materials.

Non-hazardous building materials such as packaging material (wood, plastic and glass) and construction scrap material (brick, wood, steel, metal scraps, and pine cuttings) will be stored in a separate covered storage facility adjacent other stored materials. All hazardous-waste materials such as oil filters, petroleum products, paint and equipment maintenance fluids will be stored in structurally sound and sealed containers under cover within the hazardous materials storage area.

Large items such as framing materials and stockpiled lumber will be stored in the open storage area. Such materials will be elevated on wood blocks to minimize contact with runoff.

The combined storage areas are expected to remain clean, well organized and equipped with ample cleaning supplies as appropriate for the materials being stored. Perimeter controls such as containment structures, covers and liners will be repaired or replaced as necessary to maintain proper function.

11.03 Designated Washout Areas

Designated temporary, below-ground concrete washout areas will be constructed, as required, to minimize the pollution potential associated with concrete, paint, stucco, mixers etc. Signs will, if required, be posted marking the location of the washout area to ensure that concrete equipment operators use the proper facility. Concrete pours will not be conducted during or before an anticipated precipitation event. All excess concrete and concrete washout slurries from the concrete mixer trucks and chutes will be discharged to the washout area or hauled off-site for disposal.

11.04 Equipment/Vehicle Maintenance and Fueling Areas

Several types of vehicles and equipment will be used on-site throughout the project including graders, scrapers, excavators, loaders, paving equipment, rollers, trucks and trailers, backhoes and forklifts. All major equipment/vehicle fueling and maintenance will be performed off-site. A small, 20-gallon pickup bed fuel tank will be kept on-site in the combined staging area. When vehicle fueling must occur on-site, the fueling activity will occur in the staging area. Only minor equipment maintenance will occur on-site. All equipment fluids generated from maintenance activities will be disposed of into designated drums stored on spill pallets. Absorbent, spill-cleanup materials and spill kits will be available at the combined staging and materials storage area. Drip pans will be placed under all equipment receiving maintenance and vehicles and equipment parked overnight.

11.05 Equipment/Vehicle Wash down Area

All equipment and vehicle washing will be performed off-site.

11.06 Spill Prevention Plan

A spill containment kit will be kept on-site in the Contractors trailer and/or the designated staging area throughout the duration of construction. Should there be an accidental release of petroleum product into a wetland (or within 100-feet of a wetland), the appropriate agencies will be immediately notified.

12.0 Inspections

Maintenance of existing and proposed BMP's to address Storm Water management facilities during construction is an on-going process. The purpose of the inspections is to observe all sources of Storm Water or non-Storm Water discharge as identified in the SWPPP as well as the status of the receiving waters and fulfill the requirements of the Order of Conditions. The following sections describe the appropriate inspection measures to adequately implement the projects SWPPP. A blank inspection form is provided at the end of this section. Completed inspection forms are to be maintained on site.

12.01 Inspection Personnel

The owners appointed representative will be responsible for performing regular inspections of erosion controls and ordering repairs as necessary.

12.02 Inspection Frequency

Inspections will be performed by qualified personnel once every 7 days and within 24-hours after a storm event of greater than one-half inch, in accordance with the CGP or if required by the OOC. The inspections must be documented on the inspection form provided at the end of this section, and completed forms will be provided to the on-site supervisor and maintained at the Owners office throughout the entire duration of construction.

12.03 Inspection Reporting

Each inspection report will summarize the scope of the inspection, name(s) and qualifications of personnel making the inspection, and major observations relating to the implementation of the SWPPP, including compliance and non-compliance items. Completed inspection reports will remain with the completed SWPPP on site.

SWPPP INSPECTION AND MAINTENANCE REPORT

Haggetts Pond Rail Trail
Andover, Massachusetts

TO BE COMPLETED AT LEAST EVERY 7 DAYS AND WITHIN 24 HOURS OF A STORM EVENT OF AT LEAST 0.5 INCHES. AFTER SITE STABILIZATION, TO BE COMPLETED AT LEAST ONCE PER MONTH FOR THREE YEARS OR UNTIL A NOTICE OF TERMINATION IS FILED.

INSPECTOR NAME /TITLE: _____ **DATE:** _____
START/END TIME:_____

Type of Inspection
☐ **Regular** ☐ **Pre-storm event** ☐ **During storm event** ☐ **Post-storm event (inches_____)**

Construction Activities: _____
_____
_____
_____

Weather at Time of Inspection: _____
_____

Has it rained since the last inspection?
☐Yes ☐No

If yes, provide:
Storm Start Date & Time:_____ **Storm Duration (hrs):**_____ **Approximate Rainfall (in):**_____

Do you suspect that discharges may have occurred since the last inspection?
☐Yes ☐No

Are there any discharges at the time of inspection?
☐Yes ☐No

BMP Description	In Conformance	Effective	Notes
Construction Entrance	☐Yes ☐ No ☐ NA	☐Yes ☐ No ☐ NA	
Haybales and Silt Fencing	☐Yes ☐ No ☐ NA	☐Yes ☐ No ☐ NA	
Storage/Disposal Areas	☐Yes ☐ No ☐ NA	☐Yes ☐ No ☐ NA	
Subsurface Infiltration System	☐Yes ☐ No ☐ NA	☐Yes ☐ No ☐ NA	
Catch Basins	☐Yes ☐ No ☐ NA	☐Yes ☐ No ☐ NA	
Other	☐Yes ☐ No ☐ NA	☐Yes ☐ No	
Other	☐Yes ☐ No ☐ NA	☐Yes ☐ No ☐ NA	

SITE STABILIZATION STATUS:

BMP/Activity	Implemented	Maintained	Status/Actions Required
All Slopes and disturbed areas not actively being worked properly stabilized?	☐Yes ☐ No	☐Yes ☐ No	

Are natural resource areas e.g., stream, wetlands, mature trees, etc.) protected with barriers or similar BMP's?	☐Yes ☐ No	☐Yes ☐ No	
Are perimeter controls and sediment barriers adequately installed and maintained?	☐Yes ☐ No	☐Yes ☐ No	
Are discharge points and receiving waters free of sediment deposits?	☐Yes ☐ No	☐Yes ☐ No	
Are Storm drain inlets properly protected?	☐Yes ☐ No	☐Yes ☐ No	
Is there evidence of sediment being tracked into the street?	☐Yes ☐ No	☐Yes ☐ No	
Is trash/littler from work areas collected and placed in covered dumpsters?	☐Yes ☐ No	☐Yes ☐ No	
Are washout facilities available, clearly marked, and maintained?	☐Yes ☐ No	☐Yes ☐ No	
Are vehicle and equipment fueling, cleaning and maintenance areas free of spills, leaks or any other deleterious material?	☐Yes ☐ No	☐Yes ☐ No	
Are materials that are potential stormwater contaminants stored inside or under cover?	☐Yes ☐ No	☐Yes ☐ No	
Are non-stormwater discharges (e.g., wash water, dewatering) properly controlled?	☐Yes ☐ No	☐Yes ☐ No	
Other - specify:	☐Yes ☐ No	☐Yes ☐ No	
Other - specify:	☐Yes ☐ No	☐Yes ☐ No	

ADDITIONAL OBSERVATIONS: _____

NEXT INSPECTON
TO BE PERFORMED BY: _____ **ON OR BEFORE:** _____

Certification statement:
"I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gathered and evaluated the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations."

Print name: _____

Signature: _____ Date:_____

SECTION 4.0

LONG-TERM POLLUTION PREVENTION & OPERATION AND MAINTENANCE PLAN

LONG-TERM POLLUTION PREVENTION PLAN

As required by Standard 4 of the Massachusetts Stormwater Handbook, this Long-Term Pollution Prevention Plan has been developed for source control and pollution prevention at the site after construction.

MAINTENANCE RESPONSIBILITY

The enforcement of the Long-Term Operation and Maintenance Plan will be the responsibility of the Owner, the Town of Andover, Massachusetts.

GOOD HOUSEKEEPING PRACTICES

The site is to be kept clean of trash and debris at all times. Trash, junk, etc. is not to be left outside and will be subject to removal at the owner's expense.

VEHICLE WASHING CONTROLS

The following BMP's, or equivalent measures, methods or practices are required if you are engaged in vehicle washing and/or steam cleaning:

It is allowable to rinse down the body or a vehicle, including the bed of a truck, with just water without doing any wash water control BMP's.

If you wash (with mild detergents) on an area that infiltrates water, such as gravel, grass, or loose soil, it is acceptable to let the wash water infiltrate as long as you only wash the body of vehicles.

However, if you wash on a paved area and use detergents or other cleansers, or if you wash/rinse the engine compartment or the underside of vehicles, you must take the vehicles to a commercial vehicle wash.

REQUIREMENTS FOR ROUTINE INSPECTIONS AND MAINTENANCE OF STORMWATER BEST MANAGEMENT PRACTICES

All stormwater Best Management Practices (BMP's) are to be inspected and maintain as follows:

Stormceptor® Water Quality Inlets

The Stormceptor® water quality structure will require periodic inspection and cleaning to maintain operation and function. Owners should have these units inspected on a quarterly basis and after periods of intense precipitation. Inspections of the Stormceptor® unit can be done by using a clear Plexiglas tube ("sludge judge") to extract a water column sample. When sediment depths exceed 12" then cleaning of the unit is required.
These water quality structures must and will be checked and cleaned immediately after petroleum spills; contact appropriate regulatory agencies

Maintenance of these units should be done by a vacuum truck that will remove the water, sediment, debris, floating hydrocarbons and other materials in unit. The proper cleaning and disposal of the removed materials and liquid must be followed.

Inlet and outlet pipes must be checked for any obstructions and if any obstructions are found, they must be removed. Structural parts of the Stormceptor® will be repaired as needed.

Existing Catch Basins

Regular maintenance is essential. Deep sump catch basins remain effective at removing pollutants only if they are cleaned out frequently. Inspect or clean deep sump basins at least four times per year and at the end of the foliage and snow removal seasons. Sediments must also be removed four times per year or whenever the depth of the deposits in the catch basin sump is greater than or equal to one half the depth form the bottom of the invert of the lowest pipe in the basin.

Pipe Outlet Protection

The outlet protection should be checked at least annually and after every major storm. If the riprap has been displaced, undermined or damaged, it should be repaired immediately. The channel immediately below the outlet should be checked to see that erosion is not occurring. The downstream channel should be kept clear of obstructions such as fallen trees, debris, and sediment that could change flow patterns and/or tailwater depths on the pipes. Repairs must be carried out immediately to avoid additional damage to the outlet protection apron.

Proprietary Separators

Inspect and clean these units in strict accordance with manufacturers' recommendations and requirements. Clean the units using the method specified by the manufacturer. Vactor trucks are typically used to clean these units. Clamshell buckets typically used for cleaning catch basins are almost never allowed by manufacturers. Sometimes it will be necessary to remove sediment manually.

Sediment Forebays

Sediments and associated pollutants are removed only when sediment forebays are actually cleaned out, so regular maintenance is essential. Frequently removing accumulated sediments will make it less likely that sediments will be resuspended. At a minimum, inspect sediment forebays monthly and clean them out at least four times per year. Stabilize the floor and sidewalls of the sediment forebay before making it operational, otherwise the practice will discharge excess amounts of suspended sediments.

When mowing grasses, keep the grass height no greater than 6 inches. Set mower blades no lower than 3 to 4 inches. Check for signs of rilling and gullying and repair as needed. After removing the sediment, replace any vegetation damaged during the clean-out by either reseeding or resodding. When reseeding, incorporate practices such as hydroseeding with a tackifier, blanket, or similar practice to ensure that no scour occurs in the forebay, while the seeds germinate and develop roots.

Bioretention Areas

Premature failure of bioretention areas is a significant issue caused by lack of regular maintenance. Ensuring long-term maintenance involves sustained public education and deed restrictions or covenants for privately owned cells. Bioretention areas require careful attention while plants are being established and seasonal landscaping maintenance thereafter.

In many cases, a landscaping contractor working elsewhere on the site can complete maintenance tasks. Inspect pretreatment devices and bioretention cells regularly for sediment build-up, structural damage, and standing water.

Inspect soil and repair eroded areas monthly. Re-mulch void areas as needed. Remove litter and debris monthly. Treat diseased vegetation as needed. Remove and replace dead vegetation twice per year (spring and fall).

Proper selection of plant species and support during establishment of vegetation should minimize—if not eliminate—the need for fertilizers and pesticides. Remove invasive species as needed to prevent these species from spreading into the bioretention area. Replace mulch every two years, in the early spring. Upon failure, excavate bioretention area, scarify bottom and sides, replace filter fabric and soil, replant, and mulch. A summary of maintenance activities can be found on the following table:

Bioretention Maintenance Schedule

Activity	Time of Year	Frequency
Inspect & remove trash	Year round	Monthly
Mulch	Spring	Annually
Remove dead vegetation	Fall or Spring	Annually
Replace dead vegetation	Spring	Annually
Prune	Spring or Fall	Annually
Replace entire media & all vegetation	Late Spring/early Summer	*as needed

Because the soil medium filters contaminants from runoff, the cation exchange capacity of the soil media will eventually be exhausted. When the cation exchange capacity of the soil media decreases, change the soil media to prevent contaminants from migrating to the groundwater, or from being discharged via an underdrain outlet. Using small shrubs and plants instead of larger trees will make it easier to replace the media with clean material when needed.

Plant maintenance is critical. Concentrated salts in roadway runoff may kill plants, necessitating removal of dead vegetation each spring and replanting. The operation and maintenance plan must include measures to make sure the plants are maintained. This is particularly true in residential subdivisions, where the operation and maintenance plan may assign each homeowner the legal responsibility to maintain a bioretention cell or rain garden on his or her property. Including the requirement in the property deed for new subdivisions may alert residential property owners to their legal responsibilities regarding the bioretention cells constructed on their lot.

Drainage Channels

The maintenance and inspection schedule should take into consideration the effectiveness of the drainage channel. Inspect drainage channels the first few months after construction to make sure that there is no rilling or gullying, and that vegetation in the channels is adequate. Thereafter, inspect the channel twice a year for slope integrity, soil moisture, vegetative health, soil stability, soil compaction, soil erosion, ponding, and sediment accumulation.

Regular maintenance tasks include mowing, fertilizing, liming, watering, pruning, weeding, and pest control. Mow channels at least once per year. Do not cut the grass shorter than three to four inches. Keep grass height under 6 inches to maintain the design depth necessary to serve as a conveyance. Do not mow excessively, because it may increase the design flow velocity.

Remove sediment and debris manually at least once per year. Re-seed periodically to maintain the dense growth of grass vegetation. Take care to protect drainage channels from snow removal procedures and off-street parking. When drainage channels are located on private residential property, the operation and maintenance plan must clearly specify the private property owner who is responsible for carrying out the required maintenance. If the operation and maintenance plan calls for maintenance of drainage channels on private properties to be performed by a public entity or an association (e.g. homeowners association), maintenance easements must be obtained.

Porous Pavement

In most porous pavement designs, the pavement itself acts as pretreatment to the stone reservoir below. Consequently, frequent cleaning and maintenance of the pavement surface is critical to prevent clogging. To keep the surface clean, frequent vacuum sweeping along with jet washing of asphalt and concrete pavement is required. No winter sanding shall be conducted on the porous surface. As discussed, designs that include an "overflow edge" provide a backup in case the surface clogs. If the surface clogs, stormwater will flow over the surface and into the trench, where some infiltration and treatment will occur. For proper maintenance:

• Post signs identifying porous pavement areas.
• Minimize salt use during winter months. If drinking water sources are located nearby (see setbacks), porous pavements may not be allowed.
• No winter sanding is allowed.
• Keep landscaped areas well maintained to prevent soil from being transported onto the pavement.
• Clean the surface using vacuum sweeping machines monthly. For paving stones, periodically add joint material (sand) to replace material that has been transported.
• Regularly monitor the paving surface to make sure it drains properly after storms.
• Never reseal or repave with impermeable materials.
• Inspect the surface annually for deterioration or spalling.
• Periodically reseed grass pavers to fill in bare spots.
• Attach rollers to the bottoms of snowplows to prevent them from catching on the edges of grass pavers and some paving stones.

Subsurface Infiltration Chamber Systems

Subsurface Infiltration Chamber Systems perform an important role, as they provide 80% TSS removal at the end of the treatment train system. Maintenance is required for the proper operation of the Subsurface Infiltration Systems The use of pretreatment BMPs such as deep-sump hooded catch basins will minimize failure and maintenance requirements.

After construction, the infiltration system should be inspected after every major storm for the first few months to ensure proper stabilization. Water levels in the access ports should be recorded over several days to check the drainage of the systems. It is recommended that a logbook be maintained showing the depth of water in the systems at each observation in order to determine the rate at which the system dewaters after runoff producing storm events. Once the performance characteristics of the system have been verified, the monitoring schedule can be reduced to an annual basis, unless the performance data suggests that a more frequent schedule is required.

Preventive maintenance on the systems should be performed at least twice a year, and sediment should be removed from any, and all pretreatment and collection structures. Sediment should be removed when deposits approach within six inches of the invert heights of connecting pipes, or in sumped inlet structures.

The system is designed with access covers such that a vacuum truck tube that can be used to remove sediment.

SNOW DISPOSAL AND PLOWING PLANS

Snow removal and disposal is not anticipated for the proposed trail or parking areas.

WINTER ROAD SALT AND/OR SAND USE AND STORAGE RESTRICTIONS

Road salt and sand is prohibited from being stored onsite.

STREET SWEEPING SCHEDULES

Effective sweeping requires access to the areas to be swept. It is essential that applicants or those responsible for stormwater maintenance have the ability to impose parking regulations to facilitate proper sweeping, particularly in densely populated or heavily traveled areas, so that sweepers can get as close to curbs as possible. Residents are to be notified prior to street sweeping operations so that paved areas can be clear of vehicles and any other items.

There are three types of sweepers: Mechanical, Regenerative Air, and Vacuum Filter. Each has a different ability to remove TSS.

1) Mechanical: Mechanical sweepers use brooms or rotary brushes to scour the pavement. Although most of the sweepers currently in use in Massachusetts are mechanical sweepers, they are not effective at removing TSS (from 0% to 20% removal). Mechanical sweepers are especially ineffective at picking up fine particles ("fines") (less than 100 microns).
2) Regenerative Air: These sweepers blow air onto the road or parking lot surface, causing fines to rise where they are vacuumed. Regenerative air sweepers may blow fines off the vacuumed portion of the roadway or parking lot, where they contaminate stormwater when it rains.
3) Vacuum filter: These sweepers remove fines along roads. Two general types of vacuum filter sweepers are available - wet and dry. The dry type uses a broom in combination with the vacuum. The wet type uses water for dust suppression. Research indicates vacuum sweepers are highly effective in removing TSS. The best ones (in terms of pollutant removal efficiencies) typically cost about $240,000 to $310,000.

Regardless of the type chosen, the efficiency of street sweeping is increased when sweepers are operated in tandem. The following table summarizes the frequency of the site street sweeping based on the type of sweeper used.

Reuse and Disposal of Street Sweepings

Once removed from paved surfaces, the sweeping must be handled and disposed of properly. MassDEP's Bureau of Waste Prevention has issued a written policy regarding the reuse and disposal of street sweepings. These sweepings are regulated as a solid waste, and can be used in three ways:

- In one of the ways already approved by MassDEP (e.g., daily cover in a landfill, additive to compost, fill in a public way)
- If approved under a Beneficial Use Determination
- Disposed in a landfill

TRAINING OF STAFF OR PERSONNEL INVOLVED WITH IMPLEMENTING LONG-TERM POLLUTION PREVENTION PLAN

The Long-Term Pollution Prevention Plan is to be implemented by property owner of the site. Trained and, if required, licensed Professionals are to be hired by the owner as applicable to implement the Long-Term Pollution Prevention Plan.

LIST OF EMERGENCY CONTACTS FOR IMPLEMENTING LONG-TERM POLLUTION PREVENTION PLAN

The Owner along with the Lease holder will be required to maintain an updated list of Emergency Contacts for the site.

OPERATION AND MAINTENANCE PLAN

A Stormwater Pollution Prevention Plan (SWPPP) has been designed for the construction and operation of the proposed development (see previous section). The SWPPP provides Best Management Practices (BMP's) that include temporary erosion control devices and a permanent stormwater management system. The erosion control devices will serve to minimize construction impacts to wetland resource areas, and impacts to undisturbed areas. The stormwater management system is designed to minimize impacts to wetland areas and to maintain compliance with Massachusetts Surface Water Quality Standards during the operation of the proposed development.

Maintenance Responsibility

Enactment of the Operation and Maintenance Plan will be the responsibility of the Applicant.

The following is a list of temporary and permanent structural erosion control devices that are included within the Stormwater Pollution Prevention Plan:

Temporary:
- silt fence
- silt fence w/ haybale support
- earth dikes for stormwater diversion
- storm drain inlet protection
- hay bale check dams

Permanent:
- street sweeping (no credit claimed)
- Catch basins and Trench Drains with hoods and deep sumps
- Stormceptor® Water Quality Units
- Subsurface Inflitration/detention
- Pipe Outlet Protection

The temporary measures will be installed prior to any construction. They will be removed only after slopes are fully stabilized with permanent vegetation and erosion control has been fully established. The permanent measures, such as the bio-retention area, will be put into operation upon the completion of the system construction. The following is a brief description of the installation, operation, and maintenance of the BMP's.

All erosion control and drainage structures on site will be the responsibility of the owner to maintain.

Haybales, Silt Fences, and Other Temporary Measures

The temporary erosion control measures will be installed up gradient of any wetland resource area where any disturbance or alteration might otherwise allow for erosion or sedimentation. They will be regularly inspected to ensure that they are functioning adequately. Additional supplies of these temporary measures will be stockpiled on site for any immediate needs or routine replacement. Accumulated sediment shall be removed when it reaches a depth of half the height of the TEC measure or one foot, which ever is less.

Street Sweeping

Street sweeping of parking lots, driveways and streets will occur following the winter snowmelt and during the late spring, summer, and early fall months to ensure that sand and litter is removed from the catchment area and does not enter into the stormwater collection system. There will be a minimum of four street sweepings per year.

Construction Entrance

Stone used for the construction entrance should be large enough so that it does not get picked up and tracked off of the site by the vehicle traffic. Sharp edged stone should not be used to avoid puncturing tires. Additional stone may have to be added to maintain effectiveness.

If vehicles will be turning onto paved road or drive from the stabilized construction entrance, then an apron should be provided so that vehicles do not go off of the stabilized construction entrance before they leave the site.

The temporary construction entrance may be provided with a vehicle wash rack which drains to a temporary sediment trap or other sediment removing measure. This will allow vehicle tires to be washed prior to leaving the site and ensure that wash water sediments are removed and can be properly disposed of.

Catch basins and Trench Drains

Roadways and parking lots will be bermed (or curbed) and provided with catch basins to collect runoff. The entire drainage system for the project will be installed during the initial phases of construction. The collection system will be installed from the downstream end up, and in a manner, which will not allow runoff from disturbed areas to enter the pipes.

The catch basins will be inspected and cleaned as necessary (sediment depth of 12") at least two times per year. The optimum time for cleaning is during the period just after the snowmelt of late winter and prior to the onset of heavy spring rains. All sediments and hydrocarbons will be properly handled and disposed of, in accordance with local, state and federal guidelines and regulations.

Stormceptor® Water Quality Inlets

The Stormceptor® water quality structure will require periodic inspection and cleaning to maintain operation and function. Owners should have these units inspected on a quarterly basis and after periods of intense precipitation. Inspections of the Stormceptor® unit can be done by using a clear Plexiglas tube ("sludge judge") to extract a water column sample. When sediment depths exceed 12" then cleaning of the unit is required. These water quality structures must and will be checked and cleaned immediately after petroleum spills; contact appropriate regulatory agencies

Maintenance of these units should be done by a vacuum truck that will remove the water, sediment, debris, floating hydrocarbons and other materials in unit. The proper cleaning and disposal of the removed materials and liquid must be followed.

Inlet and outlet pipes must be checked for any obstructions and if any obstructions are found, they must be removed. Structural parts of the Stormceptor® will be repaired as needed.

Pipe Outlet Protection

The outlet protection should be checked at least annually and after every major storm. If the riprap has been displaced, undermined or damaged, it should be repaired immediately. The channel immediately below the outlet should be checked to see that erosion is not occurring. The downstream channel should be kept clear of obstructions such as fallen trees, debris, and sediment that could change flow patterns and/or tailwater depths on the pipes. Repairs must be carried out immediately to avoid additional damage to the outlet protection apron.

Detention/Infiltration Systems

Maintenance is required for the proper operation of the underground infiltration systems. Infiltration systems are prone to failure due to clogging if the upstream water quality units are not maintained. The use of pretreatment BMPs will minimize failure and maintenance requirements.

After construction, the infiltration systems should be inspected after every major storm for the first few months to ensure proper stabilization and function. Water levels in the access ports should be recorded over several days to check the drainage of the systems. It is recommended that a log book be maintained showing the depth of water in the detention/infiltration systems at each observation in order to determine the rate at which the system dewaters after

runoff producing storm events. Once the performance characteristics of the detention/infiltration have been verified, the monitoring schedule can be reduced to an annual basis, unless the performance data suggests that a more frequent schedule is required.

Preventive maintenance on the infiltration systems should be performed at least twice a year, and sediment should be removed from any and all pretreatment and collection structures. Sediment should be removed when deposits approach within six inches of the invert heights of connecting pipes between unit rows, or in sumped inlet structures. Ponded water inside the systems (as visible from the access ports) after several days most likely indicates that the bottom of the systems are clogged and will required cleaning or replacement.

The system is designed with a defined top portal area at the "down-flow" end of the chamber that can be cut out to accept up to a 10 inch diameter riser pipe. The 10-inch riser can be used as an observation well and for access of a vacuum truck tube that can be used to remove sediment. The "down flow" ends of the units have end walls that are closed on the bottom. The closed bottom functions similar to a coffer dam, with most of the sediment depositing prior to flowing into the next chamber, facilitating its removal through the riser pipe, which is positioned directly above this area.

CONSTRUCTION PHASE INSPECTION SCHEDULE AND EVALUATION CHECKLIST

Inspection Date	Inspector	BMP Inspected	Inspection Frequency Requirements	Comments	Recommendation	Follow-up Inspection Required (yes/no)
		Haybale & Silt Fence	Weekly and After Major Storm Events			
		Construction Entrance	Weekly and After Major Storm Events			
		Catchbasins	Weekly and After Major Storm Events			
		StormCeptor	Weekly and After Major Storm Events			
		Subsurface Infiltration/Detention System	Weekly and After Major Storm Events			
		Soil Stockpiles Areas	Weekly and After Major Storm Events			

1. Refer to the Massachusetts Stormwater Handbook Volume Two: Stormwater Technical Handbook (February 2008) for recommendations regarding frequency for inspections and maintenance of specific BMP's

2. Inspections to be conducted by a qualified professional such as an environmental scientist or civil engineer.

3. Limited or no use of sodium chloride salts, fertilizers or pesticides recommended.

Other Notes: (Include deviations form Conservation Commission Orders of Conditions, Planning Board Approvals and Approved Plans

POST CONSTRUCTON PHASE INSPECTION SCHEDULE AND EVALUATION CHECKLIST

Inspection Date	Inspector	BMP Inspected	Inspection Frequency Requirements	Comments	Recommendation	Follow-up Inspection Required (yes/no)
		Catchbasins	Twice Year and After Major Storm Events			
		StormCeptor	Twice Year and After Major Storm Events			
		Subsurface Infiltration/Detention System	Twice Year and After Major Storm Events			
		Pipe Outlet	Twice Year and After Major Storm Events			

4. Refer to the Massachusetts Stormwater Handbook Volume Two: Stormwater Technical Handbook (February 2008) for recommendations regarding frequency for inspections and maintenance of specific BMP's

5. Inspections to be conducted by a qualified professional such as an environmental scientist or civil engineer.

6. Limited or no use of sodium chloride salts, fertilizers or pesticides recommended.

Other Notes: (Include deviations form Conservation Commission Orders of Conditions, Planning Board Approvals and Approved Plans

SECTION 5.0

PEAK RUNOFF RATE CALCULATIONS

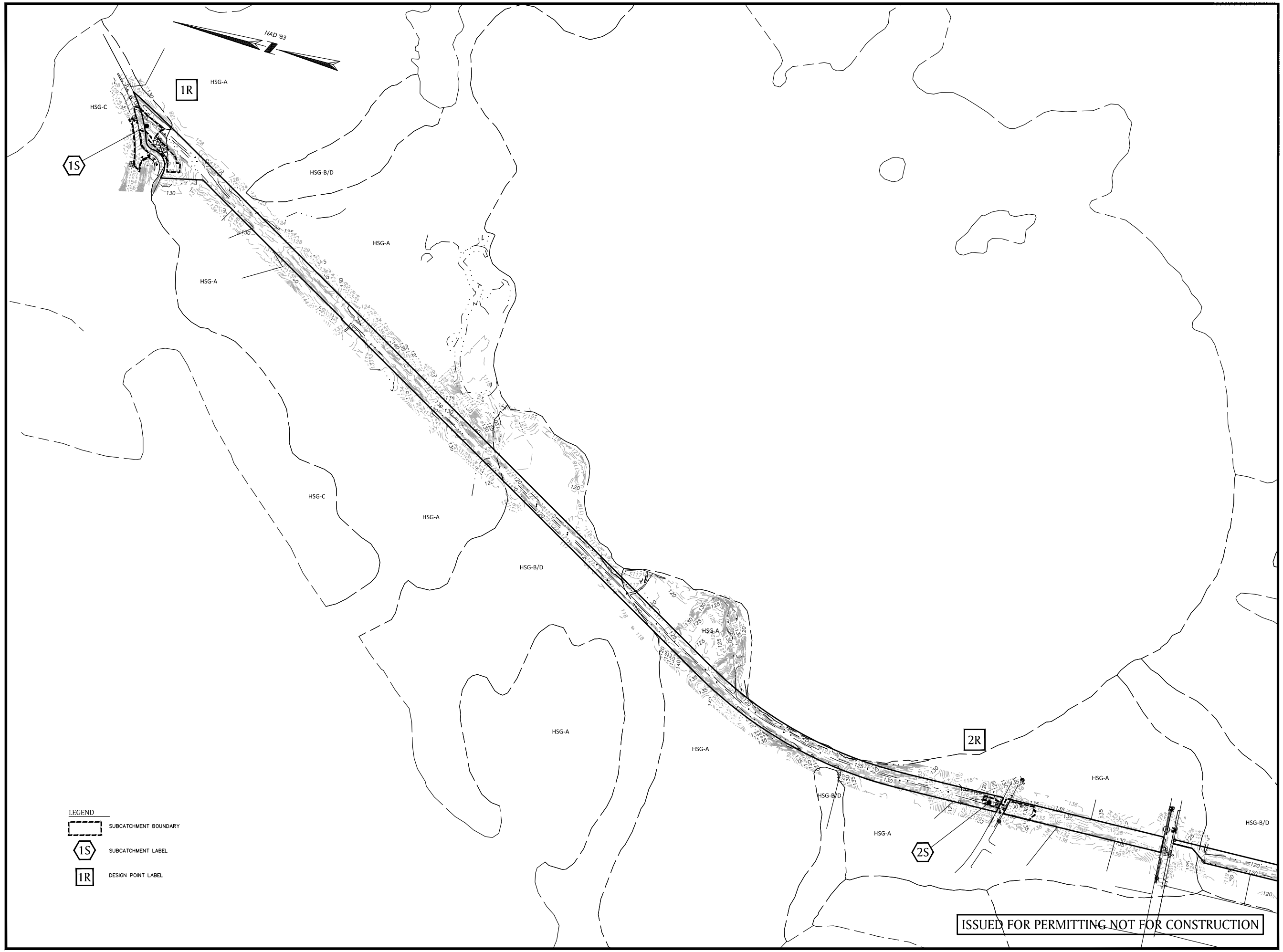
5.01 PRE-DEVELOPMENT HYDROLOGY WATERSHED PLAN

5.02 PRE-DEVELOPMENT HYDROLOGY CALCULATIONS
(HYDROCAD PRINTOUTS)

5.03 POST DEVELOPMENT HYDROLOGY WATERSHED PLAN

5.04 POST DEVELOPMENT HYDROLOGY CALCULATIONS
(HYDROCAD PRINTOUTS)

5.01 PRE-DEVELOPMENT HYDROLOGY WATERSHED PLAN



TOWN OF ANDOVER
INCORPORATED MAY 6, 1646
MASSACHUSETTS

PROFESSIONAL ENGINEER

HAGGETTS POND RAIL TRAIL

IN

ANDOVER,
MA

EXISTING WATERSHED PLAN

SEPTEMPER 25, 2023

REVISIONS:

PREPARED FOR:
TOWN OF ANDOVER
36 BARTLET STREET
ANDOVER, MA, 01810

BSC GROUP
300 Brickstone Square, Suite 203
Andover, Massachusetts
01810
617-896-4300

SCALE: 1"=200'

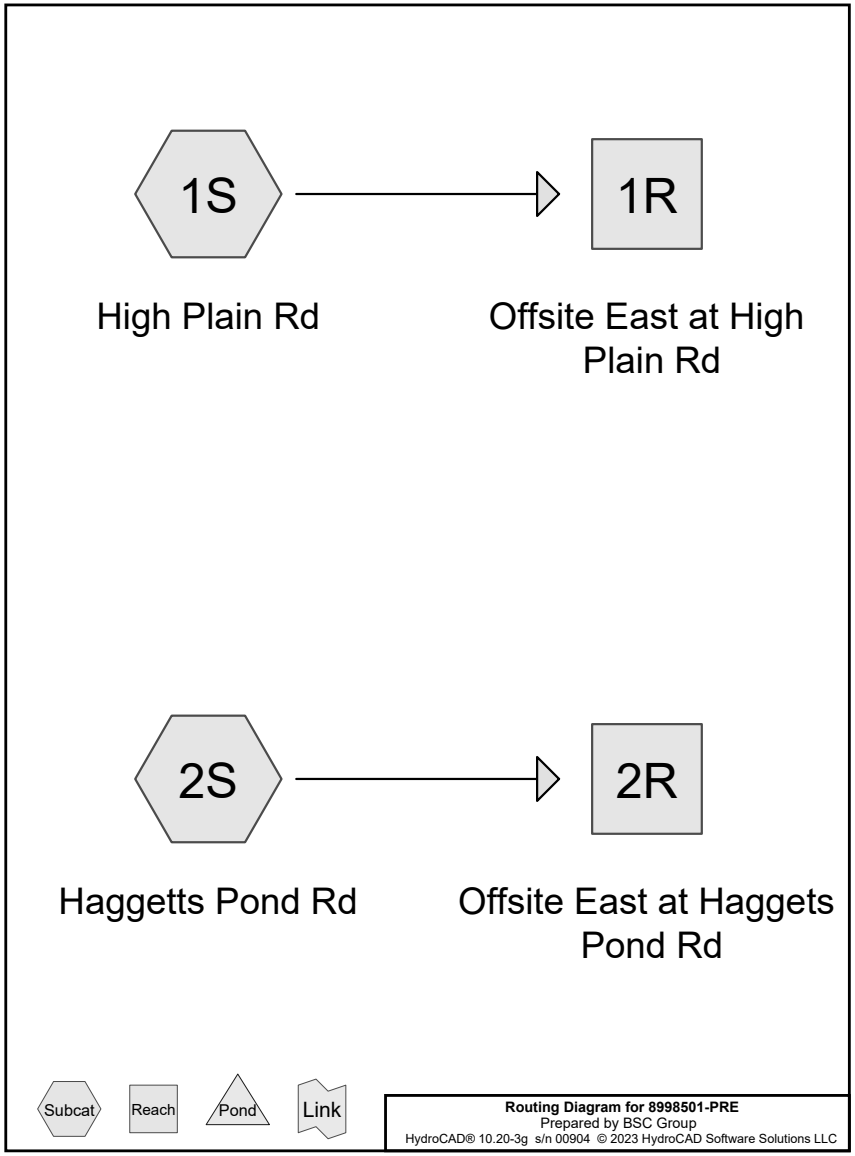
0 100 200 400 FEET

FILE: 8998501 EC WSHED.DWG

DWG. NO: EC-WSHD

JOB. NO: 8-9985.01

5.02 PRE-DEVELOPMENT HYDROLOGY WATERSHED CALCULATIONS
(HYDROCAD PRINTOUTS)



Rainfall Events Listing

Event#	Event Name	Storm Type	Curve	Mode	Duration (hours)	B/B	Depth (inches)	AMC
1	2-Year	Type III 24-hr		Default	24.00	1	3.14	2
2	10-Year	Type III 24-hr		Default	24.00	1	4.96	2
3	25-Year	Type III 24-hr		Default	24.00	1	6.09	2
4	100-Year	Type III 24-hr		Default	24.00	1	7.84	2

Area Listing (all nodes)

Area (sq-ft)	CN	Description (subcatchment-numbers)
3,754	74	>75% Grass cover, Good, HSG C (1S)
2,899	76	Gravel roads, HSG A (2S)
2,149	89	Gravel roads, HSG C (1S)
1,221	98	Paved parking, HSG A (2S)
7,459	98	Paved parking, HSG C (1S)
158	98	Water Surface, HSG C (1S)
13,600	30	Woods, Good, HSG A (1S, 2S)
8,930	70	Woods, Good, HSG C (1S)
40,170	**64**	**TOTAL AREA**

Soil Listing (all nodes)

Area (sq-ft)	Soil Group	Subcatchment Numbers
17,720	HSG A	1S, 2S
0	HSG B	
22,450	HSG C	1S
0	HSG D	
0	Other	
40,170		**TOTAL AREA**

Ground Covers (all nodes)

HSG-A (sq-ft)	HSG-B (sq-ft)	HSG-C (sq-ft)	HSG-D (sq-ft)	Other (sq-ft)	Total (sq-ft)	Ground Cover	Su Nu
0	0	3,754	0	0	3,754	>75% Grass cover, Good	
2,899	0	2,149	0	0	5,048	Gravel roads	
1,221	0	7,459	0	0	8,680	Paved parking	
0	0	158	0	0	158	Water Surface	
13,600	0	8,930	0	0	22,530	Woods, Good	
17,720	**0**	**22,450**	**0**	**0**	**40,170**	**TOTAL AREA**	

Time span=0.00-24.00 hrs, dt=0.01 hrs, 2401 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment1S: High Plain Rd Runoff Area=27,026 sf 28.18% Impervious Runoff Depth>0.94"
Flow Length=132' Tc=11.9 min CN=73 Runoff=0.52 cfs 2,121 cf

Subcatchment2S: Haggetts Pond Rd Runoff Area=13,144 sf 9.29% Impervious Runoff Depth>0.05"
Flow Length=49' Slope=0.0370 '/' Tc=8.9 min CN=46 Runoff=0.00 cfs 54 cf

Reach 1R: Offsite East at High Plain Rd Inflow=0.52 cfs 2,121 cf
Outflow=0.52 cfs 2,121 cf

Reach 2R: Offsite East at Haggets Pond Rd Inflow=0.00 cfs 54 cf
Outflow=0.00 cfs 54 cf

Total Runoff Area = 40,170 sf Runoff Volume = 2,175 cf Average Runoff Depth = 0.65"
78.00% Pervious = 31,332 sf 22.00% Impervious = 8,838 sf

Summary for Subcatchment 1S: High Plain Rd

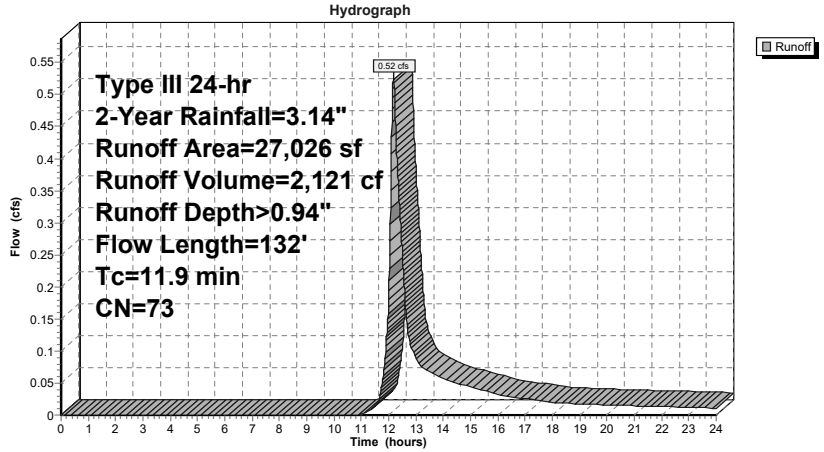
Runoff = 0.52 cfs @ 12.18 hrs, Volume= 2,121 cf, Depth> 0.94"
Routed to Reach 1R : Offsite East at High Plain Rd

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 2-Year Rainfall=3.14"

Area (sf)	CN	Description
4,576	30	Woods, Good, HSG A
3,754	74	>75% Grass cover, Good, HSG C
2,149	89	Gravel roads, HSG C
8,930	70	Woods, Good, HSG C
7,459	98	Paved parking, HSG C
158	98	Water Surface, HSG C
27,026	73	Weighted Average
19,409		71.82% Pervious Area
7,617		28.18% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.5	50	0.0260	0.08		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.60"
1.4	82	0.0400	1.00		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
11.9	132	Total			

Subcatchment 1S: High Plain Rd



Summary for Subcatchment 2S: Haggetts Pond Rd

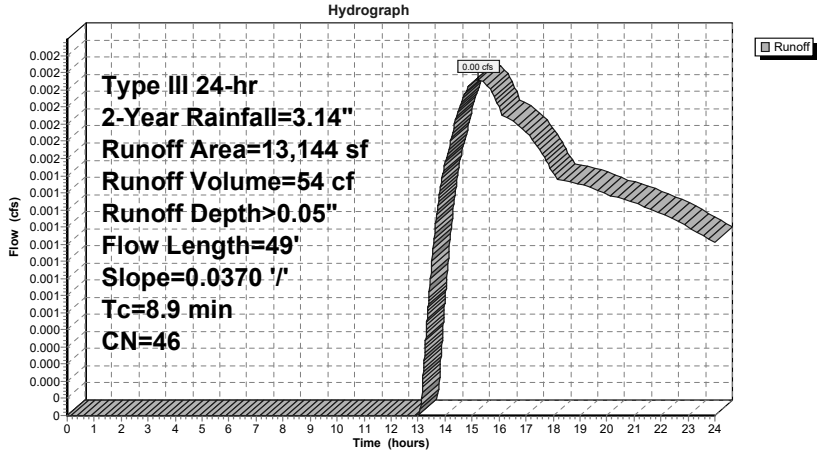
Runoff = 0.00 cfs @ 15.24 hrs, Volume= 54 cf, Depth> 0.05"
Routed to Reach 2R : Offsite East at Haggets Pond Rd

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 2-Year Rainfall=3.14"

Area (sf)	CN	Description
2,899	76	Gravel roads, HSG A
9,024	30	Woods, Good, HSG A
1,221	98	Paved parking, HSG A
13,144	46	Weighted Average
11,923		90.71% Pervious Area
1,221		9.29% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
8.9	49	0.0370	0.09		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.60"

Subcatchment 2S: Haggetts Pond Rd



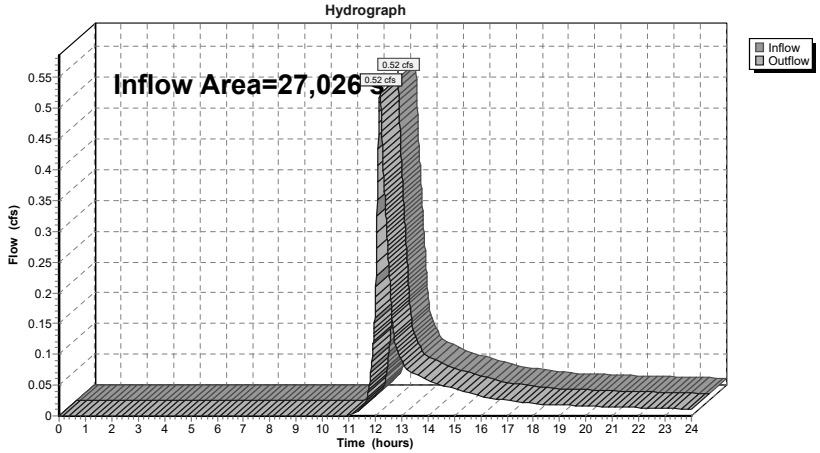
Summary for Reach 1R: Offsite East at High Plain Rd

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

Inflow Area = 27,026 sf, 28.18% Impervious, Inflow Depth > 0.94" for 2-Year event
Inflow = 0.52 cfs @ 12.18 hrs, Volume= 2,121 cf
Outflow = 0.52 cfs @ 12.18 hrs, Volume= 2,121 cf, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs

Reach 1R: Offsite East at High Plain Rd



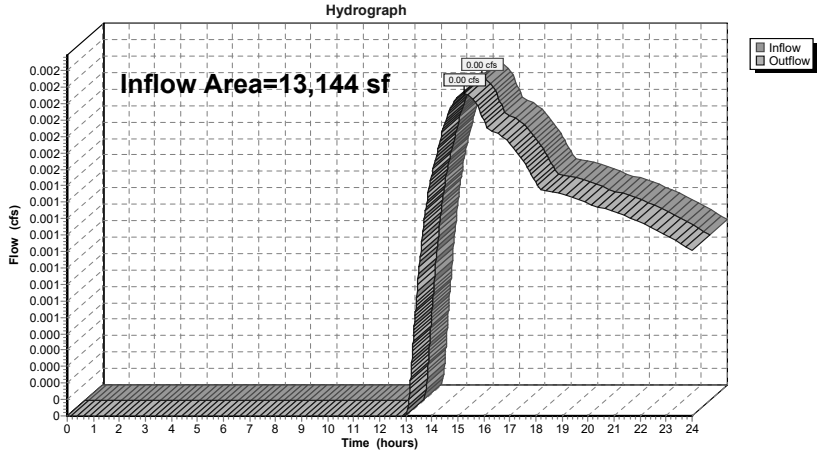
Summary for Reach 2R: Offsite East at Haggets Pond Rd

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

Inflow Area = 13,144 sf, 9.29% Impervious, Inflow Depth > 0.05" for 2-Year event
Inflow = 0.00 cfs @ 15.24 hrs, Volume= 54 cf
Outflow = 0.00 cfs @ 15.24 hrs, Volume= 54 cf, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs

Reach 2R: Offsite East at Haggets Pond Rd



Time span=0.00-24.00 hrs, dt=0.01 hrs, 2401 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment1S: High Plain Rd Runoff Area=27,026 sf 28.18% Impervious Runoff Depth>2.24"
Flow Length=132' Tc=11.9 min CN=73 Runoff=1.33 cfs 5,052 cf

Subcatchment2S: Haggetts Pond Rd Runoff Area=13,144 sf 9.29% Impervious Runoff Depth>0.47"
Flow Length=49' Slope=0.0370 '/' Tc=8.9 min CN=46 Runoff=0.07 cfs 519 cf

Reach 1R: Offsite East at High Plain Rd Inflow=1.33 cfs 5,052 cf
Outflow=1.33 cfs 5,052 cf

Reach 2R: Offsite East at Haggets Pond Rd Inflow=0.07 cfs 519 cf
Outflow=0.07 cfs 519 cf

Total Runoff Area = 40,170 sf Runoff Volume = 5,571 cf Average Runoff Depth = 1.66"
78.00% Pervious = 31,332 sf 22.00% Impervious = 8,838 sf

Summary for Subcatchment 1S: High Plain Rd

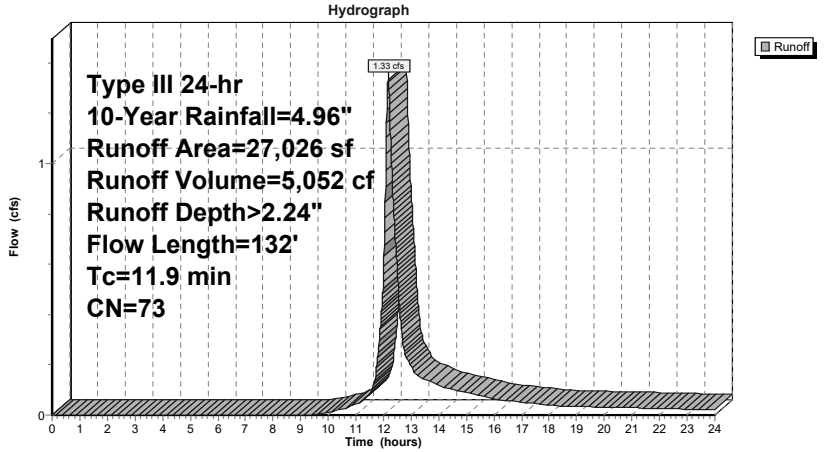
Runoff = 1.33 cfs @ 12.17 hrs, Volume= 5,052 cf, Depth> 2.24"
Routed to Reach 1R : Offsite East at High Plain Rd

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-Year Rainfall=4.96"

Area (sf)	CN	Description
4,576	30	Woods, Good, HSG A
3,754	74	>75% Grass cover, Good, HSG C
2,149	89	Gravel roads, HSG C
8,930	70	Woods, Good, HSG C
7,459	98	Paved parking, HSG C
158	98	Water Surface, HSG C
27,026	73	Weighted Average
19,409		71.82% Pervious Area
7,617		28.18% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.5	50	0.0260	0.08		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.60"
1.4	82	0.0400	1.00		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
11.9	132	Total			

Subcatchment 1S: High Plain Rd



Summary for Subcatchment 2S: Haggetts Pond Rd

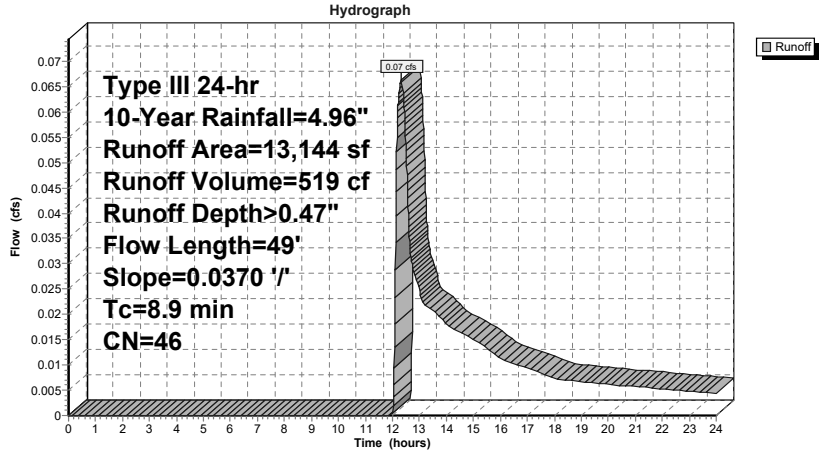
Runoff = 0.07 cfs @ 12.33 hrs, Volume= 519 cf, Depth> 0.47"
Routed to Reach 2R : Offsite East at Haggets Pond Rd

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-Year Rainfall=4.96"

Area (sf)	CN	Description
2,899	76	Gravel roads, HSG A
9,024	30	Woods, Good, HSG A
1,221	98	Paved parking, HSG A
13,144	46	Weighted Average
11,923		90.71% Pervious Area
1,221		9.29% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
8.9	49	0.0370	0.09		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.60"

Subcatchment 2S: Haggetts Pond Rd



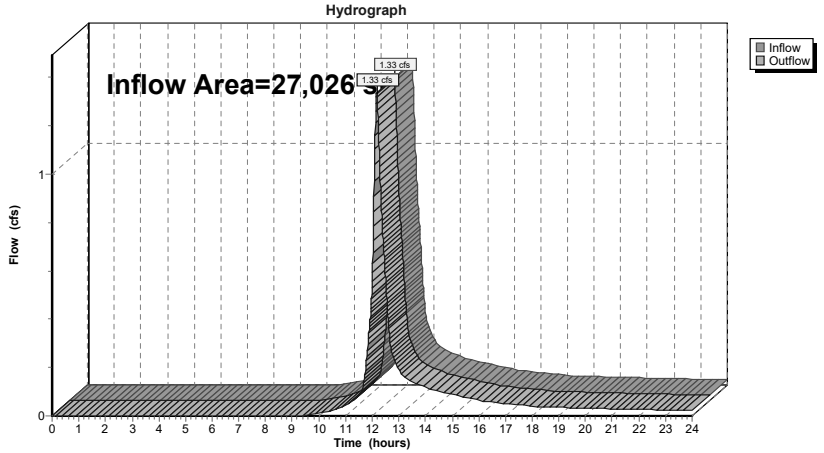
Summary for Reach 1R: Offsite East at High Plain Rd

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

Inflow Area = 27,026 sf, 28.18% Impervious, Inflow Depth > 2.24" for 10-Year event
Inflow = 1.33 cfs @ 12.17 hrs, Volume= 5,052 cf
Outflow = 1.33 cfs @ 12.17 hrs, Volume= 5,052 cf, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs

Reach 1R: Offsite East at High Plain Rd



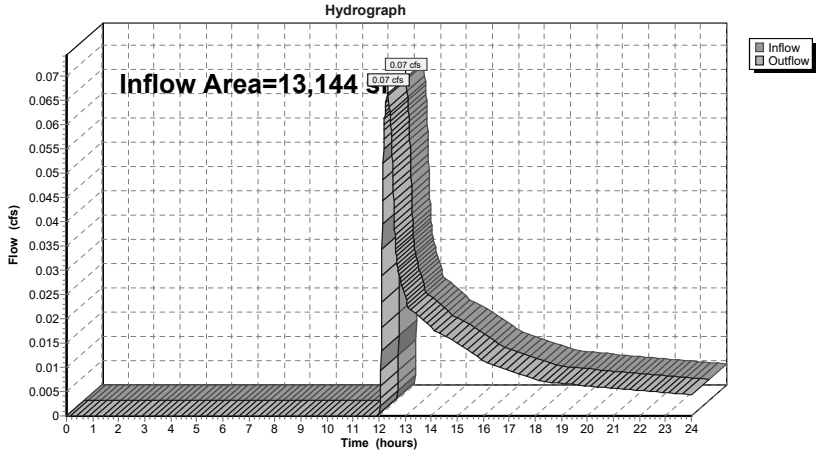
Summary for Reach 2R: Offsite East at Haggets Pond Rd

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

Inflow Area = 13,144 sf, 9.29% Impervious, Inflow Depth > 0.47" for 10-Year event
Inflow = 0.07 cfs @ 12.33 hrs, Volume= 519 cf
Outflow = 0.07 cfs @ 12.33 hrs, Volume= 519 cf, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs

Reach 2R: Offsite East at Haggets Pond Rd



Time span=0.00-24.00 hrs, dt=0.01 hrs, 2401 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment1S: High Plain Rd Runoff Area=27,026 sf 28.18% Impervious Runoff Depth>3.16"
Flow Length=132' Tc=11.9 min CN=73 Runoff=1.89 cfs 7,107 cf

Subcatchment2S: Haggetts Pond Rd Runoff Area=13,144 sf 9.29% Impervious Runoff Depth>0.90"
Flow Length=49' Slope=0.0370 '/' Tc=8.9 min CN=46 Runoff=0.19 cfs 988 cf

Reach 1R: Offsite East at High Plain Rd Inflow=1.89 cfs 7,107 cf
Outflow=1.89 cfs 7,107 cf

Reach 2R: Offsite East at Haggets Pond Rd Inflow=0.19 cfs 988 cf
Outflow=0.19 cfs 988 cf

Total Runoff Area = 40,170 sf Runoff Volume = 8,094 cf Average Runoff Depth = 2.42"
78.00% Pervious = 31,332 sf 22.00% Impervious = 8,838 sf

Summary for Subcatchment 1S: High Plain Rd

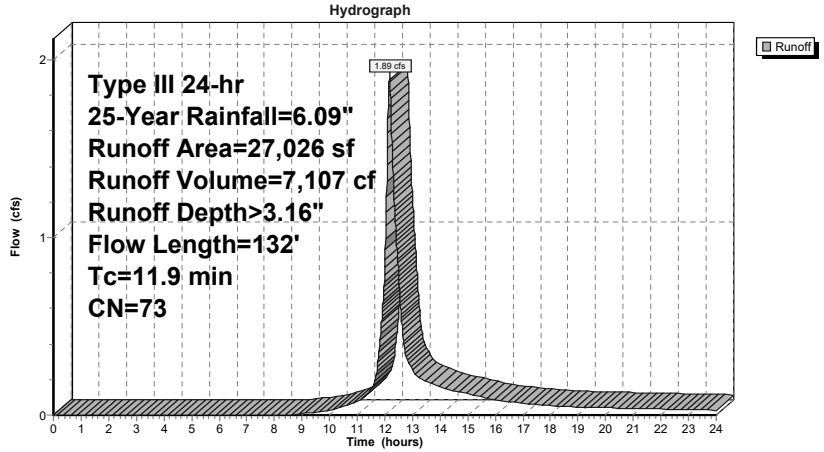
Runoff = 1.89 cfs @ 12.17 hrs, Volume= 7,107 cf, Depth> 3.16"
Routed to Reach 1R : Offsite East at High Plain Rd

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 25-Year Rainfall=6.09"

Area (sf)	CN	Description
4,576	30	Woods, Good, HSG A
3,754	74	>75% Grass cover, Good, HSG C
2,149	89	Gravel roads, HSG C
8,930	70	Woods, Good, HSG C
7,459	98	Paved parking, HSG C
158	98	Water Surface, HSG C
27,026	73	Weighted Average
19,409		71.82% Pervious Area
7,617		28.18% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.5	50	0.0260	0.08		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.60"
1.4	82	0.0400	1.00		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
11.9	132	Total			

Subcatchment 1S: High Plain Rd



Summary for Subcatchment 2S: Haggetts Pond Rd

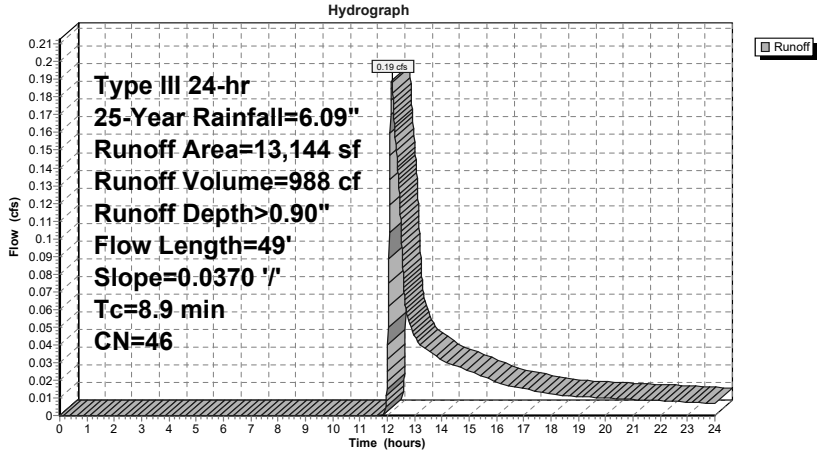
Runoff = 0.19 cfs @ 12.16 hrs, Volume= 988 cf, Depth> 0.90"
Routed to Reach 2R : Offsite East at Haggets Pond Rd

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 25-Year Rainfall=6.09"

Area (sf)	CN	Description
2,899	76	Gravel roads, HSG A
9,024	30	Woods, Good, HSG A
1,221	98	Paved parking, HSG A
13,144	46	Weighted Average
11,923		90.71% Pervious Area
1,221		9.29% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
8.9	49	0.0370	0.09		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.60"

Subcatchment 2S: Haggetts Pond Rd



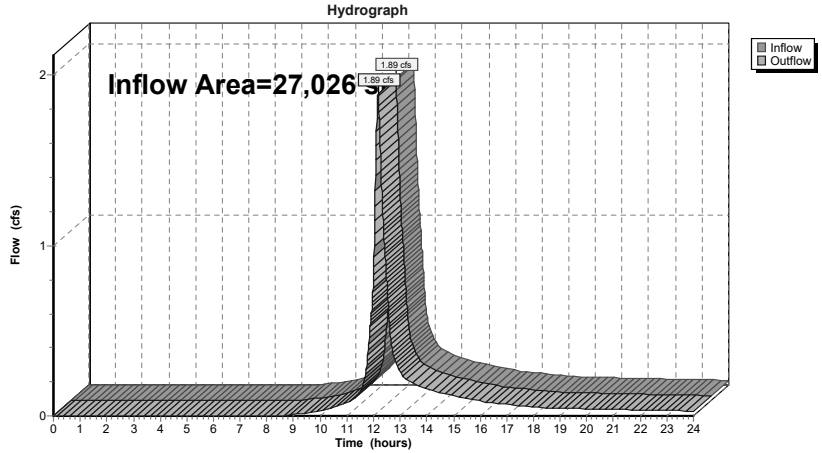
Summary for Reach 1R: Offsite East at High Plain Rd

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

Inflow Area = 27,026 sf, 28.18% Impervious, Inflow Depth > 3.16" for 25-Year event
Inflow = 1.89 cfs @ 12.17 hrs, Volume= 7,107 cf
Outflow = 1.89 cfs @ 12.17 hrs, Volume= 7,107 cf, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs

Reach 1R: Offsite East at High Plain Rd



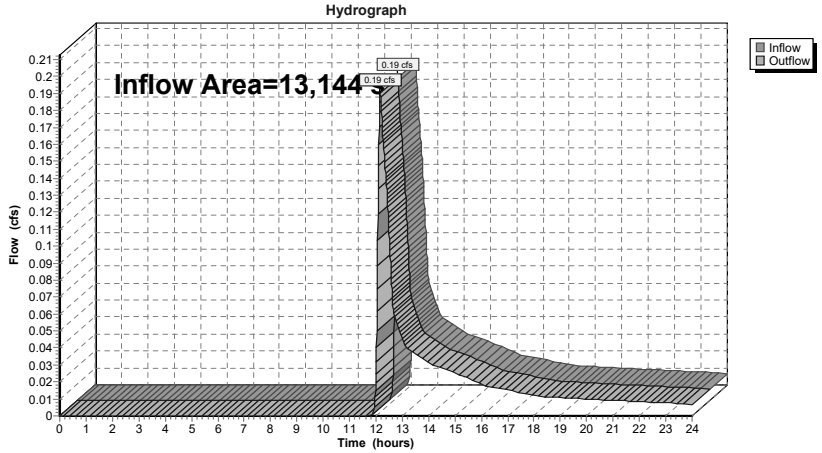
Summary for Reach 2R: Offsite East at Haggets Pond Rd

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

Inflow Area = 13,144 sf, 9.29% Impervious, Inflow Depth > 0.90" for 25-Year event
Inflow = 0.19 cfs @ 12.16 hrs, Volume= 988 cf
Outflow = 0.19 cfs @ 12.16 hrs, Volume= 988 cf, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs

Reach 2R: Offsite East at Haggets Pond Rd



Time span=0.00-24.00 hrs, dt=0.01 hrs, 2401 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment1S: High Plain Rd Runoff Area=27,026 sf 28.18% Impervious Runoff Depth>4.66"
Flow Length=132' Tc=11.9 min CN=73 Runoff=2.80 cfs 10,490 cf

Subcatchment2S: Haggetts Pond Rd Runoff Area=13,144 sf 9.29% Impervious Runoff Depth>1.75"
Flow Length=49' Slope=0.0370 '/' Tc=8.9 min CN=46 Runoff=0.47 cfs 1,912 cf

Reach 1R: Offsite East at High Plain Rd Inflow=2.80 cfs 10,490 cf
Outflow=2.80 cfs 10,490 cf

Reach 2R: Offsite East at Haggets Pond Rd Inflow=0.47 cfs 1,912 cf
Outflow=0.47 cfs 1,912 cf

Total Runoff Area = 40,170 sf Runoff Volume = 12,402 cf Average Runoff Depth = 3.70"
78.00% Pervious = 31,332 sf 22.00% Impervious = 8,838 sf

Summary for Subcatchment 1S: High Plain Rd

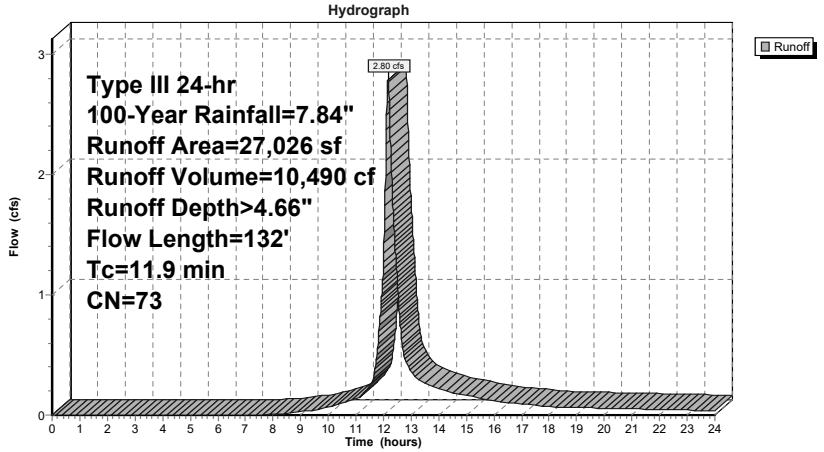
Runoff = 2.80 cfs @ 12.16 hrs, Volume= 10,490 cf, Depth> 4.66"
Routed to Reach 1R : Offsite East at High Plain Rd

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-Year Rainfall=7.84"

Area (sf)	CN	Description
4,576	30	Woods, Good, HSG A
3,754	74	>75% Grass cover, Good, HSG C
2,149	89	Gravel roads, HSG C
8,930	70	Woods, Good, HSG C
7,459	98	Paved parking, HSG C
158	98	Water Surface, HSG C
27,026	73	Weighted Average
19,409		71.82% Pervious Area
7,617		28.18% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.5	50	0.0260	0.08		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.60"
1.4	82	0.0400	1.00		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
11.9	132	Total			

Subcatchment 1S: High Plain Rd



Summary for Subcatchment 2S: Haggetts Pond Rd

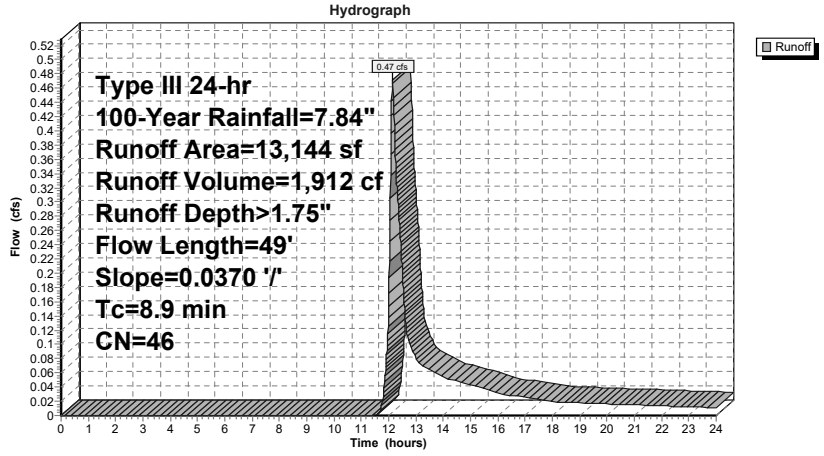
Runoff = 0.47 cfs @ 12.14 hrs, Volume= 1,912 cf, Depth> 1.75"
Routed to Reach 2R : Offsite East at Haggets Pond Rd

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-Year Rainfall=7.84"

Area (sf)	CN	Description
2,899	76	Gravel roads, HSG A
9,024	30	Woods, Good, HSG A
1,221	98	Paved parking, HSG A
13,144	46	Weighted Average
11,923		90.71% Pervious Area
1,221		9.29% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
8.9	49	0.0370	0.09		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.60"

Subcatchment 2S: Haggetts Pond Rd



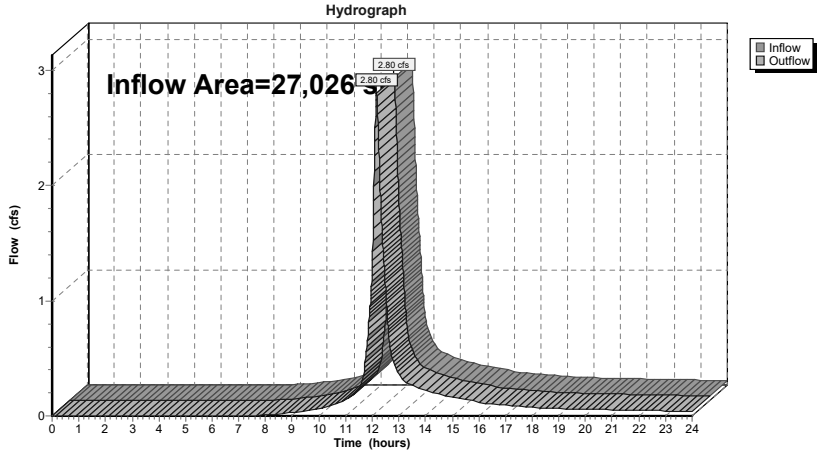
Summary for Reach 1R: Offsite East at High Plain Rd

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

Inflow Area = 27,026 sf, 28.18% Impervious, Inflow Depth > 4.66" for 100-Year event
Inflow = 2.80 cfs @ 12.16 hrs, Volume= 10,490 cf
Outflow = 2.80 cfs @ 12.16 hrs, Volume= 10,490 cf, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs

Reach 1R: Offsite East at High Plain Rd



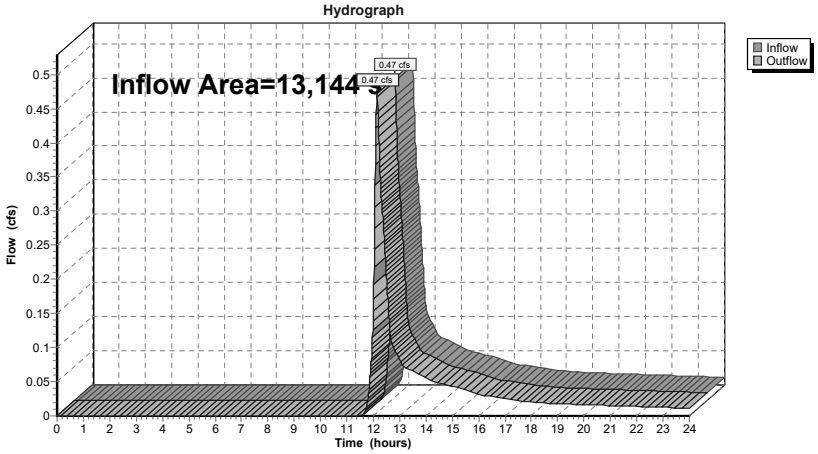
Summary for Reach 2R: Offsite East at Haggets Pond Rd

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

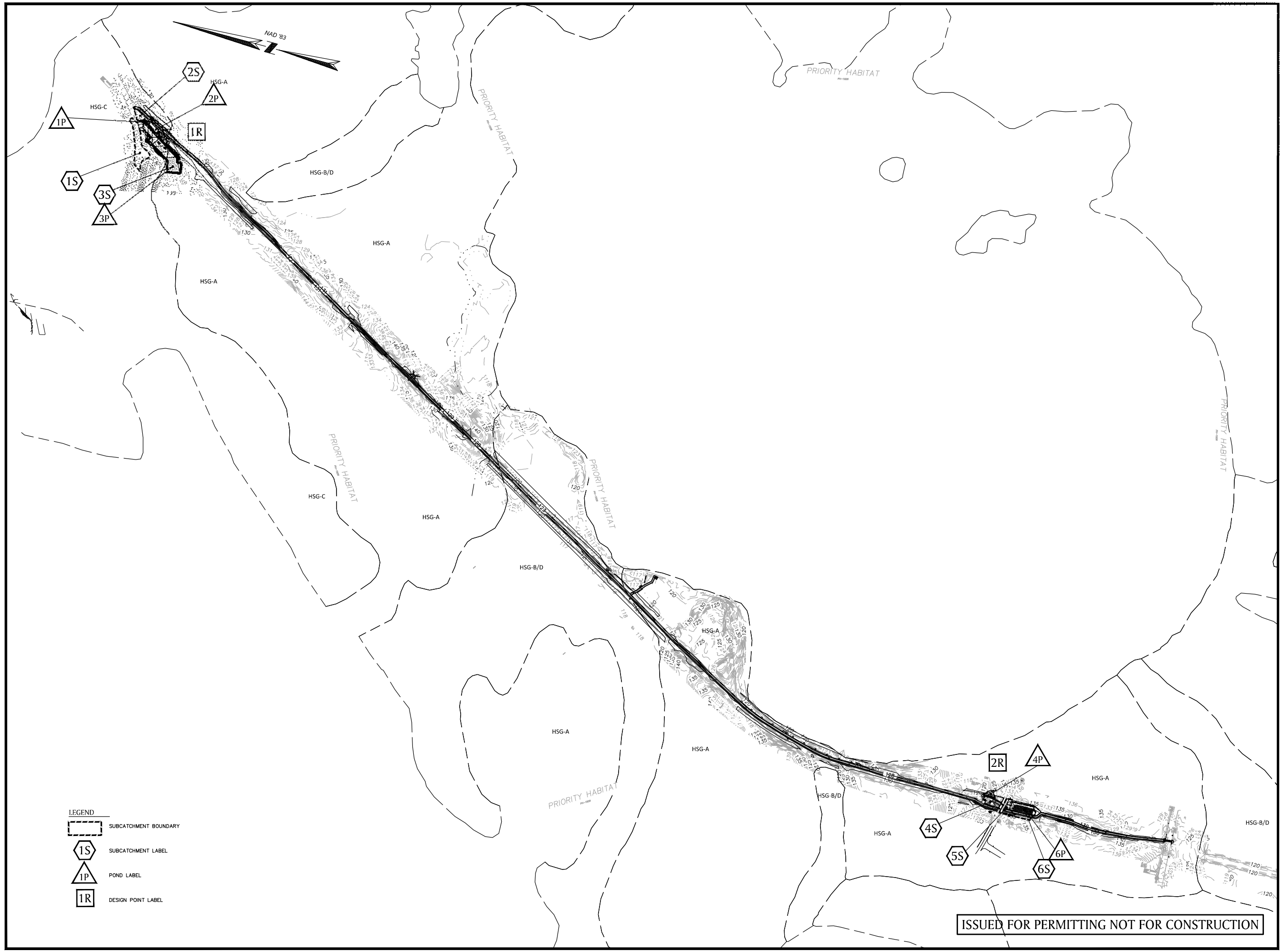
Inflow Area = 13,144 sf, 9.29% Impervious, Inflow Depth > 1.75" for 100-Year event
Inflow = 0.47 cfs @ 12.14 hrs, Volume= 1,912 cf
Outflow = 0.47 cfs @ 12.14 hrs, Volume= 1,912 cf, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs

Reach 2R: Offsite East at Haggets Pond Rd



5.03 POST-DEVELOPMENT HYDROLOGY WATERSHED PLAN



TOWN OF ANDOVER
INCORPORATED MAY 6, 1646
MASSACHUSETTS

HAGGETTS POND RAIL TRAIL

IN

ANDOVER,
MA

PROPOSED WATERSHED PLAN

NOVEMBER 7, 2023

REVISIONS:

PREPARED FOR:
TOWN OF ANDOVER
36 BARTLET STREET
ANDOVER, MA, 01810

BSC GROUP
300 Brickstone Square, Suite 203
Andover, Massachusetts
01810
617-896-4300

SCALE: 1" = 200'

0 100 200 400 FEET

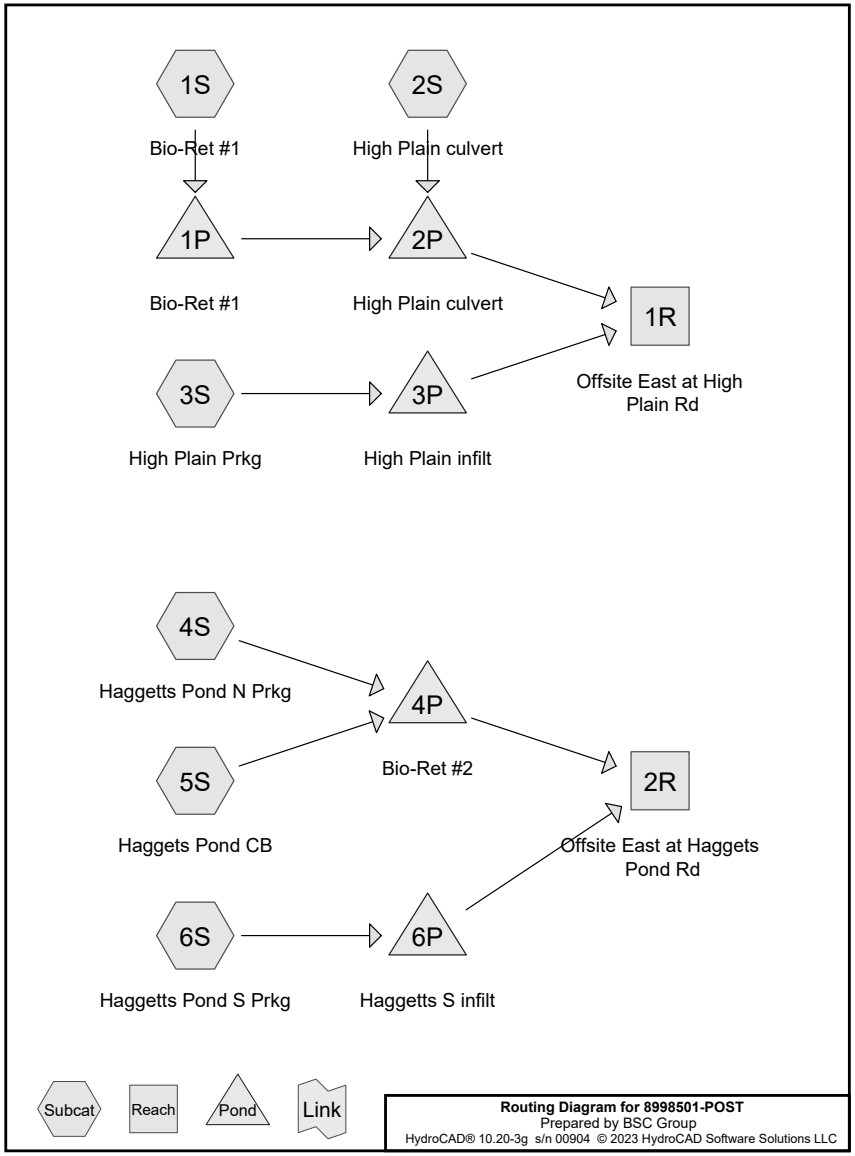
FILE: 8998501\C\DD\8998501 PC WSHED

DWG. NO:

JOB. NO: 8-9985.01

PC-WSHD

5.04 POST-DEVELOPMENT HYDROLOGY WATERSHED CALCULATIONS
(HYDROCAD PRINTOUTS)



Rainfall Events Listing (selected events)

Event#	Event Name	Storm Type	Curve	Mode	Duration (hours)	B/B	Depth (inches)	AMC
1	2-Year	Type III 24-hr		Default	24.00	1	3.14	2
2	10-Year	Type III 24-hr		Default	24.00	1	4.96	2
3	25-Year	Type III 24-hr		Default	24.00	1	6.09	2
4	100-Year	Type III 24-hr		Default	24.00	1	7.84	2

Area Listing (selected nodes)

Area (sq-ft)	CN	Description (subcatchment-numbers)
2,402	68	<50% Grass cover, Poor, HSG A (4S, 5S, 6S)
4,785	86	<50% Grass cover, Poor, HSG C (1S, 2S)
1,418	74	>75% Grass cover, Good, HSG C (2S)
697	76	Gravel roads, HSG A (5S, 6S)
1,103	89	Gravel roads, HSG C (1S, 2S)
13,544	98	Paved parking, HSG A (3S, 4S, 5S, 6S)
15,040	98	Paved parking, HSG C (1S, 2S, 3S)
104	98	Water Surface, HSG C (2S)
1,076	30	Woods, Good, HSG A (5S, 6S)
40,169	**91**	**TOTAL AREA**

Soil Listing (selected nodes)

Area (sq-ft)	Soil Group	Subcatchment Numbers
17,719	HSG A	3S, 4S, 5S, 6S
0	HSG B	
22,450	HSG C	1S, 2S, 3S
0	HSG D	
0	Other	
40,169		**TOTAL AREA**

Ground Covers (selected nodes)

HSG-A (sq-ft)	HSG-B (sq-ft)	HSG-C (sq-ft)	HSG-D (sq-ft)	Other (sq-ft)	Total (sq-ft)	Ground Cover	Su Nu
2,402	0	4,785	0	0	7,187	<50% Grass cover, Poor	
0	0	1,418	0	0	1,418	>75% Grass cover, Good	
697	0	1,103	0	0	1,800	Gravel roads	
13,544	0	15,040	0	0	28,584	Paved parking	
0	0	104	0	0	104	Water Surface	
1,076	0	0	0	0	1,076	Woods, Good	
17,719	**0**	**22,450**	**0**	**0**	**40,169**	**TOTAL AREA**	

Time span=0.00-24.00 hrs, dt=0.01 hrs, 2401 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment1S: Bio-Ret #1 Runoff Area=9,719 sf 77.71% Impervious Runoff Depth>2.58"
Tc=6.0 min CN=95 Runoff=0.64 cfs 2,093 cf

Subcatchment2S: High Plain culvert Runoff Area=7,197 sf 28.58% Impervious Runoff Depth>1.94"
Tc=6.0 min CN=88 Runoff=0.38 cfs 1,164 cf

Subcatchment3S: High Plain Prkg Runoff Area=10,110 sf 100.00% Impervious Runoff Depth>2.91"
Tc=6.0 min CN=98 Runoff=0.71 cfs 2,448 cf

Subcatchment4S: Haggetts Pond N Prkg Runoff Area=2,955 sf 68.36% Impervious Runoff Depth>2.02"
Tc=6.0 min CN=89 Runoff=0.16 cfs 499 cf

Subcatchment5S: Haggets Pond CB Runoff Area=3,202 sf 54.68% Impervious Runoff Depth>1.49"
Tc=6.0 min CN=82 Runoff=0.13 cfs 397 cf

Subcatchment6S: Haggetts Pond S Prkg Runoff Area=6,986 sf 74.39% Impervious Runoff Depth>1.86"
Tc=6.0 min CN=87 Runoff=0.35 cfs 1,083 cf

Reach 1R: Offsite East at High Plain Rd Inflow=0.00 cfs 0 cf
Outflow=0.00 cfs 0 cf

Reach 2R: Offsite East at Haggets Pond Rd Inflow=0.00 cfs 0 cf
Outflow=0.00 cfs 0 cf

Pond 1P: Bio-Ret #1 Peak Elev=131.67' Storage=685 cf Inflow=0.64 cfs 2,093 cf
Discarded=0.22 cfs 1,991 cf Primary=0.05 cfs 27 cf Outflow=0.28 cfs 2,018 cf

Pond 2P: High Plain culvert Peak Elev=131.14' Storage=344 cf Inflow=0.38 cfs 1,191 cf
Discarded=0.13 cfs 1,187 cf Primary=0.00 cfs 0 cf Outflow=0.13 cfs 1,187 cf

Pond 3P: High Plain infilt Peak Elev=133.34' Storage=33 cf Inflow=0.71 cfs 2,448 cf
Discarded=0.58 cfs 2,448 cf Primary=0.00 cfs 0 cf Outflow=0.58 cfs 2,448 cf

Pond 4P: Bio-Ret #2 Peak Elev=123.47' Storage=261 cf Inflow=0.29 cfs 896 cf
Discarded=0.07 cfs 892 cf Primary=0.00 cfs 0 cf Outflow=0.07 cfs 892 cf

Pond 6P: Haggetts S infilt Peak Elev=129.19' Storage=139 cf Inflow=0.35 cfs 1,083 cf
Discarded=0.13 cfs 1,084 cf Primary=0.00 cfs 0 cf Outflow=0.13 cfs 1,084 cf

Total Runoff Area = 40,169 sf Runoff Volume = 7,683 cf Average Runoff Depth = 2.30"
28.58% Pervious = 11,481 sf 71.42% Impervious = 28,688 sf

Summary for Subcatchment 1S: Bio-Ret #1

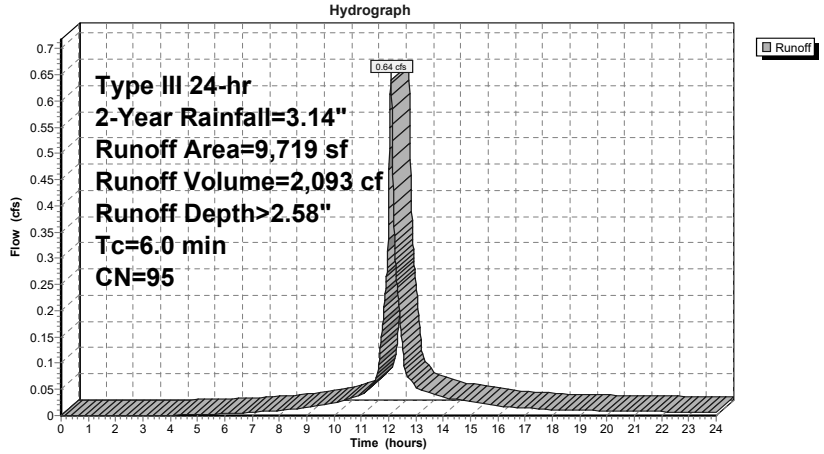
Runoff = 0.64 cfs @ 12.08 hrs, Volume= 2,093 cf, Depth> 2.58"
Routed to Pond 1P : Bio-Ret #1

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 2-Year Rainfall=3.14"

Area (sf)	CN	Description
2,119	86	<50% Grass cover, Poor, HSG C
47	89	Gravel roads, HSG C
7,553	98	Paved parking, HSG C
9,719	95	Weighted Average
2,166		22.29% Pervious Area
7,553		77.71% Impervious Area

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

Subcatchment 1S: Bio-Ret #1



Summary for Subcatchment 2S: High Plain culvert

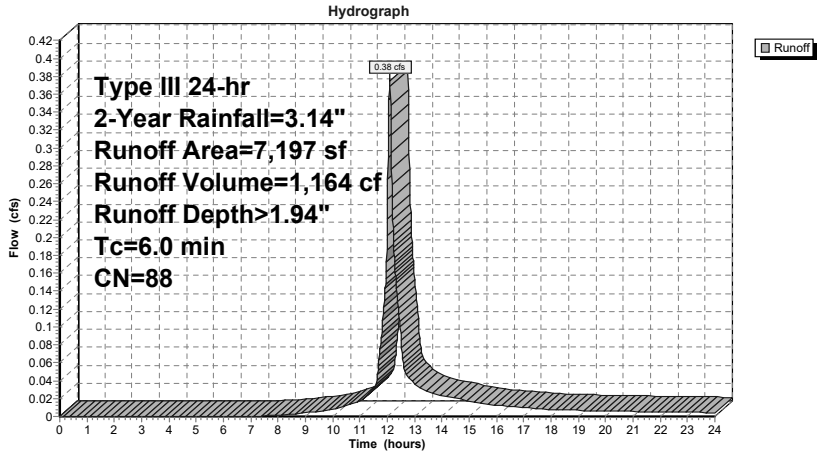
Runoff = 0.38 cfs @ 12.09 hrs, Volume= 1,164 cf, Depth> 1.94"
Routed to Pond 2P : High Plain culvert

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 2-Year Rainfall=3.14"

Area (sf)	CN	Description
2,666	86	<50% Grass cover, Poor, HSG C
1,418	74	>75% Grass cover, Good, HSG C
1,056	89	Gravel roads, HSG C
1,953	98	Paved parking, HSG C
104	98	Water Surface, HSG C
7,197	88	Weighted Average
5,140		71.42% Pervious Area
2,057		28.58% Impervious Area

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

Subcatchment 2S: High Plain culvert



Summary for Subcatchment 3S: High Plain Prkg

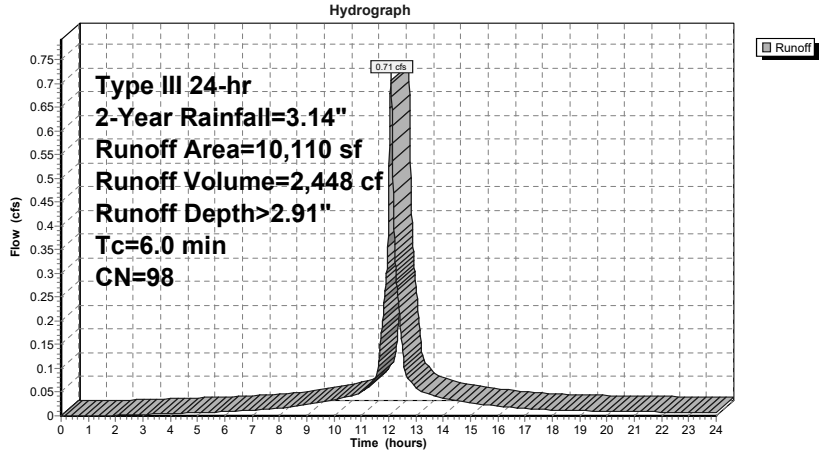
Runoff = 0.71 cfs @ 12.08 hrs, Volume= 2,448 cf, Depth> 2.91"
Routed to Pond 3P : High Plain infilt

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 2-Year Rainfall=3.14"

Area (sf)	CN	Description
4,576	98	Paved parking, HSG A
5,534	98	Paved parking, HSG C
10,110	98	Weighted Average
10,110		100.00% Impervious Area

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

Subcatchment 3S: High Plain Prkg



Summary for Subcatchment 4S: Haggetts Pond N Prkg

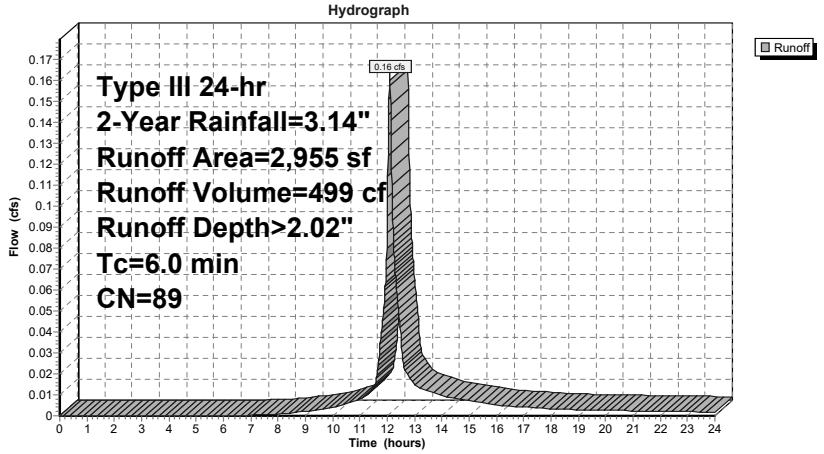
Runoff = 0.16 cfs @ 12.09 hrs, Volume= 499 cf, Depth> 2.02"
Routed to Pond 4P : Bio-Ret #2

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 2-Year Rainfall=3.14"

Area (sf)	CN	Description
2,020	98	Paved parking, HSG A
935	68	<50% Grass cover, Poor, HSG A
2,955	89	Weighted Average
935		31.64% Pervious Area
2,020		68.36% Impervious Area

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

Subcatchment 4S: Haggetts Pond N Prkg



Summary for Subcatchment 5S: Haggets Pond CB

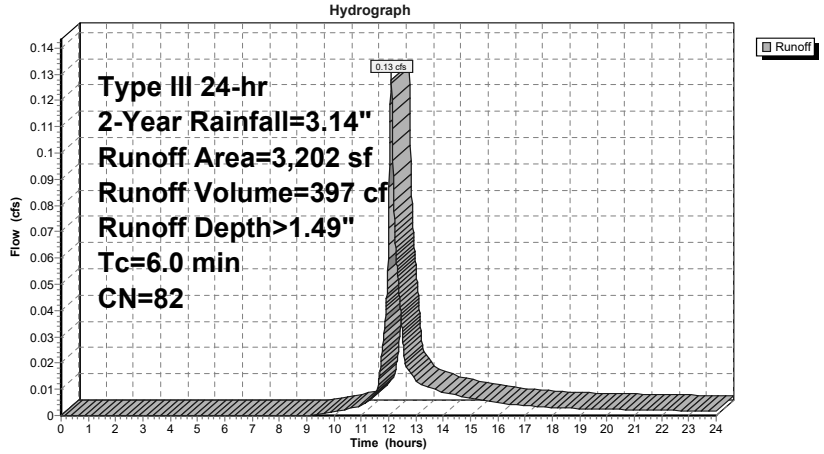
Runoff = 0.13 cfs @ 12.09 hrs, Volume= 397 cf, Depth> 1.49"
Routed to Pond 4P : Bio-Ret #2

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 2-Year Rainfall=3.14"

Area (sf)	CN	Description
1,751	98	Paved parking, HSG A
921	68	<50% Grass cover, Poor, HSG A
249	76	Gravel roads, HSG A
281	30	Woods, Good, HSG A
3,202	82	Weighted Average
1,451		45.32% Pervious Area
1,751		54.68% Impervious Area

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

Subcatchment 5S: Haggets Pond CB



Summary for Subcatchment 6S: Haggetts Pond S Prkg

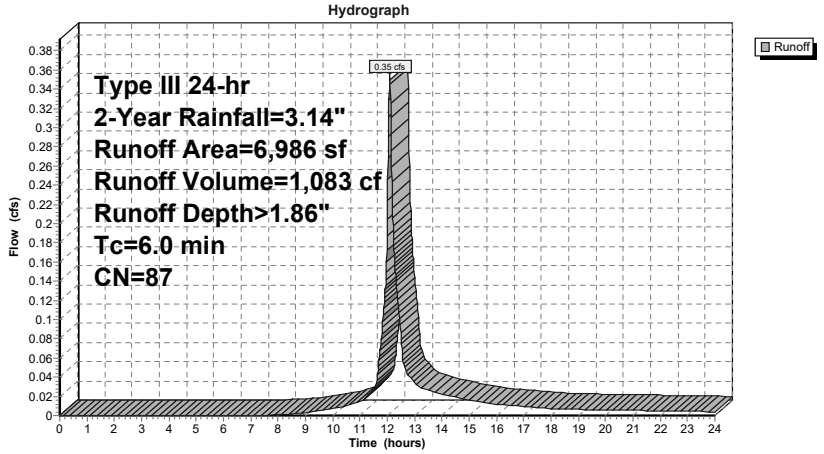
Runoff = 0.35 cfs @ 12.09 hrs, Volume= 1,083 cf, Depth> 1.86"
Routed to Pond 6P : Haggetts S infilt

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 2-Year Rainfall=3.14"

Area (sf)	CN	Description
5,197	98	Paved parking, HSG A
448	76	Gravel roads, HSG A
546	68	<50% Grass cover, Poor, HSG A
795	30	Woods, Good, HSG A
6,986	87	Weighted Average
1,789		25.61% Pervious Area
5,197		74.39% Impervious Area

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

Subcatchment 6S: Haggetts Pond S Prkg



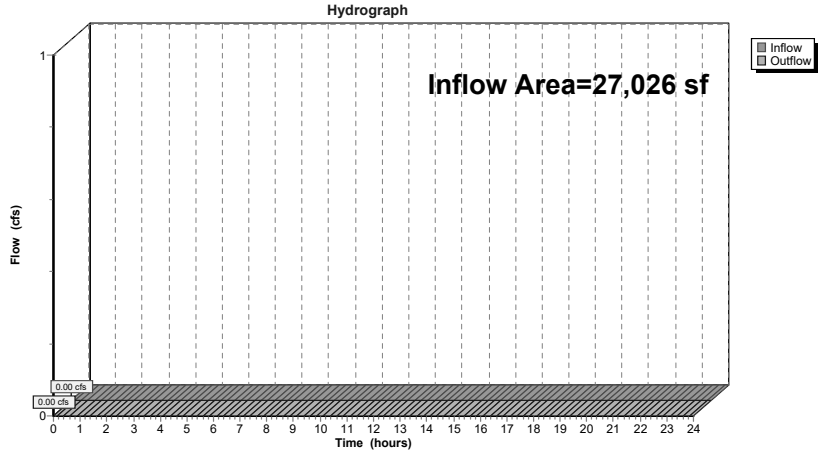
Summary for Reach 1R: Offsite East at High Plain Rd

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

Inflow Area = 27,026 sf, 72.97% Impervious, Inflow Depth = 0.00" for 2-Year event
Inflow = 0.00 cfs @ 0.00 hrs, Volume= 0 cf
Outflow = 0.00 cfs @ 0.00 hrs, Volume= 0 cf, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs

Reach 1R: Offsite East at High Plain Rd



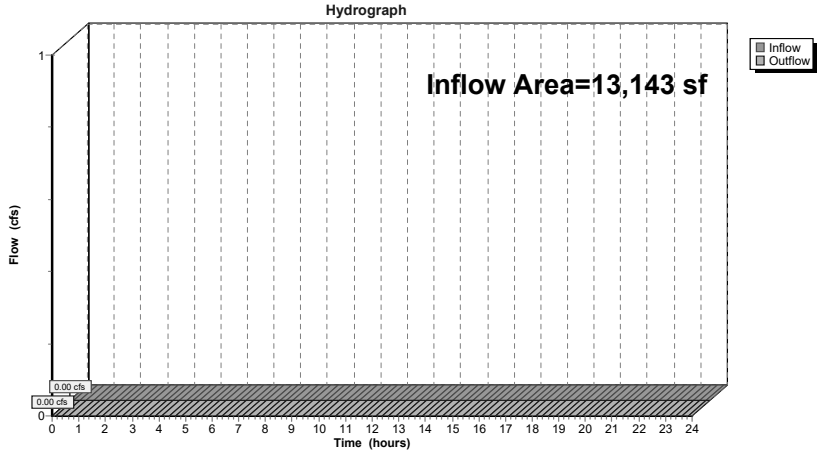
Summary for Reach 2R: Offsite East at Haggets Pond Rd

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

Inflow Area = 13,143 sf, 68.23% Impervious, Inflow Depth = 0.00" for 2-Year event
Inflow = 0.00 cfs @ 0.00 hrs, Volume= 0 cf
Outflow = 0.00 cfs @ 0.00 hrs, Volume= 0 cf, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs

Reach 2R: Offsite East at Haggets Pond Rd



Summary for Pond 1P: Bio-Ret #1

Inflow Area = 9,719 sf, 77.71% Impervious, Inflow Depth > 2.58" for 2-Year event
Inflow = 0.64 cfs @ 12.08 hrs, Volume= 2,093 cf
Outflow = 0.28 cfs @ 12.28 hrs, Volume= 2,018 cf, Atten= 57%, Lag= 11.5 min
Discarded = 0.22 cfs @ 12.28 hrs, Volume= 1,991 cf
Primary = 0.05 cfs @ 12.28 hrs, Volume= 27 cf
Routed to Pond 2P : High Plain culvert

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Peak Elev= 131.67' @ 12.28 hrs Surf.Area= 1,139 sf Storage= 685 cf

Plug-Flow detention time= (not calculated: outflow precedes inflow)
Center-of-Mass det. time= 70.1 min (851.1 - 781.0)

Volume	Invert	Avail.Storage	Storage Description
#1	130.00'	1,165 cf	**Custom Stage Data (Irregular)** Listed below (Recalc)

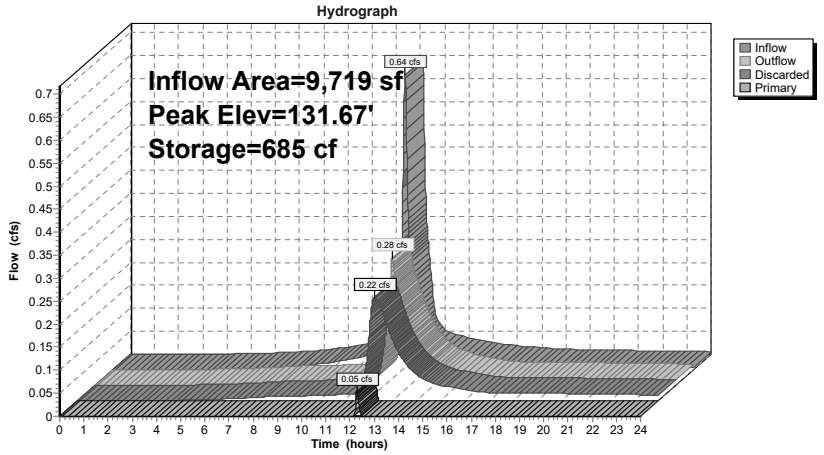
Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
130.00	174	57.4	0	0	174
131.00	301	70.0	235	235	317
132.00	1,761	305.1	930	1,165	7,337

Device	Routing	Invert	Outlet Devices
#1	Primary	131.65'	**10.0' long x 3.0' 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 4.00 4.50 Coef. (English) 2.44 2.58 2.68 2.67 2.65 2.64 2.64 2.68 2.68 2.72 2.81 2.92 2.97 3.07 3.32
#2	Discarded	130.00'	**2.410 in/hr Exfiltration over Wetted area**

Discarded OutFlow Max=0.22 cfs @ 12.28 hrs HW=131.67' (Free Discharge)
↑—**2=Exfiltration** (Exfiltration Controls 0.22 cfs)

Primary OutFlow Max=0.05 cfs @ 12.28 hrs HW=131.67' TW=131.11' (Dynamic Tailwater)
↑—**1=Broad-Crested Rectangular Weir** (Weir Controls 0.05 cfs @ 0.31 fps)

Pond 1P: Bio-Ret #1



Summary for Pond 2P: High Plain culvert

Inflow Area = 16,916 sf, 56.81% Impervious, Inflow Depth > 0.84" for 2-Year event
Inflow = 0.38 cfs @ 12.09 hrs, Volume= 1,191 cf
Outflow = 0.13 cfs @ 12.41 hrs, Volume= 1,187 cf, Atten= 67%, Lag= 19.6 min
Discarded = 0.13 cfs @ 12.41 hrs, Volume= 1,187 cf
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0 cf
Routed to Reach 1R : Offsite East at High Plain Rd

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Peak Elev= 131.14' @ 12.41 hrs Surf.Area= 786 sf Storage= 344 cf

Plug-Flow detention time= 32.4 min calculated for 1,187 cf (100% of inflow)
Center-of-Mass det. time= 30.5 min (843.9 - 813.4)

Volume	Invert	Avail.Storage	Storage Description
#1	130.00'	2,388 cf	**Custom Stage Data (Irregular)** Listed below (Recalc)

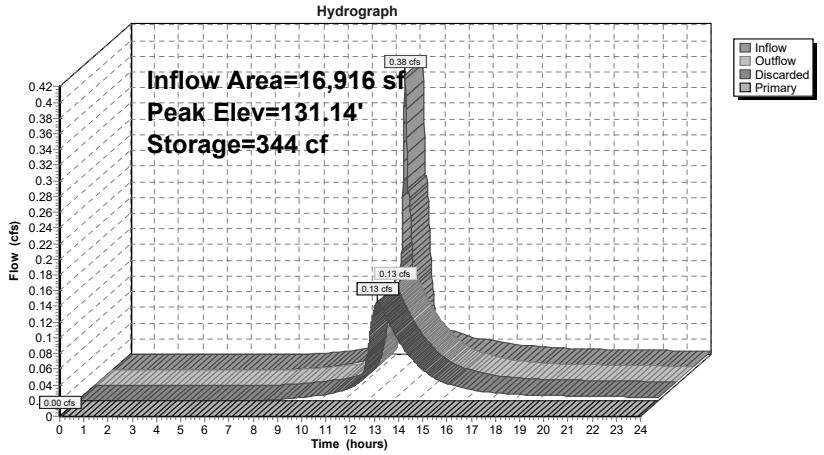
Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
130.00	5	5.0	0	0	5
131.00	663	145.5	242	242	1,689
132.00	1,761	305.1	1,168	1,410	7,417
132.50	2,157	292.9	978	2,388	8,016

Device	Routing	Invert	Outlet Devices
#1	Primary	131.50'	**36.0" Round Culvert** L= 24.0' CPP, end-section conforming to fill, Ke= 0.500 Inlet / Outlet Invert= 131.50' / 131.00' S= 0.0208 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 7.07 sf
#2	Discarded	130.00'	**2.410 in/hr Exfiltration over Wetted area**

Discarded OutFlow Max=0.13 cfs @ 12.41 hrs HW=131.14' (Free Discharge)
↑**2=Exfiltration** (Exfiltration Controls 0.13 cfs)

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=130.00' TW=0.00' (Dynamic Tailwater)
↑**1=Culvert** (Controls 0.00 cfs)

Pond 2P: High Plain culvert



Summary for Pond 3P: High Plain infilt

[92] Warning: Device #1 is above defined storage
[87] Warning: Oscillations may require smaller dt or Finer Routing (severity=587)

Inflow Area = 10,110 sf,100.00% Impervious, Inflow Depth > 2.91" for 2-Year event
Inflow = 0.71 cfs @ 12.08 hrs, Volume= 2,448 cf
Outflow = 0.58 cfs @ 12.14 hrs, Volume= 2,448 cf, Atten= 18%, Lag= 3.3 min
Discarded = 0.58 cfs @ 12.14 hrs, Volume= 2,448 cf
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0 cf
Routed to Reach 1R : Offsite East at High Plain Rd

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Peak Elev= 133.34' @ 12.14 hrs Surf.Area= 10,344 sf Storage= 33 cf

Plug-Flow detention time= (not calculated: outflow precedes inflow)
Center-of-Mass det. time= 0.1 min (756.3 - 756.2)

Volume	Invert	Avail.Storage	Storage Description
#1	133.33'	8,275 cf	**Custom Stage Data (Conic)** Listed below (Recalc) 20,688 cf Overall x 40.0% Voids

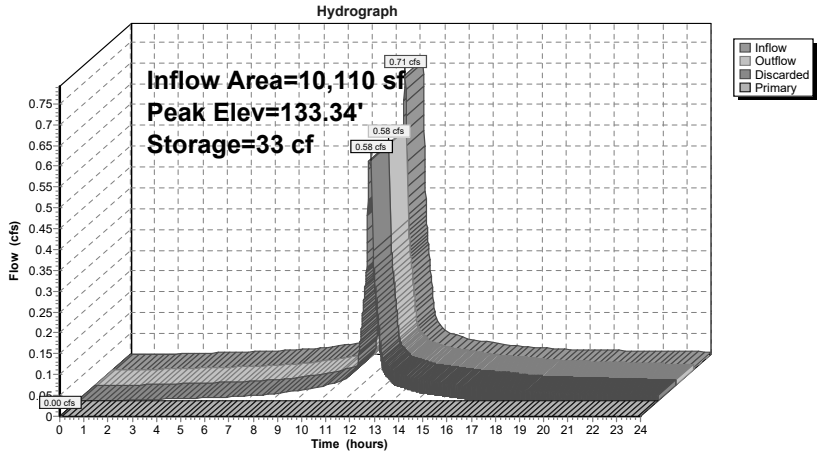
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
133.33	10,344	0	0	10,344
134.00	10,344	6,930	6,930	10,586
134.33	10,344	3,414	10,344	10,705
135.00	10,344	6,930	17,274	10,946
135.33	10,344	3,414	20,688	11,065

Device	Routing	Invert	Outlet Devices
#1	Primary	135.33'	**25.0' 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
#2	Discarded	133.33'	**2.410 in/hr Exfiltration over Wetted area**

Discarded OutFlow Max=0.58 cfs @ 12.14 hrs HW=133.34' (Free Discharge)
↑**2=Exfiltration** (Exfiltration Controls 0.58 cfs)

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=133.33' TW=0.00' (Dynamic Tailwater)
↑**1=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond 3P: High Plain infilt



Summary for Pond 4P: Bio-Ret #2

Inflow Area = 6,157 sf, 61.25% Impervious, Inflow Depth > 1.75" for 2-Year event
Inflow = 0.29 cfs @ 12.09 hrs, Volume= 896 cf
Outflow = 0.07 cfs @ 12.49 hrs, Volume= 892 cf, Atten= 75%, Lag= 24.1 min
Discarded = 0.07 cfs @ 12.49 hrs, Volume= 892 cf
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0 cf
Routed to Reach 2R : Offsite East at Haggets Pond Rd

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Peak Elev= 123.47' @ 12.49 hrs Surf.Area= 723 sf Storage= 261 cf

Plug-Flow detention time= 35.3 min calculated for 891 cf (100% of inflow)
Center-of-Mass det. time= 32.7 min (855.0 - 822.4)

Volume	Invert	Avail.Storage	Storage Description
#1	121.00'	1,103 cf	**Custom Stage Data (Irregular)** Listed below (Recalc) 2,757 cf Overall x 40.0% Voids

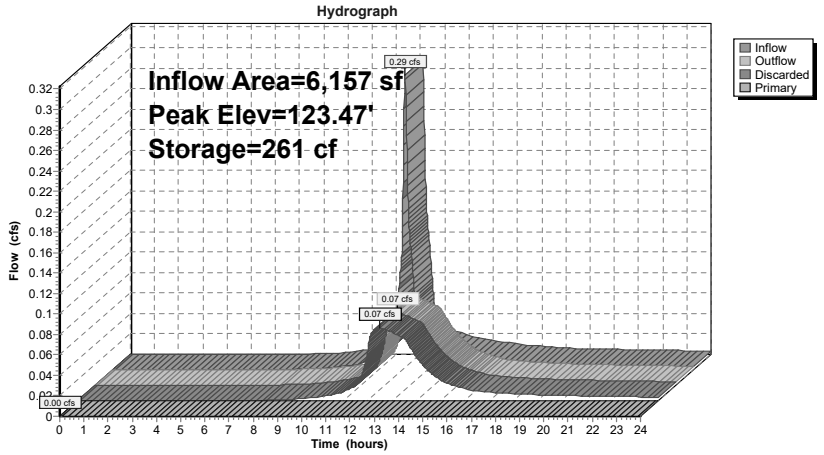
Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
121.00	5	5.0	0	0	5
122.00	61	42.0	28	28	145
123.00	643	117.1	301	329	1,100
124.00	816	134.8	728	1,056	1,476
125.00	1,251	164.0	1,026	2,082	2,186
125.50	1,451	179.7	675	2,757	2,624

Device	Routing	Invert	Outlet Devices
#1	Primary	125.00'	**10.0' long x 4.0' 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 4.00 4.50 5.00 5.50 Coef. (English) 2.38 2.54 2.69 2.68 2.67 2.67 2.65 2.66 2.66 2.68 2.72 2.73 2.76 2.79 2.88 3.07 3.32
#2	Discarded	121.00'	**2.410 in/hr Exfiltration over Wetted area**

Discarded OutFlow Max=0.07 cfs @ 12.49 hrs HW=123.47' (Free Discharge)
↑**2=Exfiltration** (Exfiltration Controls 0.07 cfs)

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=121.00' TW=0.00' (Dynamic Tailwater)
↑**1=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond 4P: Bio-Ret #2



Summary for Pond 6P: Haggetts S infilt

[87] Warning: Oscillations may require smaller dt or Finer Routing (severity=551)

Inflow Area = 6,986 sf, 74.39% Impervious, Inflow Depth > 1.86" for 2-Year event
Inflow = 0.35 cfs @ 12.09 hrs, Volume= 1,083 cf
Outflow = 0.13 cfs @ 12.36 hrs, Volume= 1,084 cf, Atten= 63%, Lag= 16.1 min
Discarded = 0.13 cfs @ 12.36 hrs, Volume= 1,084 cf
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0 cf
Routed to Reach 2R : Offsite East at Haggets Pond Rd

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Peak Elev= 129.19' @ 12.36 hrs Surf.Area= 2,313 sf Storage= 139 cf

Plug-Flow detention time= (not calculated: outflow precedes inflow)
Center-of-Mass det. time= 4.5 min (823.5 - 819.0)

Volume	Invert	Avail.Storage	Storage Description
#1A	129.04'	1,417 cf	**25.00'W x 92.50'L x 2.04'H Field A** 4,721 cf Overall - 1,179 cf Embedded = 3,542 cf x 40.0% Voids
#2A	129.54'	1,179 cf	**Cultec C-100HD** x 84 Inside #1 Effective Size= 32.1"W x 12.0"H => 1.86 sf x 7.50'L = 14.0 cf Overall Size= 36.0"W x 12.5"H x 8.00'L with 0.50' Overlap Row Length Adjustment= +0.50' x 1.86 sf x 7 rows
		2,596 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Primary	130.00'	**4.0' long Sharp-Crested Rectangular Weir** 2 End Contraction(s)
#2	Discarded	129.04'	**2.410 in/hr Exfiltration over Wetted area**

Discarded OutFlow Max=0.13 cfs @ 12.36 hrs HW=129.19' (Free Discharge)
↑—**2=Exfiltration** (Exfiltration Controls 0.13 cfs)

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=129.04' TW=0.00' (Dynamic Tailwater)
↑—**1=Sharp-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond 6P: Haggetts S infilt - Chamber Wizard Field A

Chamber Model = Cultec C-100HD (Cultec Contactor® 100HD)
Effective Size= 32.1"W x 12.0"H => 1.86 sf x 7.50'L = 14.0 cf
Overall Size= 36.0"W x 12.5"H x 8.00'L with 0.50' Overlap
Row Length Adjustment= +0.50' x 1.86 sf x 7 rows

36.0" Wide + 4.0" Spacing = 40.0" C-C Row Spacing

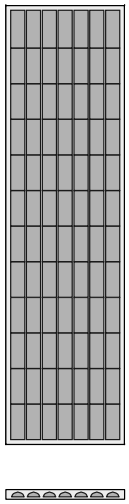
12 Chambers/Row x 7.50' Long +0.50' Row Adjustment = 90.50' Row Length +12.0" End Stone x 2 = 92.50' Base Length
7 Rows x 36.0" Wide + 4.0" Spacing x 6 + 12.0" Side Stone x 2 = 25.00' Base Width
6.0" Stone Base + 12.5" Chamber Height + 6.0" Stone Cover = 2.04' Field Height

84 Chambers x 14.0 cf +0.50' Row Adjustment x 1.86 sf x 7 Rows = 1,179.3 cf Chamber Storage

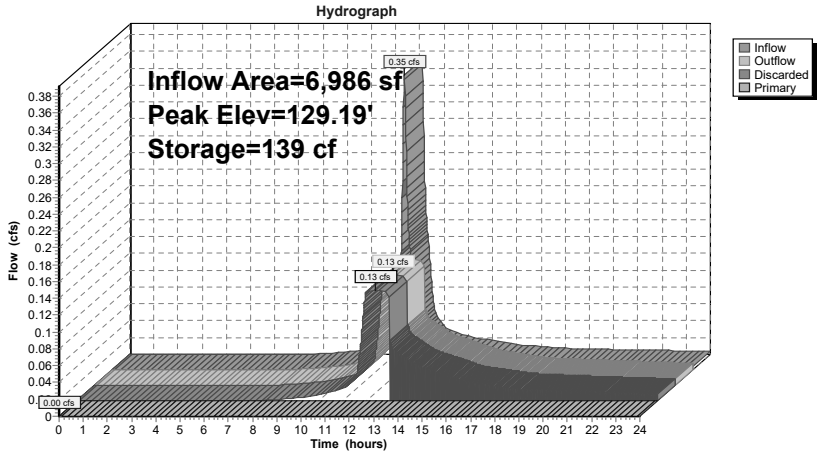
4,721.4 cf Field - 1,179.3 cf Chambers = 3,542.1 cf Stone x 40.0% Voids = 1,416.8 cf Stone Storage

Chamber Storage + Stone Storage = 2,596.1 cf = 0.060 af
Overall Storage Efficiency = 55.0%
Overall System Size = 92.50' x 25.00' x 2.04'

84 Chambers
174.9 cy Field
131.2 cy Stone



Pond 6P: Haggetts S infilt



Time span=0.00-24.00 hrs, dt=0.01 hrs, 2401 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment1S: Bio-Ret #1 Runoff Area=9,719 sf 77.71% Impervious Runoff Depth>4.38"
Tc=6.0 min CN=95 Runoff=1.05 cfs 3,544 cf

Subcatchment2S: High Plain culvert Runoff Area=7,197 sf 28.58% Impervious Runoff Depth>3.63"
Tc=6.0 min CN=88 Runoff=0.69 cfs 2,176 cf

Subcatchment3S: High Plain Prkg Runoff Area=10,110 sf 100.00% Impervious Runoff Depth>4.72"
Tc=6.0 min CN=98 Runoff=1.13 cfs 3,976 cf

Subcatchment4S: Haggetts Pond N Prkg Runoff Area=2,955 sf 68.36% Impervious Runoff Depth>3.73"
Tc=6.0 min CN=89 Runoff=0.29 cfs 919 cf

Subcatchment5S: Haggets Pond CB Runoff Area=3,202 sf 54.68% Impervious Runoff Depth>3.04"
Tc=6.0 min CN=82 Runoff=0.26 cfs 811 cf

Subcatchment6S: Haggetts Pond S Prkg Runoff Area=6,986 sf 74.39% Impervious Runoff Depth>3.53"
Tc=6.0 min CN=87 Runoff=0.65 cfs 2,053 cf

Reach 1R: Offsite East at High Plain Rd Inflow=0.25 cfs 265 cf
Outflow=0.25 cfs 265 cf

Reach 2R: Offsite East at Haggets Pond Rd Inflow=0.00 cfs 0 cf
Outflow=0.00 cfs 0 cf

Pond 1P: Bio-Ret #1 Peak Elev=131.74' Storage=778 cf Inflow=1.05 cfs 3,544 cf
Discarded=0.26 cfs 2,825 cf Primary=0.70 cfs 558 cf Outflow=0.97 cfs 3,384 cf

Pond 2P: High Plain culvert Peak Elev=131.68' Storage=914 cf Inflow=1.36 cfs 2,734 cf
Discarded=0.29 cfs 2,462 cf Primary=0.25 cfs 265 cf Outflow=0.54 cfs 2,727 cf

Pond 3P: High Plain infilt Peak Elev=133.39' Storage=257 cf Inflow=1.13 cfs 3,976 cf
Discarded=0.58 cfs 3,977 cf Primary=0.00 cfs 0 cf Outflow=0.58 cfs 3,977 cf

Pond 4P: Bio-Ret #2 Peak Elev=124.48' Storage=596 cf Inflow=0.55 cfs 1,730 cf
Discarded=0.10 cfs 1,722 cf Primary=0.00 cfs 0 cf Outflow=0.10 cfs 1,722 cf

Pond 6P: Haggetts S infilt Peak Elev=129.56' Storage=499 cf Inflow=0.65 cfs 2,053 cf
Discarded=0.14 cfs 2,053 cf Primary=0.00 cfs 0 cf Outflow=0.14 cfs 2,053 cf

Total Runoff Area = 40,169 sf Runoff Volume = 13,479 cf Average Runoff Depth = 4.03"
28.58% Pervious = 11,481 sf 71.42% Impervious = 28,688 sf

Summary for Subcatchment 1S: Bio-Ret #1

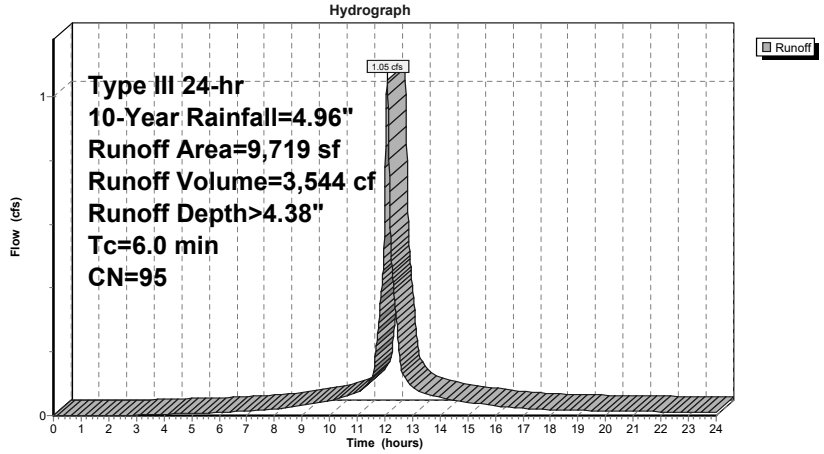
Runoff = 1.05 cfs @ 12.08 hrs, Volume= 3,544 cf, Depth> 4.38"
Routed to Pond 1P : Bio-Ret #1

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-Year Rainfall=4.96"

Area (sf)	CN	Description
2,119	86	<50% Grass cover, Poor, HSG C
47	89	Gravel roads, HSG C
7,553	98	Paved parking, HSG C
9,719	95	Weighted Average
2,166		22.29% Pervious Area
7,553		77.71% Impervious Area

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

Subcatchment 1S: Bio-Ret #1



Summary for Subcatchment 2S: High Plain culvert

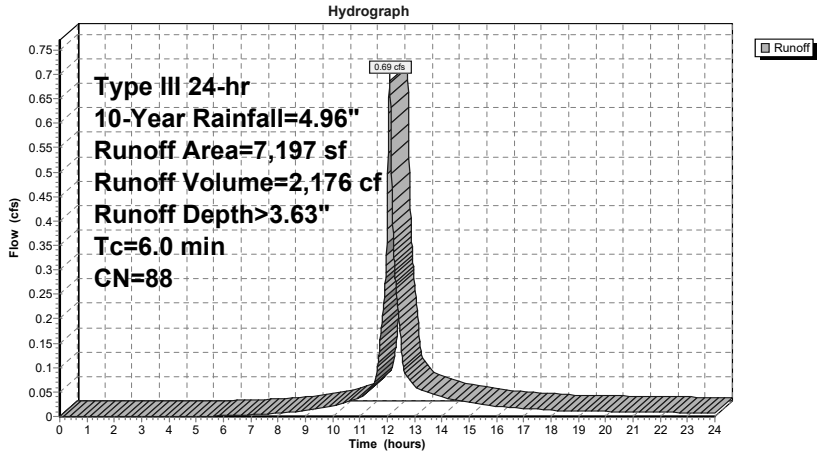
Runoff = 0.69 cfs @ 12.09 hrs, Volume= 2,176 cf, Depth> 3.63"
Routed to Pond 2P : High Plain culvert

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-Year Rainfall=4.96"

Area (sf)	CN	Description
2,666	86	<50% Grass cover, Poor, HSG C
1,418	74	>75% Grass cover, Good, HSG C
1,056	89	Gravel roads, HSG C
1,953	98	Paved parking, HSG C
104	98	Water Surface, HSG C
7,197	88	Weighted Average
5,140		71.42% Pervious Area
2,057		28.58% Impervious Area

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

Subcatchment 2S: High Plain culvert



Summary for Subcatchment 3S: High Plain Prkg

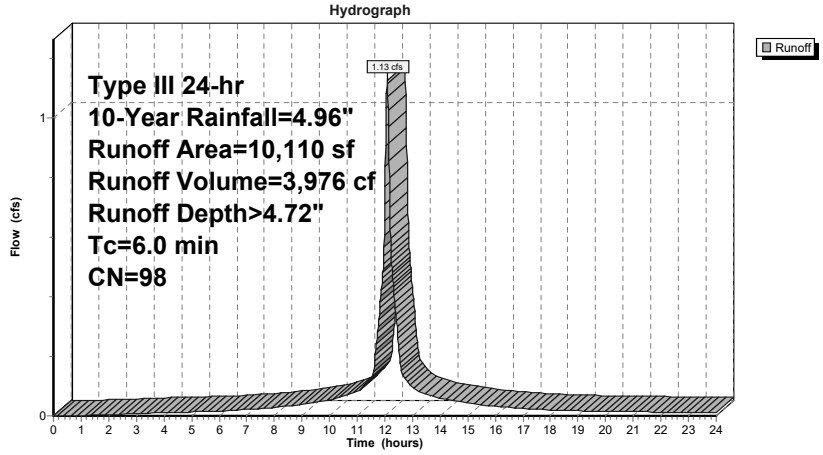
Runoff = 1.13 cfs @ 12.08 hrs, Volume= 3,976 cf, Depth> 4.72"
Routed to Pond 3P : High Plain infilt

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-Year Rainfall=4.96"

Area (sf)	CN	Description
4,576	98	Paved parking, HSG A
5,534	98	Paved parking, HSG C
10,110	98	Weighted Average
10,110		100.00% Impervious Area

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

Subcatchment 3S: High Plain Prkg



Summary for Subcatchment 4S: Haggetts Pond N Prkg

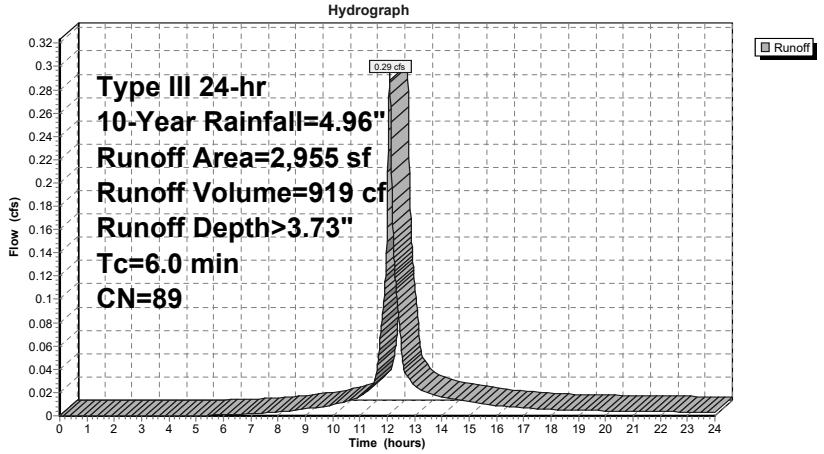
Runoff = 0.29 cfs @ 12.09 hrs, Volume= 919 cf, Depth> 3.73"
Routed to Pond 4P : Bio-Ret #2

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-Year Rainfall=4.96"

Area (sf)	CN	Description
2,020	98	Paved parking, HSG A
935	68	<50% Grass cover, Poor, HSG A
2,955	89	Weighted Average
935		31.64% Pervious Area
2,020		68.36% Impervious Area

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

Subcatchment 4S: Haggetts Pond N Prkg



Summary for Subcatchment 5S: Haggets Pond CB

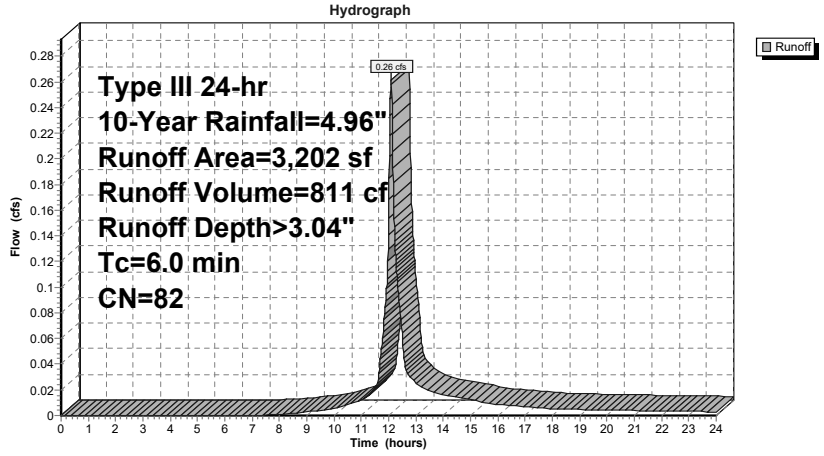
Runoff = 0.26 cfs @ 12.09 hrs, Volume= 811 cf, Depth> 3.04"
Routed to Pond 4P : Bio-Ret #2

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-Year Rainfall=4.96"

Area (sf)	CN	Description
1,751	98	Paved parking, HSG A
921	68	<50% Grass cover, Poor, HSG A
249	76	Gravel roads, HSG A
281	30	Woods, Good, HSG A
3,202	82	Weighted Average
1,451		45.32% Pervious Area
1,751		54.68% Impervious Area

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

Subcatchment 5S: Haggets Pond CB



Summary for Subcatchment 6S: Haggetts Pond S Prkg

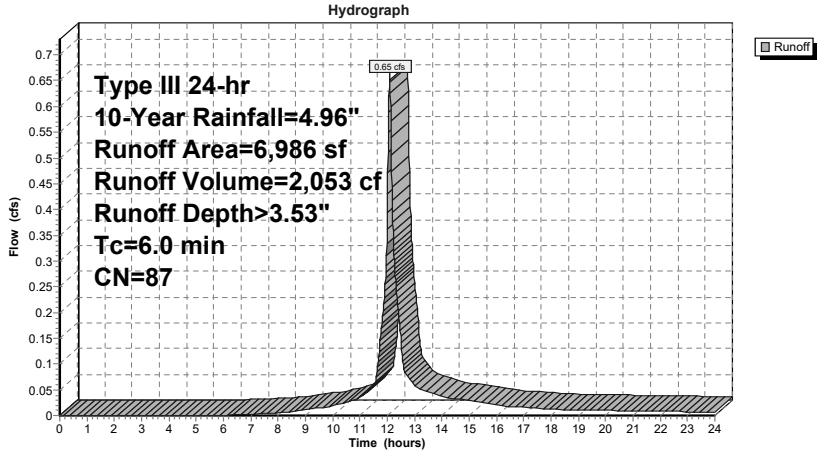
Runoff = 0.65 cfs @ 12.09 hrs, Volume= 2,053 cf, Depth> 3.53"
Routed to Pond 6P : Haggetts S infilt

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-Year Rainfall=4.96"

Area (sf)	CN	Description
5,197	98	Paved parking, HSG A
448	76	Gravel roads, HSG A
546	68	<50% Grass cover, Poor, HSG A
795	30	Woods, Good, HSG A
6,986	87	Weighted Average
1,789		25.61% Pervious Area
5,197		74.39% Impervious Area

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

Subcatchment 6S: Haggetts Pond S Prkg



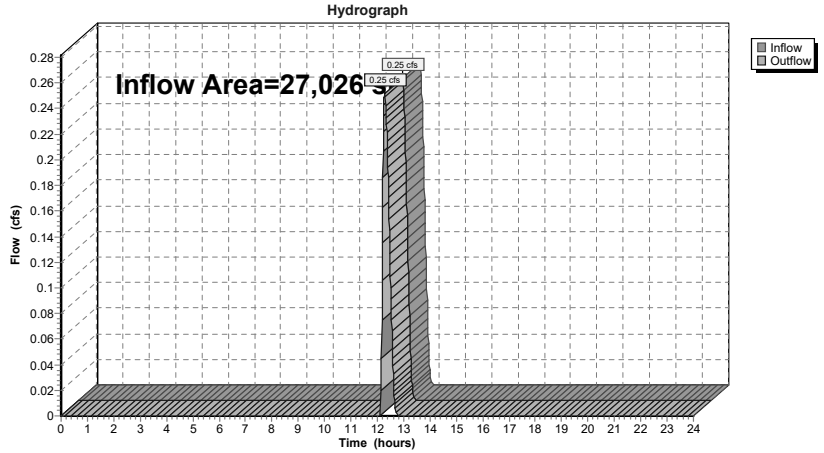
Summary for Reach 1R: Offsite East at High Plain Rd

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

Inflow Area = 27,026 sf, 72.97% Impervious, Inflow Depth = 0.12" for 10-Year event
Inflow = 0.25 cfs @ 12.28 hrs, Volume= 265 cf
Outflow = 0.25 cfs @ 12.28 hrs, Volume= 265 cf, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs

Reach 1R: Offsite East at High Plain Rd



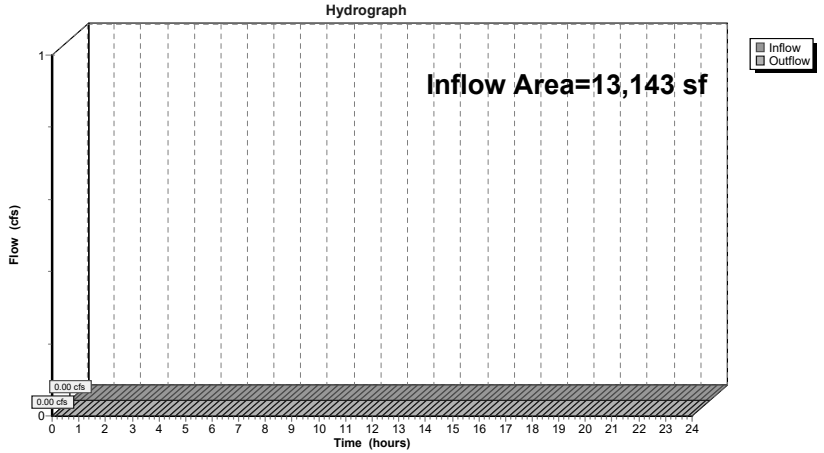
Summary for Reach 2R: Offsite East at Haggets Pond Rd

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

Inflow Area = 13,143 sf, 68.23% Impervious, Inflow Depth = 0.00" for 10-Year event
Inflow = 0.00 cfs @ 0.00 hrs, Volume= 0 cf
Outflow = 0.00 cfs @ 0.00 hrs, Volume= 0 cf, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs

Reach 2R: Offsite East at Haggets Pond Rd



Summary for Pond 1P: Bio-Ret #1

Inflow Area = 9,719 sf, 77.71% Impervious, Inflow Depth > 4.38" for 10-Year event
Inflow = 1.05 cfs @ 12.08 hrs, Volume= 3,544 cf
Outflow = 0.97 cfs @ 12.12 hrs, Volume= 3,384 cf, Atten= 8%, Lag= 2.1 min
Discarded = 0.26 cfs @ 12.12 hrs, Volume= 2,825 cf
Primary = 0.70 cfs @ 12.12 hrs, Volume= 558 cf
Routed to Pond 2P : High Plain culvert

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Peak Elev= 131.74' @ 12.12 hrs Surf.Area= 1,272 sf Storage= 778 cf

Plug-Flow detention time= 70.8 min calculated for 3,384 cf (95% of inflow)
Center-of-Mass det. time= 44.6 min (812.5 - 767.9)

Volume	Invert	Avail.Storage	Storage Description
#1	130.00'	1,165 cf	**Custom Stage Data (Irregular)** Listed below (Recalc)

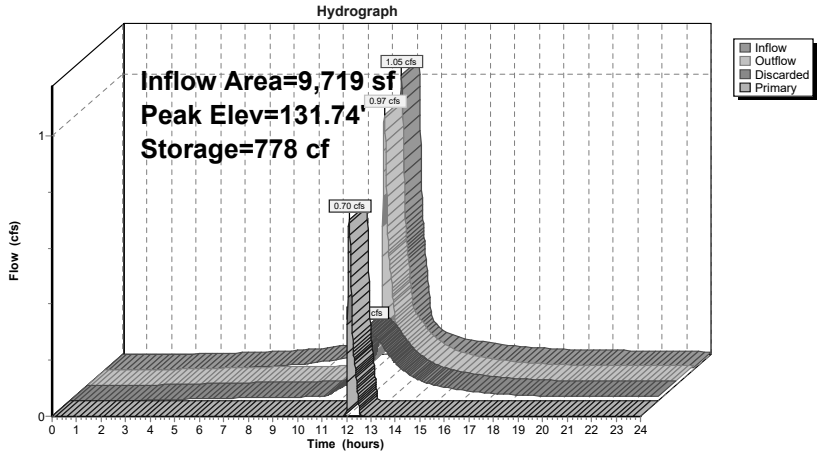
Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
130.00	174	57.4	0	0	174
131.00	301	70.0	235	235	317
132.00	1,761	305.1	930	1,165	7,337

Device	Routing	Invert	Outlet Devices
#1	Primary	131.65'	**10.0' long x 3.0' 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 4.00 4.50 Coef. (English) 2.44 2.58 2.68 2.67 2.65 2.64 2.64 2.68 2.68 2.72 2.81 2.92 2.97 3.07 3.32
#2	Discarded	130.00'	**2.410 in/hr Exfiltration over Wetted area**

Discarded OutFlow Max=0.26 cfs @ 12.12 hrs HW=131.74' (Free Discharge)
↑—**2=Exfiltration** (Exfiltration Controls 0.26 cfs)

Primary OutFlow Max=0.70 cfs @ 12.12 hrs HW=131.74' TW=131.45' (Dynamic Tailwater)
↑—**1=Broad-Crested Rectangular Weir** (Weir Controls 0.70 cfs @ 0.75 fps)

Pond 1P: Bio-Ret #1



Summary for Pond 2P: High Plain culvert

Inflow Area = 16,916 sf, 56.81% Impervious, Inflow Depth > 1.94" for 10-Year event
Inflow = 1.36 cfs @ 12.11 hrs, Volume= 2,734 cf
Outflow = 0.54 cfs @ 12.28 hrs, Volume= 2,727 cf, Atten= 60%, Lag= 10.5 min
Discarded = 0.29 cfs @ 12.28 hrs, Volume= 2,462 cf
Primary = 0.25 cfs @ 12.28 hrs, Volume= 265 cf
Routed to Reach 1R : Offsite East at High Plain Rd

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Peak Elev= 131.68' @ 12.28 hrs Surf.Area= 1,353 sf Storage= 914 cf

Plug-Flow detention time= 35.9 min calculated for 2,726 cf (100% of inflow)
Center-of-Mass det. time= 34.2 min (818.3 - 784.1)

Volume	Invert	Avail.Storage	Storage Description
#1	130.00'	2,388 cf	**Custom Stage Data (Irregular)** Listed below (Recalc)

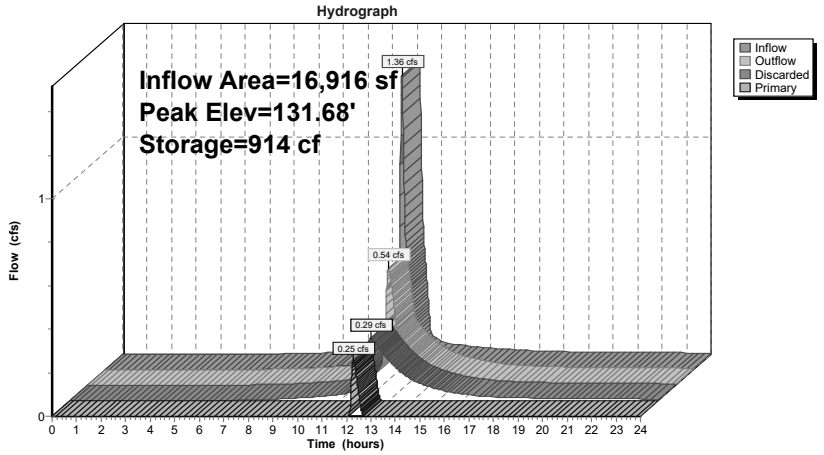
Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
130.00	5	5.0	0	0	5
131.00	663	145.5	242	242	1,689
132.00	1,761	305.1	1,168	1,410	7,417
132.50	2,157	292.9	978	2,388	8,016

Device	Routing	Invert	Outlet Devices
#1	Primary	131.50'	**36.0" Round Culvert** L= 24.0' CPP, end-section conforming to fill, Ke= 0.500 Inlet / Outlet Invert= 131.50' / 131.00' S= 0.0208 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 7.07 sf
#2	Discarded	130.00'	**2.410 in/hr Exfiltration over Wetted area**

Discarded OutFlow Max=0.29 cfs @ 12.28 hrs HW=131.68' (Free Discharge)
↑**2=Exfiltration** (Exfiltration Controls 0.29 cfs)

Primary OutFlow Max=0.25 cfs @ 12.28 hrs HW=131.68' TW=0.00' (Dynamic Tailwater)
↑**1=Culvert** (Inlet Controls 0.25 cfs @ 1.45 fps)

Pond 2P: High Plain culvert



Summary for Pond 3P: High Plain infilt

[92] Warning: Device #1 is above defined storage
[87] Warning: Oscillations may require smaller dt or Finer Routing (severity=570)

Inflow Area = 10,110 sf,100.00% Impervious, Inflow Depth > 4.72" for 10-Year event
Inflow = 1.13 cfs @ 12.08 hrs, Volume= 3,976 cf
Outflow = 0.58 cfs @ 12.22 hrs, Volume= 3,977 cf, Atten= 49%, Lag= 8.0 min
Discarded = 0.58 cfs @ 12.22 hrs, Volume= 3,977 cf
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0 cf
Routed to Reach 1R : Offsite East at High Plain Rd

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Peak Elev= 133.39' @ 12.22 hrs Surf.Area= 10,344 sf Storage= 257 cf

Plug-Flow detention time= (not calculated: outflow precedes inflow)
Center-of-Mass det. time= 1.4 min (749.0 - 747.6)

Volume	Invert	Avail.Storage	Storage Description
#1	133.33'	8,275 cf	**Custom Stage Data (Conic)** Listed below (Recalc) 20,688 cf Overall x 40.0% Voids

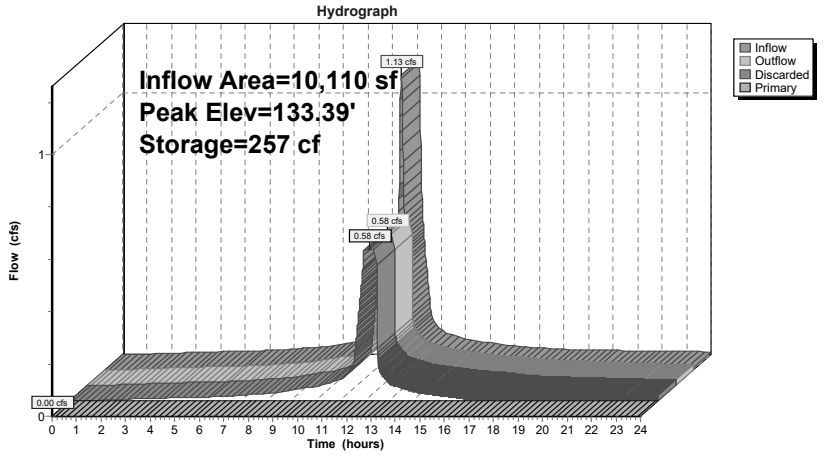
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
133.33	10,344	0	0	10,344
134.00	10,344	6,930	6,930	10,586
134.33	10,344	3,414	10,344	10,705
135.00	10,344	6,930	17,274	10,946
135.33	10,344	3,414	20,688	11,065

Device	Routing	Invert	Outlet Devices
#1	Primary	135.33'	**25.0' 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
#2	Discarded	133.33'	**2.410 in/hr Exfiltration over Wetted area**

Discarded OutFlow Max=0.58 cfs @ 12.22 hrs HW=133.39' (Free Discharge)
↑**2=Exfiltration** (Exfiltration Controls 0.58 cfs)

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=133.33' TW=0.00' (Dynamic Tailwater)
↑**1=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond 3P: High Plain infilt



Summary for Pond 4P: Bio-Ret #2

Inflow Area = 6,157 sf, 61.25% Impervious, Inflow Depth > 3.37" for 10-Year event
Inflow = 0.55 cfs @ 12.09 hrs, Volume= 1,730 cf
Outflow = 0.10 cfs @ 12.54 hrs, Volume= 1,722 cf, Atten= 82%, Lag= 27.4 min
Discarded = 0.10 cfs @ 12.54 hrs, Volume= 1,722 cf
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0 cf
Routed to Reach 2R : Offsite East at Haggets Pond Rd

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Peak Elev= 124.48' @ 12.54 hrs Surf.Area= 1,012 sf Storage= 596 cf

Plug-Flow detention time= 57.7 min calculated for 1,722 cf (100% of inflow)
Center-of-Mass det. time= 55.0 min (859.3 - 804.3)

Volume	Invert	Avail.Storage	Storage Description
#1	121.00'	1,103 cf	**Custom Stage Data (Irregular)** Listed below (Recalc) 2,757 cf Overall x 40.0% Voids

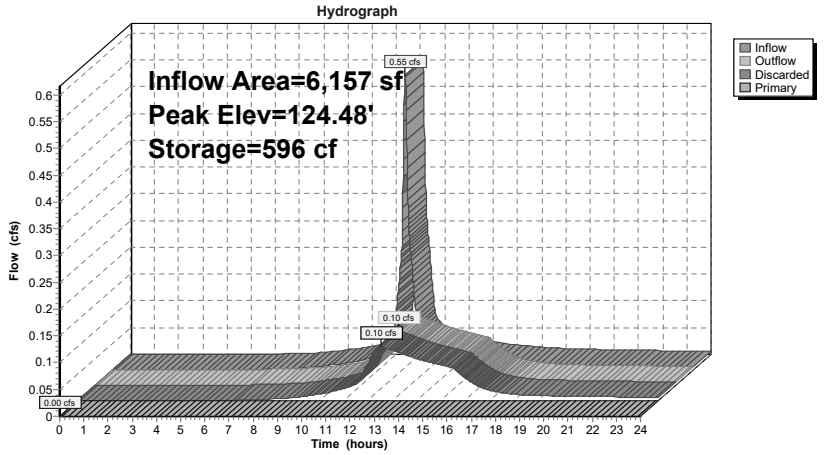
Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
121.00	5	5.0	0	0	5
122.00	61	42.0	28	28	145
123.00	643	117.1	301	329	1,100
124.00	816	134.8	728	1,056	1,476
125.00	1,251	164.0	1,026	2,082	2,186
125.50	1,451	179.7	675	2,757	2,624

Device	Routing	Invert	Outlet Devices
#1	Primary	125.00'	**10.0' long x 4.0' 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 4.00 4.50 5.00 5.50 Coef. (English) 2.38 2.54 2.69 2.68 2.67 2.67 2.65 2.66 2.66 2.68 2.72 2.73 2.76 2.79 2.88 3.07 3.32
#2	Discarded	121.00'	**2.410 in/hr Exfiltration over Wetted area**

Discarded OutFlow Max=0.10 cfs @ 12.54 hrs HW=124.48' (Free Discharge)
↑—**2=Exfiltration** (Exfiltration Controls 0.10 cfs)

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=121.00' TW=0.00' (Dynamic Tailwater)
↑—**1=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond 4P: Bio-Ret #2



Summary for Pond 6P: Haggetts S infilt

[87] Warning: Oscillations may require smaller dt or Finer Routing (severity=484)

Inflow Area = 6,986 sf, 74.39% Impervious, Inflow Depth > 3.53" for 10-Year event
Inflow = 0.65 cfs @ 12.09 hrs, Volume= 2,053 cf
Outflow = 0.14 cfs @ 12.51 hrs, Volume= 2,053 cf, Atten= 79%, Lag= 25.6 min
Discarded = 0.14 cfs @ 12.51 hrs, Volume= 2,053 cf
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0 cf
Routed to Reach 2R : Offsite East at Haggets Pond Rd

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Peak Elev= 129.56' @ 12.51 hrs Surf.Area= 2,313 sf Storage= 499 cf

Plug-Flow detention time= (not calculated: outflow precedes inflow)
Center-of-Mass det. time= 20.1 min (821.0 - 800.9)

Volume	Invert	Avail.Storage	Storage Description
#1A	129.04'	1,417 cf	**25.00'W x 92.50'L x 2.04'H Field A** 4,721 cf Overall - 1,179 cf Embedded = 3,542 cf x 40.0% Voids
#2A	129.54'	1,179 cf	**Cultec C-100HD** x 84 Inside #1 Effective Size= 32.1"W x 12.0"H => 1.86 sf x 7.50'L = 14.0 cf Overall Size= 36.0"W x 12.5"H x 8.00'L with 0.50' Overlap Row Length Adjustment= +0.50' x 1.86 sf x 7 rows
		2,596 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Primary	130.00'	**4.0' long Sharp-Crested Rectangular Weir** 2 End Contraction(s)
#2	Discarded	129.04'	**2.410 in/hr Exfiltration over Wetted area**

Discarded OutFlow Max=0.14 cfs @ 12.51 hrs HW=129.56' (Free Discharge)
↑—**2=Exfiltration** (Exfiltration Controls 0.14 cfs)

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=129.04' TW=0.00' (Dynamic Tailwater)
↑—**1=Sharp-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond 6P: Haggetts S infilt - Chamber Wizard Field A

Chamber Model = Cultec C-100HD (Cultec Contactor® 100HD)
Effective Size= 32.1"W x 12.0"H => 1.86 sf x 7.50'L = 14.0 cf
Overall Size= 36.0"W x 12.5"H x 8.00'L with 0.50' Overlap
Row Length Adjustment= +0.50' x 1.86 sf x 7 rows

36.0" Wide + 4.0" Spacing = 40.0" C-C Row Spacing

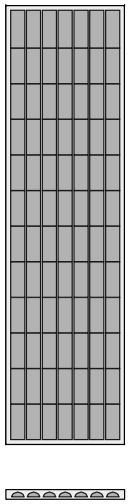
12 Chambers/Row x 7.50' Long +0.50' Row Adjustment = 90.50' Row Length +12.0" End Stone x 2 = 92.50' Base Length
7 Rows x 36.0" Wide + 4.0" Spacing x 6 + 12.0" Side Stone x 2 = 25.00' Base Width
6.0" Stone Base + 12.5" Chamber Height + 6.0" Stone Cover = 2.04' Field Height

84 Chambers x 14.0 cf +0.50' Row Adjustment x 1.86 sf x 7 Rows = 1,179.3 cf Chamber Storage

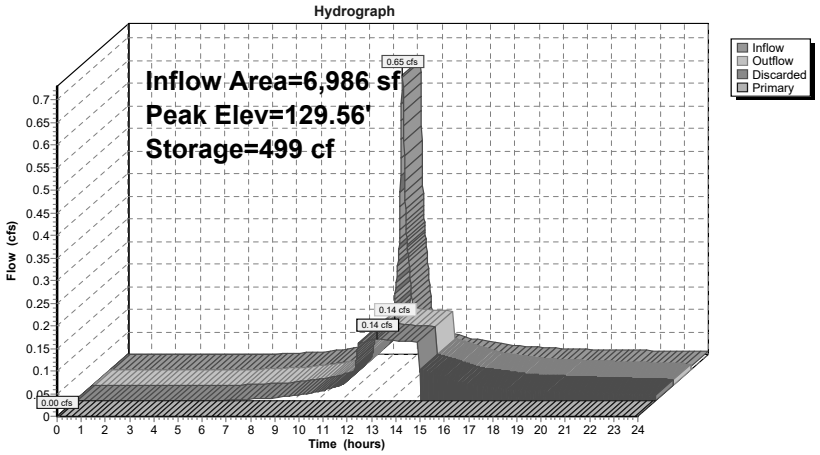
4,721.4 cf Field - 1,179.3 cf Chambers = 3,542.1 cf Stone x 40.0% Voids = 1,416.8 cf Stone Storage

Chamber Storage + Stone Storage = 2,596.1 cf = 0.060 af
Overall Storage Efficiency = 55.0%
Overall System Size = 92.50' x 25.00' x 2.04'

84 Chambers
174.9 cy Field
131.2 cy Stone



Pond 6P: Haggetts S infilt



Time span=0.00-24.00 hrs, dt=0.01 hrs, 2401 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment1S: Bio-Ret #1 Runoff Area=9,719 sf 77.71% Impervious Runoff Depth>5.50"
Tc=6.0 min CN=95 Runoff=1.31 cfs 4,452 cf

Subcatchment2S: High Plain culvert Runoff Area=7,197 sf 28.58% Impervious Runoff Depth>4.71"
Tc=6.0 min CN=88 Runoff=0.88 cfs 2,824 cf

Subcatchment3S: High Plain Prkg Runoff Area=10,110 sf 100.00% Impervious Runoff Depth>5.85"
Tc=6.0 min CN=98 Runoff=1.39 cfs 4,926 cf

Subcatchment4S: Haggetts Pond N Prkg Runoff Area=2,955 sf 68.36% Impervious Runoff Depth>4.82"
Tc=6.0 min CN=89 Runoff=0.37 cfs 1,186 cf

Subcatchment5S: Haggets Pond CB Runoff Area=3,202 sf 54.68% Impervious Runoff Depth>4.07"
Tc=6.0 min CN=82 Runoff=0.35 cfs 1,085 cf

Subcatchment6S: Haggetts Pond S Prkg Runoff Area=6,986 sf 74.39% Impervious Runoff Depth>4.60"
Tc=6.0 min CN=87 Runoff=0.84 cfs 2,677 cf

Reach 1R: Offsite East at High Plain Rd Inflow=0.59 cfs 744 cf
Outflow=0.59 cfs 744 cf

Reach 2R: Offsite East at Haggets Pond Rd Inflow=0.00 cfs 0 cf
Outflow=0.00 cfs 0 cf

Pond 1P: Bio-Ret #1 Peak Elev=131.78' Storage=831 cf Inflow=1.31 cfs 4,452 cf
Discarded=0.28 cfs 3,376 cf Primary=0.97 cfs 877 cf Outflow=1.24 cfs 4,253 cf

Pond 2P: High Plain culvert Peak Elev=131.78' Storage=1,053 cf Inflow=1.82 cfs 3,700 cf
Discarded=0.32 cfs 2,947 cf Primary=0.59 cfs 744 cf Outflow=0.92 cfs 3,691 cf

Pond 3P: High Plain infilt Peak Elev=133.44' Storage=455 cf Inflow=1.39 cfs 4,926 cf
Discarded=0.58 cfs 4,932 cf Primary=0.00 cfs 0 cf Outflow=0.58 cfs 4,932 cf

Pond 4P: Bio-Ret #2 Peak Elev=124.97' Storage=818 cf Inflow=0.72 cfs 2,271 cf
Discarded=0.12 cfs 2,261 cf Primary=0.00 cfs 0 cf Outflow=0.12 cfs 2,261 cf

Pond 6P: Haggetts S infilt Peak Elev=129.70' Storage=759 cf Inflow=0.84 cfs 2,677 cf
Discarded=0.14 cfs 2,678 cf Primary=0.00 cfs 0 cf Outflow=0.14 cfs 2,678 cf

Total Runoff Area = 40,169 sf Runoff Volume = 17,150 cf Average Runoff Depth = 5.12"
28.58% Pervious = 11,481 sf 71.42% Impervious = 28,688 sf

Summary for Subcatchment 1S: Bio-Ret #1

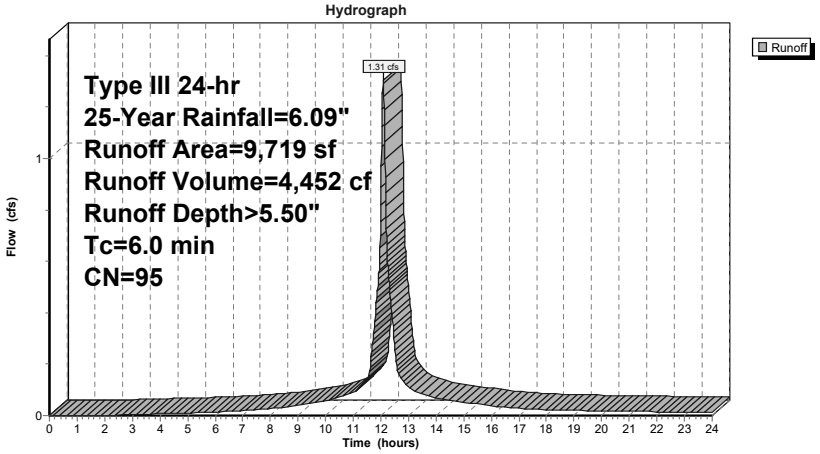
Runoff = 1.31 cfs @ 12.08 hrs, Volume= 4,452 cf, Depth> 5.50"
Routed to Pond 1P : Bio-Ret #1

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 25-Year Rainfall=6.09"

Area (sf)	CN	Description
2,119	86	<50% Grass cover, Poor, HSG C
47	89	Gravel roads, HSG C
7,553	98	Paved parking, HSG C
9,719	95	Weighted Average
2,166		22.29% Pervious Area
7,553		77.71% Impervious Area

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

Subcatchment 1S: Bio-Ret #1



Summary for Subcatchment 2S: High Plain culvert

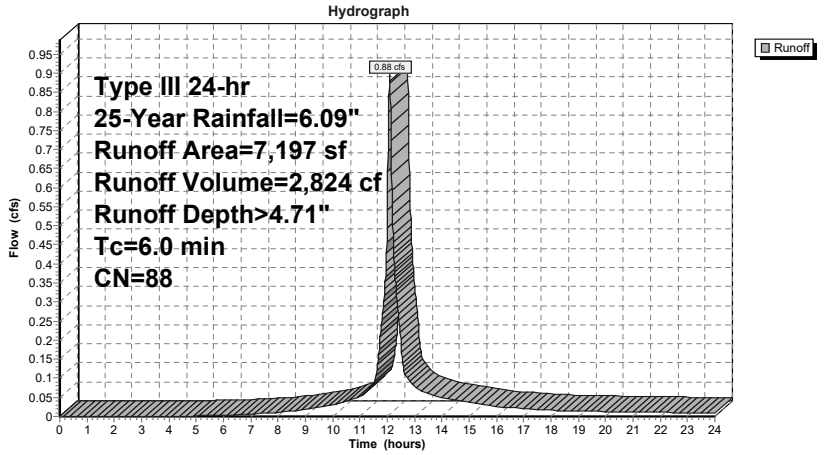
Runoff = 0.88 cfs @ 12.09 hrs, Volume= 2,824 cf, Depth> 4.71"
Routed to Pond 2P : High Plain culvert

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 25-Year Rainfall=6.09"

Area (sf)	CN	Description
2,666	86	<50% Grass cover, Poor, HSG C
1,418	74	>75% Grass cover, Good, HSG C
1,056	89	Gravel roads, HSG C
1,953	98	Paved parking, HSG C
104	98	Water Surface, HSG C
7,197	88	Weighted Average
5,140		71.42% Pervious Area
2,057		28.58% Impervious Area

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

Subcatchment 2S: High Plain culvert



Summary for Subcatchment 3S: High Plain Prkg

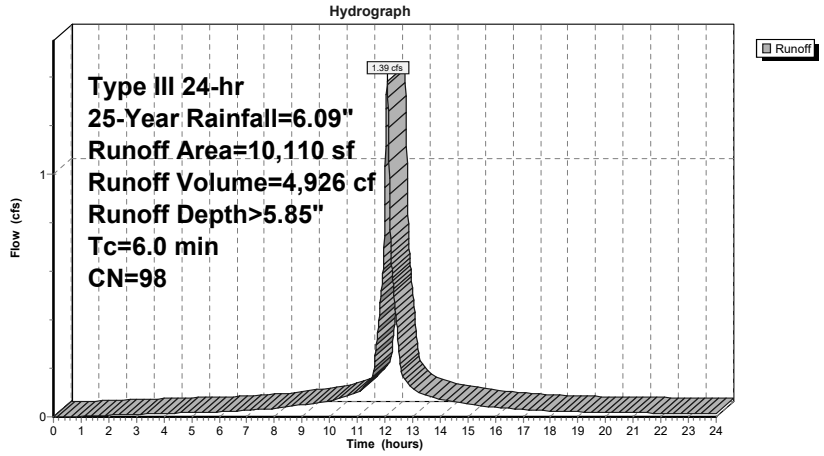
Runoff = 1.39 cfs @ 12.08 hrs, Volume= 4,926 cf, Depth> 5.85"
Routed to Pond 3P : High Plain infilt

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 25-Year Rainfall=6.09"

Area (sf)	CN	Description
4,576	98	Paved parking, HSG A
5,534	98	Paved parking, HSG C
10,110	98	Weighted Average
10,110		100.00% Impervious Area

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

Subcatchment 3S: High Plain Prkg



Summary for Subcatchment 4S: Haggetts Pond N Prkg

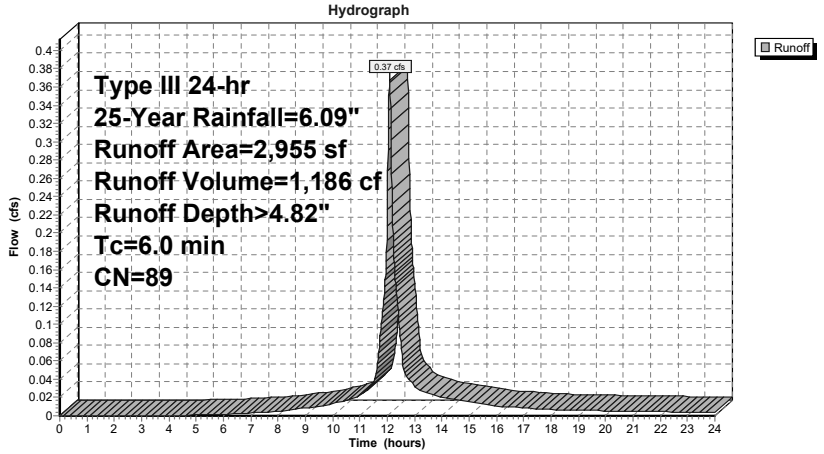
Runoff = 0.37 cfs @ 12.08 hrs, Volume= 1,186 cf, Depth> 4.82"
Routed to Pond 4P : Bio-Ret #2

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 25-Year Rainfall=6.09"

Area (sf)	CN	Description
2,020	98	Paved parking, HSG A
935	68	<50% Grass cover, Poor, HSG A
2,955	89	Weighted Average
935		31.64% Pervious Area
2,020		68.36% Impervious Area

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

Subcatchment 4S: Haggetts Pond N Prkg



Summary for Subcatchment 5S: Haggets Pond CB

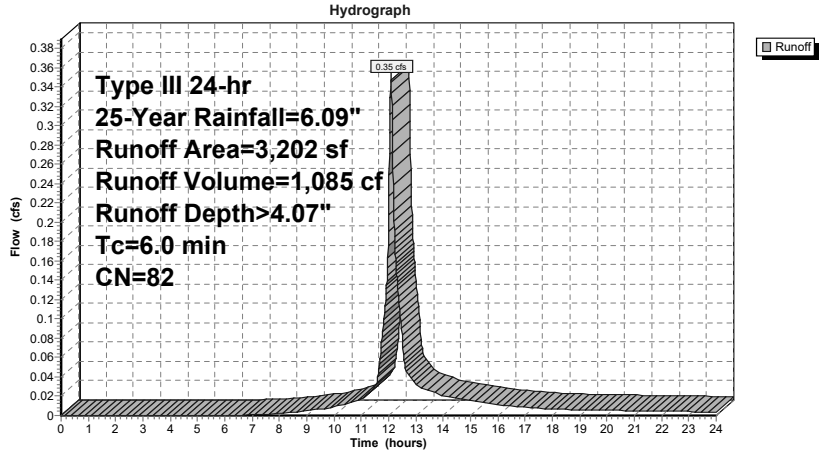
Runoff = 0.35 cfs @ 12.09 hrs, Volume= 1,085 cf, Depth> 4.07"
Routed to Pond 4P : Bio-Ret #2

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 25-Year Rainfall=6.09"

Area (sf)	CN	Description
1,751	98	Paved parking, HSG A
921	68	<50% Grass cover, Poor, HSG A
249	76	Gravel roads, HSG A
281	30	Woods, Good, HSG A
3,202	82	Weighted Average
1,451		45.32% Pervious Area
1,751		54.68% Impervious Area

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

Subcatchment 5S: Haggets Pond CB



Summary for Subcatchment 6S: Haggetts Pond S Prkg

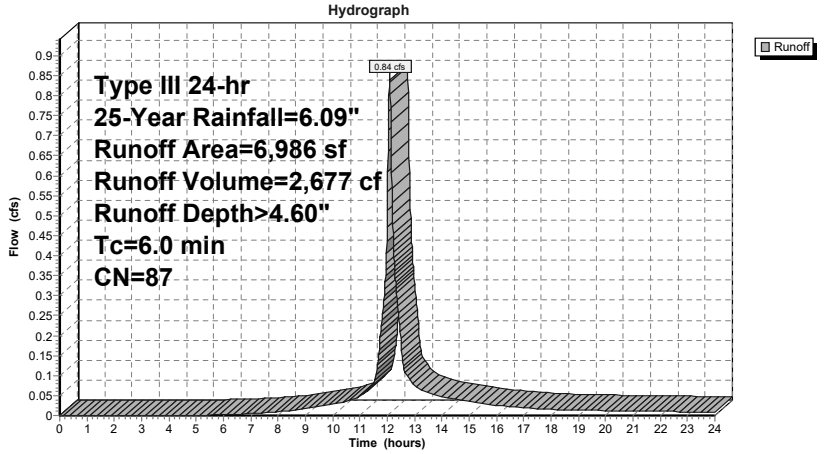
Runoff = 0.84 cfs @ 12.09 hrs, Volume= 2,677 cf, Depth> 4.60"
Routed to Pond 6P : Haggetts S infilt

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 25-Year Rainfall=6.09"

Area (sf)	CN	Description
5,197	98	Paved parking, HSG A
448	76	Gravel roads, HSG A
546	68	<50% Grass cover, Poor, HSG A
795	30	Woods, Good, HSG A
6,986	87	Weighted Average
1,789		25.61% Pervious Area
5,197		74.39% Impervious Area

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

Subcatchment 6S: Haggetts Pond S Prkg



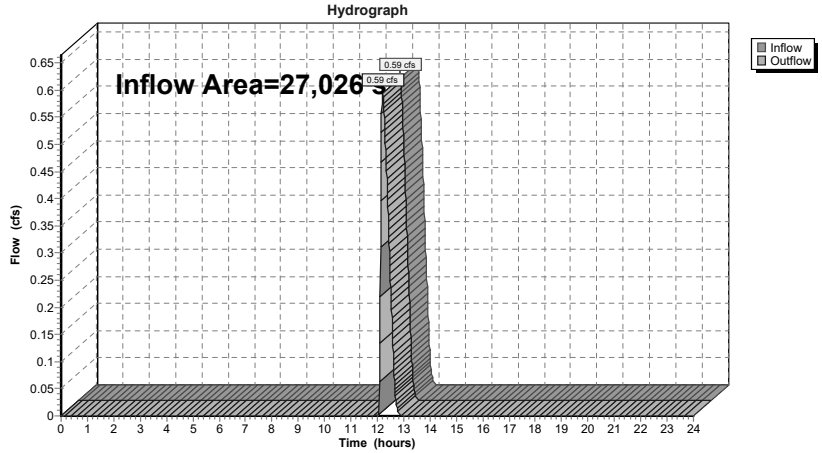
Summary for Reach 1R: Offsite East at High Plain Rd

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

Inflow Area = 27,026 sf, 72.97% Impervious, Inflow Depth = 0.33" for 25-Year event
Inflow = 0.59 cfs @ 12.20 hrs, Volume= 744 cf
Outflow = 0.59 cfs @ 12.20 hrs, Volume= 744 cf, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs

Reach 1R: Offsite East at High Plain Rd



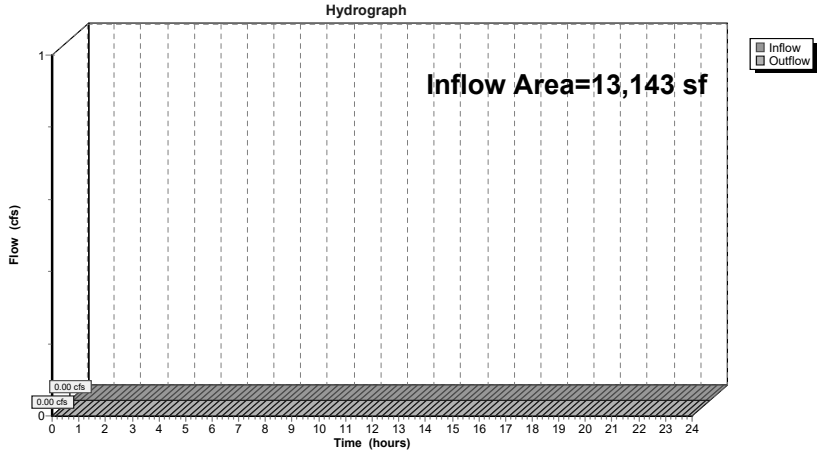
Summary for Reach 2R: Offsite East at Haggets Pond Rd

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

Inflow Area = 13,143 sf, 68.23% Impervious, Inflow Depth = 0.00" for 25-Year event
Inflow = 0.00 cfs @ 0.00 hrs, Volume= 0 cf
Outflow = 0.00 cfs @ 0.00 hrs, Volume= 0 cf, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs

Reach 2R: Offsite East at Haggets Pond Rd



Summary for Pond 1P: Bio-Ret #1

Inflow Area = 9,719 sf, 77.71% Impervious, Inflow Depth > 5.50" for 25-Year event
Inflow = 1.31 cfs @ 12.08 hrs, Volume= 4,452 cf
Outflow = 1.24 cfs @ 12.11 hrs, Volume= 4,253 cf, Atten= 5%, Lag= 1.4 min
Discarded = 0.28 cfs @ 12.21 hrs, Volume= 3,376 cf
Primary = 0.97 cfs @ 12.11 hrs, Volume= 877 cf
Routed to Pond 2P : High Plain culvert

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Peak Elev= 131.78' @ 12.21 hrs Surf.Area= 1,344 sf Storage= 831 cf

Plug-Flow detention time= 63.5 min calculated for 4,251 cf (95% of inflow)
Center-of-Mass det. time= 37.5 min (800.2 - 762.7)

Volume	Invert	Avail.Storage	Storage Description
#1	130.00'	1,165 cf	**Custom Stage Data (Irregular)** Listed below (Recalc)

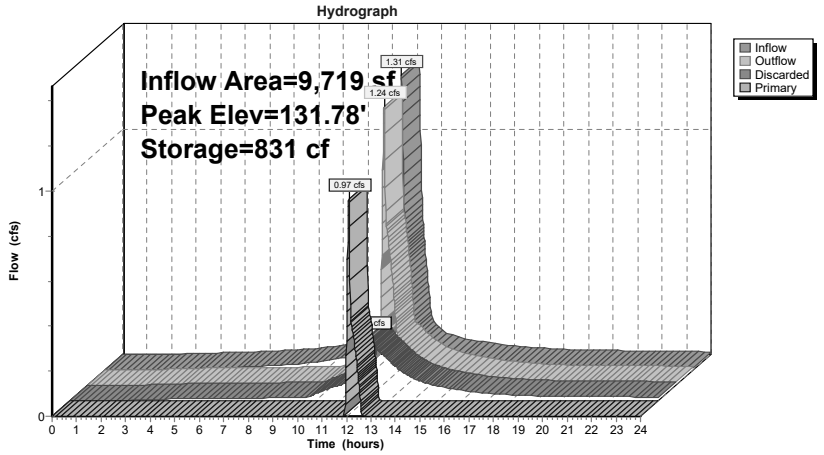
Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
130.00	174	57.4	0	0	174
131.00	301	70.0	235	235	317
132.00	1,761	305.1	930	1,165	7,337

Device	Routing	Invert	Outlet Devices
#1	Primary	131.65'	**10.0' long x 3.0' 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 4.00 4.50 Coef. (English) 2.44 2.58 2.68 2.67 2.65 2.64 2.64 2.68 2.68 2.72 2.81 2.92 2.97 3.07 3.32
#2	Discarded	130.00'	**2.410 in/hr Exfiltration over Wetted area**

Discarded OutFlow Max=0.28 cfs @ 12.21 hrs HW=131.78' (Free Discharge)
↑—**2=Exfiltration** (Exfiltration Controls 0.28 cfs)

Primary OutFlow Max=0.95 cfs @ 12.11 hrs HW=131.77' TW=131.66' (Dynamic Tailwater)
↑—**1=Broad-Crested Rectangular Weir** (Weir Controls 0.95 cfs @ 0.82 fps)

Pond 1P: Bio-Ret #1



Summary for Pond 2P: High Plain culvert

Inflow Area = 16,916 sf, 56.81% Impervious, Inflow Depth > 2.63" for 25-Year event
Inflow = 1.82 cfs @ 12.10 hrs, Volume= 3,700 cf
Outflow = 0.92 cfs @ 12.20 hrs, Volume= 3,691 cf, Atten= 50%, Lag= 6.2 min
Discarded = 0.32 cfs @ 12.20 hrs, Volume= 2,947 cf
Primary = 0.59 cfs @ 12.20 hrs, Volume= 744 cf
Routed to Reach 1R : Offsite East at High Plain Rd

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Peak Elev= 131.78' @ 12.20 hrs Surf.Area= 1,473 sf Storage= 1,053 cf

Plug-Flow detention time= 32.4 min calculated for 3,689 cf (100% of inflow)
Center-of-Mass det. time= 30.7 min (807.2 - 776.5)

Volume	Invert	Avail.Storage	Storage Description
#1	130.00'	2,388 cf	**Custom Stage Data (Irregular)** Listed below (Recalc)

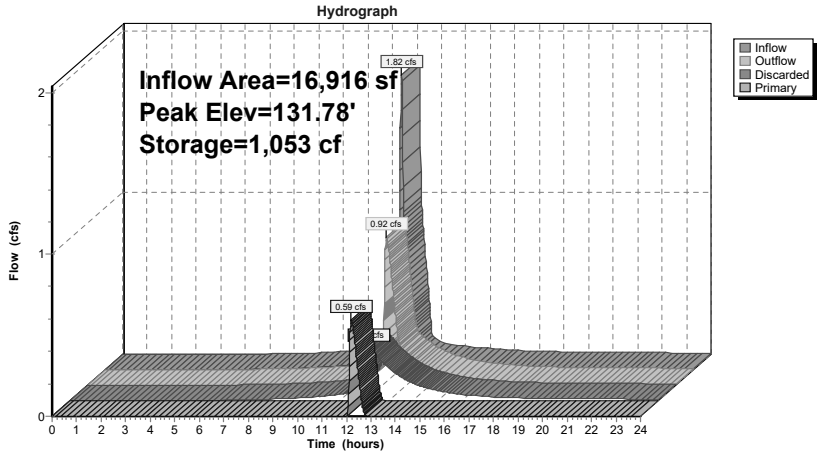
Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
130.00	5	5.0	0	0	5
131.00	663	145.5	242	242	1,689
132.00	1,761	305.1	1,168	1,410	7,417
132.50	2,157	292.9	978	2,388	8,016

Device	Routing	Invert	Outlet Devices
#1	Primary	131.50'	**36.0" Round Culvert** L= 24.0' CPP, end-section conforming to fill, Ke= 0.500 Inlet / Outlet Invert= 131.50' / 131.00' S= 0.0208 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 7.07 sf
#2	Discarded	130.00'	**2.410 in/hr Exfiltration over Wetted area**

Discarded OutFlow Max=0.32 cfs @ 12.20 hrs HW=131.78' (Free Discharge)
↑**2=Exfiltration** (Exfiltration Controls 0.32 cfs)

Primary OutFlow Max=0.59 cfs @ 12.20 hrs HW=131.78' TW=0.00' (Dynamic Tailwater)
↑**1=Culvert** (Inlet Controls 0.59 cfs @ 1.80 fps)

Pond 2P: High Plain culvert



Summary for Pond 3P: High Plain infilt

[92] Warning: Device #1 is above defined storage
[87] Warning: Oscillations may require smaller dt or Finer Routing (severity=560)

Inflow Area = 10,110 sf,100.00% Impervious, Inflow Depth > 5.85" for 25-Year event
Inflow = 1.39 cfs @ 12.08 hrs, Volume= 4,926 cf
Outflow = 0.58 cfs @ 12.28 hrs, Volume= 4,932 cf, Atten= 58%, Lag= 11.7 min
Discarded = 0.58 cfs @ 12.28 hrs, Volume= 4,932 cf
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0 cf
Routed to Reach 1R : Offsite East at High Plain Rd

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Peak Elev= 133.44' @ 12.28 hrs Surf.Area= 10,344 sf Storage= 455 cf

Plug-Flow detention time= (not calculated: outflow precedes inflow)
Center-of-Mass det. time= 2.8 min (747.2 - 744.4)

Volume	Invert	Avail.Storage	Storage Description
#1	133.33'	8,275 cf	**Custom Stage Data (Conic)** Listed below (Recalc) 20,688 cf Overall x 40.0% Voids

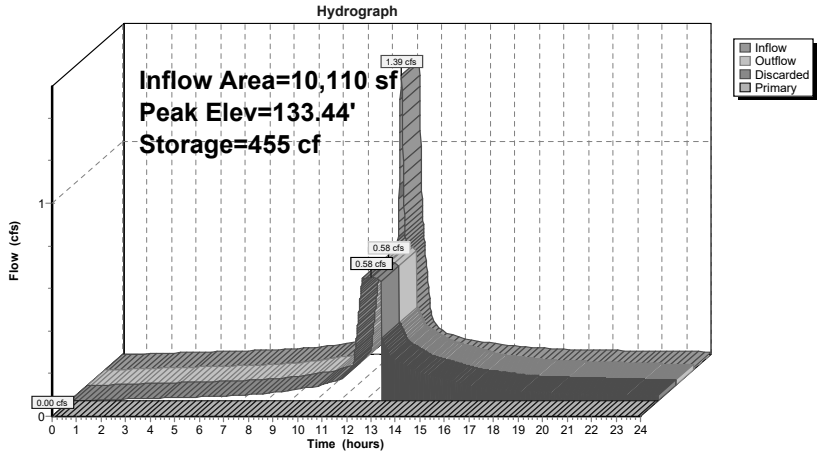
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
133.33	10,344	0	0	10,344
134.00	10,344	6,930	6,930	10,586
134.33	10,344	3,414	10,344	10,705
135.00	10,344	6,930	17,274	10,946
135.33	10,344	3,414	20,688	11,065

Device	Routing	Invert	Outlet Devices
#1	Primary	135.33'	**25.0' 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
#2	Discarded	133.33'	**2.410 in/hr Exfiltration over Wetted area**

Discarded OutFlow Max=0.58 cfs @ 12.28 hrs HW=133.44' (Free Discharge)
↑**2=Exfiltration** (Exfiltration Controls 0.58 cfs)

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=133.33' TW=0.00' (Dynamic Tailwater)
↑**1=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond 3P: High Plain infilt



Summary for Pond 4P: Bio-Ret #2

Inflow Area = 6,157 sf, 61.25% Impervious, Inflow Depth > 4.43" for 25-Year event
Inflow = 0.72 cfs @ 12.09 hrs, Volume= 2,271 cf
Outflow = 0.12 cfs @ 12.56 hrs, Volume= 2,261 cf, Atten= 83%, Lag= 28.2 min
Discarded = 0.12 cfs @ 12.56 hrs, Volume= 2,261 cf
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0 cf
Routed to Reach 2R : Offsite East at Haggets Pond Rd

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Peak Elev= 124.97' @ 12.56 hrs Surf.Area= 1,237 sf Storage= 818 cf

Plug-Flow detention time= 68.1 min calculated for 2,261 cf (100% of inflow)
Center-of-Mass det. time= 65.3 min (862.2 - 796.9)

Volume	Invert	Avail.Storage	Storage Description
#1	121.00'	1,103 cf	**Custom Stage Data (Irregular)** Listed below (Recalc) 2,757 cf Overall x 40.0% Voids

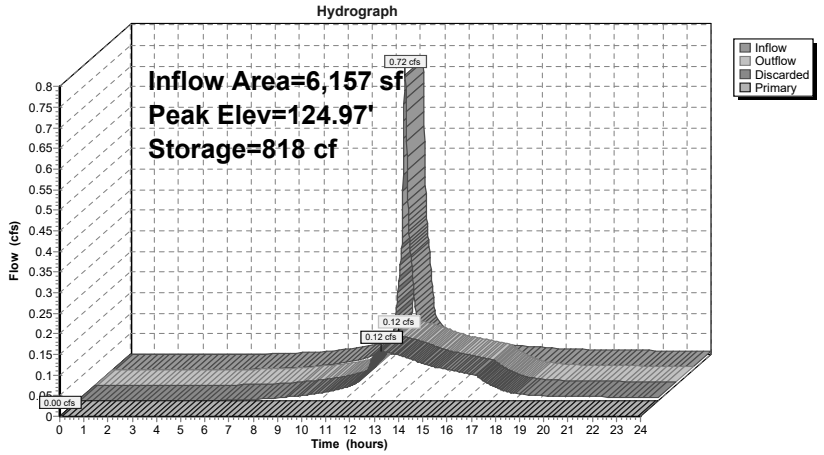
Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
121.00	5	5.0	0	0	5
122.00	61	42.0	28	28	145
123.00	643	117.1	301	329	1,100
124.00	816	134.8	728	1,056	1,476
125.00	1,251	164.0	1,026	2,082	2,186
125.50	1,451	179.7	675	2,757	2,624

Device	Routing	Invert	Outlet Devices
#1	Primary	125.00'	**10.0' long x 4.0' 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 4.00 4.50 5.00 5.50 Coef. (English) 2.38 2.54 2.69 2.68 2.67 2.67 2.65 2.66 2.66 2.68 2.72 2.73 2.76 2.79 2.88 3.07 3.32
#2	Discarded	121.00'	**2.410 in/hr Exfiltration over Wetted area**

Discarded OutFlow Max=0.12 cfs @ 12.56 hrs HW=124.97' (Free Discharge)
↳**2=Exfiltration** (Exfiltration Controls 0.12 cfs)

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=121.00' TW=0.00' (Dynamic Tailwater)
↳**1=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond 4P: Bio-Ret #2



Summary for Pond 6P: Haggetts S infilt

[87] Warning: Oscillations may require smaller dt or Finer Routing (severity=435)

Inflow Area = 6,986 sf, 74.39% Impervious, Inflow Depth > 4.60" for 25-Year event
Inflow = 0.84 cfs @ 12.09 hrs, Volume= 2,677 cf
Outflow = 0.14 cfs @ 12.56 hrs, Volume= 2,678 cf, Atten= 84%, Lag= 28.4 min
Discarded = 0.14 cfs @ 12.56 hrs, Volume= 2,678 cf
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0 cf
Routed to Reach 2R : Offsite East at Haggets Pond Rd

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Peak Elev= 129.70' @ 12.56 hrs Surf.Area= 2,313 sf Storage= 759 cf

Plug-Flow detention time= (not calculated: outflow precedes inflow)
Center-of-Mass det. time= 33.4 min (826.9 - 793.5)

Volume	Invert	Avail.Storage	Storage Description
#1A	129.04'	1,417 cf	**25.00'W x 92.50'L x 2.04'H Field A** 4,721 cf Overall - 1,179 cf Embedded = 3,542 cf x 40.0% Voids
#2A	129.54'	1,179 cf	**Cultec C-100HD** x 84 Inside #1 Effective Size= 32.1"W x 12.0"H => 1.86 sf x 7.50'L = 14.0 cf Overall Size= 36.0"W x 12.5"H x 8.00'L with 0.50' Overlap Row Length Adjustment= +0.50' x 1.86 sf x 7 rows
		2,596 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Primary	130.00'	**4.0' long Sharp-Crested Rectangular Weir** 2 End Contraction(s)
#2	Discarded	129.04'	**2.410 in/hr Exfiltration over Wetted area**

Discarded OutFlow Max=0.14 cfs @ 12.56 hrs HW=129.70' (Free Discharge)
↑—**2=Exfiltration** (Exfiltration Controls 0.14 cfs)

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=129.04' TW=0.00' (Dynamic Tailwater)
↑—**1=Sharp-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond 6P: Haggetts S infilt - Chamber Wizard Field A

Chamber Model = Cultec C-100HD (Cultec Contactor® 100HD)
Effective Size= 32.1"W x 12.0"H => 1.86 sf x 7.50'L = 14.0 cf
Overall Size= 36.0"W x 12.5"H x 8.00'L with 0.50' Overlap
Row Length Adjustment= +0.50' x 1.86 sf x 7 rows

36.0" Wide + 4.0" Spacing = 40.0" C-C Row Spacing

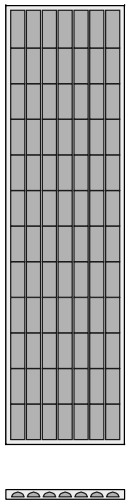
12 Chambers/Row x 7.50' Long +0.50' Row Adjustment = 90.50' Row Length +12.0" End Stone x 2 = 92.50' Base Length
7 Rows x 36.0" Wide + 4.0" Spacing x 6 + 12.0" Side Stone x 2 = 25.00' Base Width
6.0" Stone Base + 12.5" Chamber Height + 6.0" Stone Cover = 2.04' Field Height

84 Chambers x 14.0 cf +0.50' Row Adjustment x 1.86 sf x 7 Rows = 1,179.3 cf Chamber Storage

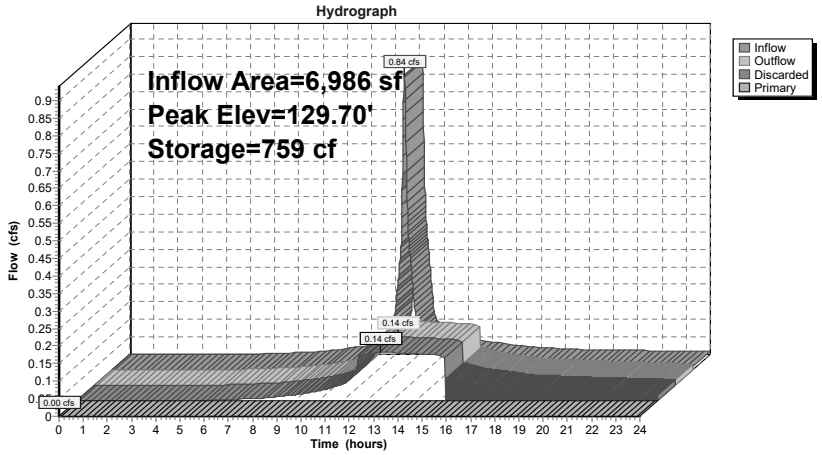
4,721.4 cf Field - 1,179.3 cf Chambers = 3,542.1 cf Stone x 40.0% Voids = 1,416.8 cf Stone Storage

Chamber Storage + Stone Storage = 2,596.1 cf = 0.060 af
Overall Storage Efficiency = 55.0%
Overall System Size = 92.50' x 25.00' x 2.04'

84 Chambers
174.9 cy Field
131.2 cy Stone



Pond 6P: Haggetts S infilt



Time span=0.00-24.00 hrs, dt=0.01 hrs, 2401 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment1S: Bio-Ret #1 Runoff Area=9,719 sf 77.71% Impervious Runoff Depth>7.24"
Tc=6.0 min CN=95 Runoff=1.70 cfs 5,861 cf

Subcatchment2S: High Plain culvert Runoff Area=7,197 sf 28.58% Impervious Runoff Depth>6.41"
Tc=6.0 min CN=88 Runoff=1.18 cfs 3,842 cf

Subcatchment3S: High Plain Prkg Runoff Area=10,110 sf 100.00% Impervious Runoff Depth>7.59"
Tc=6.0 min CN=98 Runoff=1.79 cfs 6,398 cf

Subcatchment4S: Haggetts Pond N Prkg Runoff Area=2,955 sf 68.36% Impervious Runoff Depth>6.52"
Tc=6.0 min CN=89 Runoff=0.49 cfs 1,607 cf

Subcatchment5S: Haggets Pond CB Runoff Area=3,202 sf 54.68% Impervious Runoff Depth>5.70"
Tc=6.0 min CN=82 Runoff=0.48 cfs 1,522 cf

Subcatchment6S: Haggetts Pond S Prkg Runoff Area=6,986 sf 74.39% Impervious Runoff Depth>6.29"
Tc=6.0 min CN=87 Runoff=1.13 cfs 3,661 cf

Reach 1R: Offsite East at High Plain Rd Inflow=1.14 cfs 1,575 cf
Outflow=1.14 cfs 1,575 cf

Reach 2R: Offsite East at Haggets Pond Rd Inflow=0.48 cfs 375 cf
Outflow=0.48 cfs 375 cf

Pond 1P: Bio-Ret #1 Peak Elev=131.89' Storage=988 cf Inflow=1.70 cfs 5,861 cf
Discarded=0.34 cfs 4,241 cf Primary=0.99 cfs 1,390 cf Outflow=1.27 cfs 5,631 cf

Pond 2P: High Plain culvert Peak Elev=131.89' Storage=1,223 cf Inflow=2.11 cfs 5,232 cf
Discarded=0.37 cfs 3,643 cf Primary=1.14 cfs 1,575 cf Outflow=1.51 cfs 5,218 cf

Pond 3P: High Plain infilt Peak Elev=133.54' Storage=857 cf Inflow=1.79 cfs 6,398 cf
Discarded=0.58 cfs 6,401 cf Primary=0.00 cfs 0 cf Outflow=0.58 cfs 6,401 cf

Pond 4P: Bio-Ret #2 Peak Elev=125.07' Storage=870 cf Inflow=0.97 cfs 3,128 cf
Discarded=0.13 cfs 2,741 cf Primary=0.48 cfs 375 cf Outflow=0.60 cfs 3,116 cf

Pond 6P: Haggetts S infilt Peak Elev=129.93' Storage=1,181 cf Inflow=1.13 cfs 3,661 cf
Discarded=0.14 cfs 3,661 cf Primary=0.00 cfs 0 cf Outflow=0.14 cfs 3,661 cf

Total Runoff Area = 40,169 sf Runoff Volume = 22,890 cf Average Runoff Depth = 6.84"
28.58% Pervious = 11,481 sf 71.42% Impervious = 28,688 sf

Summary for Subcatchment 1S: Bio-Ret #1

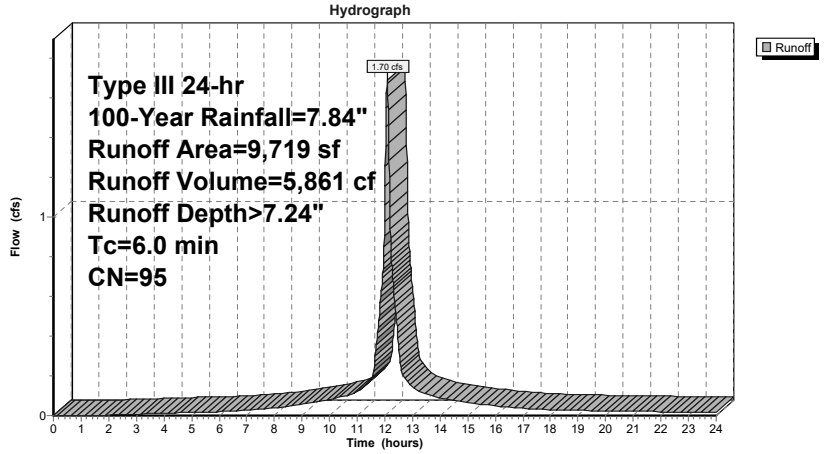
Runoff = 1.70 cfs @ 12.08 hrs, Volume= 5,861 cf, Depth> 7.24"
Routed to Pond 1P : Bio-Ret #1

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-Year Rainfall=7.84"

Area (sf)	CN	Description
2,119	86	<50% Grass cover, Poor, HSG C
47	89	Gravel roads, HSG C
7,553	98	Paved parking, HSG C
9,719	95	Weighted Average
2,166		22.29% Pervious Area
7,553		77.71% Impervious Area

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

Subcatchment 1S: Bio-Ret #1



Summary for Subcatchment 2S: High Plain culvert

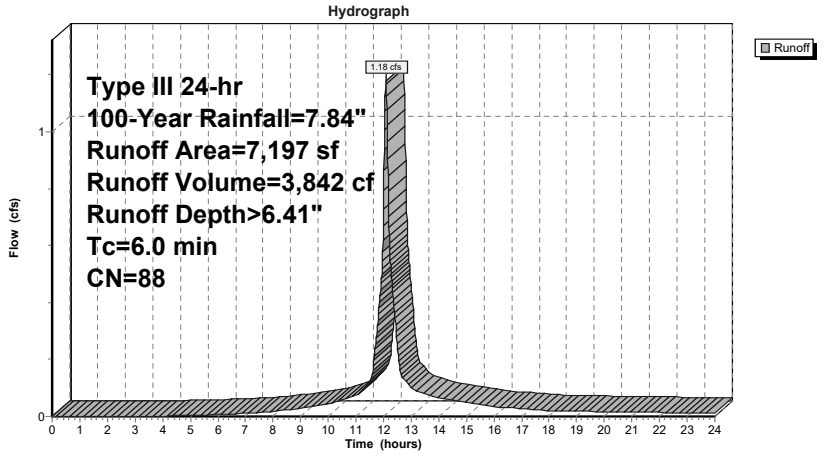
Runoff = 1.18 cfs @ 12.08 hrs, Volume= 3,842 cf, Depth> 6.41"
Routed to Pond 2P : High Plain culvert

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-Year Rainfall=7.84"

Area (sf)	CN	Description
2,666	86	<50% Grass cover, Poor, HSG C
1,418	74	>75% Grass cover, Good, HSG C
1,056	89	Gravel roads, HSG C
1,953	98	Paved parking, HSG C
104	98	Water Surface, HSG C
7,197	88	Weighted Average
5,140		71.42% Pervious Area
2,057		28.58% Impervious Area

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

Subcatchment 2S: High Plain culvert



Summary for Subcatchment 3S: High Plain Prkg

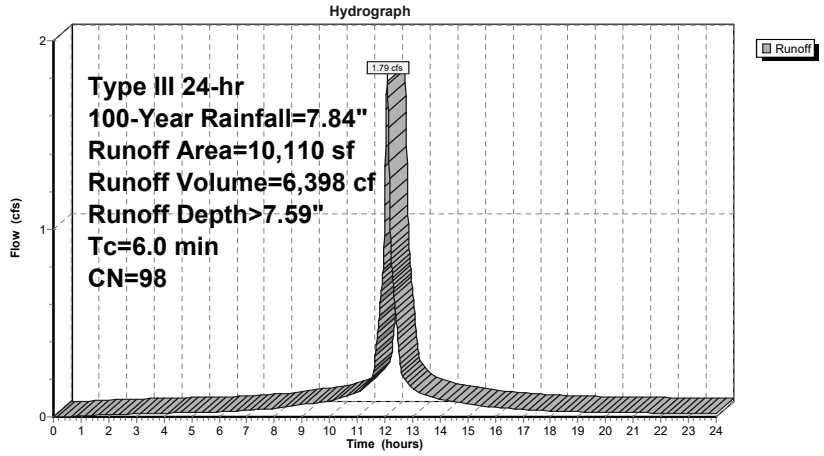
Runoff = 1.79 cfs @ 12.08 hrs, Volume= 6,398 cf, Depth> 7.59"
Routed to Pond 3P : High Plain infilt

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-Year Rainfall=7.84"

Area (sf)	CN	Description
4,576	98	Paved parking, HSG A
5,534	98	Paved parking, HSG C
10,110	98	Weighted Average
10,110		100.00% Impervious Area

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

Subcatchment 3S: High Plain Prkg



Summary for Subcatchment 4S: Haggetts Pond N Prkg

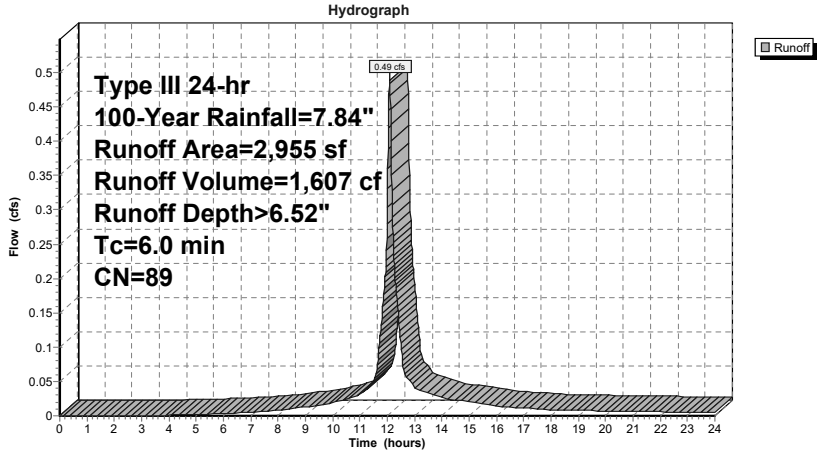
Runoff = 0.49 cfs @ 12.08 hrs, Volume= 1,607 cf, Depth> 6.52"
Routed to Pond 4P : Bio-Ret #2

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-Year Rainfall=7.84"

Area (sf)	CN	Description
2,020	98	Paved parking, HSG A
935	68	<50% Grass cover, Poor, HSG A
2,955	89	Weighted Average
935		31.64% Pervious Area
2,020		68.36% Impervious Area

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

Subcatchment 4S: Haggetts Pond N Prkg



Summary for Subcatchment 5S: Haggets Pond CB

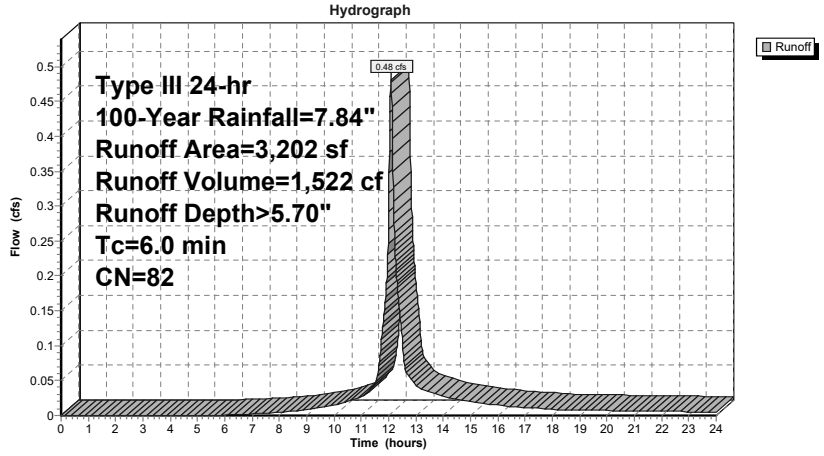
Runoff = 0.48 cfs @ 12.09 hrs, Volume= 1,522 cf, Depth> 5.70"
Routed to Pond 4P : Bio-Ret #2

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-Year Rainfall=7.84"

Area (sf)	CN	Description
1,751	98	Paved parking, HSG A
921	68	<50% Grass cover, Poor, HSG A
249	76	Gravel roads, HSG A
281	30	Woods, Good, HSG A
3,202	82	Weighted Average
1,451		45.32% Pervious Area
1,751		54.68% Impervious Area

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

Subcatchment 5S: Haggets Pond CB



Summary for Subcatchment 6S: Haggetts Pond S Prkg

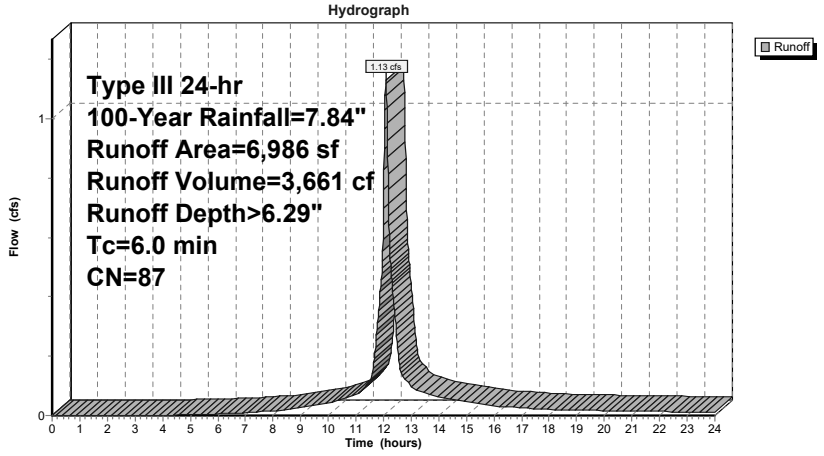
Runoff = 1.13 cfs @ 12.08 hrs, Volume= 3,661 cf, Depth> 6.29"
Routed to Pond 6P : Haggetts S infilt

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-Year Rainfall=7.84"

Area (sf)	CN	Description
5,197	98	Paved parking, HSG A
448	76	Gravel roads, HSG A
546	68	<50% Grass cover, Poor, HSG A
795	30	Woods, Good, HSG A
6,986	87	Weighted Average
1,789		25.61% Pervious Area
5,197		74.39% Impervious Area

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

Subcatchment 6S: Haggetts Pond S Prkg



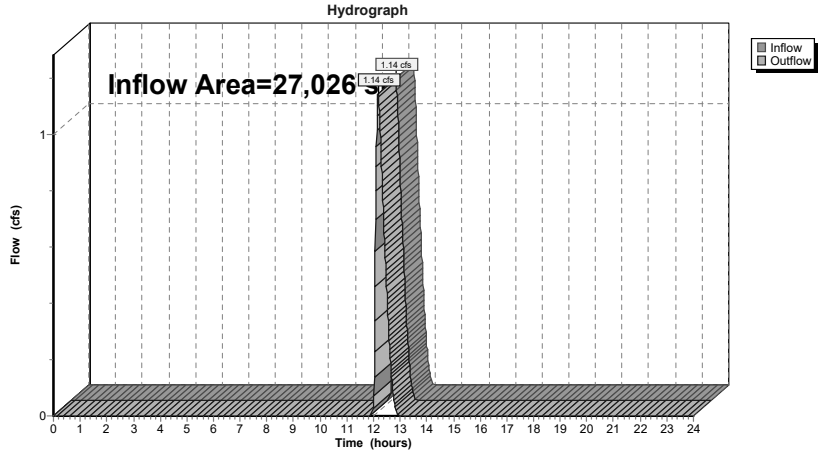
Summary for Reach 1R: Offsite East at High Plain Rd

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

Inflow Area = 27,026 sf, 72.97% Impervious, Inflow Depth = 0.70" for 100-Year event
Inflow = 1.14 cfs @ 12.17 hrs, Volume= 1,575 cf
Outflow = 1.14 cfs @ 12.17 hrs, Volume= 1,575 cf, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs

Reach 1R: Offsite East at High Plain Rd



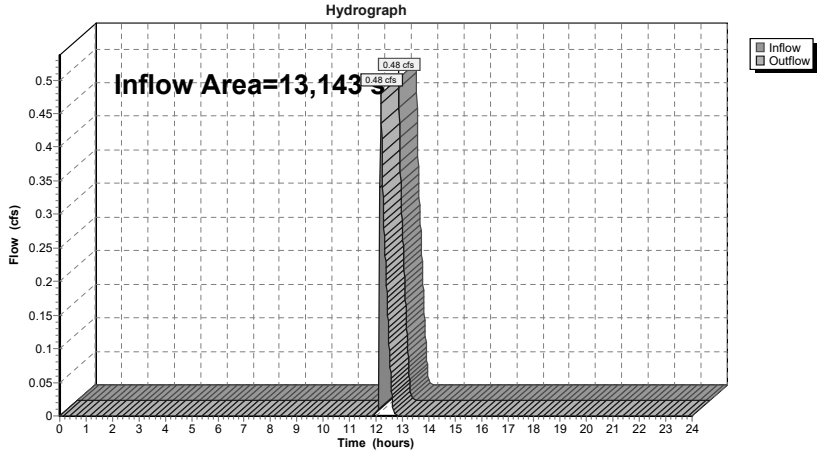
Summary for Reach 2R: Offsite East at Haggets Pond Rd

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

Inflow Area = 13,143 sf, 68.23% Impervious, Inflow Depth = 0.34" for 100-Year event
Inflow = 0.48 cfs @ 12.18 hrs, Volume= 375 cf
Outflow = 0.48 cfs @ 12.18 hrs, Volume= 375 cf, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs

Reach 2R: Offsite East at Haggets Pond Rd



Summary for Pond 1P: Bio-Ret #1

Inflow Area = 9,719 sf, 77.71% Impervious, Inflow Depth > 7.24" for 100-Year event
Inflow = 1.70 cfs @ 12.08 hrs, Volume= 5,861 cf
Outflow = 1.27 cfs @ 12.05 hrs, Volume= 5,631 cf, Atten= 25%, Lag= 0.0 min
Discarded = 0.34 cfs @ 12.18 hrs, Volume= 4,241 cf
Primary = 0.99 cfs @ 12.05 hrs, Volume= 1,390 cf
Routed to Pond 2P : High Plain culvert

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Peak Elev= 131.89' @ 12.18 hrs Surf.Area= 1,547 sf Storage= 988 cf

Plug-Flow detention time= 56.2 min calculated for 5,631 cf (96% of inflow)
Center-of-Mass det. time= 32.8 min (789.7 - 756.9)

Volume	Invert	Avail.Storage	Storage Description
#1	130.00'	1,165 cf	**Custom Stage Data (Irregular)** Listed below (Recalc)

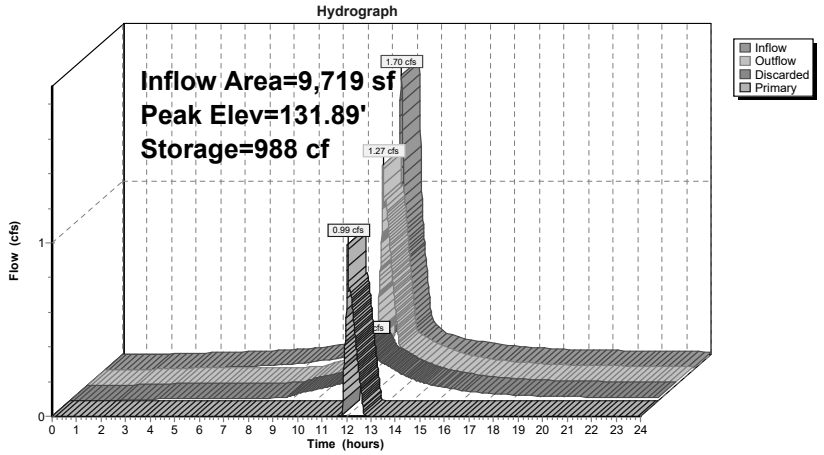
Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
130.00	174	57.4	0	0	174
131.00	301	70.0	235	235	317
132.00	1,761	305.1	930	1,165	7,337

Device	Routing	Invert	Outlet Devices
#1	Primary	131.65'	**10.0' long x 3.0' 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 4.00 4.50 Coef. (English) 2.44 2.58 2.68 2.67 2.65 2.64 2.64 2.68 2.68 2.72 2.81 2.92 2.97 3.07 3.32
#2	Discarded	130.00'	**2.410 in/hr Exfiltration over Wetted area**

Discarded OutFlow Max=0.34 cfs @ 12.18 hrs HW=131.89' (Free Discharge)
↳**2=Exfiltration** (Exfiltration Controls 0.34 cfs)

Primary OutFlow Max=0.84 cfs @ 12.05 hrs HW=131.77' TW=131.72' (Dynamic Tailwater)
↳**1=Broad-Crested Rectangular Weir** (Weir Controls 0.84 cfs @ 0.68 fps)

Pond 1P: Bio-Ret #1



Summary for Pond 2P: High Plain culvert

[80] Warning: Exceeded Pond 1P by 0.01' @ 12.10 hrs (0.68 cfs 129 cf)

Inflow Area = 16,916 sf, 56.81% Impervious, Inflow Depth > 3.71" for 100-Year event
Inflow = 2.11 cfs @ 12.06 hrs, Volume= 5,232 cf
Outflow = 1.51 cfs @ 12.17 hrs, Volume= 5,218 cf, Atten= 28%, Lag= 6.5 min
Discarded = 0.37 cfs @ 12.17 hrs, Volume= 3,643 cf
Primary = 1.14 cfs @ 12.17 hrs, Volume= 1,575 cf
Routed to Reach 1R : Offsite East at High Plain Rd

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Peak Elev= 131.89' @ 12.17 hrs Surf.Area= 1,613 sf Storage= 1,223 cf

Plug-Flow detention time= 29.0 min calculated for 5,216 cf (100% of inflow)
Center-of-Mass det. time= 27.3 min (796.1 - 768.8)

Volume	Invert	Avail.Storage	Storage Description
#1	130.00'	2,388 cf	**Custom Stage Data (Irregular)** Listed below (Recalc)

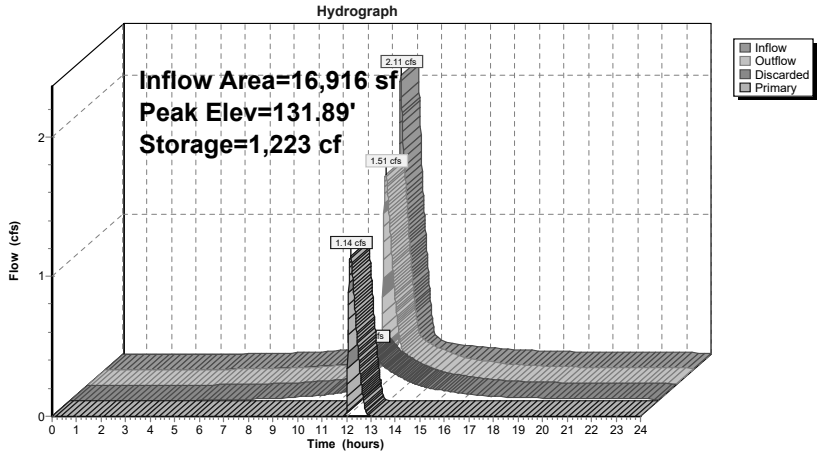
Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
130.00	5	5.0	0	0	5
131.00	663	145.5	242	242	1,689
132.00	1,761	305.1	1,168	1,410	7,417
132.50	2,157	292.9	978	2,388	8,016

Device	Routing	Invert	Outlet Devices
#1	Primary	131.50'	**36.0" Round Culvert** L= 24.0' CPP, end-section conforming to fill, Ke= 0.500 Inlet / Outlet Invert= 131.50' / 131.00' S= 0.0208 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 7.07 sf
#2	Discarded	130.00'	**2.410 in/hr Exfiltration over Wetted area**

Discarded OutFlow Max=0.37 cfs @ 12.17 hrs HW=131.89' (Free Discharge)
↑—**2=Exfiltration** (Exfiltration Controls 0.37 cfs)

Primary OutFlow Max=1.14 cfs @ 12.17 hrs HW=131.89' TW=0.00' (Dynamic Tailwater)
↑—**1=Culvert** (Inlet Controls 1.14 cfs @ 2.12 fps)

Pond 2P: High Plain culvert



Summary for Pond 3P: High Plain infilt

[92] Warning: Device #1 is above defined storage
[87] Warning: Oscillations may require smaller dt or Finer Routing (severity=543)

Inflow Area = 10,110 sf,100.00% Impervious, Inflow Depth > 7.59" for 100-Year event
Inflow = 1.79 cfs @ 12.08 hrs, Volume= 6,398 cf
Outflow = 0.58 cfs @ 12.37 hrs, Volume= 6,401 cf, Atten= 67%, Lag= 17.1 min
Discarded = 0.58 cfs @ 12.37 hrs, Volume= 6,401 cf
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0 cf
Routed to Reach 1R : Offsite East at High Plain Rd

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Peak Elev= 133.54' @ 12.37 hrs Surf.Area= 10,344 sf Storage= 857 cf

Plug-Flow detention time= (not calculated: outflow precedes inflow)
Center-of-Mass det. time= 5.7 min (746.6 - 740.9)

Volume	Invert	Avail.Storage	Storage Description
#1	133.33'	8,275 cf	**Custom Stage Data (Conic)** Listed below (Recalc) 20,688 cf Overall x 40.0% Voids

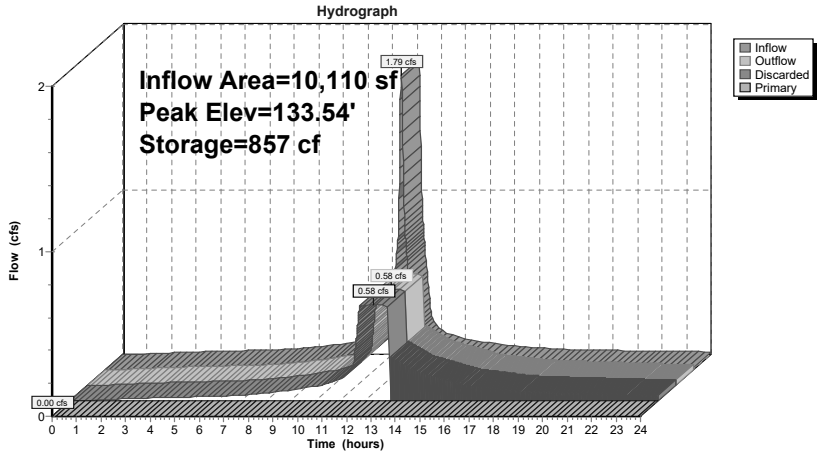
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
133.33	10,344	0	0	10,344
134.00	10,344	6,930	6,930	10,586
134.33	10,344	3,414	10,344	10,705
135.00	10,344	6,930	17,274	10,946
135.33	10,344	3,414	20,688	11,065

Device	Routing	Invert	Outlet Devices
#1	Primary	135.33'	**25.0' 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
#2	Discarded	133.33'	**2.410 in/hr Exfiltration over Wetted area**

Discarded OutFlow Max=0.58 cfs @ 12.37 hrs HW=133.54' (Free Discharge)
↑**2=Exfiltration** (Exfiltration Controls 0.58 cfs)

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=133.33' TW=0.00' (Dynamic Tailwater)
↑**1=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond 3P: High Plain infilt



Summary for Pond 4P: Bio-Ret #2

Inflow Area = 6,157 sf, 61.25% Impervious, Inflow Depth > 6.10" for 100-Year event
Inflow = 0.97 cfs @ 12.09 hrs, Volume= 3,128 cf
Outflow = 0.60 cfs @ 12.18 hrs, Volume= 3,116 cf, Atten= 38%, Lag= 6.0 min
Discarded = 0.13 cfs @ 12.18 hrs, Volume= 2,741 cf
Primary = 0.48 cfs @ 12.18 hrs, Volume= 375 cf
Routed to Reach 2R : Offsite East at Haggets Pond Rd

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Peak Elev= 125.07' @ 12.18 hrs Surf.Area= 1,280 sf Storage= 870 cf

Plug-Flow detention time= 61.8 min calculated for 3,114 cf (100% of inflow)
Center-of-Mass det. time= 59.2 min (847.6 - 788.4)

Volume	Invert	Avail.Storage	Storage Description
#1	121.00'	1,103 cf	**Custom Stage Data (Irregular)** Listed below (Recalc) 2,757 cf Overall x 40.0% Voids

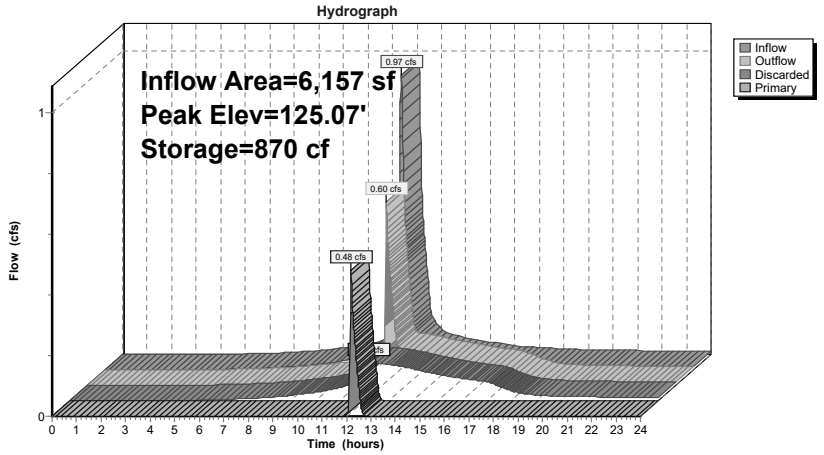
Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
121.00	5	5.0	0	0	5
122.00	61	42.0	28	28	145
123.00	643	117.1	301	329	1,100
124.00	816	134.8	728	1,056	1,476
125.00	1,251	164.0	1,026	2,082	2,186
125.50	1,451	179.7	675	2,757	2,624

Device	Routing	Invert	Outlet Devices
#1	Primary	125.00'	**10.0' long x 4.0' 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 4.00 4.50 5.00 5.50 Coef. (English) 2.38 2.54 2.69 2.68 2.67 2.67 2.65 2.66 2.66 2.68 2.72 2.73 2.76 2.79 2.88 3.07 3.32
#2	Discarded	121.00'	**2.410 in/hr Exfiltration over Wetted area**

Discarded OutFlow Max=0.13 cfs @ 12.18 hrs HW=125.07' (Free Discharge)
↑**2=Exfiltration** (Exfiltration Controls 0.13 cfs)

Primary OutFlow Max=0.48 cfs @ 12.18 hrs HW=125.07' TW=0.00' (Dynamic Tailwater)
↑**1=Broad-Crested Rectangular Weir** (Weir Controls 0.48 cfs @ 0.65 fps)

Pond 4P: Bio-Ret #2



Summary for Pond 6P: Haggetts S infilt

[87] Warning: Oscillations may require smaller dt or Finer Routing (severity=358)

Inflow Area = 6,986 sf, 74.39% Impervious, Inflow Depth > 6.29" for 100-Year event
Inflow = 1.13 cfs @ 12.08 hrs, Volume= 3,661 cf
Outflow = 0.14 cfs @ 12.65 hrs, Volume= 3,661 cf, Atten= 88%, Lag= 34.0 min
Discarded = 0.14 cfs @ 12.65 hrs, Volume= 3,661 cf
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0 cf
Routed to Reach 2R : Offsite East at Haggets Pond Rd

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Peak Elev= 129.93' @ 12.65 hrs Surf.Area= 2,313 sf Storage= 1,181 cf

Plug-Flow detention time= (not calculated: outflow precedes inflow)
Center-of-Mass det. time= 56.8 min (841.8 - 785.0)

Volume	Invert	Avail.Storage	Storage Description
#1A	129.04'	1,417 cf	**25.00'W x 92.50'L x 2.04'H Field A** 4,721 cf Overall - 1,179 cf Embedded = 3,542 cf x 40.0% Voids
#2A	129.54'	1,179 cf	**Cultec C-100HD** x 84 Inside #1 Effective Size= 32.1"W x 12.0"H => 1.86 sf x 7.50'L = 14.0 cf Overall Size= 36.0"W x 12.5"H x 8.00'L with 0.50' Overlap Row Length Adjustment= +0.50' x 1.86 sf x 7 rows
		2,596 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Primary	130.00'	**4.0' long Sharp-Crested Rectangular Weir** 2 End Contraction(s)
#2	Discarded	129.04'	**2.410 in/hr Exfiltration over Wetted area**

Discarded OutFlow Max=0.14 cfs @ 12.65 hrs HW=129.93' (Free Discharge)
↑**2=Exfiltration** (Exfiltration Controls 0.14 cfs)

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=129.04' TW=0.00' (Dynamic Tailwater)
↑**1=Sharp-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond 6P: Haggetts S infilt - Chamber Wizard Field A

Chamber Model = Cultec C-100HD (Cultec Contactor® 100HD)
Effective Size= 32.1"W x 12.0"H => 1.86 sf x 7.50'L = 14.0 cf
Overall Size= 36.0"W x 12.5"H x 8.00'L with 0.50' Overlap
Row Length Adjustment= +0.50' x 1.86 sf x 7 rows

36.0" Wide + 4.0" Spacing = 40.0" C-C Row Spacing

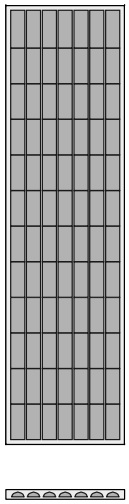
12 Chambers/Row x 7.50' Long +0.50' Row Adjustment = 90.50' Row Length +12.0" End Stone x 2 = 92.50' Base Length
7 Rows x 36.0" Wide + 4.0" Spacing x 6 + 12.0" Side Stone x 2 = 25.00' Base Width
6.0" Stone Base + 12.5" Chamber Height + 6.0" Stone Cover = 2.04' Field Height

84 Chambers x 14.0 cf +0.50' Row Adjustment x 1.86 sf x 7 Rows = 1,179.3 cf Chamber Storage

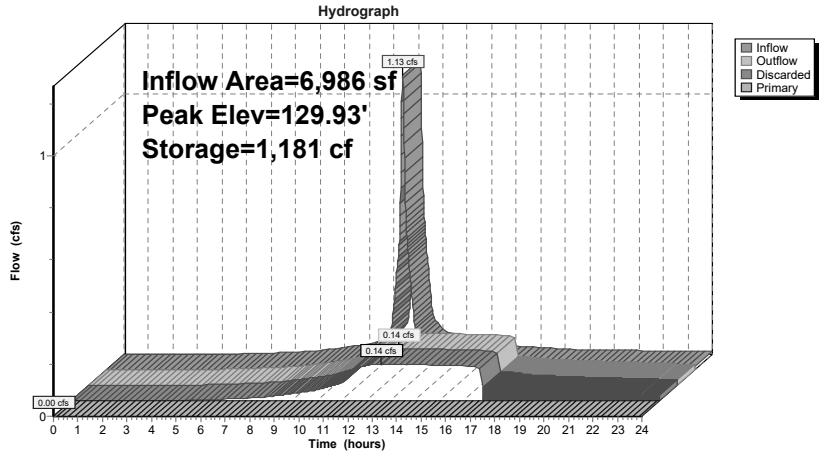
4,721.4 cf Field - 1,179.3 cf Chambers = 3,542.1 cf Stone x 40.0% Voids = 1,416.8 cf Stone Storage

Chamber Storage + Stone Storage = 2,596.1 cf = 0.060 af
Overall Storage Efficiency = 55.0%
Overall System Size = 92.50' x 25.00' x 2.04'

84 Chambers
174.9 cy Field
131.2 cy Stone



Pond 6P: Haggetts S infilt



SECTION 6.0

ADDITIONAL DRAINAGE CALCULATIONS

6.01 GROUNDWATER RECHARGE STORAGE TABLES

6.02 WATER QUALITY FLOW RATE CALCULATIONS

6.03 WATER QUALITY UNIT SIZING

6.04 TSS REMOVAL CALCULATIONS

6.01 GROUNDWATER RECHARGE STORAGE TABLES

Stage-Area-Storage for Pond 1P: Bio-Ret #1

Elevation (feet)	Surface (sq-ft)	Wetted (sq-ft)	Storage (cubic-feet)
130.00	174	174	0
130.05	180	180	9
130.10	185	187	18
130.15	191	194	27
130.20	197	200	37
130.25	203	207	47
130.30	208	214	57
130.35	215	221	68
130.40	221	228	79
130.45	227	235	90
130.50	233	242	101
130.55	240	249	113
130.60	246	256	125
130.65	253	264	138
130.70	259	271	151
130.75	266	278	164
130.80	273	286	177
130.85	280	294	191
130.90	287	301	205
130.95	294	309	220
131.00	301	317	235
131.05	345	459	251
131.10	392	623	269
131.15	443	809	290
131.20	496	1,017	314
131.25	552	1,247	340
131.30	612	1,499	369
131.35	674	1,773	401
131.40	740	2,069	436
131.45	808	2,387	475
131.50	880	2,727	517
131.55	954	3,089	563
131.60	1,032	3,473	613
131.65	1,112	3,879	666
131.70	1,196	4,307	724
131.75	1,282	4,757	786
131.80	1,372	5,229	852
131.85	1,465	5,723	923
131.90	1,560	6,239	999
131.95	1,659	6,777	1,079
132.00	**1,761**	**7,337**	**1,165**

Stage-Area-Storage for Pond 3P: High Plain infilt

Elevation (feet)	Surface (sq-ft)	Wetted (sq-ft)	Storage (cubic-feet)
133.33	**10,344**	10,344	0
133.38	10,344	10,362	207
133.43	10,344	10,380	414
133.48	10,344	10,398	621
133.53	10,344	10,416	828
133.58	10,344	10,434	1,034
133.63	10,344	10,452	1,241
133.68	10,344	10,470	1,448
133.73	10,344	10,488	1,655
133.78	10,344	10,506	1,862
133.83	10,344	10,524	2,069
133.88	10,344	10,542	2,276
133.93	10,344	10,560	2,483
133.98	10,344	10,578	2,689
134.03	10,344	10,596	2,896
134.08	10,344	10,614	3,103
134.13	10,344	10,632	3,310
134.18	10,344	10,650	3,517
134.23	10,344	10,668	3,724
134.28	10,344	10,687	3,931
134.33	10,344	10,705	4,138
134.38	10,344	10,723	4,344
134.43	10,344	10,741	4,551
134.48	10,344	10,759	4,758
134.53	10,344	10,777	4,965
134.58	10,344	10,795	5,172
134.63	10,344	10,813	5,379
134.68	10,344	10,831	5,586
134.73	10,344	10,849	5,793
134.78	10,344	10,867	6,000
134.83	10,344	10,885	6,206
134.88	10,344	10,903	6,413
134.93	10,344	10,921	6,620
134.98	10,344	10,939	6,827
135.03	10,344	10,957	7,034
135.08	10,344	10,975	7,241
135.13	10,344	10,993	7,448
135.18	10,344	11,011	7,655
135.23	10,344	11,029	7,861
135.28	10,344	11,047	8,068
135.33	10,344	**11,065**	**8,275**

Stage-Area-Storage for Pond 4P: Bio-Ret #2

Elevation (feet)	Surface (sq-ft)	Wetted (sq-ft)	Storage (cubic-feet)
121.00	5	5	0
121.10	8	9	0
121.20	11	15	1
121.30	15	24	1
121.40	20	35	2
121.50	25	48	3
121.60	31	63	4
121.70	38	80	5
121.80	45	100	7
121.90	53	121	9
122.00	61	145	11
122.10	91	200	14
122.20	128	264	19
122.30	171	337	24
122.40	220	419	32
122.50	275	510	42
122.60	336	610	54
122.70	404	719	69
122.80	477	837	87
122.90	557	964	107
123.00	643	1,100	131
123.10	659	1,135	157
123.20	676	1,171	184
123.30	693	1,207	212
123.40	710	1,244	240
123.50	727	1,281	268
123.60	744	1,319	298
123.70	762	1,358	328
123.80	780	1,396	359
123.90	798	1,436	390
124.00	816	1,476	423
124.10	855	1,541	456
124.20	896	1,607	491
124.30	937	1,674	528
124.40	979	1,743	566
124.50	1,022	1,814	606
124.60	1,066	1,885	648
124.70	1,111	1,959	691
124.80	1,157	2,033	737
124.90	1,203	2,109	784
125.00	1,251	2,186	833
125.10	1,298	2,271	884
125.20	1,329	2,357	936
125.30	1,369	2,444	990
125.40	1,410	2,533	1,046
125.50	**1,451**	**2,624**	**1,103**

Stage-Area-Storage for Pond 6P: Haggetts S infilt

Elevation (feet)	Wetted (sq-ft)	Storage (cubic-feet)
129.04	2,313	0
129.05	2,315	9
129.06	2,317	19
129.07	2,320	28
129.08	2,322	37
129.09	2,324	46
129.10	2,327	56
129.11	2,329	65
129.12	2,331	74
129.13	2,334	83
129.14	2,336	92
129.15	2,338	102
129.16	2,341	111
129.17	2,343	120
129.18	2,345	129
129.19	2,348	139
129.20	2,350	148
129.21	2,352	157
129.22	2,355	167
129.23	2,357	176
129.24	2,359	185
129.25	2,362	194
129.26	2,364	203
129.27	2,367	213
129.28	2,369	222
129.29	2,371	231
129.30	2,374	240
129.31	2,376	250
129.32	2,378	259
129.33	2,381	268
129.34	2,383	278
129.35	2,385	287
129.36	2,388	296
129.37	2,390	305
129.38	2,392	315
129.39	2,395	324
129.40	2,397	333
129.41	2,399	342
129.42	2,402	351
129.43	2,404	361
129.44	2,407	370
129.45	2,409	379
129.46	2,411	388
129.47	2,414	398
129.48	2,416	407
129.49	2,418	416
129.50	2,421	426
129.51	2,423	435
129.52	2,425	444
129.53	2,428	453
129.54	2,430	463
129.55	2,432	482
129.56	2,435	501
129.57	2,437	521
129.58	2,439	540
129.59	2,442	559
129.60	2,444	578
129.61	2,446	597
129.62	2,449	616
129.63	2,451	635
129.64	2,453	654
129.65	2,456	673
129.66	2,458	692
129.67	2,461	710
129.68	2,463	729
129.69	2,465	748
129.70	2,468	766
129.71	2,470	785
129.72	2,472	803
129.73	2,475	822
129.74	2,477	840
129.75	2,479	859
129.76	2,482	877
129.77	2,484	896
129.78	2,486	914
129.79	2,489	933
129.80	2,491	951
129.81	2,493	970
129.82	2,496	988
129.83	2,498	1,007
129.84	2,501	1,025
129.85	2,503	1,043
129.86	2,505	1,062
129.87	2,508	1,080
129.88	2,510	1,098
129.89	2,512	1,116
129.90	2,515	1,135
129.91	2,517	1,153
129.92	2,519	1,171
129.93	2,522	1,189
129.94	2,524	1,207
129.95	2,526	1,224
129.96	2,529	1,242
129.97	2,531	1,260
129.98	2,533	1,278
129.99	2,536	1,296
130.00	2,538	1,313
130.01	2,540	1,331
130.02	2,543	1,348
130.03	2,545	1,366
130.04	2,548	1,383
130.05	2,550	1,401
130.06	2,552	1,418
130.07	2,555	1,435

Stage-Area-Storage for Pond 6P: Haggetts S infilt (continued)

Elevation (feet)	Wetted (sq-ft)	Storage (cubic-feet)
130.08	2,557	1,452
130.09	2,559	1,469
130.10	2,562	1,486
130.11	2,564	1,503
130.12	2,566	1,520
130.13	2,569	1,537
130.14	2,571	1,554
130.15	2,573	1,571
130.16	2,576	1,587
130.17	2,578	1,604
130.18	2,580	1,620
130.19	2,583	1,636
130.20	2,585	1,652
130.21	2,587	1,668
130.22	2,590	1,684
130.23	2,592	1,700
130.24	2,594	1,716
130.25	2,597	1,731
130.26	2,599	1,747
130.27	2,602	1,762
130.28	2,604	1,777
130.29	2,606	1,792
130.30	2,609	1,807
130.31	2,611	1,822
130.32	2,613	1,836
130.33	2,616	1,850
130.34	2,618	1,864
130.35	2,620	1,878
130.36	2,623	1,892
130.37	2,625	1,905
130.38	2,627	1,918
130.39	2,630	1,931
130.40	2,632	1,944
130.41	2,634	1,956
130.42	2,637	1,969
130.43	2,639	1,980
130.44	2,642	1,992
130.45	2,644	2,003
130.46	2,646	2,014
130.47	2,649	2,025
130.48	2,651	2,036
130.49	2,653	2,046
130.50	2,656	2,056
130.51	2,658	2,066
130.52	2,660	2,076
130.53	2,663	2,086
130.54	2,665	2,095
130.55	2,667	2,104
130.56	2,670	2,114
130.57	2,672	2,123
130.58	2,674	2,132
130.59	2,677	2,141
130.60	2,679	2,151
130.61	2,681	2,160
130.62	2,684	2,169
130.63	2,686	2,178
130.64	2,688	2,188
130.65	2,691	2,197
130.66	2,693	2,206
130.67	2,696	2,215
130.68	2,698	2,225
130.69	2,700	2,234
130.70	2,703	2,243
130.71	2,705	2,252
130.72	2,707	2,262
130.73	2,710	2,271
130.74	2,712	2,280
130.75	2,714	2,289
130.76	2,717	2,299
130.77	2,719	2,308
130.78	2,721	2,317
130.79	2,724	2,326
130.80	2,726	2,336
130.81	2,728	2,345
130.82	2,731	2,354
130.83	2,733	2,363
130.84	2,736	2,373
130.85	2,738	2,382
130.86	2,740	2,391
130.87	2,743	2,400
130.88	2,745	2,410
130.89	2,747	2,419
130.90	2,750	2,428
130.91	2,752	2,437
130.92	2,754	2,447
130.93	2,757	2,456
130.94	2,759	2,465
130.95	2,761	2,474
130.96	2,764	2,484
130.97	2,766	2,493
130.98	2,768	2,502
130.99	2,771	2,511
131.00	2,773	2,521
131.01	2,775	2,530
131.02	2,778	2,539
131.03	2,780	2,548
131.04	2,783	2,558
131.05	2,785	2,567
131.06	2,787	2,576
131.07	2,790	2,585
131.08	**2,792**	**2,595**

6.02 WATER QUALITY FLOW RATE CALCULATIONS

Calculation Sheet

BSC GROUP

Project No.	8-9985.01	**Calc By**	DMG
Subject	Proprietary WQV Sizing - 1	**Date**	11/7/2023
Location	Andover, MA	**Checked by**	
		Date	

2013 MA DEP Standard Method to Convert Required Water Quality Volume to a Discharge Rate for Sizing Flow Based Manufactured Proprietary Stormwater Treatment Systems (2013 MADEP Q Rate)

WQU-1

For 1.0-inch Water Quality Depth Requirement

Q = (qu)(A)(WQD) **0.05** **cfs**

Q = peak flow rate associated with the first 1-inch of runoff

qu = the unit peak discharge (csm/in)	752	(see 2013 MADEP Q Rate for Tc=0.1 hours)
A = impervious surface (sq.miles)	0.000072	
WQD = water quality depth (in)	1	

STC 450i Maximum Water Quality Flow Rate = 0.40 cfs

Calculation Sheet

BSC GROUP

Project No.	8-9985.01	**Calc By**	DMG
Subject	Proprietary WQV Sizing - 2	**Date**	11/7/2023
Location	Andover, MA	**Checked by**	
		Date	

2013 MA DEP Standard Method to Convert Required Water Quality Volume to a Discharge Rate for Sizing Flow Based Manufactured Proprietary Stormwater Treatment Systems (2013 MADEP Q Rate)

WQU-2

For 1.0-inch Water Quality Depth Requirement

Q = (qu)(A)(WQD) **0.14** **cfs**

Q = peak flow rate associated with the first 1-inch of runoff

qu = the unit peak discharge (csm/in)	752	(see 2013 MADEP Q Rate for Tc=0.1 hours)
A = impervious surface (sq.miles)	0.000186	
WQD = water quality depth (in)	1	

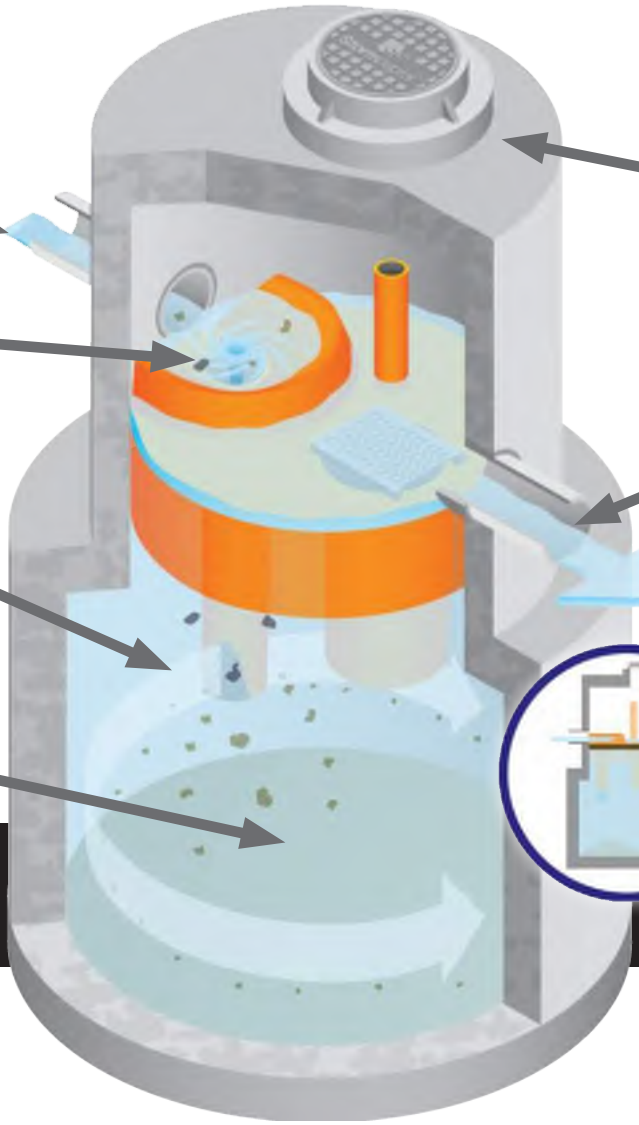
STC 450i Maximum Water Quality Flow Rate = 0.40 cfs

6.03 WATER QUALITY UNIT SIZING

Stormceptor®

Stormwater Treatment Made Simple!

TSS & Oil Removal ■ *Scour Prevention* ■ *Small Footprint*



Design Flexibility

Proven Performance

Environmentally Engineered Stormwater Solutions...
that exceed your client's needs!

www.rinkerstormceptor.com
Phone: (413) 562-3647

Rinker MATERIALS™

Stormceptor® STC

Stormceptor® is an underground stormwater quality treatment device that is unparalleled in its effectiveness for pollutant capture and retention. With thousands of systems operating worldwide, Stormceptor delivers protection every day in every storm.

With patented technology, optimal treatment occurs by allowing free oil to rise and sediment to settle. The Stormceptor design prohibits scour and release of previously captured pollutants, ensuring superior treatment and protection during even the most extreme storm events.

Stormceptor is very easy to design and provides flexibility under varying site constraints such as tight right-of-ways, zero lot lines and retrofit projects. Design flexibility allows for a cost-effective approach to stormwater treatment. Stormceptor has proven performance backed by the longest record of lab and field verification in the industry.

Tested Performance

- Fine particle capture
- Prevents scour or release
- 95%+ Oil removal

Massachusetts – Water Quality (Q) Flow Rate

Stormceptor STC Model	Inside Diameter	Typical Depth Below Inlet Pipe Invert [1]	Water Quality Flow Rate Q [2]	Peak Conveyance Flow Rate [3]	Hydrocarbon Capacity [4]	Maximum Sediment Capacity [4]
	(ft)	(in)	(cfs)	(cfs)	(Gallons)	(ft^3)
STC 450i	4	68	0.40	5.5	86	46
STC 900	6	63	0.89	22	251	89
STC 2400	8	104	1.58	22	840	205
STC 4800	10	140	2.47	22	909	543
STC 7200	12	148	3.56	22	1,059	839
STC 11000	2 x 10	142	4.94	48	2,792	1,086
STC 16000	2 x 12	148	7.12	48	3,055	1,677

[1] Depth Below Pipe Inlet Invert to the Bottom of Base Slab, and Maximum Sediment Capacity can vary to accommodate specific site designs and pollutant loads. Depths can vary to accommodate special designs or site conditions. Contact your local representative for assistance.
[2] Water Quality Flow Rate (Q) is based on 80% annual average TSS removal of the OK110 particle size distribution.
[3] Peak Conveyance Flow Rate is based upon ideal velocity of 3 feet per second and outlet pipe diameters of 18-inch, 36-inch, and 54-inch diameters.
[4] Hydrocarbon & Sediment capacities can be modified to accommodate specific site design requirements, contact your local representative for assistance.

Rinker MATERIALS™
www.rinkerstormceptor.com
Manufacturing Plant: Westfield, MA
Phone: (413) 562-3647
11-22-13-R13-802 MDEP

6.04 TSS REMOVAL CALCULATIONS

TSS Removal Calculation Worksheet

Location: Haggetts Pond, Andover, MA

Project: 89985.01

Prepared By: DMG

Date: 11/7/2023

1S - Bio-Retention w/deep sump hooded CB pretreatment

Total Impervious Area, Acres= 0.173

A	B	C	D	E
BMP	TSS Removal Rate	Starting TSS Load*	Amount Removed (BxC)	Remaining Load (C-D)
Bio-Retention Area	0.9	1	0.9	0.1
		0.10		0.10

TSS Removal = 0.90

TSS Removal Calculation Worksheet

Location: Haggetts Pond, Andover, MA

Project: 89985.01

Prepared By: DMG

Date: 11/7/2023

3S - Porous Pavement

Total Impervious Area, Acres= 0.232

A	B	C	D	E
BMP	TSS Removal Rate	Starting TSS Load*	Amount Removed (BxC)	Remaining Load (C-D)
Porous Pavement	0.8	1	0.8	0.2

TSS Removal = 0.80

TSS Removal Calculation Worksheet

Location: Haggetts Pond, Andover, MA

Project: 89985.01

Prepared By: DMG

Date: 11/7/2023

4S - Bio-Retention w/ WQU pretreatment in an ORW

Total Impervious Area, Acres= 0.046

A	B	C	D	E
BMP	TSS Removal Rate	Starting TSS Load*	Amount Removed (BxC)	Remaining Load (C-D)
Stormceptor Water Quality Unit	0.77	1	0.77	0.23
		0.23		0.23

TSS Pretreatment = 0.77 (44% min)

Bio-Retention Area	0.9	1	0.9	0.1
		0.10		0.10

TSS Removal = 0.90

TSS Removal Calculation Worksheet

Location: Haggetts Pond, Andover, MA

Project: 89985.01

Prepared By: DMG

Date: 11/7/2023

5S - Bio-Retention w/ deep-sump hooded CB and forebay pretreatment in an ORW

Total Impervious Area, Acres= 0.040

A	B	C	D	E
BMP	TSS Removal Rate	Starting TSS Load*	Amount Removed (BxC)	Remaining Load (C-D)
Deep-Sump Hooded Catch Basin	0.25	1	0.25	0.75
Sediment Forebay	0.25	0.75	0.19	0.56

TSS Pretreatment = 0.44 (44% min)

Bio-Retention Area	0.9	1	0.9	0.1
		0.10		0.10

TSS Removal = 0.90

TSS Removal Calculation Worksheet

Location: Haggetts Pond, Andover, MA

Project: 89985.01

Prepared By: DMG

Date: 11/7/2023

6S - Subsurface Infiltration w/ WQU pretreatment in an ORW

Total Impervious Area, Acres= 0.119

A	B	C	D	E
BMP	TSS Removal Rate	Starting TSS Load*	Amount Removed (BxC)	Remaining Load (C-D)
Stormceptor Water Quality Unit	0.77	1	0.77	0.23
		0.23		0.23

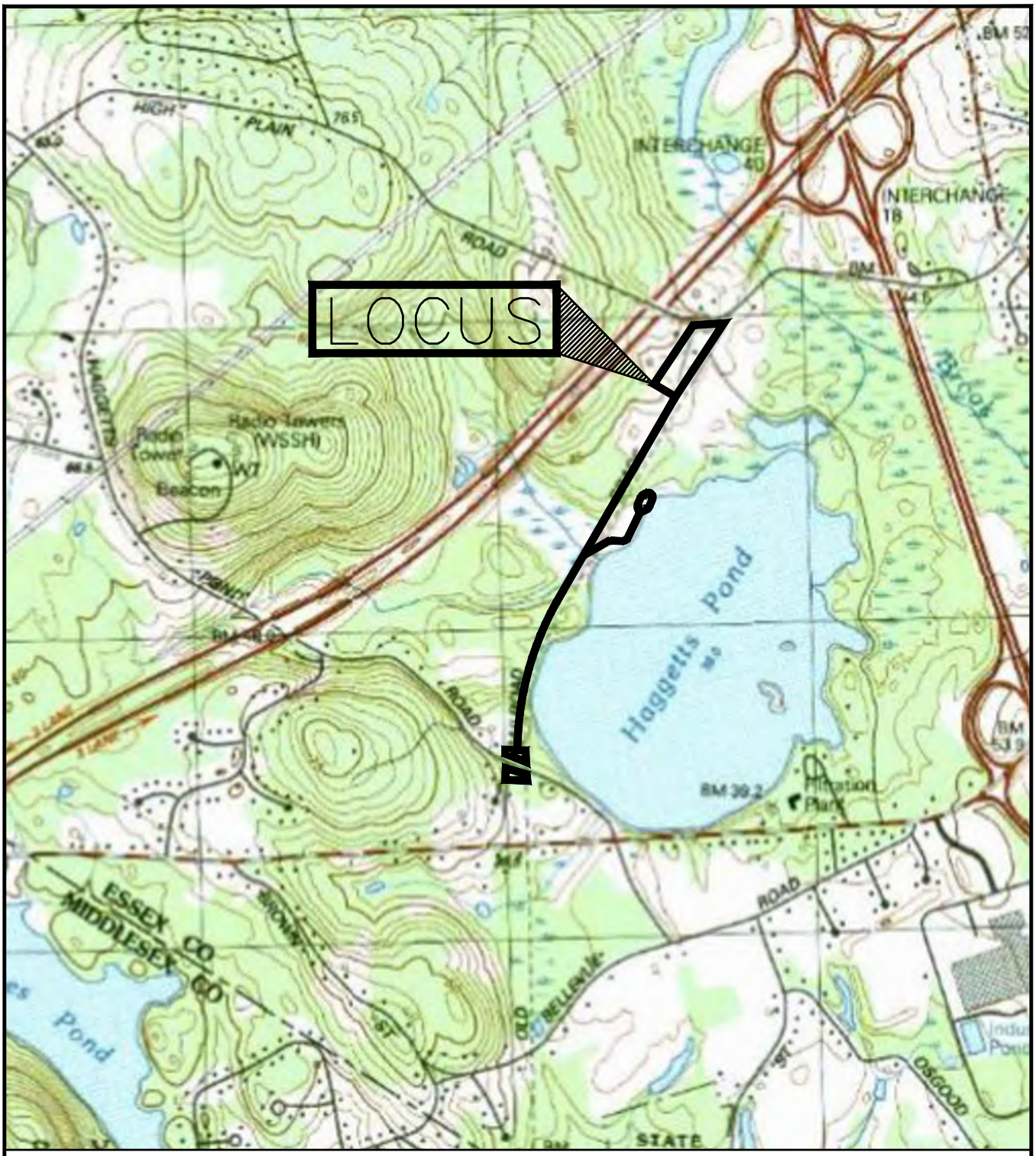
TSS Pretreatment = 0.77 (44% min)

Bio-Retention Area	0.9	1	0.9	0.1
		0.10		0.10

TSS Removal = 0.90

APPENDICES

USGS LOCUS MAP



SCALE: 1" = 2000'

0 1000 2000 4000 FEET

PREPARED FOR:

TOWN OF ANDOVER
ANDOVER, MA
01810

HAGGETTS POND RAIL TRAIL
USGS LOCUS MAP

5 CAMPANELLI DRIVE
TOWN OF ANDOVER
ANDOVER, MA
01810

BSC GROUP
300 Brickstone Square- Suite 203
Andover, Massachusetts
01810
617 896 4300

Job No.: 8-9985.01 Date: 09/18/2023
Scale: 1"=2000' Revised:
Dwg. No: C\D\Gr\USGS Figure:

FEMA MAP

NOTES TO USERS

This map is for use in administering the National Flood Insurance Program. It does not necessarily identify all areas subject to flooding, particularly from local drainage sources of small size. The **community map repository** should be consulted for possible updated or additional flood hazard information.

To obtain more detailed information in areas where **Base Flood Elevations** (BFEs) and/or **floodways** have been determined, users are encouraged to consult the Flood Profiles and Floodway Data and/or Summary of Stillwater Elevations tables contained within the Flood Insurance Study (FIS) Report that accompanies this FIRM. Users should be aware that BFEs shown on the FIRM represent rounded whole-foot elevations. These BFEs are intended for flood insurance rating purposes only and should not be used as the sole source of flood elevation information. Accordingly, flood elevation data presented in the FIS Report should be utilized in conjunction with the FIRM for purposes of construction and/or floodplain management.

Coastal Base Flood Elevations shown on this map apply only landward of 0.0' North American Vertical Datum of 1988 (NAVD 88). Users of this FIRM should be aware that coastal flood elevations are also provided in the Summary of Stillwater Elevations table in the Flood Insurance Study Report for this jurisdiction. Elevations shown in the Summary of Stillwater Elevations table should be used for construction and/or floodplain management purposes when they are higher than the elevations shown on this FIRM.

Boundaries of the **floodways** were computed at cross sections and interpolated between cross sections. The floodways were based on hydraulic considerations with regard to requirements of the National Flood Insurance Program. Floodway widths and other pertinent floodway data are provided in the Flood Insurance Study Report for this jurisdiction.

Certain areas not in Special Flood Hazard Areas may be protected by **flood control structures**. Refer to Section 2.4 "Flood Protection Measures" of the Flood Insurance Study Report for information on flood control structures for this jurisdiction.

The **projection** used in the preparation of this map was Massachusetts State Plane Mainland Zone (FIPS zone 2001). The **horizontal datum** was NAD 83, GRS 1980 spheroid. Differences in datum, spheroid, projection or UTM zones used in the production of FIRMs for adjacent jurisdictions may result in slight positional differences in map features across jurisdiction boundaries. These differences do not affect the accuracy of this FIRM.

Flood elevations on this map are referenced to the North American Vertical Datum of 1988. These flood elevations must be compared to structure and ground elevations referenced to the same **vertical datum**. For information regarding conversion between the National Geodetic Vertical Datum of 1929 and the North American Vertical Datum of 1988, visit the National Geodetic Survey website at http://www.ngs.noaa.gov or contact the National Geodetic Survey at the following address:

NGS Information Services
NOAA, NINGS12
National Geodetic Survey
SSMC-3, #9202
1315 East-West Highway
Silver Spring, Maryland 20910-3282
(301) 713-3242

To obtain current elevation, description, and/or location information for **bench marks** shown on this map, please contact the Information Services Branch of the National Geodetic Survey at **(301) 713- 3242**, or visit its website at http://www.ngs.noaa.gov.

Base map information shown on this FIRM was derived from digital orthophotography provided by the Massachusetts Geographic Information System. This information was created from photography dated 2005.

The **profile baselines** depicted on this map represent the hydraulic modeling baselines that match the flood profiles in the FIS report. As a result of improved topographic data, the **profile baseline**, in some cases, may deviate significantly from the channel centerline or appear outside the SFHA.

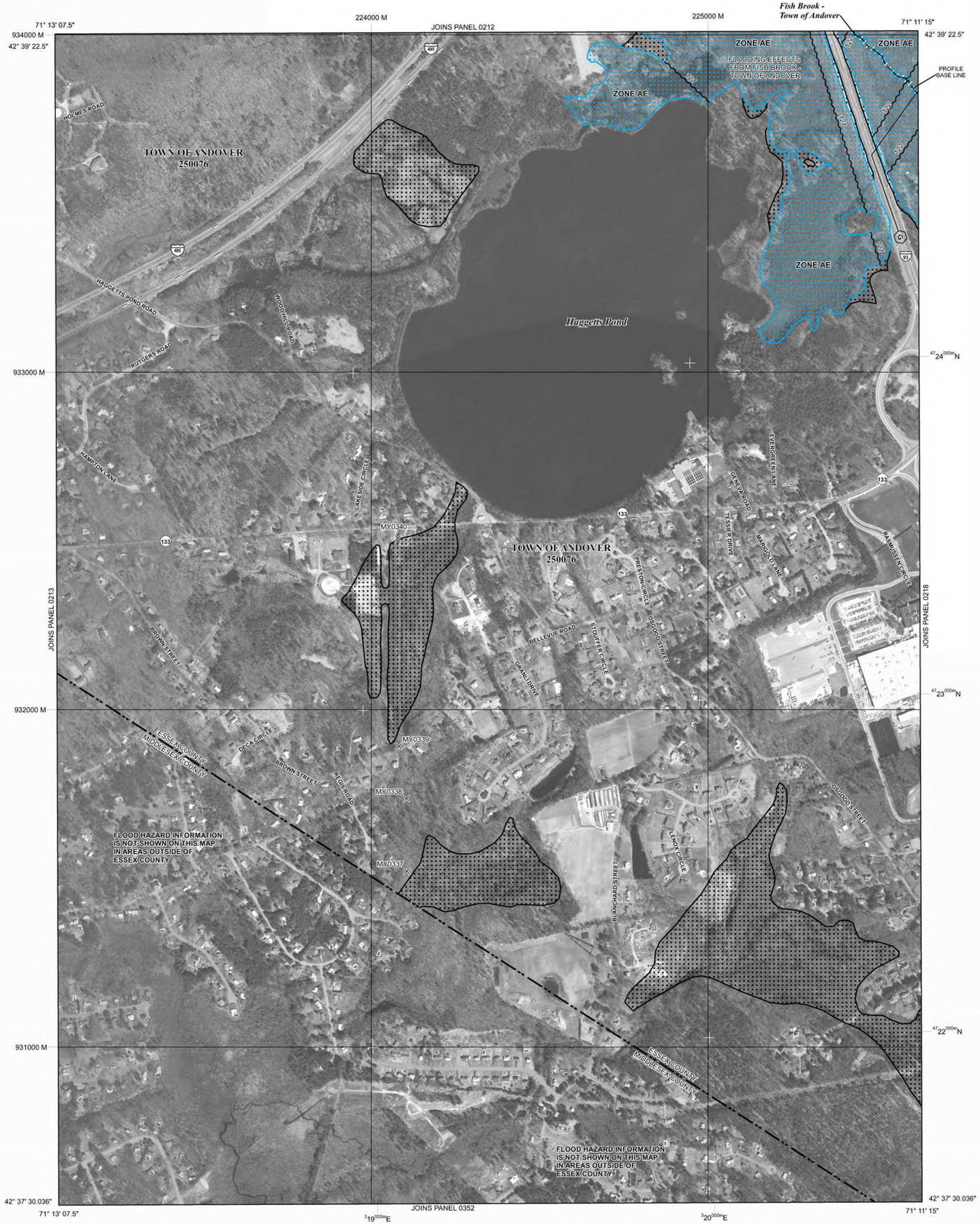
Based on updated topographic information, this map reflects more detailed and up-to-date **stream channel configurations and floodplain delineations** than those shown on the previous FIRM for this jurisdiction. As a result, the Flood Profiles and Floodway Data tables for multiple streams in the Flood Insurance Study Report (which contains authoritative hydraulic data) may reflect stream channel distances that differ from what is shown on the map. Also, the road to floodplain relationships for unrevised streams may differ from what is shown on previous maps.

Corporate limits shown on this map are based on the best data available at the time of publication. Because changes due to annexations or de-annexations may have occurred after this map was published, map users should contact appropriate community officials to verify current corporate limit locations.

Please refer to the separately printed **Map Index** for an overview map of the county showing the layout of map panels; community map repository addresses; and a Listing of Communities table containing National Flood Insurance Program dates for each community as well as a listing of the panels on which each community is located.

For information on available products associated with this FIRM visit the **Map Service Center (MSC)** website at http://msc.fema.gov. Available products may include previously issued Letters of Map Change, a Flood Insurance Study Report, and/or digital versions of this map. Many of these products can be ordered or obtained directly from the MSC website.

If you have **questions about this map,** how to order products, or the National Flood Insurance Program in general, please call the **FEMA Map Information eXchange (FMIX)** at **1-877-FEMA-MAP** (1-877-336-2627) or visit the FEMA website at http://www.fema.gov/business/nfip.



LEGEND

SPECIAL FLOOD HAZARD AREAS (SFHAs) SUBJECT TO INUNDATION BY THE 1% ANNUAL CHANCE FLOOD

The 1% annual chance flood (100-year flood), also known as the base flood, is the flood that has a 1% chance of being equaled or exceeded in any given year. The Special Flood Hazard Area is the area subject to flooding by the 1% annual chance flood. Areas of Special Flood Hazard include Zones A, AE, AH, AO, AR, A99, V, and VE. The Base Flood Elevation is the water-surface elevation of the 1% annual chance flood.

ZONE A	No Base Flood Elevations determined.
ZONE AE	Base Flood Elevations determined.
ZONE AH	Flood depths of 1 to 3 feet (usually areas of ponding); Base Flood Elevations determined.
ZONE AO	Flood depths of 1 to 3 feet (usually sheet flow on sloping terrain); average depths determined. For areas of alluvial fan flooding, velocities also determined.
ZONE AR	Special Flood Hazard Areas formerly protected from the 1% annual chance flood by a flood control system that was subsequently decertified. Zone AR indicates that the former flood control system is being restored to provide protection from the 1% annual chance or greater flood.
ZONE A99	Area to be protected from 1% annual chance flood by a Federal flood protection system under construction; no Base Flood Elevations determined.
ZONE V	Coastal flood zone with velocity hazard (wave action); no Base Flood Elevations determined.
ZONE VE	Coastal flood zone with velocity hazard (wave action); Base Flood Elevations determined.

FLOODWAY AREAS IN ZONE AE

The floodway is the channel of a stream plus any adjacent floodplain areas that must be kept free of encroachment so that the 1% annual chance flood can be carried without substantial increases in flood heights.

OTHER FLOOD AREAS

ZONE X	Areas of 0.2% annual chance flood; areas of 1% annual chance flood with average depths of less than 1 foot or with drainage areas less than 1 square mile; and areas protected by levees from 1% annual chance flood.

OTHER AREAS

ZONE X	Areas determined to be outside the 0.2% annual chance floodplain.
ZONE D	Areas in which flood hazards are undetermined, but possible.

COASTAL BARRIER RESOURCES SYSTEM (CBRS) AREAS

OTHERWISE PROTECTED AREAS (OPAs)

CBRS areas and OPAs are normally located within or adjacent to Special Flood Hazard Areas.

	1% Annual Chance Floodplain Boundary
	0.2% Annual Chance Floodplain Boundary
	Floodway boundary
	Zone D boundary
	CBRS and OPA boundary
	Boundary dividing Special Flood Hazard Area Zones and boundary dividing Special Flood Hazard Areas of different Base Flood Elevations, flood depths, or flood velocities.
513	Base Flood Elevation line and value; elevation in feet*
(EL 987)	Base Flood Elevation value where uniform within zone; elevation in feet*

*Referenced to the North American Vertical Datum of 1988

A — A	Cross section line
23 — 23	Transect line
	Culvert
	Bridge
45° 02' 08", 93° 02' 12"	Geographic coordinates referenced to the North American Datum of 1983 (NAD 83) Western Hemisphere
4989000 M	1000-meter ticks: Massachusetts State Plane Mainland Zone (FIPS Zone 2001), Lambert Conformal Conic projection
4988000 N	1000-meter Universal Transverse Mercator grid values, zone 19N
DX5510	Bench mark (see explanation in Notes to Users section of this FIRM panel)
M1.5	River Mile

MAP REPOSITORIES
Refer to Map Repositories list on Map Index

EFFECTIVE DATE OF COUNTYWIDE FLOOD INSURANCE RATE MAP
July 3, 2012

EFFECTIVE DATE(S) OF REVISION(S) TO THIS PANEL

For community map revision history prior to countywide mapping, refer to the Community Map History table located in the Flood Insurance Study report for this jurisdiction.

To determine if flood insurance is available in this community, contact your insurance agent or call the National Flood Insurance Program at 1-800-638-6620.

MAP SCALE 1" = 500'

250 0 500 1000 FEET
150 0 150 300 METERS

NFIP NATIONAL FLOOD INSURANCE PROGRAM

PANEL 0214F

FIRM

FLOOD INSURANCE RATE MAP

ESSEX COUNTY, MASSACHUSETTS (ALL JURISDICTIONS)

PANEL 214 OF 600
(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
ANDOVER, TOWN OF	250076	0214	F

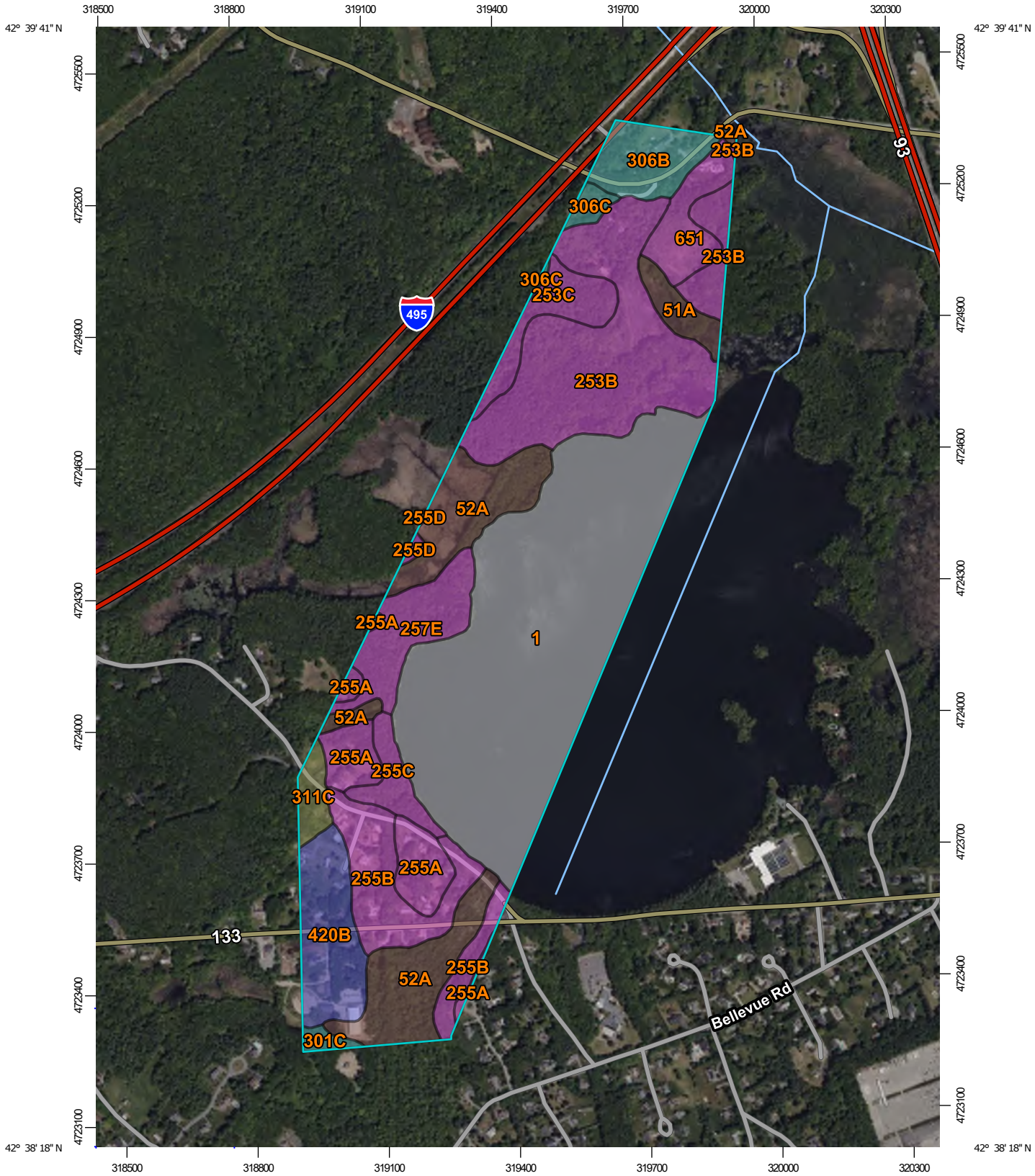
Notice to User: The **Map Number** shown below should be used when placing map orders; the **Community Number** shown above should be used on insurance applications for the subject community.

MAP NUMBER
25009C0214F
EFFECTIVE DATE
JULY 3, 2012

Federal Emergency Management Agency

SOIL SURVEY MAP

Hydrologic Soil Group—Essex County, Massachusetts, Northern Part
(8-9985.01 Haggetts Pond Rail Trail)



Map Scale: 1:12,400 if printed on A portrait (8.5" x 11") sheet.

N

Meters
0 150 300 600 900

Feet
0 500 1000 2000 3000

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 Rating Polygons

A
A/D
B
B/D
C
C/D
D
Not rated or not available

Soil Rating Lines

A
A/D
B
B/D
C
C/D
D
Not rated or not available

Soil Rating Points

A
A/D
B
B/D
C
C/D
D
Not rated or not available

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 1:15,800.

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: Essex County, Massachusetts, Northern Part
Survey Area Data: Version 19, Sep 10, 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.

Hydrologic Soil Group

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
1	Water		88.7	34.9%
51A	Swansea muck, 0 to 1 percent slopes	B/D	4.0	1.6%
52A	Freetown muck, 0 to 1 percent slopes	B/D	27.7	10.9%
253B	Hinckley loamy sand, 3 to 8 percent slopes	A	44.3	17.4%
253C	Hinckley loamy sand, 8 to 15 percent slopes	A	7.3	2.9%
255A	Windsor loamy sand, 0 to 3 percent slopes	A	11.0	4.3%
255B	Windsor loamy sand, 3 to 8 percent slopes	A	17.6	6.9%
255C	Windsor loamy sand, 8 to 15 percent slopes	A	4.8	1.9%
255D	Windsor loamy sand, 15 to 25 percent slopes	A	0.5	0.2%
257E	Hinckley and Windsor soils, 25 to 35 percent slopes	A	11.4	4.5%
301C	Montauk fine sandy loam, 8 to 15 percent slopes, very stony	C	1.2	0.5%
306B	Paxton fine sandy loam, 0 to 8 percent slopes, very stony	C	9.0	3.5%
306C	Paxton fine sandy loam, 8 to 15 percent slopes, very stony	C	1.9	0.7%
311C	Woodbridge fine sandy loam, 8 to 15 percent slopes, very stony	C/D	3.2	1.3%
420B	Canton fine sandy loam, 3 to 8 percent slopes	B	13.8	5.4%
651	Udorthents, smoothed	A	7.6	3.0%
Totals for Area of Interest			**254.1**	**100.0%**

Description

Hydrologic soil groups are based on estimates of runoff potential. Soils are assigned to one of four groups according to the rate of water infiltration when the soils are not protected by vegetation, are thoroughly wet, and receive precipitation from long-duration storms.

The soils in the United States are assigned to four groups (A, B, C, and D) and three dual classes (A/D, B/D, and C/D). The groups are defined as follows:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

If a soil is assigned to a dual hydrologic group (A/D, B/D, or C/D), the first letter is for drained areas and the second is for undrained areas. Only the soils that in their natural condition are in group D are assigned to dual classes.

Rating Options

Aggregation Method: Dominant Condition

Component Percent Cutoff: None Specified

Tie-break Rule: Higher

SOIL TEST PIT LOGS

TPS 182 High Plain

Commonwealth of Massachusetts
City/Town of

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

A. Facility Information

Town of Andover
Owner Name

36 Bartlett Street
Street Address

195-1
Map/Lot #

Andover
City

MA
State

01810
Zip Code

B. Site Information

1. (Check one) ☒ New Construction ☐ Upgrade

2. Soil Survey — Web Soil Survey (Source) — 306B/253B (Soil Map Unit) — Hinckley Loamy Sand (Soil Series)

Ground moraines, hills, drumlins. / Outwash deltas, outwash terraces, moraines, eskers, kames, outwash plains, kame terraces
Landform

Possibly shallow water table. (18-37 inches, 20-43 inches to densic material)
Soil Limitations

Coarse-loamy lodgment till derived from gneiss, granite, and/or schist / Sandy and gravelly glaciofluvial deposits derived from gneiss and/or granite and/or schist.
Soil Parent material

3. Surficial Geological Report — 2018 Surficial Materials of Massachusetts, Stone Map (Year Published/Source) — Coarse deposits (Map Unit)

These deposits include gravel deposits, sand and gravel deposits, and sand deposits. Deposits of finer material are well sorted while deposits of larger particles will be less/poorly sorted.
Description of Geologic Map Unit:

4. Flood Rate Insurance Map — Within a regulatory floodway? ☐ Yes ☒ No

5. Within a velocity zone? ☐ Yes ☒ No

6. Within a Mapped Wetland Area? ☐ Yes ☒ No — If yes, MassGIS Wetland Data Layer: ____ (Wetland Type)

7. Current Water Resource Conditions (USGS): 8/28/2023 (Month/Day/ Year) — Range: ☒ Above Normal ☐ Normal ☐ Below Normal

8. Other references reviewed: (Zone II, IWPA, Zone A, EEA Data Portal, etc.)
Zone I, Zone II, IWPA, Zone A, are not within the project area.
These were reviewed via MassMapper on 9/25/23

Commonwealth of Massachusetts
City/Town of

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

C. On-Site Review *(minimum of two holes required at every proposed primary and reserve disposal area)*

Deep Observation Hole Number: TP-1 (Hole #) | 9/26/23 (Date) | 2:00PM (Time) | Mid 50s, cloudy (Weather) | 42.657893 (Latitude) | -71.199380 (Longitude)

1. Land Use: Woodland/conservation area (e.g., woodland, agricultural field, vacant lot, etc.) | Vegetation: Pines and deciduous. Grasses & shrubs at footslope | Surface Stones (e.g., cobbles, stones, boulders, etc.): few to none | Slope (%): 0-5%

Description of Location: 75-80' into the woods, off High Plain Road. Pits are on the "plateau" between two slopes.

2. Soil Parent Material: Coarse deposits | Landform: — | Position on Landscape (SU, SH, BS, FS, TS, Plain): shoulder

3. Distances from: Open Water Body 31 feet | Drainage Way 31 feet | Wetlands 31 feet | Property Line 50 feet | Drinking Water Well >200 feet | Other — feet

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

5. Groundwater Observed: ☒ Yes ☐ No If yes: _____ Depth to Weeping in Hole | 60" Depth to Standing Water in Hole

Soil Log

Depth (in)	Soil Horizon /Layer	Soil Texture (USDA	Soil Matrix: Color-Moist (Munsell)	Redoximorphic Features: Depth	Redoximorphic Features: Color	Redoximorphic Features: Percent	Coarse Fragments % by Volume: Gravel	Coarse Fragments % by Volume: Cobbles & Stones	Soil Structure	Soil Consistence (Moist)	Other
0-10	Ap	FS	10YR 3/3	-	Cnc: - Dpl: -	-	5-10%	0-5%	M	vfr.	—
10-30	Bw	FS	10YR 6/6	-	Cnc: - Dpl: -	-	0-5%	0-5%	g	l	—
30-56	C	FS	10YR 6/3	40	Cnc: 7.5YR 5/8 Dpl: -	7-10%	5-10%	0-5%	g	l	—
56-60+	2C	Till	—	56	Cnc: 7.5YR 5/8 Dpl: —	10-15%	-	-	—	-	—
					Cnc: Dpl:						
					Cnc: Dpl:						

Additional Notes:
Hole was originally >6' deep but water wept heavily into the hole & settled @ 60" from the top.

Commonwealth of Massachusetts
City/Town of

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

C. On-Site Review (*minimum of two holes required at every proposed primary and reserve disposal area*)

Deep Observation Hole Number: TP-2 (Hole #) | 9/26/23 (Date) | 1:26 PM (Time) | Mid 50s, cloudy (Weather) | 42.657893 (Latitude) | -71.199380 (Longitude)

1. Land Use: Woodland/conservation area (e.g., woodland, agricultural field, vacant lot, etc.) | Pines and deciduous. Grasses & shrubs at footslope (Vegetation) | few to none (Surface Stones (e.g., cobbles, stones, boulders, etc.)) | 0-5% (Slope (%))

Description of Location: 75-80' into the woods, off High Plain Road. Pits are on the "plateau" between two slopes.

2. Soil Parent Material: coarse deposits. | Landform | ~~Shoulder~~ (Position on Landscape (SU, SH, BS, FS, TS, Plain))

3. Distances from: Open Water Body 34 feet | Drainage Way 34 feet | Wetlands 34 feet | Property Line 41 feet | Drinking Water Well >200 feet | Other — feet

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

5. Groundwater Observed: ☐ Yes ☒ No If yes: ____ Depth to Weeping in Hole ____ Depth Standing Water in Hole

Soil Log

Depth (in)	Soil Horizon /Layer	Soil Texture (USDA)	Soil Matrix: Color-Moist (Munsell)	Redoximorphic Features: Depth	Redoximorphic Features: Color	Redoximorphic Features: Percent	Coarse Fragments % by Volume: Gravel	Coarse Fragments % by Volume: Cobbles & Stones	Soil Structure	Soil Consistence (Moist)	Other
0-10"	Ap	S	10YR 3/3	—	Cnc: — Dpl: —	—	30-40%	0-5%	1	gr	
10-32"	Bw	S	10YR 5/6	—	Cnc: — Dpl: —	—	30-40%	10-15%	~~FS~~ 1	gr	
32-38"	C	FS	10YR 7/6	—	Cnc: — Dpl: —	—	0	0	1	gr	
38+"	2C	Till	—	38"	Cnc: Dpl: 10YR 6/2	25-30%	—	—	—	—	—
					Cnc: Dpl:						
					Cnc: Dpl:						

Additional Notes:

Commonwealth of Massachusetts
City/Town of

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

D. Determination of High Groundwater Elevation

1. Method Used (Choose one):

	Obs. Hole # TP-1	Obs. Hole # TP-2
☐ Depth to soil redoximorphic features	40 inches	38 inches
☐ Depth to observed standing water in observation hole	_____ inches	_____ inches
☐ Depth to adjusted seasonal high groundwater (S_h) (USGS methodology)	_____ inches	_____ inches

_____ Index Well Number _____ Reading Date

$S_h = S_c - [S_f \times (OW_c - OW_{max})/OW_f]$

Obs. Hole/Well# _____ S_c _____ S_f _____ OW_c _____ OW_{max} _____ OW_f _____ S_h _____

E. Depth of Pervious Material

1. Depth of Naturally Occurring Pervious Material

   a. Does at least four feet of naturally occurring pervious material exist in all areas observed throughout the area proposed for the soil absorption system?

   ☐ Yes ☒ No

   b. If yes, at what depth was it observed (exclude O, A, and E Horizons)? Upper boundary: _____ inches Lower boundary: _____ inches

   c. If no, at what depth was impervious material observed? Upper boundary: _____ inches Lower boundary: _____ inches

Commonwealth of Massachusetts
City/Town of

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

F. 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 required training, expertise and experience described in 310 CMR 15.017. I further certify that the results of my soil evaluation, as indicated in the attached Soil Evaluation Form, are accurate and in accordance with 310 CMR 15.100 through 15.107.

Signature of Soil Evaluator	9/26/2023 Date
Robert Feltes Typed or Printed Name of Soil Evaluator / License #	5/1/2026 Expiration Date of License
Name of Approving Authority Witness	Approving Authority

Note: In accordance with 310 CMR 15.018(2) this form must be submitted to the approving authority within 60 days of the date of field testing, and to the designer and the property owner with Percolation Test Form 12.

Field Diagrams: Use this area for field diagrams:

TPs 324, Haggetts

Commonwealth of Massachusetts
City/Town of

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

A. Facility Information

Town of Andover
Owner Name

36 Bartlett Street
Street Address

196-14
Map/Lot #

Andover
City

MA
State

01810
Zip Code

B. Site Information

1. (Check one) ☒ New Construction ☐ Upgrade

2. Soil Survey — Web Soil Survey (Source) | 255B/C (Soil Map Unit) | Windsor Loamy Sand (Soil Series)

Dunes, outwash plains, deltas, outwash terraces (Landform) | None listed. (Soil Limitations)

oose sandy glaciofluvial deposits derived from granite and/or loose sandy glaciofluvial deposits derived from schist and/or loose sandy glaciofluvial deposits derived from gneiss
Soil Parent material

3. Surficial Geological Report — 2018 Surficial Materials of Massachusetts, Stone Map (Year Published/Source) | Coarse deposits (Map Unit)

These deposits include gravel deposits, sand and gravel deposits, and sand deposits. Deposits of finer material are well sorted while deposits of larger particles will be less/poorly sorted.
Description of Geologic Map Unit:

4. Flood Rate Insurance Map — Within a regulatory floodway? ☒ Yes ☐ No

5. Within a velocity zone? ☐ Yes ☒ No

6. Within a Mapped Wetland Area? ☐ Yes ☒ No — If yes, MassGIS Wetland Data Layer: _____ (Wetland Type)

7. Current Water Resource Conditions (USGS): 8/28/2023 (Month/Day/ Year) — Range: ☒ Above Normal ☐ Normal ☐ Below Normal

8. Other references reviewed: (Zone II, IWPA, Zone A, EEA Data Portal, etc.)
Zone I, Zone II, IWPA, Zone A, are not within the project area.
These were reviewed via MassMapper on 9/25/23

Commonwealth of Massachusetts
City/Town of

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

C. On-Site Review *(minimum of two holes required at every proposed primary and reserve disposal area)*

Deep Observation Hole Number: TP-3 (Hole #) | 9/26/23 (Date) | 10:00 AM (Time) | Mid 80s cloudy (Weather) | 42.643048 (Latitude) | -71.206425 (Longitude)

1. Land Use: Woodland/conservation area (e.g., woodland, agricultural field, vacant lot, etc.) | Pines and deciduous. Thick grasses & shrubs (Vegetation) | Some boulders & stones from 5-10' (Surface Stones (e.g., cobbles, stones, boulders, etc.)) | 0-3 % (Slope (%))

Description of Location: 70-80', off Haggett's Pond Road. Pit is off the main trail..

2. Soil Parent Material: Outwash | Outwash plain (Landform) | shoulder of hillside (Position on Landscape (SU, SH, BS, FS, TS, Plain))

3. Distances from: Open Water Body ____ feet | Drainage Way — feet | Wetlands 26 feet | Property Line 46 feet | Drinking Water Well — feet | Other — feet

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

5. Groundwater Observed: ☐ Yes ☒ No If yes: ____ Depth to Weeping in Hole ____ Depth to Standing Water in Hole

Soil Log

Depth (in)	Soil Horizon /Layer	Soil Texture (USDA	Soil Matrix: Color-Moist (Munsell)	Redoximorphic Features			Coarse Fragments % by Volume		Soil Structure	Soil Consistence (Moist)	Other
				Depth	Color	Percent	Gravel	Cobbles & Stones			
0-12"	Ap	MS	7.5YR 3/2	—	Cnc: — Dpl: —	—	—	—	M	VFr	—
12-25"	Bw	MS	7.5YR 4/4	21"	Cnc: 7.5YR 5/8 Dpl: —	1-3%	—	—	g	l	Redox was isolated. Doubtful that its ESHWT
25-36"	C	FS	7.5YR 5/4	25"	Cnc: 7.5YR 5/8 Dpl: —	15-25%	2-5%	0-10%	g	l	—
36"+	2C	FLS	10YR 5/6	—	Cnc: — Dpl: —	—	2-5%	—	M	fr	—
					Cnc: Dpl:						
					Cnc: Dpl:						

Additional Notes:

Commonwealth of Massachusetts
City/Town of

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

C. On-Site Review (*minimum of two holes required at every proposed primary and reserve disposal area*)

Deep Observation Hole Number: TP-4 (Hole #) | 9/26/23 (Date) | 9:30AM (Time) | Mid 50s, cloudy (Weather) | 42.643048 (Latitude) | -71.206425 (Longitude)

1. Land Use: Woodland/conservation area (e.g., woodland, agricultural field, vacant lot, etc.) | Pines and deciduous. Thick grasses & shrubs (Vegetation) | some boulders & stones from SW (Surface Stones (e.g., cobbles, stones, boulders, etc.) | 0-3% (Slope (%))

Description of Location: 50', off Haggett's Pond Road. Pit is off the main trail.

2. Soil Parent Material: outwash | outwash plain (Landform) | shoulder of rail trail (Position on Landscape (SU, SH, BS, FS, TS, Plain))

3. Distances from: Open Water Body — feet | Drainage Way — feet | Wetlands — feet | Property Line 27 feet | Drinking Water Well — feet | Other — feet

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

5. Groundwater Observed: ☒ Yes ☐ No If yes: 6 Depth to Weeping in Hole _____ Depth Standing Water in Hole

Soil Log

Depth (in)	Soil Horizon /Layer	Soil Texture (USDA)	Soil Matrix: Color-Moist (Munsell)	Redoximorphic Features: Depth	Redoximorphic Features: Color	Redoximorphic Features: Percent	Coarse Fragments % by Volume: Gravel	Coarse Fragments % by Volume: Cobbles & Stones	Soil Structure	Soil Consistence (Moist)	Other
0-17"	Ap	MS	7.5YR 5/2	—	Cnc: — Dpl: —	—	0-5%	—	g	l	—
17-27"	Bw	MS	10YR 6/4	—	Cnc: — Dpl: —	—	0-5%	—	g	l	—
27"-40"	C	FS	10YR 6/3	30"	Cnc: 10YR 6/6 Dpl: —	10-15%	0-5%	—	g	l	—
40"+	2C	—	—	—	Cnc: — Dpl: —	—	—	—	—	—	—
					Cnc: Dpl:						
					Cnc: Dpl:						

Additional Notes:
Due to sandy soils, walls of pit were caving in & access to bottom was not possible. Samples for coloring & texturing were collected from the top of the pit using a shovel.

Commonwealth of Massachusetts
City/Town of

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

D. Determination of High Groundwater Elevation

1. Method Used (Choose one):

	Obs. Hole # TP-3	Obs. Hole # TP-4
☒ Depth to soil redoximorphic features	27 inches	30 inches
☐ Depth to observed standing water in observation hole	_____ inches	_____ inches
☐ Depth to adjusted seasonal high groundwater (S_h) (USGS methodology)	_____ inches	_____ inches

_____ Index Well Number _____ Reading Date

$S_h = S_c - [S_r \times (OW_c - OW_{max})/OW_r]$

Obs. Hole/Well# _____ S_c _____ S_r _____ OW_c _____ OW_{max} _____ OW_r _____ S_h _____

E. Depth of Pervious Material

1. Depth of Naturally Occurring Pervious Material

   a. Does at least four feet of naturally occurring pervious material exist in all areas observed throughout the area proposed for the soil absorption system?

   ☐ Yes ☐ No

   b. If yes, at what depth was it observed (exclude O, A, and E Horizons)? Upper boundary: _____ inches Lower boundary: _____ inches

   c. If no, at what depth was impervious material observed? Upper boundary: _____ inches Lower boundary: _____ inches

Commonwealth of Massachusetts
City/Town of

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

F. 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 required training, expertise and experience described in 310 CMR 15.017. I further certify that the results of my soil evaluation, as indicated in the attached Soil Evaluation Form, are accurate and in accordance with 310 CMR 15.100 through 15.107.

Signature of Soil Evaluator	9/26/2023 Date
Robert Feltes Typed or Printed Name of Soil Evaluator / License #	5/1/2026 Expiration Date of License
Name of Approving Authority Witness	Approving Authority

Note: In accordance with 310 CMR 15.018(2) this form must be submitted to the approving authority within 60 days of the date of field testing, and to the designer and the property owner with Percolation Test Form 12.

Field Diagrams: Use this area for field diagrams:

TPs 526, Bellevue

Commonwealth of Massachusetts
City/Town of

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

A. Facility Information

Town of Andover
Owner Name

36 Bartlett Street
Street Address

197-11
Map/Lot #

Andover
City

MA
State

01810
Zip Code

B. Site Information

1. (Check one) ☒ New Construction ☐ Upgrade

2. Soil Survey — Web Soil Survey (Source) | 52A (Soil Map Unit) | Freetown muck (Soil Series)

Depressions, depressions, swamps, kettles, marshes, bogs
Landform

Depth to water table is expected at 6 inches.
Soil Limitations

Highly decomposed organic material.
Soil Parent material

3. Surficial Geological Report — 2018 Surficial Materials of Massachusetts, Stone Map (Year Published/Source) | Coarse deposits (Map Unit)

These deposits include gravel deposits, sand and gravel deposits, and sand deposits. Deposits of finer material are well sorted while deposits of larger particles will be less/poorly sorted.
Description of Geologic Map Unit:

4. Flood Rate Insurance Map — Within a regulatory floodway? ☐ Yes ☒ No

5. Within a velocity zone? ☐ Yes ☒ No

6. Within a Mapped Wetland Area? ☐ Yes ☒ No — If yes, MassGIS Wetland Data Layer: ____ (Wetland Type)

7. Current Water Resource Conditions (USGS): 8/28/2023 (Month/Day/Year) — Range: ☒ Above Normal ☐ Normal ☐ Below Normal

8. Other references reviewed: (Zone II, IWPA, Zone A, EEA Data Portal, etc.)
Zone I, Zone II, IWPA, Zone A, are not within the project area.
These were reviewed via MassMapper on 9/25/23

Commonwealth of Massachusetts
City/Town of

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

C. On-Site Review *(minimum of two holes required at every proposed primary and reserve disposal area)*

Deep Observation Hole Number: TP-5 (Hole #) | 9/26/23 (Date) | 11:00 AM (Time) | Mid 50s, Cloudy (Weather) | 42.637271 (Latitude) | -71.206444 (Longitude)

1. Land Use: Woodland/conservation area (e.g., woodland, agricultural field, vacant lot, etc.) | Pines and deciduous. Thick grasses & shrubs. (Vegetation) | Very few. (Surface Stones (e.g., cobbles, stones, boulders, etc.)) | 3-5% (Slope (%))

Description of Location: 30' off Bellevue Road. Pit is off the main trail.

2. Soil Parent Material: Till/coarse deposits | - (Landform) | Footslope of hill (Position on Landscape (SU, SH, BS, FS, TS, Plain))

3. Distances from: Open Water Body - feet | Drainage Way - feet | Wetlands 58 feet | Property Line 46 feet | Drinking Water Well ____ feet | Other - feet

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

5. Groundwater Observed: ☒ Yes ☐ No If yes: ____ Depth to Weeping in Hole | 52" Depth to Standing Water in Hole

Soil Log

Depth (in)	Soil Horizon /Layer	Soil Texture (USDA	Soil Matrix: Color-Moist (Munsell)	Redoximorphic Features: Depth	Redoximorphic Features: Color	Redoximorphic Features: Percent	Coarse Fragments % by Volume: Gravel	Coarse Fragments % by Volume: Cobbles & Stones	Soil Structure	Soil Consistence (Moist)	Other
0-16"	Ap	FLS	10YR 3/2	-	Cnc: - Dpl: -	-	5-10%	0-5%	M	F	
16-31"	Bw	FLS	7.5YR 6/6	-	Cnc: - Dpl: -	-	5-10%	7-12%	M	VFr	
31"+	Cr	Till	-	-	Cnc: - Dpl: -	-	-	-	-	-	Layer is extremely coarse/stony
					Cnc: Dpl:						
					Cnc: Dpl:						
					Cnc: Dpl:						

Additional Notes:
Large boulders @ bottom & sides of pit, preventing deeper exploration

Commonwealth of Massachusetts
City/Town of

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

C. On-Site Review (*minimum of two holes required at every proposed primary and reserve disposal area*)

Deep Observation Hole Number: TP-6 (Hole #) | 9/26/23 (Date) | 11:40 AM (Time) | Mid 50s, cloudy (Weather) | 42.637271 (Latitude) | -71.206444 (Longitude)

1. Land Use: Woodland/conservation area (e.g., woodland, agricultural field, vacant lot, etc.) | Pines and deciduous. Thick grasses & shrubs (Vegetation) | Few stones. (Surface Stones (e.g., cobbles, stones, boulders, etc.)) | 3-5% (Slope (%))

Description of Location: 50', off Haggett's Pond Road. Pit is off the main trail.

2. Soil Parent Material: Till/ Coarse Deposits. | – (Landform) | Footslope of hill (Position on Landscape (SU, SH, BS, FS, TS, Plain))

3. Distances from: Open Water Body – feet | Drainage Way – feet | Wetlands 35 feet | Property Line 27 feet | Drinking Water Well >100' feet | Other – feet

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

5. Groundwater Observed: ☒ Yes ☐ No If yes: 46" Depth to Weeping in Hole _____ Depth Standing Water in Hole

Soil Log

Depth (in)	Soil Horizon /Layer	Soil Texture (USDA)	Soil Matrix: Color-Moist (Munsell)	Redoximorphic Features: Depth	Redoximorphic Features: Color	Redoximorphic Features: Percent	Coarse Fragments % by Volume: Gravel	Coarse Fragments % by Volume: Cobbles & Stones	Soil Structure	Soil Consistence (Moist)	Other
0-12"	Ap	FS	10YR 5/3	–	Cnc: – Dpl: –	–	0-5%	0-5%	M	VFr	–
12-24"	Bw	FS	10YR 5/4	24"	Cnc: 10YR 6/6 Dpl: 10YR 6/3	30-40%	15-20%	5-10%	l	g	Very depleted, matrix color in layer is grayish.
24"+	Cr	Till	–	–	Cnc: – Dpl: –	–	–	–	–	–	Layer is extremely stony/dense.
					Cnc: Dpl:						
					Cnc: Dpl:						
					Cnc: Dpl:						

Additional Notes: Large boulders on bottom & sides of pit

Commonwealth of Massachusetts
City/Town of

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

D. Determination of High Groundwater Elevation

1. Method Used (Choose one):

	Obs. Hole # TP-5	Obs. Hole # TP-6
☒ Depth to soil redoximorphic features	N/A inches	24 inches
☐ Depth to observed standing water in observation hole	_____ inches	_____ inches
☐ Depth to adjusted seasonal high groundwater (S_h) (USGS methodology)	_____ inches	_____ inches

_____ Index Well Number _____ Reading Date

$S_h = S_c - [S_r \times (OW_c - OW_{max})/OW_r]$

Obs. Hole/Well# _____ S_c _____ S_r _____ OW_c _____ OW_{max} _____ OW_r _____ S_h _____

E. Depth of Pervious Material

1. Depth of Naturally Occurring Pervious Material

   a. Does at least four feet of naturally occurring pervious material exist in all areas observed throughout the area proposed for the soil absorption system?

   ☐ Yes ☒ No

   b. If yes, at what depth was it observed (exclude O, A, and E Horizons)? Upper boundary: — inches Lower boundary: — inches

   c. If no, at what depth was impervious material observed? Upper boundary: 24" inches Lower boundary: — inches

Commonwealth of Massachusetts
City/Town of

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

F. 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 required training, expertise and experience described in 310 CMR 15.017. I further certify that the results of my soil evaluation, as indicated in the attached Soil Evaluation Form, are accurate and in accordance with 310 CMR 15.100 through 15.107.

Signature of Soil Evaluator	9/26/2023 Date
Robert Feltes Typed or Printed Name of Soil Evaluator / License #	5/1/2026 Expiration Date of License
Name of Approving Authority Witness	Approving Authority

Note: In accordance with 310 CMR 15.018(2) this form must be submitted to the approving authority within 60 days of the date of field testing, and to the designer and the property owner with Percolation Test Form 12.

Field Diagrams: Use this area for field diagrams:

MA MS4 GENERAL PERMIT TABLES 3-8 & 3-14

Table 3- 8: Infiltration Trench (IR = 2.41 in/hr) BMP Performance Table

Infiltration Trench (IR = 2.41 in/hr) BMP Performance Table: Long-Term Phosphorus Load Reduction								
BMP Capacity: Depth of Runoff Treated from Impervious Area (inches)	0.1	0.2	0.4	0.6	0.8	1.0	1.5	2.0
Runoff Volume Reduction	34.0%	54.7%	78.3%	88.4%	93.4%	96.0%	98.8%	99.8%
Cumulative Phosphorus Load Reduction	33%	55%	81%	91%	96%	98%	100%	100%

Figure 3- 5: BMP Performance Curve: Infiltration Trench (infiltration rate = 2.41 in/hr)

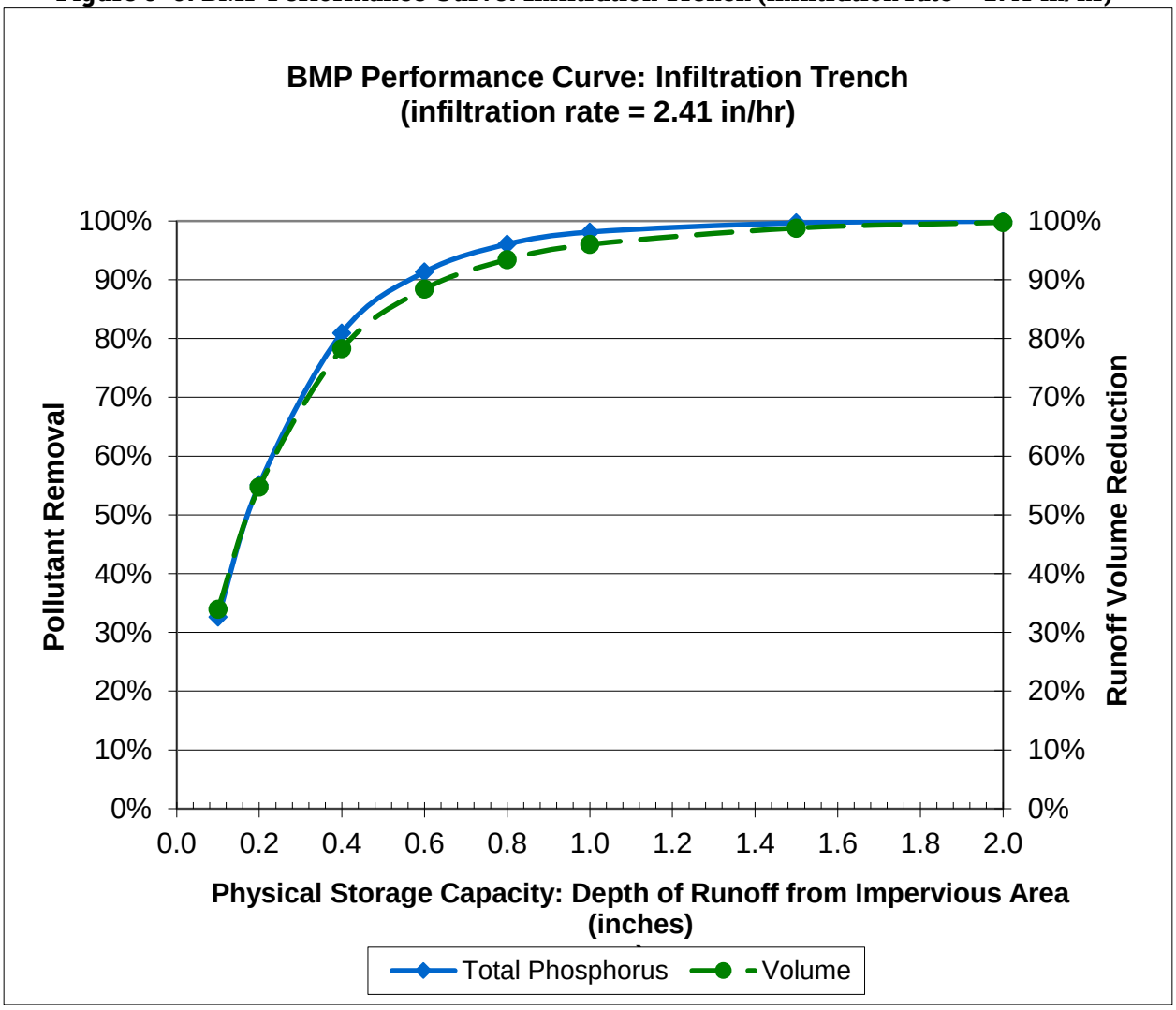
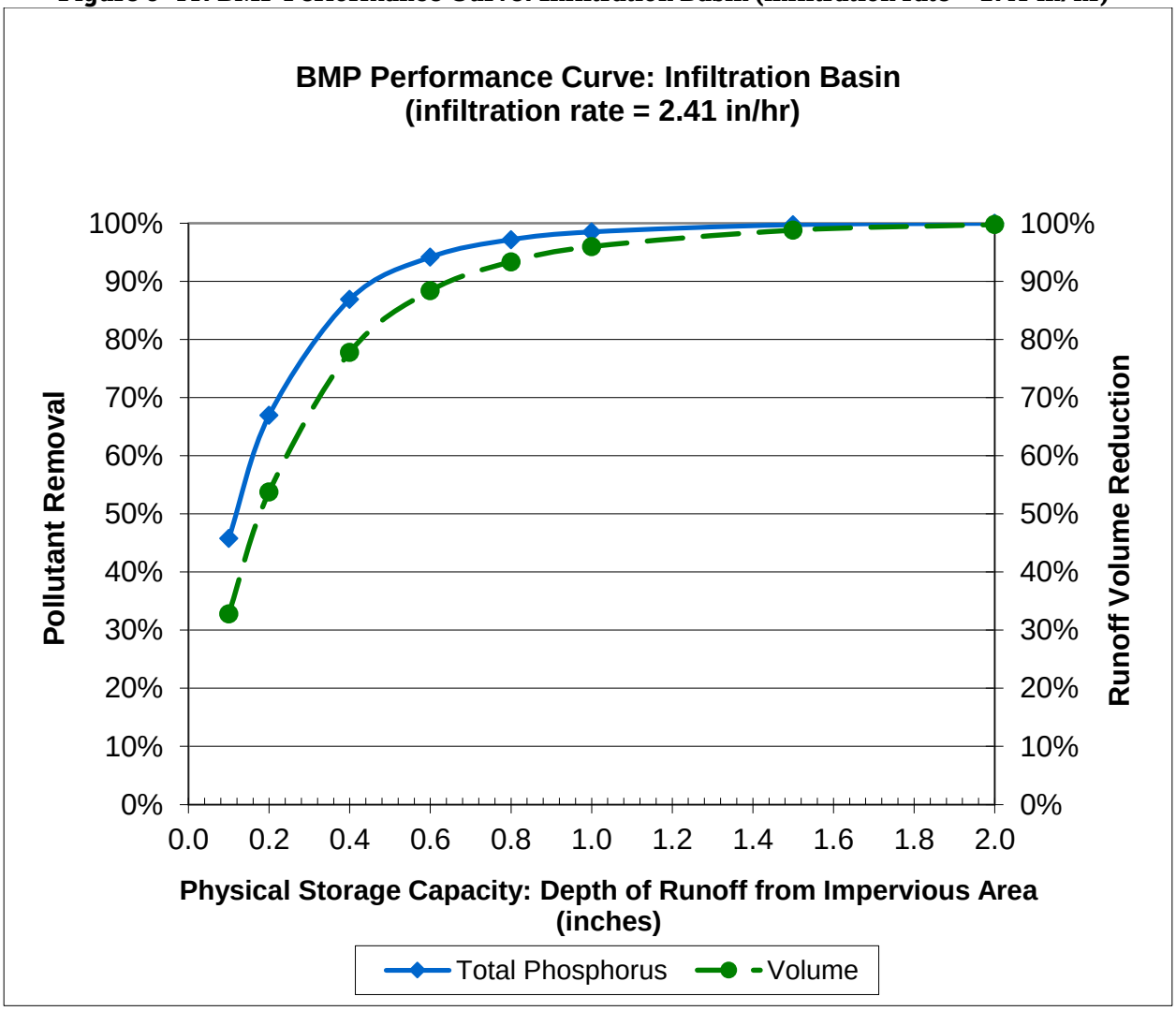


Table 3- 14: Infiltration Basin (2.41 in/hr) BMP Performance Table

Infiltration Basin (2.41 in/hr) BMP Performance Table: Long-Term Phosphorus Load Reduction								
BMP Capacity: Depth of Runoff Treated from Impervious Area (inches)	0.1	0.2	0.4	0.6	0.8	1.0	1.5	2.0
Runoff Volume Reduction	32.8%	53.8%	77.8%	88.4%	93.4%	96.0%	98.8%	99.8%
Cumulative Phosphorus Load Reduction	46%	67%	87%	94%	97%	98%	100%	100%

Figure 3- 11: BMP Performance Curve: Infiltration Basin (infiltration rate = 2.41 in/hr)



NOAA ATLAS 14 PRECIPITATION FREQUENCY TABLE

NOAA Atlas 14, Volume 10, Version 3
Location name: Andover, Massachusetts, USA*
Latitude: 42.6487°, Longitude: -71.2081°
Elevation: 137 ft**
* source: ESRI Maps
** source: USGS

POINT PRECIPITATION FREQUENCY ESTIMATES

Sanja Perica, Sandra Pavlovic, Michael St. Laurent, Carl Trypaluk, Dale Unruh, Orlan Wilhite

NOAA, National Weather Service, Silver Spring, Maryland

PF_tabular | PF_graphical | Maps_&_aerials

PF tabular

PDS-based point precipitation frequency estimates with 90% confidence intervals (in inches)[1]

Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	**0.312** (0.246-0.385)	**0.372** (0.294-0.460)	**0.471** (0.370-0.585)	**0.552** (0.432-0.690)	**0.665** (0.502-0.866)	**0.750** (0.554-0.997)	**0.838** (0.599-1.16)	**0.937** (0.634-1.32)	**1.08** (0.700-1.57)	**1.19** (0.756-1.78)
10-min	**0.442** (0.349-0.546)	**0.527** (0.416-0.652)	**0.666** (0.524-0.828)	**0.782** (0.611-0.977)	**0.941** (0.711-1.23)	**1.06** (0.784-1.41)	**1.19** (0.849-1.64)	**1.33** (0.898-1.87)	**1.53** (0.992-2.23)	**1.69** (1.07-2.52)
15-min	**0.520** (0.411-0.642)	**0.620** (0.489-0.767)	**0.784** (0.617-0.974)	**0.920** (0.719-1.15)	**1.11** (0.836-1.44)	**1.25** (0.923-1.66)	**1.40** (0.999-1.93)	**1.56** (1.06-2.20)	**1.80** (1.17-2.62)	**1.99** (1.26-2.96)
30-min	**0.714** (0.564-0.883)	**0.852** (0.673-1.06)	**1.08** (0.847-1.34)	**1.27** (0.990-1.58)	**1.52** (1.15-1.99)	**1.72** (1.27-2.29)	**1.92** (1.38-2.65)	**2.15** (1.46-3.03)	**2.48** (1.61-3.62)	**2.74** (1.74-4.09)
60-min	**0.908** (0.718-1.12)	**1.08** (0.856-1.34)	**1.37** (1.08-1.71)	**1.61** (1.26-2.01)	**1.94** (1.47-2.53)	**2.19** (1.62-2.91)	**2.45** (1.75-3.38)	**2.74** (1.85-3.87)	**3.16** (2.05-4.61)	**3.50** (2.22-5.21)
2-hr	**1.16** (0.926-1.43)	**1.40** (1.11-1.72)	**1.79** (1.42-2.21)	**2.11** (1.66-2.62)	**2.56** (1.95-3.32)	**2.89** (2.16-3.84)	**3.24** (2.35-4.49)	**3.67** (2.49-5.15)	**4.32** (2.81-6.27)	**4.88** (3.10-7.21)
3-hr	**1.34** (1.07-1.64)	**1.62** (1.30-1.99)	**2.08** (1.66-2.56)	**2.46** (1.95-3.04)	**2.99** (2.29-3.88)	**3.38** (2.54-4.49)	**3.80** (2.78-5.27)	**4.32** (2.94-6.04)	**5.13** (3.35-7.42)	**5.83** (3.71-8.59)
6-hr	**1.71** (1.38-2.08)	**2.08** (1.68-2.53)	**2.68** (2.15-3.28)	**3.18** (2.54-3.91)	**3.88** (2.99-5.00)	**4.38** (3.32-5.80)	**4.94** (3.64-6.82)	**5.64** (3.85-7.83)	**6.73** (4.40-9.67)	**7.68** (4.90-11.2)
12-hr	**2.15** (1.75-2.59)	**2.62** (2.13-3.17)	**3.40** (2.76-4.13)	**4.05** (3.26-4.94)	**4.94** (3.84-6.33)	**5.60** (4.26-7.35)	**6.32** (4.67-8.65)	**7.20** (4.94-9.94)	**8.59** (5.64-12.3)	**9.79** (6.26-14.2)
24-hr	**2.54** (2.08-3.04)	**3.14** (2.58-3.78)	**4.14** (3.38-4.98)	**4.96** (4.02-6.00)	**6.09** (4.77-7.76)	**6.92** (5.31-9.04)	**7.84** (5.84-10.7)	**8.98** (6.19-12.3)	**10.8** (7.10-15.3)	**12.4** (7.93-17.8)
2-day	**2.84** (2.35-3.39)	**3.50** (2.96-4.28)	**4.69** (3.95-5.75)	**5.81** (4.75-6.99)	**7.29** (5.69-9.14)	**8.21** (6.36-10.7)	**9.31** (7.04-12.7)	**10.6** (7.46-14.7)	**13.1** (8.68-18.5)	**15.2** (9.79-21.8)
3-day	**3.12** (2.59-3.70)	**3.91** (3.25-4.65)	**5.22** (4.31-6.22)	**6.30** (5.17-7.54)	**7.78** (6.18-9.85)	**8.87** (6.90-11.5)	**10.1** (7.63-13.7)	**11.7** (8.07-15.8)	**14.2** (9.40-19.9)	**16.4** (10.6-23.5)
4-day	**3.38** (2.82-4.00)	**4.20** (3.50-4.98)	**5.55** (4.60-6.59)	**6.66** (5.49-7.96)	**8.19** (6.52-10.3)	**9.31** (7.26-12.0)	**10.6** (8.00-14.3)	**12.2** (8.46-16.5)	**14.8** (9.82-20.7)	**17.1** (11.1-24.4)
7-day	**4.12** (3.46-4.85)	**4.97** (4.17-5.85)	**6.36** (5.32-7.52)	**7.51** (6.23-8.93)	**9.10** (7.29-11.4)	**10.3** (8.03-13.2)	**11.5** (8.78-15.5)	**13.2** (9.22-17.8)	**15.9** (10.6-22.1)	**18.3** (11.8-25.9)
10-day	**4.79** (4.04-5.61)	**5.66** (4.77-6.64)	**7.09** (5.95-8.35)	**8.27** (6.90-9.80)	**9.90** (7.95-12.3)	**11.1** (8.70-14.1)	**12.4** (9.43-16.5)	**14.1** (9.86-18.9)	**16.7** (11.2-23.2)	**19.0** (12.3-26.8)
20-day	**6.69** (5.70-7.79)	**7.66** (6.51-8.92)	**9.23** (7.81-10.8)	**10.5** (8.85-12.4)	**12.3** (9.94-15.1)	**13.7** (10.7-17.1)	**15.1** (11.4-19.6)	**16.7** (11.8-22.2)	**19.1** (12.8-26.2)	**21.0** (13.7-29.5)
30-day	**8.29** (7.09-9.61)	**9.33** (7.97-10.8)	**11.0** (9.38-12.8)	**12.4** (10.5-14.6)	**14.4** (11.6-17.5)	**15.9** (12.4-19.6)	**17.4** (13.0-22.2)	**18.9** (13.4-25.0)	**21.1** (14.2-28.8)	**22.8** (14.9-31.8)
45-day	**10.3** (8.88-11.9)	**11.4** (9.83-13.2)	**13.3** (11.4-15.4)	**14.8** (12.6-17.3)	**16.9** (13.7-20.4)	**18.5** (14.6-22.8)	**20.2** (15.1-25.5)	**21.7** (15.4-28.5)	**23.7** (16.0-32.2)	**25.2** (16.4-35.0)
60-day	**12.1** (10.4-13.9)	**13.3** (11.4-15.3)	**15.2** (13.1-17.6)	**16.8** (14.3-19.6)	**19.0** (15.5-22.9)	**20.8** (16.4-25.4)	**22.5** (16.9-28.2)	**24.0** (17.1-31.5)	**26.0** (17.6-35.2)	**27.3** (17.9-37.9)

[1] Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS).

Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and average recurrence interval) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper bounds are not checked against probable maximum precipitation (PMP) estimates and may be higher than currently valid PMP values.

Please refer to NOAA Atlas 14 document for more information.

Back to Top