

STORMWATER MANAGEMENT REPORT

Triangle Farm
Mill Street
Holliston, Massachusetts

June 15, 2020

Prepared for:

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Project Introduction:

The applicant, Murch Prentice Realty Trust, is proposing to develop a seven (7) lot single family Open Space Residential Subdivision located off Mill Street in Holliston, Massachusetts. The existing property consist of approximately 12.4 acres of land area, with additional land area to be considered Open Space.

The Project will be serviced by town water, onsite sewage disposal systems and other available public utilities. The stormwater generated from the Project will be captured, conveyed, treated and mitigated on-site utilizing Best Management Practices.

The purpose of these calculations is to demonstrate design compliance of the Project's stormwater management system for water quality and quantity, specifically post-development peak discharge rates per the DEP's Stormwater Management Policy, the Town of Holliston Land Subdivision Regulations. As designed, the system will mitigate peak rates of runoff for storms up to and including the 100-year event under post-construction conditions.

Methodology/Sources of Data:

The overall storm water management plan for the project is designed to maintain the peak rate of storm water runoff and runoff volumes from the site after development. The Soil Conservation Service Modified Soil Cover Complex Method, the computer program "HydroCAD" by Applied Microcomputer Systems, and the procedures specified in Urban Hydrology for storm Small Watersheds were used to determine pre-and post-developed peak flow rates of runoff from the site. The storm events have been compiled from the Soil Conservation Services Technical Report No. 55 and the U.S. Department of Commerce Technical Paper (TP 40). The 2-year, 10-year, 25-year and 100-year storm events have been utilized for hydrology calculations. The rainfall data for the Type III, 24-hour storm events follow:

<u>24-Hour Storm</u>	<u>Rainfall (inches)</u>
2	3.20
10	4.80
25	5.50
100	7.0

The storm water runoff will be controlled through the use of "Best Management Practices" and in conformance with the MADEP Stormwater Management Policy. The proposed Project will result in an improvement over the existing conditions, by constructing a storm water management system that will provide treatment, groundwater recharge and reduce the peak rates of runoff and offsite runoff volumes.

The piped drainage system has been designed utilizing the Rational Method for the 25 year storm event to size street drains.

Soils:

The Natural Resources Conservation Service (NRCS), Hydrologic Soils Group Map for Middlesex county, Massachusetts indicates that the on-site soils consist of Paxton Fine Sandy Loam-307B, and Scituate fine sandy loam-315B. NRCS assigned hydrologic soil rating for these soils ranges from C and D soil classification. The upper regions of the site consists of C hydrologic soil rating and D rating in the wetland area. On-site soil testing was performed to determine groundwater elevations and confirm soil classifications.

Existing Conditions Overview:

The Project is located off Mill Street and identified as Assessor Map 7, Block 4, Lot 55.2 containing approximately 12.4 +/- acres. The site is currently undeveloped historical farm lands that has become overgrown with brush and woods mix. There is a bordering vegetated wetland area located at the rear of property. The site gently slopes from Mill Street (North) to the rear property boundary (South) with a change in elevation of approximately fourteen (14) feet.

The existing site is divided into three (3) existing watershed subcatchment areas. See the attached Pre-Development Subcatchment Area Plan for delineations. Subcatchment E1 flows overland towards Mill Street and the wetland area to the south. Subcatchments E1 and E2 are combined with Link 1L and discharge via overland flow the rear wetland area.

<u>Description</u>	<u>Design Point Comments</u>
E1	Overland flow to Mill Street area
E2	Overland flow to the rear wetland
E3	Overland flow to the rear wetland

Proposed Conditions Overview:

The proposal is to subdivide the property as an Open Space Residential Subdivision consisting of seven (7) single family dwellings. The proposed roadway extends from Mill Street to a cul-de-sac approximately five-hundred (500) feet in length. The proposed stormwater drainage system is designed to capture the runoff utilizing catch basins, manholes and culverts to convey the stormwater to a drainage basin located at the end of the proposed roadway. The roof runoff from the proposed dwellings will be conveyed via gutters and downspouts to underground recharge systems.

The proposed runoff areas have been divided into four (4) subcatchments. Subcatchment P1 discharges via overland flow towards Mill Street and the wetland area to the south. Subcatchments P3 and P4 bypass the proposed drainage basin and discharge via overland flow to the rear wetland. Subcatchment P4 is directed to the proposed stormwater drainage basin. The outflow from the drainage basin has been combined with the discharge from P3 and P4 in Link 2L for comparison with predeveloped flows.

The proposed systems will reduce all post-development flow rates and volumes of runoff up to and including the 100-year event to existing levels at all abutting areas. Existing uncaptured off-site runoff not associated with the Project will continue to flow overland without change.

<u>Description</u>	<u>Design Point Comments</u>
P1	Overland flow to Mill Street area
P2	Overland flow to the rear wetland
P3	Overland flow to the rear wetland
P4	To drainage basin

The following is summary comparison of Pre- and Post-Developed Rates and Volumes of Runoff:

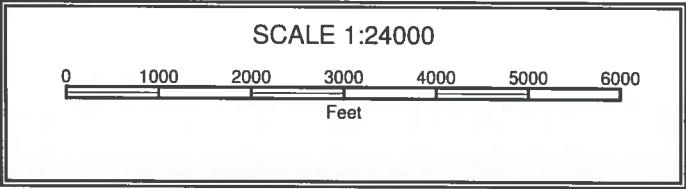
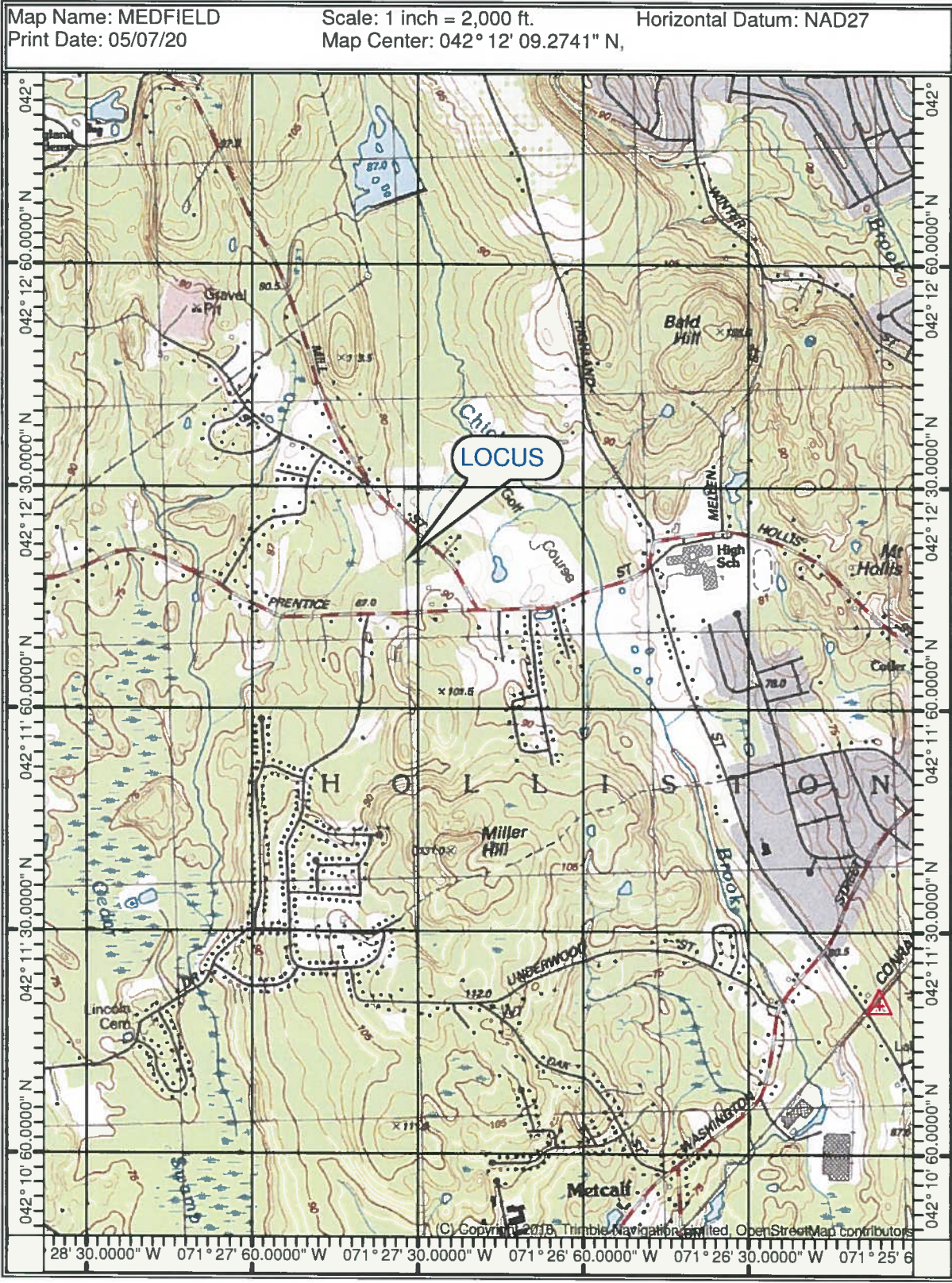
<u>Summary of Peak Stormwater Runoff Rates:</u>								
<u>Design Point</u>	<u>2-Yr Peak Flow (cfs)</u>		<u>10-Yr Peak Flow (cfs)</u>		<u>25-Yr Peak Flow (cfs)</u>		<u>100-Yr Peak Flow (cfs)</u>	
	<u>Existing</u>	<u>Proposed</u>	<u>Existing</u>	<u>Proposed</u>	<u>Existing</u>	<u>Proposed</u>	<u>Existing</u>	<u>Proposed</u>
E1/ P1	2.59	2.58	5.94	5.63	6.62	6.25	11.15	10.29
1L/ 2L	4.52	3.64	10.67	9.09	11.93	10.31	20.34	18.31

The following is a summary of the Retention Basin:

<u>Summary of Retention Basin</u>								
<u>Design Point</u>	<u>2-Yr Volume (cu.ft.)</u>		<u>10-Yr Volume (ac-ft)</u>		<u>25-Yr Volume (ac-ft)</u>		<u>100-Yr Volume (ac-ft)</u>	
	<u>Peak Elev.Ft.</u>	<u>Outflow (cfs)</u>	<u>Peak Elev. Ft.</u>	<u>Outflow (cfs)</u>	<u>Peak Elev.Ft.</u>	<u>Outflow (cfs)</u>	<u>Peak Elev.Ft.</u>	<u>Outflow (cfs)</u>
1P	280.73	0.65	281.43	2.20	281.53	2.54	282.06	4.61

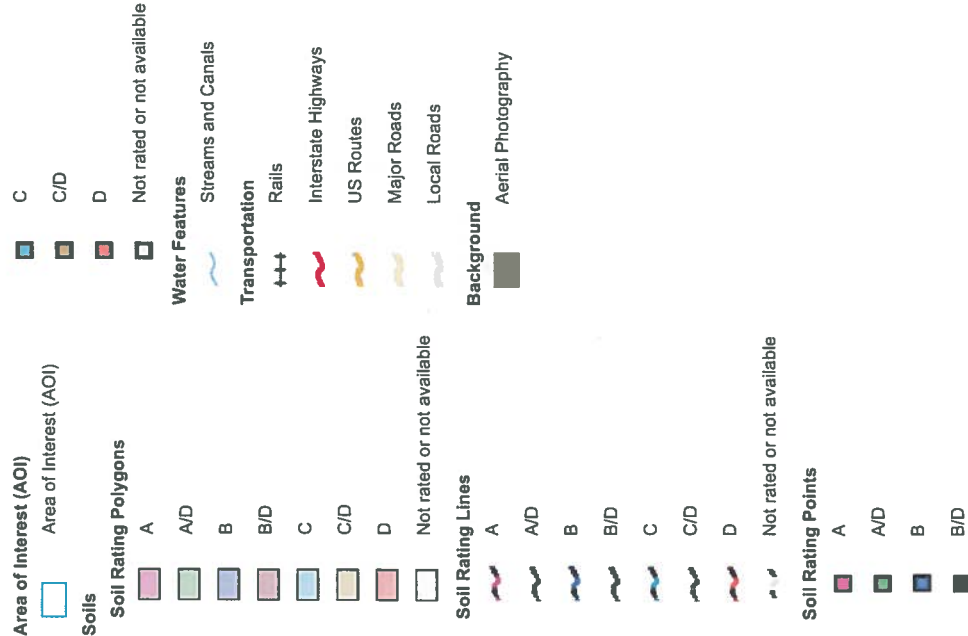
Summary:

The calculations performed for all design storm events indicate that the total peak rates and volumes of runoff for the Project as proposed will not exceed those of existing conditions with the implementation of the stormwater management system. With the implementation of the stormwater management system as designed, along with the Operation and Maintenance plan contained herein, all of the objectives of the DEP's Stormwater Management Regulations are satisfied.



Web Soil Survey
National Cooperative Soil Survey

MAP LEGEND



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:
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Middlesex County, Massachusetts
Survey Area Data: Version 19, Sep 12, 2019

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

Date(s) aerial images were photographed: Jul 28, 2019—Aug 15, 2019

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

Hydrologic Soil Group

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
33B	Raypol silt loam, 0 to 5 percent slopes	B/D	3.8	1.0%
44A	Birdsall mucky silt loam, 0 to 1 percent slopes	C/D	19.1	4.9%
51A	Swansea muck, 0 to 1 percent slopes	B/D	11.8	3.0%
52A	Freetown muck, 0 to 1 percent slopes	B/D	25.2	6.4%
71B	Ridgebury fine sandy loam, 3 to 8 percent slopes, extremely stony	D	9.9	2.5%
73B	Whitman fine sandy loam, 0 to 3 percent slopes, extremely stony	D	24.1	6.1%
103C	Charlton-Hollis-Rock outcrop complex, 8 to 15 percent slopes	B	0.2	0.0%
104C	Hollis-Rock outcrop-Charlton complex, 0 to 15 percent slopes	D	4.0	1.0%
106C	Narragansett-Hollis-Rock outcrop complex, 3 to 15 percent slopes	A	25.7	6.5%
251B	Haven silt loam, 3 to 8 percent slopes	A	24.8	6.3%
253C	Hinckley loamy sand, 8 to 15 percent slopes	A	0.1	0.0%
253D	Hinckley loamy sand, 15 to 25 percent slopes	A	4.8	1.2%
254B	Merrimac fine sandy loam, 3 to 8 percent slopes	A	21.6	5.5%
255B	Windsor loamy sand, 3 to 8 percent slopes	A	23.2	5.9%
261A	Tisbury silt loam, 0 to 3 percent slopes	C	16.8	4.3%
302B	Montauk fine sandy loam, 0 to 8 percent slopes, extremely stony	C	6.1	1.5%

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
302C	Montauk fine sandy loam, 8 to 15 percent slopes, extremely stony	C	5.2	1.3%
307B	Paxton fine sandy loam, 0 to 8 percent slopes, extremely stony	C	23.2	5.9%
307C	Paxton fine sandy loam, 8 to 15 percent slopes, extremely stony	C	5.7	1.5%
315B	Scituate fine sandy loam, 3 to 8 percent slopes	D	41.2	10.4%
317B	Scituate fine sandy loam, 3 to 8 percent slopes, extremely stony	D	35.8	9.1%
335B	Rainbow silt loam, 3 to 8 percent slopes	C/D	0.2	0.1%
336B	Rainbow silt loam, 3 to 8 percent slopes, very stony	C/D	5.0	1.3%
340B	Broadbrook very fine sandy loam, 3 to 8 percent slopes	D	1.1	0.3%
341B	Broadbrook very fine sandy loam, 3 to 8 percent slopes, very stony	D	12.8	3.2%
341C	Broadbrook very fine sandy loam, 8 to 15 percent slopes, very stony	D	0.8	0.2%
424B	Canton fine sandy loam, 3 to 8 percent slopes, extremely bouldery	A	19.5	4.9%
424C	Canton fine sandy loam, 8 to 15 percent slopes, extremely bouldery	A	16.9	4.3%
424D	Canton fine sandy loam, 15 to 25 percent slopes, extremely bouldery	A	5.6	1.4%
Totals for Area of Interest			394.2	100.0%

Description

Hydrologic soil groups are based on estimates of runoff potential. Soils are assigned to one of four groups according to the rate of water infiltration when the soils are not protected by vegetation, are thoroughly wet, and receive precipitation from long-duration storms.

The soils in the United States are assigned to four groups (A, B, C, and D) and three dual classes (A/D, B/D, and C/D). The groups are defined as follows:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

If a soil is assigned to a dual hydrologic group (A/D, B/D, or C/D), the first letter is for drained areas and the second is for undrained areas. Only the soils that in their natural condition are in group D are assigned to dual classes.

Rating Options

Aggregation Method: Dominant Condition

Component Percent Cutoff: None Specified

Tie-break Rule: Higher



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 8²
- Operation and Maintenance Plan required by Standard 9

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

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

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

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

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



Checklist for Stormwater Report

B. Stormwater Checklist and Certification

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

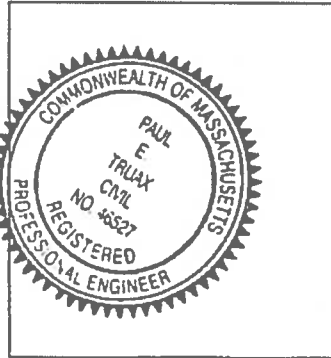
Note: Because stormwater requirements vary from project to project, it is possible that a complete Stormwater Report may not include information on some of the subjects specified in the Checklist. If it is determined that a specific item does not apply to the project under review, please note that the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

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

Registered Professional Engineer's Certification

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

Registered Professional Engineer Block and Signature



Paul F. Truax 6-15-2020
Signature and Date

Checklist

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

- ☒ New development
☐ Redevelopment
☐ Mix of New Development and Redevelopment



Checklist for Stormwater Report

Checklist (continued)

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

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

Standard 1: No New Untreated Discharges

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



Checklist for Stormwater Report

Checklist (continued)

Standard 2: Peak Rate Attenuation

- ☐ Standard 2 waiver requested because the project is located in land subject to coastal storm flowage and stormwater discharge is to a wetland subject to coastal flooding.
- ☐ Evaluation provided to determine whether off-site flooding increases during the 100-year 24-hour storm.
- ☒ Calculations provided to show that post-development peak discharge rates do not exceed pre-development rates for the 2-year and 10-year 24-hour storms. If evaluation shows that off-site flooding increases during the 100-year 24-hour storm, calculations are also provided to show that post-development peak discharge rates do not exceed pre-development rates for the 100-year 24-hour storm.

Standard 3: Recharge

- ☒ Soil Analysis provided.
- ☒ Required Recharge Volume calculation provided.
- ☐ Required Recharge volume reduced through use of the LID site Design Credits.
- ☒ Sizing the infiltration, BMPs is based on the following method: Check the method used.
 - ☒ Static
 - ☒ Simple Dynamic
 - ☐ Dynamic Field¹
- ☐ Runoff from all impervious areas at the site discharging to the infiltration BMP.
- ☒ Runoff from all impervious areas at the site is *not* discharging to the infiltration BMP and calculations are provided showing that the drainage area contributing runoff to the infiltration BMPs is sufficient to generate the required recharge volume.
- ☒ Recharge BMPs have been sized to infiltrate the Required Recharge Volume.
- ☐ Recharge BMPs have been sized to infiltrate the Required Recharge Volume *only* to the maximum extent practicable for the following reason:
 - ☐ Site is comprised solely of C and D soils and/or bedrock at the land surface
 - ☐ M.G.L. c. 21E sites pursuant to 310 CMR 40.0000
 - ☐ Solid Waste Landfill pursuant to 310 CMR 19.000
 - ☐ Project is otherwise subject to Stormwater Management Standards only to the maximum extent practicable.
- ☒ Calculations showing that the infiltration BMPs will drain in 72 hours are provided.
- ☐ Property includes a M.G.L. c. 21E site or a solid waste landfill and a mounding analysis is included.

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



Checklist for Stormwater Report

Checklist (continued)

Standard 3: Recharge (continued)

- ☒ The infiltration BMP is used to attenuate peak flows during storms greater than or equal to the 10-year 24-hour storm and separation to seasonal high groundwater is less than 4 feet and a mounding analysis is provided.
- ☐ Documentation is provided showing that infiltration BMPs do not adversely impact nearby wetland resource areas.

Standard 4: Water Quality

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

- Good housekeeping practices;
 - Provisions for storing materials and waste products inside or under cover;
 - Vehicle washing controls;
 - Requirements for routine inspections and maintenance of stormwater BMPs;
 - Spill prevention and response plans;
 - Provisions for maintenance of lawns, gardens, and other landscaped areas;
 - Requirements for storage and use of fertilizers, herbicides, and pesticides;
 - Pet waste management provisions;
 - Provisions for operation and management of septic systems;
 - Provisions for solid waste management;
 - Snow disposal and plowing plans relative to Wetland Resource Areas;
 - Winter Road Salt and/or Sand Use and Storage restrictions;
 - Street sweeping schedules;
 - Provisions for prevention of illicit discharges to the stormwater management system;
 - Documentation that Stormwater BMPs are designed to provide for shutdown and containment in the event of a spill or discharges to or near critical areas or from LUHPPL;
 - Training for staff or personnel involved with implementing Long-Term Pollution Prevention Plan;
 - List of Emergency contacts for implementing Long-Term Pollution Prevention Plan.
- ☒ A Long-Term Pollution Prevention Plan is attached to Stormwater Report and is included as an attachment to the Wetlands Notice of Intent.
 - ☐ Treatment BMPs subject to the 44% TSS removal pretreatment requirement and the one inch rule for calculating the water quality volume are included, and discharge:
 - ☐ is within the Zone II or Interim Wellhead Protection Area
 - ☐ is near or to other critical areas
 - ☐ is within soils with a rapid infiltration rate (greater than 2.4 inches per hour)
 - ☐ involves runoff from land uses with higher potential pollutant loads.
 - ☐ The Required Water Quality Volume is reduced through use of the LID site Design Credits.
 - ☒ Calculations documenting that the treatment train meets the 80% TSS removal requirement and, if applicable, the 44% TSS removal pretreatment requirement, are provided.



Checklist for Stormwater Report

Checklist (continued)

Standard 4: Water Quality (continued)

- ☒ The BMP is sized (and calculations provided) based on:
 - ☒ The ½" or 1" Water Quality Volume or
 - ☐ The equivalent flow rate associated with the Water Quality Volume and documentation is provided showing that the BMP treats the required water quality volume.
- ☐ The applicant proposes to use proprietary BMPs, and documentation supporting use of proprietary BMP and proposed TSS removal rate is provided. This documentation may be in the form of the propriety BMP checklist found in Volume 2, Chapter 4 of the Massachusetts Stormwater Handbook and submitting copies of the TARP Report, STEP Report, and/or other third party studies verifying performance of the proprietary BMPs.
- ☐ A TMDL exists that indicates a need to reduce pollutants other than TSS and documentation showing that the BMPs selected are consistent with the TMDL is provided.

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

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

Standard 6: Critical Areas

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



Checklist for Stormwater Report

Checklist (continued)

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

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

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

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

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



Checklist for Stormwater Report

Checklist (continued)

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

- ☐ The project is highly complex and information is included in the Stormwater Report that explains why it is not possible to submit the Construction Period Pollution Prevention and Erosion and Sedimentation Control Plan with the application. A Construction Period Pollution Prevention and Erosion and Sedimentation Control has **not** been included in the Stormwater Report but will be submitted **before** land disturbance begins.
- ☐ The project is **not** covered by a NPDES Construction General Permit.
- ☐ The project is covered by a NPDES Construction General Permit and a copy of the SWPPP is in the Stormwater Report.
- ☒ The project is covered by a NPDES Construction General Permit but no SWPPP been submitted. The SWPPP will be submitted BEFORE land disturbance begins.

Standard 9: Operation and Maintenance Plan

- ☒ The Post Construction Operation and Maintenance Plan is included in the Stormwater Report and includes the following information:
 - ☒ Name of the stormwater management system owners;
 - ☒ Party responsible for operation and maintenance;
 - ☒ Schedule for implementation of routine and non-routine maintenance tasks;
 - ☒ Plan showing the location of all stormwater BMPs maintenance access areas;
 - ☒ Description and delineation of public safety features;
 - ☒ Estimated operation and maintenance budget; and
 - ☒ Operation and Maintenance Log Form.
- ☐ The responsible party is **not** the owner of the parcel where the BMP is located and the Stormwater Report includes the following submissions:
 - ☐ A copy of the legal instrument (deed, homeowner's association, utility trust or other legal entity) that establishes the terms of and legal responsibility for the operation and maintenance of the project site stormwater BMPs;
 - ☐ A plan and easement deed that allows site access for the legal entity to operate and maintain BMP functions.

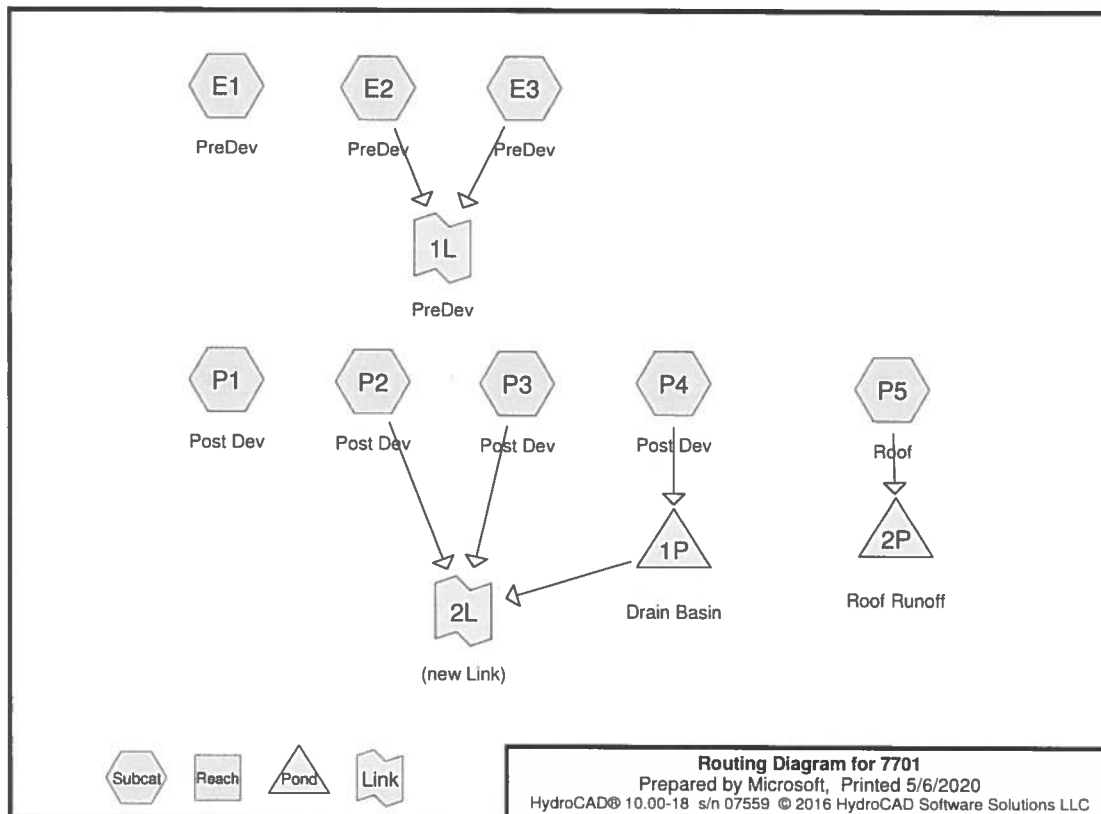
Standard 10: Prohibition of Illicit Discharges

- ☐ The Long-Term Pollution Prevention Plan includes measures to prevent illicit discharges;
- ☒ An Illicit Discharge Compliance Statement is attached;
- ☐ NO Illicit Discharge Compliance Statement is attached but will be submitted **prior to** the discharge of any stormwater to post-construction BMPs.

APPENDIX – A

**Hydrogeological Calculations for Pre & Post Development
Hydraulic Design (Manning's Equation)**

Standard 2



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Type III 24-hr 2 Yr Rainfall=3.20"

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Page 2

Summary for Subcatchment E1: PreDev

Runoff = 2.59 cfs @ 12.24 hrs, Volume= 0.266 af, Depth> 0.98"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs

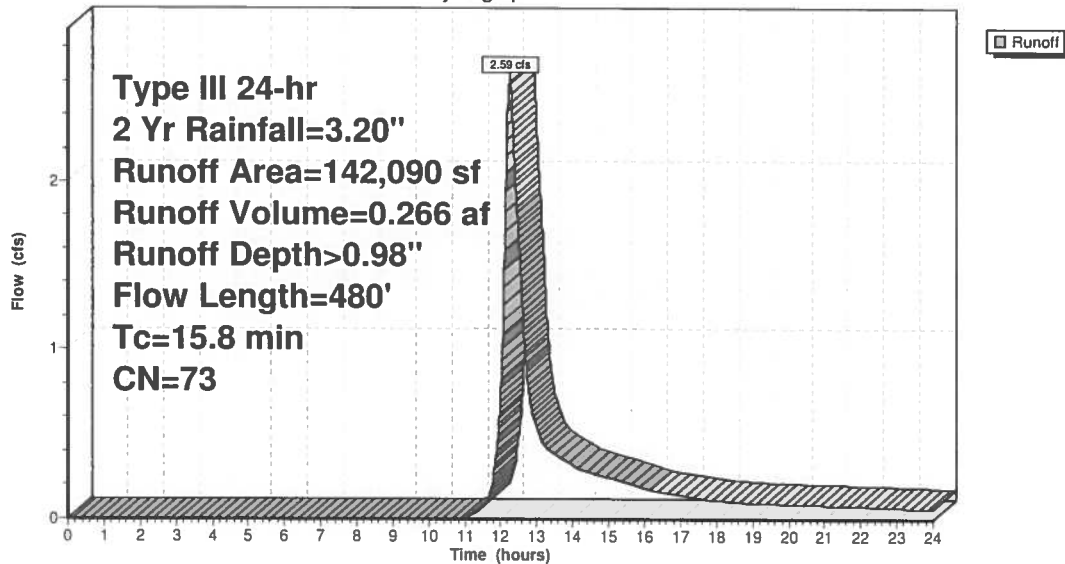
Type III 24-hr 2 Yr Rainfall=3.20"

Area (sf)	CN	Description
5,670	98	Paved parking, HSG C
136,420	72	Woods/grass comb., Good, HSG C
142,090	73	Weighted Average
136,420		96.01% Pervious Area
5,670		3.99% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
13.5	50	0.0160	0.06		Sheet Flow, A-B
					Woods: Light underbrush n= 0.400 P2= 3.20"
0.6	130	0.0500	3.60		Shallow Concentrated Flow, B-C
					Unpaved Kv= 16.1 fps
1.7	300	0.0200	2.87		Shallow Concentrated Flow, C-D
					Paved Kv= 20.3 fps
15.8	480	Total			

Subcatchment E1: PreDev

Hydrograph



Summary for Subcatchment E2: PreDev

Runoff = 3.29 cfs @ 12.25 hrs, Volume= 0.346 af, Depth> 0.93"

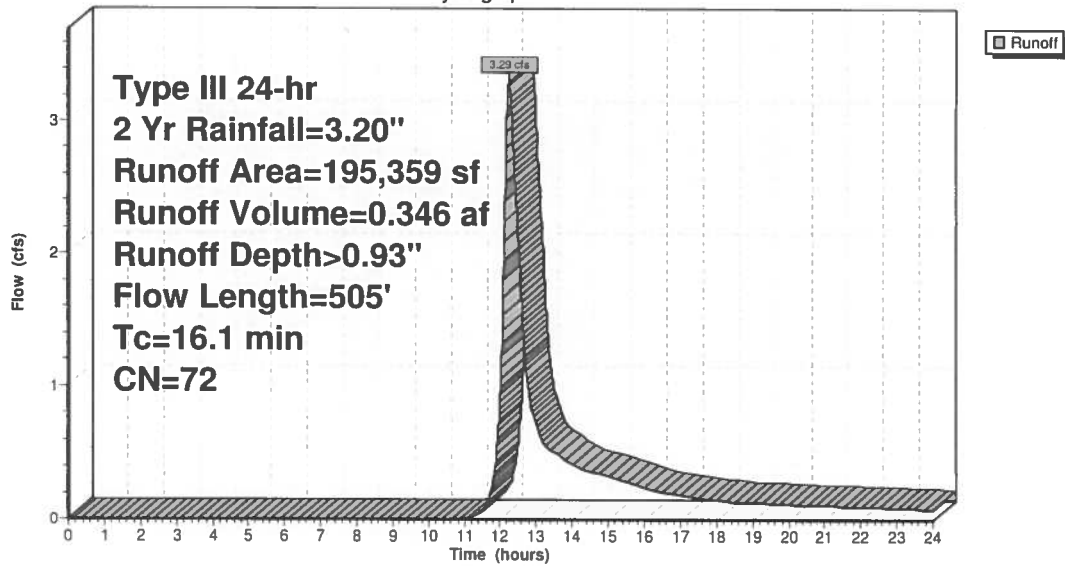
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
 Type III 24-hr 2 Yr Rainfall=3.20"

Area (sf)	CN	Description
195,359	72	Woods/grass comb., Good, HSG C
195,359		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
13.2	50	0.0170	0.06		Sheet Flow, A-B
					Woods: Light underbrush n= 0.400 P2= 3.20"
2.2	270	0.0160	2.04		Shallow Concentrated Flow, B-C
					Unpaved Kv= 16.1 fps
0.7	185	0.0800	4.55		Shallow Concentrated Flow, C-D
					Unpaved Kv= 16.1 fps
16.1	505	Total			

Subcatchment E2: PreDev

Hydrograph



Summary for Subcatchment E3: PreDev

Runoff = 1.26 cfs @ 12.29 hrs, Volume= 0.142 af, Depth> 0.92"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs

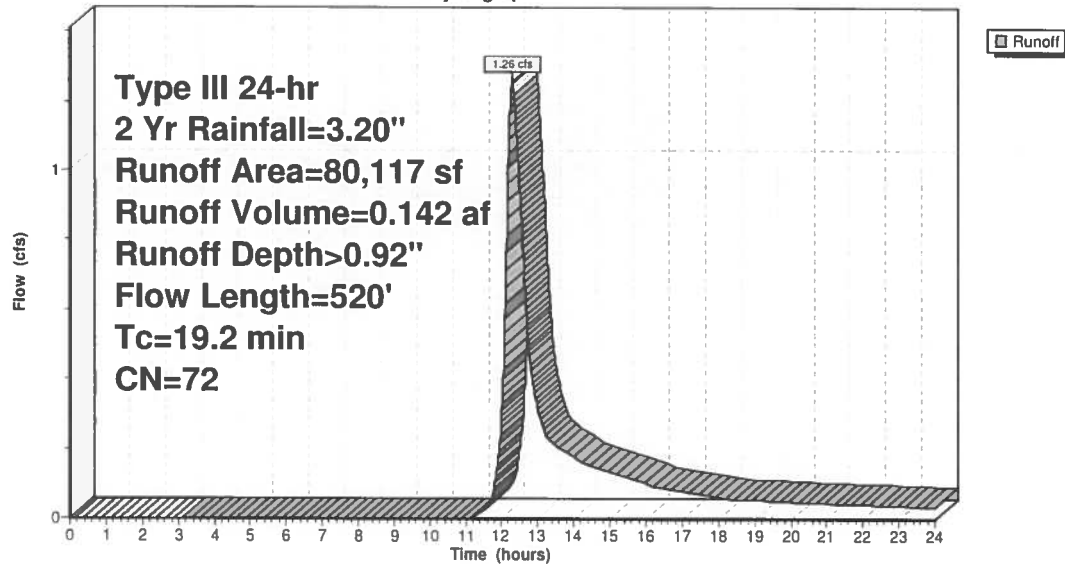
Type III 24-hr 2 Yr Rainfall=3.20"

Area (sf)	CN	Description
80,117	72	Woods/grass comb., Good, HSG C
80,117		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
16.3	50	0.0100	0.05		Sheet Flow, A-B
					Woods: Light underbrush n= 0.400 P2= 3.20"
2.9	470	0.0280	2.69		Shallow Concentrated Flow, B-C
					Unpaved Kv= 16.1 fps
19.2	520	Total			

Subcatchment E3: PreDev

Hydrograph



Summary for Subcatchment P1: Post Dev

Runoff = 2.58 cfs @ 12.21 hrs, Volume= 0.247 af, Depth> 1.09"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs

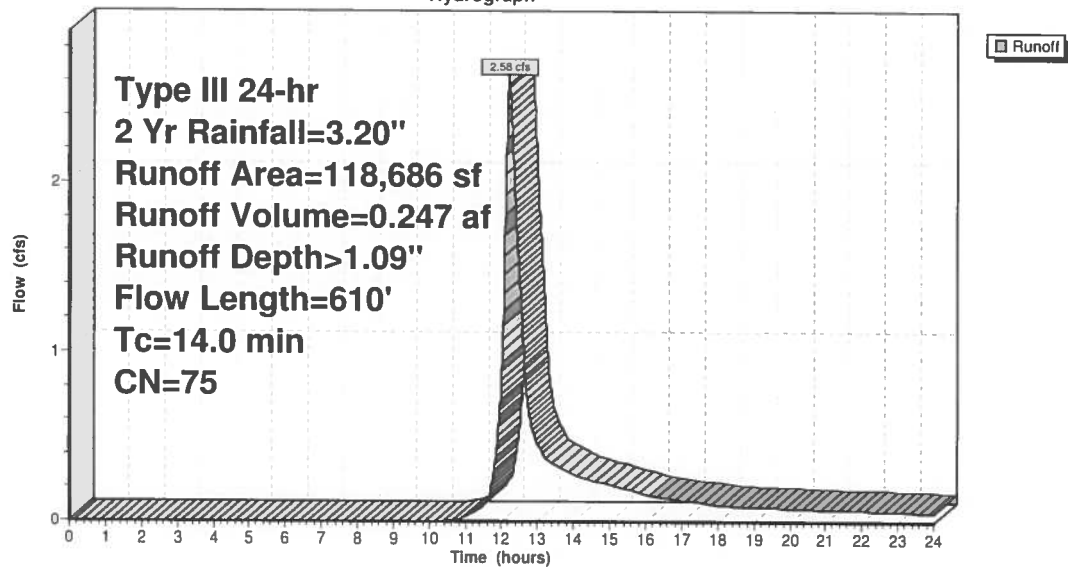
Type III 24-hr 2 Yr Rainfall=3.20"

Area (sf)	CN	Description
0	98	
8,060	98	Paved parking, HSG C
51,270	74	>75% Grass cover, Good, HSG C
59,356	72	Woods/grass comb., Good, HSG C
118,686	75	Weighted Average
110,626		93.21% Pervious Area
8,060		6.79% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.8	50	0.0100	0.08		Sheet Flow, A-B
					Grass: Dense n= 0.240 P2= 3.20"
0.6	110	0.0400	3.22		Shallow Concentrated Flow, B-C
					Unpaved Kv= 16.1 fps
2.6	450	0.0200	2.87		Shallow Concentrated Flow, C-D
					Paved Kv= 20.3 fps
14.0	610	Total			

Subcatchment P1: Post Dev

Hydrograph



Summary for Subcatchment P2: Post Dev

Runoff = 1.94 cfs @ 12.15 hrs, Volume= 0.170 af, Depth> 0.98"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs

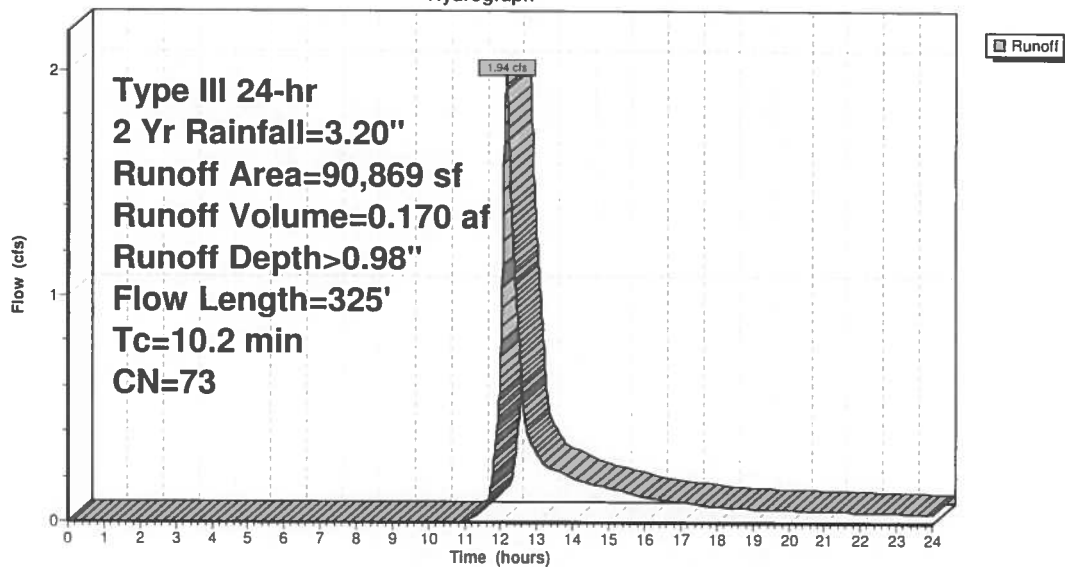
Type III 24-hr 2 Yr Rainfall=3.20"

Area (sf)	CN	Description
43,772	72	Woods/grass comb., Good, HSG C
47,097	74	>75% Grass cover, Good, HSG C
90,869	73	Weighted Average
90,869		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
9.2	50	0.0150	0.09		Sheet Flow, A-B
					Grass: Dense n= 0.240 P2= 3.20"
1.0	275	0.0800	4.55		Shallow Concentrated Flow, B-C
					Unpaved Kv= 16.1 fps
10.2	325	Total			

Subcatchment P2: Post Dev

Hydrograph



Summary for Subcatchment P3: Post Dev

Runoff = 1.75 cfs @ 12.21 hrs, Volume= 0.172 af, Depth> 0.98"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs

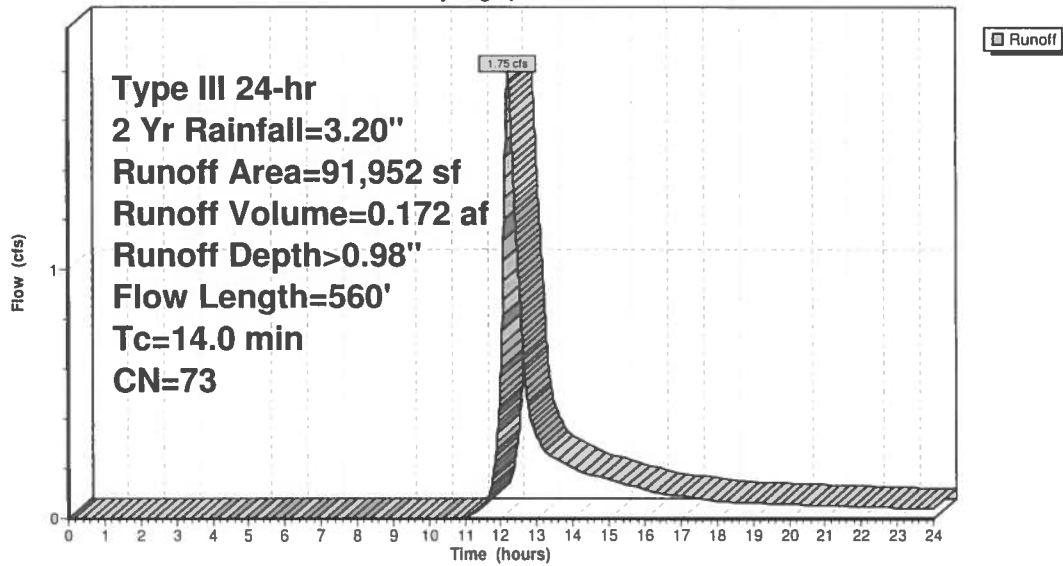
Type III 24-hr 2 Yr Rainfall=3.20"

Area (sf)	CN	Description
62,580	72	Woods/grass comb., Good, HSG C
29,372	74	>75% Grass cover, Good, HSG C
91,952	73	Weighted Average
91,952		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.8	50	0.0100	0.08		Sheet Flow, A-B
					Grass: Dense n= 0.240 P2= 3.20"
3.2	510	0.0280	2.69		Shallow Concentrated Flow, B-C
					Unpaved Kv= 16.1 fps
14.0	560	Total			

Subcatchment P3: Post Dev

Hydrograph



Summary for Subcatchment P4: Post Dev

Runoff = 3.02 cfs @ 12.19 hrs, Volume= 0.275 af, Depth> 1.40"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs

Type III 24-hr 2 Yr Rainfall=3.20"

Area (sf)	CN	Description
12,535	98	Paved parking, HSG C
13,138	98	Paved roads HSG C
77,201	74	>75% Grass cover, Good, HSG C
102,874	80	Weighted Average
77,201		75.04% Pervious Area
25,673		24.96% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.8	50	0.0100	0.08		Sheet Flow, A-B
					Grass: Dense n= 0.240 P2= 3.20"
1.1	150	0.0200	2.28		Shallow Concentrated Flow, B-C
					Unpaved Kv= 16.1 fps
1.0	160	0.0170	2.65		Shallow Concentrated Flow, C-D
					Paved Kv= 20.3 fps
0.6	170	0.0100	4.54	3.56	Pipe Channel, D-E
					12.0" Round Area= 0.8 sf Perim= 3.1' r= 0.25'
					n= 0.013
13.5	530	Total			

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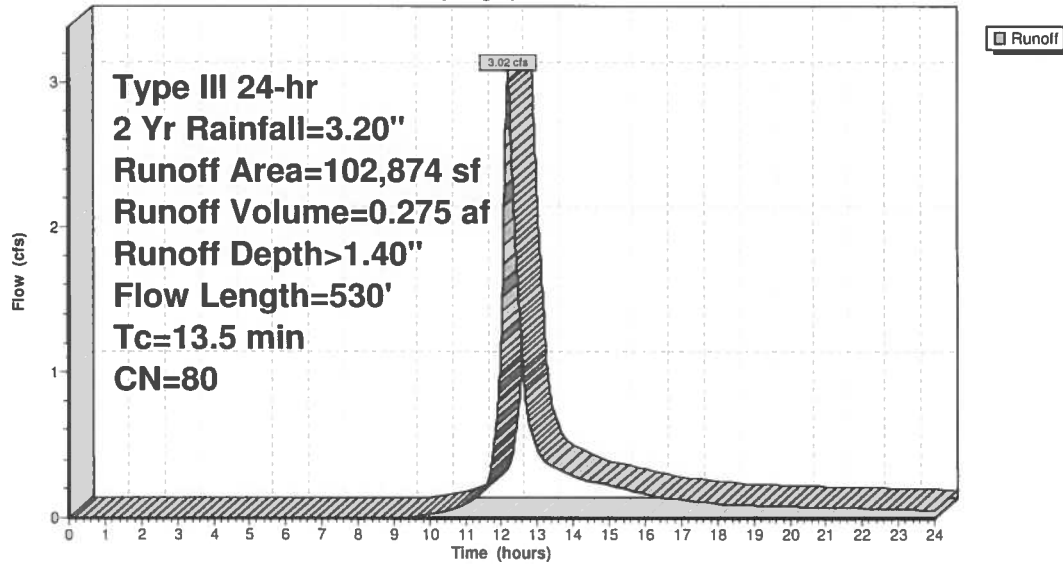
Type III 24-hr 2 Yr Rainfall=3.20"

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Subcatchment P4: Post Dev

Hydrograph



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Summary for Subcatchment P5: Roof

Runoff = 0.07 cfs @ 12.08 hrs, Volume= 0.006 af, Depth> 2.97"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs

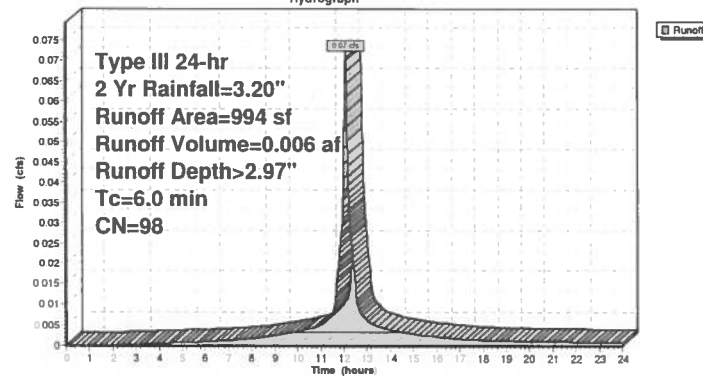
Type III 24-hr 2 Yr Rainfall=3.20"

Area (sf)	CN	Description
994	98	Roofs, HSG A
994		100.00% Impervious Area

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

Subcatchment P5: Roof

Hydrograph



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Type III 24-hr 2 Yr Rainfall=3.20"

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Summary for Pond 1P: Drain Basin

Inflow Area = 2.362 ac, 24.96% Impervious, Inflow Depth > 1.40" for 2 Yr event
Inflow = 3.02 cfs @ 12.19 hrs, Volume= 0.275 af
Outflow = 0.69 cfs @ 12.73 hrs, Volume= 0.215 af, Atten= 77%, Lag= 32.6 min
Discarded = 0.04 cfs @ 12.73 hrs, Volume= 0.030 af
Primary = 0.65 cfs @ 12.73 hrs, Volume= 0.185 af

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Peak Elev= 280.73' @ 12.73 hrs Surf.Area= 4,280 sf Storage= 5,028 cf

Plug-Flow detention time= 164.9 min calculated for 0.214 af (78% of inflow)
Center-of-Mass det. time= 82.0 min (929.8 - 847.9)

Volume	Invert	Avail.Storage	Storage Description		
#1	278.80'	22,321 cf	Custom Stage Data (Irregular) Listed below (Recalc) x 1.25		
Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
278.80	236	73.0	0	0	236
279.00	950	223.0	111	111	3,769
280.00	2,622	260.0	1,717	1,827	5,212
281.00	3,750	285.0	3,169	4,997	6,330
281.10	5,052	379.0	438	5,435	11,297
282.00	6,503	376.0	5,186	10,621	11,681
283.00	7,994	400.0	7,236	17,857	13,213

Device	Routing	Invert	Outlet Devices
#1	Discarded	278.80'	0.270 in/hr Exfiltration over Surface area Conductivity to Groundwater Elevation = 276.00'
#2	Primary	278.80'	18.0" Round Culvert L= 25.0' RCP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 278.80' / 277.50' S= 0.0520 '/ Cc= 0.900 n= 0.013, Flow Area= 1.77 sf
#3	Device 2	280.00'	6.0" Vert. Orifice/Grate C= 0.600
#4	Device 2	280.90'	1.0' long Sharp-Crested Rectangular Weir 2 End Contraction(s) 2.1' Crest Height

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Type III 24-hr 2 Yr Rainfall=3.20"

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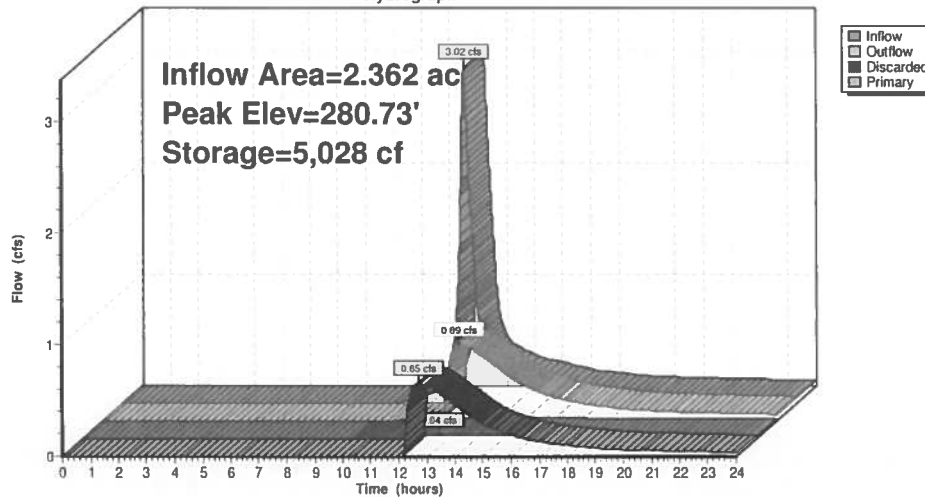
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Discarded OutFlow Max=0.04 cfs @ 12.73 hrs HW=280.73' (Free Discharge)
1=Exfiltration (Controls 0.04 cfs)

Primary OutFlow Max=0.65 cfs @ 12.73 hrs HW=280.73' (Free Discharge)
2=Culvert (Passes 0.65 cfs of 9.24 cfs potential flow)
3=Orifice/Grate (Orifice Controls 0.65 cfs @ 3.33 fps)
4=Sharp-Crested Rectangular Weir (Controls 0.00 cfs)

Pond 1P: Drain Basin

Hydrograph



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Type III 24-hr 2 Yr Rainfall=3.20"

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Summary for Pond 2P: Roof Runoff

Inflow Area = 0.023 ac, 100.00% Impervious, Inflow Depth > 2.97" for 2 Yr event
 Inflow = 0.07 cfs @ 12.08 hrs, Volume= 0.006 af
 Outflow = 0.05 cfs @ 12.16 hrs, Volume= 0.006 af, Atten= 28%, Lag= 4.5 min
 Discarded = 0.05 cfs @ 12.16 hrs, Volume= 0.006 af

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

Peak Elev= 200.55' @ 12.16 hrs Surf.Area= 50 sf Storage= 11 cf

Plug-Flow detention time= 0.8 min calculated for 0.006 af (100% of inflow)

Center-of-Mass det. time= 0.8 min (756.7 - 755.8)

Volume	Invert	Avail.Storage	Storage Description
#1A	200.00'	35 cf	5.00'W x 10.00'L x 2.04'H Field A 102 cf Overall - 15 cf Embedded = 87 cf x 40.0% Voids
#2A	200.50'	15 cf	Cultec C-100HD Inside #1 Effective Size= 32.1"W x 12.0"H => 1.86 sf x 7.50'L = 14.0 cf Overall Size= 36.0"W x 12.5"H x 8.00'L with 0.50' Overlap Row Length Adjustment= +0.50' x 1.86 sf x 1 rows
		50 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Discarded	200.00'	27.000 in/hr Exfiltration over Wetted area Conductivity to Groundwater Elevation = 198.00'

Discarded OutFlow Max=0.05 cfs @ 12.16 hrs HW=200.55' (Free Discharge)

1=Exfiltration (Controls 0.05 cfs)

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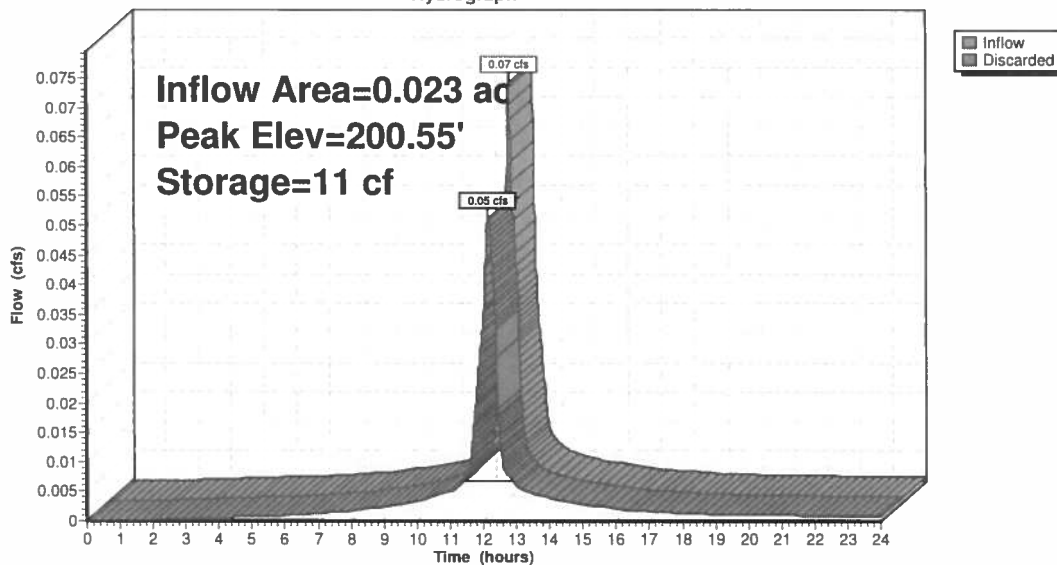
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Type III 24-hr 2 Yr Rainfall=3.20"

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Pond 2P: Roof Runoff**Hydrograph**

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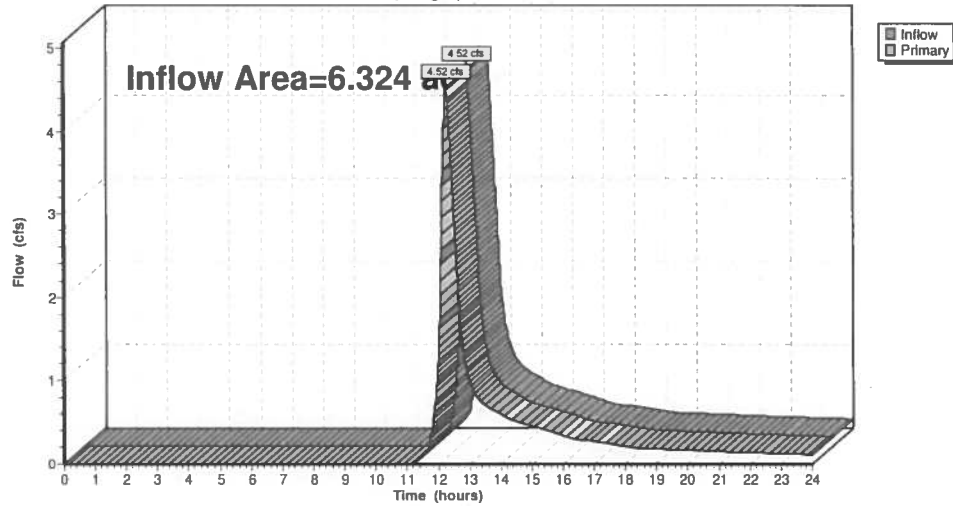
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Summary for Link 1L: PreDev

Inflow Area = 6.324 ac, 0.00% Impervious, Inflow Depth > 0.93" for 2 Yr event
 Inflow = 4.52 cfs @ 12.25 hrs, Volume= 0.488 af
 Primary = 4.52 cfs @ 12.25 hrs, Volume= 0.488 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs

Link 1L: PreDev**Hydrograph**

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Type III 24-hr 2 Yr Rainfall=3.20"

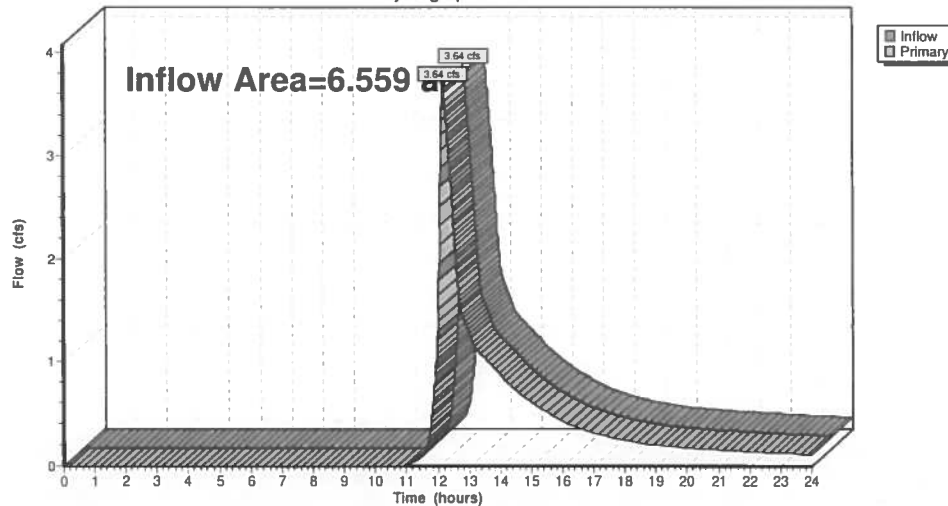
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Summary for Link 2L: (new Link)

Inflow Area = 6.559 ac, 8.99% Impervious, Inflow Depth > 0.96" for 2 Yr event
 Inflow = 3.64 cfs @ 12.18 hrs, Volume= 0.527 af
 Primary = 3.64 cfs @ 12.18 hrs, Volume= 0.527 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs

Link 2L: (new Link)**Hydrograph**

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Type III 24-hr 10 Yr Rainfall=4.80"

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Summary for Subcatchment E1: PreDev

Runoff = 5.94 cfs @ 12.22 hrs, Volume= 0.575 af, Depth> 2.12"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 10 Yr Rainfall=4.80"

Area (sf)	CN	Description
5,670	98	Paved parking, HSG C
136,420	72	Woods/grass comb., Good, HSG C
142,090	73	Weighted Average
136,420		96.01% Pervious Area
5,670		3.99% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
13.5	50	0.0160	0.06		Sheet Flow, A-B
					Woods: Light underbrush n= 0.400 P2= 3.20"
0.6	130	0.0500	3.60		Shallow Concentrated Flow, B-C
					Unpaved Kv= 16.1 fps
1.7	300	0.0200	2.87		Shallow Concentrated Flow, C-D
					Paved Kv= 20.3 fps
15.8	480	Total			

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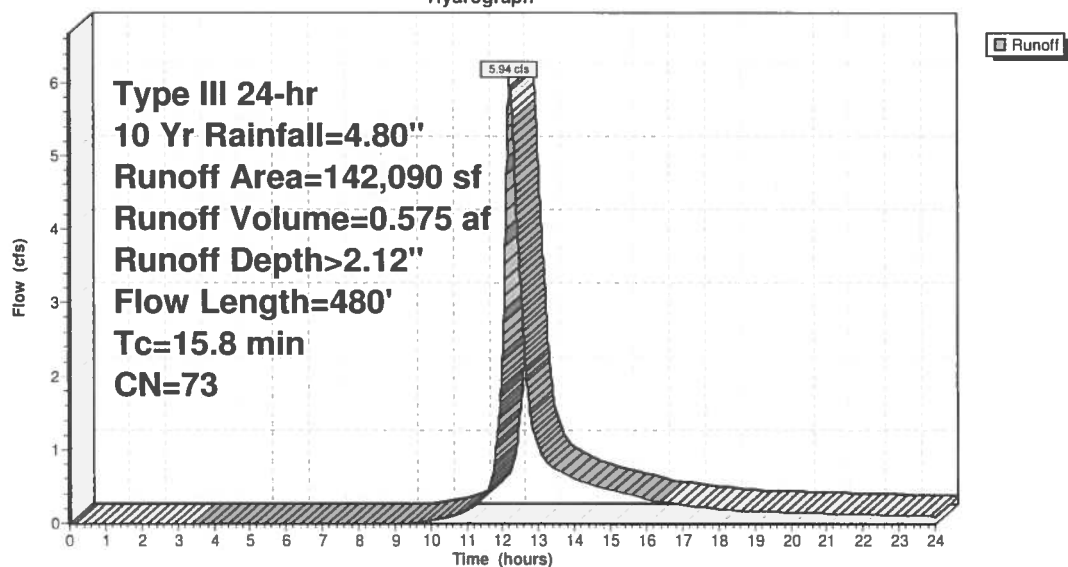
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Type III 24-hr 10 Yr Rainfall=4.80"

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Subcatchment E1: PreDev**Hydrograph**

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Type III 24-hr 10 Yr Rainfall=4.80"

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Summary for Subcatchment E2: PreDev

Runoff = 7.78 cfs @ 12.22 hrs, Volume= 0.761 af, Depth> 2.04"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 10 Yr Rainfall=4.80"

Area (sf)	CN	Description
195,359	72	Woods/grass comb., Good, HSG C
195,359		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
13.2	50	0.0170	0.06		Sheet Flow, A-B
					Woods: Light underbrush n= 0.400 P2= 3.20"
2.2	270	0.0160	2.04		Shallow Concentrated Flow, B-C
					Unpaved Kv= 16.1 fps
0.7	185	0.0800	4.55		Shallow Concentrated Flow, C-D
					Unpaved Kv= 16.1 fps
16.1	505	Total			

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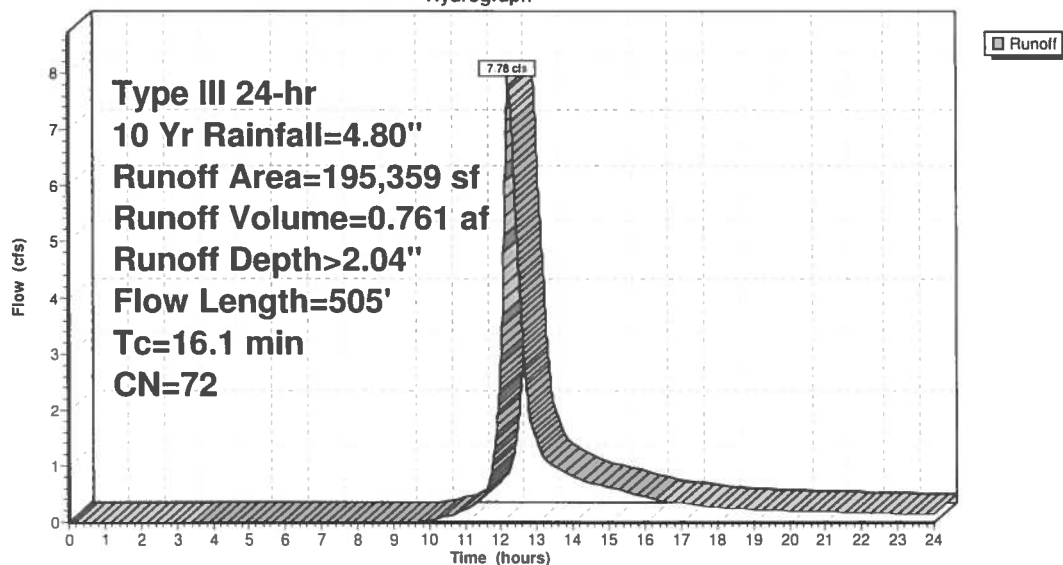
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Type III 24-hr 10 Yr Rainfall=4.80"

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Subcatchment E2: PreDev**Hydrograph**

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Type III 24-hr 10 Yr Rainfall=4.80"

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Summary for Subcatchment E3: PreDev

Runoff = 2.97 cfs @ 12.27 hrs, Volume= 0.312 af, Depth> 2.04"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 10 Yr Rainfall=4.80"

Area (sf)	CN	Description
80,117	72	Woods/grass comb., Good, HSG C
80,117		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
16.3	50	0.0100	0.05		Sheet Flow, A-B
2.9	470	0.0280	2.69		Woods: Light underbrush n= 0.400 P2= 3.20"
					Shallow Concentrated Flow, B-C
					Unpaved Kv= 16.1 fps
19.2	520	Total			

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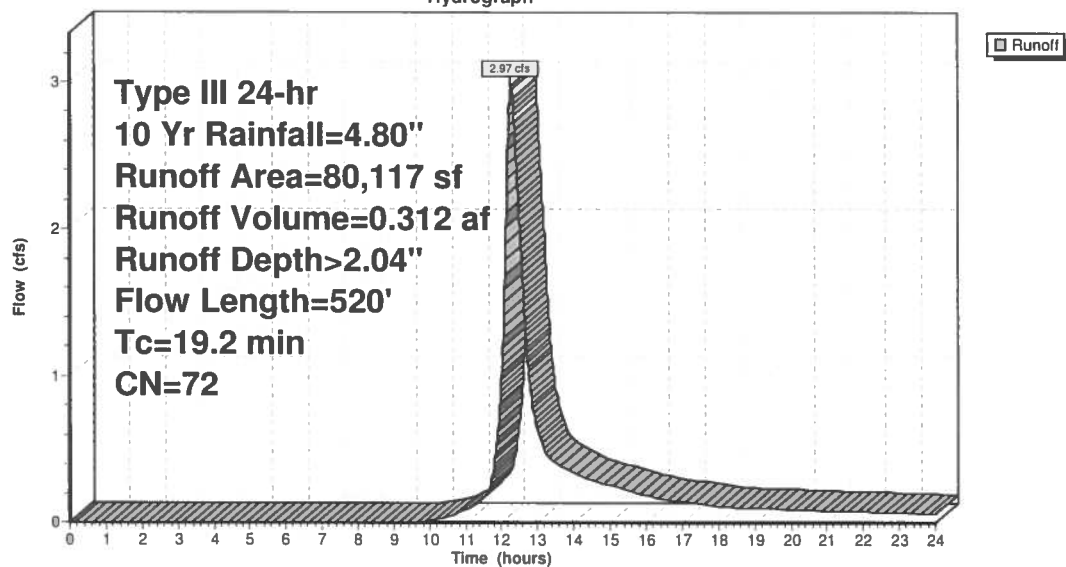
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Type III 24-hr 10 Yr Rainfall=4.80"

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Subcatchment E3: PreDev**Hydrograph**

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Type III 24-hr 10 Yr Rainfall=4.80"

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Summary for Subcatchment P1: Post Dev

Runoff = 5.63 cfs @ 12.20 hrs, Volume= 0.518 af, Depth> 2.28"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 10 Yr Rainfall=4.80"

Area (sf)	CN	Description
0	98	
8,060	98	Paved parking, HSG C
51,270	74	>75% Grass cover, Good, HSG C
59,356	72	Woods/grass comb., Good, HSG C
118,686	75	Weighted Average
110,626		93.21% Pervious Area
8,060		6.79% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.8	50	0.0100	0.08		Sheet Flow, A-B
					Grass: Dense n= 0.240 P2= 3.20"
0.6	110	0.0400	3.22		Shallow Concentrated Flow, B-C
					Unpaved Kv= 16.1 fps
2.6	450	0.0200	2.87		Shallow Concentrated Flow, C-D
					Paved Kv= 20.3 fps
14.0	610	Total			

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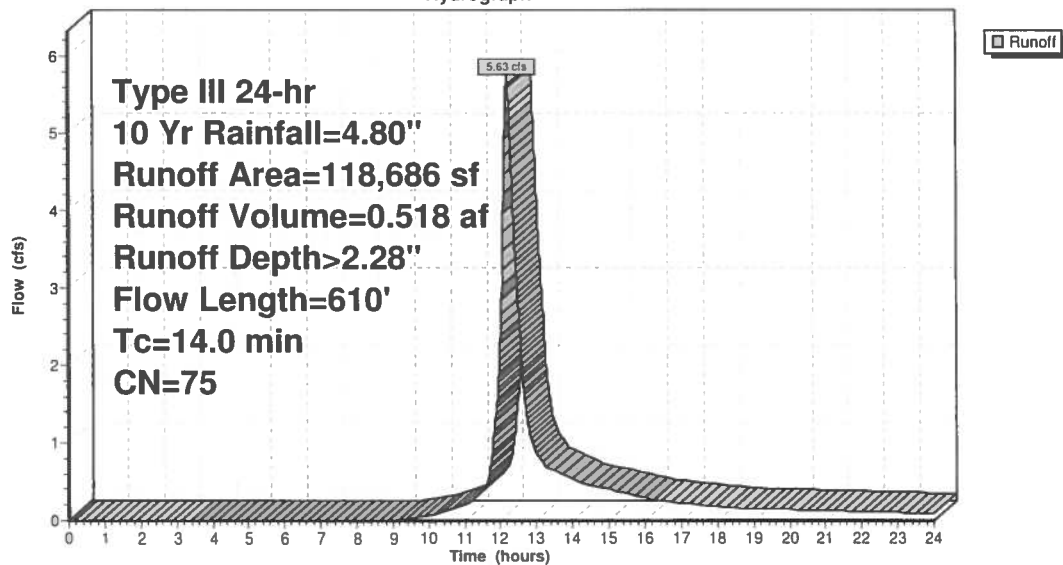
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Type III 24-hr 10 Yr Rainfall=4.80"

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Subcatchment P1: Post Dev**Hydrograph**

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Type III 24-hr 10 Yr Rainfall=4.80"

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Summary for Subcatchment P2: Post Dev

Runoff = 4.46 cfs @ 12.15 hrs, Volume= 0.369 af, Depth> 2.12"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 10 Yr Rainfall=4.80"

Area (sf)	CN	Description
43,772	72	Woods/grass comb., Good, HSG C
47,097	74	>75% Grass cover, Good, HSG C
90,869	73	Weighted Average
90,869		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
9.2	50	0.0150	0.09		Sheet Flow, A-B
					Grass: Dense n= 0.240 P2= 3.20"
1.0	275	0.0800	4.55		Shallow Concentrated Flow, B-C
					Unpaved Kv= 16.1 fps
10.2	325	Total			

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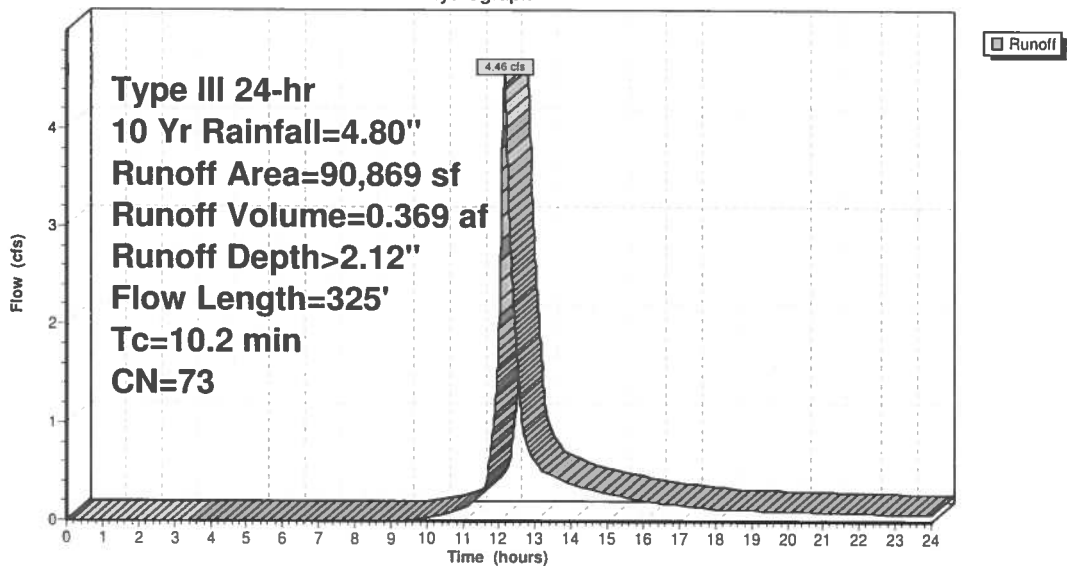
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Type III 24-hr 10 Yr Rainfall=4.80"

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Subcatchment P2: Post Dev**Hydrograph**

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Type III 24-hr 10 Yr Rainfall=4.80"

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Summary for Subcatchment P3: Post Dev

Runoff = 4.03 cfs @ 12.20 hrs, Volume= 0.373 af, Depth> 2.12"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 10 Yr Rainfall=4.80"

Area (sf)	CN	Description
62,580	72	Woods/grass comb., Good, HSG C
29,372	74	>75% Grass cover, Good, HSG C
91,952	73	Weighted Average
91,952		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.8	50	0.0100	0.08		Sheet Flow, A-B
					Grass: Dense n= 0.240 P2= 3.20"
3.2	510	0.0280	2.69		Shallow Concentrated Flow, B-C
					Unpaved Kv= 16.1 fps
14.0	560	Total			

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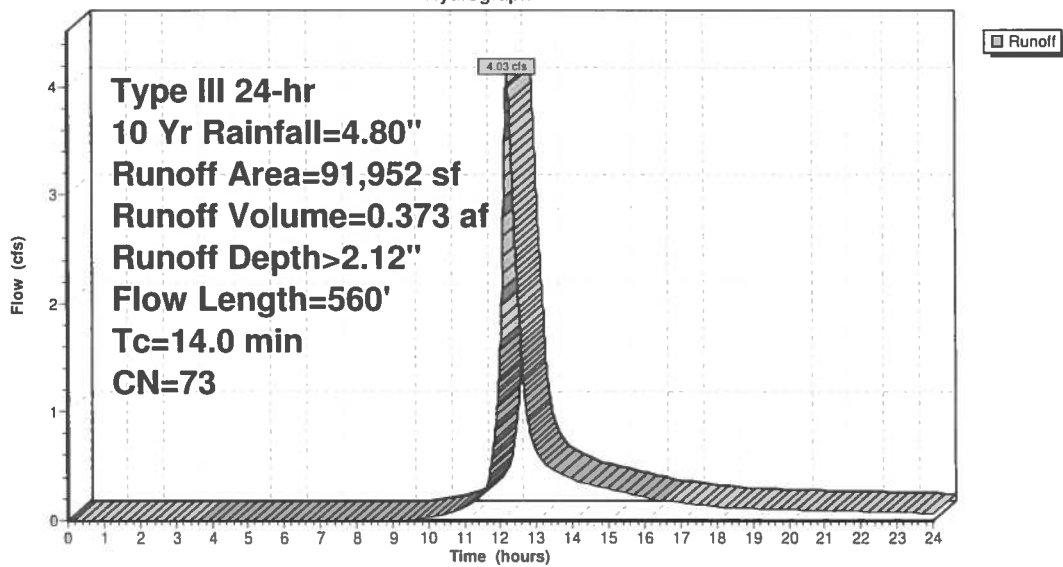
Type III 24-hr 10 Yr Rainfall=4.80"

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Subcatchment P3: Post Dev

Hydrograph



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Type III 24-hr 10 Yr Rainfall=4.80"

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Summary for Subcatchment P4: Post Dev

Runoff = 5.93 cfs @ 12.19 hrs, Volume= 0.534 af, Depth> 2.71"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 10 Yr Rainfall=4.80"

Area (sf)	CN	Description
12,535	98	Paved parking, HSG C
13,138	98	Paved roads HSG C
77,201	74	>75% Grass cover, Good, HSG C
102,874	80	Weighted Average
77,201		75.04% Pervious Area
25,673		24.96% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.8	50	0.0100	0.08		Sheet Flow, A-B Grass: Dense n= 0.240 P2= 3.20"
1.1	150	0.0200	2.28		Shallow Concentrated Flow, B-C Unpaved Kv= 16.1 fps
1.0	160	0.0170	2.65		Shallow Concentrated Flow, C-D Paved Kv= 20.3 fps
0.6	170	0.0100	4.54	3.56	Pipe Channel, D-E 12.0" Round Area= 0.8 sf Perim= 3.1' r= 0.25' n= 0.013
13.5	530	Total			

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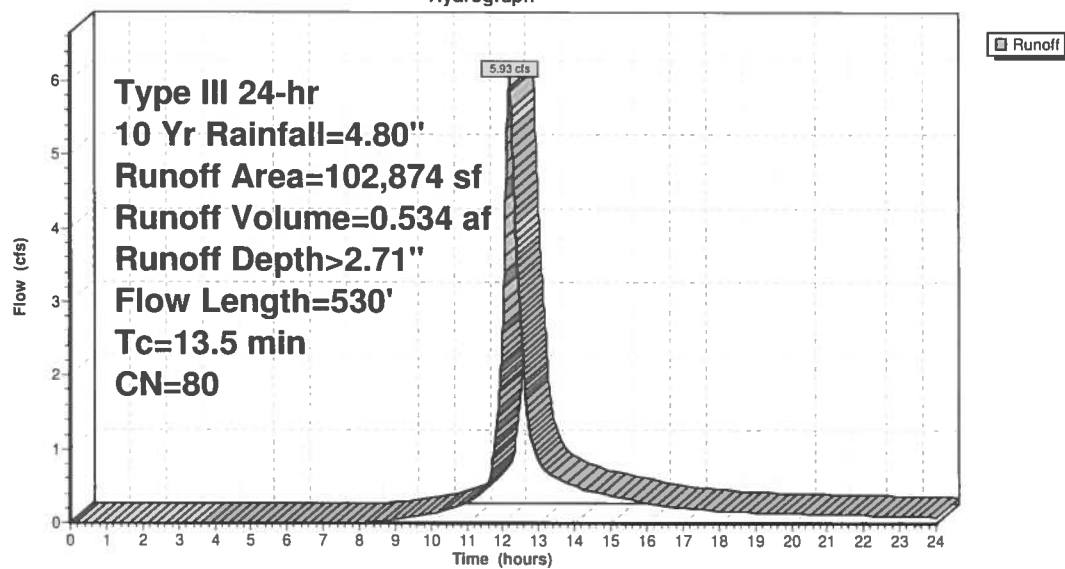
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Type III 24-hr 10 Yr Rainfall=4.80"

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Subcatchment P4: Post Dev**Hydrograph**

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Type III 24-hr 10 Yr Rainfall=4.80"

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Summary for Subcatchment P5: Roof

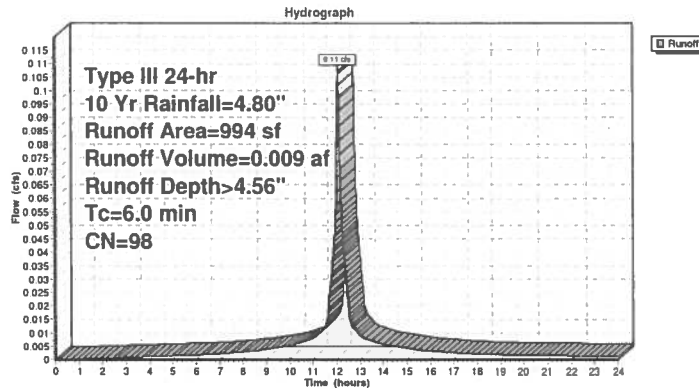
Runoff = 0.11 cfs @ 12.08 hrs, Volume= 0.009 af, Depth> 4.56"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 10 Yr Rainfall=4.80"

Area (sf)	CN	Description
994	98	Roofs, HSG A
994		100.00% Impervious Area

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

Subcatchment P5: Roof



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Type III 24-hr 10 Yr Rainfall=4.80"

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Summary for Pond 1P: Drain Basin

Inflow Area = 2.362 ac, 24.96% Impervious, Inflow Depth > 2.71" for 10 Yr event
Inflow = 5.93 cfs @ 12.19 hrs, Volume= 0.534 af
Outflow = 2.25 cfs @ 12.56 hrs, Volume= 0.469 af, Atten= 62%, Lag= 22.2 min
Discarded = 0.06 cfs @ 12.56 hrs, Volume= 0.037 af
Primary = 2.20 cfs @ 12.56 hrs, Volume= 0.433 af

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Peak Elev= 281.43' @ 12.56 hrs Surf.Area= 6,956 sf Storage= 8,992 cf

Plug-Flow detention time= 121.8 min calculated for 0.469 af (88% of inflow)
Center-of-Mass det. time= 66.9 min (895.7 - 828.9)

Volume	Invert	Avail.Storage	Storage Description		
#1	278.80'	22,321 cf	Custom Stage Data (Irregular) Listed below (Recalc) x 1.25		

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
278.80	236	73.0	0	0	236
279.00	950	223.0	111	111	3,769
280.00	2,622	260.0	1,717	1,827	5,212
281.00	3,750	285.0	3,169	4,997	6,330
281.10	5,052	379.0	438	5,435	11,297
282.00	6,503	376.0	5,186	10,621	11,681
283.00	7,994	400.0	7,236	17,857	13,213

Device	Routing	Invert	Outlet Devices
#1	Discarded	278.80'	0.270 in/hr Exfiltration over Surface area Conductivity to Groundwater Elevation = 276.00'
#2	Primary	278.80'	18.0" Round Culvert L= 25.0' RCP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 278.80' / 277.50' S= 0.0520 ' S= 0.0520 ' Cc= 0.900 n= 0.013, Flow Area= 1.77 sf
#3	Device 2	280.00'	6.0" Vert. Orifice/Grate C= 0.600
#4	Device 2	280.90'	1.0' long Sharp-Crested Rectangular Weir 2 End Contraction(s) 2.1' Crest Height

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Type III 24-hr 10 Yr Rainfall=4.80"

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Discarded OutFlow Max=0.06 cfs @ 12.56 hrs HW=281.43' (Free Discharge)

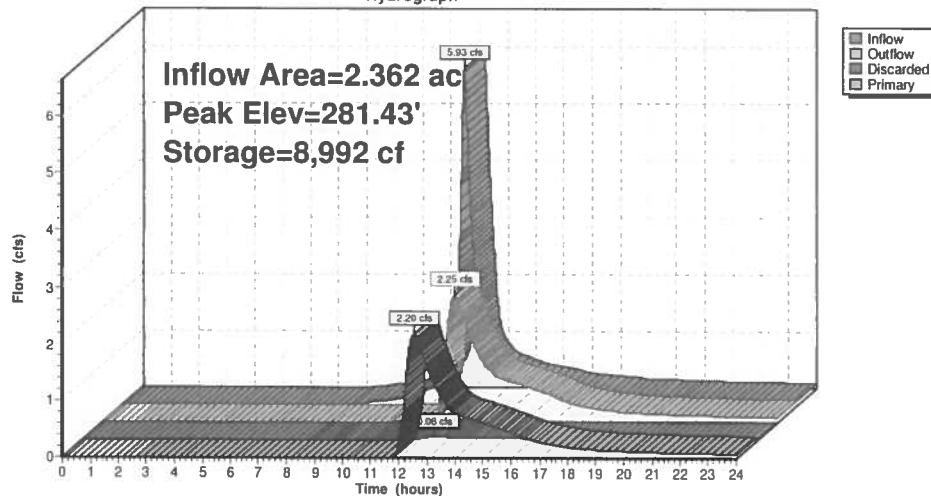
1=Exfiltration (Controls 0.06 cfs)

Primary OutFlow Max=2.19 cfs @ 12.56 hrs HW=281.43' (Free Discharge)

2=Culvert (Passes 2.19 cfs of 11.67 cfs potential flow)

3=Orifice/Grate (Orifice Controls 1.03 cfs @ 5.23 fps)

4=Sharp-Crested Rectangular Weir (Weir Controls 1.17 cfs @ 2.46 fps)

Pond 1P: Drain Basin**Hydrograph**

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Type III 24-hr 10 Yr Rainfall=4.80"

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Summary for Pond 2P: Roof Runoff

Inflow Area = 0.023 ac, 100.00% Impervious, Inflow Depth > 4.56" for 10 Yr event
 Inflow = 0.11 cfs @ 12.08 hrs, Volume= 0.009 af
 Outflow = 0.07 cfs @ 12.17 hrs, Volume= 0.009 af, Atten= 34%, Lag= 5.3 min
 Discarded = 0.07 cfs @ 12.17 hrs, Volume= 0.009 af

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

Peak Elev= 201.02' @ 12.17 hrs Surf.Area= 50 sf Storage= 27 cf

Plug-Flow detention time= 1.6 min calculated for 0.009 af (100% of inflow)

Center-of-Mass det. time= 1.6 min (749.8 - 748.2)

Volume	Invert	Avail.Storage	Storage Description
#1A	200.00'	35 cf	5.00'W x 10.00'L x 2.04'H Field A
			102 cf Overall - 15 cf Embedded = 87 cf x 40.0% Voids
#2A	200.50'	15 cf	Cultec C-100HD Inside #1
			Effective Size= 32.1"W x 12.0"H => 1.86 sf x 7.50'L = 14.0 cf
			Overall Size= 36.0"W x 12.5"H x 8.00'L with 0.50' Overlap
			Row Length Adjustment= +0.50' x 1.86 sf x 1 rows
		50 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Discarded	200.00'	27.000 in/hr Exfiltration over Wetted area Conductivity to Groundwater Elevation = 198.00'

Discarded OutFlow Max=0.07 cfs @ 12.17 hrs HW=201.02' (Free Discharge)

1=Exfiltration (Controls 0.07 cfs)

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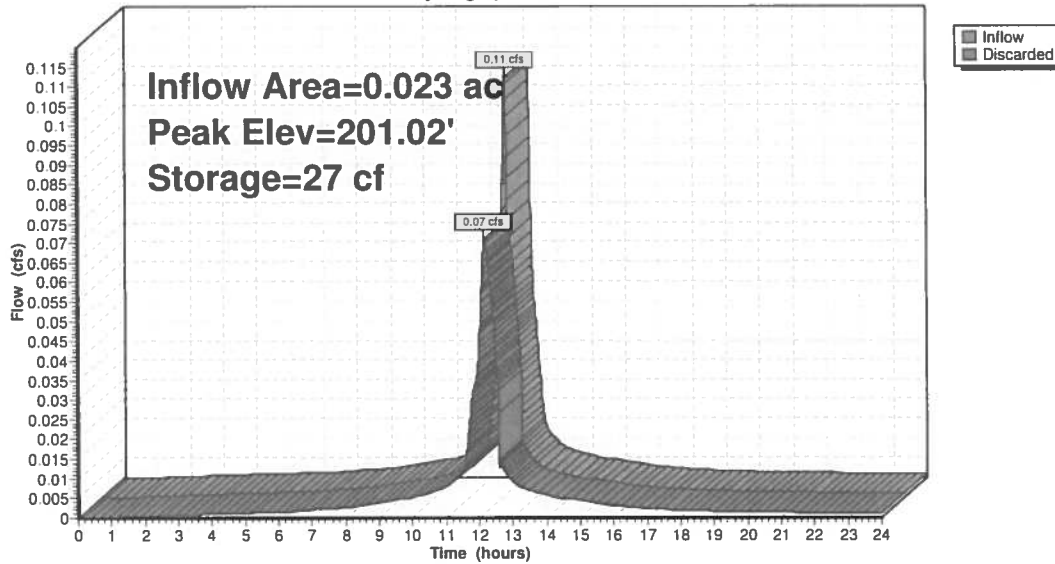
Type III 24-hr 10 Yr Rainfall=4.80"

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Pond 2P: Roof Runoff

Hydrograph



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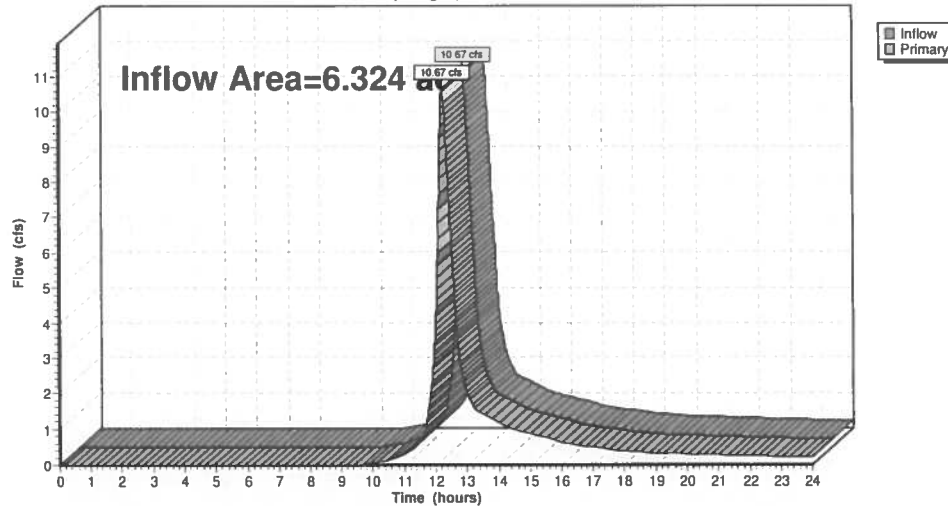
Summary for Link 1L: PreDev

Inflow Area = 6.324 ac, 0.00% Impervious, Inflow Depth > 2.04" for 10 Yr event
 Inflow = 10.67 cfs @ 12.24 hrs, Volume= 1.073 af
 Primary = 10.67 cfs @ 12.24 hrs, Volume= 1.073 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs

Link 1L: PreDev

Hydrograph



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Type III 24-hr 10 Yr Rainfall=4.80"

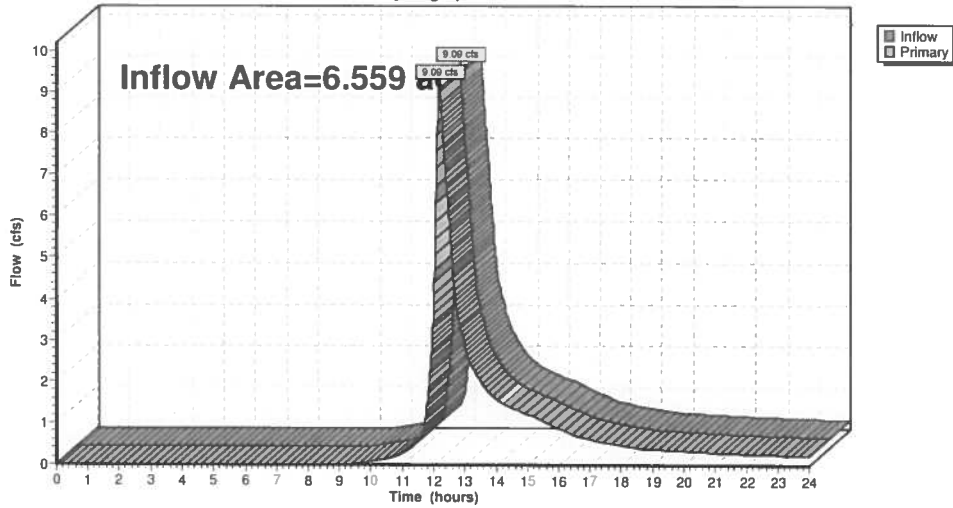
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Summary for Link 2L: (new Link)

Inflow Area = 6.559 ac, 8.99% Impervious, Inflow Depth > 2.15" for 10 Yr event
 Inflow = 9.09 cfs @ 12.18 hrs, Volume= 1.174 af
 Primary = 9.09 cfs @ 12.18 hrs, Volume= 1.174 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs

Link 2L: (new Link)**Hydrograph**

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Type III 24-hr 25 Yr Rainfall=5.10"

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Summary for Subcatchment E1: PreDev

Runoff = 6.62 cfs @ 12.22 hrs, Volume= 0.639 af, Depth> 2.35"

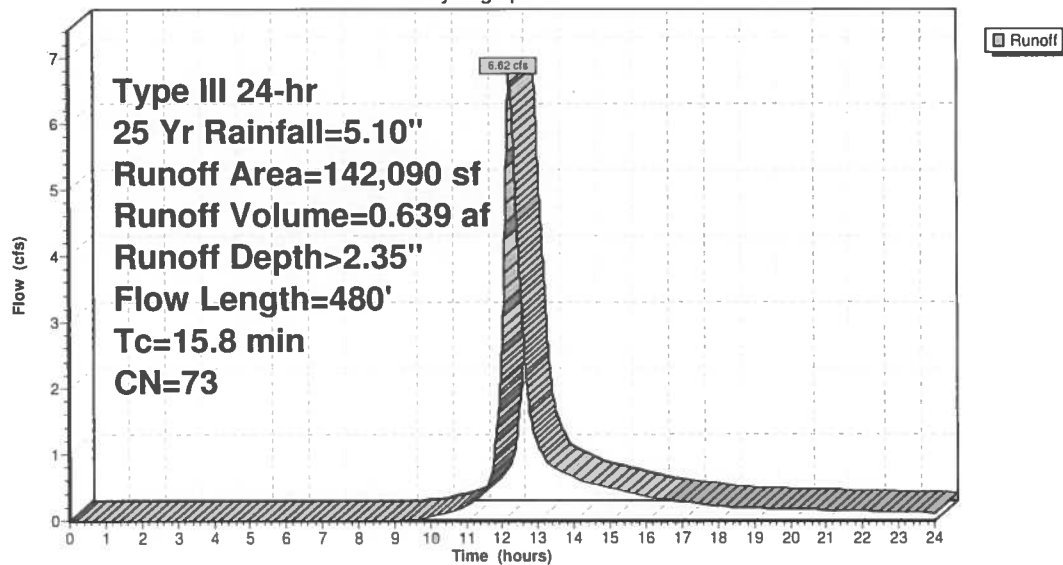
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
 Type III 24-hr 25 Yr Rainfall=5.10"

Area (sf)	CN	Description
5,670	98	Paved parking, HSG C
136,420	72	Woods/grass comb., Good, HSG C
142,090	73	Weighted Average
136,420		96.01% Pervious Area
5,670		3.99% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
13.5	50	0.0160	0.06		Sheet Flow, A-B
					Woods: Light underbrush n= 0.400 P2= 3.20"
0.6	130	0.0500	3.60		Shallow Concentrated Flow, B-C
					Unpaved Kv= 16.1 fps
1.7	300	0.0200	2.87		Shallow Concentrated Flow, C-D
					Paved Kv= 20.3 fps
15.8	480	Total			

Subcatchment E1: PreDev

Hydrograph



Summary for Subcatchment E2: PreDev

Runoff = 8.70 cfs @ 12.22 hrs, Volume= 0.847 af, Depth> 2.27"

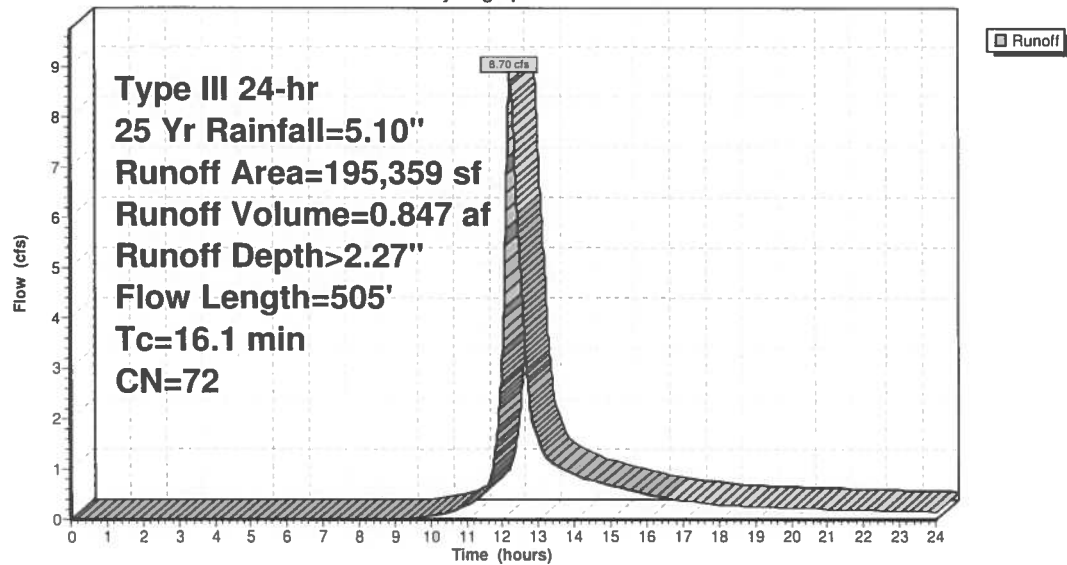
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 25 Yr Rainfall=5.10"

Area (sf)	CN	Description
195,359	72	Woods/grass comb., Good, HSG C
195,359		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
13.2	50	0.0170	0.06		Sheet Flow, A-B Woods: Light underbrush n= 0.400 P2= 3.20"
2.2	270	0.0160	2.04		Shallow Concentrated Flow, B-C Unpaved Kv= 16.1 fps
0.7	185	0.0800	4.55		Shallow Concentrated Flow, C-D Unpaved Kv= 16.1 fps
16.1	505	Total			

Subcatchment E2: PreDev

Hydrograph



Summary for Subcatchment E3: PreDev

Runoff = 3.33 cfs @ 12.27 hrs, Volume= 0.347 af, Depth> 2.27"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs

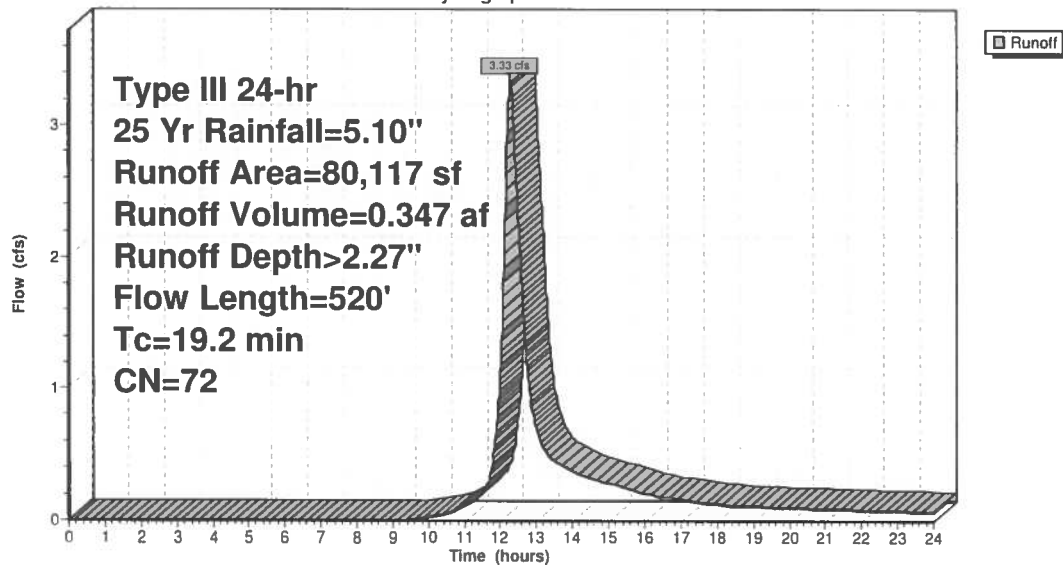
Type III 24-hr 25 Yr Rainfall=5.10"

Area (sf)	CN	Description
80,117	72	Woods/grass comb., Good, HSG C
80,117		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
16.3	50	0.0100	0.05		Sheet Flow, A-B
					Woods: Light underbrush n= 0.400 P2= 3.20"
2.9	470	0.0280	2.69		Shallow Concentrated Flow, B-C
					Unpaved Kv= 16.1 fps
19.2	520	Total			

Subcatchment E3: PreDev

Hydrograph



Summary for Subcatchment P1: Post Dev

Runoff = 6.25 cfs @ 12.20 hrs, Volume= 0.573 af, Depth> 2.52"

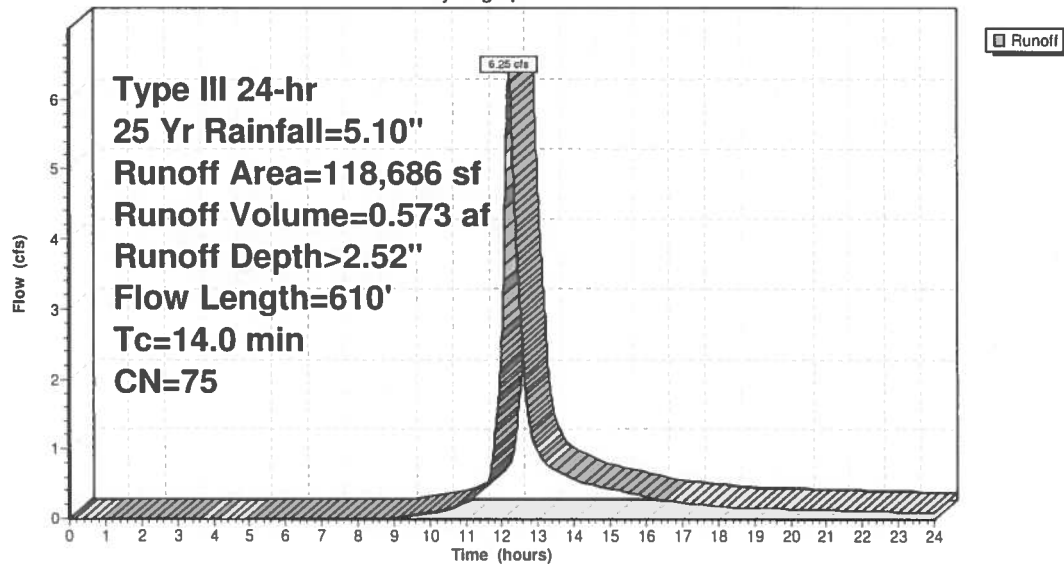
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
 Type III 24-hr 25 Yr Rainfall=5.10"

Area (sf)	CN	Description
0	98	
8,060	98	Paved parking, HSG C
51,270	74	>75% Grass cover, Good, HSG C
59,356	72	Woods/grass comb., Good, HSG C
118,686	75	Weighted Average
110,626		93.21% Pervious Area
8,060		6.79% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.8	50	0.0100	0.08		Sheet Flow, A-B
					Grass: Dense n= 0.240 P2= 3.20"
0.6	110	0.0400	3.22		Shallow Concentrated Flow, B-C
					Unpaved Kv= 16.1 fps
2.6	450	0.0200	2.87		Shallow Concentrated Flow, C-D
					Paved Kv= 20.3 fps
14.0	610	Total			

Subcatchment P1: Post Dev

Hydrograph



Summary for Subcatchment P2: Post Dev

Runoff = 4.97 cfs @ 12.14 hrs, Volume= 0.409 af, Depth> 2.35"

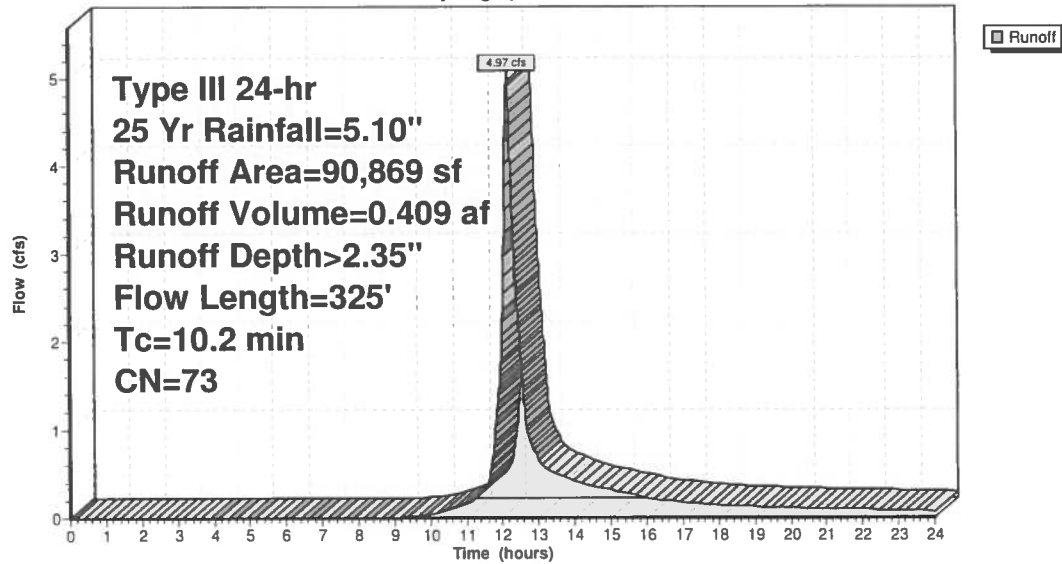
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
 Type III 24-hr 25 Yr Rainfall=5.10"

Area (sf)	CN	Description
43,772	72	Woods/grass comb., Good, HSG C
47,097	74	>75% Grass cover, Good, HSG C
90,869	73	Weighted Average
90,869		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
9.2	50	0.0150	0.09		Sheet Flow, A-B
					Grass: Dense n= 0.240 P2= 3.20"
1.0	275	0.0800	4.55		Shallow Concentrated Flow, B-C
					Unpaved Kv= 16.1 fps
10.2	325	Total			

Subcatchment P2: Post Dev

Hydrograph



Summary for Subcatchment P3: Post Dev

Runoff = 4.49 cfs @ 12.20 hrs, Volume= 0.414 af, Depth> 2.35"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
 Type III 24-hr 25 Yr Rainfall=5.10"

Area (sf)	CN	Description
62,580	72	Woods/grass comb., Good, HSG C
29,372	74	>75% Grass cover, Good, HSG C
91,952	73	Weighted Average
91,952		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.8	50	0.0100	0.08		Sheet Flow, A-B
					Grass: Dense n= 0.240 P2= 3.20"
3.2	510	0.0280	2.69		Shallow Concentrated Flow, B-C
					Unpaved Kv= 16.1 fps
14.0	560	Total			

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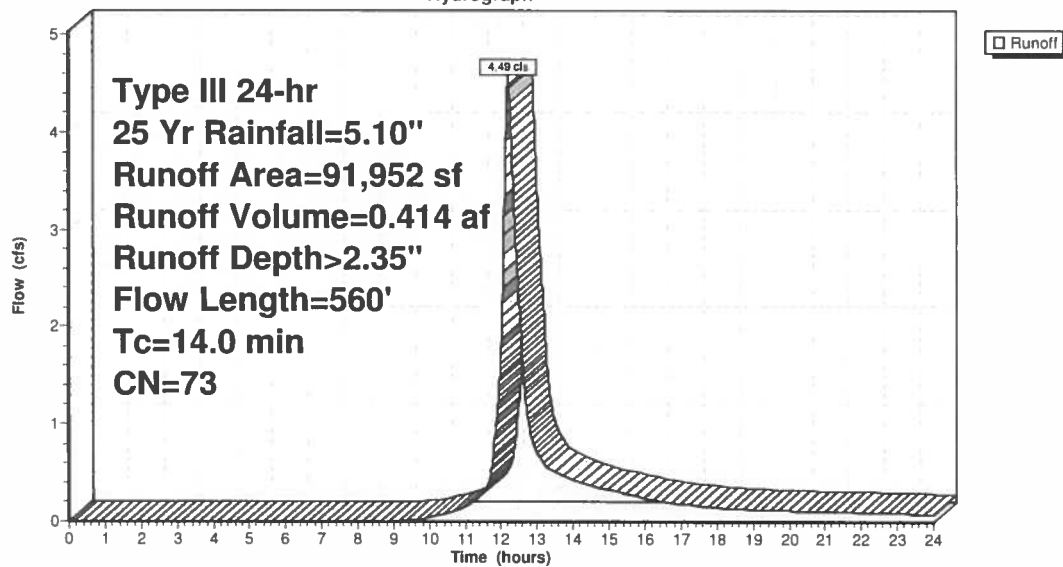
Type III 24-hr 25 Yr Rainfall=5.10"

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Subcatchment P3: Post Dev

Hydrograph



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Type III 24-hr 25 Yr Rainfall=5.10"

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Summary for Subcatchment P4: Post Dev

Runoff = 6.50 cfs @ 12.19 hrs, Volume= 0.585 af, Depth> 2.97"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs

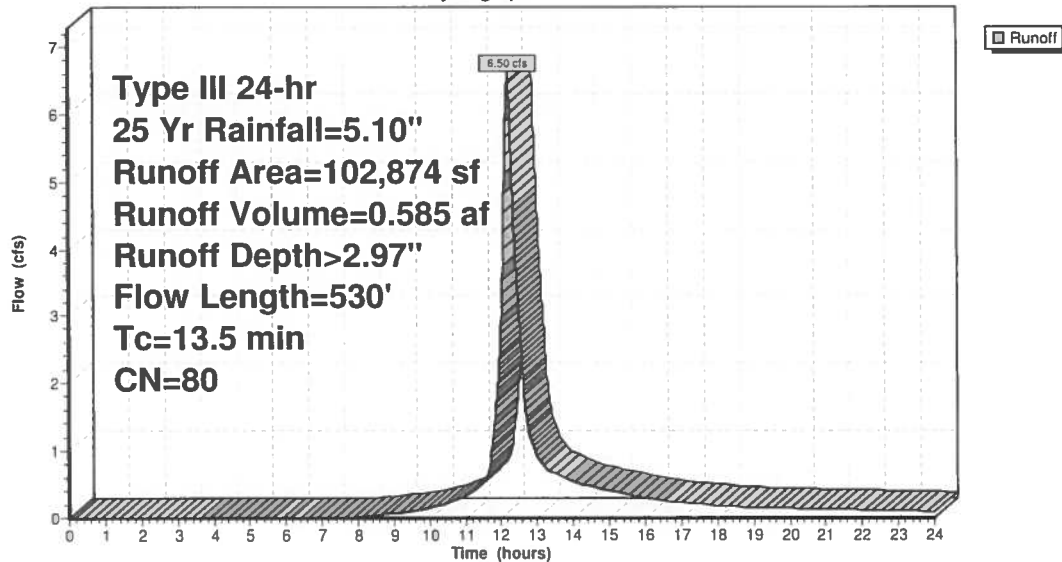
Type III 24-hr 25 Yr Rainfall=5.10"

Area (sf)	CN	Description
12,535	98	Paved parking, HSG C
13,138	98	Paved roads HSG C
77,201	74	>75% Grass cover, Good, HSG C
102,874	80	Weighted Average
77,201		75.04% Pervious Area
25,673		24.96% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.8	50	0.0100	0.08		Sheet Flow, A-B
					Grass: Dense n= 0.240 P2= 3.20"
1.1	150	0.0200	2.28		Shallow Concentrated Flow, B-C
					Unpaved Kv= 16.1 fps
1.0	160	0.0170	2.65		Shallow Concentrated Flow, C-D
					Paved Kv= 20.3 fps
0.6	170	0.0100	4.54	3.56	Pipe Channel, D-E
					12.0" Round Area= 0.8 sf Perim= 3.1' r= 0.25'
					n= 0.013
13.5	530	Total			

Subcatchment P4: Post Dev

Hydrograph



Summary for Subcatchment P5: Roof

Runoff = 0.11 cfs @ 12.08 hrs, Volume= 0.009 af, Depth> 4.86"

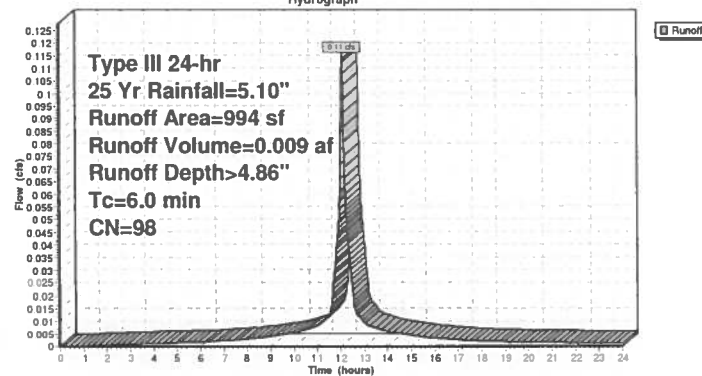
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 25 Yr Rainfall=5.10"

Area (sf)	CN	Description
994	98	Roofs, HSG A
994		100.00% Impervious Area

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

Subcatchment P5: Roof

Hydrograph



Summary for Pond 1P: Drain Basin

Inflow Area = 2.362 ac, 24.96% Impervious, Inflow Depth > 2.97" for 25 Yr event
 Inflow = 6.50 cfs @ 12.19 hrs, Volume= 0.585 af
 Outflow = 2.60 cfs @ 12.54 hrs, Volume= 0.520 af, Atten= 60%, Lag= 21.2 min
 Discarded = 0.06 cfs @ 12.54 hrs, Volume= 0.038 af
 Primary = 2.54 cfs @ 12.54 hrs, Volume= 0.482 af

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
 Peak Elev= 281.53' @ 12.54 hrs Surf.Area= 7,147 sf Storage= 9,665 cf

Plug-Flow detention time= 116.8 min calculated for 0.520 af (89% of inflow)
 Center-of-Mass det. time= 65.0 min (891.3 - 826.3)

Volume	Invert	Avail.Storage	Storage Description
#1	278.80'	22,321 cf	Custom Stage Data (Irregular) Listed below (Recalc) x 1.25

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
278.80	236	73.0	0	0	236
279.00	950	223.0	111	111	3,769
280.00	2,622	260.0	1,717	1,827	5,212
281.00	3,750	285.0	3,169	4,997	6,330
281.10	5,052	379.0	438	5,435	11,297
282.00	6,503	376.0	5,186	10,621	11,681
283.00	7,994	400.0	7,236	17,857	13,213

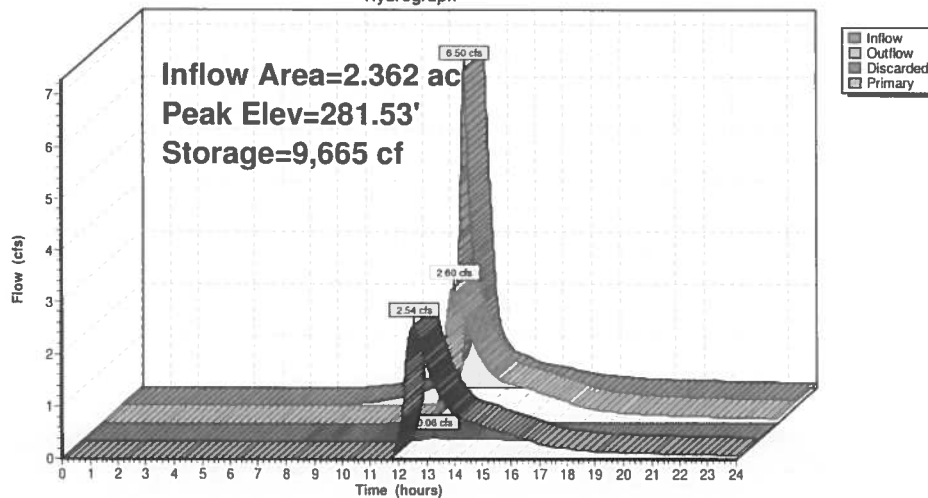
Device	Routing	Invert	Outlet Devices
#1	Discarded	278.80'	0.270 in/hr Exfiltration over Surface area Conductivity to Groundwater Elevation = 276.00'
#2	Primary	278.80'	18.0" Round Culvert L= 25.0' RCP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 278.80' / 277.50' S= 0.0520 ' S= 0.0520 ' Cc= 0.900 n= 0.013, Flow Area= 1.77 sf
#3	Device 2	280.00'	6.0" Vert. Orifice/Grate C= 0.600
#4	Device 2	280.90'	1.0' long Sharp-Crested Rectangular Weir 2 End Contraction(s) 2.1' Crest Height

Discarded OutFlow Max=0.06 cfs @ 12.54 hrs HW=281.53' (Free Discharge)
 1=Exfiltration (Controls 0.06 cfs)

Primary OutFlow Max=2.54 cfs @ 12.54 hrs HW=281.53' (Free Discharge)
 2=Culvert (Passes 2.54 cfs of 11.96 cfs potential flow)
 3=Orifice/Grate (Orifice Controls 1.07 cfs @ 5.44 fps)
 4=Sharp-Crested Rectangular Weir (Weir Controls 1.47 cfs @ 2.68 fps)

Pond 1P: Drain Basin

Hydrograph



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Type III 24-hr 25 Yr Rainfall=5.10"

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Summary for Pond 2P: Roof Runoff

Inflow Area = 0.023 ac, 100.00% Impervious, Inflow Depth > 4.86" for 25 Yr event
 Inflow = 0.11 cfs @ 12.08 hrs, Volume= 0.009 af
 Outflow = 0.07 cfs @ 12.17 hrs, Volume= 0.009 af, Atten= 34%, Lag= 5.3 min
 Discarded = 0.07 cfs @ 12.17 hrs, Volume= 0.009 af

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

Peak Elev= 201.12' @ 12.17 hrs Surf.Area= 50 sf Storage= 29 cf

Plug-Flow detention time= 1.8 min calculated for 0.009 af (100% of inflow)

Center-of-Mass det. time= 1.7 min (748.9 - 747.1)

Volume	Invert	Avail.Storage	Storage Description
#1A	200.00'	35 cf	5.00'W x 10.00'L x 2.04'H Field A 102 cf Overall - 15 cf Embedded = 87 cf x 40.0% Voids
#2A	200.50'	15 cf	Cultec C-100HD Inside #1 Effective Size= 32.1"W x 12.0"H => 1.86 sf x 7.50'L = 14.0 cf Overall Size= 36.0"W x 12.5"H x 8.00'L with 0.50' Overlap Row Length Adjustment= +0.50' x 1.86 sf x 1 rows
		50 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Discarded	200.00'	27.000 in/hr Exfiltration over Wetted area Conductivity to Groundwater Elevation = 198.00'

Discarded OutFlow Max=0.07 cfs @ 12.17 hrs HW=201.12' (Free Discharge)

1=Exfiltration (Controls 0.07 cfs)

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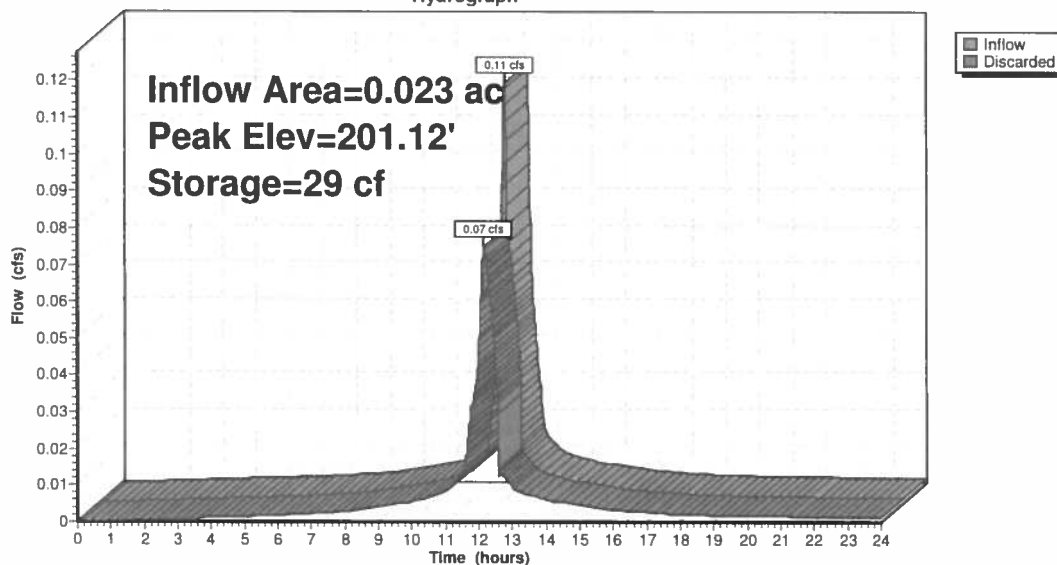
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Type III 24-hr 25 Yr Rainfall=5.10"

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Pond 2P: Roof Runoff**Hydrograph**

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Type III 24-hr 25 Yr Rainfall=5.10"

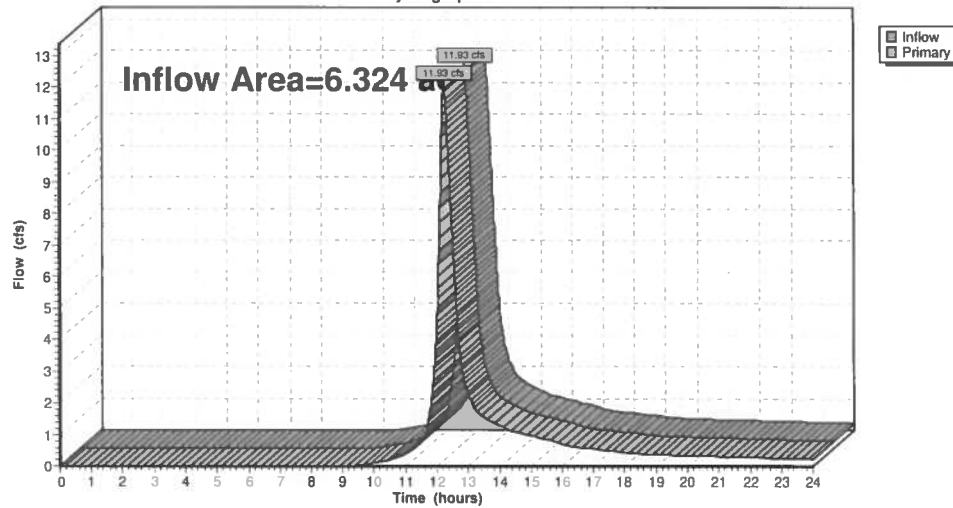
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Summary for Link 1L: PreDev

Inflow Area = 6.324 ac, 0.00% Impervious, Inflow Depth > 2.27" for 25 Yr event
 Inflow = 11.93 cfs @ 12.24 hrs, Volume= 1.194 af
 Primary = 11.93 cfs @ 12.24 hrs, Volume= 1.194 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs

Link 1L: PreDev**Hydrograph**

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Type III 24-hr 25 Yr Rainfall=5.10"

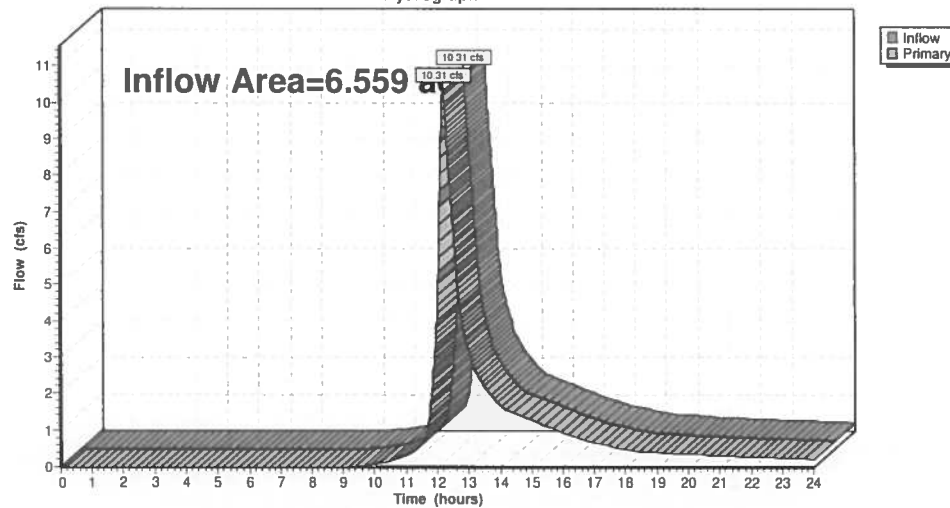
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Summary for Link 2L: (new Link)

Inflow Area = 6.559 ac, 8.99% Impervious, Inflow Depth > 2.39" for 25 Yr event
 Inflow = 10.31 cfs @ 12.18 hrs, Volume= 1.305 af
 Primary = 10.31 cfs @ 12.18 hrs, Volume= 1.305 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs

Link 2L: (new Link)**Hydrograph**

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Type III 24-hr 100 Yr Rainfall=7.00"

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Summary for Subcatchment E1: PreDev

Runoff = 11.15 cfs @ 12.22 hrs, Volume= 1.066 af, Depth> 3.92"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 100 Yr Rainfall=7.00"

Area (sf)	CN	Description
5,670	98	Paved parking, HSG C
136,420	72	Woods/grass comb., Good, HSG C
142,090	73	Weighted Average
136,420		96.01% Pervious Area
5,670		3.99% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
13.5	50	0.0160	0.06		Sheet Flow, A-B
					Woods: Light underbrush n= 0.400 P2= 3.20"
0.6	130	0.0500	3.60		Shallow Concentrated Flow, B-C
					Unpaved Kv= 16.1 fps
1.7	300	0.0200	2.87		Shallow Concentrated Flow, C-D
					Paved Kv= 20.3 fps
15.8	480	Total			

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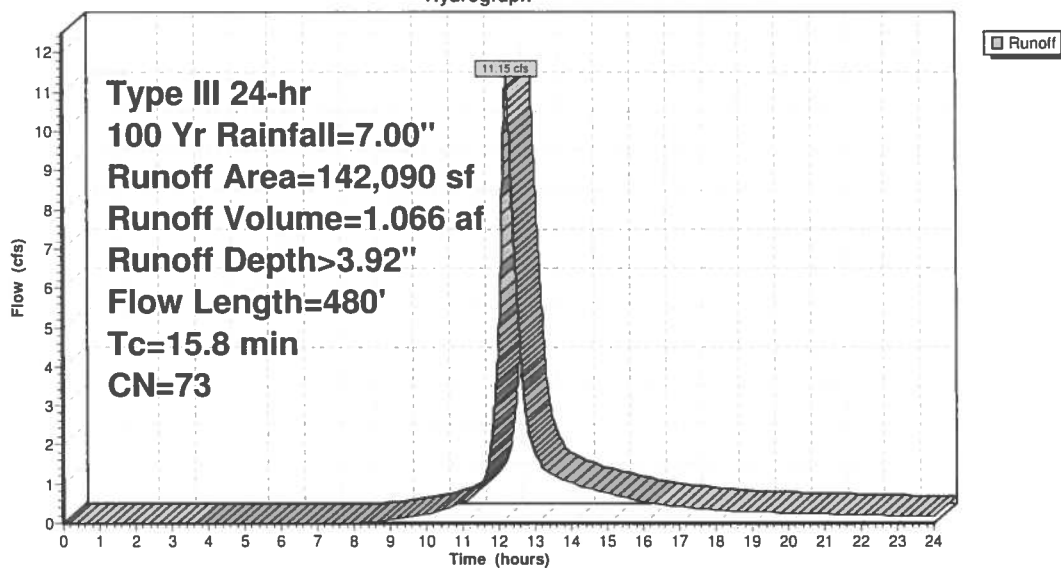
Type III 24-hr 100 Yr Rainfall=7.00"

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Subcatchment E1: PreDev

Hydrograph



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Summary for Subcatchment E2: PreDev

Runoff = 14.84 cfs @ 12.22 hrs, Volume= 1.426 af, Depth> 3.82"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 100 Yr Rainfall=7.00"

Area (sf)	CN	Description
195,359	72	Woods/grass comb., Good, HSG C
195,359		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
13.2	50	0.0170	0.06		Sheet Flow, A-B Woods: Light underbrush n= 0.400 P2= 3.20"
2.2	270	0.0160	2.04		Shallow Concentrated Flow, B-C Unpaved Kv= 16.1 fps
0.7	185	0.0800	4.55		Shallow Concentrated Flow, C-D Unpaved Kv= 16.1 fps
16.1	505	Total			

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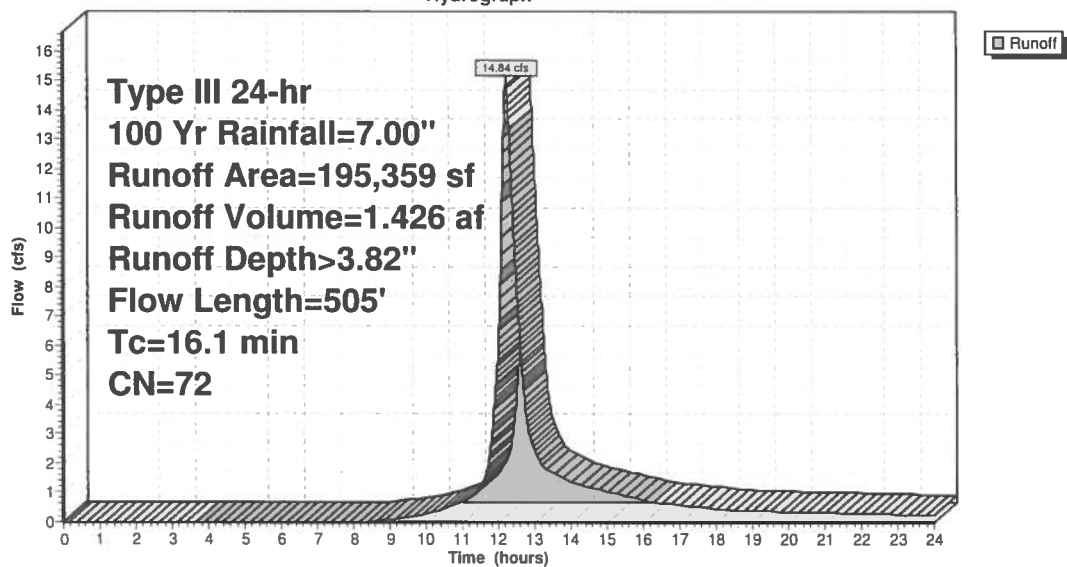
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Type III 24-hr 100 Yr Rainfall=7.00"

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Subcatchment E2: PreDev**Hydrograph**

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Type III 24-hr 100 Yr Rainfall=7.00"

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Summary for Subcatchment E3: PreDev

Runoff = 5.67 cfs @ 12.27 hrs, Volume= 0.585 af, Depth> 3.81"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 100 Yr Rainfall=7.00"

Area (sf)	CN	Description
80,117	72	Woods/grass comb., Good, HSG C
80,117		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
16.3	50	0.0100	0.05		Sheet Flow, A-B
2.9	470	0.0280	2.69		Woods: Light underbrush n= 0.400 P2= 3.20"
					Shallow Concentrated Flow, B-C
					Unpaved Kv= 16.1 fps
19.2	520	Total			

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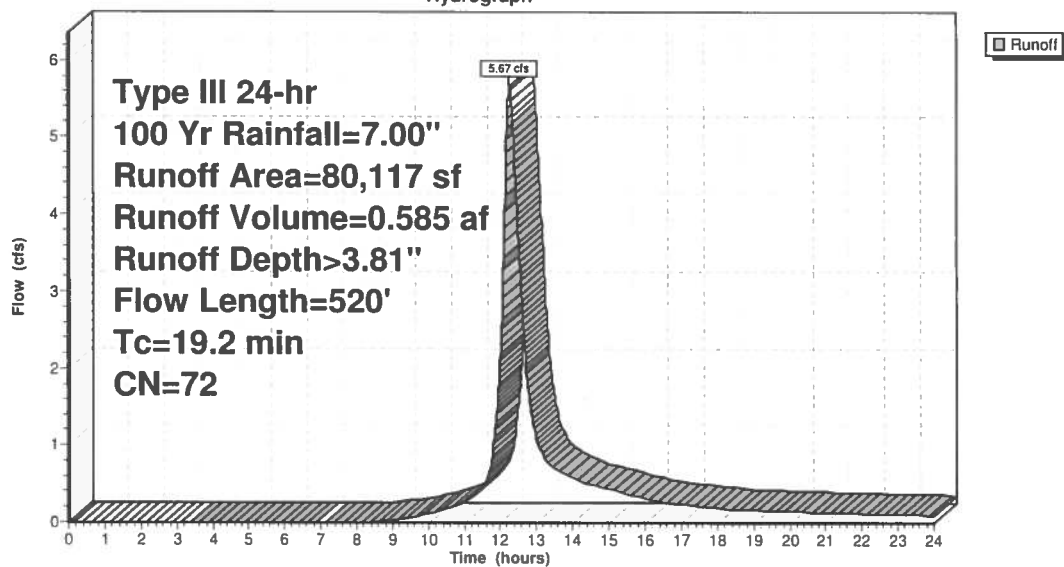
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Type III 24-hr 100 Yr Rainfall=7.00"

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Subcatchment E3: PreDev**Hydrograph**

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Type III 24-hr 100 Yr Rainfall=7.00"

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Summary for Subcatchment P1: Post Dev

Runoff = 10.29 cfs @ 12.19 hrs, Volume= 0.940 af, Depth> 4.14"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 100 Yr Rainfall=7.00"

Area (sf)	CN	Description
0	98	
8,060	98	Paved parking, HSG C
51,270	74	>75% Grass cover, Good, HSG C
59,356	72	Woods/grass comb., Good, HSG C
118,686	75	Weighted Average
110,626		93.21% Pervious Area
8,060		6.79% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.8	50	0.0100	0.08		Sheet Flow, A-B
					Grass: Dense n= 0.240 P2= 3.20"
0.6	110	0.0400	3.22		Shallow Concentrated Flow, B-C
					Unpaved Kv= 16.1 fps
2.6	450	0.0200	2.87		Shallow Concentrated Flow, C-D
					Paved Kv= 20.3 fps
14.0	610	Total			

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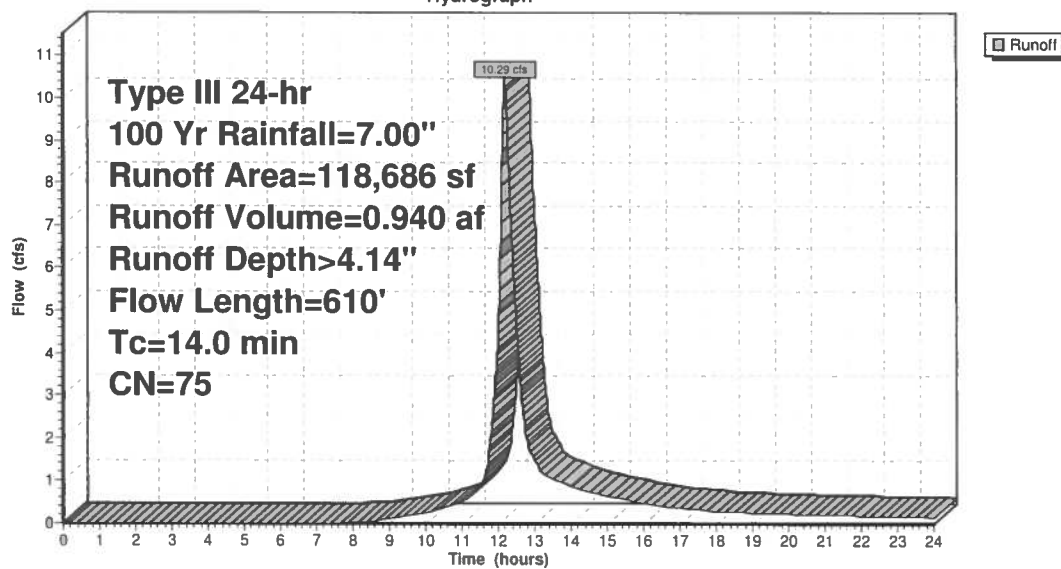
Type III 24-hr 100 Yr Rainfall=7.00"

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Subcatchment P1: Post Dev

Hydrograph



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Type III 24-hr 100 Yr Rainfall=7.00"

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Summary for Subcatchment P2: Post Dev

Runoff = 8.36 cfs @ 12.14 hrs, Volume= 0.683 af, Depth> 3.93"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 100 Yr Rainfall=7.00"

Area (sf)	CN	Description
43,772	72	Woods/grass comb., Good, HSG C
47,097	74	>75% Grass cover, Good, HSG C
90,869	73	Weighted Average
90,869		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
9.2	50	0.0150	0.09		Sheet Flow, A-B Grass: Dense n= 0.240 P2= 3.20"
1.0	275	0.0800	4.55		Shallow Concentrated Flow, B-C Unpaved Kv= 16.1 fps
10.2	325	Total			

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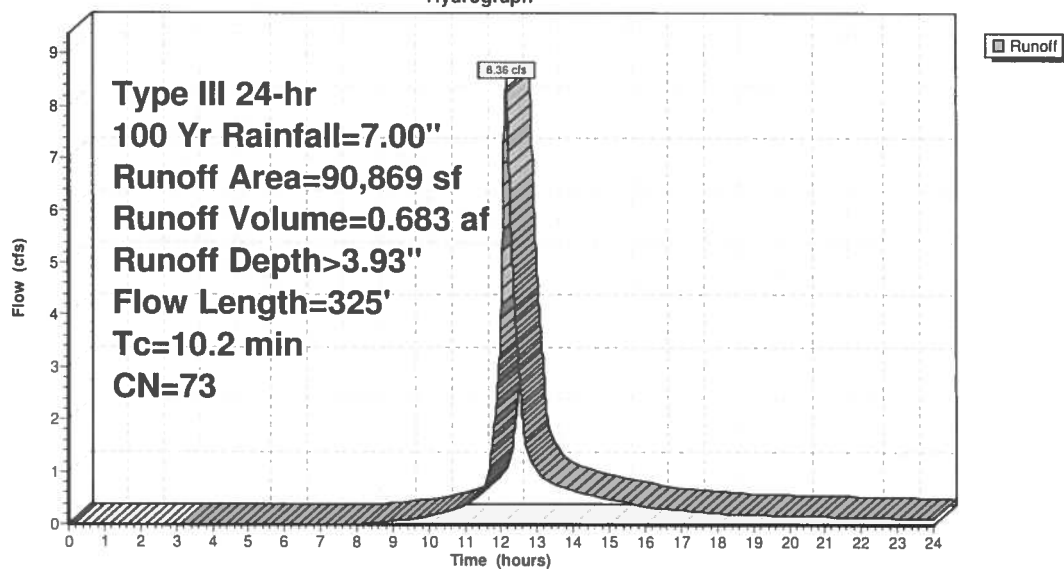
Type III 24-hr 100 Yr Rainfall=7.00"

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Subcatchment P2: Post Dev

Hydrograph



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Type III 24-hr 100 Yr Rainfall=7.00"

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Summary for Subcatchment P3: Post Dev

Runoff = 7.56 cfs @ 12.19 hrs, Volume= 0.690 af, Depth> 3.92"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 100 Yr Rainfall=7.00"

Area (sf)	CN	Description
62,580	72	Woods/grass comb., Good, HSG C
29,372	74	>75% Grass cover, Good, HSG C
91,952	73	Weighted Average
91,952		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.8	50	0.0100	0.08		Sheet Flow, A-B
					Grass: Dense n= 0.240 P2= 3.20"
3.2	510	0.0280	2.69		Shallow Concentrated Flow, B-C
					Unpaved Kv= 16.1 fps
14.0	560	Total			

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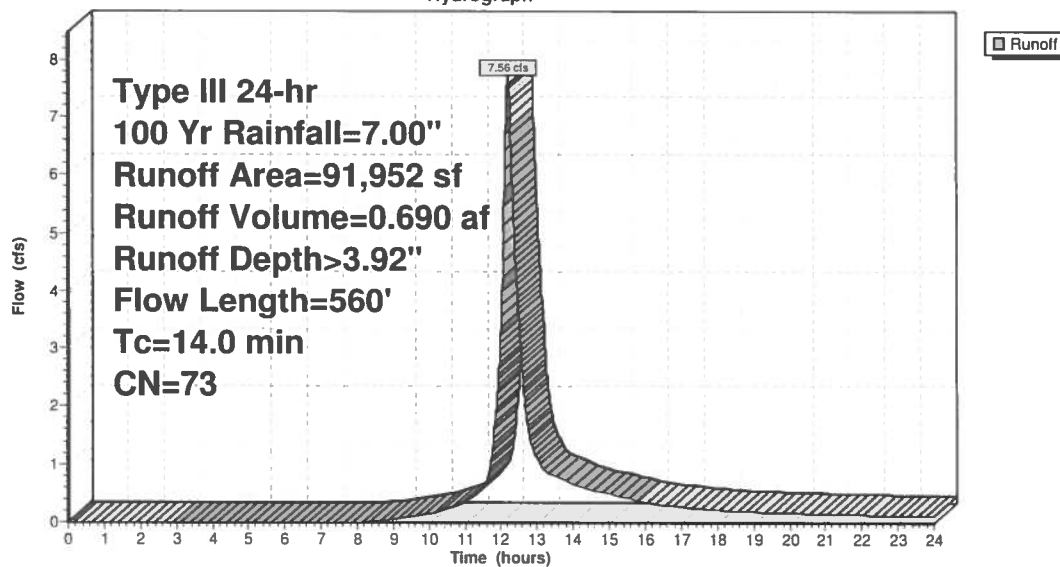
Type III 24-hr 100 Yr Rainfall=7.00"

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Subcatchment P3: Post Dev

Hydrograph



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Type III 24-hr 100 Yr Rainfall=7.00"

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Summary for Subcatchment P4: Post Dev

Runoff = 10.16 cfs @ 12.18 hrs, Volume= 0.922 af, Depth> 4.68"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 100 Yr Rainfall=7.00"

Area (sf)	CN	Description
12,535	98	Paved parking, HSG C
13,138	98	Paved roads HSG C
77,201	74	>75% Grass cover, Good, HSG C
102,874	80	Weighted Average
77,201		75.04% Pervious Area
25,673		24.96% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.8	50	0.0100	0.08		Sheet Flow, A-B Grass: Dense n= 0.240 P2= 3.20"
1.1	150	0.0200	2.28		Shallow Concentrated Flow, B-C Unpaved Kv= 16.1 fps
1.0	160	0.0170	2.65		Shallow Concentrated Flow, C-D Paved Kv= 20.3 fps
0.6	170	0.0100	4.54	3.56	Pipe Channel, D-E 12.0" Round Area= 0.8 sf Perim= 3.1' r= 0.25' n= 0.013
13.5	530	Total			

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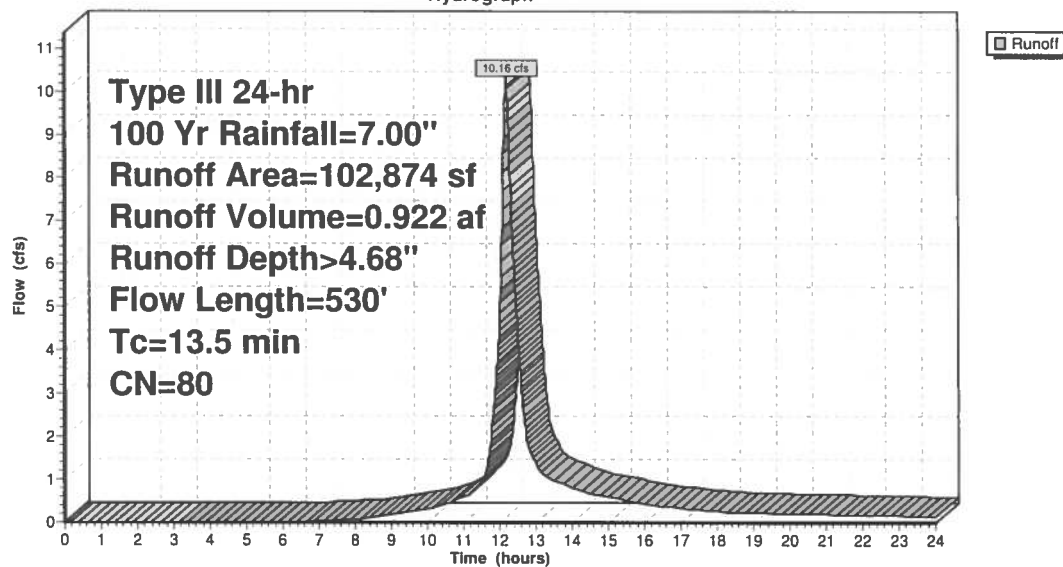
Type III 24-hr 100 Yr Rainfall=7.00"

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Subcatchment P4: Post Dev

Hydrograph



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Type III 24-hr 100 Yr Rainfall=7.00"

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Summary for Subcatchment P5: Roof

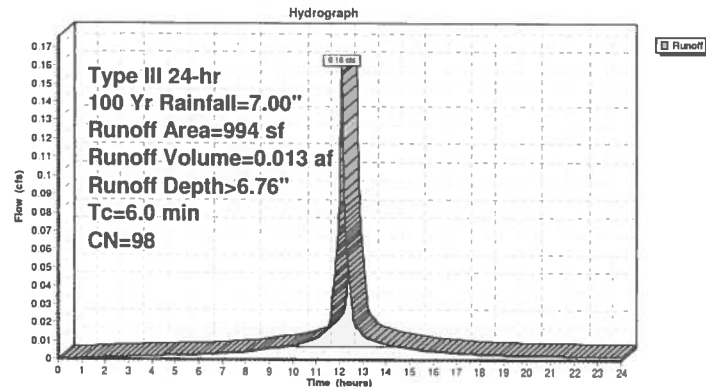
Runoff = 0.16 cfs @ 12.08 hrs, Volume= 0.013 af, Depth> 6.76"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 100 Yr Rainfall=7.00"

Area (sf)	CN	Description
994	98	Roofs, HSG A
994		100.00% Impervious Area

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

Subcatchment P5: Roof



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Type III 24-hr 100 Yr Rainfall=7.00"

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Summary for Pond 1P: Drain Basin

Inflow Area = 2.362 ac, 24.96% Impervious, Inflow Depth > 4.68" for 100 Yr event

Inflow = 10.16 cfs @ 12.18 hrs, Volume= 0.922 af

Outflow = 4.69 cfs @ 12.48 hrs, Volume= 0.853 af, Atten= 54%, Lag= 17.9 min

Discarded = 0.07 cfs @ 12.48 hrs, Volume= 0.044 af

Primary = 4.61 cfs @ 12.48 hrs, Volume= 0.809 af

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

Peak Elev= 282.06' @ 12.48 hrs Surf.Area= 8,232 sf Storage= 13,754 cf

Plug-Flow detention time= 95.9 min calculated for 0.852 af (92% of inflow)

Center-of-Mass det. time= 57.9 min (871.3 - 813.4)

Volume	Invert	Avail.Storage	Storage	Description
#1	278.80'	22,321 cf		Custom Stage Data (Irregular) Listed below (Recalc) x 1.25

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
278.80	236	73.0	0	0	236
279.00	950	223.0	111	111	3,769
280.00	2,622	260.0	1,717	1,827	5,212
281.00	3,750	285.0	3,169	4,997	6,330
281.10	5,052	379.0	438	5,435	11,297
282.00	6,503	376.0	5,186	10,621	11,681
283.00	7,994	400.0	7,236	17,857	13,213

Device	Routing	Invert	Outlet Devices
#1	Discarded	278.80'	0.270 in/hr Exfiltration over Surface area Conductivity to Groundwater Elevation = 276.00'
#2	Primary	278.80'	18.0" Round Culvert L= 25.0' RCP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 278.80' / 277.50' S= 0.0520 ' S= 0.0520 ' Cc= 0.900 n= 0.013, Flow Area= 1.77 sf
#3	Device 2	280.00'	6.0" Vert. Orifice/Grate C= 0.600
#4	Device 2	280.90'	1.0' long Sharp-Crested Rectangular Weir 2 End Contraction(s) 2.1' Crest Height

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Type III 24-hr 100 Yr Rainfall=7.00"

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Discarded OutFlow Max=0.07 cfs @ 12.48 hrs HW=282.06' (Free Discharge)

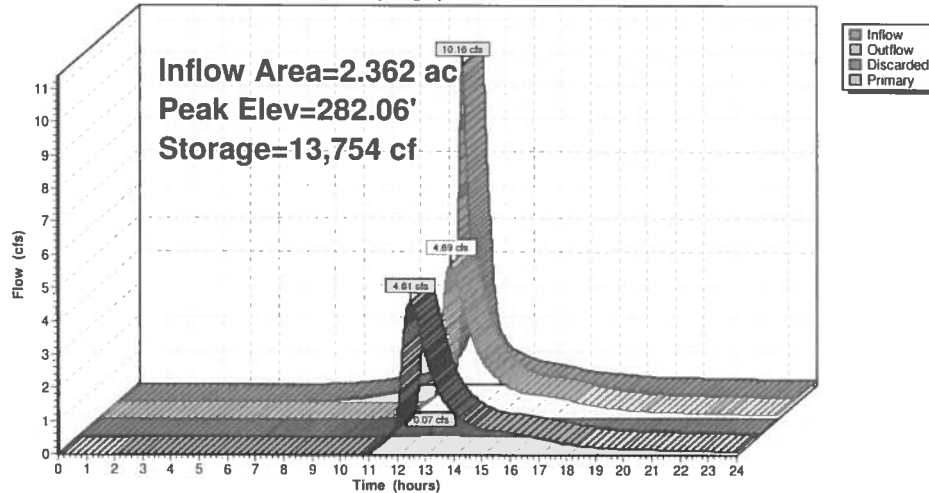
1=Exfiltration (Controls 0.07 cfs)

Primary OutFlow Max=4.61 cfs @ 12.48 hrs HW=282.06' (Free Discharge)

2=Culvert (Passes 4.61 cfs of 13.48 cfs potential flow)

3=Orifice/Grate (Orifice Controls 1.27 cfs @ 6.47 fps)

4=Sharp-Crested Rectangular Weir (Weir Controls 3.34 cfs @ 3.76 fps)

Pond 1P: Drain Basin**Hydrograph**

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Type III 24-hr 100 Yr Rainfall=7.00"

Printed 5/6/2020

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Summary for Pond 2P: Roof Runoff

Inflow Area = 0.023 ac, 100.00% Impervious, Inflow Depth > 6.76" for 100 Yr event
 Inflow = 0.16 cfs @ 12.08 hrs, Volume= 0.013 af
 Outflow = 0.11 cfs @ 12.16 hrs, Volume= 0.013 af, Atten= 31%, Lag= 4.8 min
 Discarded = 0.11 cfs @ 12.16 hrs, Volume= 0.013 af

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
 Peak Elev= 201.88' @ 12.16 hrs Surf.Area= 50 sf Storage= 47 cf

Plug-Flow detention time= 2.3 min calculated for 0.013 af (100% of inflow)
 Center-of-Mass det. time= 2.3 min (744.7 - 742.4)

Volume	Invert	Avail.Storage	Storage Description
#1A	200.00'	35 cf	5.00'W x 10.00'L x 2.04'H Field A 102 cf Overall - 15 cf Embedded = 87 cf x 40.0% Voids
#2A	200.50'	15 cf	Cultec C-100HD Inside #1 Effective Size= 32.1"W x 12.0"H => 1.86 sf x 7.50'L = 14.0 cf Overall Size= 36.0"W x 12.5"H x 8.00'L with 0.50' Overlap Row Length Adjustment= +0.50' x 1.86 sf x 1 rows
		50 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Discarded	200.00'	27.000 in/hr Exfiltration over Wetted area Conductivity to Groundwater Elevation = 198.00'

Discarded OutFlow Max=0.11 cfs @ 12.16 hrs HW=201.88' (Free Discharge)

1=Exfiltration (Controls 0.11 cfs)

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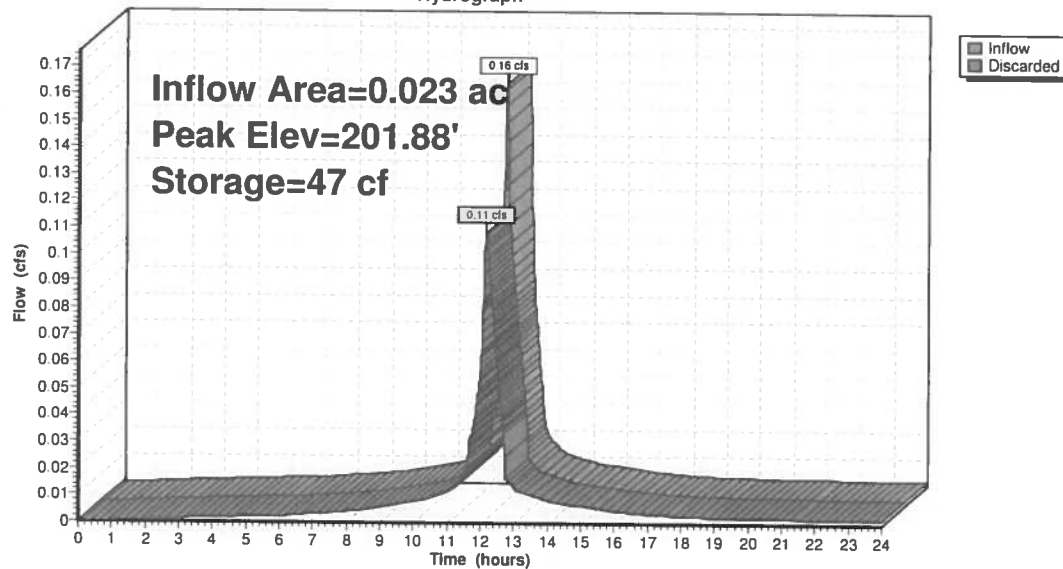
Type III 24-hr 100 Yr Rainfall=7.00"

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Pond 2P: Roof Runoff

Hydrograph



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Type III 24-hr 100 Yr Rainfall=7.00"

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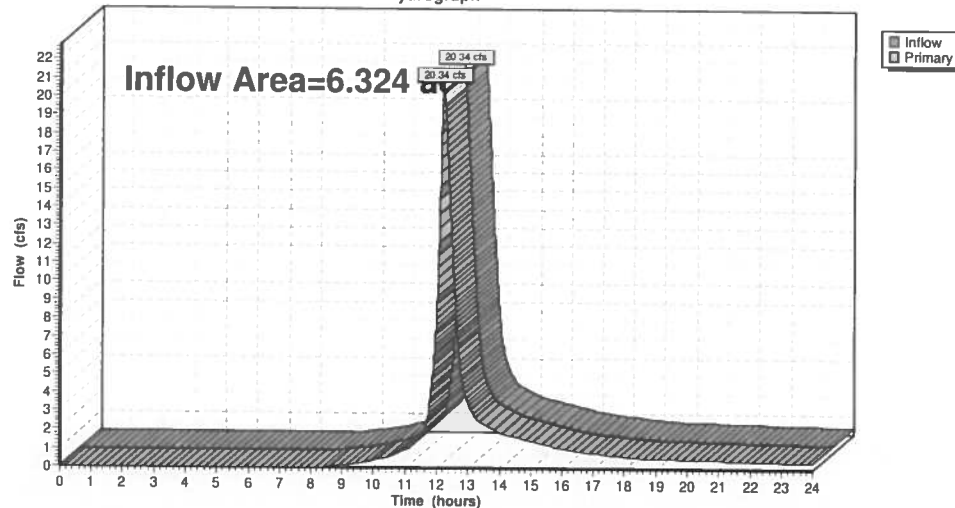
Summary for Link 1L: PreDev

Inflow Area = 6.324 ac, 0.00% Impervious, Inflow Depth > 3.82" for 100 Yr event
 Inflow = 20.34 cfs @ 12.23 hrs, Volume= 2.011 af
 Primary = 20.34 cfs @ 12.23 hrs, Volume= 2.011 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs

Link 1L: PreDev

Hydrograph



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Type III 24-hr 100 Yr Rainfall=7.00"

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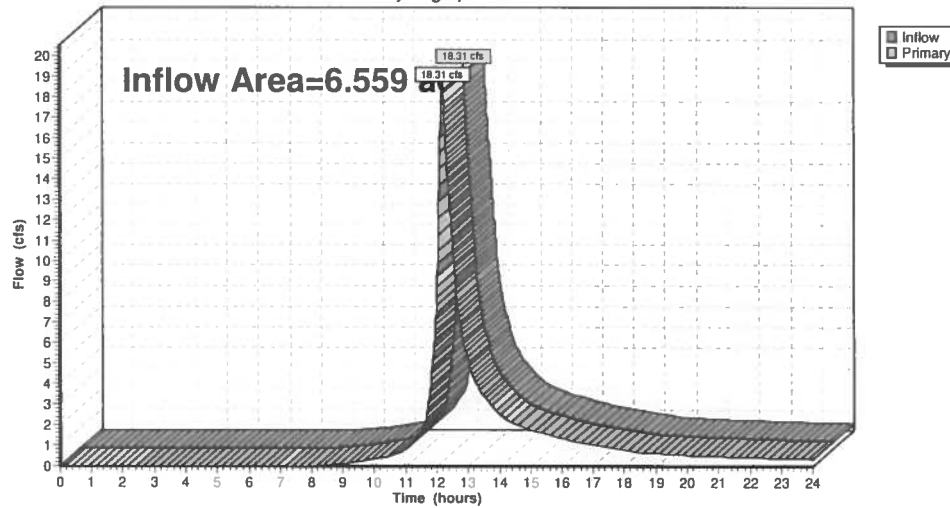
Summary for Link 2L: (new Link)

Inflow Area = 6.559 ac, 8.99% Impervious, Inflow Depth > 3.99" for 100 Yr event
Inflow = 18.31 cfs @ 12.18 hrs, Volume= 2.182 af
Primary = 18.31 cfs @ 12.18 hrs, Volume= 2.182 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs

Link 2L: (new Link)

Hydrograph



APPENDIX – B

Hydraulic Design (Manning's Equation)
Time of Flow, Average CN values
Groundwater Mounding Calculations

Standard 2

i = Rainfall Intensity at 25 Year Storm

Revised:

Job No: 7.701

Calc. by: rst

Project: Triangle Farm
Town: Holliston, MA

Line		Length (Feet)	Drain Area (Ac)	Total Area (Ac)	Runoff "C"	Time of Concentration (min.)			Rainfall i (in./hr.)	Required Capacity Q(cfs)		Pipe Diameter (in.)	Design Conditions		Invert Elevation		Rim Elev.	
From	To					Upper End	In Pipe	Total		Inlet	Pipe		Slope (ft./ft.)	Depth (in.)	Velocity (f.p.s.)	Upper	Lower	Upper
CB 1	DNH 3	10	0.22		0.50	16.08	0.04	16.12	4.33	0.49	12	0.020	2.50	4.10	284.50	284.30	287.61	0.013
CB 2	DNH 3	5	0.42		0.41	23.29	0.01	23.30	3.67	0.63	12	0.040	2.40	5.60	284.50	284.30	287.61	0.013
DNH 3	DNH 4	260		0.64	0.44	23.30	1.40	24.70	3.67	1.05	12	0.005	5.40	3.10	284.20	282.90	288.12	0.013
CB 5	DNH 4	10	0.29		0.48	13.19	0.03	13.22	4.69	0.66	12	0.060	2.20	6.50	283.50	282.90	288.03	0.013
CB 6	DNH 4	5	0.33		0.45	12.34	0.01	12.34	4.81	0.72	12	0.120	2.00	8.60	283.50	282.90	288.03	0.013
DNH 4	DNH 7	110		1.26	0.46	24.70	0.51	25.21	3.57	2.05	12	0.005	8.20	3.60	282.80	282.20	287.92	0.013
CB 8	DNH 7	2	0.73		0.56	12.34	0.00	12.34	4.81	1.95	12	0.100	3.40	10.70	282.40	282.20	286.00	0.013
DNH 7	HW 9	40		1.99	0.49	25.21	0.09	25.30	3.53	3.46	12	0.022	7.10	7.20	282.40	281.50	286.10	0.013

OVERLAND FLOW TRAVEL TIME

STORM RUNOFF DATA

Project: **Triangle Farm**
Town: **Holliston, MA**

Date: **5/7/20**
Revised:
Job No: **7,701**
Calc. by: **rst**

Structure	Impervious			Lawn			Wooded			Total
	Length (ft)	Slope ('/')	Time (min.)	Length (ft)	Slope ('/')	Time (min.)	Length (ft)	Slope ('/')	Time (min.)	Travel Time (min.)
1	90	0.008	1.60	80	0.020	14.48				16.08
2	90	0.008	1.60	190	0.020	21.69				23.29
5	140	0.017	1.68	60	0.030	11.51				13.19
6	140	0.015	1.77	50	0.030	10.57				12.34
8	140	0.015	1.77	50.00	0.030	10.57				12.34

AVERAGE 'c' VALUE FOR STRUCTURES

STORM RUNOFF DATA

Date: **5/7/20**

Revised:

Project: **Triangle Farm**
Town: **Holliston, MA**

Job No: **7,701**

Calc. by: **RST**

Structure	Total Area (SF)	Ground Cover	Area (SF)	c	$\Sigma(\text{Area} \cdot c)$	Average c	Total Area (Ac)
CB#1	9,766	imp	3,058	0.95	2,905.10	0.50	0.224
		lawn	6,708	0.30	2,012.40		
		wooded	0	0.20	0.00		
CB#2	18,259	imp	3,111	0.95	2,955.45	0.41	0.419
		lawn	15,148	0.30	4,544.40		
		wooded	0	0.20	0.00		
CB#5	12,630	imp	3,549	0.95	3,371.55	0.48	0.290
		lawn	9,081	0.30	2,724.30		
		wooded	0	0.20	0.00		
CB#6	14,304	imp	3,399	0.95	3,229.05	0.45	0.328
		lawn	10,905	0.30	3,271.50		
		wooded	0	0.20	0.00		
CB#8	31,753	imp	12,554	0.95	11,926.30	0.56	0.729
		lawn	19,199	0.30	5,759.70		
		wooded	0	0.20	0.00		

APPENDIX – C

**Stormwater Recharge Calculations, Water Quality Volumes, TSS Removal &
Infiltration BMP Drain Time
Groundwater Mounding Calculations**

Standards 3 & 4:

APPENDIX – B
Stormwater Recharge, Water Quality & Forebay Calculations
Standard 3 & 4:

Project:

Triangle Farm
Holliston, Massachusetts
Date: May 8, 2020

Water Quality Volume (WQV): Based on 1.0 inch rainfall

Recharge Volume(Rv): Based on Soil Classification

$R_v = F * \text{Impervious Area}$

Rv = Required Recharge Volume

F = Depth Factor

Soil Type A – 0.60 inch

Soil Type B – 0.35 inch

Soil Type C – 0.25 inch

Soil Type D – 0.00 inch

Total Impervious Area:

Roadway/Drives: 25,673 s.f. (To drainage basin)

Roadway(bypass basin) 2,390 s.f.

Roof: (to basins) 13,184 s.f.

Total Imp. Area: 41,247 s.f.

Total Impervious to Recharge Basins: 38,857 s.f.

Total Impervious Area Uncaptured: 2,390 s.f.

Capture Adjustment:

$38,857 \text{ s.f.} / 41,247 \text{ s.f.} = 94.2\% > 65\%$

$41,247 \text{ s.f.} / 38,857 \text{ s.f.} = 1.06 \text{ capture adjustment}$

Recharge Volume required Roof Area:

Each system captures 50% of the roof area.

Roof Area: (Largest house) 1,988 s.f.

$R_v = (0.25 \text{ inch} * 994 \text{ s.f.}) / 12 = 21 \text{ c.f.}$

Recharge Volume Provided:

Cultec Unit C-100HD w/stone:

Tot. Volume: 50 c.f.

Time to drain:

$\text{Drawdown time} = \text{Volume} / (K * \text{Bottom Area})$

Volume = 21 cf

$K = 0.27 \text{ in/hr} = 0.023 \text{ ft/hr}$

Bottom Area = 50 sf

$\text{Drawdown time} = 21 / (0.023 \text{ ft/hr} * 50 \text{ sf})$

Drawdown time = 18 hr < 72 hr ok

Drainage Basin #1 :

Imp. Area Pavement: 25,673 s.f.

WQV = $(25,673 \text{ sf} * 1.0 \text{ in}) / 12 = \underline{2139 \text{ c.f.}}$

Recharge Volume Required: (Soil Type C – 0.25 inch)

Tot. Imp Area: 25,673 s.f.

Rv = $(25,673 \text{ sf} * 0.25 \text{ in}) / 12 = \underline{534 \text{ c.f.}}$ x Capture Adjustment (1.06) = 567 c.f.

Storage Volume below outlet

"Static" Storage Volume Provided:

Volume (Outlet 280.0) provided = 2,284 c.f.

2,284 > 2,139 c.f. OK

Forebay Sizing:

Forebay Volume Required: (Paved Area) x 0.10 inch of runoff

$(25,673 \text{ s.f.} * 0.10 \text{ in}) / 12 = 214 \text{ cu.ft.}$

Forebay Volume Provided:

Elev. (ft.)	Area (s.f.)	Inc.Store (cu.ft.)	Cum.Store (cu.ft.)
280.0	702	0	0
281.0	1195	950	950

Total Storage Provided: 950 c.f.

950 cf > 214 cf ok

Time to drain:

Drawdown time = Volume / (K * Bottom Area)

Volume = 2139 cf

K = 0.27 in/hr = 0.023 ft/hr

Bottom Area = 2622 sf

Drawdown time = $2139 / (0.023 \text{ ft/hr} * 2622 \text{ sf})$

Drawdown time = 35 hr < 72 hr ok

INSTRUCTIONS:

1. In BMP Column, click on Blue Cell to Activate Drop Down Menu
2. Select BMP from Drop Down Menu
3. After BMP is selected, TSS Removal and other Columns are automatically completed.

Version 1, Automated: Mar. 4, 2008

Location: Drainage Outlet #9

BMP ¹	C TSS Removal Rate ¹	D Starting TSS Load*	E Amount Removed (C*D)	F Remaining Load (D-E)
Deep Sump and Hooded Catch Basin	0.25	1.00	0.25	0.75
Sediment Forebay	0.25	0.75	0.19	0.56
Infiltration Basin	0.80	0.56	0.45	0.11
	0.00	0.11	0.00	0.11
	0.00	0.11	0.00	0.11

Separate Form Needs to be Completed for Each Outlet or BMP Train

Total TSS Removal =

Project:	Triangle Farm
Prepared By:	GLM
Date:	5/8/2020

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

Non-automated TSS Calculation Sheet must be used if Proprietary BMP Proposed

1. From MassDEP Stormwater Handbook Vol. 1

Mound Calculation Basin
Triangle Farm, Holliston, MA
Date: 05/8/2020

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

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

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

Input Values		use consistent units (e.g. feet & days or inches & hours)	Conversion Table		
			inch/hour	feet/day	
0.2300	R	Recharge (Infiltration) rate (feet/day)	0.67	1.33	
0.200	Sy	Specific yield, Sy (dimensionless, between 0 and 1)			
5.40	K	Horizontal hydraulic conductivity, Kh (feet/day)*	2.00	4.00	
55.000	x	1/2 length of basin (x direction, in feet)			
12.000	y	1/2 width of basin (y direction, in feet)	hours	days	
1.000	t	duration of infiltration period (days)	36	1.50	
25.000	hi(0)	initial thickness of saturated zone (feet)			

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

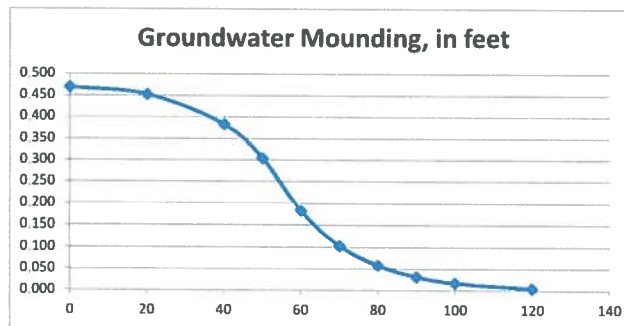
Ground-water Mounding, in feet

Distance from center of basin in x direction, in feet

0.470	0
0.465	20
0.444	40
0.394	50
0.300	60
0.200	70
0.093	80
0.023	90
0.000	100
0.000	120



Re-Calculate Now



Disclaimer

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

APPENDIX – D

Stormwater Operation and Maintenance Plan
and
Long Term Pollution Prevention Plan

Standard 9

Triangle Farm
Holliston, Massachusetts

Stormwater Management Operation and Maintenance Plan
And Long Term Pollution Prevention Plan

Triangle Farm
Holliston, Massachusetts

May 8, 2020

In accordance with Standard 9 of the Massachusetts Department of Environmental Protection Stormwater Handbook (February 2008), the attached on-site maintenance program for the proposed stormwater management system has been developed to ensure the Best Management Practices (BMP's) in place will remain functioning as designed. The Plan contains both construction period operations and maintenance as well as post construction responsibilities that shall "run" with the property if ownership is transferred.

Land Owner/Operator:

Thomas Murch
Murch Prentice Realty Trust
5855 Lyman Road
Turin, NY 13473

Date

Estimated Maintenance Yearly Budget:

Annual Catch Basin and Oil/Grit Chamber Cleaning:	\$ 600.00
Mowing, vegetation maintenance of Drainage Basins:	\$ 300.00
Repairs:	<u>\$ 250.00</u>
Total	\$1,150.00

Construction Period Operation and Maintenance:

Good Housekeeping Practices:

- Remove all debris from site and dispose of in trash dumpsters
- Plan for adequate disposal of scrap, waste and surplus materials
- Keep work area clean
- Secure loose or light material that is stored on the site
- Store flammable materials apart from other materials
- Secure all materials at the end of each work day
- Maintain a clean neat and orderly site

Safety:

Keep safety considerations at the forefront of inspection procedures at all times. Likely hazards should be anticipated and avoided. Never enter a confined space (outlet structure, manhole, etc) without proper training or equipment. A confined space should never be entered without at least one additional person present. If a toxic or flammable substance is discovered, leave the immediate area and contact the local authorities at 911.

All cast iron storm water structure grates and covers shall be kept in good condition and kept closed at all times. Any damaged or broken structures will be replaced immediately upon discovery.

Erosion Control Barriers:

Compost filter socks shall be installed where indicated on the plans and in other appropriate locations where warranted. These barriers shall be installed prior to the commencement of any work on-site and in accordance with the construction plans. A supply of filter socks and compost filter material shall be kept on-site to replace and/or repair barriers that are damaged or degraded. The barriers shall be observed and maintained on a weekly basis during construction.

Construction Entrances:

The existing paved site entrance shall be utilized for construction access.

Catch Basin Protection:

Temporary inlet protection barriers consisting of Silt Sacks® will be placed within all constructed inlets to prevent inflow of sediments into the constructed drainage system. The barriers shall remain in place until a permanent cover is established or diversions away from the inlets are constructed. The barriers shall be observed and maintained as necessary on a weekly basis and after every rainfall of 0.5 inches or more.

Dust Control:

Soils information for the site indicates that it is comprised of sandy soils. Therefore, Dust control BMPs to reduce surface activities and air movement that causes dust to be generated from disturbed soil surfaces will be required. The preferred measure for dust control is sprinkling/irrigation. This is an on-going/as-needed requirement until surfaces have been stabilized. There shall be a water truck on-site available as needed.

Spill Control:

A contingency plan to address the spillage/release of petroleum products and any hazardous materials will be implemented for the site during construction. The plan will include the following measures:

- Equipment necessary to quickly attend to inadvertent spills or leaks shall be on-site in a secure but accessible location. Such equipment will include, but not be limited to, the following: urethane drain cover seals (mats), a spill containment kit which includes sand and shovels, suitable absorbent materials, storage containers, safety goggles, chemically resistant gloves and overshoe boots, water and chemical fire extinguishers, and first aid equipment.
- Spills or leaks will be treated properly according to material type, volume of spillage and location of spill. Mitigation will include preventing further spillage, containing any spilled material to the smallest practical area, removing spilled material in a safe and environmentally friendly manner, and remediating any damage to the environment.
- The contractor shall be familiar with the reporting requirements of the Massachusetts Contingency Plan (310 CMR 40.00) as issued by the Massachusetts Department of Environmental Protection (DEP); specifically Subpart C Notification of Releases and Threats of Release of Oil and Hazardous Materials and Subpart D Preliminary Response Activities and Risk Reduction Measures.
- For any large spills. The Massachusetts DEP Hazardous Waste Incident Response Group shall be notified immediately at 1-617-792-7653 and an emergency response contractor will be called in.

Post-Construction Period Operation and Maintenance:

Pavement Sweeping:

Sweeping has been shown to be an effective initial treatment for reducing contaminants in stormwater runoff. Sweeping is not required to meet TSS removal goals in this case but should be performed in the spring to remove winter accumulations or at other when warranted.

Gutter Cleaning:

Gutter cleaning shall be done at least once per year, in the fall after the trees have dropped their leaves. Inspect downspouts and overflows periodically to prevent debris buildup.

Deep Sump Catch Basins:

Deep sump catch basins remain effective at removing pollutants only if they are cleaned out frequently. Inspect and clean sumps when sediments whenever the depth of deposits is greater than or equal to one half the depth from the bottom of the invert to the lowest pipe in the basin, at least once (1) time per year, at the end of the foliage and snow removal seasons. Clamshell buckets or vacuum trucks shall be utilized.

Recharge Systems (Infiltration Chambers) :

The inlet pipe and observation access port shall be inspected 4 times per year. Inspect recharge facilities following a rainfall event greater than 2.5 inches in a 24 hour period. Any accumulated debris shall be removed.

If standing water is observed for more than 72 hours following a storm event, immediately retain a qualified professional to assess whether infiltration function has been lost and develop recommended correction actions.

If upon visual inspection it is found that sediment has accumulated, a stadia rod should be inserted to determine the depth of sediment. When the average depth of sediment exceeds 3 inches throughout the length of the chambers, clean-out should be performed. Maintenance is accomplished with the JetVac process. The JetVac process utilizes a high pressure water nozzle to propel itself down the Isolator Row while scouring and suspending sediments. As the nozzle is retrieved, the captured pollutants are flushed back into the manhole for vacuuming. Most sewer and pipe maintenance companies have vacuum/JetVac combination vehicles.

Drainage Basin & Forebay:

Vehicle access if necessary will be via the 10 foot wide access around the top of the retention basin. The drainage easement shall be mowed twice a year and kept clear of any trees. The easement will be used for access to the basin.

Inspect it after every major storm for the first few months to ensure it is stabilized and functioning properly and if necessary to take corrective action. Also inspect the basin every time there is a discharge through the high outlet weir. A major storm is defined as a storm that is equal to or greater than the 2.5 inches in a 24-hour storm. Note how long the water remains standing after a

Triangle Farm

Holliston, Massachusetts

storm. If longer than 72 hours, there may be clogging of the infiltrative surfaces. Inspect the basin and mow it as needed. When mowing keep the grass height no greater than 6 inches. Set mower blades no lower than 3 to 4 inches. Remove grass clippings, organic matter and trash. Use deep tilling to break up compacted or clogged surfaces.

Check for signs of gullyng and repair as needed. After removing the sediment, replace any vegetation damaged during the clean-out by reseeding.

Outlet Structure:

Inspection: Inspect semi-annually the first year, and at least once a year thereafter. Inspect the grass for growth and the side slopes for signs of erosion and formation of rills and gullies. Plant an alternative grass species if the original grass cover is not successfully established.

The stone riprap outlet channel shall be inspected semi-annually for debris, sediment buildup and any vegetated growth.

Sediment Removal: Check on a yearly basis and clean as needed. Use hand methods (i.e., a person with a shovel) when cleaning to minimize disturbance to vegetation and underlying soils.

Snow Removal and De-icing:

The use of Sodium Chloride ("rock salt") for de-icing of paved surfaces will be limited; except when found to be necessary for safety of the workers. Sand will be the primary icing control agent. Alternative de-icing products such as calcium chloride may be used as temperatures or other conditions warrant.

Fertilizer:

Slow release organic fertilizers will be used in landscape areas to limit nutrient transport to groundwater and wetland areas. Application will be limited to 3 lbs. per 1000 sf of lawn area.

Spill Control:

See Construction Period Spill control requirements.

Triangle Farm
Holliston, Massachusetts

Stormwater Construction Site Inspection Report

General Information			
Project Name	Triangle Farm		
MA DEP File No.		Location	
Date of Inspection		Start/End Time	
Inspector's Name(s)			
Inspector's Title(s)			
Inspector's Contact Information			
Inspector's Qualifications			
Describe present phase of construction			
Type of Inspection: <input type="checkbox"/> Regular <input type="checkbox"/> Pre-storm event <input type="checkbox"/> During storm event <input type="checkbox"/> Post-storm event			
Weather Information			
Has there been a storm event since the last inspection? <input type="checkbox"/> Yes <input type="checkbox"/> No If yes, provide: Storm Start Date & Time: Storm Duration (hrs): Approximate Amount of Precipitation (in):			
Weather at time of this inspection? <input type="checkbox"/> Clear <input type="checkbox"/> Cloudy <input type="checkbox"/> Rain <input type="checkbox"/> Sleet <input type="checkbox"/> Fog <input type="checkbox"/> Snowing <input type="checkbox"/> High Winds <input type="checkbox"/> Other: Temperature:			
Have any discharges occurred since the last inspection? <input type="checkbox"/> Yes <input type="checkbox"/> No If yes, describe:			
Are there any discharges at the time of inspection? <input type="checkbox"/> Yes <input type="checkbox"/> No If yes, describe:			

Site-specific BMPs

- Number the structural and non-structural BMPs identified in your SWPPP on your site map and list them below (add as many BMPs as necessary). Carry a copy of the numbered site map with you during your inspections. This list will ensure that you are inspecting all required BMPs at your site.
- Describe corrective actions initiated, date completed, and note the person that completed the work in the Corrective Action Log.

	BMP	BMP Installed?	BMP Maintenance Required?	Corrective Action Needed and Notes
1		<input type="checkbox"/> Yes <input type="checkbox"/> No	<input type="checkbox"/> Yes <input type="checkbox"/> No	
2		<input type="checkbox"/> Yes <input type="checkbox"/> No	<input type="checkbox"/> Yes <input type="checkbox"/> No	
3		<input type="checkbox"/> Yes <input type="checkbox"/> No	<input type="checkbox"/> Yes <input type="checkbox"/> No	
4		<input type="checkbox"/> Yes <input type="checkbox"/> No	<input type="checkbox"/> Yes <input type="checkbox"/> No	
5		<input type="checkbox"/> Yes <input type="checkbox"/> No	<input type="checkbox"/> Yes <input type="checkbox"/> No	
6		<input type="checkbox"/> Yes <input type="checkbox"/> No	<input type="checkbox"/> Yes <input type="checkbox"/> No	
7		<input type="checkbox"/> Yes <input type="checkbox"/> No	<input type="checkbox"/> Yes <input type="checkbox"/> No	
8		<input type="checkbox"/> Yes <input type="checkbox"/> No	<input type="checkbox"/> Yes <input type="checkbox"/> No	
9		<input type="checkbox"/> Yes <input type="checkbox"/> No	<input type="checkbox"/> Yes <input type="checkbox"/> No	

Triangle Farm
Holliston, Massachusetts

	BMP	BMP Installed?	BMP Maintenance Required?	Corrective Action Needed and Notes
10		<input type="checkbox"/> Yes <input type="checkbox"/> No	<input type="checkbox"/> Yes <input type="checkbox"/> No	

Non-Compliance

Describe any incidents of non-compliance not described above:

CERTIFICATION STATEMENT

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

Print name and title: _____

Signature: _____ **Date:** _____

APPENDIX – E

Illicit Discharge Statement

Standard 10

Triangle Farm
Holliston, Massachusetts

Illicit Discharge Compliance Statement

Triangle Farm
Holliston, Massachusetts

May 8, 2020

This statement is provided in accordance with the provisions of the Massachusetts Stormwater Management Standard #10.

To the best of the applicant's/owners knowledge there are no illicit discharges to the site's stormwater management system.

All proposed uses on the site will not generate, store or discharge any pollutants to the groundwater and/or wetland resource areas.

Any illicit discharges identified during or after construction will be terminated immediately.

Applicant/Owner:

Thomas Murch, Trustee
Murch Prentice Realty Trust
2855 Lyman Road
Turin, NY 13743

Signature

Date

APPENDIX – F

Soil Evaluation Forms

Location Address or Lot No. LOT 2 Mill St HoustonOn-site ReviewDeep Hole Number 2A Date: 5/12/97 Time: AM Weather: 50° Sun

Location (identify on site plan)

Land Use OPEN FIELDSlope (%): <5Surface Stones N/AVegetation HIGH GRASSLandform TERRACE

Position on landscape (sketch on the back)

Distances from:

Open Water Body - feet Drainage way - feetPossible Wet Area 140+ feet Property Line - feetDrinking Water Well - feet Other -

DEEP OBSERVATION HOLE LOG

Depth from Surface (feet)	Soil Horizon	Soil Texture (USDA)	Soil Color (Munsell)	Soil Moisture	Other (Structures, Stones, Boulders, Concretes, etc., Gravel)
9	A _p	Loam	10YR 2/3		
25"	B _w	Sandy Loam	10YR 5/6		
42"	C ₁		2.5Y 5/2		30% Gravel
68"	C ₂		2.5Y 5/4	68"	COARSE 70% Gravel
124"	C ₃		2.5Y 5/2		30% Gravel

* MINIMUM OF 2 HOLES REQUIRED AT EVERY PROPOSED DISPOSAL AREA

Parent Material (geology) TILL Depth to Bedrock N/ADepth to Groundwater: Standing Water in the Hole - Weeping from Pit Face 68"Estimated Seasonal High Ground Water 68"

Location Address or Lot No. LOT 2 MILL ST HOUSTONOn-site ReviewDeep Hole Number ZB Date: 5/12/97 Time: AM Weather: 50° SW

Location (Identify on site plan)

Land Use OPEN FIELDSlope (%) <5 Surface Stones NoVegetation HIGH GRASSLandform TERRACE

Position on landscape (sketch on the back)

Distances from:

Open Water Body - feet Drainage way - feetPossible Wet Area 140+ feet Property Line - feetDrinking Water Well - feet Other -

DEEP OBSERVATION HOLE LOG

Depth from Surface (Inches)	Soil Horizon	Soil Texture (USDA)	Soil Color (Munsie)	Soil Moisture	Other (Structures, Stones, Boulders, Consistency, etc. Gravel)
12"	A _p	Loam	10YR 2 3/3		
26"	B _w	SANDY LOAM	10YR 5/6		
				0 46"	
130"	C	SANDY LOAM	2.5Y 5/2		20% GRAVEL

* MINIMUM OF 2 HOLES REQUIRED AT EVERY PROPOSED DISPOSAL AREA

Parent Material (geologic): TILL Depth to Bedrock: N/ADepth to Groundwater: Standing Water in the Hole: - Weeping from Pit Side: 104"Estimated Seasonal High Ground Water: 46"

Location Address or Lot No. LOT 2 Mill St. HOUSTONOn-site ReviewHSE HoleDeep Hole Number 2C Date 5/12/97 Time: AM Weather: 50° SW

Location (identify on site plan)

Land Use OPEN FIELD Slope (ft) <5 Surface Stones NoVegetation HIGH GRASSLandform TERRACE

Position on landscape (sketch on the back)

Distances from:

Open Water Body - feet Drainage way - feetPossible Wet Area 140+ feet Property Line - feetDrinking Water Well - feet Other -

DEEP OBSERVATION HOLE LOG*

Depth from Surface (inches)	Soil Horizon	Soil Texture (USDA)	Soil Color (Munsell)	Soil Moisture	Other (Structure, Stones, Boulders, Consistency, etc. Gravel)
<u>10</u>	<u>A₁</u>	<u>Loam</u>	<u>10YR 5/3</u>		
<u>32"</u>	<u>B_w</u>	<u>SANDY LOAM</u>	<u>10YR 5/6</u>	<u>C 32"</u>	
<u>120"</u>	<u>C₁</u>	<u>SANDY LOAM</u>	<u>2.5Y 5/2</u>		

* MINIMUM OF 2 HOLES REQUIRED AT EVERY PROPOSED DISPOSAL AREA

Parent Material (geology) TILL Depth to Bedrock N/ADepth to Groundwater: Standing Water in the Hole - Weeping from Pit Face -Estimated Seasonal High Ground Water 32"

FORM 12 - PERCOLATION TEST

Location Address or Lot No. LOT 2 MILL STREET HOLLISTON

COMMONWEALTH OF MASSACHUSETTS
 , Massachusetts

Percolation Test*		
Date: <u>5/12/97</u>		Time: _____
Observation Hole #	<u>1</u>	<u>2</u> ^{OVERNIGHT}
Depth of Perc	<u>46"</u>	<u>50"</u>
Start Pre-soak	<u>11:17</u>	<u>8:13</u>
End Pre-soak	<u>11:32</u>	<u>8:28</u>
Time at 12"	<u>11:32</u>	<u>8:28</u>
Time at 9"	<u>11:55</u>	<u>9:01</u>
Time at 6"	<u>12:25</u>	<u>10:00</u>
Time (9"-6")		
Rate Min./Inch	<u>10.0</u>	<u>20.0</u>

* Minimum of 1 percolation test must be performed in both the primary area AND reserve area.

Site Passed ☒ Site Failed ☐

Performed By: JOSEPH NICHILL

Witnessed By: _____

Comments: _____



Location Address or Lot No. Lot 18 Mill St. HollistonOn-site ReviewDeep Hole Number 18A Date: 10/20/98 Time: AM Weather 50 Sun

Location (identify on site plan)

Land Use OPEN FIELD Slope (%) < 5 Surface Stones NOVegetation HIGH GRASSLandform TERRACE

Position on landscape (sketch on the back)

Distances from:

Open Water Body — feet Drainage way — feetPossible Wet Area 120+ feet Property Line — feetDrinking Water Well — feet Other —

DEEP OBSERVATION HOLE LOG*

Depth from Surface (Inches)	Soil Horizon	Soil Texture (USDA)	Soil Color (Munsell)	Soil Mottling	Other (Structure, Stones, Boulders, Consistency, % Gravel)
8"	A _p	Loam	10YR 3/2		
24"	B _w	Sandy Loam	10YR 5/6		
120"	C	Sandy Loam	2.5Y 5/3	24"	20% GRAVEL COBBLES / STONES

* MINIMUM OF 2 HOLES REQUIRED AT EVERY PROPOSED DISPOSAL AREA

Parent Material (geologic) TILL Depth to Bedrock: N/ADepth to Groundwater: Standing Water in the Hole: NONE Weeping from Pit Face: 100"Estimated Seasonal High Ground Water: 24"

Location Address or Lot No. Lot 18 Mill St. HoustonOn-site ReviewDeep Hole Number 183 Date: 10/20/98 Time: AM Weather 50° Sun

Location (identify on site plan)

Land Use OPEN FIELD Slope (%) <5 Surface Stones NoVegetation HIGH GRASSLandform TERRACE

Position on landscape (sketch on the back)

Distances from:

Open Water Body - feet Drainage way - feetPossible Wet Area 140+ feet Property Line - feetDrinking Water Well - feet Other -

DEEP OBSERVATION HOLE LOG*

Depth from Surface (Inches)	Soil Horizon	Soil Texture (USDA)	Soil Color (Munsell)	Soil Mottling	Other (Structure, Stones, Boulders, Consistency, % Gravel)
10"	A _p	Loam	10YR 3/2		
24"	B _w	Sandy Loam	10YR 5/6		
				228"	
					15% GRAVEL
122"	C	Sandy Loam	2.5Y 5/3		

* MINIMUM OF 2 HOLES REQUIRED AT EVERY PROPOSED DISPOSAL AREA

Parent Material (geologic) TILL Depth to Bedrock N/ADepth to Groundwater: Standing Water in the Hole NO Weeping from Pit Face: 90"Estimated Seasonal High Ground Water: 28"

FORM 12 - PERCOLATION TEST

Location Address or Lot No. Lot 18 Mill St. Holliston

COMMONWEALTH OF MASSACHUSETTS

, Massachusetts

Percolation Test*		
Date: <u>10/21/98</u>		Time: _____
Observation Hole #	<u>1</u>	<u>2</u>
Depth of Perc	<u>42"</u>	<u>42"</u>
Start Pre-soak (OVERNIGHTS)	<u>8:26</u>	<u>8:28</u>
End Pre-soak	<u>8:41</u>	<u>8:43</u>
Time at 12"	<u>8:41</u>	<u>8:43</u>
Time at 9"	<u>9:32</u>	<u>9:05</u>
Time at 6"	<u>11:02</u>	<u>9:34</u>
Time (9"-6")	<u>90 min.</u>	<u>29 min.</u>
Rate Min./Inch	<u>30</u>	<u>10</u>

* Minimum of 1 percolation test must be performed in both the primary area AND reserve area.

Site Passed ☒ Site Failed ☐

Performed By: JOSEPH NIHILL

Witnessed By: NICOLE LETENDRE

Comments: _____



Location Address or Lot No. LOT 17 MILL ST. HOLLISTON

On-site Review

Deep Hole Number 17 A Date: 10/20/98 Time: A M Weather 50° SUN

Location (identify on site plan)

Land Use OPEN FIELD Slope (%) < 5 Surface Stones NO

Vegetation HIGH GRASS

Landform TERRACE

Position on landscape (sketch on the back)

Distances from:

Open Water Body - feet Drainage way - feet

Possible Wet Area 120+ feet Property Line - feet

Drinking Water Well - feet Other -

DEEP OBSERVATION HOLE LOG					
Depth from Surface (Inches)	Soil Horizon	Soil Texture (USDA)	Soil Color (Munsell)	Soil Mottling	Other (Structure, Stones, Boulders, Consistency, % Gravel)
12"	A _p	Loam	10YR 3/2		
24"	B _w	SANDY LOAM	10YR 5/6	20"	
126"	C	SANDY LOAM	2.5Y 5/3		15% GRAVEL COBBLES / STONES

* MINIMUM OF 2 HOLES REQUIRED AT EVERY PROPOSED DISPOSAL AREA

Parent Material (geologic) Till Depth to Bedrock: N/A

Depth to Groundwater: Standing Water in the Hole: 96" Weeping from Pit Face: 50"

Estimated Seasonal High Ground Water: 20"



Location Address or Lot No. Lot 17 Mill St. HoustonOn-site ReviewDeep Hole Number 17B Date: 10/20/98 Time: A.M. Weather 50° Sun

Location (identify on site plan)

Land Use OPEN FIELD Slope (%) < 5 Surface Stones NOVegetation HIGH GRASSLandform TERRACE

Position on landscape (sketch on the back)

Distances from:

Open Water Body - feet Drainage way - feetPossible Wet Area 120+ feet Property Line - feetDrinking Water Well - feet Other -

DEEP OBSERVATION HOLE LOG*

Depth from Surface (Inches)	Soil Horizon	Soil Texture (USDA)	Soil Color (Munsell)	Soil Mottling	Other (Structure, Stones, Boulders, Consistency, % Gravel)
6"	A _p	Loam	10YR 3/2		
24"	B ₁	Sandy Loam	10YR 5/6	222"	
34"	C ₁	SILTY Loam	10YR 4/4		
120"	C ₂	SANDY Loam	2.5Y 5/4		20% GRAVEL COBBLES/STONES

* MINIMUM OF 2 HOLES REQUIRED AT EVERY PROPOSED DISPOSAL AREA

Parent Material (geologic) TILL Depth to Bedrock: 0/ADepth to Groundwater: Standing Water in the Hole 72" Weeping from Pit Face: 72"Estimated Seasonal High Ground Water: 22"

Location Address or Lot No. LOT 16 MILL ST. HOLLISTONOn-site ReviewDeep Hole Number 16A Date: 10/20/98 Time: A M Weather 50° SUN

Location (identify on site plan)

Land Use OPEN FIELD Slope (%) < 5 Surface Stones NOVegetation HIGH GRASSLandform TERRACE

Position on landscape (sketch on the back)

Distances from:

Open Water Body - feet Drainage way - feetPossible Wet Area 100+ feet Property Line - feetDrinking Water Well - feet Other -

DEEP OBSERVATION HOLE LOG*

Depth from Surface (Inches)	Soil Horizon	Soil Texture (USDA)	Soil Color (Munsell)	Soil Mottling	Other (Structure, Stones, Boulders, Consistency, % Gravel)
8"	A _p	Loam	10YR 3/2		
24"	B _u	Sandy Loam	10YR 5/6	216"	
126"	C	Sandy Loam	2.5Y 5/3		10% GRAVEL COBBLES / BLDRS

* MINIMUM OF 2 HOLES REQUIRED AT EVERY PROPOSED DISPOSAL AREA

Parent Material (geologic) Till Depth to Bedrock: N/ADepth to Groundwater: Standing Water in the Hole - Weeping from Pit Face: 92"Estimated Seasonal High Ground Water: 16"

Location Address or Lot No. LOT 16 MILL ST. HOLLISTONOn-site ReviewDeep Hole Number 16B Date: 10/20/98 Time: A M Weather 50° SUN

Location (Identify on site plan)

Land Use OPEN FIELDSlope (%) < 5Surface Stones NOVegetation HIGH GRASSLandform TERRACE

Position on landscape (sketch on the back)

Distances from:

Open Water Body — feet Drainage way — feetPossible Wet Area 100+ feet Property Line — feetDrinking Water Well — feet Other —

DEEP OBSERVATION HOLE LOG

Depth from Surface (Inches)	Soil Horizon	Soil Texture (USDA)	Soil Color (Munsell)	Soil Mottling	Other (Structure, Stones, Boulders, Consistency, % Gravel)
12"	A _p	Loam	10YR 3/2		
28"	B ₀	Sandy Loam	10YR 5/6	22"	
132"	C	Sandy Loam	2.5Y 5/3		20% GRAVEL COBBLES/STONES

* MINIMUM OF 2 HOLES REQUIRED AT EVERY PROPOSED DISPOSAL AREA

Parent Material (geologic) TIll Depth to Bedrock: N/ADepth to Groundwater: Standing Water in the Hole: 108" Weeping from Pit Face: 72"Estimated Seasonal High Ground Water: 22"

Location Address or Lot No. LOT 15 MILL ST HOLLISTONOn-site ReviewDeep Hole Number 15A Date: 10/20/98 Time: AM Weather 50° Sun

Location (identify on site plan)

Land Use FIELD Slope (%) < 5 Surface Stones NOVegetation HIGH GRASSLandform TERRACE

Position on landscape (sketch on the back)

Distances from:

Open Water Body - feet Drainage way - feetPossible Wet Area 130+ feet Property Line - feetDrinking Water Well - feet Other -

DEEP OBSERVATION HOLE LOG*

Depth from Surface (Inches)	Soil Horizon	Soil Texture (USDA)	Soil Color (Munsell)	Soil Mottling	Other (Structure, Stones, Boulders, Consistency, % Gravel)
12"	A _p	Loam	10YR 3/2		
28"	B _w	Sandy Loam	10YR 5/6	220"	
50"	C ₁	Silty Loam	10YR 4/4		COBBLES / BLDERS
122"	C ₂	Sandy Loam	2.5Y 5/4		25% GRAVEL COBBLES / BLDERS

* MINIMUM OF 2 HOLES REQUIRED AT EVERY PROPOSED DISPOSAL AREA

Parent Material (geologic) TILL Depth to Bedrock: N/ADepth to Groundwater: Standing Water in the Hole 100" Weeping from Pit Face: 72"Estimated Seasonal High Ground Water: 20"

Location Address or Lot No. Lot 15 Mill St. HollistonOn-site ReviewDeep Hole Number 15B Date: 10/20/98 Time: 1M Weather 50° Sun

Location (identify on site plan)

Land Use OPEN FIELD Slope (%) <5 Surface Stones NOVegetation HIGH GRASSLandform TERRACE

Position on landscape (sketch on the back)

Distances from:

Open Water Body - feet Drainage way - feetPossible Wet Area 130+ feet Property Line - feetDrinking Water Well - feet Other -

DEEP OBSERVATION HOLE LOG*

Depth from Surface (Inches)	Soil Horizon	Soil Texture (USDA)	Soil Color (Munsell)	Soil Moisture	Other (Structure, Stones, Boulders, Consistency, % Gravel)
10"	A _p	Loam	10YR 3/2		
24"	B _w	SANDY LOAM	10YR 5/6	220"	
52"	C ₁	SILTY LOAM	10YR 4/4		
124"	C ₂	SANDY LOAM	2.5Y 5/4		15% GRAVEL COBBLES/BLDRS

* MINIMUM OF 2 HOLES REQUIRED AT EVERY PROPOSED DISPOSAL AREA

Parent Material (geologic) TILL Depth to Bedrock: N/ADepth to Groundwater: Standing Water in the Hole: 96" Weeping from Pit Face: 60"Estimated Seasonal High Ground Water: 20"

Location Address or Lot No. Lot 15 Mill St. Houston (RETEST)On-site ReviewDeep Hole Number 1 Date: 5/23/01 Time: AM Weather: 50° Sun

Location (identify on site plan)

Land Use OPEN FIELDSlope (%) <5Surface Stones NoVegetation HIGH GRASSLandform TERRACE

Position on landscape (sketch on the back)

Distances from:

Open Water Body - feet Drainage way - feetPossible Wet Area 140+ feet Property Line - feetDrinking Water Well - feet Other -

DEEP OBSERVATION HOLE LOG*

Depth from Surface (feet)	Soil Horizon	Soil Texture (USDA)	Soil Color (Munsell)	Soil Moisture	Other (Structures, Stones, Boulders, Consistency, etc., Gravel)
12	A ₁ P	Loam	10YR 3/2		
24'	B _w	SANDY LOAM	10YR 5/6		
120	C	SANDY LOAM	2.5Y 5/3	C 24"	MED-FINE 10% Cabbles Cabb/STONES

* MINIMUM OF 2 HOLES REQUIRED AT EVERY PROPOSED DISPOSAL AREA

Parent Material (geologic) TILL Depth to Bedrock N/ADepth to Groundwater Standing Water in the Hole Weeding from P. Face 100"Estimated Seasonal High Ground Water 24"

Location Address or Lot No. Lot 15 Mill St. Houston (RE-Test)On-site ReviewDeep Hole Number 2 Date: 5/23/01 Time: 4:11 Weather: 50° SW

Location (Identify on site plan)

Land Use OPEN FIELD Slope (%) <5 Surface Stones NoVegetation HIGH GRASSLandform TERRACE

Position on landscape (sketch on the back)

Distances from:

Open Water Body - feet Drainage way - feetPossible Wet Area 140+ feet Property Line - feetDrinking Water Well - feet Other -

DEEP OBSERVATION HOLE LOG*

Depth from Surface (Inches)	Soil Horizon	Soil Texture (USDA)	Soil Color (Munsell)	Soil Moisture	Other (Structure, Stones, Boulders, Consistency, etc., Gravel)
10	A _p	Loam	10YR 3/2		
24"	B _w	Sandy Loam	10YR 5/6		
				e 24"	
120"	C	SANDY Loam	2.5Y 5/3		MED-FINE 10% GRAVEL C/b/STONES

* MINIMUM OF 2 HOLES REQUIRED AT EVERY PROPOSED DISPOSAL AREA

Parent Material (geologic) TILL Depth to Bedrock 2/11Depth to Groundwater Standing Water in the Hole - Weeping from Pit Face 112"Estimated Seasonal High Ground Water 24"

FORM 12 - PERCOLATION TEST

Location Address or Lot No. LOT 15 MILL ST HOLLISTON

COMMONWEALTH OF MASSACHUSETTS

, Massachusetts

Percolation Test*		
Date: <u>5/23/01</u>		Time: _____
Observation Hole #	<u>1</u>	<u>2</u>
Depth of Perc	<u>OVERNIGHT</u> <u>36"-54"</u>	<u>OVERNIGHT</u> <u>32"/50"</u>
Start Pre-soak	<u>7:55</u>	<u>7:52</u>
End Pre-soak	<u>8:10</u>	<u>8:07</u>
Time at 12"	<u>8:10</u>	<u>8:07</u>
Time at 9"	<u>8:50</u>	<u>9:01</u>
Time at 6"	<u>10:00</u>	<u>10:25</u>
Time (9"-6")		
Rate Min./Inch	<u>24.0</u>	<u>28.0</u>

* Minimum of 1 percolation test must be performed in both the primary area AND reserve area.

Site Passed ☒ Site Failed ☐

Performed By: JOSEPH N HILL

Witnessed By: _____

Comments: _____



Location Address or Lot No. Lot 4 Mill St. HoustonOn-site ReviewDeep Hole Number 4A Date: 5/12/97 Time: AM Weather: 50° SW

Location (Identify on site plan)

Land Use OPEN FIELD Slope (%) <5 Surface Stones NoVegetation HIGH GRASSLandform TERRACE

Position on landscape (sketch on the back)

Distances from:

Open Water Body - feet: Drainage way - feet:Possible Wet Area 140+ feet: Property Line - feet:Drinking Water Well - feet: Other -

DEEP OBSERVATION HOLE LOG*

Depth from Surface (inches)	Soil Horizon	Soil Texture (USDA)	So. Color (Munsell)	So. Moisture	Other: (Stratified Stones, Boulders, Consistency, etc. Gravel)
10"	A _p	Loam	10YR 2/2		
24"	B _w	SANDY LOAM	10YR 5/6		
120"	C	SANDY LOAM	2.5Y 5/3	© 24"	20% GRAVEL w/ cobbles

* MINIMUM OF 2 HOLES REQUIRED AT EVERY PROPOSED DISPOSAL AREA

Parent Material (geologic) TILL Depth to Bedrock N/ADepth to Groundwater: Standing Water in the Hole - Weeding from Pit Edge 28"Estimated Seasonal High Ground Water 24"

Location Address or Lot no: LOT 4 Mill St. HoustonOn-site ReviewDeep Hole Number: 4B Date: 5/12/97 Time: 4:11 Weather: 50° SW

Location (identify on site plan):

Land Use: OPEN FIELD Slope (%): <5 Surface Stones: NoVegetation: HIGH GRASSLandform: TERRACE

Position on landscape (sketch on the back)

Distances from:

Open Water Body: - feet Drainage way: - feetPossible Wet Area: 140+ feet Property Line: - feetDrinking Water Well: - feet Other: -

DEEP OBSERVATION HOLE LOG*

Depth from Surface (inches)	Soil Horizon	Soil Texture (USDA)	Soil Color (Munsell)	Soil Moisture	Other (Structure, Stones, Boulders, Consistency, etc. Grave)
10"	A _p	Loam	10YR 3/3		
24"	B _w	Sandy Loam	10YR 5/6		
				~ 24"	
132"	C	Sandy Loam	2.5Y 5/2		20% GRAVEL w/ Cabbles

* MINIMUM OF 2 HOLES REQUIRED AT EVERY PROPOSED DISPOSAL AREA

Parent Material (geology): CLL Depth to Bedrock: N/ADepth to Groundwater: Standing Water in the Hole: - Weeping from Base: 32"Estimated Seasonal High Ground Water: 24"

Location Address or Lot No. LOT 4 Mill St. HoustonOn-site ReviewHSE HoleDeep Hole Number: 4C Date: 5/12/97 Time: 11:1 Weather: 50° Sun

Location (identify on site plan)

Land Use OPEN FIELDSlope (%) <5 Surface Stones NoVegetation HIGH GRASSLandform TERRACE

Position on landscape (sketch on the back)

Distances from:

Open Water Body - feet Drainage way - feetPossible Wet Area 140 + feet Property Line - feetDrinking Water Well - feet Other -

DEEP OBSERVATION HOLE LOG*

Depth from Surface (Inches)	Soil Horizon	Soil Texture (USDA)	Soil Color (Munsell)	Soil Moisture	Other (Structural Stones, Boulders, Concretions, etc. Grave)
<u>10</u>	<u>A_p</u>	<u>Loam</u>	<u>10YR 3/3</u>		
<u>20"</u>	<u>B_w</u>	<u>SANDY LOAM</u>	<u>10YR 5/6</u>		
				<u>C 24"</u>	
<u>120"</u>	<u>C</u>	<u>SANDY LOAM</u>	<u>2.5Y 5/2</u>		

* MINIMUM OF 2 HOLES REQUIRED AT EVERY PROPOSED DISPOSAL AREA

Parent Material (geologic) TILL Depth to Bedrock N/ADepth to Groundwater Standing Water in the hole - Weeding from Pit Face 24"Estimated Seasonal High Ground Water 24"

TDA APPROVED FORM #11-07-01

FORM 12 - PERCOLATION TEST

Location Address or Lot No. LOT 4 MILL ST HOLLISTON

COMMONWEALTH OF MASSACHUSETTS
, Massachusetts

Percolation Test*		
Date: 9/10/97		Time:
Observation Hole #	1 ^{OVERNIGHT}	2 ^{OVERNIGHT}
Depth of Perc	44"	40"
Start Pre-soak	2:07 8:07	8:10
End Pre-soak	8:22	8:26
Time at 12"	8:22	8:26
Time at 9"	9:05	8:57
Time at 6"	10:14	9:50
Time (9"-6")		
Rate Min./Inch	25.0	18.0

* Minimum of 1 percolation test must be performed in both the primary area AND reserve area.

Site Passed ☒ Site Failed ☐

Performed By: JOSEPH NICHIL

Witnessed By: _____

Comments: _____



Location Address or Lot No. LOT 3 Mill St. HOLLISTONOn-site ReviewDeep Hole Number 3A Date: 5/12/97 Time: AM Weather: 52° Sun

Location (identify on site plan)

Land Use OPEN FIELDSlope (%) <5 Surface Stones NoVegetation HIGH GRASSLandform TERRACE

Position on landscape (sketch on the back)

Distances from:

Open Water Body - feet: Drainage way - feet:Possible Wet Area 140+ feet: Property Line - feet:Drinking Water Well - feet: Other -

DEEP OBSERVATION HOLE LOG*

Depth from Surface (inches)	Soil Horizon	Soil Texture (USDA)	So. Color (Munsell)	So. Moisture	Other (Structures, Stones, Boulders, Cans, stumps, etc. Grave)
12"	A _p	Loam	10YR 3/3		
28"	B _w	SANDY Loam	10YR 5/6		
				32"	
134"	C	SANDY Loam	2.5Y 5/2		POCKETS OF COARSE GRMEL

* MINIMUM OF 2 HOLES REQUIRED AT EVERY PROPOSED DISPOSAL AREA

Parent Material (geologic) TILL Depth to Bedrock N/ADepth to Groundwater: Standing Water in the Hole - Weeping from Pit Face 96"Estimated Seasonal High Ground Water 32"

Location Address or Lot No. LOT 3 Mill St HOUSTONOn-site ReviewDeep Hole Number 3B Date: 5/12/97 Time: AM Weather: 50° SW

Location (Identify on site plan):

Land Use OPEN FIELD Slope (%) <5 Surface Stones NoVegetation HIW GRASSLandform TERRACE

Position on landscape (sketch on the back)

Distances from:

Open Water Body - feet Drainage way - feetPossible Wet Area 140+ feet Property Line - feetDrinking Water Well - feet Other -DEEP OBSERVATION HOLE LOG¹

Depth from Surface (inches)	Soil Horizon	Soil Texture (USDA)	Soil Color (Munsie)	Soil Moisture	Other (Structures, Stones, Boulders, Concretes, etc., Grave)
10"	A _p	Loam	10YR 3/3		
24"	B _w	SANDY LOAM	10YR 5/6		
				0 32"	
128"	C	SANDY LOAM	2.5Y 5/3		Pockets of FINE SAND

¹ MINIMUM OF 2 HOLES REQUIRED AT EVERY PROPOSED DISPOSAL AREAParent Material (geologic) TILL Depth to Bedrock N/ADepth to Groundwater Standing Water in the Hole - Weeding from P. Page 64"Estimated Seasonal High Ground Water 32"

Location Address or Lot No. LOT 3 Mill St. HoustonOn-site Review

HOUSE HOLE

Deep Hole Number 3E Date: 5/12/97 Time: AM Weather: 50° Sun

Location (identify on site plan)

Land Use OPEN FIELD Slope (%) <5 Surface Stones NoVegetation HIGH GRASSLandform TERRACE

Position on landscape (sketch on the back)

Distances from:

Open Water Body - feet Drainage way - feetPossible Wet Area 140+ feet Property Line - feetDrinking Water Well - feet Other -

DEEP OBSERVATION HOLE LOG

Depth from Surface (inches)	Soil Horizon	Soil Texture (USDA)	Soil Color (Munsell)	Soil Moisture	Other (Structural Stones, Boulders, Consistency, etc.)
12"	A _p	Loam	10YR 4/3		
36"	B _w	Sandy Loam	10YR 5/6		
				28"	
132"	C ₁	SANDY LOAM	2.5Y 5/2		

* MINIMUM OF 2 HOLES REQUIRED AT EACH PROPOSED DISPOSAL AREA

Parent Material (geologic) TILL Depth to Bedrock N/ADepth to Groundwater: Standing Water in the hole - Weeping from Pit/Pipe 7E"Estimated Seasonal High Ground Water 28"

FORM 12 - PERCOLATION TEST

Location Address or Lot No. LOT 3 MILL ST HOLLISTON

COMMONWEALTH OF MASSACHUSETTS

, Massachusetts

Percolation Test*		
Date:		Time:
Observation Hole #	1	2
Depth of Perc	44"	44"
Start Pre-soak	12:55	1:52
End Pre-soak	1:11	2:07
Time at 12"	1:11	2:07
Time at 9"	1:18	2:26
Time at 6"	1:28	2:54
Time (9"-6")		
Rate Min./Inch	4.0	10.0

* Minimum of 1 percolation test must be performed in both the primary area AND reserve area.

Site Passed ☒ Site Failed ☐

Performed By: JOSEPH N. HILL

Witnessed By: _____

Comments: _____



APPENDIX – G

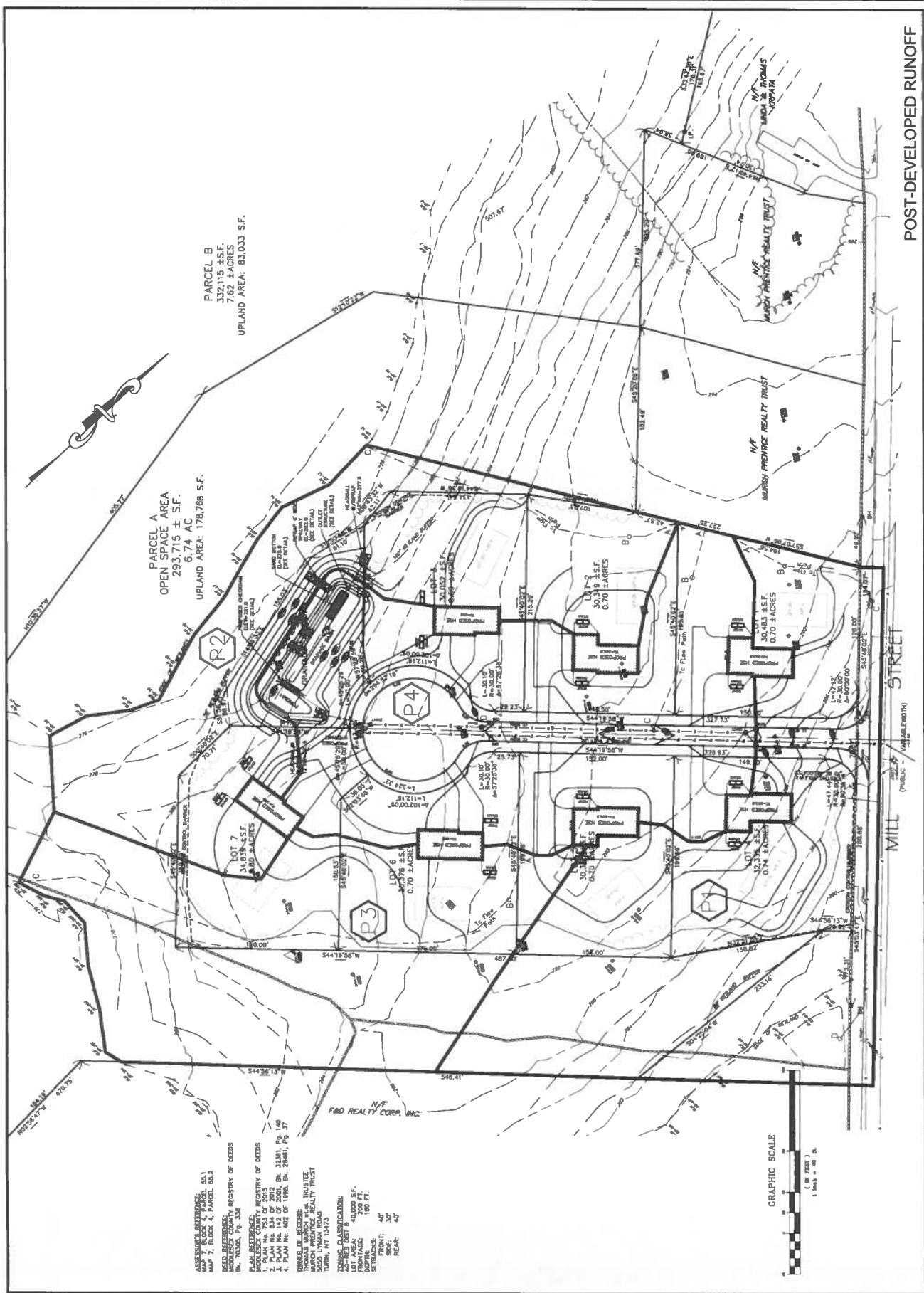
Supplemental Stormwater Plans

Pre-Development Subcatchment Areas

Post-Development Subcatchment Areas

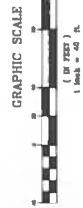
Hydraulic Subcatchment Areas

DEFINITIVE OPEN SPACE SUBDIVISION	REVISIONS	DATE	NO.
A 7 LOT SINGLE FAMILY SUBDIVISION			
TRIANGLE FARM			
WALPOLE, MASSACHUSETTS			
PREPARED FOR:			
MURCH MURCH & TRUSTEE			
5855 LYMAN ROAD			
TUFTS, MA 01474			
GLM Engineering Inc.			
18 EXCHANGE STREET			
HOLLISTON, MA 01746			
P: 508-428-1100			
F: 508-428-7180			
www.glmengineering.com			
JOB NO. 770DEF			
DATE MAY 8, 2020			
SCALE 1"=40'			
SHEET 2 of 3			
PLAN # 27.404			



POST-DEVELOPED RUNOFF

MILL STREET



ASSESSOR'S REFERENCE:
MAP 7, BLOCK 4, PARCEL 55.1
MAP 7, BLOCK 4, PARCEL 55.1
MASSACHUSETTS DEPARTMENT OF REVENUE
Bk. 71300, Pg. 336

PLAN REFERENCE:
1. PLAN No. 783 OF 2012 Bk. 32481, Pg. 140
2. PLAN No. 834 OF 2012 Bk. 32481, Pg. 140
3. PLAN No. 402 OF 1988 Bk. 28481, Pg. 37
4. PLAN No. 402 OF 1988 Bk. 28481, Pg. 37

OWNER OF RECORD:
THOMAS MURCH & TRUSTEE
5855 LYMAN ROAD
TUFTS, MA 01474

ZONING CLASSIFICATION:
R-1
LOT AREA: 43,000 S.F.
LOT AREA: 100 FT.
DEPTH: 100 FT.
SETBACKS: 40'
SIDE: 40'
REAR: 40'

