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

Checklist for Stormwater Report

A. Introduction

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

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

The Stormwater Report must include:

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

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

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

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

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

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

B. Stormwater Checklist and Certification

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

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

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

Registered Professional Engineer's Certification

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

Registered Professional Engineer Block and Signature

Signature and Date

Checklist

Project Type: Is the application for new development, redevelopment, or a mix of new and redevelopment?

☒ New development

☐ Redevelopment

☐ Mix of New Development and Redevelopment

Checklist (continued)

LID Measures: Stormwater Standards require LID measures to be considered. Document what environmentally sensitive design and LID Techniques were considered during the planning and design of the project:

- ☐ No disturbance to any Wetland Resource Areas
- ☐ Site Design Practices (e.g. clustered development, reduced frontage setbacks)
- ☐ Reduced Impervious Area (Redevelopment Only)
- ☒ Minimizing disturbance to existing trees and shrubs
- ☐ LID Site Design Credit Requested:
  - ☐ Credit 1
  - ☐ Credit 2
  - ☐ Credit 3
- ☐ Use of “country drainage” versus curb and gutter conveyance and pipe
- ☐ Bioretention Cells (includes Rain Gardens)
- ☐ Constructed Stormwater Wetlands (includes Gravel Wetlands designs)
- ☐ Treebox Filter
- ☐ Water Quality Swale
- ☐ Grass Channel
- ☐ Green Roof
- ☐ Other (describe): ______________________

Standard 1: No New Untreated Discharges

- ☒ No new untreated discharges
- ☐ Outlets have been designed so there is no erosion or scour to wetlands and waters of the Commonwealth
- ☐ Supporting calculations specified in Volume 3 of the Massachusetts Stormwater Handbook included.

Checklist (continued)

Standard 2: Peak Rate Attenuation

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

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

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

Standard 3: Recharge

☒ Soil Analysis provided.

☒ Required Recharge Volume calculation provided.

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

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

☒ Static ☐ Simple Dynamic ☐ Dynamic Field[1]

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

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

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

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

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

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

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

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

Checklist (continued)

Standard 3: Recharge (continued)

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

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

Standard 4: Water Quality

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

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

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

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

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

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

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

Checklist (continued)

Standard 4: Water Quality (continued)

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

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

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

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

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

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

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

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

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

☐ All exposure has been eliminated.

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

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

Standard 6: Critical Areas

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

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

Checklist for Stormwater Report

Checklist (continued)

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

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

- ☐ Limited Project
- ☐ Small Residential Projects: 5-9 single family houses or 5-9 units in a multi-family development provided there is no discharge that may potentially affect a critical area.
- ☐ Small Residential Projects: 2-4 single family houses or 2-4 units in a multi-family development with a discharge to a critical area
- ☐ Marina and/or boatyard provided the hull painting, service and maintenance areas are protected from exposure to rain, snow, snow melt and runoff
- ☐ Bike Path and/or Foot Path
- ☐ Redevelopment Project
- ☐ Redevelopment portion of mix of new and redevelopment.

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

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

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

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

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

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

Checklist (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.

Land
Planning
Inc.

Theroux Dental Complex

Stormwater Management Standards Compliance

Standard 1: No New Untreated Discharges

The proposed office building, parking areas, and driveways will be constructed without any point discharges. Runoff from all proposed impervious surfaces is infiltrated within a subsurface chamber system and the existing kettle hole. Additional calculations demonstrating compliance with Standard 1 are not required.

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www.landplanninginc.com

Standard 2: Peak Rate Attenuation

Runoff collected by the proposed building will be infiltrated within the existing kettle hole. Runoff from the parking areas will be infiltrated within a subsurface chamber system. The infiltration has been sized to retain all runoff collected. Runoff from the remaining areas of the site will be reduced as some of these areas have been redirected to the infiltration system. The attached drainage analysis demonstrates that the proposed development will not result in an increase in peak discharge rates as compared to the existing site.

Pre and Post Development Drainage Analysis
For

Theroux Dental Complex

Grafton, MA

Prepared for

Marc Theroux
2 Stonegate Circle
Grafton, MA 01519

Revised May 16, 2016

Prepared by

LAND PLANNING, INC.
214 Worcester Street
North Grafton, MA 01536

EXISTING CONDITIONS:

The site is located on the northwest corner of Worcester Street and Harris Street in Grafton. The property is a combination of two tracts of land: Assessor's map 46, lots 15 and 19. The total area is 1.59 acres. The property is bounded to the east by Worcester Street, to the south by Harris Street, to the west and north by Bernard Road and the Quinsigamond River.

The existing site contains a single family home, detached garage, and gravel driveway with access to Harris Street. The remainder of the property is a mix of lawn and woodland.

The central portion of the site is gently sloped and transitions to steeply sloped along the Quinsigamond River and Worcester Street. A retaining wall is located along the Worcester Street right-of-way line.

Stormwater within the proposed development area flows in all directions from the center of the site to it's perimeter. A kettle hole exists in the southwest corner of the property that provides infiltration of some of the site runoff as well as a portion of the runoff collected on the surface of Clark Street, Bernard Road, and Harris Street.

The soils within the area of proposed development have been classified by the NRCS as Hinckley loamy sand. Soil tests performed by Land Planning, Inc. confirm that these classifications are accurate and the existing soil is highly permeable.

DEVELOPED CONDITIONS:

Development plans for the site include the construction of an office building with its accessory parking areas and driveways. The proposed single story office building has a gross floor area of 8,748 ft^2. The parking areas and driveways will be surfaced with bituminous concrete. All roof runoff will be infiltrated within the regraded kettle hole. All parking area runoff will be collected, pretreated, and infiltrated through a proposed Cultec chamber systems located at the east side of the property.

ANALYSIS:

The existing and proposed sites were each divided into 3 subcatchments for this analysis: designated as S1, S2, and S3 within the calculations. Subcatchment S1is defined as the area tributary to the existing kettle hole in the southwest corner of the property. Subcatchment S2 is the area that drains onto the surface of Harris Street. Subcatchment S3 is the area of the site that drains to the Quinsigamond River.

Although a portion of S3 is first intercepted by the Worcester Street drainage system, this system discharges directly to the river nearby. Therefore, the area tributary to Worcester Street and the area tributary to the river were considered a single watershed.

The goal of the stormwater management system proposed is to ensure that there is no increase in peak run-off rates at either the Quinsigamond River or adjacent streets. This goal is achieved through infiltrating the runoff from nearly all of the proposed impervious surfaces. Additional protection is provided through routing one of the infiltration system overflows to the existing kettle hole.

SUMMARY:

Discharges for the existing and proposed subcatchment areas are summarized in the table below. Note that discharge from S1 is shown as 0 for both pre and post development as the kettle hole does not overtop in either condition.

Hydrologic Analysis Summary						
Area	2 Year Storm		10 Year Storm		100 Year Storm	
	Pre	Post	Pre	Post	Pre	Post
1	0 cfs	0 cfs	0 cfs	0 cfs	0 cfs	0 cfs
2	0 cfs	0 cfs	0.08 cfs	0 cfs	0.77 cfs	0.11 cfs
3	0 cfs	0 cfs	0 cfs	0 cfs	0.96 cfs	0.55 cfs

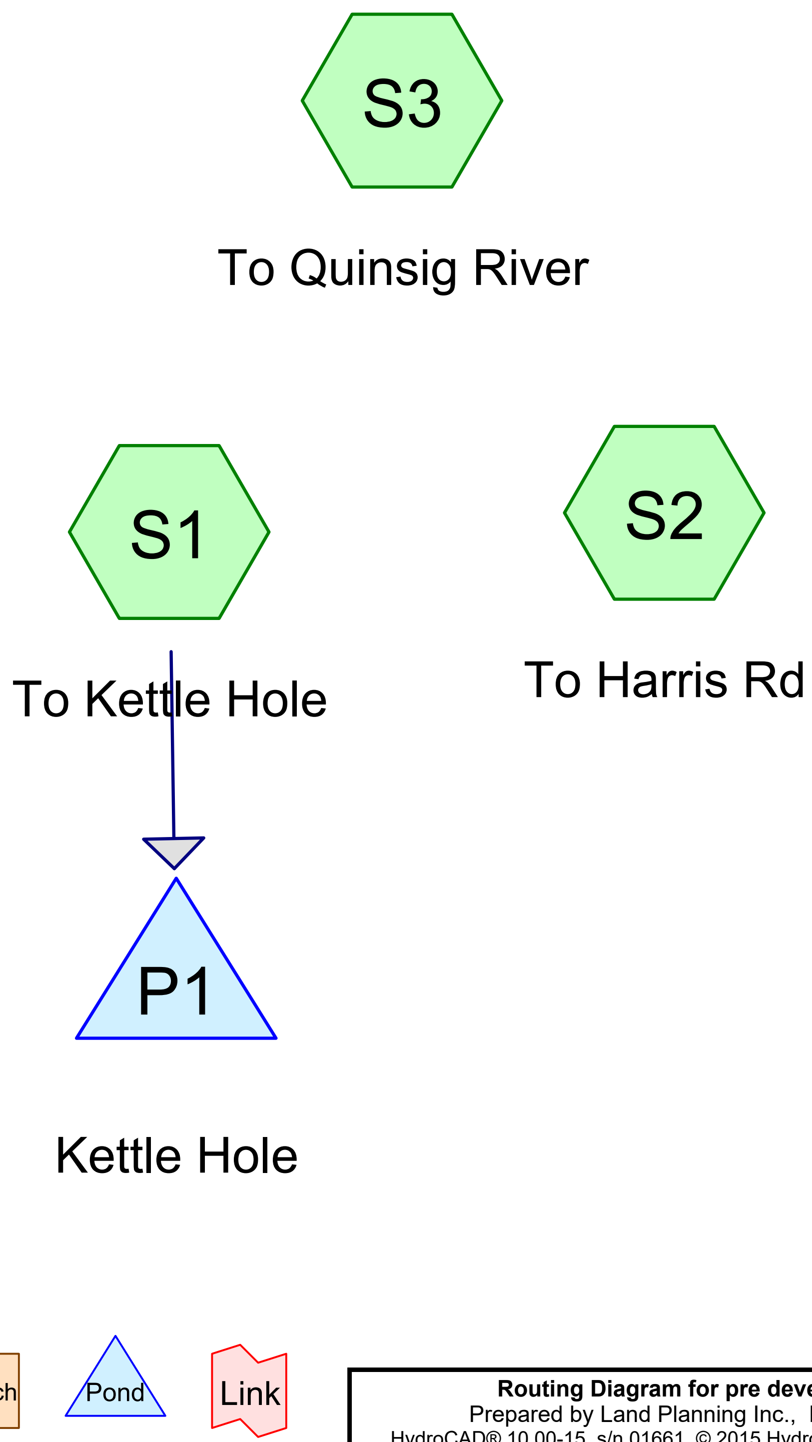
Table 1

CONCLUSIONS:

The proposed development will not result in any increase in peak runoff rates for all storms up to and including the 100 year storm.

Pre-development Analysis

Pre Development



Routing Diagram for pre development rev5
Prepared by Land Planning Inc., Printed 5/16/2016
HydroCAD® 10.00-15 s/n 01661 © 2015 HydroCAD Software Solutions LLC

Time span=0.00-48.00 hrs, dt=0.05 hrs, 961 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

SubcatchmentS1: To Kettle Hole Runoff Area=107,750 sf 28.28% Impervious Runoff Depth=0.24"
Flow Length=626' Tc=11.7 min CN=54.1 Runoff=0.22 cfs 0.049 af

SubcatchmentS2: To Harris Rd Runoff Area=11,834 sf 10.79% Impervious Runoff Depth=0.08"
Flow Length=124' Tc=2.9 min CN=46.9 Runoff=0.00 cfs 0.002 af

SubcatchmentS3: To Quinsig River Runoff Area=97,573 sf 2.13% Impervious Runoff Depth=0.00"
Flow Length=330' Tc=9.0 min CN=32.9 Runoff=0.00 cfs 0.000 af

Pond P1: Kettle Hole Peak Elev=318.68' Storage=331 cf Inflow=0.22 cfs 0.049 af
Outflow=0.08 cfs 0.049 af

Total Runoff Area = 4.985 ac Runoff Volume = 0.051 af Average Runoff Depth = 0.12"
84.42% Pervious = 4.209 ac 15.58% Impervious = 0.777 ac

Summary for Subcatchment S1: To Kettle Hole

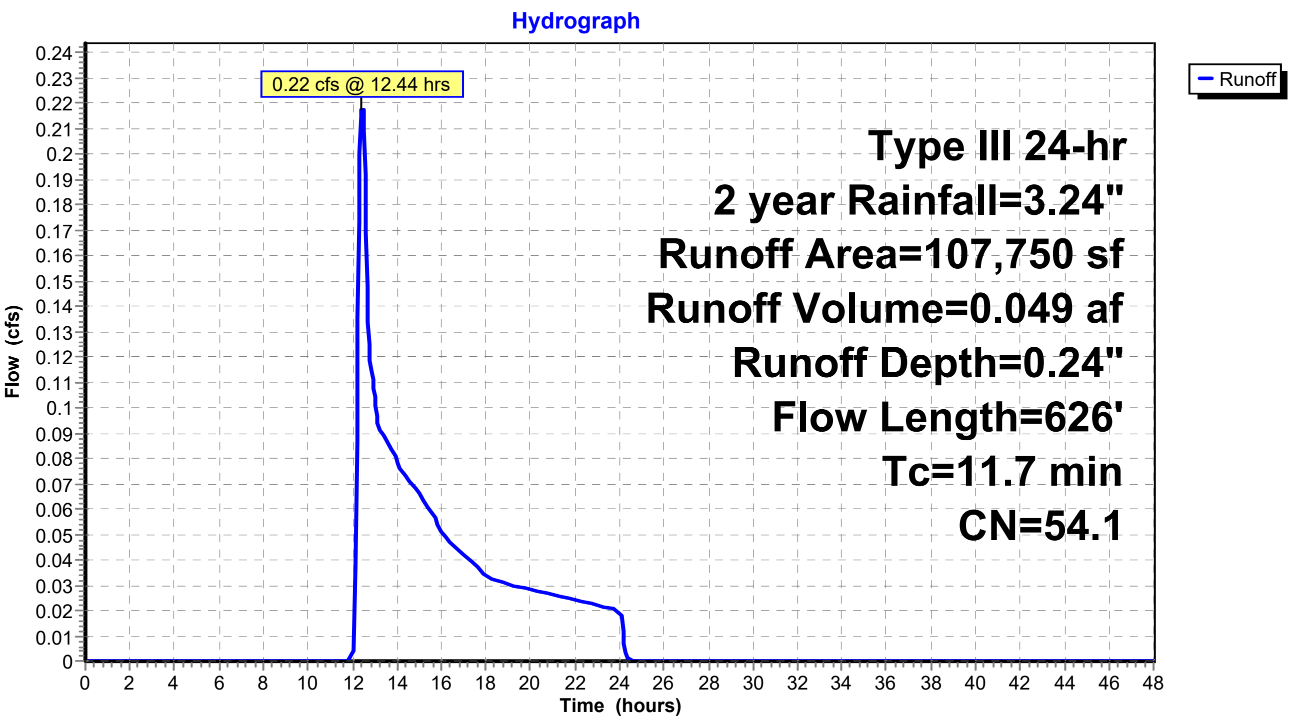
Runoff = 0.22 cfs @ 12.44 hrs, Volume= 0.049 af, Depth= 0.24"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type III 24-hr 2 year Rainfall=3.24"

Area (sf)	CN	Description
30,475	98.0	Paved parking, HSG A
58,119	39.0	>75% Grass cover, Good, HSG A
19,156	30.0	Woods, Good, HSG A
107,750	54.1	Weighted Average
77,275		71.72% Pervious Area
30,475		28.28% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.5	50	0.0100	0.11		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.10"
1.3	80	0.0200	0.99		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
2.9	496	0.0200	2.87		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
11.7	626	Total			

Subcatchment S1: To Kettle Hole



Summary for Subcatchment S2: To Harris Rd

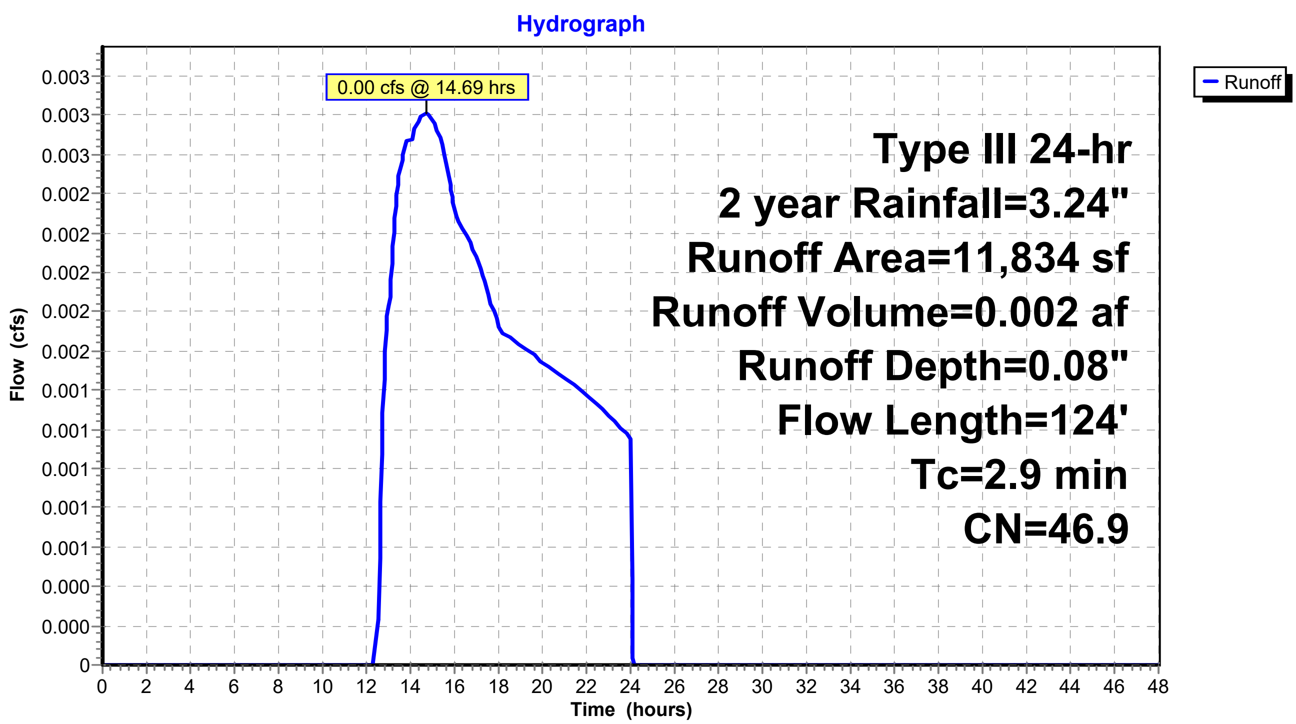
Runoff = 0.00 cfs @ 14.69 hrs, Volume= 0.002 af, Depth= 0.08"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type III 24-hr 2 year Rainfall=3.24"

Area (sf)	CN	Description
1,277	98.0	Roofs, HSG A
1,506	76.0	Gravel roads, HSG A
4,833	39.0	>75% Grass cover, Good, HSG A
4,218	30.0	Woods, Good, HSG A
11,834	46.9	Weighted Average
10,557		89.21% Pervious Area
1,277		10.79% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
2.5	36	0.0800	0.24		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.10"
0.3	50	0.2600	2.55		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
0.1	38	0.1000	6.42		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
2.9	124	Total			

Subcatchment S2: To Harris Rd



Summary for Subcatchment S3: To Quinsig River

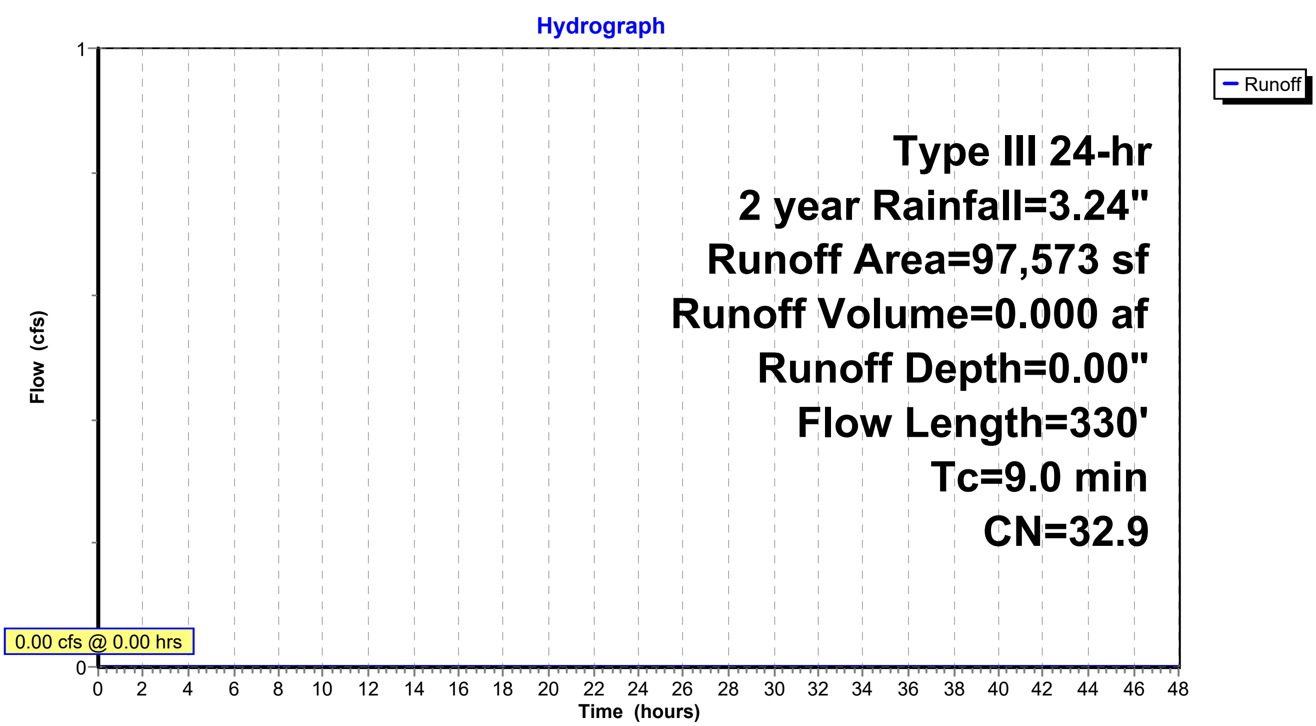
Runoff = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af, Depth= 0.00"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type III 24-hr 2 year Rainfall=3.24"

Area (sf)	CN	Description
2,082	98.0	Roofs, HSG A
15,407	39.0	>75% Grass cover, Good, HSG A
80,084	30.0	Woods, Good, HSG A
97,573	32.9	Weighted Average
95,491		97.87% Pervious Area
2,082		2.13% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.7	50	0.0200	0.15		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.10"
1.7	102	0.0200	0.99		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
1.6	178	0.1400	1.87		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
9.0	330	Total			

Subcatchment S3: To Quinsig River



Summary for Pond P1: Kettle Hole

Inflow Area = 2.474 ac, 28.28% Impervious, Inflow Depth = 0.24" for 2 year event
Inflow = 0.22 cfs @ 12.44 hrs, Volume= 0.049 af
Outflow = 0.08 cfs @ 14.08 hrs, Volume= 0.049 af, Atten= 65%, Lag= 98.4 min
Discarded = 0.08 cfs @ 14.08 hrs, Volume= 0.049 af

Routing by Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Peak Elev= 318.68'@ 14.08 hrs Surf.Area= 664 sf Storage= 331 cf

Plug-Flow detention time=46.8 min calculated for 0.049 af (100% of inflow)
Center-of-Mass det. time=46.8 min (1,012.6 - 965.8)

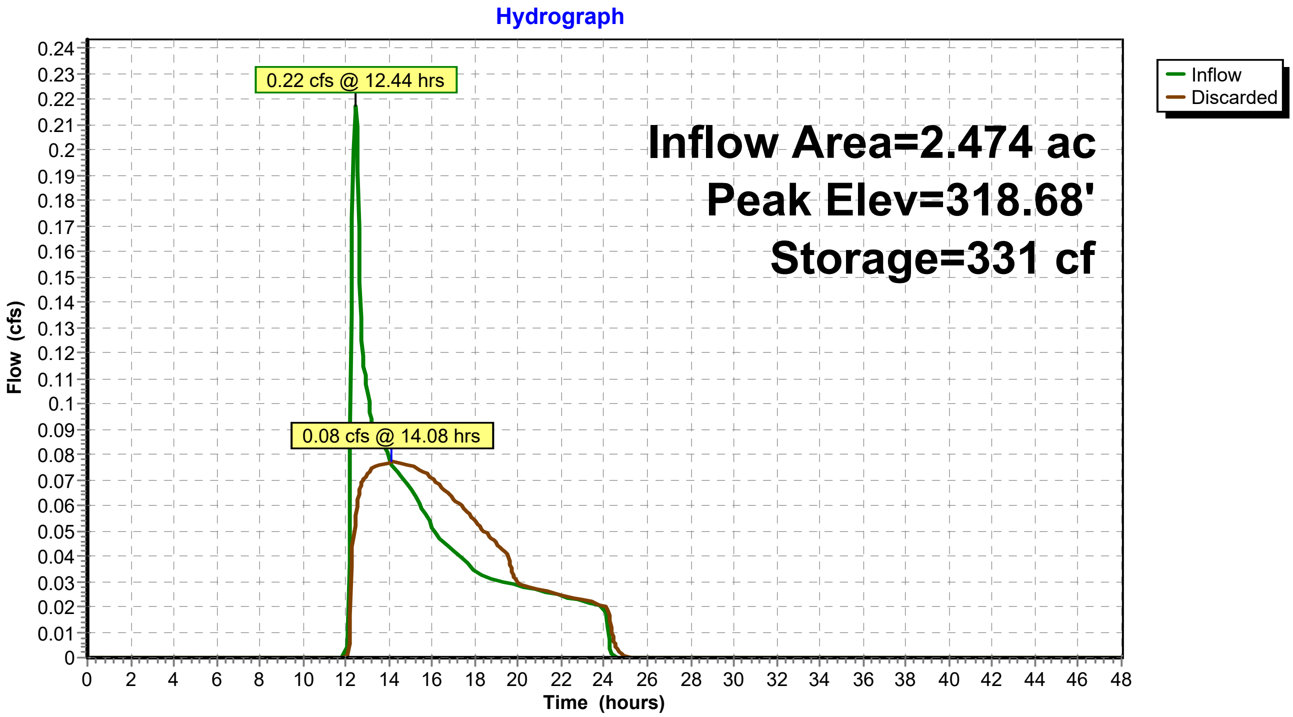
Volume	Invert	Avail.Storage	Storage Description
#1	318.00'	36,627 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
318.00	302	0	0
320.00	1,359	1,661	1,661
322.00	2,385	3,744	5,405
324.00	3,647	6,032	11,437
326.00	5,674	9,321	20,758
328.00	10,195	15,869	36,627

Device	Routing	Invert	Outlet Devices
#1	Discarded	318.00'	**5.000 in/hr Exfiltration over Surface area** Conductivity to Groundwater Elevation = 0.00'

Discarded OutFlow Max=0.08 cfs @ 14.08 hrs HW=318.68' (Free Discharge)
↑**1=Exfiltration** (Controls 0.08 cfs)

Pond P1: Kettle Hole



Time span=0.00-48.00 hrs, dt=0.05 hrs, 961 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment S1: To Kettle Hole Runoff Area=107,750 sf 28.28% Impervious Runoff Depth=0.87"
Flow Length=626' Tc=11.7 min CN=54.1 Runoff=1.56 cfs 0.180 af

Subcatchment S2: To Harris Rd Runoff Area=11,834 sf 10.79% Impervious Runoff Depth=0.49"
Flow Length=124' Tc=2.9 min CN=46.9 Runoff=0.08 cfs 0.011 af

Subcatchment S3: To Quinsig River Runoff Area=97,573 sf 2.13% Impervious Runoff Depth=0.03"
Flow Length=330' Tc=9.0 min CN=32.9 Runoff=0.01 cfs 0.006 af

Pond P1: Kettle Hole Peak Elev=320.80' Storage=2,913 cf Inflow=1.56 cfs 0.180 af
Outflow=0.21 cfs 0.180 af

Total Runoff Area = 4.985 ac Runoff Volume = 0.197 af Average Runoff Depth = 0.47"
84.42% Pervious = 4.209 ac 15.58% Impervious = 0.777 ac

Summary for Subcatchment S1: To Kettle Hole

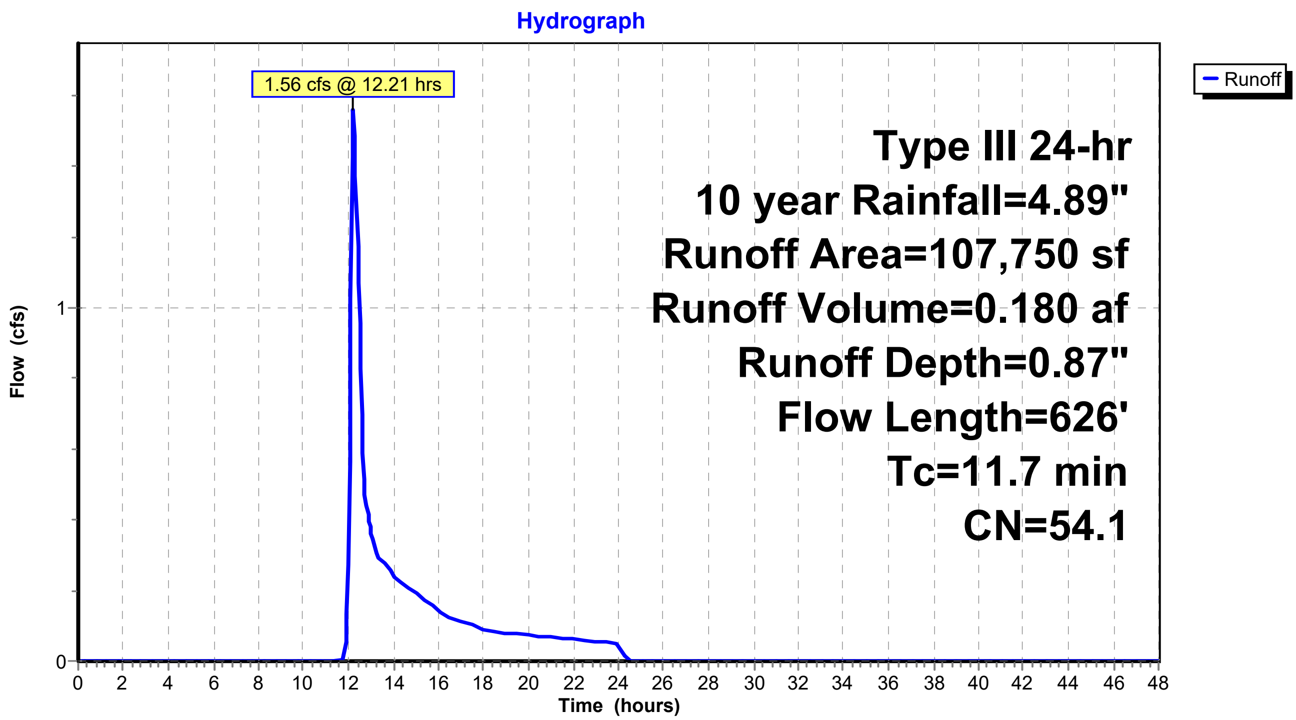
Runoff = 1.56 cfs @ 12.21 hrs, Volume= 0.180 af, Depth= 0.87"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type III 24-hr 10 year Rainfall=4.89"

Area (sf)	CN	Description
30,475	98.0	Paved parking, HSG A
58,119	39.0	>75% Grass cover, Good, HSG A
19,156	30.0	Woods, Good, HSG A
107,750	54.1	Weighted Average
77,275		71.72% Pervious Area
30,475		28.28% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.5	50	0.0100	0.11		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.10"
1.3	80	0.0200	0.99		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
2.9	496	0.0200	2.87		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
11.7	626	Total			

Subcatchment S1: To Kettle Hole



Summary for Subcatchment S2: To Harris Rd

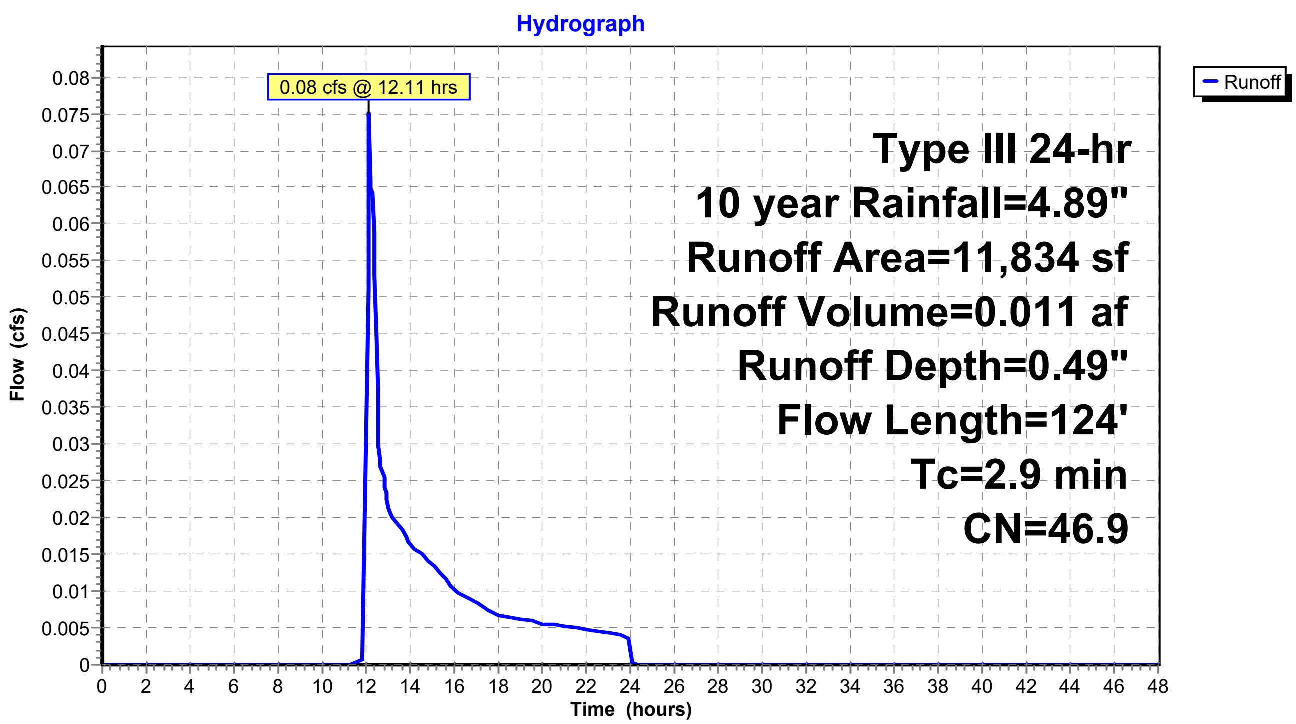
Runoff = 0.08 cfs @ 12.11 hrs, Volume= 0.011 af, Depth= 0.49"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type III 24-hr 10 year Rainfall=4.89"

Area (sf)	CN	Description
1,277	98.0	Roofs, HSG A
1,506	76.0	Gravel roads, HSG A
4,833	39.0	>75% Grass cover, Good, HSG A
4,218	30.0	Woods, Good, HSG A
11,834	46.9	Weighted Average
10,557		89.21% Pervious Area
1,277		10.79% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
2.5	36	0.0800	0.24		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.10"
0.3	50	0.2600	2.55		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
0.1	38	0.1000	6.42		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
2.9	124	Total			

Subcatchment S2: To Harris Rd



Summary for Subcatchment S3: To Quinsig River

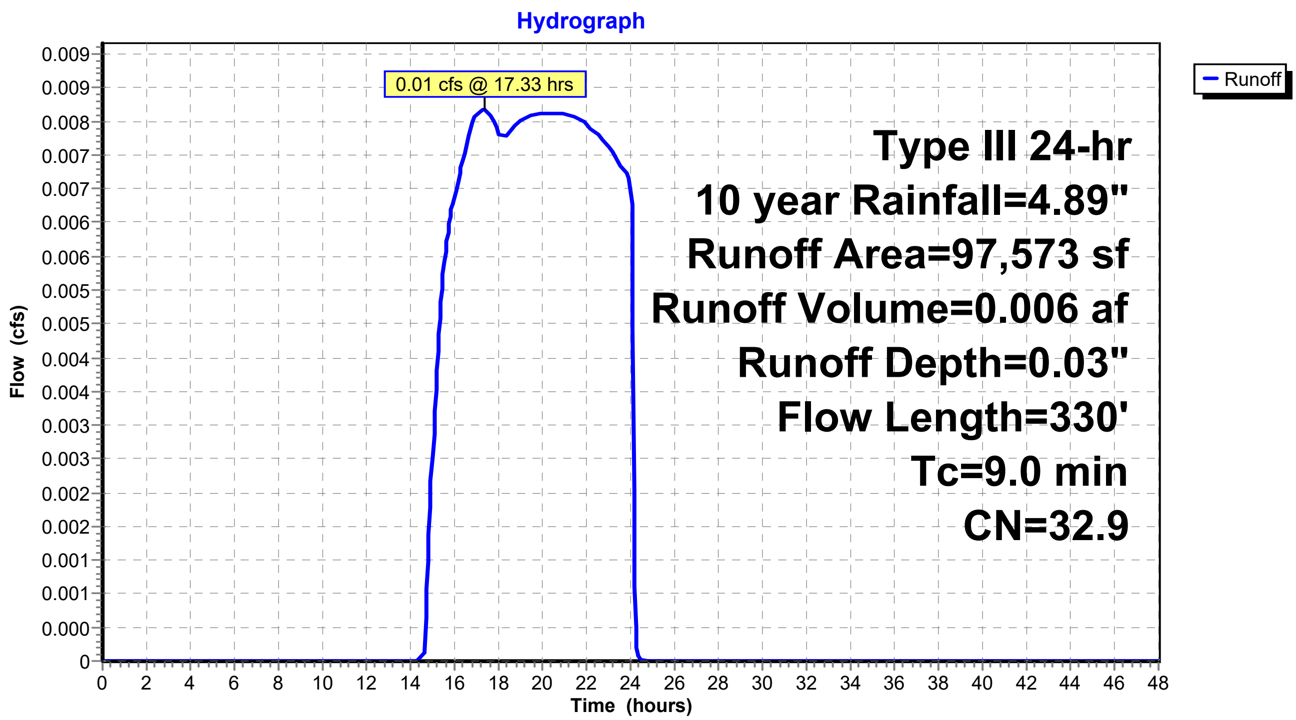
Runoff = 0.01 cfs @ 17.33 hrs, Volume= 0.006 af, Depth= 0.03"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type III 24-hr 10 year Rainfall=4.89"

Area (sf)	CN	Description
2,082	98.0	Roofs, HSG A
15,407	39.0	>75% Grass cover, Good, HSG A
80,084	30.0	Woods, Good, HSG A
97,573	32.9	Weighted Average
95,491		97.87% Pervious Area
2,082		2.13% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.7	50	0.0200	0.15		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.10"
1.7	102	0.0200	0.99		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
1.6	178	0.1400	1.87		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
9.0	330	Total			

Subcatchment S3: To Quinsig River



Summary for Pond P1: Kettle Hole

Inflow Area = 2.474 ac, 28.28% Impervious, Inflow Depth = 0.87" for 10 year event
Inflow = 1.56 cfs @ 12.21 hrs, Volume= 0.180 af
Outflow = 0.21 cfs @ 14.68 hrs, Volume= 0.180 af, Atten= 87%, Lag= 148.4 min
Discarded = 0.21 cfs @ 14.68 hrs, Volume= 0.180 af

Routing by Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Peak Elev= 320.80'@ 14.68 hrs Surf.Area= 1,770 sf Storage= 2,913 cf

Plug-Flow detention time=183.9 min calculated for 0.180 af (100% of inflow)
Center-of-Mass det. time=183.8 min (1,087.6 - 903.8)

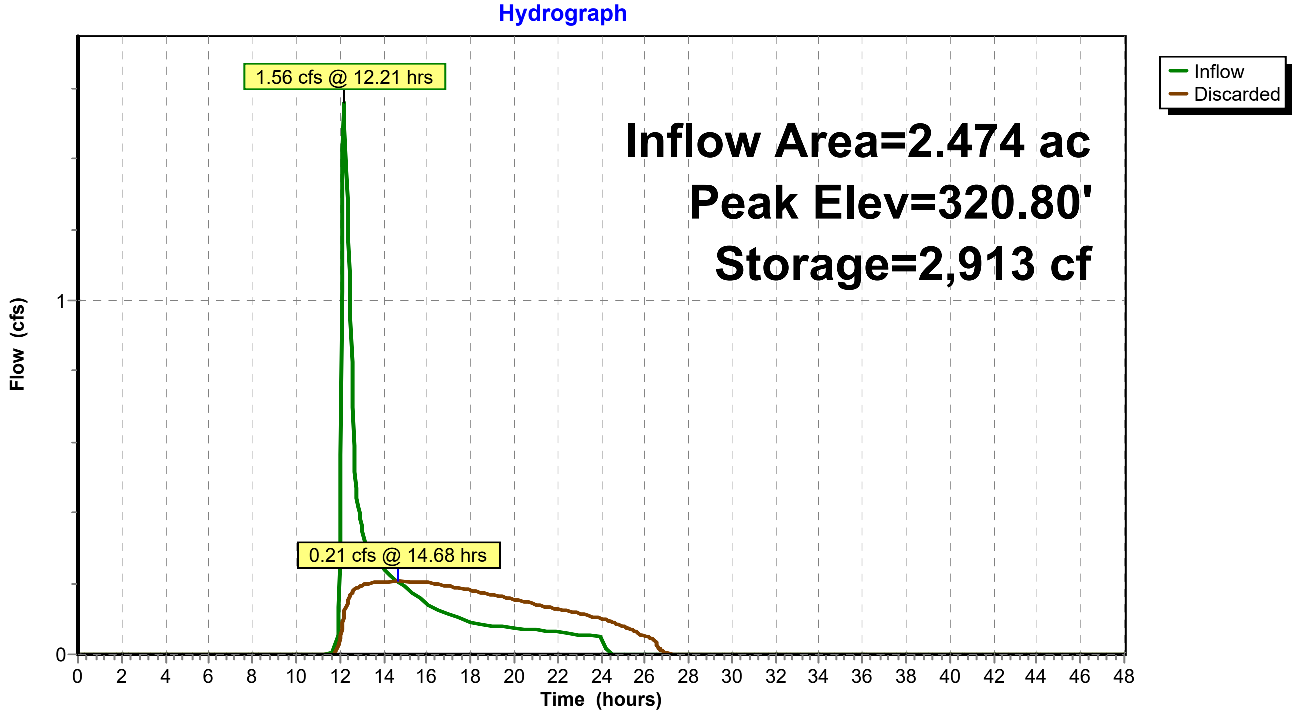
Volume	Invert	Avail.Storage	Storage Description
#1	318.00'	36,627 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
318.00	302	0	0
320.00	1,359	1,661	1,661
322.00	2,385	3,744	5,405
324.00	3,647	6,032	11,437
326.00	5,674	9,321	20,758
328.00	10,195	15,869	36,627

Device	Routing	Invert	Outlet Devices
#1	Discarded	318.00'	**5.000 in/hr Exfiltration over Surface area** Conductivity to Groundwater Elevation = 0.00'

Discarded OutFlow Max=0.21 cfs @ 14.68 hrs HW=320.80' (Free Discharge)
└─**1=Exfiltration** (Controls 0.21 cfs)

Pond P1: Kettle Hole



Time span=0.00-48.00 hrs, dt=0.05 hrs, 961 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

SubcatchmentS1: To Kettle Hole Runoff Area=107,750 sf 28.28% Impervious Runoff Depth=3.26"
Flow Length=626' Tc=11.7 min CN=54.1 Runoff=7.51 cfs 0.672 af

SubcatchmentS2: To Harris Rd Runoff Area=11,834 sf 10.79% Impervious Runoff Depth=2.41"
Flow Length=124' Tc=2.9 min CN=46.9 Runoff=0.77 cfs 0.055 af

SubcatchmentS3: To Quinsig River Runoff Area=97,573 sf 2.13% Impervious Runoff Depth=0.90"
Flow Length=330' Tc=9.0 min CN=32.9 Runoff=0.96 cfs 0.168 af

Pond P1: Kettle Hole Peak Elev=324.97' Storage=15,448 cf Inflow=7.51 cfs 0.672 af
Outflow=0.54 cfs 0.672 af

Total Runoff Area = 4.985 ac Runoff Volume = 0.894 af Average Runoff Depth = 2.15"
84.42% Pervious = 4.209 ac 15.58% Impervious = 0.777 ac

Summary for Subcatchment S1: To Kettle Hole

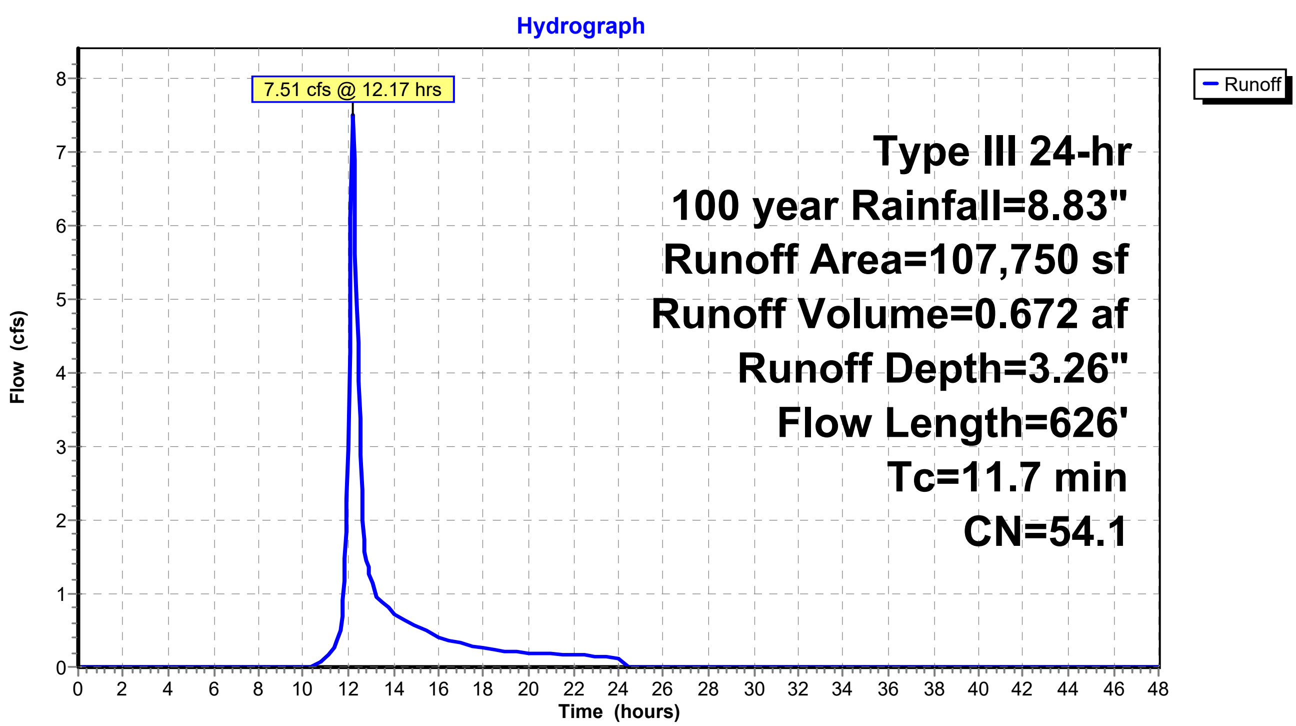
Runoff = 7.51 cfs @ 12.17 hrs, Volume= 0.672 af, Depth= 3.26"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type III 24-hr 100 year Rainfall=8.83"

Area (sf)	CN	Description
30,475	98.0	Paved parking, HSG A
58,119	39.0	>75% Grass cover, Good, HSG A
19,156	30.0	Woods, Good, HSG A
107,750	54.1	Weighted Average
77,275		71.72% Pervious Area
30,475		28.28% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.5	50	0.0100	0.11		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.10"
1.3	80	0.0200	0.99		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
2.9	496	0.0200	2.87		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
11.7	626	Total			

Subcatchment S1: To Kettle Hole



Summary for Subcatchment S2: To Harris Rd

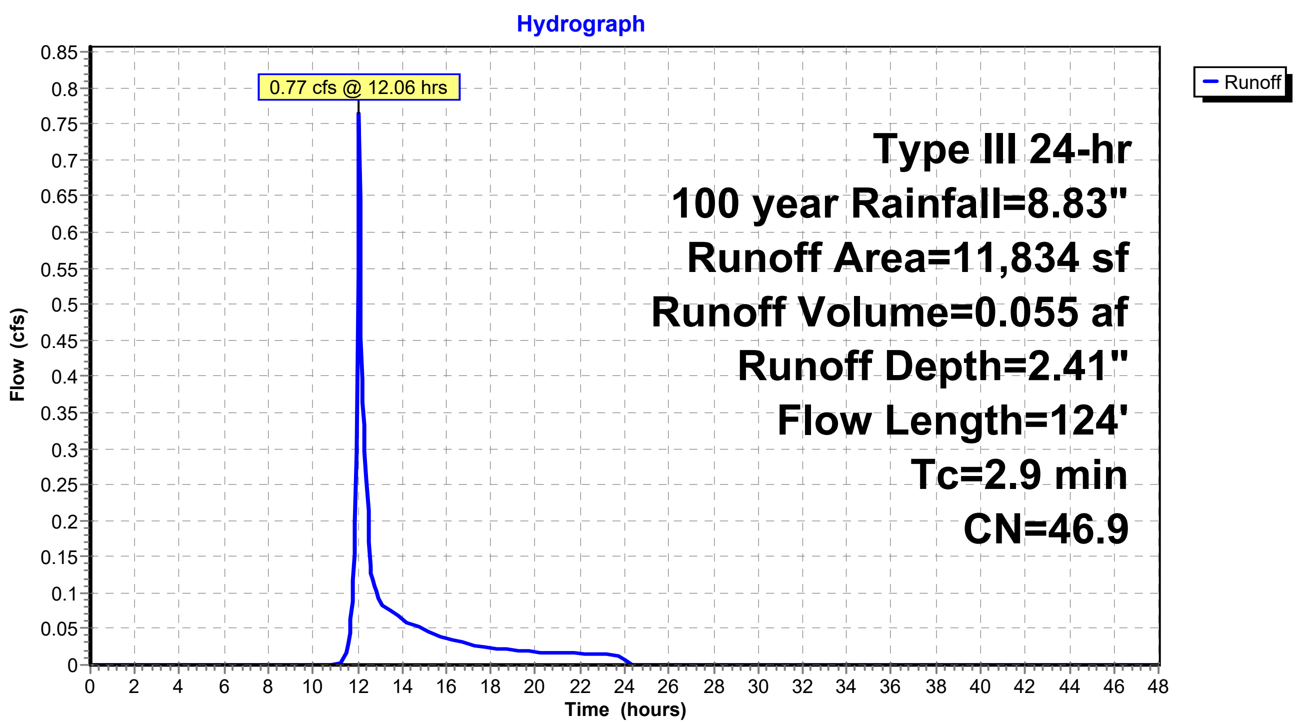
Runoff = 0.77 cfs @ 12.06 hrs, Volume= 0.055 af, Depth= 2.41"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type III 24-hr 100 year Rainfall=8.83"

Area (sf)	CN	Description
1,277	98.0	Roofs, HSG A
1,506	76.0	Gravel roads, HSG A
4,833	39.0	>75% Grass cover, Good, HSG A
4,218	30.0	Woods, Good, HSG A
11,834	46.9	Weighted Average
10,557		89.21% Pervious Area
1,277		10.79% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
2.5	36	0.0800	0.24		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.10"
0.3	50	0.2600	2.55		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
0.1	38	0.1000	6.42		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
2.9	124	Total			

Subcatchment S2: To Harris Rd



Summary for Subcatchment S3: To Quinsig River

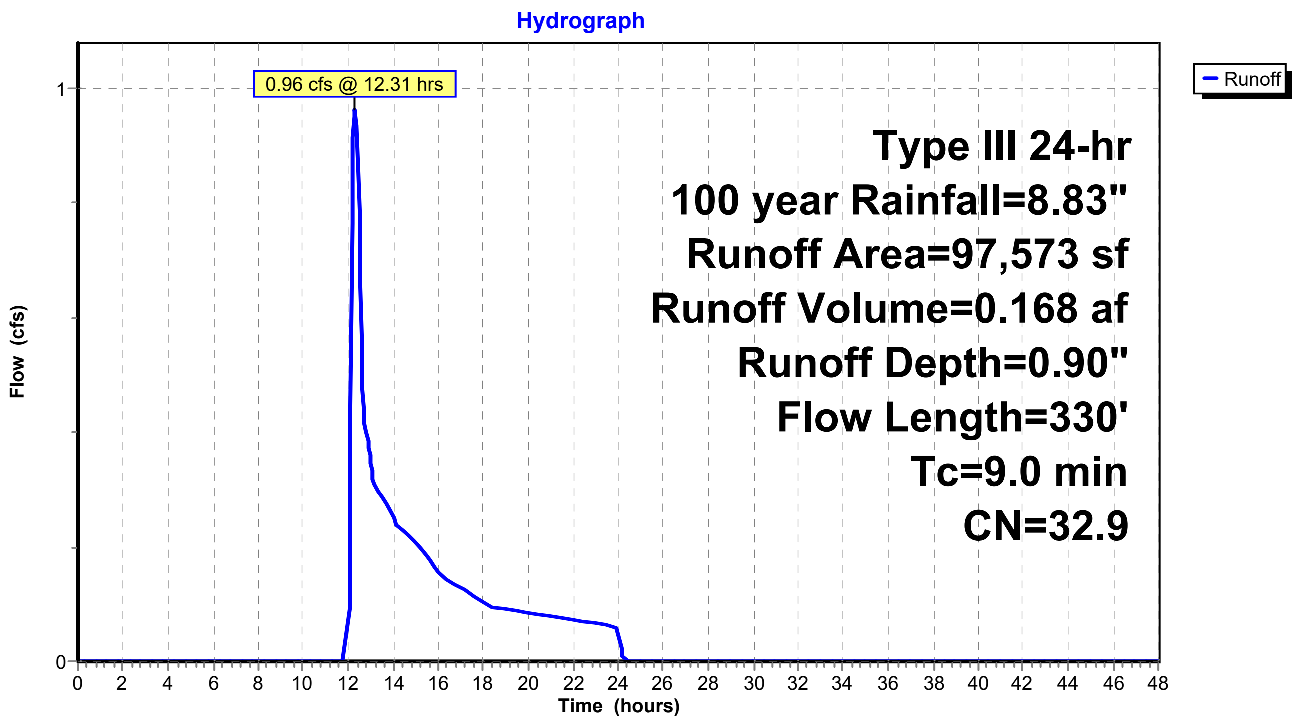
Runoff = 0.96 cfs @ 12.31 hrs, Volume= 0.168 af, Depth= 0.90"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type III 24-hr 100 year Rainfall=8.83"

Area (sf)	CN	Description
2,082	98.0	Roofs, HSG A
15,407	39.0	>75% Grass cover, Good, HSG A
80,084	30.0	Woods, Good, HSG A
97,573	32.9	Weighted Average
95,491		97.87% Pervious Area
2,082		2.13% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.7	50	0.0200	0.15		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.10"
1.7	102	0.0200	0.99		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
1.6	178	0.1400	1.87		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
9.0	330	Total			

Subcatchment S3: To Quinsig River



Summary for Pond P1: Kettle Hole

Inflow Area = 2.474 ac, 28.28% Impervious, Inflow Depth = 3.26" for 100 year event
Inflow = 7.51 cfs @ 12.17 hrs, Volume= 0.672 af
Outflow = 0.54 cfs @ 15.15 hrs, Volume= 0.672 af, Atten= 93%, Lag= 178.5 min
Discarded = 0.54 cfs @ 15.15 hrs, Volume= 0.672 af

Routing by Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Peak Elev= 324.97'@ 15.15 hrs Surf.Area= 4,629 sf Storage= 15,448 cf

Plug-Flow detention time=392.5 min calculated for 0.671 af (100% of inflow)
Center-of-Mass det. time=392.9 min (1,252.2 - 859.3)

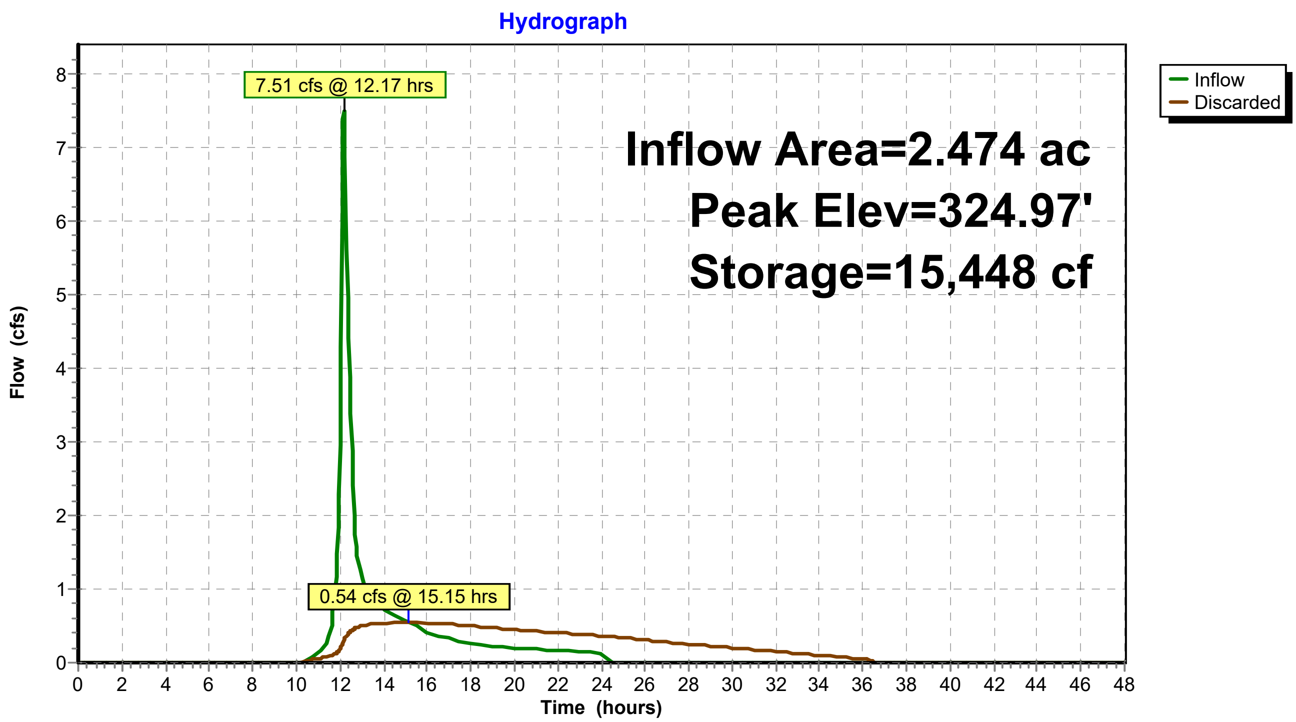
Volume	Invert	Avail.Storage	Storage Description
#1	318.00'	36,627 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
318.00	302	0	0
320.00	1,359	1,661	1,661
322.00	2,385	3,744	5,405
324.00	3,647	6,032	11,437
326.00	5,674	9,321	20,758
328.00	10,195	15,869	36,627

Device	Routing	Invert	Outlet Devices
#1	Discarded	318.00'	**5.000 in/hr Exfiltration over Surface area** Conductivity to Groundwater Elevation = 0.00'

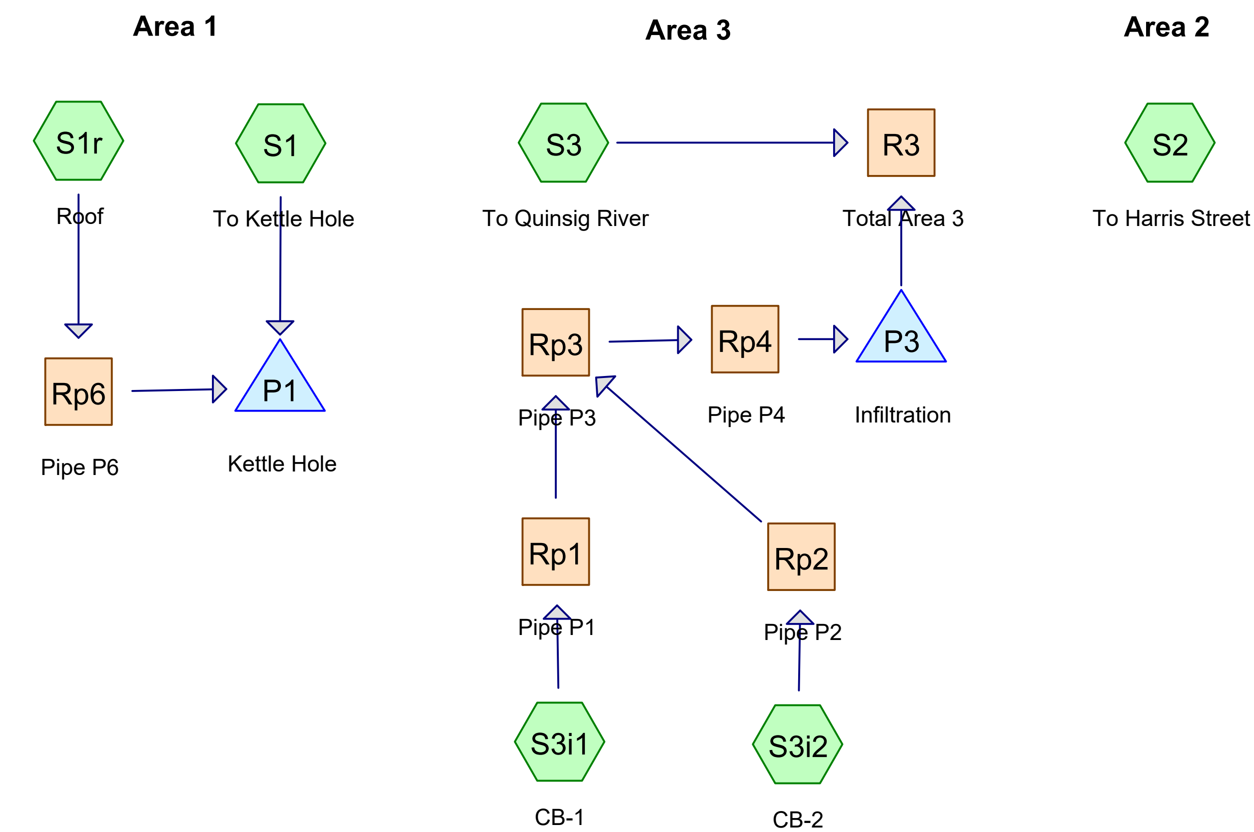
Discarded OutFlow Max=0.54 cfs @ 15.15 hrs HW=324.97' (Free Discharge)
└─**1=Exfiltration** (Controls 0.54 cfs)

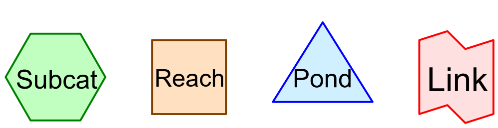
Pond P1: Kettle Hole



Post-development Analysis

Post Development





Routing Diagram for post development rev5
Prepared by Land Planning Inc., Printed 5/16/2016
HydroCAD® 10.00-15 s/n 01661 © 2015 HydroCAD Software Solutions LLC

Time span=0.00-48.00 hrs, dt=0.01 hrs, 4801 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind method - Pond routing by Stor-Ind method

Subcatchment S1: To Kettle Hole Runoff Area=99,577 sf 29.97% Impervious Runoff Depth=0.30"
Flow Length=622' Tc=11.6 min CN=56.1 Runoff=0.29 cfs 0.056 af

Subcatchment S1r: Roof Runoff Area=8,748 sf 100.00% Impervious Runoff Depth=3.01"
Flow Length=146' Tc=0.5 min CN=98.0 Runoff=0.76 cfs 0.050 af

Subcatchment S2: To Harris Street Runoff Area=2,110 sf 7.25% Impervious Runoff Depth=0.03"
Flow Length=106' Tc=2.2 min CN=43.3 Runoff=0.00 cfs 0.000 af

Subcatchment S3: To Quinsig River Runoff Area=82,086 sf 0.00% Impervious Runoff Depth=0.00"
Flow Length=222' Tc=6.6 min CN=30.8 Runoff=0.00 cfs 0.000 af

Subcatchment S3i1: CB-1 Runoff Area=11,739 sf 93.82% Impervious Runoff Depth=2.62"
Flow Length=155' Tc=2.2 min CN=94.4 Runoff=0.91 cfs 0.059 af

Subcatchment S3i2: CB-2 Runoff Area=12,861 sf 73.05% Impervious Runoff Depth=1.58"
Flow Length=114' Tc=4.2 min CN=82.1 Runoff=0.58 cfs 0.039 af

Reach R3: Total Area 3 Inflow=0.00 cfs 0.000 af
Outflow=0.00 cfs 0.000 af

Reach Rp1: Pipe P1 Avg. Flow Depth=0.33' Max Vel=4.00 fps Inflow=0.91 cfs 0.059 af
12.0" Round Pipe n=0.012 L=99.2' S=0.0100 '/' Capacity=3.86 cfs Outflow=0.90 cfs 0.059 af

Reach Rp2: Pipe P2 Avg. Flow Depth=0.26' Max Vel=3.56 fps Inflow=0.58 cfs 0.039 af
12.0" Round Pipe n=0.012 L=18.6' S=0.0102 '/' Capacity=3.90 cfs Outflow=0.58 cfs 0.039 af

Reach Rp3: Pipe P3 Avg. Flow Depth=0.25' Max Vel=9.28 fps Inflow=1.45 cfs 0.098 af
12.0" Round Pipe n=0.012 L=3.9' S=0.0718 '/' Capacity=10.34 cfs Outflow=1.45 cfs 0.098 af

Reach Rp4: Pipe P4 Avg. Flow Depth=0.30' Max Vel=7.43 fps Inflow=1.45 cfs 0.098 af
12.0" Round Pipe n=0.012 L=2.6' S=0.0385 '/' Capacity=7.57 cfs Outflow=1.45 cfs 0.098 af

Reach Rp6: Pipe P6 Avg. Flow Depth=0.22' Max Vel=5.89 fps Inflow=0.76 cfs 0.050 af
12.0" Round Pipe n=0.012 L=79.2' S=0.0337 '/' Capacity=7.09 cfs Outflow=0.76 cfs 0.050 af

Pond P1: Kettle Hole Peak Elev=320.98' Storage=1,040 cf Inflow=0.76 cfs 0.107 af
Outflow=0.16 cfs 0.107 af

Pond P3: Infiltration Peak Elev=320.06' Storage=613 cf Inflow=1.45 cfs 0.098 af
Discarded=0.47 cfs 0.098 af Primary=0.00 cfs 0.000 af Outflow=0.47 cfs 0.098 af

Total Runoff Area = 4.984 ac Runoff Volume = 0.204 af Average Runoff Depth = 0.49"
72.76% Pervious = 3.627 ac 27.24% Impervious = 1.358 ac

Summary for Subcatchment S1: To Kettle Hole

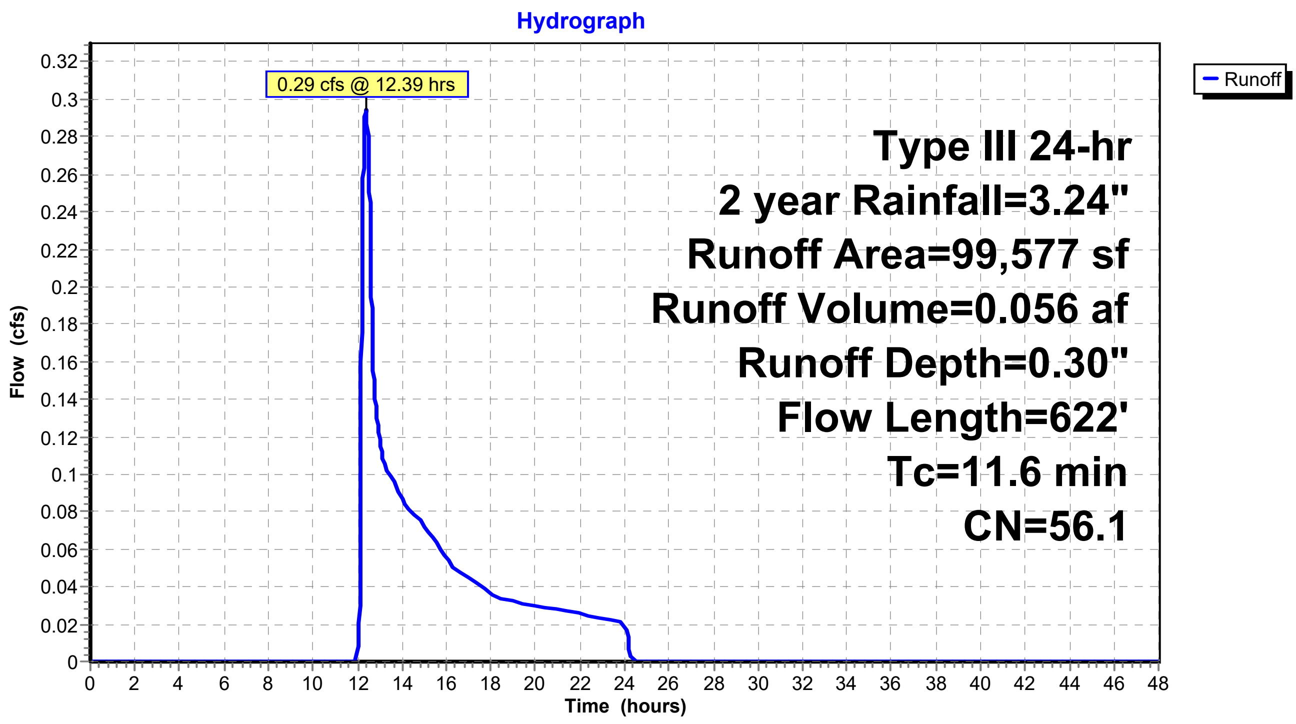
Runoff = 0.29 cfs @ 12.39 hrs, Volume= 0.056 af, Depth= 0.30"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Type III 24-hr 2 year Rainfall=3.24"

Area (sf)	CN	Description
29,840	98.0	Paved parking, HSG A
62,961	39.0	>75% Grass cover, Good, HSG A
6,776	30.0	Woods, Good, HSG A
99,577	56.1	Weighted Average
69,737		70.03% Pervious Area
29,840		29.97% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.4	50	0.0100	0.11		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.24"
1.3	80	0.0200	0.99		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
2.9	492	0.0200	2.87		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
11.6	622	Total			

Subcatchment S1: To Kettle Hole



Summary for Subcatchment S1r: Roof

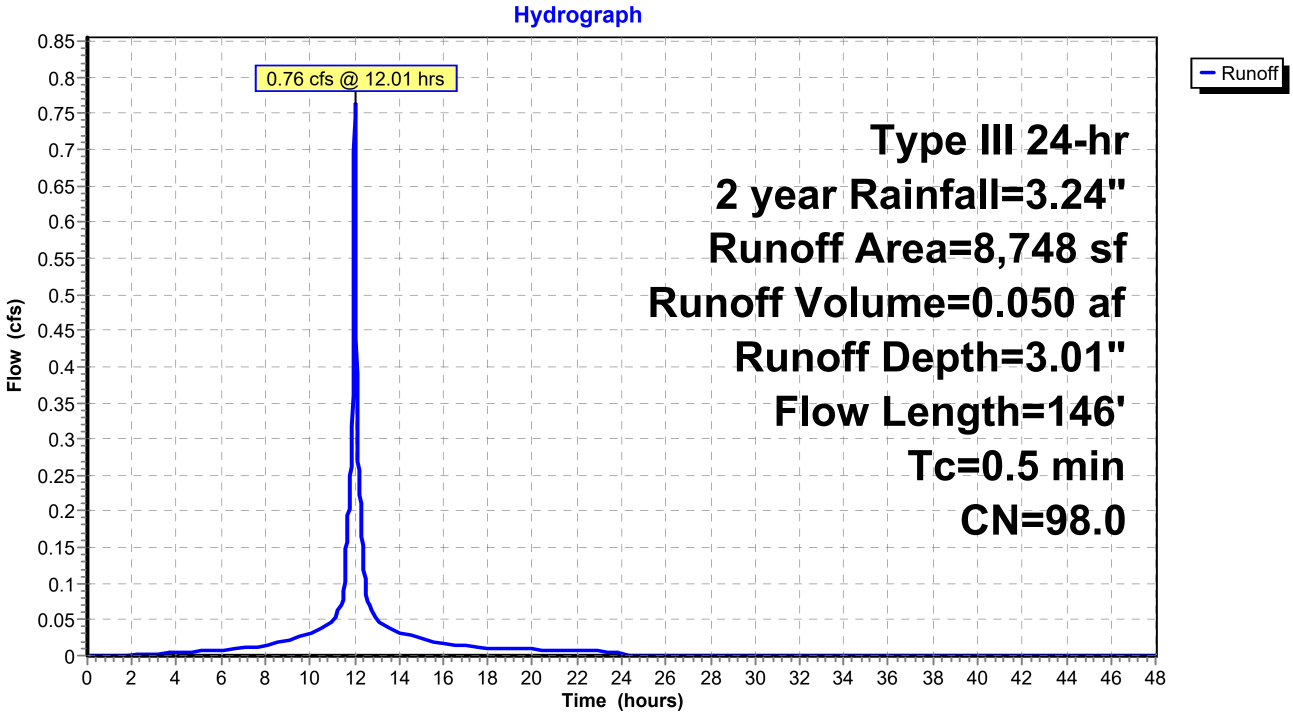
Runoff = 0.76 cfs @ 12.01 hrs, Volume= 0.050 af, Depth= 3.01"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Type III 24-hr 2 year Rainfall=3.24"

Area (sf)	CN	Description
8,748	98.0	Roofs, HSG A
8,748		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.1	22	0.7500	4.36		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 3.24"
0.4	124	0.0100	4.91	3.86	**Pipe Channel, DMH-4 to FE-1** 12.0" Round Area= 0.8 sf Perim= 3.1' r= 0.25' n= 0.012
0.5	146	Total			

Subcatchment S1r: Roof



Summary for Subcatchment S2: To Harris Street

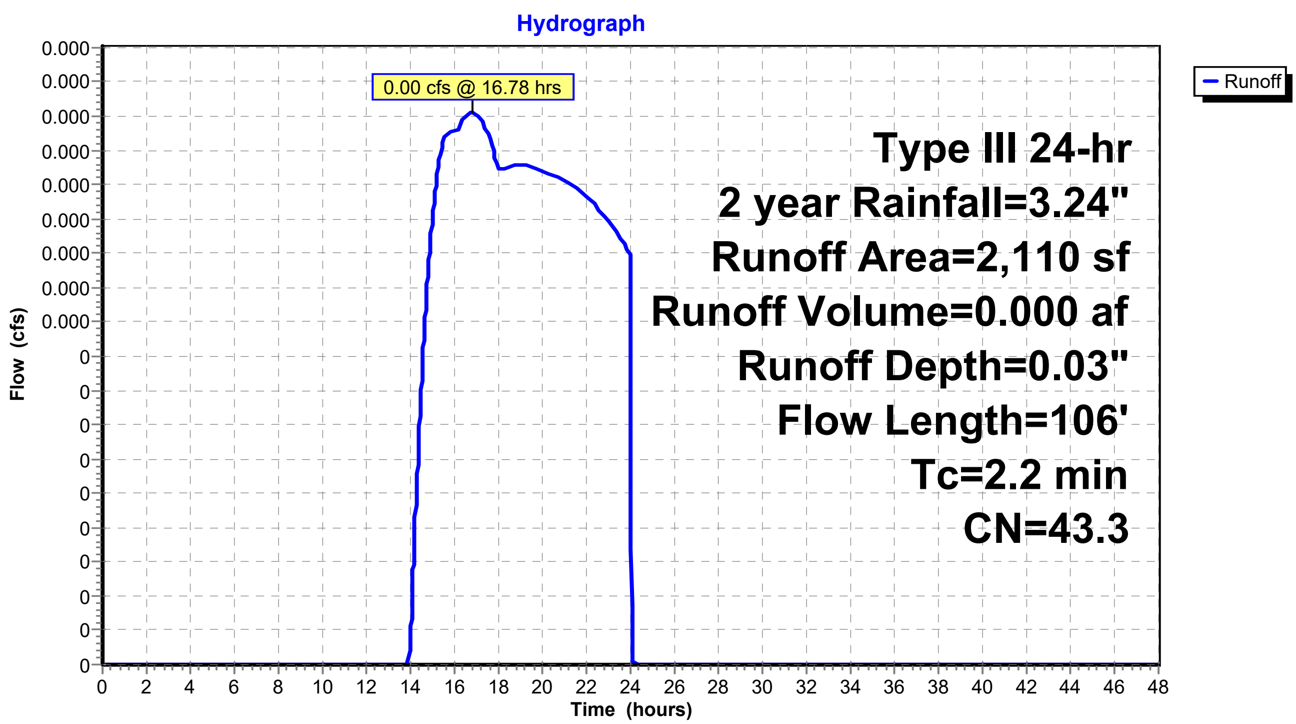
Runoff = 0.00 cfs @ 16.78 hrs, Volume= 0.000 af, Depth= 0.03"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Type III 24-hr 2 year Rainfall=3.24"

Area (sf)	CN	Description
1,957	39.0	>75% Grass cover, Good, HSG A
153	98.0	Paved parking, HSG A
2,110	43.3	Weighted Average
1,957		92.75% Pervious Area
153		7.25% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.5	21	0.1000	0.24		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.24"
0.1	21	0.0400	4.06		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
0.6	64	0.0600	1.71		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
2.2	106	Total			

Subcatchment S2: To Harris Street



Summary for Subcatchment S3: To Quinsig River

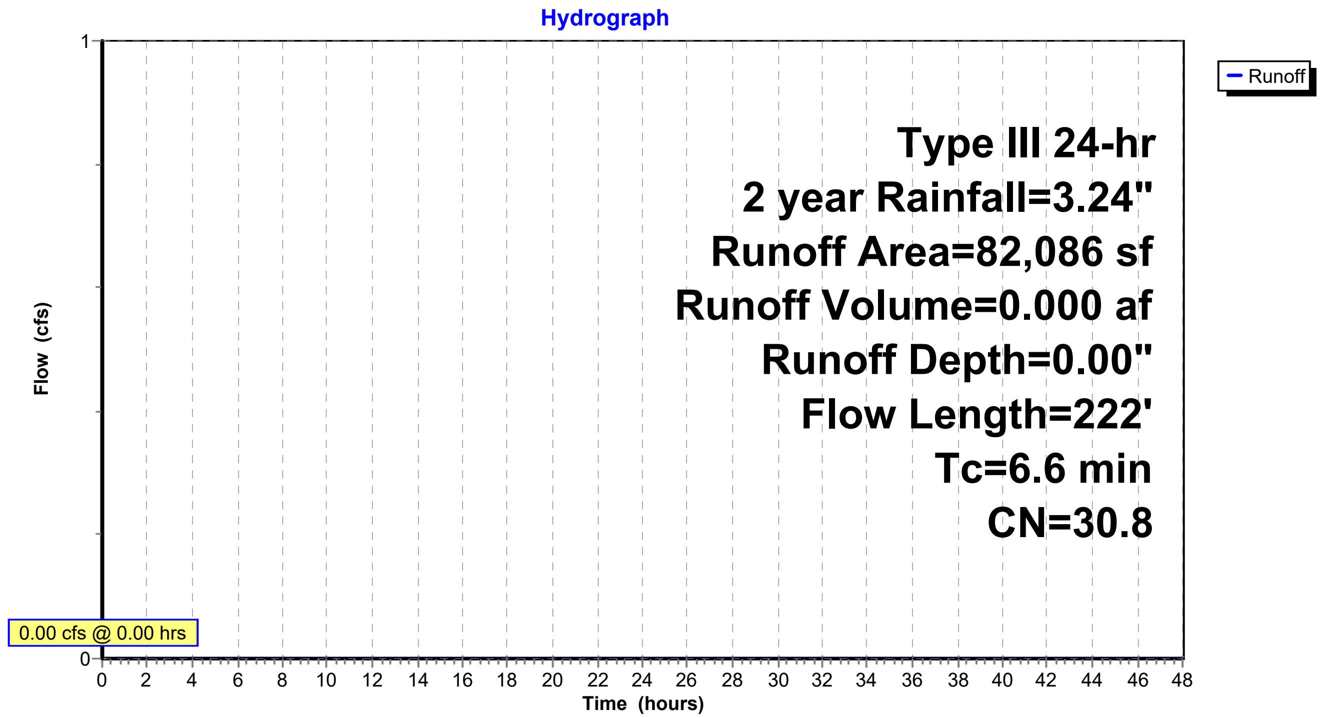
Runoff = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af, Depth= 0.00"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Type III 24-hr 2 year Rainfall=3.24"

Area (sf)	CN	Description
7,047	39.0	>75% Grass cover, Good, HSG A
75,039	30.0	Woods, Good, HSG A
82,086	30.8	Weighted Average
82,086		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0	44	0.0200	0.15		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.24"
1.6	178	0.1400	1.87		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
6.6	222	Total			

Subcatchment S3: To Quinsig River



Summary for Subcatchment S3i1: CB-1

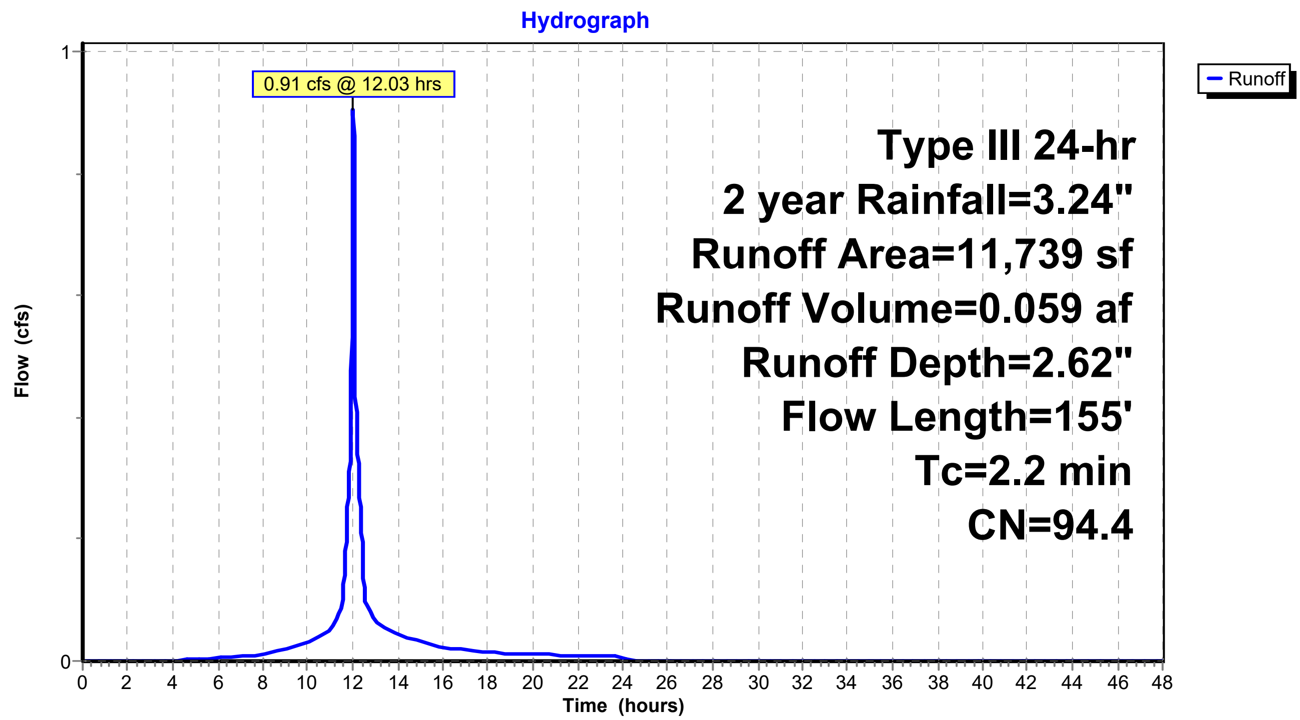
Runoff = 0.91 cfs @ 12.03 hrs, Volume= 0.059 af, Depth= 2.62"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Type III 24-hr 2 year Rainfall=3.24"

Area (sf)	CN	Description
11,014	98.0	Paved parking, HSG A
725	39.0	>75% Grass cover, Good, HSG A
11,739	94.4	Weighted Average
725		6.18% Pervious Area
11,014		93.82% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.0	13	0.1000	0.22		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.24"
1.2	142	0.0100	2.03		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
2.2	155	Total			

Subcatchment S3i1: CB-1



Summary for Subcatchment S3i2: CB-2

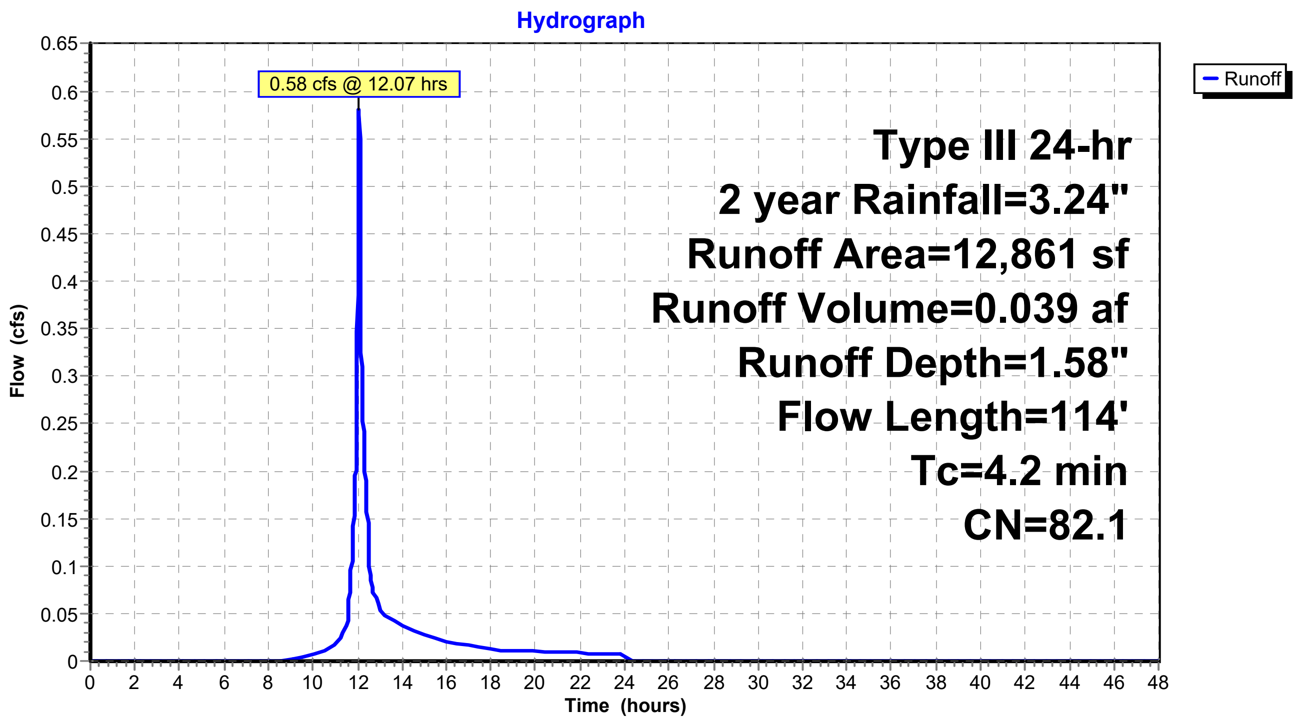
Runoff = 0.58 cfs @ 12.07 hrs, Volume= 0.039 af, Depth= 1.58"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Type III 24-hr 2 year Rainfall=3.24"

Area (sf)	CN	Description
9,395	98.0	Paved parking, HSG A
3,466	39.0	>75% Grass cover, Good, HSG A
12,861	82.1	Weighted Average
3,466		26.95% Pervious Area
9,395		73.05% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.8	38	0.0300	0.17		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.24"
0.4	76	0.0260	3.27		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
4.2	114	Total			

Subcatchment S3i2: CB-2

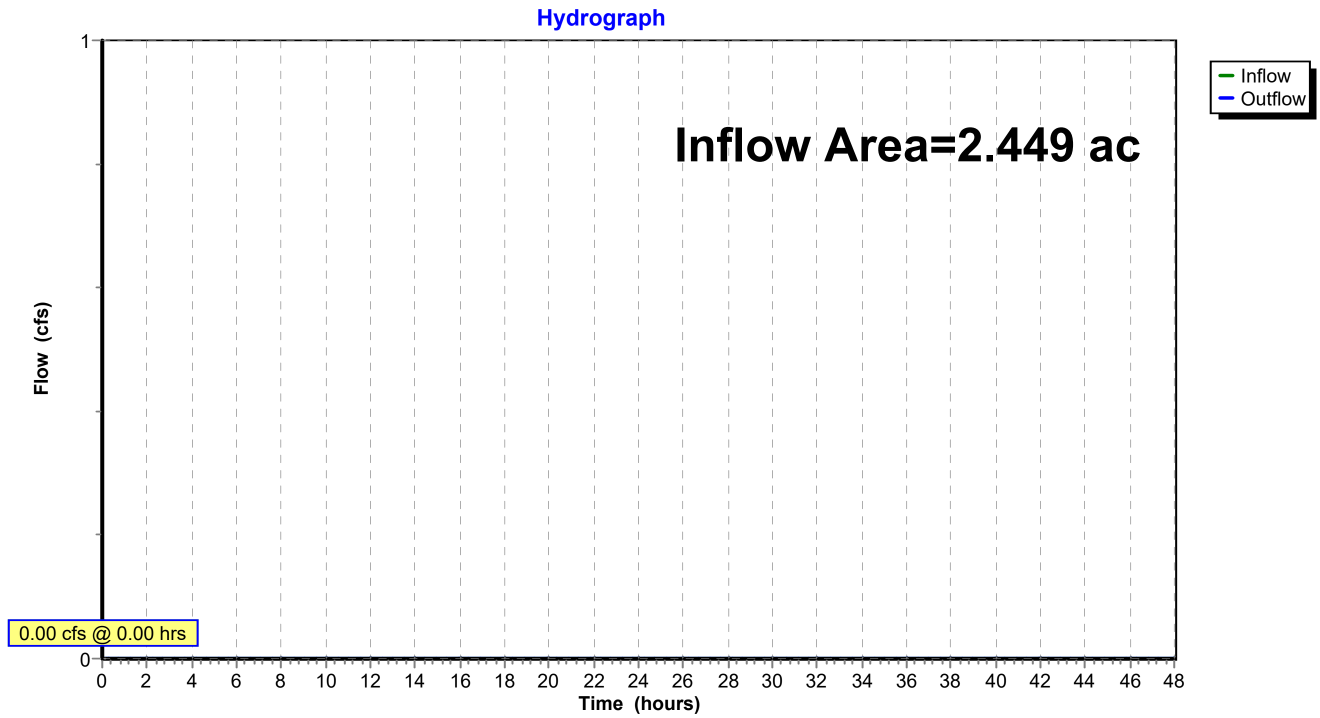


Summary for Reach R3: Total Area 3

Inflow Area = 2.449 ac, 19.13% Impervious, Inflow Depth = 0.00" for 2 year event
Inflow = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af
Outflow = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs

Reach R3: Total Area 3



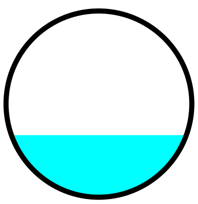
Summary for Reach Rp1: Pipe P1

Inflow Area = 0.269 ac, 93.82% Impervious, Inflow Depth = 2.62" for 2 year event
Inflow = 0.91 cfs @ 12.03 hrs, Volume= 0.059 af
Outflow = 0.90 cfs @ 12.04 hrs, Volume= 0.059 af, Atten= 1%, Lag= 0.3 min

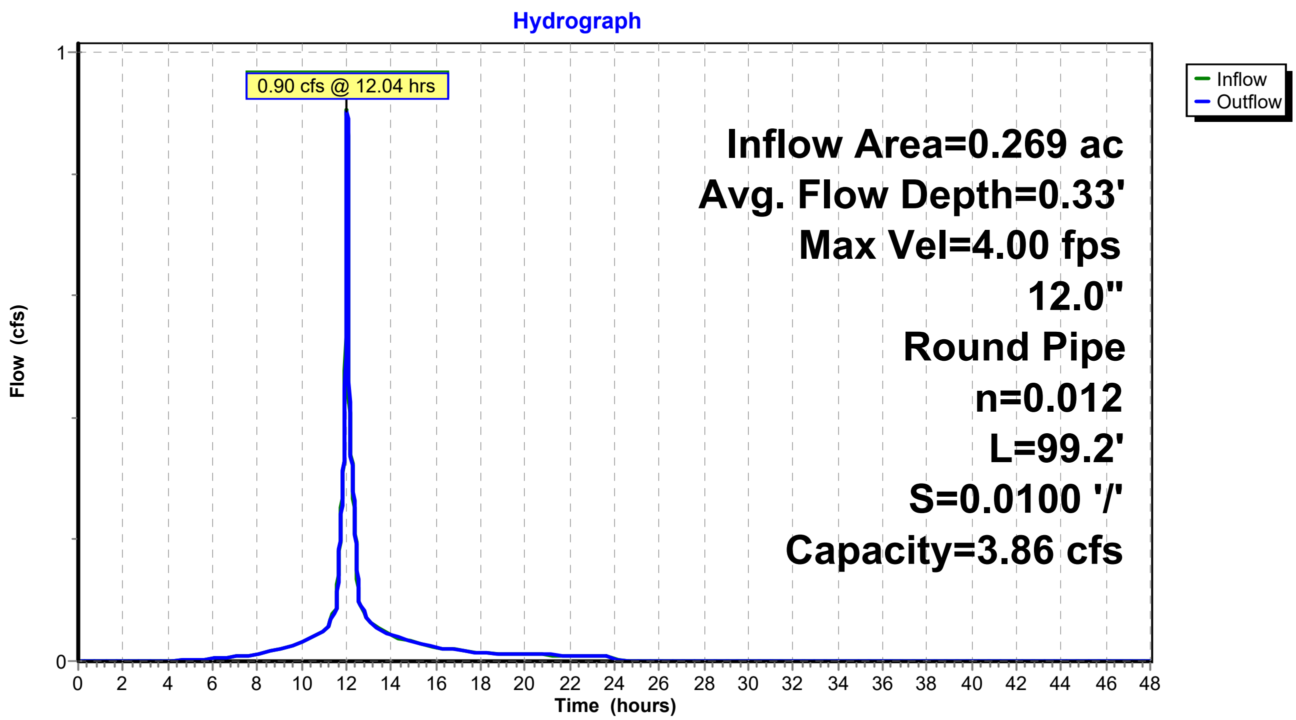
Routing by Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Max. Velocity= 4.00 fps, Min. Travel Time= 0.4 min
Avg. Velocity = 1.26 fps, Avg. Travel Time= 1.3 min

Peak Storage= 22 cf @ 12.04 hrs
Average Depth at Peak Storage= 0.33'
Bank-Full Depth= 1.00' Flow Area= 0.8 sf, Capacity= 3.86 cfs

12.0" Round Pipe
n= 0.012
Length= 99.2' Slope= 0.0100 '/'
Inlet Invert= 323.25', Outlet Invert= 322.26'



Reach Rp1: Pipe P1



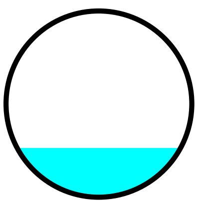
Summary for Reach Rp2: Pipe P2

Inflow Area = 0.295 ac, 73.05% Impervious, Inflow Depth = 1.58" for 2 year event
Inflow = 0.58 cfs @ 12.07 hrs, Volume= 0.039 af
Outflow = 0.58 cfs @ 12.07 hrs, Volume= 0.039 af, Atten= 0%, Lag= 0.1 min

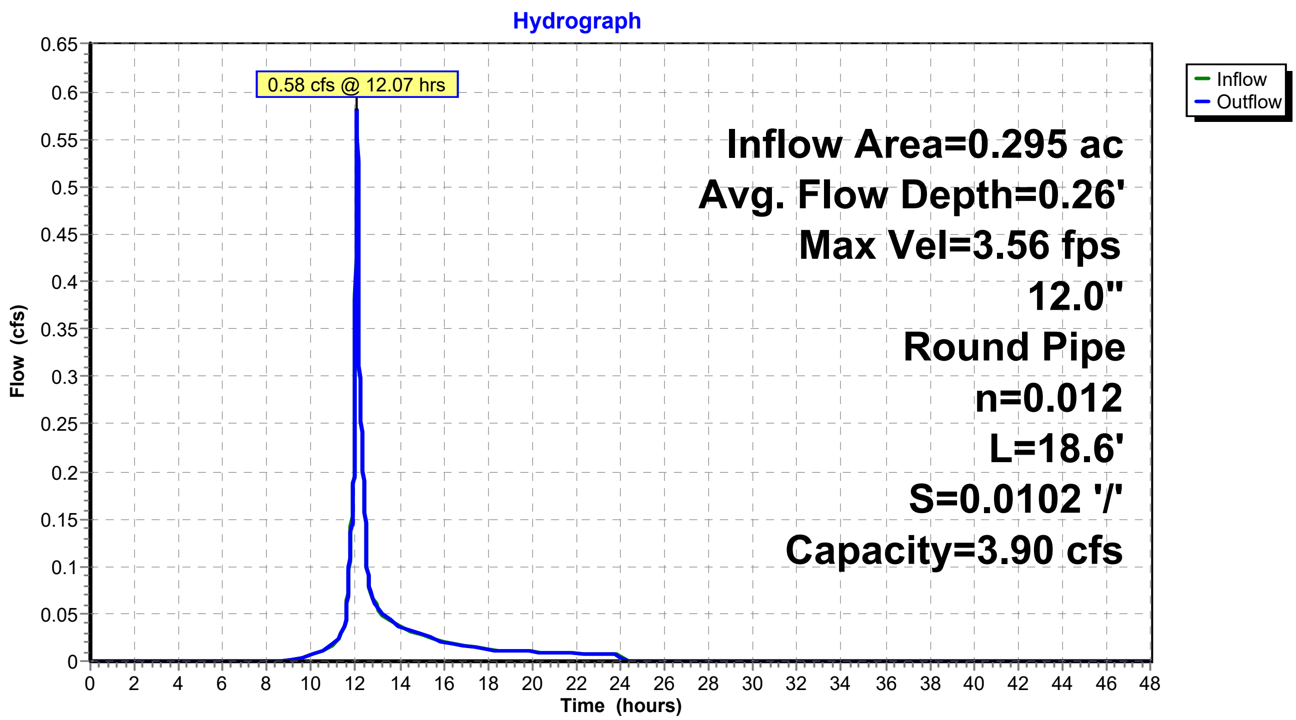
Routing by Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Max. Velocity= 3.56 fps, Min. Travel Time= 0.1 min
Avg. Velocity = 1.26 fps, Avg. Travel Time= 0.2 min

Peak Storage= 3 cf @ 12.07 hrs
Average Depth at Peak Storage= 0.26'
Bank-Full Depth= 1.00' Flow Area= 0.8 sf, Capacity= 3.90 cfs

12.0" Round Pipe
n= 0.012
Length= 18.6' Slope= 0.0102 '/'
Inlet Invert= 321.15', Outlet Invert= 320.96'



Reach Rp2: Pipe P2



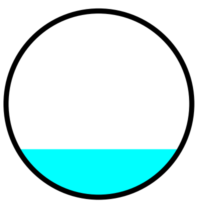
Summary for Reach Rp3: Pipe P3

Inflow Area = 0.565 ac, 82.96% Impervious, Inflow Depth = 2.08" for 2 year event
Inflow = 1.45 cfs @ 12.05 hrs, Volume= 0.098 af
Outflow = 1.45 cfs @ 12.05 hrs, Volume= 0.098 af, Atten= 0%, Lag= 0.0 min

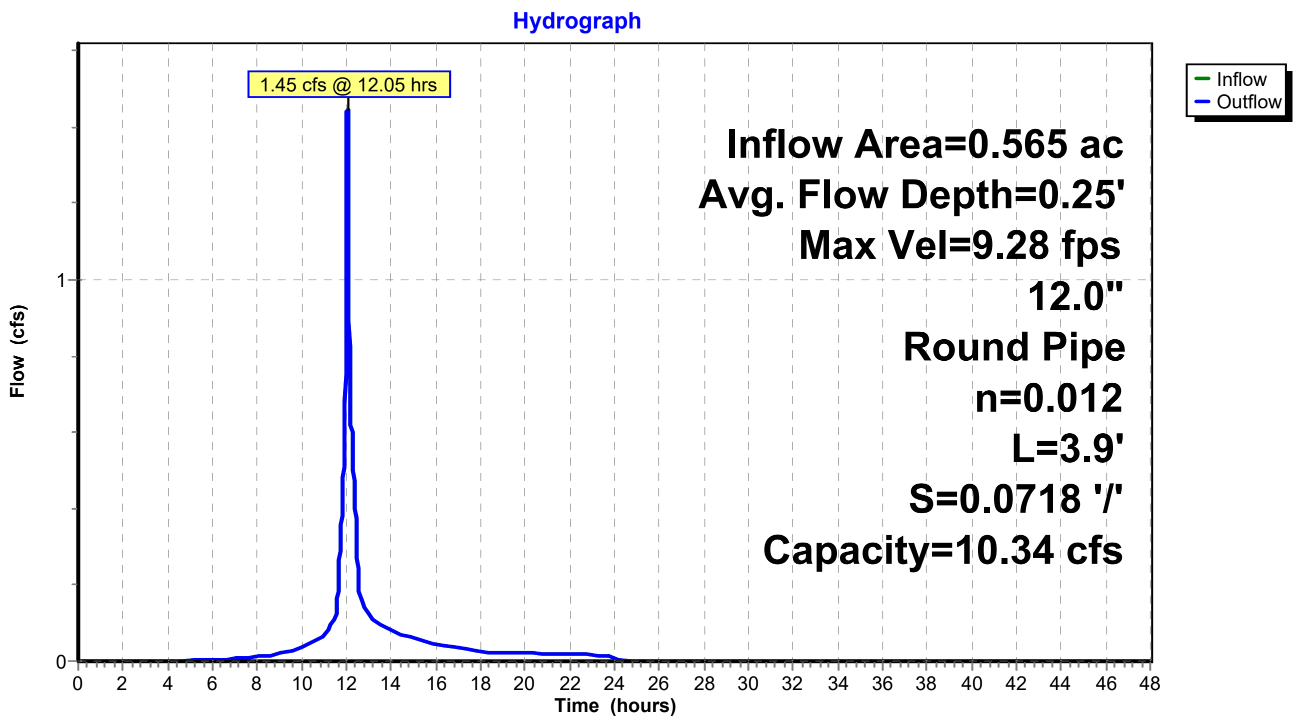
Routing by Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Max. Velocity= 9.28 fps, Min. Travel Time= 0.0 min
Avg. Velocity = 2.91 fps, Avg. Travel Time= 0.0 min

Peak Storage= 1 cf @ 12.05 hrs
Average Depth at Peak Storage= 0.25'
Bank-Full Depth= 1.00' Flow Area= 0.8 sf, Capacity= 10.34 cfs

12.0" Round Pipe
n= 0.012
Length= 3.9' Slope= 0.0718 '/'
Inlet Invert= 320.46', Outlet Invert= 320.18'



Reach Rp3: Pipe P3



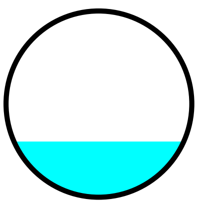
Summary for Reach Rp4: Pipe P4

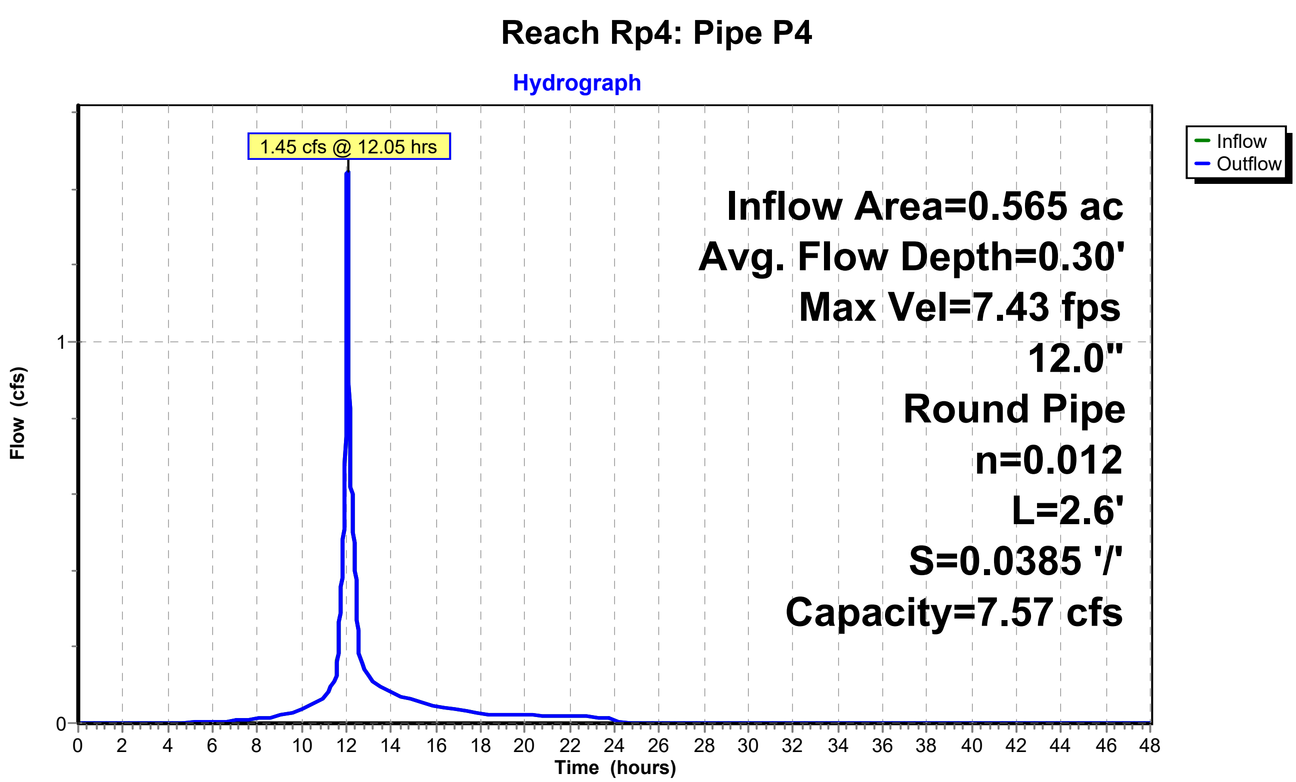
Inflow Area = 0.565 ac, 82.96% Impervious, Inflow Depth = 2.08" for 2 year event
Inflow = 1.45 cfs @ 12.05 hrs, Volume= 0.098 af
Outflow = 1.45 cfs @ 12.05 hrs, Volume= 0.098 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Max. Velocity= 7.43 fps, Min. Travel Time= 0.0 min
Avg. Velocity = 2.33 fps, Avg. Travel Time= 0.0 min

Peak Storage= 1 cf @ 12.05 hrs
Average Depth at Peak Storage= 0.30'
Bank-Full Depth= 1.00' Flow Area= 0.8 sf, Capacity= 7.57 cfs

12.0" Round Pipe
n= 0.012
Length= 2.6' Slope= 0.0385 '/'
Inlet Invert= 320.10', Outlet Invert= 320.00'





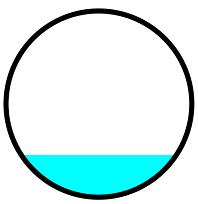
Summary for Reach Rp6: Pipe P6

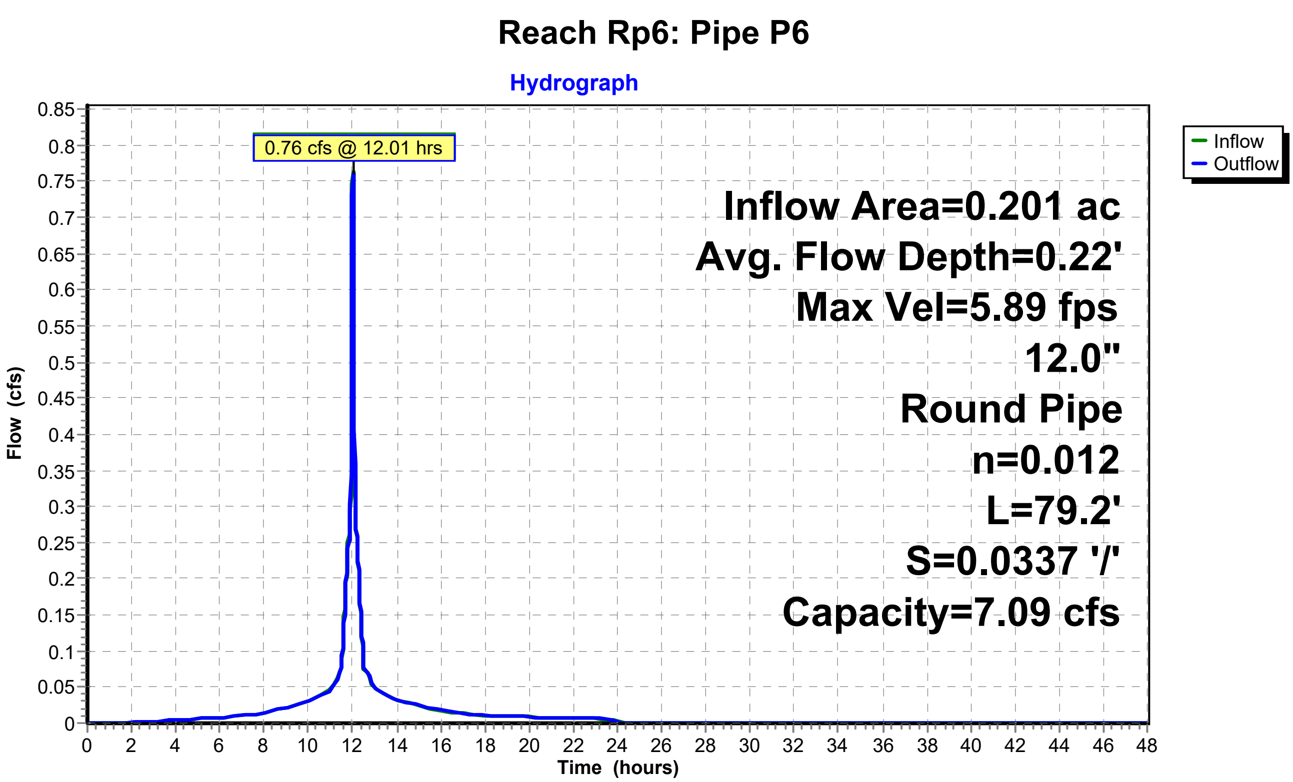
Inflow Area = 0.201 ac,100.00% Impervious, Inflow Depth = 3.01" for 2 year event
Inflow = 0.76 cfs @ 12.01 hrs, Volume= 0.050 af
Outflow = 0.76 cfs @ 12.01 hrs, Volume= 0.050 af, Atten= 0%, Lag= 0.1 min

Routing by Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Max. Velocity= 5.89 fps, Min. Travel Time= 0.2 min
Avg. Velocity = 1.82 fps, Avg. Travel Time= 0.7 min

Peak Storage= 10 cf @ 12.01 hrs
Average Depth at Peak Storage= 0.22'
Bank-Full Depth= 1.00' Flow Area= 0.8 sf, Capacity= 7.09 cfs

12.0" Round Pipe
n= 0.012
Length= 79.2' Slope= 0.0337 '/'
Inlet Invert= 323.17', Outlet Invert= 320.50'





Summary for Pond P1: Kettle Hole

Inflow Area = 2.487 ac, 35.62% Impervious, Inflow Depth = 0.51" for 2 year event
Inflow = 0.76 cfs @ 12.01 hrs, Volume= 0.107 af
Outflow = 0.16 cfs @ 13.07 hrs, Volume= 0.107 af, Atten= 79%, Lag= 63.3 min
Discarded = 0.16 cfs @ 13.07 hrs, Volume= 0.107 af

Routing by Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Peak Elev= 320.98'@ 13.07 hrs Surf.Area= 1,387 sf Storage= 1,040 cf

Plug-Flow detention time=59.0 min calculated for 0.107 af (100% of inflow)
Center-of-Mass det. time=59.0 min (914.9 - 855.9)

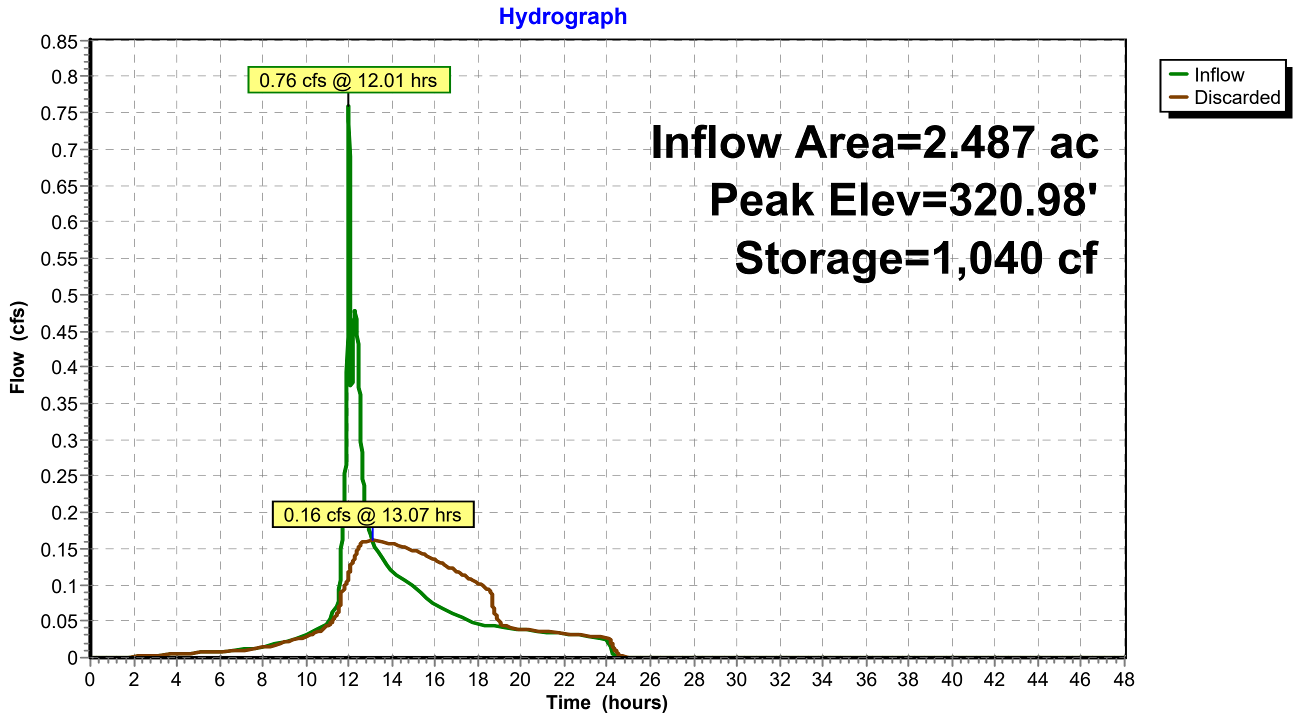
Volume	Invert	Avail.Storage	Storage Description
#1	320.00'	30,825 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
320.00	737	0	0
322.00	2,066	2,803	2,803
324.00	3,622	5,688	8,491
326.00	5,403	9,025	17,516
328.00	7,906	13,309	30,825

Device	Routing	Invert	Outlet Devices
#1	Discarded	320.00'	**5.000 in/hr Exfiltration over Surface area** Conductivity to Groundwater Elevation = 0.00'

Discarded OutFlow Max=0.16 cfs @ 13.07 hrs HW=320.98' (Free Discharge)
↑—**1=Exfiltration** (Controls 0.16 cfs)

Pond P1: Kettle Hole



Summary for Pond P3: Infiltration

Inflow Area = 0.565 ac, 82.96% Impervious, Inflow Depth = 2.08" for 2 year event
Inflow = 1.45 cfs @ 12.05 hrs, Volume= 0.098 af
Outflow = 0.47 cfs @ 12.33 hrs, Volume= 0.098 af, Atten= 68%, Lag= 17.2 min
Discarded = 0.47 cfs @ 12.33 hrs, Volume= 0.098 af
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Peak Elev= 320.06'@ 12.33 hrs Surf.Area= 2,426 sf Storage= 613 cf

Plug-Flow detention time=6.5 min calculated for 0.098 af (100% of inflow)
Center-of-Mass det. time=6.5 min (808.9 - 802.4)

Volume	Invert	Avail.Storage	Storage Description
#1A	319.50'	2,058 cf	**25.67'W x 94.50'L x 3.54'H Field A** 8,590 cf Overall - 3,446 cf Embedded = 5,144 cf x 40.0% Voids
#2A	320.00'	3,446 cf	**Cultec R-330XLHD** x 65 Inside #1 Effective Size= 47.8"W x 30.0"H => 7.45 sf x 7.00'L = 52.2 cf Overall Size= 52.0"W x 30.5"H x 8.50'L with 1.50' Overlap Row Length Adjustment= +1.50' x 7.45 sf x 5 rows
		5,504 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Discarded	319.50'	**8.270 in/hr Exfiltration over Surface area** Conductivity to Groundwater Elevation = 0.00'
#2	Primary	323.00'	**24.0" x 24.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads

Discarded OutFlow Max=0.47 cfs @ 12.33 hrs HW=320.06' (Free Discharge)
↑—**1=Exfiltration** (Controls 0.47 cfs)

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=319.50' (Free Discharge)
↑—**2=Orifice/Grate** (Controls 0.00 cfs)

Pond P3: Infiltration - Chamber Wizard Field A

ChamberModel = Cultec R-330XLHD (Cultec Recharger® 330XLHD)
Effective Size= 47.8"W x 30.0"H => 7.45 sf x 7.00'L = 52.2 cf
Overall Size= 52.0"W x 30.5"H x 8.50'L with 1.50' Overlap
Row Length Adjustment= +1.50' x 7.45 sf x 5 rows

52.0" Wide + 6.0" Spacing = 58.0" C-C Row Spacing

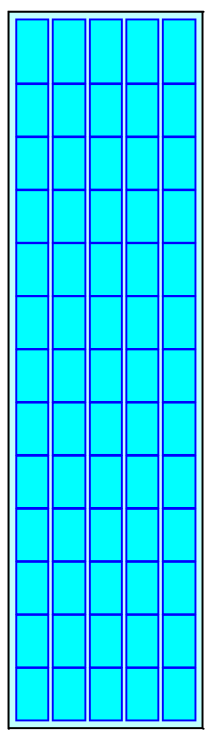
13 Chambers/Row x 7.00' Long +1.50' Row Adjustment = 92.50' Row Length +12.0" End Stone x 2 = 94.50' Base Length
5 Rows x 52.0" Wide + 6.0" Spacing x 4 + 12.0" Side Stone x 2 = 25.67' Base Width
6.0" Base + 30.5" Chamber Height + 6.0" Cover = 3.54' Field Height

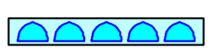
65 Chambers x 52.2 cf +1.50' Row Adjustment x 7.45 sf x 5 Rows = 3,446.1 cf Chamber Storage

8,590.3 cf Field - 3,446.1 cf Chambers = 5,144.2 cf Stone x 40.0% Voids = 2,057.7 cf Stone Storage

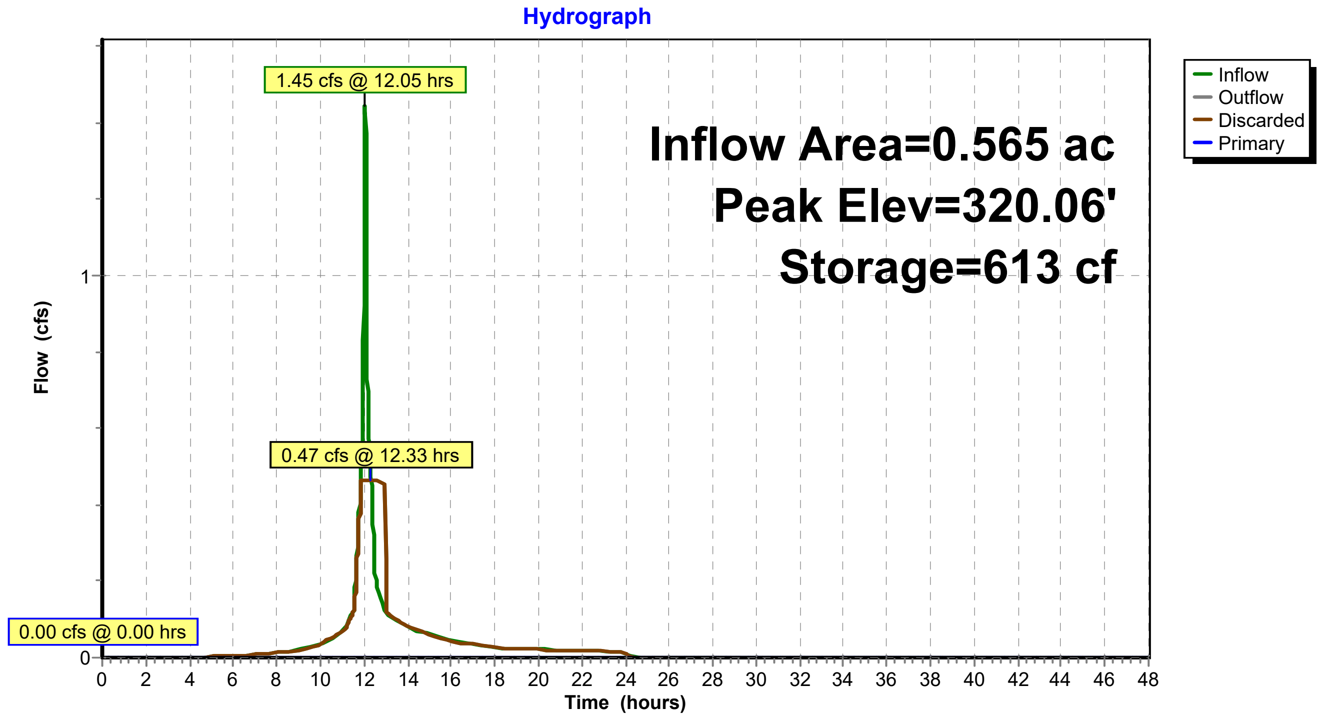
Chamber Storage + Stone Storage = 5,503.8 cf = 0.126 af
Overall Storage Efficiency = 64.1%

65 Chambers
318.2 cy Field
190.5 cy Stone





Pond P3: Infiltration



Time span=0.00-48.00 hrs, dt=0.01 hrs, 4801 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind method - Pond routing by Stor-Ind method

SubcatchmentS1: To Kettle Hole Runoff Area=99,577 sf 29.97% Impervious Runoff Depth=0.99"
Flow Length=622' Tc=11.6 min CN=56.1 Runoff=1.77 cfs 0.189 af

SubcatchmentS1r: Roof Runoff Area=8,748 sf 100.00% Impervious Runoff Depth=4.65"
Flow Length=146' Tc=0.5 min CN=98.0 Runoff=1.16 cfs 0.078 af

SubcatchmentS2: To Harris Street Runoff Area=2,110 sf 7.25% Impervious Runoff Depth=0.34"
Flow Length=106' Tc=2.2 min CN=43.3 Runoff=0.01 cfs 0.001 af

SubcatchmentS3: To Quinsig River Runoff Area=82,086 sf 0.00% Impervious Runoff Depth=0.01"
Flow Length=222' Tc=6.6 min CN=30.8 Runoff=0.00 cfs 0.001 af

SubcatchmentS3i1: CB-1 Runoff Area=11,739 sf 93.82% Impervious Runoff Depth=4.24"
Flow Length=155' Tc=2.2 min CN=94.4 Runoff=1.42 cfs 0.095 af

SubcatchmentS3i2: CB-2 Runoff Area=12,861 sf 73.05% Impervious Runoff Depth=2.99"
Flow Length=114' Tc=4.2 min CN=82.1 Runoff=1.10 cfs 0.074 af

Reach R3: Total Area 3 Inflow=0.00 cfs 0.001 af
Outflow=0.00 cfs 0.001 af

Reach Rp1: Pipe P1 Avg. Flow Depth=0.42' Max Vel=4.53 fps Inflow=1.42 cfs 0.095 af
12.0" Round Pipe n=0.012 L=99.2' S=0.0100 '/' Capacity=3.86 cfs Outflow=1.42 cfs 0.095 af

Reach Rp2: Pipe P2 Avg. Flow Depth=0.36' Max Vel=4.27 fps Inflow=1.10 cfs 0.074 af
12.0" Round Pipe n=0.012 L=18.6' S=0.0102 '/' Capacity=3.90 cfs Outflow=1.10 cfs 0.074 af

Reach Rp3: Pipe P3 Avg. Flow Depth=0.33' Max Vel=10.79 fps Inflow=2.46 cfs 0.169 af
12.0" Round Pipe n=0.012 L=3.9' S=0.0718 '/' Capacity=10.34 cfs Outflow=2.46 cfs 0.169 af

Reach Rp4: Pipe P4 Avg. Flow Depth=0.39' Max Vel=8.61 fps Inflow=2.46 cfs 0.169 af
12.0" Round Pipe n=0.012 L=2.6' S=0.0385 '/' Capacity=7.57 cfs Outflow=2.46 cfs 0.169 af

Reach Rp6: Pipe P6 Avg. Flow Depth=0.27' Max Vel=6.65 fps Inflow=1.16 cfs 0.078 af
12.0" Round Pipe n=0.012 L=79.2' S=0.0337 '/' Capacity=7.09 cfs Outflow=1.16 cfs 0.078 af

Pond P1: Kettle Hole Peak Elev=322.63' Storage=4,270 cf Inflow=2.17 cfs 0.267 af
Outflow=0.30 cfs 0.267 af

Pond P3: Infiltration Peak Elev=320.63' Storage=1,777 cf Inflow=2.46 cfs 0.169 af
Discarded=0.47 cfs 0.169 af Primary=0.00 cfs 0.000 af Outflow=0.47 cfs 0.169 af

Total Runoff Area = 4.984 ac Runoff Volume = 0.438 af Average Runoff Depth = 1.05"
72.76% Pervious = 3.627 ac 27.24% Impervious = 1.358 ac

Summary for Subcatchment S1: To Kettle Hole

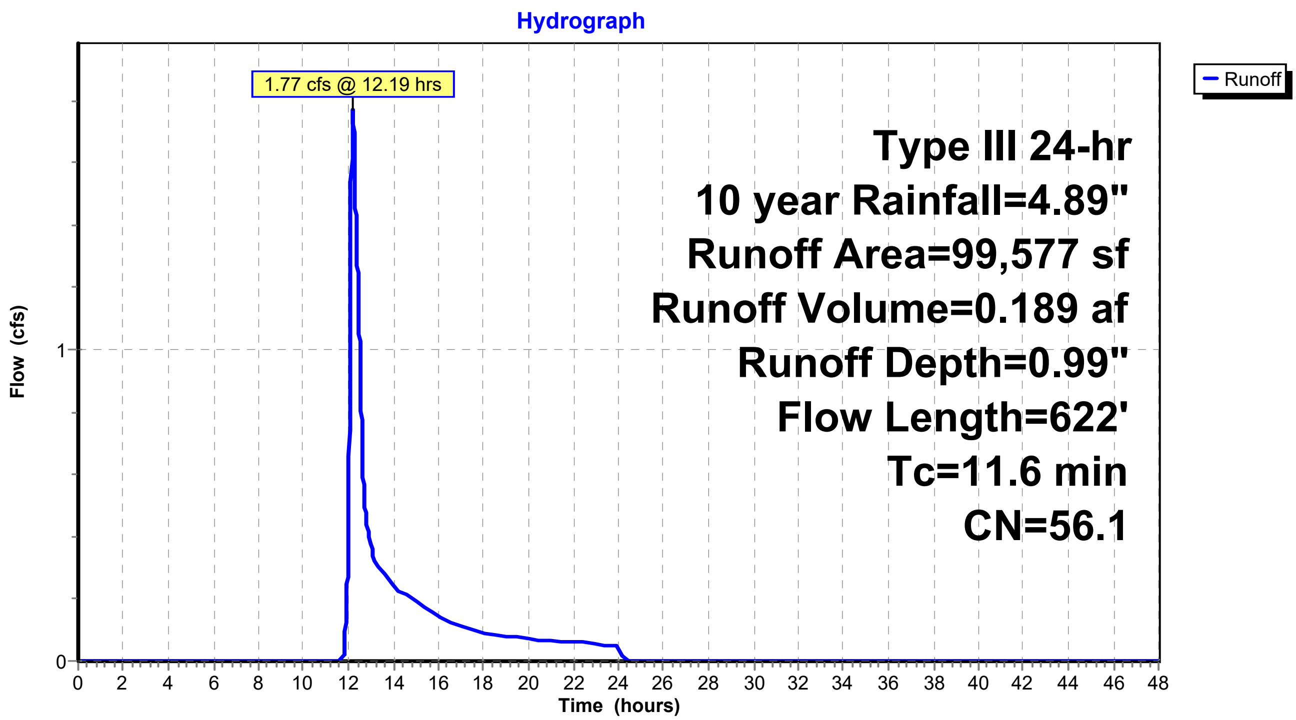
Runoff = 1.77 cfs @ 12.19 hrs, Volume= 0.189 af, Depth= 0.99"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Type III 24-hr 10 year Rainfall=4.89"

Area (sf)	CN	Description
29,840	98.0	Paved parking, HSG A
62,961	39.0	>75% Grass cover, Good, HSG A
6,776	30.0	Woods, Good, HSG A
99,577	56.1	Weighted Average
69,737		70.03% Pervious Area
29,840		29.97% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.4	50	0.0100	0.11		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.24"
1.3	80	0.0200	0.99		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
2.9	492	0.0200	2.87		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
11.6	622	Total			

Subcatchment S1: To Kettle Hole



Summary for Subcatchment S1r: Roof

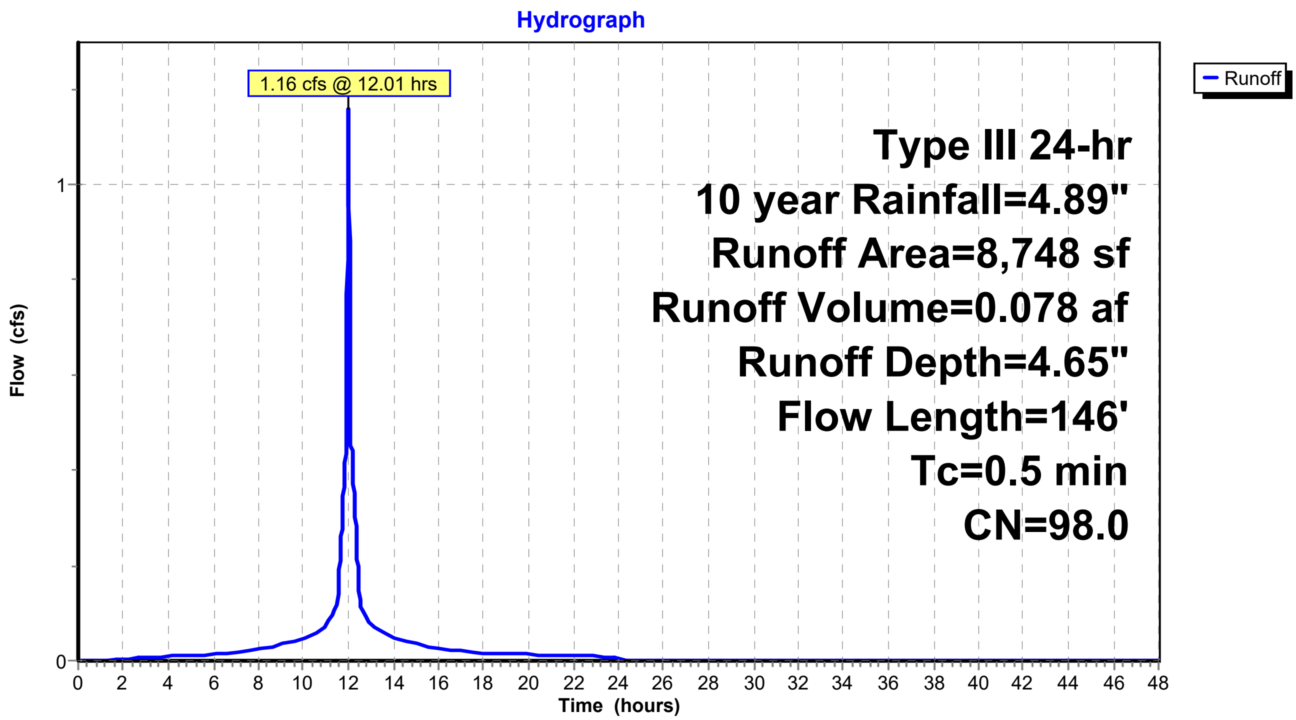
Runoff = 1.16 cfs @ 12.01 hrs, Volume= 0.078 af, Depth= 4.65"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Type III 24-hr 10 year Rainfall=4.89"

Area (sf)	CN	Description
8,748	98.0	Roofs, HSG A
8,748		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.1	22	0.7500	4.36		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 3.24"
0.4	124	0.0100	4.91	3.86	**Pipe Channel, DMH-4 to FE-1** 12.0" Round Area= 0.8 sf Perim= 3.1' r= 0.25' n= 0.012
0.5	146	Total			

Subcatchment S1r: Roof



Summary for Subcatchment S2: To Harris Street

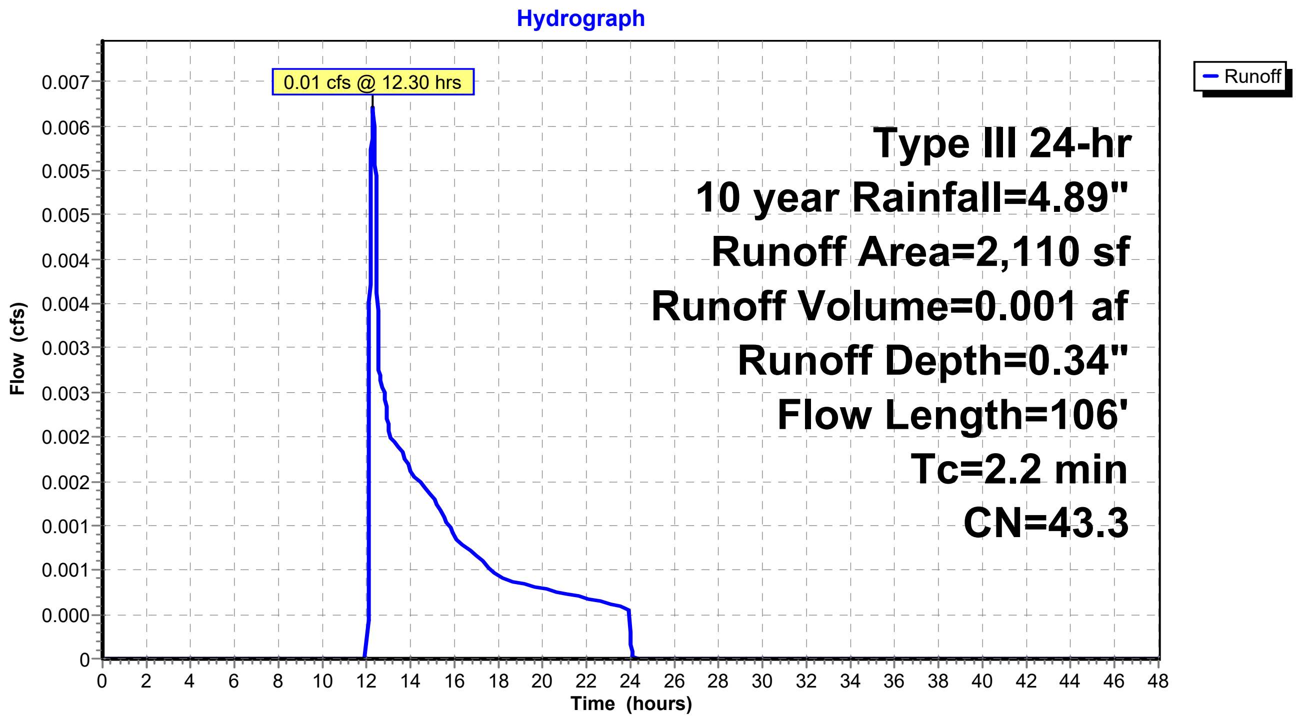
Runoff = 0.01 cfs @ 12.30 hrs, Volume= 0.001 af, Depth= 0.34"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Type III 24-hr 10 year Rainfall=4.89"

Area (sf)	CN	Description
1,957	39.0	>75% Grass cover, Good, HSG A
153	98.0	Paved parking, HSG A
2,110	43.3	Weighted Average
1,957		92.75% Pervious Area
153		7.25% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.5	21	0.1000	0.24		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.24"
0.1	21	0.0400	4.06		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
0.6	64	0.0600	1.71		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
2.2	106	Total			

Subcatchment S2: To Harris Street



Summary for Subcatchment S3: To Quinsig River

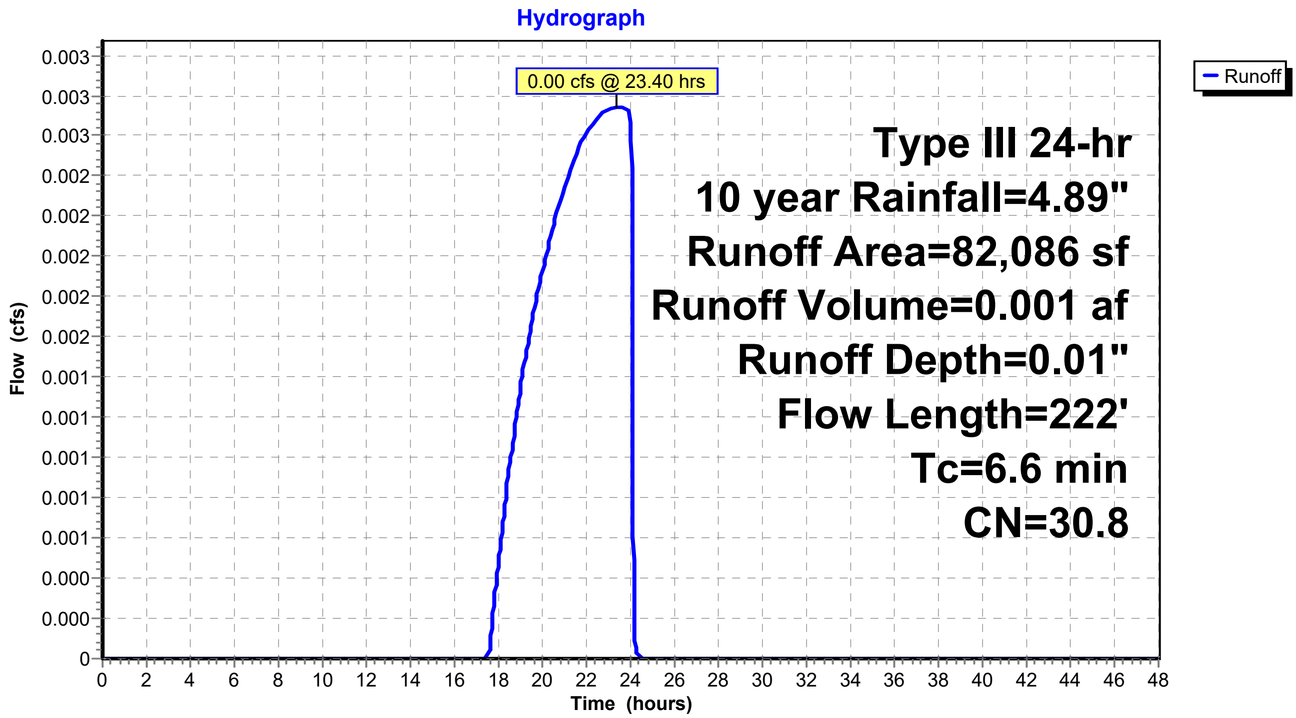
Runoff = 0.00 cfs @ 23.40 hrs, Volume= 0.001 af, Depth= 0.01"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Type III 24-hr 10 year Rainfall=4.89"

Area (sf)	CN	Description
7,047	39.0	>75% Grass cover, Good, HSG A
75,039	30.0	Woods, Good, HSG A
82,086	30.8	Weighted Average
82,086		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0	44	0.0200	0.15		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.24"
1.6	178	0.1400	1.87		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
6.6	222	Total			

Subcatchment S3: To Quinsig River



Summary for Subcatchment S3i1: CB-1

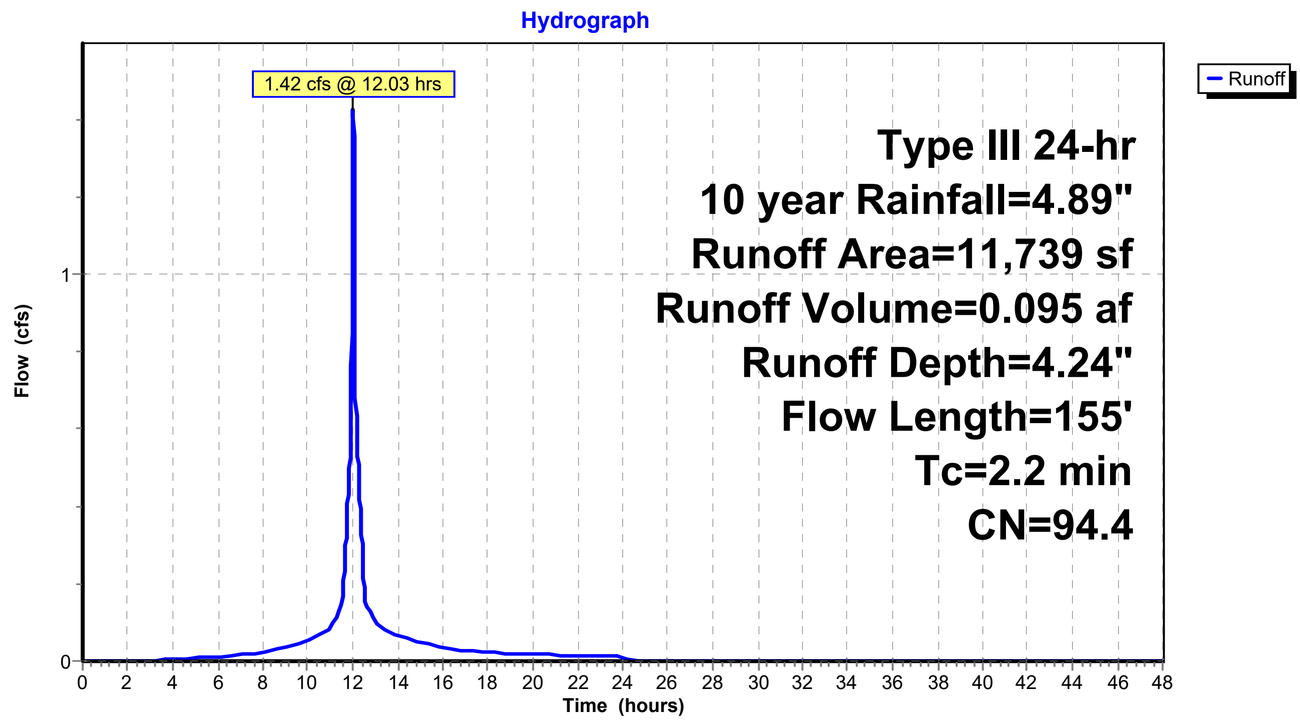
Runoff = 1.42 cfs @ 12.03 hrs, Volume= 0.095 af, Depth= 4.24"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Type III 24-hr 10 year Rainfall=4.89"

Area (sf)	CN	Description
11,014	98.0	Paved parking, HSG A
725	39.0	>75% Grass cover, Good, HSG A
11,739	94.4	Weighted Average
725		6.18% Pervious Area
11,014		93.82% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.0	13	0.1000	0.22		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.24"
1.2	142	0.0100	2.03		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
2.2	155	Total			

Subcatchment S3i1: CB-1



Summary for Subcatchment S3i2: CB-2

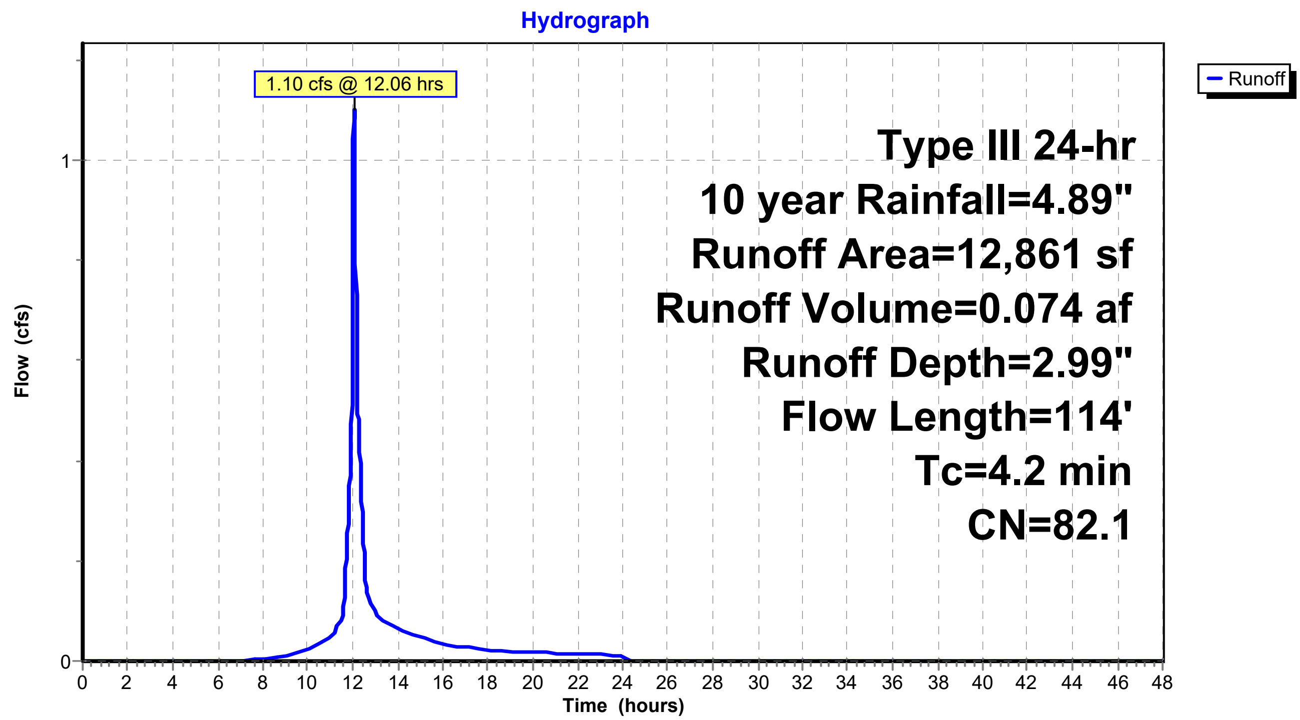
Runoff = 1.10 cfs @ 12.06 hrs, Volume= 0.074 af, Depth= 2.99"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Type III 24-hr 10 year Rainfall=4.89"

Area (sf)	CN	Description
9,395	98.0	Paved parking, HSG A
3,466	39.0	>75% Grass cover, Good, HSG A
12,861	82.1	Weighted Average
3,466		26.95% Pervious Area
9,395		73.05% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.8	38	0.0300	0.17		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.24"
0.4	76	0.0260	3.27		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
4.2	114	Total			

Subcatchment S3i2: CB-2

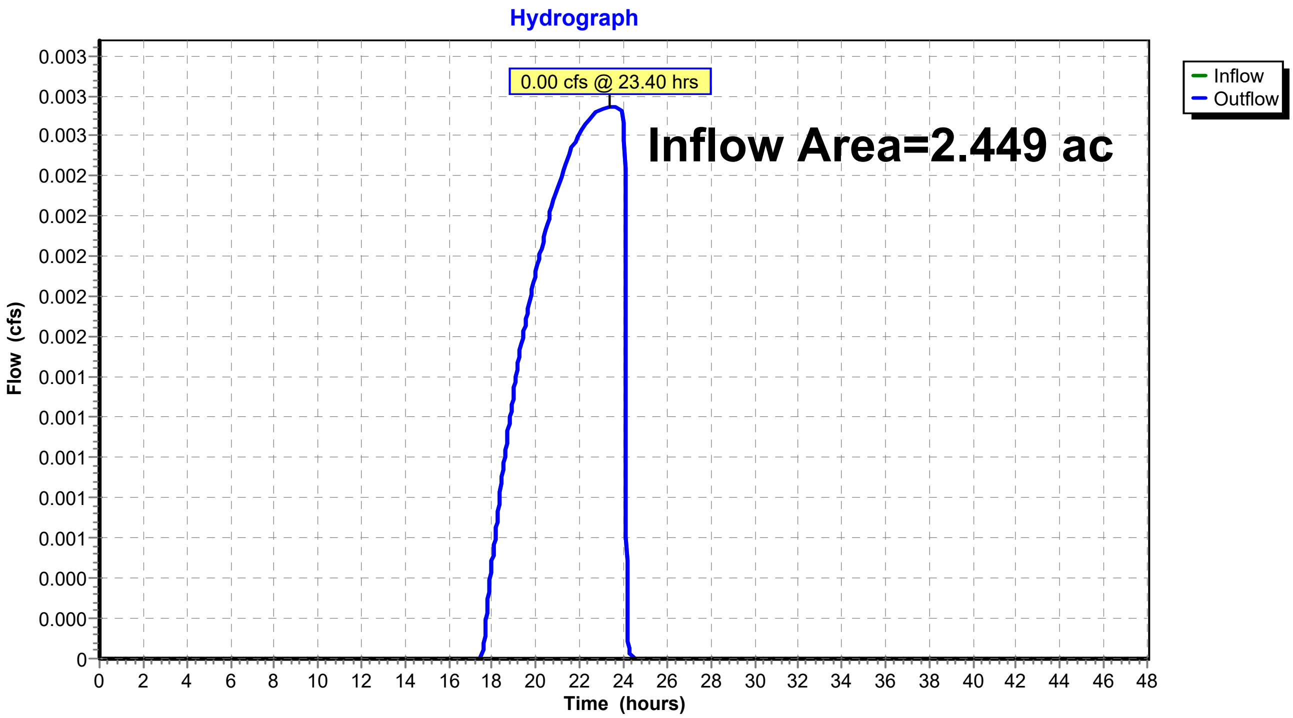


Summary for Reach R3: Total Area 3

Inflow Area = 2.449 ac, 19.13% Impervious, Inflow Depth = 0.01" for 10 year event
Inflow = 0.00 cfs @ 23.40 hrs, Volume= 0.001 af
Outflow = 0.00 cfs @ 23.40 hrs, Volume= 0.001 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs

Reach R3: Total Area 3



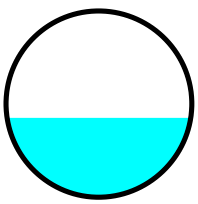
Summary for Reach Rp1: Pipe P1

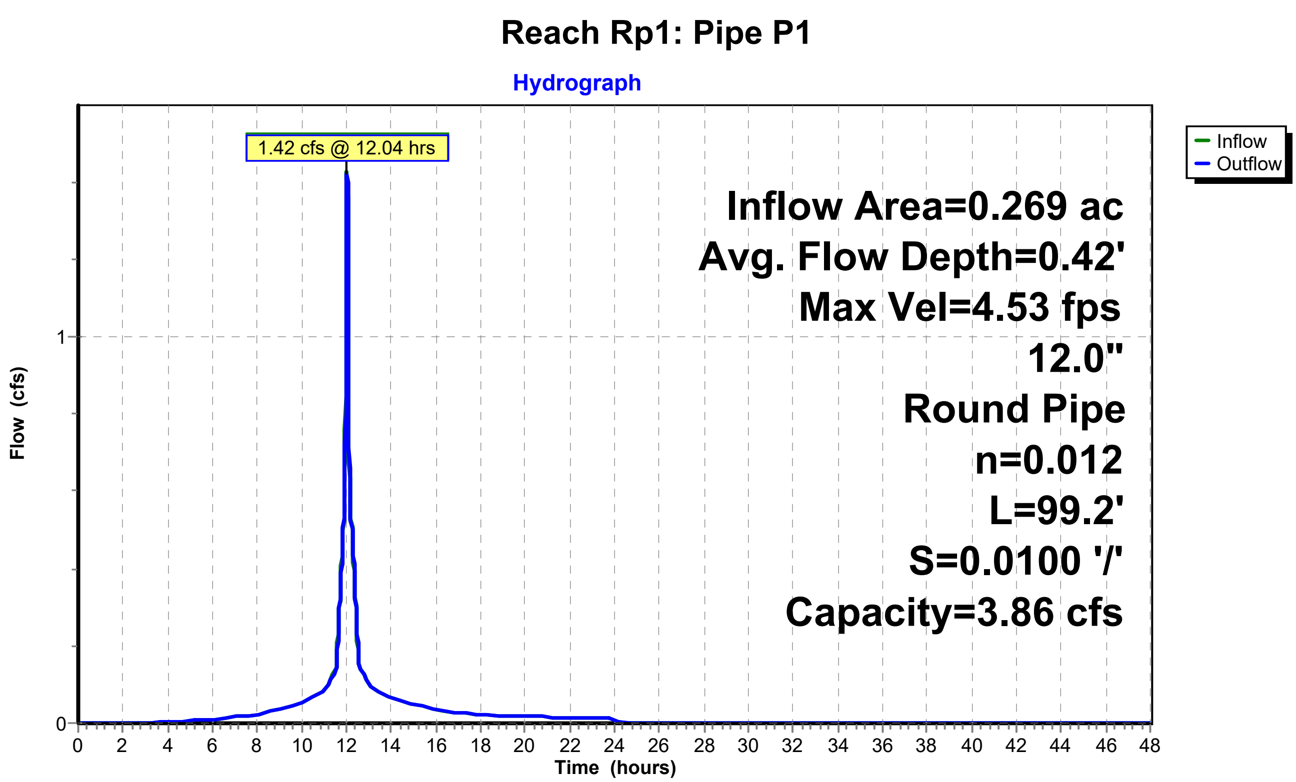
Inflow Area = 0.269 ac, 93.82% Impervious, Inflow Depth = 4.24" for 10 year event
Inflow = 1.42 cfs @ 12.03 hrs, Volume= 0.095 af
Outflow = 1.42 cfs @ 12.04 hrs, Volume= 0.095 af, Atten= 0%, Lag= 0.3 min

Routing by Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Max. Velocity= 4.53 fps, Min. Travel Time= 0.4 min
Avg. Velocity = 1.44 fps, Avg. Travel Time= 1.2 min

Peak Storage= 31 cf @ 12.04 hrs
Average Depth at Peak Storage= 0.42'
Bank-Full Depth= 1.00' Flow Area= 0.8 sf, Capacity= 3.86 cfs

12.0" Round Pipe
n= 0.012
Length= 99.2' Slope= 0.0100 '/'
Inlet Invert= 323.25', Outlet Invert= 322.26'





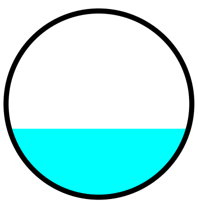
Summary for Reach Rp2: Pipe P2

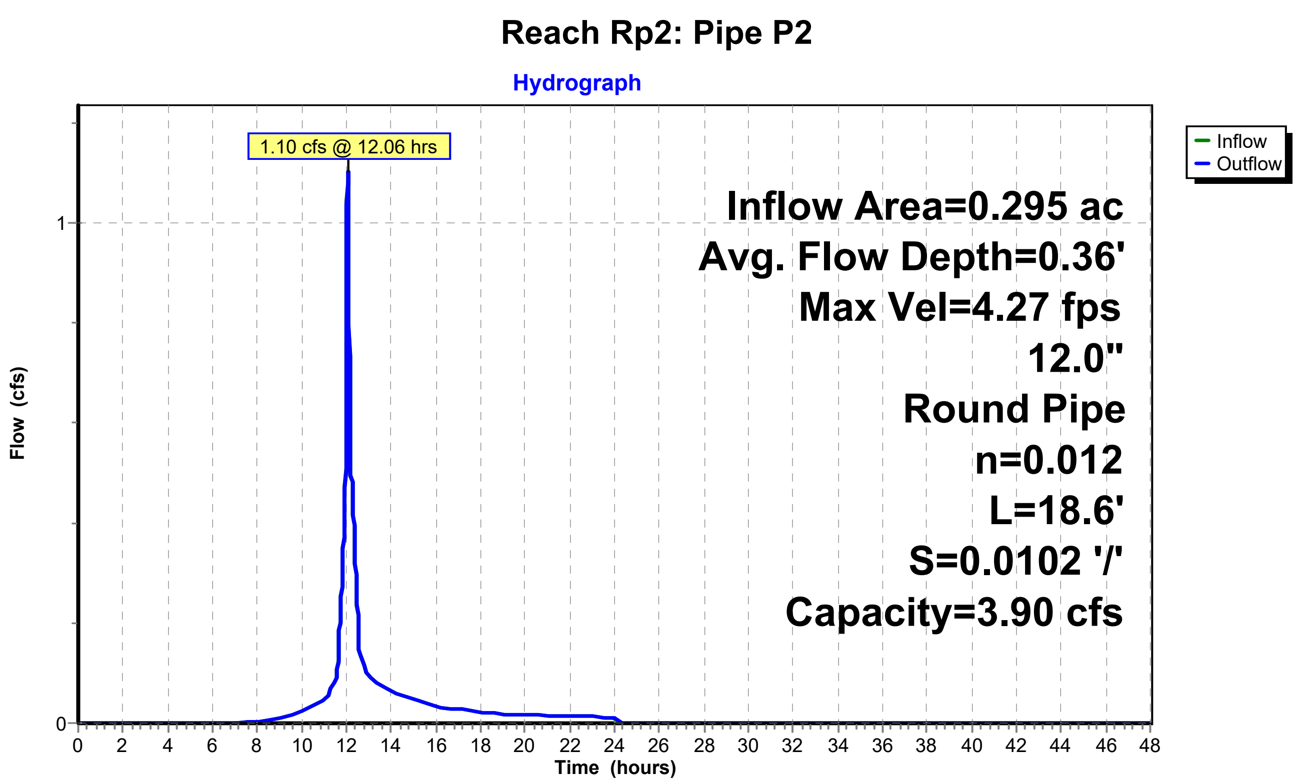
Inflow Area = 0.295 ac, 73.05% Impervious, Inflow Depth = 2.99" for 10 year event
Inflow = 1.10 cfs @ 12.06 hrs, Volume= 0.074 af
Outflow = 1.10 cfs @ 12.06 hrs, Volume= 0.074 af, Atten= 0%, Lag= 0.1 min

Routing by Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Max. Velocity= 4.27 fps, Min. Travel Time= 0.1 min
Avg. Velocity = 1.46 fps, Avg. Travel Time= 0.2 min

Peak Storage= 5 cf @ 12.06 hrs
Average Depth at Peak Storage= 0.36'
Bank-Full Depth= 1.00' Flow Area= 0.8 sf, Capacity= 3.90 cfs

12.0" Round Pipe
n= 0.012
Length= 18.6' Slope= 0.0102 '/'
Inlet Invert= 321.15', Outlet Invert= 320.96'





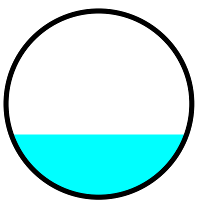
Summary for Reach Rp3: Pipe P3

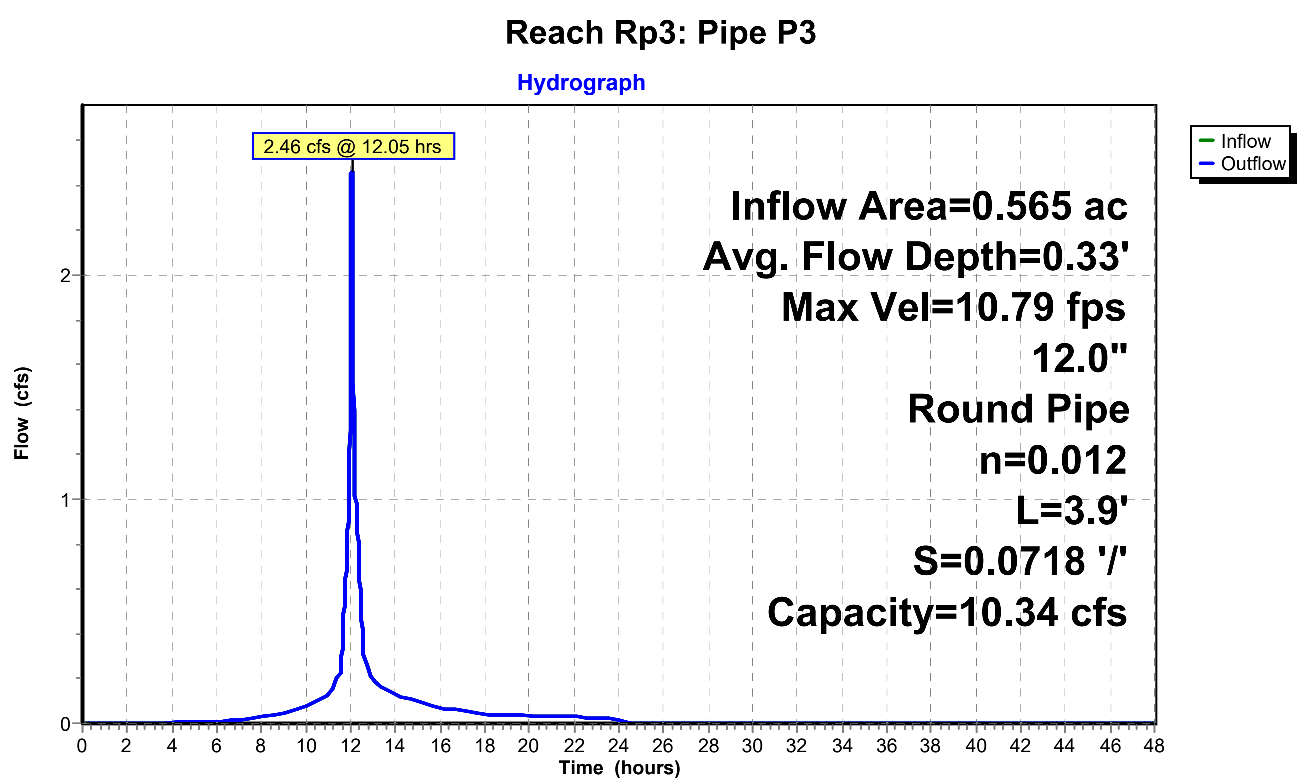
Inflow Area = 0.565 ac, 82.96% Impervious, Inflow Depth = 3.59" for 10 year event
Inflow = 2.46 cfs @ 12.05 hrs, Volume= 0.169 af
Outflow = 2.46 cfs @ 12.05 hrs, Volume= 0.169 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Max. Velocity= 10.79 fps, Min. Travel Time= 0.0 min
Avg. Velocity = 3.35 fps, Avg. Travel Time= 0.0 min

Peak Storage= 1 cf @ 12.05 hrs
Average Depth at Peak Storage= 0.33'
Bank-Full Depth= 1.00' Flow Area= 0.8 sf, Capacity= 10.34 cfs

12.0" Round Pipe
n= 0.012
Length= 3.9' Slope= 0.0718 '/'
Inlet Invert= 320.46', Outlet Invert= 320.18'





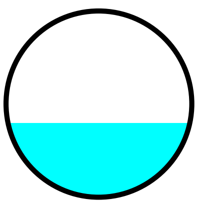
Summary for Reach Rp4: Pipe P4

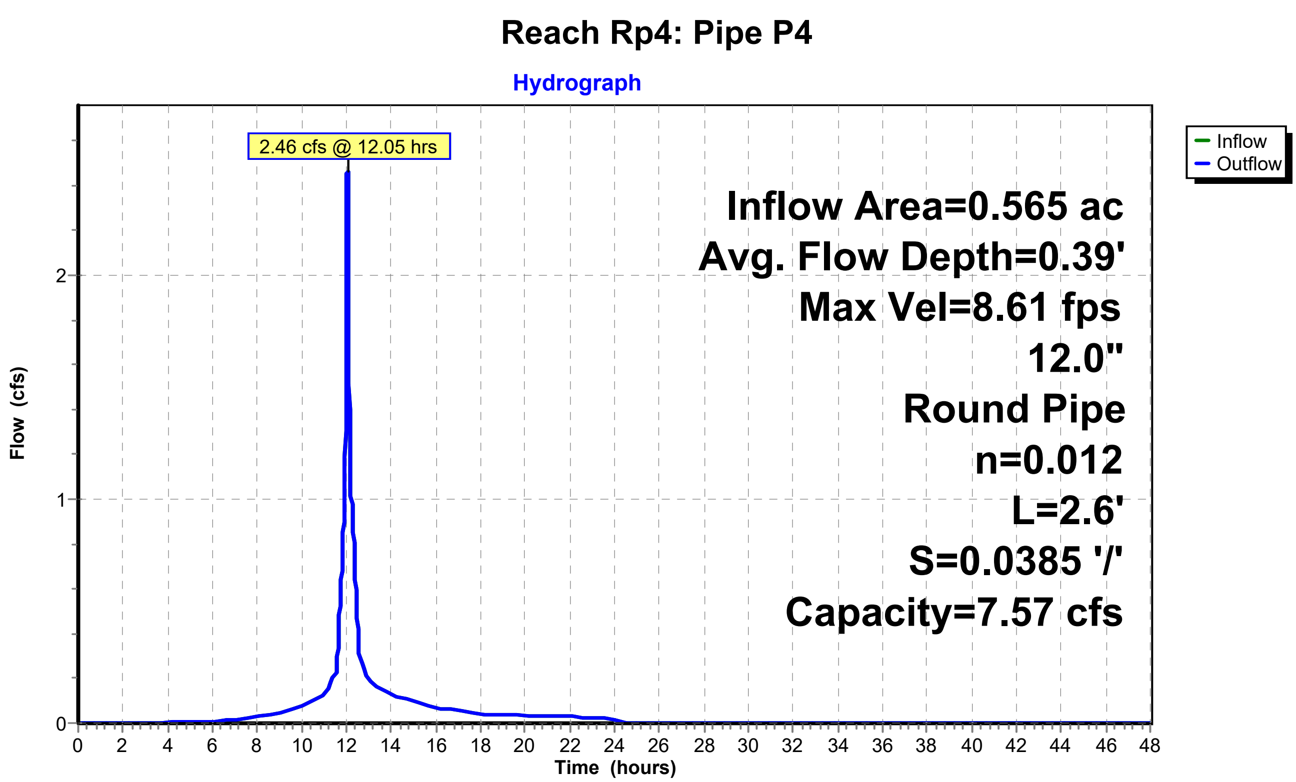
Inflow Area = 0.565 ac, 82.96% Impervious, Inflow Depth = 3.59" for 10 year event
Inflow = 2.46 cfs @ 12.05 hrs, Volume= 0.169 af
Outflow = 2.46 cfs @ 12.05 hrs, Volume= 0.169 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Max. Velocity= 8.61 fps, Min. Travel Time= 0.0 min
Avg. Velocity = 2.69 fps, Avg. Travel Time= 0.0 min

Peak Storage= 1 cf @ 12.05 hrs
Average Depth at Peak Storage= 0.39'
Bank-Full Depth= 1.00' Flow Area= 0.8 sf, Capacity= 7.57 cfs

12.0" Round Pipe
n= 0.012
Length= 2.6' Slope= 0.0385 '/'
Inlet Invert= 320.10', Outlet Invert= 320.00'





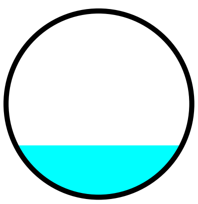
Summary for Reach Rp6: Pipe P6

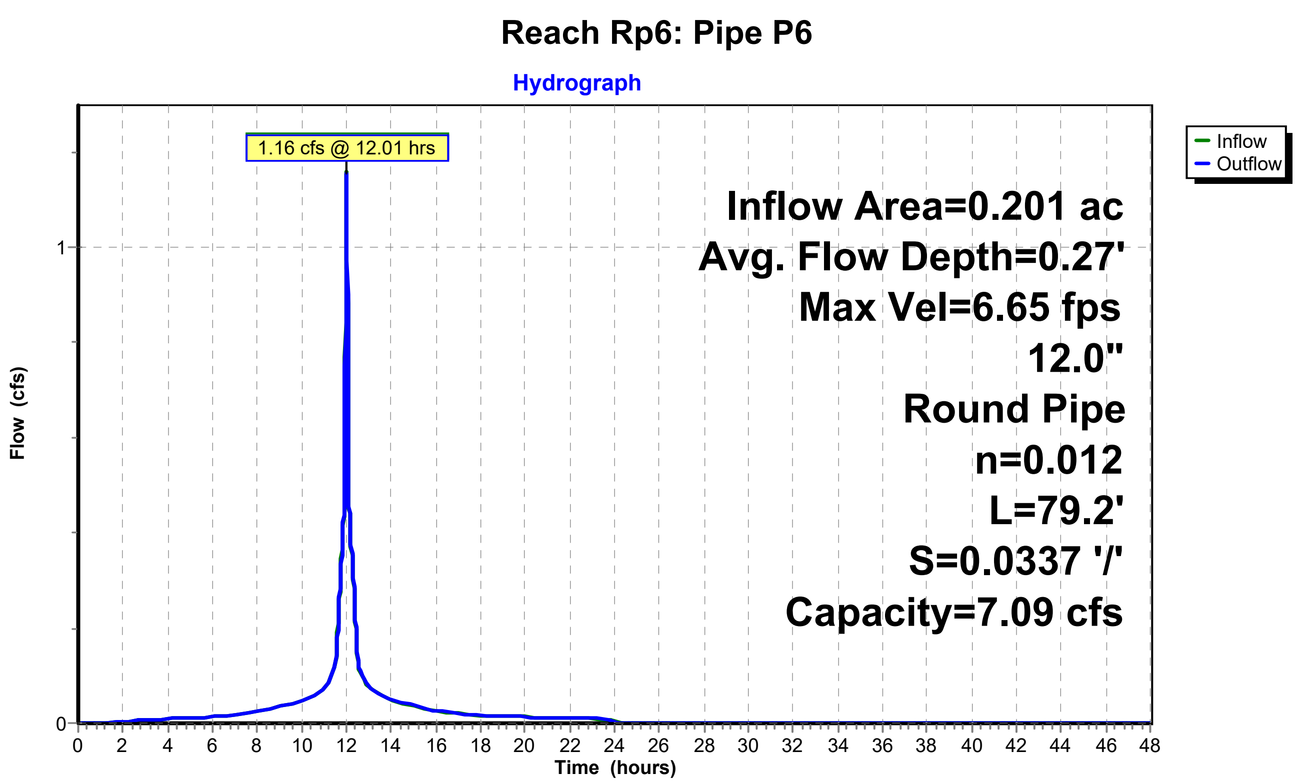
Inflow Area = 0.201 ac,100.00% Impervious, Inflow Depth = 4.65" for 10 year event
Inflow = 1.16 cfs @ 12.01 hrs, Volume= 0.078 af
Outflow = 1.16 cfs @ 12.01 hrs, Volume= 0.078 af, Atten= 0%, Lag= 0.1 min

Routing by Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Max. Velocity= 6.65 fps, Min. Travel Time= 0.2 min
Avg. Velocity = 2.07 fps, Avg. Travel Time= 0.6 min

Peak Storage= 14 cf @ 12.01 hrs
Average Depth at Peak Storage= 0.27'
Bank-Full Depth= 1.00' Flow Area= 0.8 sf, Capacity= 7.09 cfs

12.0" Round Pipe
n= 0.012
Length= 79.2' Slope= 0.0337 '/'
Inlet Invert= 323.17', Outlet Invert= 320.50'





Summary for Pond P1: Kettle Hole

Inflow Area = 2.487 ac, 35.62% Impervious, Inflow Depth = 1.29" for 10 year event
Inflow = 2.17 cfs @ 12.18 hrs, Volume= 0.267 af
Outflow = 0.30 cfs @ 13.97 hrs, Volume= 0.267 af, Atten= 86%, Lag= 107.5 min
Discarded = 0.30 cfs @ 13.97 hrs, Volume= 0.267 af

Routing by Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Peak Elev= 322.63'@ 13.97 hrs Surf.Area= 2,559 sf Storage= 4,270 cf

Plug-Flow detention time=167.9 min calculated for 0.267 af (100% of inflow)
Center-of-Mass det. time=167.9 min (1,019.2 - 851.4)

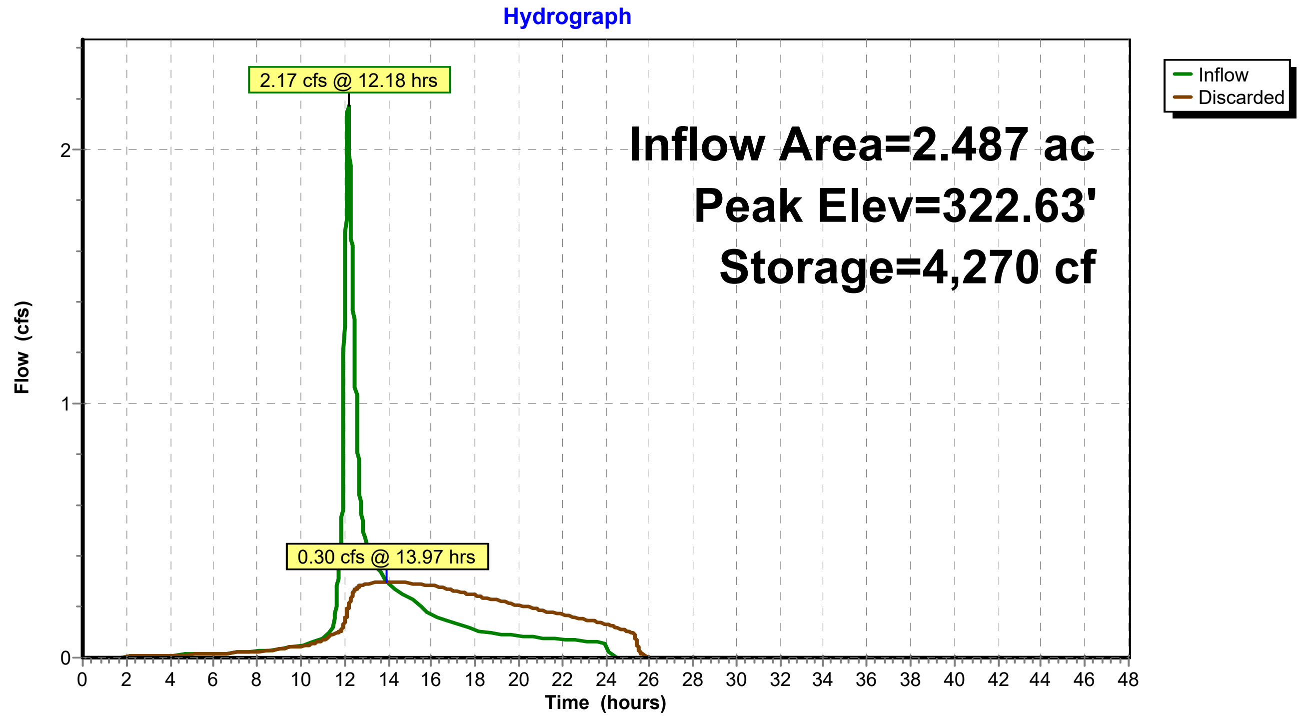
Volume	Invert	Avail.Storage	Storage Description
#1	320.00'	30,825 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
320.00	737	0	0
322.00	2,066	2,803	2,803
324.00	3,622	5,688	8,491
326.00	5,403	9,025	17,516
328.00	7,906	13,309	30,825

Device	Routing	Invert	Outlet Devices
#1	Discarded	320.00'	**5.000 in/hr Exfiltration over Surface area** Conductivity to Groundwater Elevation = 0.00'

Discarded OutFlow Max=0.30 cfs @ 13.97 hrs HW=322.63' (Free Discharge)
↑**1=Exfiltration** (Controls 0.30 cfs)

Pond P1: Kettle Hole



Summary for Pond P3: Infiltration

Inflow Area = 0.565 ac, 82.96% Impervious, Inflow Depth = 3.59" for 10 year event
Inflow = 2.46 cfs @ 12.05 hrs, Volume= 0.169 af
Outflow = 0.47 cfs @ 12.48 hrs, Volume= 0.169 af, Atten= 81%, Lag= 25.8 min
Discarded = 0.47 cfs @ 12.48 hrs, Volume= 0.169 af
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Peak Elev= 320.63'@ 12.48 hrs Surf.Area= 2,426 sf Storage= 1,777 cf

Plug-Flow detention time=20.8 min calculated for 0.169 af (100% of inflow)
Center-of-Mass det. time=20.8 min (810.2 - 789.4)

Volume	Invert	Avail.Storage	Storage Description
#1A	319.50'	2,058 cf	**25.67'W x 94.50'L x 3.54'H Field A** 8,590 cf Overall - 3,446 cf Embedded = 5,144 cf x 40.0% Voids
#2A	320.00'	3,446 cf	**Cultec R-330XLHD** x 65 Inside #1 Effective Size= 47.8"W x 30.0"H => 7.45 sf x 7.00'L = 52.2 cf Overall Size= 52.0"W x 30.5"H x 8.50'L with 1.50' Overlap Row Length Adjustment= +1.50' x 7.45 sf x 5 rows
		5,504 cf	Total Available Storage

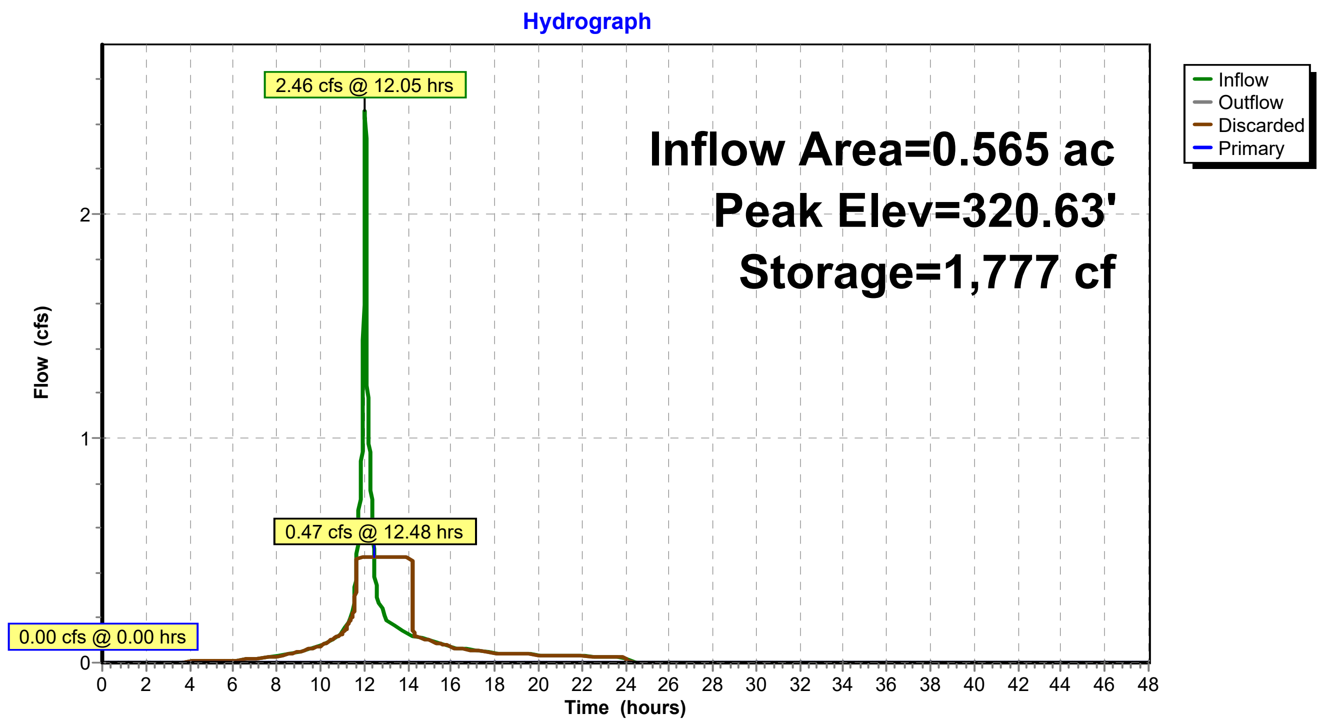
Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Discarded	319.50'	**8.270 in/hr Exfiltration over Surface area** Conductivity to Groundwater Elevation = 0.00'
#2	Primary	323.00'	**24.0" x 24.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads

Discarded OutFlow Max=0.47 cfs @ 12.48 hrs HW=320.63' (Free Discharge)
↑—**1=Exfiltration** (Controls 0.47 cfs)

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=319.50' (Free Discharge)
↑—**2=Orifice/Grate** (Controls 0.00 cfs)

Pond P3: Infiltration



Time span=0.00-48.00 hrs, dt=0.01 hrs, 4801 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind method - Pond routing by Stor-Ind method

Subcatchment S1: To Kettle Hole Runoff Area=99,577 sf 29.97% Impervious Runoff Depth=3.50"
Flow Length=622' Tc=11.6 min CN=56.1 Runoff=7.59 cfs 0.666 af

Subcatchment S1r: Roof Runoff Area=8,748 sf 100.00% Impervious Runoff Depth=8.59"
Flow Length=146' Tc=0.5 min CN=98.0 Runoff=2.10 cfs 0.144 af

Subcatchment S2: To Harris Street Runoff Area=2,110 sf 7.25% Impervious Runoff Depth=2.00"
Flow Length=106' Tc=2.2 min CN=43.3 Runoff=0.11 cfs 0.008 af

Subcatchment S3: To Quinsig River Runoff Area=82,086 sf 0.00% Impervious Runoff Depth=0.70"
Flow Length=222' Tc=6.6 min CN=30.8 Runoff=0.55 cfs 0.110 af

Subcatchment S3i1: CB-1 Runoff Area=11,739 sf 93.82% Impervious Runoff Depth=8.16"
Flow Length=155' Tc=2.2 min CN=94.4 Runoff=2.64 cfs 0.183 af

Subcatchment S3i2: CB-2 Runoff Area=12,861 sf 73.05% Impervious Runoff Depth=6.66"
Flow Length=114' Tc=4.2 min CN=82.1 Runoff=2.39 cfs 0.164 af

Reach R3: Total Area 3 Inflow=0.55 cfs 0.110 af
Outflow=0.55 cfs 0.110 af

Reach Rp1: Pipe P1 Avg. Flow Depth=0.61' Max Vel=5.28 fps Inflow=2.64 cfs 0.183 af
12.0" Round Pipe n=0.012 L=99.2' S=0.0100 '/' Capacity=3.86 cfs Outflow=2.63 cfs 0.183 af

Reach Rp2: Pipe P2 Avg. Flow Depth=0.57' Max Vel=5.22 fps Inflow=2.39 cfs 0.164 af
12.0" Round Pipe n=0.012 L=18.6' S=0.0102 '/' Capacity=3.90 cfs Outflow=2.39 cfs 0.164 af

Reach Rp3: Pipe P3 Avg. Flow Depth=0.49' Max Vel=13.00 fps Inflow=4.91 cfs 0.347 af
12.0" Round Pipe n=0.012 L=3.9' S=0.0718 '/' Capacity=10.34 cfs Outflow=4.91 cfs 0.347 af

Reach Rp4: Pipe P4 Avg. Flow Depth=0.59' Max Vel=10.25 fps Inflow=4.91 cfs 0.347 af
12.0" Round Pipe n=0.012 L=2.6' S=0.0385 '/' Capacity=7.57 cfs Outflow=4.91 cfs 0.347 af

Reach Rp6: Pipe P6 Avg. Flow Depth=0.37' Max Vel=7.86 fps Inflow=2.10 cfs 0.144 af
12.0" Round Pipe n=0.012 L=79.2' S=0.0337 '/' Capacity=7.09 cfs Outflow=2.10 cfs 0.144 af

Pond P1: Kettle Hole Peak Elev=326.10' Storage=18,052 cf Inflow=8.35 cfs 0.810 af
Outflow=0.65 cfs 0.810 af

Pond P3: Infiltration Peak Elev=322.66' Storage=5,135 cf Inflow=4.91 cfs 0.347 af
Discarded=0.47 cfs 0.347 af Primary=0.00 cfs 0.000 af Outflow=0.47 cfs 0.347 af

Total Runoff Area = 4.984 ac Runoff Volume = 1.275 af Average Runoff Depth = 3.07"
72.76% Pervious = 3.627 ac 27.24% Impervious = 1.358 ac

Summary for Subcatchment S1: To Kettle Hole

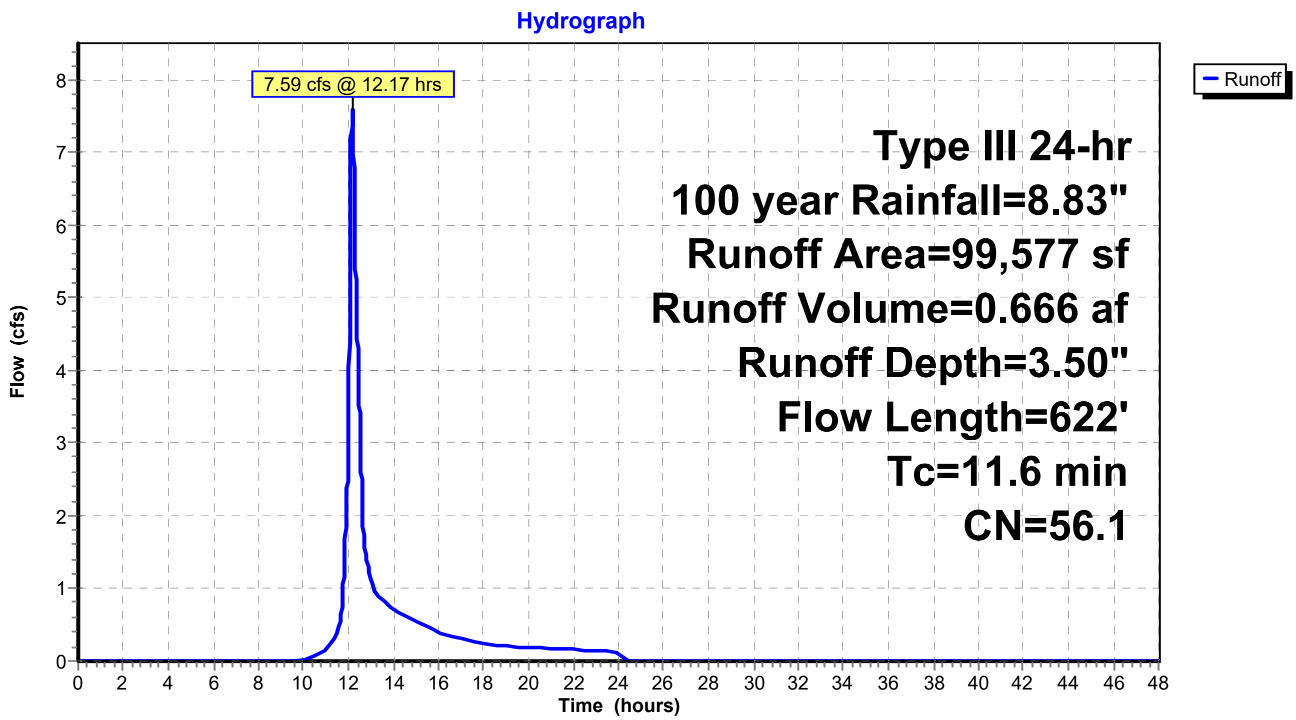
Runoff = 7.59 cfs @ 12.17 hrs, Volume= 0.666 af, Depth= 3.50"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Type III 24-hr 100 year Rainfall=8.83"

Area (sf)	CN	Description
29,840	98.0	Paved parking, HSG A
62,961	39.0	>75% Grass cover, Good, HSG A
6,776	30.0	Woods, Good, HSG A
99,577	56.1	Weighted Average
69,737		70.03% Pervious Area
29,840		29.97% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.4	50	0.0100	0.11		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.24"
1.3	80	0.0200	0.99		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
2.9	492	0.0200	2.87		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
11.6	622	Total			

Subcatchment S1: To Kettle Hole



Summary for Subcatchment S1r: Roof

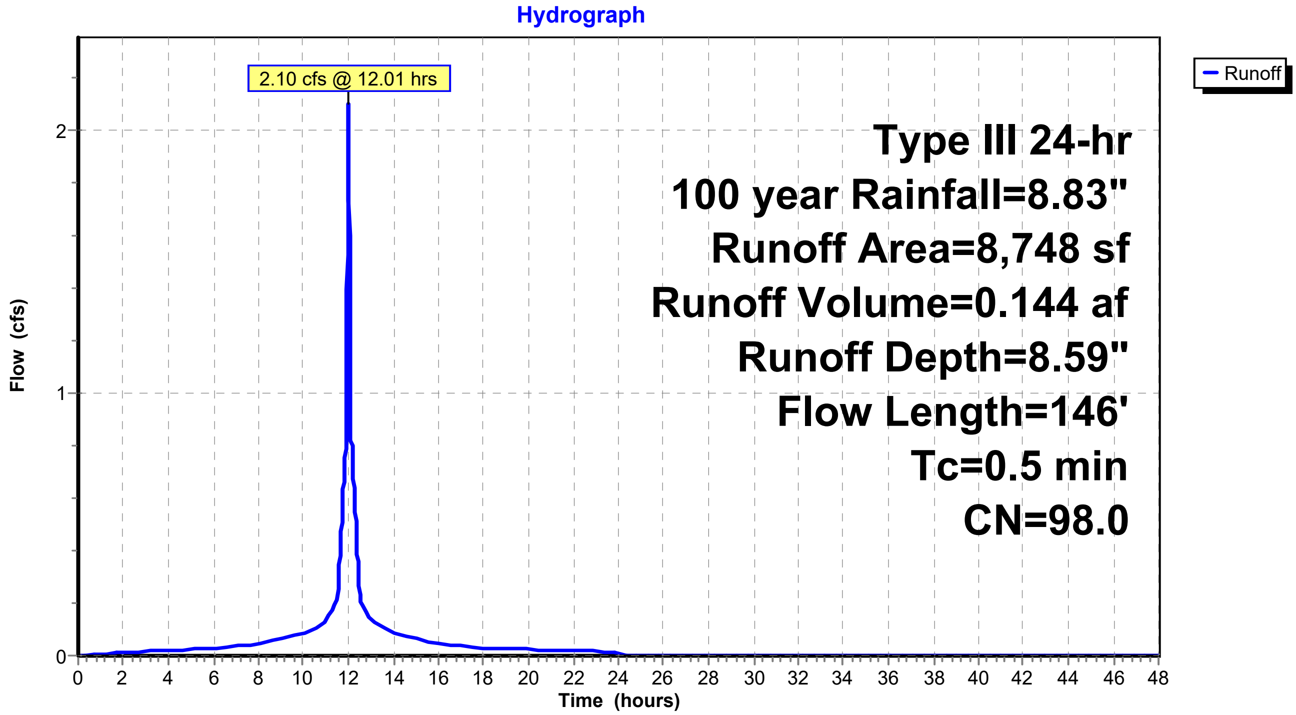
Runoff = 2.10 cfs @ 12.01 hrs, Volume= 0.144 af, Depth= 8.59"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Type III 24-hr 100 year Rainfall=8.83"

Area (sf)	CN	Description
8,748	98.0	Roofs, HSG A
8,748		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.1	22	0.7500	4.36		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 3.24"
0.4	124	0.0100	4.91	3.86	**Pipe Channel, DMH-4 to FE-1** 12.0" Round Area= 0.8 sf Perim= 3.1' r= 0.25' n= 0.012
0.5	146	Total			

Subcatchment S1r: Roof



Summary for Subcatchment S2: To Harris Street

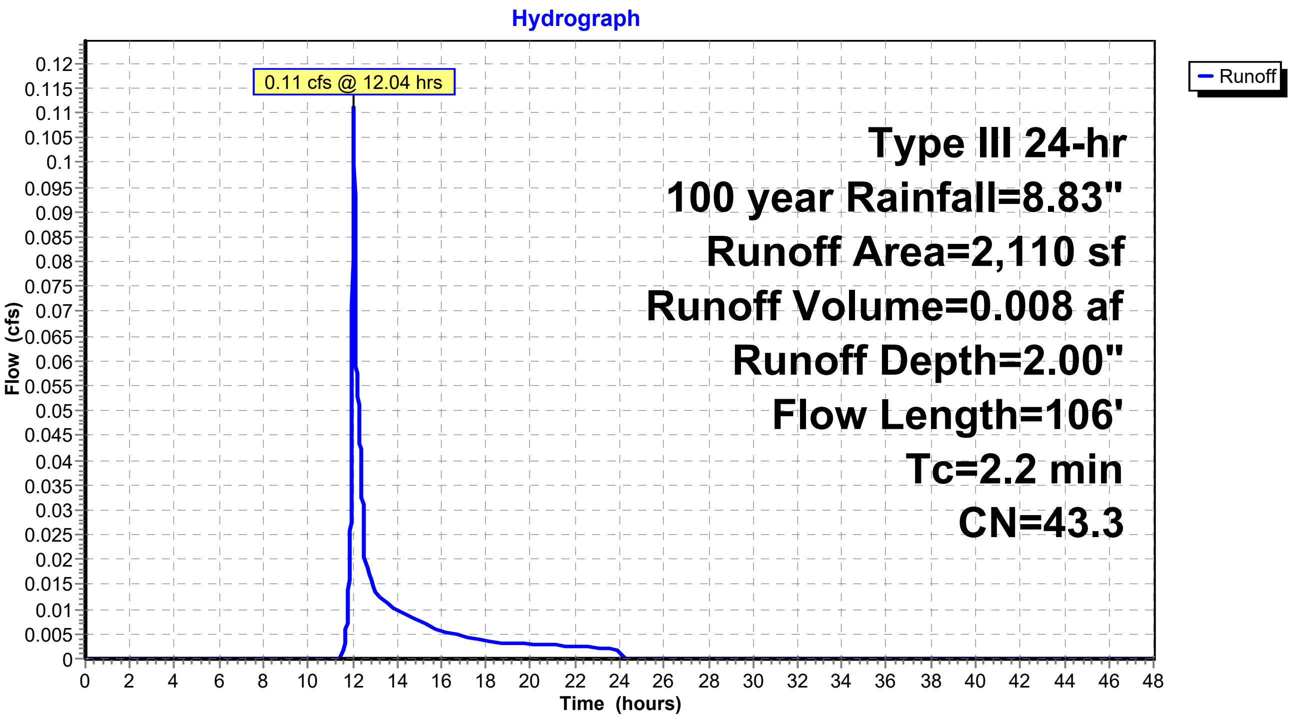
Runoff = 0.11 cfs @ 12.04 hrs, Volume= 0.008 af, Depth= 2.00"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Type III 24-hr 100 year Rainfall=8.83"

Area (sf)	CN	Description
1,957	39.0	>75% Grass cover, Good, HSG A
153	98.0	Paved parking, HSG A
2,110	43.3	Weighted Average
1,957		92.75% Pervious Area
153		7.25% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.5	21	0.1000	0.24		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.24"
0.1	21	0.0400	4.06		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
0.6	64	0.0600	1.71		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
2.2	106	Total			

Subcatchment S2: To Harris Street



Summary for Subcatchment S3: To Quinsig River

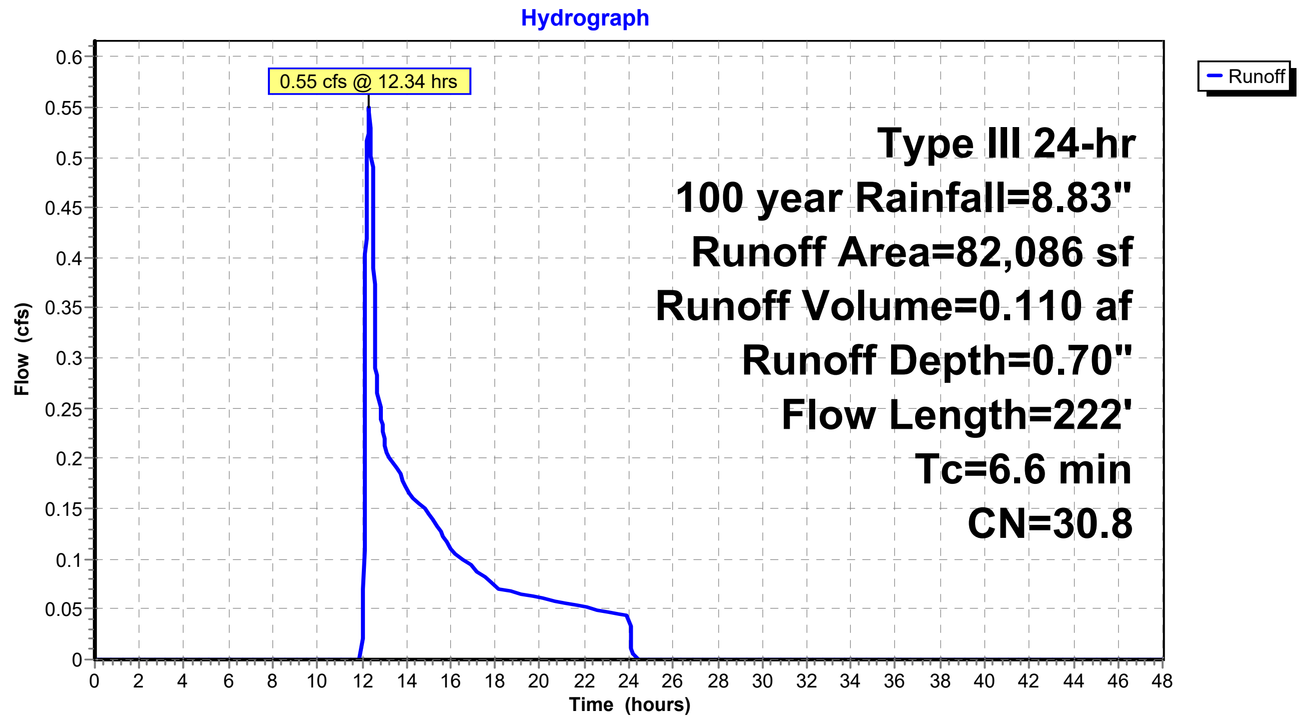
Runoff = 0.55 cfs @ 12.34 hrs, Volume= 0.110 af, Depth= 0.70"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Type III 24-hr 100 year Rainfall=8.83"

Area (sf)	CN	Description
7,047	39.0	>75% Grass cover, Good, HSG A
75,039	30.0	Woods, Good, HSG A
82,086	30.8	Weighted Average
82,086		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0	44	0.0200	0.15		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.24"
1.6	178	0.1400	1.87		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
6.6	222	Total			

Subcatchment S3: To Quinsig River



Summary for Subcatchment S3i1: CB-1

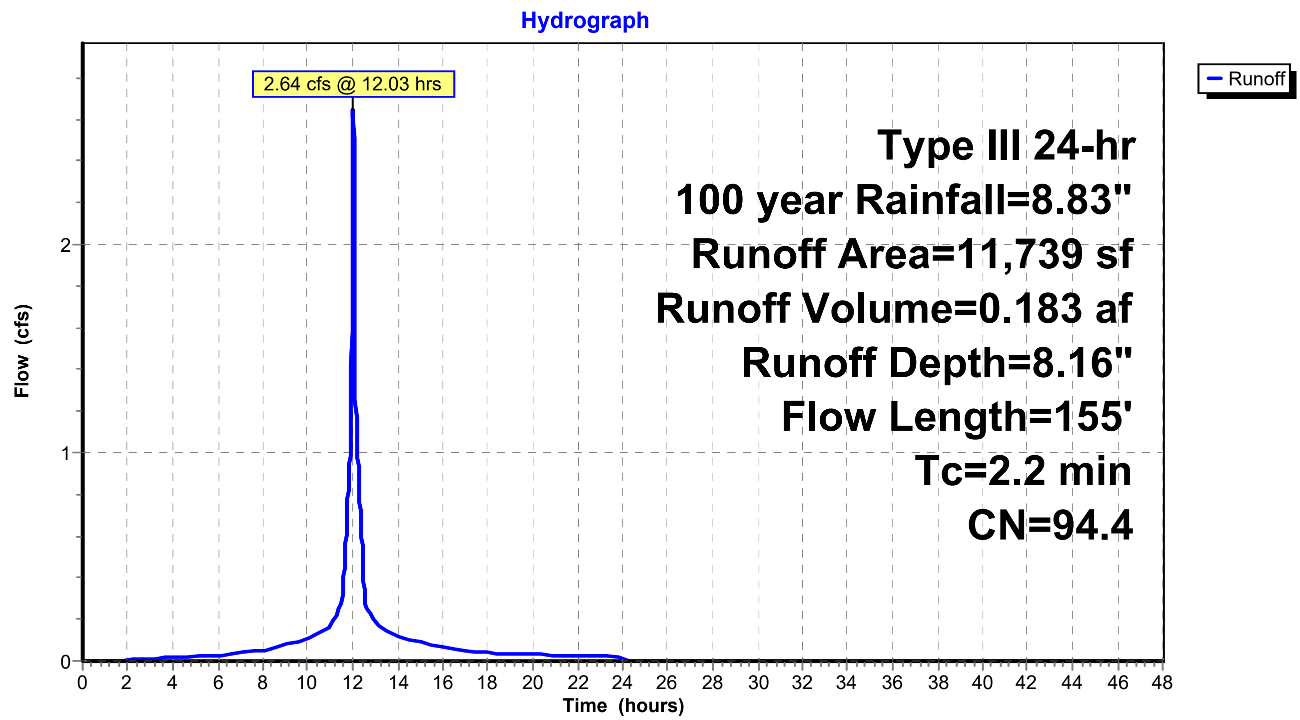
Runoff = 2.64 cfs @ 12.03 hrs, Volume= 0.183 af, Depth= 8.16"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Type III 24-hr 100 year Rainfall=8.83"

Area (sf)	CN	Description
11,014	98.0	Paved parking, HSG A
725	39.0	>75% Grass cover, Good, HSG A
11,739	94.4	Weighted Average
725		6.18% Pervious Area
11,014		93.82% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.0	13	0.1000	0.22		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.24"
1.2	142	0.0100	2.03		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
2.2	155	Total			

Subcatchment S3i1: CB-1



Summary for Subcatchment S3i2: CB-2

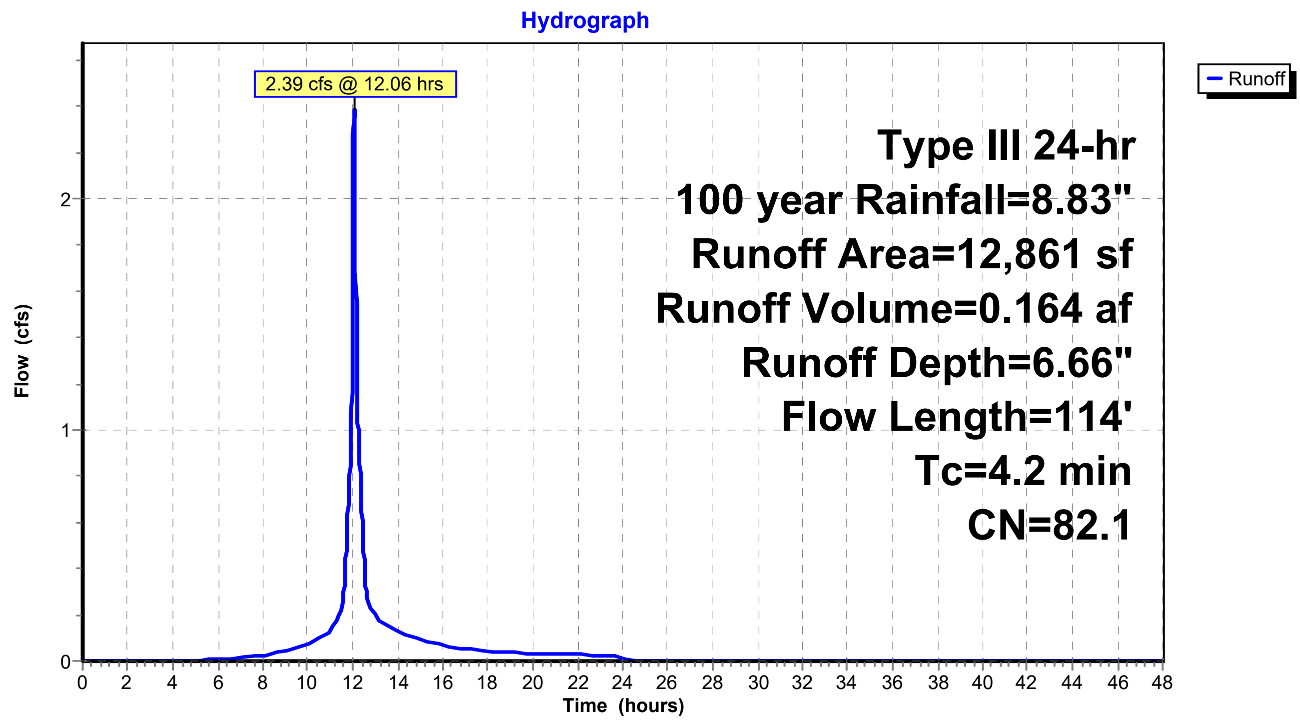
Runoff = 2.39 cfs @ 12.06 hrs, Volume= 0.164 af, Depth= 6.66"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Type III 24-hr 100 year Rainfall=8.83"

Area (sf)	CN	Description
9,395	98.0	Paved parking, HSG A
3,466	39.0	>75% Grass cover, Good, HSG A
12,861	82.1	Weighted Average
3,466		26.95% Pervious Area
9,395		73.05% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.8	38	0.0300	0.17		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.24"
0.4	76	0.0260	3.27		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
4.2	114	Total			

Subcatchment S3i2: CB-2

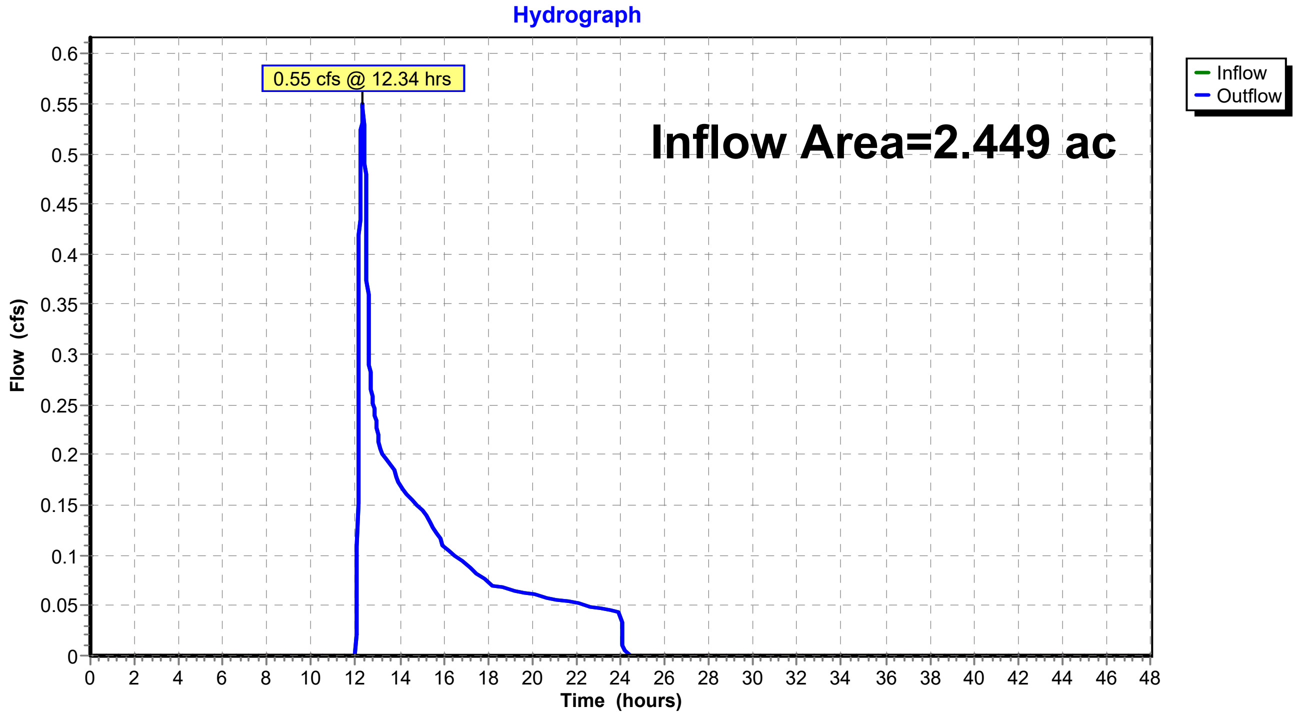


Summary for Reach R3: Total Area 3

Inflow Area =	2.449 ac, 19.13% Impervious,	Inflow Depth = 0.54"	for 100 year event
Inflow =	0.55 cfs @ 12.34 hrs,	Volume= 0.110 af	
Outflow =	0.55 cfs @ 12.34 hrs,	Volume= 0.110 af,	Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs

Reach R3: Total Area 3



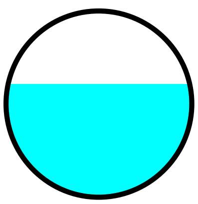
Summary for Reach Rp1: Pipe P1

Inflow Area = 0.269 ac, 93.82% Impervious, Inflow Depth = 8.16" for 100 year event
Inflow = 2.64 cfs @ 12.03 hrs, Volume= 0.183 af
Outflow = 2.63 cfs @ 12.04 hrs, Volume= 0.183 af, Atten= 0%, Lag= 0.3 min

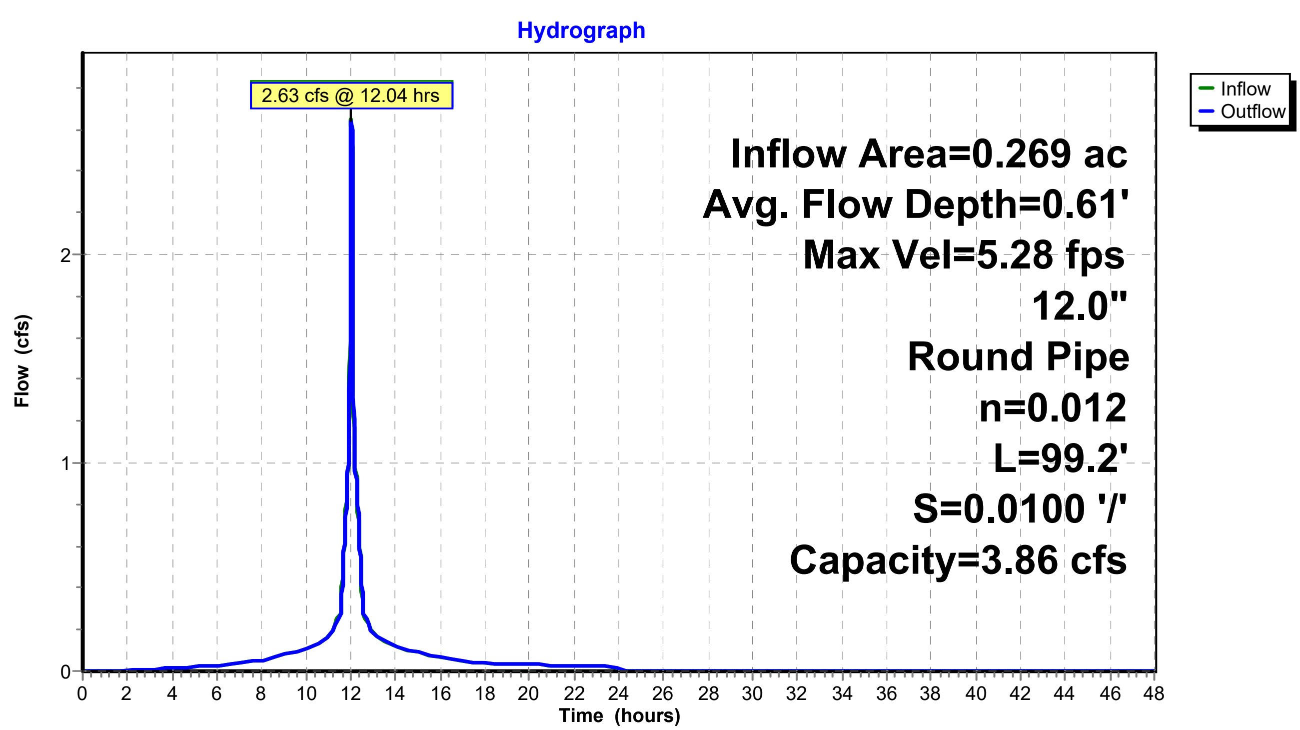
Routing by Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Max. Velocity= 5.28 fps, Min. Travel Time= 0.3 min
Avg. Velocity = 1.73 fps, Avg. Travel Time= 1.0 min

Peak Storage= 49 cf @ 12.04 hrs
Average Depth at Peak Storage= 0.61'
Bank-Full Depth= 1.00' Flow Area= 0.8 sf, Capacity= 3.86 cfs

12.0" Round Pipe
n= 0.012
Length= 99.2' Slope= 0.0100 '/'
Inlet Invert= 323.25', Outlet Invert= 322.26'



Reach Rp1: Pipe P1



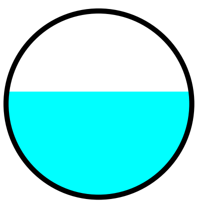
Summary for Reach Rp2: Pipe P2

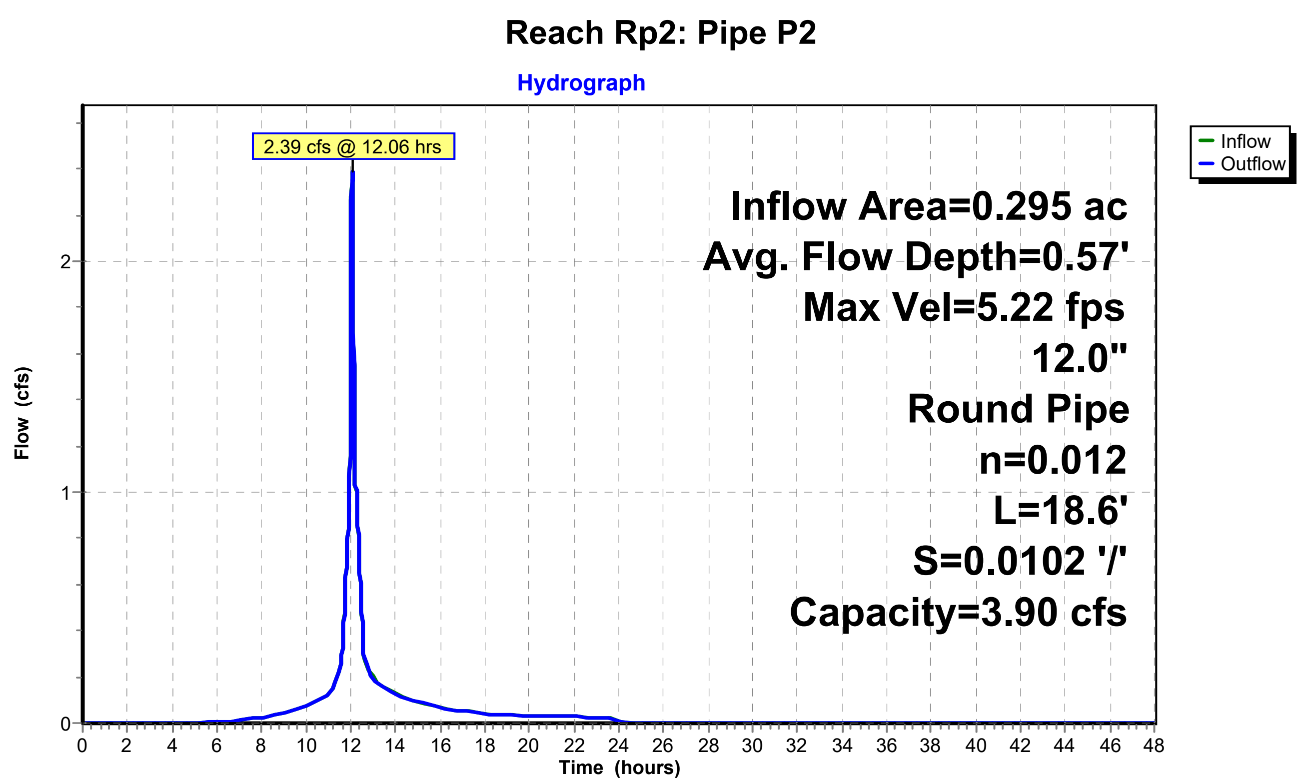
Inflow Area = 0.295 ac, 73.05% Impervious, Inflow Depth = 6.66" for 100 year event
Inflow = 2.39 cfs @ 12.06 hrs, Volume= 0.164 af
Outflow = 2.39 cfs @ 12.06 hrs, Volume= 0.164 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Max. Velocity= 5.22 fps, Min. Travel Time= 0.1 min
Avg. Velocity = 1.75 fps, Avg. Travel Time= 0.2 min

Peak Storage= 9 cf @ 12.06 hrs
Average Depth at Peak Storage= 0.57'
Bank-Full Depth= 1.00' Flow Area= 0.8 sf, Capacity= 3.90 cfs

12.0" Round Pipe
n= 0.012
Length= 18.6' Slope= 0.0102 '/'
Inlet Invert= 321.15', Outlet Invert= 320.96'





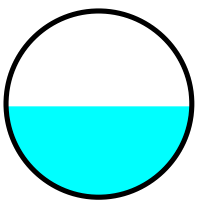
Summary for Reach Rp3: Pipe P3

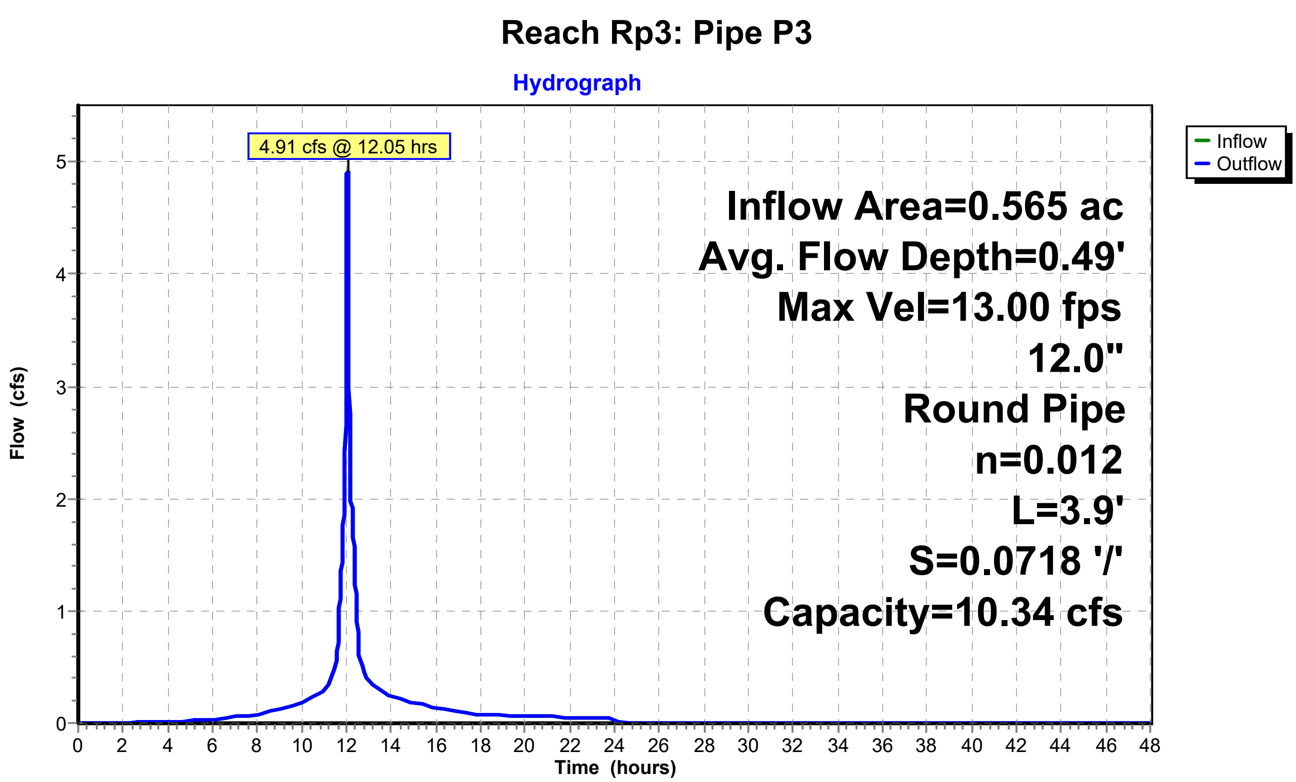
Inflow Area = 0.565 ac, 82.96% Impervious, Inflow Depth = 7.38" for 100 year event
Inflow = 4.91 cfs @ 12.05 hrs, Volume= 0.347 af
Outflow = 4.91 cfs @ 12.05 hrs, Volume= 0.347 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Max. Velocity= 13.00 fps, Min. Travel Time= 0.0 min
Avg. Velocity = 4.11 fps, Avg. Travel Time= 0.0 min

Peak Storage= 1 cf @ 12.05 hrs
Average Depth at Peak Storage= 0.49'
Bank-Full Depth= 1.00' Flow Area= 0.8 sf, Capacity= 10.34 cfs

12.0" Round Pipe
n= 0.012
Length= 3.9' Slope= 0.0718 '/'
Inlet Invert= 320.46', Outlet Invert= 320.18'





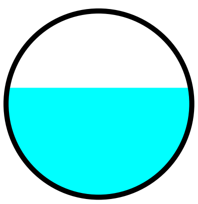
Summary for Reach Rp4: Pipe P4

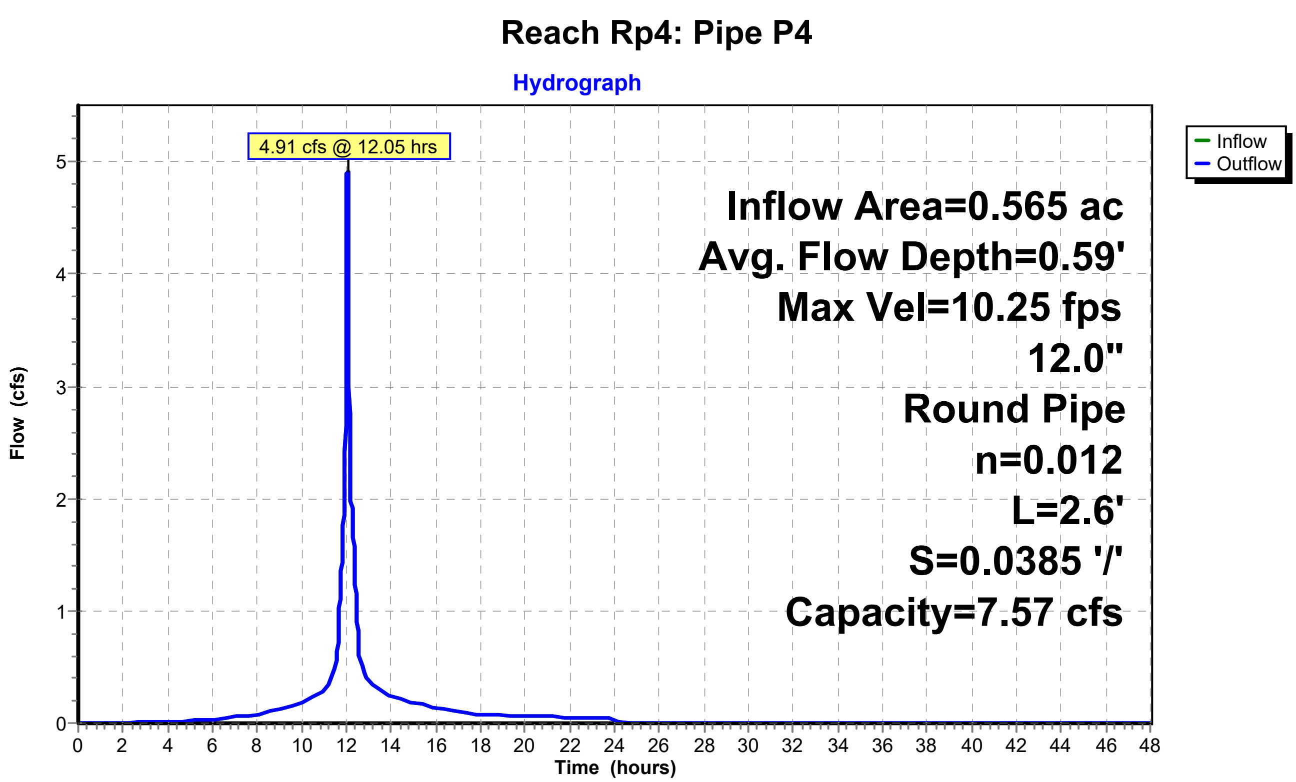
Inflow Area = 0.565 ac, 82.96% Impervious, Inflow Depth = 7.38" for 100 year event
Inflow = 4.91 cfs @ 12.05 hrs, Volume= 0.347 af
Outflow = 4.91 cfs @ 12.05 hrs, Volume= 0.347 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Max. Velocity= 10.25 fps, Min. Travel Time= 0.0 min
Avg. Velocity = 3.30 fps, Avg. Travel Time= 0.0 min

Peak Storage= 1 cf @ 12.05 hrs
Average Depth at Peak Storage= 0.59'
Bank-Full Depth= 1.00' Flow Area= 0.8 sf, Capacity= 7.57 cfs

12.0" Round Pipe
n= 0.012
Length= 2.6' Slope= 0.0385 '/'
Inlet Invert= 320.10', Outlet Invert= 320.00'





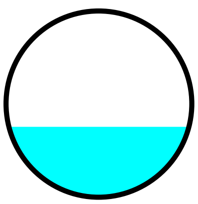
Summary for Reach Rp6: Pipe P6

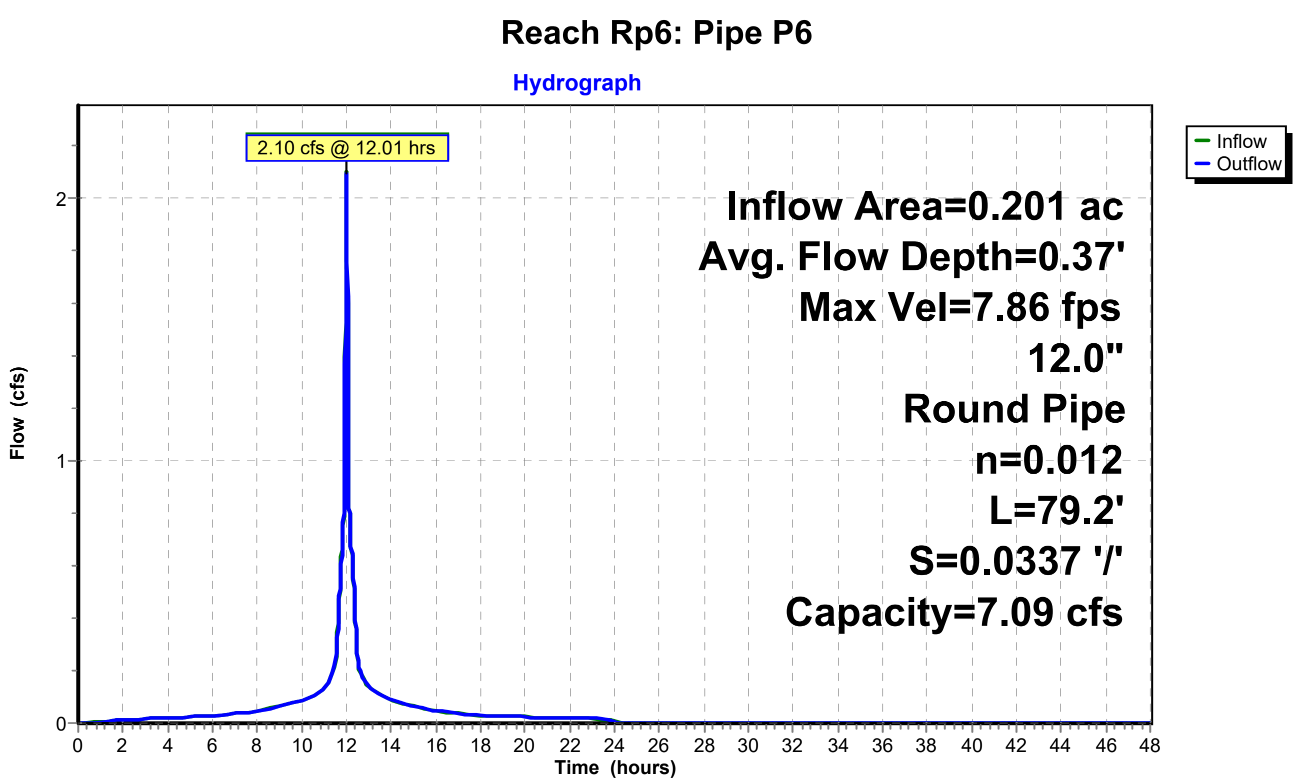
Inflow Area = 0.201 ac,100.00% Impervious, Inflow Depth = 8.59" for 100 year event
Inflow = 2.10 cfs @ 12.01 hrs, Volume= 0.144 af
Outflow = 2.10 cfs @ 12.01 hrs, Volume= 0.144 af, Atten= 0%, Lag= 0.1 min

Routing by Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Max. Velocity= 7.86 fps, Min. Travel Time= 0.2 min
Avg. Velocity = 2.50 fps, Avg. Travel Time= 0.5 min

Peak Storage= 21 cf @ 12.01 hrs
Average Depth at Peak Storage= 0.37'
Bank-Full Depth= 1.00' Flow Area= 0.8 sf, Capacity= 7.09 cfs

12.0" Round Pipe
n= 0.012
Length= 79.2' Slope= 0.0337 '/'
Inlet Invert= 323.17', Outlet Invert= 320.50'





Summary for Pond P1: Kettle Hole

Inflow Area = 2.487 ac, 35.62% Impervious, Inflow Depth = 3.91" for 100 year event
Inflow = 8.35 cfs @ 12.16 hrs, Volume= 0.810 af
Outflow = 0.65 cfs @ 14.79 hrs, Volume= 0.810 af, Atten= 92%, Lag= 157.5 min
Discarded = 0.65 cfs @ 14.79 hrs, Volume= 0.810 af

Routing by Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Peak Elev= 326.10'@ 14.79 hrs Surf.Area= 5,526 sf Storage= 18,052 cf

Plug-Flow detention time=354.1 min calculated for 0.810 af (100% of inflow)
Center-of-Mass det. time=354.1 min (1,187.6 - 833.5)

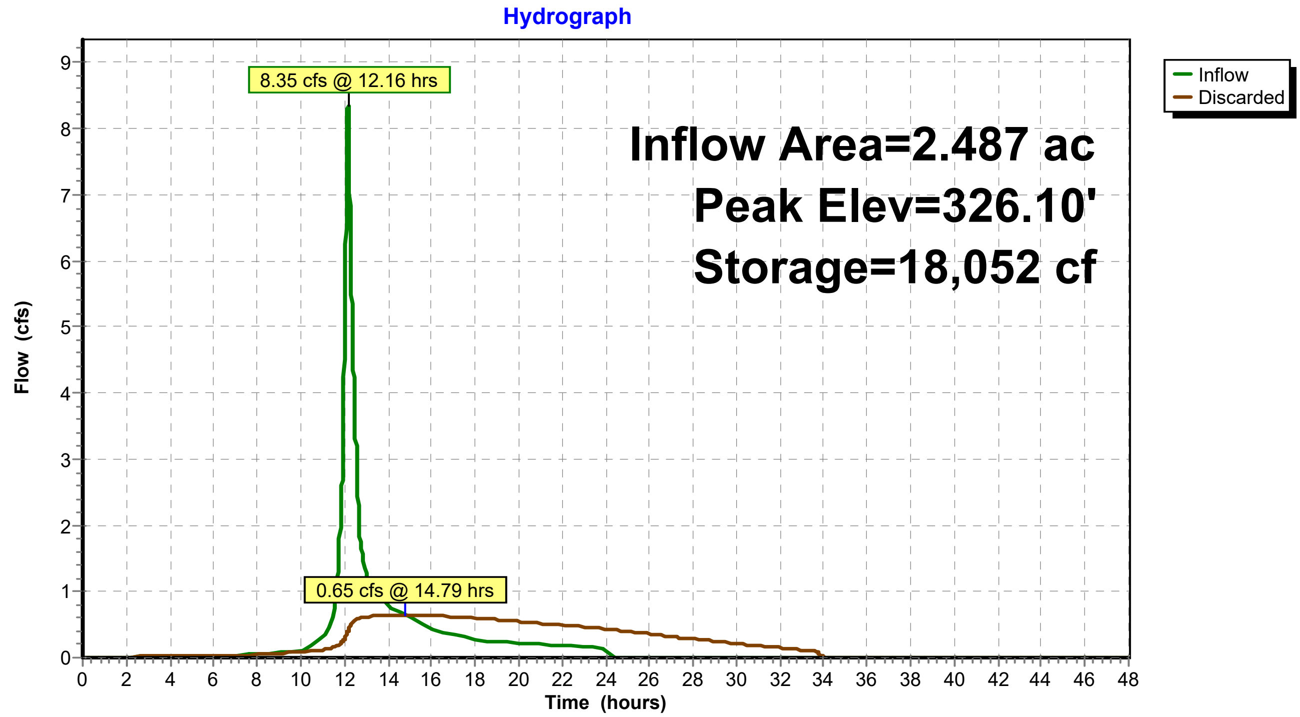
Volume	Invert	Avail.Storage	Storage Description
#1	320.00'	30,825 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
320.00	737	0	0
322.00	2,066	2,803	2,803
324.00	3,622	5,688	8,491
326.00	5,403	9,025	17,516
328.00	7,906	13,309	30,825

Device	Routing	Invert	Outlet Devices
#1	Discarded	320.00'	**5.000 in/hr Exfiltration over Surface area** Conductivity to Groundwater Elevation = 0.00'

Discarded OutFlow Max=0.65 cfs @ 14.79 hrs HW=326.10' (Free Discharge)
↑—**1=Exfiltration** (Controls 0.65 cfs)

Pond P1: Kettle Hole



Summary for Pond P3: Infiltration

Inflow Area = 0.565 ac, 82.96% Impervious, Inflow Depth = 7.38" for 100 year event
Inflow = 4.91 cfs @ 12.05 hrs, Volume= 0.347 af
Outflow = 0.47 cfs @ 12.79 hrs, Volume= 0.347 af, Atten= 90%, Lag= 44.7 min
Discarded = 0.47 cfs @ 12.79 hrs, Volume= 0.347 af
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Peak Elev= 322.66'@ 12.79 hrs Surf.Area= 2,426 sf Storage= 5,135 cf

Plug-Flow detention time=76.4 min calculated for 0.347 af (100% of inflow)
Center-of-Mass det. time=76.4 min (849.1 - 772.7)

Volume	Invert	Avail.Storage	Storage Description
#1A	319.50'	2,058 cf	**25.67'W x 94.50'L x 3.54'H Field A**
			8,590 cf Overall - 3,446 cf Embedded = 5,144 cf x 40.0% Voids
#2A	320.00'	3,446 cf	**Cultec R-330XLHD** x 65 Inside #1
			Effective Size= 47.8"W x 30.0"H => 7.45 sf x 7.00'L = 52.2 cf
			Overall Size= 52.0"W x 30.5"H x 8.50'L with 1.50' Overlap
			Row Length Adjustment= +1.50' x 7.45 sf x 5 rows
		5,504 cf	Total Available Storage

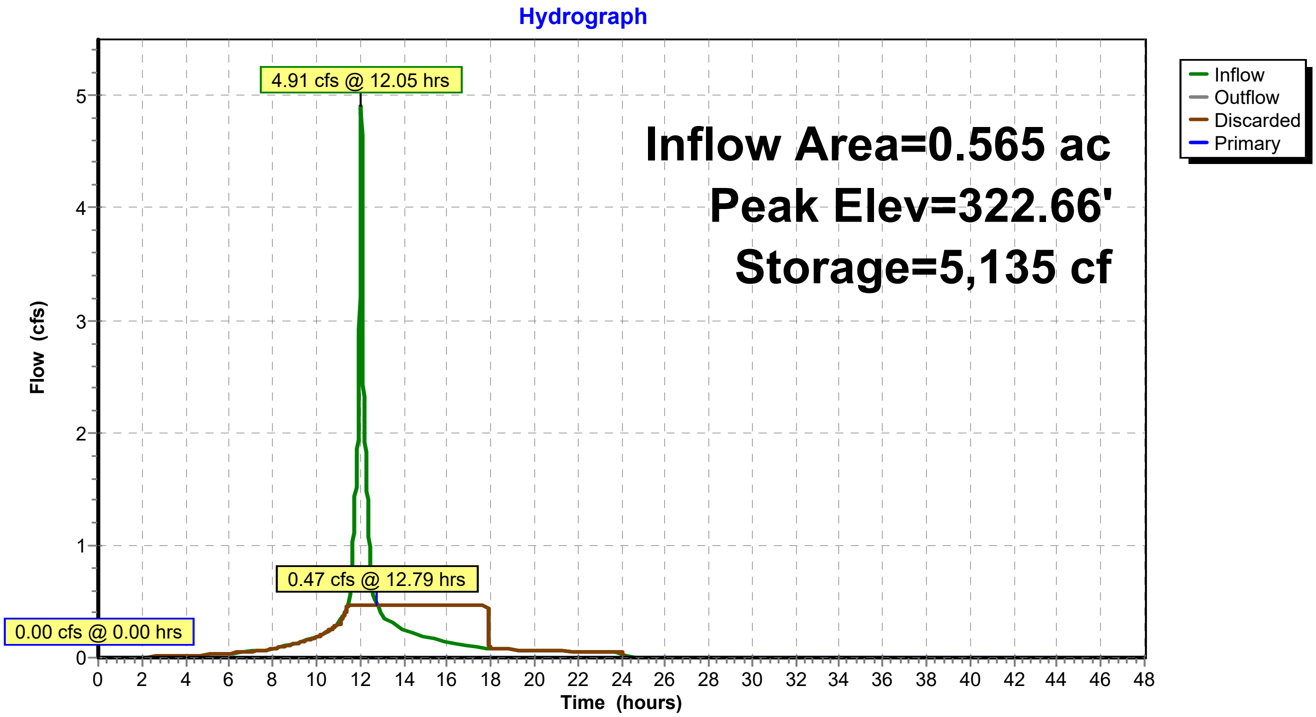
Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Discarded	319.50'	**8.270 in/hr Exfiltration over Surface area**
			Conductivity to Groundwater Elevation = 0.00'
#2	Primary	323.00'	**24.0" x 24.0" Horiz. Orifice/Grate** C= 0.600
			Limited to weir flow at low heads

Discarded OutFlow Max=0.47 cfs @ 12.79 hrs HW=322.66' (Free Discharge)
└─**1=Exfiltration** (Controls 0.47 cfs)

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=319.50' (Free Discharge)
└─**2=Orifice/Grate** (Controls 0.00 cfs)

Pond P3: Infiltration



Pipe Sizing Analysis

Pipe Listing (selected nodes)

Line#	Node Number	In-Invert (feet)	Out-Invert (feet)	Length (feet)	Slope (ft/ft)	n	Diam/Width (inches)	Height (inches)	Inside-Fill (inches)
1	Rp1	323.25	322.26	99.2	0.0100	0.012	12.0	0.0	0.0
2	Rp2	321.15	320.96	18.6	0.0102	0.012	12.0	0.0	0.0
3	Rp3	320.46	320.18	3.9	0.0718	0.012	12.0	0.0	0.0
4	Rp4	320.10	320.00	2.6	0.0385	0.012	12.0	0.0	0.0
5	Rp6	323.17	320.50	79.2	0.0337	0.012	12.0	0.0	0.0

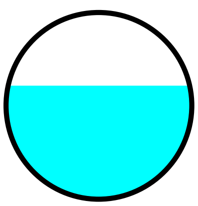
Summary for Reach Rp1: Pipe P1

Inflow Area = 0.269 ac, 93.82% Impervious, Inflow Depth = 8.16" for 100 year event
Inflow = 2.64 cfs @ 12.03 hrs, Volume= 0.183 af
Outflow = 2.63 cfs @ 12.04 hrs, Volume= 0.183 af, Atten= 0%, Lag= 0.3 min

Routing by Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Max. Velocity= 5.28 fps, Min. Travel Time= 0.3 min
Avg. Velocity = 1.73 fps, Avg. Travel Time= 1.0 min

Peak Storage= 49 cf @ 12.04 hrs
Average Depth at Peak Storage= 0.61'
Bank-Full Depth= 1.00' Flow Area= 0.8 sf, Capacity= 3.86 cfs

12.0" Round Pipe
n= 0.012
Length= 99.2' Slope= 0.0100 '/'
Inlet Invert= 323.25', Outlet Invert= 322.26'



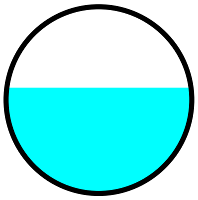
Summary for Reach Rp2: Pipe P2

Inflow Area = 0.295 ac, 73.05% Impervious, Inflow Depth = 6.66" for 100 year event
Inflow = 2.39 cfs @ 12.06 hrs, Volume= 0.164 af
Outflow = 2.39 cfs @ 12.06 hrs, Volume= 0.164 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Max. Velocity= 5.22 fps, Min. Travel Time= 0.1 min
Avg. Velocity = 1.75 fps, Avg. Travel Time= 0.2 min

Peak Storage= 9 cf @ 12.06 hrs
Average Depth at Peak Storage= 0.57'
Bank-Full Depth= 1.00' Flow Area= 0.8 sf, Capacity= 3.90 cfs

12.0" Round Pipe
n= 0.012
Length= 18.6' Slope= 0.0102 '/'
Inlet Invert= 321.15', Outlet Invert= 320.96'



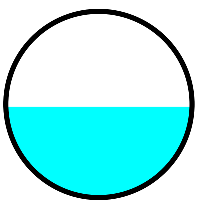
Summary for Reach Rp3: Pipe P3

Inflow Area = 0.565 ac, 82.96% Impervious, Inflow Depth = 7.38" for 100 year event
Inflow = 4.91 cfs @ 12.05 hrs, Volume= 0.347 af
Outflow = 4.91 cfs @ 12.05 hrs, Volume= 0.347 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Max. Velocity= 13.00 fps, Min. Travel Time= 0.0 min
Avg. Velocity = 4.11 fps, Avg. Travel Time= 0.0 min

Peak Storage= 1 cf @ 12.05 hrs
Average Depth at Peak Storage= 0.49'
Bank-Full Depth= 1.00' Flow Area= 0.8 sf, Capacity= 10.34 cfs

12.0" Round Pipe
n= 0.012
Length= 3.9' Slope= 0.0718 '/'
Inlet Invert= 320.46', Outlet Invert= 320.18'



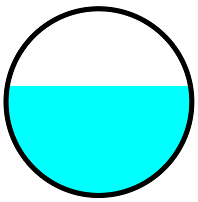
Summary for Reach Rp4: Pipe P4

Inflow Area = 0.565 ac, 82.96% Impervious, Inflow Depth = 7.38" for 100 year event
Inflow = 4.91 cfs @ 12.05 hrs, Volume= 0.347 af
Outflow = 4.91 cfs @ 12.05 hrs, Volume= 0.347 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Max. Velocity= 10.25 fps, Min. Travel Time= 0.0 min
Avg. Velocity = 3.30 fps, Avg. Travel Time= 0.0 min

Peak Storage= 1 cf @ 12.05 hrs
Average Depth at Peak Storage= 0.59'
Bank-Full Depth= 1.00' Flow Area= 0.8 sf, Capacity= 7.57 cfs

12.0" Round Pipe
n= 0.012
Length= 2.6' Slope= 0.0385 '/'
Inlet Invert= 320.10', Outlet Invert= 320.00'



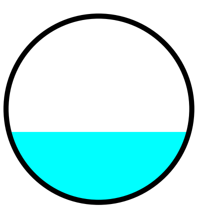
Summary for Reach Rp6: Pipe P6

Inflow Area = 0.201 ac,100.00% Impervious, Inflow Depth = 8.59" for 100 year event
Inflow = 2.10 cfs @ 12.01 hrs, Volume= 0.144 af
Outflow = 2.10 cfs @ 12.01 hrs, Volume= 0.144 af, Atten= 0%, Lag= 0.1 min

Routing by Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Max. Velocity= 7.86 fps, Min. Travel Time= 0.2 min
Avg. Velocity = 2.50 fps, Avg. Travel Time= 0.5 min

Peak Storage= 21 cf @ 12.01 hrs
Average Depth at Peak Storage= 0.37'
Bank-Full Depth= 1.00' Flow Area= 0.8 sf, Capacity= 7.09 cfs

12.0" Round Pipe
n= 0.012
Length= 79.2' Slope= 0.0337 '/'
Inlet Invert= 323.17', Outlet Invert= 320.50'



Standard 3: Recharge

Calculate required recharge volume:

Hydrologic Soil Type	F (Inches)	New Impervious Area (Acres)	Rv (ft^3)
A	0.60	0.513	1,118 ft^3
B	0.35	0	0 ft^3
C	0.25	0	0 ft^3
D	0.10	0	0 ft^3
Total Recharge Volume		**1,118 ft^3**	

Please see the attached soil report, watershed maps, and hydrologic analysis for additional information.

The volume of runoff infiltrated at Infiltration Sysem 1 during the WQS is 1.00" depth x 24,600 ft^2 = 2,050 ft^3. The volume of runoff infiltrated at the remaining kettle hole is 1.00" depth x 108,325 ft^2 = 9,027 ft^3. The total infiltrated volume is 11,077 ft^3.
(The 1" runoff volume depth within the infiltration system and kettle hole are below the overflow elevations. Therefore, the entire volume is infiltrated.)

11,077 ft^3 > 1,118 ft^3, Infiltration volume is sufficient to satisfy the requirement.

Calculate infiltration drawdown time:

Subsurface Chamber System

System bottom area = 2,385 ft^2
Runoff volume to be infiltrated = 2,050 ft^3
K=8.27 in/hr

Dt=Rv/((K)(Bottom area))
Dt=2,050 ft^3/((8.27 in/hr)(1 ft/12 in)(2,385 ft^2)) = 1.25 hrs

1.25 hrs < 72 hrs, Drawdown time is adequate.

Remainder of Existing Kettle Hole

Runoff volume to be infiltrated = 9,027 ft^3
Elevation at 9,027 ft^3 = 324.1
Area at 324.1 = 3,714 ft^2
Area at bottom elevation of 320 = 737ft^2
Average area for infiltrated volume = 4,451 ft^2

K=5 in/hr (Rate reduced in consideration of sediment accumulation)

Dt=Rv/((K)(Bottom area))
Dt=9,027 ft^3/((5 in/hr)(1 ft/12 in)(4,451 ft^2)) = 4.9 hrs

4.9 hrs < 72 hrs, Drawdown time is adequate.

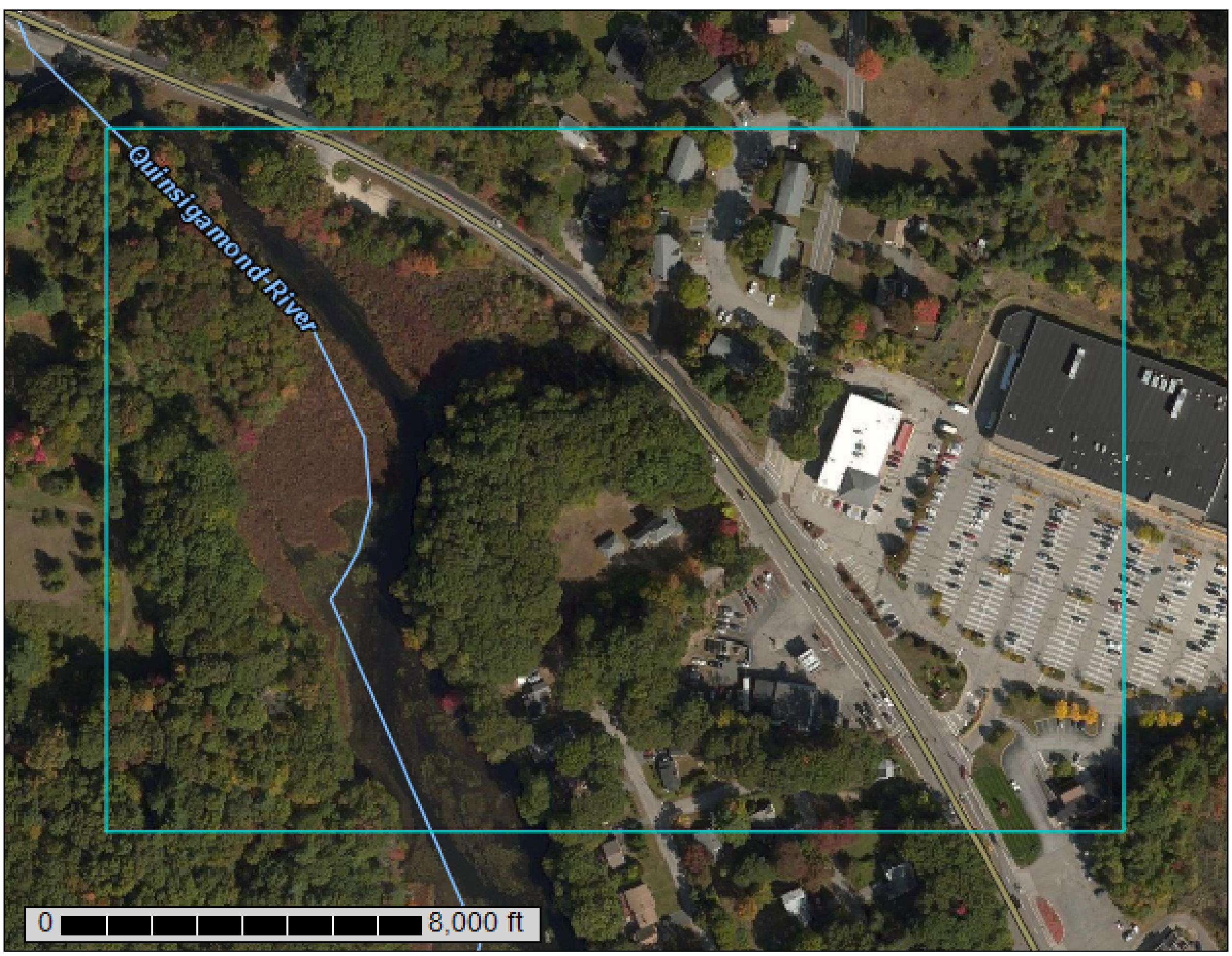
United States Department of Agriculture

NRCS

Natural Resources Conservation Service

A product of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local participants

Custom Soil Resource Report for Worcester County, Massachusetts, Southern Part



January 19, 2016

Preface

Soil surveys contain information that affects land use planning in survey areas. They highlight soil limitations that affect various land uses and provide information about the properties of the soils in the survey areas. Soil surveys are designed for many different users, including farmers, ranchers, foresters, agronomists, urban planners, community officials, engineers, developers, builders, and home buyers. Also, conservationists, teachers, students, and specialists in recreation, waste disposal, and pollution control can use the surveys to help them understand, protect, or enhance the environment.

Various land use regulations of Federal, State, and local governments may impose special restrictions on land use or land treatment. Soil surveys identify soil properties that are used in making various land use or land treatment decisions. The information is intended to help the land users identify and reduce the effects of soil limitations on various land uses. The landowner or user is responsible for identifying and complying with existing laws and regulations.

Although soil survey information can be used for general farm, local, and wider area planning, onsite investigation is needed to supplement this information in some cases. Examples include soil quality assessments (http://www.nrcs.usda.gov/wps/portal/nrcs/main/soils/health/) and certain conservation and engineering applications. For more detailed information, contact your local USDA Service Center (http://offices.sc.egov.usda.gov/locator/app?agency=nrcs) or your NRCS State Soil Scientist (http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/contactus/?cid=nrcs142p2_053951).

Great differences in soil properties can occur within short distances. Some soils are seasonally wet or subject to flooding. Some are too unstable to be used as a foundation for buildings or roads. Clayey or wet soils are poorly suited to use as septic tank absorption fields. A high water table makes a soil poorly suited to basements or underground installations.

The National Cooperative Soil Survey is a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local agencies. The Natural Resources Conservation Service (NRCS) has leadership for the Federal part of the National Cooperative Soil Survey.

Information about soils is updated periodically. Updated information is available through the NRCS Web Soil Survey, the site for official soil survey information.

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Contents

How Soil Surveys Are Made

Soil surveys are made to provide information about the soils and miscellaneous areas in a specific area. They include a description of the soils and miscellaneous areas and their location on the landscape and tables that show soil properties and limitations affecting various uses. Soil scientists observed the steepness, length, and shape of the slopes; the general pattern of drainage; the kinds of crops and native plants; and the kinds of bedrock. They observed and described many soil profiles. A soil profile is the sequence of natural layers, or horizons, in a soil. The profile extends from the surface down into the unconsolidated material in which the soil formed or from the surface down to bedrock. The unconsolidated material is devoid of roots and other living organisms and has not been changed by other biological activity.

Currently, soils are mapped according to the boundaries of major land resource areas (MLRAs). MLRAs are geographically associated land resource units that share common characteristics related to physiography, geology, climate, water resources, soils, biological resources, and land uses (USDA, 2006). Soil survey areas typically consist of parts of one or more MLRA.

The soils and miscellaneous areas in a survey area occur in an orderly pattern that is related to the geology, landforms, relief, climate, and natural vegetation of the area. Each kind of soil and miscellaneous area is associated with a particular kind of landform or with a segment of the landform. By observing the soils and miscellaneous areas in the survey area and relating their position to specific segments of the landform, a soil scientist develops a concept, or model, of how they were formed. Thus, during mapping, this model enables the soil scientist to predict with a considerable degree of accuracy the kind of soil or miscellaneous area at a specific location on the landscape.

Commonly, individual soils on the landscape merge into one another as their characteristics gradually change. To construct an accurate soil map, however, soil scientists must determine the boundaries between the soils. They can observe only a limited number of soil profiles. Nevertheless, these observations, supplemented by an understanding of the soil-vegetation-landscape relationship, are sufficient to verify predictions of the kinds of soil in an area and to determine the boundaries.

Soil scientists recorded the characteristics of the soil profiles that they studied. They noted soil color, texture, size and shape of soil aggregates, kind and amount of rock fragments, distribution of plant roots, reaction, and other features that enable them to identify soils. After describing the soils in the survey area and determining their properties, the soil scientists assigned the soils to taxonomic classes (units). Taxonomic classes are concepts. Each taxonomic class has a set of soil characteristics with precisely defined limits. The classes are used as a basis for comparison to classify soils systematically. Soil taxonomy, the system of taxonomic classification used in the United States, is based mainly on the kind and character of soil properties and the arrangement of horizons within the profile. After the soil scientists classified and named the soils in the survey area, they compared the individual soils with similar soils in the same taxonomic class in other areas so that they could confirm data and assemble additional data based on experience and research.

The objective of soil mapping is not to delineate pure map unit components; the objective is to separate the landscape into landforms or landform segments that have similar use and management requirements. Each map unit is defined by a unique combination of soil components and/or miscellaneous areas in predictable proportions. Some components may be highly contrasting to the other components of the map unit. The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The delineation of such landforms and landform segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, onsite investigation is needed to define and locate the soils and miscellaneous areas.

Soil scientists make many field observations in the process of producing a soil map. The frequency of observation is dependent upon several factors, including scale of mapping, intensity of mapping, design of map units, complexity of the landscape, and experience of the soil scientist. Observations are made to test and refine the soil-landscape model and predictions and to verify the classification of the soils at specific locations. Once the soil-landscape model is refined, a significantly smaller number of measurements of individual soil properties are made and recorded. These measurements may include field measurements, such as those for color, depth to bedrock, and texture, and laboratory measurements, such as those for content of sand, silt, clay, salt, and other components. Properties of each soil typically vary from one point to another across the landscape.

Observations for map unit components are aggregated to develop ranges of characteristics for the components. The aggregated values are presented. Direct measurements do not exist for every property presented for every map unit component. Values for some properties are estimated from combinations of other properties.

While a soil survey is in progress, samples of some of the soils in the area generally are collected for laboratory analyses and for engineering tests. Soil scientists interpret the data from these analyses and tests as well as the field-observed characteristics and the soil properties to determine the expected behavior of the soils under different uses. Interpretations for all of the soils are field tested through observation of the soils in different uses and under different levels of management. Some interpretations are modified to fit local conditions, and some new interpretations are developed to meet local needs. Data are assembled from other sources, such as research information, production records, and field experience of specialists. For example, data on crop yields under defined levels of management are assembled from farm records and from field or plot experiments on the same kinds of soil.

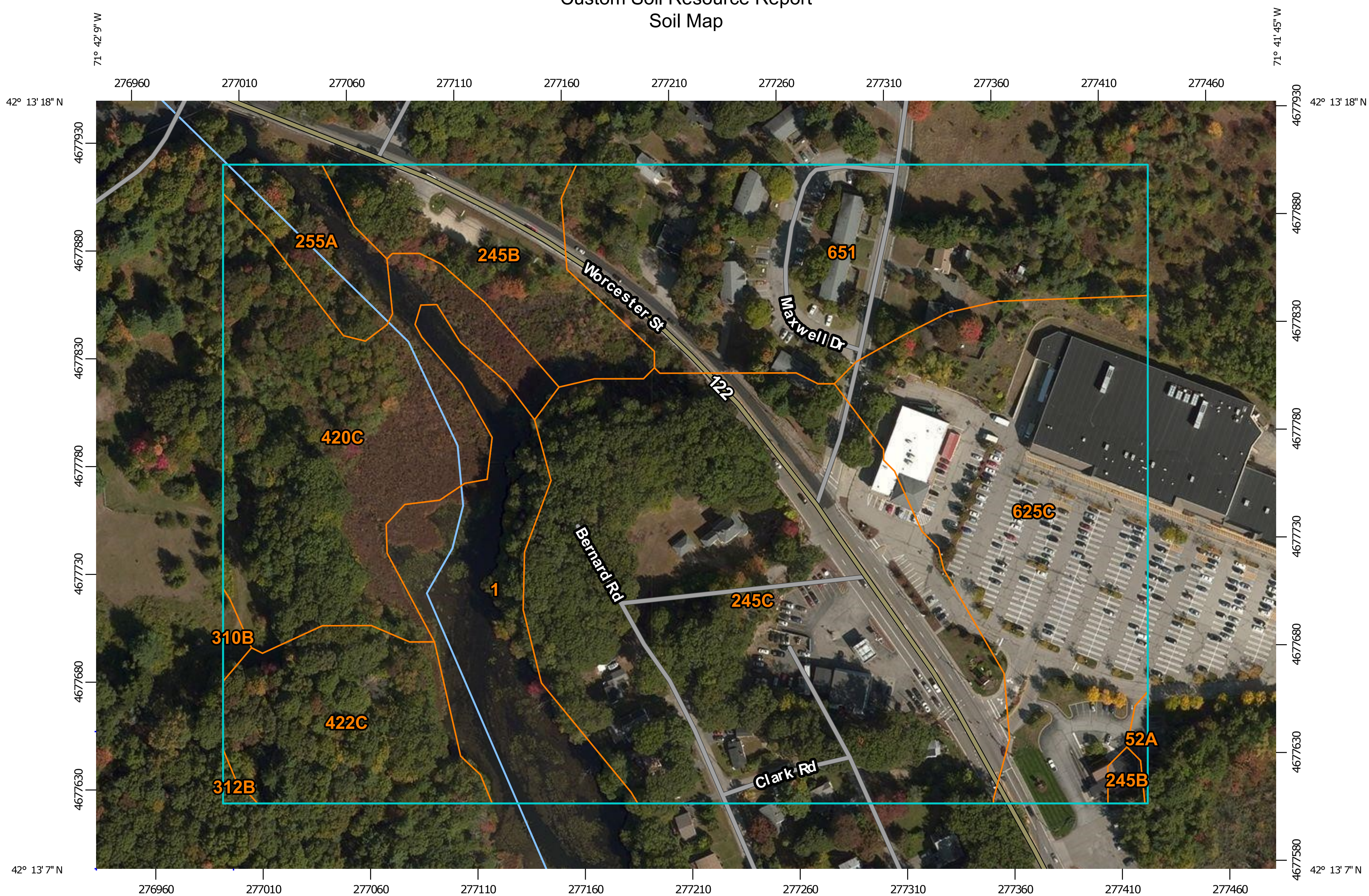
Predictions about soil behavior are based not only on soil properties but also on such variables as climate and biological activity. Soil conditions are predictable over long periods of time, but they are not predictable from year to year. For example, soil scientists can predict with a fairly high degree of accuracy that a given soil will have a high water table within certain depths in most years, but they cannot predict that a high water table will always be at a specific level in the soil on a specific date.

After soil scientists located and identified the significant natural bodies of soil in the survey area, they drew the boundaries of these bodies on aerial photographs and identified each as a specific map unit. Aerial photographs show trees, buildings, fields, roads, and rivers, all of which help in locating boundaries accurately.

Soil Map

The soil map section includes the soil map for the defined area of interest, a list of soil map units on the map and extent of each map unit, and cartographic symbols displayed on the map. Also presented are various metadata about data used to produce the map, and a description of each soil map unit.

Soil Map



Map Scale: 1:2,510 if printed on A landscape (11" x 8.5") sheet.

N

Meters: 0, 35, 70, 140, 210

Feet: 0, 100, 200, 400, 600

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

MAP LEGEND

Area of Interest (AOI)
- Area of Interest (AOI)

Soils
- Soil Map Unit Polygons
- Soil Map Unit Lines
- Soil Map Unit Points

Special Point Features
- Blowout
- Borrow Pit
- Clay Spot
- Closed Depression
- Gravel Pit
- Gravelly Spot
- Landfill
- Lava Flow
- Marsh or swamp
- Mine or Quarry
- Miscellaneous Water
- Perennial Water
- Rock Outcrop
- Saline Spot
- Sandy Spot
- Severely Eroded Spot
- Sinkhole
- Slide or Slip
- Sodic Spot
- Spoil Area
- Stony Spot
- Very Stony Spot
- Wet Spot
- Other
- Special Line Features

Water Features
- Streams and Canals

Transportation
- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

Background
- Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:25,000.

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

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

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

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL: http://websoilsurvey.nrcs.usda.gov
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: Worcester County, Massachusetts, Southern Part
Survey Area Data: Version 8, Sep 28, 2015

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

Date(s) aerial images were photographed: Sep 12, 2014—Sep 28, 2014

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

Map Unit Legend

Worcester County, Massachusetts, Southern Part (MA615)			
Map Unit Symbol	**Map Unit Name**	**Acres in AOI**	**Percent of AOI**
1	Water	2.5	7.9%
52A	Freetown muck, 0 to 1 percent slopes	0.1	0.2%
245B	Hinckley loamy sand, 3 to 8 percent slopes	1.9	6.1%
245C	Hinckley loamy sand, 8 to 15 percent slopes	9.0	28.5%
255A	Windsor loamy sand, 0 to 3 percent slopes	0.8	2.6%
310B	Woodbridge fine sandy loam, 3 to 8 percent slopes	0.1	0.2%
312B	Woodbridge fine sandy loam, 0 to 8 percent slopes, extremely stony	0.0	0.1%
420C	Canton fine sandy loam, 8 to 15 percent slopes	4.4	14.0%
422C	Canton fine sandy loam, 8 to 15 percent slopes, extremely stony	2.0	6.4%
625C	Hinckley-Urban land complex, 0 to 15 percent slopes	5.5	17.3%
651	Udorthents, smoothed	5.3	16.6%
Totals for Area of Interest		**31.7**	**100.0%**

Map Unit Descriptions

The map units delineated on the detailed soil maps in a soil survey represent the soils or miscellaneous areas in the survey area. The map unit descriptions, along with the maps, can be used to determine the composition and properties of a unit.

A map unit delineation on a soil map represents an area dominated by one or more major kinds of soil or miscellaneous areas. A map unit is identified and named according to the taxonomic classification of the dominant soils. Within a taxonomic class there are precisely defined limits for the properties of the soils. On the landscape, however, the soils are natural phenomena, and they have the characteristic variability of all natural phenomena. Thus, the range of some observed properties may extend beyond the limits defined for a taxonomic class. Areas of soils of a single taxonomic class rarely, if ever, can be mapped without including areas of other taxonomic classes. Consequently, every map unit is made up of the soils or miscellaneous areas for which it is named and some minor components that belong to taxonomic classes other than those of the major soils.

Most minor soils have properties similar to those of the dominant soil or soils in the map unit, and thus they do not affect use and management. These are called noncontrasting, or similar, components. They may or may not be mentioned in a particular map unit description. Other minor components, however, have properties and behavioral characteristics divergent enough to affect use or to require different management. These are called contrasting, or dissimilar, components. They generally are in small areas and could not be mapped separately because of the scale used. Some small areas of strongly contrasting soils or miscellaneous areas are identified by a special symbol on the maps. If included in the database for a given area, the contrasting minor components are identified in the map unit descriptions along with some characteristics of each. A few areas of minor components may not have been observed, and consequently they are not mentioned in the descriptions, especially where the pattern was so complex that it was impractical to make enough observations to identify all the soils and miscellaneous areas on the landscape.

The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The objective of mapping is not to delineate pure taxonomic classes but rather to separate the landscape into landforms or landform segments that have similar use and management requirements. The delineation of such segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, however, onsite investigation is needed to define and locate the soils and miscellaneous areas.

An identifying symbol precedes the map unit name in the map unit descriptions. Each description includes general facts about the unit and gives important soil properties and qualities.

Soils that have profiles that are almost alike make up a *soil series*. Except for differences in texture of the surface layer, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement.

Soils of one series can differ in texture of the surface layer, slope, stoniness, salinity, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into *soil phases*. Most of the areas shown on the detailed soil maps are phases of soil series. The name of a soil phase commonly indicates a feature that affects use or management. For example, Alpha silt loam, 0 to 2 percent slopes, is a phase of the Alpha series.

Some map units are made up of two or more major soils or miscellaneous areas. These map units are complexes, associations, or undifferentiated groups.

A *complex* consists of two or more soils or miscellaneous areas in such an intricate pattern or in such small areas that they cannot be shown separately on the maps. The pattern and proportion of the soils or miscellaneous areas are somewhat similar in all areas. Alpha-Beta complex, 0 to 6 percent slopes, is an example.

An *association* is made up of two or more geographically associated soils or miscellaneous areas that are shown as one unit on the maps. Because of present or anticipated uses of the map units in the survey area, it was not considered practical or necessary to map the soils or miscellaneous areas separately. The pattern and relative proportion of the soils or miscellaneous areas are somewhat similar. Alpha-Beta association, 0 to 2 percent slopes, is an example.

An *undifferentiated group* is made up of two or more soils or miscellaneous areas that could be mapped individually but are mapped as one unit because similar interpretations can be made for use and management. The pattern and proportion of the soils or miscellaneous areas in a mapped area are not uniform. An area can be made up of only one of the major soils or miscellaneous areas, or it can be made up of all of them. Alpha and Beta soils, 0 to 2 percent slopes, is an example.

Some surveys include *miscellaneous areas*. Such areas have little or no soil material and support little or no vegetation. Rock outcrop is an example.

Worcester County, Massachusetts, Southern Part

1—Water

Map Unit Setting

National map unit symbol: 9bgp
Mean annual precipitation: 32 to 50 inches
Mean annual air temperature: 45 to 50 degrees F
Frost-free period: 145 to 240 days
Farmland classification: Not prime farmland

Map Unit Composition

Water: 100 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Water

Setting

Landform: Lakes

52A—Freetown muck, 0 to 1 percent slopes

Map Unit Setting

National map unit symbol: 2t2q9
Elevation: 0 to 1,110 feet
Mean annual precipitation: 36 to 71 inches
Mean annual air temperature: 39 to 55 degrees F
Frost-free period: 140 to 240 days
Farmland classification: Farmland of unique importance

Map Unit Composition

Freetown and similar soils: 85 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Freetown

Setting

Landform: Bogs, depressions, depressions, kettles, marshes, swamps
Landform position (two-dimensional): Toeslope
Landform position (three-dimensional): Tread, dip
Down-slope shape: Concave
Across-slope shape: Concave
Parent material: Highly decomposed organic material

Typical profile

Oe - 0 to 2 inches: mucky peat
Oa - 2 to 79 inches: muck

Properties and qualities

Slope: 0 to 1 percent

Percent of area covered with surface fragments: 0.0 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Very poorly drained
Runoff class: Negligible
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to high (0.14 to 14.17 in/hr)
Depth to water table: About 0 to 6 inches
Frequency of flooding: Rare
Frequency of ponding: Frequent
Available water storage in profile: Very high (about 19.2 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 5w
Hydrologic Soil Group: B/D

Minor Components

Swansea

Percent of map unit: 5 percent
Landform: Marshes, swamps, bogs, depressions, depressions, kettles
Landform position (two-dimensional): Toeslope
Landform position (three-dimensional): Tread, dip
Down-slope shape: Concave
Across-slope shape: Concave

Scarboro

Percent of map unit: 5 percent
Landform: Depressions, drainageways
Landform position (two-dimensional): Toeslope
Landform position (three-dimensional): Base slope, tread, dip
Down-slope shape: Concave
Across-slope shape: Concave

Whitman

Percent of map unit: 5 percent
Landform: Depressions, drainageways
Landform position (two-dimensional): Toeslope
Landform position (three-dimensional): Base slope
Down-slope shape: Concave
Across-slope shape: Concave

245B—Hinckley loamy sand, 3 to 8 percent slopes

Map Unit Setting

National map unit symbol: 2svm8
Elevation: 0 to 1,430 feet
Mean annual precipitation: 36 to 53 inches
Mean annual air temperature: 39 to 55 degrees F
Frost-free period: 140 to 250 days
Farmland classification: Farmland of statewide importance

Map Unit Composition

Hinckley and similar soils: 85 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Hinckley

Setting

Landform: Eskers, outwash deltas, moraines, outwash terraces, outwash plains, kame terraces, kames
Landform position (two-dimensional): Summit, shoulder, backslope, footslope
Landform position (three-dimensional): Base slope, crest, nose slope, side slope, riser, tread
Down-slope shape: Linear, convex, concave
Across-slope shape: Convex, linear, concave
Parent material: Sandy and gravelly glaciofluvial deposits derived from gneiss and/or granite and/or schist

Typical profile

Oe - 0 to 1 inches: moderately decomposed plant material
A - 1 to 8 inches: loamy sand
Bw1 - 8 to 11 inches: gravelly loamy sand
Bw2 - 11 to 16 inches: gravelly loamy sand
BC - 16 to 19 inches: very gravelly loamy sand
C - 19 to 65 inches: very gravelly sand

Properties and qualities

Slope: 3 to 8 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Excessively drained
Runoff class: Very low
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to very high (1.42 to 99.90 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Salinity, maximum in profile: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water storage in profile: Very low (about 3.0 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 3s
Hydrologic Soil Group: A

Minor Components

Windsor

Percent of map unit: 8 percent
Landform: Moraines, outwash terraces, outwash plains, kame terraces, kames, eskers, outwash deltas
Landform position (two-dimensional): Summit, shoulder, backslope, footslope
Landform position (three-dimensional): Nose slope, side slope, base slope, crest, riser, tread
Down-slope shape: Linear, convex, concave
Across-slope shape: Convex, linear, concave

Sudbury

Percent of map unit: 5 percent
Landform: Kame terraces, outwash deltas, moraines, outwash terraces, outwash plains
Landform position (two-dimensional): Backslope, footslope
Landform position (three-dimensional): Side slope, base slope, head slope, tread
Down-slope shape: Concave, linear
Across-slope shape: Linear, concave

Agawam

Percent of map unit: 2 percent
Landform: Kames, eskers, outwash deltas, moraines, outwash terraces, outwash plains, kame terraces
Landform position (two-dimensional): Summit, shoulder, backslope, footslope
Landform position (three-dimensional): Nose slope, side slope, base slope, crest, riser, tread
Down-slope shape: Linear, convex, concave
Across-slope shape: Convex, linear, concave

245C—Hinckley loamy sand, 8 to 15 percent slopes

Map Unit Setting

National map unit symbol: 2svm9
Elevation: 0 to 1,480 feet
Mean annual precipitation: 36 to 71 inches
Mean annual air temperature: 39 to 55 degrees F
Frost-free period: 140 to 240 days
Farmland classification: Not prime farmland

Map Unit Composition

Hinckley and similar soils: 85 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Hinckley

Setting

Landform: Outwash terraces, outwash plains, kame terraces, kames, eskers, outwash deltas, moraines
Landform position (two-dimensional): Shoulder, toeslope, footslope, backslope
Landform position (three-dimensional): Nose slope, side slope, crest, head slope, riser
Down-slope shape: Linear, concave, convex
Across-slope shape: Convex, linear, concave
Parent material: Sandy and gravelly glaciofluvial deposits derived from gneiss and/or granite and/or schist

Typical profile

Oe - 0 to 1 inches: moderately decomposed plant material
A - 1 to 8 inches: loamy sand

Bw1 - 8 to 11 inches: gravelly loamy sand
Bw2 - 11 to 16 inches: gravelly loamy sand
BC - 16 to 19 inches: very gravelly loamy sand
C - 19 to 65 inches: very gravelly sand

Properties and qualities

Slope: 8 to 15 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Excessively drained
Runoff class: Very low
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to very high (1.42 to 99.90 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Salinity, maximum in profile: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water storage in profile: Low (about 3.1 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 4e
Hydrologic Soil Group: A

Minor Components

Windsor

Percent of map unit: 5 percent
Landform: Outwash plains, kame terraces, kames, eskers, outwash deltas, moraines, outwash terraces
Landform position (two-dimensional): Shoulder, backslope, footslope, toeslope
Landform position (three-dimensional): Nose slope, side slope, crest, head slope, riser
Down-slope shape: Convex, linear, concave
Across-slope shape: Linear, convex, concave

Merrimac

Percent of map unit: 5 percent
Landform: Outwash plains, kames, eskers, moraines, outwash terraces
Landform position (two-dimensional): Shoulder, backslope, footslope, toeslope
Landform position (three-dimensional): Side slope, crest, head slope, nose slope, riser
Down-slope shape: Convex
Across-slope shape: Convex

Sudbury

Percent of map unit: 5 percent
Landform: Moraines, outwash terraces, outwash plains, kame terraces, outwash deltas
Landform position (two-dimensional): Backslope, footslope
Landform position (three-dimensional): Base slope, tread
Down-slope shape: Concave, linear
Across-slope shape: Linear, concave

255A—Windsor loamy sand, 0 to 3 percent slopes

Map Unit Setting

National map unit symbol: 2svkg
Elevation: 0 to 990 feet
Mean annual precipitation: 36 to 71 inches
Mean annual air temperature: 39 to 55 degrees F
Frost-free period: 140 to 240 days
Farmland classification: Farmland of statewide importance

Map Unit Composition

Windsor, loamy sand, and similar soils: 85 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Windsor, Loamy Sand

Setting

Landform: Deltas, dunes, outwash plains, outwash terraces
Landform position (three-dimensional): Riser, tread
Down-slope shape: Linear, convex
Across-slope shape: Linear, convex
Parent material: Loose sandy glaciofluvial deposits derived from granite and/or loose sandy glaciofluvial deposits derived from schist and/or loose sandy glaciofluvial deposits derived from gneiss

Typical profile

O - 0 to 1 inches: moderately decomposed plant material
A - 1 to 3 inches: loamy sand
Bw - 3 to 25 inches: loamy sand
C - 25 to 65 inches: sand

Properties and qualities

Slope: 0 to 3 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Excessively drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to very high (1.42 to 99.90 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Salinity, maximum in profile: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water storage in profile: Low (about 3.6 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 2s
Hydrologic Soil Group: A

Minor Components

Deerfield, loamy sand

Percent of map unit: 10 percent
Landform: Deltas, outwash plains, terraces
Landform position (two-dimensional): Footslope
Landform position (three-dimensional): Tread, talf
Down-slope shape: Linear
Across-slope shape: Linear

Hinckley, loamy sand

Percent of map unit: 5 percent
Landform: Kames, outwash plains, deltas, eskers
Landform position (two-dimensional): Backslope, shoulder, summit
Landform position (three-dimensional): Nose slope, side slope, crest, head slope, rise
Down-slope shape: Convex
Across-slope shape: Convex, linear

310B—Woodbridge fine sandy loam, 3 to 8 percent slopes

Map Unit Setting

National map unit symbol: 2t2ql
Elevation: 0 to 1,470 feet
Mean annual precipitation: 36 to 71 inches
Mean annual air temperature: 39 to 55 degrees F
Frost-free period: 140 to 240 days
Farmland classification: All areas are prime farmland

Map Unit Composition

Woodbridge, fine sandy loam, and similar soils: 82 percent
Minor components: 18 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Woodbridge, Fine Sandy Loam

Setting

Landform: Ground moraines, hills, drumlins
Landform position (two-dimensional): Summit, footslope, backslope
Landform position (three-dimensional): Side slope
Down-slope shape: Concave
Across-slope shape: Linear
Parent material: Coarse-loamy lodgment till derived from gneiss, granite, and/or schist

Typical profile

Ap - 0 to 7 inches: fine sandy loam
Bw1 - 7 to 18 inches: fine sandy loam
Bw2 - 18 to 30 inches: fine sandy loam
Cd - 30 to 65 inches: gravelly fine sandy loam

Properties and qualities

Slope: 3 to 8 percent
Depth to restrictive feature: 20 to 39 inches to densic material
Natural drainage class: Moderately well drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately low (0.00 to 0.14 in/hr)
Depth to water table: About 18 to 30 inches
Frequency of flooding: None
Frequency of ponding: None
Salinity, maximum in profile: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water storage in profile: Low (about 3.6 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 2w
Hydrologic Soil Group: C/D

Minor Components

Paxton

Percent of map unit: 10 percent
Landform: Drumlins, ground moraines, hills
Landform position (two-dimensional): Shoulder, summit, backslope
Landform position (three-dimensional): Side slope, crest, nose slope
Down-slope shape: Linear, convex
Across-slope shape: Convex

Ridgebury

Percent of map unit: 8 percent
Landform: Drainageways, hills, depressions, ground moraines
Landform position (two-dimensional): Toeslope, footslope, backslope
Landform position (three-dimensional): Head slope, base slope, dip
Down-slope shape: Concave
Across-slope shape: Concave

312B—Woodbridge fine sandy loam, 0 to 8 percent slopes, extremely stony

Map Unit Setting

National map unit symbol: 2t2qs
Elevation: 0 to 1,580 feet
Mean annual precipitation: 36 to 71 inches
Mean annual air temperature: 39 to 55 degrees F
Frost-free period: 140 to 240 days
Farmland classification: Not prime farmland

Map Unit Composition

Woodbridge, extremely stony, and similar soils: 82 percent
Minor components: 18 percent

Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Woodbridge, Extremely Stony

Setting

Landform: Ground moraines, drumlins, hills
Landform position (two-dimensional): Backslope, footslope, summit
Landform position (three-dimensional): Side slope
Down-slope shape: Concave
Across-slope shape: Linear
Parent material: Coarse-loamy lodgment till derived from gneiss, granite, and/or schist

Typical profile

Oe - 0 to 2 inches: moderately decomposed plant material
A - 2 to 9 inches: fine sandy loam
Bw1 - 9 to 20 inches: fine sandy loam
Bw2 - 20 to 32 inches: fine sandy loam
Cd - 32 to 67 inches: gravelly fine sandy loam

Properties and qualities

Slope: 0 to 8 percent
Percent of area covered with surface fragments: 9.0 percent
Depth to restrictive feature: 20 to 43 inches to densic material
Natural drainage class: Moderately well drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately low (0.00 to 0.14 in/hr)
Depth to water table: About 19 to 27 inches
Frequency of flooding: None
Frequency of ponding: None
Salinity, maximum in profile: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water storage in profile: Low (about 4.0 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7s
Hydrologic Soil Group: C/D

Minor Components

Paxton, extremely stony

Percent of map unit: 10 percent
Landform: Hills, ground moraines, drumlins
Landform position (two-dimensional): Shoulder, backslope, summit
Landform position (three-dimensional): Crest, side slope
Down-slope shape: Linear, convex
Across-slope shape: Convex, linear

Ridgebury, extremely stony

Percent of map unit: 8 percent
Landform: Drainageways, ground moraines, drumlins, depressions, hills
Landform position (two-dimensional): Toeslope
Landform position (three-dimensional): Head slope, base slope
Down-slope shape: Concave
Across-slope shape: Concave

420C—Canton fine sandy loam, 8 to 15 percent slopes

Map Unit Setting

National map unit symbol: 9bdd
Elevation: 0 to 1,000 feet
Mean annual precipitation: 32 to 50 inches
Mean annual air temperature: 45 to 50 degrees F
Frost-free period: 145 to 240 days
Farmland classification: Farmland of statewide importance

Map Unit Composition

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

Description of Canton

Setting

Landform: Hills
Landform position (two-dimensional): Shoulder
Landform position (three-dimensional): Side slope
Down-slope shape: Convex
Across-slope shape: Convex
Parent material: Friable coarse-loamy eolian deposits over friable sandy basal till derived from granite and gneiss

Typical profile

O - 0 to 2 inches: muck
H2 - 2 to 5 inches: fine sandy loam
H3 - 5 to 22 inches: fine sandy loam
H4 - 22 to 65 inches: gravelly loamy sand

Properties and qualities

Slope: 8 to 15 percent
Depth to restrictive feature: 18 to 36 inches to strongly contrasting textural stratification
Natural drainage class: Well drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.60 to 6.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Low (about 3.2 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 3e
Hydrologic Soil Group: A

Minor Components

Hinckley

Percent of map unit: 5 percent

Montauk

Percent of map unit: 5 percent

Charlton

Percent of map unit: 5 percent

Scituate

Percent of map unit: 5 percent

422C—Canton fine sandy loam, 8 to 15 percent slopes, extremely stony

Map Unit Setting

National map unit symbol: 9bdh
Elevation: 0 to 1,000 feet
Mean annual precipitation: 32 to 50 inches
Mean annual air temperature: 45 to 50 degrees F
Frost-free period: 145 to 240 days
Farmland classification: Not prime farmland

Map Unit Composition

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

Description of Canton

Setting

Landform: Ridges, hills
Landform position (two-dimensional): Footslope
Landform position (three-dimensional): Side slope
Down-slope shape: Linear
Across-slope shape: Convex
Parent material: Friable coarse-loamy eolian deposits over friable sandy basal till derived from granite and gneiss

Typical profile

O - 0 to 2 inches: muck
H2 - 2 to 5 inches: fine sandy loam
H3 - 5 to 22 inches: fine sandy loam
H4 - 22 to 65 inches: gravelly loamy sand

Properties and qualities

Slope: 8 to 15 percent
Percent of area covered with surface fragments: 9.0 percent
Depth to restrictive feature: 18 to 36 inches to strongly contrasting textural stratification

Natural drainage class: Well drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.60 to 6.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Low (about 3.2 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7s
Hydrologic Soil Group: A

Minor Components

Charlton

Percent of map unit: 10 percent

Hinckley

Percent of map unit: 10 percent

625C—Hinckley-Urban land complex, 0 to 15 percent slopes

Map Unit Setting

National map unit symbol: 2svm1
Elevation: 140 to 770 feet
Mean annual precipitation: 36 to 71 inches
Mean annual air temperature: 39 to 55 degrees F
Frost-free period: 140 to 240 days
Farmland classification: Not prime farmland

Map Unit Composition

Hinckley and similar soils: 45 percent
Urban land: 35 percent
Minor components: 20 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Hinckley

Setting

Landform: Kame terraces, kames, eskers, outwash deltas, moraines, outwash terraces, outwash plains
Landform position (two-dimensional): Summit, footslope, shoulder, backslope, toeslope
Landform position (three-dimensional): Nose slope, side slope, crest, head slope, riser, tread
Down-slope shape: Linear, convex, concave
Across-slope shape: Convex, linear, concave
Parent material: Sandy and gravelly glaciofluvial deposits derived from gneiss and/or granite and/or schist

Typical profile

A - 0 to 8 inches: loamy sand
Bw1 - 8 to 11 inches: gravelly loamy sand
Bw2 - 11 to 16 inches: gravelly loamy sand
BC - 16 to 19 inches: very gravelly loamy sand
C - 19 to 65 inches: very gravelly sand

Properties and qualities

Slope: 0 to 15 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Excessively drained
Runoff class: Very low
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to very high (1.42 to 99.90 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Salinity, maximum in profile: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water storage in profile: Very low (about 2.9 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 4e
Hydrologic Soil Group: A

Description of Urban Land

Typical profile

M - 0 to 6 inches: cemented material

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 8
Hydrologic Soil Group: D

Minor Components

Udorthents

Percent of map unit: 10 percent

Merrimac

Percent of map unit: 5 percent
Landform: Kames, eskers, moraines, outwash terraces, outwash plains, kame terraces
Landform position (two-dimensional): Backslope, footslope, shoulder, summit, toeslope
Landform position (three-dimensional): Side slope, crest, head slope, nose slope, riser, tread
Down-slope shape: Convex, concave, linear
Across-slope shape: Concave, convex, linear

Windsor

Percent of map unit: 5 percent
Landform: Kames, eskers, outwash deltas, moraines, outwash terraces, outwash plains, kame terraces
Landform position (two-dimensional): Summit, toeslope, backslope, footslope, shoulder

Landform position (three-dimensional): Nose slope, side slope, crest, head slope, riser, tread
Down-slope shape: Linear, concave, convex
Across-slope shape: Linear, concave, convex

651—Udorthents, smoothed

Map Unit Setting

National map unit symbol: 9bfc
Elevation: 0 to 3,000 feet
Mean annual precipitation: 32 to 50 inches
Mean annual air temperature: 45 to 50 degrees F
Frost-free period: 145 to 240 days
Farmland classification: Not prime farmland

Map Unit Composition

Udorthents and similar soils: 80 percent
Urban land: 20 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Udorthents

Setting

Parent material: Made land over firm coarse-loamy basal till and/or dense coarse-loamy lodgment till

Typical profile

H1 - 0 to 6 inches: variable
H2 - 6 to 60 inches: variable

Properties and qualities

Slope: 0 to 25 percent
Depth to restrictive feature: More than 80 inches
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to very high (0.06 to 20.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 6s
Hydrologic Soil Group: A

Soil Information for All Uses

Soil Properties and Qualities

The Soil Properties and Qualities section includes various soil properties and qualities displayed as thematic maps with a summary table for the soil map units in the selected area of interest. A single value or rating for each map unit is generated by aggregating the interpretive ratings of individual map unit components. This aggregation process is defined for each property or quality.

Soil Qualities and Features

Soil qualities are behavior and performance attributes that are not directly measured, but are inferred from observations of dynamic conditions and from soil properties. Example soil qualities include natural drainage, and frost action. Soil features are attributes that are not directly part of the soil. Example soil features include slope and depth to restrictive layer. These features can greatly impact the use and management of the soil.

Hydrologic Soil Group

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.

Map—Hydrologic Soil Group

Map Scale: 1:2,510 if printed on A landscape (11" x 8.5") sheet.

Meters: 0, 35, 70, 140, 210

Feet: 0, 100, 200, 400, 600

N

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 1:25,000.

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

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

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

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL: http://websoilsurvey.nrcs.usda.gov
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: Worcester County, Massachusetts, Southern Part
Survey Area Data: Version 8, Sep 28, 2015

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

Date(s) aerial images were photographed: Sep 12, 2014—Sep 28, 2014

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.

Table—Hydrologic Soil Group

Hydrologic Soil Group— Summary by Map Unit — Worcester County, Massachusetts, Southern Part (MA615)				
Map unit symbol	**Map unit name**	**Rating**	**Acres in AOI**	**Percent of AOI**
1	Water		2.5	7.9%
52A	Freetown muck, 0 to 1 percent slopes	B/D	0.1	0.2%
245B	Hinckley loamy sand, 3 to 8 percent slopes	A	1.9	6.1%
245C	Hinckley loamy sand, 8 to 15 percent slopes	A	9.0	28.5%
255A	Windsor loamy sand, 0 to 3 percent slopes	A	0.8	2.6%
310B	Woodbridge fine sandy loam, 3 to 8 percent slopes	C/D	0.1	0.2%
312B	Woodbridge fine sandy loam, 0 to 8 percent slopes, extremely stony	C/D	0.0	0.1%
420C	Canton fine sandy loam, 8 to 15 percent slopes	A	4.4	14.0%
422C	Canton fine sandy loam, 8 to 15 percent slopes, extremely stony	A	2.0	6.4%
625C	Hinckley-Urban land complex, 0 to 15 percent slopes	A	5.5	17.3%
651	Udorthents, smoothed	A	5.3	16.6%
Totals for Area of Interest			**31.7**	**100.0%**

Rating Options—Hydrologic Soil Group

Aggregation Method: Dominant Condition

Component Percent Cutoff: None Specified

Tie-break Rule: Higher

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Standard 4: Water Quality

Water Quality Treatment Volume:

Calculate required water quality treatment volume:

A_{imp} (New Impervious area) = 22,366 ft^2
D_{wq} (Water quality depth) = 1.00” (Soil infiltration rate > 2.41 in/hr)

V_{wq}=(Dwq/12 in/ft)(A_{imp})
V_{wq}=(1.00 in/12 in/ft)(22,366 ft^2) = 1,863 ft^3 required

With all runoff being from the water quality storm being infiltrated, the water quality treatment volume equals the volume of water infiltrated at the 2 infiltration areas during the storm event that produces 1” of rainfall.

The volume of water treated for the subsurface infiltration system is:
(24,600 ft^2)(1.00 in/12 in/ft) = 2,050 ft^3

The volume of water treated at the kettle hole is:
(108,325 ft^2)(1.00 in/12 in/ft) = 9,027 ft^3

The total volume of water treated is:
2,050 ft^3 + 9,027 ft^3 = 11,077 ft^3

11,077 ft^3 > 1,863 ft^3 , Water quality volume treated is adequate.

TSS Removal Requirements:

The DEP's "Standard Method to Convert Required Water Quality Volume to a Discharge Rate for Sizing Flow Based Manufactured Proprietary Stormwater Treatment Practices" has been used to establish the water quality objectives input into the Stormceptor sizing software. The TSS rate objective is 44% for pretreatment prior to the infiltration system. A summary of the calculations is provided in the following table.

Water Quality Volume to Treatment Rate Conversion					
Stormceptor	Impervious Area (s.f.)	Water Quality Volume	Tc (min.)	qu	Discharge Rate
STC-1	20409	1"	4.2	803	0.6 cfs
* Tc value from HydroCAD subcatchment S3i2					

The results of the Stormceptor sizing analysis are attached hereto. While the calculated TSS removal rate for the Strormceptor is much higher, the pretreatment objective of 44% is used for the TSS removal calculations for the treatment train.

Location: **Infiltration 1**

TSS Removal Calculation Worksheet

B BMP	C TSS Removal Rate	D Starting TSS Load*	E Amount Removed (C*D)	F Remaining Load (D-E)
Deep sump catch basin	25%	1.00	0.25	0.75
Stormceptor	44%	0.75	0.33	0.42
Infiltration system	80%	0.42	0.34	0.08

Total TSS Removal = 92%

Project: **Theroux Dental**
Prepared By: MG
Date: 5/16/2016

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

Neither TSS removal nor pre-treatment are required at the kettle hole. Runoff entering the kettle hole is either from existing impervious areas or clean roof runoff.

Stormceptor® Rinker MATERIALS™

Brief Stormceptor Sizing Report - Theroux Dental Complex

Project Information & Location			
Project Name	G8723	**Project Number**	1030
City	Grafton	**State/ Province**	Massachusetts
Country	United States of America	**Date**	5/16/2016
Designer Information		**EOR Information (optional)**	
Name	Norman Hill	**Name**	
Company	Land Planning, Inc	**Company**	
Phone #	508-839-9526	**Phone #**	
Email	mainoffice@landplanninginc.com	**Email**	

Stormwater Treatment Recommendation

The recommended Stormceptor Model(s) which achieve or exceed the user defined water quality objective for each site within the project are listed in the below Sizing Summary table.

Site Name	Theroux Dental Complex
Target TSS Removal (%)	44
TSS Removal (%) Provided	85
Recommended Stormceptor Model	STC 450i

The recommended Stormceptor Model achieves the water quality objectives based on the selected inputs, historical rainfall records and selected particle size distribution.

Stormceptor Sizing Summary	
Stormceptor Model	**% TSS Removal Provided**
STC 450i	85
STC 900	91
STC 1200	91
STC 1800	91
STC 2400	93
STC 3600	93
STC 4800	95
STC 6000	95
STC 7200	96
STC 11000	97
STC 13000	97
STC 16000	98
Stormceptor MAX	Custom

Stormceptor®

Rinker MATERIALS™

Sizing Details

Drainage Area	
Total Area (acres)	0.56
Imperviousness %	83.0

Rainfall	
Station Name	WORCESTER WSO AP
State/Province	Massachusetts
Station ID #	9923
Years of Records	58
Latitude	42°16'2"N
Longitude	71°52'34"W

Water Quality Objective	
TSS Removal (%)	44.0
Runoff Volume Capture (%)	
Oil Spill Capture Volume (Gal)	
Peak Conveyed Flow Rate (CFS)	4.91
Water Quality Flow Rate (CFS)	0.60

Up Stream Storage	
Storage (ac-ft)	Discharge (cfs)
0.000	0.000

Up Stream Flow Diversion	
Max. Flow to Stormceptor (cfs)	

Particle Size Distribution (PSD)
The selected PSD defines TSS removal
Fine Distribution

Particle Diameter (microns)	Distribution %	Specific Gravity
20.0	20.0	1.30
60.0	20.0	1.80
150.0	20.0	2.20
400.0	20.0	2.65
2000.0	20.0	2.65

Notes

- Stormceptor performance estimates are based on simulations using PCSWMM for Stormceptor, which uses the EPA Rainfall and Runoff modules.
- Design estimates listed are only representative of specific project requirements based on total suspended solids (TSS) removal defined by the selected PSD, and based on stable site conditions only, after construction is completed.
- For submerged applications or sites specific to spill control, please contact your local Stormceptor representative for further design assistance.

For Stormceptor Specifications and Drawings Please Visit:
http://www.imbriumsystems.com/technical-specifications

Standard 5: Land Uses with Higher Potential Pollutant Loads

The existing and proposed use of the property is not classified as a Land Use with Higher Potential Pollutant Loads (LUHPPL). This standard is not applicable to this site.

Standard 6: Critical Areas

The property is not located within or near any Critical Areas. This standard is not applicable to this site.

Standard 7: Redevelopment Project

This project does not qualify as a redevelopment project. This standard is not applicable to this site.

Standard 8: Construction Period Pollution Prevention and Erosion Control

See attached report.

Standard 9: Operation and Maintenance Plan

See attached report.

Standard 10: Prohibition of Illicit Discharges
Illicit Discharge Compliance Statement

I have inspected the site and have not found any evidence of an existing illicit discharge located on the property.

The developer, contractor, property owner, and stormwater management system operator shall continue to be responsible for the prevention, detection, and elimination of illicit discharges.

Land Planning, Inc.

Norman G. Hill, P.E.
President

Construction Storm Water Pollution Prevention Plan

Theroux Dental Complex

Grafton, MA

Site Owner/Operator
Marc Theroux
2 Stonegate Circle
Grafton, MA 01519

Prepared by:
Land Planning, Inc.
214 Worcester Street
North Grafton, MA 01536

Revised May 16, 2016

Introduction

Storm Water Pollution Prevention Plan Requirements

This Storm water Pollution Prevention Plan (SWPPP) was developed consistent with the requirements of the National Pollutant Discharge Elimination System (NPDES) General Storm water Permit for Construction Activities.

The Plan, properly implemented, should result in the discharge of water to the environment without the violation of Water Quality Standards.

Content

This SWPPP is broken down into the following sections, consistent with the requirements of the NPDES Construction General Permit.

- Identification of the SWPPP coordinator with a description of this person's duties;
- Description of the existing site conditions including existing land use for the site (i.e. wooded areas, open grassed areas, pavement, buildings, etc.), soil types at the site, as well as the locations of surface waters which are located on or next to the site (wetlands, streams, rivers, lakes, ponds, etc.);
- Identification of the body of water(s) which will receive runoff from the construction site, including the ultimate body of water that receives the storm water;
- Identification of drainage areas and potential storm water contaminants;
- Description of storm water management controls and various Best Management Practices (BMPs) necessary to reduce erosion, sediment and pollutants in storm water discharge;
- Description of the facility monitoring plan and how controls will be coordinated with construction activities and a
- Description of the implementation schedule and provisions for amendment of the plan.

Purpose

The purpose of this SWPPP is to:

- Describe the BMPs used to minimize erosion and sediment runoff at the site
- Identify, reduce, eliminate, or prevent the pollution of storm water
- Prevent violations of surface water quality or groundwater quality standards

Facility Description

Site Location

The site is located on the northwest corner of Worcester Street and Harris Street in Grafton. The property is a combination of two tracts of land: Assessor's map 46, lots 15 and 19. The total area is 1.59 acres. The property is bounded to the east by Worcester Street, to the south by Harris Street, to the west and north by Bernard Road and the Quinsigamond River.

Construction Type

The site is to be developed for an office building with accessory parking and driveway. Development of the parcel will require the disturbance of 0.75 acres of land. The development requires construction activities associated with each of the following proposed components:

- Construction of the proposed driveway and parking areas;
- Building construction;
- Grading the site;
- Surfacing the parking areas and driveway with bituminous concrete;

The owners and their various sub-contractors will be on site from approximately 7am until 5pm, five days per week. Clearing and grading, construction of the driveway, drainage structures, building construction, utilities and site landscaping is expected to be completed 6 months following ground-breaking.

Existing Conditions

The subject property is approximately 330 feet above mean sea level, and is within the Blackstone River Drainage Basin.

The existing site contains a single family home, detached garage, and gravel driveway with access to Harris Street. The remainder of the property is a mix of lawn and woodland

Site Plan

During the construction process, approximately 0.75 acres of land will be disturbed. The majority of the proposed construction occurs in areas that had been developed for residential use.

A stormwater management system is proposed to ensure that there is no increase in peak runoff rates or degradation of stormwater quality downstream of the site. This is achieved through infiltration of the runoff within a subsurface chamber system and preservation of an existing kettle hole.

Identification of Potential Stormwater Contaminants

Significant Material Inventory

Pollutants that result from clearing, grading, excavation and building materials and have the potential to be present in stormwater runoff are listed in **Table 1**. This table includes information regarding material type, chemical and physical description, and the specific regulated stormwater pollutants associated with each material.

Potential Areas for Stormwater Contamination

The following potential source areas of stormwater contamination were identified and evaluated:

- Cleared and graded areas
- Excavated areas
- Asphalt parking areas and driveway construction
- Tree removal
- Building construction

Table 2 presents site specific information regarding stormwater pollution potential from each of these areas.

Table 1
Potential Construction Site Stormwater Pollutants

Trade Name material	Chemical/physical Description	Stormwater pollutants
Pesticides	Various colored to colorless liquid, powder, grains, or pellets	Chlorinated hydrocarbons, organophosphates, carbamates, arsenic
Fertilizer	Liquid or solid grains	Nitrogen, Phosphorous
Plaster	White granules or powder	Calcium sulphate, calcium carbonate, sulfuric acid
Cleaning solvents	Colorless, blue, or yellow-green liquid	Perchloroethylene, methylene chloride, trichloroethylene, petroleum distillates
Asphalt	Black solid	Oil, petroleum distillates
Concrete	White solid	Limestone, sand
Glue, adhesives	White or yellow liquid	Polymers, epoxies
Paints	Various colored liquid	Metal oxides, stoddard solvent, talc, calcium carbonate, arsenic
Curing compounds	Creamy white liquid	Naphtha
Waste water from construction equipment washing	Water	Soil, oil and grease, solids
Wood preservatives	Clear amber or dark brown liquid	Stoddard solvent, petroleum distillates, arsenic, copper, chromium
Hydraulic oil/fluids	Brown oily petroleum hydrocarbon	Mineral oil
Gasoline	Colorless, pale brown or pink petroleum hydrocarbon	Benzene, ethyl benzene, toluene, xylene, MTBE
Diesel fuel	Clear, blue-green to yellow liquid	Petroleum distillate, oil and grease, naphthalene, xylenes
Kerosene	Pale yellow liquid petroleum hydrocarbon	Coal oil, petroleum distillates
Antifreeze/coolant	Clear green/yellow liquid	Ethylene glycol, propylene glycol, heavy metals (copper, zinc, lead)
Erosion	Solid particles	Soil, sediment

Table 2
Locations of Potential Sources of Stormwater Contamination

Potential storm water contamination point	Potential pollutants	Potential problems
Cleared and graded areas	Soil erosion, fertilizer, pesticides	Erosion of soils from cleared and graded areas have the potential to discharge into the intermittent stream and BVW.
Driveway and utility construction	Asphalt, hydraulic oil, gasoline, antifreeze, soil erosion, fertilizer, pesticides	Leaking of hydraulic oil and antifreeze from clearing, grading and asphalt application construction equipment, gasoline and diesel fuel spills while fueling construction equipment, erosion of exposed and stockpiled soils. Asphalt chemicals can be released to storm water if a rain even occurs before curing is complete. Tracking of soil into the road through the construction site entrance.
Building construction	Plaster, cleaning solvents, asphalt, concrete, paints, hydraulic oil, gasoline, antifreeze, soil erosion, fertilizer, pesticides, glue adhesives, curing, compounds wood preservatives, kerosene	Leaking hydraulic oil and antifreeze from clearing, grading and asphalt application construction equipment, gasoline and diesel fuel spills while fueling construction equipment, erosion of exposed and stockpiled soils, and degradation of scrap dry wall can contaminate storm water. Asphalt chemicals can be released to storm water if a rain event occurs before curing is complete.
Tree removal area	Soil erosion, fertilizer, pesticides	Ruts caused by logging equipment can fill with water, preventing complete re-vegetation.
All undisturbed areas	None	No storm water related issues with this completely vegetated area.

Stormwater Management Controls

Temporary Erosion Control Practices

A list of best management practices (BMPs) has been developed and the locations of these BMPs are shown on the Sedimentation and Erosion Control Plan, a copy of which may be found attached. A number of BMPs included in this plan have been developed to serve as post-construction storm water controls.

Construction BMPs

To prevent soil from washing off the site during construction, the following Construction BMPs will be implemented:

- **Sediment Control Barrier:** A sediment control barrier consisting of straw wattles will be placed along the downhill perimeter of the of the construction area before any clearing or grading takes place.
- **Diversion Berms:** Throughout site grading activities, diversion berms will be placed at the direction of the SWPPP coordinator to ensure runoff is directed toward the other construction BMPs for treatment.
- **Stabilization:** All areas which will not be impacted by construction will be seeded. A permanent seed mix consisting of 20% Red Top, 60% Chewings Fescue and 20% Kentucky Bluegrass is recommended. Each area will be "Hydro-seeded" with high fiber content or mulched with 4,000 pounds per acre of straw. The straw mulch is to be tacked into place by a disk with blades set nearly straight.
- **Stockpiling:** Stockpiles of fill material and gravel shall be surrounded with compost socks. Top soil stockpiles shall be surrounded with straw wattles and, if not required for use within 14 days, stabilized with temporary seed and mulch. The recommended temporary seed is Rye (grain).
- **Construction Entrance:** A crushed stone pad will serve as a temporary construction entrance. The construction entrance will minimize the tracking of soil onto the existing ways from vehicles exiting the work site.

Construction Practices to Minimize Stormwater Contamination

All waste materials will be collected and stored in a securely lidded metal dumpster rented from a licensed solid waste management company. All trash and construction debris will be deposited in the dumpster. No construction materials will be buried on-site. All personnel will be instructed regarding the current procedure for waste disposal. All sanitary waste will be collected from portable units by a licensed sanitary waste management company. Good housekeeping and spill control practices will be followed during construction to minimize storm water contamination from petroleum products, fertilizers, paints and concrete. Good housekeeping practices for the site are listed below:

- Fertilizers will be applied only in the minimum amounts recommended by the manufacturer.
- Fertilizers will be worked into the soil to limit exposure to storm water.

- All vehicles on-site will be monitored for leaks and receive regular preventative maintenance to reduce the chance of leakage.
- Petroleum products will be stored in tightly sealed containers which are clearly labeled.
- Spill kits will be included with all fueling sources and maintenance activities.
- Any asphalt substances used on-site will be applied according to the manufacturer's recommendation.
- Sanitary waste will be collected from portable units a minimum of two times a week.
- A covered dumpster will be used for all waste materials
- All paint containers and curing compounds will be tightly sealed and stored when not required for use. Excess paint will not be discharged to the storm system, but will be disposed of according to the manufacturer's instructions.
- Materials and equipment necessary for spill cleanup will be kept on-site. Equipment will include, but not be limited to, brooms, dust pans, mops, rags, gloves, goggles, kitty litter, sand, saw dust and plastic and metal trash containers.
- Spray guns will be cleaned on a removable tarp.
- All spills will be cleaned up immediately upon discovery. Spills large enough to reach the storm system will be reported to the National Response Center at 1-800-424-8802
- The paved street adjacent to the site entrance will be swept daily to remove excess mud, dirt or rock tracked from the site.
- Dump trucks hauling material to and from the construction site will be covered with tarpaulins.
- All ruts caused by equipment used for cutting and removing trees will be graded.

Coordination of BMPs with Construction Activities

BMPs will be coordinated with construction activities so the BMP is in place before construction begins. The following BMPs will be coordinated with construction activities:

- The temporary perimeter controls (straw wattle sediment barriers) will be installed before any clearing or grading begins.
- Clearing and grading will not occur in an area until it is necessary for construction to proceed.
- Diversion berms and the sediment basin will be constructed, and pumping will be performed at the direction of the SWPPP Coordinator as required throughout construction.
- Once construction activity ceases permanently in an area, that area will be stabilized with permanent seed and mulch.
- After the entire site is stabilized, the accumulated sediment will be removed from all drainage structures.
- The temporary perimeter controls (silt fencing and straw wattles) will not be removed until all construction activities at the site are complete and soils have been stabilized.

Certification of Compliance with Federal, State and Local Regulations

This SWPPP reflects the requirement for stormwater management and control as established in the Massachusetts Wetlands Protection Act (310 CMR), the Water Quality Certification Regulations (314 CMR), and the Federal Water Pollution Control Act Amendments of 1972. To ensure compliance, this plan was prepared in accordance with the *Massachusetts Erosion and Sediment Control Guidelines for Urban and Suburban Areas*, published by the Massachusetts Executive Office of Environmental Affairs.

Maintenance and Inspection Procedures

Inspections

Visual inspections of all cleared and graded areas of the construction site will be performed daily and within 12 hours of the end of a storm with rainfall amounts exceeding 0.5 inches. The inspection will be conducted by the SWPPP Coordinator or his designated stormwater team members. The inspection will verify that the structural BMPs described are in good condition and minimizing erosion. The inspection will also verify that the procedures used to prevent stormwater contamination from construction materials and petroleum products are effective. The following inspection and maintenance practices will be used to maintain erosion and sediment controls:

- Built up sediment will be removed from sediment barriers when it has reached one-third the height of the barrier.
- Temporary and permanent seeding will be inspected for bare spots, washouts and healthy growth.
- The construction area entrance will be inspected for sediment tracked on the road.

A maintenance inspection report will be made after each inspection. A copy of the report form to be completed by the SWPPP Coordinator is provided in herein. Completed forms will be maintained on-site during the entire construction project. Following construction, the completed forms will be retained at the operators's office for a minimum of 1 year.

If construction activities or design modifications are made to the site plan which could impact stormwater, this SWPPP will be amended appropriately. The amended SWPPP will have a description of the new activities that contribute to the increased pollutant loading and the planned source control activities.

Employee Training

An employee training program will be developed and implemented to educate employees about the requirements of the SWPPP. This education program will include background on the components and goals of the SWPPP and hands-on training in erosion controls, spill prevention and response, good housekeeping, proper material handling, disposal and control of waste, equipment fueling and proper storage, washing and inspection procedures. All employees will be trained prior to their first day on the site.

SWPPP Coordinator and Duties

The construction site SWPPP Coordinator for the facility is:

____ Phone:___________________.

The SWPPP Coordinator's duties include the following:

- Implement the SWPPP plan;
- Oversee maintenance practices identified as BMPs in the SWPPP;
- Implement and oversee employee training;
- Conduct or provide for inspection and monitoring activities;
- Identify other potential pollutant sources and make sure they are added to the SWPPP;
- Identify any deficiencies in the SWPPP and make sure they are corrected and
- Ensure that any changes in construction plans are addressed in the SWPPP.

Site Contact Information

PROJECT ENGINEER	PHONE NUMBERS
Norman Hill, P.E. **Land Planning, Inc.**	**Phone: (508) 839-9526** **Cell: (508) 962-3237** **Fax: (508) 839-9528** **Home: N/A**
PROJECT MANAGER	
	Phone: **Cell:** **Fax:** **Home: N/A**

Emergency Numbers

Fire, Police, Ambulance:		911
Operator:		
General Contractor:	Office:	
	Mobile #	
Subcontractors:		
	Office:	
	Office:	
MassDEP Emergency Response Line		1-888-304-1133
National Response Center		1-800-424-8802

Inspection and Maintenance Report Form

Note: This form is to be completed every 7 days and within 24 hours of a rainfall event of 0.5 inches or more.

Inspector: ____________________ Date: _______________

Inspector's Qualifications:

Days since last rainfall: ______________ Amount of last rainfall: __ inches

Stabilization Measures

Date of Last Disturbance	Date of Next Disturbance	Stabilized (Y/N)	Stabilized With	Condition

Stabilization required:

To be performed by: __________________ On or before: __________

Construction Entrance

Does Much Sediment Get Tracked on to Road?	Is the Gravel Clean or is it Filled with Sediment?	Does all Traffic use the Stabilized Entrance to Leave the Site?

Maintenance required:

To be performed by: __________________ On or before: __________

Straw Wattles

Drainage Area	Has Silt Reached 1/3 of fence?	Is Fence Properly Secured?	Is There Evidence of Washout or Over-topping?

Maintenance required:

To be performed by: ___________________ On or before: __________

Spill Report Form

LOCATION:______________________________

		Date:______________ Time:______________

Regulatory agencies notified (date, time, person, agency, and how):______________________________

____

____

Material spilled:______________________________

Quantity spilled:______________________________

Source:______________________________

Cause:______________________________

____

Extent of injuries (if any):______________________________

____

Adverse environmental impact (if any):______________________________

____

Immediate remedial actions taken at time of spill:______________________________

____

Measures taken or planned to prevent recurrence:______________________________

____

____

Additional comments:______________________________

____

____

This report prepared by: ______________________________

(Signature)

______________________________ ______________________________

Stormwater Management
Operation & Maintenance Plan

Theroux Dental Complex

Site Owner/Operator:
Marc Theroux
2 Stonegate Circle
Grafton, MA 01519

Project Location:
103 Worcester Street
Grafton, MA

Prepared by:
Land Planning, Inc.
214 Worcester Street
North Grafton, MA 01536

Revised May 16, 2016

Site Owner / Operator:

The owner and operator of the site at the time of construction will be Marc Theroux. Mr. Theroux's offices are located at 2 Stonegate Circle, Grafton, MA. This Operation & Maintenance Plan is transferable to future property owners.

Site Location:

The site is located on the northwest corner of Worcester Street and Harris Street in Grafton. The property is a combination of two tracts of land: Assessor's map 46, lots 15 and 19. The total area is 1.59 acres. The property is bounded to the east by Worcester Street, to the south by Harris Street, to the west and north by Bernard Road and the Quinsigamond River.

Stormwater Management System:

Development plans for the site include the construction of an office building with its accessory parking areas and driveways. All roof and parking area runoff will be:

- Collected by a catch basing to manhole drainage system
- Pretreated through a Stormceptor STC-900 prior to the infiltration system
- Infiltrated through a Cultec chamber system located on the east side of the property.

This stormwater management system is designed to treat runoff for the pollutants associated with this land use.

The locations of the permanent BMP devices are shown on the site development plans attached to this report.

Proper maintenance of this stormwater management system is critical for the protection of the surface water quality. It is the responsibility of the site operator to inspect and maintain the stormwater management system in accordance with the included maintenance schedules for both the construction and operation phases of this sites usage. Maintenance shall be performed per the attached O&M manuals for the proprietary devices and in accordance with the schedule below for the remaining required O&M activities:

Operation & Maintenace Schedule

Loacation	Maintenance Activity	Frequency
Parking areas and driveways	Sweeping	Twice per year including once after winter snowmelt
Catch Basins	Inspection and cleaning	Inspect 4 times per year and clean when deposits exceed ½ the sump depth
Manholes	Inspection and cleaning	Inspect 2 times per year and remove any debris within the invert
Stormceptor	See attached manufacturers O& M manual	See attached manufacturers O& M manual
Cultec chambers	See attached manufacturers O& M manual	See attached manufacturers O& M manual
Rip rap at kettle hole	Remove debris and reset stones	Twice per year
Kettle hole	Remove trash, debris, and deadfall	Twice per year

General Maintenance and Housekeeping Requirements:

The site operator will be responsible for the maintenance of the property. The following specifications for maintenance and housekeeping activities are necessary to provide for long-term pollution prevention:

- **Driveways and parking areas:** The surfaces shall be cleaned as per the methods and frequency described within the maintenance schedule.

- **Snow Removal and Storage:** The designated area for the stockpiling of snow removed from the driveway is located on the turf grass areas adjacent to the parking lots.

- **Deicing Material Storage and Application:** The outside storage of deicing materials on this property is forbidden (MGL Chapter 85, Section 7A). The application of deicing materials should be kept to the minimum practicable quantities that ensure safe vehicular and pedestrian movement throughout the site. The use of alternative materials including sand and calcium chloride is recommended. Sanding of the permeable surfaces is prohibited.

- **Landscape Maintenance:** Leaves and yard trimmings shall be properly disposed of. If these materials are to be composted on-site, it shall be done outside of any wetland resource area or buffer zones. Pesticides and fertilizers shall be applied per the manufacturer's recommendations at the minimum effective application rates. Leaves and trimmings shall not be dumped into the kettle hole.

- **Material and Waste Product Storage:** Materials and waste products, including vehicle fluids, pesticides, herbicides, fertilizers, paints and solvents, and hazardous chemicals, must be kept inside or under cover. All materials shall be stored in clearly labeled containers.

- **Trash Disposal:** A covered dumpster shall be provided for waste materials. The dumpster shall be emptied as needed.

- **Spill Response:** All spills will be cleaned up immediately upon discovery. Spills shall be reported to the Grafton Fire Department and the Mass DEP Emergency Response Section at 1-888-304-1133. Spills large enough to reach the storm system will be reported to the National Response Center at 1-800-424-8802.

Contactor® & Recharger®
Stormwater Chambers The Chamber With The Stripe®

Operation and Maintenance Guidelines

CULTEC™

Operation & Maintenance

This manual contains guidelines recommended by CULTEC, Inc. and may be used in conjunction with, but not to supersede, local regulations or regulatory authorities. OSHA Guidelines must be followed when inspecting or cleaning any structure.

Introduction

The CULTEC Subsurface Stormwater Management System is a high-density polyethylene (HDPE) chamber system arranged in parallel rows surrounded by washed stone. The CULTEC chambers create arch-shaped voids within the washed stone to provide stormwater detention, retention, infiltration, and reclamation. Filter fabric is placed between the native soil and stone interface to prevent the intrusion of fines into the system. In order to minimize the amount of sediment which may enter the CULTEC system, a sediment collection device (stormwater pretreatment device) is recommended upstream from the CULTEC chamber system. Examples of pretreatment devices include, but are not limited to, an appropriately sized catch basin with sump, pretreatment catchment device, oil grit separator, or baffled distribution box. Manufactured pretreatment devices may also be used in accordance with CULTEC chambers. Installation, operation, and maintenance of these devices shall be in accordance with manufacturer's recommendations. Almost all of the sediment entering the stormwater management system will be collected within the pretreatment device.

Best Management Practices allow for the maintenance of the preliminary collection systems prior to feeding the CULTEC chambers. The pretreatment structures shall be inspected for any debris that will restrict inlet flow rates. Outfall structures, if any, such as outlet control must also be inspected for any obstructions that would restrict outlet flow rates. OSHA Guidelines must be followed when inspecting or cleaning any structure.

Operation and Maintenance Requirements

I. Operation

CULTEC stormwater management systems shall be operated to receive only stormwater run-off in accordance with applicable local regulations. CULTEC subsurface stormwater management chambers operate at peak performance when installed in series with pretreatment. Pretreatment of suspended solids is superior to treatment of solids once they have been introduced into the system. The use of pretreatment is adequate as long as the structure is maintained and the site remains stable with finished impervious surfaces such as parking lots, walkways, and pervious areas are properly maintained. If there is to be an unstable condition, such as improvements to buildings or parking areas, all proper silt control measures shall be implemented according to local regulations.

II. Inspection and Maintenance Options

A. The CULTEC system may be equipped with an inspection port located on the inlet row. The inspection port is a circular cast box placed in a rectangular concrete collar. When the lid is removed, a 6-inch (150 mm) pipe with a screw-in plug will be exposed. Remove the plug. This will provide access to the CULTEC Chamber row below. From the surface, through this access, the sediment may be measured at this location. A stadia rod may be used to measure the depth of sediment if any in this row. If the depth of sediment is in excess of 3 inches (76 mm), then this row should be cleaned with high pressure water through a culvert cleaning nozzle. This would be carried out through an upstream manhole or through the CULTEC StormFilter Unit (or other pre-treatment device). CCTV inspection of this row can be deployed through this access port to determine if any sediment has accumulated in the inlet row.

B. If the CULTEC bed is not equipped with an inspection port, then access to the inlet row will be through an upstream manhole or the CULTEC StormFilter.

1. **Manhole Access**
   This inspection should only be carried out by persons trained in confined space entry and sewer inspection services. After the manhole cover has been removed a gas detector must be lowered into the manhole to ensure that there are not high concentrations of toxic gases present. The inspector should be lowered into the manhole with the proper safety equipment as per OSHA requirements. The inspector may be able to observe sediment from this location. If this is not possible, the inspector will need to deploy a CCTV robot to permit viewing of the sediment.

2. **StormFilter Access**
Remove the manhole cover to allow access to the unit. Typically a 30-inch (750 mm) pipe is used as a riser from the StormFilter to the surface. As in the case with manhole access, this access point requires a technician trained in confined space entry with proper gas detection equipment. This individual must be equipped with the proper safety equipment for entry into the StormFilter. The technician will be lowered onto the StormFilter unit. The hatch on the unit must be removed. Inside the unit are two filters which may be removed according to StormFilter maintenance guidelines. Once these filters are removed the inspector can enter the StormFilter unit to launch the CCTV camera robot.

C. The inlet row of the CULTEC system is placed on a polyethylene liner to prevent scouring of the washed stone beneath this row. This also facilitates the flushing of this row with high pressure water through a culvert cleaning nozzle. The nozzle is deployed through a manhole or the StormFilter and extended to the end of the row. The water is turned on and the inlet row is back-flushed into the manhole or StormFilter. This water is to be removed from the manhole or StormFilter using a vacuum truck.

III. Maintenance Guidelines

The following guidelines shall be adhered to for the operation and maintenance of the CULTEC stormwater management system:

A. The owner shall keep a maintenance log which shall include details of any events which would have an effect on the system's operational capacity.

B. The operation and maintenance procedure shall be reviewed periodically and changed to meet site conditions.

C. Maintenance of the stormwater management system shall be performed by qualified workers and shall follow applicable occupational health and safety requirements.

D. Debris removed from the stormwater management system shall be disposed of in accordance with applicable laws and regulations.

IV. Suggested Maintenance Schedules

A. **Minor Maintenance**
The following suggested schedule shall be followed for routine maintenance during the regular operation of the stormwater system:

Frequency	Action
Monthly in first year	Check inlets and outlets for clogging and remove any debris as required.
Spring and Fall	Check inlets and outlets for clogging and remove any debris as required.
One year after commissioning and every third year following	Check inlets and outlets for clogging and remove any debris as required.

B. **Major Maintenance**
The following suggested maintenance schedule shall be followed to maintain the performance of the CULTEC stormwater management chambers. Additional work may be necessary due to insufficient performance and other issues that might be found during the inspection of the stormwater management chambers. (See table on next page)

Major Maintenance *(continued)*

	Frequency	Action
Inlets and Outlets	Every 3 years	• Obtain documentation that the inlets, outlets and vents have been cleaned and will function as intended.
	Spring and Fall	• Check inlet and outlets for clogging and remove any debris as required.
CULTEC Stormwater Chambers	2 years after commissioning	• Inspect the interior of the stormwater management chambers through inspection port for deficiencies using CCTV or comparable technique. • Obtain documentation that the stormwater management chambers and feed connectors will function as anticipated.
	9 years after commissioning every 9 years following	• Clean stormwater management chambers and feed connectors of any debris. • Inspect the interior of the stormwater management structures for deficiencies using CCTV or comparable technique. • Obtain documentation that the stormwater management chambers and feed connectors have been cleaned and will function as intended.
	45 years after commissioning	• Clean stormwater management chambers and feed connectors of any debris. • Determine the remaining life expectancy of the stormwater management chambers and recommended schedule and actions to rehabilitate the stormwater management chambers as required. • Inspect the interior of the stormwater management chambers for deficiencies using CCTV or comparable technique.
	45 to 50 years after commissioning	• Replace or restore the stormwater management chambers in accordance with the schedule determined at the 45-year inspection. • Attain the appropriate approvals as required. • Establish a new operation and maintenance schedule.
Surrounding Site	Monthly in 1st year	• Check for depressions in areas over and surrounding the stormwater management system.
	Spring and Fall	• Check for depressions in areas over and surrounding the stormwater management system.
	Yearly	• Confirm that no unauthorized modifications have been performed to the site.

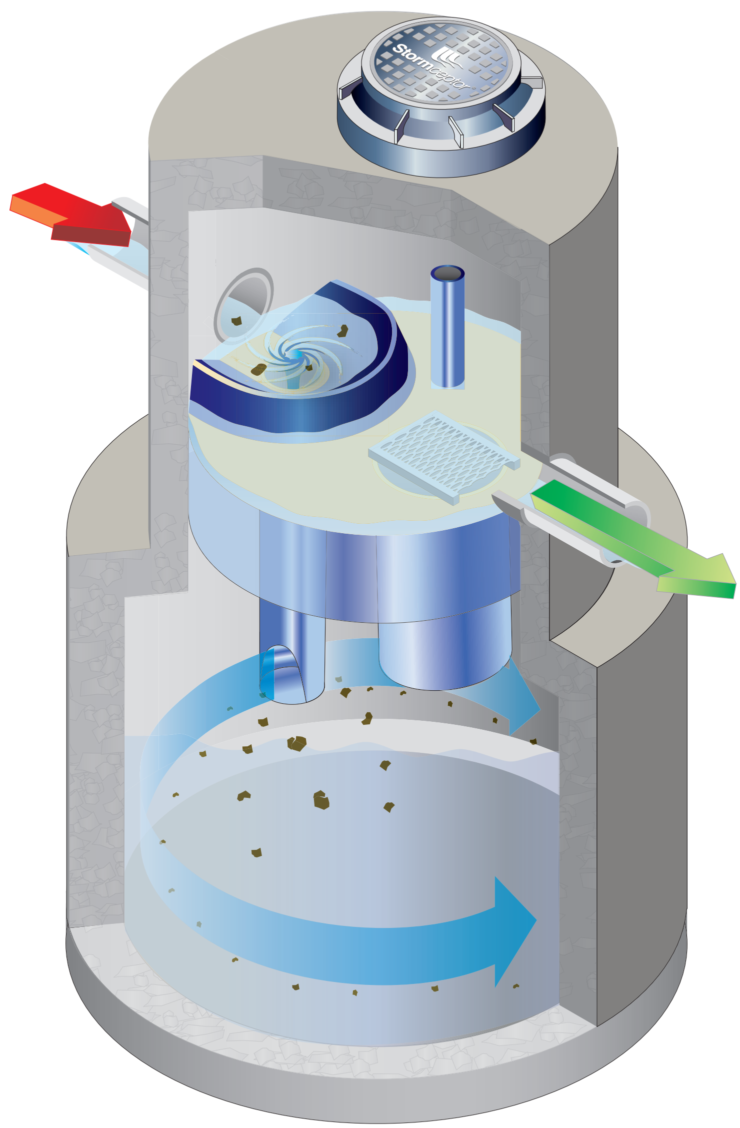
For additional information concerning the maintenance of CULTEC Subsurface Stormwater Management Chambers, please contact CULTEC, Inc. at 1-800-428-5832.

CULTEC
Chamber of Choice™

CULTEC, Inc.
878 Federal Road • P.O. Box 280 • Brookfield, CT 06804
Phone: 203-775-4416 • Toll Free: 800-4-CULTEC • Fax: 203-775-1462
Web: www.cultec.com • E-mail: custservice@cultec.com

Rinker

MATERIALS™



Stormceptor®

Owner's Manual

Stormceptor is protected by one or more of the following patents:

Canadian Patent No. 2,137,942
Canadian Patent No. 2,175,277
Canadian Patent No. 2,180,305
Canadian Patent No. 2,180,338
Canadian Patent No. 2,206,338
Canadian Patent No. 2,327,768
U.S. Patent No. 5,753,115
U.S. Patent No. 5,849,181
U.S. Patent No. 6,068,765
U.S. Patent No. 6,371,690
U.S. Patent No. 7,582,216
U.S. Patent No. 7,666,303
Australia Patent No. 693.164
Australia Patent No. 707,133
Australia Patent No. 729,096
Australia Patent No. 779,401
Australia Patent No. 2008,279,378
Australia Patent No. 2008,288,900
Japan Patent No. 9-11476
Korean Patent No. 0519212
New Zealand Patent No. 314,646
New Zealand Patent No. 583,008
New Zealand Patent No. 583,583
South African Patent No. 2010/00682
South African Patent No. 2010/01796
Other Patents Pending

Table of Contents

Congratulations!

Your selection of a Stormceptor® means that you have chosen the most recognized and efficient stormwater oil/sediment separator available for protecting the environment. Stormceptor is a pollution control device often referred to as a “Hydrodynamic Separator (HDS)” or an “Oil Grit Separator (OGS)”, engineered to remove and retain pollutants from stormwater runoff to protect our lakes, rivers and streams from the harmful effects of non-point source pollution.

1 – Stormceptor Overview

Stormceptor is a patented stormwater quality structure most often utilized as a treatment component of the underground storm drain network for stormwater pollution prevention. Stormceptor is designed to remove sediment, total suspended solids (TSS), other pollutants attached to sediment, hydrocarbons and free oil from stormwater runoff. Collectively the Stormceptor provides spill protection and prevents non-point source pollution from entering downstream waterways.

Key benefits of Stormceptor include:

- Removes sediment, suspended solids, debris, nutrients, heavy metals, and hydrocarbons (oil and grease) from runoff and snowmelt.
- Will not scour or re-suspend trapped pollutants.
- Provides sediment and oil storage.
- Provides spill control for accidents, commercial and industrial developments.
- Easy to inspect and maintain (vacuum truck).
- “STORMCEPTOR” is *clearly* marked on the access cover (excluding inlet designs).
- Relatively small footprint.
- 3rd Party tested and independently verified.
- Dedicated team of experts available to provide support.

Model Types:

- STC (Standard)
- EOS (Extended Oil Storage)
- OSR (Oil and Sand Removal)
- MAX (Custom designed unit, specific to site)

Configuration Types:

- Inlet unit (accommodates inlet flow entry, and multi-pipe entry)
- In-Line (accommodates multi-pipe entry)
- Submerged Unit (accommodates the site’s tailwater conditions)
- Series Unit (combines treatment in two systems)

Please Maintain Your Stormceptor

To ensure long-term environmental protection through continued performance as originally designed for your site, **Stormceptor must be maintained**, as any stormwater treatment practice does. The need for maintenance is determined through inspection of the Stormceptor. Procedures for inspection are provided within this document. Maintenance of the Stormceptor is performed from the surface via vacuum truck.

If you require information about Stormceptor, or assistance in finding resources to facilitate inspections or maintenance of your Stormceptor please call your local Rinker Materials Representative or the Stormceptor Information Line at (800) 909-7763.

2 – Stormceptor Operation & Components

Stormceptor is a flexibly designed underground stormwater quality treatment device that is unparalleled in its effectiveness for pollutant capture and retention using patented flow separation technology.

Stormceptor creates a non-turbulent treatment environment below the insert platform within the system. The insert diverts water into the lower chamber, allowing free oils and debris to rise, and sediment to settle under relatively low velocity conditions. These pollutants are trapped and stored below the insert and protected from large runoff events for later removal during the maintenance procedure.

With thousands of units operating worldwide, Stormceptor delivers reliable protection every day, in every storm. The patented Stormceptor design prohibits the scour and release of captured pollutants, ensuring superior water quality treatment and protection during even the most extreme storm events. Stormceptor's proven performance is backed by the longest record of lab and field verification in the industry.

Stormceptor Schematic and Component Functions

Below are schematics of two common Stormceptor configurations with key components identified and their functions briefly described.

Figure 1.

Inline Stormceptor

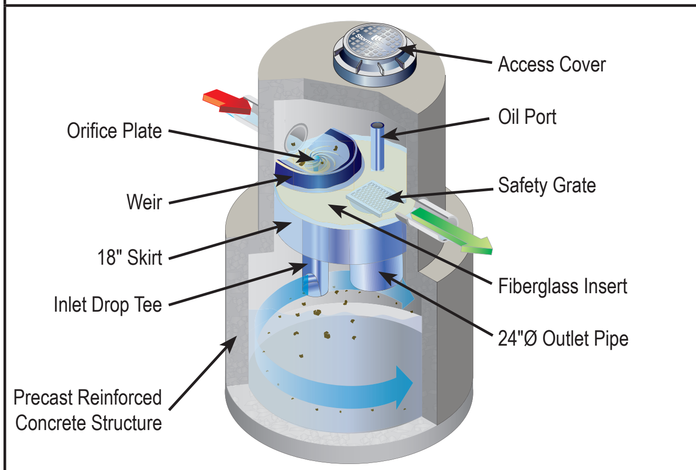
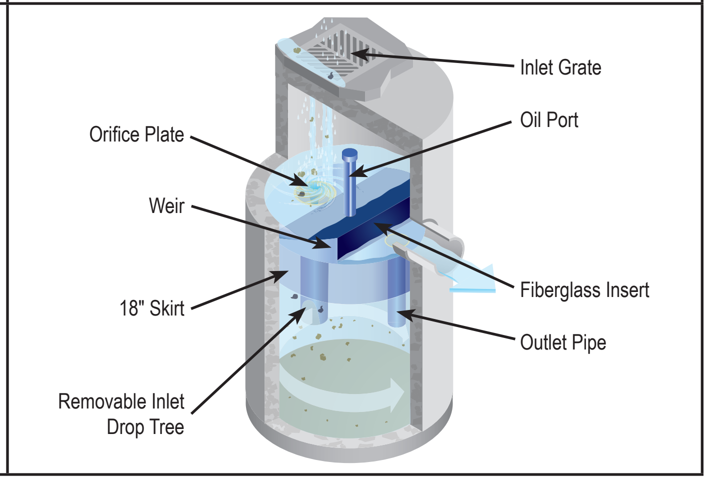


Figure 2.

Inlet Stormceptor



- **Manhole access cover** – provides access to the subsurface components
- **Precast reinforced concrete structure** – provides the vessel's watertight structural support
- **Fiberglass insert** – separates vessel into upper and lower chambers
- **Weir** – directs incoming stormwater and oil spills into the lower chamber
- **Orifice plate** – prevents scour of accumulated pollutants
- **Inlet drop tee** – conveys stormwater into the lower chamber
- **Fiberglass skirt** – provides double-wall containment of hydrocarbons
- **Outlet riser pipe** – conveys treated water to the upper chamber; primary vacuum line access port for sediment removal
- **Oil inspection port** – primary access for measuring oil depth and oil removal
- **Safety grate** – safety measure to cover riser pipe in the event of manned entry into vessel

3 – Stormceptor Identification

Stormceptor is available in both precast concrete and fiberglass vessels, with precast concrete often being the dominant material of construction.

In the Stormceptor, a patented, engineered fiberglass insert separates the structure into an upper chamber and lower chamber. The lower chamber will remain full of water, as this is where the pollutants are sequestered for later removal. Multiple Stormceptor model (STC, OSR, EOS and MAX) configurations exist, each to be inspected and maintained in a similar fashion.

Each unit is easily identifiable as a Stormceptor by the trade name "Stormceptor" embossed on each access cover at the surface. To determine the location of "inlet" Stormceptor units with horizontal catch basin inlet, look down into the grate as the Stormceptor insert will be visible. The name "Stormceptor" is not embossed on inlet models due to the variability of inlet grates used/approved across North America.

Once the location of the Stormceptor is determined, the model number may be identified by comparing the measured depth from the fiberglass insert level at the outlet pipe's invert (water level) to the bottom of the tank using **Table 1**.

In addition, starting in 1996 a metal serial number tag containing the model number has been affixed to the inside of the unit, on the fiberglass insert. If the unit does not have a serial number, or if there is any uncertainty regarding the size of the unit using depth measurements, please contact your local Rinker Materials Representative for assistance.

Sizes/Models

Typical general dimensions and capacities of the standard precast STC, EOS & OSR Stormceptor models are provided in **Tables 1 and 2**. Typical rim to invert measurements are provided later in this document. The total depth for cleaning will be the sum of the depth from outlet pipe invert (generally the water level) to rim (grade) and the depth from outlet pipe invert to the precast bottom of the unit. Note that depths and capacities may vary slightly between regions.

Table 1. Stormceptor Dimensions – Insert to Base of Structure

STC Model	Insert to Base (in.)
450	60
900	55
1200	71
1800	105
2400	94
3600	134
4800	128
6000	150
7200	134
11000*	128
13000*	150
16000*	134

EOS Model	Insert to Base (in.)
4-175	60
9-365	55
12-590	71
18-1000	105
24-1400	94
36-1700	134
48-2000	128
60-2500	150
72-3400	134
110-5000*	128
130-6000*	150
160-7800*	134

OSR Model	Insert to Base (in.)
65	60
140	55
250	94
390	128
560	134
780*	128
1125*	134

Notes:

1. *Depth Below Pipe Inlet Invert to the Bottom of Base Slab can vary slightly by manufacturing facility, and can be modified to accommodate specific site designs, pollutant loads or site conditions. Contact your local representative for assistance.*

   **Consist of two chamber structures in series.*

Table 2. Storage Capacities

STC Model	Hydrocarbon Storage Capacity gal	Sediment Capacity ft^3	EOS Model	Hydrocarbon Storage Capacity gal	OSR Model	Hydrocarbon Storage Capacity gal	Sediment Capacity ft^3
450	86	46	**4-175**	175	**065**	115	46
900	251	89	**9-365**	365	**140**	233	58
1200	251	127	**12-590**	591			
1800	251	207	**18-1000**	1198			
2400	840	205	**24-1400**	1457	**250**	792	156
3600	840	373	**36-1700**	1773			
4800	909	543	**48-2000**	2005	**390**	1233	465
6000	909	687	**60-2500**	2514			
7200	1059	839	**72-3400**	3418	**560**	1384	690
11000*	2797	1089	**110-5000***	5023	**780***	2430	930
13000*	2797	1374	**130-6000***	6041			
16000*	3055	1677	**160-7800***	7850	**1125***	2689	1378

Notes:

1. *Hydrocarbon & Sediment capacities can be modified to accommodate specific site design requirements, contact your local representative for assistance.*

   **Consist of two chamber structures in series.*

4 – Stormceptor Inspection & Maintenance

Regular inspection and maintenance is a proven, cost-effective way to maximize water resource protection for all stormwater pollution control practices, and is required to insure proper functioning of the Stormceptor. Both inspection and maintenance of the Stormceptor is easily performed from the surface. Stormceptor's patented technology has no moving parts, simplifying the inspection and maintenance process.

Please refer to the following information and guidelines before conducting inspection and maintenance activities.

When is inspection needed?

- Post-construction inspection is required prior to putting the Stormceptor into service.
- Routine inspections are recommended during the first year of operation to accurately assess the sediment accumulation.
- Inspection frequency in subsequent years is based on the maintenance plan developed in the first year.
- Inspections should also be performed immediately after oil, fuel, or other chemical spills.

When is maintenance cleaning needed?

- For optimum performance, the unit should be cleaned out once the sediment depth reaches the recommended maintenance sediment depth, which is approximately 15% of the unit's total storage capacity (see **Table 3**). The frequency should be adjusted based on historical inspection results due to variable site pollutant loading.
- Sediment removal is easier when removed on a regular basis at or prior to the recommended maintenance sediment depths, as sediment build-up can compact making removal more difficult.
- The unit should be cleaned out immediately after an oil, fuel or chemical spill.

What conditions can compromise Stormceptor performance?

- If construction sediment and debris is not removed prior to activating the Stormceptor unit, maintenance frequency may be reduced.
- If the system is not maintained regularly and fills with sediment and debris beyond the capacity as indicated in **Table 2**, pollutant removal efficiency may be reduced.
- If an oil spill(s) exceeds the oil capacity of the system, subsequent spills may not be captured.
- If debris clogs the inlet of the system, removal efficiency of sediment and hydrocarbons may be reduced.
- If a downstream blockage occurs, a backwater condition may occur for the Stormceptor and removal efficiency of sediment and hydrocarbons may be reduced.

What training is required?

The Stormceptor is to be inspected and maintained by professional vacuum cleaning service providers with experience in the maintenance of underground tanks, sewers and catch basins. For typical inspection and maintenance activities, no specific supplemental training is required for the Stormceptor. Information provided within this Manual (provided to the site owner) contains sufficient guidance to maintain the system properly.

In unusual circumstances, such as if a damaged component needs replacement or some other condition requires manned entry into the vessel, confined space entry procedures must be followed. Only professional maintenance service providers trained in these procedures should enter the vessel. Service provider companies typically have personnel who are trained and certified in confined space entry procedures according to local, state, and federal standards.

What equipment is typically required for inspection?

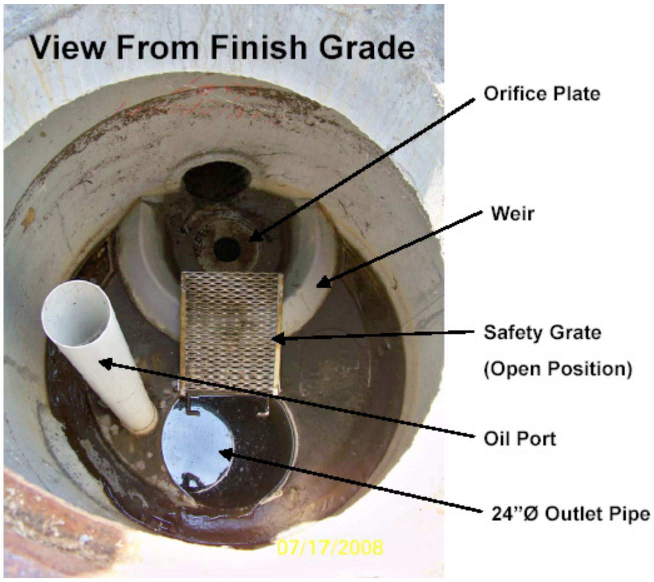
- Manhole access cover lifting tool
- Oil dipstick / Sediment probe with ball valve (typically ¾-inch to 1-inch diameter)
- Flashlight
- Camera
- Data log / Inspection Report
- Safety cones and caution tape
- Hard hat, safety shoes, safety glasses, and chemical-resistant gloves

Recommended Stormceptor Inspection Procedure:

- Stormceptor is to be inspected from grade through a standard surface manhole access cover.
- Sediment and oil depth inspections are performed with a sediment probe and oil dipstick.
- Oil depth is measured through the oil inspection port, either a 4-inch or 6-inch diameter port.
- Sediment depth can be measured through the oil inspection port or the 24-inch diameter outlet riser pipe.
- Inspections also involve a visual inspection of the internal components of the system.

Figure 3.

Figure 4.



What equipment is typically required for maintenance?

- Vacuum truck equipped with water hose and jet nozzle
- Small pump and tubing for oil removal
- Manhole access cover lifting tool
- Oil dipstick / Sediment probe with ball valve (typically ¾-inch to 1-inch diameter)
- Flashlight
- Camera
- Data log / Inspection Report
- Safety cones
- Hard hats, safety shoes, safety glasses, chemical-resistant gloves, and hearing protection for service providers
- Gas analyzer, respiratory gear, hoist and safety harness for specially trained personnel if confined space entry is required

Recommended Stormceptor Maintenance Procedure

Maintenance of Stormceptor is performed using a vacuum truck.

No entry into the unit is required for maintenance. ***DO NOT ENTER THE STORMCEPTOR CHAMBER*** unless you have the proper personal safety equipment, have been trained and are qualified to enter a confined space, as identified by local Occupational Safety and Health Regulations (e.g. 29 CFR 1910.146). Without the proper equipment, training and permit, entry into confined spaces can result in serious bodily harm and potentially death. Consult local and/or state regulations to determine the requirements for confined space entry. Be aware, and take precaution that the Stormceptor fiberglass insert may be slippery. In addition, be aware that some units do not have a safety grate to cover the outlet riser pipe that leads to the submerged, lower chamber.

- Ideally maintenance should be conducted during dry weather conditions when no flow is entering the unit.
- Stormceptor is to be maintained through a standard surface manhole access cover.
- Insert the oil dipstick into the oil inspection port. If oil is present, pump off the oil layer into separate containment using a small pump and tubing.
- Maintenance cleaning of accumulated sediment is performed with a vacuum truck.
    - For 6-ft diameter models and larger, the vacuum hose is inserted into the lower chamber via the 24-inch outlet riser pipe (See Fig. 5).
    - For 4-ft diameter model, the removable drop tee is lifted out, and the vacuum hose is inserted into the lower chamber via the 12-inch drop tee hole (See Fig. 6).

Figure 5.

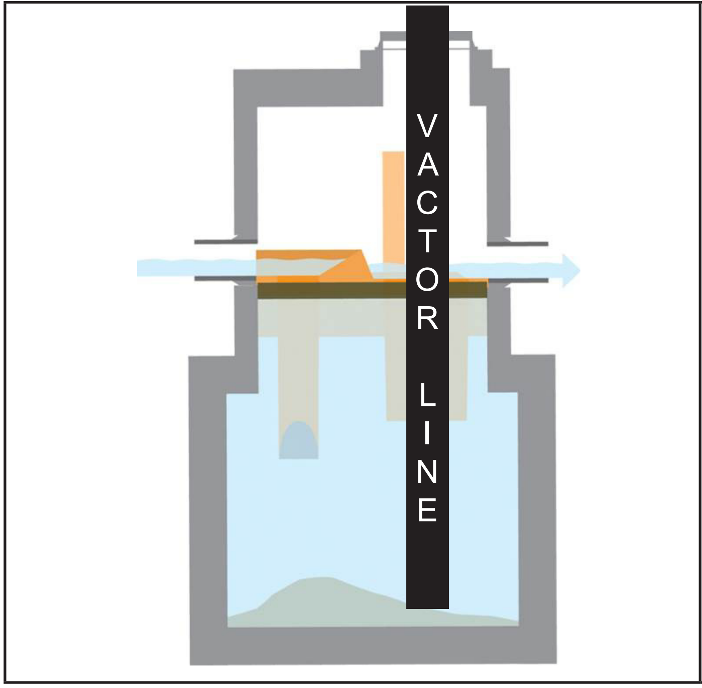
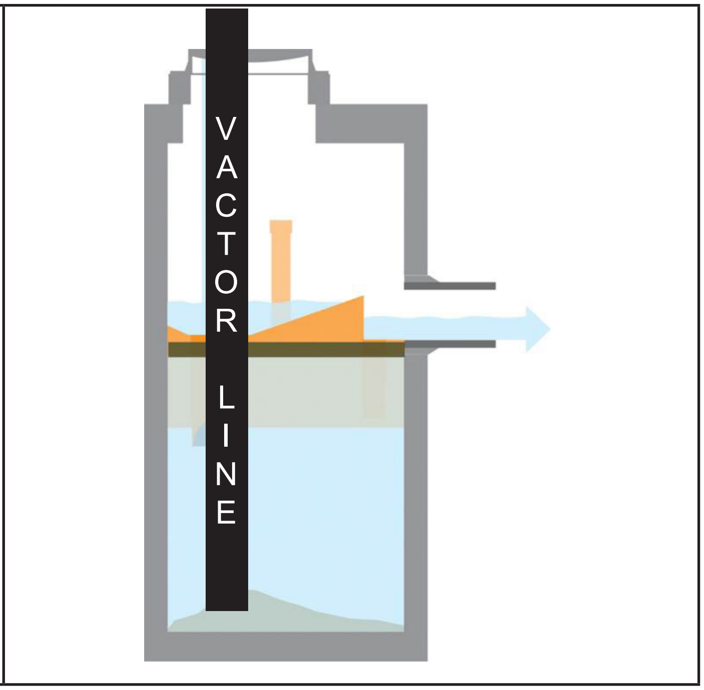


Figure 6.



- Using the vacuum hose, decant the water from the lower chamber into a separate containment tank or to the sanitary sewer, if permitted by the local regulating authority.
- Remove the sediment sludge from the bottom of the unit using the vacuum hose. For large Stormceptor units, a flexible hose is often connected to the primary vacuum line for ease of movement in the lower chamber.
- Units that have not been maintained regularly, have surpassed the maximum recommended sediment capacity, or contain damaged components may require manned entry by trained personnel using safe and proper confined space entry procedures.

Figure 7.

Figure 8.

A maintenance worker stationed at the above ground surface uses a vacuum hose to evacuate water, sediment, and debris from the system.

What is required for proper disposal?

The requirements for the disposal of material removed from Stormceptor units are similar to that of any other stormwater treatment Best Management Practices (BMP). Local guidelines should be consulted prior to disposal of the separator contents. In most areas the sediment, once dewatered, can be disposed of in a sanitary landfill. It is not anticipated that the sediment would be classified as hazardous waste. This could be site and pollutant dependent. In some cases, approval from the disposal facility operator/agency may be required.

What about oil spills?

Stormceptor is often implemented in areas where there is high potential for oil, fuel or other hydrocarbon or chemical spills. Stormceptor units should be cleaned immediately after a spill occurs by a licensed liquid waste hauler. You should also notify the appropriate regulatory agencies as required in the event of a spill.

What if I see an oil rainbow or sheen at the Stormceptor outlet?

With a steady influx of water with high concentrations of oil, a sheen may be noticeable at the Stormceptor outlet. This may occur because a hydrocarbon rainbow or sheen can be seen at very small oil concentrations (< 10 ppm). Stormceptor is effective at removing 95% of free oil, and the appearance of a sheen at the outlet with high influent oil concentrations does not mean that the unit is not working to this level of removal. In addition, if the influent oil is emulsified, the Stormceptor will not be able to remove it. The Stormceptor is designed for free oil removal and not emulsified or dissolved oil conditions.

What factors affect the costs involved with inspection/maintenance?
The Vacuum Service Industry for stormwater drainage and sewer systems is a well-established sector of the service industry that cleans underground tanks, sewers and catch basins. Costs to clean Stormceptor units will vary. Inspection and maintenance costs are most often based on unit size, the number of units on a site, sediment/oil/hazardous material loads, transportation distances, tipping fees, disposal requirements and other local regulations.

What factors predict maintenance frequency?
Maintenance frequency will vary with the amount of pollution on your site (number of hydrocarbon spills, amount of sediment, site activity and use, etc.). It is recommended that the frequency of maintenance be increased or reduced based on local conditions. If the sediment load is high from an unstable site or sediment loads transported from upstream catchments, maintenance may be required semi-annually. Conversely once a site has stabilized, maintenance may be required less frequently (for example: two to seven year, site and situation dependent). Maintenance should be performed immediately after an oil spill or once the sediment depth in Stormceptor reaches the value specified in **Table 3** based on the unit size.

Table 3. Recommended Sediment Depths Indicating Maintenance

STC Model	Maintenance Sediment depth (in)	EOS Model	Maintenance Sediment depth (in)	Oil Storage Depth (in)	OSR Model	Maintenance Sediment depth (in)
450	8	**4-175**	9	24	**065**	8
900	8	**9-365**	9	24	**140**	8
1200	10	**12-590**	11	39		
1800	15					
2400	12	**24-1400**	14	68	**250**	12
3600	17	**36-1700**	19	79		
4800	15	**48-2000**	16	68	**390**	17
6000	18	**60-2500**	20	79		
7200	15	**72-3400**	17	79	**560**	17
11000*	17	**110-5000***	16	68	**780***	17
13000*	20	**130-6000***	20	79		
16000*	17	**160-7800***	17	79	**1125***	17

Note:

1. *The values above are for typical standard units.*

   **Per structure.*

Replacement parts
Since there are no moving parts during operation in a Stormceptor, broken, damaged, or worn parts are not typically encountered. Therefore, inspection and maintenance activities are generally focused on pollutant removal. However, if replacements parts are necessary, they may be purchased by contacting your local Rinker Materials Representative or the Stormceptor Information Line at (800) 909-7763.

The benefits of regular inspection and maintenance are many – from ensuring maximum operation efficiency, to keeping maintenance costs low, to the continued protection of natural waterways – and provide the key to Stormceptor's long and effective service life.

<u>Stormceptor Inspection and Maintenance Log</u>

Stormceptor Model No: ______________________________

Allowable Sediment Depth: ______________________________

Serial Number: ______________________________

Installation Date: ______________________________

Location Description of Unit: ______________________________

Other Comments: ______________________________

Contact Information

Questions regarding the Stormceptor can be addressed by contacting your Local Rinker Materials representative, the Stormceptor Information Line at (800) 909-7763 or visit our website www.rinkerstormceptor.com.

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