

# STORMWATER REPORT

**HAGGETTS POND RAIL TRAIL  
ANDOVER, MASSACHUSETTS**

NOVEMBER 7, 2023  
*REVISED: JULY 17, 2024*

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 1.03 miles of existing rail trail between Haggetts Pond Road 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 consist of an 8-ft wide asphalt surface and 1-ft wide vegetative shoulders on each side. The project work is located in buffers to State and Local wetland resource areas and within a NHESP Priority Habitat, and stormwater runoff 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 areas, 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, which is the drinking water supply for the Town of Andover. All 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:

**Existing High Plain Road Runoff** – Existing runoff from High Plain Road in the vicinity of the trail is currently 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 loop just to the west currently sheet flows 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. Both existing runoff sources will then discharge to a rip-rap dissipation bowl 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, and in an effort to preserve as many mature trees as possible, this flow has been treated to the maximum extent practicable.

**High Plain Road Parking Lot Runoff** - The proposed High Plain Road Parking Lot will be constructed as asphalt pavement. Stormwater runoff will be captured and pretreated using a proprietary water quality unit, then discharged to subsurface precast infiltration chambers 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 initial water quality unit is necessary to provide the minimum 44% TSS removal pretreatment prior to discharging to the infiltration chambers as this system is within the Zone A to a surface drinking water supply.

**Haggetts Pond Road/Lakeside Circle Runoff** – Existing runoff from Haggetts Pond Road and Lakeside Circle in the vicinity of the trailhead is currently collected in a series of catch basin on the south side of Haggetts Pond Road and discharges, untreated, via a 15” 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 83%. The existing catch basin will be replaced with a new deep-sump hooded catch basin directed to a water quality unit to provide improved pre-treatment. Additionally, the existing headwall outlet will have a new rip-rap dissipation bowl appropriately sized for the contributory area to prevent erosion and scour installed prior to flowing to Haggetts Pond. Due to the existing pipe inverts and shallow ground water, and in an effort to preserve as many mature trees as possible, the treatment of the existing roadway has been provided to the maximum extent practicable at 83%, which exceeds MassDEP’s requirement of 80%, but is less than the Town of Andover requirement of 90%.

**Haggetts Pond Parking Lot Runoff** – The proposed Haggetts Pond Road Parking Lot will be constructed as asphalt pavement. Stormwater runoff will be captured and pretreated using a proprietary water quality unit, then discharged to subsurface arched infiltration chambers 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 initial water quality unit is necessary to provide the minimum 44% TSS removal pretreatment prior to discharging to the infiltration chambers as this system is within the Zone A to a surface drinking water supply.

**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 right-of-way. Stormwater will be managed from the rail trail by sloping the trail cross section away from Haggetts Pond through a 1-ft vegetative buffer and the 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 paved trail surface is overlaid over the existing compacted 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 practicable, revegetated with native vegetation. The paving of the trail over the existing gravel rail bed in some areas of the trail will actually reduce the TSS associated with the runoff over the existing gravel/natural surface.

**1.04 COMPLIANCE WITH STORMWATER STANDARDS**

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, rain gardens, and/or subsurface infiltration systems at all new parking areas generating untreated stormwater. Riprap dissipation bowls provide protection 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 Project is 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. Both parking area subsurface detention/infiltration systems have been oversized to mitigate any increase in runoff associated with the trail paving.

Table 1.1 – Peak Flow Rates Summary to 4R: Total Offsite Runoff

	Existing Conditions (cfs)	Proposed Improvements (cfs)	Peak Runoff Decrease (cfs)
2-year Peak Runoff	8.2	8.3	+0.1
10-year Peak Runoff	17.6	17.6	0.0
25-year Peak Runoff	24.1	23.8	-0.3
100-year Peak Runoff	34.4	33.8	-0.6

Standard 3 - Groundwater Recharge

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

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

*Rv* = 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.

Based on the above, the unadjusted stormwater runoff required to be recharged was determined for the total site within the project limits, as well as for the two proposed parking lots individually (see Section 6.01 for complete calculations).

**Unadjusted Required Recharge**

- Total Site: 905 cubic feet
- High Plain Parking: 168 cubic feet
- Haggetts Pond Parking: 294 cubic feet

Although both proposed parking areas are capturing and directing 100% of their impervious runoff to a recharge BMP, only roughly 27% of the project-wide proposed impervious area is routed to an infiltration measure. Applying these ratios as adjustment factors to the original runoff volumes yields the adjusted required recharge volumes below (see Section 6.01 for complete calculations).

**Adjusted Required Recharge**

- Total Site: 3,419 cubic feet
- High Plain Parking: 168 cubic feet
- Haggetts Pond Parking: 294 cubic feet

To meet/exceed this adjusted required stormwater runoff volume to be recharged to the groundwater, the Project proposes the construction of two large subsurface infiltration systems beneath the two proposed parking lots. Several small infiltrating rain gardens and infiltration trenches are also included where the site allows in order to provide the maximum extent of groundwater recharge practicable. 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 6.1 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 1P (High Plain Parking Infiltr.):	1,799 c.f.	(EL.135.50)
- Pond 3P (Rain Garden #2):	115 c.f.	(EL.130.30)
- Rail Trail Infiltr. Trench at STA34+00:	*99 c.f.	(1.5' Depth)
- Rail Trail Infiltr. Trench at STA39+65	*90 c.f.	(1.5' Depth)
- Pond 4P (Haggetts Pond Parking Infiltr.):	<u>1,924 c.f.</u>	(EL.130.50)
	<b>4,027 c.f.</b>	

\*Trailside crushed stone trenches not modeled in HydroCAD are dimensioned below:

- STA34+00 110'L x 1.5'W x 1.5'D x 0.4 stone void ratio = 99 c.f.
- STA39+65 100'L x 1.5'W x 1.5'D x 0.4 stone void ratio = 90 c.f.

**Total Recharge Volume Provided:    4,027 c.f. (>3,419 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	Storage Volume R <sub>v</sub>	Sat. Hydraulic Conductivity K	System Bottom Area	Draw Down Time (72hrs max.)
Pond 1P	1,799 c.f.	2.41 in/hr (0.20 ft/hr)	1,536 s.f.	<b>5.86 hr.</b>
Pond 2P	152 c.f.	2.41 in/hr (0.20 ft/hr)	167 s.f.	<b>4.55 hr.</b>
Pond 3P	115 c.f.	2.41 in/hr (0.20 ft/hr)	343 s.f.	<b>1.68 hr.</b>
STA34+00	99 c.f.	2.41 in/hr (0.20 ft/hr)	165 s.f.	<b>3.00 hr.</b>
STA39+65	90 c.f.	2.41 in/hr (0.20 ft/hr)	150 s.f.	<b>3.00 hr.</b>
Pond 4P	1,924 c.f.	2.41 in/hr (0.20 ft/hr)	2,123 s.f.	<b>4.53 hr.</b>

Standard 4 - Water Quality

The proposed stormwater management system has been designed to provide treatment for stormwater runoff from the new parking areas, as well as portions of the existing connecting public roadways (Haggetts Pond Road, Lakeside Circle, and High Plain Road). Treatment is achieved by subsurface infiltration and rain garden areas where possible, with pretreatment being provided by deep sump hooded catch basins and proprietary water quality units wherever required. At the proposed parking 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.

In instances where existing untreated roadway drainage enters the site, this runoff is treated to the maximum extent practicable using water quality units (WQUs) that can be fit into the existing system with limited disturbance to the existing roadways, drainage network, and mature trees. Runoff from the proposed non-vehicular paved rail trail is treated to the maximum extent practicable by providing a continuous grassed shoulder along the trail, acting as a filter strip while fully avoiding impacts to wetlands, vernal pools, priority habitat, and mature trees. As this filter strip cannot fully comply with dimensional standards of the Handbook, TSS removal credit is not quantified. Complete TSS removal calculations can be found in Section 6.4 of this report and are summarized below.

TSS Removal Summary

Runoff Source	TSS Removal %	Impervious Area Treated
- Existing High Plain Rd (nodes 4S & 5S)	90%	9,766 s.f.
- Proposed Parking Lots (nodes 1S & 9S)	95%	12,998 s.f.
- Existing Haggetts Pond Rd (node 8S)	81%	47,755 s.f.
- Rail Trail, uncaptured areas (nodes 3S, 6S, & 7S)	0%*	45,673 s.f.

\*It should be noted, that per the MassDEP Stormwater Handbook, TSS is associated with potential pollutant sources. The paved portion of the trail is not anticipated to have common types of pollutants typically found in runoff associated with vehicles, pesticides, herbicides, fertilizers and deicing chemicals and sand. Limited pollutant sources may be pet waste or trash, and the project proposes trash and dog waste stations at each parking area/trail head to reduce these pollutant sources that currently exist today with the trail. Stormwater runoff from the asphalt trail will be lower in sediment and dust inputs than that produced from a stone dust trail, reducing the risk of impacts. Note that chemical contaminants associated with asphalt roadways are predominantly linked to drippings and/or tire and brake dust from vehicles, chemical deicers, and road salt, none of which will be used on the trail proposed. Chemical sealants which have been linked to amphibian toxicity (including coal-tar sealants), will not be used in the trail surface. Additionally, the project is prohibiting the use of any recycled asphalt materials in any imported gravel base materials.

Infiltration BMPs such as the parking lot subsurface systems, infiltrating rain gardens, and trail-side infiltration trenches are sized to contain and infiltrate the Water Quality Volume (WQV) for the given contributory watershed. Water quality volumes are calculated using the following formula.

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

$WQV$  = Required Water Quality Volume (in cubic feet)

$WQD$  = Water Quality Depth: **1-inch**. (Requirement of the Town stormwater regulations)

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

The provided treatment volume (storage volume below the lowest invert out of each infiltration BMP) at each location can be found in Section 6.1 and is shown after each calculation below.

High Plain Rd Parking Infiltration (Pond 1P):

$$\begin{aligned} WQV &= (1.0 \text{ in.} / 12 \text{ inches/ft}) * (7,110 \text{ s.f.}) \\ &= \mathbf{593 \text{ c.f.}} (1,799 \text{ c.f. provided}) \end{aligned}$$

Infiltrating Rain Garden #2 (Pond 3P):

$$\begin{aligned} WQV &= (1.0 \text{ in.} / 12 \text{ inches/ft}) * (10,835 \text{ s.f.}) \\ &= \mathbf{903 \text{ c.f.}} (115 \text{ c.f. provided}) \end{aligned}$$

STA34+00 Infiltration Trench:

$$\begin{aligned} WQV &= (1.0 \text{ in.} / 12 \text{ inches/ft}) * (893 \text{ s.f.}) \\ &= \mathbf{74 \text{ c.f.}} (99 \text{ c.f. provided}) \end{aligned}$$

STA39+65 Infiltration Trench:

$$\begin{aligned} WQV &= (1.0 \text{ in.} / 12 \text{ inches/ft}) * (801 \text{ s.f.}) \\ &= \mathbf{67 \text{ c.f.}} (90 \text{ c.f. provided}) \end{aligned}$$

Haggetts Pond Rd Parking Infiltration (Pond 4P):

$$\begin{aligned} WQV &= (1.0 \text{ in.} / 12 \text{ inches/ft}) * (5,888 \text{ s.f.}) \\ &= \mathbf{491 \text{ c.f.}} (1,924 \text{ c.f. provided}) \end{aligned}$$

At the infiltrating Rain Garden #2, water quality volume is met to the maximum extent practicable in an effort to fully avoid any disturbance to wetlands, vernal pools, priority habitat, and mature trees. The required water quality volumes of both proposed parking lot infiltration systems are provided fully.

Besides infiltration BMPs, Water Quality Units (WQU) are another stormwater treatment practice proposed. Sizing calculations of these proprietary treatment structures were performed using the contributory 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). Water Quality flow rates for the WQUs are calculated using the equation below, and then compared to manufacturer's parameters. Complete sizing calculations can be found in Section 6.02 and 6.03 of this Report.

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

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

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

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

The two methods for stormwater infiltration in the Project are through subsurface infiltration chambers and through infiltration rain gardens. The MA MS4 General Permit lists subsurface infiltration as a type of "infiltration trench" and rain gardens (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>59,508 s.f.</b>
- Infiltrated impervious area:	15,761 s.f.
- Other impervious area:	43,747 s.f.
Total proposed infiltration (recharge) volume:	<b>4,027 c.f.</b> (volume below lowest outlets)

$$\text{Treated depth: } \frac{4,027 \text{ c.f.}}{15,761 \text{ s.f.}} = 0.256 \text{ ft.} = \mathbf{3.0 \text{ in.}}$$

$$\text{Untreated depth: } \frac{0 \text{ c.f.}}{43,747 \text{ s.f.}} = 0 \text{ ft.} = \mathbf{0 \text{ in.}}$$

$$\text{Weighted average depth: } \frac{(15,761 * 3.0) + (43,747 * 0)}{59,508} = \mathbf{0.96 \text{ in.}}$$

A treated runoff depth of 0.96 inches, given the applicable BMPs and infiltration rates, yields an expected cumulative phosphorus load reduction of approximately 95.5% 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 at all proposed vehicular travelled ways, and to the maximum extent practicable for all other areas. 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 a surface public drinking water supply 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 infiltrating rain gardens and subsurface infiltration systems.

High Plain Parking Area Treatment Train – Pre-treatment in inlet WQU to subsurface infiltration system.

Water Quality Unit TSS removal rate: **75%**

Haggetts Pond Parking Area Treatment Trains – Pre-treatment in inlet WQU to subsurface system with isolation row/infiltration.

Water Quality Unit TSS removal rate: **75%**

Standard 7 – Redevelopment Projects and Other Projects Subject to the Standards only to the maximum extent practicable.

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

The trail is only required to meet the Standards to the maximum extent practicable. Because the trail itself runs along an existing old rail bed, through a sensitive wooded environment, there is little to no area to provide mitigation along the trail without clearing and cutting trees, causing damage to the natural areas. Thus, the project has oversized the stormwater systems in both parking areas to meet the Standard 2: Stormwater Runoff Rates, and Standard 3: Groundwater Recharge requirements. Additionally, all other Standards are met other than Standard 4: Water Quality. As noted previously above, the paved portion of the trail is not anticipated to have common types of pollutants typically found in runoff associated with vehicles, pesticides, herbicides, fertilizers and deicing chemicals and sand. Limited pollutant sources may be pet waste or trash, and the project proposes trash and dog waste stations at each parking area/trail head to reduce these pollutant sources that currently exist today with the trail. Stormwater runoff from the asphalt trail will be lower in sediment and dust inputs than that produced from a stone dust trail, reducing the risk of impacts. Chemical contaminants associated with asphalt roadways are predominantly linked to drippings and/or tire and brake dust from vehicles, chemical deicers, and road salt, none of which will be used on the trail proposed. Chemical sealants which have been linked to amphibian toxicity (including coal-tar sealants), will not be used in the trail surface. Additionally, the project is prohibiting the use of any recycled asphalt materials in any imported gravel base materials.

*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 separately.

*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 located on High Plain Road and Haggetts Pond Road. With the provisions of water quality units, subsurface infiltration, and/or infiltrating rain garden 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**

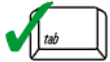


Massachusetts Department of Environmental Protection  
Bureau of Resource Protection - Wetlands Program

# Checklist for Stormwater Report

## A. Introduction

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



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

The Stormwater Report must include:

- The Stormwater Checklist completed and stamped by a Registered Professional Engineer (see page 2) that certifies that the Stormwater Report contains all required submittals.<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.

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<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

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Signature and Date



# 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): \_\_\_\_\_



# 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 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.

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**

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 wildlife habitat.
- Prevent existing wildlife from entering work areas.
- Protect and maintain existing vegetation wherever possible.
- Minimize the area of disturbance.
- To the extent possible, route unpolluted stormwater 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.

#### Construction Phasing

- Beginning of each workday, an approved person, shall walk the limits of work and remove any turtles that may have entered the work zone.
- Install TEC devices for the Haggetts Pond Parking area and the Haggetts Pond Road outlets.
- Construct the Haggetts Pond Road Rain Garden.
- Construct the Haggetts Pond Parking lot to Binder. This parking area will be used as the trail and High Plain Road Parking area staging area.
- Clean existing culverts ensure that they are working properly and install all TEC devices.
- Construct the High Plain Parking Area.
- Construct the Boardwalk
- Construct the Haggetts Pond Rail Trail
- Install Top Paving at the Haggetts Pond Parking area.
- Remove TEC measures once all disturbed areas are stabilized.

#### Demolition, Grubbing and Stripping of Limits of Construction Phase

- Install TEC devices as required to prevent sediment transport into resource areas.
- Clean existing culverts ensure that they are working properly.
- Place a ring of composite filter socks and/or straw bales around stockpiles.
- Stabilize all exposed surfaces that will not be under immediate construction.
- Store and/or dispose all pavement and demolition debris as indicated in accordance with all applicable local, state, and federal regulations.

#### Parking/Trail Areas Sub-base Construction

- Any 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 composite filter sock, silt fence or straw bale dike situated in an arc at the low point of the berm.
- If intense precipitation is anticipated, composite filter socks, straw 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.
- Composite filter sock 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

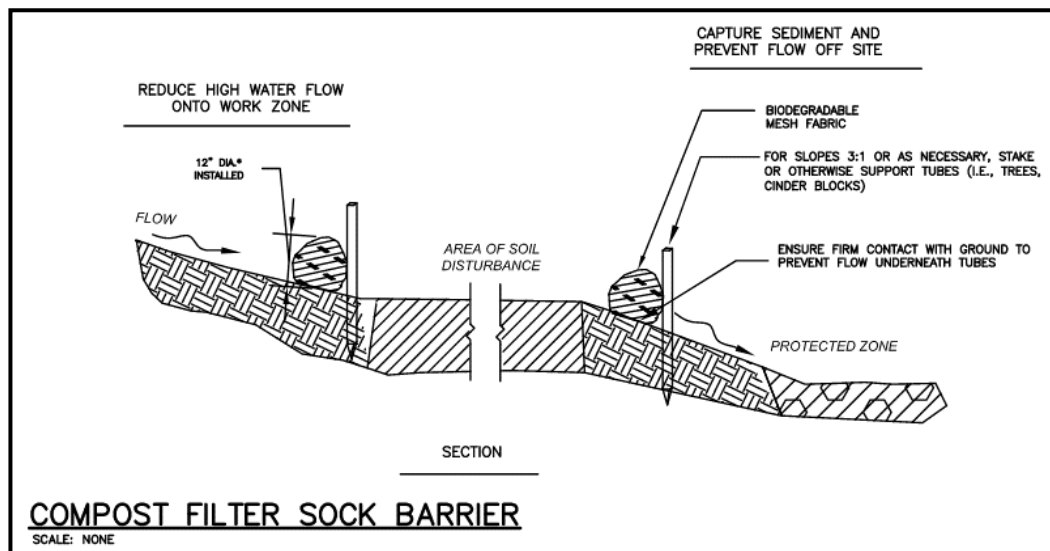
- Stabilization of surfaces includes the placement of pavement, rip-rap, wood bark mulch and the establishment of vegetated surfaces.
- Upon completion of construction, all surfaces shall be stabilized even though it is apparent that future construction efforts will cause their disturbance.
- Vegetated 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.

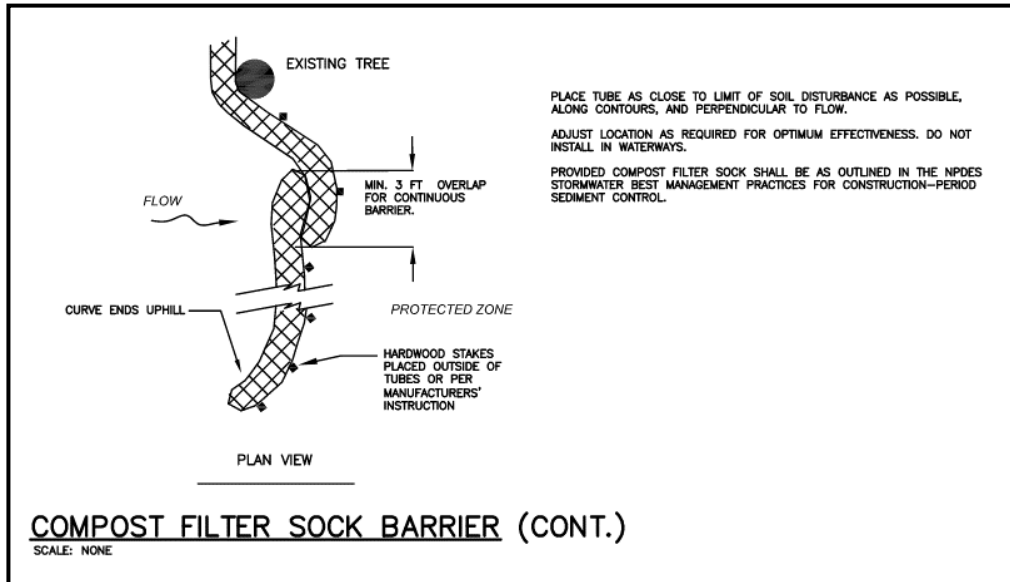
## **9.0 Temporary Structural Erosion Control Measures**

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 Composite Filter Socks, Straw Bales, and Silt Fencing**

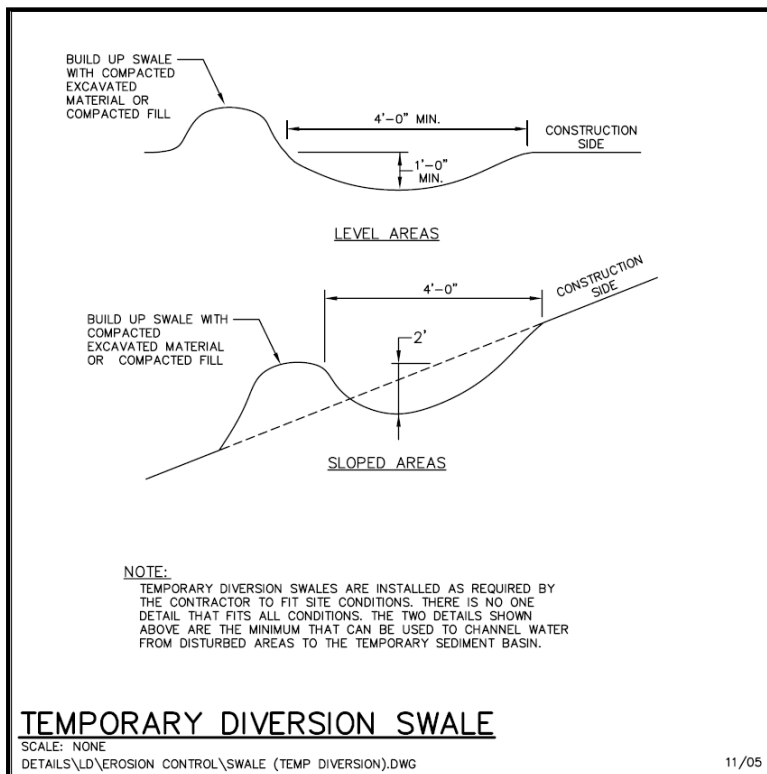
Siltation barriers composed of composite filter socks will be installed within the 100-foot buffer zone along the upland side of delineated wetland resources. The siltation barriers will demarcate the limit of work, form a work envelope and provide additional assurance that construction equipment will 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

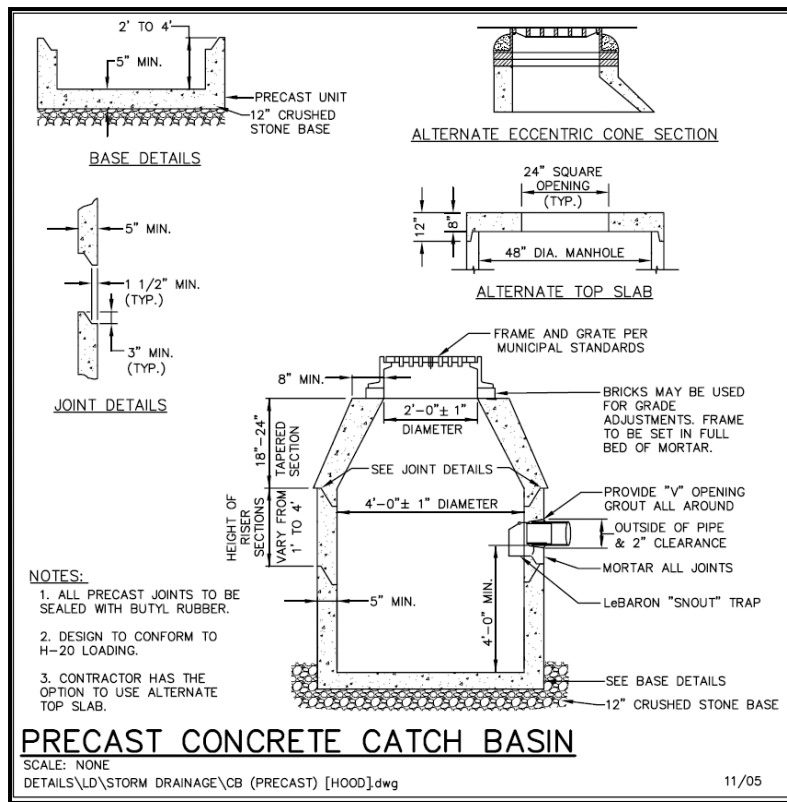
There will be no storage of soil, gravel or construction debris within the 100-foot buffer zone to wetland resource areas. It is anticipated that all excavated material will be placed in a dump truck and stockpiled outside the 100-foot buffer zone during construction activities. Piping and trench excavate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

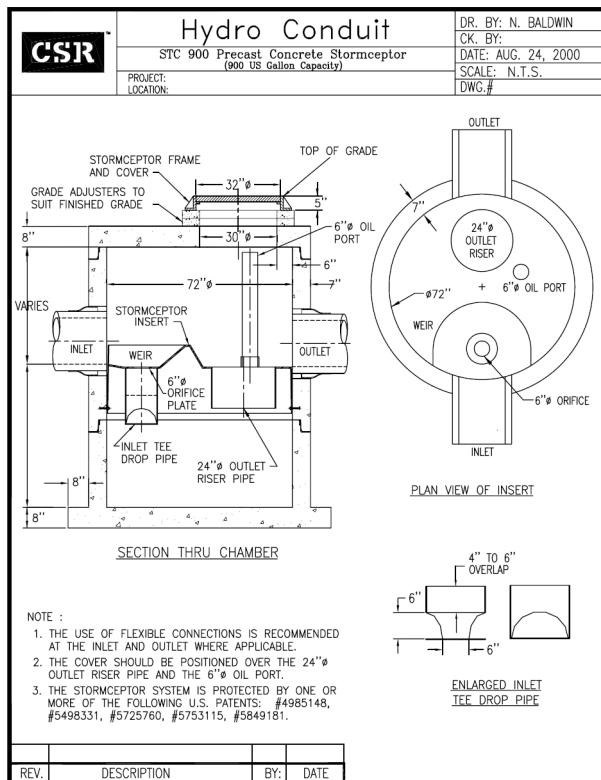
Parking lots will be bermed (or curbed) and provided with catch basins to collect runoff. The entire drainage system for each respective project phase will be installed during the initial phases of construction. The collection system will be installed from the downstream end up, and in a manner which 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 four 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 Water Quality Units

The water quality unit (WQU) structure will require periodic inspection and cleaning to maintain operation and function during construction. Owners should have these units inspected weekly and after periods of intense precipitation during construction. Inspection of the WQU 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 WQU 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 WQU 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.

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	
Straw Bales 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	
Water Quality Units	<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/littler 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	

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

**NEXT INSPECTON**

**TO BE PERFORMED BY:** \_\_\_\_\_

**ON OR BEFORE:** \_\_\_\_\_

**Certification statement:**

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

Print name: \_\_\_\_\_

Signature: \_\_\_\_\_ Date: \_\_\_\_\_

## **SECTION 4.0**

### **LONG-TERM POLLUTION PREVENTION & OPERATION AND MAINTENANCE PLAN**

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 DATE

HAGGETTS POND RAIL TRAIL

IN ANDOVER, MASSACHUSETTS

EXISTING WATERSHED PLAN

NOVEMBER 7, 2023

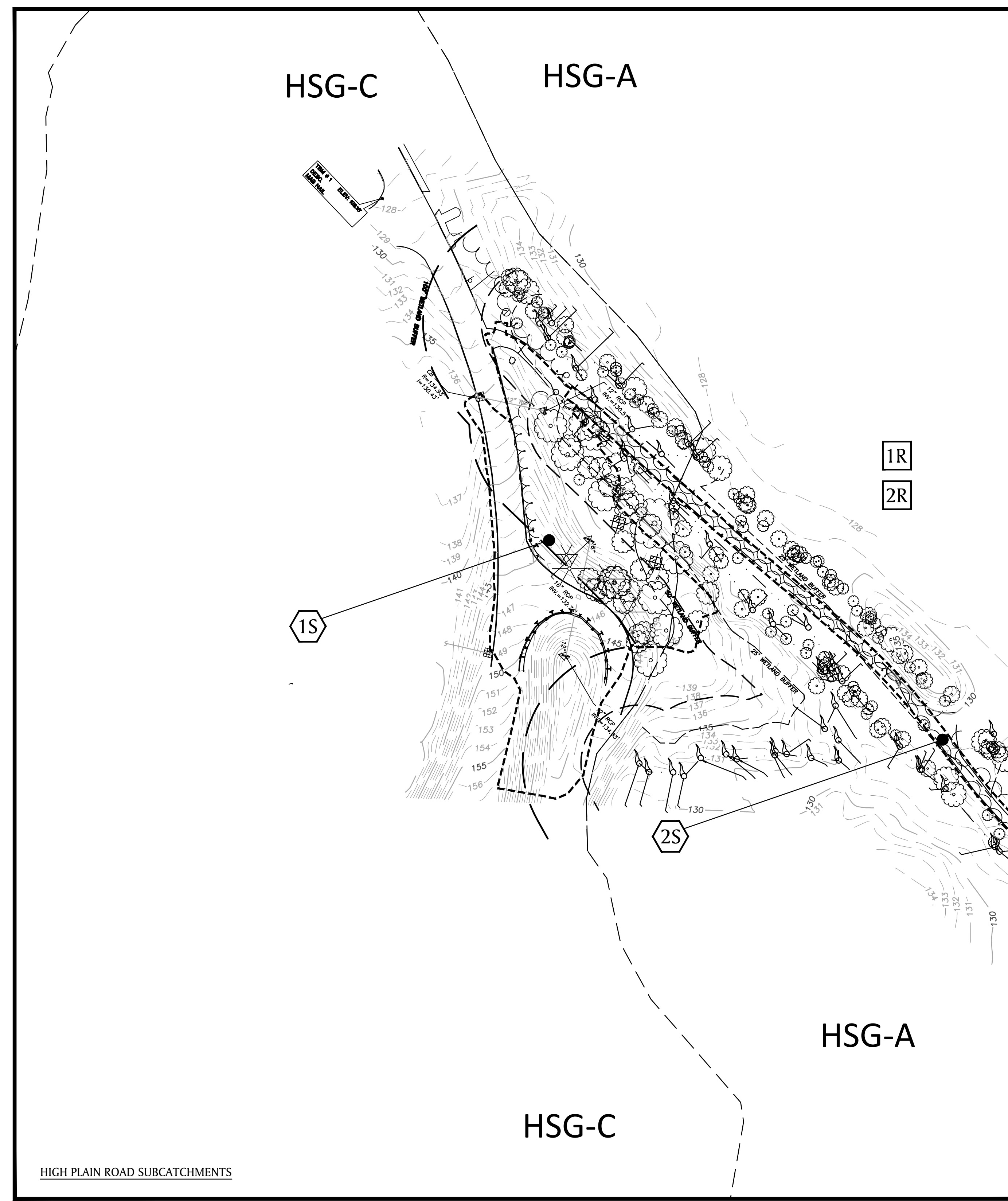
REVISIONS:

NO.	DATE	DESCRIPTION
1	12/21/23	REDUCED ENV. IMPACTS
2	4/12/24	PEER REVIEW COMMENTS

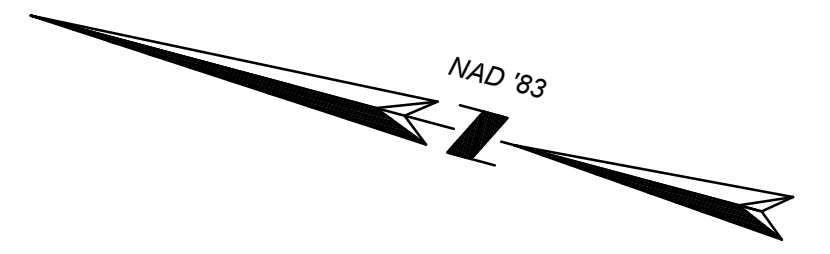
PREPARED FOR:  
TOWN OF ANDOVER  
36 BARTLET STREET  
ANDOVER, MA, 01810

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

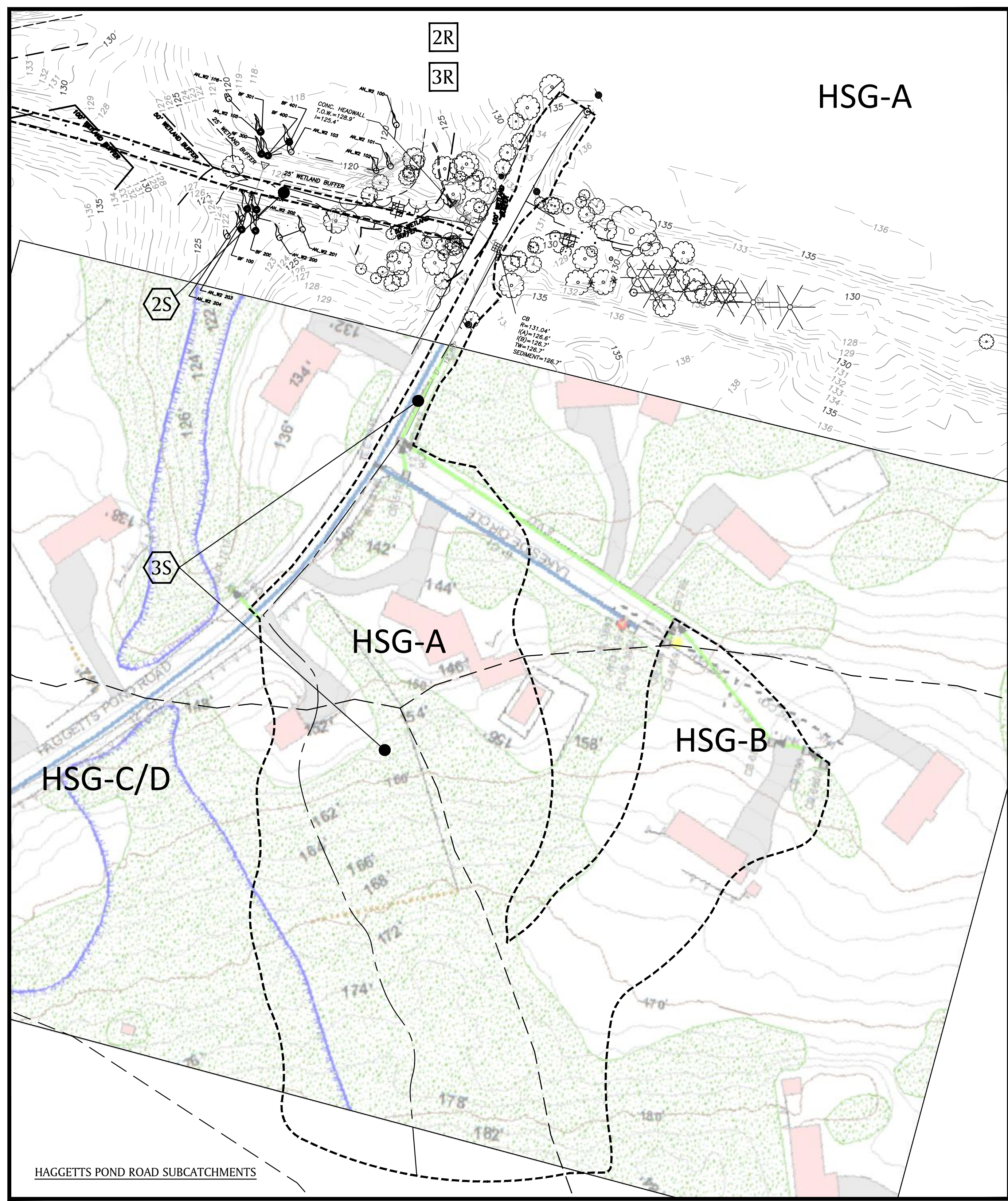
© 2024 BSC GROUP, INC.  
SCALE: 1"=60'  
0 30 60 120 FEET  
FILE: P:\8998501\C\\_DD\EC WSHED  
DWG.: EC-WSHD  
JOB. NO: 8-9985.01



HIGH PLAIN ROAD SUBCATCHMENTS



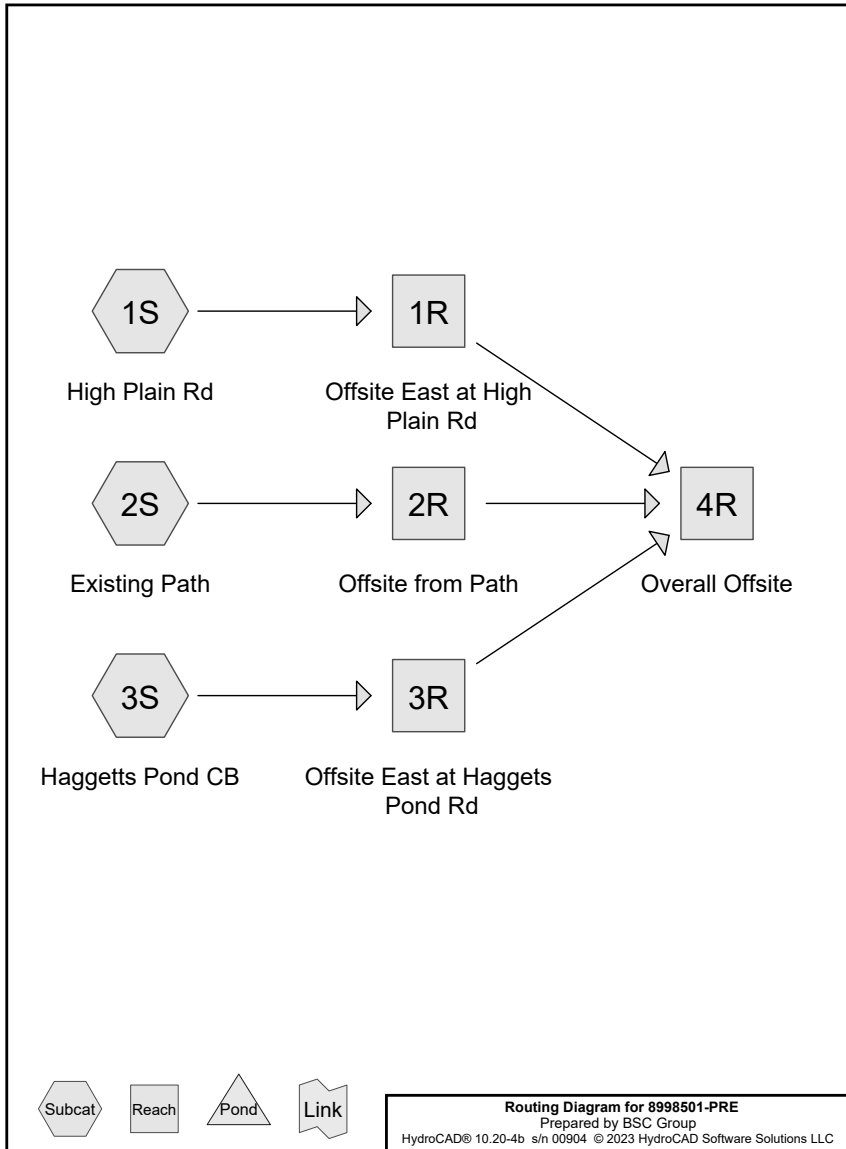
- LEGEND
- SUBCATCHMENT BOUNDARY
  - SUBCATCHMENT LABEL
  - DESIGN POINT LABEL
  - TIME OF CONCENTRATION (TC) LINE



HAGGETTS POND ROAD SUBCATCHMENTS

ISSUED FOR PERMITTING  
NOT FOR CONSTRUCTION

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



**8998501-PRE**

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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)
22,439	39	>75% Ex. Grass cover, Good, HSG A (3S)
44,580	61	>75% Ex. Grass cover, Good, HSG B (3S)
13,232	74	>75% Ex. Grass cover, Good, HSG C (3S)
3,734	74	>75% Grass cover, Good, HSG C (1S)
21,360	98	Ex. Paved parking, HSG B (3S)
2,159	98	Ex. Paved parking, HSG C (3S)
23,399	98	Ex. paved parking, HSG A (3S)
277	96	Gravel surface, HSG A (3S)
1,026	96	Gravel surface, HSG C (1S)
64,794	96	Gravel surface, HSG D (2S)
9,770	98	Paved parking, HSG C (1S)
2,779	30	Woods, Good, HSG A (1S, 3S)
2,036	55	Woods, Good, HSG B (3S)
84,650	70	Woods, Good, HSG C (1S, 3S)
<b>296,235</b>	<b>77</b>	<b>TOTAL AREA</b>

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**Soil Listing (all nodes)**

Area (sq-ft)	Soil Group	Subcatchment Numbers
48,894	HSG A	1S, 3S
67,976	HSG B	3S
114,571	HSG C	1S, 3S
64,794	HSG D	2S
0	Other	
<b>296,235</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
22,439	44,580	13,232	0	0	80,251	>75% Ex. Grass cover, Good
0	0	3,734	0	0	3,734	>75% Grass cover, Good
0	21,360	2,159	0	0	23,519	Ex. Paved parking
23,399	0	0	0	0	23,399	Ex. paved parking
277	0	1,026	64,794	0	66,097	Gravel surface
0	0	9,770	0	0	9,770	Paved parking
2,779	2,036	84,650	0	0	89,465	Woods, Good
<b>48,894</b>	<b>67,976</b>	<b>114,571</b>	<b>64,794</b>	<b>0</b>	<b>296,235</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=40,968 sf 23.85% Impervious Runoff Depth>1.11"  
Flow Length=118' Slope=0.0400 '/' Tc=9.9 min CN=76 Runoff=1.0 cfs 3,782 cf

**Subcatchment 2S: Existing Path** Runoff Area=64,794 sf 0.00% Impervious Runoff Depth>2.69"  
Tc=6.0 min CN=96 Runoff=4.4 cfs 14,512 cf

**Subcatchment 3S: Haggetts Pond CB** Runoff Area=190,473 sf 24.63% Impervious Runoff Depth>0.84"  
Flow Length=713' Tc=10.2 min CN=71 Runoff=3.4 cfs 13,330 cf

**Reach 1R: Offsite East at High Plain Rd** Inflow=1.0 cfs 3,782 cf  
Outflow=1.0 cfs 3,782 cf

**Reach 2R: Offsite from Path** Inflow=4.4 cfs 14,512 cf  
Outflow=4.4 cfs 14,512 cf

**Reach 3R: Offsite East at Haggetts Pond Rd** Inflow=3.4 cfs 13,330 cf  
Outflow=3.4 cfs 13,330 cf

**Reach 4R: Overall Offsite** Inflow=8.1 cfs 31,624 cf  
Outflow=8.1 cfs 31,624 cf

**Total Runoff Area = 296,235 sf Runoff Volume = 31,624 cf Average Runoff Depth = 1.28"**  
**80.86% Pervious = 239,547 sf 19.14% Impervious = 56,688 sf**

**8998501-PRE**

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

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

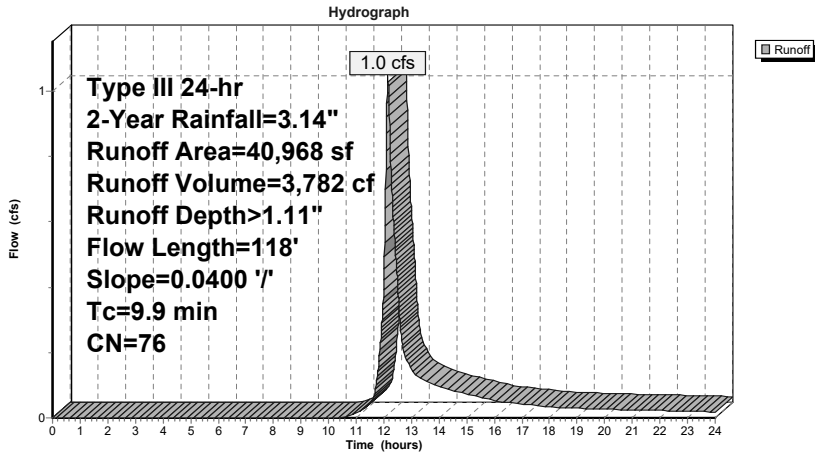
Runoff = 1.0 cfs @ 12.15 hrs, Volume= 3,782 cf, Depth> 1.11"  
 Routed to Reach 1R : Offsite East at High Plain Rd

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
1,026	96	Gravel surface, HSG C
3,734	74	>75% Grass cover, Good, HSG C
1,726	30	Woods, Good, HSG A
24,712	70	Woods, Good, HSG C
9,770	98	Paved parking, HSG C
40,968	76	Weighted Average
31,198		76.15% Pervious Area
9,770		23.85% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
8.8	50	0.0400	0.09		Sheet Flow, Woods: Light underbrush n= 0.400 P2= 3.60"
1.1	68	0.0400	1.00		Shallow Concentrated Flow, Woodland Kv= 5.0 fps
9.9	118	Total			

**Subcatchment 1S: High Plain Rd**



**8998501-PRE**

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

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**Summary for Subcatchment 2S: Existing Path**

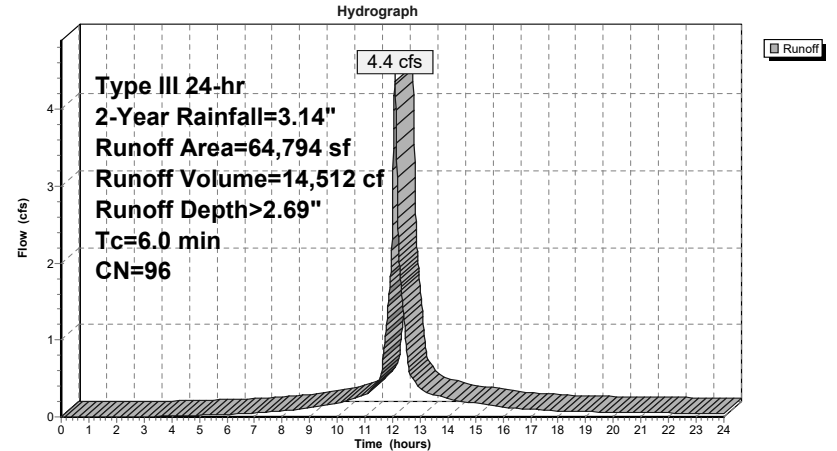
Runoff = 4.4 cfs @ 12.08 hrs, Volume= 14,512 cf, Depth> 2.69"  
 Routed to Reach 2R : Offsite from Path

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
64,794	96	Gravel surface, HSG D
64,794		100.00% Pervious Area

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

**Subcatchment 2S: Existing Path**



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

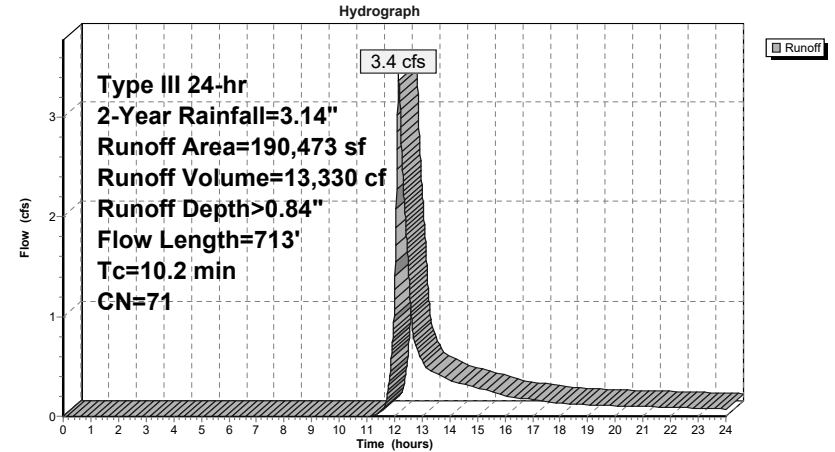
Runoff = 3.4 cfs @ 12.16 hrs, Volume= 13,330 cf, Depth> 0.84"  
 Routed to Reach 3R : Offsite East at Haggetts Pond Rd

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
* 23,399	98	Ex. paved parking, HSG A
* 21,360	98	Ex. Paved parking, HSG B
* 2,159	98	Ex. Paved parking, HSG C
* 22,439	39	>75% Ex. Grass cover, Good, HSG A
* 44,580	61	>75% Ex. Grass cover, Good, HSG B
* 13,232	74	>75% Ex. Grass cover, Good, HSG C
277	96	Gravel surface, HSG A
1,053	30	Woods, Good, HSG A
2,036	55	Woods, Good, HSG B
59,938	70	Woods, Good, HSG C
190,473	71	Weighted Average
143,555		75.37% Pervious Area
46,918		24.63% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.2	50	0.1500	0.16		<b>Sheet Flow,</b> Woods: Light underbrush n= 0.400 P2= 3.60"
3.8	307	0.0720	1.34		<b>Shallow Concentrated Flow,</b> Woodland Kv= 5.0 fps
1.2	356	0.0610	5.01		<b>Shallow Concentrated Flow,</b> Paved Kv= 20.3 fps
10.2	713	Total			

**Subcatchment 3S: Haggetts Pond CB**



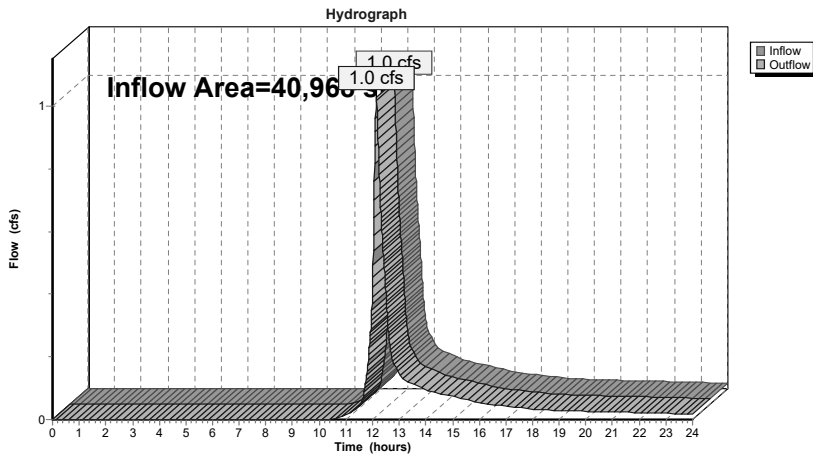
Summary for Reach 1R: Offsite East at High Plain Rd

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

Inflow Area = 40,968 sf, 23.85% Impervious, Inflow Depth > 1.11" for 2-Year event  
 Inflow = 1.0 cfs @ 12.15 hrs, Volume= 3,782 cf  
 Outflow = 1.0 cfs @ 12.15 hrs, Volume= 3,782 cf, Atten= 0%, Lag= 0.0 min  
 Routed to Reach 4R : Overall Offsite

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



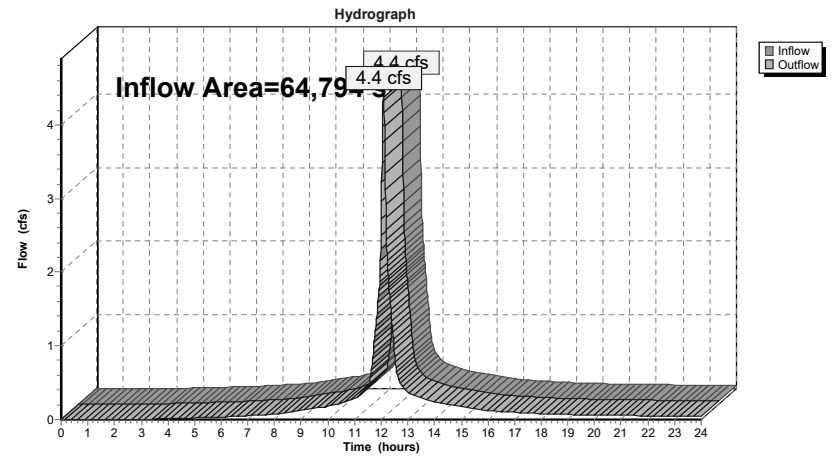
Summary for Reach 2R: Offsite from Path

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

Inflow Area = 64,794 sf, 0.00% Impervious, Inflow Depth > 2.69" for 2-Year event  
 Inflow = 4.4 cfs @ 12.08 hrs, Volume= 14,512 cf  
 Outflow = 4.4 cfs @ 12.08 hrs, Volume= 14,512 cf, Atten= 0%, Lag= 0.0 min  
 Routed to Reach 4R : Overall Offsite

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

Reach 2R: Offsite from Path



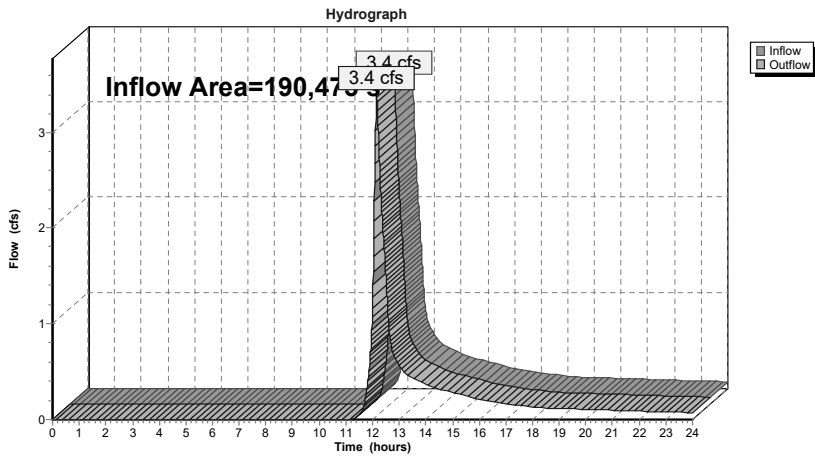
Summary for Reach 3R: Offsite East at Haggets Pond Rd

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

Inflow Area = 190,473 sf, 24.63% Impervious, Inflow Depth > 0.84" for 2-Year event  
 Inflow = 3.4 cfs @ 12.16 hrs, Volume= 13,330 cf  
 Outflow = 3.4 cfs @ 12.16 hrs, Volume= 13,330 cf, Atten= 0%, Lag= 0.0 min  
 Routed to Reach 4R : Overall Offsite

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

Reach 3R: Offsite East at Haggets Pond Rd



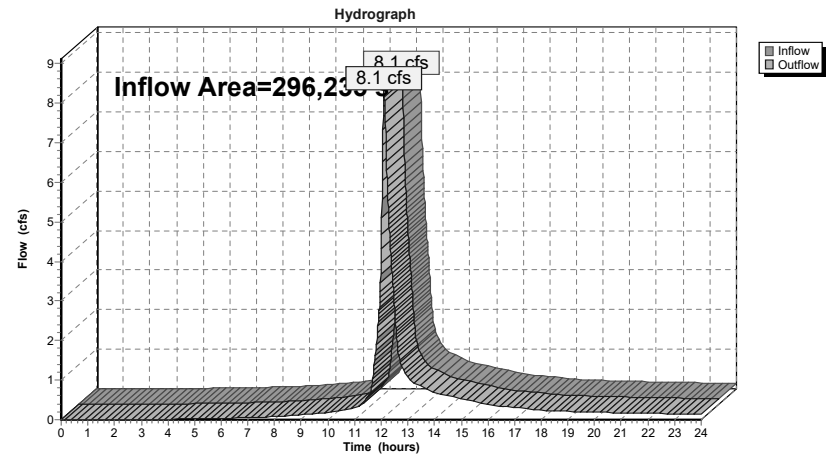
Summary for Reach 4R: Overall Offsite

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

Inflow Area = 296,235 sf, 19.14% Impervious, Inflow Depth > 1.28" for 2-Year event  
 Inflow = 8.1 cfs @ 12.11 hrs, Volume= 31,624 cf  
 Outflow = 8.1 cfs @ 12.11 hrs, Volume= 31,624 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 4R: Overall Offsite



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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=40,968 sf 23.85% Impervious Runoff Depth>2.50"  
Flow Length=118' Slope=0.0400 '/' Tc=9.9 min CN=76 Runoff=2.4 cfs 8,526 cf**Subcatchment 2S: Existing Path**Runoff Area=64,794 sf 0.00% Impervious Runoff Depth>4.49"  
Tc=6.0 min CN=96 Runoff=7.1 cfs 24,239 cf**Subcatchment 3S: Haggetts Pond CB**Runoff Area=190,473 sf 24.63% Impervious Runoff Depth>2.08"  
Flow Length=713' Tc=10.2 min CN=71 Runoff=9.1 cfs 33,037 cf**Reach 1R: Offsite East at High Plain Rd**Inflow=2.4 cfs 8,526 cf  
Outflow=2.4 cfs 8,526 cf**Reach 2R: Offsite from Path**Inflow=7.1 cfs 24,239 cf  
Outflow=7.1 cfs 24,239 cf**Reach 3R: Offsite East at Haggetts Pond Rd**Inflow=9.1 cfs 33,037 cf  
Outflow=9.1 cfs 33,037 cf**Reach 4R: Overall Offsite**Inflow=17.6 cfs 65,802 cf  
Outflow=17.6 cfs 65,802 cfTotal Runoff Area = 296,235 sf Runoff Volume = 65,802 cf Average Runoff Depth = 2.67"  
80.86% Pervious = 239,547 sf 19.14% Impervious = 56,688 sf**8998501-PRE**

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

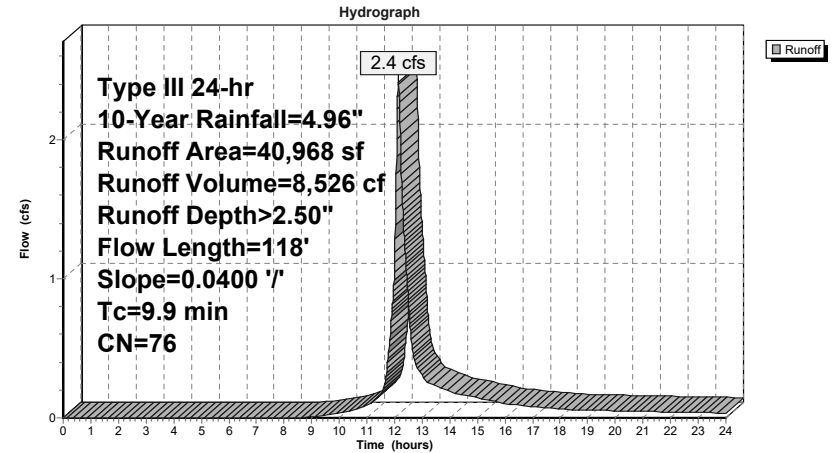
Page 16

**Summary for Subcatchment 1S: High Plain Rd**Runoff = 2.4 cfs @ 12.14 hrs, Volume= 8,526 cf, Depth> 2.50"  
Routed to Reach 1R : Offsite East at High Plain RdRunoff 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
1,026	96	Gravel surface, HSG C
3,734	74	>75% Grass cover, Good, HSG C
1,726	30	Woods, Good, HSG A
24,712	70	Woods, Good, HSG C
9,770	98	Paved parking, HSG C
40,968	76	Weighted Average
31,198		76.15% Pervious Area
9,770		23.85% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
8.8	50	0.0400	0.09		Sheet Flow, Woods: Light underbrush n= 0.400 P2= 3.60"
1.1	68	0.0400	1.00		Shallow Concentrated Flow, Woodland Kv= 5.0 fps
9.9	118	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: Existing Path**

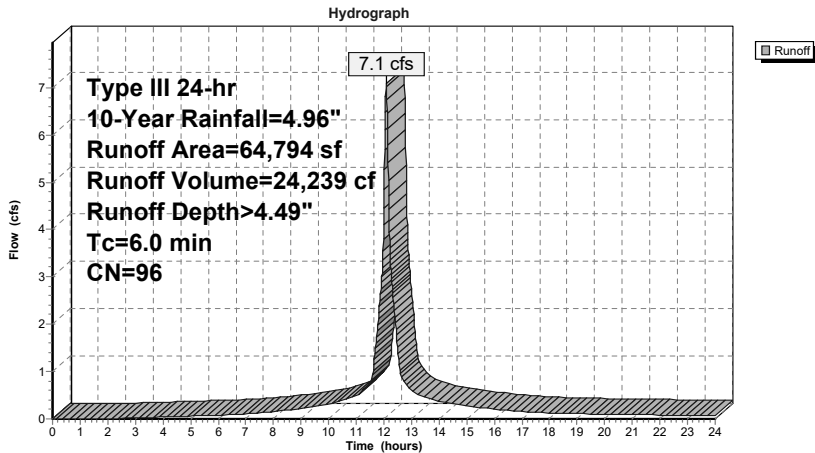
Runoff = 7.1 cfs @ 12.08 hrs, Volume= 24,239 cf, Depth> 4.49"  
Routed to Reach 2R : Offsite from Path

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
64,794	96	Gravel surface, HSG D
64,794		100.00% Pervious Area

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

**Subcatchment 2S: Existing Path**



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

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

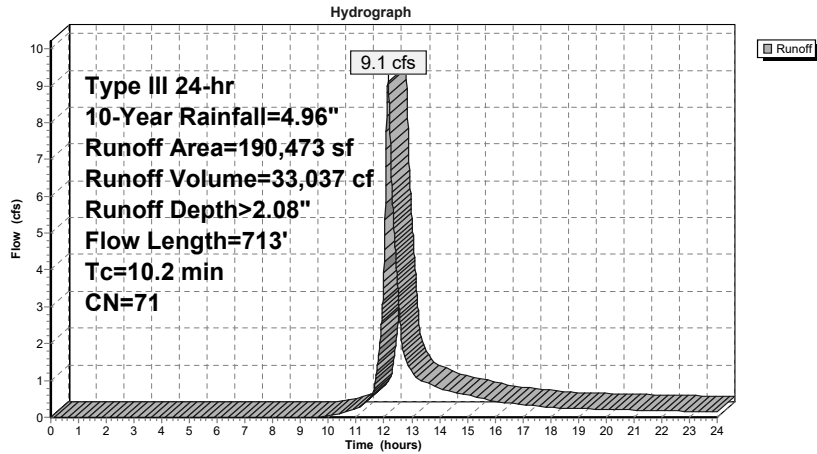
Runoff = 9.1 cfs @ 12.15 hrs, Volume= 33,037 cf, Depth> 2.08"  
Routed to Reach 3R : Offsite East at Haggetts Pond Rd

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
* 23,399	98	Ex. paved parking, HSG A
* 21,360	98	Ex. Paved parking, HSG B
* 2,159	98	Ex. Paved parking, HSG C
* 22,439	39	>75% Ex. Grass cover, Good, HSG A
* 44,580	61	>75% Ex. Grass cover, Good, HSG B
* 13,232	74	>75% Ex. Grass cover, Good, HSG C
	277	Gravel surface, HSG A
	1,053	Woods, Good, HSG A
	2,036	Woods, Good, HSG B
	59,938	Woods, Good, HSG C
190,473	71	Weighted Average
143,555		75.37% Pervious Area
46,918		24.63% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.2	50	0.1500	0.16		Sheet Flow, Woods: Light underbrush n= 0.400 P2= 3.60"
3.8	307	0.0720	1.34		Shallow Concentrated Flow, Woodland Kv= 5.0 fps
1.2	356	0.0610	5.01		Shallow Concentrated Flow, Paved Kv= 20.3 fps
10.2	713				Total

Subcatchment 3S: Haggetts Pond CB



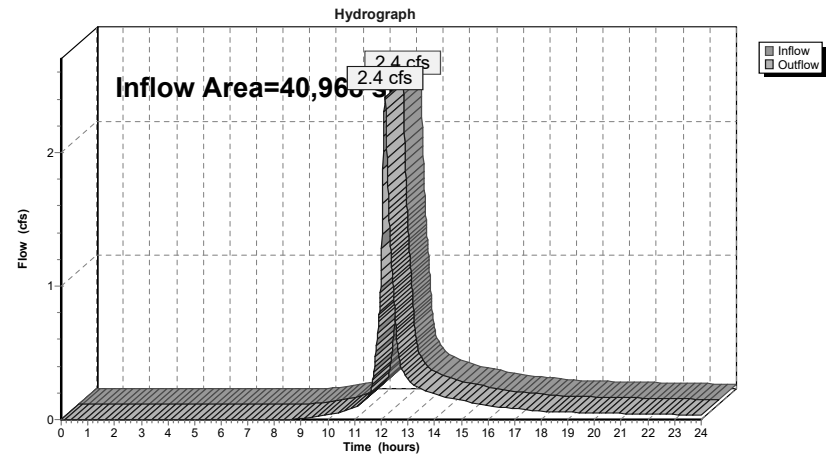
Summary for Reach 1R: Offsite East at High Plain Rd

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

Inflow Area = 40,968 sf, 23.85% Impervious, Inflow Depth > 2.50" for 10-Year event  
 Inflow = 2.4 cfs @ 12.14 hrs, Volume= 8,526 cf  
 Outflow = 2.4 cfs @ 12.14 hrs, Volume= 8,526 cf, Atten= 0%, Lag= 0.0 min  
 Routed to Reach 4R : Overall Offsite

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



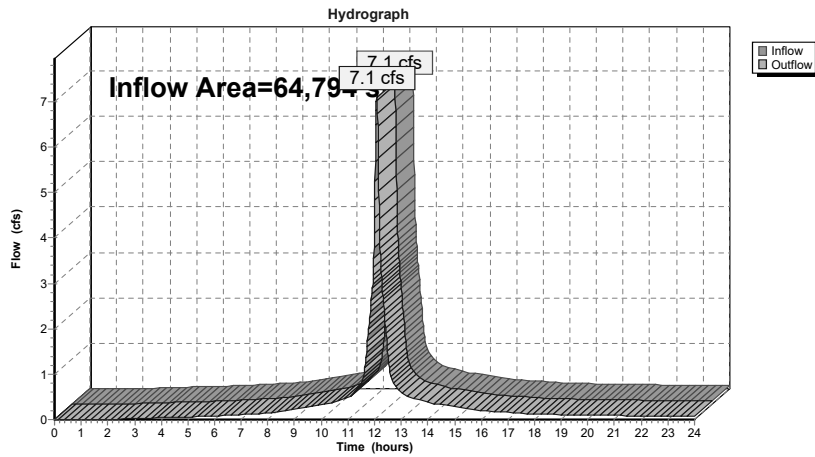
Summary for Reach 2R: Offsite from Path

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

Inflow Area = 64,794 sf, 0.00% Impervious, Inflow Depth > 4.49" for 10-Year event  
 Inflow = 7.1 cfs @ 12.08 hrs, Volume= 24,239 cf  
 Outflow = 7.1 cfs @ 12.08 hrs, Volume= 24,239 cf, Atten= 0%, Lag= 0.0 min  
 Routed to Reach 4R : Overall Offsite

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

Reach 2R: Offsite from Path



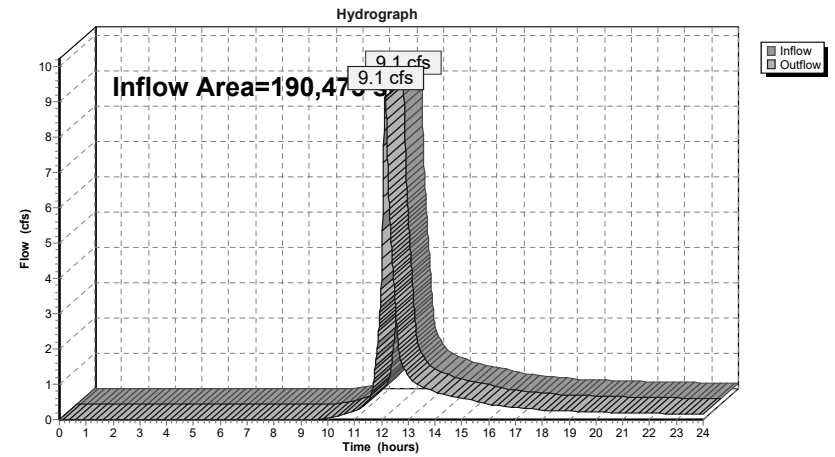
Summary for Reach 3R: Offsite East at Haggets Pond Rd

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

Inflow Area = 190,473 sf, 24.63% Impervious, Inflow Depth > 2.08" for 10-Year event  
 Inflow = 9.1 cfs @ 12.15 hrs, Volume= 33,037 cf  
 Outflow = 9.1 cfs @ 12.15 hrs, Volume= 33,037 cf, Atten= 0%, Lag= 0.0 min  
 Routed to Reach 4R : Overall Offsite

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

Reach 3R: Offsite East at Haggets Pond Rd



Summary for Reach 4R: Overall Offsite

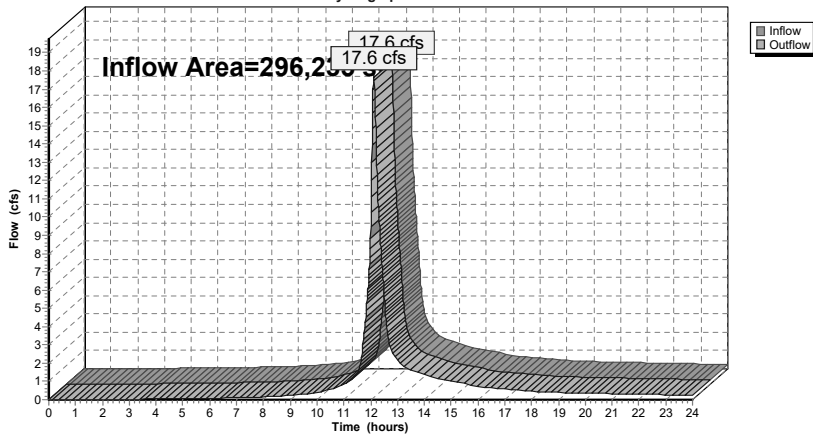
[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 296,235 sf, 19.14% Impervious, Inflow Depth > 2.67" for 10-Year event  
 Inflow = 17.6 cfs @ 12.12 hrs, Volume= 65,802 cf  
 Outflow = 17.6 cfs @ 12.12 hrs, Volume= 65,802 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 4R: Overall Offsite

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

**Subcatchment 1S: High Plain Rd** Runoff Area=40,968 sf 23.85% Impervious Runoff Depth>3.45"  
 Flow Length=118' Slope=0.0400 '/' Tc=9.9 min CN=76 Runoff=3.3 cfs 11,782 cf

**Subcatchment 2S: Existing Path** Runoff Area=64,794 sf 0.00% Impervious Runoff Depth>5.61"  
 Tc=6.0 min CN=96 Runoff=8.8 cfs 30,305 cf

**Subcatchment 3S: Haggetts Pond CB** Runoff Area=190,473 sf 24.63% Impervious Runoff Depth>2.96"  
 Flow Length=713' Tc=10.2 min CN=71 Runoff=13.2 cfs 47,062 cf

**Reach 1R: Offsite East at High Plain Rd** Inflow=3.3 cfs 11,782 cf  
 Outflow=3.3 cfs 11,782 cf

**Reach 2R: Offsite from Path** Inflow=8.8 cfs 30,305 cf  
 Outflow=8.8 cfs 30,305 cf

**Reach 3R: Offsite East at Haggetts Pond Rd** Inflow=13.2 cfs 47,062 cf  
 Outflow=13.2 cfs 47,062 cf

**Reach 4R: Overall Offsite** Inflow=24.1 cfs 89,149 cf  
 Outflow=24.1 cfs 89,149 cf

**Total Runoff Area = 296,235 sf Runoff Volume = 89,149 cf Average Runoff Depth = 3.61"**  
**80.86% Pervious = 239,547 sf 19.14% Impervious = 56,688 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**

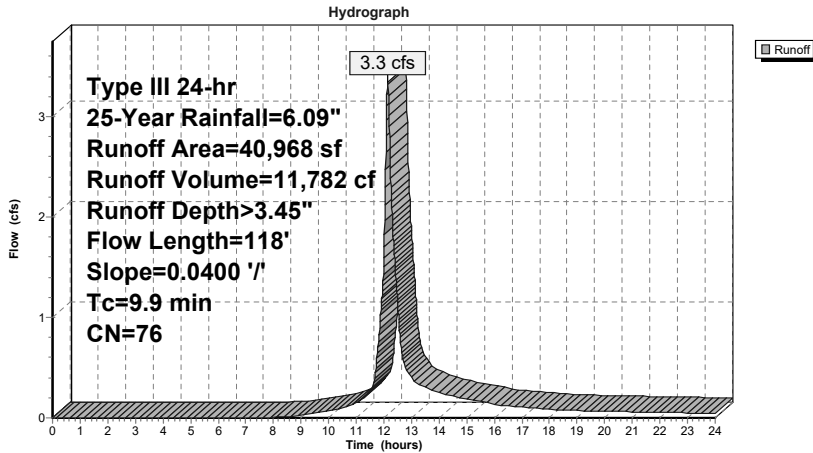
Runoff = 3.3 cfs @ 12.14 hrs, Volume= 11,782 cf, Depth> 3.45"  
Routed to Reach 1R : Offsite East at High Plain Rd

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
1,026	96	Gravel surface, HSG C
3,734	74	>75% Grass cover, Good, HSG C
1,726	30	Woods, Good, HSG A
24,712	70	Woods, Good, HSG C
9,770	98	Paved parking, HSG C
40,968	76	Weighted Average
31,198		76.15% Pervious Area
9,770		23.85% 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"
1.1	68	0.0400	1.00		<b>Shallow Concentrated Flow,</b> Woodland Kv= 5.0 fps
9.9	118	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: Existing Path**

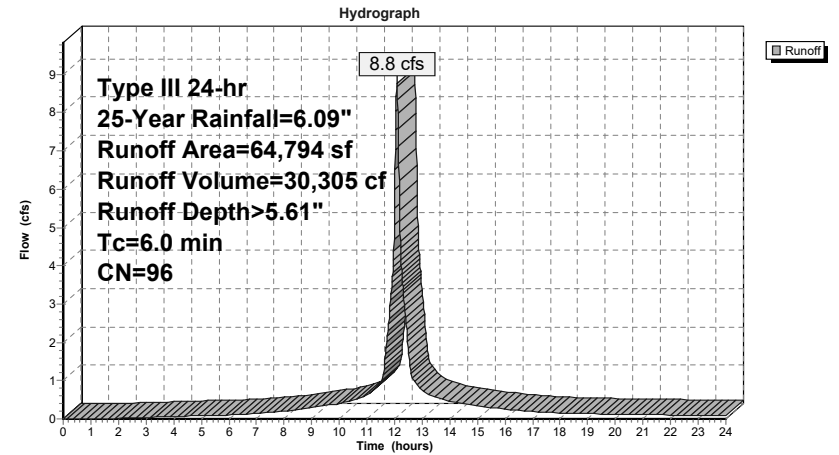
Runoff = 8.8 cfs @ 12.08 hrs, Volume= 30,305 cf, Depth> 5.61"  
Routed to Reach 2R : Offsite from Path

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
64,794	96	Gravel surface, HSG D
64,794		100.00% Pervious Area

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

**Subcatchment 2S: Existing Path**



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

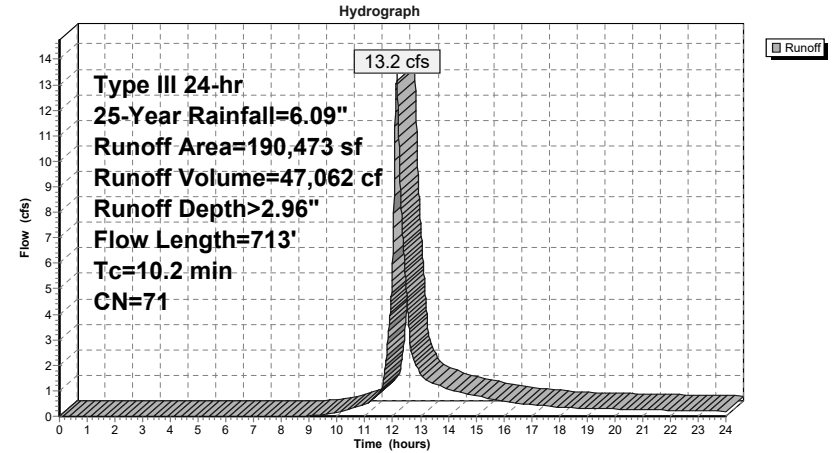
Runoff = 13.2 cfs @ 12.14 hrs, Volume= 47,062 cf, Depth> 2.96"  
 Routed to Reach 3R : Offsite East at Haggetts Pond Rd

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
* 23,399	98	Ex. paved parking, HSG A
* 21,360	98	Ex. Paved parking, HSG B
* 2,159	98	Ex. Paved parking, HSG C
* 22,439	39	>75% Ex. Grass cover, Good, HSG A
* 44,580	61	>75% Ex. Grass cover, Good, HSG B
* 13,232	74	>75% Ex. Grass cover, Good, HSG C
277	96	Gravel surface, HSG A
1,053	30	Woods, Good, HSG A
2,036	55	Woods, Good, HSG B
59,938	70	Woods, Good, HSG C
190,473	71	Weighted Average
143,555		75.37% Pervious Area
46,918		24.63% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.2	50	0.1500	0.16		<b>Sheet Flow,</b> Woods: Light underbrush n= 0.400 P2= 3.60"
3.8	307	0.0720	1.34		<b>Shallow Concentrated Flow,</b> Woodland Kv= 5.0 fps
1.2	356	0.0610	5.01		<b>Shallow Concentrated Flow,</b> Paved Kv= 20.3 fps
10.2	713	Total			

**Subcatchment 3S: Haggetts Pond CB**



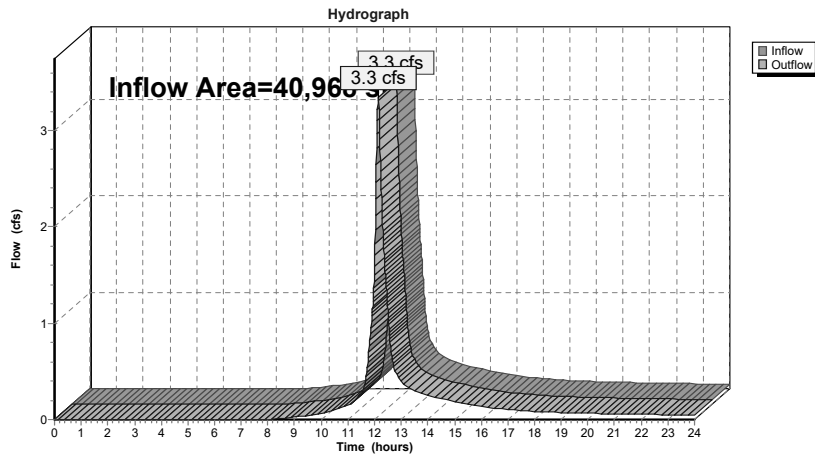
Summary for Reach 1R: Offsite East at High Plain Rd

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

Inflow Area = 40,968 sf, 23.85% Impervious, Inflow Depth > 3.45" for 25-Year event  
 Inflow = 3.3 cfs @ 12.14 hrs, Volume= 11,782 cf  
 Outflow = 3.3 cfs @ 12.14 hrs, Volume= 11,782 cf, Atten= 0%, Lag= 0.0 min  
 Routed to Reach 4R : Overall Offsite

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



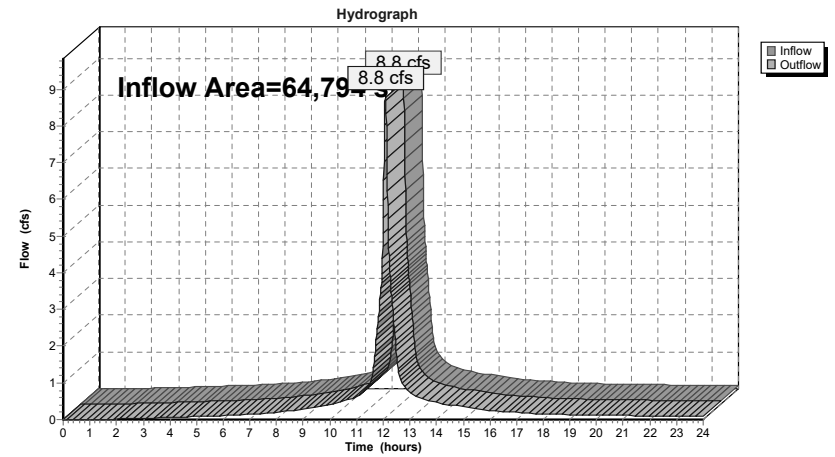
Summary for Reach 2R: Offsite from Path

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

Inflow Area = 64,794 sf, 0.00% Impervious, Inflow Depth > 5.61" for 25-Year event  
 Inflow = 8.8 cfs @ 12.08 hrs, Volume= 30,305 cf  
 Outflow = 8.8 cfs @ 12.08 hrs, Volume= 30,305 cf, Atten= 0%, Lag= 0.0 min  
 Routed to Reach 4R : Overall Offsite

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

Reach 2R: Offsite from Path



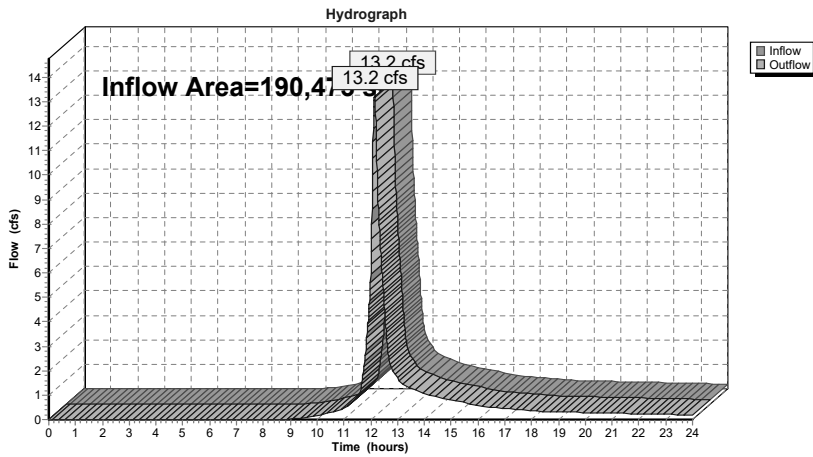
Summary for Reach 3R: Offsite East at Haggets Pond Rd

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

Inflow Area = 190,473 sf, 24.63% Impervious, Inflow Depth > 2.96" for 25-Year event  
 Inflow = 13.2 cfs @ 12.14 hrs, Volume= 47,062 cf  
 Outflow = 13.2 cfs @ 12.14 hrs, Volume= 47,062 cf, Atten= 0%, Lag= 0.0 min  
 Routed to Reach 4R : Overall Offsite

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

Reach 3R: Offsite East at Haggets Pond Rd



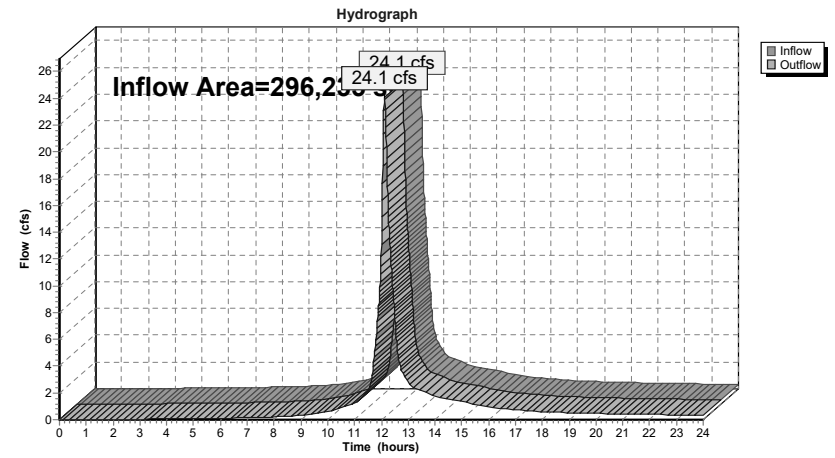
Summary for Reach 4R: Overall Offsite

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

Inflow Area = 296,235 sf, 19.14% Impervious, Inflow Depth > 3.61" for 25-Year event  
 Inflow = 24.1 cfs @ 12.12 hrs, Volume= 89,149 cf  
 Outflow = 24.1 cfs @ 12.12 hrs, Volume= 89,149 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 4R: Overall Offsite



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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=40,968 sf 23.85% Impervious Runoff Depth>5.00"  
Flow Length=118' Slope=0.0400 '/' Tc=9.9 min CN=76 Runoff=4.8 cfs 17,082 cf

**Subcatchment 2S: Existing Path** Runoff Area=64,794 sf 0.00% Impervious Runoff Depth>7.36"  
Tc=6.0 min CN=96 Runoff=11.4 cfs 39,715 cf

**Subcatchment 3S: Haggetts Pond CB** Runoff Area=190,473 sf 24.63% Impervious Runoff Depth>4.43"  
Flow Length=713' Tc=10.2 min CN=71 Runoff=19.8 cfs 70,342 cf

**Reach 1R: Offsite East at High Plain Rd** Inflow=4.8 cfs 17,082 cf  
Outflow=4.8 cfs 17,082 cf

**Reach 2R: Offsite from Path** Inflow=11.4 cfs 39,715 cf  
Outflow=11.4 cfs 39,715 cf

**Reach 3R: Offsite East at Haggetts Pond Rd** Inflow=19.8 cfs 70,342 cf  
Outflow=19.8 cfs 70,342 cf

**Reach 4R: Overall Offsite** Inflow=34.4 cfs 127,140 cf  
Outflow=34.4 cfs 127,140 cf

Total Runoff Area = 296,235 sf Runoff Volume = 127,140 cf Average Runoff Depth = 5.15"  
80.86% Pervious = 239,547 sf 19.14% Impervious = 56,688 sf

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

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

Runoff = 4.8 cfs @ 12.14 hrs, Volume= 17,082 cf, Depth> 5.00"  
Routed to Reach 1R : Offsite East at High Plain Rd

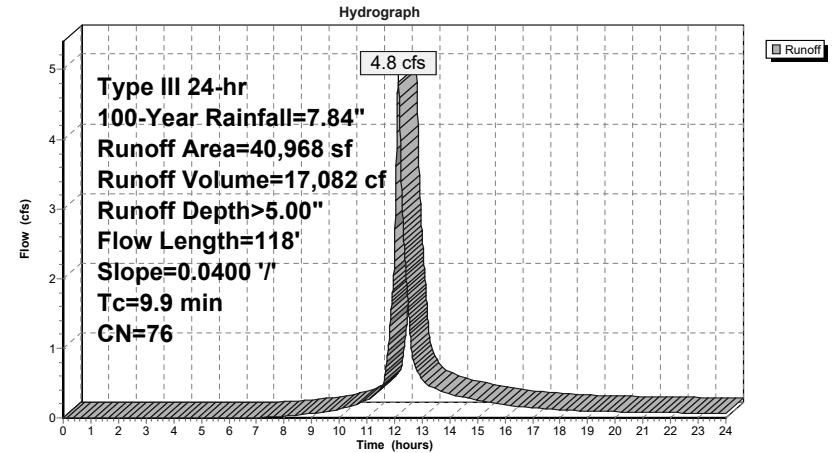
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs  
Type III 24-hr 100-Year Rainfall=7.84"

Area (sf)	CN	Description
1,026	96	Gravel surface, HSG C
3,734	74	>75% Grass cover, Good, HSG C
1,726	30	Woods, Good, HSG A
24,712	70	Woods, Good, HSG C
9,770	98	Paved parking, HSG C
40,968	76	Weighted Average
31,198		76.15% Pervious Area
9,770		23.85% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
8.8	50	0.0400	0.09		Sheet Flow, Woods: Light underbrush n= 0.400 P2= 3.60"
1.1	68	0.0400	1.00		Shallow Concentrated Flow, Woodland Kv= 5.0 fps
9.9	118	Total			

**Subcatchment 1S: High Plain Rd**



**8998501-PRE**

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

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**Summary for Subcatchment 2S: Existing Path**

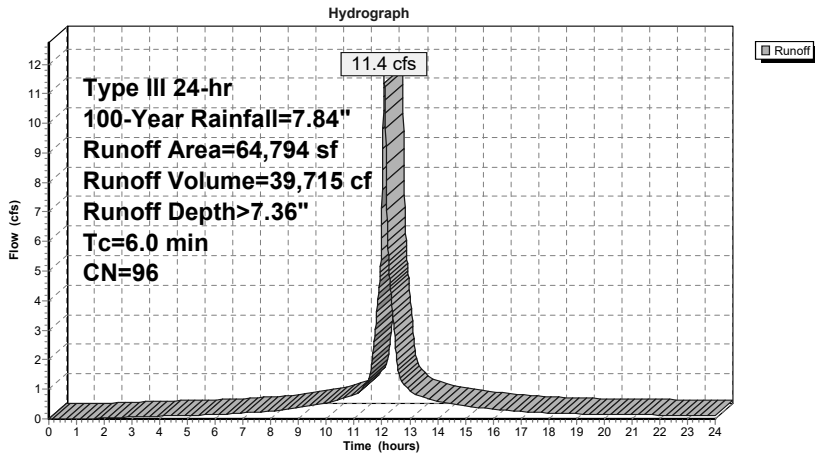
Runoff = 11.4 cfs @ 12.08 hrs, Volume= 39,715 cf, Depth> 7.36"  
Routed to Reach 2R : Offsite from Path

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
64,794	96	Gravel surface, HSG D
64,794		100.00% Pervious Area

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

**Subcatchment 2S: Existing Path**



**8998501-PRE**

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

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

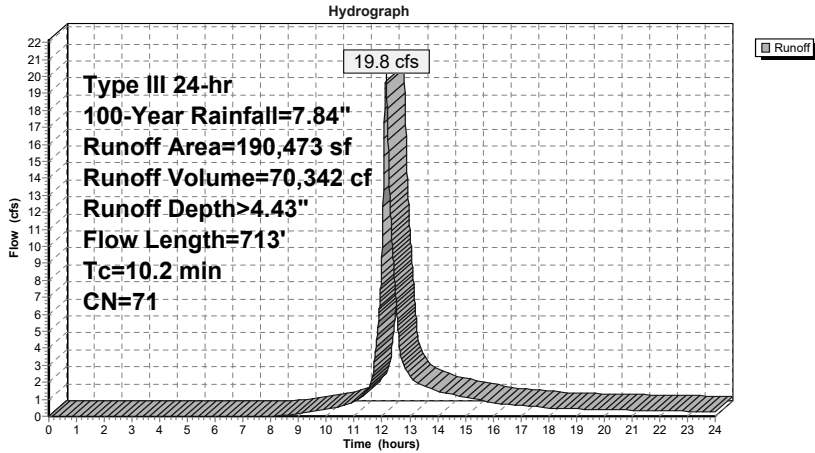
Runoff = 19.8 cfs @ 12.14 hrs, Volume= 70,342 cf, Depth> 4.43"  
Routed to Reach 3R : Offsite East at Haggetts Pond Rd

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
* 23,399	98	Ex. paved parking, HSG A
* 21,360	98	Ex. Paved parking, HSG B
* 2,159	98	Ex. Paved parking, HSG C
* 22,439	39	>75% Ex. Grass cover, Good, HSG A
* 44,580	61	>75% Ex. Grass cover, Good, HSG B
* 13,232	74	>75% Ex. Grass cover, Good, HSG C
	277	Gravel surface, HSG A
	1,053	Woods, Good, HSG A
	2,036	Woods, Good, HSG B
	59,938	Woods, Good, HSG C
190,473	71	Weighted Average
143,555		75.37% Pervious Area
46,918		24.63% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.2	50	0.1500	0.16		Sheet Flow, Woods: Light underbrush n= 0.400 P2= 3.60"
3.8	307	0.0720	1.34		Shallow Concentrated Flow, Woodland Kv= 5.0 fps
1.2	356	0.0610	5.01		Shallow Concentrated Flow, Paved Kv= 20.3 fps
10.2	713				Total

Subcatchment 3S: Haggetts Pond CB



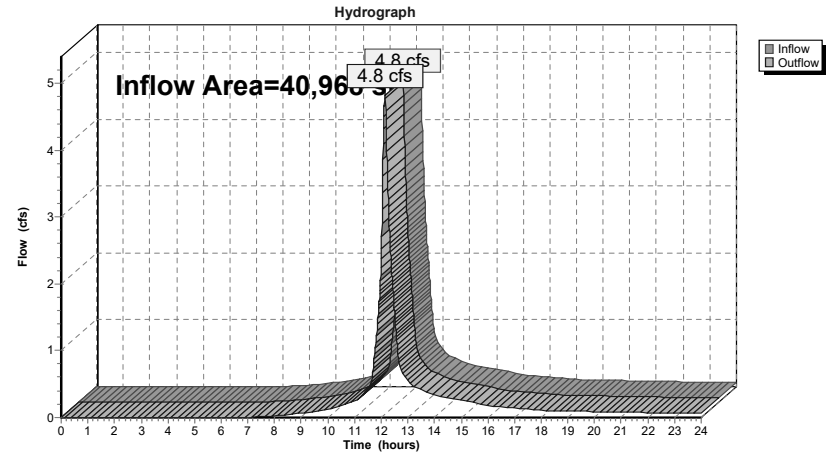
Summary for Reach 1R: Offsite East at High Plain Rd

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

Inflow Area = 40,968 sf, 23.85% Impervious, Inflow Depth > 5.00" for 100-Year event  
 Inflow = 4.8 cfs @ 12.14 hrs, Volume= 17,082 cf  
 Outflow = 4.8 cfs @ 12.14 hrs, Volume= 17,082 cf, Atten= 0%, Lag= 0.0 min  
 Routed to Reach 4R : Overall Offsite

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



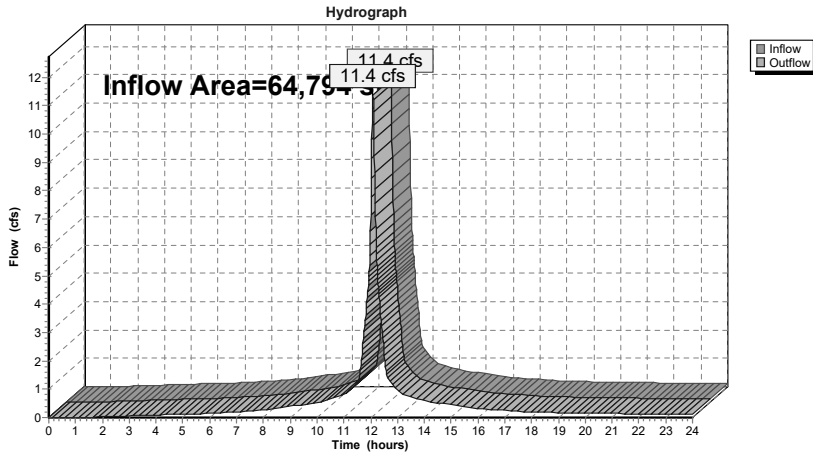
Summary for Reach 2R: Offsite from Path

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

Inflow Area = 64,794 sf, 0.00% Impervious, Inflow Depth > 7.36" for 100-Year event  
 Inflow = 11.4 cfs @ 12.08 hrs, Volume= 39,715 cf  
 Outflow = 11.4 cfs @ 12.08 hrs, Volume= 39,715 cf, Atten= 0%, Lag= 0.0 min  
 Routed to Reach 4R : Overall Offsite

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

Reach 2R: Offsite from Path



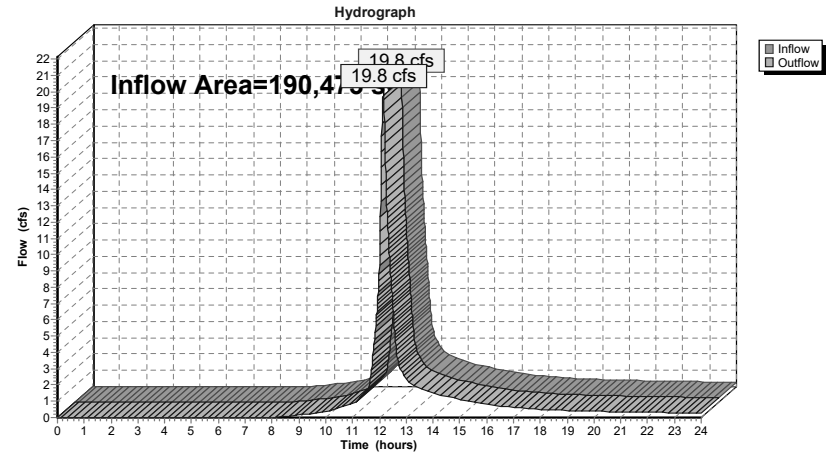
Summary for Reach 3R: Offsite East at Haggets Pond Rd

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

Inflow Area = 190,473 sf, 24.63% Impervious, Inflow Depth > 4.43" for 100-Year event  
 Inflow = 19.8 cfs @ 12.14 hrs, Volume= 70,342 cf  
 Outflow = 19.8 cfs @ 12.14 hrs, Volume= 70,342 cf, Atten= 0%, Lag= 0.0 min  
 Routed to Reach 4R : Overall Offsite

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

Reach 3R: Offsite East at Haggets Pond Rd



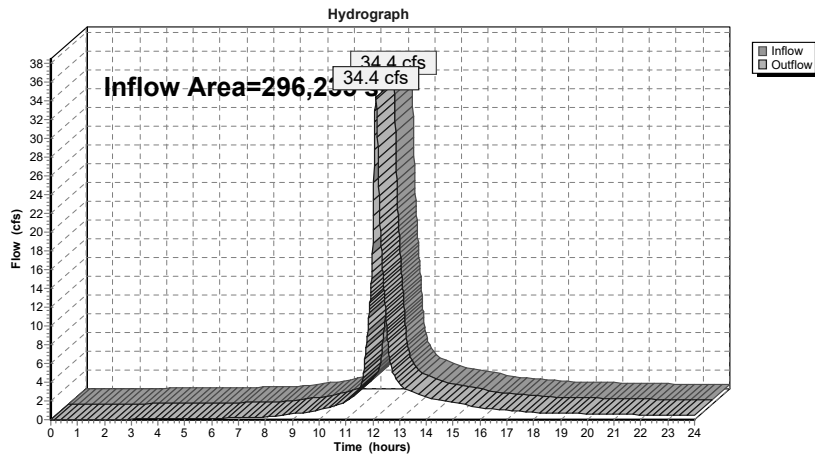
**Summary for Reach 4R: Overall Offsite**

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

Inflow Area = 296,235 sf, 19.14% Impervious, Inflow Depth > 5.15" for 100-Year event  
Inflow = 34.4 cfs @ 12.12 hrs, Volume= 127,140 cf  
Outflow = 34.4 cfs @ 12.12 hrs, Volume= 127,140 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 4R: Overall Offsite**



**5.03 POST-DEVELOPMENT HYDROLOGY WATERSHED PLAN**



PROFESSIONAL ENGINEER DATE

**HAGGETTS POND  
RAIL TRAIL**

IN  
ANDOVER,  
MASSACHUSETTS

**PROPOSED WATERSHED  
PLAN**

NOVEMBER 7, 2023

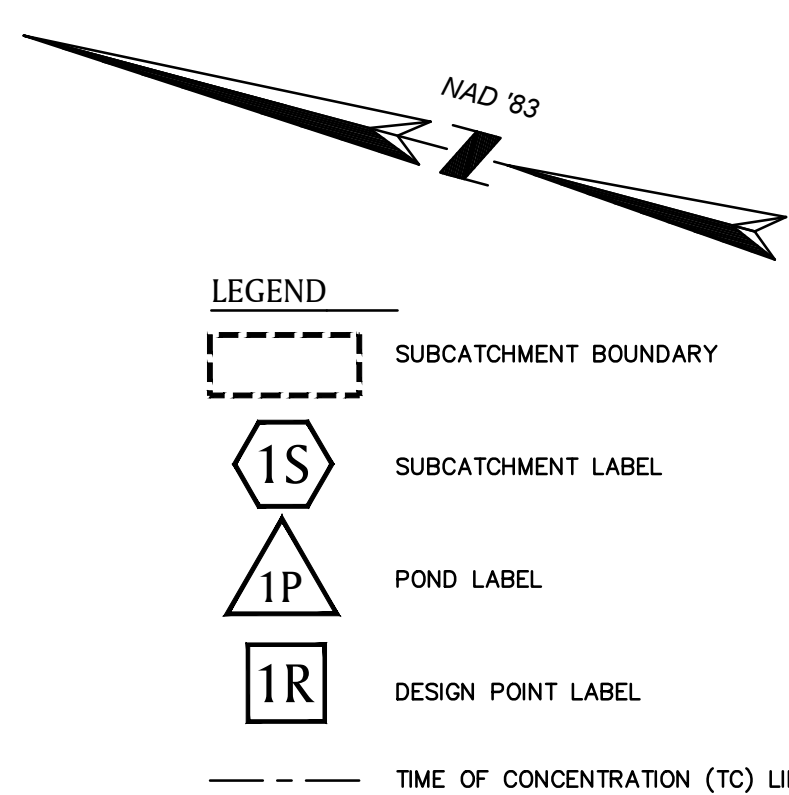
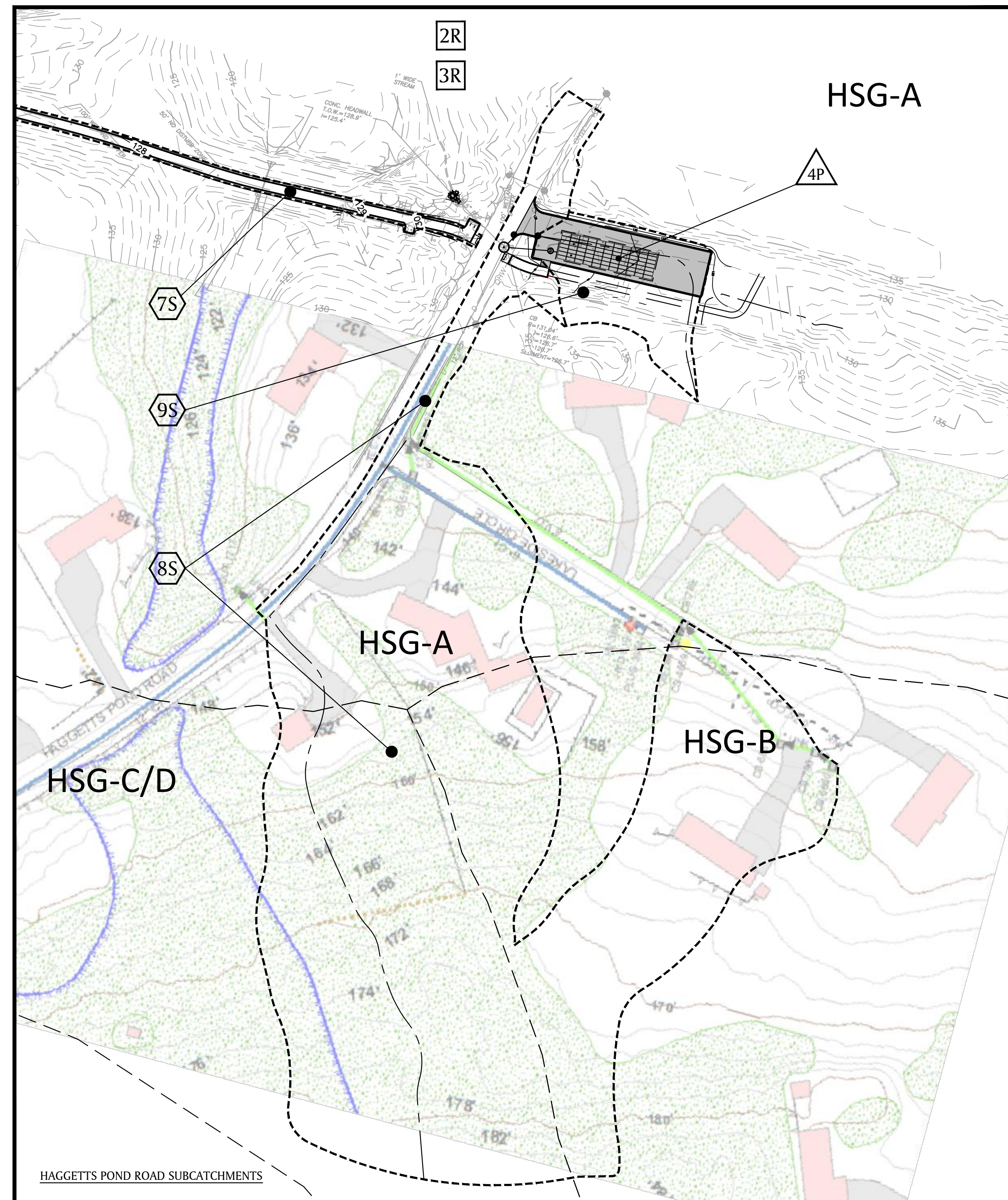
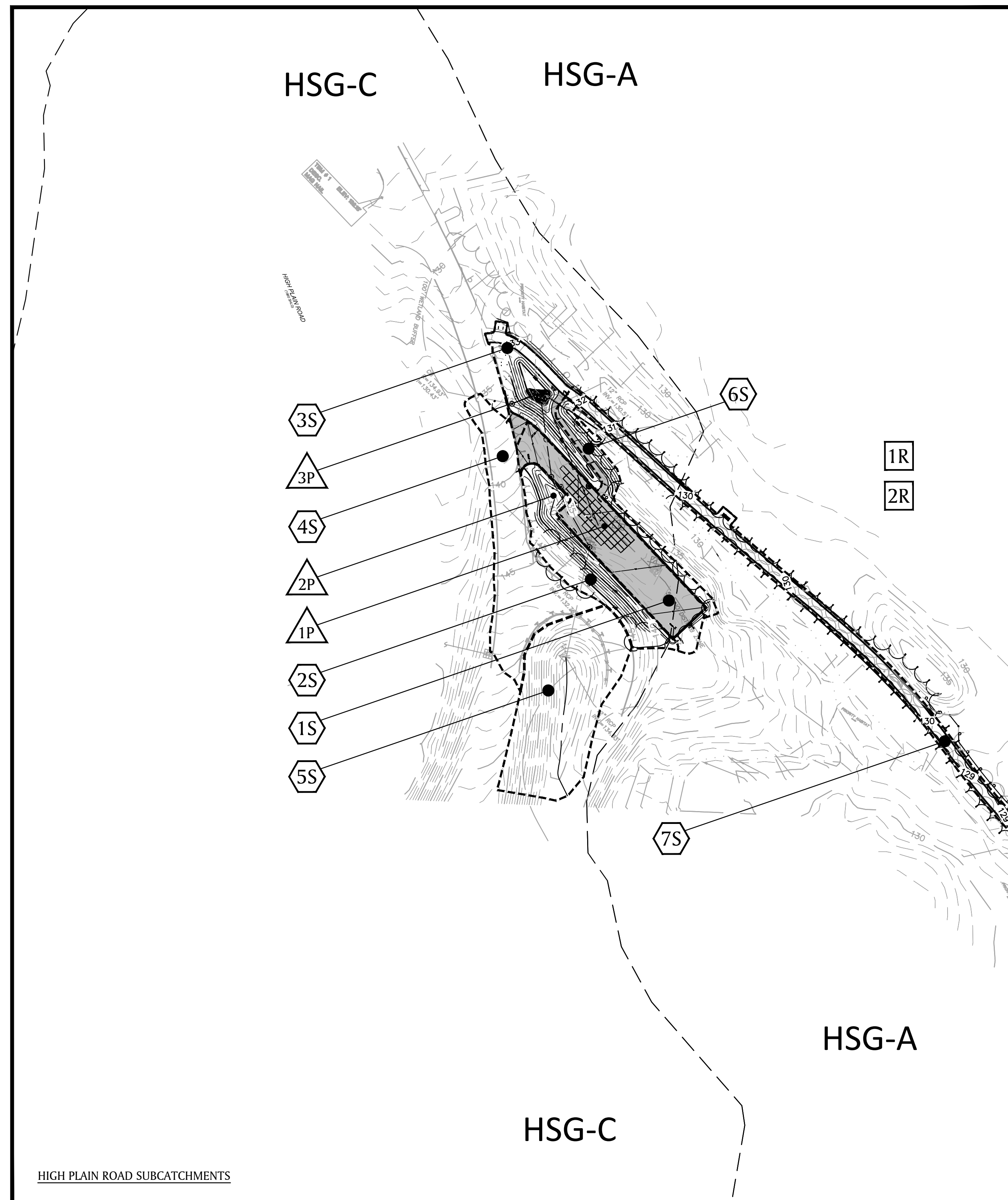
REVISIONS:

NO.	DATE	DESCRIPTION
1	12/21/23	REDUCED ENV. IMPACTS
2	4/16/24	PEER REVIEW COMMENTS
3	7/02/24	PEER REVIEW COMMENTS

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

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

© 2024 BSC GROUP, INC.  
SCALE: 1"=60'  
0 30 60 120 FEET  
FILE: P:\8998501\C\_DD\PC WSHED  
DWG.:  
JOB. NO: 8-9985.01 **PR-WSHD**



**ISSUED FOR PERMITTING  
NOT FOR CONSTRUCTION**

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

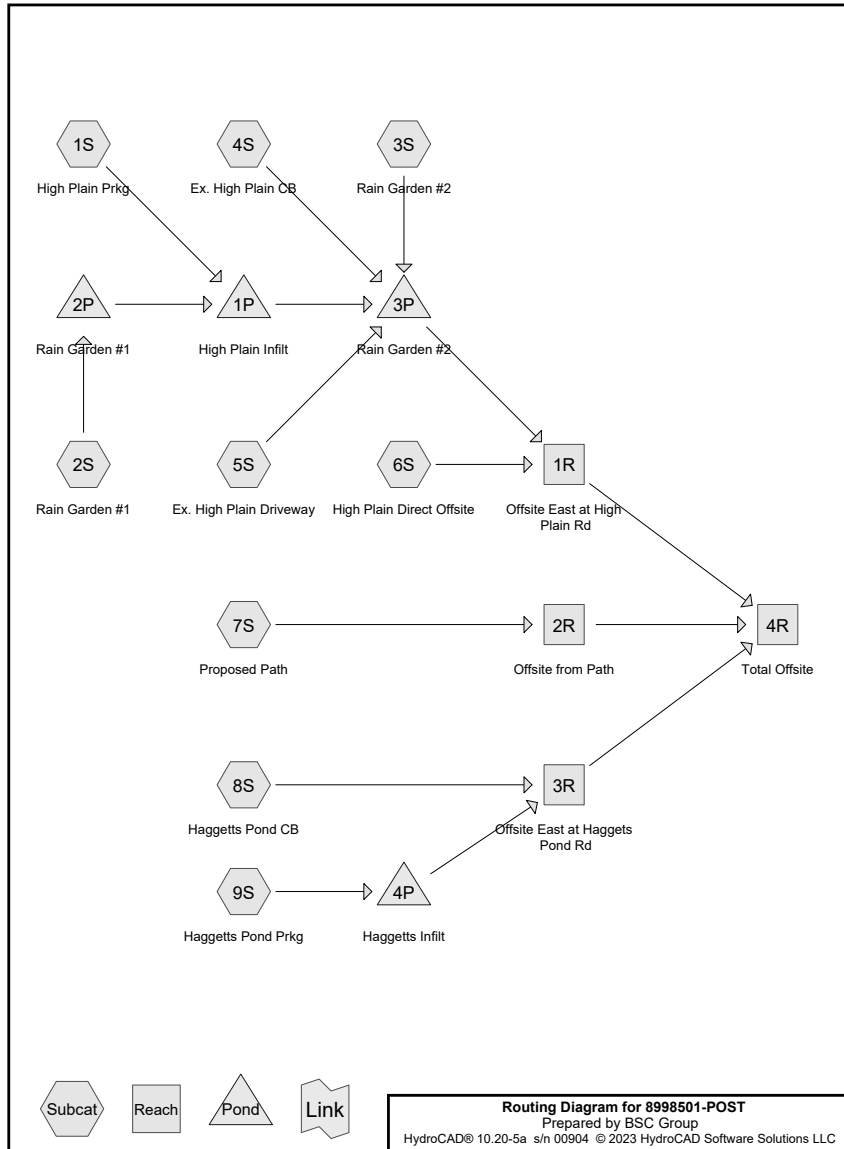
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**Rainfall Events Listing**

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)
22,247	39	>75% Ex. Grass cover, Good, HSG A (8S)
44,580	61	>75% Ex. Grass cover, Good, HSG B (8S)
14,644	74	>75% Ex. Grass cover, Good, HSG C (4S, 8S)
23,399	98	Ex. paved parking, HSG A (8S)
21,360	98	Ex. paved parking, HSG B (8S)
11,925	98	Ex. paved parking, HSG C (4S, 5S, 8S)
61	76	Gravel roads, HSG A (8S)
21,681	96	Gravel surface, HSG D (3S, 7S)
4,398	43	Mulch, HSG A (1S, 2S, 6S, 8S, 9S)
8,172	76	Mulch, HSG C (2S, 3S, 6S)
7,414	98	New paved parking, HSG A (1S, 8S, 9S)
8,048	98	New paved parking, HSG C (1S, 3S, 6S)
44,046	98	New paved parking, HSG D (7S)
7,275	30	Woods, Good, HSG A (1S, 2S, 8S, 9S)
2,036	55	Woods, Good, HSG B (8S)
71,700	70	Woods, Good, HSG C (2S, 3S, 5S, 8S)
<b>312,986</b>	<b>78</b>	<b>TOTAL AREA</b>

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**Soil Listing (all nodes)**

Area (sq-ft)	Soil Group	Subcatchment Numbers
64,794	HSG A	1S, 2S, 6S, 8S, 9S
67,976	HSG B	8S
114,489	HSG C	1S, 2S, 3S, 4S, 5S, 6S, 8S
65,727	HSG D	3S, 7S
0	Other	
<b>312,986</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
22,247	44,580	14,644	0	0	81,471	>75% Ex. Grass cover, Good
23,399	21,360	11,925	0	0	56,684	Ex. paved parking
61	0	0	0	0	61	Gravel roads
0	0	0	21,681	0	21,681	Gravel surface
4,398	0	8,172	0	0	12,570	Mulch
7,414	0	8,048	44,046	0	59,508	New paved parking
7,275	2,036	71,700	0	0	81,011	Woods, Good
<b>64,794</b>	<b>67,976</b>	<b>114,489</b>	<b>65,727</b>	<b>0</b>	<b>312,986</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

<b>Subcatchment 1S: High Plain Prkg</b>	Runoff Area=7,616 sf 93.36% Impervious Runoff Depth>2.48" Tc=6.0 min CN=94 Runoff=0.5 cfs 1,576 cf
<b>Subcatchment 2S: Rain Garden #1</b>	Runoff Area=5,635 sf 0.00% Impervious Runoff Depth>1.00" Flow Length=193' Tc=7.5 min CN=74 Runoff=0.1 cfs 468 cf
<b>Subcatchment 3S: Rain Garden #2</b>	Runoff Area=4,486 sf 23.83% Impervious Runoff Depth>1.42" Tc=6.0 min CN=81 Runoff=0.2 cfs 531 cf
<b>Subcatchment 4S: Ex. High Plain CB</b>	Runoff Area=9,171 sf 84.60% Impervious Runoff Depth>2.48" Tc=6.0 min CN=94 Runoff=0.6 cfs 1,898 cf
<b>Subcatchment 5S: Ex. High Plain Driveway</b>	Runoff Area=11,508 sf 17.44% Impervious Runoff Depth>1.05" Flow Length=121' Tc=8.4 min CN=75 Runoff=0.3 cfs 1,008 cf
<b>Subcatchment 6S: High Plain Direct Offsite</b>	Runoff Area=2,552 sf 21.87% Impervious Runoff Depth>1.05" Tc=6.0 min CN=75 Runoff=0.1 cfs 224 cf
<b>Subcatchment 7S: Proposed Path</b>	Runoff Area=65,644 sf 67.10% Impervious Runoff Depth>2.79" Tc=6.0 min CN=97 Runoff=4.5 cfs 15,288 cf
<b>Subcatchment 8S: Haggetts Pond CB</b>	Runoff Area=193,579 sf 24.74% Impervious Runoff Depth>0.84" Flow Length=713' Tc=10.2 min CN=71 Runoff=3.4 cfs 13,547 cf
<b>Subcatchment 9S: Haggetts Pond Prkg</b>	Runoff Area=12,795 sf 44.89% Impervious Runoff Depth>0.49" Flow Length=246' Tc=11.4 min CN=63 Runoff=0.1 cfs 523 cf
<b>Reach 1R: Offsite East at High Plain Rd</b>	Inflow=1.0 cfs 2,327 cf Outflow=1.0 cfs 2,327 cf
<b>Reach 2R: Offsite from Path</b>	Inflow=4.5 cfs 15,288 cf Outflow=4.5 cfs 15,288 cf
<b>Reach 3R: Offsite East at Haggetts Pond Rd</b>	Inflow=3.4 cfs 13,547 cf Outflow=3.4 cfs 13,547 cf
<b>Reach 4R: Total Offsite</b>	Inflow=8.3 cfs 31,163 cf Outflow=8.3 cfs 31,163 cf
<b>Pond 1P: High Plain Infiltr</b>	Peak Elev=134.42' Storage=455 cf Inflow=0.5 cfs 1,891 cf Discarded=0.1 cfs 1,892 cf Primary=0.0 cfs 0 cf Outflow=0.1 cfs 1,892 cf
<b>Pond 2P: Rain Garden #1</b>	Peak Elev=136.53' Storage=162 cf Inflow=0.1 cfs 468 cf Outflow=0.1 cfs 315 cf
<b>Pond 3P: Rain Garden #2</b>	Peak Elev=130.75' Storage=320 cf Inflow=1.0 cfs 3,437 cf Discarded=0.0 cfs 1,317 cf Primary=0.9 cfs 2,104 cf Outflow=0.9 cfs 3,420 cf

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

**Pond 4P: Haggetts Infil**

Peak Elev=129.00' Storage=0 cf Inflow=0.1 cfs 523 cf  
Discarded=0.1 cfs 523 cf Primary=0.0 cfs 0 cf Outflow=0.1 cfs 523 cf

**Total Runoff Area = 312,986 sf Runoff Volume = 35,063 cf Average Runoff Depth = 1.34"**  
**62.88% Pervious = 196,794 sf 37.12% Impervious = 116,192 sf**

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

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

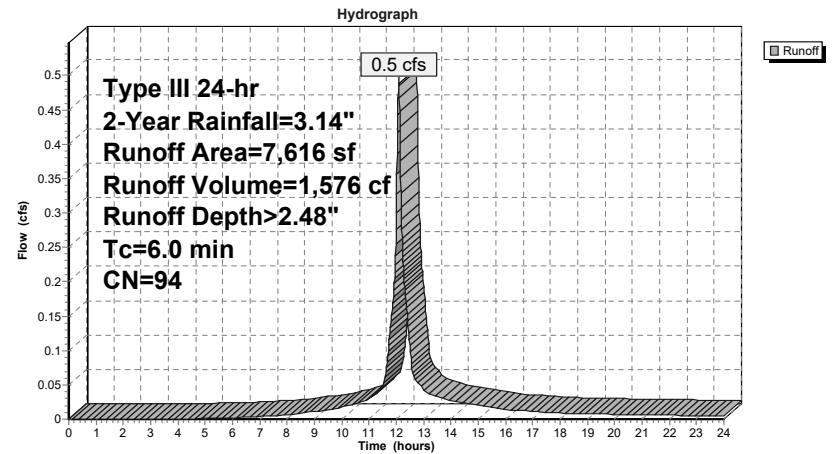
Runoff = 0.5 cfs @ 12.08 hrs, Volume= 1,576 cf, Depth> 2.48"  
Routed to Pond 1P : High Plain Infil

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
* 189	43	Mulch, HSG A
317	30	Woods, Good, HSG A
* 689	98	New paved parking, HSG A
* 6,421	98	New paved parking, HSG C
7,616	94	Weighted Average
506		6.64% Pervious Area
7,110		93.36% Impervious Area

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

**Subcatchment 1S: High Plain Prkg**



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

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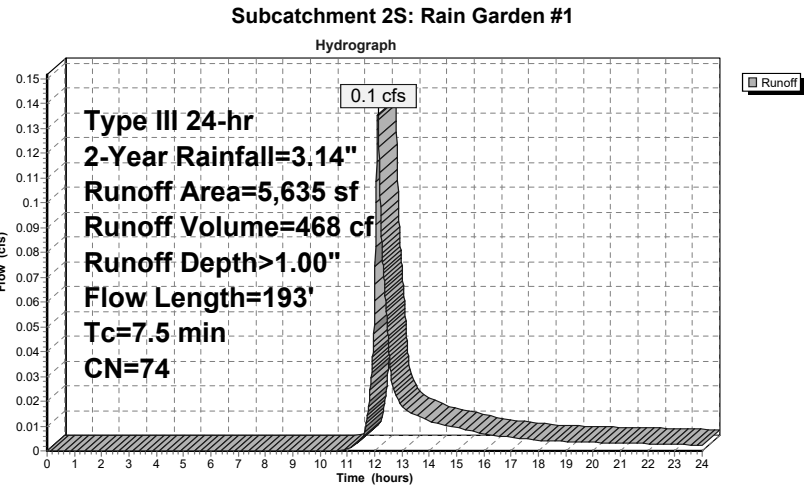
**Summary for Subcatchment 2S: Rain Garden #1**

Runoff = 0.1 cfs @ 12.12 hrs, Volume= 468 cf, Depth> 1.00"  
Routed to Pond 2P : 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
* 33	43	Mulch, HSG A
* 3,911	76	Mulch, HSG C
38	30	Woods, Good, HSG A
1,653	70	Woods, Good, HSG C
5,635	74	Weighted Average
5,635		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.2	33	0.1700	0.09		<b>Sheet Flow,</b> Woods: Dense underbrush n= 0.800 P2= 3.60"
0.1	17	0.1300	2.52		<b>Shallow Concentrated Flow,</b> Short Grass Pasture Kv= 7.0 fps
1.2	143	0.0175	1.98		<b>Shallow Concentrated Flow,</b> Grassed Waterway Kv= 15.0 fps



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

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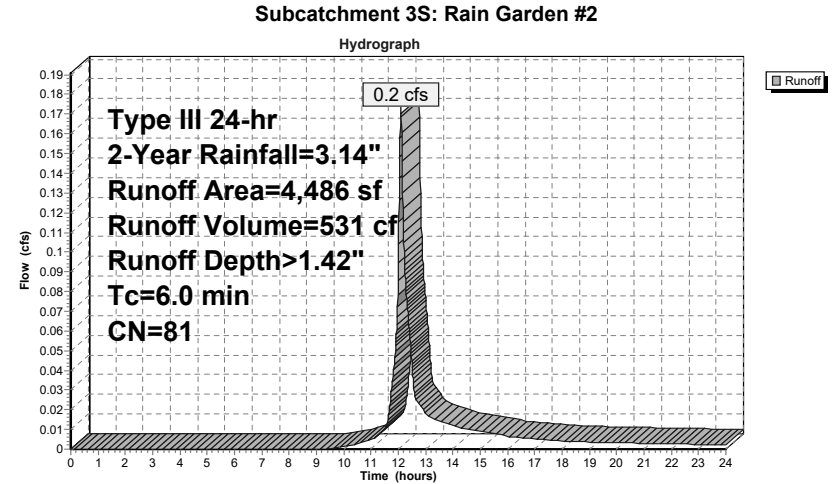
**Summary for Subcatchment 3S: Rain Garden #2**

Runoff = 0.2 cfs @ 12.09 hrs, Volume= 531 cf, Depth> 1.42"  
Routed to Pond 3P : Rain Garden #2

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

Area (sf)	CN	Description
* 2,726	76	Mulch, HSG C
83	96	Gravel surface, HSG D
608	70	Woods, Good, HSG C
* 1,069	98	New paved parking, HSG C
4,486	81	Weighted Average
3,417		76.17% Pervious Area
1,069		23.83% Impervious Area

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



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

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**Summary for Subcatchment 4S: Ex. High Plain CB**

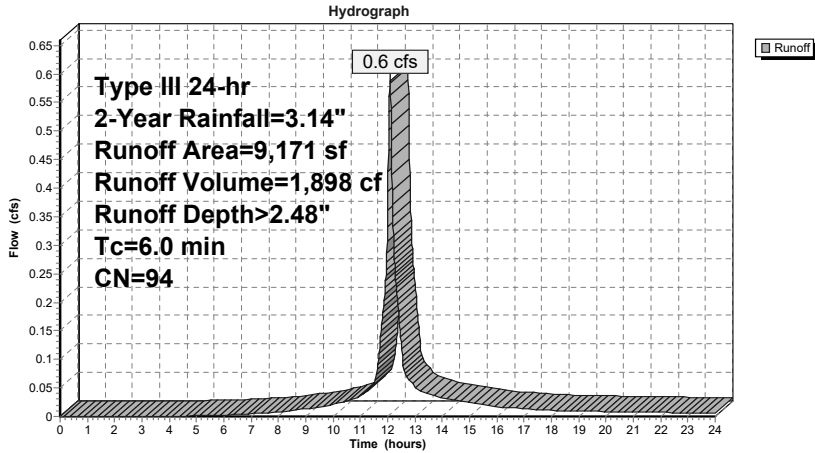
Runoff = 0.6 cfs @ 12.08 hrs, Volume= 1,898 cf, Depth> 2.48"  
Routed to Pond 3P : Rain Garden #2

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

Area (sf)	CN	Description
* 1,412	74	>75% Ex. Grass cover, Good, HSG C
* 7,759	98	Ex. paved parking, HSG C
9,171	94	Weighted Average
1,412		15.40% Pervious Area
7,759		84.60% Impervious Area

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

**Subcatchment 4S: Ex. High Plain CB**



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

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**Summary for Subcatchment 5S: Ex. High Plain Driveway**

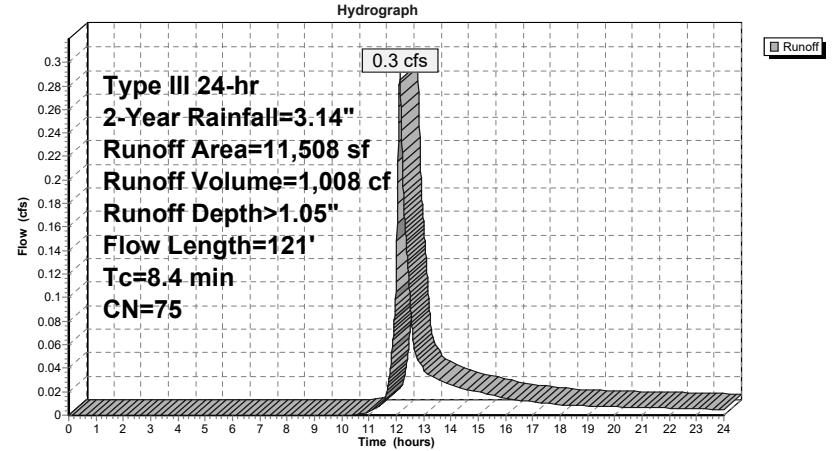
Runoff = 0.3 cfs @ 12.13 hrs, Volume= 1,008 cf, Depth> 1.05"  
Routed to Pond 3P : Rain Garden #2

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

Area (sf)	CN	Description
9,501	70	Woods, Good, HSG C
* 2,007	98	Ex. paved parking, HSG C
11,508	75	Weighted Average
9,501		82.56% Pervious Area
2,007		17.44% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.0	50	0.0710	0.12		<b>Sheet Flow,</b> Woods: Light underbrush n= 0.400 P2= 3.60"
1.4	71	0.0290	0.85		<b>Shallow Concentrated Flow,</b> Woodland Kv= 5.0 fps
8.4	121				<b>Total</b>

**Subcatchment 5S: Ex. High Plain Driveway**



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

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**Summary for Subcatchment 6S: High Plain Direct Offsite**

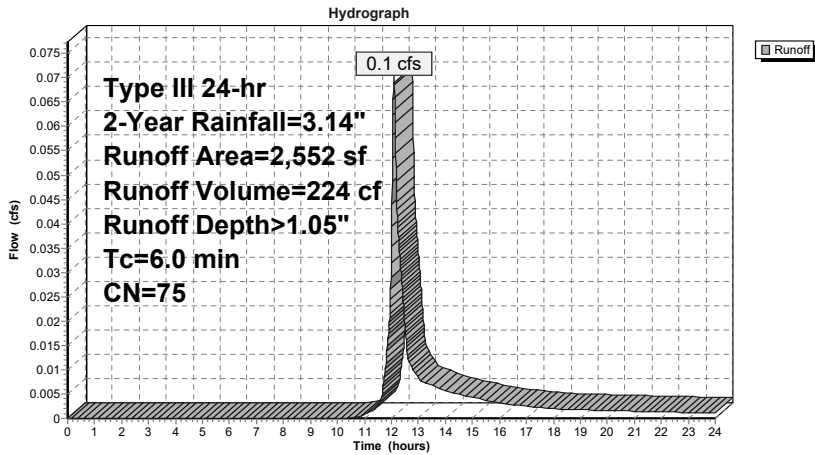
Runoff = 0.1 cfs @ 12.10 hrs, Volume= 224 cf, Depth> 1.05"  
Routed to Reach 1R : Offsite East at High Plain Rd

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
* 459	43	Mulch, HSG A
* 1,535	76	Mulch, HSG C
* 558	98	New paved parking, HSG C
2,552	75	Weighted Average
1,994		78.13% Pervious Area
558		21.87% Impervious Area

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

**Subcatchment 6S: High Plain Direct Offsite**



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

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**Summary for Subcatchment 7S: Proposed Path**

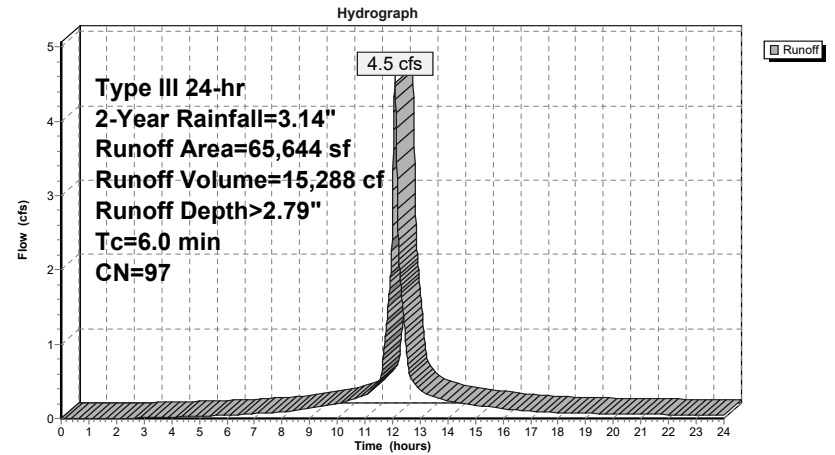
Runoff = 4.5 cfs @ 12.08 hrs, Volume= 15,288 cf, Depth> 2.79"  
Routed to Reach 2R : Offsite from Path

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
* 44,046	98	New paved parking, HSG D
21,598	96	Gravel surface, HSG D
65,644	97	Weighted Average
21,598		32.90% Pervious Area
44,046		67.10% Impervious Area

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

**Subcatchment 7S: Proposed Path**



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

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**Summary for Subcatchment 8S: Haggetts Pond CB**

Runoff = 3.4 cfs @ 12.16 hrs, Volume= 13,547 cf, Depth> 0.84"  
 Routed to Reach 3R : 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
* 981	98	New paved parking, HSG A
* 23,399	98	Ex. paved parking, HSG A
* 21,360	98	Ex. paved parking, HSG B
* 2,159	98	Ex. paved parking, HSG C
* 1,056	43	Mulch, HSG A
* 22,247	39	>75% Ex. Grass cover, Good, HSG A
* 44,580	61	>75% Ex. Grass cover, Good, HSG B
* 13,232	74	>75% Ex. Grass cover, Good, HSG C
61	76	Gravel roads, HSG A
2,530	30	Woods, Good, HSG A
2,036	55	Woods, Good, HSG B
59,938	70	Woods, Good, HSG C
193,579	71	Weighted Average
145,680		75.26% Pervious Area
47,899		24.74% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.2	50	0.1500	0.16		<b>Sheet Flow,</b> Woods: Light underbrush n= 0.400 P2= 3.60"
3.8	307	0.0720	1.34		<b>Shallow Concentrated Flow,</b> Woodland Kv= 5.0 fps
1.2	356	0.0610	5.01		<b>Shallow Concentrated Flow,</b> Paved Kv= 20.3 fps
10.2	713	Total			

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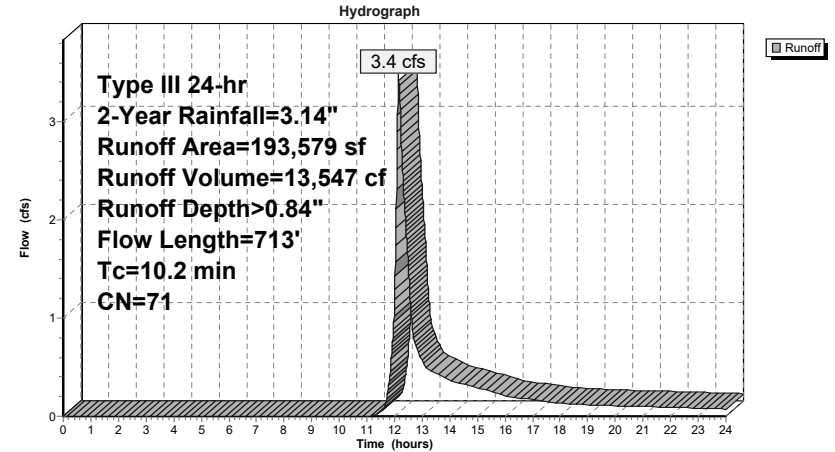
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Type III 24-hr 2-Year Rainfall=3.14"

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**Subcatchment 8S: Haggetts Pond CB**



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

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**Summary for Subcatchment 9S: Haggetts Pond Prkg**

Runoff = 0.1 cfs @ 12.20 hrs, Volume= 523 cf, Depth > 0.49"  
 Routed to Pond 4P : Haggetts Infiltr

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
* 5,744	98	New paved parking, HSG A
* 2,661	43	Mulch, HSG A
4,390	30	Woods, Good, HSG A
12,795	63	Weighted Average
7,051		55.11% Pervious Area
5,744		44.89% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
9.1	50	0.0370	0.09		<b>Sheet Flow,</b> Woods: Light underbrush n= 0.400 P2= 3.60"
0.2	11	0.0370	0.96		<b>Shallow Concentrated Flow,</b> Woodland Kv= 5.0 fps
0.0	8	0.3660	3.02		<b>Shallow Concentrated Flow,</b> Woodland Kv= 5.0 fps
0.7	13	0.0043	0.33		<b>Shallow Concentrated Flow,</b> Woodland Kv= 5.0 fps
0.3	10	0.0043	0.66		<b>Shallow Concentrated Flow,</b> Nearly Bare & Untilled Kv= 10.0 fps
1.1	154	0.0130	2.31		<b>Shallow Concentrated Flow,</b> Paved Kv= 20.3 fps
11.4	246	Total			

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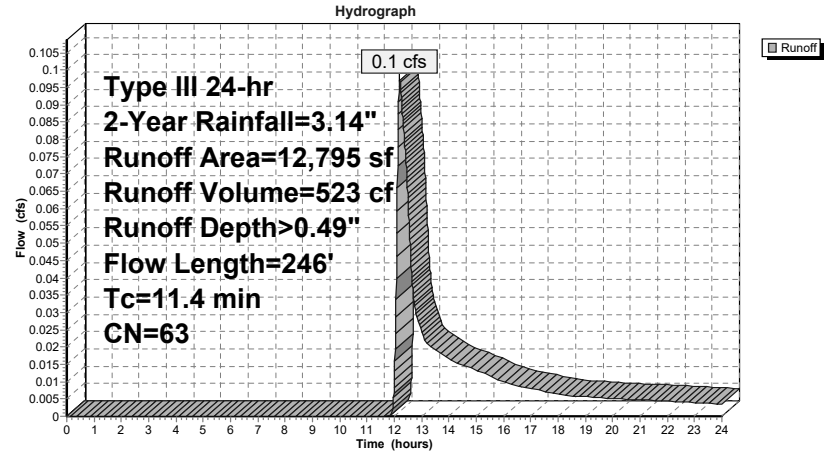
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Type III 24-hr 2-Year Rainfall=3.14"

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**Subcatchment 9S: Haggetts Pond Prkg**



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

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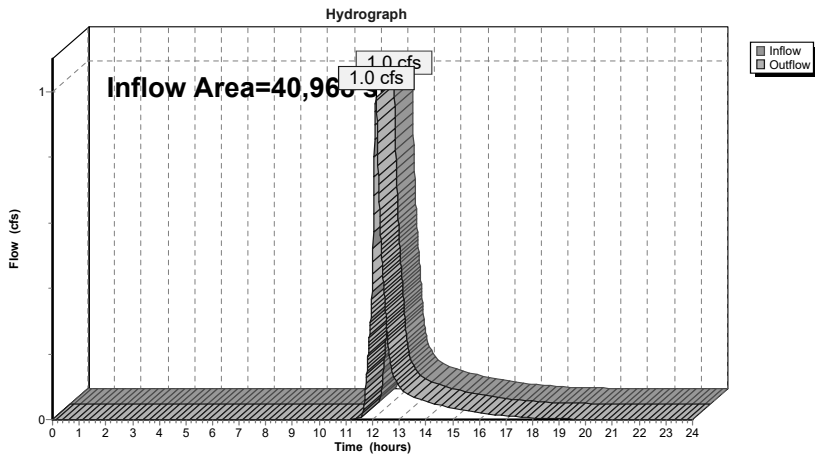
**Summary for Reach 1R: Offsite East at High Plain Rd**

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

Inflow Area = 40,968 sf, 45.16% Impervious, Inflow Depth > 0.68" for 2-Year event  
 Inflow = 1.0 cfs @ 12.13 hrs, Volume= 2,327 cf  
 Outflow = 1.0 cfs @ 12.13 hrs, Volume= 2,327 cf, Atten= 0%, Lag= 0.0 min  
 Routed to Reach 4R : Total Offsite

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**



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

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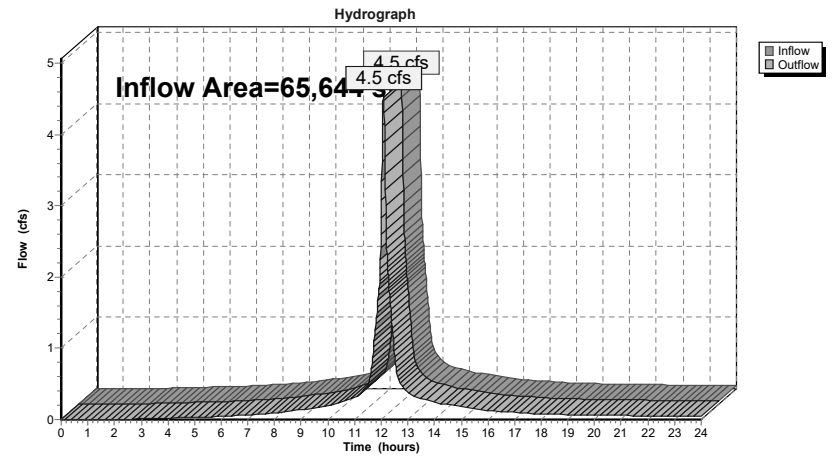
**Summary for Reach 2R: Offsite from Path**

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

Inflow Area = 65,644 sf, 67.10% Impervious, Inflow Depth > 2.79" for 2-Year event  
 Inflow = 4.5 cfs @ 12.08 hrs, Volume= 15,288 cf  
 Outflow = 4.5 cfs @ 12.08 hrs, Volume= 15,288 cf, Atten= 0%, Lag= 0.0 min  
 Routed to Reach 4R : Total Offsite

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

**Reach 2R: Offsite from Path**



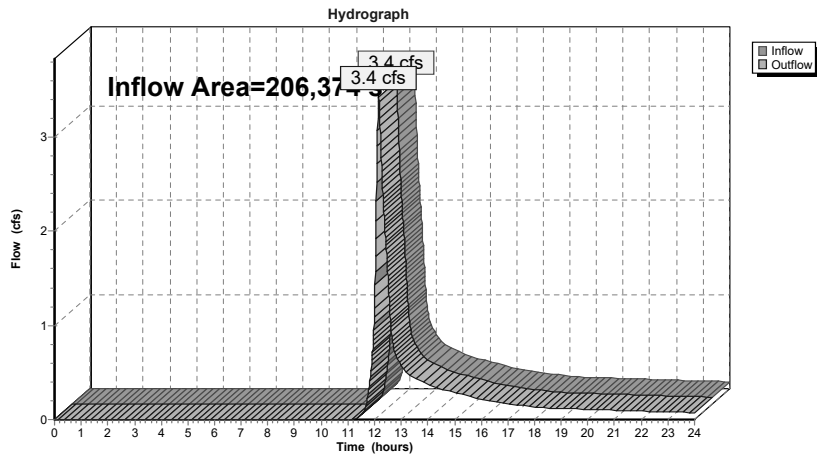
Summary for Reach 3R: Offsite East at Haggets Pond Rd

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

Inflow Area = 206,374 sf, 25.99% Impervious, Inflow Depth > 0.79" for 2-Year event  
 Inflow = 3.4 cfs @ 12.16 hrs, Volume= 13,547 cf  
 Outflow = 3.4 cfs @ 12.16 hrs, Volume= 13,547 cf, Atten= 0%, Lag= 0.0 min  
 Routed to Reach 4R : Total Offsite

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

Reach 3R: Offsite East at Haggets Pond Rd



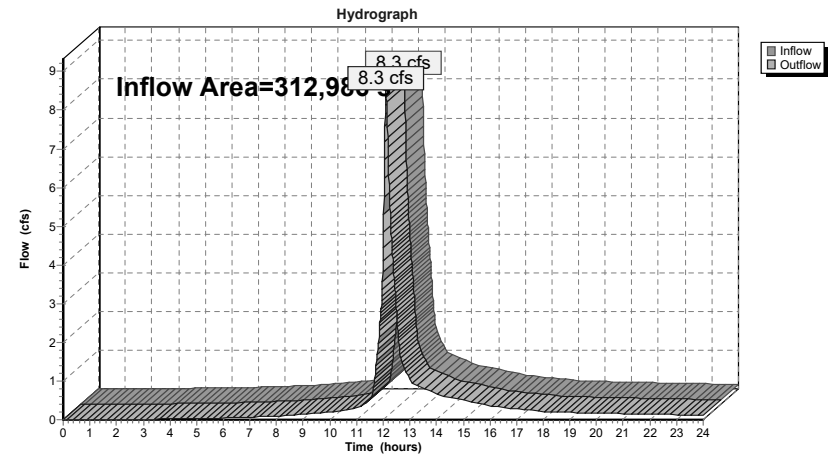
Summary for Reach 4R: Total Offsite

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

Inflow Area = 312,986 sf, 37.12% Impervious, Inflow Depth > 1.19" for 2-Year event  
 Inflow = 8.3 cfs @ 12.11 hrs, Volume= 31,163 cf  
 Outflow = 8.3 cfs @ 12.11 hrs, Volume= 31,163 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 4R: Total Offsite



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

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**Summary for Pond 1P: High Plain Infiltr**

[87] Warning: Oscillations may require smaller dt or Finer Routing (severity=426)

Inflow Area = 13,251 sf, 53.66% Impervious, Inflow Depth > 1.71" for 2-Year event  
 Inflow = 0.5 cfs @ 12.08 hrs, Volume= 1,891 cf  
 Outflow = 0.1 cfs @ 12.64 hrs, Volume= 1,892 cf, Atten= 81%, Lag= 33.5 min  
 Discarded = 0.1 cfs @ 12.64 hrs, Volume= 1,892 cf  
 Primary = 0.0 cfs @ 0.00 hrs, Volume= 0 cf  
 Routed to Pond 3P : Rain Garden #2

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs  
 Peak Elev= 134.42' @ 12.64 hrs Surf.Area= 1,536 sf Storage= 455 cf  
 Flood Elev= 135.80' Surf.Area= 1,536 sf Storage= 1,852 cf

Plug-Flow detention time= (not calculated: outflow precedes inflow)  
 Center-of-Mass det. time= 30.3 min ( 841.9 - 811.7 )

Volume	Invert	Avail.Storage	Storage Description
#1A	133.80'	307 cf	<b>24.00'W x 64.00'L x 2.00'H Field A</b> 3,072 cf Overall - 2,304 cf Embedded = 768 cf x 40.0% Voids
#2A	134.30'	1,544 cf	<b>Shea Leaching Chamber 4x8x1.5 x 48</b> Inside #1 Inside= 42.0"W x 15.0"H => 4.29 sf x 7.50'L = 32.2 cf Outside= 48.0"W x 18.0"H => 6.00 sf x 8.00'L = 48.0 cf 48 Chambers in 6 Rows
		1,852 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Primary	135.50'	<b>4.0' long Sharp-Crested Rectangular Weir</b> 2 End Contraction(s)
#2	Discarded	133.80'	<b>2.410 in/hr Exfiltration over Wetted area</b>

**Discarded OutFlow** Max=0.1 cfs @ 12.64 hrs HW=134.42' (Free Discharge)  
 ↳2=Exfiltration (Exfiltration Controls 0.1 cfs)

**Primary OutFlow** Max=0.0 cfs @ 0.00 hrs HW=133.80' TW=130.00' (Dynamic Tailwater)  
 ↳1=Sharp-Crested Rectangular Weir ( Controls 0.0 cfs)

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

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**Pond 1P: High Plain Infiltr - Chamber Wizard Field A**

**Chamber Model = Shea Leaching Chamber 4x8x1.5 (Shea Leaching Chamber)**

Inside= 42.0"W x 15.0"H => 4.29 sf x 7.50'L = 32.2 cf  
 Outside= 48.0"W x 18.0"H => 6.00 sf x 8.00'L = 48.0 cf

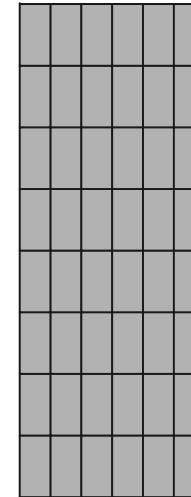
8 Chambers/Row x 8.00' Long = 64.00' Row Length  
 6 Rows x 48.0" Wide = 24.00' Base Width  
 6.0" Stone Base + 18.0" Chamber Height = 2.00' Field Height

48 Chambers x 32.2 cf = 1,544.4 cf Chamber Storage  
 48 Chambers x 48.0 cf = 2,304.0 cf Displacement

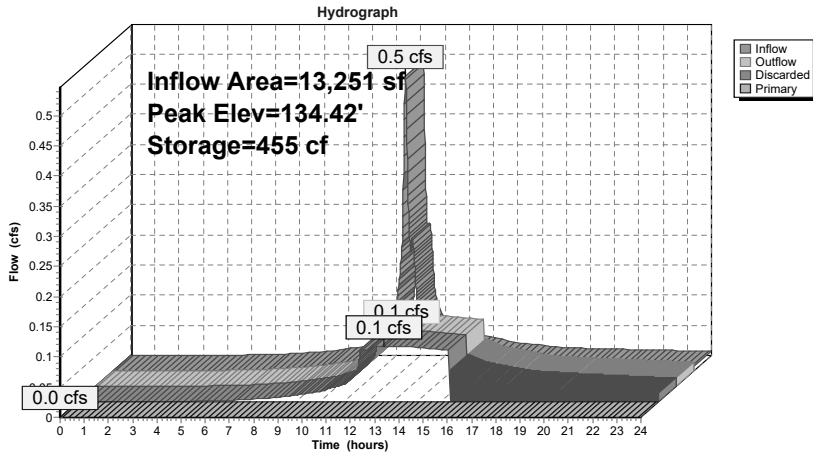
3,072.0 cf Field - 2,304.0 cf Chambers = 768.0 cf Stone x 40.0% Voids = 307.2 cf Stone Storage

Chamber Storage + Stone Storage = 1,851.6 cf = 0.043 af  
 Overall Storage Efficiency = 60.3%  
 Overall System Size = 64.00' x 24.00' x 2.00'

48 Chambers  
 113.8 cy Field  
 28.4 cy Stone



**Pond 1P: High Plain Infil**



**Summary for Pond 2P: Rain Garden #1**

Inflow Area = 5,635 sf, 0.00% Impervious, Inflow Depth > 1.00" for 2-Year event  
 Inflow = 0.1 cfs @ 12.12 hrs, Volume= 468 cf  
 Outflow = 0.1 cfs @ 12.40 hrs, Volume= 315 cf, Atten= 56%, Lag= 17.3 min  
 Primary = 0.1 cfs @ 12.40 hrs, Volume= 315 cf  
 Routed to Pond 1P : High Plain Infil

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs  
 Peak Elev= 136.53' @ 12.40 hrs Surf.Area= 324 sf Storage= 162 cf

Plug-Flow detention time= 179.3 min calculated for 315 cf (67% of inflow)  
 Center-of-Mass det. time= 70.8 min ( 934.3 - 863.5 )

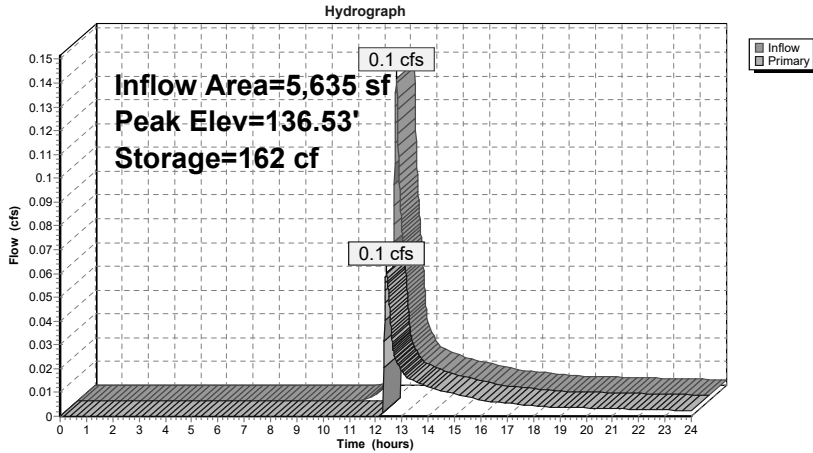
Volume	Invert	Avail.Storage	Storage Description
#1	135.50'	354 cf	<b>Custom Stage Data (Irregular)</b> Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
135.50	5	5.0	0	0	5
136.00	167	57.2	33	33	264
137.00	505	178.4	321	354	2,539

Device	Routing	Invert	Outlet Devices
#1	Primary	136.50'	<b>12.0" Horiz. Orifice/Grate</b> C= 0.600 Limited to weir flow at low heads

**Primary OutFlow** Max=0.1 cfs @ 12.40 hrs HW=136.53' TW=134.38' (Dynamic Tailwater)  
 ↑**1=Orifice/Grate** (Weir Controls 0.1 cfs @ 0.59 fps)

**Pond 2P: Rain Garden #1**



**Summary for Pond 3P: Rain Garden #2**

Inflow Area = 38,416 sf, 46.71% Impervious, Inflow Depth > 1.07" for 2-Year event  
 Inflow = 1.0 cfs @ 12.10 hrs, Volume= 3,437 cf  
 Outflow = 0.9 cfs @ 12.13 hrs, Volume= 3,420 cf, Atten= 7%, Lag= 2.1 min  
 Discarded = 0.0 cfs @ 12.13 hrs, Volume= 1,317 cf  
 Primary = 0.9 cfs @ 12.13 hrs, Volume= 2,104 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= 130.75' @ 12.13 hrs Surf.Area= 499 sf Storage= 320 cf  
 Flood Elev= 132.25' Surf.Area= 792 sf Storage= 1,118 cf

Plug-Flow detention time= (not calculated: outflow precedes inflow)  
 Center-of-Mass det. time= 24.7 min ( 841.6 - 816.9 )

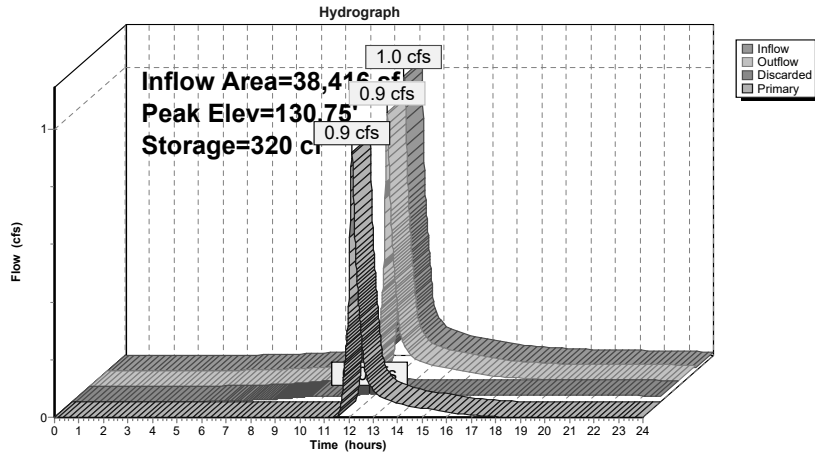
Volume	Invert	Avail.Storage	Storage Description		
#1	130.00'	1,118 cf	<b>Custom Stage Data (Irregular)</b> Listed below (Recalc)		
Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
130.00	356	91.4	0	0	356
131.00	551	104.0	450	450	575
132.00	792	122.3	668	1,118	923

Device	Routing	Invert	Outlet Devices
#1	Primary	130.30'	<b>15.0" Round Culvert</b> L= 18.0' CPP, end-section conforming to fill, Ke= 0.500 Inlet / Outlet Invert= 130.30' / 130.00' S= 0.0167 '/ Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 1.23 sf
#2	Discarded	130.00'	<b>2.410 in/hr Exfiltration over Wetted area</b>

**Discarded OutFlow** Max=0.0 cfs @ 12.13 hrs HW=130.75' (Free Discharge)  
 ↳ **2=Exfiltration** (Exfiltration Controls 0.0 cfs)

**Primary OutFlow** Max=0.9 cfs @ 12.13 hrs HW=130.75' TW=0.00' (Dynamic Tailwater)  
 ↳ **1=Culvert** (Inlet Controls 0.9 cfs @ 2.29 fps)

**Pond 3P: Rain Garden #2**



**Summary for Pond 4P: Haggets Infiltr**

Inflow Area = 12,795 sf, 44.89% Impervious, Inflow Depth > 0.49" for 2-Year event  
 Inflow = 0.1 cfs @ 12.20 hrs, Volume= 523 cf  
 Outflow = 0.1 cfs @ 12.20 hrs, Volume= 523 cf, Atten= 0%, Lag= 0.0 min  
 Discarded = 0.1 cfs @ 12.20 hrs, Volume= 523 cf  
 Primary = 0.0 cfs @ 0.00 hrs, Volume= 0 cf  
 Routed to Reach 3R : Offsite East at Haggets Pond Rd

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs  
 Peak Elev= 129.00' @ 12.20 hrs Surf.Area= 2,125 sf Storage= 0 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= 0.0 min ( 909.5 - 909.5 )

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	130.50'	<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=0.1 cfs @ 12.20 hrs HW=129.00' (Free Discharge)  
 ↳2=Exfiltration (Exfiltration Controls 0.1 cfs)

**Primary OutFlow** Max=0.0 cfs @ 0.00 hrs HW=129.00' TW=0.00' (Dynamic Tailwater)  
 ↳1=Sharp-Crested Rectangular Weir ( Controls 0.0 cfs)

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

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**Pond 4P: Haggetts Infiltr - 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

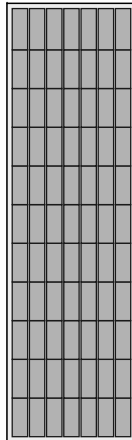
Overall Storage Efficiency = 55.0%

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

77 Chambers

160.7 cy Field

120.6 cy Stone



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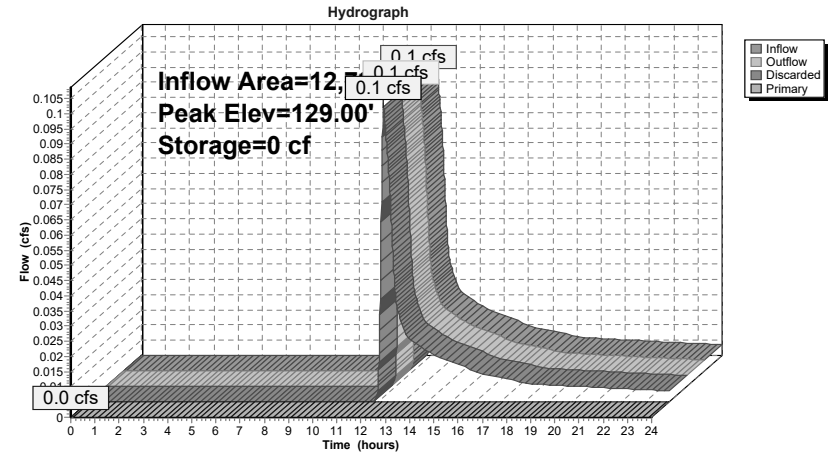
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Type III 24-hr 2-Year Rainfall=3.14"

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**Pond 4P: Haggetts Infiltr**



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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

<b>Subcatchment 1S: High Plain Prkg</b>	Runoff Area=7,616 sf 93.36% Impervious Runoff Depth>4.26" Tc=6.0 min CN=94 Runoff=0.8 cfs 2,707 cf
<b>Subcatchment 2S: Rain Garden #1</b>	Runoff Area=5,635 sf 0.00% Impervious Runoff Depth>2.33" Flow Length=193' Tc=7.5 min CN=74 Runoff=0.3 cfs 1,093 cf
<b>Subcatchment 3S: Rain Garden #2</b>	Runoff Area=4,486 sf 23.83% Impervious Runoff Depth>2.95" Tc=6.0 min CN=81 Runoff=0.4 cfs 1,102 cf
<b>Subcatchment 4S: Ex. High Plain CB</b>	Runoff Area=9,171 sf 84.60% Impervious Runoff Depth>4.26" Tc=6.0 min CN=94 Runoff=1.0 cfs 3,259 cf
<b>Subcatchment 5S: Ex. High Plain Driveway</b>	Runoff Area=11,508 sf 17.44% Impervious Runoff Depth>2.41" Flow Length=121' Tc=8.4 min CN=75 Runoff=0.7 cfs 2,314 cf
<b>Subcatchment 6S: High Plain Direct Offsite</b>	Runoff Area=2,552 sf 21.87% Impervious Runoff Depth>2.41" Tc=6.0 min CN=75 Runoff=0.2 cfs 513 cf
<b>Subcatchment 7S: Proposed Path</b>	Runoff Area=65,644 sf 67.10% Impervious Runoff Depth>4.60" Tc=6.0 min CN=97 Runoff=7.3 cfs 25,183 cf
<b>Subcatchment 8S: Haggetts Pond CB</b>	Runoff Area=193,579 sf 24.74% Impervious Runoff Depth>2.08" Flow Length=713' Tc=10.2 min CN=71 Runoff=9.3 cfs 33,576 cf
<b>Subcatchment 9S: Haggetts Pond Prkg</b>	Runoff Area=12,795 sf 44.89% Impervious Runoff Depth>1.48" Flow Length=246' Tc=11.4 min CN=63 Runoff=0.4 cfs 1,577 cf
<b>Reach 1R: Offsite East at High Plain Rd</b>	Inflow=2.0 cfs 5,549 cf Outflow=2.0 cfs 5,549 cf
<b>Reach 2R: Offsite from Path</b>	Inflow=7.3 cfs 25,183 cf Outflow=7.3 cfs 25,183 cf
<b>Reach 3R: Offsite East at Haggetts Pond Rd</b>	Inflow=9.3 cfs 33,576 cf Outflow=9.3 cfs 33,576 cf
<b>Reach 4R: Total Offsite</b>	Inflow=17.6 cfs 64,307 cf Outflow=17.6 cfs 64,307 cf
<b>Pond 1P: High Plain Infiltr</b>	Peak Elev=135.12' Storage=1,339 cf Inflow=1.1 cfs 3,647 cf Discarded=0.1 cfs 3,647 cf Primary=0.0 cfs 0 cf Outflow=0.1 cfs 3,647 cf
<b>Pond 2P: Rain Garden #1</b>	Peak Elev=136.60' Storage=185 cf Inflow=0.3 cfs 1,093 cf Outflow=0.3 cfs 940 cf
<b>Pond 3P: Rain Garden #2</b>	Peak Elev=130.98' Storage=440 cf Inflow=2.0 cfs 6,675 cf Discarded=0.0 cfs 1,520 cf Primary=1.8 cfs 5,035 cf Outflow=1.9 cfs 6,556 cf

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

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**Pond 4P: Haggetts Infiltr**Peak Elev=129.36' Storage=305 cf Inflow=0.4 cfs 1,577 cf  
Discarded=0.1 cfs 1,578 cf Primary=0.0 cfs 0 cf Outflow=0.1 cfs 1,578 cf**Total Runoff Area = 312,986 sf Runoff Volume = 71,324 cf Average Runoff Depth = 2.73"**  
**62.88% Pervious = 196,794 sf 37.12% Impervious = 116,192 sf**

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

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

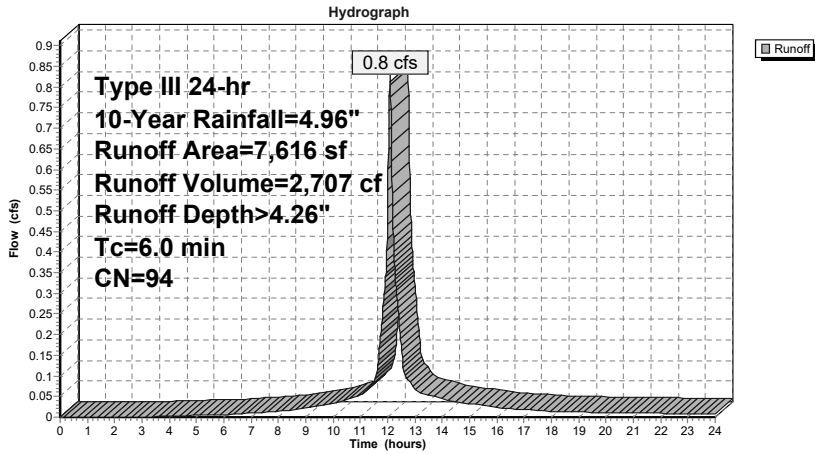
Runoff = 0.8 cfs @ 12.08 hrs, Volume= 2,707 cf, Depth> 4.26"  
Routed to Pond 1P : High Plain Infiltr

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
* 189	43	Mulch, HSG A
317	30	Woods, Good, HSG A
* 689	98	New paved parking, HSG A
* 6,421	98	New paved parking, HSG C
7,616	94	Weighted Average
506		6.64% Pervious Area
7,110		93.36% Impervious Area

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

**Subcatchment 1S: High Plain Prkg**



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

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**Summary for Subcatchment 2S: Rain Garden #1**

Runoff = 0.3 cfs @ 12.11 hrs, Volume= 1,093 cf, Depth> 2.33"  
Routed to Pond 2P : Rain Garden #1

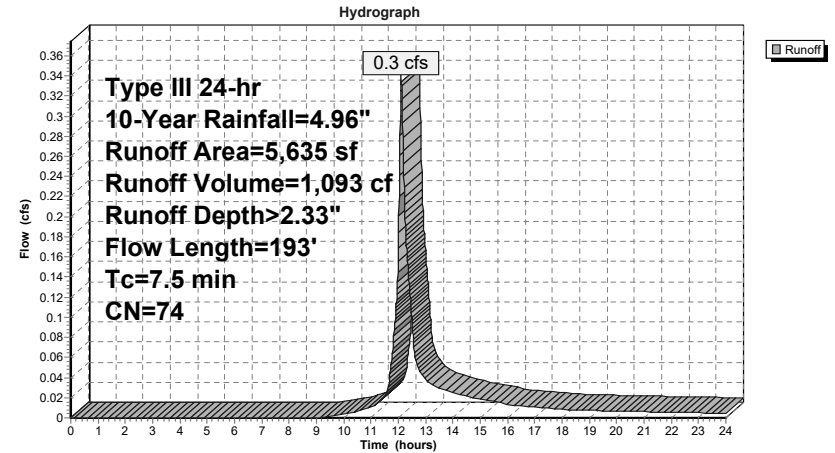
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs  
Type III 24-hr 10-Year Rainfall=4.96"

Area (sf)	CN	Description
* 33	43	Mulch, HSG A
* 3,911	76	Mulch, HSG C
38	30	Woods, Good, HSG A
1,653	70	Woods, Good, HSG C
5,635	74	Weighted Average
5,635		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.2	33	0.1700	0.09		Sheet Flow, Woods: Dense underbrush n= 0.800 P2= 3.60"
0.1	17	0.1300	2.52		Shallow Concentrated Flow, Short Grass Pasture Kv= 7.0 fps
1.2	143	0.0175	1.98		Shallow Concentrated Flow, Grassed Waterway Kv= 15.0 fps

7.5 193 Total

**Subcatchment 2S: Rain Garden #1**



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

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**Summary for Subcatchment 3S: Rain Garden #2**

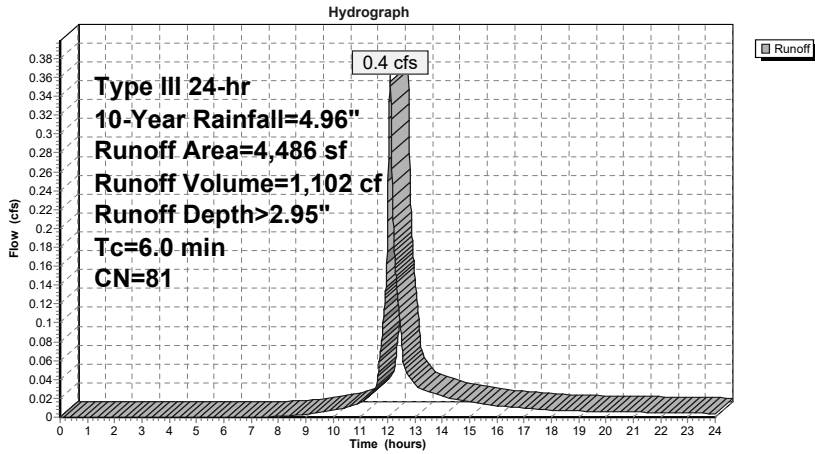
Runoff = 0.4 cfs @ 12.09 hrs, Volume= 1,102 cf, Depth> 2.95"  
Routed to Pond 3P : Rain Garden #2

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

Area (sf)	CN	Description
* 2,726	76	Mulch, HSG C
83	96	Gravel surface, HSG D
608	70	Woods, Good, HSG C
* 1,069	98	New paved parking, HSG C
4,486	81	Weighted Average
3,417		76.17% Pervious Area
1,069		23.83% Impervious Area

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

**Subcatchment 3S: Rain Garden #2**



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

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**Summary for Subcatchment 4S: Ex. High Plain CB**

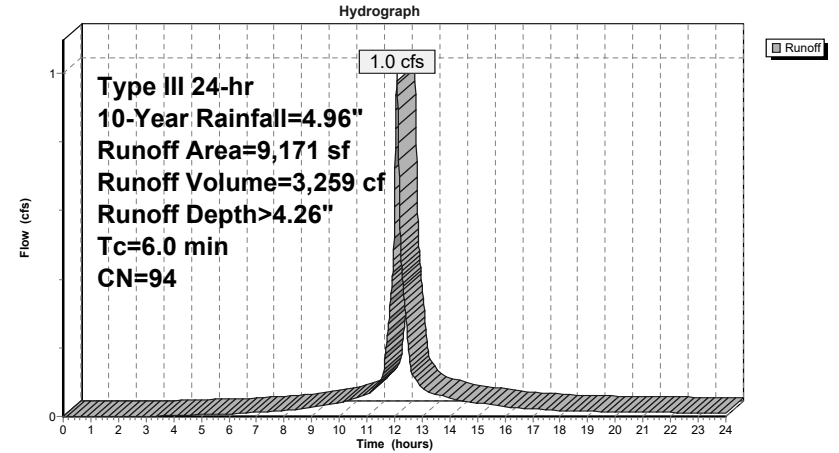
Runoff = 1.0 cfs @ 12.08 hrs, Volume= 3,259 cf, Depth> 4.26"  
Routed to Pond 3P : Rain Garden #2

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

Area (sf)	CN	Description
* 1,412	74	>75% Ex. Grass cover, Good, HSG C
* 7,759	98	Ex. paved parking, HSG C
9,171	94	Weighted Average
1,412		15.40% Pervious Area
7,759		84.60% Impervious Area

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

**Subcatchment 4S: Ex. High Plain CB**



**Summary for Subcatchment 5S: Ex. High Plain Driveway**

Runoff = 0.7 cfs @ 12.12 hrs, Volume= 2,314 cf, Depth> 2.41"  
 Routed to Pond 3P : Rain Garden #2

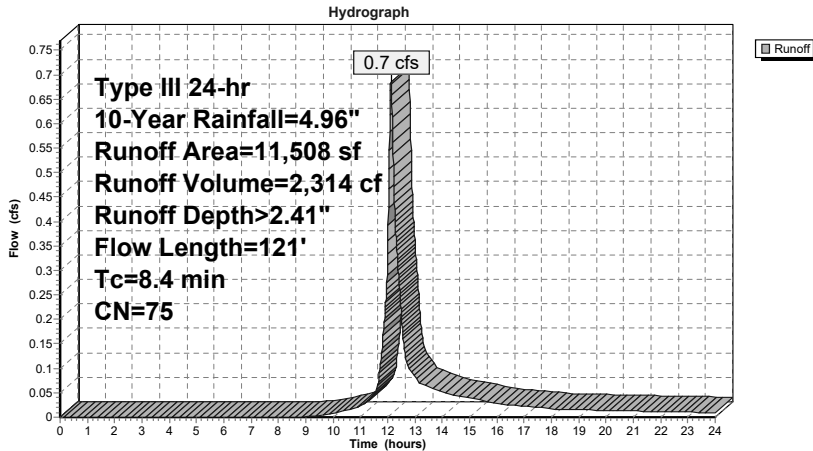
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs  
 Type III 24-hr 10-Year Rainfall=4.96"

Area (sf)	CN	Description
9,501	70	Woods, Good, HSG C
2,007	98	Ex. paved parking, HSG C
11,508	75	Weighted Average
9,501		82.56% Pervious Area
2,007		17.44% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.0	50	0.0710	0.12		<b>Sheet Flow,</b> Woods: Light underbrush n= 0.400 P2= 3.60"
1.4	71	0.0290	0.85		<b>Shallow Concentrated Flow,</b> Woodland Kv= 5.0 fps
8.4	121	Total			

**Subcatchment 5S: Ex. High Plain Driveway**



**Summary for Subcatchment 6S: High Plain Direct Offsite**

Runoff = 0.2 cfs @ 12.09 hrs, Volume= 513 cf, Depth> 2.41"  
 Routed to Reach 1R : Offsite East at High Plain Rd

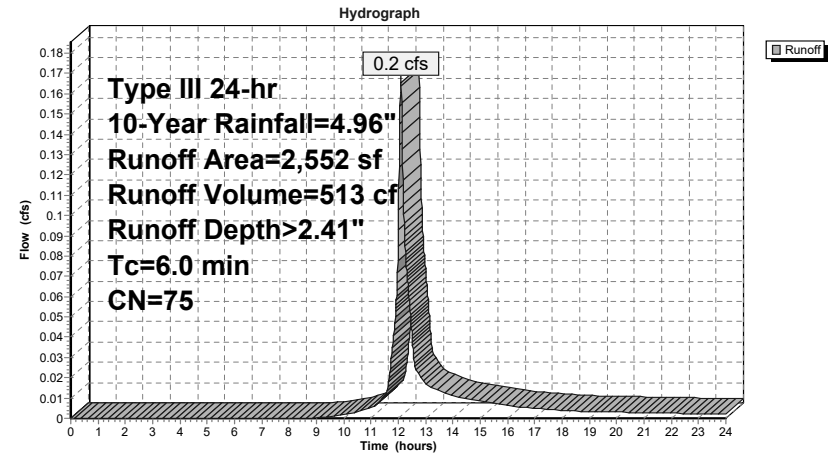
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs  
 Type III 24-hr 10-Year Rainfall=4.96"

Area (sf)	CN	Description
459	43	Mulch, HSG A
1,535	76	Mulch, HSG C
558	98	New paved parking, HSG C
2,552	75	Weighted Average
1,994		78.13% Pervious Area
558		21.87% Impervious Area

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

**Subcatchment 6S: High Plain Direct Offsite**



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

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**Summary for Subcatchment 7S: Proposed Path**

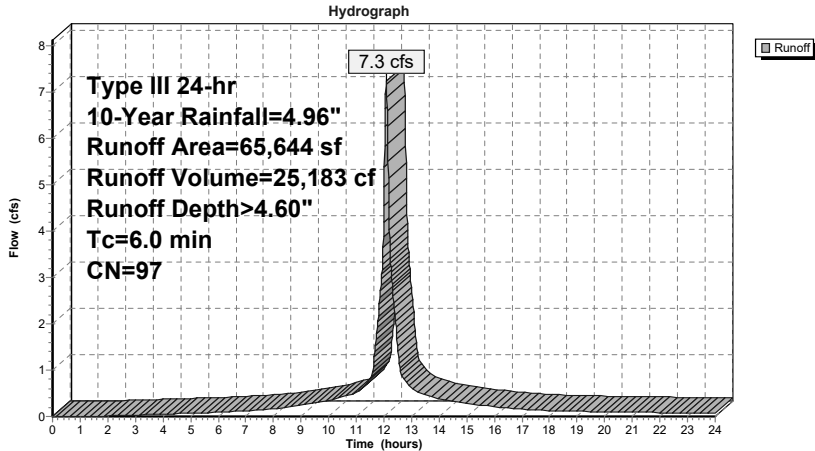
Runoff = 7.3 cfs @ 12.08 hrs, Volume= 25,183 cf, Depth> 4.60"  
Routed to Reach 2R : Offsite from Path

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
* 44,046	98	New paved parking, HSG D
21,598	96	Gravel surface, HSG D
65,644	97	Weighted Average
21,598		32.90% Pervious Area
44,046		67.10% Impervious Area

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

**Subcatchment 7S: Proposed Path**



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

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**Summary for Subcatchment 8S: Haggetts Pond CB**

Runoff = 9.3 cfs @ 12.15 hrs, Volume= 33,576 cf, Depth> 2.08"  
Routed to Reach 3R : Offsite East at Haggetts Pond Rd

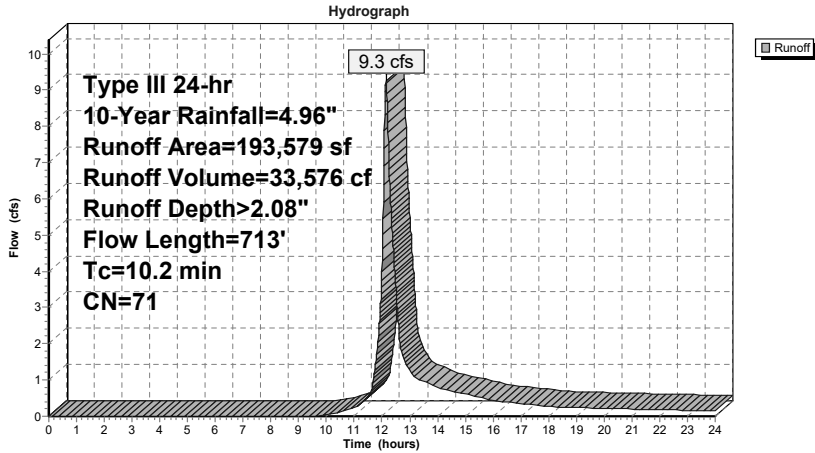
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs  
Type III 24-hr 10-Year Rainfall=4.96"

Area (sf)	CN	Description
* 981	98	New paved parking, HSG A
* 23,399	98	Ex. paved parking, HSG A
* 21,360	98	Ex. paved parking, HSG B
* 2,159	98	Ex. paved parking, HSG C
* 1,056	43	Mulch, HSG A
* 22,247	39	>75% Ex. Grass cover, Good, HSG A
* 44,580	61	>75% Ex. Grass cover, Good, HSG B
* 13,232	74	>75% Ex. Grass cover, Good, HSG C
61	76	Gravel roads, HSG A
2,530	30	Woods, Good, HSG A
2,036	55	Woods, Good, HSG B
59,938	70	Woods, Good, HSG C

193,579	71	Weighted Average
145,680		75.26% Pervious Area
47,899		24.74% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.2	50	0.1500	0.16		Sheet Flow, Woods: Light underbrush n= 0.400 P2= 3.60"
3.8	307	0.0720	1.34		Shallow Concentrated Flow, Woodland Kv= 5.0 fps
1.2	356	0.0610	5.01		Shallow Concentrated Flow, Paved Kv= 20.3 fps
10.2	713	Total			

**Subcatchment 8S: Haggetts Pond CB**



**Summary for Subcatchment 9S: Haggetts Pond Prkg**

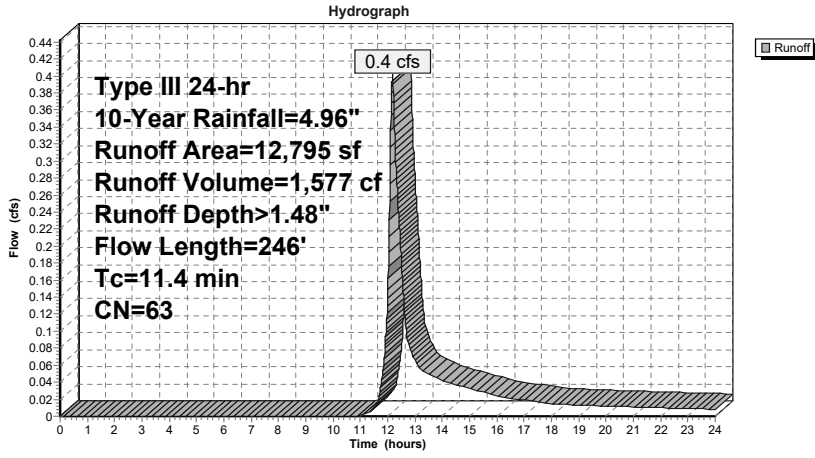
Runoff = 0.4 cfs @ 12.17 hrs, Volume= 1,577 cf, Depth> 1.48"  
Routed to Pond 4P : Haggetts Infiltr

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
* 5,744	98	New paved parking, HSG A
* 2,661	43	Mulch, HSG A
4,390	30	Woods, Good, HSG A
12,795	63	Weighted Average
7,051		55.11% Pervious Area
5,744		44.89% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
9.1	50	0.0370	0.09		<b>Sheet Flow,</b> Woods: Light underbrush n= 0.400 P2= 3.60"
0.2	11	0.0370	0.96		<b>Shallow Concentrated Flow,</b> Woodland Kv= 5.0 fps
0.0	8	0.3660	3.02		<b>Shallow Concentrated Flow,</b> Woodland Kv= 5.0 fps
0.7	13	0.0043	0.33		<b>Shallow Concentrated Flow,</b> Woodland Kv= 5.0 fps
0.3	10	0.0043	0.66		<b>Shallow Concentrated Flow,</b> Nearly Bare & Untilled Kv= 10.0 fps
1.1	154	0.0130	2.31		<b>Shallow Concentrated Flow,</b> Paved Kv= 20.3 fps
11.4	246	Total			

Subcatchment 9S: Haggetts Pond Prkg



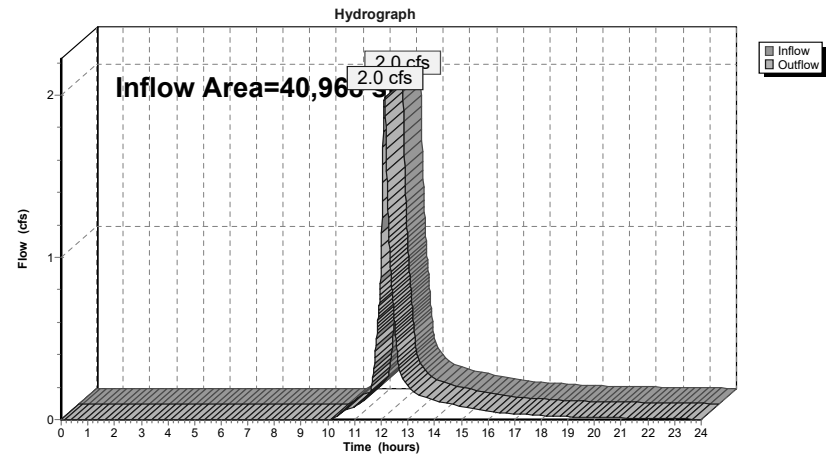
Summary for Reach 1R: Offsite East at High Plain Rd

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

Inflow Area = 40,968 sf, 45.16% Impervious, Inflow Depth > 1.63" for 10-Year event  
Inflow = 2.0 cfs @ 12.12 hrs, Volume= 5,549 cf  
Outflow = 2.0 cfs @ 12.12 hrs, Volume= 5,549 cf, Atten= 0%, Lag= 0.0 min  
Routed to Reach 4R : Total Offsite

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



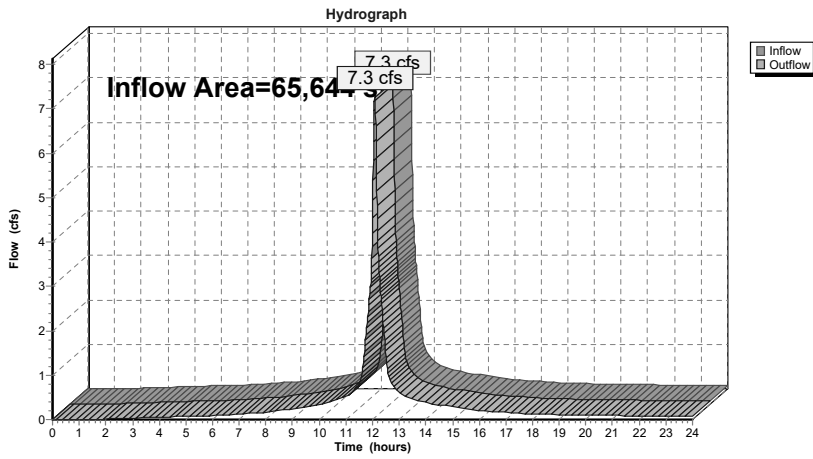
Summary for Reach 2R: Offsite from Path

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

Inflow Area = 65,644 sf, 67.10% Impervious, Inflow Depth > 4.60" for 10-Year event  
 Inflow = 7.3 cfs @ 12.08 hrs, Volume= 25,183 cf  
 Outflow = 7.3 cfs @ 12.08 hrs, Volume= 25,183 cf, Atten= 0%, Lag= 0.0 min  
 Routed to Reach 4R : Total Offsite

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

Reach 2R: Offsite from Path



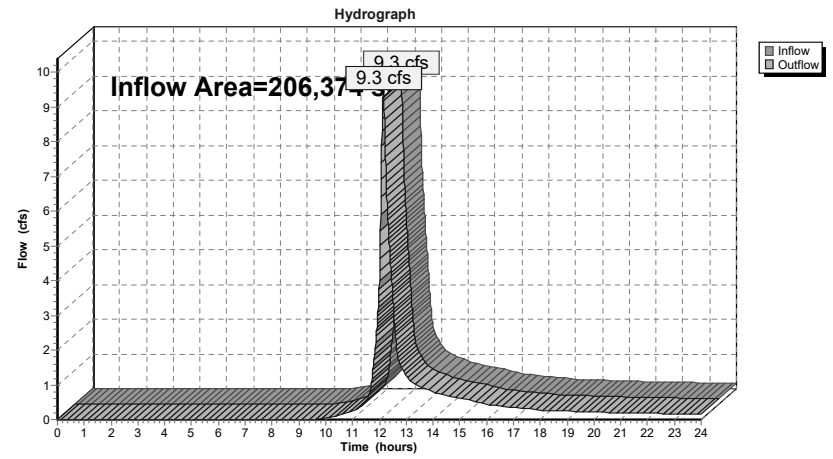
Summary for Reach 3R: Offsite East at Haggets Pond Rd

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

Inflow Area = 206,374 sf, 25.99% Impervious, Inflow Depth > 1.95" for 10-Year event  
 Inflow = 9.3 cfs @ 12.15 hrs, Volume= 33,576 cf  
 Outflow = 9.3 cfs @ 12.15 hrs, Volume= 33,576 cf, Atten= 0%, Lag= 0.0 min  
 Routed to Reach 4R : Total Offsite

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

Reach 3R: Offsite East at Haggets Pond Rd



**Summary for Reach 4R: Total Offsite**

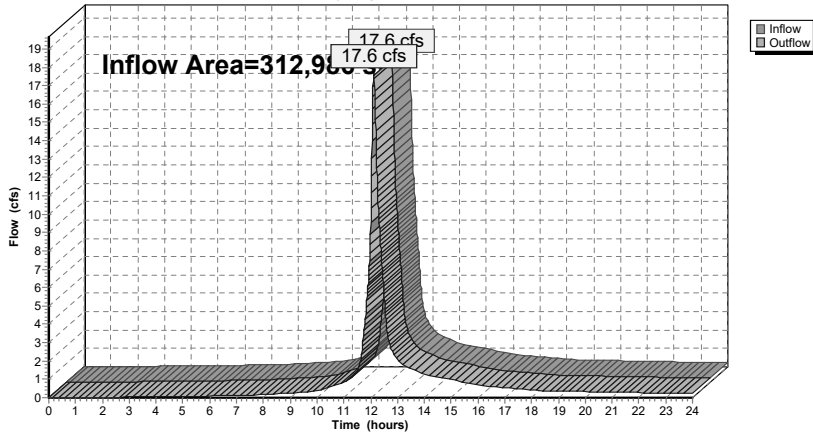
[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 312,986 sf, 37.12% Impervious, Inflow Depth > 2.47" for 10-Year event  
 Inflow = 17.6 cfs @ 12.12 hrs, Volume= 64,307 cf  
 Outflow = 17.6 cfs @ 12.12 hrs, Volume= 64,307 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 4R: Total Offsite**

Hydrograph



**Summary for Pond 1P: High Plain Infill**

[87] Warning: Oscillations may require smaller dt or Finer Routing (severity=197)

Inflow Area = 13,251 sf, 53.66% Impervious, Inflow Depth > 3.30" for 10-Year event  
 Inflow = 1.1 cfs @ 12.10 hrs, Volume= 3,647 cf  
 Outflow = 0.1 cfs @ 13.10 hrs, Volume= 3,647 cf, Atten= 91%, Lag= 60.5 min  
 Discarded = 0.1 cfs @ 13.10 hrs, Volume= 3,647 cf  
 Primary = 0.0 cfs @ 0.00 hrs, Volume= 0 cf  
 Routed to Pond 3P : Rain Garden #2

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs  
 Peak Elev= 135.12' @ 13.10 hrs Surf.Area= 1,536 sf Storage= 1,339 cf  
 Flood Elev= 135.80' Surf.Area= 1,536 sf Storage= 1,852 cf

Plug-Flow detention time= (not calculated: outflow precedes inflow)  
 Center-of-Mass det. time= 110.3 min ( 907.1 - 796.8 )

Volume	Invert	Avail.Storage	Storage Description
#1A	133.80'	307 cf	<b>24.00'W x 64.00'L x 2.00'H Field A</b> 3,072 cf Overall - 2,304 cf Embedded = 768 cf x 40.0% Voids
#2A	134.30'	1,544 cf	<b>Shea Leaching Chamber 4x8x1.5 x 48</b> Inside #1 Inside= 42.0"W x 15.0"H => 4.29 sf x 7.50'L = 32.2 cf Outside= 48.0"W x 18.0"H => 6.00 sf x 8.00'L = 48.0 cf 48 Chambers in 6 Rows
		1,852 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Primary	135.50'	<b>4.0' long Sharp-Crested Rectangular Weir</b> 2 End Contraction(s)
#2	Discarded	133.80'	<b>2.410 in/hr Exfiltration over Wetted area</b>

**Discarded OutFlow** Max=0.1 cfs @ 13.10 hrs HW=135.12' (Free Discharge)  
 ↳2=Exfiltration (Exfiltration Controls 0.1 cfs)

**Primary OutFlow** Max=0.0 cfs @ 0.00 hrs HW=133.80' TW=130.00' (Dynamic Tailwater)  
 ↳1=Sharp-Crested Rectangular Weir ( Controls 0.0 cfs)

**Pond 1P: High Plain Infiltr - Chamber Wizard Field A**

**Chamber Model = Shea Leaching Chamber 4x8x1.5 (Shea Leaching Chamber)**

Inside= 42.0"W x 15.0"H => 4.29 sf x 7.50'L = 32.2 cf

Outside= 48.0"W x 18.0"H => 6.00 sf x 8.00'L = 48.0 cf

8 Chambers/Row x 8.00' Long = 64.00' Row Length

6 Rows x 48.0" Wide = 24.00' Base Width

6.0" Stone Base + 18.0" Chamber Height = 2.00' Field Height

48 Chambers x 32.2 cf = 1,544.4 cf Chamber Storage

48 Chambers x 48.0 cf = 2,304.0 cf Displacement

3,072.0 cf Field - 2,304.0 cf Chambers = 768.0 cf Stone x 40.0% Voids = 307.2 cf Stone Storage

Chamber Storage + Stone Storage = 1,851.6 cf = 0.043 af

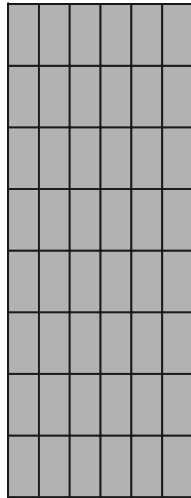
Overall Storage Efficiency = 60.3%

Overall System Size = 64.00' x 24.00' x 2.00'

48 Chambers

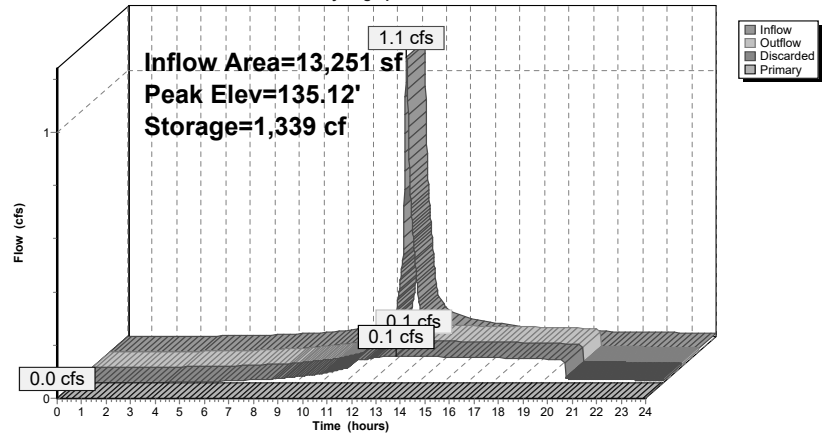
113.8 cy Field

28.4 cy Stone



**Pond 1P: High Plain Infiltr**

Hydrograph



**8998501-POST**

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

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**Summary for Pond 2P: Rain Garden #1**

Inflow Area = 5,635 sf, 0.00% Impervious, Inflow Depth > 2.33" for 10-Year event  
 Inflow = 0.3 cfs @ 12.11 hrs, Volume= 1,093 cf  
 Outflow = 0.3 cfs @ 12.13 hrs, Volume= 940 cf, Atten= 2%, Lag= 1.2 min  
 Primary = 0.3 cfs @ 12.13 hrs, Volume= 940 cf  
 Routed to Pond 1P : High Plain Infiltr

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs  
 Peak Elev= 136.60' @ 12.13 hrs Surf.Area= 348 sf Storage= 185 cf

Plug-Flow detention time= 88.7 min calculated for 940 cf (86% of inflow)  
 Center-of-Mass det. time= 26.7 min ( 865.0 - 838.2 )

Volume	Invert	Avail.Storage	Storage Description
#1	135.50'	354 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)
135.50	5	5.0	0	0	5
136.00	167	57.2	33	33	264
137.00	505	178.4	321	354	2,539

Device	Routing	Invert	Outlet Devices
#1	Primary	136.50'	<b>12.0" Horiz. Orifice/Grate</b> C= 0.600 Limited to weir flow at low heads

**Primary OutFlow** Max=0.3 cfs @ 12.13 hrs HW=136.60' TW=134.57' (Dynamic Tailwater)  
 ↳1=Orifice/Grate (Weir Controls 0.3 cfs @ 1.03 fps)

**8998501-POST**

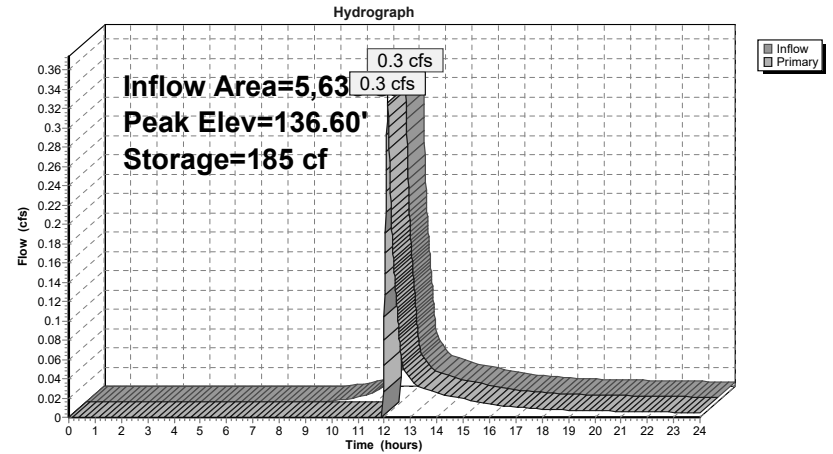
Type III 24-hr 10-Year Rainfall=4.96"

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**Pond 2P: Rain Garden #1**



**Summary for Pond 3P: Rain Garden #2**

Inflow Area = 38,416 sf, 46.71% Impervious, Inflow Depth > 2.08" for 10-Year event  
 Inflow = 2.0 cfs @ 12.10 hrs, Volume= 6,675 cf  
 Outflow = 1.9 cfs @ 12.13 hrs, Volume= 6,556 cf, Atten= 6%, Lag= 1.9 min  
 Discarded = 0.0 cfs @ 12.13 hrs, Volume= 1,520 cf  
 Primary = 1.8 cfs @ 12.13 hrs, Volume= 5,035 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= 130.98' @ 12.13 hrs Surf.Area= 547 sf Storage= 440 cf  
 Flood Elev= 132.25' Surf.Area= 792 sf Storage= 1,118 cf

Plug-Flow detention time= (not calculated: outflow precedes inflow)  
 Center-of-Mass det. time= 9.3 min ( 811.9 - 802.6 )

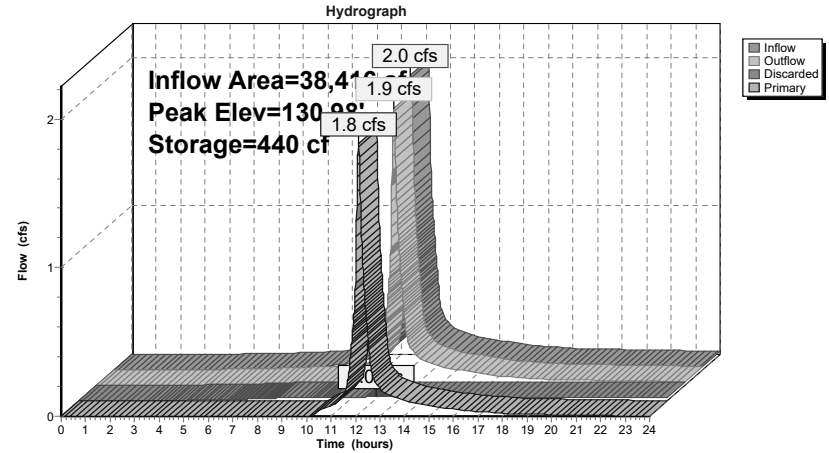
Volume	Invert	Avail.Storage	Storage Description		
#1	130.00'	1,118 cf	<b>Custom Stage Data (Irregular)</b> Listed below (Recalc)		
Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
130.00	356	91.4	0	0	356
131.00	551	104.0	450	450	575
132.00	792	122.3	668	1,118	923

Device	Routing	Invert	Outlet Devices
#1	Primary	130.30'	<b>15.0" Round Culvert</b> L= 18.0' CPP, end-section conforming to fill, Ke= 0.500 Inlet / Outlet Invert= 130.30' / 130.00' S= 0.0167 ' S= 0.0167 ' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 1.23 sf
#2	Discarded	130.00'	<b>2.410 in/hr Exfiltration over Wetted area</b>

**Discarded OutFlow** Max=0.0 cfs @ 12.13 hrs HW=130.98' (Free Discharge)  
 ↳2=Exfiltration (Exfiltration Controls 0.0 cfs)

**Primary OutFlow** Max=1.8 cfs @ 12.13 hrs HW=130.98' TW=0.00' (Dynamic Tailwater)  
 ↳1=Culvert (Barrel Controls 1.8 cfs @ 3.89 fps)

**Pond 3P: Rain Garden #2**



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

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**Summary for Pond 4P: Haggetts Infil**

[87] Warning: Oscillations may require smaller dt or Finer Routing (severity=497)

Inflow Area = 12,795 sf, 44.89% Impervious, Inflow Depth > 1.48" for 10-Year event  
 Inflow = 0.4 cfs @ 12.17 hrs, Volume= 1,577 cf  
 Outflow = 0.1 cfs @ 12.62 hrs, Volume= 1,578 cf, Atten= 69%, Lag= 26.8 min  
 Discarded = 0.1 cfs @ 12.62 hrs, Volume= 1,578 cf  
 Primary = 0.0 cfs @ 0.00 hrs, Volume= 0 cf

Routed to Reach 3R : Offsite East at Haggetts Pond Rd

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

Peak Elev= 129.36' @ 12.62 hrs Surf.Area= 2,125 sf Storage= 305 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= 13.5 min ( 883.7 - 870.2 )

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	130.50'	<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=0.1 cfs @ 12.62 hrs HW=129.36' (Free Discharge)

↳ **2=Exfiltration** (Exfiltration Controls 0.1 cfs)

**Primary OutFlow** Max=0.0 cfs @ 0.00 hrs HW=129.00' TW=0.00' (Dynamic Tailwater)

↳ **1=Sharp-Crested Rectangular Weir** ( Controls 0.0 cfs)

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

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**Pond 4P: Haggetts 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

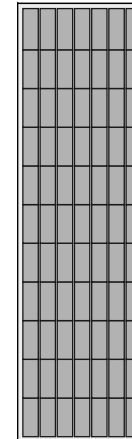
Overall Storage Efficiency = 55.0%

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

77 Chambers

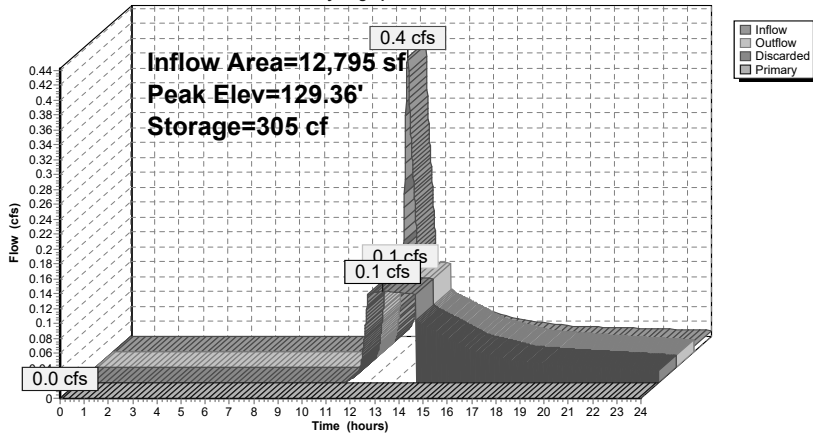
160.7 cy Field

120.6 cy Stone



**Pond 4P: Haggetts Infiltr**

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: High Plain Prkg</b>	Runoff Area=7,616 sf 93.36% Impervious Runoff Depth>5.38" Tc=6.0 min CN=94 Runoff=1.0 cfs 3,415 cf
<b>Subcatchment 2S: Rain Garden #1</b>	Runoff Area=5,635 sf 0.00% Impervious Runoff Depth>3.26" Flow Length=193' Tc=7.5 min CN=74 Runoff=0.5 cfs 1,529 cf
<b>Subcatchment 3S: Rain Garden #2</b>	Runoff Area=4,486 sf 23.83% Impervious Runoff Depth>3.96" Tc=6.0 min CN=81 Runoff=0.5 cfs 1,481 cf
<b>Subcatchment 4S: Ex. High Plain CB</b>	Runoff Area=9,171 sf 84.60% Impervious Runoff Depth>5.38" Tc=6.0 min CN=94 Runoff=1.2 cfs 4,113 cf
<b>Subcatchment 5S: Ex. High Plain Driveway</b>	Runoff Area=11,508 sf 17.44% Impervious Runoff Depth>3.35" Flow Length=121' Tc=8.4 min CN=75 Runoff=1.0 cfs 3,216 cf
<b>Subcatchment 6S: High Plain Direct Offsite</b>	Runoff Area=2,552 sf 21.87% Impervious Runoff Depth>3.35" Tc=6.0 min CN=75 Runoff=0.2 cfs 713 cf
<b>Subcatchment 7S: Proposed Path</b>	Runoff Area=65,644 sf 67.10% Impervious Runoff Depth>5.73" Tc=6.0 min CN=97 Runoff=9.0 cfs 31,342 cf
<b>Subcatchment 8S: Haggetts Pond CB</b>	Runoff Area=193,579 sf 24.74% Impervious Runoff Depth>2.96" Flow Length=713' Tc=10.2 min CN=71 Runoff=13.4 cfs 47,830 cf
<b>Subcatchment 9S: Haggetts Pond Prkg</b>	Runoff Area=12,795 sf 44.89% Impervious Runoff Depth>2.23" Flow Length=246' Tc=11.4 min CN=63 Runoff=0.6 cfs 2,381 cf
<b>Reach 1R: Offsite East at High Plain Rd</b>	Inflow=2.6 cfs 7,966 cf Outflow=2.6 cfs 7,966 cf
<b>Reach 2R: Offsite from Path</b>	Inflow=9.0 cfs 31,342 cf Outflow=9.0 cfs 31,342 cf
<b>Reach 3R: Offsite East at Haggetts Pond Rd</b>	Inflow=13.4 cfs 47,830 cf Outflow=13.4 cfs 47,830 cf
<b>Reach 4R: Total Offsite</b>	Inflow=23.8 cfs 87,137 cf Outflow=23.8 cfs 87,137 cf
<b>Pond 1P: High Plain Infiltr</b>	Peak Elev=135.54' Storage=1,841 cf Inflow=1.4 cfs 4,790 cf Discarded=0.1 cfs 4,607 cf Primary=0.1 cfs 184 cf Outflow=0.2 cfs 4,791 cf
<b>Pond 2P: Rain Garden #1</b>	Peak Elev=136.63' Storage=194 cf Inflow=0.5 cfs 1,529 cf Outflow=0.5 cfs 1,375 cf
<b>Pond 3P: Rain Garden #2</b>	Peak Elev=131.11' Storage=512 cf Inflow=2.6 cfs 8,993 cf Discarded=0.0 cfs 1,612 cf Primary=2.4 cfs 7,252 cf Outflow=2.5 cfs 8,865 cf

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

**Pond 4P: Haggetts Infil**

Peak Elev=129.63' Storage=651 cf Inflow=0.6 cfs 2,381 cf  
Discarded=0.1 cfs 2,381 cf Primary=0.0 cfs 0 cf Outflow=0.1 cfs 2,381 cf

**Total Runoff Area = 312,986 sf Runoff Volume = 96,020 cf Average Runoff Depth = 3.68"**  
**62.88% Pervious = 196,794 sf 37.12% Impervious = 116,192 sf**

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

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

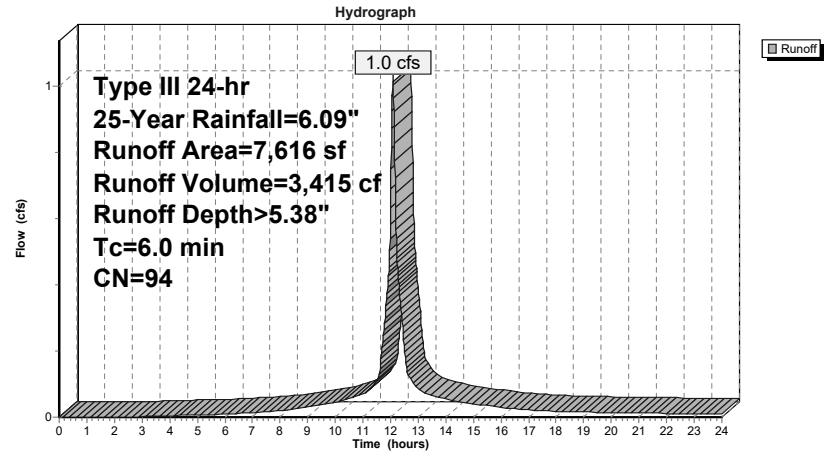
Runoff = 1.0 cfs @ 12.08 hrs, Volume= 3,415 cf, Depth> 5.38"  
Routed to Pond 1P : High Plain Infil

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
* 189	43	Mulch, HSG A
317	30	Woods, Good, HSG A
* 689	98	New paved parking, HSG A
* 6,421	98	New paved parking, HSG C
7,616	94	Weighted Average
506		6.64% Pervious Area
7,110		93.36% Impervious Area

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

**Subcatchment 1S: High Plain Prkg**



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

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**Summary for Subcatchment 2S: Rain Garden #1**

Runoff = 0.5 cfs @ 12.11 hrs, Volume= 1,529 cf, Depth> 3.26"  
Routed to Pond 2P : Rain Garden #1

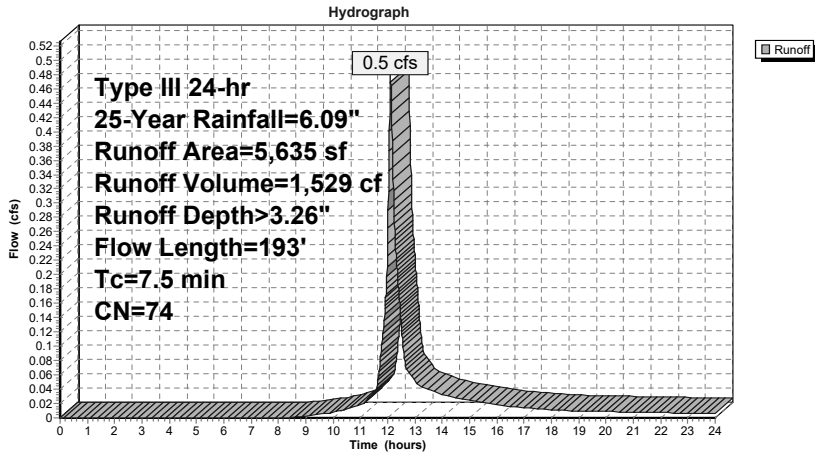
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs  
Type III 24-hr 25-Year Rainfall=6.09"

Area (sf)	CN	Description
* 33	43	Mulch, HSG A
* 3,911	76	Mulch, HSG C
38	30	Woods, Good, HSG A
1,653	70	Woods, Good, HSG C
5,635	74	Weighted Average
5,635		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.2	33	0.1700	0.09		<b>Sheet Flow,</b> Woods: Dense underbrush n= 0.800 P2= 3.60"
0.1	17	0.1300	2.52		<b>Shallow Concentrated Flow,</b> Short Grass Pasture Kv= 7.0 fps
1.2	143	0.0175	1.98		<b>Shallow Concentrated Flow,</b> Grassed Waterway Kv= 15.0 fps
7.5	193	Total			

**Subcatchment 2S: Rain Garden #1**



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

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**Summary for Subcatchment 3S: Rain Garden #2**

Runoff = 0.5 cfs @ 12.09 hrs, Volume= 1,481 cf, Depth> 3.96"  
Routed to Pond 3P : Rain Garden #2

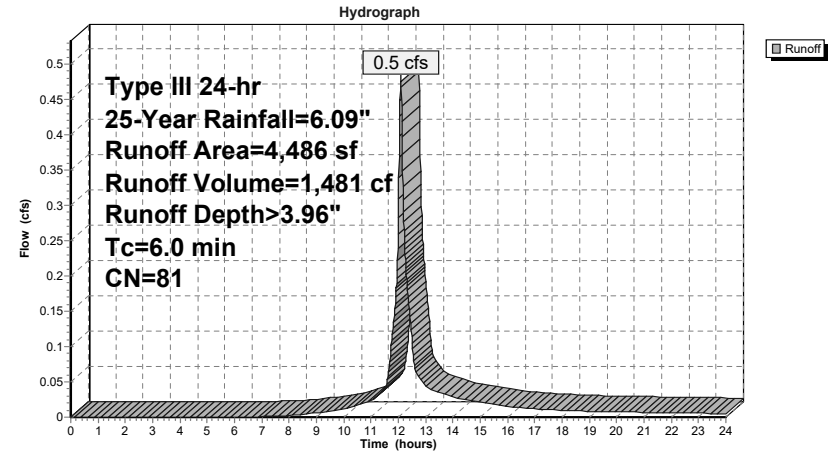
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs  
Type III 24-hr 25-Year Rainfall=6.09"

Area (sf)	CN	Description
* 2,726	76	Mulch, HSG C
83	96	Gravel surface, HSG D
608	70	Woods, Good, HSG C
* 1,069	98	New paved parking, HSG C
4,486	81	Weighted Average
3,417		76.17% Pervious Area
1,069		23.83% Impervious Area

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

**Subcatchment 3S: Rain Garden #2**



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

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**Summary for Subcatchment 4S: Ex. High Plain CB**

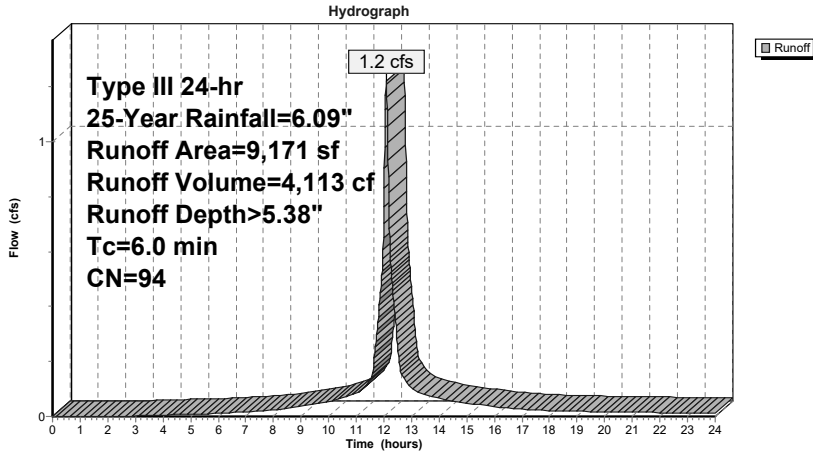
Runoff = 1.2 cfs @ 12.08 hrs, Volume= 4,113 cf, Depth> 5.38"  
Routed to Pond 3P : Rain Garden #2

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

Area (sf)	CN	Description
* 1,412	74	>75% Ex. Grass cover, Good, HSG C
* 7,759	98	Ex. paved parking, HSG C
9,171	94	Weighted Average
1,412		15.40% Pervious Area
7,759		84.60% Impervious Area

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

**Subcatchment 4S: Ex. High Plain CB**



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

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**Summary for Subcatchment 5S: Ex. High Plain Driveway**

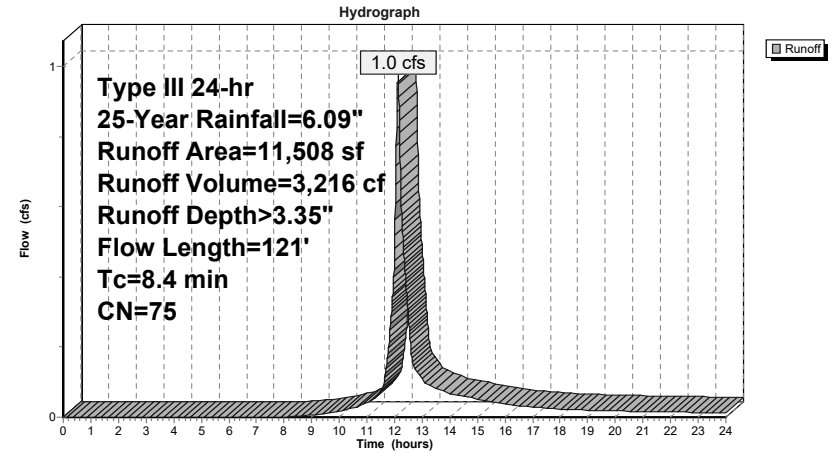
Runoff = 1.0 cfs @ 12.12 hrs, Volume= 3,216 cf, Depth> 3.35"  
Routed to Pond 3P : Rain Garden #2

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

Area (sf)	CN	Description
* 9,501	70	Woods, Good, HSG C
* 2,007	98	Ex. paved parking, HSG C
11,508	75	Weighted Average
9,501		82.56% Pervious Area
2,007		17.44% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.0	50	0.0710	0.12		<b>Sheet Flow,</b> Woods: Light underbrush n= 0.400 P2= 3.60"
1.4	71	0.0290	0.85		<b>Shallow Concentrated Flow,</b> Woodland Kv= 5.0 fps
8.4	121				<b>Total</b>

**Subcatchment 5S: Ex. High Plain Driveway**



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

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**Summary for Subcatchment 6S: High Plain Direct Offsite**

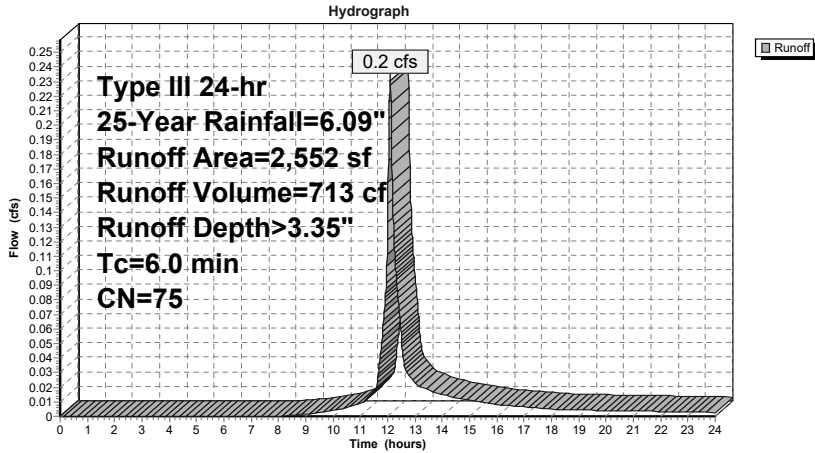
Runoff = 0.2 cfs @ 12.09 hrs, Volume= 713 cf, Depth> 3.35"  
 Routed to Reach 1R : Offsite East at High Plain Rd

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
* 459	43	Mulch, HSG A
* 1,535	76	Mulch, HSG C
* 558	98	New paved parking, HSG C
2,552	75	Weighted Average
1,994		78.13% Pervious Area
558		21.87% Impervious Area

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

**Subcatchment 6S: High Plain Direct Offsite**



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

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**Summary for Subcatchment 7S: Proposed Path**

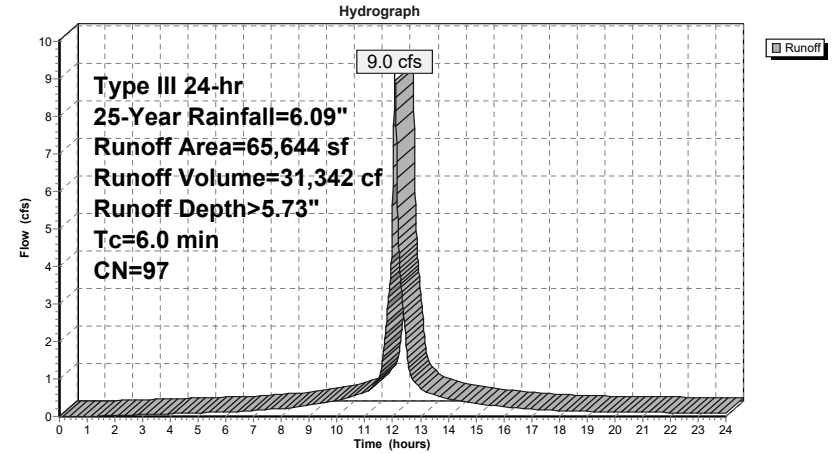
Runoff = 9.0 cfs @ 12.08 hrs, Volume= 31,342 cf, Depth> 5.73"  
 Routed to Reach 2R : Offsite from Path

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
* 44,046	98	New paved parking, HSG D
21,598	96	Gravel surface, HSG D
65,644	97	Weighted Average
21,598		32.90% Pervious Area
44,046		67.10% Impervious Area

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

**Subcatchment 7S: Proposed Path**



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

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**Summary for Subcatchment 8S: Haggetts Pond CB**

Runoff = 13.4 cfs @ 12.14 hrs, Volume= 47,830 cf, Depth> 2.96"  
 Routed to Reach 3R : 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
* 981	98	New paved parking, HSG A
* 23,399	98	Ex. paved parking, HSG A
* 21,360	98	Ex. paved parking, HSG B
* 2,159	98	Ex. paved parking, HSG C
* 1,056	43	Mulch, HSG A
* 22,247	39	>75% Ex. Grass cover, Good, HSG A
* 44,580	61	>75% Ex. Grass cover, Good, HSG B
* 13,232	74	>75% Ex. Grass cover, Good, HSG C
61	76	Gravel roads, HSG A
2,530	30	Woods, Good, HSG A
2,036	55	Woods, Good, HSG B
59,938	70	Woods, Good, HSG C
193,579	71	Weighted Average
145,680		75.26% Pervious Area
47,899		24.74% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.2	50	0.1500	0.16		<b>Sheet Flow,</b> Woods: Light underbrush n= 0.400 P2= 3.60"
3.8	307	0.0720	1.34		<b>Shallow Concentrated Flow,</b> Woodland Kv= 5.0 fps
1.2	356	0.0610	5.01		<b>Shallow Concentrated Flow,</b> Paved Kv= 20.3 fps
10.2	713	Total			

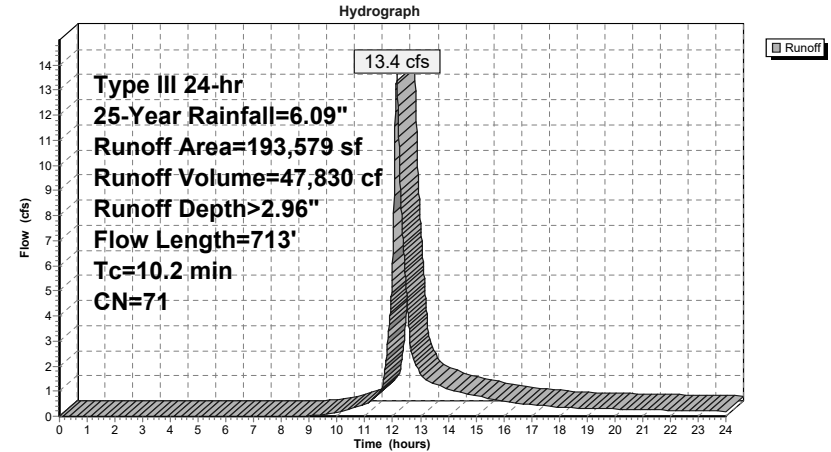
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Type III 24-hr 25-Year Rainfall=6.09"

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**Subcatchment 8S: Haggetts Pond CB**

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

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**Summary for Subcatchment 9S: Haggetts Pond Prkg**

Runoff = 0.6 cfs @ 12.17 hrs, Volume= 2,381 cf, Depth> 2.23"  
 Routed to Pond 4P : Haggetts Infiltr

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
* 5,744	98	New paved parking, HSG A
* 2,661	43	Mulch, HSG A
4,390	30	Woods, Good, HSG A
12,795	63	Weighted Average
7,051		55.11% Pervious Area
5,744		44.89% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
9.1	50	0.0370	0.09		<b>Sheet Flow,</b> Woods: Light underbrush n= 0.400 P2= 3.60"
0.2	11	0.0370	0.96		<b>Shallow Concentrated Flow,</b> Woodland Kv= 5.0 fps
0.0	8	0.3660	3.02		<b>Shallow Concentrated Flow,</b> Woodland Kv= 5.0 fps
0.7	13	0.0043	0.33		<b>Shallow Concentrated Flow,</b> Woodland Kv= 5.0 fps
0.3	10	0.0043	0.66		<b>Shallow Concentrated Flow,</b> Nearly Bare & Untilled Kv= 10.0 fps
1.1	154	0.0130	2.31		<b>Shallow Concentrated Flow,</b> Paved Kv= 20.3 fps
11.4	246	Total			

**8998501-POST**

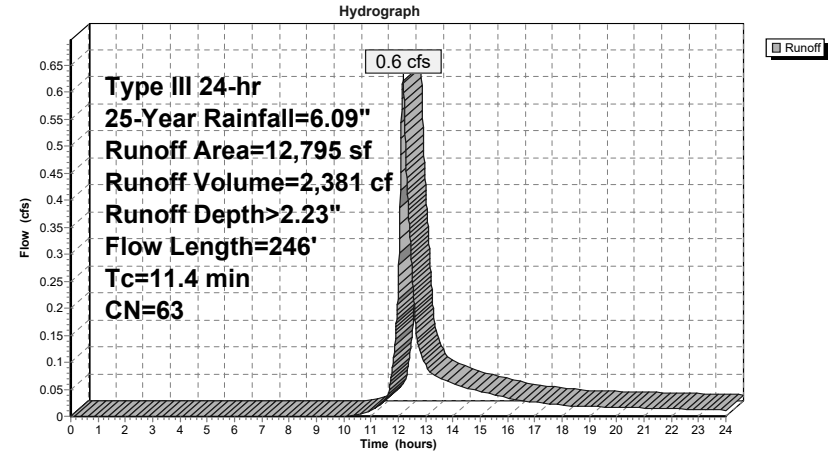
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Type III 24-hr 25-Year Rainfall=6.09"

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**Subcatchment 9S: Haggetts Pond Prkg**



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

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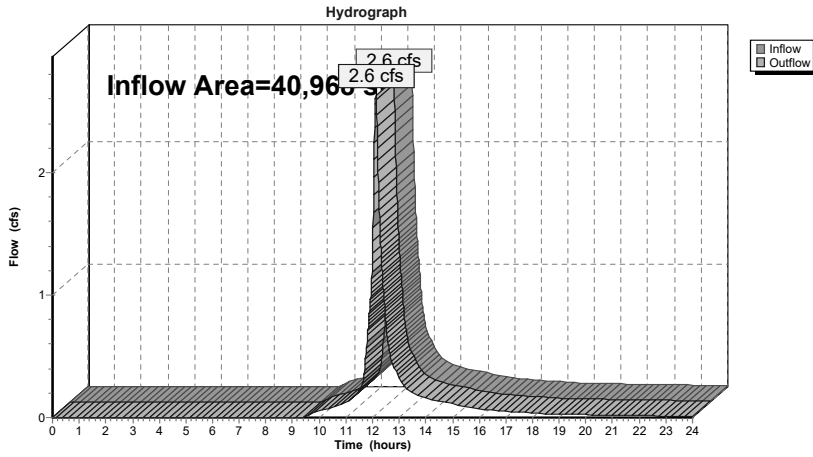
**Summary for Reach 1R: Offsite East at High Plain Rd**

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

Inflow Area = 40,968 sf, 45.16% Impervious, Inflow Depth > 2.33" for 25-Year event  
 Inflow = 2.6 cfs @ 12.12 hrs, Volume= 7,966 cf  
 Outflow = 2.6 cfs @ 12.12 hrs, Volume= 7,966 cf, Atten= 0%, Lag= 0.0 min  
 Routed to Reach 4R : Total Offsite

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**



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

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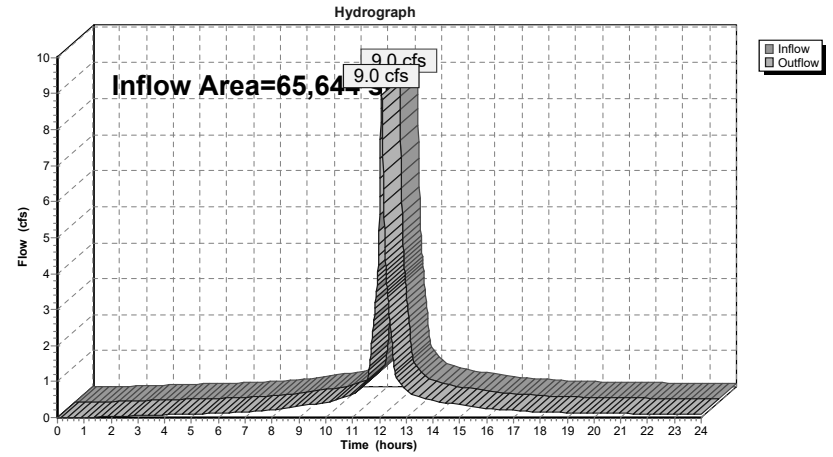
**Summary for Reach 2R: Offsite from Path**

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

Inflow Area = 65,644 sf, 67.10% Impervious, Inflow Depth > 5.73" for 25-Year event  
 Inflow = 9.0 cfs @ 12.08 hrs, Volume= 31,342 cf  
 Outflow = 9.0 cfs @ 12.08 hrs, Volume= 31,342 cf, Atten= 0%, Lag= 0.0 min  
 Routed to Reach 4R : Total Offsite

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

**Reach 2R: Offsite from Path**



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

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**Summary for Reach 3R: Offsite East at Haggets Pond Rd**

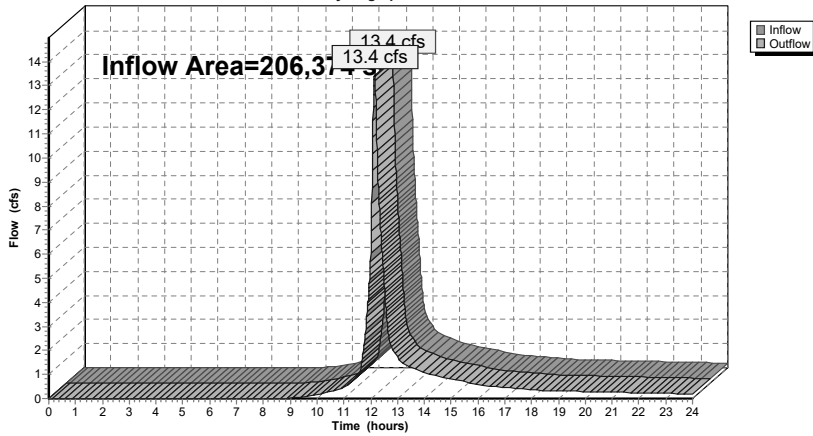
[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 206,374 sf, 25.99% Impervious, Inflow Depth > 2.78" for 25-Year event  
 Inflow = 13.4 cfs @ 12.14 hrs, Volume= 47,830 cf  
 Outflow = 13.4 cfs @ 12.14 hrs, Volume= 47,830 cf, Atten= 0%, Lag= 0.0 min  
 Routed to Reach 4R : Total Offsite

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

**Reach 3R: Offsite East at Haggets Pond Rd**

Hydrograph



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

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**Summary for Reach 4R: Total Offsite**

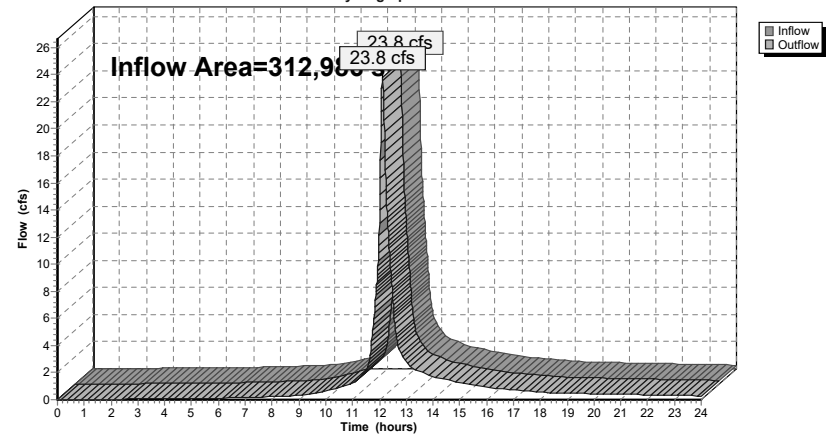
[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 312,986 sf, 37.12% Impervious, Inflow Depth > 3.34" for 25-Year event  
 Inflow = 23.8 cfs @ 12.12 hrs, Volume= 87,137 cf  
 Outflow = 23.8 cfs @ 12.12 hrs, Volume= 87,137 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 4R: Total Offsite**

Hydrograph



**8998501-POST**

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

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**Summary for Pond 1P: High Plain Infiltr**

[87] Warning: Oscillations may require smaller dt or Finer Routing (severity=78)

Inflow Area = 13,251 sf, 53.66% Impervious, Inflow Depth > 4.34" for 25-Year event  
 Inflow = 1.4 cfs @ 12.10 hrs, Volume= 4,790 cf  
 Outflow = 0.2 cfs @ 12.65 hrs, Volume= 4,791 cf, Atten= 86%, Lag= 33.0 min  
 Discarded = 0.1 cfs @ 12.65 hrs, Volume= 4,607 cf  
 Primary = 0.1 cfs @ 12.65 hrs, Volume= 184 cf  
 Routed to Pond 3P : Rain Garden #2

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs  
 Peak Elev= 135.54' @ 12.65 hrs Surf.Area= 1,536 sf Storage= 1,841 cf  
 Flood Elev= 135.80' Surf.Area= 1,536 sf Storage= 1,852 cf

Plug-Flow detention time= (not calculated: outflow precedes inflow)  
 Center-of-Mass det. time= 148.6 min ( 939.7 - 791.1 )

Volume	Invert	Avail.Storage	Storage Description
#1A	133.80'	307 cf	<b>24.00'W x 64.00'L x 2.00'H Field A</b> 3,072 cf Overall - 2,304 cf Embedded = 768 cf x 40.0% Voids
#2A	134.30'	1,544 cf	<b>Shea Leaching Chamber 4x8x1.5 x 48</b> Inside #1 Inside= 42.0"W x 15.0"H => 4.29 sf x 7.50'L = 32.2 cf Outside= 48.0"W x 18.0"H => 6.00 sf x 8.00'L = 48.0 cf 48 Chambers in 6 Rows
		1,852 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Primary	135.50'	<b>4.0' long Sharp-Crested Rectangular Weir</b> 2 End Contraction(s)
#2	Discarded	133.80'	<b>2.410 in/hr Exfiltration over Wetted area</b>

**Discarded OutFlow** Max=0.1 cfs @ 12.65 hrs HW=135.54' (Free Discharge)  
 ↳2=Exfiltration (Exfiltration Controls 0.1 cfs)

**Primary OutFlow** Max=0.1 cfs @ 12.65 hrs HW=135.54' TW=130.63' (Dynamic Tailwater)  
 ↳1=Sharp-Crested Rectangular Weir (Weir Controls 0.1 cfs @ 0.65 fps)

**8998501-POST**

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

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**Pond 1P: High Plain Infiltr - Chamber Wizard Field A**

**Chamber Model = Shea Leaching Chamber 4x8x1.5 (Shea Leaching Chamber)**

Inside= 42.0"W x 15.0"H => 4.29 sf x 7.50'L = 32.2 cf  
 Outside= 48.0"W x 18.0"H => 6.00 sf x 8.00'L = 48.0 cf

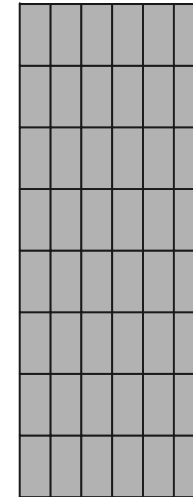
8 Chambers/Row x 8.00' Long = 64.00' Row Length  
 6 Rows x 48.0" Wide = 24.00' Base Width  
 6.0" Stone Base + 18.0" Chamber Height = 2.00' Field Height

48 Chambers x 32.2 cf = 1,544.4 cf Chamber Storage  
 48 Chambers x 48.0 cf = 2,304.0 cf Displacement

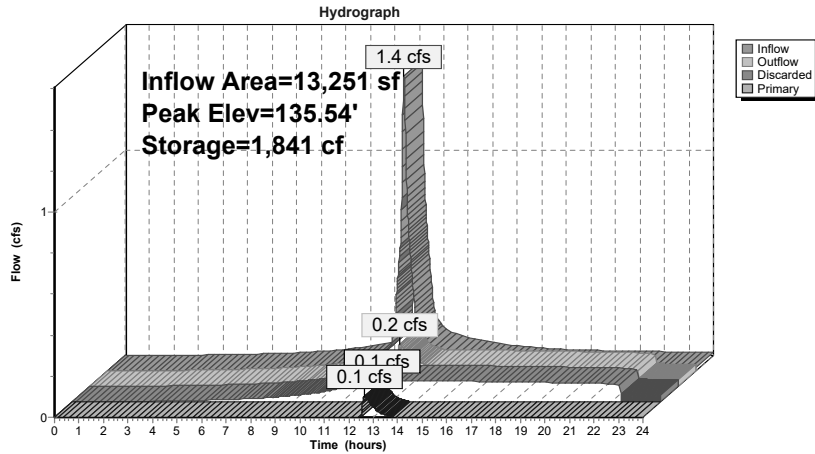
3,072.0 cf Field - 2,304.0 cf Chambers = 768.0 cf Stone x 40.0% Voids = 307.2 cf Stone Storage

Chamber Storage + Stone Storage = 1,851.6 cf = 0.043 af  
 Overall Storage Efficiency = 60.3%  
 Overall System Size = 64.00' x 24.00' x 2.00'

48 Chambers  
 113.8 cy Field  
 28.4 cy Stone



**Pond 1P: High Plain Infil**



**Summary for Pond 2P: Rain Garden #1**

Inflow Area = 5,635 sf, 0.00% Impervious, Inflow Depth > 3.26" for 25-Year event  
 Inflow = 0.5 cfs @ 12.11 hrs, Volume= 1,529 cf  
 Outflow = 0.5 cfs @ 12.13 hrs, Volume= 1,375 cf, Atten= 2%, Lag= 1.1 min  
 Primary = 0.5 cfs @ 12.13 hrs, Volume= 1,375 cf  
 Routed to Pond 1P : High Plain Infil

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs  
 Peak Elev= 136.63' @ 12.13 hrs Surf.Area= 357 sf Storage= 194 cf

Plug-Flow detention time= 69.6 min calculated for 1,375 cf (90% of inflow)  
 Center-of-Mass det. time= 21.1 min ( 849.7 - 828.6 )

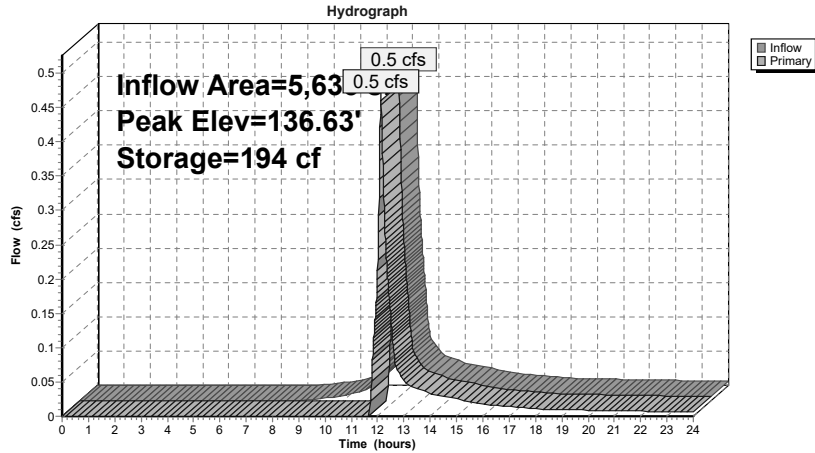
Volume	Invert	Avail.Storage	Storage Description
#1	135.50'	354 cf	<b>Custom Stage Data (Irregular)</b> Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
135.50	5	5.0	0	0	5
136.00	167	57.2	33	33	264
137.00	505	178.4	321	354	2,539

Device	Routing	Invert	Outlet Devices
#1	Primary	136.50'	<b>12.0" Horiz. Orifice/Grate</b> C= 0.600 Limited to weir flow at low heads

**Primary OutFlow** Max=0.5 cfs @ 12.13 hrs HW=136.63' TW=134.84' (Dynamic Tailwater)  
 ↑1=Orifice/Grate (Weir Controls 0.5 cfs @ 1.16 fps)

**Pond 2P: Rain Garden #1**



**Summary for Pond 3P: Rain Garden #2**

Inflow Area = 38,416 sf, 46.71% Impervious, Inflow Depth > 2.81" for 25-Year event  
 Inflow = 2.6 cfs @ 12.10 hrs, Volume= 8,993 cf  
 Outflow = 2.5 cfs @ 12.13 hrs, Volume= 8,865 cf, Atten= 6%, Lag= 1.9 min  
 Discarded = 0.0 cfs @ 12.13 hrs, Volume= 1,612 cf  
 Primary = 2.4 cfs @ 12.13 hrs, Volume= 7,252 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= 131.11' @ 12.13 hrs Surf.Area= 575 sf Storage= 512 cf  
 Flood Elev= 132.25' Surf.Area= 792 sf Storage= 1,118 cf

Plug-Flow detention time= (not calculated: outflow precedes inflow)  
 Center-of-Mass det. time= 8.0 min ( 803.9 - 795.9 )

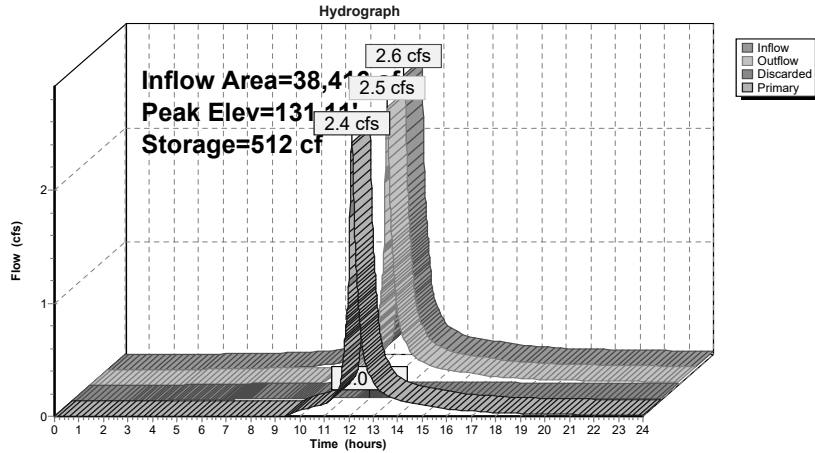
Volume #1	Invert	Avail.Storage	Storage Description		
	130.00'	1,118 cf	<b>Custom Stage Data (Irregular)</b> Listed below (Recalc)		
Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
130.00	356	91.4	0	0	356
131.00	551	104.0	450	450	575
132.00	792	122.3	668	1,118	923

Device	Routing	Invert	Outlet Devices
#1	Primary	130.30'	<b>15.0" Round Culvert</b> L= 18.0' CPP, end-section conforming to fill, Ke= 0.500 Inlet / Outlet Invert= 130.30' / 130.00' S= 0.0167 '/ Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 1.23 sf
#2	Discarded	130.00'	<b>2.410 in/hr Exfiltration over Wetted area</b>

**Discarded OutFlow** Max=0.0 cfs @ 12.13 hrs HW=131.11' (Free Discharge)  
 ↳ **2=Exfiltration** (Exfiltration Controls 0.0 cfs)

**Primary OutFlow** Max=2.4 cfs @ 12.13 hrs HW=131.11' TW=0.00' (Dynamic Tailwater)  
 ↳ **1=Culvert** (Barrel Controls 2.4 cfs @ 4.09 fps)

**Pond 3P: Rain Garden #2**



**Summary for Pond 4P: Haggets Infil**

[87] Warning: Oscillations may require smaller dt or Finer Routing (severity=413)

Inflow Area = 12,795 sf, 44.89% Impervious, Inflow Depth > 2.23" for 25-Year event  
 Inflow = 0.6 cfs @ 12.17 hrs, Volume= 2,381 cf  
 Outflow = 0.1 cfs @ 12.75 hrs, Volume= 2,381 cf, Atten= 80%, Lag= 34.9 min  
 Discarded = 0.1 cfs @ 12.75 hrs, Volume= 2,381 cf  
 Primary = 0.0 cfs @ 0.00 hrs, Volume= 0 cf

Routed to Reach 3R : Offsite East at Haggets Pond Rd

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

Peak Elev= 129.63' @ 12.75 hrs Surf.Area= 2,125 sf Storage= 651 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= 36.0 min ( 893.6 - 857.6 )

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	130.50'	<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=0.1 cfs @ 12.75 hrs HW=129.63' (Free Discharge)

↳2=Exfiltration (Exfiltration Controls 0.1 cfs)

**Primary OutFlow** Max=0.0 cfs @ 0.00 hrs HW=129.00' TW=0.00' (Dynamic Tailwater)

↳1=Sharp-Crested Rectangular Weir ( Controls 0.0 cfs)

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

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**Pond 4P: Haggetts Infiltr - 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

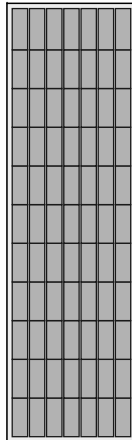
Overall Storage Efficiency = 55.0%

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

77 Chambers

160.7 cy Field

120.6 cy Stone



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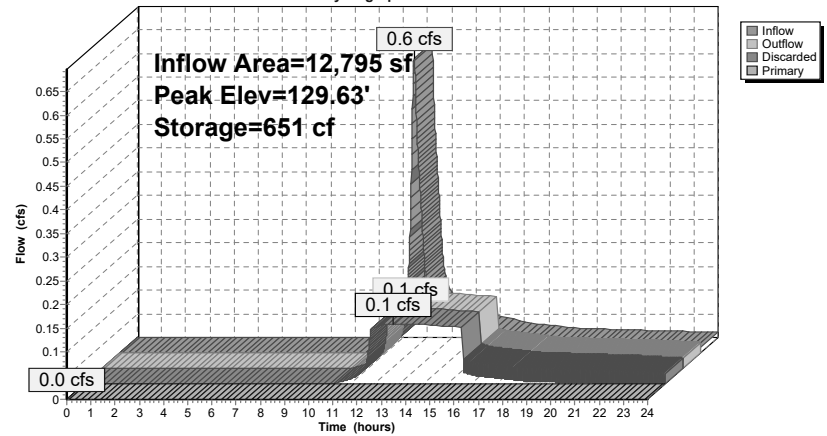
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Type III 24-hr 25-Year Rainfall=6.09"

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**Pond 4P: Haggetts Infiltr**

Hydrograph



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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

<b>Subcatchment 1S: High Plain Prkg</b>	Runoff Area=7,616 sf 93.36% Impervious Runoff Depth>7.12" Tc=6.0 min CN=94 Runoff=1.3 cfs 4,517 cf
<b>Subcatchment 2S: Rain Garden #1</b>	Runoff Area=5,635 sf 0.00% Impervious Runoff Depth>4.78" Flow Length=193' Tc=7.5 min CN=74 Runoff=0.7 cfs 2,243 cf
<b>Subcatchment 3S: Rain Garden #2</b>	Runoff Area=4,486 sf 23.83% Impervious Runoff Depth>5.59" Tc=6.0 min CN=81 Runoff=0.7 cfs 2,088 cf
<b>Subcatchment 4S: Ex. High Plain CB</b>	Runoff Area=9,171 sf 84.60% Impervious Runoff Depth>7.12" Tc=6.0 min CN=94 Runoff=1.6 cfs 5,439 cf
<b>Subcatchment 5S: Ex. High Plain Driveway</b>	Runoff Area=11,508 sf 17.44% Impervious Runoff Depth>4.89" Flow Length=121' Tc=8.4 min CN=75 Runoff=1.4 cfs 4,689 cf
<b>Subcatchment 6S: High Plain Direct Offsite</b>	Runoff Area=2,552 sf 21.87% Impervious Runoff Depth>4.89" Tc=6.0 min CN=75 Runoff=0.3 cfs 1,040 cf
<b>Subcatchment 7S: Proposed Path</b>	Runoff Area=65,644 sf 67.10% Impervious Runoff Depth>7.47" Tc=6.0 min CN=97 Runoff=11.6 cfs 40,890 cf
<b>Subcatchment 8S: Haggetts Pond CB</b>	Runoff Area=193,579 sf 24.74% Impervious Runoff Depth>4.43" Flow Length=713' Tc=10.2 min CN=71 Runoff=20.1 cfs 71,489 cf
<b>Subcatchment 9S: Haggetts Pond Prkg</b>	Runoff Area=12,795 sf 44.89% Impervious Runoff Depth>3.53" Flow Length=246' Tc=11.4 min CN=63 Runoff=1.0 cfs 3,768 cf
<b>Reach 1R: Offsite East at High Plain Rd</b>	Inflow=3.7 cfs 12,731 cf Outflow=3.7 cfs 12,731 cf
<b>Reach 2R: Offsite from Path</b>	Inflow=11.6 cfs 40,890 cf Outflow=11.6 cfs 40,890 cf
<b>Reach 3R: Offsite East at Haggetts Pond Rd</b>	Inflow=20.1 cfs 71,489 cf Outflow=20.1 cfs 71,489 cf
<b>Reach 4R: Total Offsite</b>	Inflow=33.8 cfs 125,110 cf Outflow=33.8 cfs 125,110 cf
<b>Pond 1P: High Plain Infiltr</b>	Peak Elev=135.73' Storage=1,852 cf Inflow=1.9 cfs 6,605 cf Discarded=0.1 cfs 5,262 cf Primary=1.4 cfs 1,343 cf Outflow=1.5 cfs 6,606 cf
<b>Pond 2P: Rain Garden #1</b>	Peak Elev=136.66' Storage=207 cf Inflow=0.7 cfs 2,243 cf Outflow=0.7 cfs 2,089 cf
<b>Pond 3P: Rain Garden #2</b>	Peak Elev=131.30' Storage=625 cf Inflow=3.9 cfs 13,560 cf Discarded=0.0 cfs 1,733 cf Primary=3.3 cfs 11,691 cf Outflow=3.4 cfs 13,423 cf

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

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**Pond 4P: Haggetts Infiltr**Peak Elev=130.04' Storage=1,339 cf Inflow=1.0 cfs 3,768 cf  
Discarded=0.1 cfs 3,770 cf Primary=0.0 cfs 0 cf Outflow=0.1 cfs 3,770 cf**Total Runoff Area = 312,986 sf Runoff Volume = 136,165 cf Average Runoff Depth = 5.22"**  
**62.88% Pervious = 196,794 sf 37.12% Impervious = 116,192 sf**

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

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

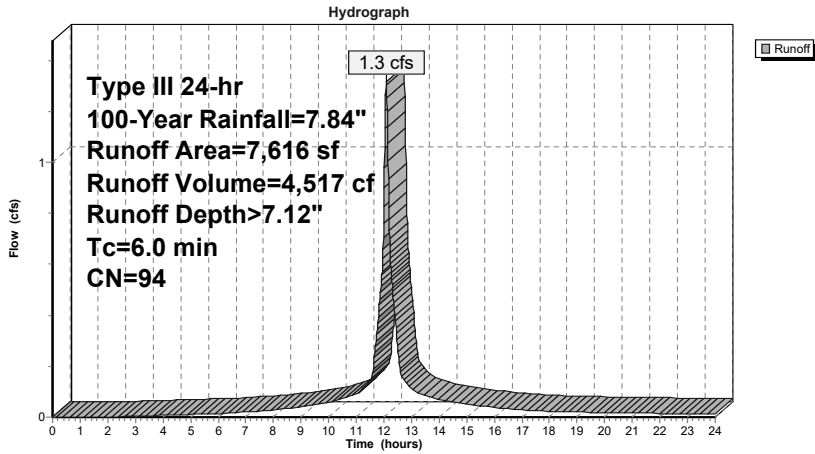
Runoff = 1.3 cfs @ 12.08 hrs, Volume= 4,517 cf, Depth> 7.12"  
Routed to Pond 1P : High Plain Infiltr

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
* 189	43	Mulch, HSG A
317	30	Woods, Good, HSG A
* 689	98	New paved parking, HSG A
* 6,421	98	New paved parking, HSG C
7,616	94	Weighted Average
506		6.64% Pervious Area
7,110		93.36% Impervious Area

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

**Subcatchment 1S: High Plain Prkg**



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

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**Summary for Subcatchment 2S: Rain Garden #1**

Runoff = 0.7 cfs @ 12.11 hrs, Volume= 2,243 cf, Depth> 4.78"  
Routed to Pond 2P : Rain Garden #1

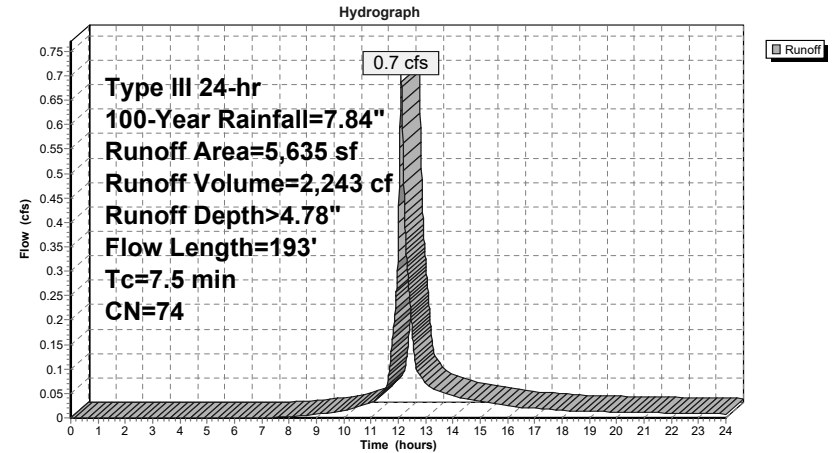
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs  
Type III 24-hr 100-Year Rainfall=7.84"

Area (sf)	CN	Description
* 33	43	Mulch, HSG A
* 3,911	76	Mulch, HSG C
38	30	Woods, Good, HSG A
1,653	70	Woods, Good, HSG C
5,635	74	Weighted Average
5,635		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.2	33	0.1700	0.09		Sheet Flow, Woods: Dense underbrush n= 0.800 P2= 3.60"
0.1	17	0.1300	2.52		Shallow Concentrated Flow, Short Grass Pasture Kv= 7.0 fps
1.2	143	0.0175	1.98		Shallow Concentrated Flow, Grassed Waterway Kv= 15.0 fps

7.5 193 Total

**Subcatchment 2S: Rain Garden #1**



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

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**Summary for Subcatchment 3S: Rain Garden #2**

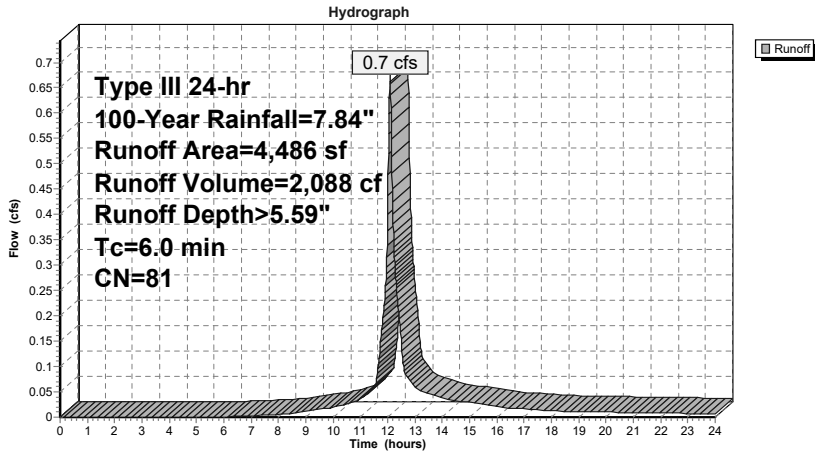
Runoff = 0.7 cfs @ 12.09 hrs, Volume= 2,088 cf, Depth> 5.59"  
Routed to Pond 3P : Rain Garden #2

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

Area (sf)	CN	Description
* 2,726	76	Mulch, HSG C
83	96	Gravel surface, HSG D
608	70	Woods, Good, HSG C
* 1,069	98	New paved parking, HSG C
4,486	81	Weighted Average
3,417		76.17% Pervious Area
1,069		23.83% Impervious Area

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

**Subcatchment 3S: Rain Garden #2**



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

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**Summary for Subcatchment 4S: Ex. High Plain CB**

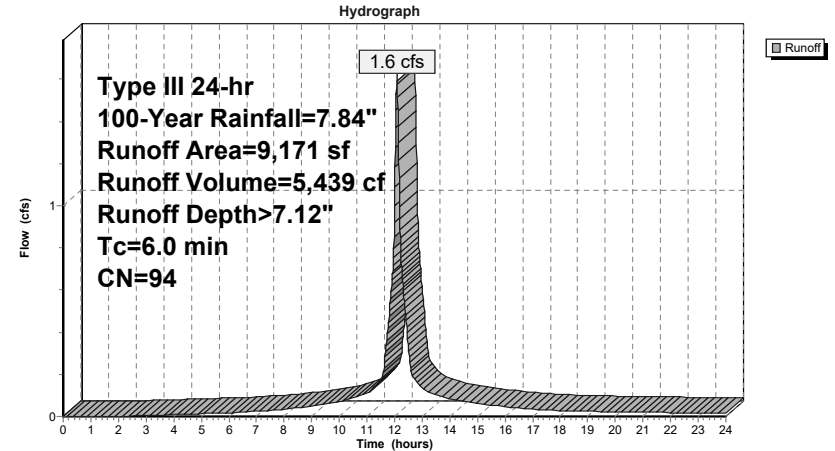
Runoff = 1.6 cfs @ 12.08 hrs, Volume= 5,439 cf, Depth> 7.12"  
Routed to Pond 3P : Rain Garden #2

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

Area (sf)	CN	Description
* 1,412	74	>75% Ex. Grass cover, Good, HSG C
* 7,759	98	Ex. paved parking, HSG C
9,171	94	Weighted Average
1,412		15.40% Pervious Area
7,759		84.60% Impervious Area

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

**Subcatchment 4S: Ex. High Plain CB**



**Summary for Subcatchment 5S: Ex. High Plain Driveway**

Runoff = 1.4 cfs @ 12.12 hrs, Volume= 4,689 cf, Depth> 4.89"  
 Routed to Pond 3P : Rain Garden #2

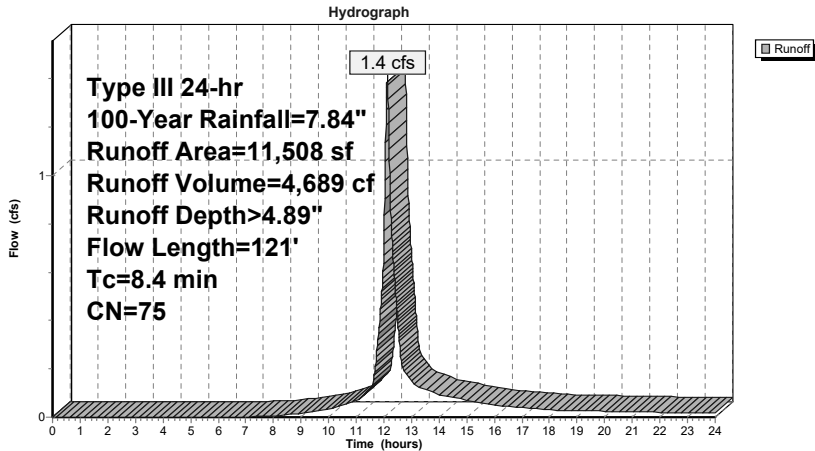
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs  
 Type III 24-hr 100-Year Rainfall=7.84"

Area (sf)	CN	Description
9,501	70	Woods, Good, HSG C
* 2,007	98	Ex. paved parking, HSG C
11,508	75	Weighted Average
9,501		82.56% Pervious Area
2,007		17.44% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.0	50	0.0710	0.12		<b>Sheet Flow,</b> Woods: Light underbrush n= 0.400 P2= 3.60"
1.4	71	0.0290	0.85		<b>Shallow Concentrated Flow,</b> Woodland Kv= 5.0 fps
8.4	121	Total			

**Subcatchment 5S: Ex. High Plain Driveway**



**Summary for Subcatchment 6S: High Plain Direct Offsite**

Runoff = 0.3 cfs @ 12.09 hrs, Volume= 1,040 cf, Depth> 4.89"  
 Routed to Reach 1R : Offsite East at High Plain Rd

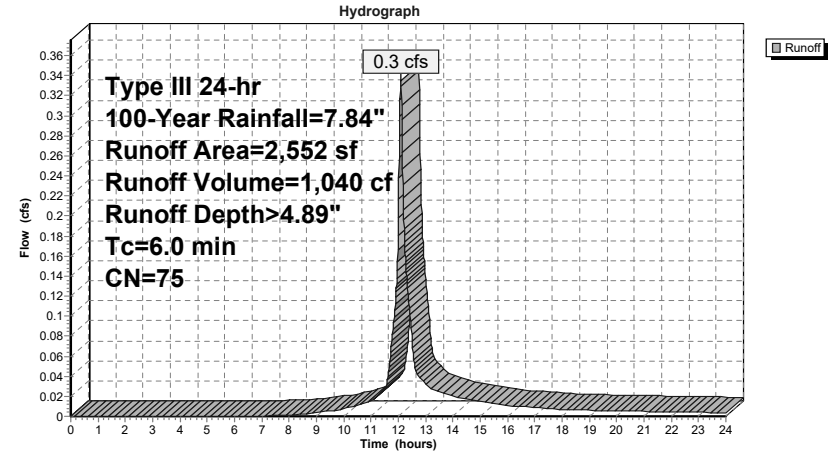
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs  
 Type III 24-hr 100-Year Rainfall=7.84"

Area (sf)	CN	Description
* 459	43	Mulch, HSG A
* 1,535	76	Mulch, HSG C
* 558	98	New paved parking, HSG C
2,552	75	Weighted Average
1,994		78.13% Pervious Area
558		21.87% Impervious Area

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

**Subcatchment 6S: High Plain Direct Offsite**



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

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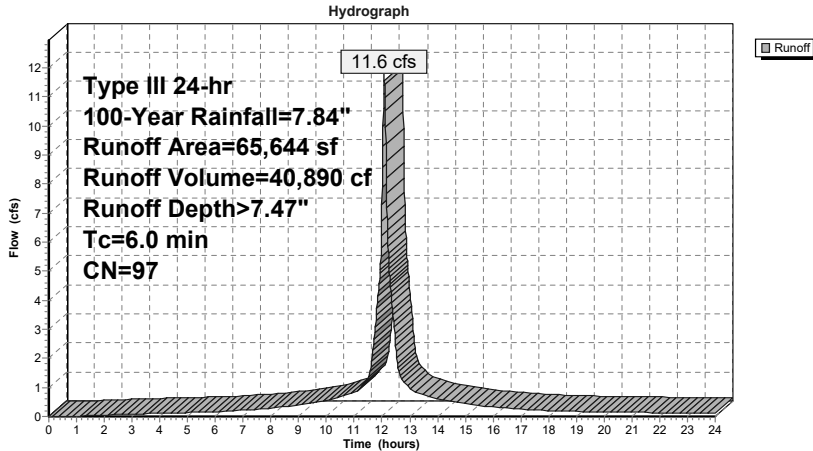
**Summary for Subcatchment 7S: Proposed Path**

Runoff = 11.6 cfs @ 12.08 hrs, Volume= 40,890 cf, Depth> 7.47"  
 Routed to Reach 2R : Offsite from Path

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
* 44,046	98	New paved parking, HSG D
21,598	96	Gravel surface, HSG D
65,644	97	Weighted Average
21,598		32.90% Pervious Area
44,046		67.10% Impervious Area

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

**Subcatchment 7S: Proposed Path****8998501-POST**

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

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**Summary for Subcatchment 8S: Haggetts Pond CB**

Runoff = 20.1 cfs @ 12.14 hrs, Volume= 71,489 cf, Depth> 4.43"  
 Routed to Reach 3R : Offsite East at Haggetts Pond Rd

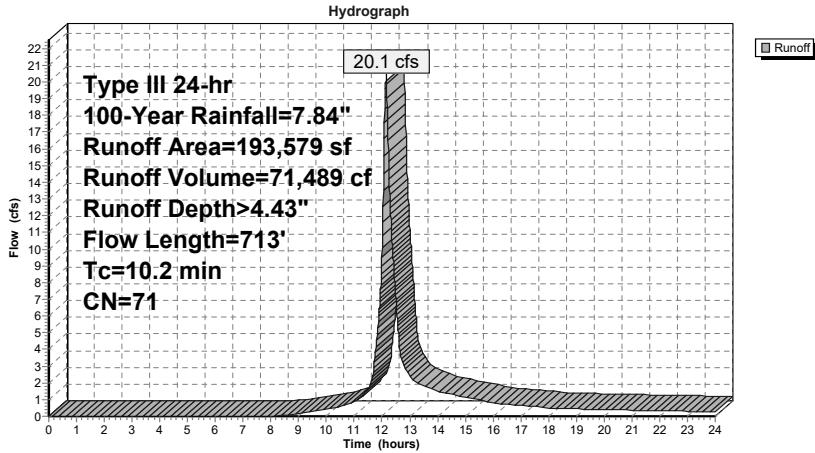
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs  
 Type III 24-hr 100-Year Rainfall=7.84"

Area (sf)	CN	Description
* 981	98	New paved parking, HSG A
* 23,399	98	Ex. paved parking, HSG A
* 21,360	98	Ex. paved parking, HSG B
* 2,159	98	Ex. paved parking, HSG C
* 1,056	43	Mulch, HSG A
* 22,247	39	>75% Ex. Grass cover, Good, HSG A
* 44,580	61	>75% Ex. Grass cover, Good, HSG B
* 13,232	74	>75% Ex. Grass cover, Good, HSG C
61	76	Gravel roads, HSG A
2,530	30	Woods, Good, HSG A
2,036	55	Woods, Good, HSG B
59,938	70	Woods, Good, HSG C

193,579	71	Weighted Average
145,680		75.26% Pervious Area
47,899		24.74% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.2	50	0.1500	0.16		<b>Sheet Flow,</b> Woods: Light underbrush n= 0.400 P2= 3.60"
3.8	307	0.0720	1.34		<b>Shallow Concentrated Flow,</b> Woodland Kv= 5.0 fps
1.2	356	0.0610	5.01		<b>Shallow Concentrated Flow,</b> Paved Kv= 20.3 fps
10.2	713	Total			

**Subcatchment 8S: Haggetts Pond CB**



**Summary for Subcatchment 9S: Haggetts Pond Prkg**

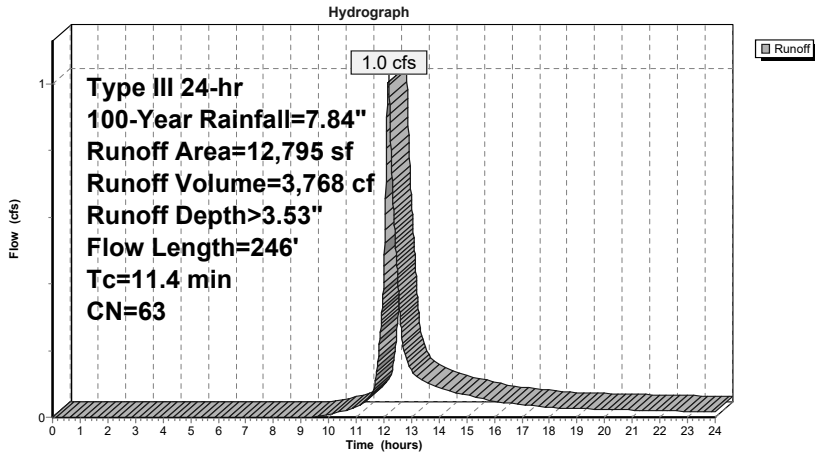
Runoff = 1.0 cfs @ 12.16 hrs, Volume= 3,768 cf, Depth> 3.53"  
Routed to Pond 4P : Haggetts Infiltr

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
*	5,744	98	New paved parking, HSG A
*	2,661	43	Mulch, HSG A
	4,390	30	Woods, Good, HSG A
	12,795	63	Weighted Average
	7,051		55.11% Pervious Area
	5,744		44.89% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
9.1	50	0.0370	0.09		<b>Sheet Flow,</b> Woods: Light underbrush n= 0.400 P2= 3.60"
0.2	11	0.0370	0.96		<b>Shallow Concentrated Flow,</b> Woodland Kv= 5.0 fps
0.0	8	0.3660	3.02		<b>Shallow Concentrated Flow,</b> Woodland Kv= 5.0 fps
0.7	13	0.0043	0.33		<b>Shallow Concentrated Flow,</b> Woodland Kv= 5.0 fps
0.3	10	0.0043	0.66		<b>Shallow Concentrated Flow,</b> Nearly Bare & Untilled Kv= 10.0 fps
1.1	154	0.0130	2.31		<b>Shallow Concentrated Flow,</b> Paved Kv= 20.3 fps
11.4	246	Total			

Subcatchment 9S: Haggetts Pond Prkg



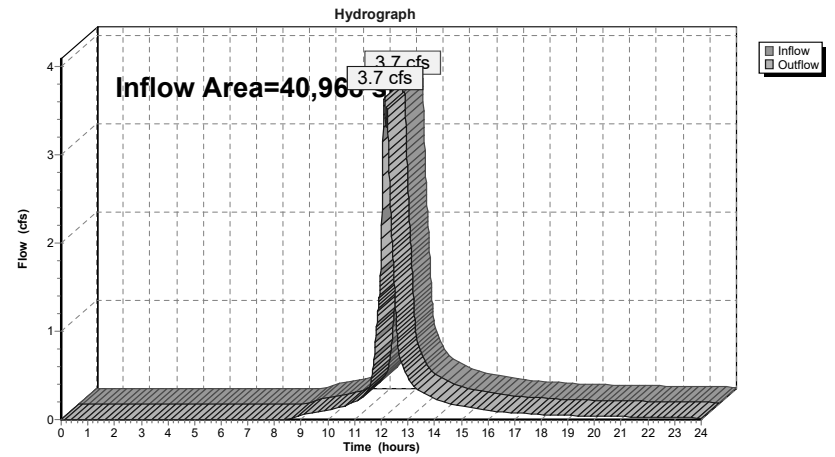
Summary for Reach 1R: Offsite East at High Plain Rd

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

Inflow Area = 40,968 sf, 45.16% Impervious, Inflow Depth > 3.73" for 100-Year event  
 Inflow = 3.7 cfs @ 12.12 hrs, Volume= 12,731 cf  
 Outflow = 3.7 cfs @ 12.12 hrs, Volume= 12,731 cf, Atten= 0%, Lag= 0.0 min  
 Routed to Reach 4R : Total Offsite

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 from Path

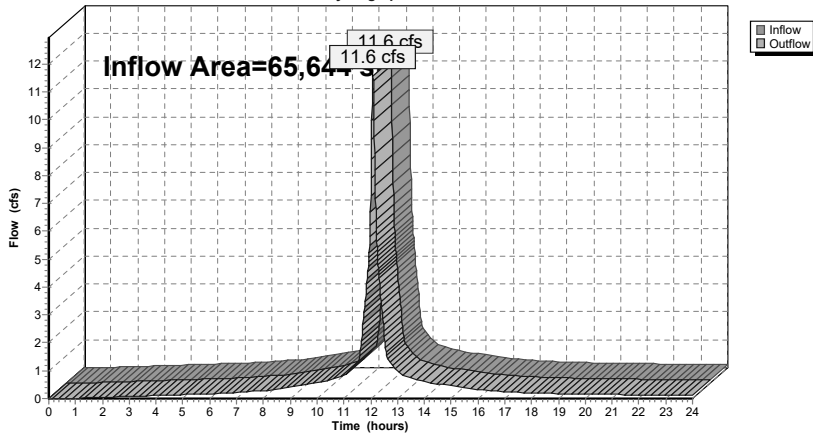
[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 65,644 sf, 67.10% Impervious, Inflow Depth > 7.47" for 100-Year event  
 Inflow = 11.6 cfs @ 12.08 hrs, Volume= 40,890 cf  
 Outflow = 11.6 cfs @ 12.08 hrs, Volume= 40,890 cf, Atten= 0%, Lag= 0.0 min  
 Routed to Reach 4R : Total Offsite

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

Reach 2R: Offsite from Path

Hydrograph



Summary for Reach 3R: Offsite East at Haggets Pond Rd

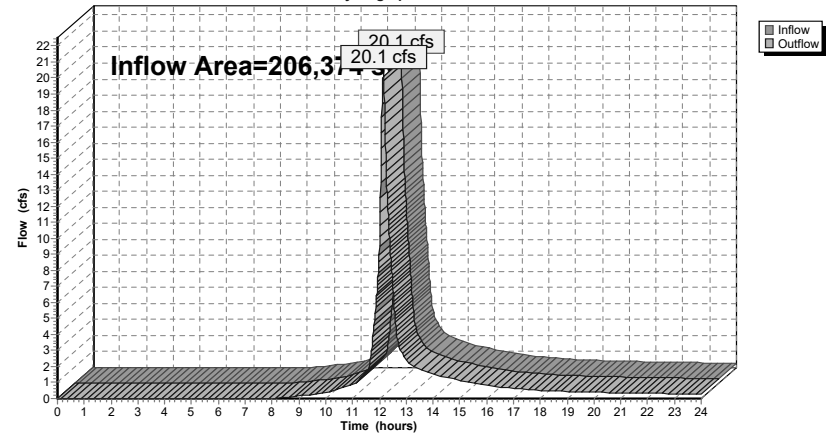
[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 206,374 sf, 25.99% Impervious, Inflow Depth > 4.16" for 100-Year event  
 Inflow = 20.1 cfs @ 12.14 hrs, Volume= 71,489 cf  
 Outflow = 20.1 cfs @ 12.14 hrs, Volume= 71,489 cf, Atten= 0%, Lag= 0.0 min  
 Routed to Reach 4R : Total Offsite

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

Reach 3R: Offsite East at Haggets Pond Rd

Hydrograph



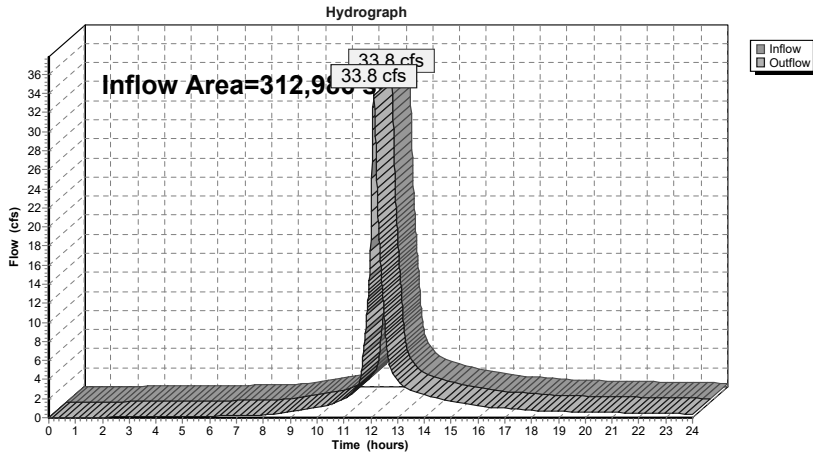
**Summary for Reach 4R: Total Offsite**

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

Inflow Area = 312,986 sf, 37.12% Impervious, Inflow Depth > 4.80" for 100-Year event  
 Inflow = 33.8 cfs @ 12.12 hrs, Volume= 125,110 cf  
 Outflow = 33.8 cfs @ 12.12 hrs, Volume= 125,110 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 4R: Total Offsite**



**Summary for Pond 1P: High Plain Infiltr**

[87] Warning: Oscillations may require smaller dt or Finer Routing (severity=40)

Inflow Area = 13,251 sf, 53.66% Impervious, Inflow Depth > 5.98" for 100-Year event  
 Inflow = 1.9 cfs @ 12.10 hrs, Volume= 6,605 cf  
 Outflow = 1.5 cfs @ 12.19 hrs, Volume= 6,606 cf, Atten= 23%, Lag= 5.6 min  
 Discarded = 0.1 cfs @ 12.19 hrs, Volume= 5,262 cf  
 Primary = 1.4 cfs @ 12.19 hrs, Volume= 1,343 cf  
 Routed to Pond 3P : Rain Garden #2

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs  
 Peak Elev= 135.73' @ 12.19 hrs Surf.Area= 1,536 sf Storage= 1,852 cf  
 Flood Elev= 135.80' Surf.Area= 1,536 sf Storage= 1,852 cf

Plug-Flow detention time= (not calculated: outflow precedes inflow)  
 Center-of-Mass det. time= 128.4 min ( 913.0 - 784.6 )

Volume	Invert	Avail.Storage	Storage Description
#1A	133.80'	307 cf	<b>24.00'W x 64.00'L x 2.00'H Field A</b> 3,072 cf Overall - 2,304 cf Embedded = 768 cf x 40.0% Voids
#2A	134.30'	1,544 cf	<b>Shea Leaching Chamber 4x8x1.5 x 48</b> Inside #1 Inside= 42.0"W x 15.0"H => 4.29 sf x 7.50'L = 32.2 cf Outside= 48.0"W x 18.0"H => 6.00 sf x 8.00'L = 48.0 cf 48 Chambers in 6 Rows
		1,852 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Primary	135.50'	<b>4.0' long Sharp-Crested Rectangular Weir</b> 2 End Contraction(s)
#2	Discarded	133.80'	<b>2.410 in/hr Exfiltration over Wetted area</b>

**Discarded OutFlow** Max=0.1 cfs @ 12.19 hrs HW=135.72' (Free Discharge)  
 ↳2=Exfiltration (Exfiltration Controls 0.1 cfs)

**Primary OutFlow** Max=1.4 cfs @ 12.19 hrs HW=135.72' TW=131.28' (Dynamic Tailwater)  
 ↳1=Sharp-Crested Rectangular Weir (Weir Controls 1.4 cfs @ 1.54 fps)

**Pond 1P: High Plain Infil - Chamber Wizard Field A**

**Chamber Model = Shea Leaching Chamber 4x8x1.5 (Shea Leaching Chamber)**

Inside= 42.0"W x 15.0"H => 4.29 sf x 7.50'L = 32.2 cf

Outside= 48.0"W x 18.0"H => 6.00 sf x 8.00'L = 48.0 cf

8 Chambers/Row x 8.00' Long = 64.00' Row Length

6 Rows x 48.0" Wide = 24.00' Base Width

6.0" Stone Base + 18.0" Chamber Height = 2.00' Field Height

48 Chambers x 32.2 cf = 1,544.4 cf Chamber Storage

48 Chambers x 48.0 cf = 2,304.0 cf Displacement

3,072.0 cf Field - 2,304.0 cf Chambers = 768.0 cf Stone x 40.0% Voids = 307.2 cf Stone Storage

Chamber Storage + Stone Storage = 1,851.6 cf = 0.043 af

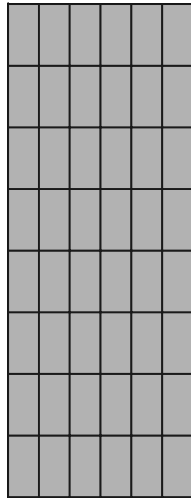
Overall Storage Efficiency = 60.3%

Overall System Size = 64.00' x 24.00' x 2.00'

48 Chambers

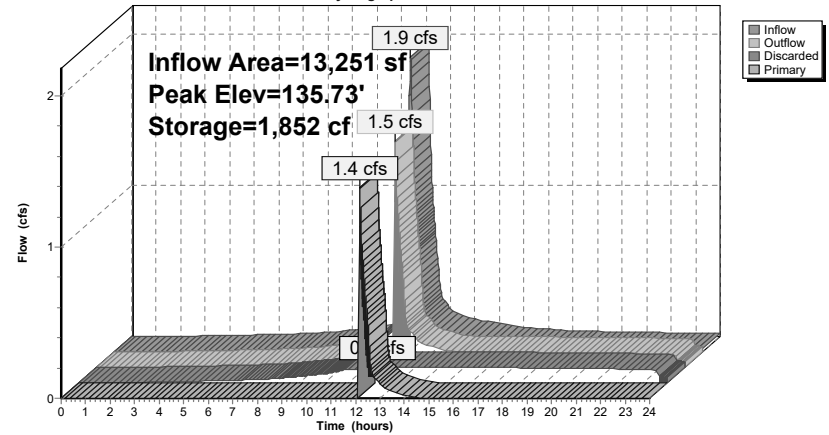
113.8 cy Field

28.4 cy Stone



**Pond 1P: High Plain Infil**

Hydrograph



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

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**Summary for Pond 2P: Rain Garden #1**

Inflow Area = 5,635 sf, 0.00% Impervious, Inflow Depth > 4.78" for 100-Year event  
 Inflow = 0.7 cfs @ 12.11 hrs, Volume= 2,243 cf  
 Outflow = 0.7 cfs @ 12.12 hrs, Volume= 2,089 cf, Atten= 2%, Lag= 1.0 min  
 Primary = 0.7 cfs @ 12.12 hrs, Volume= 2,089 cf  
 Routed to Pond 1P : High Plain Infiltr

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs  
 Peak Elev= 136.66' @ 12.12 hrs Surf.Area= 371 sf Storage= 207 cf

Plug-Flow detention time= 53.2 min calculated for 2,088 cf (93% of inflow)  
 Center-of-Mass det. time= 17.5 min ( 835.1 - 817.7 )

Volume	Invert	Avail.Storage	Storage Description
#1	135.50'	354 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)
135.50	5	5.0	0	0	5
136.00	167	57.2	33	33	264
137.00	505	178.4	321	354	2,539

Device	Routing	Invert	Outlet Devices
#1	Primary	136.50'	<b>12.0" Horiz. Orifice/Grate</b> C= 0.600 Limited to weir flow at low heads

**Primary OutFlow** Max=0.7 cfs @ 12.12 hrs HW=136.66' TW=135.30' (Dynamic Tailwater)  
 ↳=Orifice/Grate (Weir Controls 0.7 cfs @ 1.32 fps)

**8998501-POST**

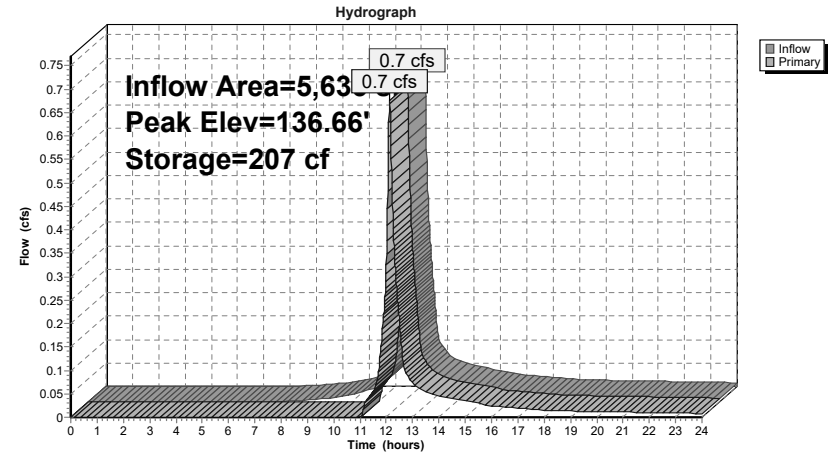
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Type III 24-hr 100-Year Rainfall=7.84"

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**Pond 2P: Rain Garden #1**



**Summary for Pond 3P: Rain Garden #2**

Inflow Area = 38,416 sf, 46.71% Impervious, Inflow Depth > 4.24" for 100-Year event  
 Inflow = 3.9 cfs @ 12.19 hrs, Volume= 13,560 cf  
 Outflow = 3.4 cfs @ 12.21 hrs, Volume= 13,423 cf, Atten= 12%, Lag= 1.2 min  
 Discarded = 0.0 cfs @ 12.21 hrs, Volume= 1,733 cf  
 Primary = 3.3 cfs @ 12.21 hrs, Volume= 11,691 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= 131.30' @ 12.21 hrs Surf.Area= 619 sf Storage= 625 cf  
 Flood Elev= 132.25' Surf.Area= 792 sf Storage= 1,118 cf

Plug-Flow detention time= (not calculated: outflow precedes inflow)  
 Center-of-Mass det. time= 6.6 min ( 792.2 - 785.6 )

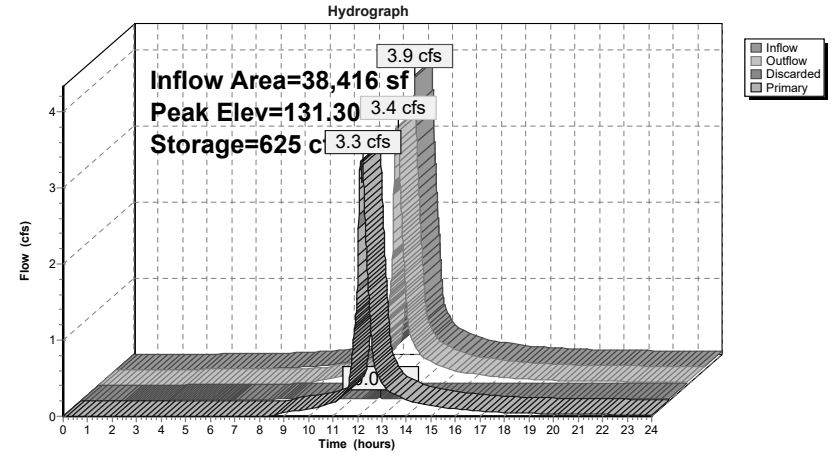
Volume	Invert	Avail.Storage	Storage Description		
#1	130.00'	1,118 cf	<b>Custom Stage Data (Irregular)</b> Listed below (Recalc)		
Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
130.00	356	91.4	0	0	356
131.00	551	104.0	450	450	575
132.00	792	122.3	668	1,118	923

Device	Routing	Invert	Outlet Devices
#1	Primary	130.30'	<b>15.0" Round Culvert</b> L= 18.0' CPP, end-section conforming to fill, Ke= 0.500 Inlet / Outlet Invert= 130.30' / 130.00' S= 0.0167 ' S= 0.0167 ' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 1.23 sf
#2	Discarded	130.00'	<b>2.410 in/hr Exfiltration over Wetted area</b>

**Discarded OutFlow** Max=0.0 cfs @ 12.21 hrs HW=131.30' (Free Discharge)  
 ↳2=Exfiltration (Exfiltration Controls 0.0 cfs)

**Primary OutFlow** Max=3.3 cfs @ 12.21 hrs HW=131.30' TW=0.00' (Dynamic Tailwater)  
 ↳1=Culvert (Barrel Controls 3.3 cfs @ 4.36 fps)

**Pond 3P: Rain Garden #2**



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

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**Summary for Pond 4P: Haggetts Infil**

[87] Warning: Oscillations may require smaller dt or Finer Routing (severity=269)

Inflow Area = 12,795 sf, 44.89% Impervious, Inflow Depth > 3.53" for 100-Year event  
 Inflow = 1.0 cfs @ 12.16 hrs, Volume= 3,768 cf  
 Outflow = 0.1 cfs @ 13.08 hrs, Volume= 3,770 cf, Atten= 87%, Lag= 54.8 min  
 Discarded = 0.1 cfs @ 13.08 hrs, Volume= 3,770 cf  
 Primary = 0.0 cfs @ 0.00 hrs, Volume= 0 cf

Routed to Reach 3R : Offsite East at Haggetts Pond Rd

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs  
 Peak Elev= 130.04' @ 13.08 hrs Surf.Area= 2,125 sf Storage= 1,339 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= 87.4 min ( 931.5 - 844.1 )

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	130.50'	<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=0.1 cfs @ 13.08 hrs HW=130.04' (Free Discharge)  
 ↳2=Exfiltration (Exfiltration Controls 0.1 cfs)

**Primary OutFlow** Max=0.0 cfs @ 0.00 hrs HW=129.00' TW=0.00' (Dynamic Tailwater)  
 ↳1=Sharp-Crested Rectangular Weir ( Controls 0.0 cfs)

**8998501-POST**

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

Prepared by BSC Group

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**Pond 4P: Haggetts 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

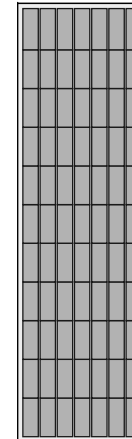
11 Chambers/Row x 7.50' Long +0.50' Row Adjustment = 83.00' Row Length +12.0" End Stone x 2 = 85.00' Base Length  
 7 Rows x 36.0" Wide + 4.0" Spacing x 6 + 12.0" Side Stone x 2 = 25.00' Base Width  
 6.0" Stone Base + 12.5" Chamber Height + 6.0" Stone Cover = 2.04' Field Height

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

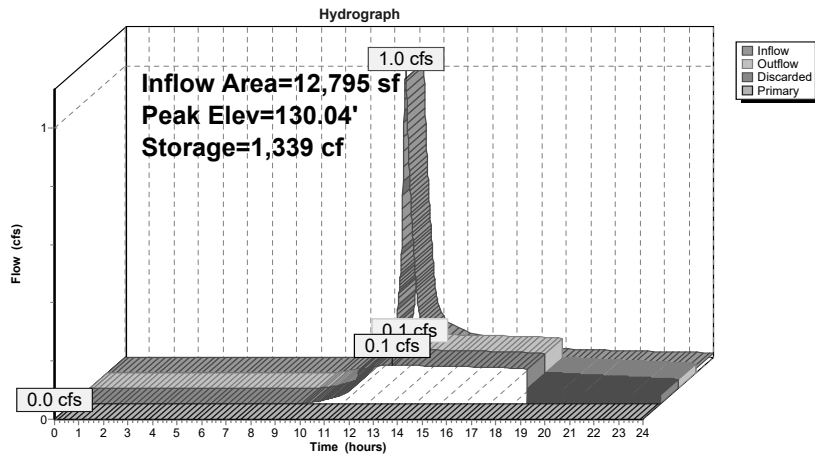
4,338.5 cf Field - 1,081.5 cf Chambers = 3,257.0 cf Stone x 40.0% Voids = 1,302.8 cf Stone Storage

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 4P: Haggetts Infiltr



## **SECTION 6.0**

### **ADDITIONAL DRAINAGE CALCULATIONS**

- 6.01 GROUNDWATER RECHARGE CALCULATIONS AND 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
- 6.06 MOUNDING ANALYSES

**6.01 GROUNDWATER RECHARGE CALCULATIONS AND STORAGE TABLES**

# Calculation Sheet



Project No. 8-9985.01  
 Subject Required Recharge Volume  
 Location Andover, MA

Calc By DMG  
 Date 7/1/2024  
 Checked by DPB  
 Date 7/2/2024

## Required Recharge Volume - Total Site

Hydrologic Group	Proposed Impervious Area	Recharge Required	Total Prescribed Stormwater Runoff Volume to Recharge
A	0.170 ac. (7414 sf)	0.6 inches	0.009 acre-feet (371 cubic feet)
B	0.000 ac. (0 sf)	0.35 inches	0.000 acre-feet (0 cubic feet)
C	0.185 ac. (8048 sf)	0.25 inches	0.004 acre-feet (168 cubic feet)
D	1.011 ac. (44046 sf)	0.1 inches	0.008 acre-feet (367 cubic feet)
<b>Totals</b>	<b>1.366 ac. (59508 sf)</b>		<b>0.021 acre-feet (905 cubic feet)</b>

## Adjusted Minimum Required Recharge Volume

Required Recharge Volume: 0.021 ac. ft. (905 cf)  
Impervious Area to Recharge BMPs: 0.362 ac. (15761 sf)  
Total Site Impervious Area: 1.366 ac. (59508 sf)

Adjustment Factor:  $\frac{59508}{15761} = 3.78$       0.265

Adjusted Req. Recharge Volume:  $905 \text{ cf} * 3.78 = \mathbf{3419 \text{ cubic feet}}$   
 (4027 cu. ft. provided)

**8998501-POST**

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

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**Stage-Area-Storage for Pond 1P: High Plain Infiltr**

Elevation (feet)	Wetted (sq-ft)	Storage (cubic-feet)	Elevation (feet)	Wetted (sq-ft)	Storage (cubic-feet)
133.80	1,536	0	134.86	1,723	1,013
133.82	1,540	12	134.88	1,726	1,038
133.84	1,543	25	134.90	1,730	1,063
133.86	1,547	37	134.92	1,733	1,088
133.88	1,550	49	134.94	1,737	1,114
133.90	1,554	61	134.96	1,740	1,139
133.92	1,557	74	134.98	1,744	1,164
133.94	1,561	86	135.00	1,747	1,189
133.96	1,564	98	135.02	1,751	1,214
133.98	1,568	111	135.04	1,754	1,240
134.00	1,571	123	135.06	1,758	1,265
134.02	1,575	135	135.08	1,761	1,290
134.04	1,578	147	135.10	1,765	1,315
134.06	1,582	160	135.12	1,768	1,340
134.08	1,585	172	135.14	1,772	1,366
134.10	1,589	184	135.16	1,775	1,391
134.12	1,592	197	135.18	1,779	1,416
134.14	1,596	209	135.20	1,782	1,441
134.16	1,599	221	135.22	1,786	1,466
134.18	1,603	233	135.24	1,789	1,492
134.20	1,606	246	135.26	1,793	1,517
134.22	1,610	258	135.28	1,796	1,542
134.24	1,613	270	135.30	1,800	1,567
134.26	1,617	283	135.32	1,804	1,592
134.28	1,620	295	135.34	1,807	1,618
134.30	1,624	307	135.36	1,811	1,643
134.32	1,628	332	135.38	1,814	1,668
134.34	1,631	358	135.40	1,818	1,690
134.36	1,635	383	135.42	1,821	1,712
134.38	1,638	408	135.44	1,825	1,734
134.40	1,642	433	135.46	1,828	1,756
134.42	1,645	458	135.48	1,832	1,777
134.44	1,649	484	135.50	1,835	1,799
134.46	1,652	509	135.52	1,839	1,820
134.48	1,656	534	135.54	1,842	1,841
134.50	1,659	559	135.56	1,846	1,852
134.52	1,663	584	135.58	1,849	1,852
134.54	1,666	610	135.60	1,853	1,852
134.56	1,670	635	135.62	1,856	1,852
134.58	1,673	660	135.64	1,860	1,852
134.60	1,677	685	135.66	1,863	1,852
134.62	1,680	710	135.68	1,867	1,852
134.64	1,684	736	135.70	1,870	1,852
134.66	1,687	761	135.72	1,874	1,852
134.68	1,691	786	135.74	1,877	1,852
134.70	1,694	811	135.76	1,881	1,852
134.72	1,698	836	135.78	1,884	1,852
134.74	1,701	862	135.80	1,888	1,852
134.76	1,705	887			
134.78	1,708	912			
134.80	1,712	937			
134.82	1,716	962			
134.84	1,719	988			

**8998501-POST**

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

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**Stage-Area-Storage for Pond 3P: Rain Garden #2**

Elevation (feet)	Surface (sq-ft)	Wetted (sq-ft)	Storage (cubic-feet)
130.00	356	356	0
130.05	365	366	18
130.10	374	377	36
130.15	383	387	55
130.20	392	398	75
130.25	401	408	95
130.30	410	419	115
130.35	419	429	136
130.40	429	440	157
130.45	439	451	178
130.50	448	462	201
130.55	458	473	223
130.60	468	484	246
130.65	478	495	270
130.70	488	506	294
130.75	498	518	319
130.80	509	529	344
130.85	519	540	370
130.90	530	552	396
130.95	540	563	423
131.00	551	575	450
131.05	562	591	478
131.10	573	607	506
131.15	584	624	535
131.20	596	640	565
131.25	607	657	595
131.30	619	674	625
131.35	630	690	657
131.40	642	708	688
131.45	654	725	721
131.50	666	742	754
131.55	678	760	787
131.60	690	777	822
131.65	703	795	856
131.70	715	813	892
131.75	728	831	928
131.80	740	849	965
131.85	753	868	1,002
131.90	766	886	1,040
131.95	779	905	1,079
132.00	<b>792</b>	<b>923</b>	<b>1,118</b>
132.05	792	923	1,118
132.10	792	923	1,118
132.15	792	923	1,118
132.20	792	923	1,118
132.25	792	923	1,118

**8998501-POST**

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

Prepared by BSC Group

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**Stage-Area-Storage for Pond 4P: Haggetts Infil**

Elevation (feet)	Wetted (sq-ft)	Storage (cubic-feet)	Elevation (feet)	Wetted (sq-ft)	Storage (cubic-feet)
129.00	2,125	0	130.06	2,358	1,365
129.02	2,129	17	130.08	2,363	1,396
129.04	2,134	34	130.10	2,367	1,427
129.06	2,138	51	130.12	2,371	1,457
129.08	2,143	68	130.14	2,376	1,488
129.10	2,147	85	130.16	2,380	1,517
129.12	2,151	102	130.18	2,385	1,547
129.14	2,156	119	130.20	2,389	1,576
129.16	2,160	136	130.22	2,393	1,604
129.18	2,165	153	130.24	2,398	1,632
129.20	2,169	170	130.26	2,402	1,659
129.22	2,173	187	130.28	2,407	1,686
129.24	2,178	204	130.30	2,411	1,712
129.26	2,182	221	130.32	2,415	1,737
129.28	2,187	238	130.34	2,420	1,762
129.30	2,191	255	130.36	2,424	1,785
129.32	2,195	272	130.38	2,429	1,808
129.34	2,200	289	130.40	2,433	1,829
129.36	2,204	306	130.42	2,437	1,850
129.38	2,209	323	130.44	2,442	1,869
129.40	2,213	340	130.46	2,446	1,888
129.42	2,217	357	130.48	2,451	1,907
129.44	2,222	374	130.50	2,455	1,924
129.46	2,226	391	130.52	2,459	1,941
129.48	2,231	408	130.54	2,464	1,958
129.50	2,235	425	130.56	2,468	1,975
129.52	2,239	461	130.58	2,473	1,992
129.54	2,244	496	130.60	2,477	2,009
129.56	2,248	531	130.62	2,481	2,026
129.58	2,253	566	130.64	2,486	2,043
129.60	2,257	601	130.66	2,490	2,060
129.62	2,261	635	130.68	2,495	2,077
129.64	2,266	670	130.70	2,499	2,094
129.66	2,270	704	130.72	2,503	2,111
129.68	2,275	738	130.74	2,508	2,128
129.70	2,279	772	130.76	2,512	2,145
129.72	2,283	806	130.78	2,517	2,162
129.74	2,288	840	130.80	2,521	2,179
129.76	2,292	874	130.82	2,525	2,196
129.78	2,297	908	130.84	2,530	2,213
129.80	2,301	941	130.86	2,534	2,230
129.82	2,305	975	130.88	2,539	2,247
129.84	2,310	1,009	130.90	2,543	2,264
129.86	2,314	1,042	130.92	2,547	2,281
129.88	2,319	1,075	130.94	2,552	2,298
129.90	2,323	1,108	130.96	2,556	2,315
129.92	2,327	1,141	130.98	2,561	2,332
129.94	2,332	1,173	131.00	2,565	2,349
129.96	2,336	1,206	131.02	2,569	2,366
129.98	2,341	1,238	131.04	<b>2,574</b>	<b>2,383</b>
130.00	2,345	1,270	131.06	<b>2,574</b>	<b>2,384</b>
130.02	2,349	1,302	131.08	2,574	2,384
130.04	2,354	1,334			

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

# Calculation Sheet



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

**Calc By** DMG  
**Date** 7/1/2024  
**Checked by** DPB  
**Date** 7/2/2024

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)** 1.33 cfs

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

qu = the unit peak discharge (csm/in) 774 (see 2013 MADEP Q Rate for Tc=0.1 hours)

A = impervious surface (sq.miles) 0.001713

A = impervious surface (acres) 1.100

WQD = water quality depth (in) 1

**STC 4800 Maximum Water Quality Flow Rate = 1.77 cfs**  
**STC 4800 Maximum Impervious Treatment Area = 2.35 ac.**

**6.03 RIDEM WATER QUALITY UNIT CERTIFICATION/SIZING**



**Rhode Island Department of Environmental Management**  
**Office of Water Resources – Stormwater Technology Review Committee**  
**235 Promenade St. Providence, RI 02908 Ph: 401-222-4700**

**Alternative Stormwater Technology Program**

**Vendor Information:**

**Contech Engineered Solutions, LLC**  
71 US Route 1, Suite F  
Scarborough, Maine 04074

**Contact:**

Derek M. Berg  
Director of Stormwater Management  
Email: [Derek.Berg@ContechLLC.com](mailto:Derek.Berg@ContechLLC.com)  
Web: [www.conteches.com](http://www.conteches.com)  
Phone: 207-885-6174

**Technology Name:**

**Stormceptor® STC Models:**  
450i, 900, 1200, 1800, EOS 12-590, 2400, 3600,  
4800, 6000, 7200, 11000, 13000 and 16000

**Approval Type**

Pretreatment / Retrofit

**Re-certification Dates:**

Issued: June 1, 2021  
Revised: June 2, 2022  
Expires: June 1, 2026

**RE-CERTIFICATION:**

The Rhode Island Stormwater Technology Review Committee which consists of members from the Department of Environmental Management (DEM), Department of Transportation (DOT) and the Coastal Resources Management Council (CRMC) have reviewed the **Stormceptor®** application for re-certification of its Technology Approval and accepted use for Stormwater Treatment in the State of Rhode Island.

In accordance with Stormwater Rule 250-RICR-150-10-8.9B, **Contech Engineered Solutions, LLC** has petitioned the permitting agencies to re-certify the **Stormceptor®** as an acceptable structural stormwater control described in Stormwater Rule 250-RICR-150-10-8.31. They have submitted a re-certification application which documents any changes made to the design of the **Stormceptor®**, additional studies that have been conducted on the **Stormceptor®**, reported system failures and annual lists of all units installed in the state of Rhode Island since original certification was issued on February 5, 2016.

The **Stormceptor®** is a proprietary hydrodynamic separator pre-treatment/retrofit device which has seen widespread use for decades. Several studies have been conducted to verify the **Stormceptor®**'s performance. Additionally, in accordance with provisions of the Technology Assessment Protocol for Innovative and Emerging Technologies as described in Stormwater Rule 250-RICR-150-10 Sections 8.39 and 8.40, the Stormceptor has been recognized as an effective proprietary pre-treatment device and hydrodynamic separator by several states which are members of the Technology Acceptance Reciprocity Partnership (TARP). The Massachusetts Department of Environmental Protection provided a fact sheet titled "Stormwater Technology: Stormceptor (Hydro Conduit, formerly CSR New England Pipe)" which was revised in 2003. This fact sheet explained the results of a Strategic Envirotechnology Partnership (STEP) evaluation of the entitled "Technology Assessment, Stormceptor CSR New England Pipe, January 1998". The Maryland Department of the Environment's Alternative/Innovative Technology List of Approved Stormwater Practices (August 2017) lists the **Stormceptor®** as a hydrodynamic device that is approved for stormwater pre-treatment, with an original approval date of April 16, 2001. The New Jersey Department of Environmental Protection also issued the **Stormceptor®** certification as a manufactured treatment device (MTD) to pre-treat stormwater in September 2011, although this certification expired in September of 2013. Additionally, the Virginia Department of Environmental Quality approved the **Stormceptor®** on August 13, 2014 as a manufactured treatment device. The device is also utilized as a hydrodynamic separator pre-treatment device in the remaining TARP states, California and Pennsylvania.

The **Stormceptor**<sup>®</sup> is a pretreatment or retrofit device that captures TSS from stormwater runoff as described in Stormwater Rule 250-RICR-150-10-8.31. It is a vertically oriented cylindrical structure manufactured from pre-cast reinforced concrete and fiber reinforced plastic, designed to remove sediment and trash from stormwater. This product was developed by **Contech Engineered Solutions, LLC**. The **Stormceptor**<sup>®</sup> is approved for on-line and off-line use.

The manufacturer has demonstrated that this product meets the minimum water quality standards for pretreatment as described in Stormwater Rule 250-RICR-150-10-8.31. It is approved for the following pollutant removal: **75% TSS**. The **Stormceptor**<sup>®</sup> is NOT recognized for removal of Pathogens, Total Phosphorus or Nitrogen. This device may be used as an approved pre-treatment or retrofit device provided that the design, installation, and maintenance are conducted in accordance with the following terms and conditions:

## I. GENERAL CERTIFICATION REQUIREMENTS

1. The system must be designed and installed to adhere to the manufacturer's specifications titled "Stormceptor General Specification". This specification is located in the Technical Guides section of the manufacturer's website (<https://www.conteches.com/technical-guides/search?filter=1WBC005EYX>).
2. The STC devices listed in the attached "Approved Stormceptor<sup>®</sup> Models Sizing Table" are **certified as pretreatment** devices in accordance with Stormwater Rule 250-RICR-150-10-8.31, provided the device treats the flow of the first inch of runoff from the capture area, unless waived by the state permitting agency. The system's design must utilize the flow rates, impervious catchment sizes, and maximum sediment capacities listed in the attached "Approved Stormceptor<sup>®</sup> Models Sizing Table".
3. The applicant must provide the RI specific manufacturers design sheet for Departmental review or provide the manufacturer's review approval. All units that capture greater than one acre of impervious cover must be reviewed by the manufacturer.
4. This device is **certified as a retrofit device** in accordance with Stormwater Rule 250-RICR-150-10-8.6A. Retrofits are allowed flexibility with regards to the eleven minimum standards described in Sections 8.6 through 8.17 of Stormwater Rule 250-RICR-150-10, but in general they are considered effective if they capture at least 50% of the catchment and meet the target water quality treatment of at least the first 0.5 inches of the water quality volume.
5. The approved devices shall be located such that they are accessible for maintenance and/or emergency removal of oil or chemical spills.
6. The device cannot be used in series with another Hydrodynamic separator to achieve enhanced removal rates for TSS.

## II. MAINTENANCE REQUIREMENTS

1. Standard permitting conditions for inclusion of this technology will, at a minimum include the following:
  - a. Each individual owner must ensure that any and all of their proprietary stormwater treatment devices are maintained in accordance with the manufacturer's specifications, which are provided in the **Stormceptor**<sup>®</sup> Operation & Maintenance Manual. <https://www.conteches.com/Portals/0/Documents/Maintenance%20Guides/Stormceptor-STC-Maintenance-Guide.pdf?ver=2020-05-21-114420-030>
  - b. Each individual owner must ensure that any and all of their proprietary stormwater pre-treatment devices' are maintained in accordance with the requirements stated in Stormwater

Rule 250-RICR-150-10-8.31-C, which requires the sump to be inspected a minimum of 2 times per year. Additionally, the device must be cleaned out when either pollutant removal capacity is reduced by 50% or more, or when 50% or more of the device's pollutant storage capacity is filled or displaced.

- c. All material removed from the unit must be properly disposed of and is the responsibility of the owner.
  - d. The applicant must include a copy of the **Stormceptor**<sup>®</sup> Operation & Maintenance Manual in their project specific long term operation and maintenance plan.
2. The applicant must provide evidence of a maintenance contract which extends for a minimum of two years. The contracted maintenance provider must receive training by **Contech Engineered Solutions, LLC** on how to properly maintain **Stormceptor**<sup>®</sup> devices. This requirement excludes maintenance providers recognized by the RIDEM to be qualified in maintenance of **Stormceptor**<sup>®</sup> devices.

### III. REPORTING REQUIREMENTS

1. Upon request from the owner of any **Stormceptor**<sup>®</sup> system installed in the State of Rhode Island, the vendor shall provide the owner with a recommended maintenance schedule after the first year of operation. If a recommended maintenance schedule is requested by the owner after the first year of the device's operation, then the owner is responsible for notifying the vendor of any additional pollutant loads on sites where contributing drainage areas may be subject to further development (i.e., strip malls).
2. The Vendor shall provide a listing to the RIDEM Office of Water Resources of all systems installed within the State of Rhode Island on an annual basis.
3. The Vendor shall provide an annual listing to the RIDEM Office of Water Resources of all Rhode Island maintenance providers that they trained in **Stormceptor**<sup>®</sup> maintenance.
4. The Vendor shall immediately notify the RIDEM Office of Water Resources if and when any changes are made to the model name or number of any **Stormceptor**<sup>®</sup> device for all models applicable to this certification.
5. The Vendor shall immediately notify the RIDEM Office of Water Resources if and when any revisions are made to the design, installation operation and maintenance manuals for all models applicable to this certification. Revisions deemed by the RIDEM to be substantial, may require re-application to the Alternative Stormwater Technology Program.
6. The Vendor shall notify the RIDEM at least thirty (30) days following any proposed transfer of ownership of the Component technology. Notification shall include the name and address of the new owner and a written agreement between the existing and new owner specifying a date for transfer of ownership, responsibility, and liability for the Component. All provisions of this Certification shall be applicable to any new owners.

### IV. RIGHTS OF THE RIDEM AND CRMC

1. The RIDEM may suspend, modify or revoke this approval for cause, including but not limited to: non-compliance with any of the conditions or provisions of this approval, mis-representation or failure to fully disclose all relevant data, or receipt of new information indicating that the use of the **Stormceptor**<sup>®</sup> system is contrary to the public interest, public health or the environment.

2. This approval does not represent an endorsement of the **Stormceptor**<sup>®</sup> system by the RIDEM, RIDOT or CRMC. This letter of approval may be reproduced only in its entirety.
3. The **Stormceptor**<sup>®</sup> General Specification and **Stormceptor**<sup>®</sup> operation and maintenance manual referenced herein are approved upon the date of approval of this Certification.
4. The RIDEM reserves the right to suspend or revoke this Certification if updated design, installation, and O&M manuals are not provided to the RIDEM within thirty (30) days of RIDEM request or one hundred and eighty (180) days prior to the expiration date of this Certification. All revisions must be reviewed and approved by the RIDEM prior to re-certification.

**Eric Beck**

Digitally signed by Eric Beck  
Date: 2022.07.06 16:25:56 -04'00'

Eric A. Beck, P.E.

Date

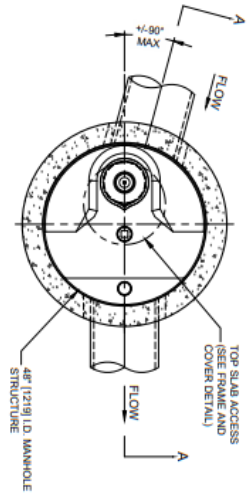
Administrator of Groundwater and Wetlands Protection  
RIDEM – Office of Water Resources

## ATTACHMENT

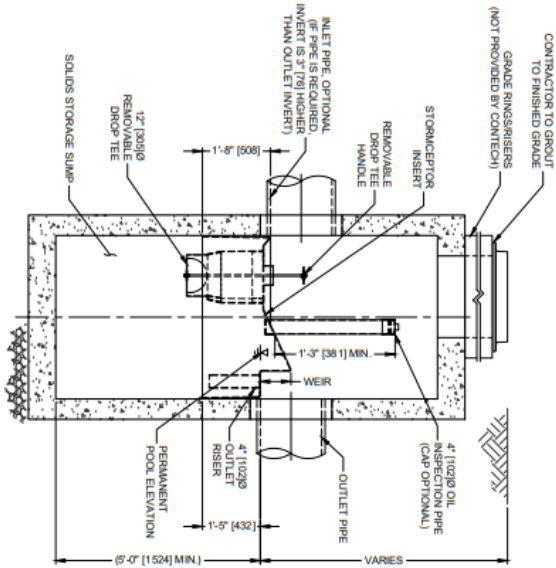
**Table 1: Stormceptor Sizing Table for 75% TSS Removal**

<b>Model #</b>	<b>Maximum Treatment Flow Rate (cfs)</b>	<b>Maximum Impervious Treatment Area (acres)</b>	<b>Max Sediment Storage Volume (ft<sup>3</sup>)</b>
STC 450i	0.28	0.38	46
STC 900	0.64	0.85	89
STC 1200	0.64	0.85	127
STC 1800	0.64	0.85	207
EOS 12-590	0.64	0.85	166
STC 2400	1.06	1.06	205
STC 3600	1.06	1.06	373
STC 4800	1.77	2.38	543
STC 6000	1.77	2.38	687
STC 7200	2.47	3.33	839
STC 11000	3.53	4.75	1,086
STC 13000	3.53	4.75	1,374
STC 16000	4.94	6.66	1,677

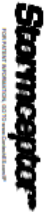
\*Impervious areas are only approximate. Actual areas will vary based on site-specific conditions.



**PLAN VIEW**  
TOP SLAB NOT SHOWN



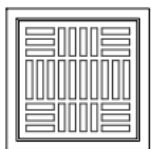
**SECTION A-A**



**STORMCEPTOR DESIGN NOTES**

THE STANDARD STC450I CONFIGURATION WITH ROUND, SOLID FRAME AND COVER, AND INLET PIPE IS SHOWN. ALTERNATE CONFIGURATIONS ARE AVAILABLE AND ARE LISTED BELOW. SOME CONFIGURATIONS MAY BE COMBINED TO SUIT SITE REQUIREMENTS.

CONFIGURATION DESCRIPTION
GRADED INLET ONLY (NO INLET PIPE)
GRADED INLET WITH INLET PIPE OR PIPES
CURB INLET ONLY (NO INLET PIPE)
CURB INLET WITH INLET PIPE OR PIPES



**FRAME AND COVER**  
(MAY VARY)  
NOT TO SCALE

**FRAME AND GRATE**  
(MAY VARY)  
NOT TO SCALE

**SITE SPECIFIC DATA REQUIREMENTS**

STRUCTURE ID	WATER QUALITY FLOW RATE (cfs [L/s])
	PEAK FLOW RATE (cfs [L/s])
	RETURN PERIOD OF PEAK FLOW (yrs)
	RAW ELEVATION
PIPE DATA:	
INLET PIPE 1	INVERT MATERIAL DIAMETER
INLET PIPE 2	
OUTLET PIPE	

NOTES / SPECIAL REQUIREMENTS:

- GENERAL NOTES**
- CONTECH TO PROVIDE ALL MATERIALS UNLESS NOTED OTHERWISE.
  - FOR SITE SPECIFIC DRAWINGS WITH DETAILED STRUCTURE DIMENSIONS AND WEIGHT, PLEASE CONTACT YOUR CONTECH ENGINEERED STRUCTURES REPRESENTATIVE.
  - STORMCEPTOR WATER QUALITY STRUCTURE SHALL BE IN ACCORDANCE WITH ALL DESIGN DATA AND INFORMATION CONTAINED IN THIS DRAWING. CONSTRUCTION TO CONFIRM STRUCTURE MEETS REQUIREMENTS OF PROJECT.
  - STORMCEPTOR STRUCTURE SHALL MEET ASHTO H20-10-10 RATING, ASSUMING EARTH COVER OF 0', 2' (0.0), AND GROUNDWATER ELEVATION AT OR BELOW THE OUTLET PIPE INVERT ELEVATION. ENGINEER OF RECORD TO CONFIRM ACTUAL GROUNDWATER ELEVATION.
  - STORMCEPTOR STRUCTURE SHALL BE PRECAST CONCRETE CONFORMING TO ASTM C478 AND ASHTO LOAD FACTOR DESIGN METHOD.
  - ALTERNATE UNITS ARE SHOWN IN MILLIMETERS [mm].
- INSTALLATION NOTES**
- INVERT, DEPTH, AND/OR ANTI-FLOATION PROVISIONS ARE SITE SPECIFIC DESIGN CONSIDERATIONS AND SHALL BE SPECIFIED BY ENGINEER OF RECORD.
  - CONTRACTOR TO PROVIDE EQUIPMENT WITH SUFFICIENT LIFTING AND REACH CAPACITY TO LIFT AND SET THE STORMCEPTOR MANHOLE STRUCTURE.
  - CONTRACTOR TO INSTALL JOINT SEALANT BETWEEN ALL STRUCTURE SECTIONS AND ASSEMBLE STRUCTURE.
  - CONTRACTOR TO PROVIDE ANSILL AND GROUND INLET AND OUTLET PIPES. MATCH PIPE INVERTS WITH ELEVATIONS SHOWN. ALL PIPE SHALL BE PRECAST CONCRETE CONFORMING TO ASTM C478 AND ASHTO LOAD FACTOR DESIGN METHOD.
  - CONTRACTOR TO TAKE APPROPRIATE MEASURES TO ASSURE JOINT IS WATER TIGHT, HOLDING WATER TO FLOWLINE INVERT MINIMUM. IT IS SUGGESTED THAT ALL JOINTS BELOW PIPE INVERTS ARE GROUTED.

**CONTECH**  
www.contech.com  
8025 Center Parkway, Suite 400, West Chester, OH 45390  
800-538-1122 513-845-7700 513-845-7917 FAX

STC450I  
STORMCEPTOR  
STANDARD DETAIL

## **6.04 TSS REMOVAL CALCULATIONS**

# TSS Removal Calculation Worksheet

Location: Haggetts Pond, Andover, MA

Project: 89985.01



Prepared By: DMG

Date: 4/4/2024

## Treatment Train 1

(Water Quality Unit to Rain Garden - Nodes 4S & 5S)

**Total Impervious Area = 0.224 ac. (9,766 sf.)**

A	B	C	D	E
BMP	TSS Removal Rate	Starting TSS Load*	Amount Removed (BxC)	Remaining Load (C-D)
Water Quality Unit	0.75	1	0.75	0.25

**TSS Pretreatment = 0.75 (25% min to a Rain Garden)**

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: 4/4/2024

## Treatment Train 2

(Water Quality Unit to Subsurface Infiltration - Nodes 1S & 9S)

**Total Impervious Area = 0.298 ac. (12,998 sf.)**

A	B	C	D	E
BMP	TSS Removal Rate	Starting TSS Load*	Amount Removed (BxC)	Remaining Load (C-D)
Water Quality Unit	0.75	1.00	0.75	0.25
Subsurface Infiltration	0.8	0.25	0.20	0.05

**TSS Removal = 0.95**

# TSS Removal Calculation Worksheet

Location: Haggetts Pond, Andover, MA

Project: 89985.01



Prepared By: DMG

DMG

Date:

4/4/2024

## Treatment Train 3

(Deep-sump Hooded CB to Water Quality Unit to Forebay - Node 8S)

**Total Impervious Area = 1.096 ac. (47,755 sf.)**

A	B	C	D	E
BMP	TSS Removal Rate	Starting TSS Load*	Amount Removed (BxC)	Remaining Load (C-D)
Catch Basin	0.25	1.00	0.25	0.75
Water Quality Unit	0.75	0.75	0.56	0.19

**TSS Removal = 0.81**

# TSS Removal Calculation Worksheet

Location: Haggetts Pond, Andover, MA

Project: 89985.01



Prepared By: DMG

Date: 4/4/2024

## Treatment Train 4

(Filter Strip - Node 7S)

**Total Impervious Area = 1.011 ac. (44,046 sf.)**

A	B	C	D	E
BMP	TSS Removal Rate	Starting TSS Load*	Amount Removed (BxC)	Remaining Load (C-D)
Filter Strip	0.00	1.00	0.00	1

**TSS Removal = 0.00**

# TSS Removal Calculation Worksheet

Location: Haggetts Pond, Andover, MA

Project: 89985.01



Prepared By: DMG

Date: 4/4/2024

## Treatment Train 5

(Untreated Flow - Nodes 3S & 6S)

**Total Impervious Area = 0.037 ac. (1,627 sf.)**

A	B	C	D	E
BMP	TSS Removal Rate	Starting TSS Load*	Amount Removed (BxC)	Remaining Load (C-D)
	0.00	1.00	0.00	1.00

**TSS Removal = 0.00**

## **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** 4/4/2024  
**Checked by** DPB  
**Date** 4/5/2024

## FES-1 (into Rain Garden #2 from High Plain Rd)

Q=Design Discharge, (ft<sup>3</sup>/s) = 1.59 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**

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

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

$$D_{50} = 0.2 \left[ \frac{1.59}{5.67} \right]^{(4/3)} \left[ \frac{1.00}{0.40} \right] = 0.09 \text{ ft}$$

**= 1 inches**

**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> = 3.85 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** 4/4/2024  
**Checked by** DPB  
**Date** 4/5/2024

**FES-2** (into Rain Garden #2 from High Plain parking lot)

Q=Design Discharge, (ft<sup>3</sup>/s) = 2.24 cfs  
 D=Culvert Diameter, (ft) = 1.25 ft  
 TW=Tailwater Depth, (ft) = 0.5 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**

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

$$D_{50} = 0.25 \left| \frac{2.24}{9.91} \right|^{(4/3)} \left| \frac{1.25}{0.50} \right| = 0.09 \text{ ft}$$

$$= 1 \text{ inches}$$

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 = 5 ft  
 Depth=3.5D<sub>50</sub> = 3.50 inches  
 Width=3D+(2/3)L = 7.08 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** 4/4/2024  
**Checked by** DPB  
**Date** 4/5/2024

**HWL** (existing Haggetts Pond Rd headwall outlet)

Q=Design Discharge, (ft<sup>3</sup>/s) = 19.99 cfs  
 D=Culvert Diameter, (ft) = 1.25 ft  
 TW=Tailwater Depth, (ft) = 0.5 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**

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

$$D_{50} = 0.25 \left| \frac{19.99}{9.91} \right|^{(4/3)} \left| \frac{1.25}{0.50} \right| = 1.59 \text{ ft}$$

$$= 19 \text{ inches}$$

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>
<b>5</b>	<b>20</b>	<b>7D</b>	<b>2.0D<sub>50</sub></b>
6	22	8D	2.0D <sub>50</sub>

**Use Class 5**

**Apron Dimensions**

Length, L=7D = 9 ft  
 Depth=2.0D<sub>50</sub> = 38.22 inches  
 Width=3D+(2/3)L = 9.58 ft (at apron end)

**Riprap Rock Sizing Gradation**

% of Weight Smaller than Given Size	Size of Stone, inches
100	29 to 38
85	25 to 34
50	19 to 29
15	25 to 10

## **6.06 MOUNDING ANALYSES**

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

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

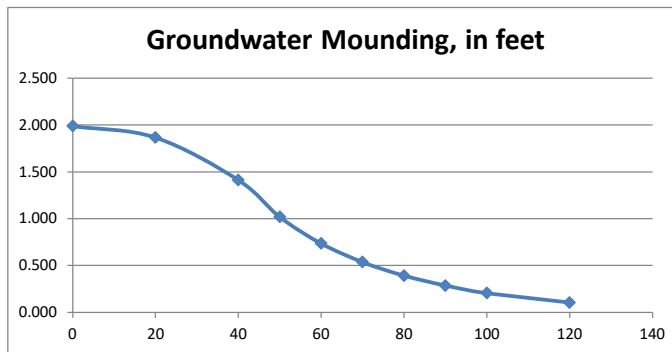
Input Values		use consistent units (e.g. feet & days or inches & hours)	Conversion Table		
			inch/hour	feet/day	
3.4250	R	Recharge (infiltration) rate (feet/day)	0.67	1.33	
0.280	Sy	Specific yield, Sy (dimensionless, between 0 and 1)			
39.00	K	Horizontal hydraulic conductivity, Kh (feet/day)*	2.00	4.00	In the report accompanying this spreadsheet (USGS SIR 2010-5102), vertical soil permeability (ft/d) is assumed to be one-tenth horizontal hydraulic conductivity (ft/d).
44.000	x	1/2 length of basin (x direction, in feet)			
12.000	y	1/2 width of basin (y direction, in feet)	hours	days	
0.867	t	duration of infiltration period (days)	36	1.50	
19.000	hi(0)	initial thickness of saturated zone (feet)			
20.990	h(max)	maximum thickness of saturated zone (beneath center of basin at end of infiltration period)			
1.990	Δh(max)	maximum groundwater mounding (beneath center of basin at end of infiltration period)			

Ground- Distance from  
 water center of basin  
 Mounding, in in x direction, in  
 feet feet

1.990	0
1.867	20
1.413	40
1.020	50
0.736	60
0.537	70
0.392	80
0.285	90
0.206	100
0.105	120



Re-Calculate Now



**Disclaimer**

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

Pond 1P (High Plain Infiltration) Mounding - Input Values

Time (hours)	Inflow (cfs)	Storage (cubic-feet)	Elevation (feet)	Outflow (cfs)	Discarded (cfs)	Primary (cfs)	
3.25	0	0	133.8	0	0	0	
3.3	0.01	0	133.8	0.01	0.01	0	7110 Impervious Surface (sft) (see HydroCAD)
3.35	0.01	0	133.8	0.01	0.01	0	0.00340 Recharge volume (acre-ft) (0.25" for HSG-C)
3.4	0.01	0	133.8	0.01	0.01	0	0.061 Average infiltration rate (cfs)
3.45	0.01	0	133.8	0.01	0.01	0	
3.5	0.01	0	133.8	0.01	0.01	0	
3.55	0.01	0	133.8	0.01	0.01	0	
3.6	0.01	0	133.8	0.01	0.01	0	5260.48 Average infiltration rate (cf/day)
3.65	0.01	0	133.8	0.01	0.01	0	
3.7	0.01	0	133.8	0.01	0.01	0	1536 System bottom area (sft) Irregular Shape, See CAD drawing)
3.75	0.01	0	133.8	0.01	0.01	0	
3.8	0.01	0	133.8	0.01	0.01	0	
3.85	0.01	0	133.8	0.01	0.01	0	3.425 Recharge/infiltration rate (ft/day)
3.9	0.01	0	133.8	0.01	0.01	0	
--- Full tabular hydrograph data not shown for brevity; refer to HydroCAD output ---							3.3 Infiltration start time
23.45	0.01	0	133.8	0	0	0	
23.5	0.01	0	133.8	0.03	0.03	0	24.1 Infiltration end time
23.55	0.01	0	133.8	0	0	0	
23.6	0.01	0	133.8	0.02	0.02	0	20.8 Time (hrs)
23.65	0.01	0	133.8	0	0	0	
23.7	0.01	0	133.8	0.02	0.02	0	0.867 Time (days)
23.75	0.01	0	133.8	0	0	0	
23.8	0.01	0	133.8	0.02	0.02	0	39 Hydraulic conductivity (ft/day) ("Medium Sand" per DEP Brainshark table)
23.85	0.01	0	133.8	0	0	0	
23.9	0.01	0	133.8	0.02	0.02	0	0.28 Specific yield ("Sand" per DEP Brainshark table)
23.95	0.01	0	133.8	0	0	0	Initial saturated thickness (ft)
24	0.01	0	133.8	0.02	0.02	0	
24.05	0.01	0	133.8	0	0	0	
24.1	0	0	133.8	0.01	0.01	0	Legend:
24.15	0	0	133.8	0	0	0	= user-supplied values
24.2	0	0	133.8	0	0	0	= input values in Results sheet

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

The user must specify infiltration rate (R), specific yield (Sy), horizontal hydraulic conductivity (Kh), basin dimensions (x, y), duration of infiltration period (t), and the initial thickness of the saturated zone (hi(0), height of the water table if the bottom of the aquifer is the datum). For a square basin the half width equals the half length (x = y). For a rectangular basin, if the user wants the water-table changes perpendicular to the long side, specify x as the short dimension and y as the long dimension. Conversely, if the user wants the values perpendicular to the short side, specify y as the short dimension, x as the long dimension. All distances are from the center of the basin. Users can change the distances from the center of the basin at which water-table aquifer thickness are calculated.

Cells highlighted in yellow are values that can be changed by the user. Cells highlighted in red are output values based on user-specified inputs. The user MUST click the blue "Re-Calculate Now" button each time ANY of the user-specified inputs are changed otherwise necessary iterations to converge on the correct solution will not be done and values shown will be incorrect. Use consistent units for all input values (for example, feet and days)

Input Values		use consistent units (e.g. feet & days or inches & hours)	Conversion Table		
			inch/hour	feet/day	
3.0790	R	Recharge (infiltration) rate (feet/day)	0.67	1.33	
0.280	Sy	Specific yield, Sy (dimensionless, between 0 and 1)			
39.00	K	Horizontal hydraulic conductivity, Kh (feet/day)*	2.00	4.00	In the report accompanying this spreadsheet (USGS SIR 2010-5102), vertical soil permeability (ft/d) is assumed to be one-tenth horizontal hydraulic conductivity (ft/d).
42.500	x	1/2 length of basin (x direction, in feet)			
12.500	y	1/2 width of basin (y direction, in feet)	hours	days	
0.600	t	duration of infiltration period (days)	36	1.50	
13.000	hi(0)	initial thickness of saturated zone (feet)			

14.978	h(max)	maximum thickness of saturated zone (beneath center of basin at end of infiltration period)
1.978	Δh(max)	maximum groundwater mounding (beneath center of basin at end of infiltration period)

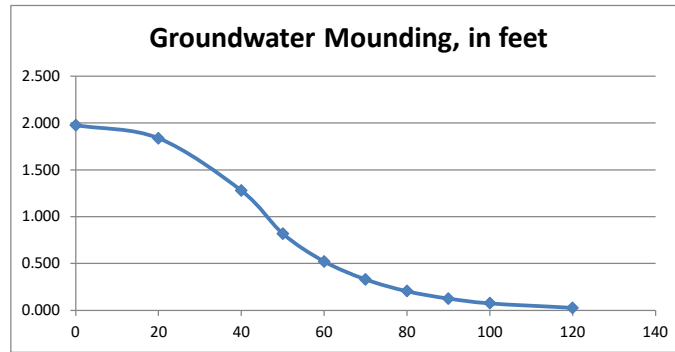
Ground-water Mounding, in feet

Distance from center of basin in x direction, in feet

1.978	0
1.837	20
1.278	40
0.819	50
0.522	60
0.330	70
0.206	80
0.126	90
0.076	100
0.026	120



Re-Calculate Now



**Disclaimer**

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

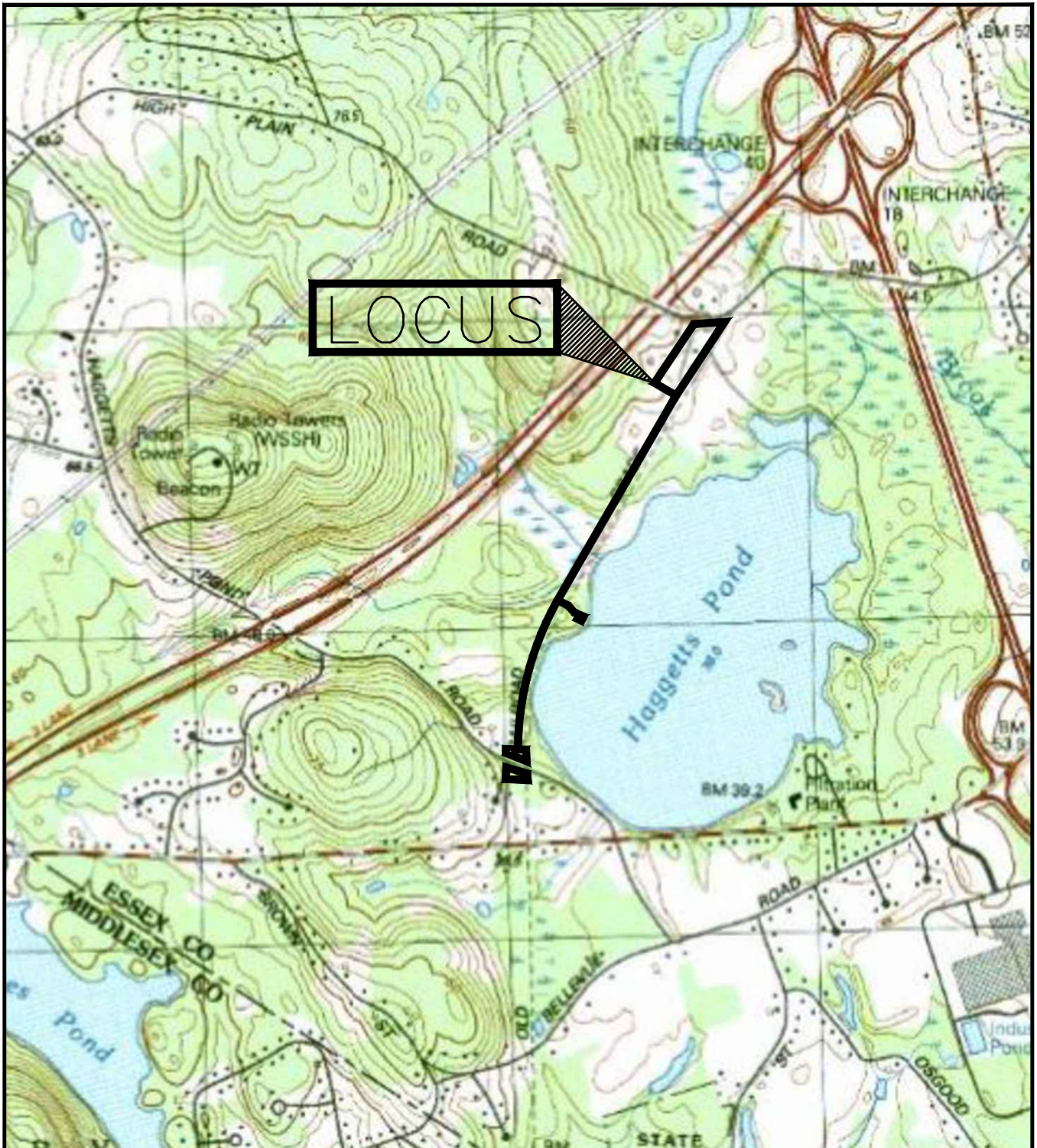
Pond 4P (Haggetts Pond Infiltration) Mounding - Input Values

Time (hours)	Inflow (cfs)	Storage (cubic-feet)	Elevation (feet)	Outflow (cfs)	Discarded (cfs)	Primary (cfs)	
9.85	0	0	129	0	0	0	
9.9	0.01	0	129	0.01	0.01	0	5888 Impervious Surface (sft) (see HydroCAD)
9.95	0.01	0	129	0.01	0.01	0	0.00676 Recharge volume (acre-ft) (0.60" for HSG-A)
10	0.01	0	129	0.01	0.01	0	0.076 Average infiltration rate (cfs)
10.05	0.01	0	129	0.01	0.01	0	
10.1	0.01	0	129	0.01	0.01	0	
10.15	0.01	0	129	0.01	0.01	0	
10.2	0.01	0	129	0.01	0.01	0	6542.57 Average infiltration rate (cf/day)
10.25	0.01	0	129	0.01	0.01	0	
10.3	0.01	0	129	0.01	0.01	0	2125 System bottom area (sft) (25'x85')
10.35	0.01	0	129	0.01	0.01	0	
10.4	0.01	0	129	0.01	0.01	0	
10.45	0.02	0	129	0.02	0.02	0	3.079 Recharge/infiltration rate (ft/day)
10.5	0.02	0	129	0.02	0.02	0	
--- Full tabular hydrograph data not shown for brevity; refer to HydroCAD output ---							9.9 Infiltration start time
23.6	0.02	0	129	0	0	0	
23.65	0.02	0	129	0.04	0.04	0	24.3 Infiltration end time
23.7	0.02	0	129	0	0	0	
23.75	0.02	0	129	0.03	0.03	0	14.4 Time (hrs)
23.8	0.02	0	129	0	0	0	
23.85	0.02	0	129	0.03	0.03	0	0.600 Time (days)
23.9	0.02	0	129	0	0	0	
23.95	0.02	0	129	0.03	0.03	0	39 Hydraulic conductivity (ft/day) ("Medium Sand" per DEP Brainshark table)
24	0.02	0	129	0	0	0	
24.05	0.02	0	129	0.03	0.03	0	0.28 Specific yield ("Medium Sand" per DEP Brainshark table)
24.1	0.01	0	129	0	0	0	
24.15	0.01	0	129	0.02	0.02	0	13 Initial saturated thickness (ft)
24.2	0.01	0	129	0	0	0	
24.25	0	0	129	0.01	0.01	0	
24.3	0	0	129	0	0	0	

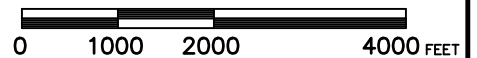
Legend:  
  = user-supplied values  
  = input values in Results sheet

## **APPENDICES**

## USGS LOCUS MAP



SCALE: 1" = 2000'



PREPARED FOR:

TOWN OF ANDOVER  
36 BARTLET ST  
ANDOVER, MA  
01810

HAGGETTS POND RAIL TRAIL  
USGS LOCUS MAP

HAGGETTS POND RD  
& HIGH PLAIN RD  
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: 04/12/2024  
Dwg. No: C:\D\Gr\USGS Figure: \_\_\_\_\_

**FEMA MAP**

**NOTES TO USERS**

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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.

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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>.

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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.

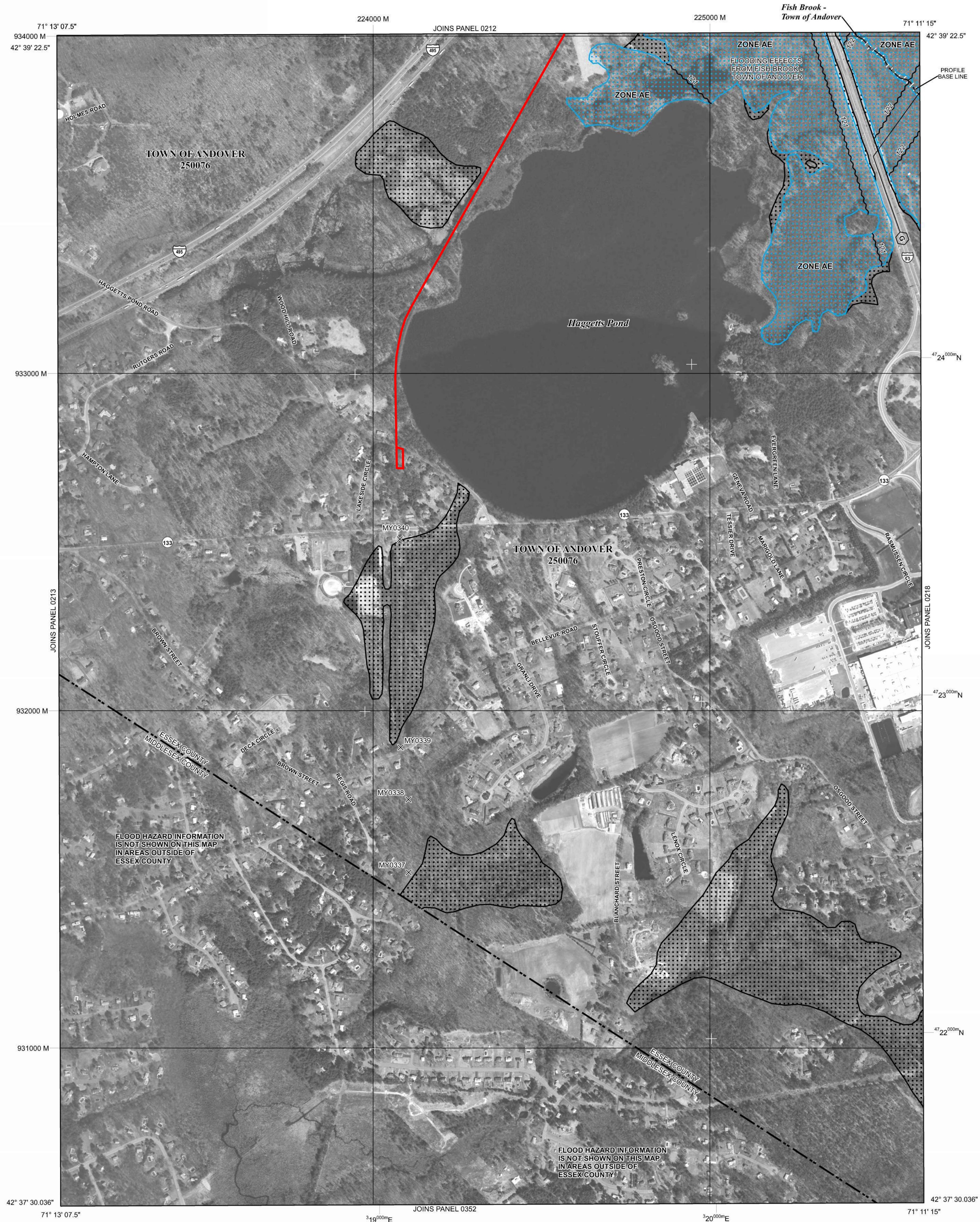
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**LEGEND**

**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 equalled 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.
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**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**
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- Base Flood Elevation line and value; elevation in feet\*
- Base Flood Elevation value where uniform within zone; elevation in feet\*

\*Referenced to the North American Vertical Datum of 1988

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

**MAP REPOSITORIES**  
Refer to Map Repositories list on Map Index

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

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

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

To determine if flood insurance is available in this community, contact your insurance agent or call the National Flood Insurance Program at 1-800-438-6620.

**MAP SCALE 1" = 500'**

250 0 500 1000 FEET  
150 0 150 300 METERS

**NATIONAL FLOOD INSURANCE PROGRAM**

**PANEL 0214F**

**FIRM**  
**FLOOD INSURANCE RATE MAP**  
**ESSEX COUNTY, MASSACHUSETTS**  
**(ALL JURISDICTIONS)**

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

**CONTAINS:**

COMMUNITY	NUMBER	PANEL	SUFFIX
ANDOVER, TOWN OF	250076	0214	F

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

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

**Federal Emergency Management Agency**

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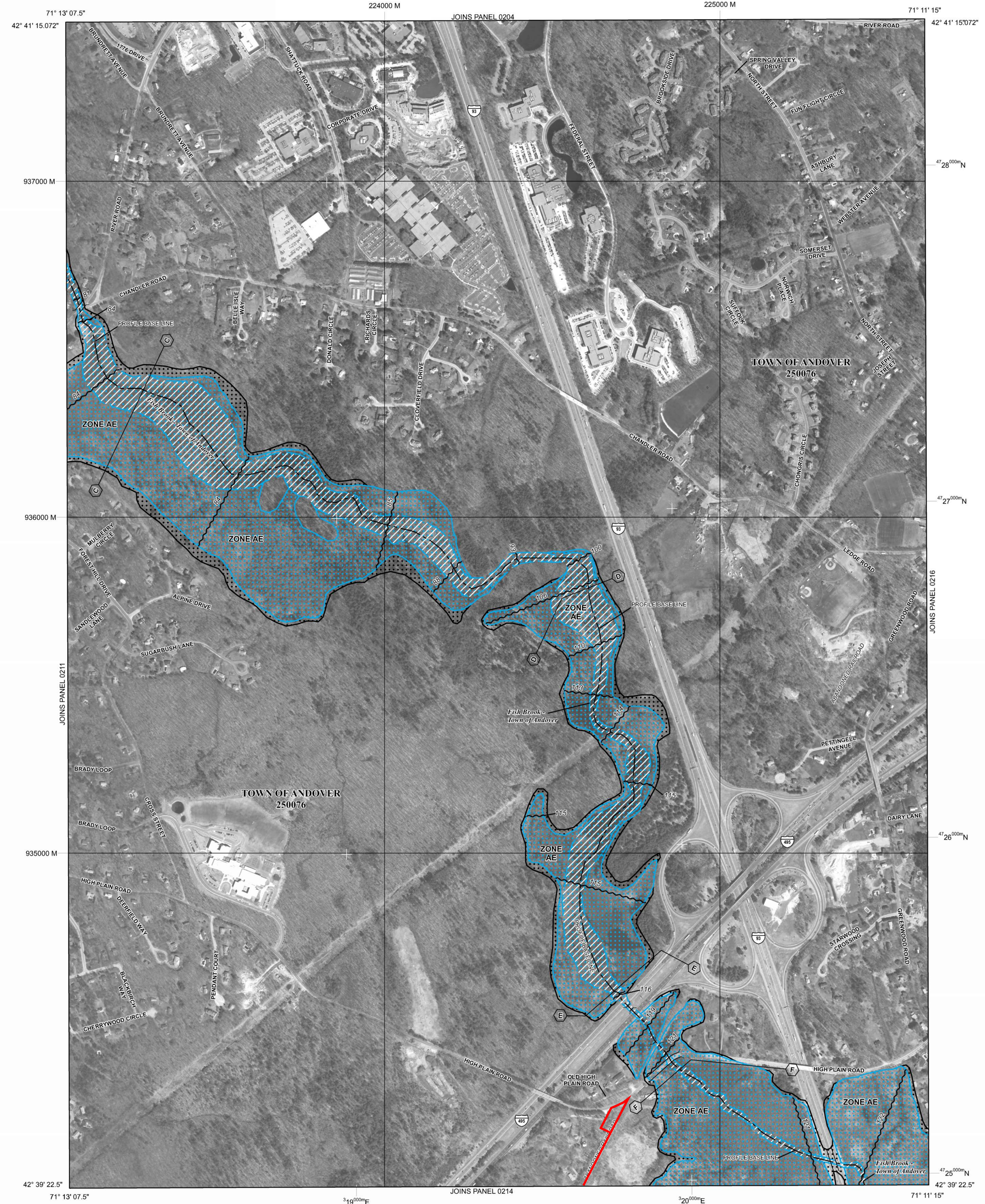
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- Floodway boundary
- Zone D boundary
- CBRS and OPA boundary
- Boundary dividing Special Flood Hazard Area Zones and boundary dividing Special Flood Hazard Areas of different Base Flood Elevations, flood depths, or flood velocities.
- Base Flood Elevation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

\*Referenced to the North American Vertical Datum of 1988

- 45° 02' 08", 93° 02' 12" Geographic coordinates referenced to the North American Datum of 1983 (NAD 83) Western Hemisphere
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- 4989000 N 1000-meter Universal Transverse Mercator grid values, zone 19N
- DX5510 X Bench mark (see explanation in Notes to Users section of this FIRM panel)
- M1.5 River Mile
- MAP REPOSITORIES Refer to Map Repositories list on Map Index
- EFFECTIVE DATE OF COUNTYWIDE FLOOD INSURANCE RATE MAP July 3, 2012
- EFFECTIVE DATE(S) OF REVISION(S) TO THIS PANEL

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**MAP SCALE 1" = 500'**

**NATIONAL FLOOD INSURANCE PROGRAM**

**PANEL 0212F**

**FIRM**  
**FLOOD INSURANCE RATE MAP**  
**ESSEX COUNTY, MASSACHUSETTS (ALL JURISDICTIONS)**

**PANEL 212 OF 600**  
(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

**CONTAINS:**

COMMUNITY	NUMBER	PANEL	SUFFIX
ANDOVER, TOWN OF	250076	0212	F

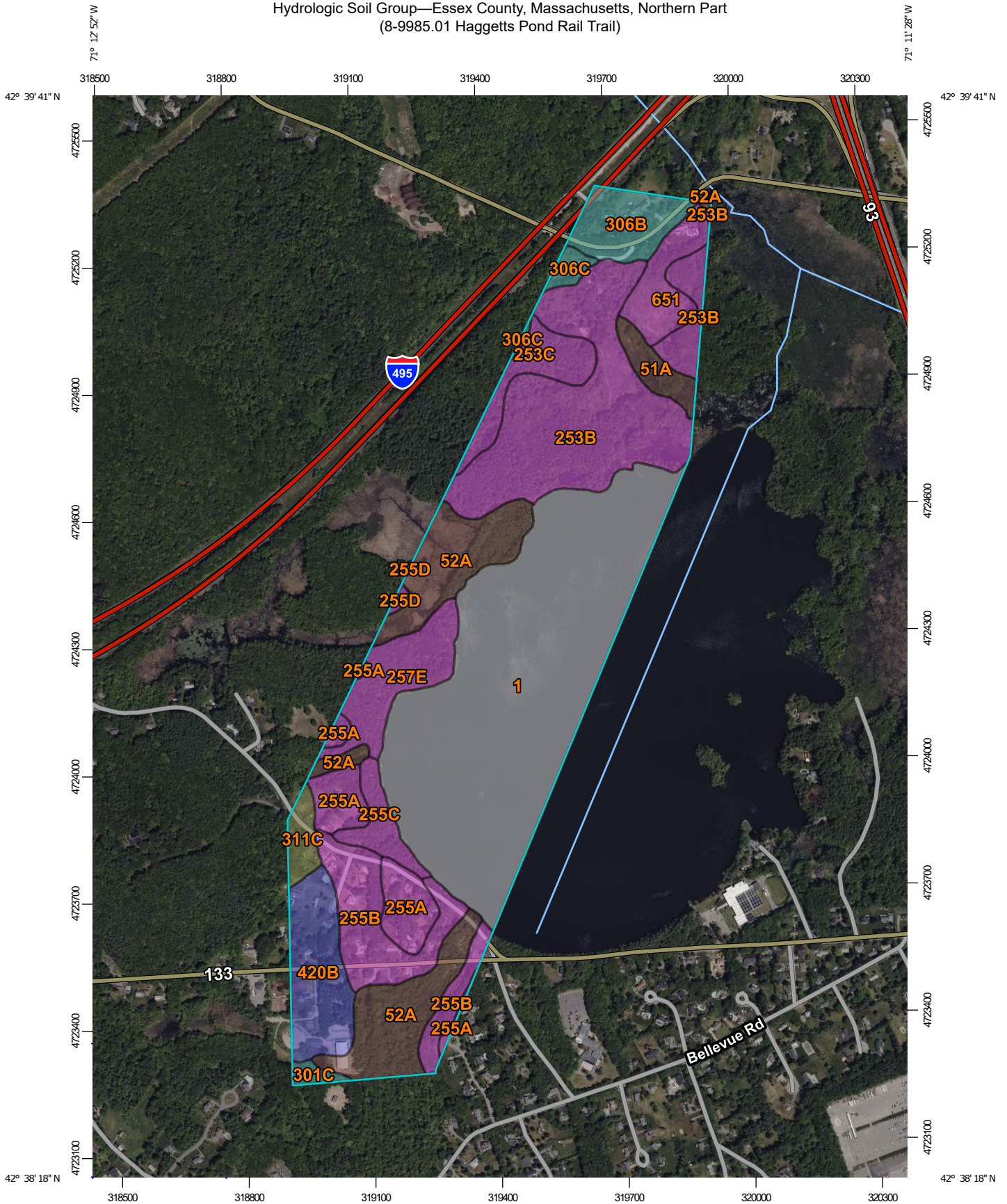
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**MAP NUMBER 25009C0212F**  
**EFFECTIVE DATE JULY 3, 2012**

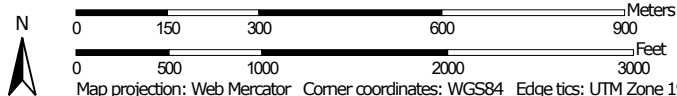
**Federal Emergency Management Agency**

## **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

306B/253B

Hinckley Loamy Sand

Source

Soil Map Unit

Soil Series

Ground moraines, hills, drumlins. / Outwash deltas, outwash terraces, moraines, eskers, kames, outwash plains, kame terraces

Possibly shallow water table. (18-37 inches. 20-43 inches to densic material)

Landform

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

Coarse deposits

Year Published/Source

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 <sub>1</sub>	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 7 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"	A <sub>0</sub>	S	10YR 3/3	-	Cnc: - Dpl: -	-	30-40%	0-5%	1	gr	
10-32"	B <sub>w</sub>	S	10YR 5/6	-	Cnc: - Dpl: -	-	30-40%	10-15%	2	gr	
32-58"	C	FS	10YR 7/6	-	Cnc: - Dpl: -	-	0	0	2	gr	
58"	2CL	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, Haggitts



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 255B/C Windsor Loamy Sand  
Source Soil Map Unit Soil Series

Dunes, outwash plains, deltas, outwash terraces None listed.  
Landform 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 Coarse deposits  
Year Published/Source Map Unit

These deposits include gravel deposits, sand and gravel deposits, and sand deposits. Deposits of finer material are well sorted while deposits of larger particles will be less/poorly sorted.  
Description of Geologic Map Unit:

4. Flood Rate Insurance Map Within a regulatory floodway?  Yes  No

5. Within a velocity zone?  Yes  No

6. Within a Mapped Wetland Area?  Yes  No If yes, MassGIS Wetland Data Layer: \_\_\_\_\_  
Wetland Type

7. Current Water Resource Conditions (USGS): 8/28/2023 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-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      9/26/23      9:30 AM      Mid 50s, cloudy      42.643048      -71.206425  
Hole #      Date      Time      Weather      Latitude      Longitude

1. Land Use: Woodland/conservation area      Pines and deciduous. Thick      some boulders & stones from SW      0-3%  
(e.g., woodland, agricultural field, vacant lot, etc.)      Vegetation      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: outwash      outwash plain      shoulder of rail trail  
Landform      Position on Landscape (SU, SH, BS, FS, TS, Plain)

3. Distances from:      Open Water Body — feet      Drainage Way — feet      Wetlands — feet  
    Property Line 27 feet      Drinking Water Well — feet      Other — feet

4. Unsuitable Materials Present:  Yes  No      If Yes:  Disturbed Soil/Fill Material       Weathered/Fractured Rock       Bedrock

5. Groundwater Observed:  Yes       No      If yes: 6 Depth to Weeping in Hole      \_\_\_\_\_ Depth Standing Water in Hole

### Soil Log

Depth (in)	Soil Horizon / Layer	Soil Texture (USDA)	Soil Matrix: Color-Moist (Munsell)	Redoximorphic Features			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 : — Dpl: —	-	0-5%	-	g	l	—
17-27"	Bw	MS	10YR 6/4	-	Cnc : — Dpl: —	-	0-5%	-	g	l	—
27"-40"	C	FS	10YR 6/3	30"	Cnc : 10YR 6/3 Dpl: —	10-15%	0-5%	-	g	l	—
40"+	2C	-	—	-	Cnc : — Dpl: —	-	-	-	-	-	-
					Cnc : — Dpl: —						
					Cnc : — Dpl: —						

Additional Notes:

Due to sandy soils, walls of pit were caving in & access to bottom was not possible. Samples for coloring & texturing were collected from the top of the pit using a shovel.



## 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](#).

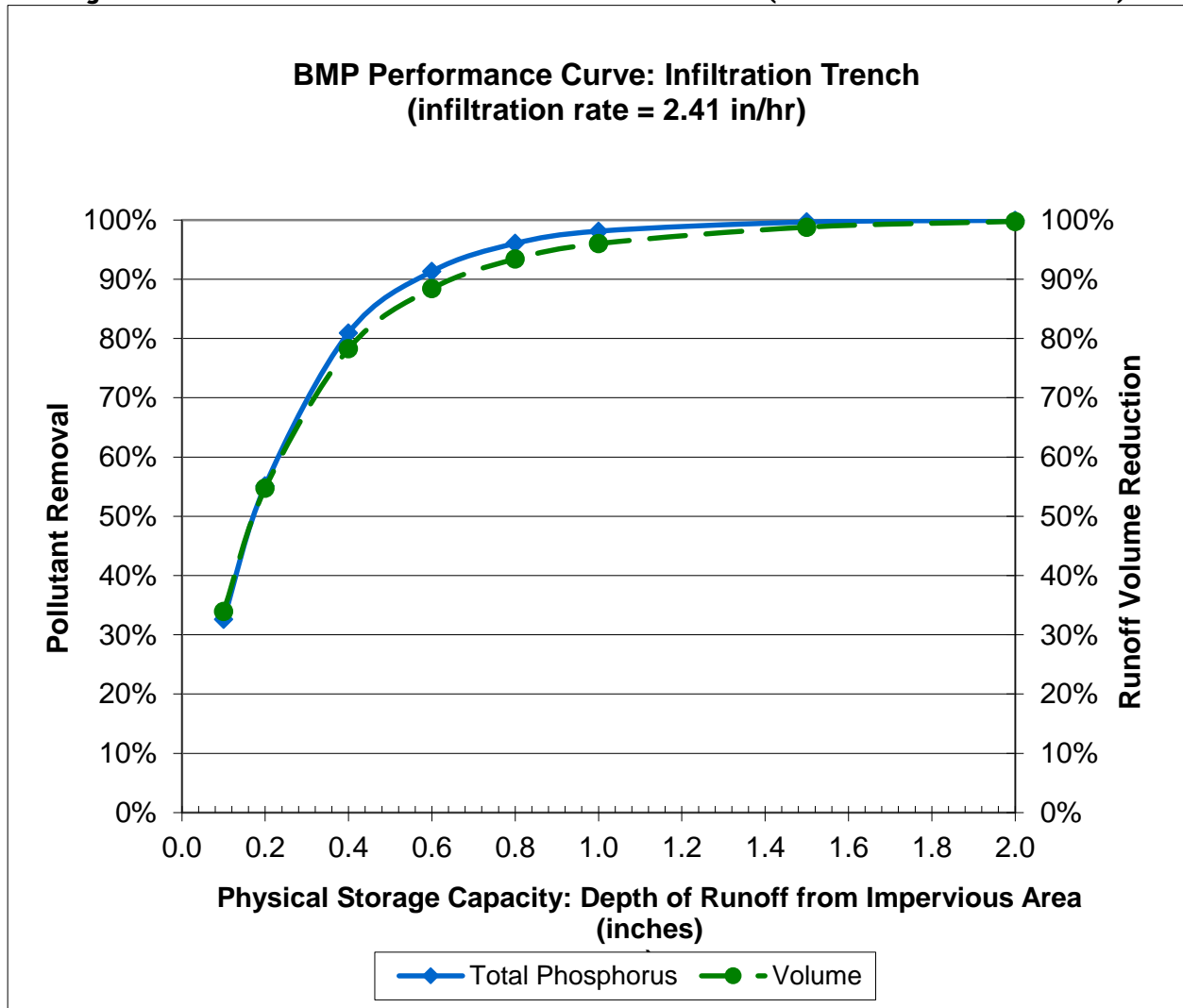
**Field Diagrams:** Use this area for field diagrams:

**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%

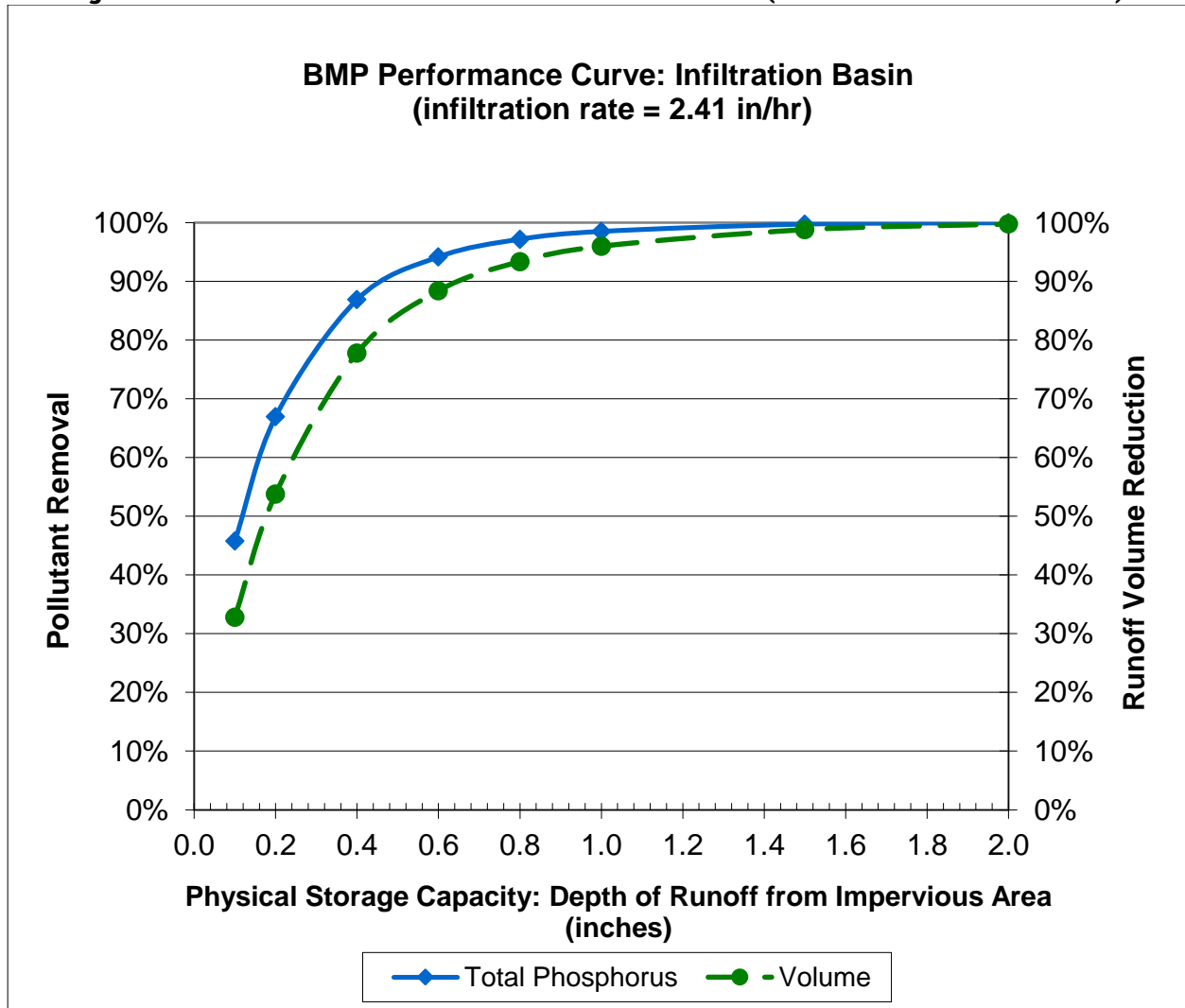
**Figure 3- 5: BMP Performance Curve: Infiltration Trench (infiltration rate = 2.41 in/hr)**



**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**



**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**

<b>PDS-based point precipitation frequency estimates with 90% confidence intervals (in inches)<sup>1</sup></b>										
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 (10.1-19.4)	17.7 (12.8-24.4)	22.3 (16.1-30.1)	26.8 (19.6-36.4)	31.4 (22.8-43.1)	37.1 (27.1-50.1)	44.1 (32.1-58.1)	51.2 (37.1-68.1)
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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