

# STORMWATER REPORT

HAGGETTS POND RAIL TRAIL  
ANDOVER, MASSACHUSETTS

NOVEMBER 7, 2023  
*REVISED: DECEMBER 21, 2023*

Applicant:

Town of Andover  
36 Bartlet Street  
Andover, Massachusetts, 01810

BSC Job Number: 8-9985.01



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Prepared by:



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## **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 area on the south side of Haggetts Pond Road, and the creation of additional parking on the south side of High Plain Road. The proposed trail will comprise an 8-ft wide asphalt surface. The project work is located in buffers to State and Local wetland resource areas, as well as a NHESP Priority Habitat and stormwater discharges to an Outstanding Resource Water (Haggetts Pond public water supply).

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 an existing 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. Additionally, the roadway driveway spur sheet flows the existing runoff to a 12” RCP culvert that also discharges untreated to the same wetlands located on the project site.

The Project proposes to treat the existing runoff collected in the existing catch basin and existing 12” RCP. Treatment is provided in two water quality units per the Mass Stormwater Handbook to improve water quality associated with this runoff. The existing catch basin and 12” RCP are redirected to water quality units to provide pre-treatment of the existing collected runoff. The catch basin runoff is then discharged to a rip-rap dissipation/forebay and rain garden area prior to flowing to the adjacent wetlands. Due to the existing pipe inverts and proximity to the existing wetlands and seasonal high groundwater, this flow as been treated to the maximum extent feasible. The existing runoff collected in the existing 12” RCP is directed to a water quality unit prior to discharging to a bio-retention area.

**High Plain Road Parking Lot Runoff** - The proposed High Plain Road Parking Lot will be constructed as asphalt pavement. Stormwater runoff will be captured, detained, and treated using a proprietary water quality unit, subsurface storage pipes, and a constructed bio-retention area 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. The water quality unit will provide the minimum 44% TSS removal prior to discharging to the bio-retention area.

**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 to the extent feasible. The existing catch basin will be replaced with a water quality inlet to provide improved pre-treatment. Additionally, the existing headwall outlet will have a rip-rap dissipation bowl installed and then directed to a rain garden prior to flowing to Haggetts Pond providing additional treatment. Due to the existing pipe inverts and shallow ground water, the treatment of the existing roadway has been provided to the maximum extent feasible.

**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 with a water quality unit and discharged to subsurface infiltration/detention chambers under the parking area. The system has been designed to achieve a minimum pre-treatment of 44% prior and an overall 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 Shared-Use Path along the Rail Trail will overlay the existing relatively impervious gravel railroad bed within the rail ROW. Stormwater will be managed from the rail trail by sloping the trail cross section away from Haggetts Pond to a 1-ft vegetative buffer and existing woodlands. The 1-ft wide vegetative shoulders will trap sediment and aid in infiltration, directing 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 water quality outlets, bioretention areas, and/or subsurface detention/infiltration systems at all new parking 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 is provided within the trail vegetive shoulders and wooded areas.

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	0.6	0.3	-0.3
10-year Peak Runoff	1.2	1.0	-0.2
25-year Peak Runoff	1.6	1.3	-0.3
100-year Peak Runoff	2.2	1.7	-0.5

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	0.2	0.0	0.0
10-year Peak Runoff	0.4	0.2	-0.2
25-year Peak Runoff	0.6	0.5	-0.1
100-year Peak Runoff	0.9	0.9	0.0

Standard 3 - Groundwater Recharge

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

$$R_v = F \times \text{impervious area}$$

$R_v$  = Required Recharge Volume, expressed in Ft<sup>3</sup>, 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	<b>0.6-inch</b>
B	loam	<b>0.35-inch</b>
C	silty loam	<b>0.25-inch</b>
D	clay	<b>0.1-inch</b>

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	0.207 ac; 9,009 sf	0.60 inches	0.010 acre-feet; 450 cubic feet
B	0 acres	0.35 inches	0 acre-feet
C	0.140 acres; 6,113 sf	0.25 inches	0.003 acre-feet; 127 cubic feet
D	0 acres	0.10 inches	0 acre-feet
<b>Totals</b>	<b>0.347 acres; 15,122 sf</b>	<b>-</b>	<b>0.013 acre-feet, 577 cubic feet</b>

Approximately 96% (14,454 s.f.) of proposed impervious areas subject to these Standards will be directed to a recharge BMP, satisfying the 65% minimum requirement of the Standards and resulting in an additional adjustment factor below.

Recharge Volume Required (Adjusted)

$$= 577 \text{ c.f.} \times \frac{15,122 \text{ s.f.}}{14,454 \text{ s.f.}}$$

$$= \mathbf{604 \text{ c.f.}}$$

To meet/exceed the required stormwater runoff volume to be recharged to the groundwater, the Project proposes the construction of new asphalt pavement parking lots with new bio-retention areas and water quality units treating the proposed 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' storage tables.

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

Infiltration BMP	Recharge Volume	(Lowest outlet elevation)
- Pond 3P (Bio Retention Area #2):	131 c.f.	(EL.132.00)
- Pond 4P (Bio Retention Area #3):	403 c.f.	(EL.125.00)
- Pond 5P (Haggetts Infiltration System):	<u>1,502 c.f.</u> 2,036 c.f.	(EL.130.15)

**Total Recharge Volume Provided:**    **2,036 c.f.** (>604 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
<b>Loamy Sand</b>	<b>A</b>	<b>2.41</b>
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 <sub>v</sub>	Sat. Hydraulic Conductivity K	System Bottom Area	Draw Down Time (72hrs max.)
Pond 3P	131 c.f.	2.41 in/hr (0.20 ft/hr)	212 s.f.	<b>3.09 hr.</b>
Pond 4P	403 c.f.	2.41 in/hr (0.20 ft/hr)	150 s.f.	<b>13.43 hr.</b>
Pond 5P	1,502 c.f.	2.41 in/hr (0.20 ft/hr)	2,125 s.f.	<b>3.5 hr.</b>

Standard 4 - Water Quality

The proposed stormwater management system has been designed to provide treatment for stormwater runoff from new paved vehicular areas, as well as portions of the existing connecting public roadways. Treatment is achieved by bio-retention areas 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.

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

$$WQV = \text{Required Water Quality Volume (in cubic feet)}$$

$$WQD = \text{Water Quality Depth: } \mathbf{1\text{-inch.}}$$
 (Requirement of the Town stormwater regulations)

$$A_{IMP} = \text{Impervious Area (in square feet)}$$

WQU-1 – High Plain Parking:

$$WQV = (1.0 \text{ in.} / 12 \text{ inches/ft}) * (6,993 \text{ s.f.})$$

$$= \underline{\mathbf{583 \text{ c.f.}}}$$

WQU-2 – Ex. Headwall west of High Plain Parking:

$$WQV = (1.0 \text{ in.} / 12 \text{ inches/ft}) * (3,474 \text{ s.f.})$$

$$= \underline{\mathbf{290 \text{ c.f.}}}$$

WQU-3 – Ex. High Plain CB:

$$WQV = (1.0 \text{ in.} / 12 \text{ inches/ft}) * (7,553 \text{ s.f.})$$

$$= \underline{\mathbf{629 \text{ c.f.}}}$$

WQU-4 – Haggetts Pond South Parking:

$$WQV = (1.0 \text{ in.} / 12 \text{ inches/ft}) * (6,829 \text{ s.f.})$$

$$= \underline{\mathbf{569 \text{ c.f.}}}$$

WQU-5 – Haggetts Pond Roadway CB:

$$WQV = (1.0 \text{ in.} / 12 \text{ inches/ft}) * (4,870 \text{ s.f.})$$

$$= \underline{\mathbf{406 \text{ c.f.}}}$$

Water Quality Flow Rates for the corresponding WQUs are then calculated using the equation below. Complete sizing calculations can be found in Section 6.02 and 6.03 of this Report, with full TSS removal tables at each distinct treatment train found in Section 6.04.

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

$WQF$  = 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

Summary of Water Quality Unit Sizing

	Calculated Water Quality Volume	Calculated Water Quality Discharge Rate	STC 450i Max Water Quality Discharge Rate
WQU-1	583 cf	0.19 cfs	0.40 cfs
WQU-2	290 cf	0.09 cfs	0.40 cfs
WQU-3	629 cf	0.20 cfs	0.40 cfs
WQU-4	569 cf	0.18 cfs	0.40 cfs
WQU-5	406 cf	0.13 cfs	0.40 cfs

\*STC 450i calculated water quality discharge rate is less than the maximum allowable flow rate of 0.40 cfs.

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 subsurface infiltration chambers and through bio-retention areas. The MA MS4 General Permit lists 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 treated runoff depth across the entire Project's impervious area is calculated below.

Total proposed impervious area:		<b>15,112 s.f.</b>
- Infiltrated impervious area:		14,454 s.f.
- Other impervious area:		658 s.f.
Total proposed infiltration (recharge) volume:		<b>2,036 c.f.</b>
		(volume below lowest outlet)
Treated depth:	$\frac{2,036 \text{ c.f.}}{14,454 \text{ s.f.}} = 0.141 \text{ ft.}$	<b>= 1.7 in.</b>
Untreated depth:	$\frac{0 \text{ c.f.}}{658 \text{ s.f.}} = 0 \text{ ft.}$	<b>= 0 in.</b>
Weighted average depth:	$\frac{(14,454 * 1.7) + (658 * 0)}{15,112}$	<b>= 1.6 in.</b>

A treated runoff depth of 1.6 inches, given the applicable BMPs and infiltration rates, yields an expected cumulative phosphorus load reduction of approximately 99.0% 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 of an 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. To satisfy the pollution prevention requirements of this Standard, all proposed vehicular areas within the ORW shedding to the Project site will

be pretreated with water quality units in order to achieve at least 44% TSS removal prior to discharging to an exfiltrating bioretention areas and the Haggetts Pond subsurface infiltration system.

Haggetts Pond Parking Area Treatment Trains – Pre-treatment in inlet WQU to Subsurface system with isolation row/infiltration, or pre-treatment in inlet WQU and riprap forebay to rain garden area.

High Plain Parking Area Treatment Train – Pre-treatment in inlet WQU to solid (non-infiltrating system) subsurface attenuation system to a riprap forebay to a bio-retention area

*Standard 7 – Redevelopment Projects*

This project is not classified as a redevelopment project and all standards are met fully for the new parking areas as required.

*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 for the proposed new parking areas locate on High Plain Road and Haggetts Pond Road. With the provisions of water quality units, subsurface attenuation and/or infiltration, and/or bio-retention areas, along with nonstructural BMPs such vegetative shoulders and construction erosion controls, the 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**



# 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.<sup>1</sup> 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<sup>2</sup>
- 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.

<sup>1</sup> 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.

<sup>2</sup> 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

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## 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.

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### 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



12/21/2023

Signature and Date

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# Checklist for Stormwater Report

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## 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

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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<sup>1</sup>

<sup>1</sup> 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

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## 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

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## 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  $\frac{1}{2}$ " 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 proprietary BMP checklist found in Volume 2, Chapter 4 of the Massachusetts Stormwater Handbook and submitting copies of the TARP Report, STEP Report, and/or other third party studies verifying performance of the proprietary BMPs.
- A TMDL exists that indicates a need to reduce pollutants other than TSS and documentation showing that the BMPs selected are consistent with the TMDL is provided.

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

- The NPDES Multi-Sector General Permit covers the land use and the Stormwater Pollution Prevention Plan (SWPPP) has been included with the Stormwater Report.
- The NPDES Multi-Sector General Permit covers the land use and the SWPPP will be submitted **prior to** the discharge of stormwater to the post-construction stormwater BMPs.
- The NPDES Multi-Sector General Permit does **not** cover the land use.
- LUHPPLs are located at the site and industry specific source control and pollution prevention measures have been proposed to reduce or eliminate the exposure of LUHPPLs to rain, snow, snow melt and runoff, and been included in the long term Pollution Prevention Plan.
- All exposure has been eliminated.
- All exposure has **not** been eliminated and all BMPs selected are on MassDEP LUHPPL list.
- The LUHPPL has the potential to generate runoff with moderate to higher concentrations of oil and grease (e.g. all parking lots with >1000 vehicle trips per day) and the treatment train includes an oil grit separator, a filtering bioretention area, a sand filter or equivalent.

### Standard 6: Critical Areas

- The discharge is near or to a critical area and the treatment train includes only BMPs that MassDEP has approved for stormwater discharges to or near that particular class of critical area.
- Critical areas and BMPs are identified in the Stormwater Report.



# Checklist for Stormwater Report

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## Checklist (continued)

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

- The project is subject to the Stormwater Management Standards only to the maximum Extent Practicable as a:
- Limited Project
  - Small Residential Projects: 5-9 single family houses or 5-9 units in a multi-family development provided there is no discharge that may potentially affect a critical area.
  - Small Residential Projects: 2-4 single family houses or 2-4 units in a multi-family development with a discharge to a critical area
  - Marina and/or boatyard provided the hull painting, service and maintenance areas are protected from exposure to rain, snow, snow melt and runoff
  - Bike Path and/or Foot Path
  - Redevelopment Project
  - Redevelopment portion of mix of new and redevelopment.
- Certain standards are not fully met (Standard No. 1, 8, 9, and 10 must always be fully met) and an explanation of why these standards are not met is contained in the Stormwater Report.
- The project involves redevelopment and a description of all measures that have been taken to improve existing conditions is provided in the Stormwater Report. The redevelopment checklist found in Volume 2 Chapter 3 of the Massachusetts Stormwater Handbook may be used to document that the proposed stormwater management system (a) complies with Standards 2, 3 and the pretreatment and structural BMP requirements of Standards 4-6 to the maximum extent practicable and (b) improves existing conditions.

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

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

- Narrative;
  - Construction Period Operation and Maintenance Plan;
  - Names of Persons or Entity Responsible for Plan Compliance;
  - Construction Period Pollution Prevention Measures;
  - Erosion and Sedimentation Control Plan Drawings;
  - Detail drawings and specifications for erosion control BMPs, including sizing calculations;
  - Vegetation Planning;
  - Site Development Plan;
  - Construction Sequencing Plan;
  - Sequencing of Erosion and Sedimentation Controls;
  - Operation and Maintenance of Erosion and Sedimentation Controls;
  - Inspection Schedule;
  - Maintenance Schedule;
  - Inspection and Maintenance Log Form.
- A Construction Period Pollution Prevention and Erosion and Sedimentation Control Plan containing the information set forth above has been included in the Stormwater Report.



# Checklist for Stormwater Report

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## 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 is 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 from 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).

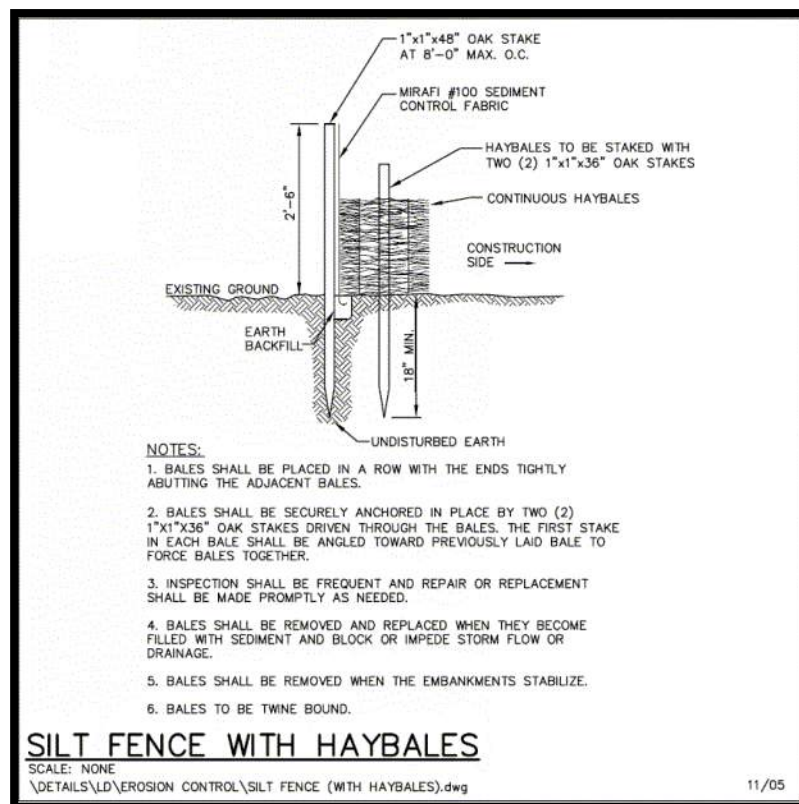
- Hydro-mulching of grass surfaces is recommended, especially if seeding of the surfaces is required outside the normal growing season.
- Hay mulch is an effective method of temporarily stabilizing surfaces, but only if it is properly secured by branches, weighted snow fences or weighted chicken wire.

## 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.

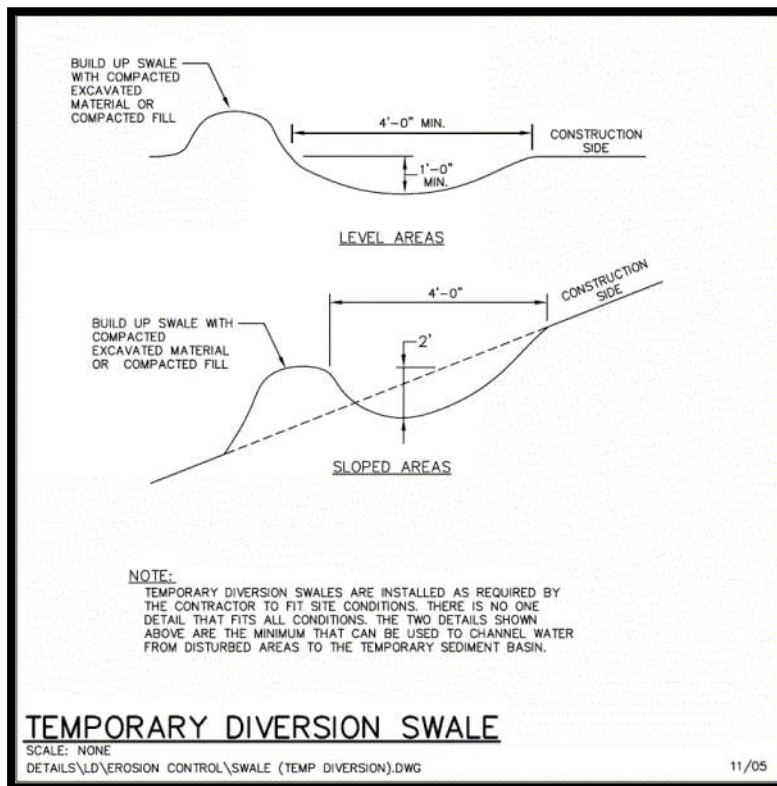
### 9.01 Silt Socks, Haybales, and Silt Fencing

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

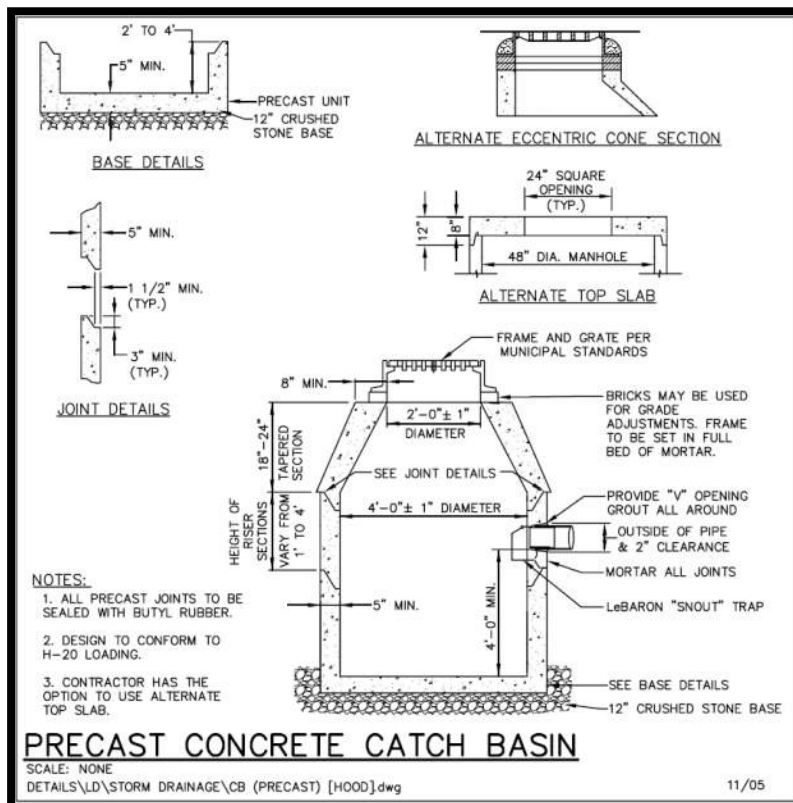
There will be no storage of soil, gravel or construction debris within the 100-foot buffer zone to wetland resource areas. It is anticipated that all excavated material will be placed in a dump truck and stockpiled outside the 100-foot buffer zone during construction activities. Piping and trench excavate 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

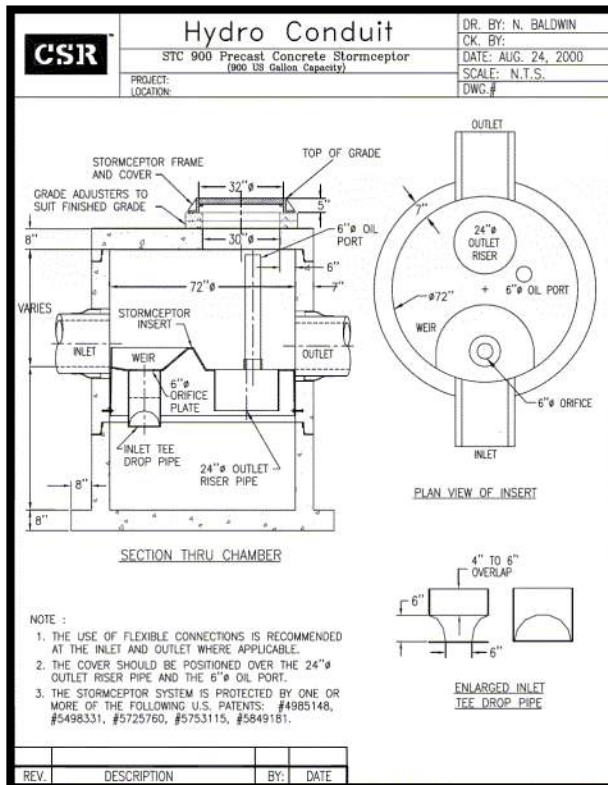
Parking lots will be bermed (or curbed) and provided with catch basins to collect runoff. The entire drainage system for each respective project phase will be installed during the initial phases of construction. The collection system will be installed from the downstream end up, and in a manner which 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 exits 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	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> NA	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> NA	
Haybales and Silt Fencing	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> NA	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> NA	
Storage/Disposal Areas	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> NA	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> NA	
Subsurface Infiltration System	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> NA	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> NA	
Catch Basins	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> NA	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> NA	
Other	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> NA	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> NA	
Other	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> NA	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> NA	

**SITE STABILIZATION STATUS:**

BMP/Activity	Implemented	Maintained	Status/Actions Required
All Slopes and disturbed areas not actively being worked properly stabilized?	<input type="checkbox"/> Yes <input type="checkbox"/> No	<input type="checkbox"/> Yes <input type="checkbox"/> No	

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

**ADDITIONAL OBSERVATIONS:** \_\_\_\_\_

**NEXT INSPECTOR 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**

**O&M PLAN PROVIDED AS A SEPARATE ATTACHMENT**

## **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**



PROFESSIONAL ENGINEER

HAGGETTS POND RAIL TRAIL

IN  
ANDOVER,  
MA

EXISTING WATERSHED  
PLAN

NOVEMBER 7, 2023

REVISIONS:

NO.	DATE	DESCRIPTION
1	12/21/23	REDUCED IMPACTS

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

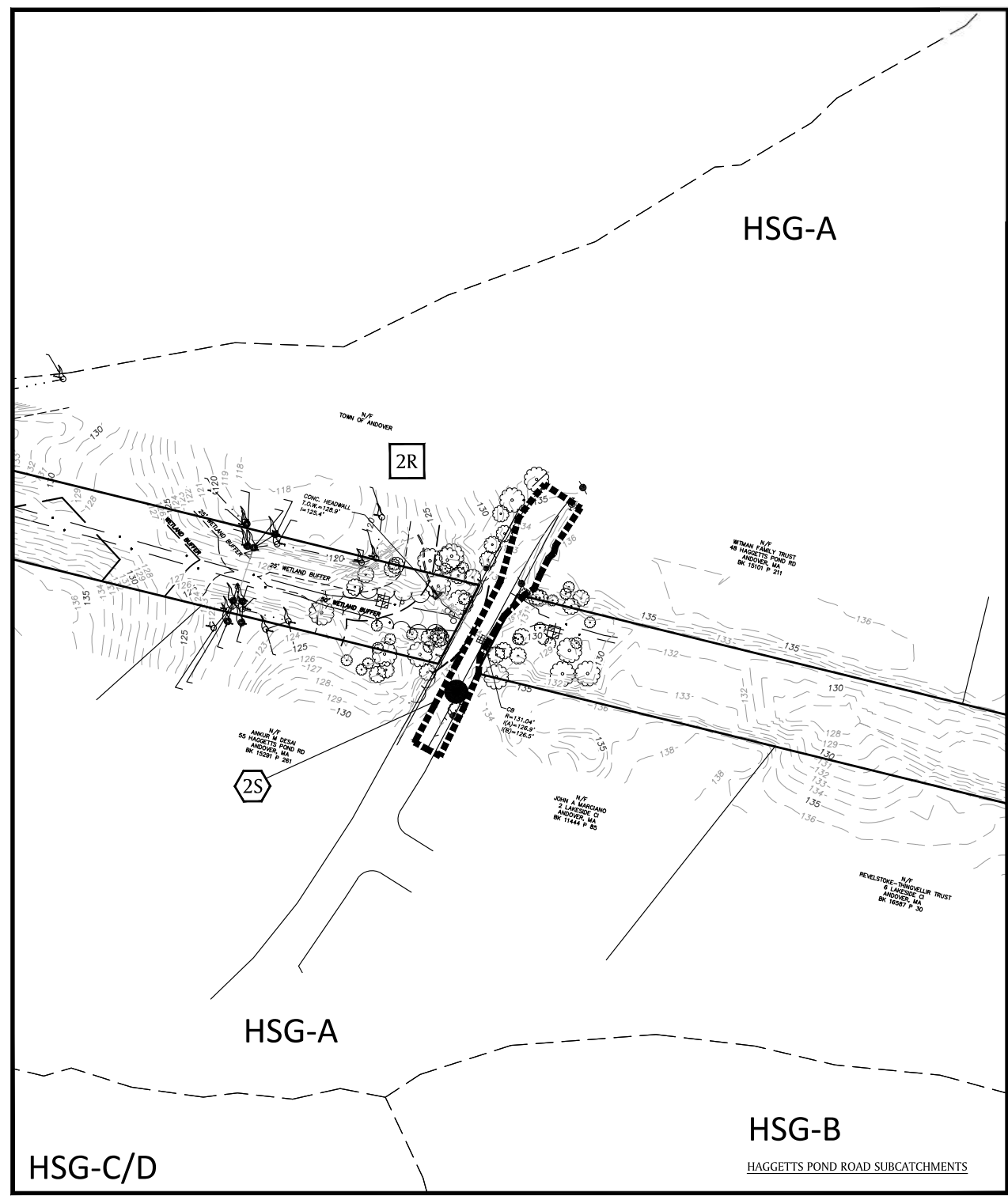
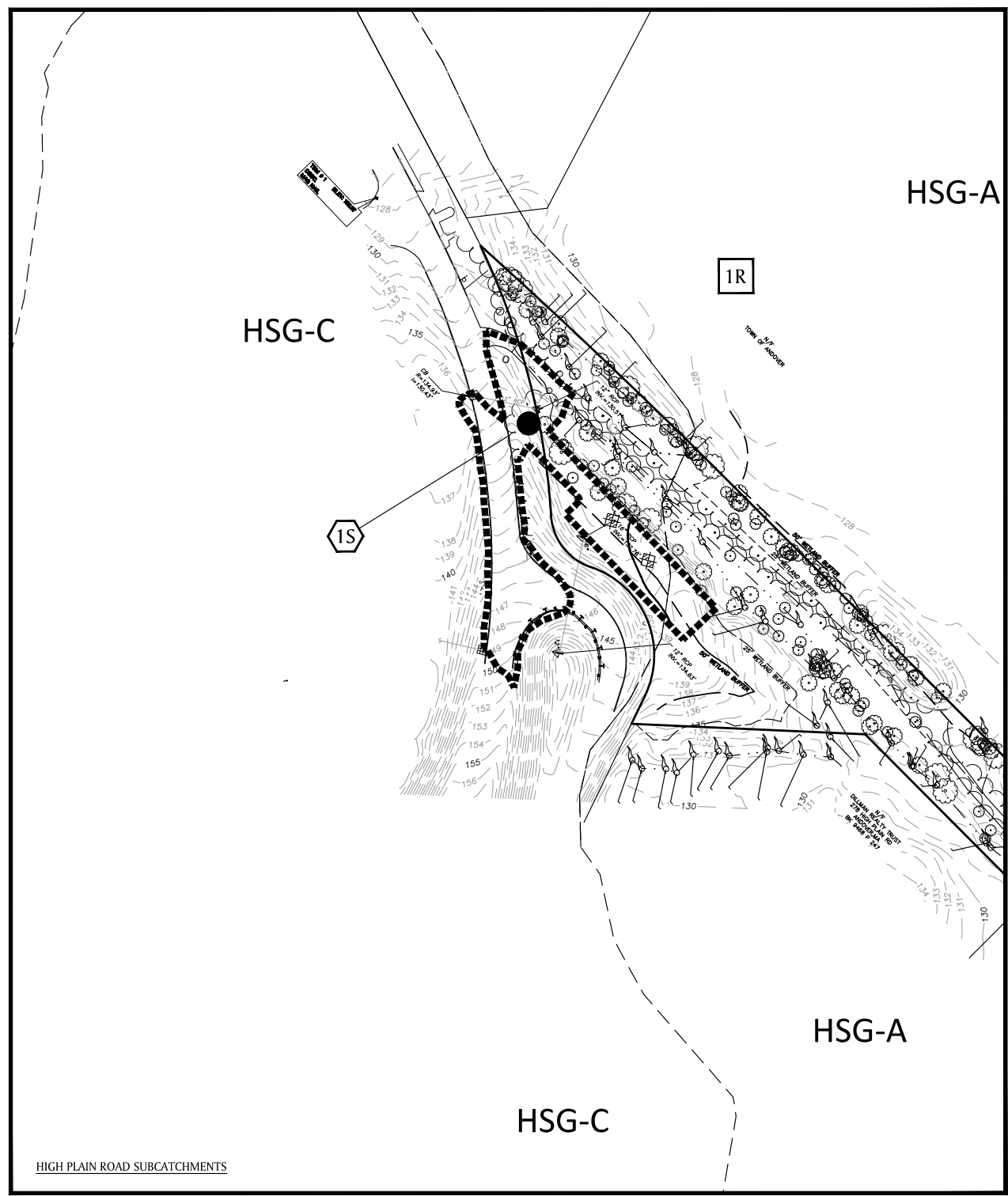
**BSC GROUP**  
300 Brickstone Square, Suite 203  
Andover, Massachusetts  
01810  
617-896-4300

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SCALE: 1"=60'



FILE: 8998501\_EC\_WSHD.DWG  
DWG. NO:  
JOB. NO: 8-9985.01

EC-WSHD



ISSUED FOR PERMITTING NOT FOR CONSTRUCTION

**5.02 PRE-DEVELOPMENT HYDROLOGY WATERSHED CALCULATIONS**  
(HYDROCAD PRINTOUTS)

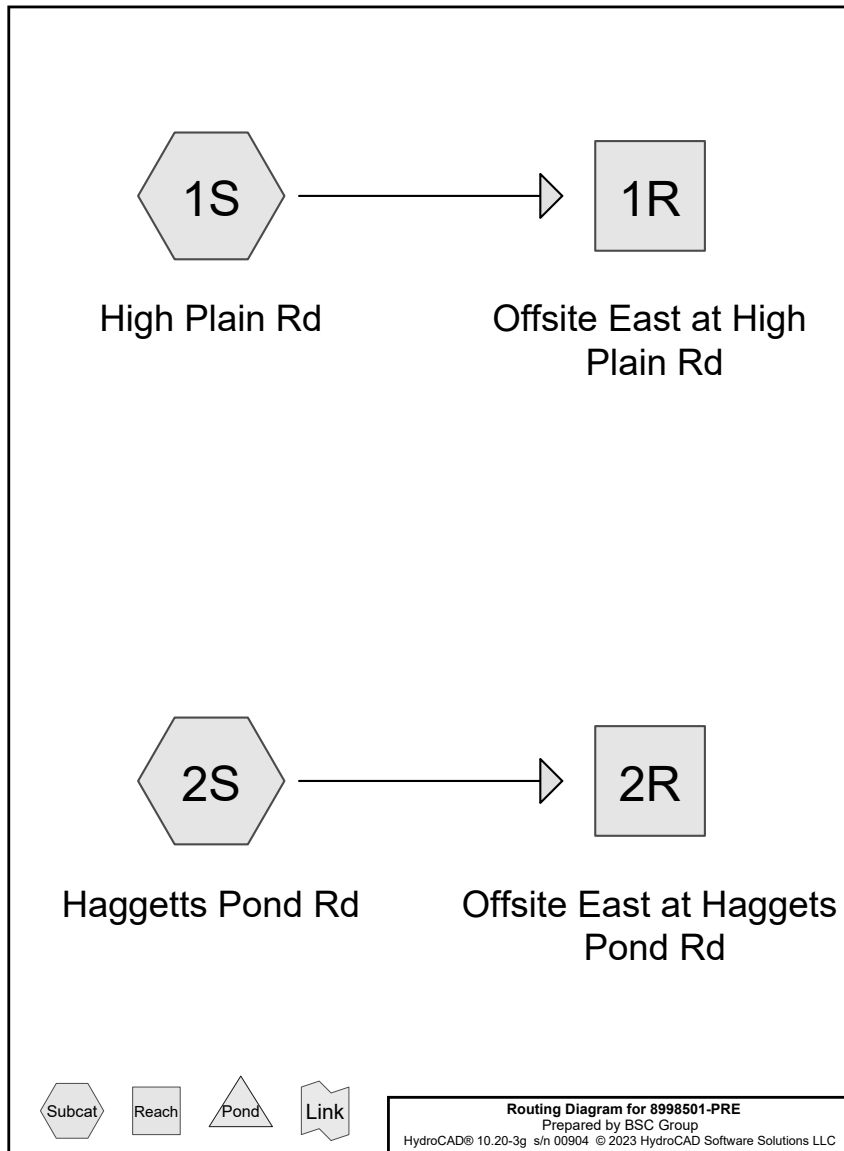
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**Rainfall Events Listing**

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



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**Area Listing (all nodes)**

Area (sq-ft)	CN	Description (subcatchment-numbers)
1,043	39	>75% Grass cover, Good, HSG A (2S)
3,754	74	>75% Grass cover, Good, HSG C (1S)
277	76	Gravel roads, HSG A (2S)
995	89	Gravel roads, HSG C (1S)
4,035	98	Paved parking, HSG A (2S)
7,553	98	Paved parking, HSG C (1S)
158	98	Water Surface, HSG C (1S)
2,596	30	Woods, Good, HSG A (1S, 2S)
2,704	70	Woods, Good, HSG C (1S)
<b>23,115</b>	<b>80</b>	<b>TOTAL AREA</b>

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**Soil Listing (all nodes)**

Area (sq-ft)	Soil Group	Subcatchment Numbers
7,951	HSG A	1S, 2S
0	HSG B	
15,164	HSG C	1S
0	HSG D	
0	Other	
<b>23,115</b>		<b>TOTAL AREA</b>

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**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
1,043	0	3,754	0	0	4,797	>75% Grass cover, Good
277	0	995	0	0	1,272	Gravel roads
4,035	0	7,553	0	0	11,588	Paved parking
0	0	158	0	0	158	Water Surface
2,596	0	2,704	0	0	5,300	Woods, Good
<b>7,951</b>	<b>0</b>	<b>15,164</b>	<b>0</b>	<b>0</b>	<b>23,115</b>	<b>TOTAL AREA</b>

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*Type III 24-hr 2-Year Rainfall=3.14"*

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

**Subcatchment 1S: High Plain Rd**

Runoff Area=16,712 sf 46.14% Impervious Runoff Depth&gt;1.42"

Flow Length=102' Slope=0.0400 '/' Tc=9.7 min CN=81 Runoff=0.56 cfs 1,976 cf

**Subcatchment 2S: Haggetts Pond Rd**

Runoff Area=6,403 sf 63.02% Impervious Runoff Depth&gt;1.11"

Tc=6.0 min CN=76 Runoff=0.18 cfs 592 cf

**Reach 1R: Offsite East at High Plain Rd**

Inflow=0.56 cfs 1,976 cf

Outflow=0.56 cfs 1,976 cf

**Reach 2R: Offsite East at Haggetts Pond Rd**

Inflow=0.18 cfs 592 cf

Outflow=0.18 cfs 592 cf

**Total Runoff Area = 23,115 sf Runoff Volume = 2,568 cf Average Runoff Depth = 1.33"**  
**49.18% Pervious = 11,369 sf 50.82% Impervious = 11,746 sf**

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Type III 24-hr 2-Year Rainfall=3.14"

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**Summary for Subcatchment 1S: High Plain Rd**

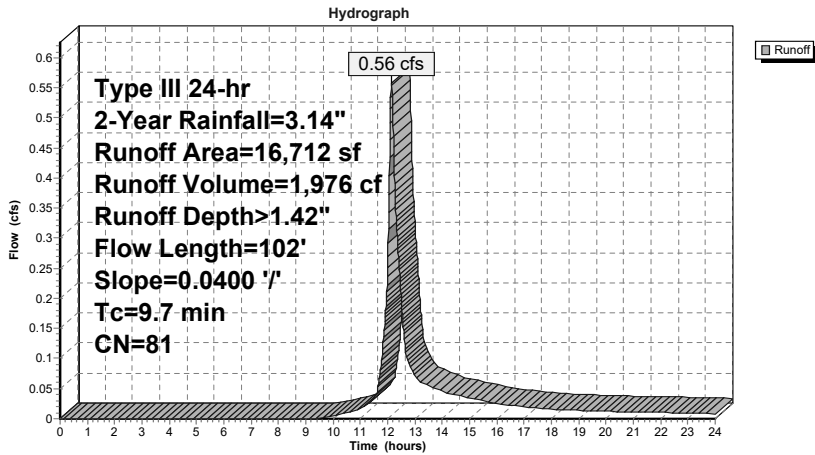
Runoff = 0.56 cfs @ 12.14 hrs, Volume= 1,976 cf, Depth> 1.42"  
 Routed to Reach 1R : Offsite East at High Plain Rd

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
1,548	30	Woods, Good, HSG A
3,754	74	>75% Grass cover, Good, HSG C
995	89	Gravel roads, HSG C
2,704	70	Woods, Good, HSG C
7,553	98	Paved parking, HSG C
158	98	Water Surface, HSG C
16,712	81	Weighted Average
9,001		53.86% Pervious Area
7,711		46.14% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
8.8	50	0.0400	0.09		<b>Sheet Flow,</b> Woods: Light underbrush n= 0.400 P2= 3.60"
0.9	52	0.0400	1.00		<b>Shallow Concentrated Flow,</b> Woodland Kv= 5.0 fps
9.7	102	Total			

**Subcatchment 1S: High Plain Rd**



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Type III 24-hr 2-Year Rainfall=3.14"

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**Summary for Subcatchment 2S: Haggetts Pond Rd**

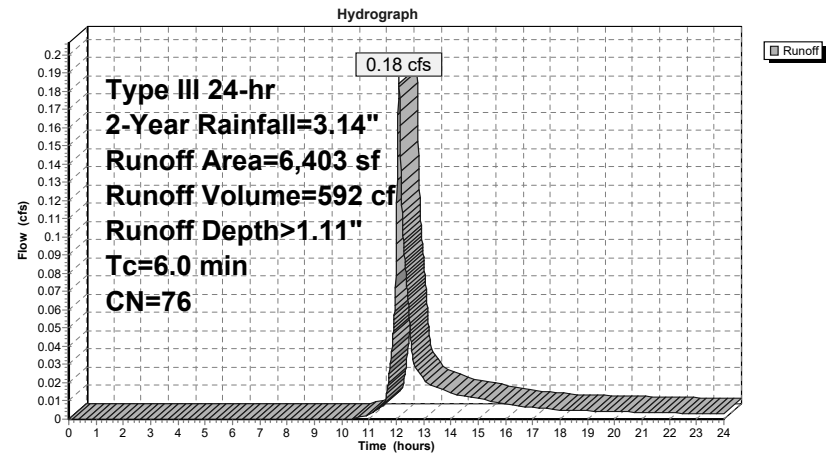
Runoff = 0.18 cfs @ 12.09 hrs, Volume= 592 cf, Depth> 1.11"  
 Routed to Reach 2R : Offsite East at Haggetts Pond Rd

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
1,043	39	>75% Grass cover, Good, HSG A
277	76	Gravel roads, HSG A
1,048	30	Woods, Good, HSG A
4,035	98	Paved parking, HSG A
6,403	76	Weighted Average
2,368		36.98% Pervious Area
4,035		63.02% Impervious Area

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

**Subcatchment 2S: Haggetts Pond Rd**



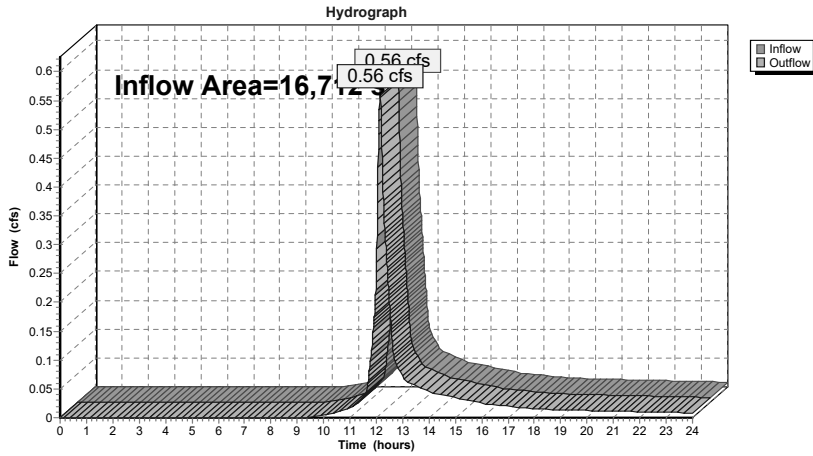
Summary for Reach 1R: Offsite East at High Plain Rd

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

Inflow Area = 16,712 sf, 46.14% Impervious, Inflow Depth > 1.42" for 2-Year event  
 Inflow = 0.56 cfs @ 12.14 hrs, Volume= 1,976 cf  
 Outflow = 0.56 cfs @ 12.14 hrs, Volume= 1,976 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



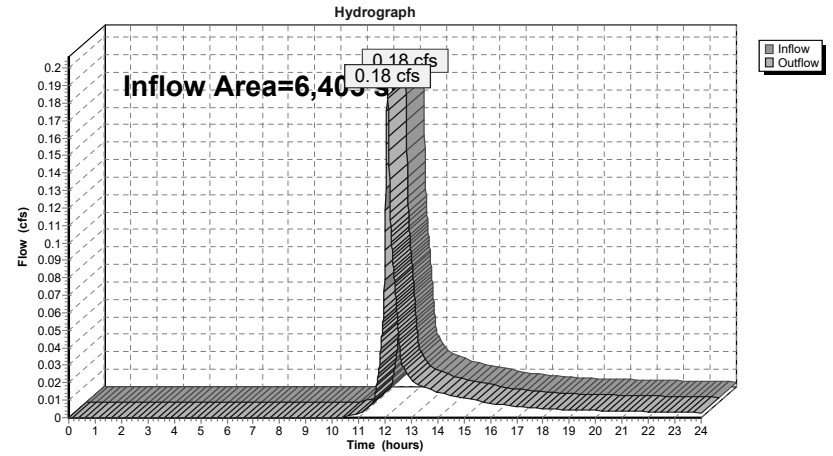
Summary for Reach 2R: Offsite East at Haggets Pond Rd

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

Inflow Area = 6,403 sf, 63.02% Impervious, Inflow Depth > 1.11" for 2-Year event  
 Inflow = 0.18 cfs @ 12.09 hrs, Volume= 592 cf  
 Outflow = 0.18 cfs @ 12.09 hrs, Volume= 592 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



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Type III 24-hr 10-Year Rainfall=4.96"

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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

**Subcatchment 1S: High Plain Rd** Runoff Area=16,712 sf 46.14% Impervious Runoff Depth>2.94"  
Flow Length=102' Slope=0.0400 '/' Tc=9.7 min CN=81 Runoff=1.17 cfs 4,101 cf

**Subcatchment 2S: Haggetts Pond Rd** Runoff Area=6,403 sf 63.02% Impervious Runoff Depth>2.50"  
Tc=6.0 min CN=76 Runoff=0.43 cfs 1,334 cf

**Reach 1R: Offsite East at High Plain Rd** Inflow=1.17 cfs 4,101 cf  
Outflow=1.17 cfs 4,101 cf

**Reach 2R: Offsite East at Haggetts Pond Rd** Inflow=0.43 cfs 1,334 cf  
Outflow=0.43 cfs 1,334 cf

**Total Runoff Area = 23,115 sf Runoff Volume = 5,434 cf Average Runoff Depth = 2.82"**  
**49.18% Pervious = 11,369 sf 50.82% Impervious = 11,746 sf**

**8998501-PRE**

Type III 24-hr 10-Year Rainfall=4.96"

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**Summary for Subcatchment 1S: High Plain Rd**

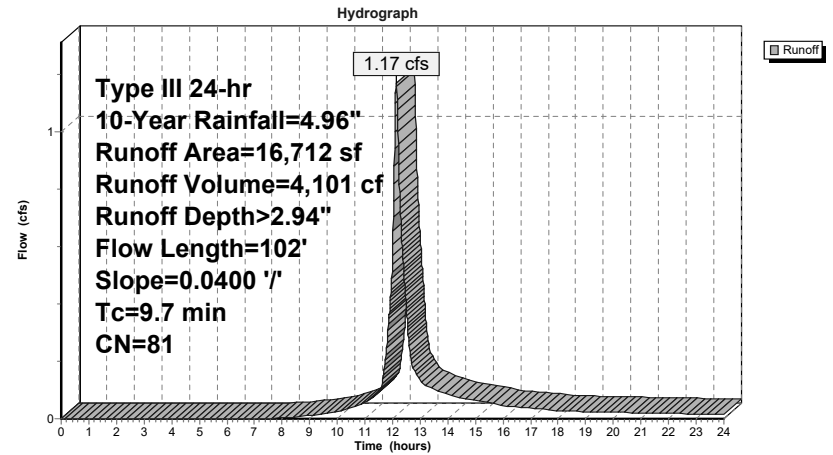
Runoff = 1.17 cfs @ 12.14 hrs, Volume= 4,101 cf, Depth> 2.94"  
Routed to Reach 1R : Offsite East at High Plain Rd

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 10-Year Rainfall=4.96"

Area (sf)	CN	Description
1,548	30	Woods, Good, HSG A
3,754	74	>75% Grass cover, Good, HSG C
995	89	Gravel roads, HSG C
2,704	70	Woods, Good, HSG C
7,553	98	Paved parking, HSG C
158	98	Water Surface, HSG C
16,712	81	Weighted Average
9,001		53.86% Pervious Area
7,711		46.14% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
8.8	50	0.0400	0.09		<b>Sheet Flow,</b> Woods: Light underbrush n= 0.400 P2= 3.60"
0.9	52	0.0400	1.00		<b>Shallow Concentrated Flow,</b> Woodland Kv= 5.0 fps
9.7	102	Total			

**Subcatchment 1S: High Plain Rd**



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Type III 24-hr 10-Year Rainfall=4.96"

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**Summary for Subcatchment 2S: Haggetts Pond Rd**

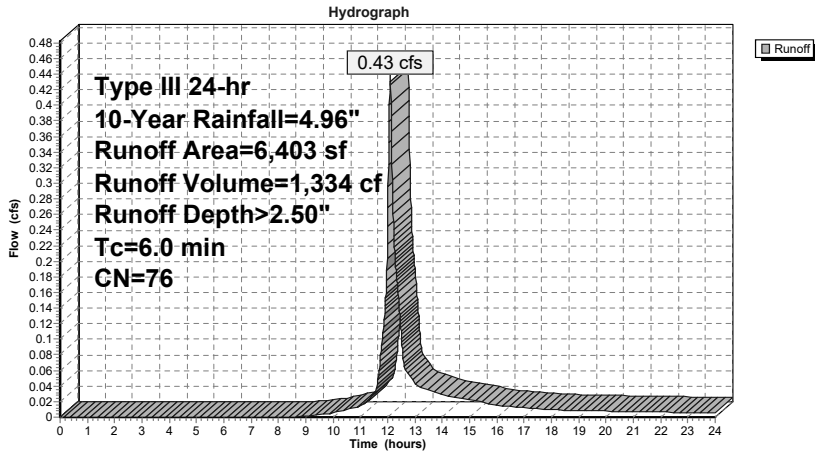
Runoff = 0.43 cfs @ 12.09 hrs, Volume= 1,334 cf, Depth> 2.50"  
 Routed to Reach 2R : Offsite East at Haggetts Pond Rd

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
1,043	39	>75% Grass cover, Good, HSG A
277	76	Gravel roads, HSG A
1,048	30	Woods, Good, HSG A
4,035	98	Paved parking, HSG A
6,403	76	Weighted Average
2,368		36.98% Pervious Area
4,035		63.02% Impervious Area

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

**Subcatchment 2S: Haggetts Pond Rd**



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Type III 24-hr 10-Year Rainfall=4.96"

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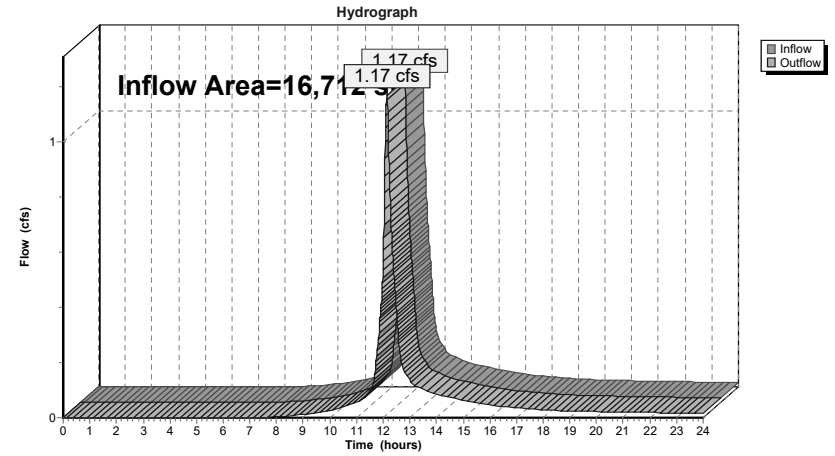
**Summary for Reach 1R: Offsite East at High Plain Rd**

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

Inflow Area = 16,712 sf, 46.14% Impervious, Inflow Depth > 2.94" for 10-Year event  
 Inflow = 1.17 cfs @ 12.14 hrs, Volume= 4,101 cf  
 Outflow = 1.17 cfs @ 12.14 hrs, Volume= 4,101 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**



**8998501-PRE**

Type III 24-hr 10-Year Rainfall=4.96"

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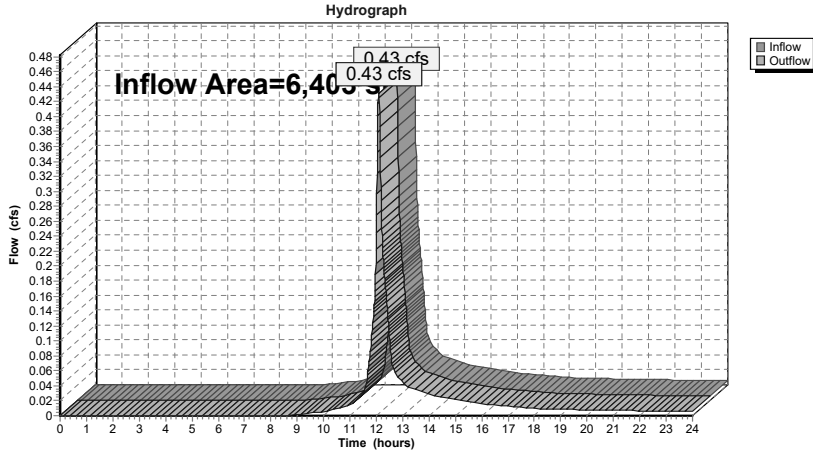
**Summary for Reach 2R: Offsite East at Haggets Pond Rd**

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

Inflow Area = 6,403 sf, 63.02% Impervious, Inflow Depth > 2.50" for 10-Year event  
 Inflow = 0.43 cfs @ 12.09 hrs, Volume= 1,334 cf  
 Outflow = 0.43 cfs @ 12.09 hrs, Volume= 1,334 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**



**8998501-PRE**

Type III 24-hr 25-Year Rainfall=6.09"

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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

**Subcatchment 1S: High Plain Rd** Runoff Area=16,712 sf 46.14% Impervious Runoff Depth>3.96"  
 Flow Length=102' Slope=0.0400 '/' Tc=9.7 min CN=81 Runoff=1.56 cfs 5,513 cf

**Subcatchment 2S: Haggets Pond Rd** Runoff Area=6,403 sf 63.02% Impervious Runoff Depth>3.45"  
 Tc=6.0 min CN=76 Runoff=0.60 cfs 1,843 cf

**Reach 1R: Offsite East at High Plain Rd** Inflow=1.56 cfs 5,513 cf  
 Outflow=1.56 cfs 5,513 cf

**Reach 2R: Offsite East at Haggets Pond Rd** Inflow=0.60 cfs 1,843 cf  
 Outflow=0.60 cfs 1,843 cf

**Total Runoff Area = 23,115 sf Runoff Volume = 7,356 cf Average Runoff Depth = 3.82"**  
**49.18% Pervious = 11,369 sf 50.82% Impervious = 11,746 sf**

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Type III 24-hr 25-Year Rainfall=6.09"

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**Summary for Subcatchment 1S: High Plain Rd**

Runoff = 1.56 cfs @ 12.13 hrs, Volume= 5,513 cf, Depth> 3.96"  
Routed to Reach 1R : Offsite East at High Plain Rd

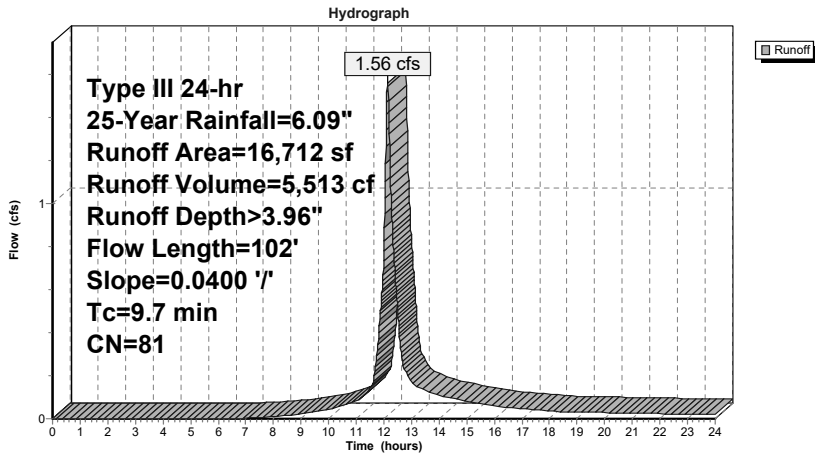
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs  
Type III 24-hr 25-Year Rainfall=6.09"

Area (sf)	CN	Description
1,548	30	Woods, Good, HSG A
3,754	74	>75% Grass cover, Good, HSG C
995	89	Gravel roads, HSG C
2,704	70	Woods, Good, HSG C
7,553	98	Paved parking, HSG C
158	98	Water Surface, HSG C
16,712	81	Weighted Average
9,001		53.86% Pervious Area
7,711		46.14% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
8.8	50	0.0400	0.09		<b>Sheet Flow,</b> Woods: Light underbrush n= 0.400 P2= 3.60"
0.9	52	0.0400	1.00		<b>Shallow Concentrated Flow,</b> Woodland Kv= 5.0 fps
9.7	102	Total			

**Subcatchment 1S: High Plain Rd**



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Type III 24-hr 25-Year Rainfall=6.09"

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**Summary for Subcatchment 2S: Haggetts Pond Rd**

Runoff = 0.60 cfs @ 12.09 hrs, Volume= 1,843 cf, Depth> 3.45"  
Routed to Reach 2R : Offsite East at Haggetts Pond Rd

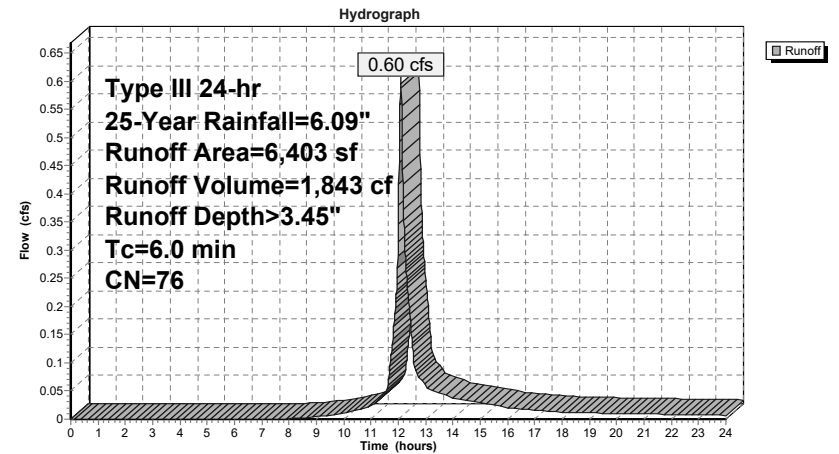
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs  
Type III 24-hr 25-Year Rainfall=6.09"

Area (sf)	CN	Description
1,043	39	>75% Grass cover, Good, HSG A
277	76	Gravel roads, HSG A
1,048	30	Woods, Good, HSG A
4,035	98	Paved parking, HSG A
6,403	76	Weighted Average
2,368		36.98% Pervious Area
4,035		63.02% Impervious Area

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

**Subcatchment 2S: Haggetts Pond Rd**



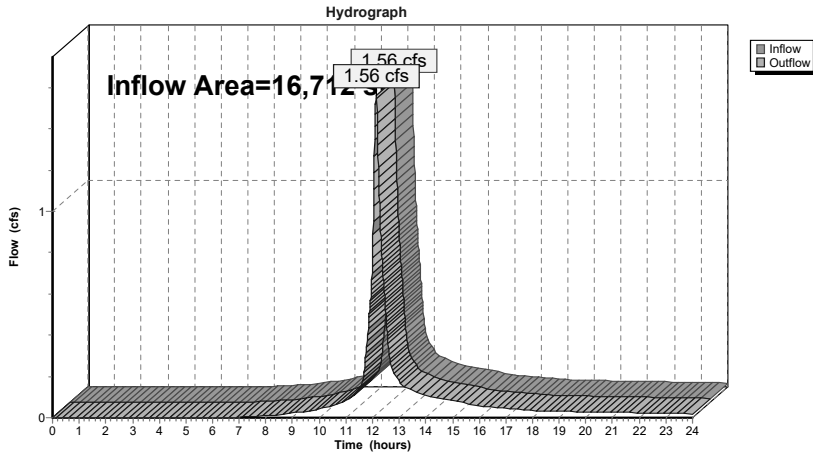
Summary for Reach 1R: Offsite East at High Plain Rd

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

Inflow Area = 16,712 sf, 46.14% Impervious, Inflow Depth > 3.96" for 25-Year event  
 Inflow = 1.56 cfs @ 12.13 hrs, Volume= 5,513 cf  
 Outflow = 1.56 cfs @ 12.13 hrs, Volume= 5,513 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



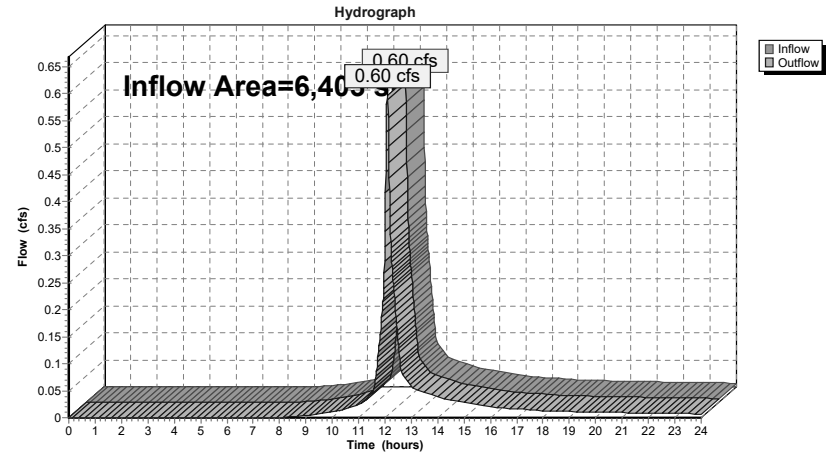
Summary for Reach 2R: Offsite East at Haggets Pond Rd

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

Inflow Area = 6,403 sf, 63.02% Impervious, Inflow Depth > 3.45" for 25-Year event  
 Inflow = 0.60 cfs @ 12.09 hrs, Volume= 1,843 cf  
 Outflow = 0.60 cfs @ 12.09 hrs, Volume= 1,843 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



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Type III 24-hr 100-Year Rainfall=7.84"

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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

**Subcatchment 1S: High Plain Rd**

Runoff Area=16,712 sf 46.14% Impervious Runoff Depth>5.58"  
Flow Length=102' Slope=0.0400 '/' Tc=9.7 min CN=81 Runoff=2.18 cfs 7,774 cf

**Subcatchment 2S: Haggetts Pond Rd**

Runoff Area=6,403 sf 63.02% Impervious Runoff Depth>5.01"  
Tc=6.0 min CN=76 Runoff=0.86 cfs 2,672 cf

**Reach 1R: Offsite East at High Plain Rd**

Inflow=2.18 cfs 7,774 cf  
Outflow=2.18 cfs 7,774 cf

**Reach 2R: Offsite East at Haggetts Pond Rd**

Inflow=0.86 cfs 2,672 cf  
Outflow=0.86 cfs 2,672 cf

**Total Runoff Area = 23,115 sf Runoff Volume = 10,446 cf Average Runoff Depth = 5.42"**  
**49.18% Pervious = 11,369 sf 50.82% Impervious = 11,746 sf**

**8998501-PRE**

Type III 24-hr 100-Year Rainfall=7.84"

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**Summary for Subcatchment 1S: High Plain Rd**

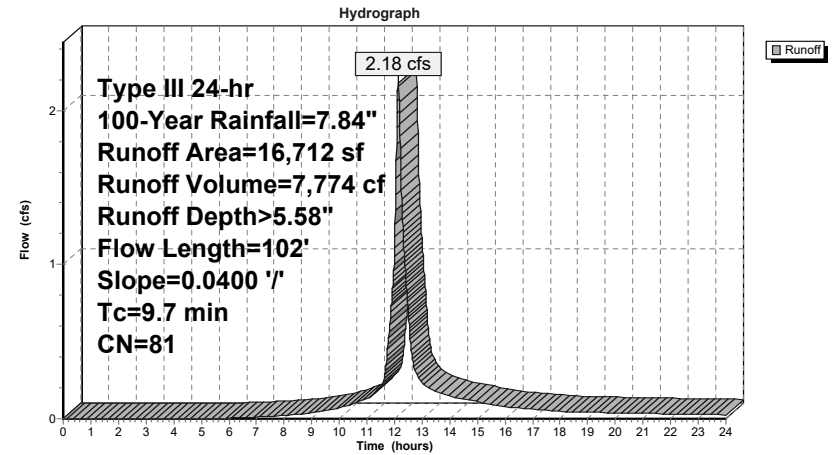
Runoff = 2.18 cfs @ 12.13 hrs, Volume= 7,774 cf, Depth> 5.58"  
Routed to Reach 1R : Offsite East at High Plain Rd

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
1,548	30	Woods, Good, HSG A
3,754	74	>75% Grass cover, Good, HSG C
995	89	Gravel roads, HSG C
2,704	70	Woods, Good, HSG C
7,553	98	Paved parking, HSG C
158	98	Water Surface, HSG C
16,712	81	Weighted Average
9,001		53.86% Pervious Area
7,711		46.14% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
8.8	50	0.0400	0.09		<b>Sheet Flow,</b> Woods: Light underbrush n= 0.400 P2= 3.60"
0.9	52	0.0400	1.00		<b>Shallow Concentrated Flow,</b> Woodland Kv= 5.0 fps
9.7	102	Total			

**Subcatchment 1S: High Plain Rd**



8998501-PRE

Type III 24-hr 100-Year Rainfall=7.84"

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Summary for Subcatchment 2S: Haggetts Pond Rd

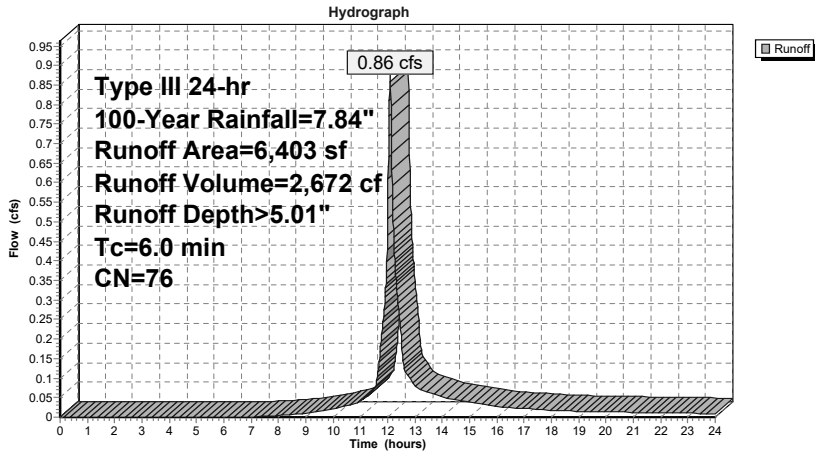
Runoff = 0.86 cfs @ 12.09 hrs, Volume= 2,672 cf, Depth> 5.01"  
Routed to Reach 2R : Offsite East at Haggetts Pond Rd

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
1,043	39	>75% Grass cover, Good, HSG A
277	76	Gravel roads, HSG A
1,048	30	Woods, Good, HSG A
4,035	98	Paved parking, HSG A
6,403	76	Weighted Average
2,368		36.98% Pervious Area
4,035		63.02% Impervious Area

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

Subcatchment 2S: Haggetts Pond Rd



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Type III 24-hr 100-Year Rainfall=7.84"

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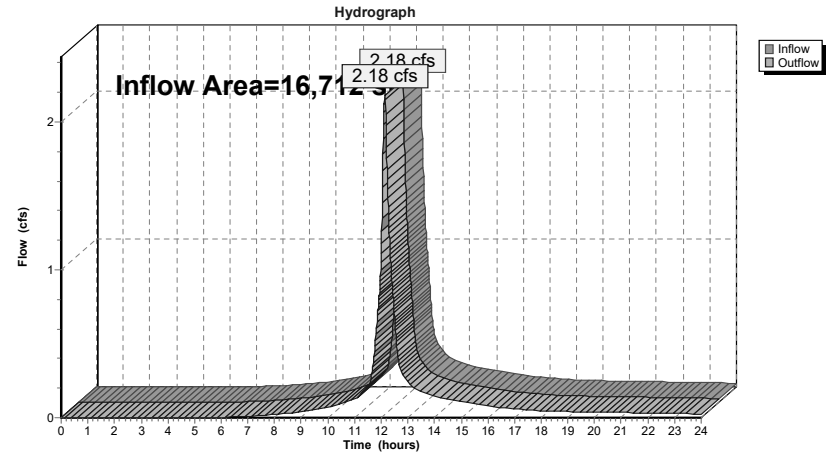
Summary for Reach 1R: Offsite East at High Plain Rd

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

Inflow Area = 16,712 sf, 46.14% Impervious, Inflow Depth > 5.58" for 100-Year event  
Inflow = 2.18 cfs @ 12.13 hrs, Volume= 7,774 cf  
Outflow = 2.18 cfs @ 12.13 hrs, Volume= 7,774 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



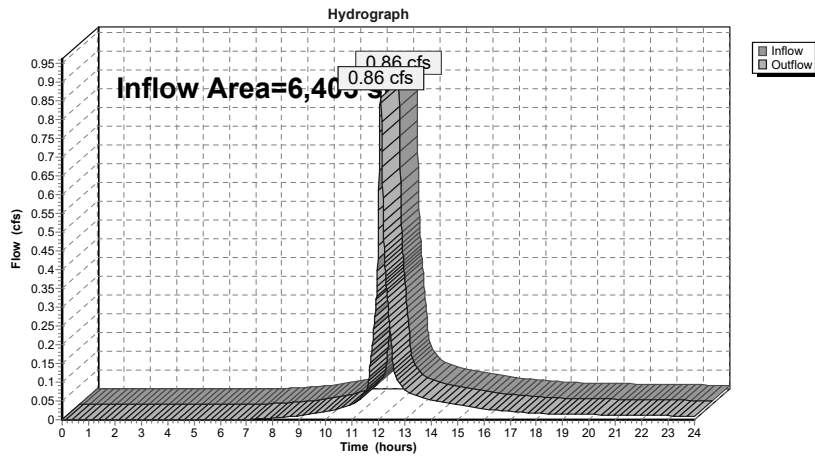
### Summary for Reach 2R: Offsite East at Haggets Pond Rd

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

Inflow Area = 6,403 sf, 63.02% Impervious, Inflow Depth > 5.01" for 100-Year event  
Inflow = 0.86 cfs @ 12.09 hrs, Volume= 2,672 cf  
Outflow = 0.86 cfs @ 12.09 hrs, Volume= 2,672 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**



HAGGETTS POND  
RAIL TRAIL

IN  
ANDOVER,  
MA

PROPOSED WATERSHED  
PLAN

NOVEMBER 7, 2023

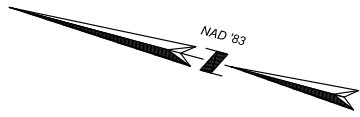
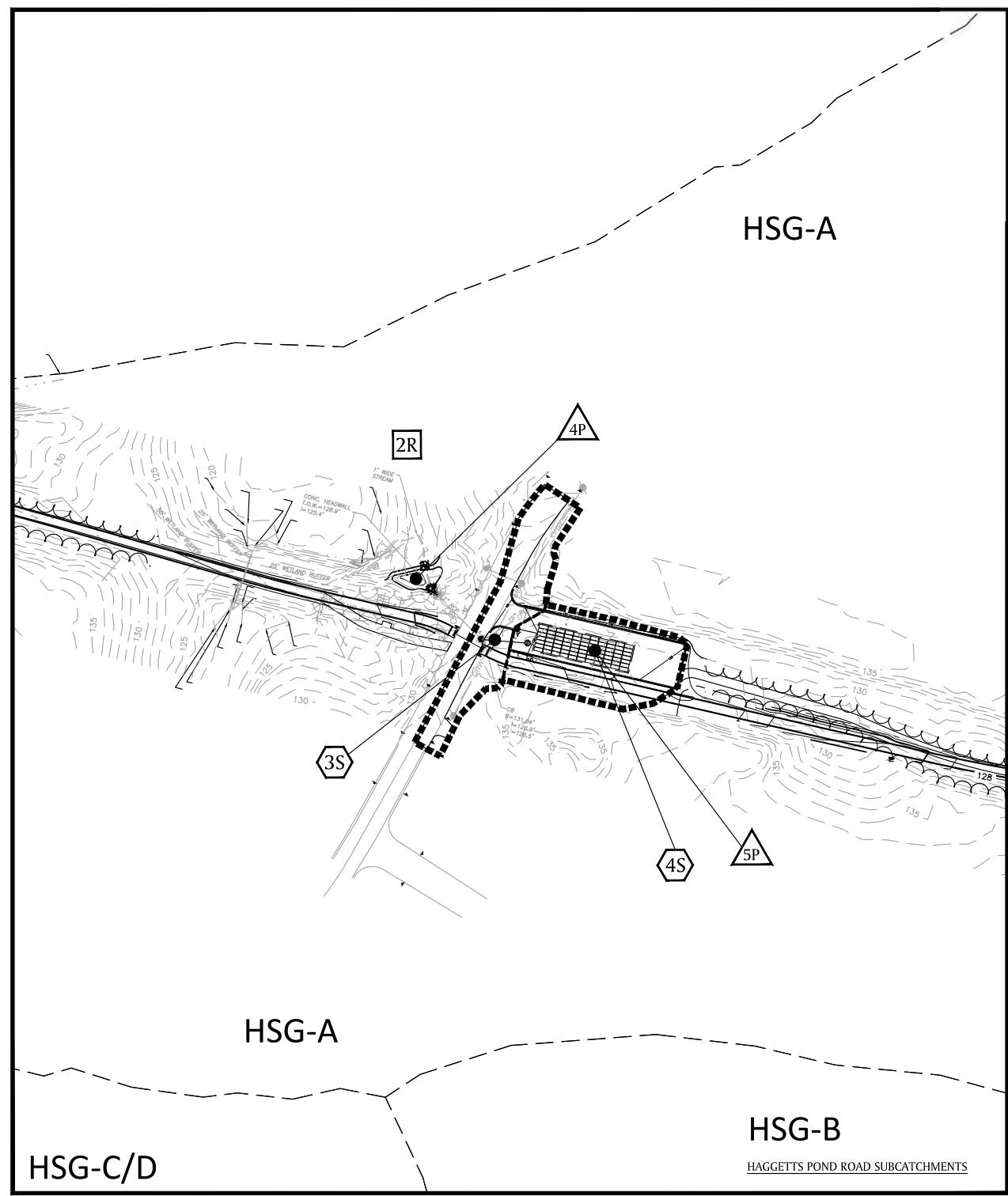
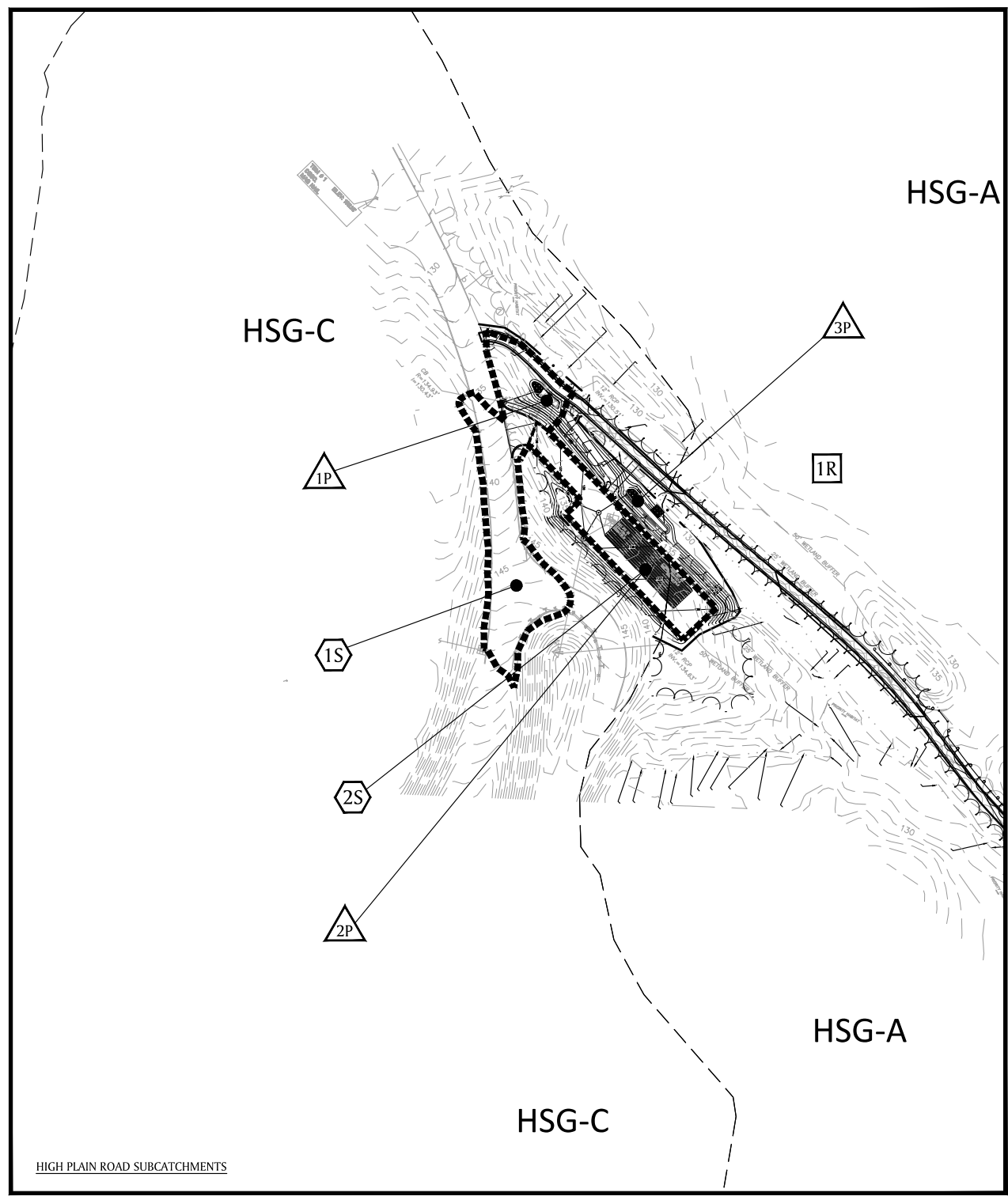
REVISIONS:

NO.	DATE	DESCRIPTION
1	12/21/23	REDUCED IMPACTS

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

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

© 2023 BSC GROUP, INC.  
SCALE: 1" = 60'  
0 30 60 120 FEET  
FILE: 8998501\C\DD\8998501\_PC\_WSHD  
DWG. NO:  
JOB. NO: 8-9985.01 **PC-WSHD**



- LEGEND
- SUBCATCHMENT BOUNDARY
  - SUBCATCHMENT LABEL
  - POND LABEL
  - DESIGN POINT LABEL

ISSUED FOR PERMITTING NOT FOR CONSTRUCTION

**5.04 POST-DEVELOPMENT HYDROLOGY WATERSHED CALCULATIONS**  
(HYDROCAD PRINTOUTS)

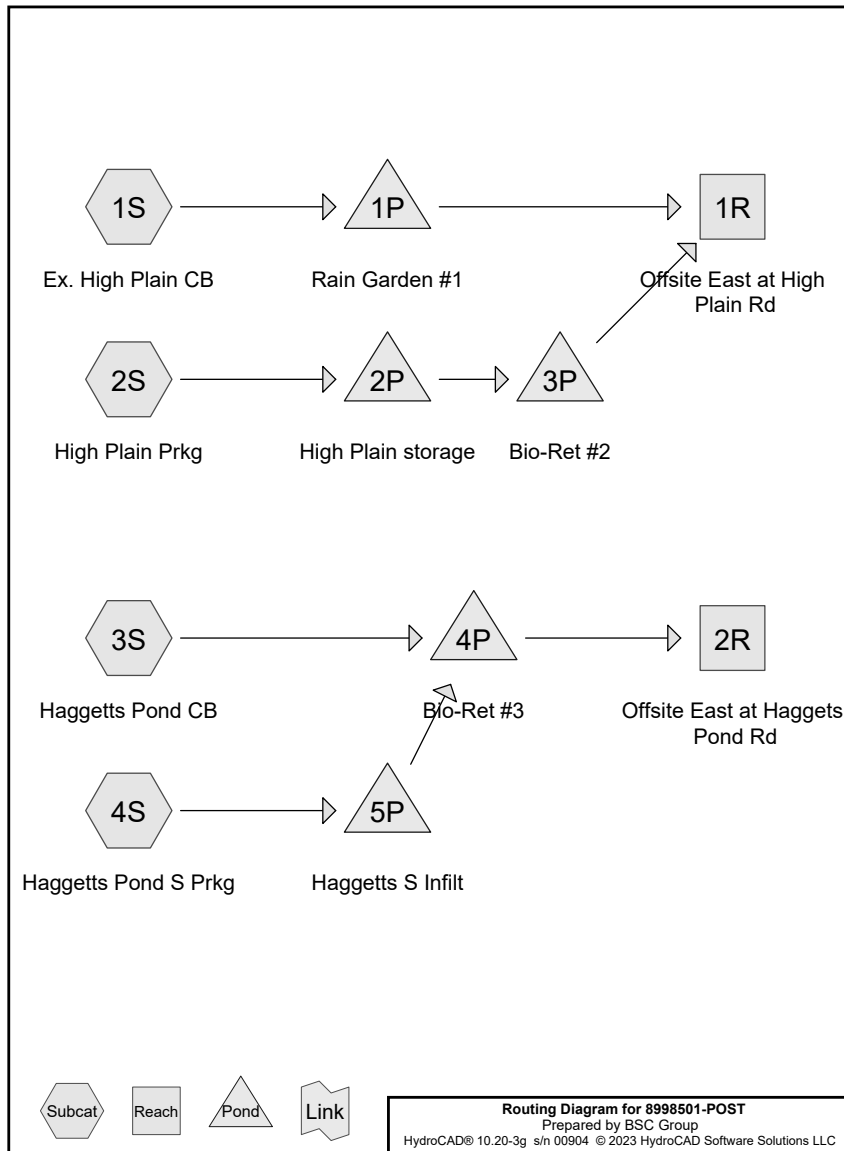
**8998501-POST**

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**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



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**Area Listing (all nodes)**

Area (sq-ft)	CN	Description (subcatchment-numbers)
2,927	68	<50% Grass cover, Poor, HSG A (3S, 4S)
2,166	86	<50% Grass cover, Poor, HSG C (1S)
1,043	39	>75% Grass cover, Good, HSG A (3S)
4,238	98	Ex. paved parking, HSG A (3S)
6,885	98	Ex. paved parking, HSG C (1S)
9,009	98	New paved parking, HSG A (2S, 3S, 4S)
6,113	98	New paved parking, HSG C (1S, 2S)
2,893	30	Woods, Good, HSG A (3S, 4S)
<b>35,274</b>	<b>87</b>	<b>TOTAL AREA</b>

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**Soil Listing (all nodes)**

Area (sq-ft)	Soil Group	Subcatchment Numbers
20,110	HSG A	2S, 3S, 4S
0	HSG B	
15,164	HSG C	1S, 2S
0	HSG D	
0	Other	
<b>35,274</b>		<b>TOTAL AREA</b>

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**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	Sub Nun
2,927	0	2,166	0	0	5,093	<50% Grass cover, Poor	
1,043	0	0	0	0	1,043	>75% Grass cover, Good	
4,238	0	6,885	0	0	11,123	Ex. paved parking	
9,009	0	6,113	0	0	15,122	New paved parking	
2,893	0	0	0	0	2,893	Woods, Good	
<b>20,110</b>	<b>0</b>	<b>15,164</b>	<b>0</b>	<b>0</b>	<b>35,274</b>	<b>TOTAL AREA</b>	

**8998501-POST**

Type III 24-hr 2-Year Rainfall=3.14"

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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

<b>Subcatchment 1S: Ex. High Plain CB</b>	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
<b>Subcatchment 2S: High Plain Prkg</b>	Runoff Area=6,993 sf 100.00% Impervious Runoff Depth>2.91" Tc=6.0 min CN=98 Runoff=0.49 cfs 1,693 cf
<b>Subcatchment 3S: Haggetts Pond CB</b>	Runoff Area=8,688 sf 56.05% Impervious Runoff Depth>0.94" Tc=6.0 min CN=73 Runoff=0.21 cfs 683 cf
<b>Subcatchment 4S: Haggetts Pond S Prkg</b>	Runoff Area=9,874 sf 69.16% Impervious Runoff Depth>1.70" Tc=6.0 min CN=85 Runoff=0.45 cfs 1,403 cf
<b>Reach 1R: Offsite East at High Plain Rd</b>	Inflow=0.26 cfs 771 cf Outflow=0.26 cfs 771 cf
<b>Reach 2R: Offsite East at Haggetts Pond Rd</b>	Inflow=0.00 cfs 0 cf Outflow=0.00 cfs 0 cf
<b>Pond 1P: Rain Garden #1</b>	Peak Elev=131.65' Storage=736 cf Inflow=0.64 cfs 2,093 cf Discarded=0.22 cfs 2,041 cf Primary=0.00 cfs 0 cf Outflow=0.22 cfs 2,041 cf
<b>Pond 2P: High Plain storage</b>	Peak Elev=132.64' Storage=294 cf Inflow=0.49 cfs 1,693 cf 6.0" Round Culvert n=0.013 L=18.0' S=0.0139 '/' Outflow=0.28 cfs 1,681 cf
<b>Pond 3P: Bio-Ret #2</b>	Peak Elev=132.07' Storage=154 cf Inflow=0.28 cfs 1,681 cf Discarded=0.02 cfs 910 cf Primary=0.26 cfs 771 cf Outflow=0.28 cfs 1,681 cf
<b>Pond 4P: Bio-Ret #3</b>	Peak Elev=124.65' Storage=233 cf Inflow=0.21 cfs 683 cf Discarded=0.03 cfs 670 cf Primary=0.00 cfs 0 cf Outflow=0.03 cfs 670 cf
<b>Pond 5P: Haggetts S Infil</b>	Peak Elev=129.32' Storage=274 cf Inflow=0.45 cfs 1,403 cf Discarded=0.12 cfs 1,403 cf Primary=0.00 cfs 0 cf Outflow=0.12 cfs 1,403 cf

**Total Runoff Area = 35,274 sf Runoff Volume = 5,871 cf Average Runoff Depth = 2.00"**  
**25.60% Pervious = 9,029 sf 74.40% Impervious = 26,245 sf**

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Type III 24-hr 2-Year Rainfall=3.14"

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**Summary for Subcatchment 1S: Ex. High Plain CB**

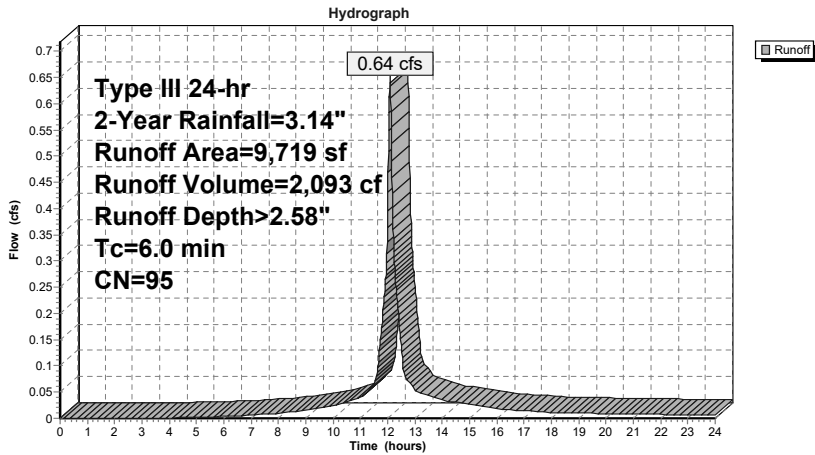
Runoff = 0.64 cfs @ 12.08 hrs, Volume= 2,093 cf, Depth> 2.58"  
Routed to Pond 1P : Rain Garden #1

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
2,166	86	<50% Grass cover, Poor, HSG C
* 6,885	98	Ex. paved parking, HSG C
* 668	98	New 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: Ex. High Plain CB**



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Type III 24-hr 2-Year Rainfall=3.14"

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**Summary for Subcatchment 2S: High Plain Prkg**

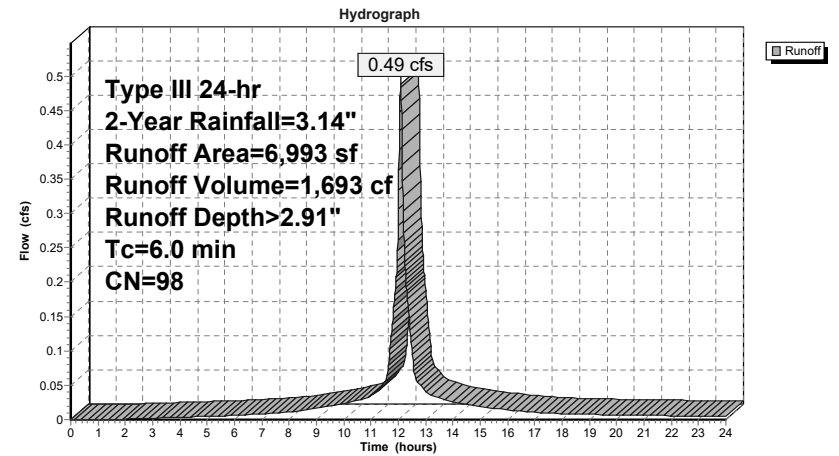
Runoff = 0.49 cfs @ 12.08 hrs, Volume= 1,693 cf, Depth> 2.91"  
Routed to Pond 2P : High Plain storage

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
* 5,445	98	New paved parking, HSG C
* 1,548	98	New paved parking, HSG A
6,993	98	Weighted Average
6,993		100.00% Impervious Area

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

**Subcatchment 2S: High Plain Prkg**



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Type III 24-hr 2-Year Rainfall=3.14"

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**Summary for Subcatchment 3S: Haggetts Pond CB**

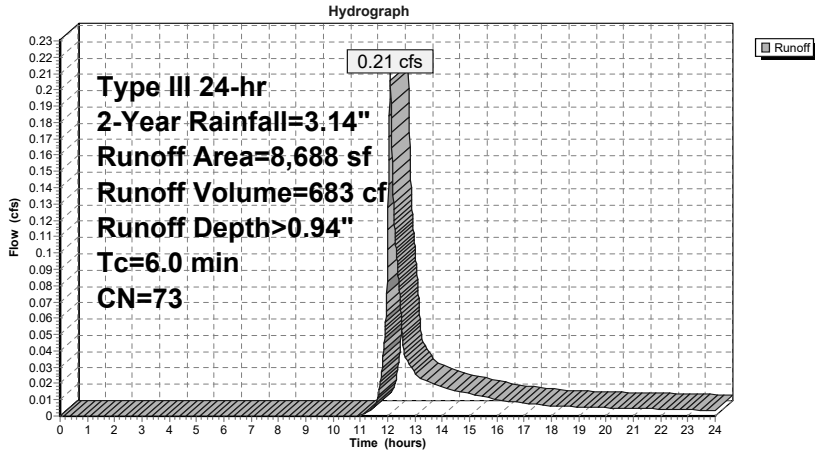
Runoff = 0.21 cfs @ 12.10 hrs, Volume= 683 cf, Depth> 0.94"  
Routed to Pond 4P : Bio-Ret #3

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
* 632	98	New paved parking, HSG A
* 4,238	98	Ex. paved parking, HSG A
925	68	<50% Grass cover, Poor, HSG A
1,043	39	>75% Grass cover, Good, HSG A
1,850	30	Woods, Good, HSG A
8,688	73	Weighted Average
3,818		43.95% Pervious Area
4,870		56.05% Impervious Area

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

**Subcatchment 3S: Haggetts Pond CB**



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Type III 24-hr 2-Year Rainfall=3.14"

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**Summary for Subcatchment 4S: Haggetts Pond S Prkg**

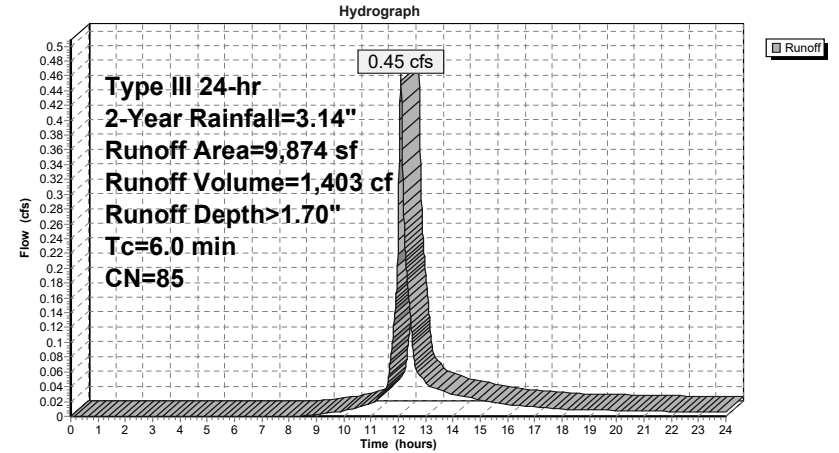
Runoff = 0.45 cfs @ 12.09 hrs, Volume= 1,403 cf, Depth> 1.70"  
Routed to Pond 5P : Haggetts S Infil

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
* 6,829	98	New paved parking, HSG A
2,002	68	<50% Grass cover, Poor, HSG A
1,043	30	Woods, Good, HSG A
9,874	85	Weighted Average
3,045		30.84% Pervious Area
6,829		69.16% Impervious Area

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

**Subcatchment 4S: Haggetts Pond S Prkg**



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Type III 24-hr 2-Year Rainfall=3.14"

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

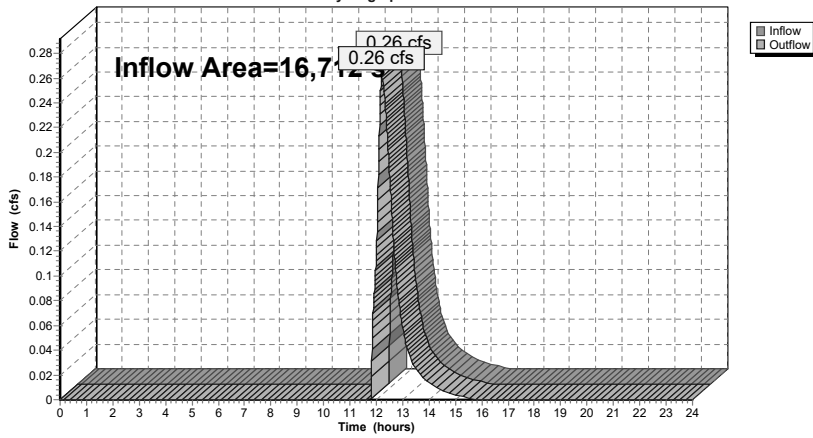
[40] Hint: Not Described (Outflow=Inflow)

Inflow Area =	16,712 sf, 87.04% Impervious, Inflow Depth = 0.55" for 2-Year event
Inflow =	0.26 cfs @ 12.21 hrs, Volume= 771 cf
Outflow =	0.26 cfs @ 12.21 hrs, Volume= 771 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**

Hydrograph



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Type III 24-hr 2-Year Rainfall=3.14"

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

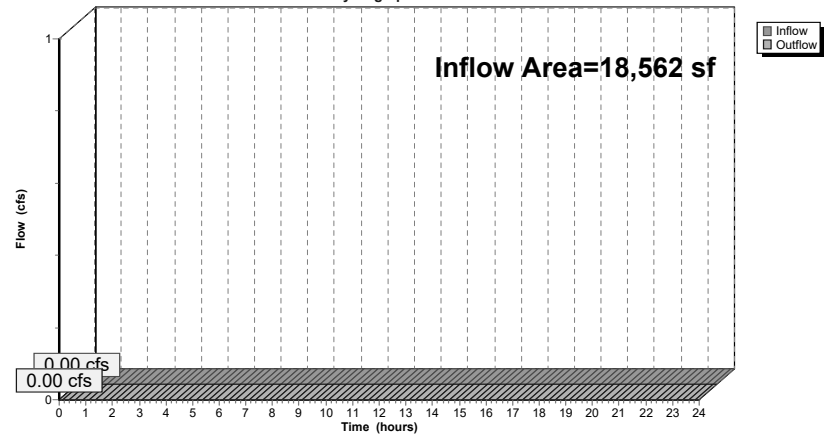
[40] Hint: Not Described (Outflow=Inflow)

Inflow Area =	18,562 sf, 63.03% 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**

Hydrograph



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Type III 24-hr 2-Year Rainfall=3.14"

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**Summary for Pond 1P: Rain Garden #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 = 0.22 cfs @ 12.36 hrs, Volume= 2,041 cf, Atten= 65%, Lag= 16.3 min  
 Discarded = 0.22 cfs @ 12.36 hrs, Volume= 2,041 cf  
 Primary = 0.00 cfs @ 12.36 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= 131.65' @ 12.36 hrs Surf.Area= 1,112 sf Storage= 736 cf

Plug-Flow detention time= 104.5 min calculated for 2,040 cf (97% of inflow)  
 Center-of-Mass det. time= 89.5 min ( 870.5 - 781.0 )

Volume	Invert	Avail.Storage	Storage Description			
#1	129.00'	1,234 cf	<b>Custom Stage Data (Irregular)</b> Listed below (Recalc)			
Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)	
129.00	5	5.0	0	0	5	
130.00	174	57.4	69	69	267	
131.00	301	70.0	235	304	410	
132.00	1,761	305.1	930	1,234	7,430	

Device	Routing	Invert	Outlet Devices
#1	Primary	131.65'	<b>6.0' long x 3.0' breadth Broad-Crested Rectangular Weir</b> 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	129.00'	<b>2.410 in/hr Exfiltration over Wetted area</b>

**Discarded OutFlow** Max=0.22 cfs @ 12.36 hrs HW=131.65' (Free Discharge)  
 ↳2=Exfiltration (Exfiltration Controls 0.22 cfs)

**Primary OutFlow** Max=0.00 cfs @ 12.36 hrs HW=131.65' TW=0.00' (Dynamic Tailwater)  
 ↳1=Broad-Crested Rectangular Weir (Weir Controls 0.00 cfs @ 0.01 fps)

**8998501-POST**

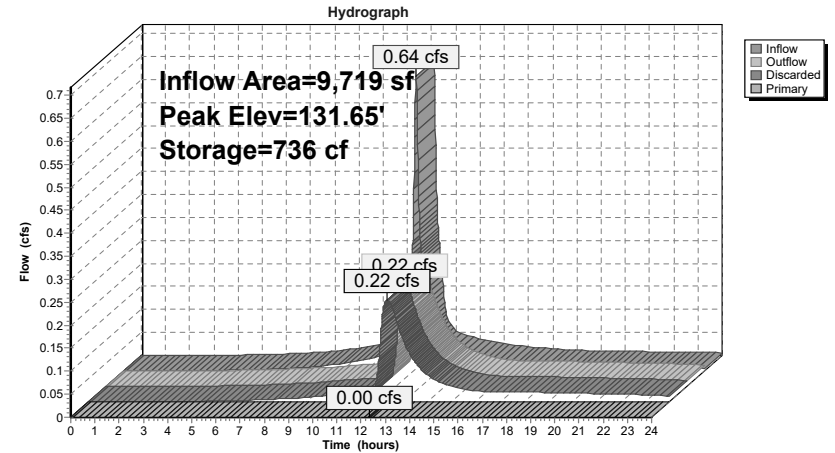
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Type III 24-hr 2-Year Rainfall=3.14"

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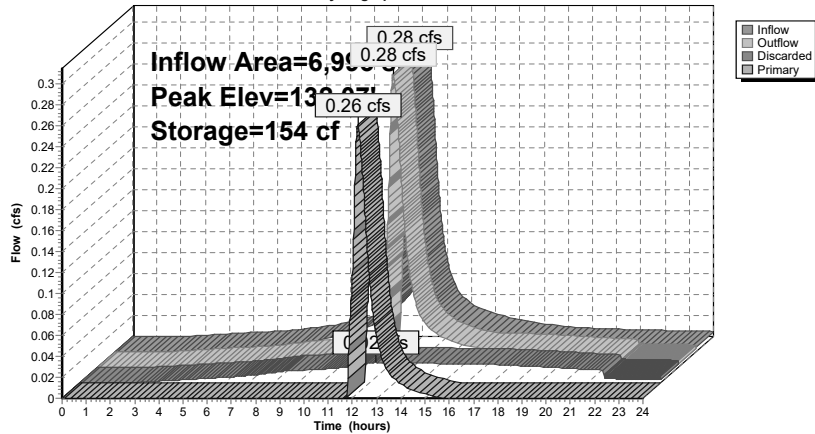
**Pond 1P: Rain Garden #1**





**Pond 3P: Bio-Ret #2**

Hydrograph



**Summary for Pond 4P: Bio-Ret #3**

Inflow Area = 18,562 sf, 63.03% Impervious, Inflow Depth > 0.44" for 2-Year event  
 Inflow = 0.21 cfs @ 12.10 hrs, Volume= 683 cf  
 Outflow = 0.03 cfs @ 12.68 hrs, Volume= 670 cf, Atten= 83%, Lag= 35.2 min  
 Discarded = 0.03 cfs @ 12.68 hrs, Volume= 670 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= 124.65' @ 12.68 hrs Surf.Area= 399 sf Storage= 233 cf

Plug-Flow detention time= 91.5 min calculated for 670 cf (98% of inflow)  
 Center-of-Mass det. time= 80.8 min ( 946.5 - 865.7 )

Volume	Invert	Avail.Storage	Storage Description		
#1	123.00'	728 cf	<b>Custom Stage Data (Irregular)</b> Listed below (Recalc)		
Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
123.00	5	5.0	0	0	5
124.00	150	52.3	61	61	223
125.00	582	107.3	342	403	926
125.50	720	115.8	325	728	1,087

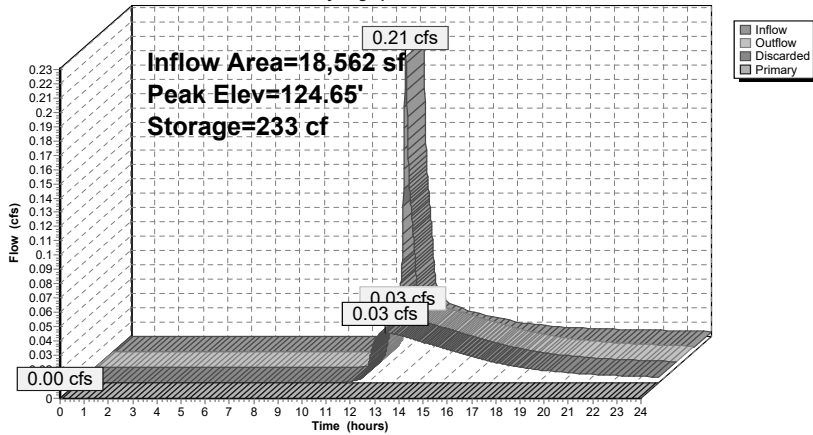
Device	Routing	Invert	Outlet Devices
#1	Primary	125.00'	<b>2.0' long x 3.0' breadth Broad-Crested Rectangular Weir</b> Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 3.50 4.00 4.50 Coef. (English) 2.44 2.58 2.68 2.67 2.65 2.64 2.64 2.68 2.68 2.72 2.81 2.92 2.97 3.07 3.32
#2	Discarded	123.00'	<b>2.410 in/hr Exfiltration over Wetted area</b>

**Discarded OutFlow** Max=0.03 cfs @ 12.68 hrs HW=124.65' (Free Discharge)  
 ↳2=Exfiltration (Exfiltration Controls 0.03 cfs)

**Primary OutFlow** Max=0.00 cfs @ 0.00 hrs HW=123.00' TW=0.00' (Dynamic Tailwater)  
 ↳1=Broad-Crested Rectangular Weir ( Controls 0.00 cfs)

**Pond 4P: Bio-Ret #3**

Hydrograph



**Summary for Pond 5P: Haggetts S Infiltr**

[87] Warning: Oscillations may require smaller dt or Finer Routing (severity=519)

Inflow Area = 9,874 sf, 69.16% Impervious, Inflow Depth > 1.70" for 2-Year event  
 Inflow = 0.45 cfs @ 12.09 hrs, Volume= 1,403 cf  
 Outflow = 0.12 cfs @ 12.47 hrs, Volume= 1,403 cf, Atten= 73%, Lag= 22.8 min  
 Discarded = 0.12 cfs @ 12.47 hrs, Volume= 1,403 cf  
 Primary = 0.00 cfs @ 0.00 hrs, Volume= 0 cf  
 Routed to Pond 4P : Bio-Ret #3

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs  
 Peak Elev= 129.32' @ 12.47 hrs Surf.Area= 2,125 sf Storage= 274 cf  
 Flood Elev= 131.08' Surf.Area= 2,125 sf Storage= 2,384 cf

Plug-Flow detention time= (not calculated: outflow precedes inflow)  
 Center-of-Mass det. time= 11.3 min ( 837.5 - 826.2 )

Volume	Invert	Avail.Storage	Storage Description
#1A	129.00'	1,303 cf	<b>25.00'W x 85.00'L x 2.04'H Field A</b> 4,339 cf Overall - 1,082 cf Embedded = 3,257 cf x 40.0% Voids
#2A	129.50'	1,082 cf	<b>Cultec C-100HD x 77 Inside #1</b> 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
		2,384 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Primary	130.15'	<b>4.0' long Sharp-Crested Rectangular Weir</b> 2 End Contraction(s)
#2	Discarded	129.00'	<b>2.410 in/hr Exfiltration over Wetted area</b>

**Discarded OutFlow** Max=0.12 cfs @ 12.47 hrs HW=129.32' (Free Discharge)  
 ↳2=Exfiltration (Exfiltration Controls 0.12 cfs)

**Primary OutFlow** Max=0.00 cfs @ 0.00 hrs HW=129.00' TW=123.00' (Dynamic Tailwater)  
 ↳1=Sharp-Crested Rectangular Weir ( Controls 0.00 cfs)

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Type III 24-hr 2-Year Rainfall=3.14"

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**Pond 5P: Haggetts S Infil - 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

11 Chambers/Row x 7.50' Long +0.50' Row Adjustment = 83.00' Row Length +12.0" End Stone x 2 =

85.00' 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

77 Chambers x 14.0 cf +0.50' Row Adjustment x 1.86 sf x 7 Rows = 1,081.5 cf Chamber Storage

4,338.5 cf Field - 1,081.5 cf Chambers = 3,257.0 cf Stone x 40.0% Voids = 1,302.8 cf Stone Storage

Chamber Storage + Stone Storage = 2,384.3 cf = 0.055 af

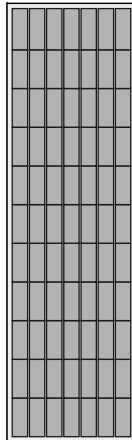
Overall Storage Efficiency = 55.0%

Overall System Size = 85.00' x 25.00' x 2.04'

77 Chambers

160.7 cy Field

120.6 cy Stone



**8998501-POST**

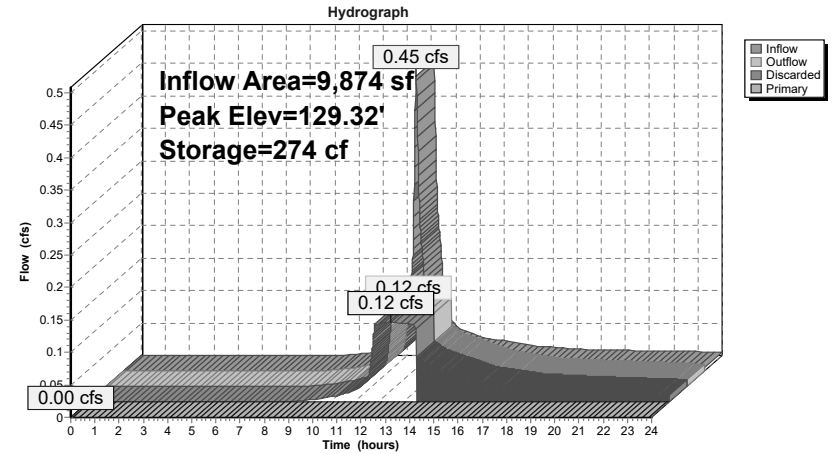
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Type III 24-hr 2-Year Rainfall=3.14"

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**Pond 5P: Haggetts S Infil**



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Type III 24-hr 10-Year Rainfall=4.96"

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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

**Subcatchment 1S: Ex. High Plain CB** 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

**Subcatchment 2S: High Plain Prkg** Runoff Area=6,993 sf 100.00% Impervious Runoff Depth>4.72"  
Tc=6.0 min CN=98 Runoff=0.78 cfs 2,750 cf

**Subcatchment 3S: Haggetts Pond CB** Runoff Area=8,688 sf 56.05% Impervious Runoff Depth>2.25"  
Tc=6.0 min CN=73 Runoff=0.52 cfs 1,626 cf

**Subcatchment 4S: Haggetts Pond S Prkg** Runoff Area=9,874 sf 69.16% Impervious Runoff Depth>3.33"  
Tc=6.0 min CN=85 Runoff=0.88 cfs 2,738 cf

**Reach 1R: Offsite East at High Plain Rd** Inflow=0.97 cfs 2,090 cf  
Outflow=0.97 cfs 2,090 cf

**Reach 2R: Offsite East at Haggetts Pond Rd** Inflow=0.20 cfs 291 cf  
Outflow=0.20 cfs 291 cf

**Pond 1P: Rain Garden #1** Peak Elev=131.77' Storage=881 cf Inflow=1.05 cfs 3,544 cf  
Discarded=0.28 cfs 2,888 cf Primary=0.61 cfs 511 cf Outflow=0.89 cfs 3,399 cf

**Pond 2P: High Plain storage** Peak Elev=132.81' Storage=463 cf Inflow=0.78 cfs 2,750 cf  
6.0" Round Culvert n=0.013 L=18.0' S=0.0139 1' Outflow=0.42 cfs 2,733 cf

**Pond 3P: Bio-Ret #2** Peak Elev=132.09' Storage=161 cf Inflow=0.42 cfs 2,733 cf  
Discarded=0.02 cfs 1,142 cf Primary=0.40 cfs 1,579 cf Outflow=0.42 cfs 2,721 cf

**Pond 4P: Bio-Ret #3** Peak Elev=125.12' Storage=474 cf Inflow=0.52 cfs 1,626 cf  
Discarded=0.05 cfs 1,298 cf Primary=0.20 cfs 291 cf Outflow=0.25 cfs 1,589 cf

**Pond 5P: Haggetts S Infil** Peak Elev=129.74' Storage=841 cf Inflow=0.88 cfs 2,738 cf  
Discarded=0.13 cfs 2,739 cf Primary=0.00 cfs 0 cf Outflow=0.13 cfs 2,739 cf

**Total Runoff Area = 35,274 sf Runoff Volume = 10,659 cf Average Runoff Depth = 3.63"**  
**25.60% Pervious = 9,029 sf 74.40% Impervious = 26,245 sf**

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Type III 24-hr 10-Year Rainfall=4.96"

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**Summary for Subcatchment 1S: Ex. High Plain CB**

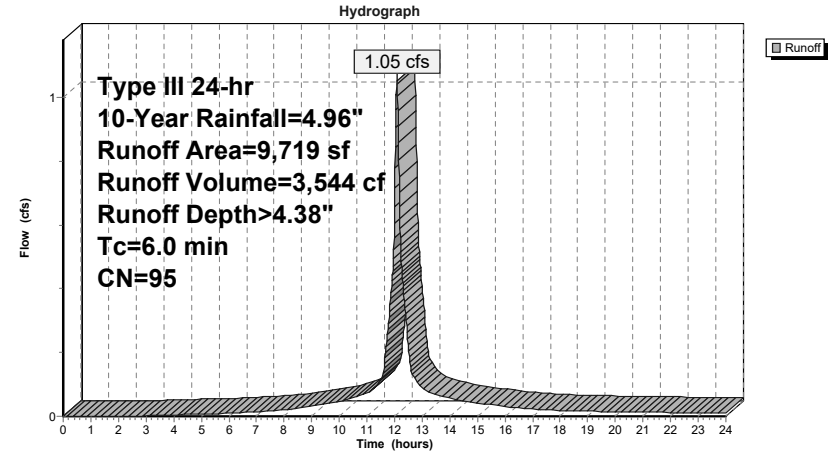
Runoff = 1.05 cfs @ 12.08 hrs, Volume= 3,544 cf, Depth> 4.38"  
Routed to Pond 1P : Rain Garden #1

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
	2,166	86	<50% Grass cover, Poor, HSG C
*	6,885	98	Ex. paved parking, HSG C
*	668	98	New 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: Ex. High Plain CB**



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Type III 24-hr 10-Year Rainfall=4.96"

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**Summary for Subcatchment 2S: High Plain Prkg**

Runoff = 0.78 cfs @ 12.08 hrs, Volume= 2,750 cf, Depth> 4.72"  
Routed to Pond 2P : High Plain storage

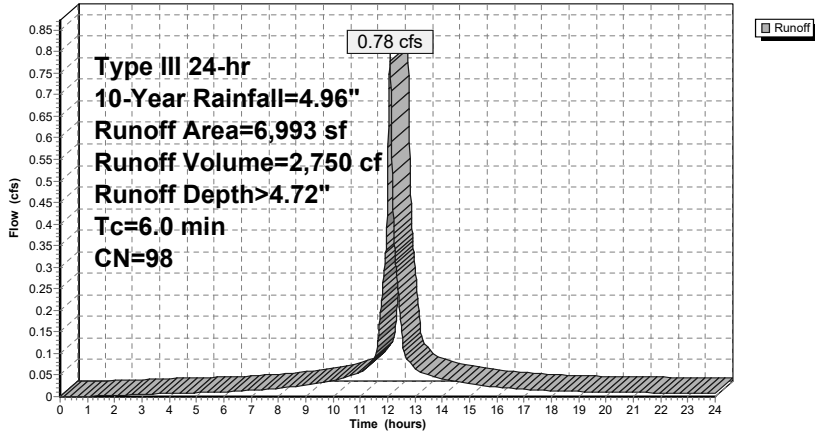
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs  
Type III 24-hr 10-Year Rainfall=4.96"

Area (sf)	CN	Description
* 5,445	98	New paved parking, HSG C
* 1,548	98	New paved parking, HSG A
6,993	98	Weighted Average
6,993		100.00% Impervious Area

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

**Subcatchment 2S: High Plain Prkg**

Hydrograph



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Type III 24-hr 10-Year Rainfall=4.96"

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**Summary for Subcatchment 3S: Haggetts Pond CB**

Runoff = 0.52 cfs @ 12.09 hrs, Volume= 1,626 cf, Depth> 2.25"  
Routed to Pond 4P : Bio-Ret #3

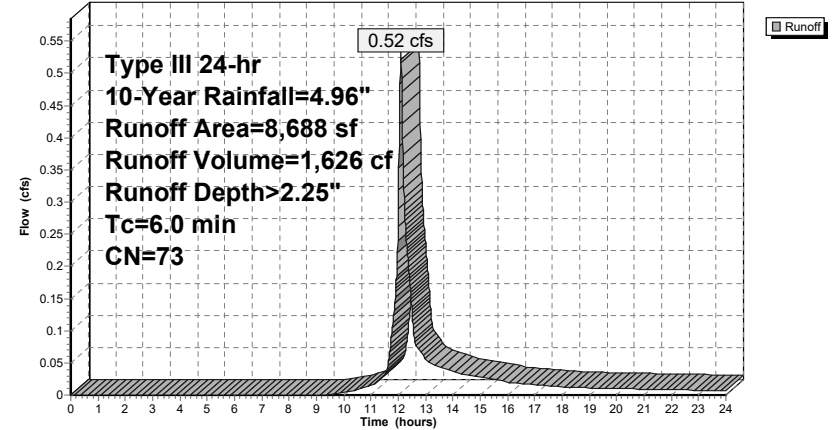
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs  
Type III 24-hr 10-Year Rainfall=4.96"

Area (sf)	CN	Description
* 632	98	New paved parking, HSG A
* 4,238	98	Ex. paved parking, HSG A
925	68	<50% Grass cover, Poor, HSG A
1,043	39	>75% Grass cover, Good, HSG A
1,850	30	Woods, Good, HSG A
8,688	73	Weighted Average
3,818		43.95% Pervious Area
4,870		56.05% Impervious Area

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

**Subcatchment 3S: Haggetts Pond CB**

Hydrograph



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Type III 24-hr 10-Year Rainfall=4.96"

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**Summary for Subcatchment 4S: Haggetts Pond S Prkg**

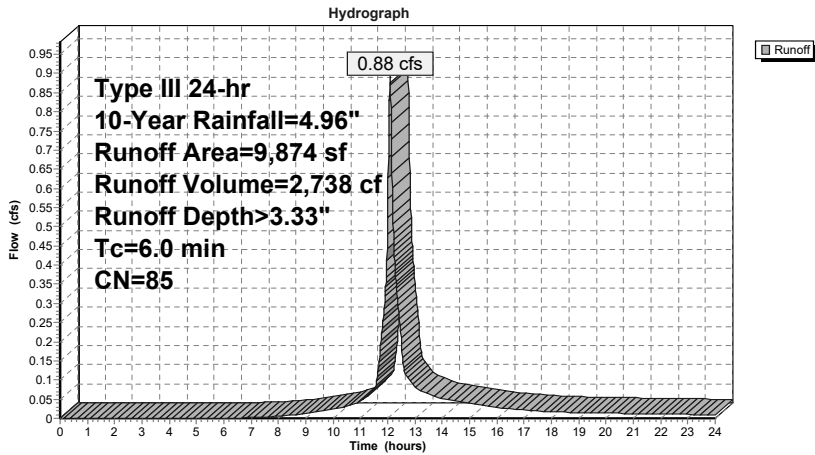
Runoff = 0.88 cfs @ 12.09 hrs, Volume= 2,738 cf, Depth> 3.33"  
Routed to Pond 5P : Haggetts S Infil

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
* 6,829	98	New paved parking, HSG A
2,002	68	<50% Grass cover, Poor, HSG A
1,043	30	Woods, Good, HSG A
9,874	85	Weighted Average
3,045		30.84% Pervious Area
6,829		69.16% Impervious Area

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

**Subcatchment 4S: Haggetts Pond S Prkg**



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Type III 24-hr 10-Year Rainfall=4.96"

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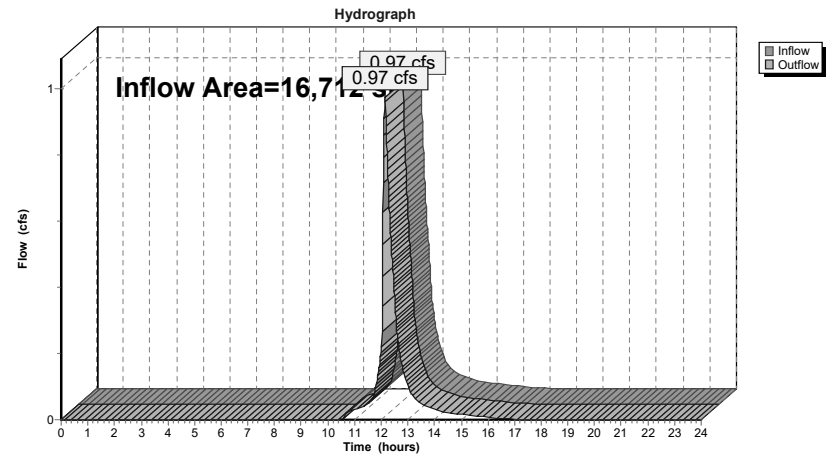
**Summary for Reach 1R: Offsite East at High Plain Rd**

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

Inflow Area = 16,712 sf, 87.04% Impervious, Inflow Depth = 1.50" for 10-Year event  
Inflow = 0.97 cfs @ 12.14 hrs, Volume= 2,090 cf  
Outflow = 0.97 cfs @ 12.14 hrs, Volume= 2,090 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**



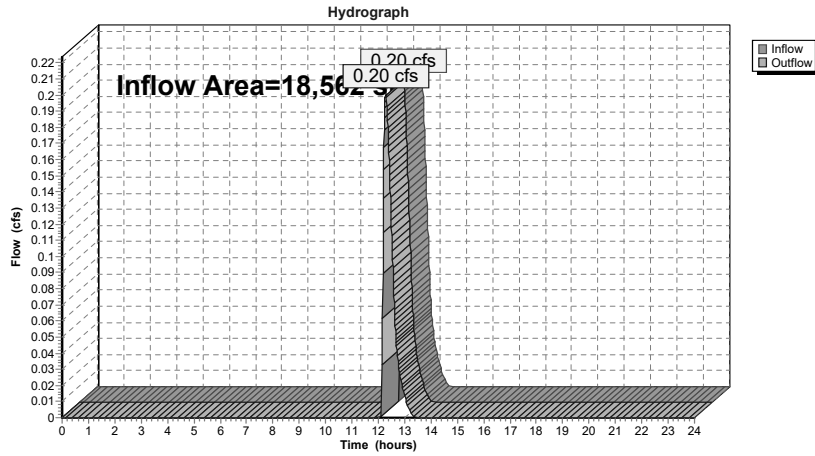
**Summary for Reach 2R: Offsite East at Haggets Pond Rd**

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

Inflow Area = 18,562 sf, 63.03% Impervious, Inflow Depth = 0.19" for 10-Year event  
 Inflow = 0.20 cfs @ 12.28 hrs, Volume= 291 cf  
 Outflow = 0.20 cfs @ 12.28 hrs, Volume= 291 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: Rain Garden #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 = 0.89 cfs @ 12.13 hrs, Volume= 3,399 cf, Atten= 16%, Lag= 3.1 min  
 Discarded = 0.28 cfs @ 12.13 hrs, Volume= 2,888 cf  
 Primary = 0.61 cfs @ 12.13 hrs, Volume= 511 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= 131.77' @ 12.13 hrs Surf.Area= 1,317 sf Storage= 881 cf

Plug-Flow detention time= 83.0 min calculated for 3,397 cf (96% of inflow)  
 Center-of-Mass det. time= 58.9 min ( 826.8 - 767.9 )

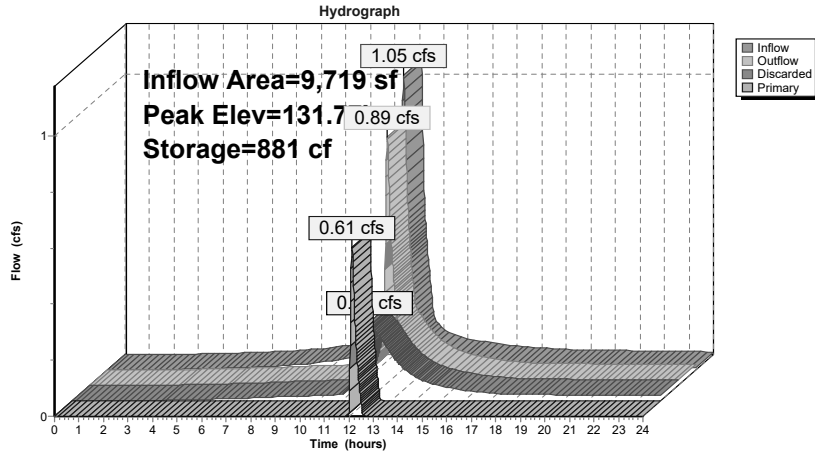
Volume	Invert	Avail.Storage	Storage Description		
#1	129.00'	1,234 cf	<b>Custom Stage Data (Irregular)</b> Listed below (Recalc)		
Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
129.00	5	5.0	0	0	5
130.00	174	57.4	69	69	267
131.00	301	70.0	235	304	410
132.00	1,761	305.1	930	1,234	7,430

Device	Routing	Invert	Outlet Devices												
#1	Primary	131.65'	<b>6.0' long x 3.0' breadth Broad-Crested Rectangular Weir</b>												
			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	129.00'	<b>2.410 in/hr Exfiltration over Wetted area</b>												

**Discarded OutFlow** Max=0.28 cfs @ 12.13 hrs HW=131.77' (Free Discharge)  
 ↳2=Exfiltration (Exfiltration Controls 0.28 cfs)

**Primary OutFlow** Max=0.60 cfs @ 12.13 hrs HW=131.77' TW=0.00' (Dynamic Tailwater)  
 ↳1=Broad-Crested Rectangular Weir (Weir Controls 0.60 cfs @ 0.84 fps)

**Pond 1P: Rain Garden #1**



**Summary for Pond 2P: High Plain storage**

Inflow Area = 6,993 sf, 100.00% Impervious, Inflow Depth > 4.72" for 10-Year event  
 Inflow = 0.78 cfs @ 12.08 hrs, Volume= 2,750 cf  
 Outflow = 0.42 cfs @ 12.21 hrs, Volume= 2,733 cf, Atten= 47%, Lag= 7.5 min  
 Primary = 0.42 cfs @ 12.21 hrs, Volume= 2,733 cf  
 Routed to Pond 3P : Bio-Ret #2

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs  
 Peak Elev= 132.81' @ 12.21 hrs Surf.Area= 1,012 sf Storage= 463 cf  
 Flood Elev= 133.25' Storage= 801 cf

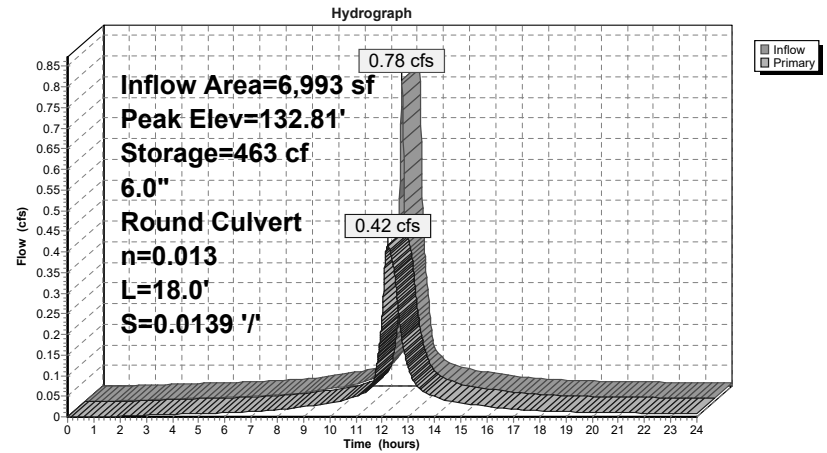
Plug-Flow detention time= 24.0 min calculated for 2,733 cf (99% of inflow)  
 Center-of-Mass det. time= 19.8 min ( 767.4 - 747.6 )

Volume	Invert	Avail.Storage	Storage Description
#1	132.25'	801 cf	<b>12.0" Round Pipe Storage x 12</b> L= 85.0'

Device	Routing	Invert	Outlet Devices
#1	Primary	132.25'	<b>6.0" Round Culvert</b> L= 18.0' CPP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 132.25' / 132.00' S= 0.0139 '/ Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.20 sf

**Primary OutFlow** Max=0.42 cfs @ 12.21 hrs HW=132.81' TW=132.09' (Dynamic Tailwater)  
 1=Culvert (Inlet Controls 0.42 cfs @ 2.12 fps)

**Pond 2P: High Plain storage**



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Type III 24-hr 10-Year Rainfall=4.96"

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**Summary for Pond 3P: Bio-Ret #2**

Inflow Area = 6,993 sf, 100.00% Impervious, Inflow Depth > 4.69" for 10-Year event  
 Inflow = 0.42 cfs @ 12.21 hrs, Volume= 2,733 cf  
 Outflow = 0.42 cfs @ 12.22 hrs, Volume= 2,721 cf, Atten= 0%, Lag= 1.0 min  
 Discarded = 0.02 cfs @ 12.22 hrs, Volume= 1,142 cf  
 Primary = 0.40 cfs @ 12.22 hrs, Volume= 1,579 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= 132.09' @ 12.22 hrs Surf.Area= 340 sf Storage= 161 cf

Plug-Flow detention time= (not calculated: outflow precedes inflow)  
 Center-of-Mass det. time= 32.1 min ( 799.5 - 767.4 )

Volume	Invert	Avail.Storage	Storage Description			
#1	131.50'	323 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)	
131.50	212	100.7	0	0	212	
132.00	316	107.0	131	131	328	
132.50	456	115.1	192	323	482	

Device	Routing	Invert	Outlet Devices
#1	Primary	132.00'	<b>6.0' long x 4.0' breadth Broad-Crested Rectangular Weir</b> 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	131.50'	<b>2.410 in/hr Exfiltration over Wetted area</b>

**Discarded OutFlow** Max=0.02 cfs @ 12.22 hrs HW=132.09' (Free Discharge)  
 ↳ **2=Exfiltration** (Exfiltration Controls 0.02 cfs)

**Primary OutFlow** Max=0.40 cfs @ 12.22 hrs HW=132.09' TW=0.00' (Dynamic Tailwater)  
 ↳ **1=Broad-Crested Rectangular Weir** (Weir Controls 0.40 cfs @ 0.72 fps)

**8998501-POST**

Type III 24-hr 10-Year Rainfall=4.96"

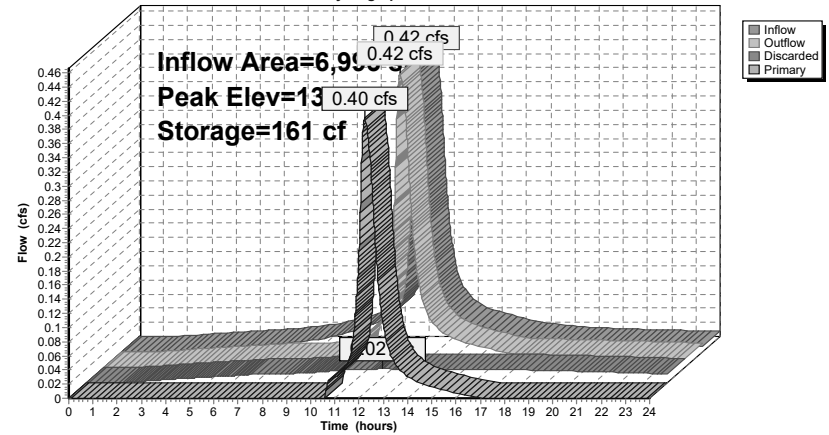
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**Pond 3P: Bio-Ret #2**

Hydrograph



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Type III 24-hr 10-Year Rainfall=4.96"

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**Summary for Pond 4P: Bio-Ret #3**

Inflow Area = 18,562 sf, 63.03% Impervious, Inflow Depth > 1.05" for 10-Year event  
 Inflow = 0.52 cfs @ 12.09 hrs, Volume= 1,626 cf  
 Outflow = 0.25 cfs @ 12.28 hrs, Volume= 1,589 cf, Atten= 51%, Lag= 11.1 min  
 Discarded = 0.05 cfs @ 12.28 hrs, Volume= 1,298 cf  
 Primary = 0.20 cfs @ 12.28 hrs, Volume= 291 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= 125.12' @ 12.28 hrs Surf.Area= 613 sf Storage= 474 cf

Plug-Flow detention time= 90.6 min calculated for 1,589 cf (98% of inflow)  
 Center-of-Mass det. time= 77.6 min ( 917.2 - 839.6 )

Volume	Invert	Avail.Storage	Storage Description			
#1	123.00'	728 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)	
123.00	5	5.0	0	0	5	
124.00	150	52.3	61	61	223	
125.00	582	107.3	342	403	926	
125.50	720	115.8	325	728	1,087	

Device	Routing	Invert	Outlet Devices
#1	Primary	125.00'	<b>2.0' long x 3.0' breadth Broad-Crested Rectangular Weir</b> 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	123.00'	<b>2.410 in/hr Exfiltration over Wetted area</b>

**Discarded OutFlow** Max=0.05 cfs @ 12.28 hrs HW=125.12' (Free Discharge)  
 ↳ **2=Exfiltration** (Exfiltration Controls 0.05 cfs)

**Primary OutFlow** Max=0.20 cfs @ 12.28 hrs HW=125.12' TW=0.00' (Dynamic Tailwater)  
 ↳ **1=Broad-Crested Rectangular Weir** (Weir Controls 0.20 cfs @ 0.84 fps)

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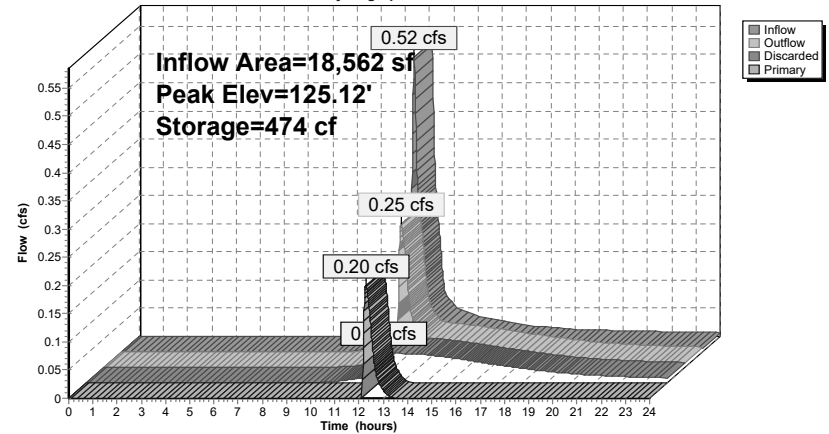
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Type III 24-hr 10-Year Rainfall=4.96"

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**Pond 4P: Bio-Ret #3**

Hydrograph



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Type III 24-hr 10-Year Rainfall=4.96"

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**Summary for Pond 5P: Haggetts S Infill**

[87] Warning: Oscillations may require smaller dt or Finer Routing (severity=401)

Inflow Area = 9,874 sf, 69.16% Impervious, Inflow Depth > 3.33" for 10-Year event  
 Inflow = 0.88 cfs @ 12.09 hrs, Volume= 2,738 cf  
 Outflow = 0.13 cfs @ 12.60 hrs, Volume= 2,739 cf, Atten= 85%, Lag= 30.8 min  
 Discarded = 0.13 cfs @ 12.60 hrs, Volume= 2,739 cf  
 Primary = 0.00 cfs @ 0.00 hrs, Volume= 0 cf  
 Routed to Pond 4P : Bio-Ret #3

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs  
 Peak Elev= 129.74' @ 12.60 hrs Surf.Area= 2,125 sf Storage= 841 cf  
 Flood Elev= 131.08' Surf.Area= 2,125 sf Storage= 2,384 cf

Plug-Flow detention time= (not calculated: outflow precedes inflow)  
 Center-of-Mass det. time= 44.0 min ( 851.2 - 807.2 )

Volume	Invert	Avail.Storage	Storage Description
#1A	129.00'	1,303 cf	<b>25.00'W x 85.00'L x 2.04'H Field A</b> 4,339 cf Overall - 1,082 cf Embedded = 3,257 cf x 40.0% Voids
#2A	129.50'	1,082 cf	<b>Cultec C-100HD x 77 Inside #1</b> 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
		2,384 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Primary	130.15'	<b>4.0' long Sharp-Crested Rectangular Weir</b> 2 End Contraction(s)
#2	Discarded	129.00'	<b>2.410 in/hr Exfiltration over Wetted area</b>

**Discarded OutFlow** Max=0.13 cfs @ 12.60 hrs HW=129.74' (Free Discharge)  
 ↳2=Exfiltration (Exfiltration Controls 0.13 cfs)

**Primary OutFlow** Max=0.00 cfs @ 0.00 hrs HW=129.00' TW=123.00' (Dynamic Tailwater)  
 ↳1=Sharp-Crested Rectangular Weir ( Controls 0.00 cfs)

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Type III 24-hr 10-Year Rainfall=4.96"

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**Pond 5P: Haggetts S Infill - 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

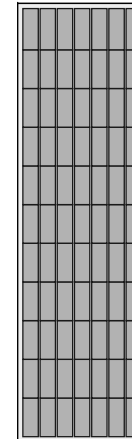
11 Chambers/Row x 7.50' Long +0.50' Row Adjustment = 83.00' Row Length +12.0" End Stone x 2 = 85.00' Base Length  
 7 Rows x 36.0" Wide + 4.0" Spacing x 6 + 12.0" Side Stone x 2 = 25.00' Base Width  
 6.0" Stone Base + 12.5" Chamber Height + 6.0" Stone Cover = 2.04' Field Height

77 Chambers x 14.0 cf +0.50' Row Adjustment x 1.86 sf x 7 Rows = 1,081.5 cf Chamber Storage

4,338.5 cf Field - 1,081.5 cf Chambers = 3,257.0 cf Stone x 40.0% Voids = 1,302.8 cf Stone Storage

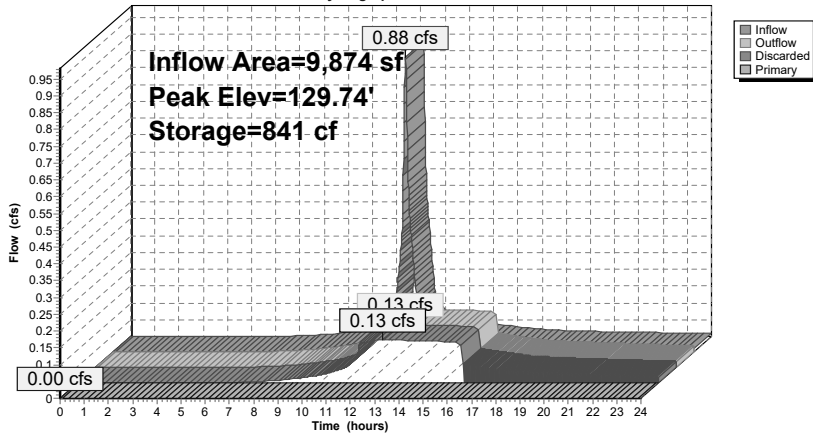
Chamber Storage + Stone Storage = 2,384.3 cf = 0.055 af  
 Overall Storage Efficiency = 55.0%  
 Overall System Size = 85.00' x 25.00' x 2.04'

77 Chambers  
 160.7 cy Field  
 120.6 cy Stone



**Pond 5P: Haggetts S Infiltration**

Hydrograph



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

<b>Subcatchment 1S: Ex. High Plain CB</b>	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
<b>Subcatchment 2S: High Plain Prkg</b>	Runoff Area=6,993 sf 100.00% Impervious Runoff Depth>5.85" Tc=6.0 min CN=98 Runoff=0.96 cfs 3,407 cf
<b>Subcatchment 3S: Haggetts Pond CB</b>	Runoff Area=8,688 sf 56.05% Impervious Runoff Depth>3.16" Tc=6.0 min CN=73 Runoff=0.74 cfs 2,288 cf
<b>Subcatchment 4S: Haggetts Pond S Prkg</b>	Runoff Area=9,874 sf 69.16% Impervious Runoff Depth>4.38" Tc=6.0 min CN=85 Runoff=1.14 cfs 3,607 cf
<b>Reach 1R: Offsite East at High Plain Rd</b>	Inflow=1.30 cfs 2,975 cf Outflow=1.30 cfs 2,975 cf
<b>Reach 2R: Offsite East at Haggetts Pond Rd</b>	Inflow=0.51 cfs 704 cf Outflow=0.51 cfs 704 cf
<b>Pond 1P: Rain Garden #1</b>	Peak Elev=131.80' Storage=926 cf Inflow=1.31 cfs 4,452 cf Discarded=0.30 cfs 3,400 cf Primary=0.88 cfs 855 cf Outflow=1.18 cfs 4,255 cf
<b>Pond 2P: High Plain storage</b>	Peak Elev=132.93' Storage=578 cf Inflow=0.96 cfs 3,407 cf 6.0" Round Culvert n=0.013 L=18.0' S=0.0139 1/8" Outflow=0.49 cfs 3,388 cf
<b>Pond 3P: Bio-Ret #2</b>	Peak Elev=132.10' Storage=165 cf Inflow=0.49 cfs 3,388 cf Discarded=0.02 cfs 1,225 cf Primary=0.47 cfs 2,120 cf Outflow=0.49 cfs 3,344 cf
<b>Pond 4P: Bio-Ret #3</b>	Peak Elev=125.22' Storage=538 cf Inflow=0.74 cfs 2,288 cf Discarded=0.06 cfs 1,529 cf Primary=0.51 cfs 704 cf Outflow=0.56 cfs 2,233 cf
<b>Pond 5P: Haggetts S Infiltration</b>	Peak Elev=129.98' Storage=1,236 cf Inflow=1.14 cfs 3,607 cf Discarded=0.13 cfs 3,607 cf Primary=0.00 cfs 0 cf Outflow=0.13 cfs 3,607 cf

**Total Runoff Area = 35,274 sf Runoff Volume = 13,753 cf Average Runoff Depth = 4.68"**  
**25.60% Pervious = 9,029 sf 74.40% Impervious = 26,245 sf**

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Type III 24-hr 25-Year Rainfall=6.09"

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**Summary for Subcatchment 1S: Ex. High Plain CB**

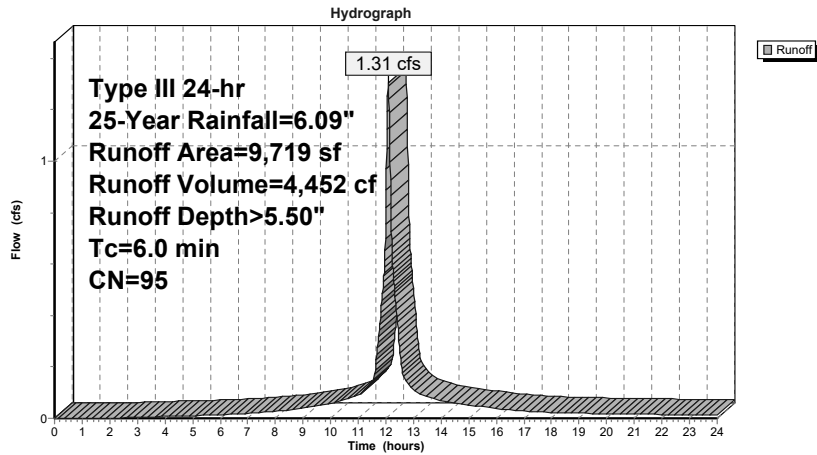
Runoff = 1.31 cfs @ 12.08 hrs, Volume= 4,452 cf, Depth> 5.50"  
Routed to Pond 1P : Rain Garden #1

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
2,166	86	<50% Grass cover, Poor, HSG C
6,885	98	Ex. paved parking, HSG C
668	98	New 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: Ex. High Plain CB**



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Type III 24-hr 25-Year Rainfall=6.09"

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**Summary for Subcatchment 2S: High Plain Prkg**

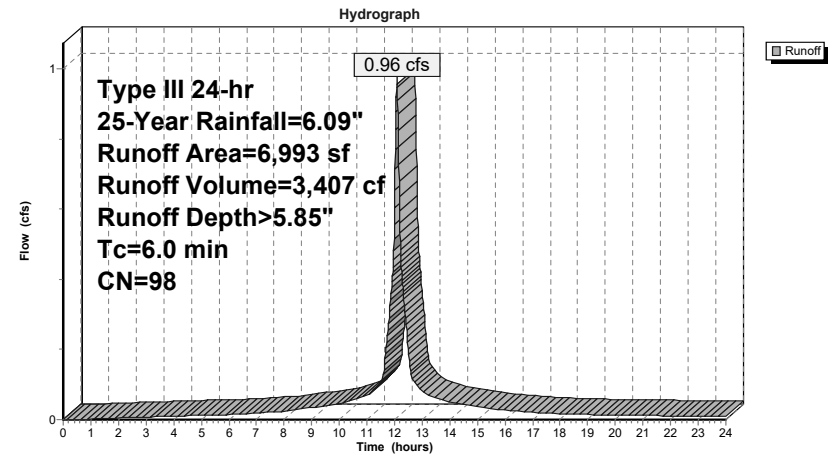
Runoff = 0.96 cfs @ 12.08 hrs, Volume= 3,407 cf, Depth> 5.85"  
Routed to Pond 2P : High Plain storage

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
5,445	98	New paved parking, HSG C
1,548	98	New paved parking, HSG A
6,993	98	Weighted Average
6,993		100.00% Impervious Area

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

**Subcatchment 2S: High Plain Prkg**



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Type III 24-hr 25-Year Rainfall=6.09"

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**Summary for Subcatchment 3S: Haggetts Pond CB**

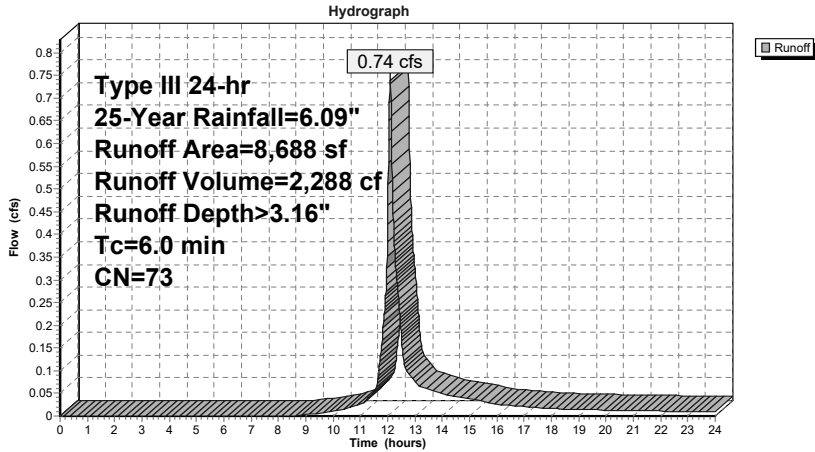
Runoff = 0.74 cfs @ 12.09 hrs, Volume= 2,288 cf, Depth> 3.16"  
Routed to Pond 4P : Bio-Ret #3

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
* 632	98	New paved parking, HSG A
* 4,238	98	Ex. paved parking, HSG A
925	68	<50% Grass cover, Poor, HSG A
1,043	39	>75% Grass cover, Good, HSG A
1,850	30	Woods, Good, HSG A
8,688	73	Weighted Average
3,818		43.95% Pervious Area
4,870		56.05% Impervious Area

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

**Subcatchment 3S: Haggetts Pond CB**



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Type III 24-hr 25-Year Rainfall=6.09"

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**Summary for Subcatchment 4S: Haggetts Pond S Prkg**

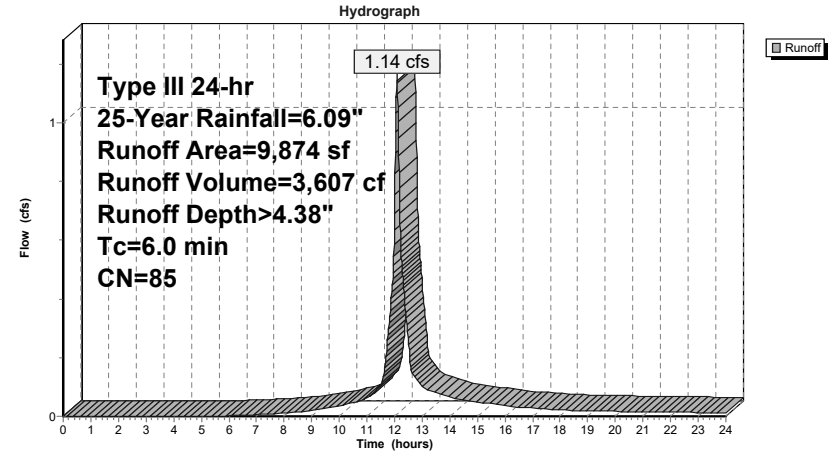
Runoff = 1.14 cfs @ 12.09 hrs, Volume= 3,607 cf, Depth> 4.38"  
Routed to Pond 5P : Haggetts S Infil

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
* 6,829	98	New paved parking, HSG A
2,002	68	<50% Grass cover, Poor, HSG A
1,043	30	Woods, Good, HSG A
9,874	85	Weighted Average
3,045		30.84% Pervious Area
6,829		69.16% Impervious Area

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

**Subcatchment 4S: Haggetts Pond S Prkg**



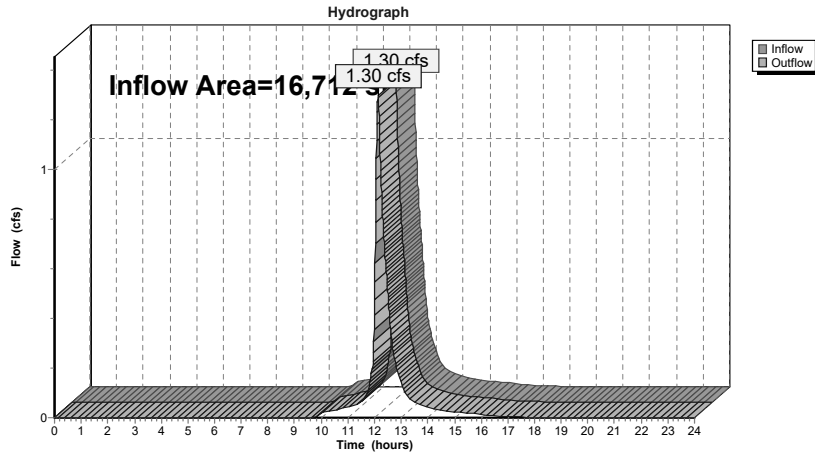
Summary for Reach 1R: Offsite East at High Plain Rd

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

Inflow Area =	16,712 sf, 87.04% Impervious,	Inflow Depth = 2.14"	for 25-Year event
Inflow =	1.30 cfs @ 12.13 hrs,	Volume=	2,975 cf
Outflow =	1.30 cfs @ 12.13 hrs,	Volume=	2,975 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



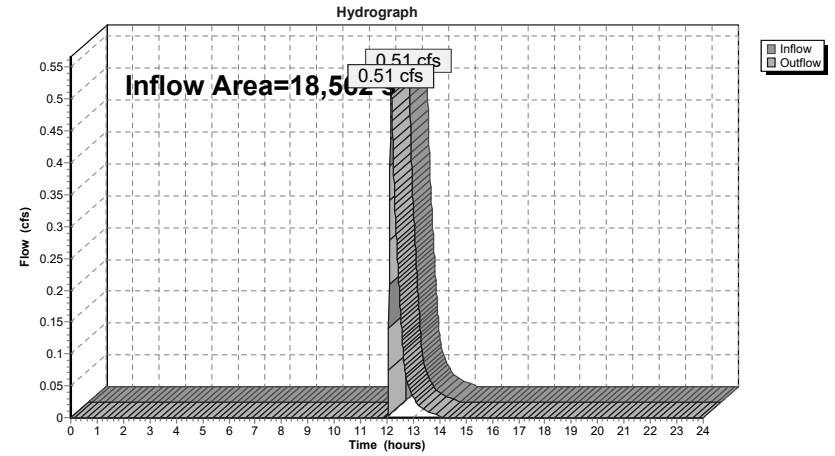
Summary for Reach 2R: Offsite East at Haggets Pond Rd

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

Inflow Area =	18,562 sf, 63.03% Impervious,	Inflow Depth = 0.45"	for 25-Year event
Inflow =	0.51 cfs @ 12.16 hrs,	Volume=	704 cf
Outflow =	0.51 cfs @ 12.16 hrs,	Volume=	704 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



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Type III 24-hr 25-Year Rainfall=6.09"

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**Summary for Pond 1P: Rain Garden #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 = 1.18 cfs @ 12.12 hrs, Volume= 4,255 cf, Atten= 10%, Lag= 2.3 min  
 Discarded = 0.30 cfs @ 12.12 hrs, Volume= 3,400 cf  
 Primary = 0.88 cfs @ 12.12 hrs, Volume= 855 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= 131.80' @ 12.12 hrs Surf.Area= 1,378 sf Storage= 926 cf

Plug-Flow detention time= 74.3 min calculated for 4,254 cf (96% of inflow)  
 Center-of-Mass det. time= 48.6 min ( 811.3 - 762.7 )

Volume	Invert	Avail.Storage	Storage Description			
#1	129.00'	1,234 cf	<b>Custom Stage Data (Irregular)</b> Listed below (Recalc)			
Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)	
129.00	5	5.0	0	0	5	
130.00	174	57.4	69	69	267	
131.00	301	70.0	235	304	410	
132.00	1,761	305.1	930	1,234	7,430	

Device	Routing	Invert	Outlet Devices
#1	Primary	131.65'	<b>6.0' long x 3.0' breadth Broad-Crested Rectangular Weir</b> 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	129.00'	<b>2.410 in/hr Exfiltration over Wetted area</b>

**Discarded OutFlow** Max=0.30 cfs @ 12.12 hrs HW=131.80' (Free Discharge)  
 ↳ **2=Exfiltration** (Exfiltration Controls 0.30 cfs)

**Primary OutFlow** Max=0.88 cfs @ 12.12 hrs HW=131.80' TW=0.00' (Dynamic Tailwater)  
 ↳ **1=Broad-Crested Rectangular Weir** (Weir Controls 0.88 cfs @ 0.95 fps)

**8998501-POST**

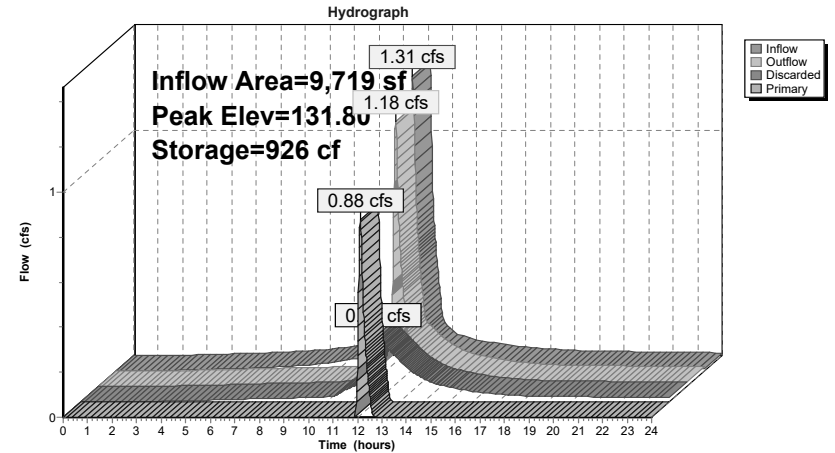
Type III 24-hr 25-Year Rainfall=6.09"

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**Pond 1P: Rain Garden #1**



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Type III 24-hr 25-Year Rainfall=6.09"

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**Summary for Pond 2P: High Plain storage**

Inflow Area = 6,993 sf, 100.00% Impervious, Inflow Depth > 5.85" for 25-Year event  
 Inflow = 0.96 cfs @ 12.08 hrs, Volume= 3,407 cf  
 Outflow = 0.49 cfs @ 12.22 hrs, Volume= 3,388 cf, Atten= 49%, Lag= 8.1 min  
 Primary = 0.49 cfs @ 12.22 hrs, Volume= 3,388 cf  
 Routed to Pond 3P : Bio-Ret #2

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs  
 Peak Elev= 132.93' @ 12.22 hrs Surf.Area= 953 sf Storage= 578 cf  
 Flood Elev= 133.25' Storage= 801 cf

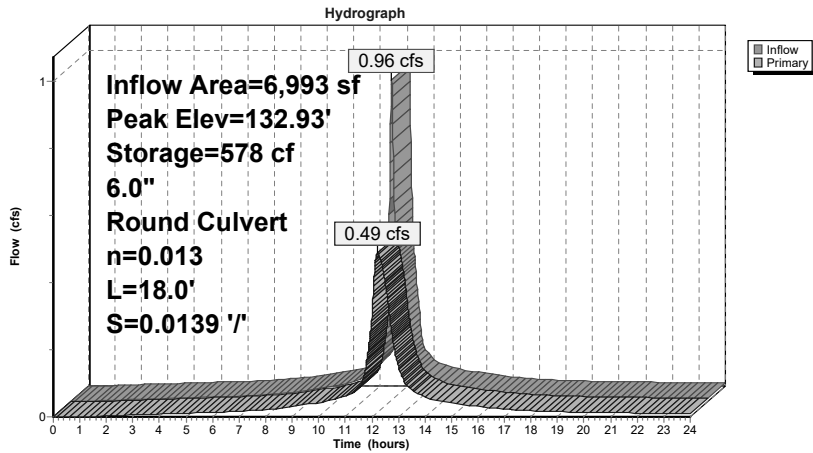
Plug-Flow detention time= 23.4 min calculated for 3,388 cf (99% of inflow)  
 Center-of-Mass det. time= 19.4 min ( 763.8 - 744.4 )

Volume	Invert	Avail.Storage	Storage Description
#1	132.25'	801 cf	<b>12.0" Round Pipe Storage x 12</b> L= 85.0'

Device	Routing	Invert	Outlet Devices
#1	Primary	132.25'	<b>6.0" Round Culvert</b> L= 18.0' CPP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 132.25' / 132.00' S= 0.0139 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.20 sf

**Primary OutFlow** Max=0.49 cfs @ 12.22 hrs HW=132.93' TW=132.10' (Dynamic Tailwater)  
 ↳1=Culvert (Inlet Controls 0.49 cfs @ 2.49 fps)

**Pond 2P: High Plain storage**



**8998501-POST**

Type III 24-hr 25-Year Rainfall=6.09"

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**Summary for Pond 3P: Bio-Ret #2**

Inflow Area = 6,993 sf, 100.00% Impervious, Inflow Depth > 5.81" for 25-Year event  
 Inflow = 0.49 cfs @ 12.22 hrs, Volume= 3,388 cf  
 Outflow = 0.49 cfs @ 12.23 hrs, Volume= 3,344 cf, Atten= 0%, Lag= 0.9 min  
 Discarded = 0.02 cfs @ 12.23 hrs, Volume= 1,225 cf  
 Primary = 0.47 cfs @ 12.23 hrs, Volume= 2,120 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= 132.10' @ 12.23 hrs Surf.Area= 343 sf Storage= 165 cf

Plug-Flow detention time= (not calculated: outflow precedes inflow)  
 Center-of-Mass det. time= 24.5 min ( 788.3 - 763.8 )

Volume	Invert	Avail.Storage	Storage Description
#1	131.50'	323 cf	<b>Custom Stage Data (Irregular)</b> Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
131.50	212	100.7	0	0	212
132.00	316	107.0	131	131	328
132.50	456	115.1	192	323	482

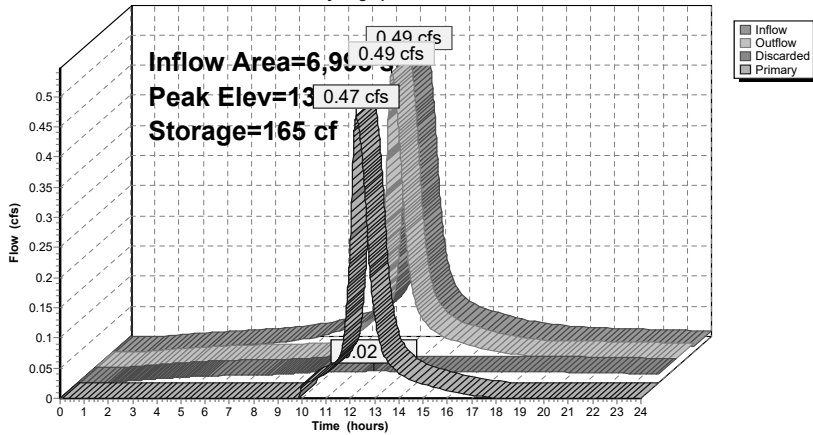
Device	Routing	Invert	Outlet Devices
#1	Primary	132.00'	<b>6.0' long x 4.0' breadth Broad-Crested Rectangular Weir</b> Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 3.50 4.00 4.50 5.00 5.50 Coef. (English) 2.38 2.54 2.69 2.68 2.67 2.67 2.65 2.66 2.66 2.68 2.72 2.73 2.76 2.79 2.88 3.07 3.32
#2	Discarded	131.50'	<b>2.410 in/hr Exfiltration over Wetted area</b>

**Discarded OutFlow** Max=0.02 cfs @ 12.23 hrs HW=132.10' (Free Discharge)  
 ↳2=Exfiltration (Exfiltration Controls 0.02 cfs)

**Primary OutFlow** Max=0.47 cfs @ 12.23 hrs HW=132.10' TW=0.00' (Dynamic Tailwater)  
 ↳1=Broad-Crested Rectangular Weir (Weir Controls 0.47 cfs @ 0.76 fps)

**Pond 3P: Bio-Ret #2**

Hydrograph



**Summary for Pond 4P: Bio-Ret #3**

Inflow Area = 18,562 sf, 63.03% Impervious, Inflow Depth > 1.48" for 25-Year event  
 Inflow = 0.74 cfs @ 12.09 hrs, Volume= 2,288 cf  
 Outflow = 0.56 cfs @ 12.16 hrs, Volume= 2,233 cf, Atten= 24%, Lag= 4.2 min  
 Discarded = 0.06 cfs @ 12.16 hrs, Volume= 1,529 cf  
 Primary = 0.51 cfs @ 12.16 hrs, Volume= 704 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= 125.22' @ 12.16 hrs Surf.Area= 641 sf Storage= 538 cf

Plug-Flow detention time= 78.1 min calculated for 2,233 cf (98% of inflow)  
 Center-of-Mass det. time= 64.4 min ( 894.1 - 829.7 )

Volume	Invert	Avail.Storage	Storage Description		
#1	123.00'	728 cf	<b>Custom Stage Data (Irregular)</b> Listed below (Recalc)		
Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
123.00	5	5.0	0	0	5
124.00	150	52.3	61	61	223
125.00	582	107.3	342	403	926
125.50	720	115.8	325	728	1,087

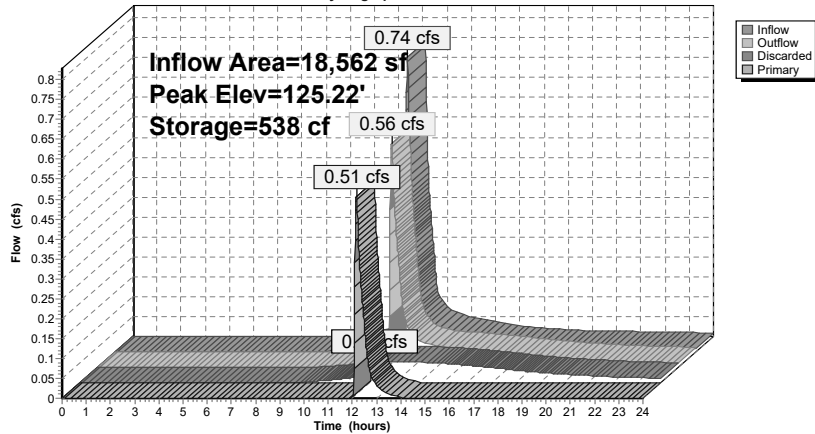
Device	Routing	Invert	Outlet Devices
#1	Primary	125.00'	<b>2.0' long x 3.0' breadth Broad-Crested Rectangular Weir</b> Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 3.50 4.00 4.50 Coef. (English) 2.44 2.58 2.68 2.67 2.65 2.64 2.64 2.68 2.68 2.72 2.81 2.92 2.97 3.07 3.32
#2	Discarded	123.00'	<b>2.410 in/hr Exfiltration over Wetted area</b>

**Discarded OutFlow** Max=0.06 cfs @ 12.16 hrs HW=125.22' (Free Discharge)  
 ↳ **2=Exfiltration** (Exfiltration Controls 0.06 cfs)

**Primary OutFlow** Max=0.51 cfs @ 12.16 hrs HW=125.22' TW=0.00' (Dynamic Tailwater)  
 ↳ **1=Broad-Crested Rectangular Weir** (Weir Controls 0.51 cfs @ 1.15 fps)

**Pond 4P: Bio-Ret #3**

Hydrograph



**Summary for Pond 5P: Haggetts S Infill**

[87] Warning: Oscillations may require smaller dt or Finer Routing (severity=323)

Inflow Area = 9,874 sf, 69.16% Impervious, Inflow Depth > 4.38" for 25-Year event  
 Inflow = 1.14 cfs @ 12.09 hrs, Volume= 3,607 cf  
 Outflow = 0.13 cfs @ 12.76 hrs, Volume= 3,607 cf, Atten= 89%, Lag= 40.7 min  
 Discarded = 0.13 cfs @ 12.76 hrs, Volume= 3,607 cf  
 Primary = 0.00 cfs @ 0.00 hrs, Volume= 0 cf  
 Routed to Pond 4P : Bio-Ret #3

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs  
 Peak Elev= 129.98' @ 12.76 hrs Surf.Area= 2,125 sf Storage= 1,236 cf  
 Flood Elev= 131.08' Surf.Area= 2,125 sf Storage= 2,384 cf

Plug-Flow detention time= (not calculated: outflow precedes inflow)  
 Center-of-Mass det. time= 69.6 min ( 869.1 - 799.5 )

Volume	Invert	Avail.Storage	Storage Description
#1A	129.00'	1,303 cf	<b>25.00'W x 85.00'L x 2.04'H Field A</b> 4,339 cf Overall - 1,082 cf Embedded = 3,257 cf x 40.0% Voids
#2A	129.50'	1,082 cf	<b>Cultec C-100HD x 77 Inside #1</b> 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
		2,384 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Primary	130.15'	<b>4.0' long Sharp-Crested Rectangular Weir</b> 2 End Contraction(s)
#2	Discarded	129.00'	<b>2.410 in/hr Exfiltration over Wetted area</b>

**Discarded OutFlow** Max=0.13 cfs @ 12.76 hrs HW=129.98' (Free Discharge)  
 ↳2=Exfiltration (Exfiltration Controls 0.13 cfs)

**Primary OutFlow** Max=0.00 cfs @ 0.00 hrs HW=129.00' TW=123.00' (Dynamic Tailwater)  
 ↳1=Sharp-Crested Rectangular Weir ( Controls 0.00 cfs)

**Pond 5P: Haggetts S Infil - 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

11 Chambers/Row x 7.50' Long +0.50' Row Adjustment = 83.00' Row Length +12.0" End Stone x 2 =

85.00' 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

77 Chambers x 14.0 cf +0.50' Row Adjustment x 1.86 sf x 7 Rows = 1,081.5 cf Chamber Storage

4,338.5 cf Field - 1,081.5 cf Chambers = 3,257.0 cf Stone x 40.0% Voids = 1,302.8 cf Stone Storage

Chamber Storage + Stone Storage = 2,384.3 cf = 0.055 af

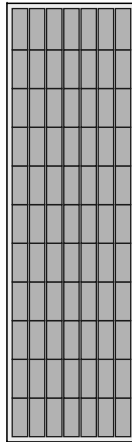
Overall Storage Efficiency = 55.0%

Overall System Size = 85.00' x 25.00' x 2.04'

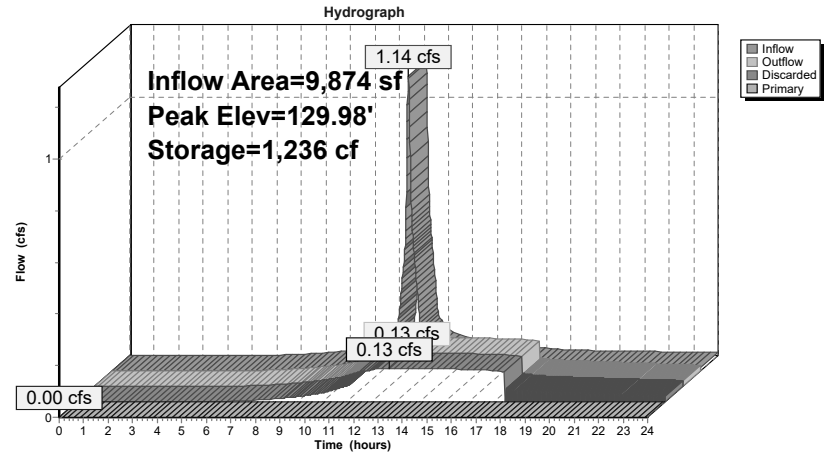
77 Chambers

160.7 cy Field

120.6 cy Stone



**Pond 5P: Haggetts S Infil**



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Type III 24-hr 100-Year Rainfall=7.84"

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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

**Subcatchment 1S: Ex. High Plain CB** 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

**Subcatchment 2S: High Plain Prkg** Runoff Area=6,993 sf 100.00% Impervious Runoff Depth>7.59"  
Tc=6.0 min CN=98 Runoff=1.24 cfs 4,426 cf

**Subcatchment 3S: Haggetts Pond CB** Runoff Area=8,688 sf 56.05% Impervious Runoff Depth>4.66"  
Tc=6.0 min CN=73 Runoff=1.09 cfs 3,376 cf

**Subcatchment 4S: Haggetts Pond S Prkg** Runoff Area=9,874 sf 69.16% Impervious Runoff Depth>6.05"  
Tc=6.0 min CN=85 Runoff=1.55 cfs 4,981 cf

**Reach 1R: Offsite East at High Plain Rd** Inflow=1.74 cfs 4,413 cf  
Outflow=1.74 cfs 4,413 cf

**Reach 2R: Offsite East at Haggetts Pond Rd** Inflow=0.93 cfs 1,855 cf  
Outflow=0.93 cfs 1,855 cf

**Pond 1P: Rain Garden #1** Peak Elev=131.84' Storage=982 cf Inflow=1.70 cfs 5,861 cf  
Discarded=0.32 cfs 4,187 cf Primary=1.24 cfs 1,416 cf Outflow=1.56 cfs 5,603 cf

**Pond 2P: High Plain storage** Peak Elev=133.16' Storage=763 cf Inflow=1.24 cfs 4,426 cf  
6.0" Round Culvert n=0.013 L=18.0' S=0.0139 '/' Outflow=0.60 cfs 4,402 cf

**Pond 3P: Bio-Ret #2** Peak Elev=132.12' Storage=170 cf Inflow=0.60 cfs 4,402 cf  
Discarded=0.02 cfs 1,319 cf Primary=0.58 cfs 2,997 cf Outflow=0.60 cfs 4,316 cf

**Pond 4P: Bio-Ret #3** Peak Elev=125.32' Storage=605 cf Inflow=1.09 cfs 3,774 cf  
Discarded=0.06 cfs 1,836 cf Primary=0.93 cfs 1,855 cf Outflow=0.99 cfs 3,691 cf

**Pond 5P: Haggetts S Infil** Peak Elev=130.23' Storage=1,624 cf Inflow=1.55 cfs 4,981 cf  
Discarded=0.13 cfs 4,583 cf Primary=0.32 cfs 398 cf Outflow=0.45 cfs 4,981 cf

**Total Runoff Area = 35,274 sf Runoff Volume = 18,643 cf Average Runoff Depth = 6.34"**  
**25.60% Pervious = 9,029 sf 74.40% Impervious = 26,245 sf**

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Type III 24-hr 100-Year Rainfall=7.84"

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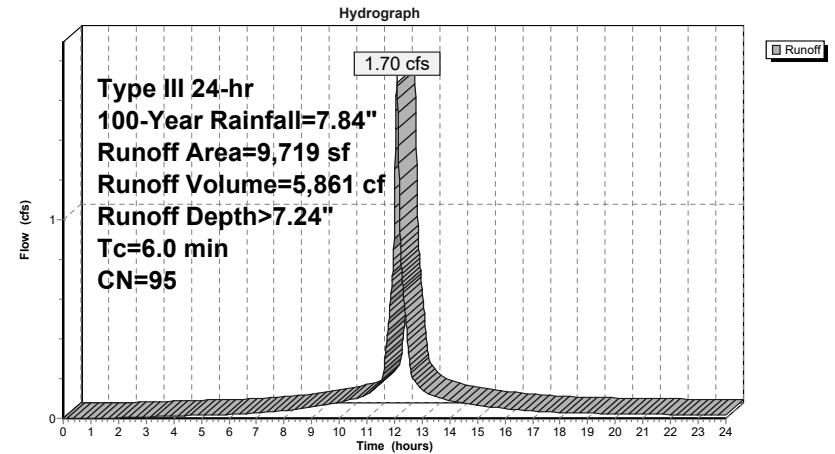
**Summary for Subcatchment 1S: Ex. High Plain CB**

Runoff = 1.70 cfs @ 12.08 hrs, Volume= 5,861 cf, Depth> 7.24"  
Routed to Pond 1P : Rain Garden #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
	2,166	86	<50% Grass cover, Poor, HSG C
*	6,885	98	Ex. paved parking, HSG C
*	668	98	New 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: Ex. High Plain CB**

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Type III 24-hr 100-Year Rainfall=7.84"

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**Summary for Subcatchment 2S: High Plain Prkg**

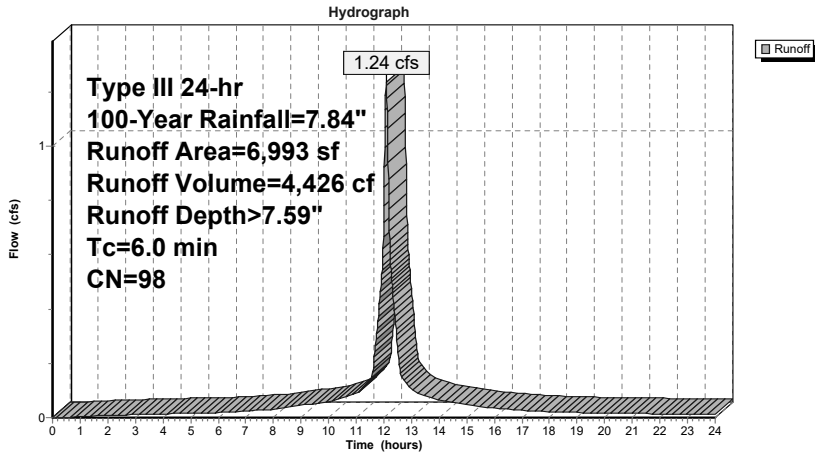
Runoff = 1.24 cfs @ 12.08 hrs, Volume= 4,426 cf, Depth> 7.59"  
Routed to Pond 2P : High Plain storage

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
* 5,445	98	New paved parking, HSG C
* 1,548	98	New paved parking, HSG A
6,993	98	Weighted Average
6,993		100.00% Impervious Area

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

**Subcatchment 2S: High Plain Prkg**



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Type III 24-hr 100-Year Rainfall=7.84"

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**Summary for Subcatchment 3S: Haggetts Pond CB**

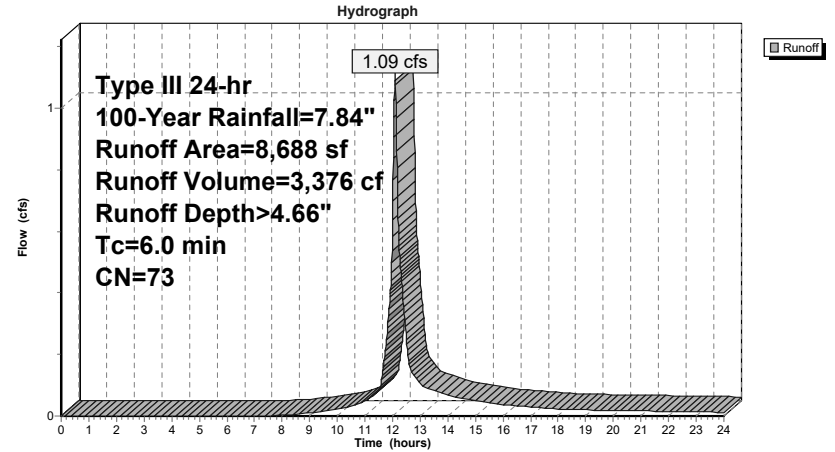
Runoff = 1.09 cfs @ 12.09 hrs, Volume= 3,376 cf, Depth> 4.66"  
Routed to Pond 4P : Bio-Ret #3

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
* 632	98	New paved parking, HSG A
* 4,238	98	Ex. paved parking, HSG A
925	68	<50% Grass cover, Poor, HSG A
1,043	39	>75% Grass cover, Good, HSG A
1,850	30	Woods, Good, HSG A
8,688	73	Weighted Average
3,818		43.95% Pervious Area
4,870		56.05% Impervious Area

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

**Subcatchment 3S: Haggetts Pond CB**



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Type III 24-hr 100-Year Rainfall=7.84"

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**Summary for Subcatchment 4S: Haggetts Pond S Prkg**

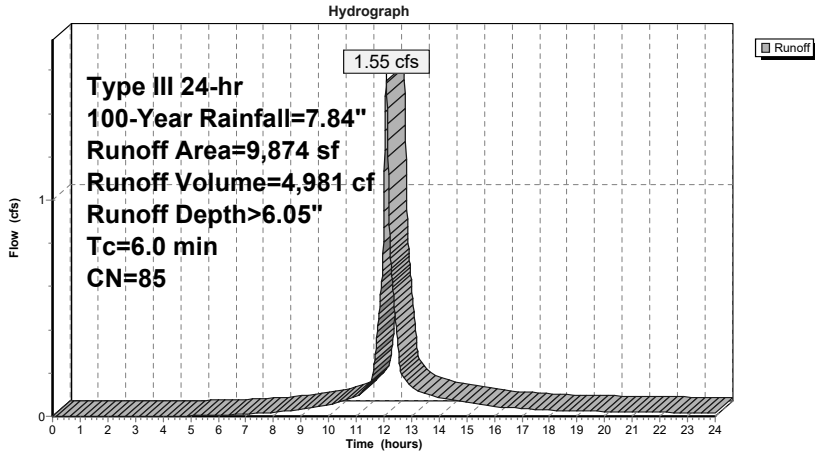
Runoff = 1.55 cfs @ 12.09 hrs, Volume= 4,981 cf, Depth> 6.05"  
Routed to Pond 5P : Haggetts S Infil

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
* 6,829	98	New paved parking, HSG A
2,002	68	<50% Grass cover, Poor, HSG A
1,043	30	Woods, Good, HSG A
9,874	85	Weighted Average
3,045		30.84% Pervious Area
6,829		69.16% Impervious Area

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

**Subcatchment 4S: Haggetts Pond S Prkg**



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Type III 24-hr 100-Year Rainfall=7.84"

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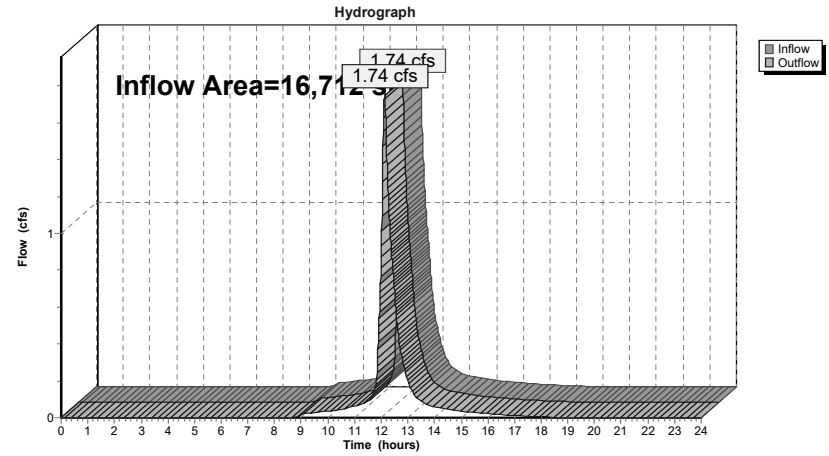
**Summary for Reach 1R: Offsite East at High Plain Rd**

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

Inflow Area = 16,712 sf, 87.04% Impervious, Inflow Depth = 3.17" for 100-Year event  
Inflow = 1.74 cfs @ 12.13 hrs, Volume= 4,413 cf  
Outflow = 1.74 cfs @ 12.13 hrs, Volume= 4,413 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**



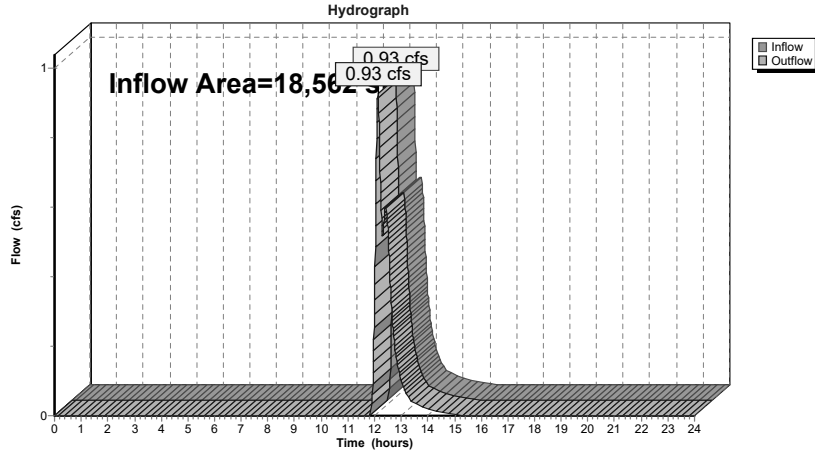
**Summary for Reach 2R: Offsite East at Haggets Pond Rd**

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

Inflow Area = 18,562 sf, 63.03% Impervious, Inflow Depth = 1.20" for 100-Year event  
 Inflow = 0.93 cfs @ 12.13 hrs, Volume= 1,855 cf  
 Outflow = 0.93 cfs @ 12.13 hrs, Volume= 1,855 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: Rain Garden #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 = 1.56 cfs @ 12.12 hrs, Volume= 5,603 cf, Atten= 8%, Lag= 2.1 min  
 Discarded = 0.32 cfs @ 12.12 hrs, Volume= 4,187 cf  
 Primary = 1.24 cfs @ 12.12 hrs, Volume= 1,416 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= 131.84' @ 12.12 hrs Surf.Area= 1,451 sf Storage= 982 cf

Plug-Flow detention time= 64.7 min calculated for 5,601 cf (96% of inflow)  
 Center-of-Mass det. time= 38.9 min ( 795.9 - 756.9 )

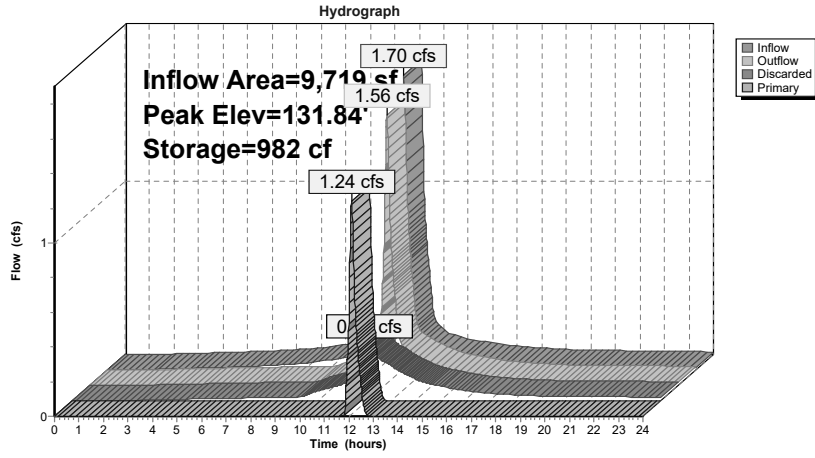
Volume	Invert	Avail.Storage	Storage Description			
#1	129.00'	1,234 cf	<b>Custom Stage Data (Irregular)</b> Listed below (Recalc)			
Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)	
129.00	5	5.0	0	0	5	
130.00	174	57.4	69	69	267	
131.00	301	70.0	235	304	410	
132.00	1,761	305.1	930	1,234	7,430	

Device	Routing	Invert	Outlet Devices											
#1	Primary	131.65'	<b>6.0' long x 3.0' breadth Broad-Crested Rectangular Weir</b>											
			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	129.00'	<b>2.410 in/hr Exfiltration over Wetted area</b>											

**Discarded OutFlow** Max=0.32 cfs @ 12.12 hrs HW=131.84' (Free Discharge)  
 ↳2=Exfiltration (Exfiltration Controls 0.32 cfs)

**Primary OutFlow** Max=1.24 cfs @ 12.12 hrs HW=131.84' TW=0.00' (Dynamic Tailwater)  
 ↳1=Broad-Crested Rectangular Weir (Weir Controls 1.24 cfs @ 1.07 fps)

**Pond 1P: Rain Garden #1**



**Summary for Pond 2P: High Plain storage**

Inflow Area = 6,993 sf, 100.00% Impervious, Inflow Depth > 7.59" for 100-Year event  
 Inflow = 1.24 cfs @ 12.08 hrs, Volume= 4,426 cf  
 Outflow = 0.60 cfs @ 12.23 hrs, Volume= 4,402 cf, Atten= 51%, Lag= 8.7 min  
 Primary = 0.60 cfs @ 12.23 hrs, Volume= 4,402 cf  
 Routed to Pond 3P : Bio-Ret #2

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs  
 Peak Elev= 133.16' @ 12.23 hrs Surf.Area= 596 sf Storage= 763 cf  
 Flood Elev= 133.25' Storage= 801 cf

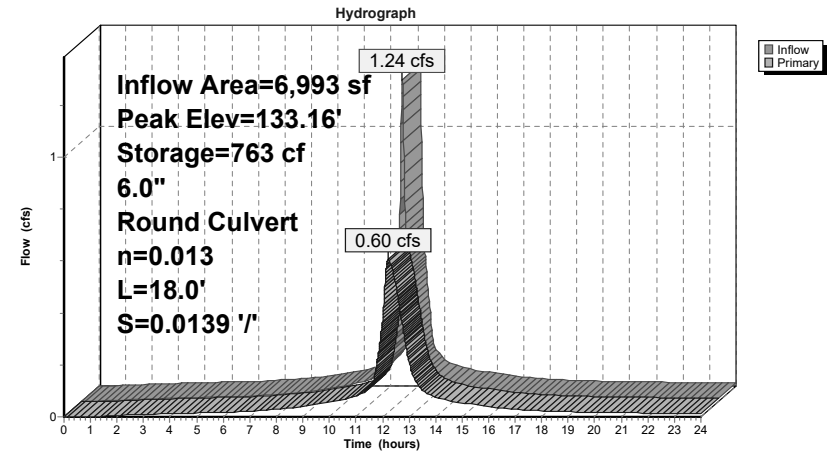
Plug-Flow detention time= 22.9 min calculated for 4,400 cf (99% of inflow)  
 Center-of-Mass det. time= 19.2 min ( 760.1 - 740.9 )

Volume	Invert	Avail.Storage	Storage Description
#1	132.25'	801 cf	<b>12.0" Round Pipe Storage x 12</b> L= 85.0'

Device	Routing	Invert	Outlet Devices
#1	Primary	132.25'	<b>6.0" Round Culvert</b> L= 18.0' CPP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 132.25' / 132.00' S= 0.0139 '/ Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.20 sf

**Primary OutFlow** Max=0.60 cfs @ 12.23 hrs HW=133.16' TW=132.12' (Dynamic Tailwater)  
 1=Culvert (Inlet Controls 0.60 cfs @ 3.08 fps)

**Pond 2P: High Plain storage**



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Type III 24-hr 100-Year Rainfall=7.84"

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**Summary for Pond 3P: Bio-Ret #2**

Inflow Area = 6,993 sf, 100.00% Impervious, Inflow Depth > 7.55" for 100-Year event  
 Inflow = 0.60 cfs @ 12.23 hrs, Volume= 4,402 cf  
 Outflow = 0.60 cfs @ 12.24 hrs, Volume= 4,316 cf, Atten= 0%, Lag= 0.9 min  
 Discarded = 0.02 cfs @ 12.24 hrs, Volume= 1,319 cf  
 Primary = 0.58 cfs @ 12.24 hrs, Volume= 2,997 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= 132.12' @ 12.24 hrs Surf.Area= 347 sf Storage= 170 cf

Plug-Flow detention time= (not calculated: outflow precedes inflow)  
 Center-of-Mass det. time= 17.0 min ( 777.1 - 760.1 )

Volume	Invert	Avail.Storage	Storage Description
#1	131.50'	323 cf	<b>Custom Stage Data (Irregular)</b> Listed below (Recalc)
Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet) Cum.Store (cubic-feet) Wet.Area (sq-ft)
131.50	212	100.7	0 0 212
132.00	316	107.0	131 131 328
132.50	456	115.1	192 323 482

Device	Routing	Invert	Outlet Devices
#1	Primary	132.00'	<b>6.0' long x 4.0' breadth Broad-Crested Rectangular Weir</b> 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	131.50'	<b>2.410 in/hr Exfiltration over Wetted area</b>

**Discarded OutFlow** Max=0.02 cfs @ 12.24 hrs HW=132.12' (Free Discharge)  
 ↳2=Exfiltration (Exfiltration Controls 0.02 cfs)

**Primary OutFlow** Max=0.58 cfs @ 12.24 hrs HW=132.12' TW=0.00' (Dynamic Tailwater)  
 ↳1=Broad-Crested Rectangular Weir (Weir Controls 0.58 cfs @ 0.82 fps)

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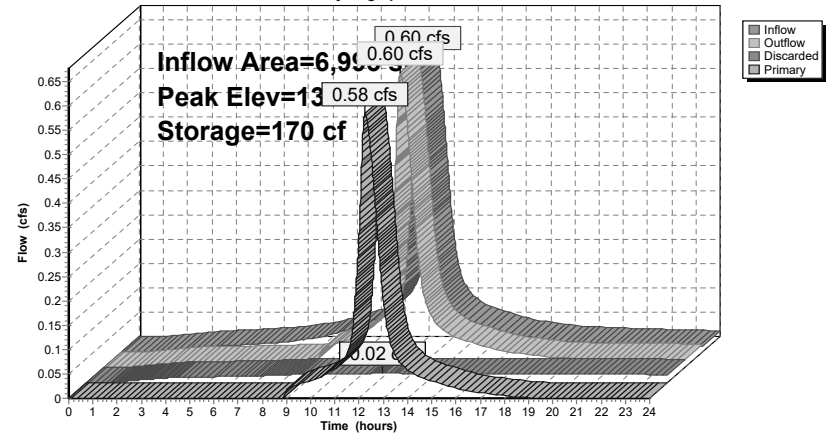
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Type III 24-hr 100-Year Rainfall=7.84"

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**Pond 3P: Bio-Ret #2**

Hydrograph



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Type III 24-hr 100-Year Rainfall=7.84"

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**Summary for Pond 4P: Bio-Ret #3**

Inflow Area = 18,562 sf, 63.03% Impervious, Inflow Depth > 2.44" for 100-Year event  
 Inflow = 1.09 cfs @ 12.09 hrs, Volume= 3,774 cf  
 Outflow = 0.99 cfs @ 12.13 hrs, Volume= 3,691 cf, Atten= 10%, Lag= 2.3 min  
 Discarded = 0.06 cfs @ 12.13 hrs, Volume= 1,836 cf  
 Primary = 0.93 cfs @ 12.13 hrs, Volume= 1,855 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= 125.32' @ 12.13 hrs Surf.Area= 670 sf Storage= 605 cf

Plug-Flow detention time= 58.7 min calculated for 3,691 cf (98% of inflow)  
 Center-of-Mass det. time= 45.7 min ( 857.4 - 811.7 )

Volume #1	Invert	Avail.Storage	Storage Description		
	123.00'	728 cf	<b>Custom Stage Data (Irregular)</b> Listed below (Recalc)		
Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
123.00	5	5.0	0	0	5
124.00	150	52.3	61	61	223
125.00	582	107.3	342	403	926
125.50	720	115.8	325	728	1,087

Device	Routing	Invert	Outlet Devices
#1	Primary	125.00'	<b>2.0' long x 3.0' breadth Broad-Crested Rectangular Weir</b> 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	123.00'	<b>2.410 in/hr Exfiltration over Wetted area</b>

**Discarded OutFlow** Max=0.06 cfs @ 12.13 hrs HW=125.32' (Free Discharge)  
 ↳2=Exfiltration (Exfiltration Controls 0.06 cfs)

**Primary OutFlow** Max=0.93 cfs @ 12.13 hrs HW=125.32' TW=0.00' (Dynamic Tailwater)  
 ↳1=Broad-Crested Rectangular Weir (Weir Controls 0.93 cfs @ 1.44 fps)

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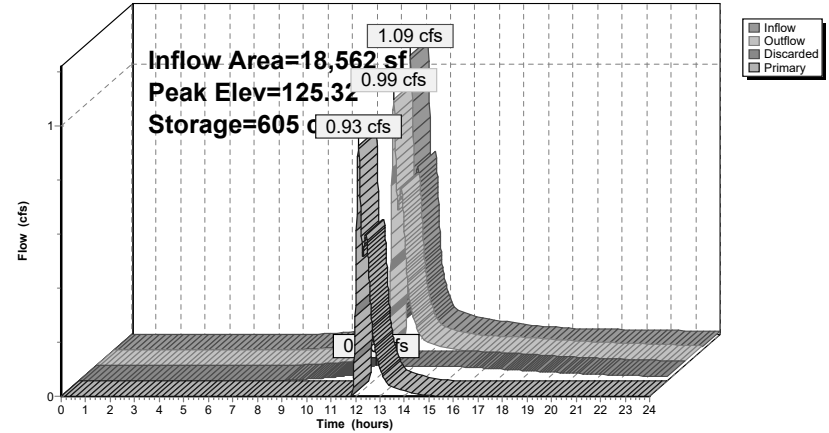
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Type III 24-hr 100-Year Rainfall=7.84"

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**Pond 4P: Bio-Ret #3**

Hydrograph



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Type III 24-hr 100-Year Rainfall=7.84"

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**Summary for Pond 5P: Haggetts S Infill**

[87] Warning: Oscillations may require smaller dt or Finer Routing (severity=251)

Inflow Area = 9,874 sf, 69.16% Impervious, Inflow Depth > 6.05" for 100-Year event  
 Inflow = 1.55 cfs @ 12.09 hrs, Volume= 4,981 cf  
 Outflow = 0.45 cfs @ 12.42 hrs, Volume= 4,981 cf, Atten= 71%, Lag= 20.0 min  
 Discarded = 0.13 cfs @ 12.42 hrs, Volume= 4,583 cf  
 Primary = 0.32 cfs @ 12.42 hrs, Volume= 398 cf  
 Routed to Pond 4P : Bio-Ret #3

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs  
 Peak Elev= 130.23' @ 12.42 hrs Surf.Area= 2,125 sf Storage= 1,624 cf  
 Flood Elev= 131.08' Surf.Area= 2,125 sf Storage= 2,384 cf

Plug-Flow detention time= (not calculated: outflow precedes inflow)  
 Center-of-Mass det. time= 82.7 min ( 873.3 - 790.5 )

Volume	Invert	Avail.Storage	Storage Description
#1A	129.00'	1,303 cf	<b>25.00'W x 85.00'L x 2.04'H Field A</b> 4,339 cf Overall - 1,082 cf Embedded = 3,257 cf x 40.0% Voids
#2A	129.50'	1,082 cf	<b>Cultec C-100HD x 77</b> 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
		2,384 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Primary	130.15'	<b>4.0' long Sharp-Crested Rectangular Weir</b> 2 End Contraction(s)
#2	Discarded	129.00'	<b>2.410 in/hr Exfiltration over Wetted area</b>

**Discarded OutFlow** Max=0.13 cfs @ 12.42 hrs HW=130.23' (Free Discharge)  
 ↳ **2=Exfiltration** (Exfiltration Controls 0.13 cfs)

**Primary OutFlow** Max=0.32 cfs @ 12.42 hrs HW=130.23' TW=125.25' (Dynamic Tailwater)  
 ↳ **1=Sharp-Crested Rectangular Weir** (Weir Controls 0.32 cfs @ 0.95 fps)

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Type III 24-hr 100-Year Rainfall=7.84"

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**Pond 5P: Haggetts S Infill - 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

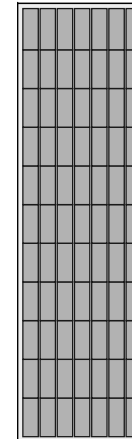
11 Chambers/Row x 7.50' Long +0.50' Row Adjustment = 83.00' Row Length +12.0" End Stone x 2 = 85.00' Base Length  
 7 Rows x 36.0" Wide + 4.0" Spacing x 6 + 12.0" Side Stone x 2 = 25.00' Base Width  
 6.0" Stone Base + 12.5" Chamber Height + 6.0" Stone Cover = 2.04' Field Height

77 Chambers x 14.0 cf +0.50' Row Adjustment x 1.86 sf x 7 Rows = 1,081.5 cf Chamber Storage

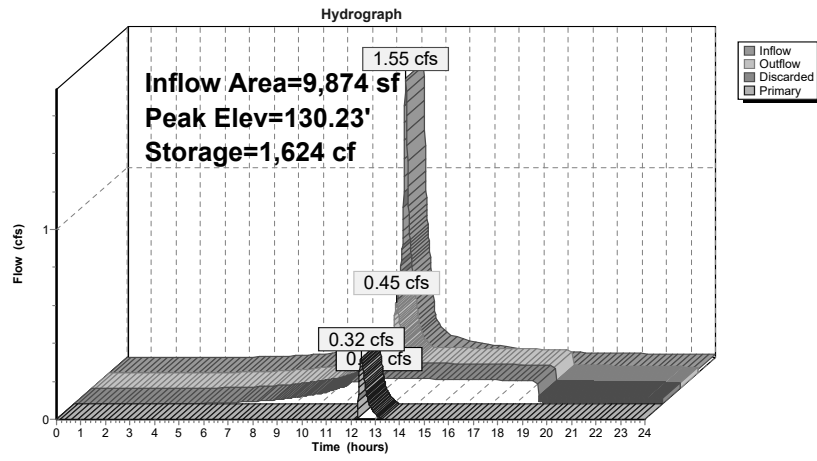
4,338.5 cf Field - 1,081.5 cf Chambers = 3,257.0 cf Stone x 40.0% Voids = 1,302.8 cf Stone Storage

Chamber Storage + Stone Storage = 2,384.3 cf = 0.055 af  
 Overall Storage Efficiency = 55.0%  
 Overall System Size = 85.00' x 25.00' x 2.04'

77 Chambers  
 160.7 cy Field  
 120.6 cy Stone



**Pond 5P: Haggetts S Infil**



## **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

6.05 OUTLET PROTECTION SIZING

**6.01 GROUNDWATER RECHARGE STORAGE TABLES**

**8998501-POST**

Type III 24-hr 2-Year Rainfall=3.14"

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**Stage-Area-Storage for Pond 3P: Bio-Ret #2**

Elevation (feet)	Surface (sq-ft)	Wetted (sq-ft)	Storage (cubic-feet)
131.50	212	212	0
131.52	216	217	4
131.54	220	221	9
131.56	223	226	13
131.58	227	230	18
131.60	231	235	22
131.62	235	239	27
131.64	239	244	32
131.66	243	248	36
131.68	247	253	41
131.70	251	258	46
131.72	255	262	51
131.74	259	267	56
131.76	263	272	62
131.78	268	276	67
131.80	272	281	72
131.82	276	286	78
131.84	280	290	83
131.86	285	295	89
131.88	289	300	95
131.90	294	305	101
131.92	298	309	107
131.94	302	314	113
131.96	307	319	119
131.98	311	324	125
132.00	316	328	131
132.02	321	334	138
132.04	326	340	144
132.06	331	346	151
132.08	337	352	157
132.10	342	358	164
132.12	347	364	171
132.14	353	370	178
132.16	358	376	185
132.18	363	382	192
132.20	369	388	200
132.22	374	395	207
132.24	380	401	215
132.26	386	407	222
132.28	391	413	230
132.30	397	419	238
132.32	403	425	246
132.34	408	432	254
132.36	414	438	262
132.38	420	444	271
132.40	426	450	279
132.42	432	457	288
132.44	438	463	296
132.46	444	469	305
132.48	450	476	314
132.50	<b>456</b>	<b>482</b>	<b>323</b>

**8998501-POST**

Type III 24-hr 2-Year Rainfall=3.14"

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**Stage-Area-Storage for Pond 4P: Bio-Ret #3**

Elevation (feet)	Surface (sq-ft)	Wetted (sq-ft)	Storage (cubic-feet)
123.00	5	5	0
123.05	7	7	0
123.10	10	11	1
123.15	14	15	1
123.20	18	20	2
123.25	22	26	3
123.30	27	33	4
123.35	33	40	6
123.40	39	49	8
123.45	45	58	10
123.50	52	69	12
123.55	60	80	15
123.60	68	92	18
123.65	76	106	22
123.70	85	120	26
123.75	95	135	30
123.80	105	150	35
123.85	115	167	41
123.90	126	185	47
123.95	138	203	54
124.00	150	223	61
124.05	165	246	69
124.10	181	271	77
124.15	197	297	87
124.20	214	324	97
124.25	232	353	108
124.30	250	383	120
124.35	269	414	133
124.40	289	446	147
124.45	309	479	162
124.50	331	514	178
124.55	353	549	195
124.60	375	586	213
124.65	399	624	233
124.70	423	664	253
124.75	448	704	275
124.80	473	746	298
124.85	499	789	322
124.90	526	834	348
124.95	554	879	375
125.00	582	926	403
125.05	595	941	433
125.10	608	957	463
125.15	622	973	494
125.20	635	989	525
125.25	649	1,005	557
125.30	663	1,021	590
125.35	677	1,037	623
125.40	691	1,053	658
125.45	706	1,070	693
125.50	<b>720</b>	<b>1,087</b>	<b>728</b>

**8998501-POST**

Type III 24-hr 2-Year Rainfall=3.14"

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**Stage-Area-Storage for Pond 5P: Haggetts S Infil (continued)**

Elevation (feet)	Wetted (sq-ft)	Storage (cubic-feet)	Elevation (feet)	Wetted (sq-ft)	Storage (cubic-feet)
130.06	2,358	1,365	130.59	2,475	2,000
130.07	2,360	1,381	130.60	2,477	2,009
130.08	2,363	1,396	130.61	2,479	2,017
130.09	2,365	1,412	130.62	2,481	2,026
130.10	2,367	1,427	130.63	2,484	2,034
130.11	2,369	1,442	130.64	2,486	2,043
130.12	2,371	1,457	130.65	2,488	2,051
130.13	2,374	1,473	130.66	2,490	2,060
130.14	2,376	1,488	130.67	2,492	2,068
130.15	2,378	1,502	130.68	2,495	2,077
130.16	2,380	1,517	130.69	2,497	2,085
130.17	2,382	1,532	130.70	2,499	2,094
130.18	2,385	1,547	130.71	2,501	2,102
130.19	2,387	1,561	130.72	2,503	2,111
130.20	2,389	1,576	130.73	2,506	2,119
130.21	2,391	1,590	130.74	2,508	2,128
130.22	2,393	1,604	130.75	2,510	2,136
130.23	2,396	1,618	130.76	2,512	2,145
130.24	2,398	1,632	130.77	2,514	2,153
130.25	2,400	1,646	130.78	2,517	2,162
130.26	2,402	1,659	130.79	2,519	2,170
130.27	2,404	1,673	130.80	2,521	2,179
130.28	2,407	1,686	130.81	2,523	2,187
130.29	2,409	1,699	130.82	2,525	2,196
130.30	2,411	1,712	130.83	2,528	2,204
130.31	2,413	1,725	130.84	2,530	2,213
130.32	2,415	1,737	130.85	2,532	2,221
130.33	2,418	1,750	130.86	2,534	2,230
130.34	2,420	1,762	130.87	2,536	2,238
130.35	2,422	1,774	130.88	2,539	2,247
130.36	2,424	1,785	130.89	2,541	2,255
130.37	2,426	1,797	130.90	2,543	2,264
130.38	2,429	1,808	130.91	2,545	2,272
130.39	2,431	1,819	130.92	2,547	2,281
130.40	2,433	1,829	130.93	2,550	2,289
130.41	2,435	1,840	130.94	2,552	2,298
130.42	2,437	1,850	130.95	2,554	2,306
130.43	2,440	1,860	130.96	2,556	2,315
130.44	2,442	1,869	130.97	2,558	2,323
130.45	2,444	1,879	130.98	2,561	2,332
130.46	2,446	1,888	130.99	2,563	2,340
130.47	2,448	1,898	131.00	2,565	2,349
130.48	2,451	1,907	131.01	2,567	2,357
130.49	2,453	1,915	131.02	2,569	2,366
130.50	2,455	1,924	131.03	2,572	2,374
130.51	2,457	1,932	131.04	2,574	2,383
130.52	2,459	1,941	131.05	<b>2,574</b>	<b>2,384</b>
130.53	2,462	1,949	131.06	2,574	2,384
130.54	2,464	1,958	131.07	2,574	2,384
130.55	2,466	1,966	131.08	2,574	2,384
130.56	2,468	1,975			
130.57	2,470	1,983			
130.58	2,473	1,992			

## **6.02 WATER QUALITY FLOW RATE CALCULATIONS**

# Calculation Sheet



**Project No.** 8-9985.01  
**Subject** Proprietary WQV Sizing - 1  
**Location** Andover, MA

**Calc By** DMG  
**Date** 12/13/2032  
**Checked by** DPB  
**Date** 12/15/2023

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 (High Plain Rd Parking)**

For 1.0-inch Water Quality Depth Requirement

**Q = (qu)(A)(WQD)** **0.19** 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) 0.000251

WQD = water quality depth (in) 1

**STC 450i Maximum Water Quality Flow Rate = 0.40 cfs**

# Calculation Sheet



**Project No.** 8-9985.01  
**Subject** Proprietary WQV Sizing - 2  
**Location** Andover, MA

**Calc By** DMG  
**Date** 12/13/2032  
**Checked by** DPB  
**Date** 12/15/2023

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 (Existing Headwall west of High Plain parking)**

For 1.0-inch Water Quality Depth Requirement

**Q = (qu)(A)(WQD)** **0.09** 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) 0.000125

WQD = water quality depth (in) 1

**STC 450i Maximum Water Quality Flow Rate = 0.40 cfs**

# Calculation Sheet



**Project No.** 8-9985.01  
**Subject** Proprietary WQV Sizing - 3  
**Location** Andover, MA

**Calc By** DMG  
**Date** 12/13/2032  
**Checked by** DPB  
**Date** 12/15/2023

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-3 (Existing High Plain Rd CB)**

For 1.0-inch Water Quality Depth Requirement

**Q = (qu)(A)(WQD)** 0.20 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) 0.000271

WQD = water quality depth (in) 1

**STC 450i Maximum Water Quality Flow Rate = 0.40 cfs**

# Calculation Sheet



**Project No.** 8-9985.01  
**Subject** Proprietary WQV Sizing - 4  
**Location** Andover, MA

**Calc By** DMG  
**Date** 12/13/2023  
**Checked by** DPB  
**Date** 12/15/2023

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-4 (Haggetts Pond Parking)**

For 1.0-inch Water Quality Depth Requirement

**Q = (qu)(A)(WQD)** **0.18** 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) 0.000239

WQD = water quality depth (in) 1

**STC 450i Maximum Water Quality Flow Rate = 0.40 cfs**

# Calculation Sheet



**Project No.** 8-9985.01  
**Subject** Proprietary WQV Sizing - 5  
**Location** Andover, MA

**Calc By** DMG  
**Date** 12/13/2023  
**Checked by** DPB  
**Date** 12/15/2023

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-5 (Existing Haggetts Pond Rd CB)**

For 1.0-inch Water Quality Depth Requirement

**Q = (qu)(A)(WQD)** **0.13** 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) 0.000175

WQD = water quality depth (in) 1

**STC 450i Maximum Water Quality Flow Rate = 0.40 cfs**

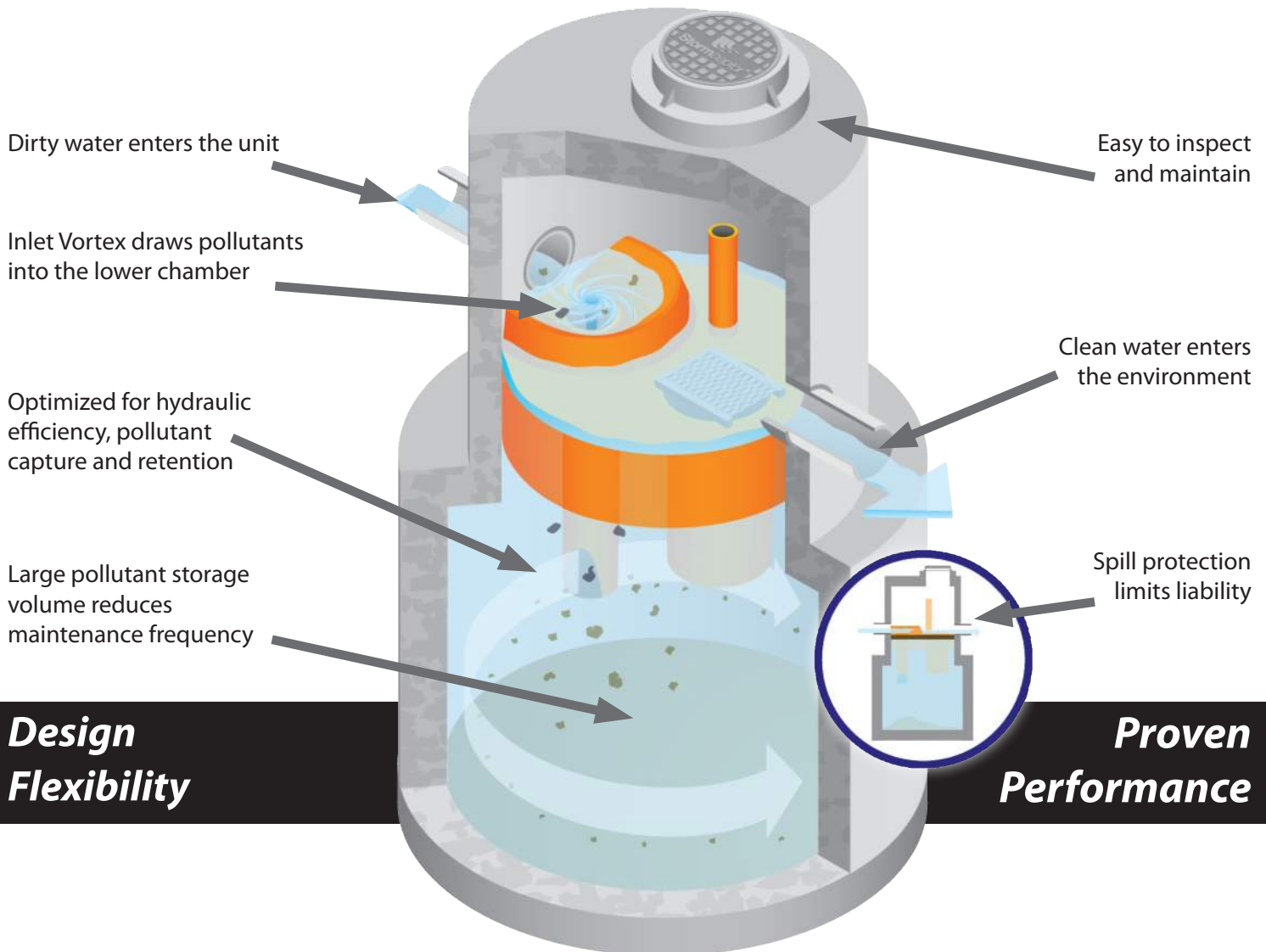
### **6.03 WATER QUALITY UNIT SIZING**



# Stormceptor®

## Stormwater Treatment Made Simple!

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



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



# 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 <sup>1</sup>	Water Quality Flow Rate Q <sup>2</sup>	Peak Conveyance Flow Rate <sup>3</sup>	Hydrocarbon Capacity <sup>4</sup>	Maximum Sediment Capacity <sup>4</sup>
	(ft)	(in)	(cfs)	(cfs)	(Gallons)	(ft <sup>3</sup> )
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

<sup>1</sup> 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.

<sup>2</sup> Water Quality Flow Rate (Q) is based on 80% annual average TSS removal of the OK110 particle size distribution.

<sup>3</sup> 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.

<sup>4</sup> Hydrocarbon & Sediment capacities can be modified to accommodate specific site design requirements, contact your local representative for assistance.

## **6.04 TSS REMOVAL CALCULATIONS**

# TSS Removal Calculation Worksheet

Location: Haggetts Pond, Andover, MA

Project: 89985.01



Prepared By: DMG

Date: 12/14/2023

**1S - Rain Garden w/deep sump hooded CB, WQU, and Forebay pretreatment**  
(Existing High Plain CB to Rain Garden #1)

**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)
Rain Garden	0.9	1	0.9	0.1

**TSS Removal = 0.90**

# TSS Removal Calculation Worksheet

Location: Haggetts Pond, Andover, MA

Project: 89985.01



Prepared By: DMG

Date: 12/14/2023

**2S - Bio-Retention w/ WQU CB and Forebay pretreatment**  
(High Plain parking lot CB to Bio-Ret #2)

**Total Impervious Area, Acres= 0.161**

A	B	C	D	E
BMP	TSS Removal Rate	Starting TSS Load*	Amount Removed (BxC)	Remaining Load (C-D)
Water Quality Unit	0.77	1	0.77	0.23
Bio-Retention Area	0.9	0.23	0.207	0.023

**TSS Removal = 0.98**

# TSS Removal Calculation Worksheet

Location: Haggetts Pond, Andover, MA

Project: 89985.01



Prepared By: DMG

Date: 12/14/2023

**3S - Bio-Retention w/ WQU CB and forebay pretreatment in an ORW**  
 (Existing Haggetts Pond Rd CB to Bio-Ret #3)

**Total Impervious Area, Acres= 0.042**

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

**TSS Removal = 0.90**

# TSS Removal Calculation Worksheet

Location: Haggetts Pond, Andover, MA

Project: 89985.01



Prepared By: DMG

Date: 12/14/2023

**4S - Subsurface Infiltration w/ WQU pretreatment in an ORW**  
 (Haggetts Pond parking lot CB to subsurface infiltration)

**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)
Water Quality Unit	0.77	1	0.77	0.23

**TSS Pretreatment = 0.77 (44% min)**

Subsurface Infiltration	0.8	1	0.8	0.2

**TSS Removal = 0.80**

## **6.05 OUTLET PROTECTION SIZING**

# OUTLET PROTECTION SIZING



**Project No.** 8-9985.01  
**Subject** Haggetts Pond Rail Trail  
**Location** Andover, MA

**Calc By** DMG  
**Date** 12/21/2023  
**Checked by** DPB  
**Date** 12/21/23

**FES-1** (into Rain Garden #1)

Q=Design Discharge, (ft<sup>3</sup>/s) = 1.05 cfs  
 D=Culvert Diameter, (ft) = 1.00 ft  
 TW=Tailwater Depth, (ft) = 0.4 ft, (0.4xD for unknow tailwater, or enter known tailwater)  
 (Tailwater depth is to be limited to between 0.4D and 1.0D)

**Riprap Rock Sizing**

$$D_{50} = 0.2D \left[ \frac{Q}{\sqrt{gD^{2.5}}} \right]^{4/3} \left[ \frac{D}{TW} \right]$$

$$D_{50} = 0.2 \left[ \frac{1.05}{5.67} \right]^{4/3} \left[ \frac{1.00}{0.40} \right] = 0.05 \text{ ft}$$

$$= 1 \text{ inches}$$

g=32.2 fps  
D<sub>50</sub> = median rock size, ft

**Table 1 : Riprap Classes and Apron Dimensions**

Class	D <sub>50</sub> (in)	Apron Length	Apron Depth
1	5	4D	3.5D <sub>50</sub>
2	6	4D	3.5D <sub>50</sub>
3	10	5D	3.3D <sub>50</sub>
4	14	6D	2.2D <sub>50</sub>
5	20	7D	2.0D <sub>50</sub>
6	22	8D	2.0D <sub>50</sub>

**Use Class 1**

**Apron Dimensions**

Length, L=4D = 4 ft  
 Depth=3.5D<sub>50</sub> = 2.21 Inches  
 Width=3D+(2/3)L = 5.67 ft (at apron end)

**Riprap Rock Sizing Gradation**

% of Weight Smaller than Given Size	Size of Stone, inches
100	1 to 1
85	1 to 1
50	1 to 1
15	1 to 0

# OUTLET PROTECTION SIZING



**Project No.** 8-9985.01  
**Subject** Haggetts Pond Rail Trail  
**Location** Andover, MA

**Calc By** DMG  
**Date** 12/21/2023  
**Checked by** DPB  
**Date** 12/21/23

## FES-2 (out of Rain Garden #1)

Q=Design Discharge, (ft<sup>3</sup>/s) = 0.69 cfs  
 D=Culvert Diameter, (ft) = 1.00 ft  
 TW=Tailwater Depth, (ft) = 0.4 ft, (0.4xD for unknow tailwater, or enter known tailwater)  
 (Tailwater depth is to be limited to between 0.4D and 1.0D)

**Riprap Rock Sizing**

$$D_{50} = 0.2D \left[ \frac{Q}{\sqrt{gD^{2.5}}} \right]^{4/3} \left[ \frac{D}{TW} \right]$$

$$D_{50} = 0.2 \left| \frac{0.69}{5.67} \right|^{(4/3)} \left| \frac{1.00}{0.40} \right| = 0.03 \text{ ft}$$

$$= 1 \text{ inches}$$

g=32.2 fps  
D<sub>50</sub> = median rock size, ft

**Table 1 : Riprap Classes and Apron Dimensions**

Class	D <sub>50</sub> (in)	Apron Length	Apron Depth
1	5	4D	3.5D <sub>50</sub>
2	6	4D	3.5D <sub>50</sub>
3	10	5D	3.3D <sub>50</sub>
4	14	6D	2.2D <sub>50</sub>
5	20	7D	2.0D <sub>50</sub>
6	22	8D	2.0D <sub>50</sub>

**Use Class 1**

**Apron Dimensions**

Length, L=4D = 4 ft  
 Depth=3.5D<sub>50</sub> = 3.50 Inches  
 Width=3D+(2/3)L = 5.67 ft (at apron end)

**Riprap Rock Sizing Gradation**

% of Weight Smaller than Given Size	Size of Stone, inches
100	2 to 2
85	1 to 2
50	1 to 2
15	1 to 1

# OUTLET PROTECTION SIZING



**Project No.** 8-9985.01  
**Subject** Haggetts Pond Rail Trail  
**Location** Andover, MA

**Calc By** DMG  
**Date** 12/21/2023  
**Checked by** DPB  
**Date** 12/21/23

**FES-3** (into Bio-Retention Area #2)

Q=Design Discharge, (ft<sup>3</sup>/s) = 0.37 cfs  
 D=Culvert Diameter, (ft) = 1.00 ft  
 TW=Tailwater Depth, (ft) = 0.4 ft, (0.4xD for unknown tailwater, or enter known tailwater)  
 (Tailwater depth is to be limited to between 0.4D and 1.0D)

**Riprap Rock Sizing**

$$D_{50} = 0.2D \left[ \frac{Q}{\sqrt{gD^{2.5}}} \right]^{4/3} \left[ \frac{D}{TW} \right]$$

$$D_{50} = 0.2 \left| \frac{0.37}{5.67} \right|^{(4/3)} \left| \frac{1.00}{0.40} \right| = 0.01 \text{ ft}$$

$$= 1 \text{ inches}$$

g=32.2 fps  
D<sub>50</sub> = median rock size, ft

**Table 1 : Riprap Classes and Apron Dimensions**

Class	D <sub>50</sub> (in)	Apron Length	Apron Depth
1	5	4D	3.5D <sub>50</sub>
2	6	4D	3.5D <sub>50</sub>
3	10	5D	3.3D <sub>50</sub>
4	14	6D	2.2D <sub>50</sub>
5	20	7D	2.0D <sub>50</sub>
6	22	8D	2.0D <sub>50</sub>

**Use Class 1**

**Apron Dimensions**

Length, L=4D = 4 ft  
 Depth=3.5D<sub>50</sub> = 3.50 Inches  
 Width=3D+(2/3)L = 5.67 ft (at apron end)

**Riprap Rock Sizing Gradation**

% of Weight Smaller than Given Size	Size of Stone, inches
100	2 to 2
85	1 to 2
50	1 to 2
15	1 to 1

# OUTLET PROTECTION SIZING



**Project No.** 8-9985.01  
**Subject** Haggetts Pond Rail Trail  
**Location** Andover, MA

**Calc By** DMG  
**Date** 12/21/2023  
**Checked by** DPB  
**Date** 12/21/23

**HWL** (existing headwall outlet into Bio-Retention Area #3)

Q=Design Discharge, (ft<sup>3</sup>/s) = 1.09 cfs  
 D=Culvert Diameter, (ft) = 1.00 ft  
 TW=Tailwater Depth, (ft) = 0.4 ft, (0.4xD for unknow tailwater, or enter known tailwater)  
 (Tailwater depth is to be limited to between 0.4D and 1.0D)

**Riprap Rock Sizing**

$$D_{50} = 0.2D \left[ \frac{Q}{\sqrt{gD^{2.5}}} \right]^{4/3} \left[ \frac{D}{TW} \right]$$

$$D_{50} = 0.2 \left[ \frac{1.09}{5.67} \right]^{4/3} \left[ \frac{1.00}{0.40} \right] = 0.06 \text{ ft} = 1 \text{ inches}$$

g=32.2 fps  
D<sub>50</sub> = median rock size, ft

**Table 1 : Riprap Classes and Apron Dimensions**

Class	D <sub>50</sub> (in)	Apron Length	Apron Depth
1	5	4D	3.5D <sub>50</sub>
2	6	4D	3.5D <sub>50</sub>
3	10	5D	3.3D <sub>50</sub>
4	14	6D	2.2D <sub>50</sub>
5	20	7D	2.0D <sub>50</sub>
6	22	8D	2.0D <sub>50</sub>

**Use Class 1**

**Apron Dimensions**

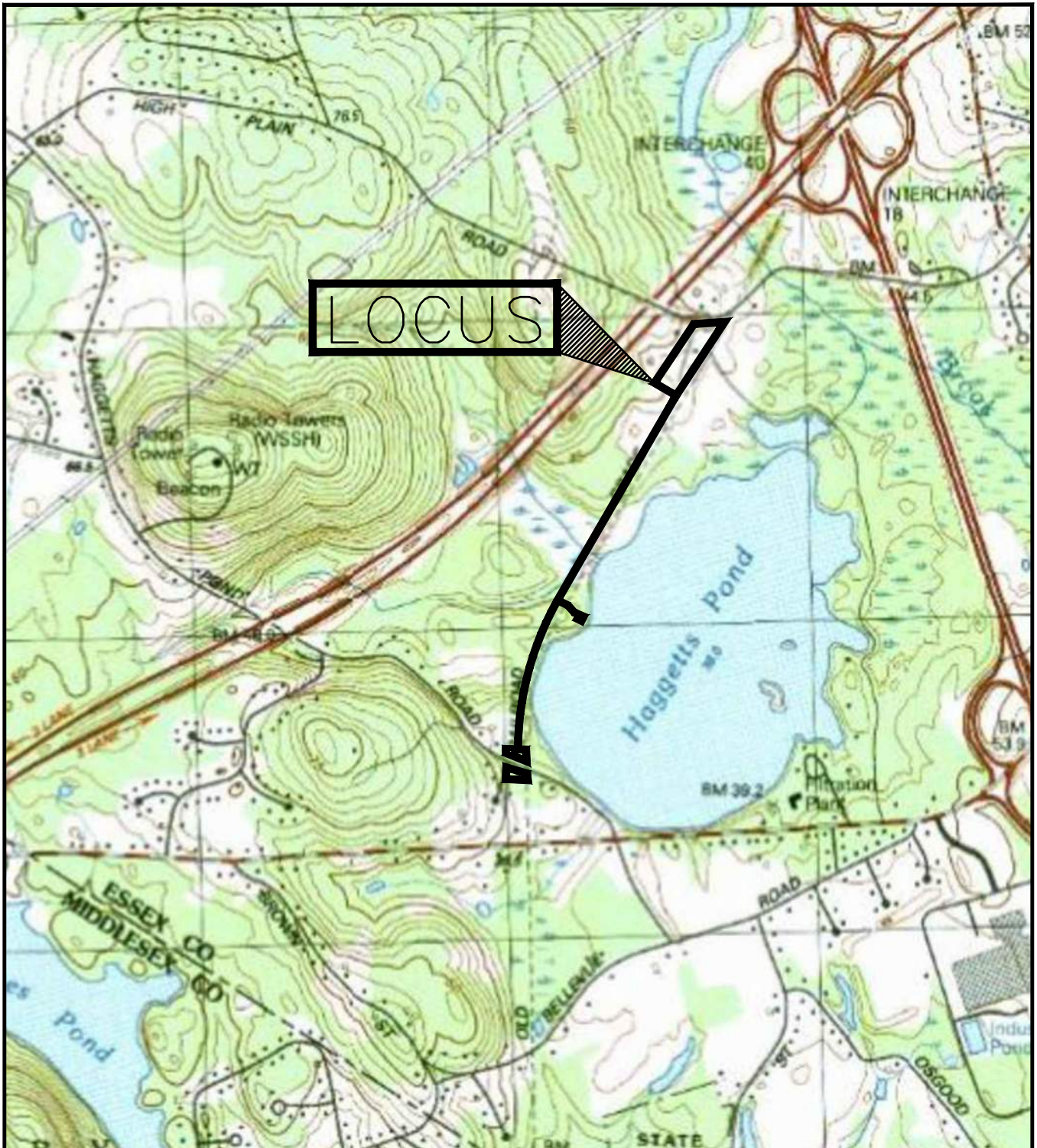
Length, L=4D = 4 ft  
 Depth=3.5D<sub>50</sub> = 2.33 inches  
 Width=3D+(2/3)L = 5.67 ft (at apron end)

**Riprap Rock Sizing Gradation**

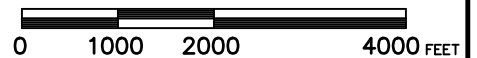
% of Weight Smaller than Given Size	Size of Stone, inches
100	1 to 1
85	1 to 1
50	1 to 1
15	1 to 0

## **APPENDICES**

**USGS LOCUS MAP**



SCALE: 1" = 2000'



PREPARED FOR:

TOWN OF ANDOVER  
ANDOVER, MA  
01810

HAGGETTS POND RAIL TRAIL  
USGS LOCUS MAP

5 CAMPANELLI DRIVE  
TOWN OF ANDOVER  
ANDOVER, MA  
01810



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

Job No.: 8-9985.01 Date: 09/18/2023  
Scale: 1"=2000' Revised: 12/21/23  
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, N/NGS12  
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.

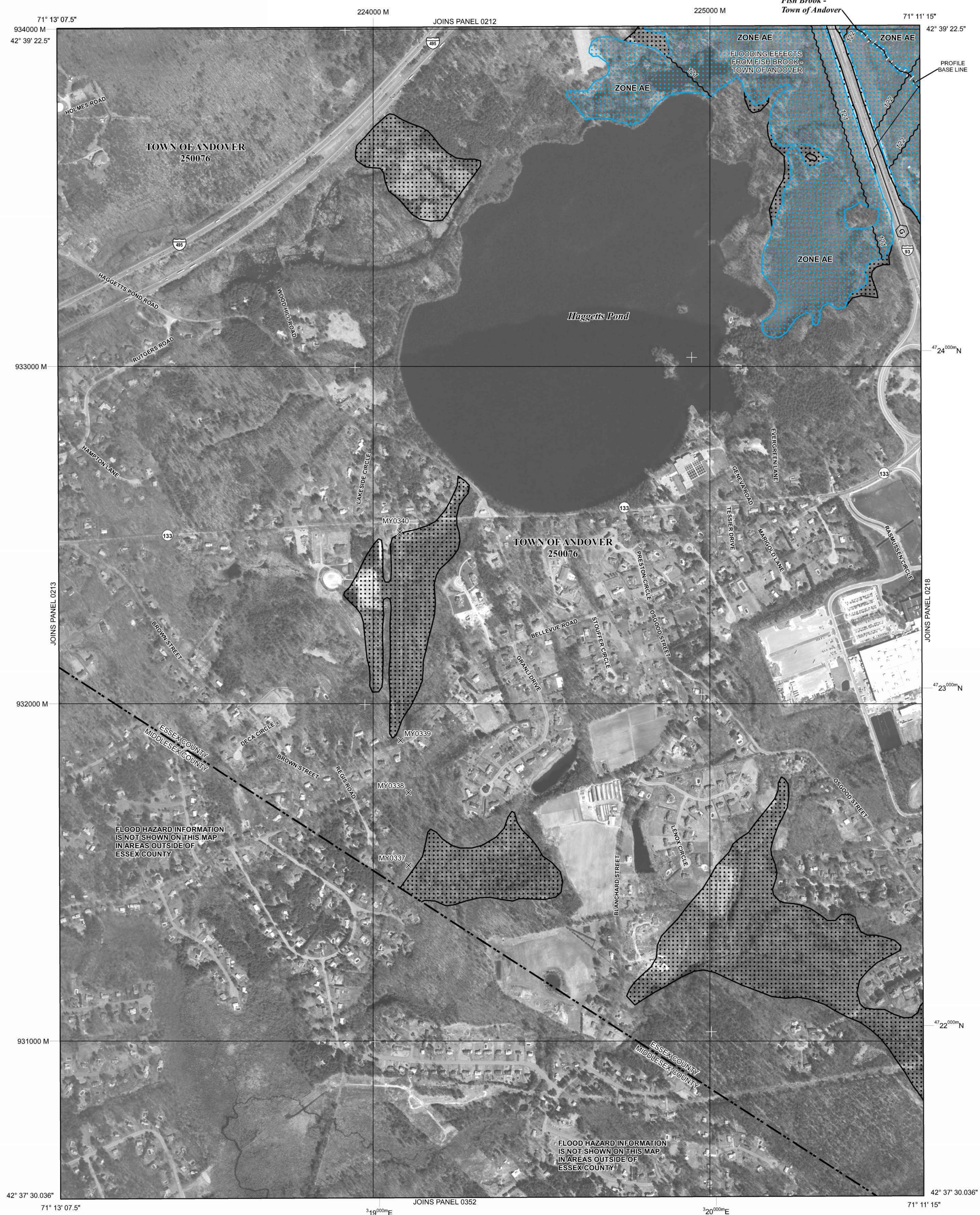
Based on updated topographic information, this map reflects more detailed and up-to-date **stream channel configurations** and floodplain delineations than those shown on the previous FIRM for this jurisdiction. As a result, the Flood Profiles and Floodway Data tables for multiple streams in the Flood 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.

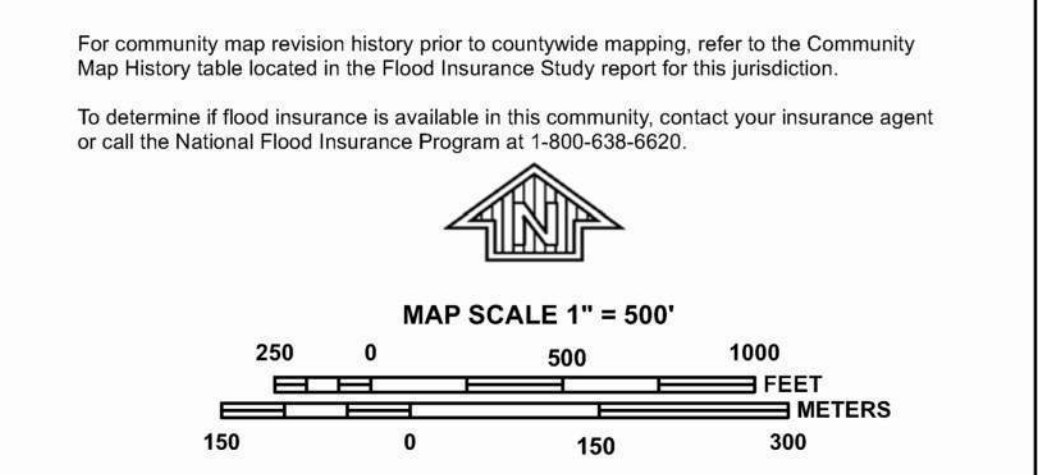
For information on available products associated with this FIRM visit the **Map Service Center (MSC)** website at <http://msc.fema.gov>. Available products may include previously issued Letters of Map Change, a Flood Insurance Study Report, and/or digital versions of this map. Many of these products 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 described. 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.
- Base Flood Elevation line and value; elevation in feet\* (EL 987)
- \*Referenced to the North American Vertical Datum of 1988
- Cross section line
- Transect line
- Culvert
- Bridge
- Geographic coordinates referenced to the North American Datum of 1983 (NAD 83) Western Hemisphere
- 1000-meter ticks; Massachusetts State Plane Mainland Zone (FIPS Zone 2001), Lambert Conformal Conic projection
- 1000-meter Universal Transverse Mercator grid values, zone 19N
- Bench mark (see explanation in Notes to Users section of this FIRM panel)
- 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.



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

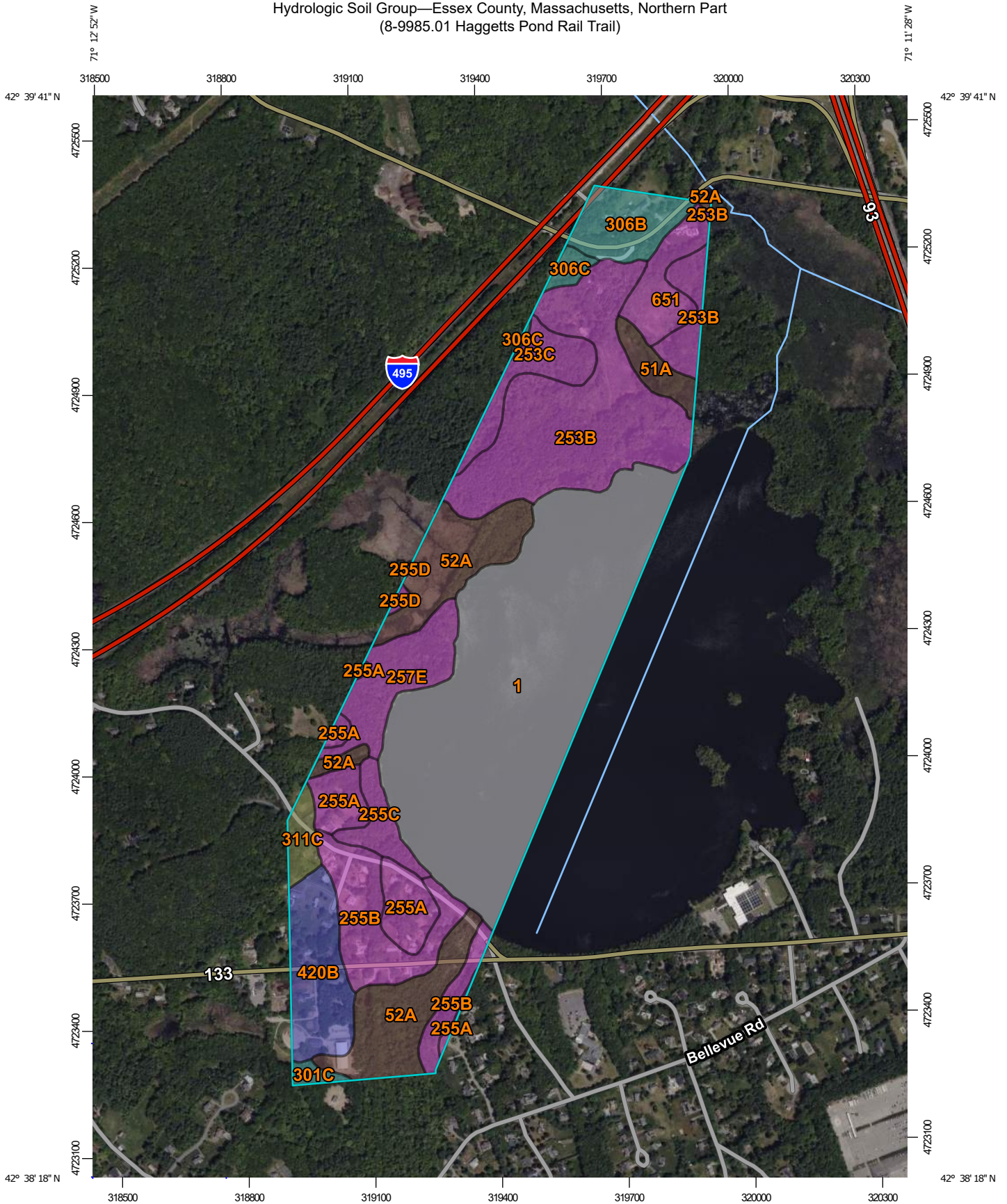
Notice to User: The **Map Number** shown below should be used when placing map orders; the **Community Number** shown above should be used on insurance applications for the subject community.

**MAP NUMBER**  
25009C0214F  
**EFFECTIVE DATE**  
JULY 3, 2012

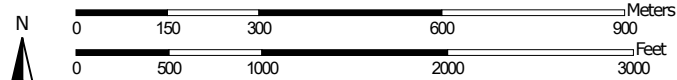
Federal Emergency Management Agency

## **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.




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%
<b>Totals for Area of Interest</b>			<b>254.1</b>	<b>100.0%</b>

## 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 1&2 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

Andover

City

MA

State

195-1

Map/Lot #

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:

7. Current Water Resource Conditions (USGS):

8/28/2022  
Month/Day/Year

Range:  Above Normal

Wetland Type

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



### 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      9/26/23      2:00PM      Mid 50s, cloudy      42.657893      -71.199380  
Hole #      Date      Time      Weather      Latitude      Longitude

1. Land Use Woodland/conservation area      Pines and deciduous. Grasses & shrubs at footslope      Few to none      0-5%  
(e.g., woodland, agricultural field, vacant lot, etc.)      Vegetation      Surface Stones (e.g., cobbles, stones, boulders, etc.)      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      shoulder  
Landform      Position on Landscape (SU, SH, BS, FS, TS, Plain)

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			Coarse Fragments % by Volume		Soil Structure	Soil Consistence (Moist)	Other
				Depth	Color	Percent	Gravel	Cobbles & Stones			
0-10	Ap	FS	10YR 7/3	-	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 : <del>7.5YR 5/8</del> Dpl: -	7-10%	5-10%	0-5%	g	l	-
56-60"	2C	Till	-	56	Cnc : <del>7.5YR 5/8</del> Dpl: -	10-15%	-	-	=	-	-
					Cnc : Dpl:						
					Cnc : Dpl:						

Additional Notes: Hole was originally 76' deep but water wept heavily into the hole & settled @ 60" from the top.



### 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      9/26/23      1:26 PM      Mid 50s, cloudy      42.657893      -71.199380  
Hole #      Date      Time      Weather      Latitude      Longitude

1. Land Use: Woodland/conservation area      Pines and deciduous. Grasses & shrubs at footslope      Few to none      0-5%  
(e.g., woodland, agricultural field, vacant lot, etc.)      Vegetation      Surface Stones (e.g., cobbles, stones, boulders, etc.)      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: COAR& deposits.      Shoulder  
Landform      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			Coarse Fragments % by Volume		Soil Structure	Soil Consistence (Moist)	Other
				Depth	Color	Percent	Gravel	Cobbles & Stones			
0-10"	Ao	S	10PR 3/3	-	Cnc : - Dpl: -	-	30-40%	0-5%	1	gr	
10-32"	Bw	S	10YR 5/6	-	Cnc : - Dpl: -	-	30-40%	10-15%	2	gr	
32-38"	C	FS	10YR 7/6	-	Cnc : - Dpl: -	-	0	0	2	gr	
38"	2C	Till	-	38"	Cnc : - Dpl: 10YR 6/2	25-30%	-	-	-	-	-
					Cnc : Dpl:						
					Cnc : Dpl:						

Additional Notes:



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

### D. Determination of High Groundwater Elevation

1. Method Used (Choose one):

Depth to soil redoximorphic features

Obs. Hole # TP-1

40 inches

Obs. Hole # TP-2

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 \_\_\_\_\_

$$S_h = S_c - [S_r \times (OW_c - OW_{max}) / OW_r]$$

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

Robert Feltes

Typed or Printed Name of Soil Evaluator / License #

9/26/2023

Date

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, Hoggetts



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

Andover

City

MA

State

196-14

Map/Lot #

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:

7. Current Water Resource Conditions (USGS): 8/28/2023  
Month/Day/ Year

Range:  Above Normal

Wetland Type

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



# 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 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: 70-80', off Haggett's Pond Road. Pit is off the main trail..

2. Soil Parent Material: Outwash Landform      outwash plain Landform      shoulder of railbed 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 3/6	-	Cnc : - Dpl: -	-	-	-	M	VFr	-
12-25"	Bw	MS	7.5YR 7/4	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	27"	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:



# 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 9:30 AM 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 Landform outwash plain Position on Landscape (SU, SH, BS, FS, TS, Plain) shoulder of rail trail

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			Coarse Fragments % by Volume		Soil Structure	Soil Consistence (Moist)	Other
				Depth	Color	Percent	Gravel	Cobbles & Stones			
0-17"	Ap	MS	7.5YR 5/2	-	Cnc : <u>—</u> Dpl: <u>—</u>	-	0-5%	-	g	l	—
17-27"	Bw	MS	10YR 6/4	-	Cnc : <u>—</u> Dpl: <u>—</u>	-	0-5%	-	g	l	—
27"-40"	C	FS	10YR 6/3	30"	Cnc : <u>10YR 6/3</u> Dpl: <u>—</u>	10-15%	0-5%	-	g	l	—
40"+	2C	-	—	-	Cnc : <u>—</u> Dpl: <u>—</u>	-	-	-	-	-	-
					Cnc : <u>—</u> Dpl: <u>—</u>						
					Cnc : <u>—</u> Dpl: <u>—</u>						

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.



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

## D. Determination of High Groundwater Elevation

1. Method Used (Choose one):

Depth to soil redoximorphic features

Obs. Hole # TP-3  
27 inches

Obs. Hole # TP-4  
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

Robert Feltes

Typed or Printed Name of Soil Evaluator / License #

9/26/2023

Date

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

197-11

Street Address

Map/Lot #

Andover

MA

01810

City

State

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:

7. Current Water Resource Conditions (USGS): 8/28/2023 Range:  Above Normal  Normal  Below Normal  
Month/Day/Year

8. Other references reviewed: Zone I, Zone II, IWPA, Zone A, are not within the project area.  
(Zone II, IWPA, Zone A, EEA Data Portal, etc.)

These were reviewed via MassMapper on 9/25/23



### 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      9/26/23      11:00 AM      Md 50s, Cloudy      42.637271      -71.206444  
Hole #      Date      Time      Weather      Latitude      Longitude

1. Land Use Woodland/conservation area      Pines and deciduous. Thick grasses & shrubs      Very few.      3-5%  
(e.g., woodland, agricultural field, vacant lot, etc.)      Vegetation      Surface Stones (e.g., cobbles, stones, boulders, etc.)      Slope (%)

Description of Location: 30' off Bellevue Road. Pit is off the main trail.

2. Soil Parent Material: Till/coarse deposits      -      Footslope of hill  
Landform      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			Coarse Fragments % by Volume		Soil Structure	Soil Consistence (Moist)	Other
				Depth	Color	Percent	Gravel	Cobbles & Stones			
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.



# 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      9/26/23      11:40 AM      Mid 50s, cloudy      42.637271      -71.206444  
Hole #      Date      Time      Weather      Latitude      Longitude

1. Land Use: Woodland/conservation area      Pines and deciduous. Thick      Few stones.      3-5%  
(e.g., woodland, agricultural field, vacant lot, etc.)      grasses & shrubs      Surface Stones (e.g., cobbles, stones, boulders, etc.)      Slope (%)

Description of Location: 50', off Haggett's Pond Road. Pit is off the main trail.

2. Soil Parent Material: Till/ Coarse Deposits.      -      Footslope of hill  
Landform      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 7100' 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			Coarse Fragments % by Volume		Soil Structure	Soil Consistence (Moist)	Other
				Depth	Color	Percent	Gravel	Cobbles & Stones			
0-12"	Ap	FS	10YR 5/3	-	Cnc : - Dpl: -	-	0-5%	0-5%	M	V Fr	-
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, most color in layer is grayed. Layer is extremely stony/dense.
24"+	Cr	Till	-	-	Cnc : - Dpl: -	-	-	-	-	-	
					Cnc : Dpl:						
					Cnc : Dpl:						
					Cnc : Dpl:						

Additional Notes: Large boulders on bottom & sides of pit.



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

## D. Determination of High Groundwater Elevation

1. Method Used (Choose one):

- Depth to soil redoximorphic features
- Depth to observed standing water in observation hole
- Depth to adjusted seasonal high groundwater ( $S_h$ ) (USGS methodology)

Obs. Hole # TP-5

N/A inches

Obs. Hole # TP-6

24 inches

\_\_\_\_\_ inches

\_\_\_\_\_ inches

\_\_\_\_\_ 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: \_\_\_\_\_

Lower boundary: \_\_\_\_\_

inches  
24"  
inches

inches  
\_\_\_\_\_  
inches

c. If no, at what depth was impervious material observed?

Upper boundary: \_\_\_\_\_

Lower boundary: \_\_\_\_\_

inches

inches



# 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

Robert Feltes

Typed or Printed Name of Soil Evaluator / License #

9/26/2023

Date

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](#).

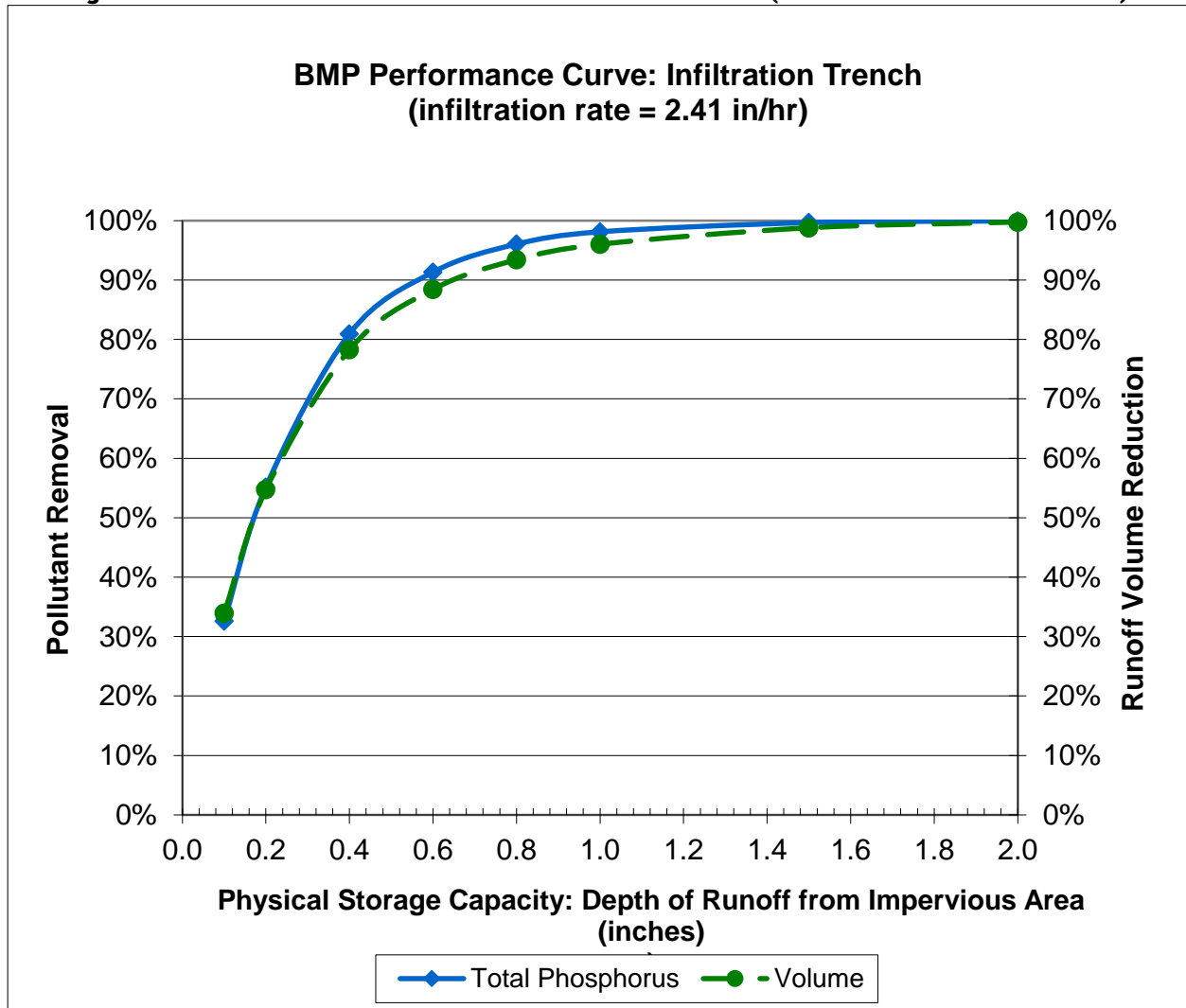
**Field Diagrams:** Use this area for field diagrams:

**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%

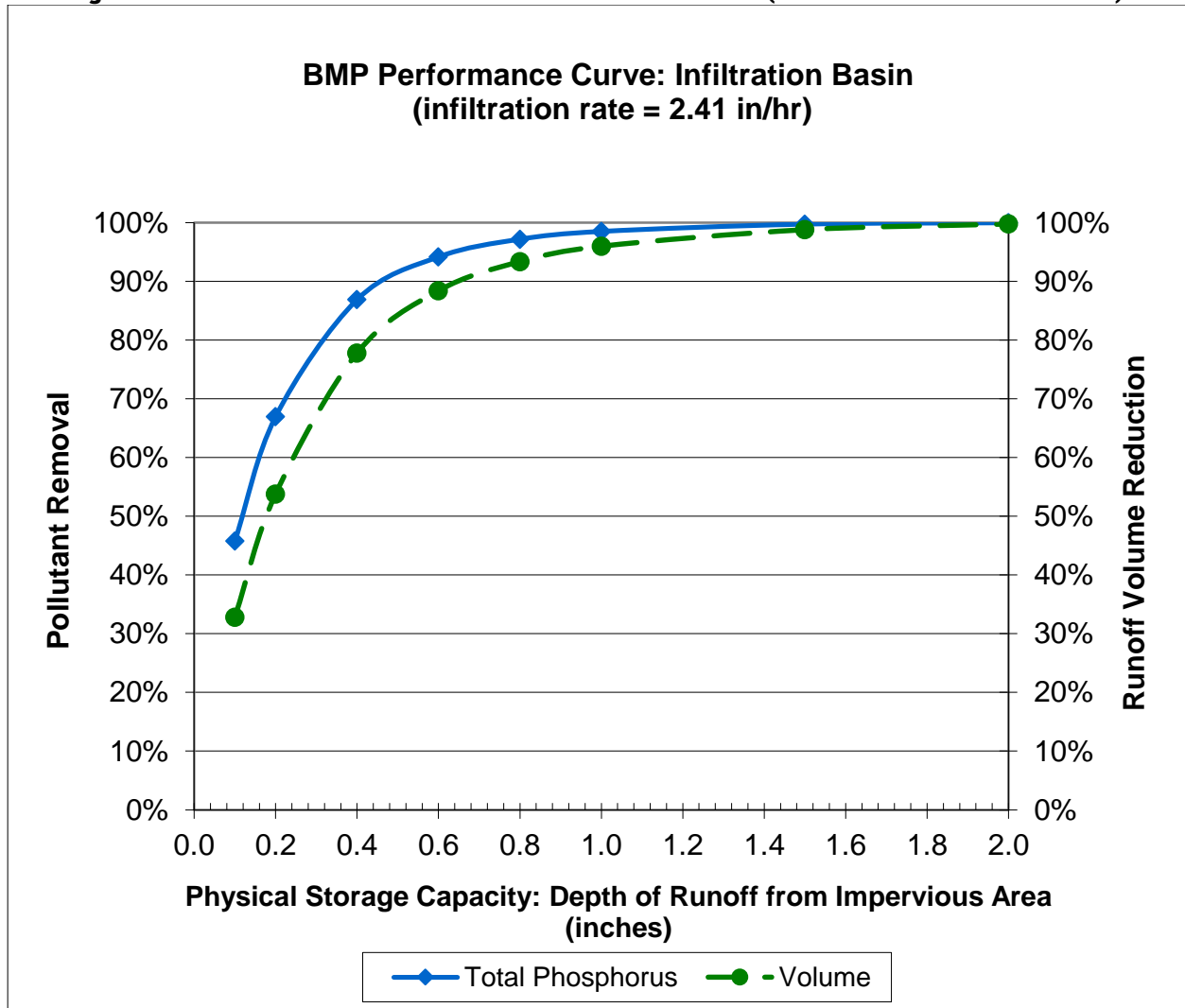
**Figure 3- 5: BMP Performance Curve: Infiltration Trench (infiltration rate = 2.41 in/hr)**



**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) <sup>1</sup>										
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	8.84 (6.36-11.9)	10.8 (7.84-14.7)	14.2 (10.2-19.2)	17.8 (12.8-24.8)	22.2 (15.8-30.6)	26.6 (19.2-36.0)	31.0 (22.2-42.8)	36.4 (26.6-49.2)	42.8 (31.0-57.6)	50.2 (36.4-68.4)
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)

<sup>1</sup> 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.

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