Stormwater Report

Greenmont Commons
Dracut, MA

Prepared for

Riverbank Properties
908 Lawrence Street
Lowell, MA 01852

May 18, 2023

REVISED February 28, 2025

Cornerstone Land Associates, LLC
Civil & Structural Engineering • Permitting
Land Surveying • Land Development & Planning
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Forward

This Stormwater Report is required by the Massachusetts Wetland Protection Act (MGL Ch. 131, Sect. 40); provisions of the Mass DEP Stormwater Management Standards per 310 CMR 10.05(6)(k)-(q); and the Town of Dracut General By Laws Chapter 24 and Town of Dracut Stormwater Management Rules and Regulations.

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SECTION 1: SITE & CONTACT DATA

1.1 Project & Site Information

Project/Site Name: Greenmont Commons
Project Street/Location: 135 Greenmont Avenue
City: Dracut State: MA ZIP Code: 01826
County or Similar Subdivision:
Applicant Name: Riverbank Properties
Applicant Address: 908 Lawrence Street City: Lowell State: MA ZIP Code: 01852

1.2 Applicant Information

Name: Riverbank Properties
Address: 908 Lawrence Street City: Lowell State: MA ZIP Code: 01852
Contact: Branco Perego Phone: (978) 771-3205

1.3 Preparer Information

Name: Kenneth M. Lania, E.I.T., Cornerstone Land Associates, LLC.
Address: 25 Dean Avenue City: Dracut State: MA ZIP Code: 01826
Registered P.E.: John A. Visniewski, P.E. Email: kmconsultants@comcast.net
Phone: (978) 835-0102 Fax:

1.4 Project Type

Scope of Work: Development of an existing vacant lot including retaining walls, drainage, utilities, and parking lot.
Function: ☒ Residential ☐ Commercial ☐ Industrial ☐ Other:
☒ New ☐ Redevelopment ☐ Industrial ☐ Mix of New & Redevelopment
Estimated Start Date.: Upon Approvals Estimated Completion Date: September 2024

1.5 Drainage Narrative

The proposed project has been revised to construct 26 Townhouse Rental Units on the 2.45 Acre parcel utilizing the State's Comprehensive Permit Statute (M.G.L. c. 40B, Sections 20-23 enacted as Chapter 774 of the Acts of 1969) known as "Chapter 40B". The property is rectangle in shape with 240 LF of frontage along Greenmont Avenue and a depth of approximately 430 LF from the road. The property contains one single family dwelling located approximately 85 ft from Greenmont Avenue with associated driveway, rear deck and patio, as well as an in-ground

pool with concrete apron. The remainder of the property is a well established lawn with Bordering Vegetated Wetlands (BVW) in the southwestern corner of the property. The BVW was established on the property with flagging and is shown as WF-1 to WF-7. The majority of the property, approximately 2.22 acres, drains from north to south to the existing BVW area with the remainder 0.23 acres draining to Greenmont Avenue.

The proposed conditions utilize a Closed Drainage System with both underground and above ground techniques to mimic the existing drainage patterns. Four proposed Deep Sump Hooded Catch Basins are utilized to collect all of the impervious stormwater flow on site. The stormwater is then directed to an alternative technology sediment removal Vortechnics 2000 & 3000 Hydrodynamic Separator's to achieve pretreatment for the overall Total Suspended Solids removal. The stormwater then enters the underground 30" ADS Detention Area for storage and mitigation of the Peak Flow and delay the runoff to minimize the amount of additional stormwater volume leaving the property. Stormwater then exits this system and enters into a Constructed Stormwater Wetland Extended Detention Wet Basin system. First, stormwater is passed into a Sedimentation Forebay for additional removal of pollutants that may pass through the underground closed pipe system. The Sedimentation Forebay then overflows into a Wet Basin that completes the cleaning of the stormwater and allows the clean stormwater to enter into the wetlands at the rear of the parcel with a reduction of Peak Flow for all storm events, 2 year to 100 year. There is a small volume increase in each storm event leaving the property and an analysis was completed to determine if the additional volume over a 24 hour period would have an effect on offsite flooding or increase in standing water within the Neighborhood Wetlands Area. It was determined upon analysis,that this additional volume will not result in the increase of the elevation of the offsite Neighborhood Wetlands Area.

SECTION 2: STORMWATER CHECKLIST

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

Checklist for Stormwater Report

A. Introduction

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

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

The Stormwater Report must include:

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

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

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

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

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

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

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

Checklist for Stormwater Report

B. Stormwater Checklist and Certification

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

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

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

Registered Professional Engineer's Certification

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

Registered Professional Engineer Block and Signature

2/28/25

Signature and Date

Checklist

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

- [x] 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 Field[1]
- ☐ Runoff from all impervious areas at the site discharging to the infiltration BMP.
- ☐ Runoff from all impervious areas at the site is *not* discharging to the infiltration BMP and calculations are provided showing that the drainage area contributing runoff to the infiltration BMPs is sufficient to generate the required recharge volume.
- ☐ Recharge BMPs have been sized to infiltrate the Required Recharge Volume.
- ☑ Recharge BMPs have been sized to infiltrate the Required Recharge Volume *only* to the maximum extent practicable for the following reason:
  - ☑ Site is comprised solely of C and D soils and/or bedrock at the land surface
  - ☐ M.G.L. c. 21E sites pursuant to 310 CMR 40.0000
  - ☐ Solid Waste Landfill pursuant to 310 CMR 19.000
  - ☐ Project is otherwise subject to Stormwater Management Standards only to the maximum extent practicable.
- ☐ Calculations showing that the infiltration BMPs will drain in 72 hours are provided.
- ☐ Property includes a M.G.L. c. 21E site or a solid waste landfill and a mounding analysis is included.

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

Checklist 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.

SECTION 3: LOW IMPACT DEVELOPMENT (LID)

Credits for LID have not been taken since the site does not comply with certain aspects of each credit item required. However, small portions of LID practices have been incorporated into the overall design. These practices are small in nature and include the utilization of Sheet Flow and a combination of multiple Best Management Practices for stormwater treatment of the entire proposed impervious surface up to and including the 100 Year Storm event to promote the use of Rain Gardens and Underground Chamber Systems for infiltration to groundwater and pollutant removal.

SECTION 4: STORMWATER STANDARDS

4.1 Standard 1: No New Untreated Discharges

New stormwater conveyances (e.g. outfalls) will not discharge untreated stormwater directly to or cause erosion in wetlands or waters of the Commonwealth.

Rip Rap Sizing at Spillways

Stormwater calculations utilizing a closed drainage system for Stormwater collection throughout the development areas attenuates the Peak Flow for all storm events 2 yr to 100 yr.

The design utilizes a Sedimentation Basin with an overflow to a Wet Basin to promote as much infiltration of runoff back into the ground as possible. Proposed flow in large storm events travels to the Underground ADS Pipe Detention Basin then into an outlet Sedimentation & Wet Basin system that utilizes stone lined spillways for outlet protection of flow leaving the property.

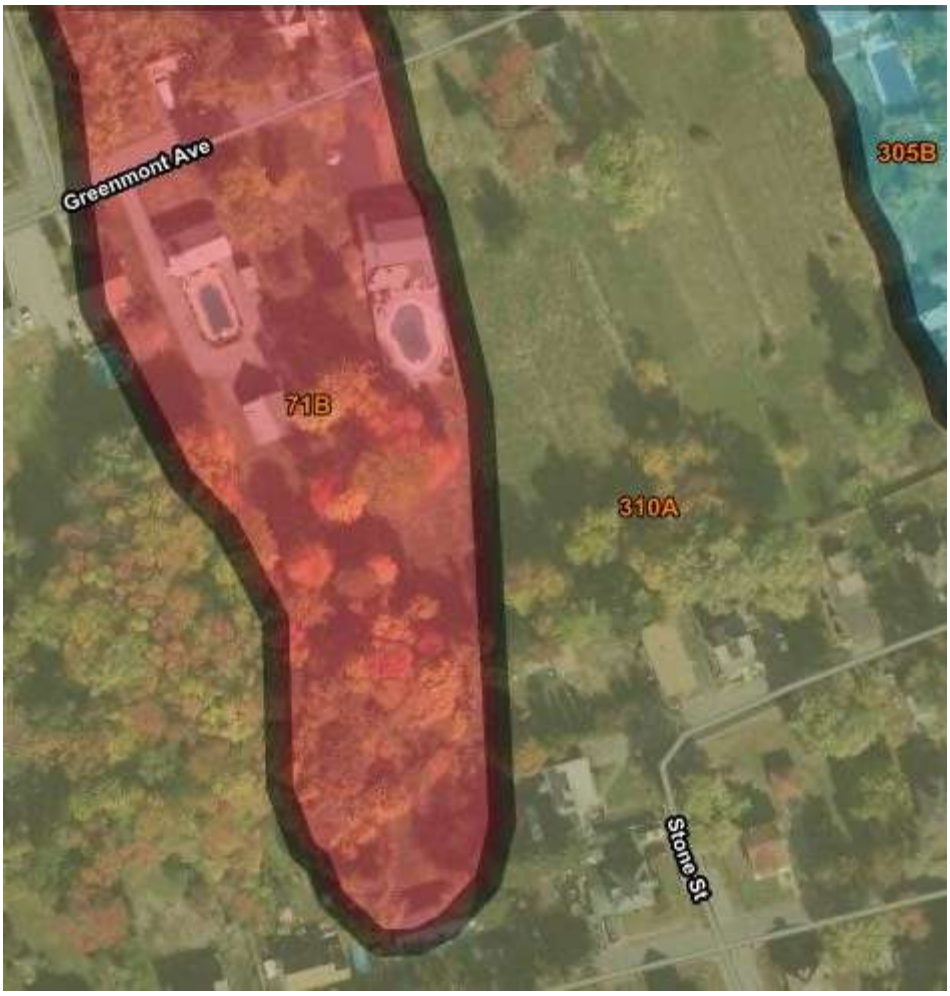
Maximum velocity of flow leaving both the Sedimentation Forebay and the Wet Basin in the 100 Year Storm Event is less than 2 fps. Utilizing this velocity it has been determined that the rip rap sizing of 6-12" D50 size stones would be sufficient.

4.2 Standard 2: Peak Rate Attenuation

Stormwater management systems have been designed so that the post-development peak discharge rates do not exceed pre-development peak discharge rates.

Soils Evaluation

Soils on the site are classified on the USDA Natural Resources Conservation Service (NRCS) Soil Map that is shown below as an overlay on the MASS GIS Aerial Photography with NRCS Soils Overlay Layer. These soil classifications have been further assigned to Hydraulic Soil Groups (HSG) by the NRCS as shown on the map. Hydraulic soil groups range from A, sandy soils, to D, clayey soils.



Hydrologic Soil Group

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
71B	Ridgebury fine sandy loam, 3 to 8 percent slopes, extremely stony	D	3.5	26.3%
305B	Paxton fine sandy loam, 3 to 8 percent slopes	C	0.5	3.9%
310A	Woodbridge fine sandy loam, 0 to 3 percent slopes	C/D	9.2	69.8%
Totals for Area of Interest			**13.2**	**100.0%**

Soils have also been evaluated in the field as shown in the following table; and soil logs are also shown on the Grading & Drainage Plan. The table shows the textural classification in each location according to direct field observation. The Estimated Seasonal High Groundwater (ESHGW) depth was determined by field observation of redoximorphic features (mottles) within the soil profile. The Rawls Rate assigned to various Hydraulic Soil Groups and textural types is used for calculations relative to exfiltration of stormwater into subsurface soils within stormwater storage facilities. In addition, soil samples were taken and sent to a soils laboratory for analysis of particle size and permeability.

Soil Evaluation

ON-SITE SOILS EVALUATION

Deep Hole Number [1.]	Textural Classification [2.]	HSG [3.]	Depth to Refusal (ft)	ESHGW [4.] (in)	Rawls Rate (in/hr) [5.]	Laboratory Results (in/hr) [6.]
TP#1	SL	D	n/a	34	0.09	0.44
TP#2	SL	D	n/a	32	0.09	0.11
TP#3	SL	C/D	n/a	36	0.27	1.08
TP#4	SL	C/D	n/a	38	0.27	

[1.] See Site Plan for deep hole locations

[2.] Laboratory soil analysis; otherwise field observation

[3.] Hydraulic Soil Group; USDA NRCS

[4.] Estimated seasonal high groundwater depth

[5.] DEP Stormwater Handbook, Table 2.3.3.

[6.] Laboratory permeability analysis per DEP Stormwater Handbook Vol. 3 Chap. 1

USDA Soils Description

Map Unit #	Soil Name	HSG
71B	Ridgebury fine sandy loam	D
310A	Woodbridge fine sandy loam	D

The following Table shows land areas associated with the hydraulic soil group for each type of ground coverage within each drainage area. Hydraulic Soil Group designations are shown as provided by the NRCS for the soil types found on this site. Curve Number (CN) values have been assigned based on the ground cover type and condition, and HSG. The curve number values are weighted according to NRCS criteria and used in the calculations for peak rate attenuation provided in Appendix C. The Pre-Development and Post-Development Drainage Maps provided in Appendix C show the relationship between the drainage areas and surface cover types.

PRE-DEVELOPMENT

Drainage Area 1S - DP#1-GREENMONT

	Hydraulic Soils Group (HSG) Area (sf) & Curve Number (CN)							
Surface Description	A	CN	B	CN	C	CN	D	CN
Roofs							981	98
Paved Parking							2,843	98
Grass > 75% Cover Good							2,107	80
Grass > 75% Cover Good							4,478	80
Subtotal Area							*10,409*	
Total Area							***10,409***	***87***

Drainage Area 2S - DP#2-EX WETLANDS AREA OUTLET

	Hydraulic Soils Group (HSG) Area (sf) & Curve Number (CN)							
Surface Description	A	CN	B	CN	C	CN	D	CN
1/2 Acre Lots							355,744	85
Subtotal Area					-		*355,744*	
Total Area							***355,744***	***85***

POST-DEVELOPMENT

Drainage Area 4S - DP#1-GREENMONT

	Hydraulic Soils Group (HSG) Area (sf) & Curve Number (CN)							
Surface Description	A	CN	B	CN	C	CN	D	CN
Roofs							3,362	98
Grass >75% Cover Good							5,908	80
Subtotal Area							*9,270*	
Total Area							***9,270***	***87***

Drainage Area 1S - DP#2-REAR WETLANDS

	Hydraulic Soils Group (HSG) Area (sf) & Curve Number (CN)							
Surface Description	A	CN	B	CN	C	CN	D	CN
Roofs							2,814	98
Paved Parking, HSG D							3,640	98
Walkways							380	98
Grass > 75% Cover Good							2,475	80
Subtotal					-			

	Area						*9,309*	
	Total Area						***9,309***	***93***

Drainage Area 3S - DP#2-REAR WETLANDS

	Hydraulic Soils Group (HSG) Area (sf) & Curve Number (CN)							
Surface Description	A	CN	B	CN	C	CN	D	CN
Roofs							2,936	98
Paved Parking, HSG D							3,906	98
Walkways							380	98
Grass >75% Cover Good							3,078	80
Subtotal Area					-		*10,300*	
Total Area							***10,300***	***93***

Drainage Area 7S - DP#2-REAR WETLANDS

	Hydraulic Soils Group (HSG) Area (sf) & Curve Number (CN)							
Surface Description	A	CN	B	CN	C	CN	D	CN
Roofs							5,946	98
Paved Parking, HSG D							6,527	98
Walkways							140	98
Patios							1,962	98
Grass >75% Cover Good							8,346	80
Subtotal Area							*22,921*	
Total Area							***22,921***	***91***

Drainage Area 8S - DP#2-REAR WETLANDS

	Hydraulic Soils Group (HSG) Area (sf) & Curve Number (CN)							
Surface Description	A	CN	B	CN	C	CN	D	CN
Roofs							5,760	98
Paved Parking, HSG D							6,532	98
Walkways							140	98
Patios							1,962	98
Grass >75% Cover Good							9,729	80
Subtotal Area							*24,123*	

Total Area	***24,123***	***91***

Drainage Area 5S - DP#2-REAR WETLANDS

Hydraulic Soils Group (HSG) Area (sf) & Curve Number (CN)

Surface Description	A	CN	B	CN	C	CN	D	CN
Roofs							2,025	98
Patios							1,160	98
Grass >75% Cover Good							5,671	80
Subtotal Area							*8,856*	
Total Area							***8,856***	***86***

Drainage Area 36S - DP#2-REAR WETLANDS

Hydraulic Soils Group (HSG) Area (sf) & Curve Number (CN)

Surface Description	A	CN	B	CN	C	CN	D	CN
Grass >75% Cover Good							3,120	80
Wet Basin Water Surface							4,215	98
Subtotal Area							*7,335*	
Total Area							***7,335***	***90***

Drainage Area 6S - DP#2-REAR WETLANDS

Hydraulic Soils Group (HSG) Area (sf) & Curve Number (CN)

Surface Description	A	CN	B	CN	C	CN	D	CN
Grass >75% Cover Good							14,183	80
Subtotal Area							*14,183*	
Total Area							***14,183***	***80***

Drainage Area 11S - DP#2-REAR WETLANDS

Hydraulic Soils Group (HSG) Area (sf) & Curve Number (CN)

Surface Description	A	CN	B	CN	C	CN	D	CN
Sediment Forebay Water Surface							1,741	98
Subtotal Area							*1,741*	
Total Area							***1,741***	***98***

Drainage Area 4S - DP#2-REAR WETLANDS

Hydraulic Soils Group (HSG) Area (sf) & Curve Number (CN)

Surface Description	A	CN	B	CN	C	CN	D	CN
1/2 Acre Lots							248,148	85
Subtotal Area							*248,148*	
Total Area							***248,148***	***85***

Peak Flow Rate Attenuation

Once the soils and drainage areas were analyzed and classified, a detailed hydrologic analysis was performed in accordance with the NRCS Technical Release 55 (TR-55) by using the HydroCAD® Stormwater Modeling System. The following tables represent a summary and comparison of the flow and volume between the pre-development and the post-development conditions. The comparison shows that there will be a net decrease in the Peak Flow and Peak Volume of stormwater runoff from the site entering the Greenmont Avenue closed drainage system at Design Point #1 (DP#1) and there will be a decrease in Peak Flow to the Rear Neighborhood Wetlands Area (DP#2).

Based on meetings with the Dracut Zoning Board of Appeals and the Dracut Conservation Commission, the applicant was tasked with utilizing the Cornell Extreme Precipitation Rain Fall Data to determine if the proposed Closed Drainage System could function appropriately with the greater rainfall amounts compared to TP-40. As a result of the increase in the rainfall amounts, the Underground Pipe Detention System was increased in size from 30” piping to 36” piping.

The comparison also shows that there will be an overall increase in Peak Volume entering the Rear Neighborhood Wetlands Area. Due to concern from the Dracut Zoning Board of Appeals, Dracut Conservation Commission, and the Town of Dracut Peer Review Engineer, our office modeled the entire neighborhood area that contributes to the Rear Neighborhood Wetlands Area to determine if the Peak Volume increase from the project would have any adverse flooding effects or wetlands elevation increase utilizing the Cornell Extreme Precipitation rainfall data. Upon review, the model shows that the increased volume from the projects Closed Drainage System will not increase the elevations within the Neighborhood Wetlands Area for any of the storm events analyzed. The detailed HydroCAD analysis is provided in Appendix C.

Standard 2: Peak Rate Attenuation

Summary of Pre- and Post-Development Peak Flow Rates

PRE-DEVELOPMENT (Existing Conditions)

Type III Storm Event:	**100-yr**	**25-yr**	**10-yr**	**2-yr**
Rainfall (in/24 hr):	8.41	5.86	4.62	3.05
FLOW TO GREENMONT AVENUE				
Flow Rate (cfs):	1.34	1.06	0.86	0.54
Volume (acre-ft):	0.092	0.072	0.058	0.036

PRE-DEVELOPMENT (Existing Conditions)

Type III Storm Event:	**100-yr**	**25-yr**	**10-yr**	**2-yr**
Rainfall (in/24 hr):	8.41	5.86	4.62	3.05
FLOW TO SPRING PARK AVENUE DRAINAGE SYSTEM				

Flow Rate (cfs):	9.37	5.89	8.80	3.95
Volume (acre-ft):	4.412	2.763	1.987	1.058
Wetland Elevation	**153.63**	**153.11**	**152.74**	**152.09**

POST-DEVELOPMENT (Proposed Conditions)				
Type III Storm Event:	**100-yr**	**25-yr**	**10-yr**	**2-yr**
Rainfall (in/24 hr):	8.41	5.86	4.62	3.05
FLOW TO GREENMONT AVENUE				
Flow Rate (cfs):	1.07	0.85	0.69	0.43
Volume (acre-ft):	0.087	0.068	0.055	0.034

POST-DEVELOPMENT (Proposed Conditions)				
Type III Storm Event:	**100-yr**	**25-yr**	**10-yr**	**2-yr**
Rainfall (in/24 hr):	8.41	5.86	4.62	3.05
FLOW TO SPRING PARK AVENUE DRAINAGE SYSTEM				
Flow Rate (cfs):	8.88	5.06	4.63	3.80
Volume (acre-ft):	4.614	2.939	2.145	1.182
Wetland Elevation	**153.52**	**152.96**	**152.60**	**151.99**

PRE & POST DEVELOPMENT COMPARISON				
Type III Storm Event:	**100-yr**	**25-yr**	**10-yr**	**2-yr**
Rainfall (in/24 hr):	8.41	5.86	4.62	3.05
TOTAL FLOW TO GREENMONT AVENUE				
Flow Rate (cfs):	**-0.27**	**-0.21**	**-0.17**	**-0.11**
Volume (acre-ft):	**-0.005**	**-0.004**	**-0.003**	**-0.002**

PRE & POST DEVELOPMENT COMPARISON				
Type III Storm Event:	**100-yr**	**25-yr**	**10-yr**	**2-yr**
Rainfall (in/24 hr):	8.41	5.86	4.62	3.05
TOTAL FLOW TO SPRING PARK AVENUE DRAINAGE SYSTEM				
Flow Rate (cfs):	**-0.49**	**-0.83**	**-4.17**	**-0.15**
Volume (acre-ft):	**0.202**	**0.176**	**0.158**	**0.124**
Elevation Change	**-0.11**	**-0.15**	**-0.14**	**-0.10**

4.3 Standard 3: Recharge

Loss of annual recharge to groundwater has been eliminated or minimized by recharging runoff.

Recharge Volume

RECHARGE VOLUME REQUIRED

Upon agreement with the Town of Dracut's Peer Review Engineer, GCG, it has been determined that this particular site is not conducive for groundwater recharge due to the restrictions within the existing soil profile. Therefore the current design meets the recharge requirement to the Maximum Extent Pracitcalbe (MEP).

As a result, the proposed project will allow all of the roof gutter systems to discharge into the newly created landscape areas within the property. The goal here is to introduce recharge into the soils as best as can be accomplished and should the roof runoff not infiltrate due to the soils, the stormwater flow will then enter into the newly installed project's Closed Drainage System.

Questions have been raised by GCG as to the ability for this project to meet this standard and has stated that the project standard can only be met to the Maximum Extent Practibable which includes the reduction in the number of units or the total amount of impervious surface. To meet this standard as outlined by GCG, the project has been reduced in the number of units from the original proposal of 28 Units in an all Town House design to 26 units including 4 duplex units and 18 Town House units and that the proposed drainage system, although increasing the volume leaving the property and entering the existing Neighborhood Wetlands Area at the rear of the property, will have no downstream flooding effects.

Total Suspended Solids (TSS)

TSS TO BE REMOVED

Stormwater management systems have been designed to remove 93% of the average annual post-construction load of Total Suspended Solids (TSS) as shown in the Treatment Train Forms Attached.

4.5 Standard 5: Higher Potential Pollutant Loads

Land Uses with Higher Potential Pollution Loads (LUHPPL) will include source controls and pollution prevention Proprietary Best Management Practices (BMPS) to ensure that the discharge of stormwater runoff from the impervious areas are treated to meet the Standard prior to conveyance to Infiltration BMPS. The project does not classify as a LUHPPL.

4.6 Standard 6: Critical Areas

Stormwater discharges to critical areas will utilize source controls, pollution prevention measures and approved Best Management Practices (BMP's). There are no stormwater discharges within the Zone II, Interim Wellhead Protection Areas of a public water supply or near an Outstanding Resource Water (ORW) or cold water fishery

4.7 Standard 7: Redevelopment

The project is proposed as new development due to the separation of the lots. An overall decrease in impervious area is proposed within the developed portion of the two lots.

4.8 Standard 8: Construction Period Controls

A plan to control construction-related impacts including erosion, sedimentation and other pollutant sources during construction has been developed.

Erosion Control Plan

An Erosion Control Plan has been provided within the Site Plan Set

Stormwater Pollution Prevention Plan

A National Pollution Discharge Elimination System (NPDES) Construction General Permit (CGP) is required for this project. CGP applications are required to be developed and submitted by the Owner/Applicant/Contractor seven (30) days prior to the commencement of construction. Due to the complex nature of this project, the Owner/Applicant will coordinate with this office and the selected contractor for the project to complete the application filing. The application, when filed, will contain a Stormwater Pollution Prevention Plan that will be kept on site and reviewed and updated weekly. The application shall be completed and submitted to the Town of Dracut Zoning Board of Appeals and Conservation Commission thirty (45-60) days prior to the commencement of construction for review.

4.9 Standard 9: Operation & Maintenance

A long term operation and maintenance plan has been developed to insure that the stormwater management systems function as designed.

Operation & Maintenance Manual

An Operation and Maintenance Manual has been provided under separate cover.

4.10 Standard 10: Illicit Discharges

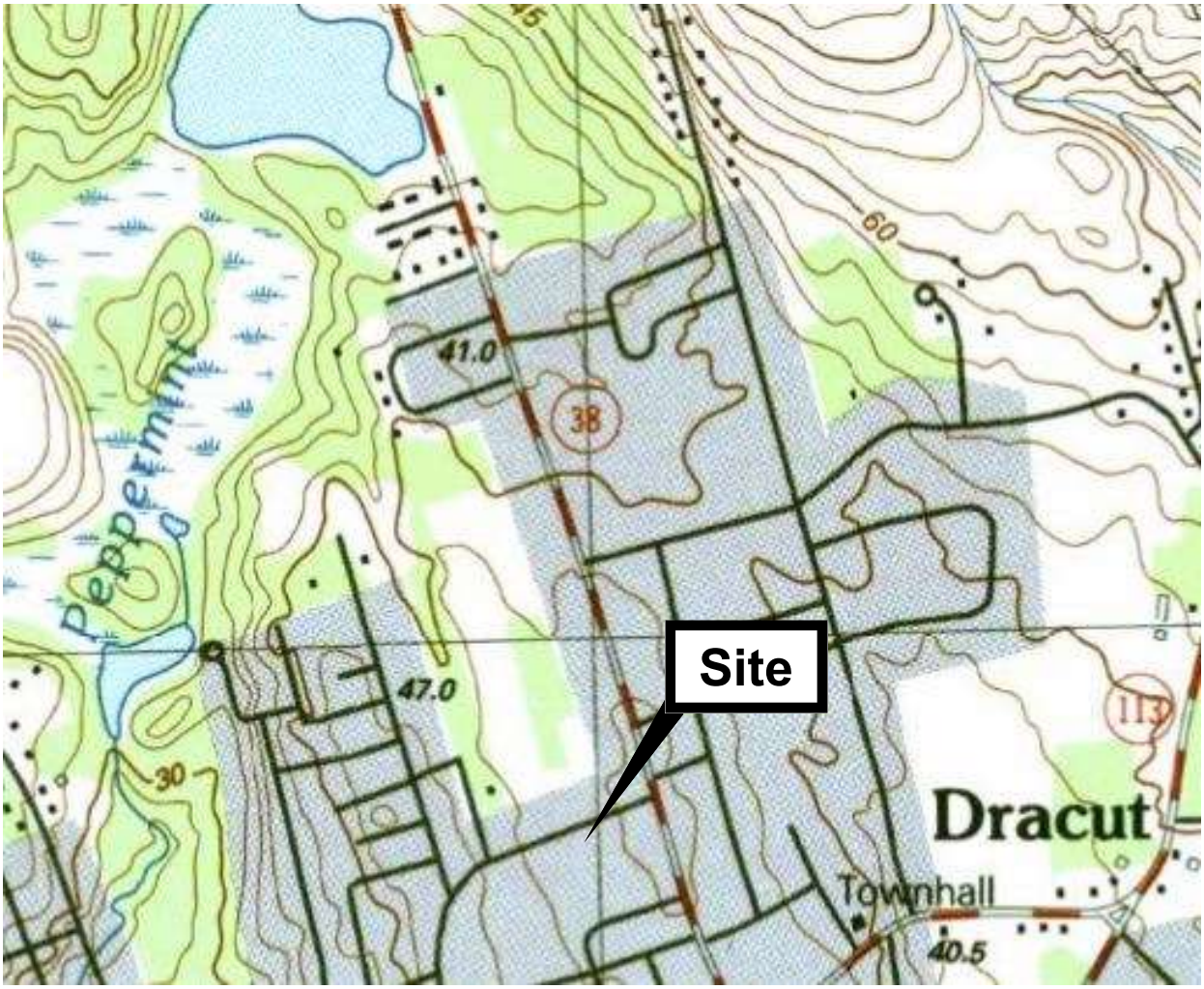
There are no known current illicit discharges of wastewater, stormwater contaminated with process wastes, raw materials, toxic pollutants, hazardous substances, oil or grease from the site. The discharge of any of these illicit materials is prohibited from the proposed stormwater management system.

APPENDICES

Appendix A: Background Data

USGS Locus Map

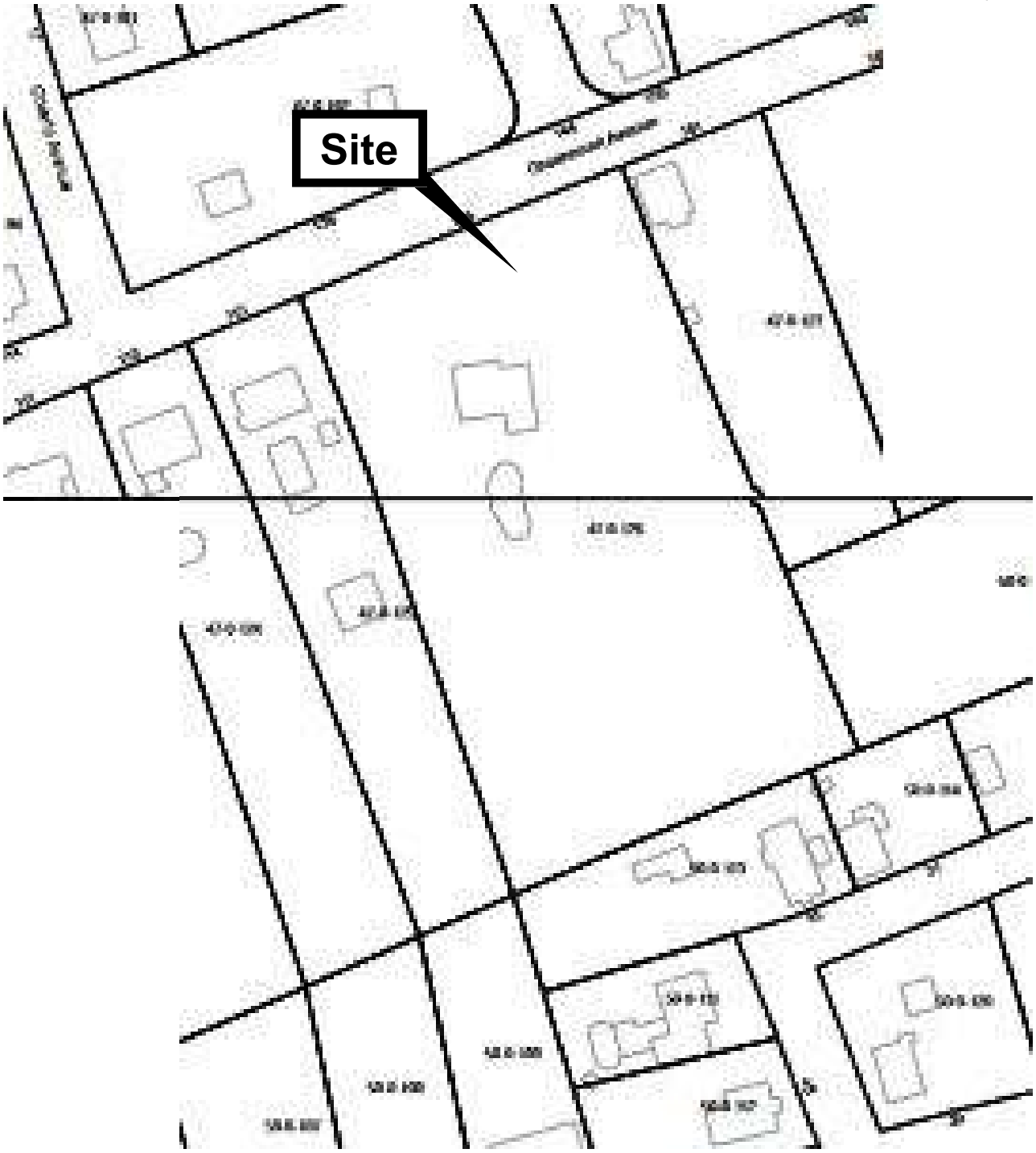
REF.: MassGIS Website



SCALE: Not to Scale

Assessor's Map

REF.: Tyngsborough Official Website

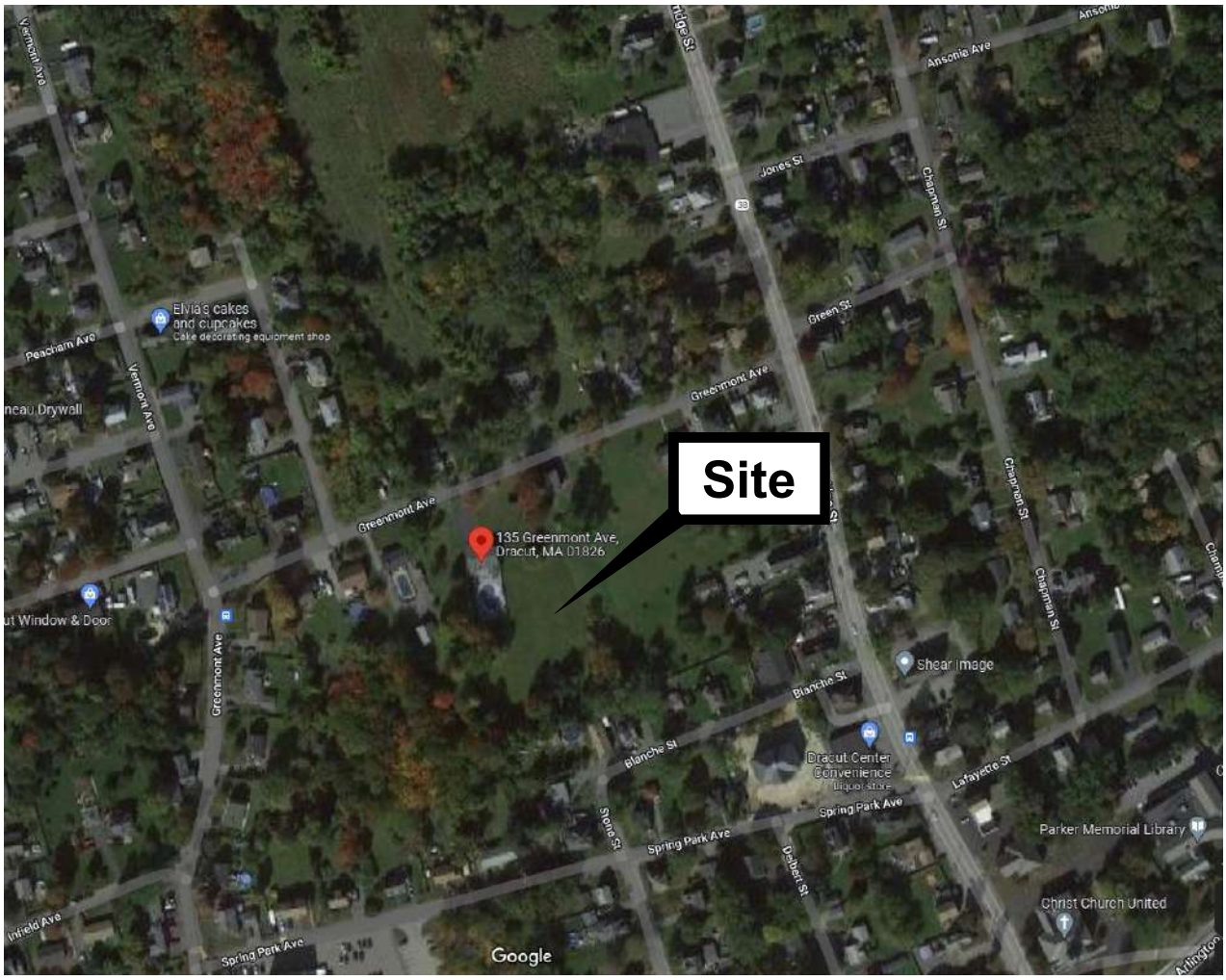


MAP 47 LOT 126

SCALE: 1" = 50 FT

Aerial Photography

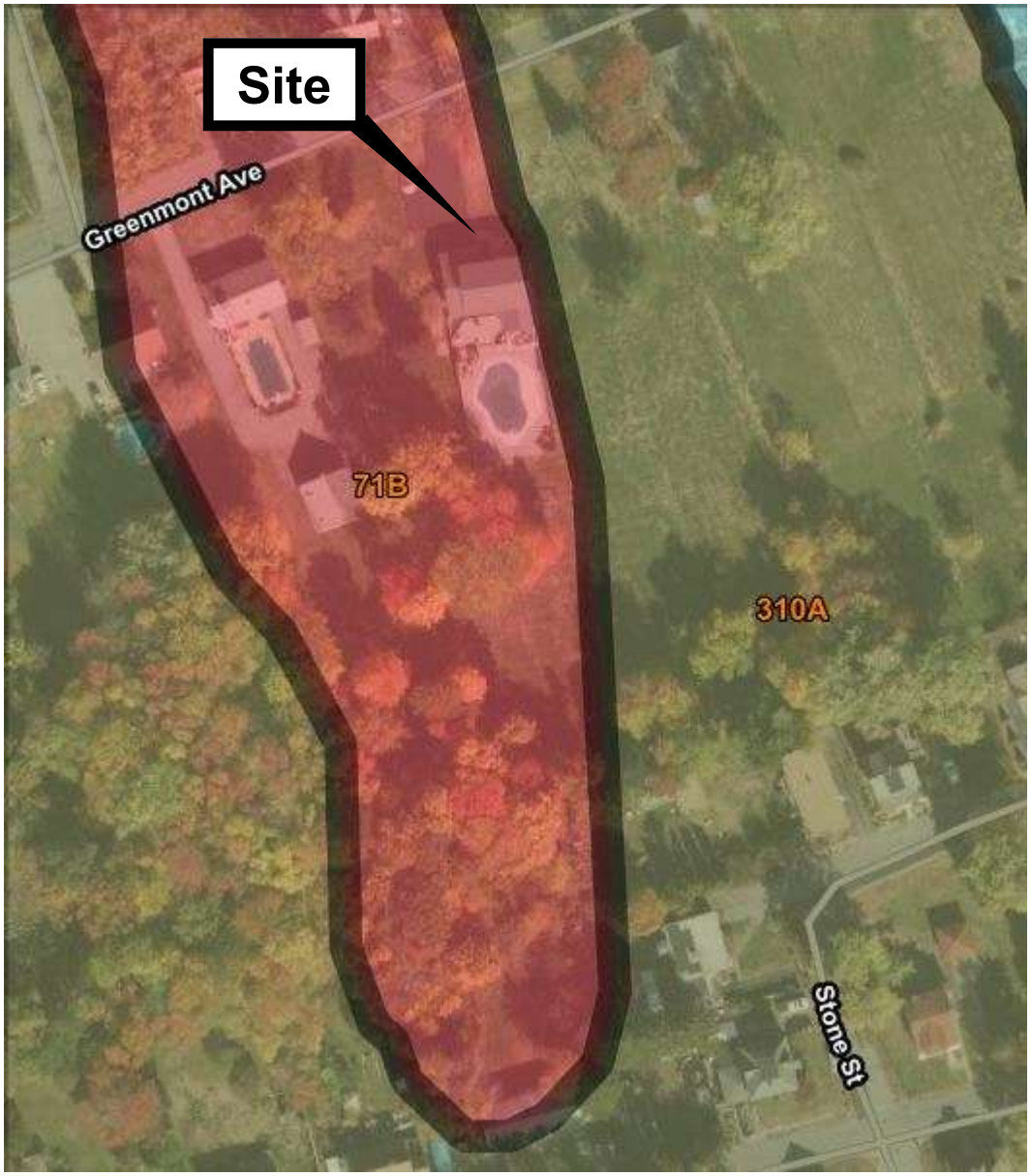
REF.: MassGIS Website



SCALE: 1” = 100 FT

NRCS Soil Map

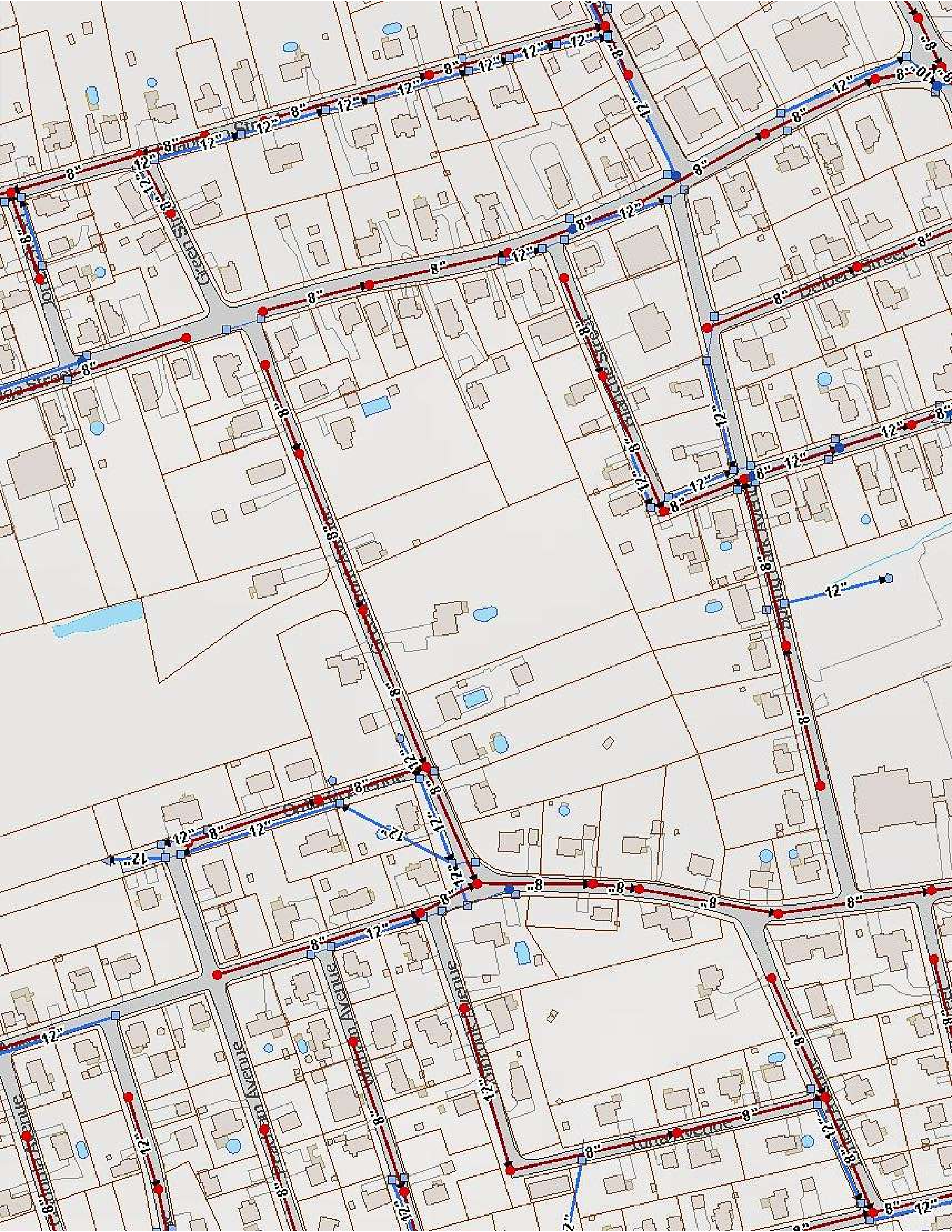
REF.: NRCS Website



Hydrologic Soil Group

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
71B	Ridgebury fine sandy loam, 3 to 8 percent slopes, extremely stony	D	3.5	26.3%
305B	Paxton fine sandy loam, 3 to 8 percent slopes	C	0.5	3.9%
310A	Woodbridge fine sandy loam, 0 to 3 percent slopes	C/D	9.2	69.8%
Totals for Area of Interest			13.2	100.0%

SCALE: Not to Scale

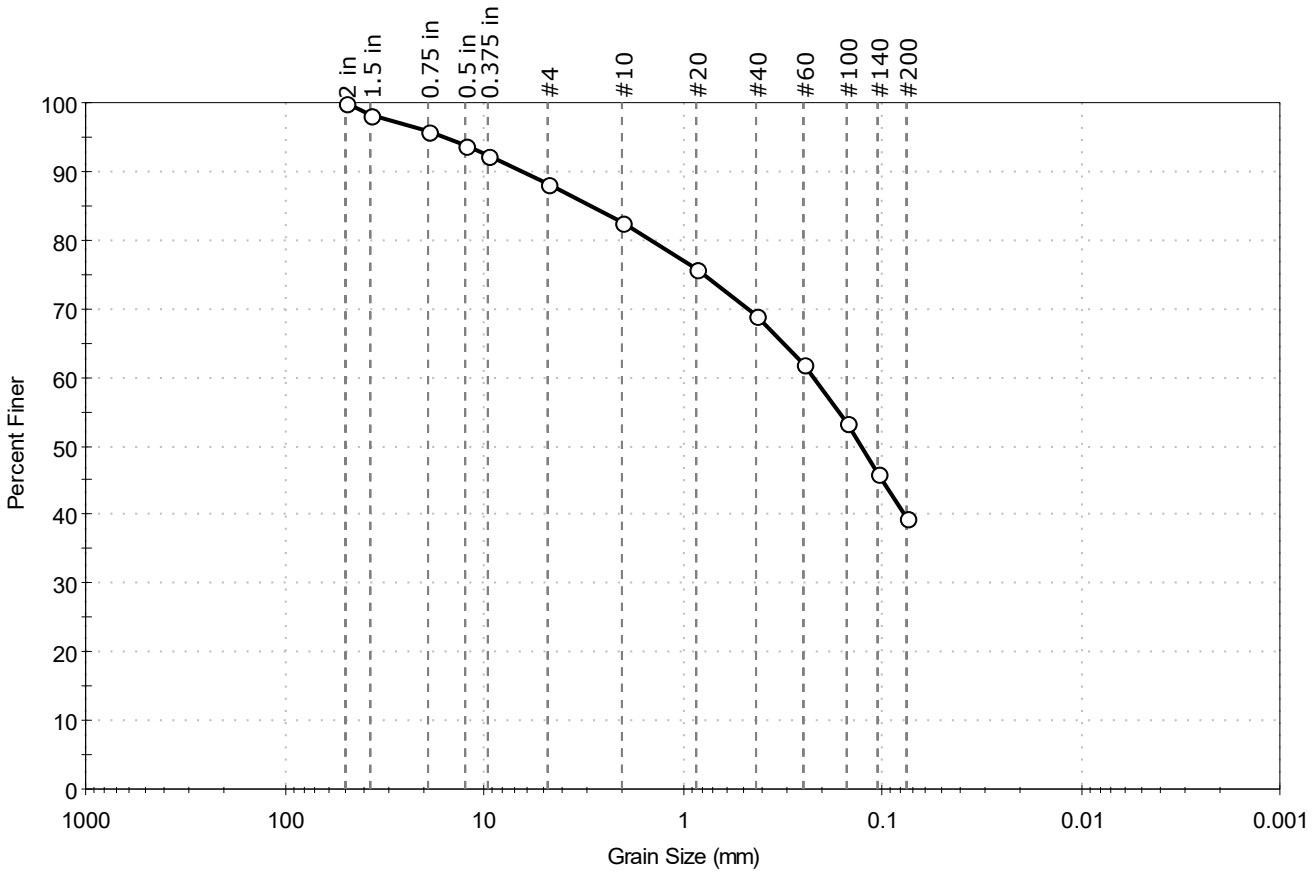

Green St
8"
12"

GeoTesting EXPRESS

Client:	Cornerstone Land Consultants				
Project:	Greenmont Commons				
Location:	Dracut, MA			Project No:	GTX-316104
Boring ID:	TP #1	Sample Type:	bucket	Tested By:	ckg
Sample ID:	---	Test Date:	09/26/22	Checked By:	jsc
Depth :	---	Test Id:	686183		

Test Comment: ---
Visual Description: Moist, light yellowish brown silty sand
Sample Comment: ---

Particle Size Analysis - ASTM D6913



% Cobble	% Gravel	% Sand	% Silt & Clay Size
--	11.8	48.7	39.5

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
2 in	50.00	100		
1.5 in	37.50	98		
0.75 in	19.00	96		
0.5 in	12.50	94		
0.375 in	9.50	92		
#4	4.75	88		
#10	2.00	83		
#20	0.85	76		
#40	0.42	69		
#60	0.25	62		
#100	0.15	53		
#140	0.11	46		
#200	0.075	40		

Coefficients

D_{85} = 2.8746 mm D_{30} = N/A
D_{60} = 0.2220 mm D_{15} = N/A
D_{50} = 0.1274 mm D_{10} = N/A
C_u = N/A C_c = N/A

Classification

ASTM N/A

AASHTO Silty Soils (A-4 (0))

Sample/Test Description

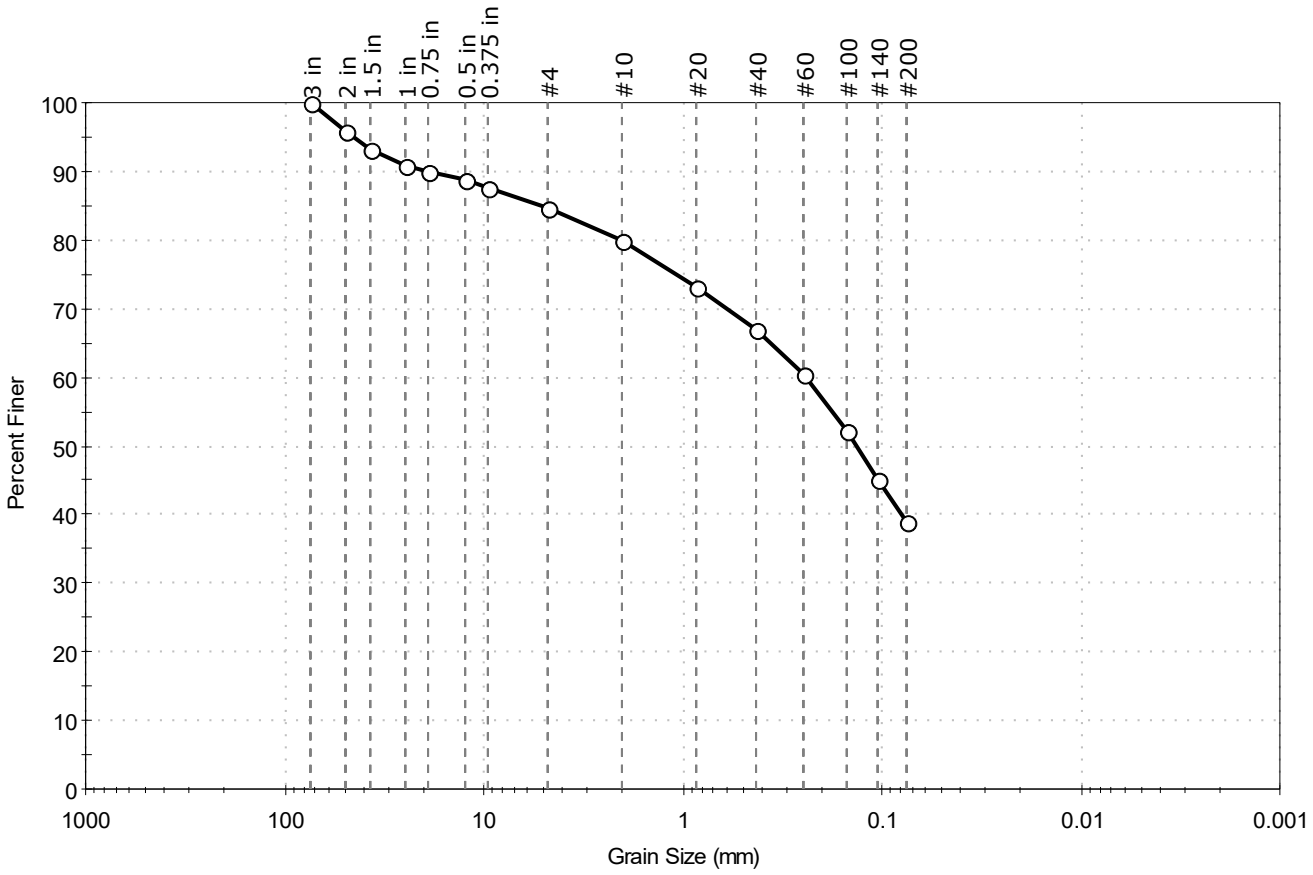
Sand/Gravel Particle Shape : ANGULAR
Sand/Gravel Hardness : HARD

GeoTesting EXPRESS

Client:	Cornerstone Land Consultants				
Project:	Greenmont Commons				
Location:	Dracut, MA			Project No:	GTX-316104
Boring ID:	TP #2	Sample Type:	bucket	Tested By:	ckg
Sample ID:	---	Test Date:	09/28/22	Checked By:	jsc
Depth :	---	Test Id:	686184		

Test Comment: ---
Visual Description: Moist, light olive brown silty sand with gravel
Sample Comment: ---

Particle Size Analysis - ASTM D6913



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	15.4	45.6	39.0

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
3 in	75.00	100		
2 in	50.00	96		
1.5 in	37.50	93		
1 in	25.00	91		
0.75 in	19.00	90		
0.5 in	12.50	89		
0.375 in	9.50	88		
#4	4.75	85		
#10	2.00	80		
#20	0.85	73		
#40	0.42	67		
#60	0.25	60		
#100	0.15	52		
#140	0.11	45		
#200	0.075	39		

Coefficients

D_{85} = 5.2042 mm D_{30} = N/A
D_{60} = 0.2449 mm D_{15} = N/A
D_{50} = 0.1347 mm D_{10} = N/A
C_u = N/A C_c = N/A

Classification

ASTM N/A

AASHTO Silty Soils (A-4 (0))

Sample/Test Description

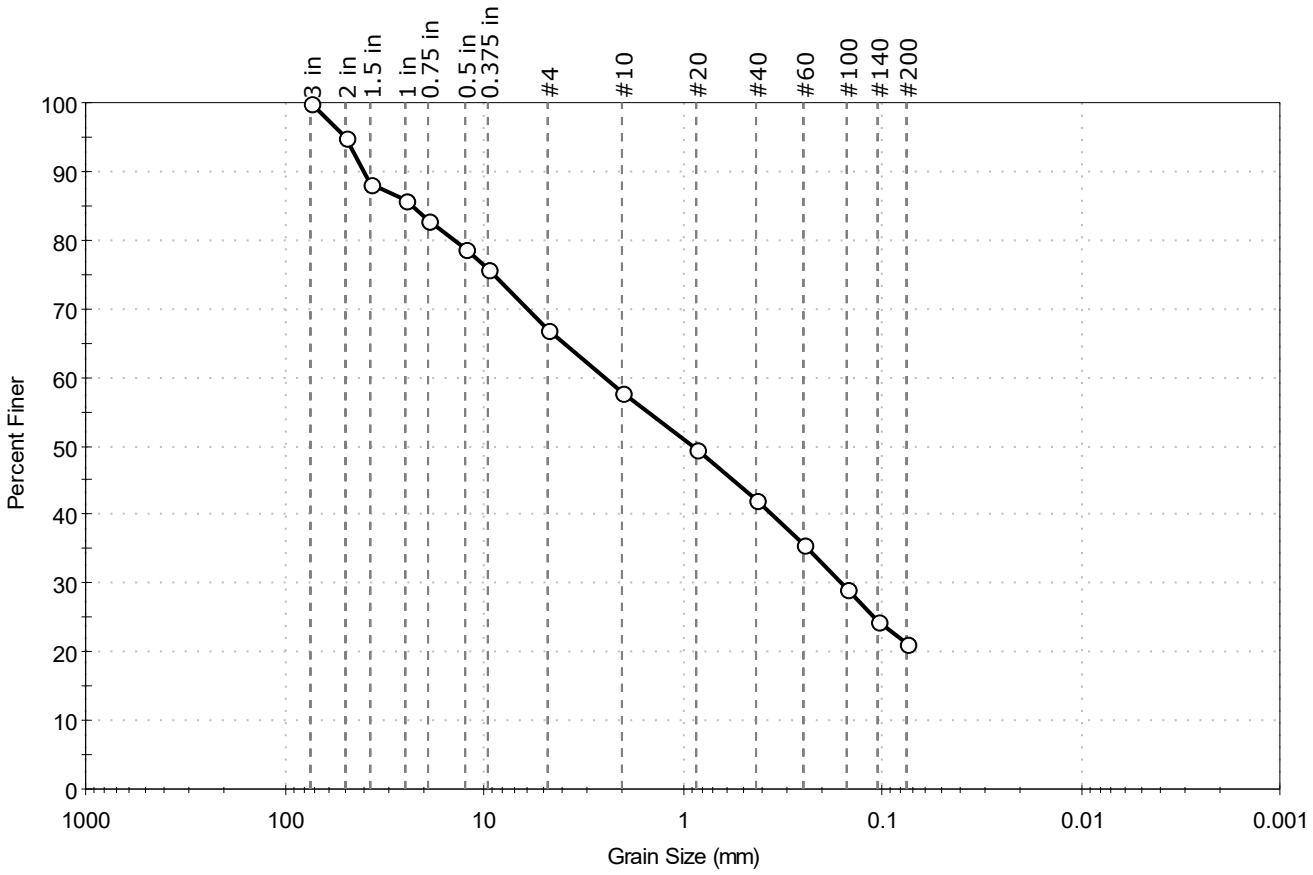
Sand/Gravel Particle Shape : ANGULAR
Sand/Gravel Hardness : HARD

GeoTesting EXPRESS

Client:	Cornerstone Land Consultants				
Project:	Greenmont Commons				
Location:	Dracut, MA			Project No:	GTX-316104
Boring ID:	TP #3	Sample Type:	bucket	Tested By:	ckg
Sample ID:	---	Test Date:	09/27/22	Checked By:	jsc
Depth :	---	Test Id:	686185		

Test Comment: ---
Visual Description: Moist, dark yellowish brown silty sand with gravel
Sample Comment: ---

Particle Size Analysis - ASTM D6913



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	32.9	45.8	21.3

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
3 in	75.00	100		
2 in	50.00	95		
1.5 in	37.50	88		
1 in	25.00	86		
0.75 in	19.00	83		
0.5 in	12.50	79		
0.375 in	9.50	76		
#4	4.75	67		
#10	2.00	58		
#20	0.85	50		
#40	0.42	42		
#60	0.25	36		
#100	0.15	29		
#140	0.11	24		
#200	0.075	21		

Coefficients

D_{85} = 23.0906 mm D_{30} = 0.1587 mm
D_{60} = 2.4279 mm D_{15} = N/A
D_{50} = 0.8828 mm D_{10} = N/A
C_u = N/A C_c = N/A

Classification

ASTM N/A

AASHTO Stone Fragments, Gravel and Sand (A-1-b (0))

Sample/Test Description

Sand/Gravel Particle Shape : ANGULAR

Sand/Gravel Hardness : HARD

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Client:	Cornerstone Land Consultants		
Project Name:	Greenmont Commons		
Project Location:	Dracut, MA		
GTX #:	316104		
Start Date:	09/30/22	Tested By:	awp
End Date:	10/04/22	Checked By:	jsc
Boring #:	TP-1		
Sample #:	---		
Depth:	---		
Visual Description:	Moist, light yellowish brown silty sand		

Permeability of Granular Soils (Constant Head) by ASTM D2434

Sample Type: Remolded

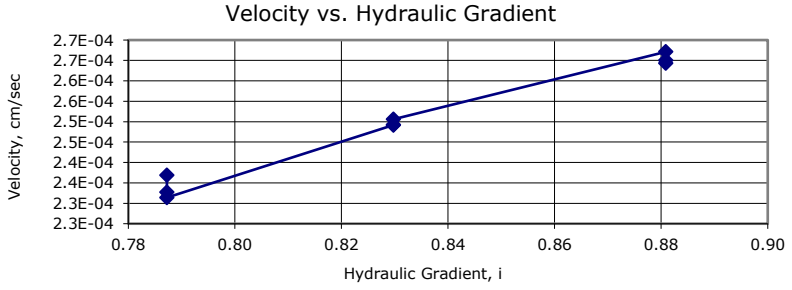
Sample Information:

Maximum Dry Density:	--- pcf
Optimum Moisture Content:	--- %
Compaction Test Method:	---
Classification (ASTM D2487):	---
Assumed Specific Gravity:	2.65

Sample Preparation / Test Setup: Test specimen compacted with moderate effort at air-dried moisture content. Material >3/4-inch removed from sample prior to testing (4.1% of sample).

Parameter	Initial	Final
Height, in	12.00	11.75
Diameter, in	9.50	9.50
Area, in^2	70.9	70.9
Volume, in^3	850.6	832.9
Mass, g	23931	---
Bulk Density, pcf	107	---
Moisture Content, %	1.2	---
Dry Density, pcf	106	---
Degree of Saturation, %	---	---
Void Ratio, e	---	---

Date	Reading #	Volume of Flow, cc	Time of Flow, sec	Flow Rate, cc/sec	Gradient	Permeability, cm/sec	Temp., °C	Correction Factor	Permeability @ 20 °C, cm/sec
10/4	1	3.3	31	0.11	0.79	3.0E-04	18.4	1.041	3.1E-04
10/4	2	3.2	30	0.11	0.79	3.0E-04	18.4	1.041	3.1E-04
10/4	3	3.2	30	0.11	0.79	2.9E-04	18.4	1.041	3.1E-04
10/4	4	3.5	31	0.11	0.83	3.0E-04	18.4	1.041	3.1E-04
10/4	5	3.5	31	0.11	0.83	3.0E-04	18.4	1.041	3.1E-04
10/4	6	3.5	31	0.11	0.83	3.0E-04	18.4	1.041	3.1E-04
10/4	7	3.7	31	0.12	0.88	3.0E-04	18.5	1.038	3.1E-04
10/4	8	3.7	30	0.12	0.88	3.0E-04	18.5	1.038	3.1E-04
10/4	9	3.7	30	0.12	0.88	3.0E-04	18.5	1.038	3.1E-04



PERMEABILITY @ 20 °C = 3.1×10^{-4} cm/sec

PERMEABILITY @ 20 °C = 3.1×10^{-6} m/sec

Client:	Cornerstone Land consultants		
Project Name:	Greenmont Commons		
Project Location:	Dracut, MA		
GTX #:	316104		
Start Date:	09/30/22	Tested By:	awp
End Date:	10/06/22	Checked By:	jsc
Boring #:	TP-2		
Sample #:	---		
Depth:	---		
Visual Description:	Moist, light olive brown silty sand with gravel		

Permeability of Granular Soils (Constant Head) by ASTM D2434

Sample Type: Remolded

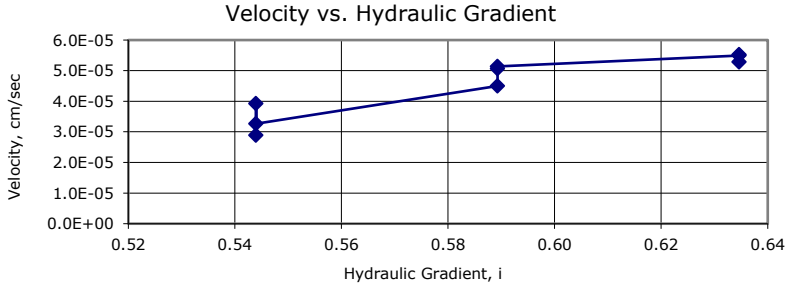
Sample Information:

Maximum Dry Density:	--- pcf
Optimum Moisture Content:	--- %
Compaction Test Method:	---
Classification (ASTM D2487):	---
Assumed Specific Gravity:	2.65

Sample Preparation / Test Setup: Test specimen compacted with moderate effort at air-dried moisture content. Material >3/8-inch removed from sample prior to testing (7% of sample).

Parameter	Initial	Final
Height, in	10.65	11.03
Diameter, in	9.50	9.50
Area, in^2	70.9	70.9
Volume, in^3	754.9	781.8
Mass, g	20807	---
Bulk Density, pcf	105	---
Moisture Content, %	0.0	---
Dry Density, pcf	105	---
Degree of Saturation, %	---	---
Void Ratio, e	---	---

Date	Reading #	Volume of Flow, cc	Time of Flow, sec	Flow Rate, cc/sec	Gradient	Permeability, cm/sec	Temp., °C	Correction Factor	Permeability @ 20 °C, cm/sec
10/5	1	4.0	300	0.01	0.54	5.3E-05	19.8	1.005	5.3E-05
10/5	2	5.4	300	0.02	0.54	7.2E-05	19.8	1.005	7.2E-05
10/5	3	4.5	300	0.01	0.54	6.0E-05	19.8	1.005	6.0E-05
10/5	4	6.2	300	0.02	0.59	7.6E-05	19.5	1.013	7.7E-05
10/5	5	6.9	300	0.02	0.59	8.6E-05	19.5	1.013	8.7E-05
10/5	6	7.0	300	0.02	0.59	8.7E-05	19.5	1.013	8.8E-05
10/5	7	7.5	300	0.03	0.63	8.7E-05	19.4	1.015	8.8E-05
10/5	8	7.6	300	0.03	0.63	8.7E-05	19.4	1.015	8.8E-05
10/5	9	7.3	300	0.02	0.63	8.3E-05	19.4	1.015	8.5E-05



PERMEABILITY @ 20 °C = 7.8×10^{-5} cm/sec

PERMEABILITY @ 20 °C = 7.8×10^{-7} m/sec

Client:	Conerstone Land Consultants		
Project Name:	Greenmont Commons		
Project Location:	Dracut, MA		
GTX #:	316104		
Start Date:	09/30/22	Tested By:	awp
End Date:	10/06/22	Checked By:	jsc
Boring #:	TP-3		
Sample #:	---		
Depth:	---		
Visual Description:	Moist, dark yellowish brown sand with gravel		

Permeability of Granular Soils (Constant Head) by ASTM D2434

Sample Type: Remolded

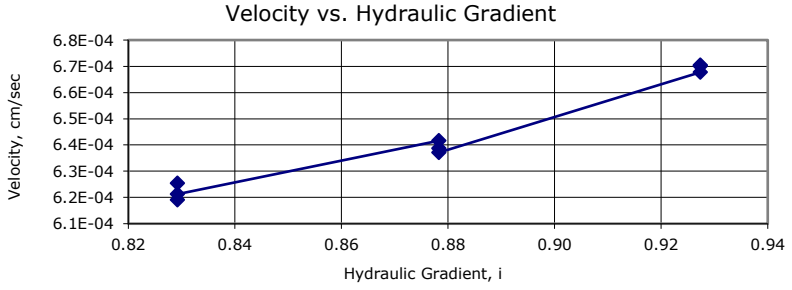
Sample Information:

Maximum Dry Density:	--- pcf
Optimum Moisture Content:	--- %
Compaction Test Method:	---
Classification (ASTM D2487):	---
Assumed Specific Gravity:	2.65

Sample Preparation / Test Setup: Test specimen compacted with moderate effort at air-dried moisture content. Material >3/4-inch removed from sample prior to testing (17.2% of sample).

Parameter	Initial	Final
Height, in	10.04	10.19
Diameter, in	9.50	9.50
Area, in^2	70.9	70.9
Volume, in^3	711.7	722.3
Mass, g	20380	---
Bulk Density, pcf	109	---
Moisture Content, %	2.9	---
Dry Density, pcf	106	---
Degree of Saturation, %	---	---
Void Ratio, e	---	---

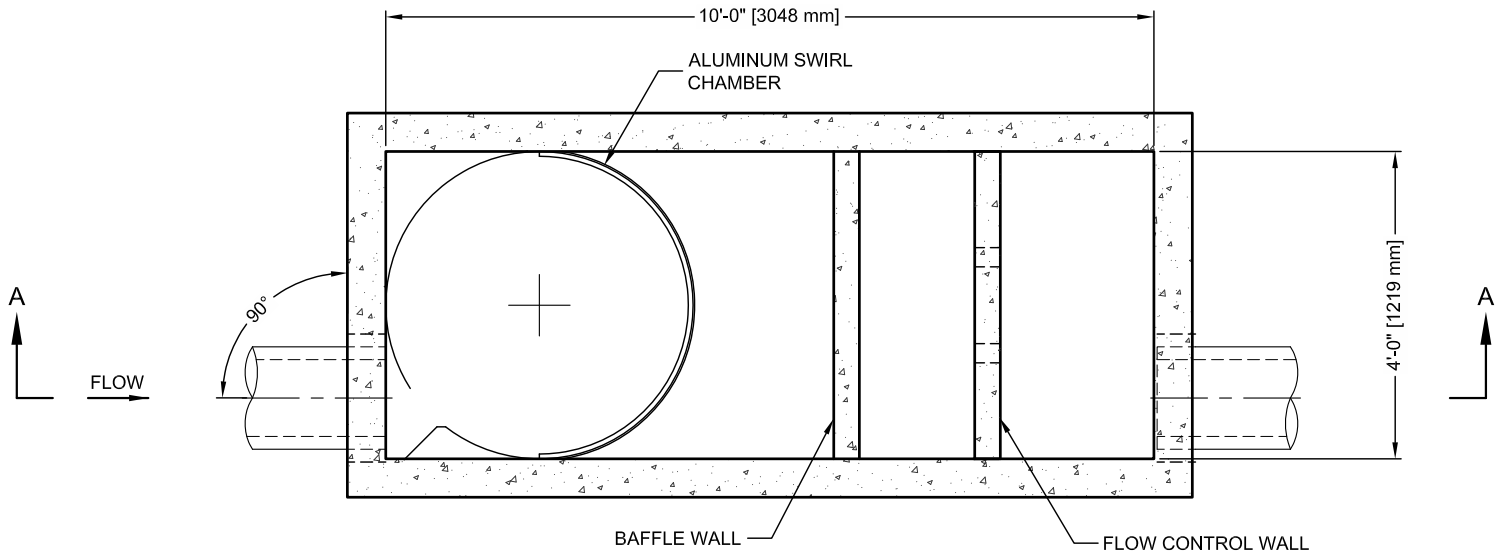
Date	Reading #	Volume of Flow, cc	Time of Flow, sec	Flow Rate, cc/sec	Gradient	Permeability, cm/sec	Temp., °C	Correction Factor	Permeability @ 20 °C, cm/sec
10/6	1	34.3	120	0.29	0.83	7.5E-04	18.6	1.036	7.8E-04
10/6	2	34.5	122	0.28	0.83	7.5E-04	18.6	1.036	7.7E-04
10/6	3	38.0	134	0.28	0.83	7.5E-04	18.6	1.036	7.8E-04
10/6	4	35.6	121	0.29	0.88	7.3E-04	18.6	1.036	7.6E-04
10/6	5	35.2	121	0.29	0.88	7.3E-04	18.6	1.036	7.5E-04
10/6	6	41.5	142	0.29	0.88	7.3E-04	18.6	1.036	7.5E-04
10/6	7	39.8	130	0.31	0.93	7.2E-04	18.4	1.041	7.5E-04
10/6	8	38.2	125	0.31	0.93	7.2E-04	18.4	1.041	7.5E-04
10/6	9	41.2	134	0.31	0.93	7.2E-04	18.4	1.041	7.5E-04



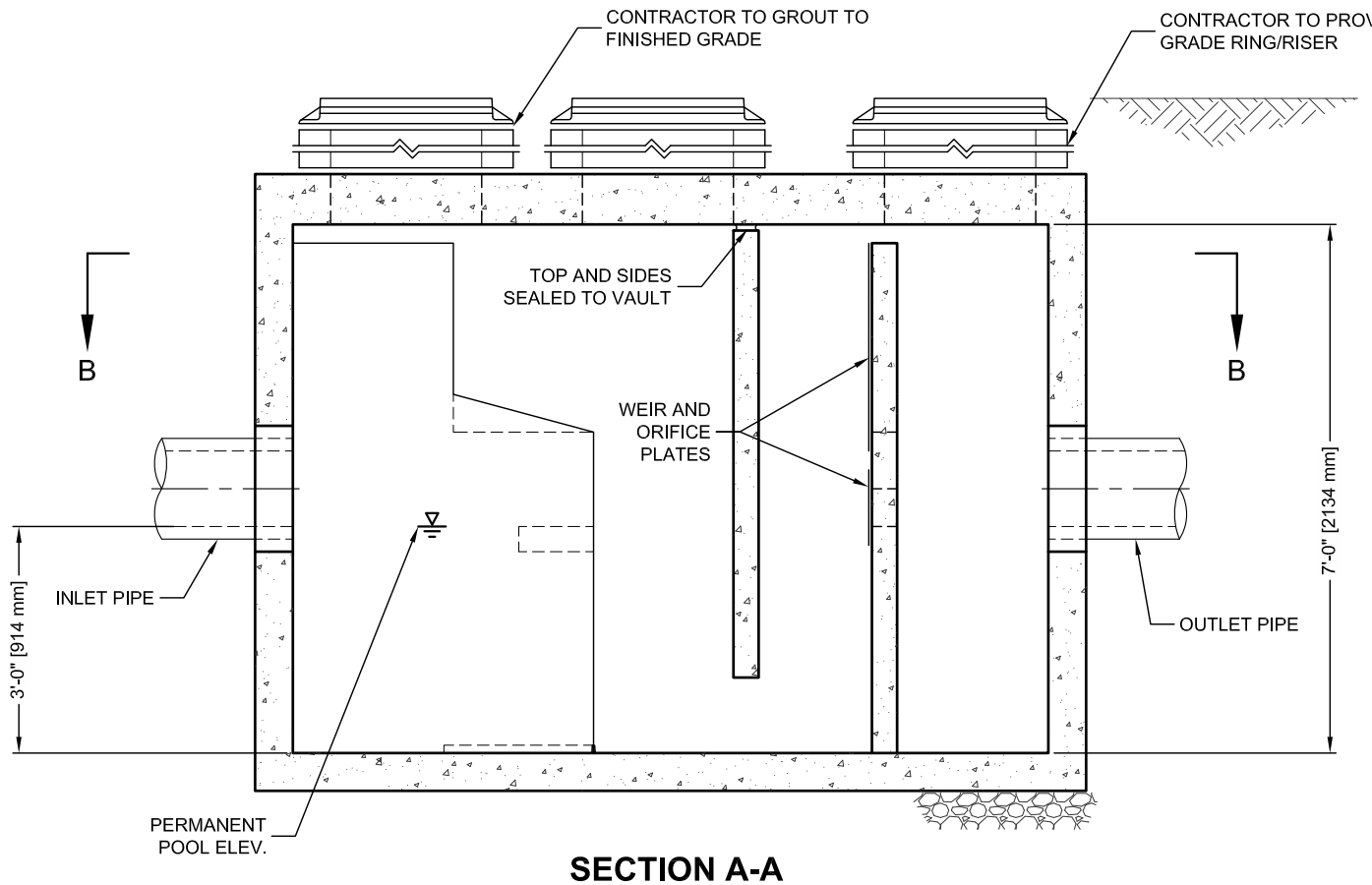
PERMEABILITY @ 20 °C = 7.6×10^{-4} cm/sec

PERMEABILITY @ 20 °C = 7.6×10^{-6} m/sec

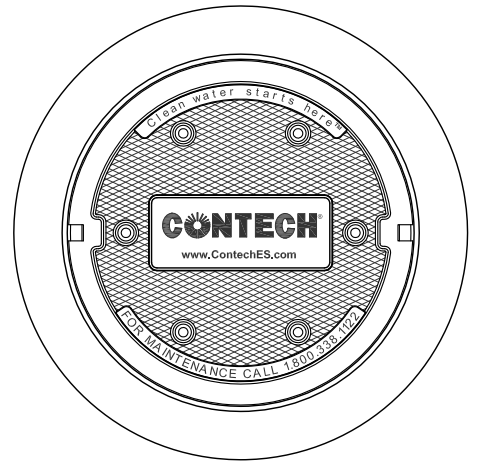
Appendix B: BMP Designs



SECTION B-B



SECTION A-A



FRAME AND COVER
(DIAMETER VARIES)
N.T.S.

VORTECHS 2000 DESIGN NOTES

VORTECHS 2000 RATED TREATMENT CAPACITY IS 2.8 CFS, OR PER LOCAL REGULATIONS. IF THE SITE CONDITIONS EXCEED RATED TREATMENT CAPACITY, AN UPSTREAM BYPASS STRUCTURE IS REQUIRED.

THE STANDARD INLET/OUTLET CONFIGURATION IS SHOWN. FOR OTHER CONFIGURATION OPTIONS , PLEASE CONTACT YOUR CONTECH REPRESENTATIVE. www.ContechES.com

SITE SPECIFIC DATA REQUIREMENTS

STRUCTURE ID	*
WATER QUALITY FLOW RATE (CFS)	*
PEAK FLOW RATE (CFS)	*
RETURN PERIOD OF PEAK FLOW (YRS)	*

PIPE DATA:	I.E.	MATERIAL	DIAMETER
INLET PIPE 1	*	*	*
INLET PIPE 2	*	*	*
OUTLET PIPE	*	*	*

RIM ELEVATION	*

ANTI-FLOTATION BALLAST	WIDTH	HEIGHT
	*	*

NOTES/SPECIAL REQUIREMENTS:

* PER ENGINEER OF RECORD

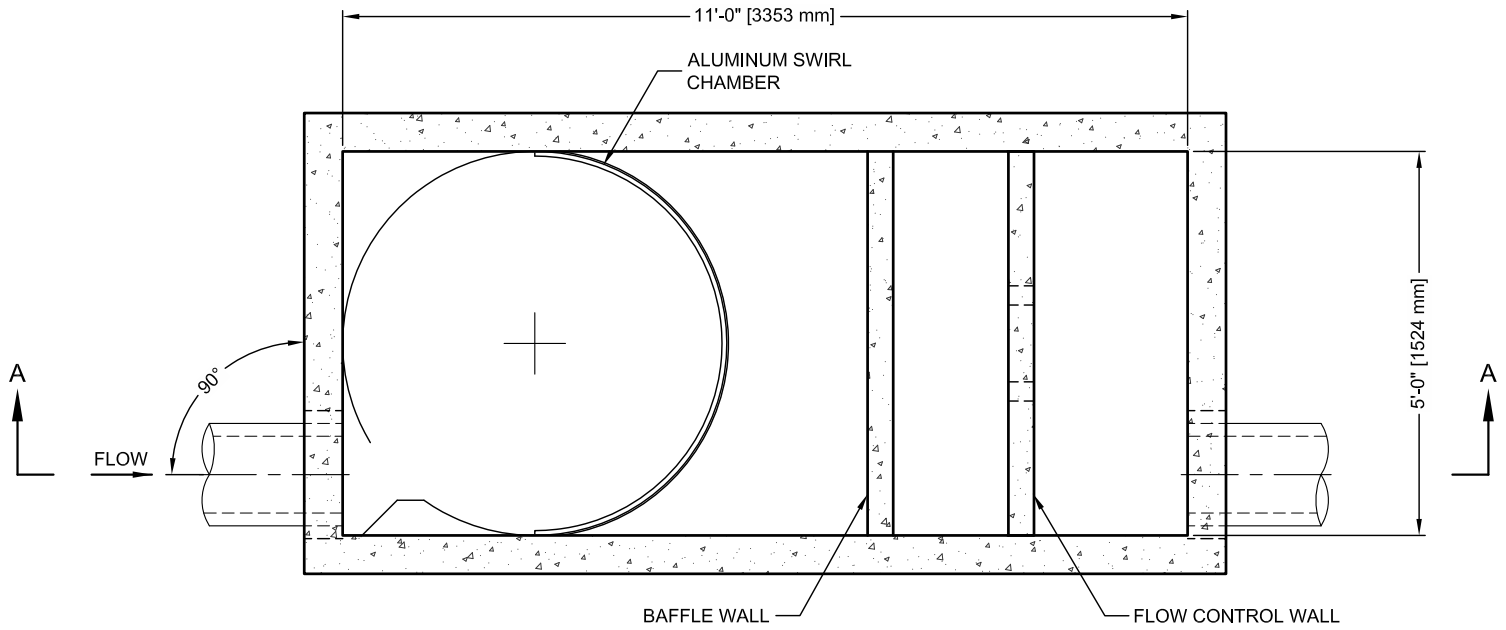
GENERAL NOTES
1. CONTECH TO PROVIDE ALL MATERIALS UNLESS NOTED OTHERWISE.
2. DIMENSIONS MARKED WITH ( ) ARE REFERENCE DIMENSIONS. ACTUAL DIMENSIONS MAY VARY.
3. FOR FABRICATION DRAWINGS WITH DETAILED STRUCTURE DIMENSIONS AND WEIGHT, PLEASE CONTACT YOUR CONTECH REPRESENTATIVE. www.ContechES.com
4. VORTECHS WATER QUALITY STRUCTURE SHALL BE IN ACCORDANCE WITH ALL DESIGN DATA AND INFORMATION CONTAINED IN THIS DRAWING.
5. STRUCTURE SHALL MEET AASHTO HS20 AND CASTINGS SHALL MEET AASHTO M306 LOAD RATING, ASSUMING GROUNDWATER ELEVATION AT, OR BELOW, THE OUTLET PIPE INVERT ELEVATION. ENGINEER OF RECORD TO CONFIRM ACTUAL GROUNDWATER ELEVATION.
6. INLET PIPE(S) MUST BE PERPEDICULAR TO THE VAULT AND AT THE CORNER TO INTRODUCE THE FLOW TANGENTIALLY TO THE SWIRL CHAMBER. DUAL INLETS NOT TO HAVE OPPOSING TANGENTIAL FLOW DIRECTIONS.
7. OUTLET PIPE(S) MUST BE DOWN STREAM OF THE FLOW CONTROL BAFFLE AND MAY BE LOCATED ON THE SIDE OR END OF THE VAULT. THE FLOW CONTROL WALL MAY BE TURNED TO ACCOMODATE OUTLET PIPE KNOCKOUTS ON THE SIDE OF THE VAULT.

INSTALLATION NOTES
A. ANY SUB-BASE, BACKFILL DEPTH, AND/OR ANTI-FLOTATION PROVISIONS ARE SITE-SPECIFIC DESIGN CONSIDERATIONS AND SHALL BE SPECIFIED BY ENGINEER OF RECORD.
B. CONTRACTOR TO PROVIDE EQUIPMENT WITH SUFFICIENT LIFTING AND REACH CAPACITY TO LIFT AND SET THE VORTECHS STRUCTURE (LIFTING CLUTCHES PROVIDED).
C. CONTRACTOR TO INSTALL JOINT SEALANT BETWEEN ALL STRUCTURE SECTIONS AND ASSEMBLE STRUCTURE.
D. CONTRACTOR TO PROVIDE, INSTALL, AND GROUT PIPES. MATCH PIPE INVERTS WITH ELEVATIONS SHOWN.
E. CONTRACTOR TO TAKE APPROPRIATE MEASURES TO ASSURE UNIT IS WATER TIGHT, HOLDING WATER TO FLOWLINE INVERT MINIMUM. IT IS SUGGESTED THAT ALL JOINTS BELOW PIPE INVERTS ARE GROUTED.

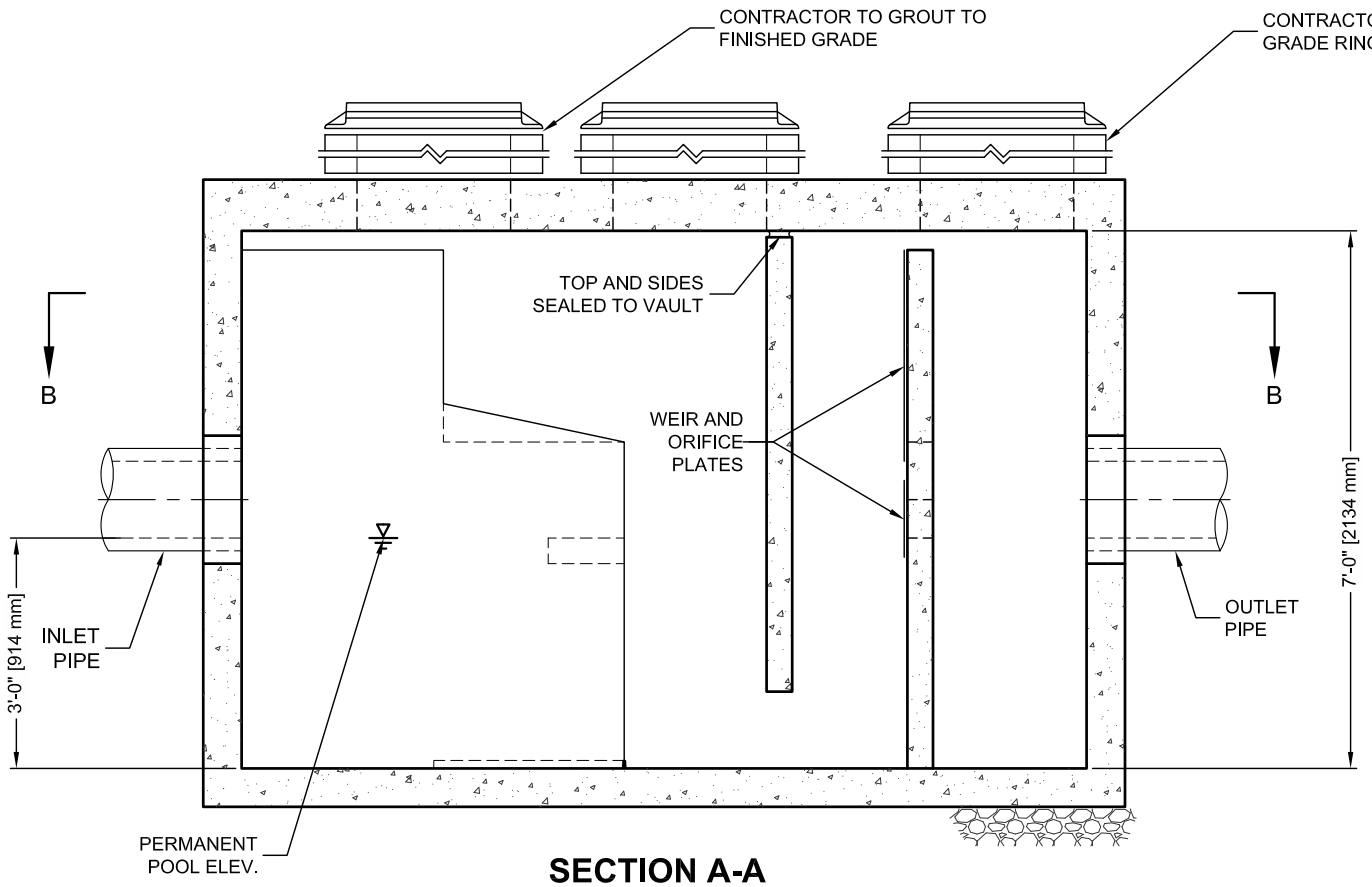
Vortechs®

CONTECH® ENGINEERED SOLUTIONS LLC
www.ContechES.com
9025 Centre Pointe Dr., Suite 400, West Chester, OH 45069
800-338-1122 513-645-7000 513-645-7993 FAX

VORTECHS 2000 STANDARD DETAIL



SECTION B-B



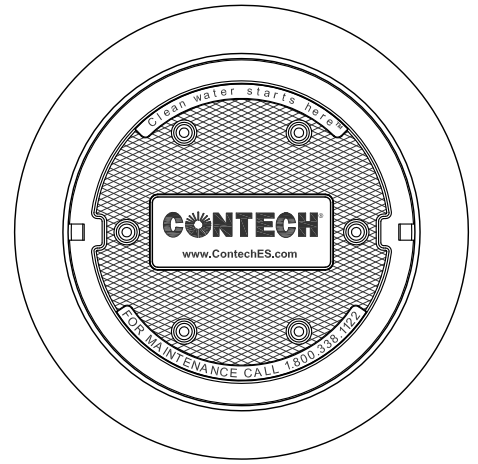
SECTION A-A

Vortechs®

VORTECHS 3000 DESIGN NOTES

VORTECHS 3000 RATED TREATMENT CAPACITY IS 4.5 CFS, OR PER LOCAL REGULATIONS. IF THE SITE CONDITIONS EXCEED RATED TREATMENT CAPACITY, AN UPSTREAM BYPASS STRUCTURE IS REQUIRED.

THE STANDARD INLET/OUTLET CONFIGURATION IS SHOWN. FOR OTHER CONFIGURATION OPTIONS , PLEASE CONTACT YOUR CONTECH REPRESENTATIVE. www.ContechES.com



FRAME AND COVER
(DIAMETER VARIES)
N.T.S.

SITE SPECIFIC DATA REQUIREMENTS

STRUCTURE ID	*
WATER QUALITY FLOW RATE (CFS)	*
PEAK FLOW RATE (CFS)	*
RETURN PERIOD OF PEAK FLOW (YRS)	*

PIPE DATA:	I.E.	MATERIAL	DIAMETER
INLET PIPE 1	*	*	*
INLET PIPE 2	*	*	*
OUTLET PIPE	*	*	*

RIM ELEVATION	*

ANTI-FLOTATION BALLAST	WIDTH	HEIGHT
	*	*

NOTES/SPECIAL REQUIREMENTS:

* PER ENGINEER OF RECORD

GENERAL NOTES
1. CONTECH TO PROVIDE ALL MATERIALS UNLESS NOTED OTHERWISE.
2. DIMENSIONS MARKED WITH ( ) ARE REFERENCE DIMENSIONS. ACTUAL DIMENSIONS MAY VARY.
3. FOR FABRICATION DRAWINGS WITH DETAILED STRUCTURE DIMENSIONS AND WEIGHT, PLEASE CONTACT YOUR CONTECH REPRESENTATIVE. www.ContechES.com
4. VORTECHS WATER QUALITY STRUCTURE SHALL BE IN ACCORDANCE WITH ALL DESIGN DATA AND INFORMATION CONTAINED IN THIS DRAWING.
5. STRUCTURE SHALL MEET AASHTO HS20 AND CASTINGS SHALL MEET AASHTO M306 LOAD RATING, ASSUMING GROUNDWATER ELEVATION AT, OR BELOW, THE OUTLET PIPE INVERT ELEVATION. ENGINEER OF RECORD TO CONFIRM ACTUAL GROUNDWATER ELEVATION.
6. INLET PIPE(S) MUST BE PERPEDICULAR TO THE VAULT AND AT THE CORNER TO INTRODUCE THE FLOW TANGENTIALLY TO THE SWIRL CHAMBER. DUAL INLETS NOT TO HAVE OPPOSING TANGENTIAL FLOW DIRECTIONS.
7. OUTLET PIPE(S) MUST BE DOWN STREAM OF THE FLOW CONTROL BAFFLE AND MAY BE LOCATED ON THE SIDE OR END OF THE VAULT. THE FLOW CONTROL WALL MAY BE TURNED TO ACCOMODATE OUTLET PIPE KNOCKOUTS ON THE SIDE OF THE VAULT.

INSTALLATION NOTES
A. ANY SUB-BASE, BACKFILL DEPTH, AND/OR ANTI-FLOTATION PROVISIONS ARE SITE-SPECIFIC DESIGN CONSIDERATIONS AND SHALL BE SPECIFIED BY ENGINEER OF RECORD.
B. CONTRACTOR TO PROVIDE EQUIPMENT WITH SUFFICIENT LIFTING AND REACH CAPACITY TO LIFT AND SET THE VORTECHS STRUCTURE (LIFTING CLUTCHES PROVIDED).
C. CONTRACTOR TO INSTALL JOINT SEALANT BETWEEN ALL STRUCTURE SECTIONS AND ASSEMBLE STRUCTURE.
D. CONTRACTOR TO PROVIDE, INSTALL, AND GROUT PIPES. MATCH PIPE INVERTS WITH ELEVATIONS SHOWN.
E. CONTRACTOR TO TAKE APPROPRIATE MEASURES TO ASSURE UNIT IS WATER TIGHT, HOLDING WATER TO FLOWLINE INVERT MINIMUM. IT IS SUGGESTED THAT ALL JOINTS BELOW PIPE INVERTS ARE GROUTED.

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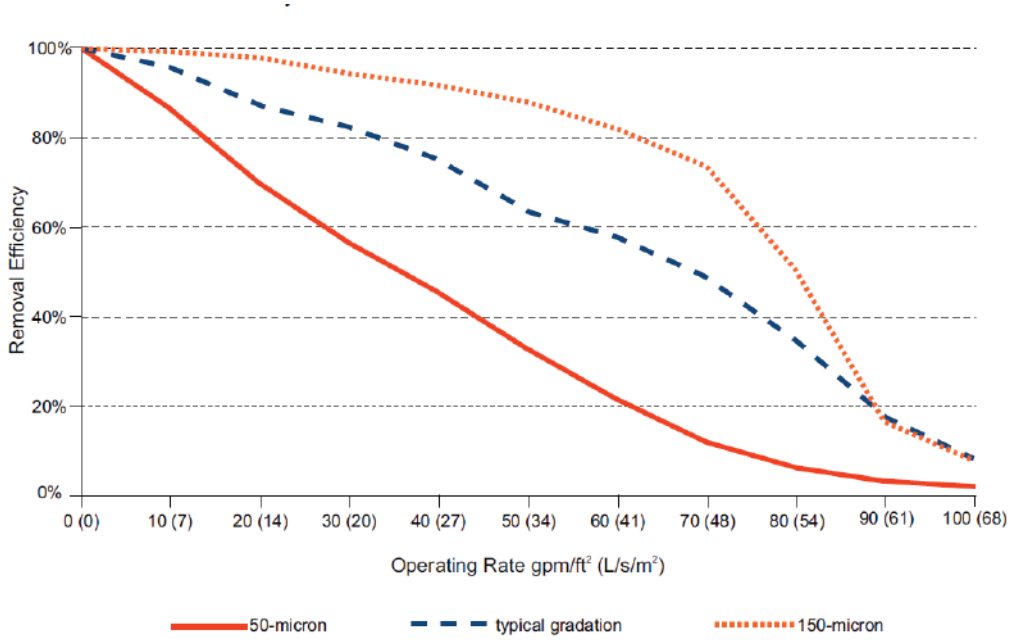
VORTECHS 3000 STANDARD DETAIL

Vortechs® System Performance:
Removal Efficiencies for Selected Particle Gradations

These performance curves are based on laboratory tests using a full scale Vortechs® model 2000. The testing protocol used is summarized on the following page. The 150-micron curve demonstrates the results of tests using particles that passed through a 60-mesh sieve and were retained on a 100-mesh sieve. The 50-micron curve is based on tests of particles passing through a 200-mesh sieve and retained on a 400-mesh sieve. A gradation with an average particle size (d50) of 80 microns, containing particles ranging from 38–500 microns in diameter was used to represent typical stormwater solids.

Vortechs® System Removal Efficiencies for Selected Particle Gradations



As the graph clearly shows, Contech Engineered Solutions systems maintain positive total suspended solids (TSS) removal efficiencies over the full range of operating rates. This allows the system to effectively treat all runoff from large, infrequent design storms, as well as runoff from more frequent low-intensity storms. Contech Engineered Solutions systems are designed to treat peak flows from 1.6 cfs (45 L/s) up to 25 cfs (710 L/s) without bypassing. However, external bypasses can be configured to convey peak flows around the system if treatment capacity is exceeded. The Contech Engineered Solutions system can be configured to direct low flows from the last chamber of the system to polishing treatment when more stringent water quality standards are imposed. In all configurations, high removal efficiencies are achieved during the lower intensity storms, which constitute the majority of annual rainfall volume

Contech Engineered Solutions systems are sized based on fl ow rate rather than volume, which allows effective treatment of runoff from the entire storm, including high-intensity flows. This design basis addresses the deficiencies of conventional volume-based BMPs, which capture the first half or whole inch of runoff but may bypass prematurely, allow resuspension of previously captured pollutants, and/or wash out at higher flow rates. For more information about the Contech Engineered Solutions sizing methodology, please refer to Technical Bulletin No. 3.

CONTECH® ENGINEERED SOLUTIONS

Vortechs®
Technical Bulletin 1

Laboratory Quality Control Brief

The following protocol contains standard operating procedures for Total Suspended Solids (TSS) testing in the Contech Engineered Solutions laboratory. These guidelines were followed in the creation of the preceding performance curves.

Sediment Source

Sediment samples are sorted according to ASTM Special Technical Publication 477 B, which establishes sieve analysis procedures. U.S. Standard Sieves in a Gilson SS-15 sieve shaker are used to separate particles to the various fractions required for our tests. To ensure uniformity of those fractions, an unsorted sample is sieved until less than 1% of that sample passes through the sieve in one minute. All sediment recovered after a test is dried and re-sieved according to this procedure before reuse. Unless otherwise specified, mineral sediments with a density of 2.65 g/cm3 are used.

Flow Calibration and Regulations

Flow calibration is accomplished by calculating the head at the baffle wall required to produce a given fl ow rate through the orifice and the weir in the fl ow control wall. Flow is regulated by a 12-inch butterfly valve located upstream of the Contech Engineered Solutions system. In order to simulate field conditions, fl ow rates are changed gradually to avoid fl ow surges through the system. The test flow rate is set by observing the head in the Contech Engineered Solutions system and adjusting the regulating valve accordingly. Before any samples are collected, the valve must remain fixed for a period equal to half of the detention time so that fl ow equalizes throughout the system. Each test group is planned so that fl ow rates increase incrementally in consecutive tests.

Sediment Metering

All sediment is injected into the inlet pipe via a ¼-inch flexible hose using a Watson Marlow 5058 peristaltic metering pump. For TSS tests, a known gradation of sediment and water are combined in approximately a ½ pound/gallon ratio in a holding tank and homogenized by a mixing propeller powered by a ½ horsepower motor. The mixer is activated at least five minutes before testing commences and runs continuously throughout the test. The metering pump is activated for a period of time equal to at least half of the detention time of the Contech Engineered Solutions system at the test fl ow rate, before the first influent sample is taken. The pump must run continuously until the last effluent sample is taken.

Sample Collection

All influent samples are taken from a six-inch gate valve located upstream of the Contech Engineered Solutions system. A collection bin housing a 500 mL sample container is positioned beneath the valve. Five seconds before each sample is taken, the valve is quickly opened and closed to eliminate any interference from particles that have settled in the low velocity region of the gate. This eliminates artificially high influent readings. The time that the influent sample was taken is recorded and the corresponding effluent sample is collected after a period of time equal to the detention time. Effluent grab samples are collected at the discharge pipe, by sweeping the mouth of a 500 mL bottle through the exiting fl ow stream. Samples are annotated and refrigerated until they can be analyzed.

Sample Analysis

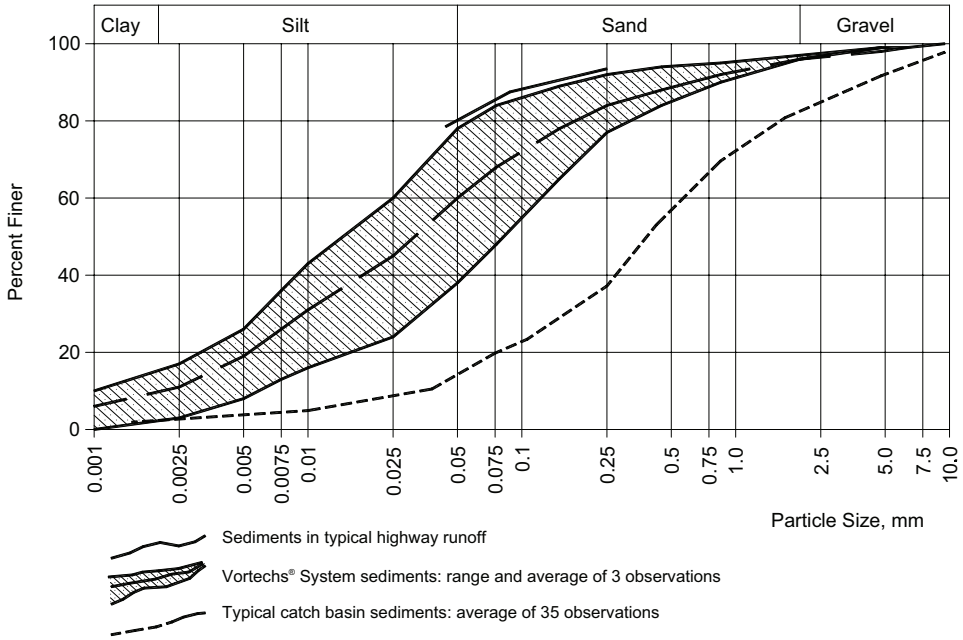
TSS samples are analyzed in the Contech Engineered Solutions laboratory, following EPA method 160.2, a method for the measurement of total non-filterable solids. Volume measurements are accurate to 0.6 mL using a 500 mL graduated cylinder. An Acculab V-1 analytical balance with a readability of 0.001 g is used to measure mass.

CONTECH® ENGINEERED SOLUTIONS

Particle Distribution of Sediments and the Effect on Heavy Metal Removal

Sediments removed from Vortechs® stormwater treatment system installations in Portland and South Portland, Maine were analyzed by a soil testing laboratory to determine size and distribution. These results were compared to similar tests done on sediments carried in highway runoff[1] and on material removed from catch basins by a Vactor truck[2]. The highway runoff sediment data is useful in characterizing typical total stormwater sediment loading. The catch basin data is indicative of sediment removed by typical plug-flow tanks. The data is plotted below for graphical comparison:

Sediment Size and Distribution Comparison



The curves describing sediments extracted from Contech Engineered Solutions systems show enhanced effectiveness across the entire range of particle sizes. In the "mid-range" for example, over 80 percent of the sediment retained by a Contech Engineered Solutions system is approximately 250 microns ("medium sand") and finer particles, compared with less than 40 percent of the sediment in catch basin sumps. The difference between the curves may be interpreted as sediment loss from the catch basins due to turbulence and the resuspension of previously deposited grit. These problems are widely recognized to occur in catch basins and, for that matter, conventional oil/grit separators during brief periods of high flow.

---

[1]Yousef, Y. A. et.al., 1991, Maintenance Guidelines in Accumulated Sediments in Retention/Detention Ponds Receiving Highway Runoff, Florida Department of Transportation, Tallahassee, FL, p. 17. The study included samples from Highway 50, (Sacramento), I-81, (Harrisburg), I-94, (Milwaukee) and I-85, (Effland). The curve shown is the average of the four samples.

[2]Analysis of sediments from 35 catch basins performed under the direction of Steven Lazoff, Laboratory Director, Aquatic Research,Inc., Seattle, WA and reported to Bob Storer, King County Surface Water Management Division, Seattle, WA, June 21, 1993.

CONTECH® ENGINEERED SOLUTIONS

The curve describing the particle size distribution of sediments found in highway runoff from the study by Dr. Yousef is the result of averaged samples taken from highway sites across the U.S. and is therefore representative of sediment loading. The curve describing sediments in highway runoff and the curves describing sediments in the Vortechs Systems are very similar. This shows that the Vortechs System is highly effective in capturing sediment particles found in highway runoff. The fact that the curves are of such similar shape suggests further that Vortechs System removal efficiency applies equally to the full spectrum of particle sizes and that the Vortechs System never washes out.

A catch basin or virtually any tank with a sump where particles can be stored can effectively settle particles out of stormwater runoff if the fl ow rate is low enough. In most wet weather the fl ow rate is low enough to achieve high efficiency. But the converse is also widely recognized to be true; that is, when the fl ow rate is high, the efficiency is low, often dropping to negative efficiency with the result that the overall efficiency over time approaches zero, especially for fine-grained particles.

Fine-grained sediments pose the greatest environmental threat. Heavy metals, nutrients, and hydrocarbons adhere to the surface of suspended particles and are transported by stormwater runoff. A large number of small particles will provide a larger total surface area for substances to adhere to than a smaller number of larger particles of the same total volume. Trapping this material will significantly reduce the presence of these harmful contaminants in surface waters.

For example, a 1.0 mm cube has a surface area of 6 square millimeters. Dividing that one cube into a thousand 0.1 mm cubes increases the total surface area tenfold to 60 square millimeters. Seventy percent of sediments found in catch basins are 1 mm or smaller, and seventy percent of the sediments removed by Vortechs Systems are 0.1 mm or smaller, so the potential for pollutant capture is much greater. Relative to more traditional Best Management Practices (BMP's) for stormwater quality improvement, the Vortechs System compares very favorably with respect to dry weight concentrations (mg/kg) of metals found in captured sediments.[3]

	Detention Basin	Sand Filter	Sand Filter w/ Sediment Chamber	Wet Pond	Grassed Swale	BMP Average	Vortechs Average	Variation
Cadmium	4	1.3	4.6	6.4	1.9	3.6	2.8	-22%
Chromium	30	30	52	36	30	36	55	53%
Copper	59	43	71	24.5	27.	45	85	89%
Lead	161	81	171	160	420	199	417	110%
Nickel	N/A	30	49	38	13	33	37	12%
Zinc	448	182	418	299	202	310	470	52%
# of Observances	11	1	1	38	8	N/A	3	N/A

Research now indicates that the greatest environmental risk appears to occur when metal and hydrocarbon-laden sediments are deposited in downstream lakes and estuaries. This material has a long-term negative impact on the health of surface waters. The data presented in this report shows the Vortechs System is approximately 50% more effective in capturing these sediments than conventional BMP's.

[3]Schueler, Thomas R. and Yousef, Y. A. 1994. Pollutant Dynamics of Pond Muck. Watershed Protection Techniques. Vol. 1, No. 2, p. 44.

CONTECH ENGINEERED SOLUTIONS

Sizing for Net Annual Sediment Removal

One of the greatest threats to aquatic ecosystems is chronic pollution caused by stormwater runoff. Sediments and other associated pollutants accumulate over time seriously degrading surface water quality. For this reason, Contech Engineered Solutions LLC recommends sizing stormwater best management practices (BMPs) to provide a specific net reduction of pollutants on an annual basis. A typical net annual removal efficiency target is 80%, but depending on sensitivity of the receiving water body or the presence of other best management practices (BMPs), greater or lesser load reduction may be required.

This Technical Bulletin provides a simple two-step sizing methodology that will produce the most appropriate, and most cost effective Contech Engineered Solutions system for your site.

Step #1 – Sizing for a Specific Net Annual Load Reduction

Contech Engineered Solutions system performance is dependent on the local rainfall intensity distribution and other site-specific factors. In order to account for regional rainfall differences, Contech Engineered Solutions developed the Rational Rainfall Method™ of sizing. Central to the method is the design ratio, which changes according to regional differences in precipitation patterns, as well as site and model characteristics. Maximum design ratios for different geographic regions across North America have been determined through analysis of historical precipitation records archived by the National Climatic Data Center.

To determine the minimum Contech Engineered Solutions system model that will meet your treatment objective, perform the following steps:

A. Determine the net annual removal efficiency target and time of concentration that best match your site.

B. Determine the design ratio for your site location that corresponds to your treatment goal and time of concentration. The design ratio for the chosen model should not exceed the target design ratio (see below equation). Please contact your local Contech Engineered Solutions representative for the appropriate design ratio number.

Imperial:

$$\text{Target Design Ratio} \geq \frac{C_dA * 448.83 \text{ gpm/cfs}}{\text{Grit Chamber Area}}$$

Metric:

$$\text{Target Design Ratio} \geq \frac{C_dA * 2.78}{\text{Grit Chamber Area}}$$

Where:

A = Drainage Area (acres/hectares)
C_d = Runoff Coefficient

C. Calculate the necessary swirl chamber area and corresponding Contech Engineered Solutions system model using the following equation:

Imperial:

$$\text{Minimum Swirl Chamber Area} \geq \frac{C_dA * 448.83 \text{ gpm/cfs}}{\text{Design Ratio}}$$

Metric:

$$\text{Minimum Swirl Chamber Area} \geq \frac{C_dA * 2.77}{\text{Design Ratio}}$$

CONTECH® ENGINEERED SOLUTIONS

D. Based on the required swirl chamber area calculated in Step C, choose the appropriate Vortechs® model number from Table 3.1.

   This is the smallest model that can be expected to achieve your treatment goal. To decide if this Contech Engineered Solutions system will be "on-line", without a bypass, or "off-line", with a bypass, proceed to Step #2.

Vortechs® Model	Grit Chamber Area	
	ft^2	m^2
1000	0 - 7	0 - 0.66
2000	7 - 13	0.66 - 1.7
3000	13 - 20	1.7 - 1.8
4000	20 - 28	1.8 - 2.6
5000	28 - 38	2.6 - 3.6
7000	38 - 50	3.6 - 4.7
9000	50 - 64	4.7 - 5.9
11000	64 - 79	5.9 - 7.3
16000	79 - 113	7.3 - 10.5

Table 3.1

Step #2 – On-Line vs. Off-Line Configuration

The Contech Engineered Solutions system has been tested at operating rates up to 100 gpm/ft2 (70 L/m2) of swirl chamber surface area, which corresponds to the peak treatment capacity for each model, and has been found to provide positive removal efficiencies of suspended solids throughout this range. Flow rates exceeding the treatment capacity of the system may cause resuspension of previously captured materials, therefore, it is recommended that flows in excess of the peak treatment capacity for each respective model be bypassed.

The appropriate configuration of the model selected in Step #1 is determined as follows:

A. Calculate the flow rate resulting from an infrequent (10 to 25-year recurrence interval) storm on your site.

B. Compare this flow rate to the peak treatment capacity (Table 3.2) of the model selected in Step #1.

   1. If it is less, the model selected in Step #1 is appropriate on-line.

   2. If it is more, either:

      a. The model selected in Step #1 should be configured with a bypass (provided by Contech Engineered Solutions) in an off-line orientation, or
      b. A system should be selected from Table 3.2 with a treatment capacity equal to or greater than the flow from above. This system should be configured on-line without a bypass.

Vortechs® Model	Peak Treatment Flow	
	cfs	L/s
1000	1.6	45
2000	2.8	80
3000	4.5	130
4000	6.0	170
5000	8.5	240
7000	11	310
9000	14	400
11000	17.5	500
16000	25	710

Table 3.2

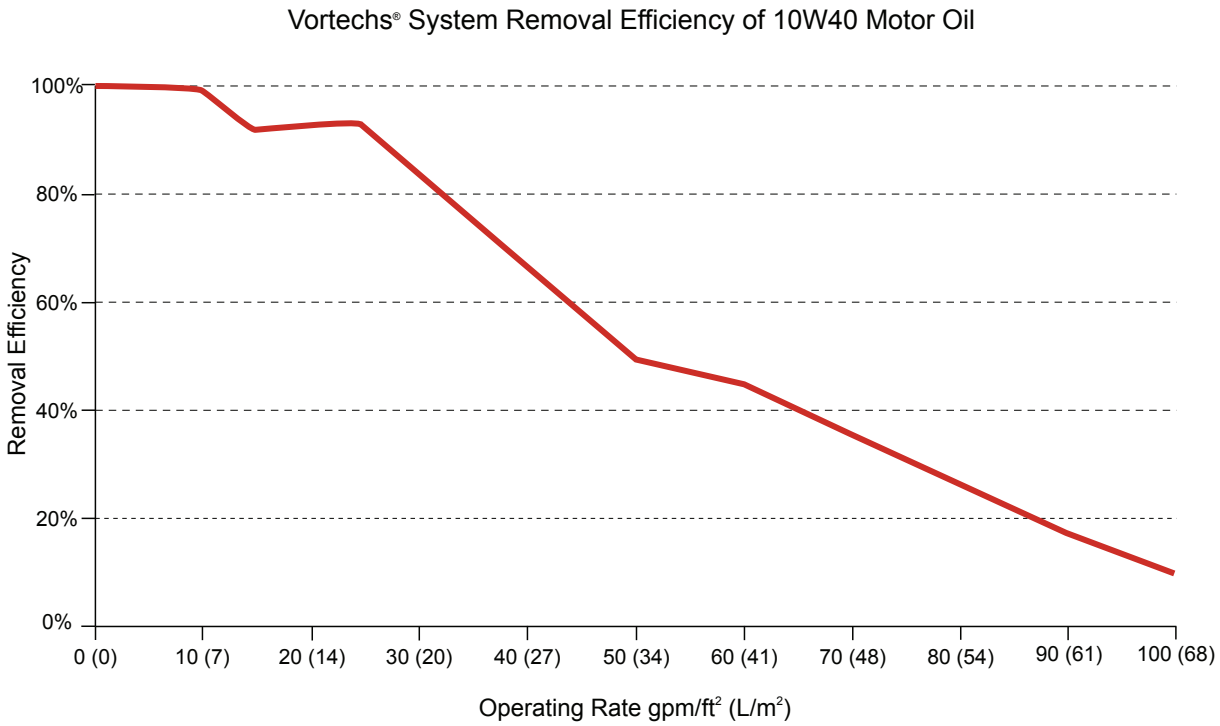
The choice between an off-line model and an on-line model is usually determined by economics. For example the cost savings gained by using the smaller off-line unit must be weighed against the cost of additional manholes typically required to split and rejoin bypassed flows. For pricing information please contact your Contech Engineered Solutions representative.

CONTECH ENGINEERED SOLUTIONS

Vortechs® System Performance: Oil Removal Efficiency

Petroleum based hydrocarbons are transported in stormwater at event mean concentrations typically ranging from two to five mg/L in residential areas to greater than 40 mg/L in concentrated traffic areas. Primary sources include leakage from improperly maintained vehicles; direct dumping of used oil and accidental spillage during maintenance and refueling of vehicles. The following Contech Engineered Solutions system performance curve was generated from tests performed in the Contech Engineered Solutions laboratory, with a full scale Vortechs® model 2000, using 10W40 motor oil. Oil was metered into the system using a variable speed peristaltic pump, producing influent concentrations between 15 mg/L and 90 mg/L. Influent concentrations decreased with operating rates, to simulate field conditions where the majority of oil is transported in the first flush and diluted at high flow rates. All samples were taken in one liter tinted glass bottles, fixed with H_2SO_4, and analyzed according to EPA Method 1664 by an independent laboratory.

Many localities recognize the potentially lethal effects of oil and grease in aquatic systems and require treatment of stormwater from high-risk areas. The Contech Engineered Solutions system can help protect sensitive watersheds by removing very high percentages of incoming free oil. All Models provide emergency spill containment and can be designed to detain specific volumes. The graph below shows the removal efficiencies of the System over the range of operating rates. Routine storm events (about 80 to 90 percent of annual runoff volume) typically produce operating rates of less than 25 gpm/ft2. At these lower operating rates, removal efficiencies are very high. Peak design storm flow rates (e.g., 10-year storms) may cause Contech Engineered Solutions systems to operate at up to 100 gpm/ft2.



SOLMAX

PVC ONE PIECE LINER

UNFOLDING INSTRUCTIONS

1) Place liner in the corner of one end of the excavation.
   If the slope is not too steep, it is best to place it at the top of the excavation.
2) Pull the liner down the slope and across the excavation and back up the other slope, as shown in the photo.
   It is back and forth folded, accordion style.
   It will easily pull off the pallet.
3) Once it is stretched out length wise across the excavation, the next step is to unfold it Left or right. Pull the liner in each direction over and up the slope.

To accomplish this with manpower, you can fold over the outer edge and poke a hole so that a rope or sling can be attached. This usually can be accomplished with 4 workers.
Depending on the length of the liner you may need to pull it with an excavator.

AIDEN ASSOCIATES, LLC

44 Pine Aire Way, Winthrop, ME 04364
aidenassociatesme@gmail.com
PH: (207) 215-6096

PIPE PENETRATION INSTALLATION INSTRUCTIONS
FOR
PVC LINERS

There are two methods currently being used for pipe penetrations

1) Cut, stretch and clamp
2) PVC Boots

1) Method 1 Cut, Stretch and Clamp

1. PULL THE LINER DOWN BELOW THE PIPE INVERT TO ALLOW SLACK IN THE MATERIAL BEFORE CUTTING.

2. CUT A VERTICAL AND HORIZONTAL CUT SLIGHTLY SMALLER THAN THE PIPE DIAMETER.

3. STRETCH THE LINER OVER THE PIPE. IT IS VERY FLEXIBLE AND IT WILL STRETCH AND FORM AROUND THE PIPE.

4) ATTACH STAINLESS STEEL CLAMP AROUND THE LINER AND PIPE.

2) PVC PIPE BOOTS

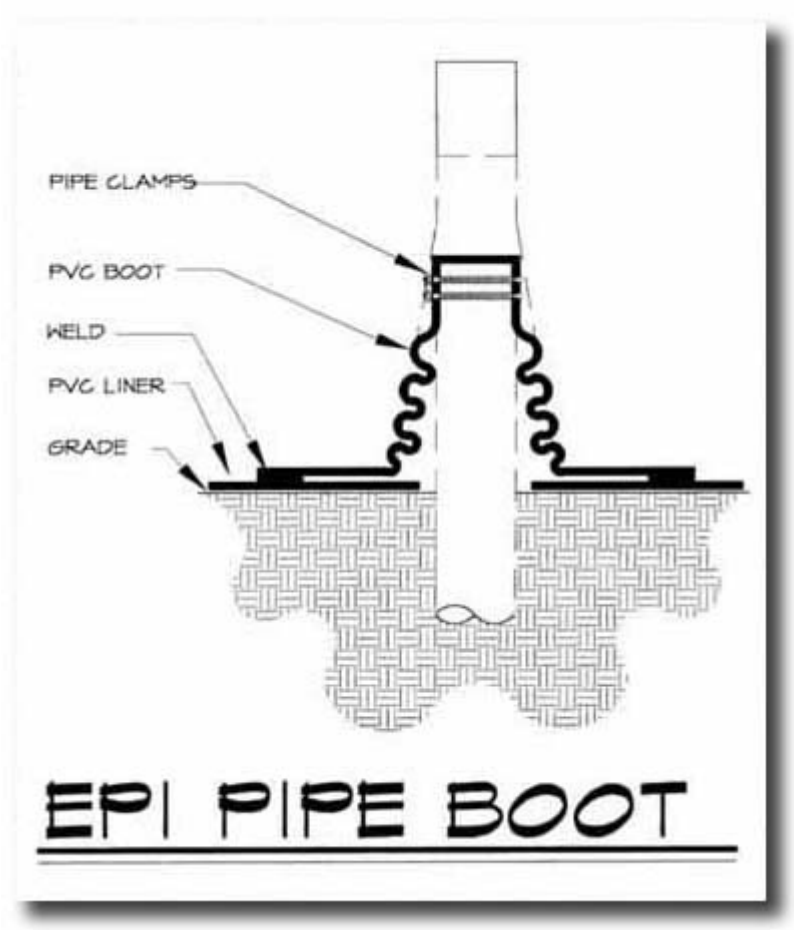
PVC Boots are made from 30 MIL PVC liner material

1) CUT A VERTICAL AND HORIZONTAL CUT SLIGHTLY SMALLER THAN THE PIPE DIAMETER.

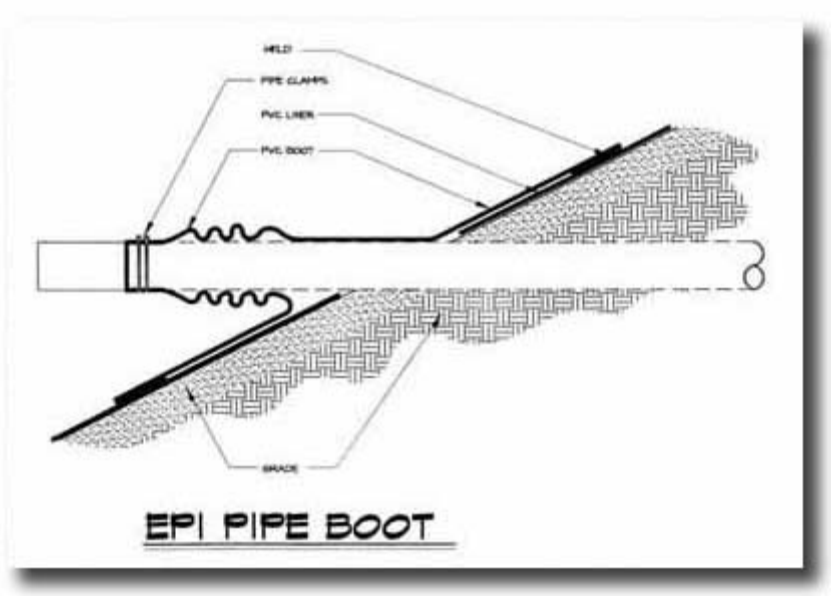
2) STRETCH THE LINER OVER THE PIPE. IT IS VERY FLEXIBLE AND IT WILL STRETCH AND FORM AROUND THE PIPE.
3) SLIDE PVC BOOT OVER THE PIPE AND TAPE OR GLUE THE BOOT TO THE LINER
Use Titus double sided moldable sealant tape or PVC Vinyl Adhesive

EPI Factory Fabricated Tapered Sleeve Pipe Boots

EPI has developed the newest innovation in pipe penetration sealing. We can now provide you with PVC boots with tapered sleeves which will accommodate movement of the pipe or subgrade by up to 3". Fabricated by EPI using 30 mil PVC, the sleeve is thermally welded to the boot apron. After installation and welding the apron to the main liner, the tapered sleeve can be compressed on both straight and sloped boots, to allow movement of the pipe or soil without damage to the boot.



Straight Pipe Boot



Sloped Pipe Boot

Boot Installation Instructions:

Step 1:

Prepare the subgrade around the area of the pipe. The sub-grade must be smooth, uniform, and free of any protrusions.

Step 2:

Clean the surface of the liner around the penetration where the boot will be welded in place. Wipe away any dirt or dust particles. The surfaces of the liner, boot, and the pipe must be completely clean and dry.

Step 3:

Slide the boot sleeve on the pipe, making sure the boot is aligned and all surfaces are smooth. It may be necessary to trim the excess tapered portion of the boot sleeve.

Step 4:

Weld the boot apron to the liner using EPI provided **adhesive**. Apply the adhesive to the liner and the boot apron. Let the adhesive setup for several seconds before pressing the boot apron and the liner together using a roller. Make sure to smooth out any bubbles or wrinkles.

Step 5:

Seal the boot sleeve to the pipe using the stainless steel hose clamps provided. The clamps around the pipe will form a watertight seal to the pipe.

Standard sloped boots will accommodate slopes from 1/1 to 4/1 because of our unique design. Straight or sloped boots are available for all standard size pipes up to 12" diameter. Larger sizes can be custom made. Just give us the diameter of the pipe and the slope angle.

- Click here for **Boot Install Instuctions** *PDF*
- Click here for **Boot Details Form** *PDF*

*For more information call **800-OK-LINER** today!*

- Custom Fabrication
- Technical Service Rep
- Terms and Conditions

B.3: Total Suspended Solids

Location: Greenmont Commons

TSS Removal Calculation Worksheet

B 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
Vortechnics Hydrodynamic Separator	0.50	0.75	0.38	0.37
Extended Detention Wetland Basin	0.80	0.37	0.30	0.07

Total TSS Removal = 93%

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

Project: Greenmont Commons

Prepared By: Cornerstone Land Associates, LLC

Date: 20-Aug-24

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

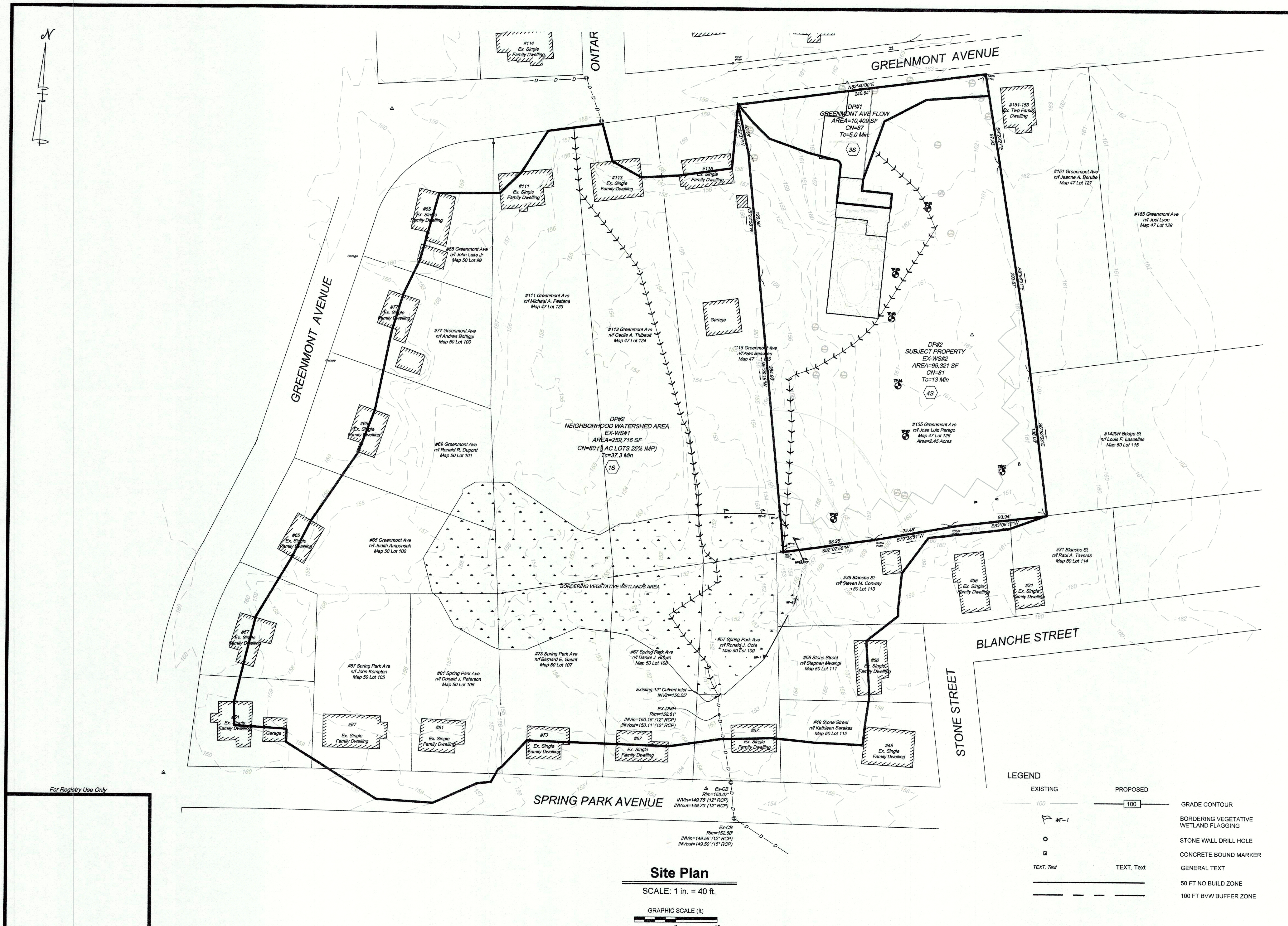
Non-automated TSS Calculation Sheet must be used if Proprietary BMP Proposed

1. From MassDEP Stormwater Handbook Vol. 1

Appendix C: Hydrologic Analysis

C.1: Pre-Development Analysis

[Existing Watershed Plan & HydroCAD calculations]



EXISTING WATERSHED PLAN

Comprehensive Permit Application

135 GREENMONT AVENUE
DRACUT, MASSACHUSETTS

JOB NO.: 2021-235
SHEET: 1 of 1

DRAWING NO.
EX-WS

SCALE: As Shown
DATE: May 18, 2023

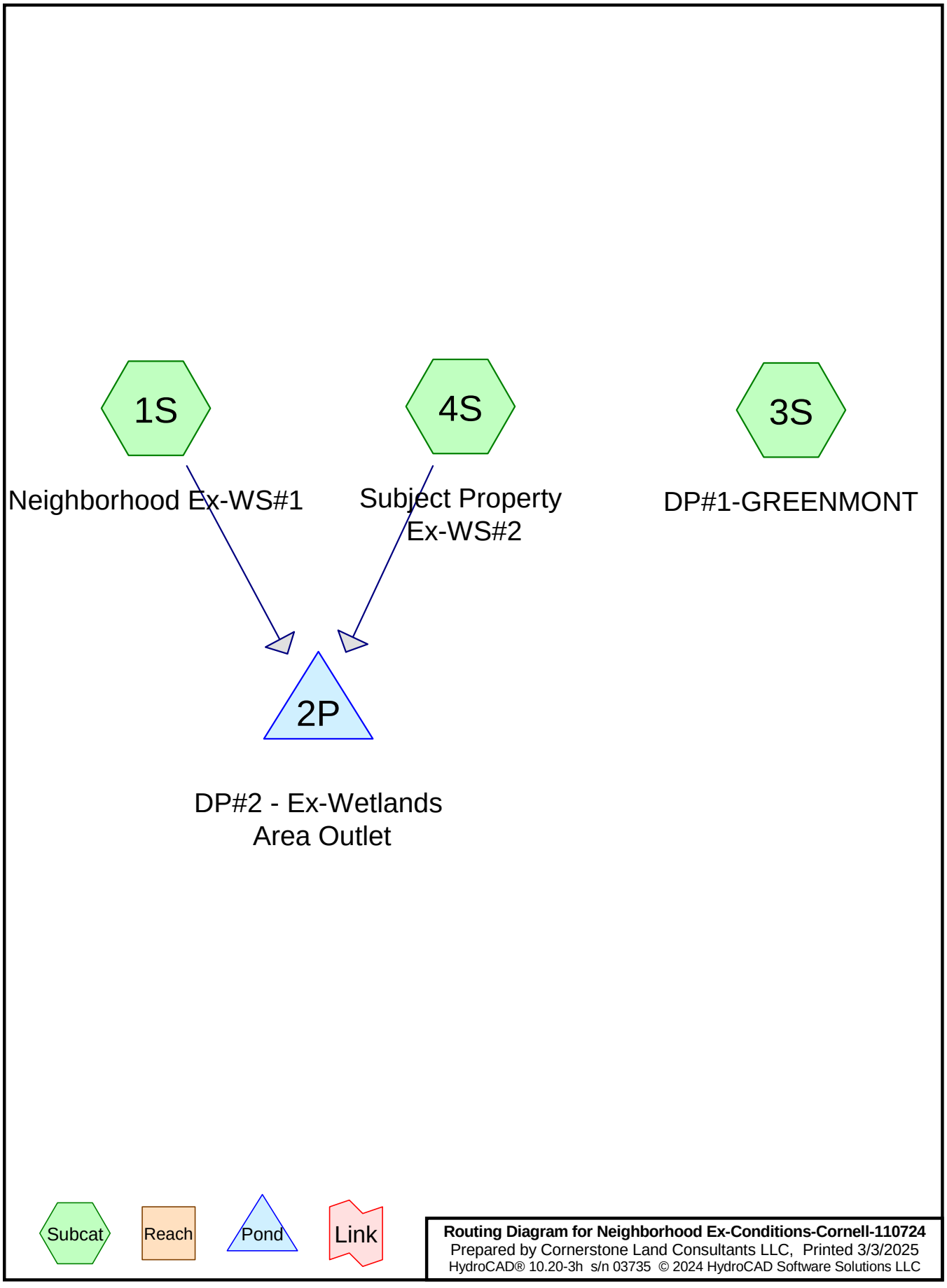
PREPARED FOR:
Riverbank Properties
908 Lawrence Street
Lowell, MA 01852

Cornerstone Land Associates, LLC
Civil & Structural Engineering
Land Surveying · Land Development
25 Dean Avenue · Dracut, MA 01826 · (978) 835-0102
kmconsultants@comcast.net

Date	Revision	BY
11/29/23	REVS PER ZONING BOARD OF APPEALS MEETING AND ZBA PEER REVIEW COMMENTS	KML
06/05/24	REVS PER ZONING BOARD OF APPEALS MEETING AND ZBA PEER REVIEW COMMENTS	KML
08/20/24	REVS PER ZONING BOARD OF APPEALS MEETING AND ZBA PEER REVIEW COMMENTS	KML
10/10/24	REVS PER ZONING BOARD OF APPEALS MEETING AND ZBA PEER REVIEW COMMENTS	KML
11/07/24	REVS PER ZONING BOARD OF APPEALS MEETING AND ZBA PEER REVIEW COMMENTS	KML

Design by KML
Survey by KML/TAJ
Draft by KML
Check by JAV/TAJ

Certification not valid without ORIGINAL stamp and/or signature



Routing Diagram for Neighborhood Ex-Conditions-Cornell-110724
Prepared by Cornerstone Land Consultants LLC, Printed 3/3/2025

Area Listing (all nodes)

Area (acres)	CN	Description (subcatchment-numbers)
5.962	85	1/2 acre lots, 25% imp, HSG D (1S)
2.239	80	>75% Grass cover, Good, HSG D (3S, 4S)
0.188	98	Paved parking, HSG D (3S, 4S)
0.023	98	Roofs, HSG D (3S)

Summary for Subcatchment 1S: Neighborhood Ex-WS#1

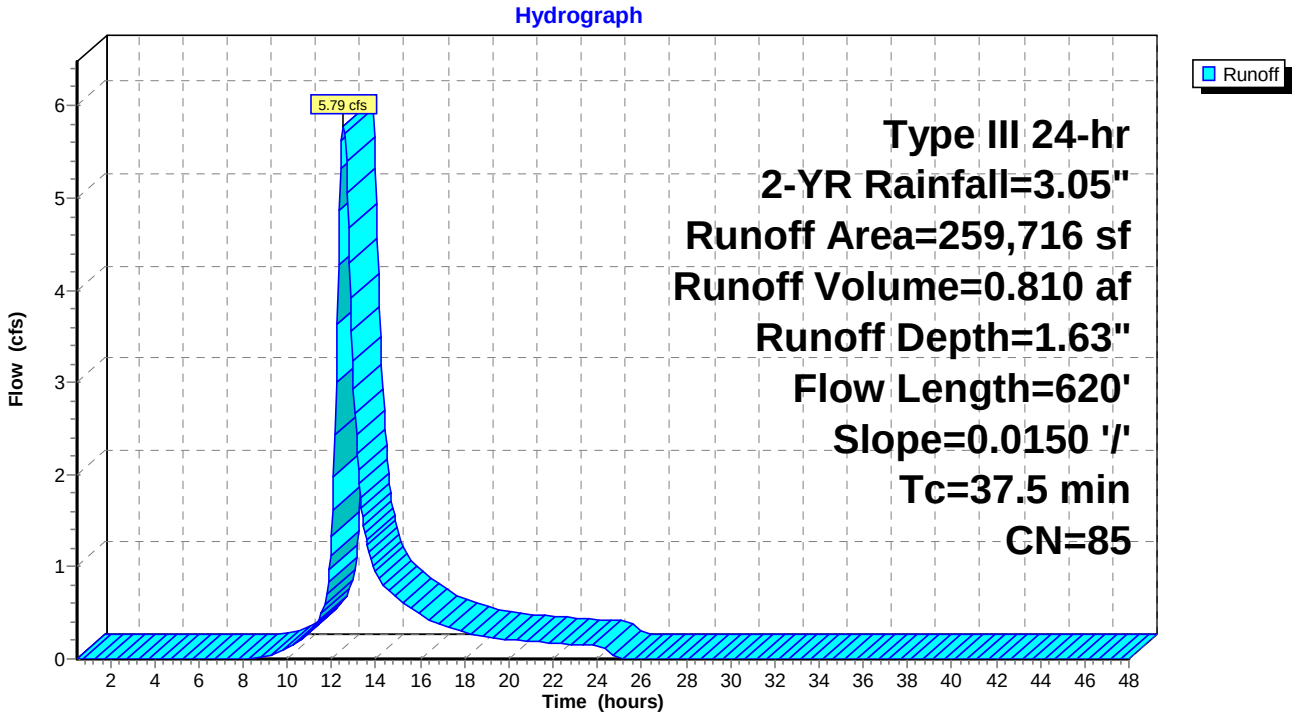
Runoff = 5.79 cfs @ 12.53 hrs, Volume= 0.810 af, Depth= 1.63"
Routed to Pond 2P : DP#2 - Ex-Wetlands Area Outlet

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.50-48.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-YR Rainfall=3.05"

Area (sf)	CN	Description
259,716	85	1/2 acre lots, 25% imp, HSG D
194,787		75.00% Pervious Area
64,929		25.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.5	50	0.0150	0.13		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.05"
31.0	570	0.0150	0.31		**Shallow Concentrated Flow,** Forest w/Heavy Litter Kv= 2.5 fps
37.5	620	Total			

Subcatchment 1S: Neighborhood Ex-WS#1



Summary for Subcatchment 3S: DP#1-GREENMONT

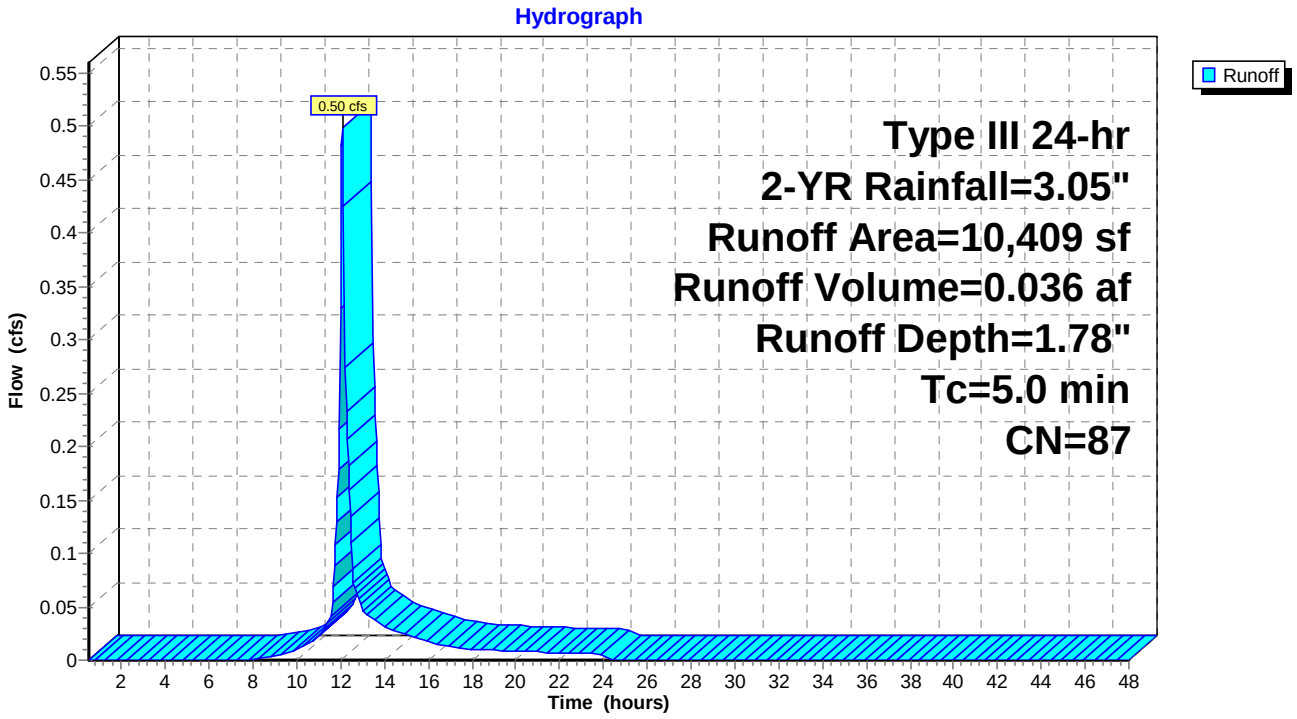
Runoff = 0.50 cfs @ 12.08 hrs, Volume= 0.036 af, Depth= 1.78"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.50-48.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-YR Rainfall=3.05"

Area (sf)	CN	Description
981	98	Roofs, HSG D
2,843	98	Paved parking, HSG D
4,478	80	>75% Grass cover, Good, HSG D
2,107	80	>75% Grass cover, Good, HSG D
10,409	87	Weighted Average
6,585		63.26% Pervious Area
3,824		36.74% Impervious Area

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

Subcatchment 3S: DP#1-GREENMONT



Summary for Subcatchment 4S: Subject Property Ex-WS#2

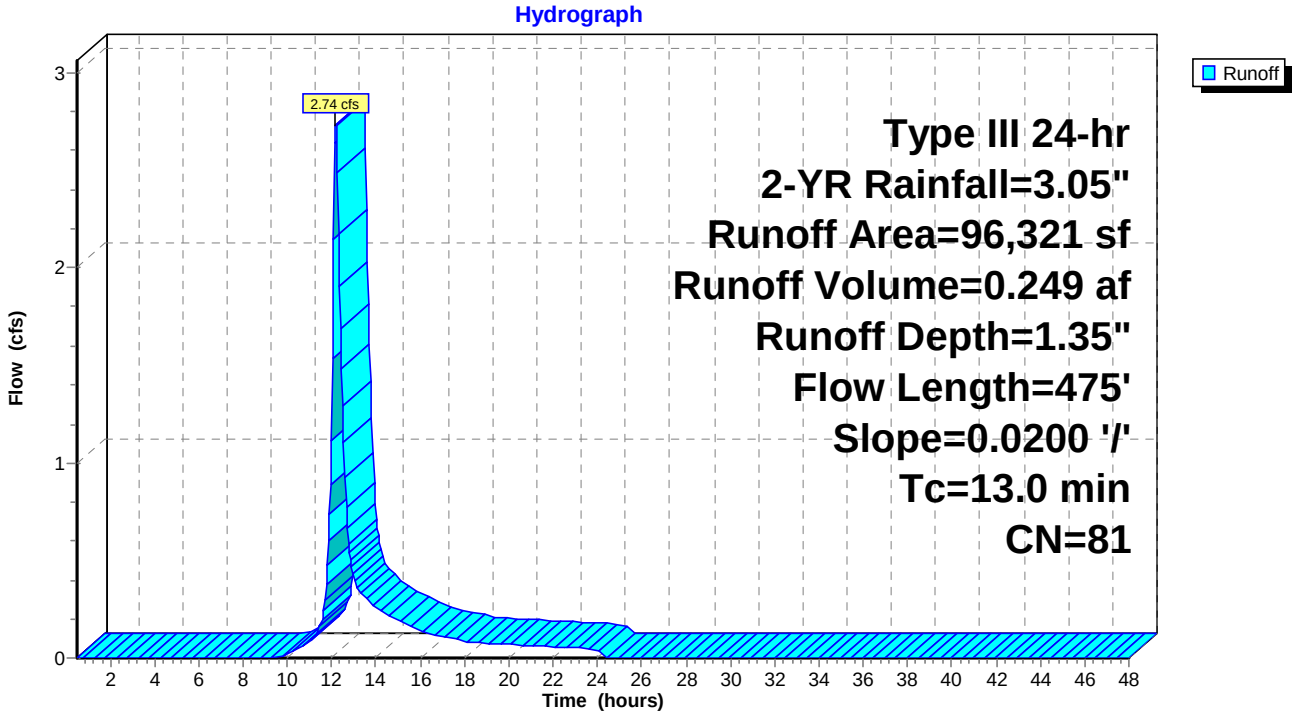
Runoff = 2.74 cfs @ 12.19 hrs, Volume= 0.249 af, Depth= 1.35"
Routed to Pond 2P : DP#2 - Ex-Wetlands Area Outlet

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.50-48.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-YR Rainfall=3.05"

Area (sf)	CN	Description
5,364	98	Paved parking, HSG D
90,957	80	>75% Grass cover, Good, HSG D
96,321	81	Weighted Average
90,957		94.43% Pervious Area
5,364		5.57% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.8	50	0.0200	0.14		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.05"
7.2	425	0.0200	0.99		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
13.0	475	Total			

Subcatchment 4S: Subject Property Ex-WS#2



Summary for Pond 2P: DP#2 - Ex-Wetlands Area Outlet

Inflow Area = 8.173 ac, 19.74% Impervious, Inflow Depth = 1.56" for 2-YR event
Inflow = 7.12 cfs @ 12.46 hrs, Volume= 1.059 af
Outflow = 3.95 cfs @ 12.91 hrs, Volume= 1.058 af, Atten= 45%, Lag= 27.2 min
Primary = 3.95 cfs @ 12.91 hrs, Volume= 1.058 af

Routing by Stor-Ind method, Time Span= 0.50-48.00 hrs, dt= 0.05 hrs
Peak Elev= 152.09' @ 12.91 hrs Surf.Area= 16,626 sf Storage= 7,474 cf

Plug-Flow detention time= 14.6 min calculated for 1.058 af (100% of inflow)
Center-of-Mass det. time= 13.5 min (868.9 - 855.3)

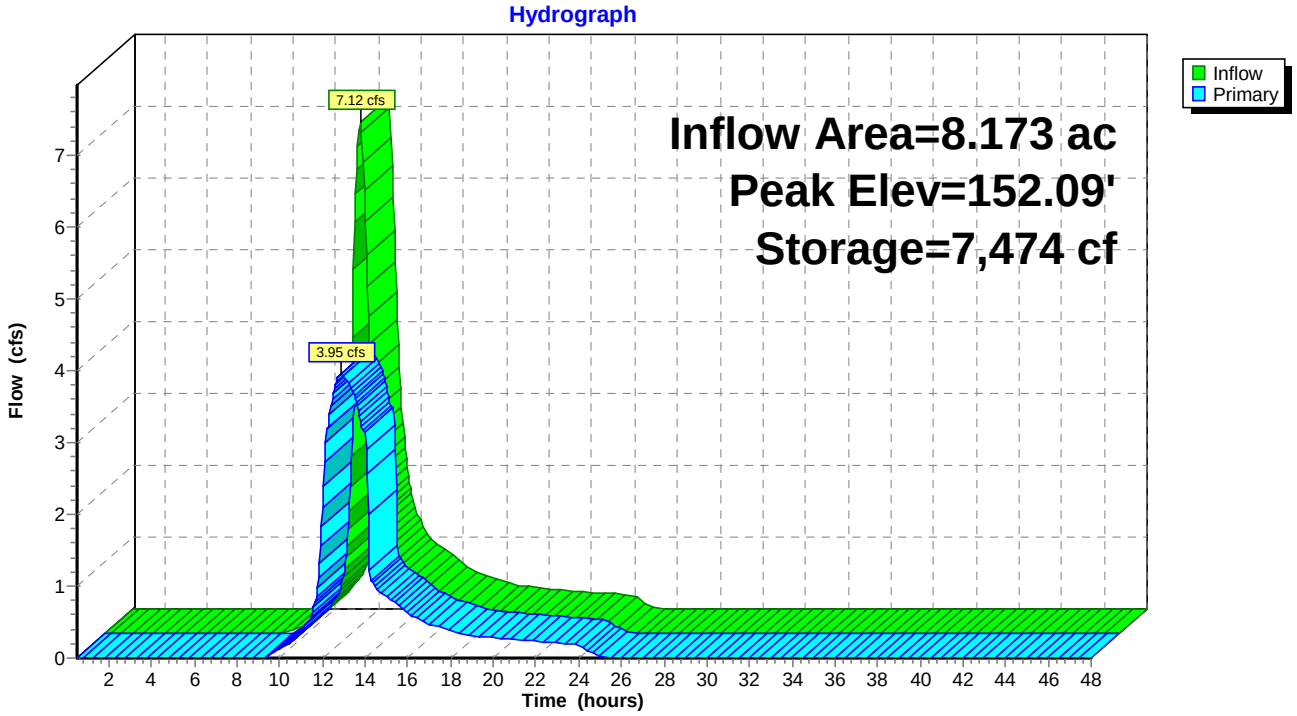
Volume	Invert	Avail.Storage	Storage Description
#1	150.00'	184,747 cf	**Custom Stage Data (Irregular)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
150.00	208	75.0	0	0	208
151.00	328	94.0	266	266	477
152.00	14,780	1,138.0	5,770	6,036	102,832
153.00	40,797	1,192.0	26,711	32,747	112,912
154.00	69,661	1,810.0	54,589	87,336	260,555
155.00	128,105	2,354.0	97,411	184,747	440,827

Device	Routing	Invert	Outlet Devices
#1	Primary	150.25'	**12.0" Round Culvert** L= 83.0' RCP, groove end projecting, Ke= 0.200 Inlet / Outlet Invert= 150.25' / 149.75' S= 0.0060 '/' Cc= 0.900 n= 0.012 Concrete pipe, finished, Flow Area= 0.79 sf
#2	Primary	153.07'	**2.0" x 2.0" Horiz. Orifice/Grate X 6.00 columns** X 6 rows C= 0.600 Limited to weir flow at low heads

Primary OutFlow Max=3.95 cfs @ 12.91 hrs HW=152.09' (Free Discharge)
└─**1=Culvert** (Barrel Controls 3.95 cfs @ 5.03 fps)
└─**2=Orifice/Grate** (Controls 0.00 cfs)

Pond 2P: DP#2 - Ex-Wetlands Area Outlet



Summary for Subcatchment 1S: Neighborhood Ex-WS#1

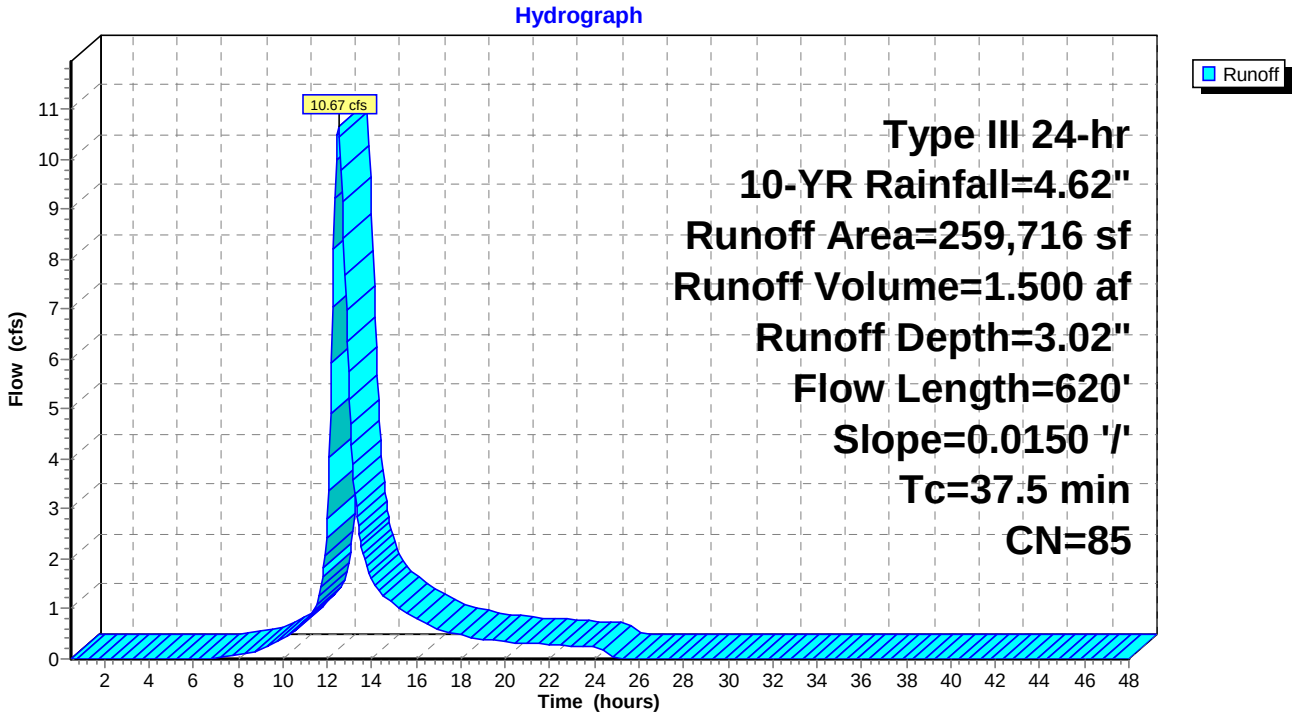
Runoff = 10.67 cfs @ 12.51 hrs, Volume= 1.500 af, Depth= 3.02"
Routed to Pond 2P : DP#2 - Ex-Wetlands Area Outlet

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.50-48.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-YR Rainfall=4.62"

Area (sf)	CN	Description
259,716	85	1/2 acre lots, 25% imp, HSG D
194,787		75.00% Pervious Area
64,929		25.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.5	50	0.0150	0.13		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.05"
31.0	570	0.0150	0.31		**Shallow Concentrated Flow,** Forest w/Heavy Litter Kv= 2.5 fps
37.5	620	Total			

Subcatchment 1S: Neighborhood Ex-WS#1



Summary for Subcatchment 3S: DP#1-GREENMONT

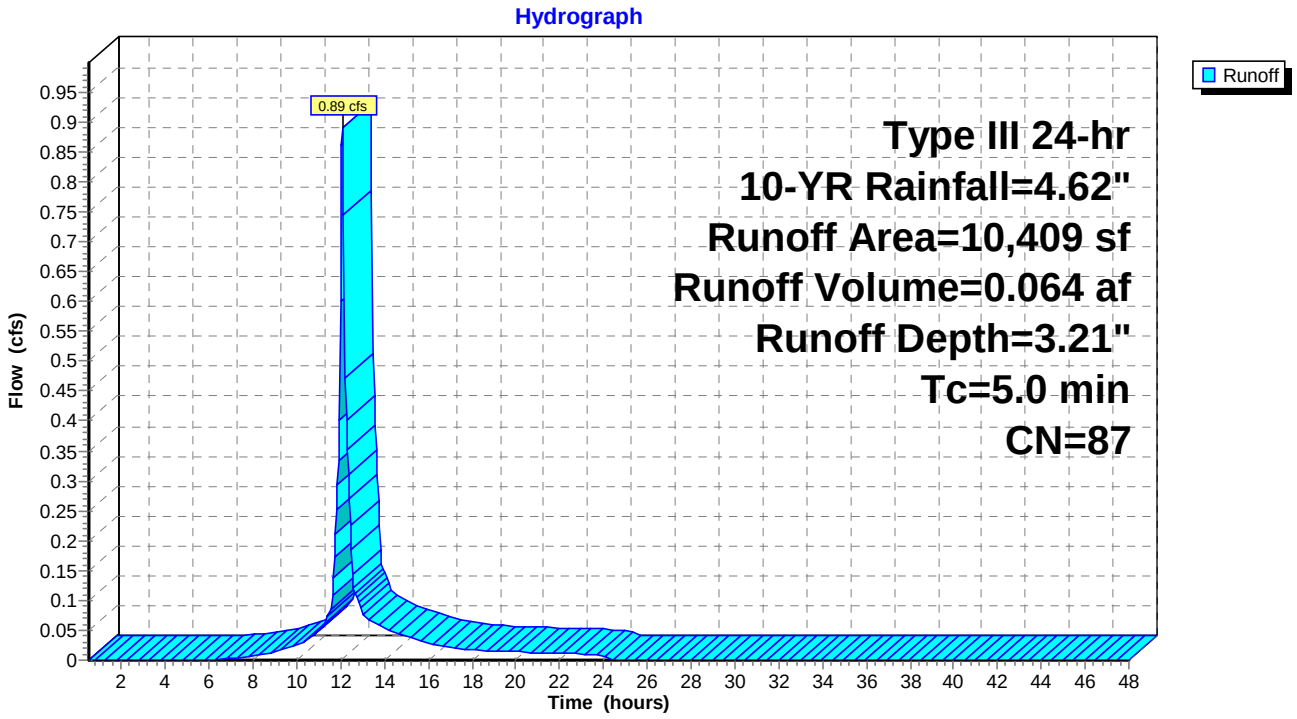
Runoff = 0.89 cfs @ 12.07 hrs, Volume= 0.064 af, Depth= 3.21"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.50-48.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-YR Rainfall=4.62"

Area (sf)	CN	Description
981	98	Roofs, HSG D
2,843	98	Paved parking, HSG D
4,478	80	>75% Grass cover, Good, HSG D
2,107	80	>75% Grass cover, Good, HSG D
10,409	87	Weighted Average
6,585		63.26% Pervious Area
3,824		36.74% Impervious Area

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

Subcatchment 3S: DP#1-GREENMONT



Summary for Subcatchment 4S: Subject Property Ex-WS#2

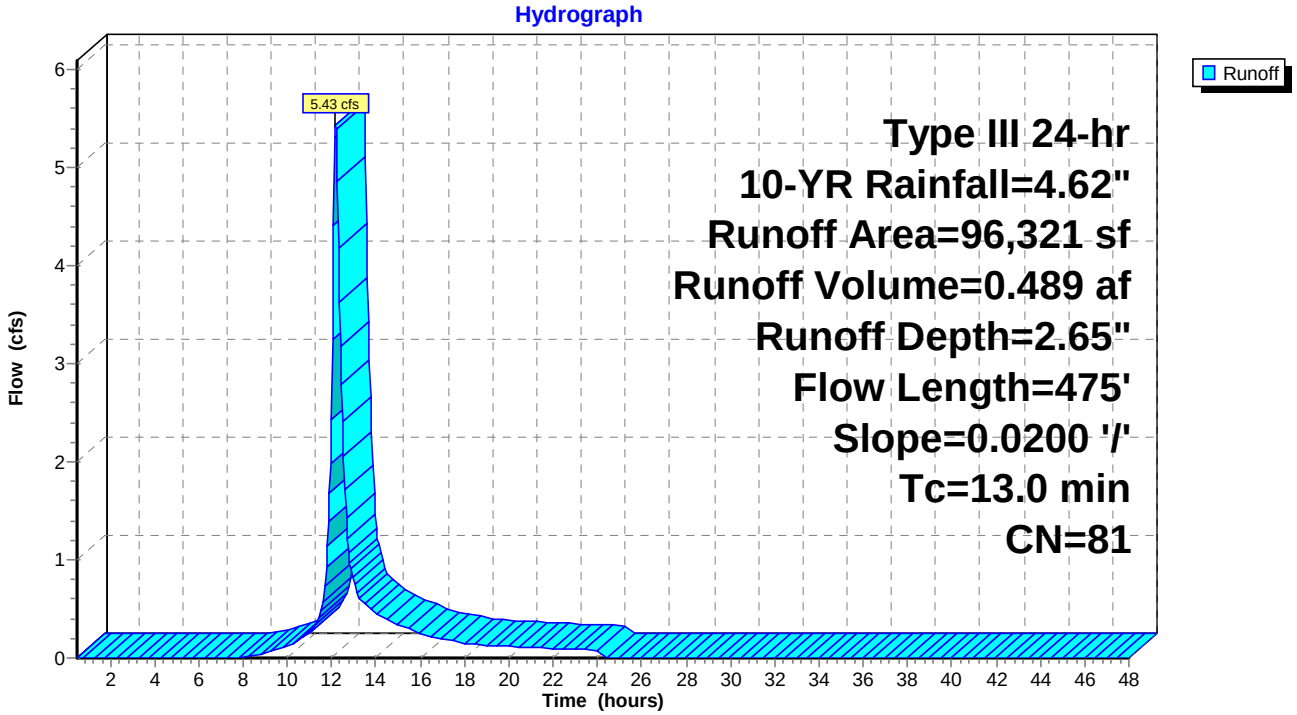
Runoff = 5.43 cfs @ 12.18 hrs, Volume= 0.489 af, Depth= 2.65"
Routed to Pond 2P : DP#2 - Ex-Wetlands Area Outlet

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.50-48.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-YR Rainfall=4.62"

Area (sf)	CN	Description
5,364	98	Paved parking, HSG D
90,957	80	>75% Grass cover, Good, HSG D
96,321	81	Weighted Average
90,957		94.43% Pervious Area
5,364		5.57% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.8	50	0.0200	0.14		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.05"
7.2	425	0.0200	0.99		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
13.0	475	Total			

Subcatchment 4S: Subject Property Ex-WS#2



Summary for Pond 2P: DP#2 - Ex-Wetlands Area Outlet

Inflow Area = 8.173 ac, 19.74% Impervious, Inflow Depth = 2.92" for 10-YR event
Inflow = 13.27 cfs @ 12.44 hrs, Volume= 1.989 af
Outflow = 4.80 cfs @ 13.12 hrs, Volume= 1.987 af, Atten= 64%, Lag= 40.7 min
Primary = 4.80 cfs @ 13.12 hrs, Volume= 1.987 af

Routing by Stor-Ind method, Time Span= 0.50-48.00 hrs, dt= 0.05 hrs
Peak Elev= 152.74' @ 13.12 hrs Surf.Area= 32,686 sf Storage= 23,084 cf

Plug-Flow detention time= 37.1 min calculated for 1.987 af (100% of inflow)
Center-of-Mass det. time= 36.4 min (873.6 - 837.2)

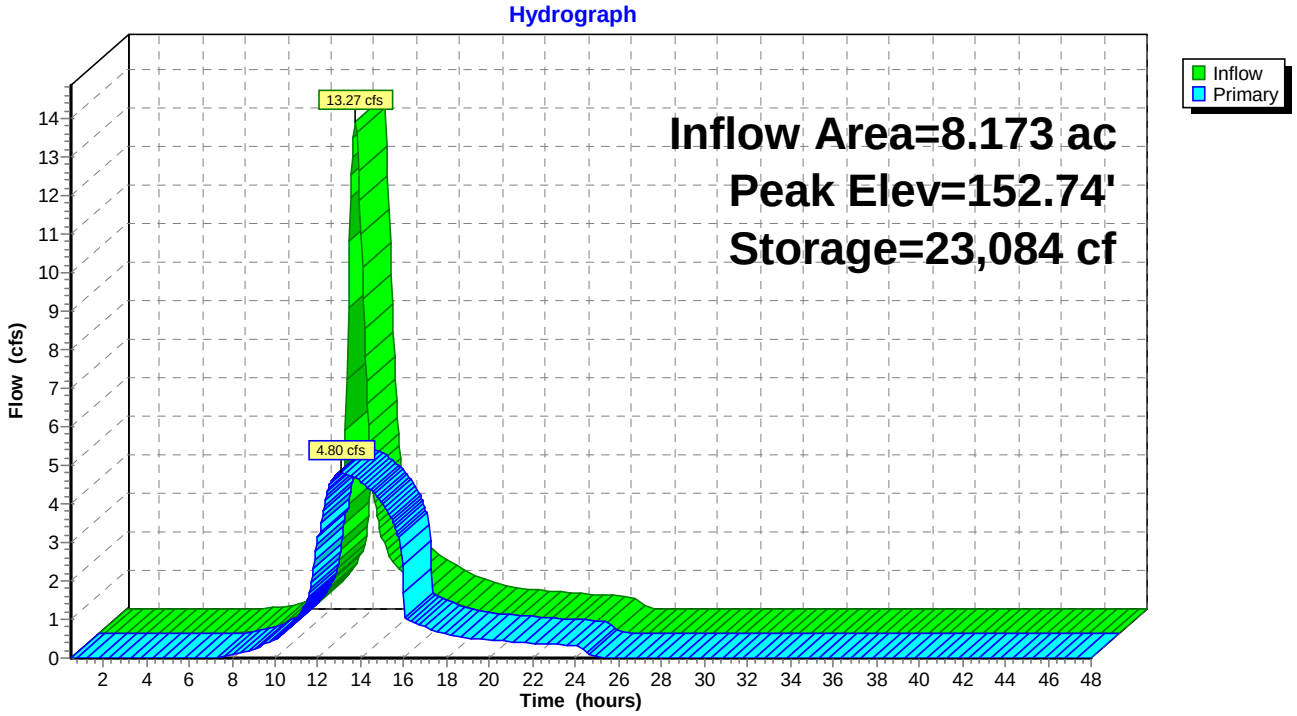
Volume	Invert	Avail.Storage	Storage Description
#1	150.00'	184,747 cf	**Custom Stage Data (Irregular)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
150.00	208	75.0	0	0	208
151.00	328	94.0	266	266	477
152.00	14,780	1,138.0	5,770	6,036	102,832
153.00	40,797	1,192.0	26,711	32,747	112,912
154.00	69,661	1,810.0	54,589	87,336	260,555
155.00	128,105	2,354.0	97,411	184,747	440,827

Device	Routing	Invert	Outlet Devices
#1	Primary	150.25'	**12.0" Round Culvert** L= 83.0' RCP, groove end projecting, Ke= 0.200 Inlet / Outlet Invert= 150.25' / 149.75' S= 0.0060 '/' Cc= 0.900 n= 0.012 Concrete pipe, finished, Flow Area= 0.79 sf
#2	Primary	153.07'	**2.0" x 2.0" Horiz. Orifice/Grate X 6.00 columns** X 6 rows C= 0.600 Limited to weir flow at low heads

Primary OutFlow Max=4.80 cfs @ 13.12 hrs HW=152.74' (Free Discharge)
└─**1=Culvert** (Barrel Controls 4.80 cfs @ 6.12 fps)
└─**2=Orifice/Grate** (Controls 0.00 cfs)

Pond 2P: DP#2 - Ex-Wetlands Area Outlet



Summary for Subcatchment 1S: Neighborhood Ex-WS#1

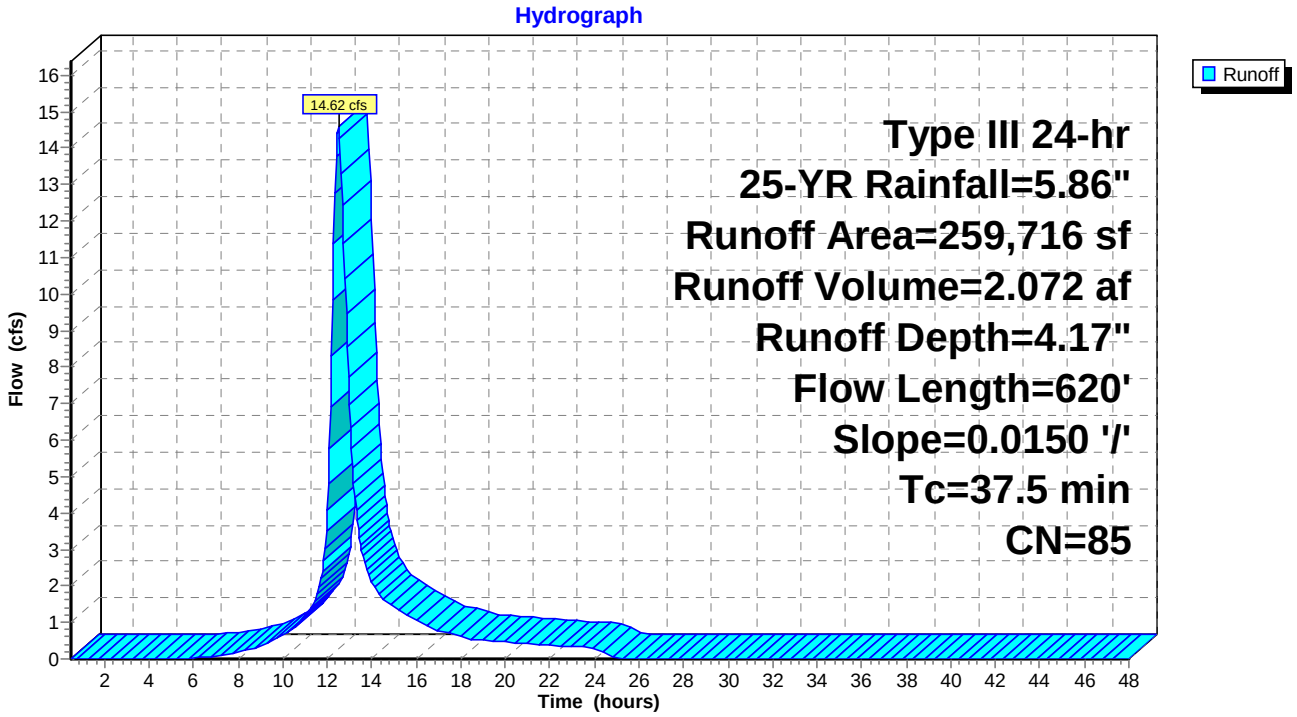
Runoff = 14.62 cfs @ 12.51 hrs, Volume= 2.072 af, Depth= 4.17"
Routed to Pond 2P : DP#2 - Ex-Wetlands Area Outlet

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.50-48.00 hrs, dt= 0.05 hrs
Type III 24-hr 25-YR Rainfall=5.86"

Area (sf)	CN	Description
259,716	85	1/2 acre lots, 25% imp, HSG D
194,787		75.00% Pervious Area
64,929		25.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.5	50	0.0150	0.13		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.05"
31.0	570	0.0150	0.31		**Shallow Concentrated Flow,** Forest w/Heavy Litter Kv= 2.5 fps
37.5	620	Total			

Subcatchment 1S: Neighborhood Ex-WS#1



Summary for Subcatchment 3S: DP#1-GREENMONT

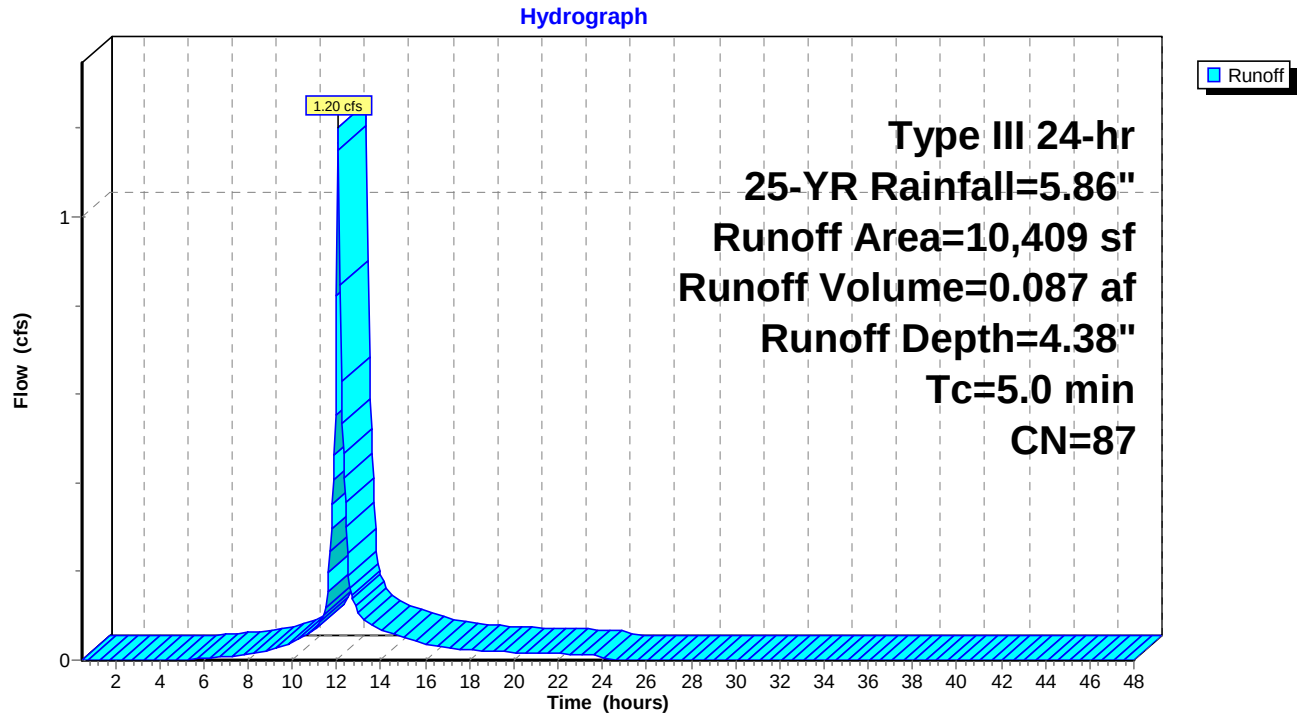
Runoff = 1.20 cfs @ 12.07 hrs, Volume= 0.087 af, Depth= 4.38"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.50-48.00 hrs, dt= 0.05 hrs
Type III 24-hr 25-YR Rainfall=5.86"

Area (sf)	CN	Description
981	98	Roofs, HSG D
2,843	98	Paved parking, HSG D
4,478	80	>75% Grass cover, Good, HSG D
2,107	80	>75% Grass cover, Good, HSG D
10,409	87	Weighted Average
6,585		63.26% Pervious Area
3,824		36.74% Impervious Area

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

Subcatchment 3S: DP#1-GREENMONT



Summary for Subcatchment 4S: Subject Property Ex-WS#2

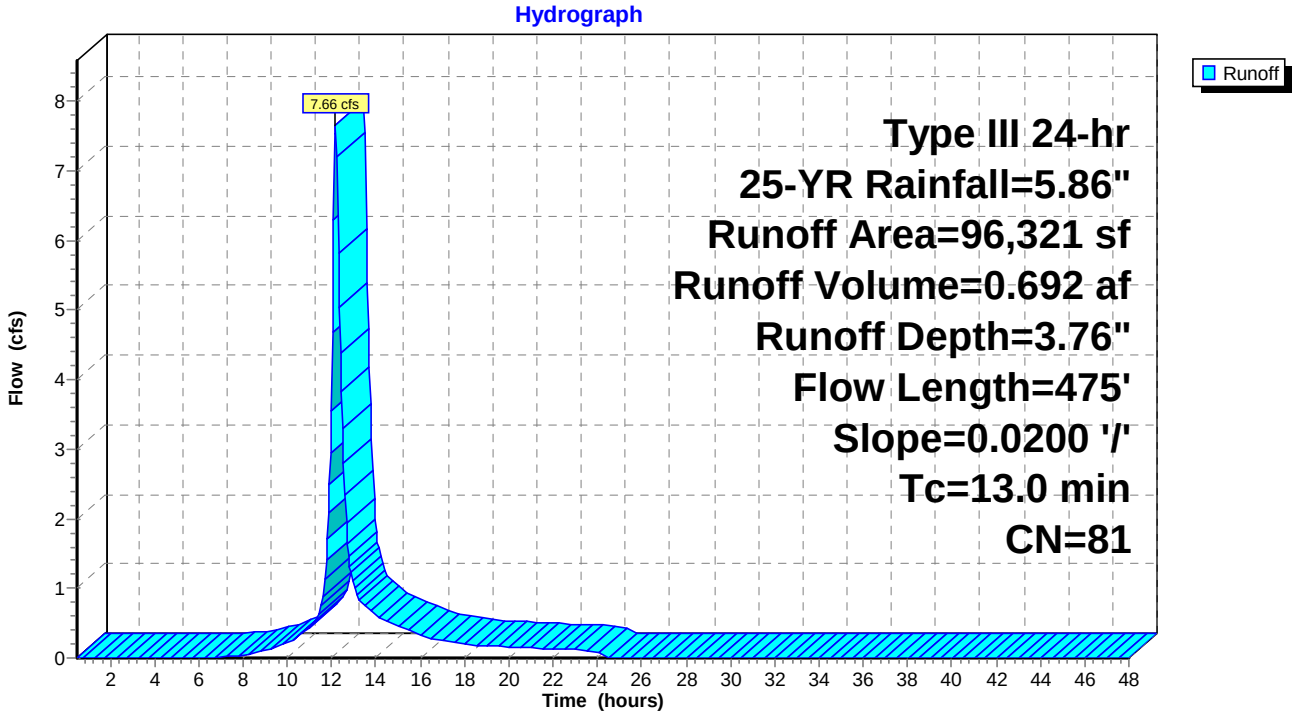
Runoff = 7.66 cfs @ 12.18 hrs, Volume= 0.692 af, Depth= 3.76"
Routed to Pond 2P : DP#2 - Ex-Wetlands Area Outlet

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.50-48.00 hrs, dt= 0.05 hrs
Type III 24-hr 25-YR Rainfall=5.86"

Area (sf)	CN	Description
5,364	98	Paved parking, HSG D
90,957	80	>75% Grass cover, Good, HSG D
96,321	81	Weighted Average
90,957		94.43% Pervious Area
5,364		5.57% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.8	50	0.0200	0.14		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.05"
7.2	425	0.0200	0.99		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
13.0	475	Total			

Subcatchment 4S: Subject Property Ex-WS#2



Summary for Pond 2P: DP#2 - Ex-Wetlands Area Outlet

Inflow Area = 8.173 ac, 19.74% Impervious, Inflow Depth = 4.06" for 25-YR event
Inflow = 18.25 cfs @ 12.43 hrs, Volume= 2.764 af
Outflow = 5.89 cfs @ 13.17 hrs, Volume= 2.763 af, Atten= 68%, Lag= 44.5 min
Primary = 5.89 cfs @ 13.17 hrs, Volume= 2.763 af

Routing by Stor-Ind method, Time Span= 0.50-48.00 hrs, dt= 0.05 hrs
Peak Elev= 153.11' @ 13.17 hrs Surf.Area= 43,670 sf Storage= 37,511 cf

Plug-Flow detention time= 56.6 min calculated for 2.760 af (100% of inflow)
Center-of-Mass det. time= 56.3 min (884.0 - 827.8)

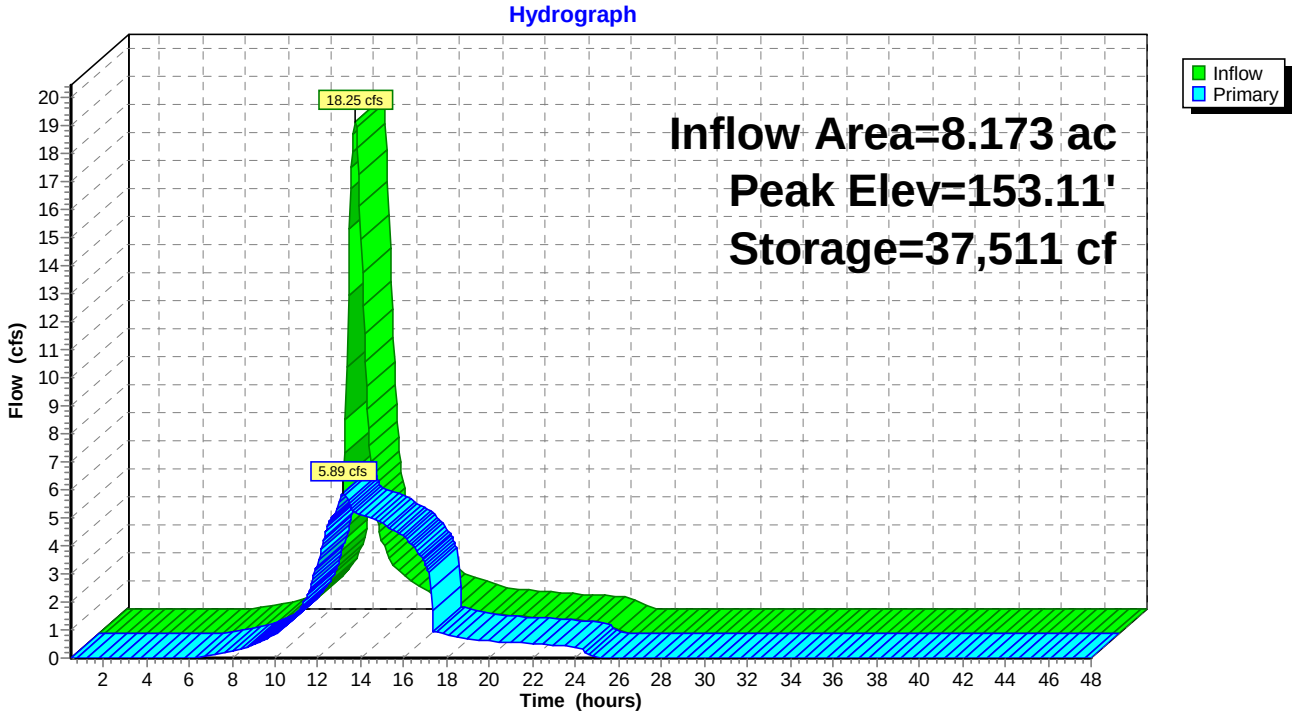
Volume	Invert	Avail.Storage	Storage Description
#1	150.00'	184,747 cf	**Custom Stage Data (Irregular)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
150.00	208	75.0	0	0	208
151.00	328	94.0	266	266	477
152.00	14,780	1,138.0	5,770	6,036	102,832
153.00	40,797	1,192.0	26,711	32,747	112,912
154.00	69,661	1,810.0	54,589	87,336	260,555
155.00	128,105	2,354.0	97,411	184,747	440,827

Device	Routing	Invert	Outlet Devices
#1	Primary	150.25'	**12.0" Round Culvert** L= 83.0' RCP, groove end projecting, Ke= 0.200 Inlet / Outlet Invert= 150.25' / 149.75' S= 0.0060 '/' Cc= 0.900 n= 0.012 Concrete pipe, finished, Flow Area= 0.79 sf
#2	Primary	153.07'	**2.0" x 2.0" Horiz. Orifice/Grate X 6.00 columns** X 6 rows C= 0.600 Limited to weir flow at low heads

Primary OutFlow Max=5.93 cfs @ 13.17 hrs HW=153.11' (Free Discharge)
1=Culvert (Barrel Controls 5.24 cfs @ 6.67 fps)
2=Orifice/Grate (Weir Controls 0.69 cfs @ 0.67 fps)

Pond 2P: DP#2 - Ex-Wetlands Area Outlet



Summary for Subcatchment 1S: Neighborhood Ex-WS#1

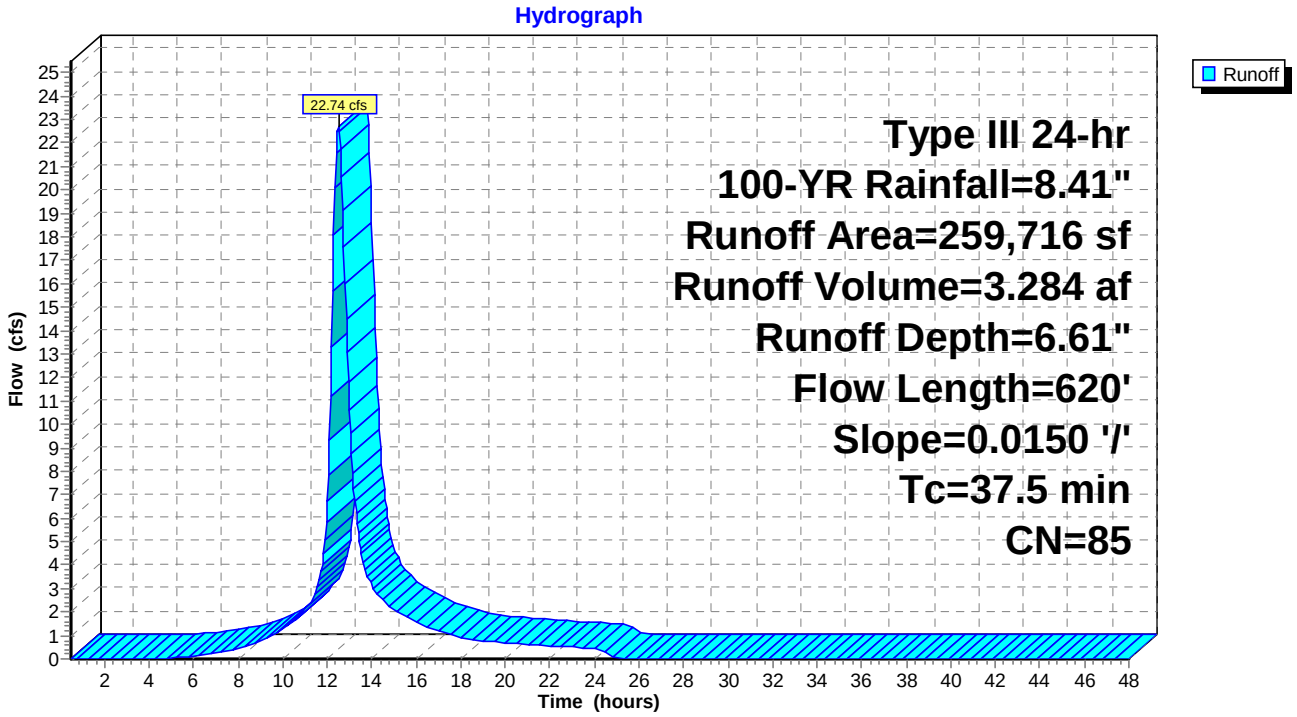
Runoff = 22.74 cfs @ 12.50 hrs, Volume= 3.284 af, Depth= 6.61"
Routed to Pond 2P : DP#2 - Ex-Wetlands Area Outlet

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.50-48.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-YR Rainfall=8.41"

Area (sf)	CN	Description
259,716	85	1/2 acre lots, 25% imp, HSG D
194,787		75.00% Pervious Area
64,929		25.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.5	50	0.0150	0.13		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.05"
31.0	570	0.0150	0.31		**Shallow Concentrated Flow,** Forest w/Heavy Litter Kv= 2.5 fps
37.5	620	Total			

Subcatchment 1S: Neighborhood Ex-WS#1



Summary for Subcatchment 3S: DP#1-GREENMONT

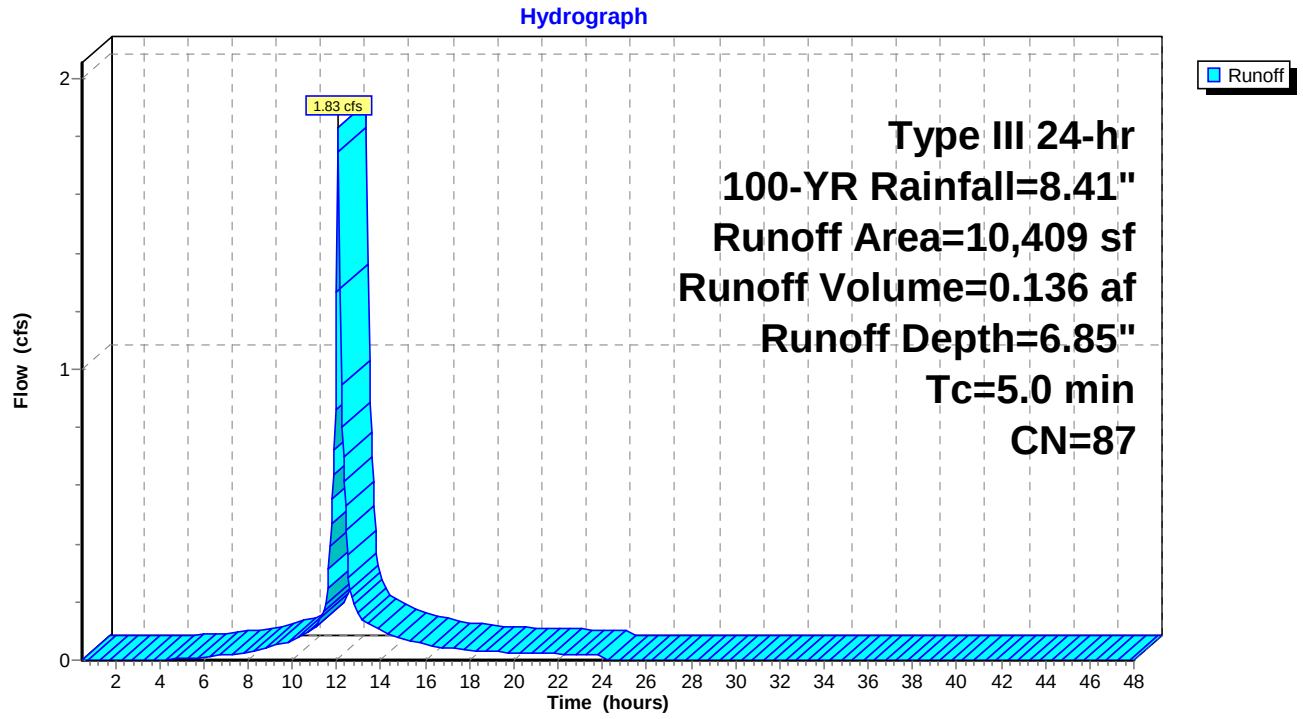
Runoff = 1.83 cfs @ 12.07 hrs, Volume= 0.136 af, Depth= 6.85"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.50-48.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-YR Rainfall=8.41"

Area (sf)	CN	Description
981	98	Roofs, HSG D
2,843	98	Paved parking, HSG D
4,478	80	>75% Grass cover, Good, HSG D
2,107	80	>75% Grass cover, Good, HSG D
10,409	87	Weighted Average
6,585		63.26% Pervious Area
3,824		36.74% Impervious Area

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

Subcatchment 3S: DP#1-GREENMONT



Summary for Subcatchment 4S: Subject Property Ex-WS#2

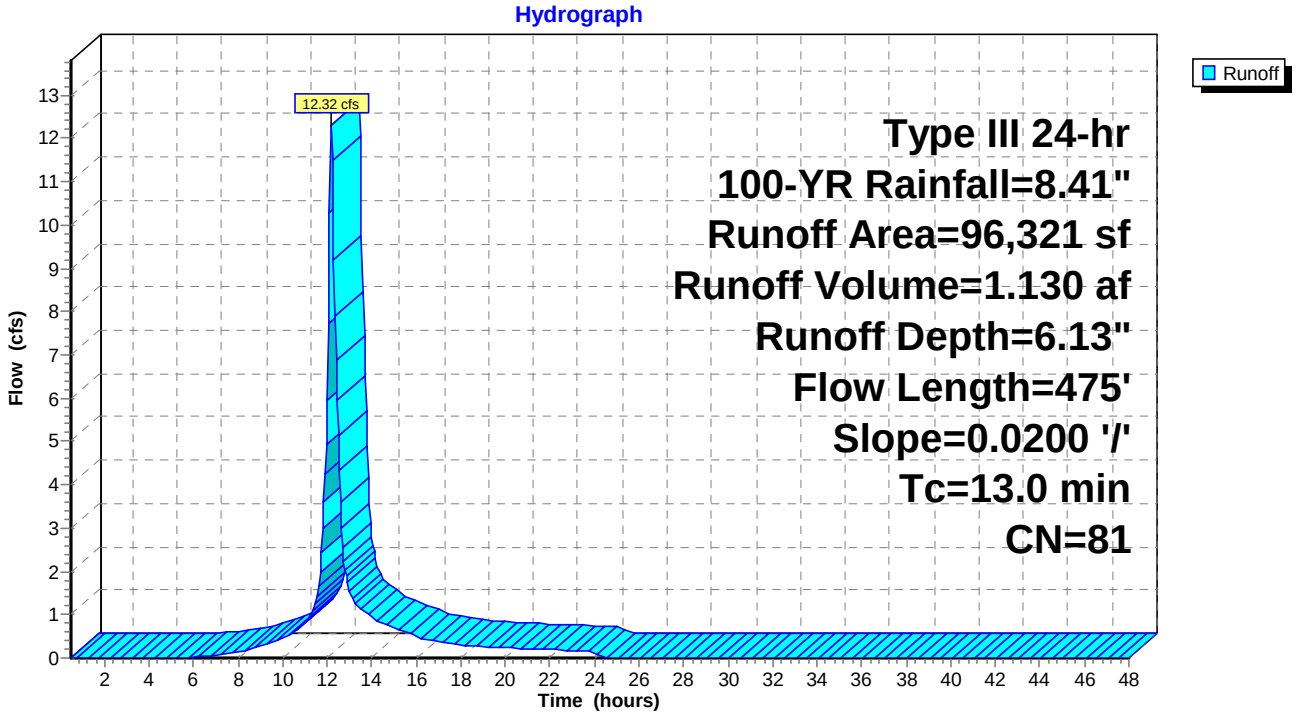
Runoff = 12.32 cfs @ 12.18 hrs, Volume= 1.130 af, Depth= 6.13"
Routed to Pond 2P : DP#2 - Ex-Wetlands Area Outlet

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.50-48.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-YR Rainfall=8.41"

Area (sf)	CN	Description
5,364	98	Paved parking, HSG D
90,957	80	>75% Grass cover, Good, HSG D
96,321	81	Weighted Average
90,957		94.43% Pervious Area
5,364		5.57% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.8	50	0.0200	0.14		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.05"
7.2	425	0.0200	0.99		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
13.0	475	Total			

Subcatchment 4S: Subject Property Ex-WS#2



Summary for Pond 2P: DP#2 - Ex-Wetlands Area Outlet

Inflow Area = 8.173 ac, 19.74% Impervious, Inflow Depth = 6.48" for 100-YR event
Inflow = 28.53 cfs @ 12.42 hrs, Volume= 4.414 af
Outflow = 9.37 cfs @ 13.15 hrs, Volume= 4.412 af, Atten= 67%, Lag= 43.4 min
Primary = 9.37 cfs @ 13.15 hrs, Volume= 4.412 af

Routing by Stor-Ind method, Time Span= 0.50-48.00 hrs, dt= 0.05 hrs
Peak Elev= 153.63' @ 13.15 hrs Surf.Area= 58,001 sf Storage= 63,568 cf

Plug-Flow detention time= 69.3 min calculated for 4.412 af (100% of inflow)
Center-of-Mass det. time= 68.8 min (883.6 - 814.7)

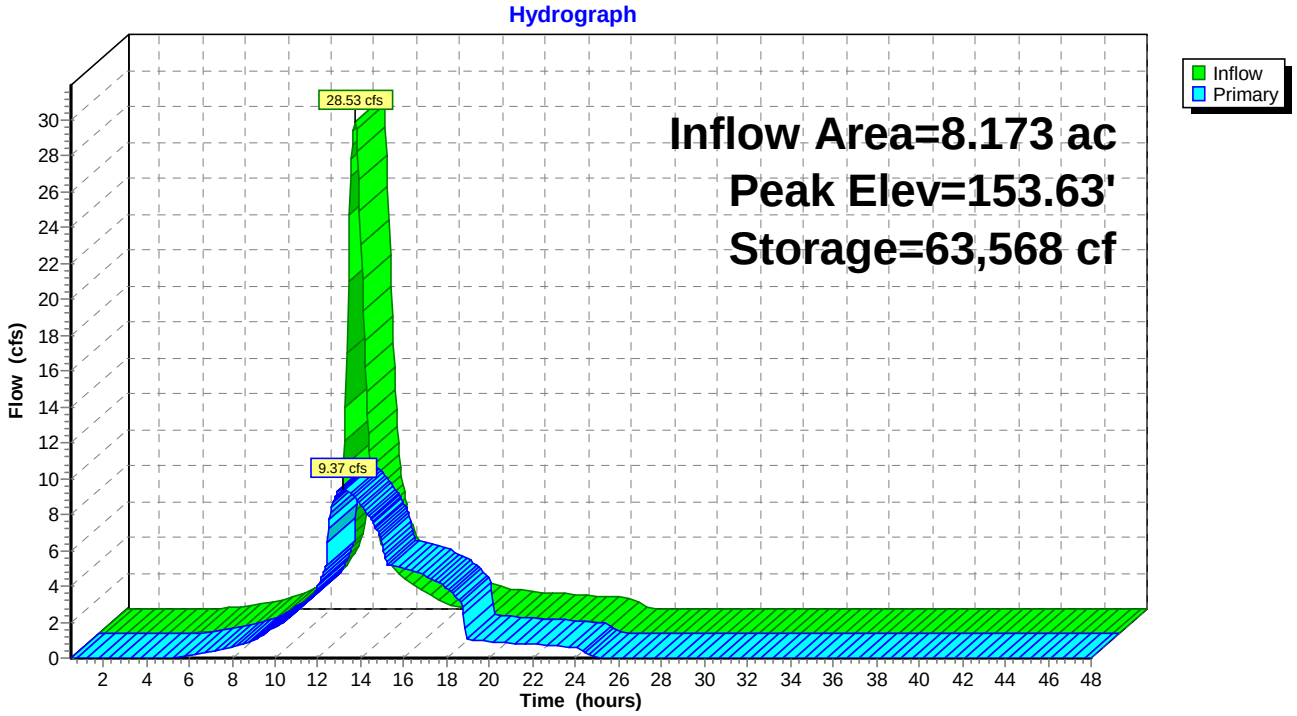
Volume	Invert	Avail.Storage	Storage Description
#1	150.00'	184,747 cf	**Custom Stage Data (Irregular)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
150.00	208	75.0	0	0	208
151.00	328	94.0	266	266	477
152.00	14,780	1,138.0	5,770	6,036	102,832
153.00	40,797	1,192.0	26,711	32,747	112,912
154.00	69,661	1,810.0	54,589	87,336	260,555
155.00	128,105	2,354.0	97,411	184,747	440,827

Device	Routing	Invert	Outlet Devices
#1	Primary	150.25'	**12.0" Round Culvert** L= 83.0' RCP, groove end projecting, Ke= 0.200 Inlet / Outlet Invert= 150.25' / 149.75' S= 0.0060 '/' Cc= 0.900 n= 0.012 Concrete pipe, finished, Flow Area= 0.79 sf
#2	Primary	153.07'	**2.0" x 2.0" Horiz. Orifice/Grate X 6.00 columns** X 6 rows C= 0.600 Limited to weir flow at low heads

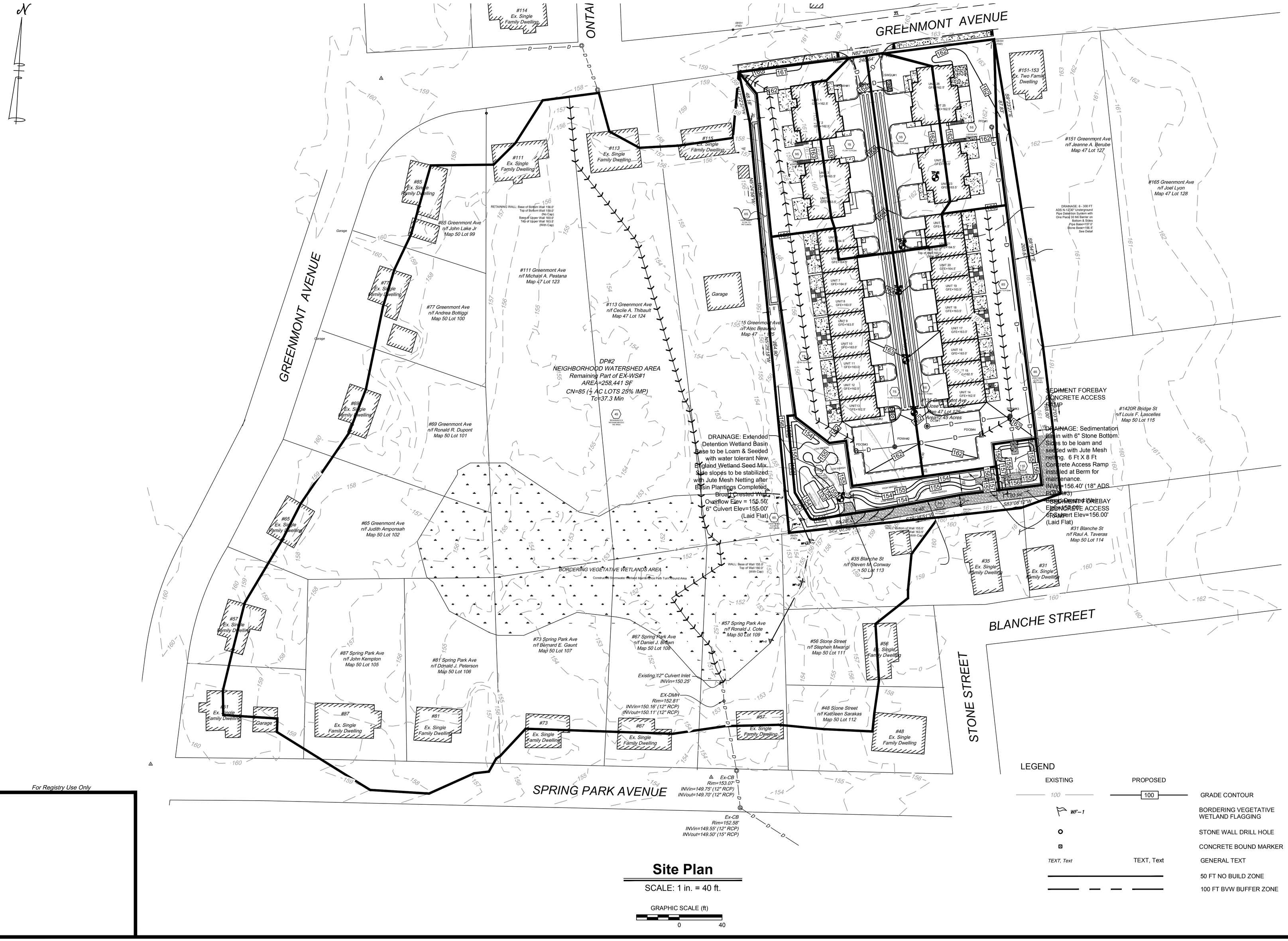
Primary OutFlow Max=9.37 cfs @ 13.15 hrs HW=153.63' (Free Discharge)
1=Culvert (Barrel Controls 5.78 cfs @ 7.36 fps)
2=Orifice/Grate (Orifice Controls 3.59 cfs @ 3.59 fps)

Pond 2P: DP#2 - Ex-Wetlands Area Outlet



C.2: Post-Development Analysis

[Proposed Watershed Plan & HydroCAD calculations]



Site Plan

SCALE: 1 in. = 40 ft.

GRAPHIC SCALE (ft)

0 40

For Registry Use Only

COMMONWEALTH OF MASSACHUSETTS JOHN A. VISNESKI No. 25775 REGISTERED PROFESSIONAL ENGINEER

Certifications not valid without ORIGINAL stamp and/or signature

	BY	Design by KML
11/29/23	KML	Survey by KML/TAJ
06/05/24	KML	Draft by KML
08/20/24	KML	Check by JAV/TAJ
10/10/24	KML	
11/07/24	KML	

11/29/23 REVS PER ZONING BOARD OF APPEALS MEETING AND ZBA PEER REVIEW COMMENTS

06/05/24 REVS PER ZONING BOARD OF APPEALS MEETING AND ZBA PEER REVIEW COMMENTS

08/20/24 REVS PER ZONING BOARD OF APPEALS MEETING AND ZBA PEER REVIEW COMMENTS

10/10/24 REVS PER ZONING BOARD OF APPEALS MEETING AND ZBA PEER REVIEW COMMENTS

11/07/24 REVS PER ZONING BOARD OF APPEALS MEETING AND ZBA PEER REVIEW COMMENTS

Cornerstone Land Associates, LLC
Civil & Structural Engineering
Land Surveying-Land Development
25 Davis Avenue - Tyngsboro, MA 01879 - (978) 835-0102
kmconsultants@comcast.net

SCALE: As Shown
DATE: May 18, 2023

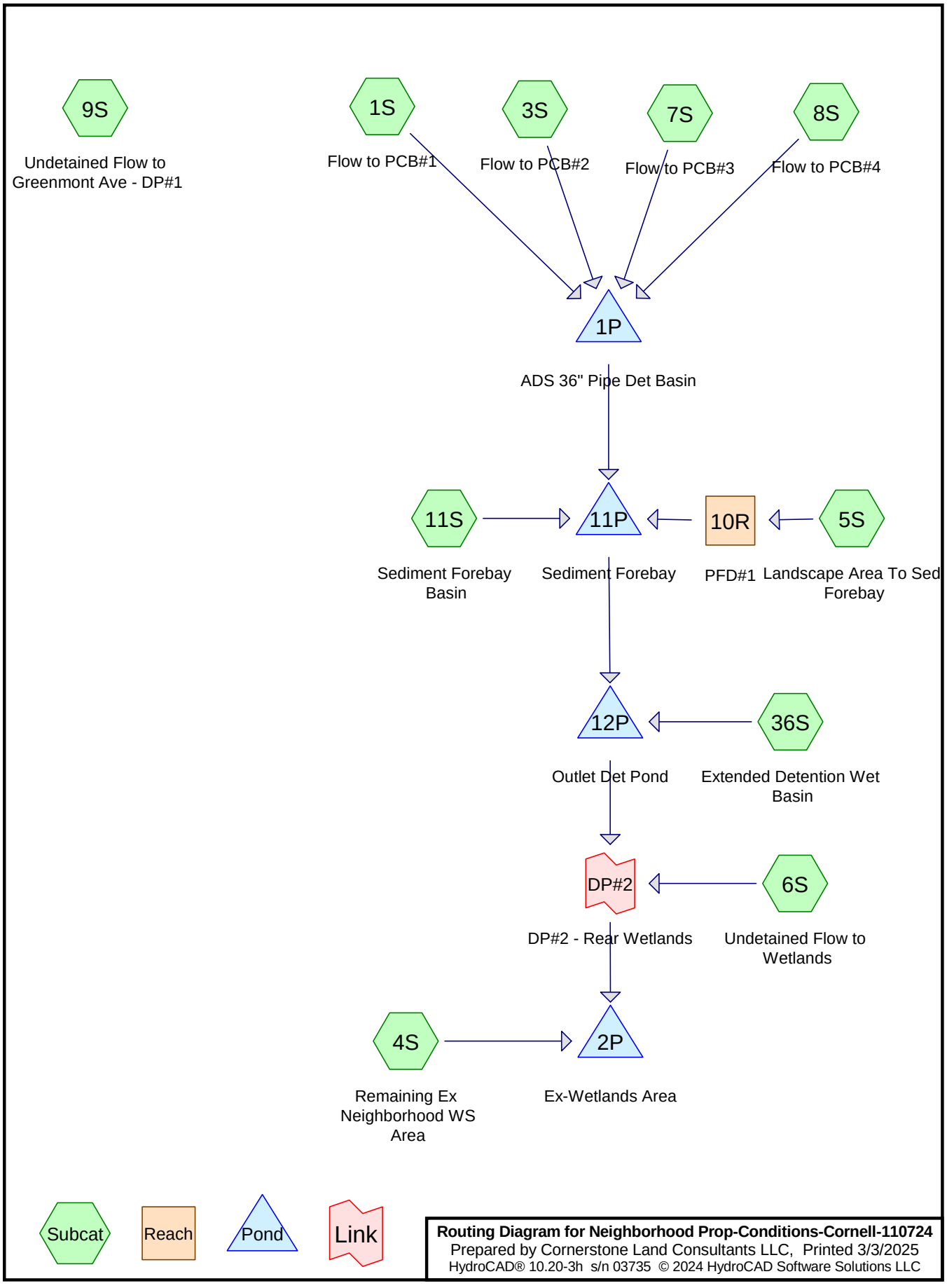
PREPARED FOR:
Riverbank Properties
908 Lawrence Street
Lowell, MA 01852

PROPOSED WATERSHED PLAN
Comprehensive Permit Application

135 GREENMONT AVENUE
DRACUT, MASSACHUSETTS

JOB NO.: 2021-235
SHEET: 1 of 1

DRAWING NO.
PROP-WS



Routing Diagram for Neighborhood Prop-Conditions-Cornell-110724
Prepared by Cornerstone Land Consultants LLC, Printed 3/3/2025

Area Listing (all nodes)

Area (acres)	CN	Description (subcatchment-numbers)
5.933	85	1/2 acre lots, 25% imp, HSG D (4S)
1.205	80	>75% Grass cover, Good, HSG D (1S, 3S, 5S, 6S, 7S, 8S, 9S, 36S)
0.117	98	Patios, HSG D (5S, 7S, 8S)
0.473	98	Paved parking, HSG D (1S, 3S, 7S, 8S)
0.388	98	Roofs, HSG D (1S, 3S, 5S, 8S, 9S)
0.066	98	Roofs, HSG D (Front Units 6-13) (7S)
0.070	98	Roofs, HSG D (Rear Units 5-13) (7S)
0.040	98	Sed Bas Wet Surface (11S)
0.009	98	Walkways (1S)
0.015	98	Walkways, HSG D (3S, 7S, 8S)
0.097	98	Wet Basin Surface Water (36S)

Summary for Subcatchment 1S: Flow to PCB#1

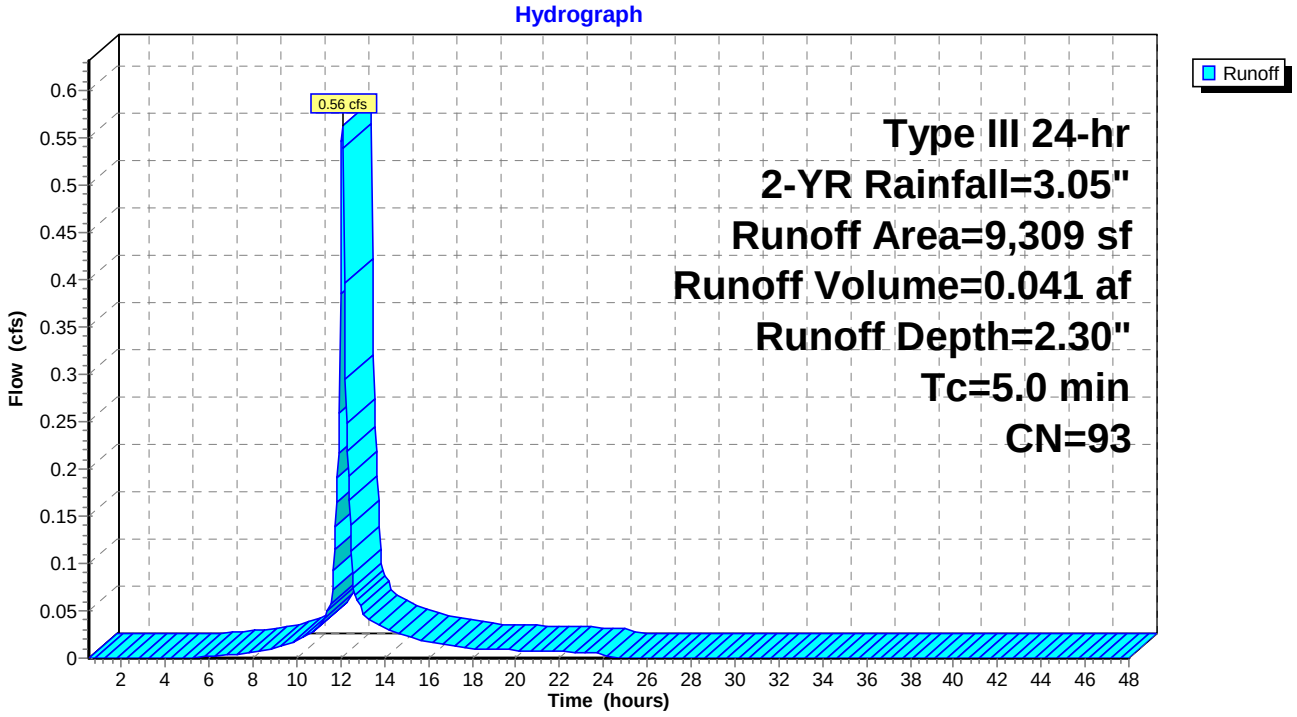
Runoff = 0.56 cfs @ 12.07 hrs, Volume= 0.041 af, Depth= 2.30"
Routed to Pond 1P : ADS 36" Pipe Det Basin

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.50-48.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-YR Rainfall=3.05"

	Area (sf)	CN	Description
	3,640	98	Paved parking, HSG D
	2,814	98	Roofs, HSG D
*	380	98	Walkways
	2,475	80	>75% Grass cover, Good, HSG D
	9,309	93	Weighted Average
	2,475		26.59% Pervious Area
	6,834		73.41% Impervious Area

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

Subcatchment 1S: Flow to PCB#1



Summary for Subcatchment 3S: Flow to PCB#2

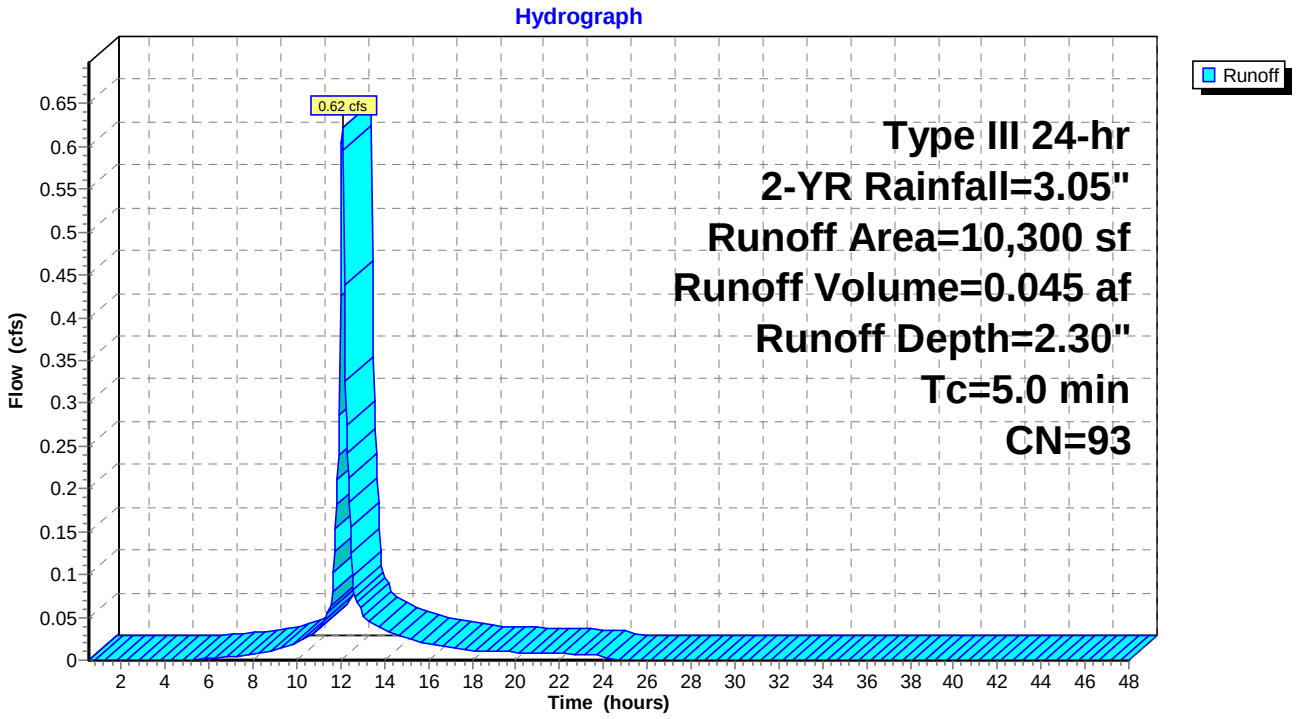
Runoff = 0.62 cfs @ 12.07 hrs, Volume= 0.045 af, Depth= 2.30"
Routed to Pond 1P : ADS 36" Pipe Det Basin

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.50-48.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-YR Rainfall=3.05"

	Area (sf)	CN	Description
	3,906	98	Paved parking, HSG D
	2,936	98	Roofs, HSG D
*	380	98	Walkways, HSG D
	3,078	80	>75% Grass cover, Good, HSG D
	10,300	93	Weighted Average
	3,078		29.88% Pervious Area
	7,222		70.12% Impervious Area

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

Subcatchment 3S: Flow to PCB#2



Summary for Subcatchment 4S: Remaining Ex Neighborhood WS Area

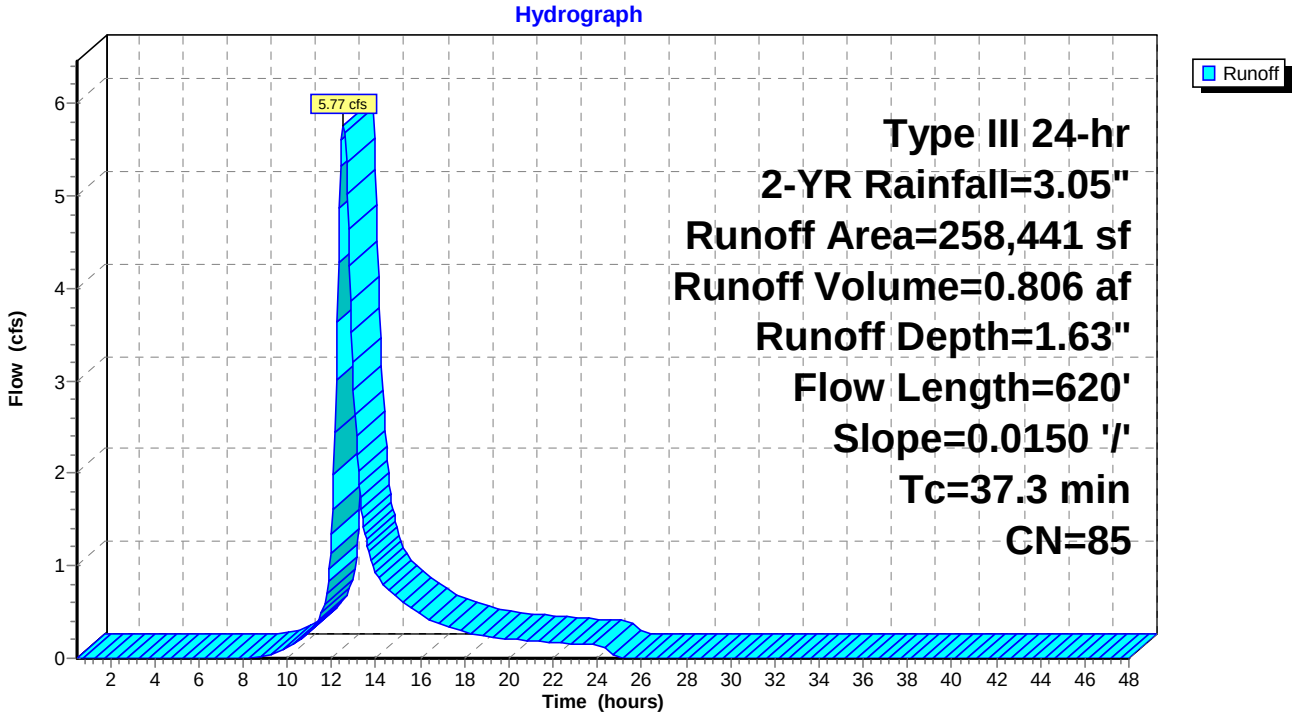
Runoff = 5.77 cfs @ 12.52 hrs, Volume= 0.806 af, Depth= 1.63"
Routed to Pond 2P : Ex-Wetlands Area

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.50-48.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-YR Rainfall=3.05"

Area (sf)	CN	Description
258,441	85	1/2 acre lots, 25% imp, HSG D
193,831		75.00% Pervious Area
64,610		25.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.3	50	0.0150	0.13		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.20"
31.0	570	0.0150	0.31		**Shallow Concentrated Flow,** Forest w/Heavy Litter Kv= 2.5 fps
37.3	620	Total			

Subcatchment 4S: Remaining Ex Neighborhood WS Area



Summary for Subcatchment 5S: Landscape Area To Sed Forebay

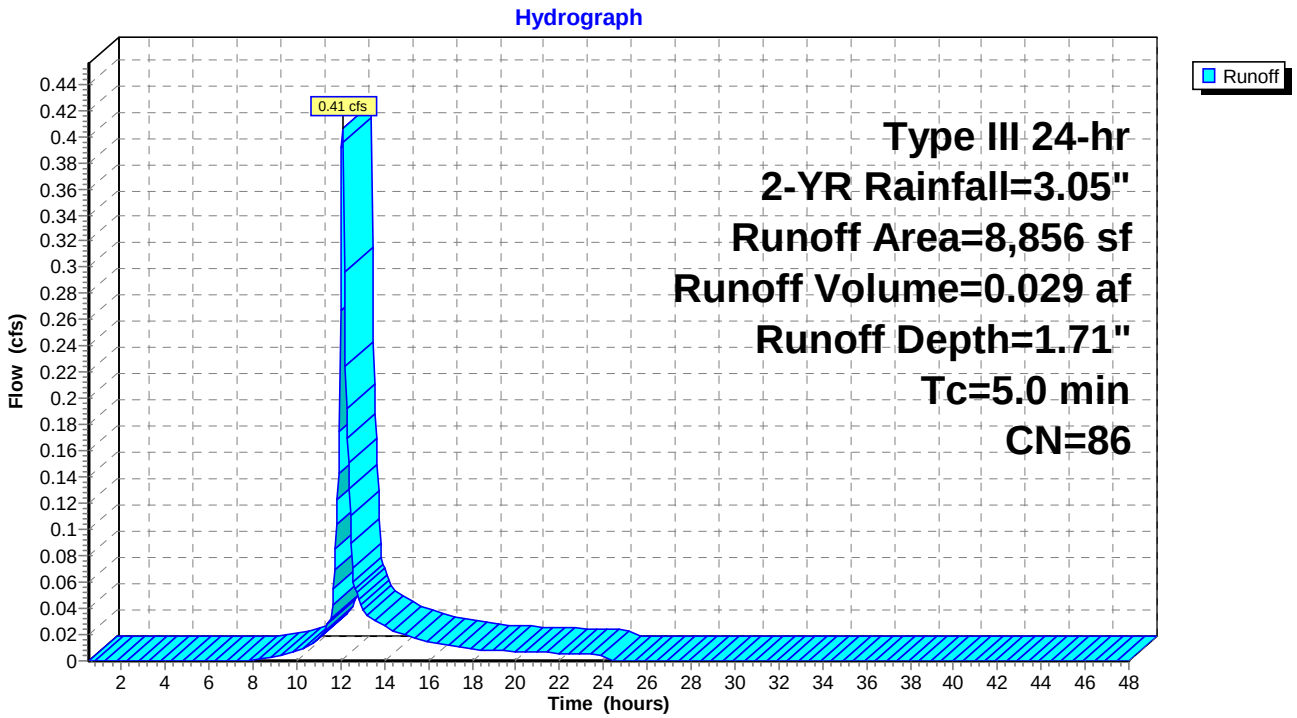
Runoff = 0.41 cfs @ 12.08 hrs, Volume= 0.029 af, Depth= 1.71"
Routed to Reach 10R : PFD#1

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.50-48.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-YR Rainfall=3.05"

	Area (sf)	CN	Description
	5,671	80	>75% Grass cover, Good, HSG D
*	1,160	98	Patios, HSG D
	2,025	98	Roofs, HSG D
	8,856	86	Weighted Average
	5,671		64.04% Pervious Area
	3,185		35.96% Impervious Area

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

Subcatchment 5S: Landscape Area To Sed Forebay



Summary for Subcatchment 6S: Undetained Flow to Wetlands

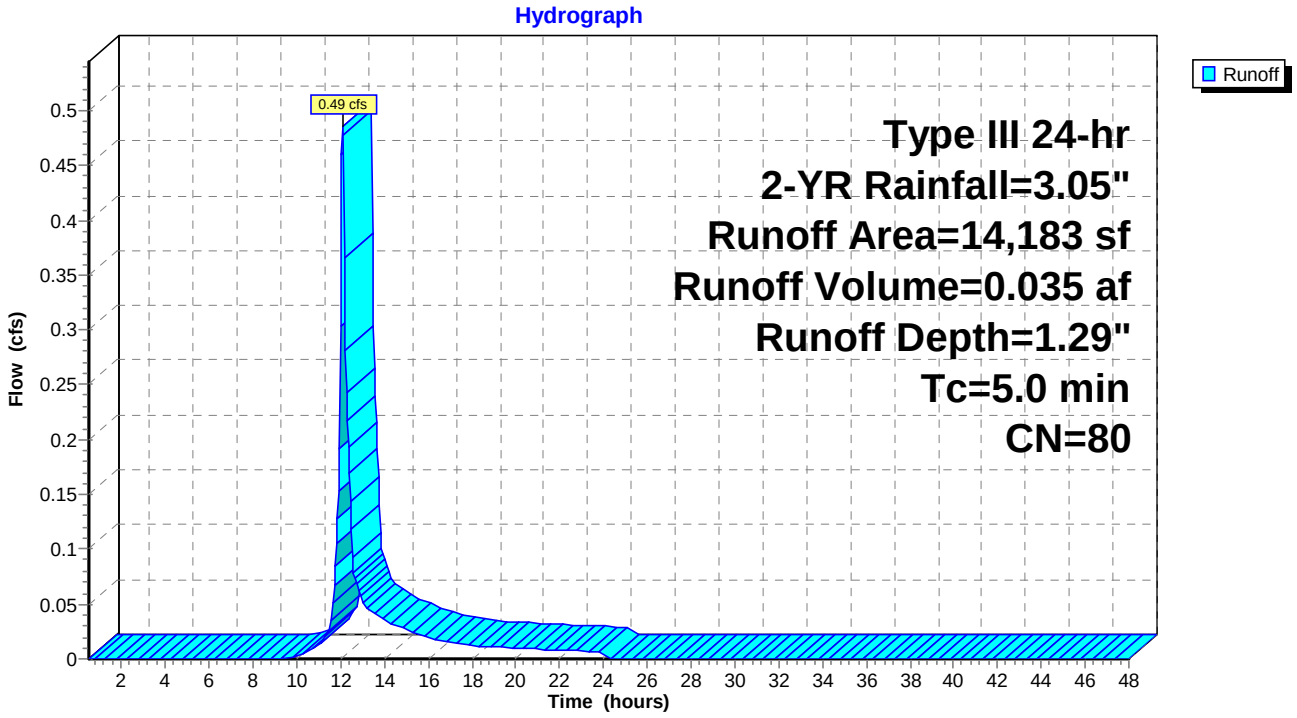
Runoff = 0.49 cfs @ 12.08 hrs, Volume= 0.035 af, Depth= 1.29"
Routed to Link DP#2 : DP#2 - Rear Wetlands

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.50-48.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-YR Rainfall=3.05"

Area (sf)	CN	Description
14,183	80	>75% Grass cover, Good, HSG D
14,183		100.00% Pervious Area

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

Subcatchment 6S: Undetained Flow to Wetlands



Summary for Subcatchment 7S: Flow to PCB#3

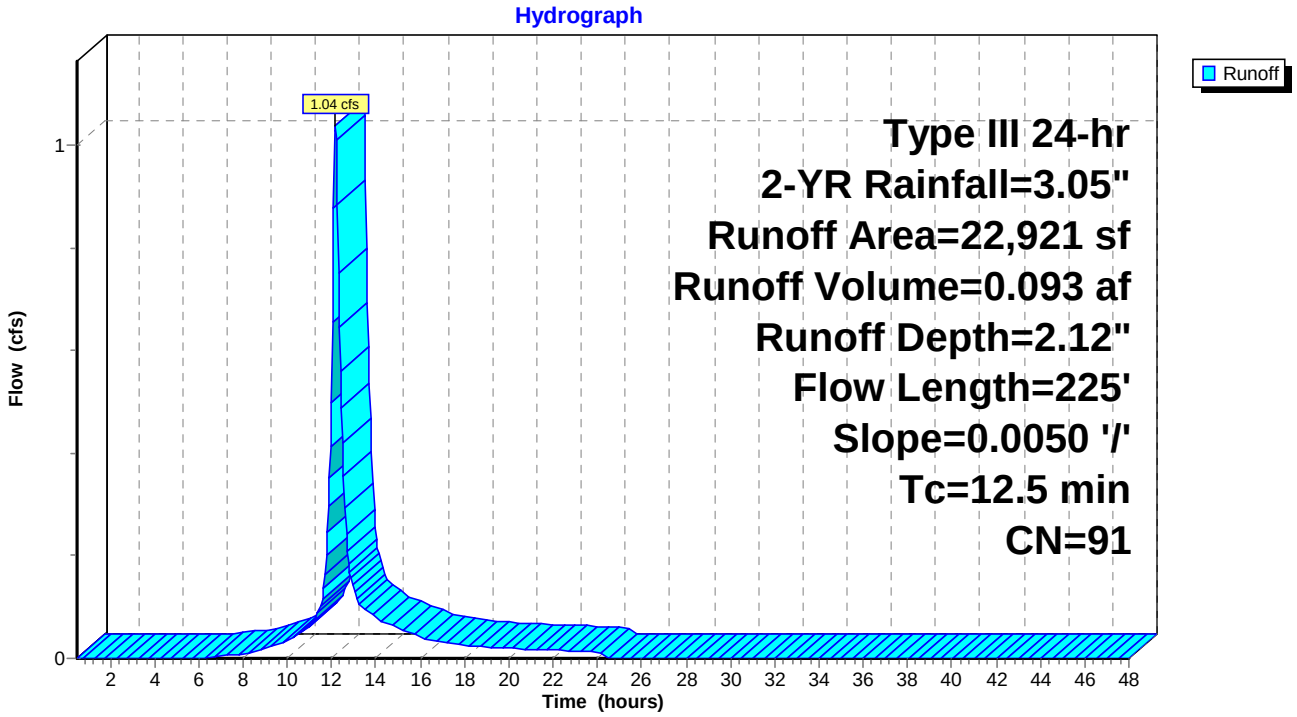
Runoff = 1.04 cfs @ 12.17 hrs, Volume= 0.093 af, Depth= 2.12"
Routed to Pond 1P : ADS 36" Pipe Det Basin

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.50-48.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-YR Rainfall=3.05"

	Area (sf)	CN	Description
	6,527	98	Paved parking, HSG D
*	2,886	98	Roofs, HSG D (Front Units 6-13)
*	140	98	Walkways, HSG D
	615	80	>75% Grass cover, Good, HSG D
*	3,060	98	Roofs, HSG D (Rear Units 5-13)
	7,731	80	>75% Grass cover, Good, HSG D
*	1,962	98	Patios, HSG D
	22,921	91	Weighted Average
	8,346		36.41% Pervious Area
	14,575		63.59% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
9.8	50	0.0050	0.09		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.20"
2.7	175	0.0050	1.06		**Shallow Concentrated Flow,** Grassed Waterway Kv= 15.0 fps
12.5	225	Total			

Subcatchment 7S: Flow to PCB#3



Summary for Subcatchment 8S: Flow to PCB#4

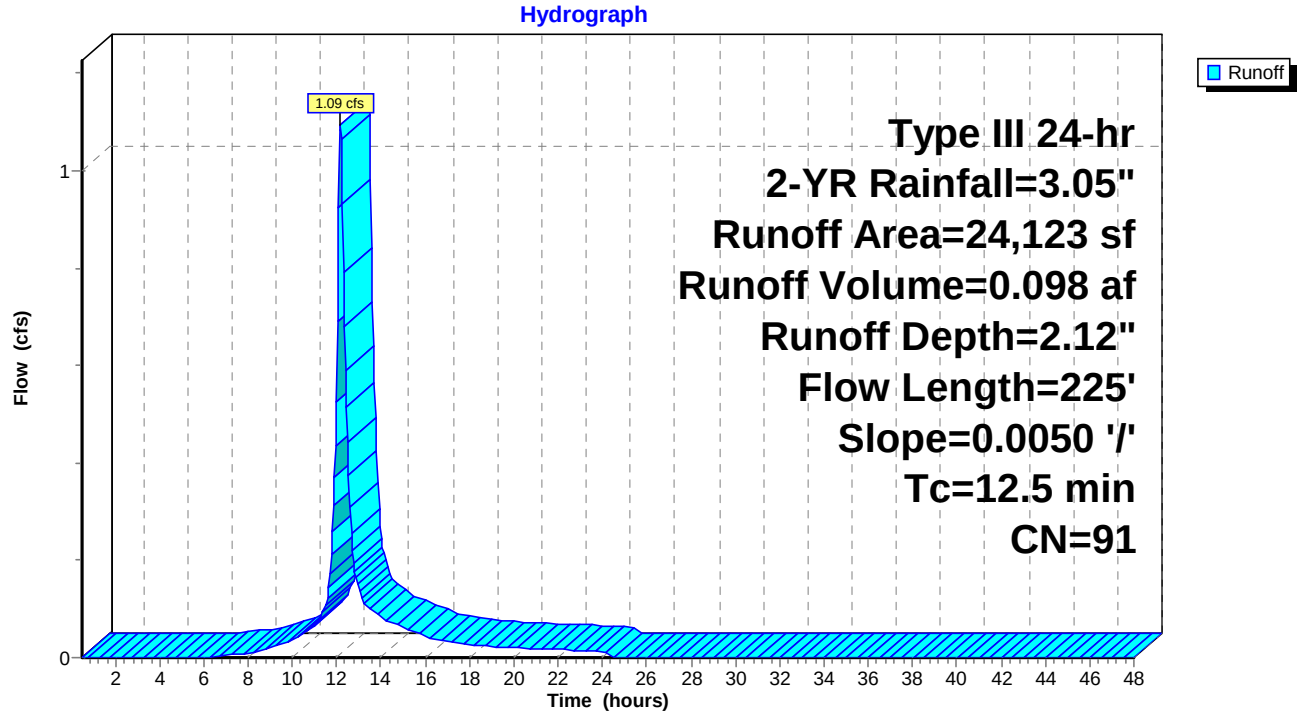
Runoff = 1.09 cfs @ 12.17 hrs, Volume= 0.098 af, Depth= 2.12"
Routed to Pond 1P : ADS 36" Pipe Det Basin

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.50-48.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-YR Rainfall=3.05"

	Area (sf)	CN	Description
	6,532	98	Paved parking, HSG D
	5,760	98	Roofs, HSG D
*	140	98	Walkways, HSG D
	9,729	80	>75% Grass cover, Good, HSG D
*	1,962	98	Patios, HSG D
	24,123	91	Weighted Average
	9,729		40.33% Pervious Area
	14,394		59.67% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
9.8	50	0.0050	0.09		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.20"
2.7	175	0.0050	1.06		**Shallow Concentrated Flow,** Grassed Waterway Kv= 15.0 fps
12.5	225	Total			

Subcatchment 8S: Flow to PCB#4



Summary for Subcatchment 9S: Undetained Flow to Greenmont Ave - DP#1

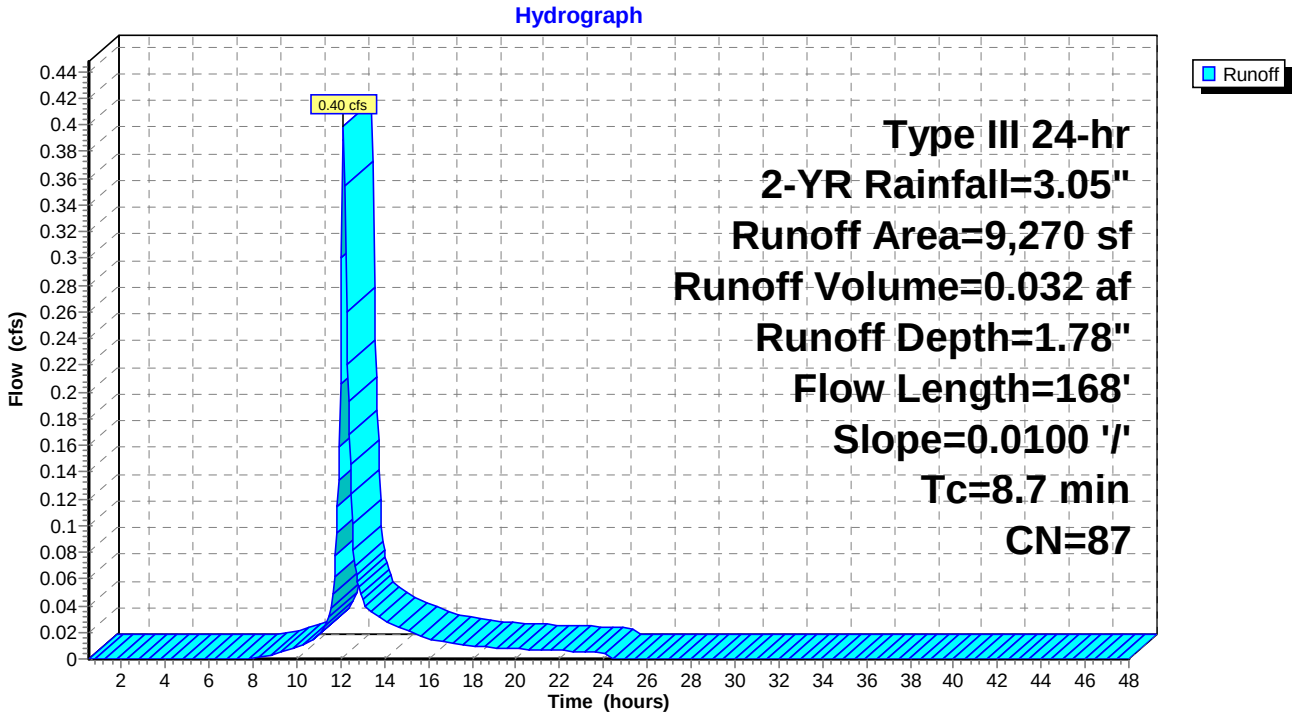
Runoff = 0.40 cfs @ 12.12 hrs, Volume= 0.032 af, Depth= 1.78"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.50-48.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-YR Rainfall=3.05"

Area (sf)	CN	Description
5,908	80	>75% Grass cover, Good, HSG D
3,362	98	Roofs, HSG D
9,270	87	Weighted Average
5,908		63.73% Pervious Area
3,362		36.27% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.4	50	0.0100	0.11		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.20"
1.3	118	0.0100	1.50		**Shallow Concentrated Flow,** Grassed Waterway Kv= 15.0 fps
8.7	168	Total			

Subcatchment 9S: Undetained Flow to Greenmont Ave - DP#1



Summary for Subcatchment 11S: Sediment Forebay Basin

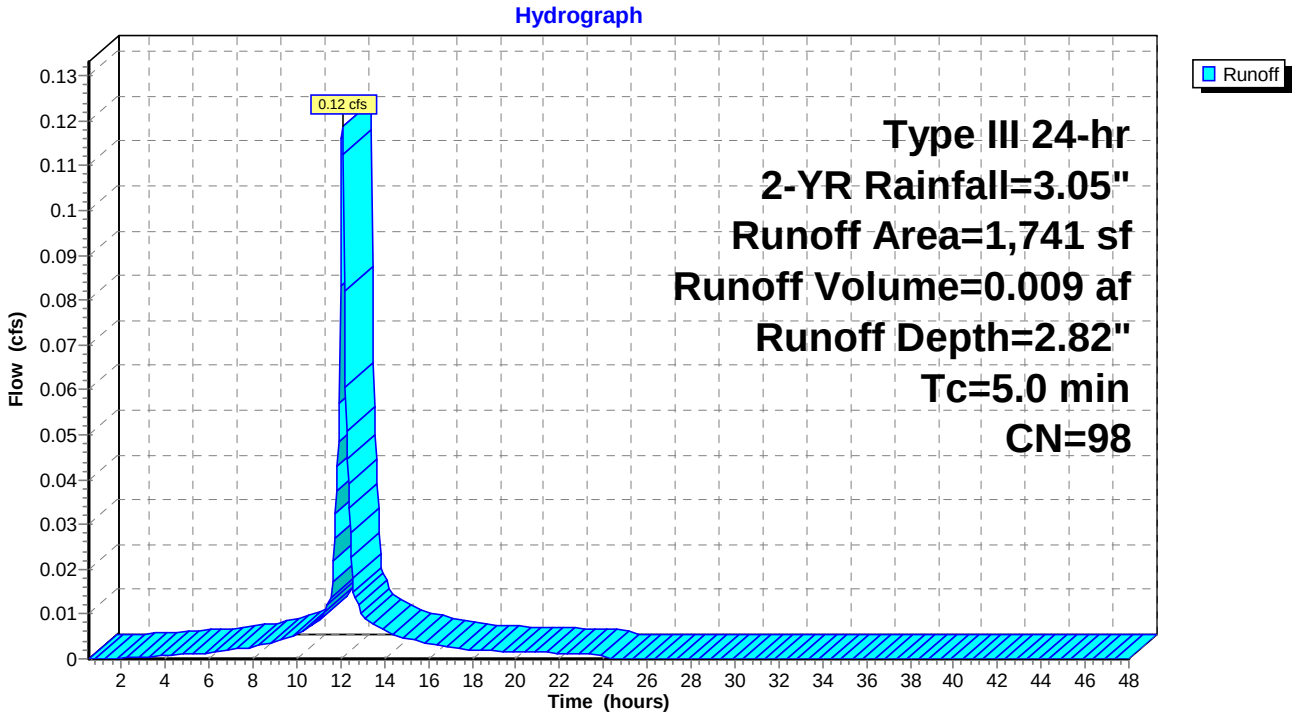
Runoff = 0.12 cfs @ 12.07 hrs, Volume= 0.009 af, Depth= 2.82"
Routed to Pond 11P : Sediment Forebay

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.50-48.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-YR Rainfall=3.05"

	Area (sf)	CN	Description
*	1,741	98	Sed Bas Wet Surface
	1,741		100.00% Impervious Area

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

Subcatchment 11S: Sediment Forebay Basin



Summary for Subcatchment 36S: Extended Detention Wet Basin

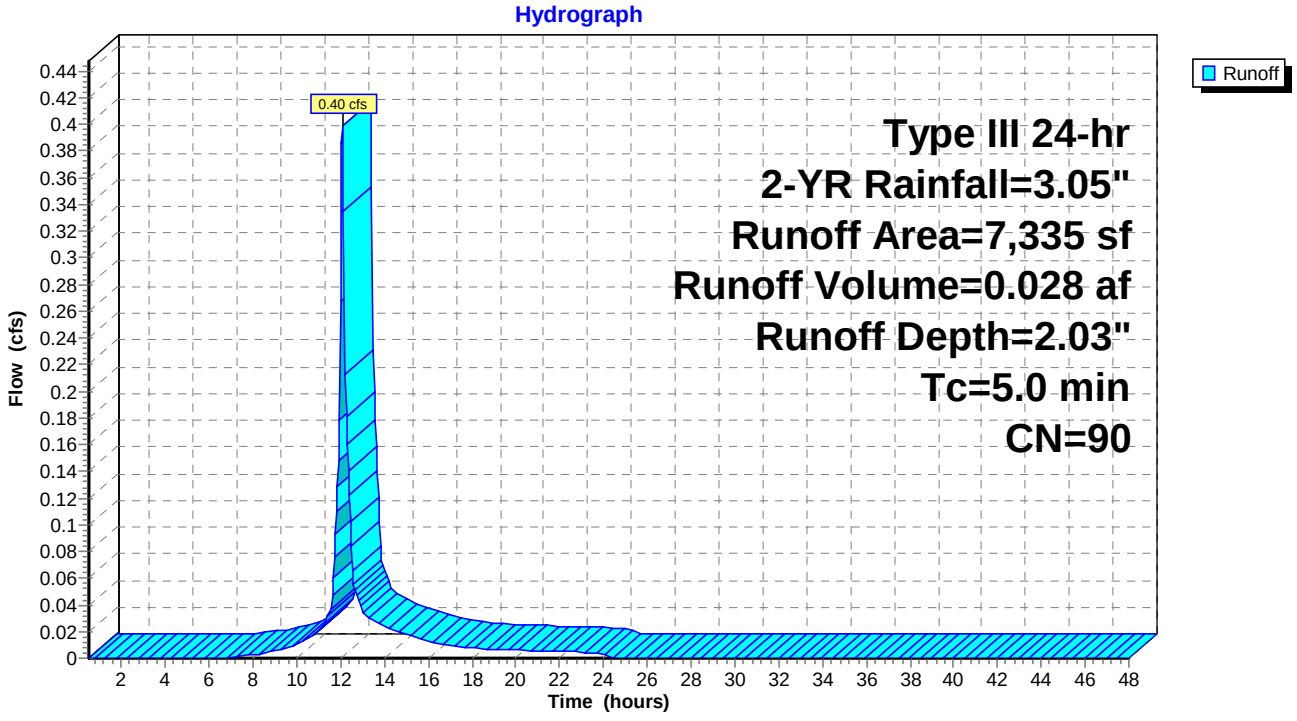
Runoff = 0.40 cfs @ 12.07 hrs, Volume= 0.028 af, Depth= 2.03"
Routed to Pond 12P : Outlet Det Pond

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.50-48.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-YR Rainfall=3.05"

	Area (sf)	CN	Description
	3,120	80	>75% Grass cover, Good, HSG D
*	4,215	98	Wet Basin Surface Water
	7,335	90	Weighted Average
	3,120		42.54% Pervious Area
	4,215		57.46% Impervious Area

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

Subcatchment 36S: Extended Detention Wet Basin



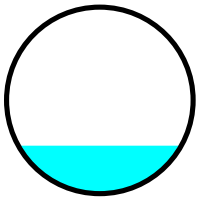
Summary for Reach 10R: PFD#1

Inflow Area = 0.203 ac, 35.96% Impervious, Inflow Depth = 1.71" for 2-YR event
Inflow = 0.41 cfs @ 12.08 hrs, Volume= 0.029 af
Outflow = 0.38 cfs @ 12.14 hrs, Volume= 0.029 af, Atten= 7%, Lag= 3.7 min
Routed to Pond 11P : Sediment Forebay

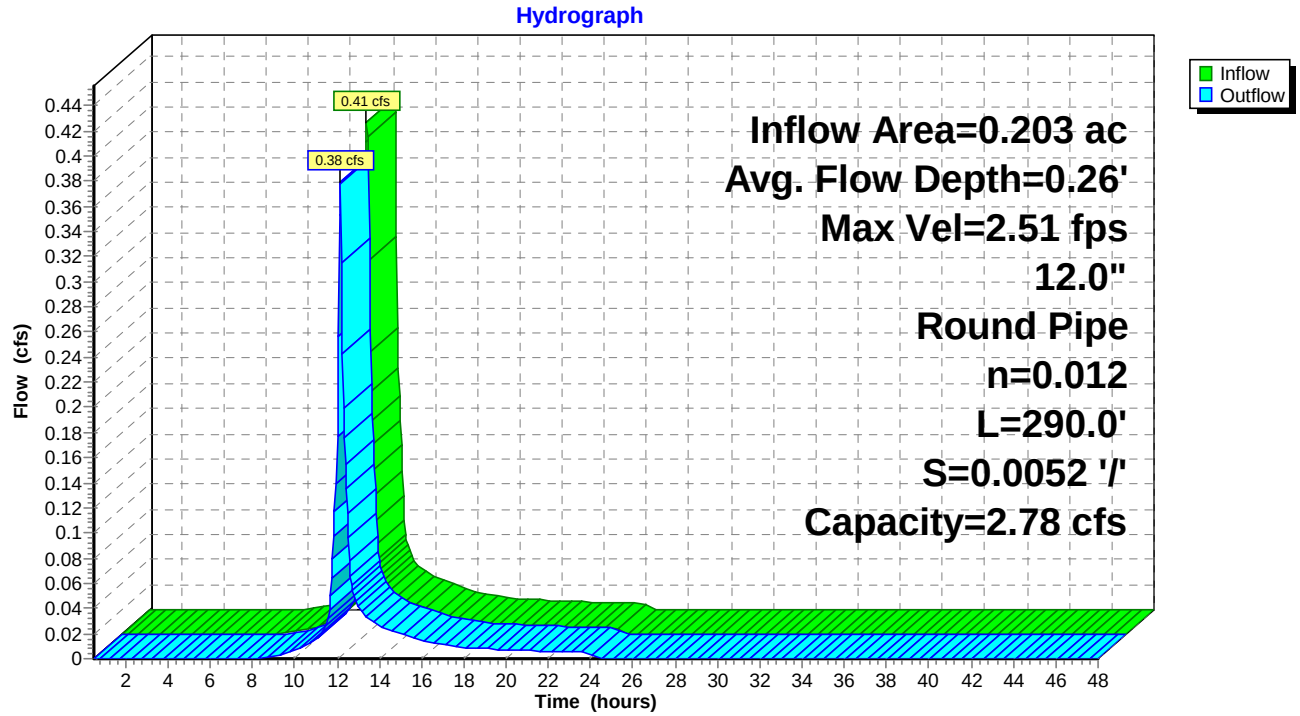
Routing by Stor-Ind+Trans method, Time Span= 0.50-48.00 hrs, dt= 0.05 hrs
Max. Velocity= 2.51 fps, Min. Travel Time= 1.9 min
Avg. Velocity = 0.86 fps, Avg. Travel Time= 5.6 min

Peak Storage= 46 cf @ 12.10 hrs
Average Depth at Peak Storage= 0.26' , Surface Width= 0.87'
Bank-Full Depth= 1.00' Flow Area= 0.8 sf, Capacity= 2.78 cfs

12.0" Round Pipe
n= 0.012 Corrugated PP, smooth interior
Length= 290.0' Slope= 0.0052 '/'
Inlet Invert= 158.00', Outlet Invert= 156.50'



Reach 10R: PFD#1



Summary for Pond 1P: ADS 36" Pipe Det Basin

Inflow Area = 1.530 ac, 64.55% Impervious, Inflow Depth = 2.17" for 2-YR event
Inflow = 2.97 cfs @ 12.13 hrs, Volume= 0.277 af
Outflow = 0.44 cfs @ 12.85 hrs, Volume= 0.277 af, Atten= 85%, Lag= 43.4 min
Primary = 0.44 cfs @ 12.85 hrs, Volume= 0.277 af
Routed to Pond 11P : Sediment Forebay

Routing by Stor-Ind method, Time Span= 0.50-48.00 hrs, dt= 0.05 hrs
Peak Elev= 157.78' @ 12.85 hrs Surf.Area= 7,550 sf Storage= 5,443 cf

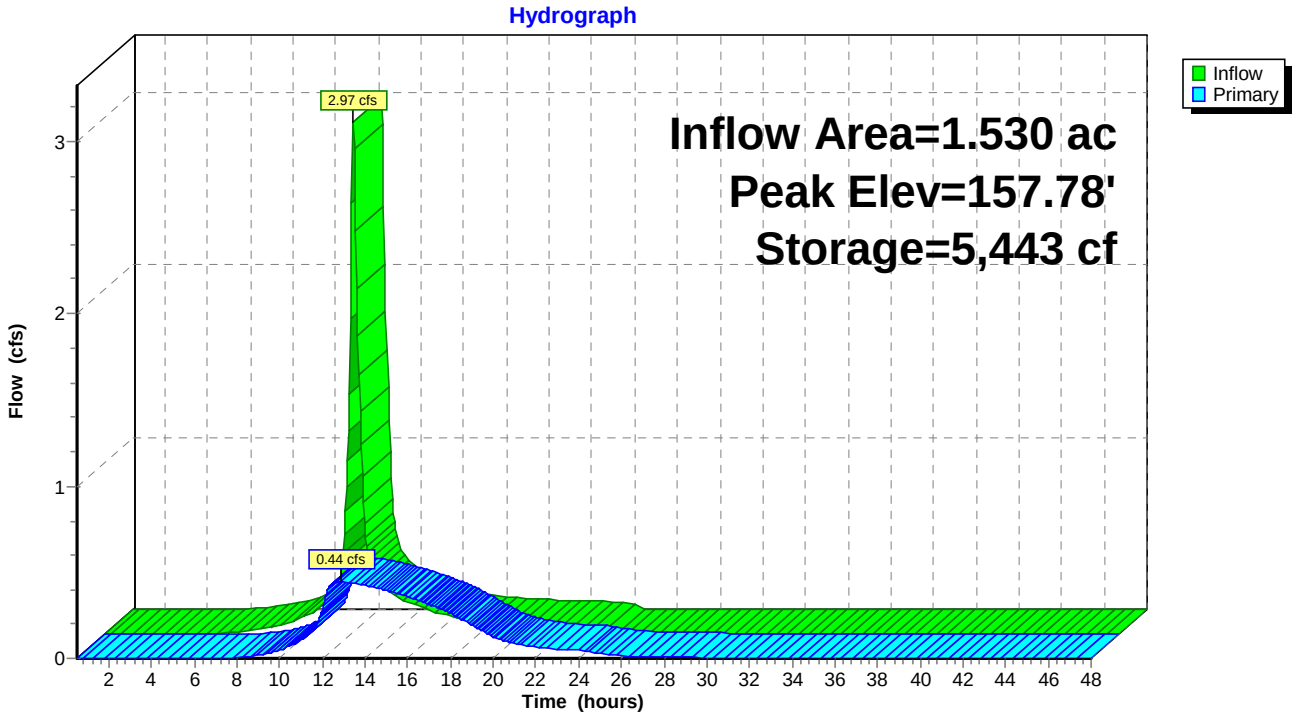
Plug-Flow detention time= 156.4 min calculated for 0.276 af (100% of inflow)
Center-of-Mass det. time= 156.8 min (961.9 - 805.0)

Volume	Invert	Avail.Storage	Storage Description
#1	157.00'	12,723 cf	**36.0" Round Pipe Storage** x 6 Inside #2 L= 300.0'
#2	156.50'	6,991 cf	**25.00'W x 302.00'L x 4.00'H Prismatoid** 30,200 cf Overall - 12,723 cf Embedded = 17,477 cf x 40.0% Voids
		19,714 cf	Total Available Storage

Device	Routing	Invert	Outlet Devices
#1	Primary	159.00'	**12.0" Vert. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#2	Primary	156.50'	**4.0" Vert. Orifice/Grate** C= 0.600 Limited to weir flow at low heads

Primary OutFlow Max=0.44 cfs @ 12.85 hrs HW=157.78' (Free Discharge)
└**1=Orifice/Grate** (Controls 0.00 cfs)
└**2=Orifice/Grate** (Orifice Controls 0.44 cfs @ 5.08 fps)

Pond 1P: ADS 36" Pipe Det Basin



Summary for Pond 2P: Ex-Wetlands Area

Inflow Area = 8.200 ac, 32.69% Impervious, Inflow Depth > 1.73" for 2-YR event
Inflow = 6.48 cfs @ 12.51 hrs, Volume= 1.183 af
Outflow = 3.80 cfs @ 12.96 hrs, Volume= 1.182 af, Atten= 41%, Lag= 26.5 min
Primary = 3.80 cfs @ 12.96 hrs, Volume= 1.182 af

Routing by Stor-Ind method, Time Span= 0.50-48.00 hrs, dt= 0.05 hrs
Peak Elev= 151.99' @ 12.96 hrs Surf.Area= 14,567 sf Storage= 5,911 cf

Plug-Flow detention time= 11.4 min calculated for 1.181 af (100% of inflow)
Center-of-Mass det. time= 10.0 min (906.1 - 896.2)

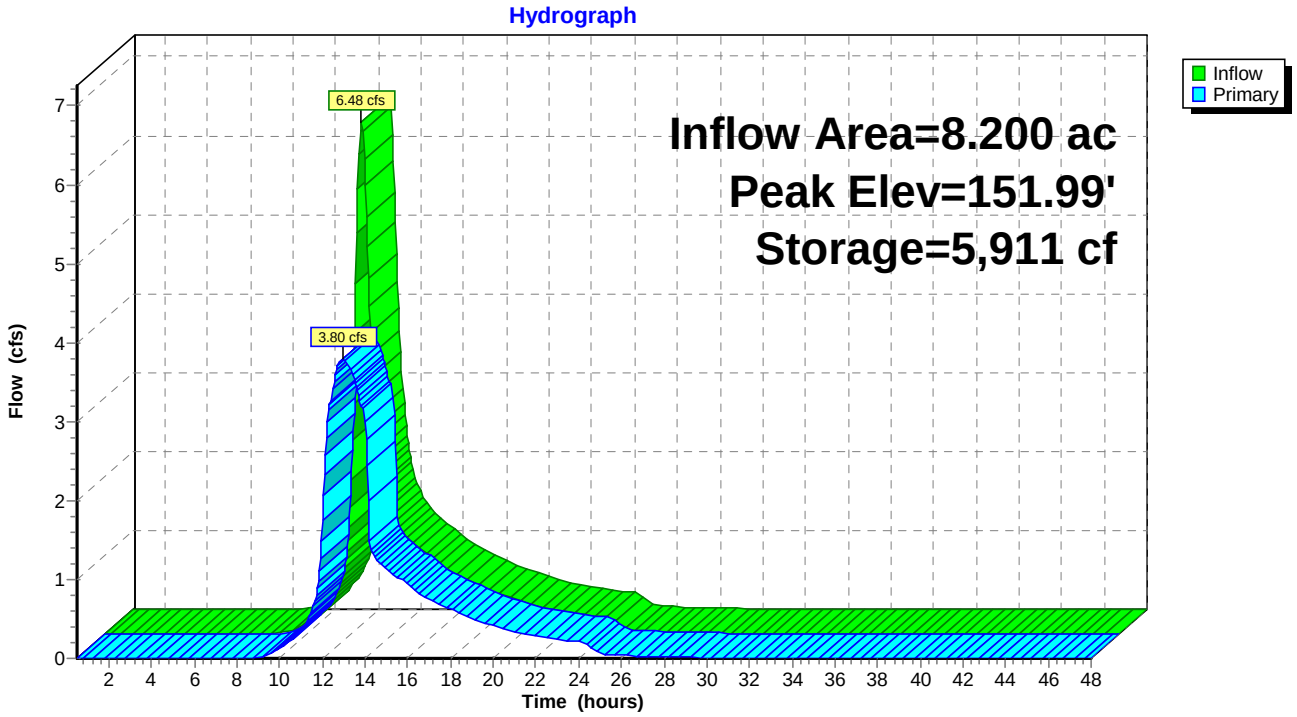
Volume	Invert	Avail.Storage	Storage Description
#1	150.00'	184,747 cf	**Custom Stage Data (Irregular)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
150.00	208	75.0	0	0	208
151.00	328	94.0	266	266	477
152.00	14,780	1,138.0	5,770	6,036	102,832
153.00	40,797	1,192.0	26,711	32,747	112,912
154.00	69,661	1,810.0	54,589	87,336	260,555
155.00	128,105	2,354.0	97,411	184,747	440,827

Device	Routing	Invert	Outlet Devices
#1	Primary	150.25'	**12.0" Round Culvert** L= 83.0' RCP, groove end projecting, Ke= 0.200 Inlet / Outlet Invert= 150.25' / 149.75' S= 0.0060 '/' Cc= 0.900 n= 0.012 Concrete pipe, finished, Flow Area= 0.79 sf
#2	Primary	153.07'	**2.0" x 2.0" Horiz. Orifice/Grate X 6.00 columns** X 6 rows C= 0.600 Limited to weir flow at low heads

Primary OutFlow Max=3.80 cfs @ 12.96 hrs HW=151.99' (Free Discharge)
└**1=Culvert** (Barrel Controls 3.80 cfs @ 4.83 fps)
└**2=Orifice/Grate** (Controls 0.00 cfs)

Pond 2P: Ex-Wetlands Area



Summary for Pond 11P: Sediment Forebay

Inflow Area = 1.773 ac, 62.07% Impervious, Inflow Depth > 2.13" for 2-YR event
Inflow = 0.82 cfs @ 12.14 hrs, Volume= 0.315 af
Outflow = 0.52 cfs @ 12.65 hrs, Volume= 0.314 af, Atten= 36%, Lag= 30.9 min
Primary = 0.52 cfs @ 12.65 hrs, Volume= 0.314 af
Routed to Pond 12P : Outlet Det Pond

Routing by Stor-Ind method, Time Span= 0.50-48.00 hrs, dt= 0.05 hrs
Starting Elev= 156.00' Surf.Area= 1,059 sf Storage= 868 cf
Peak Elev= 156.87' @ 12.65 hrs Surf.Area= 1,459 sf Storage= 1,953 cf (1,085 cf above start)

Plug-Flow detention time= 104.5 min calculated for 0.294 af (93% of inflow)
Center-of-Mass det. time= 41.5 min (985.1 - 943.6)

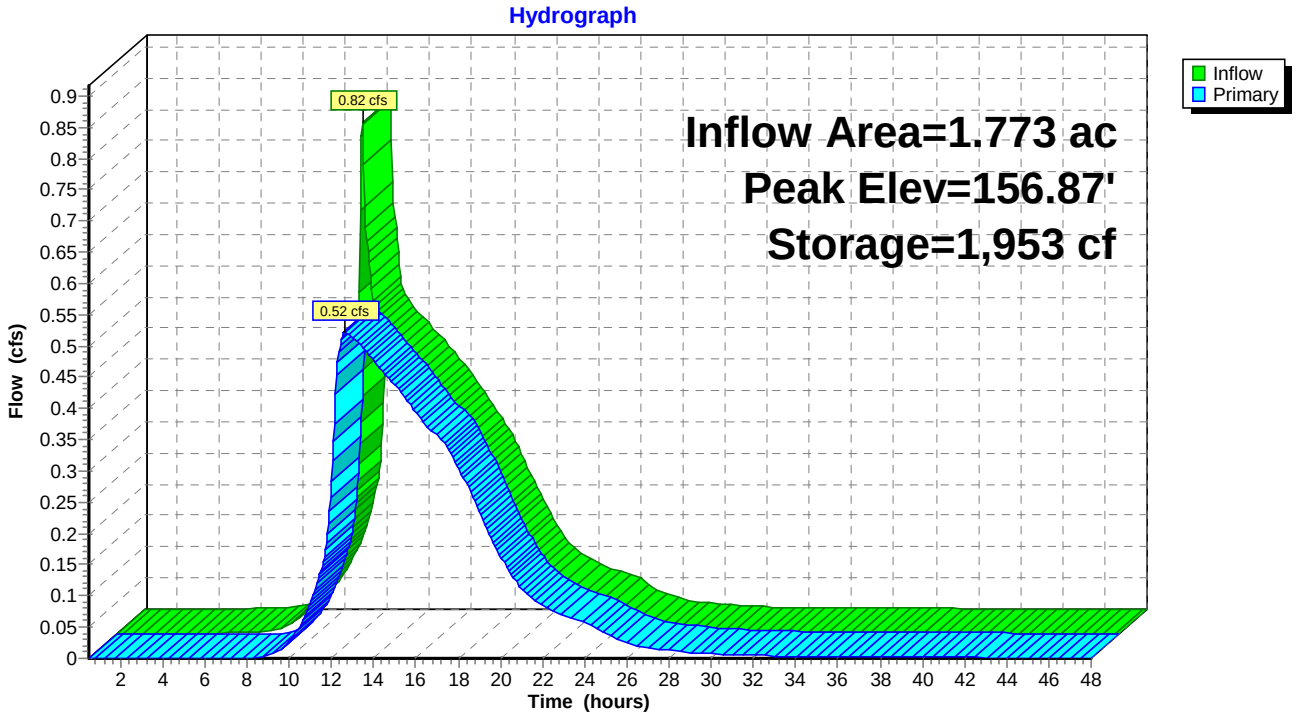
Volume	Invert	Avail.Storage	Storage Description
#1	155.00'	3,718 cf	**Custom Stage Data (Irregular)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
155.00	691	110.0	0	0	691
156.00	1,059	130.0	868	868	1,091
157.00	1,527	162.0	1,286	2,154	1,849
158.00	1,601	162.0	1,564	3,718	2,011

Device	Routing	Invert	Outlet Devices
#1	Primary	156.00'	**6.0" Round Culvert** L= 18.0' CPP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 156.00' / 156.00' S= 0.0000 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.20 sf
#2	Primary	157.00'	**6.0' long x 6.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 3.50 4.00 4.50 5.00 5.50 Coef. (English) 2.37 2.51 2.70 2.68 2.68 2.67 2.65 2.65 2.65 2.65 2.66 2.66 2.67 2.69 2.72 2.76 2.83

Primary OutFlow Max=0.52 cfs @ 12.65 hrs HW=156.87' (Free Discharge)
1=Culvert (Barrel Controls 0.52 cfs @ 2.66 fps)
2=Broad-Crested Rectangular Weir (Controls 0.00 cfs)

Pond 11P: Sediment Forebay



Summary for Pond 12P: Outlet Det Pond

Inflow Area = 1.942 ac, 61.67% Impervious, Inflow Depth > 2.12" for 2-YR event
Inflow = 0.73 cfs @ 12.09 hrs, Volume= 0.342 af
Outflow = 0.60 cfs @ 12.51 hrs, Volume= 0.342 af, Atten= 19%, Lag= 25.3 min
Primary = 0.60 cfs @ 12.51 hrs, Volume= 0.342 af
Routed to Link DP#2 : DP#2 - Rear Wetlands

Routing by Stor-Ind method, Time Span= 0.50-48.00 hrs, dt= 0.05 hrs
Starting Elev= 155.50' Surf.Area= 5,255 sf Storage= 5,215 cf
Peak Elev= 155.62' @ 12.51 hrs Surf.Area= 5,523 sf Storage= 5,864 cf (650 cf above start)

Plug-Flow detention time= 279.7 min calculated for 0.223 af (65% of inflow)
Center-of-Mass det. time= 22.6 min (992.9 - 970.4)

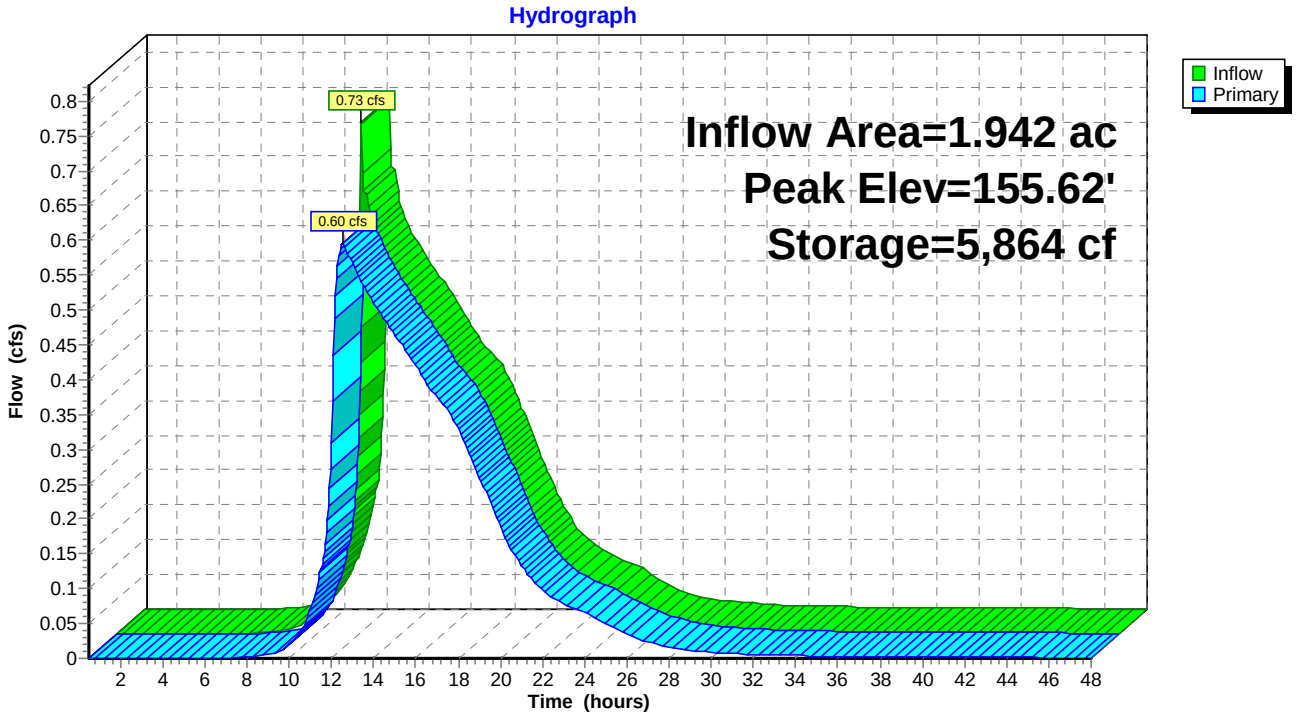
Volume	Invert	Avail.Storage	Storage Description
#1	154.00'	11,493 cf	**Custom Stage Data (Irregular)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
154.00	1,680	368.0	0	0	1,680
155.00	4,215	676.0	2,852	2,852	27,274
156.00	6,410	526.0	5,274	8,126	41,634
156.50	7,063	568.0	3,367	11,493	45,301

Device	Routing	Invert	Outlet Devices
#1	Primary	155.50'	**6.0' long x 6.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 3.50 4.00 4.50 5.00 5.50 Coef. (English) 2.37 2.51 2.70 2.68 2.68 2.67 2.65 2.65 2.65 2.65 2.66 2.66 2.67 2.69 2.72 2.76 2.83

Primary OutFlow Max=0.59 cfs @ 12.51 hrs HW=155.62' (Free Discharge)
1=Broad-Crested Rectangular Weir (Weir Controls 0.59 cfs @ 0.82 fps)

Pond 12P: Outlet Det Pond

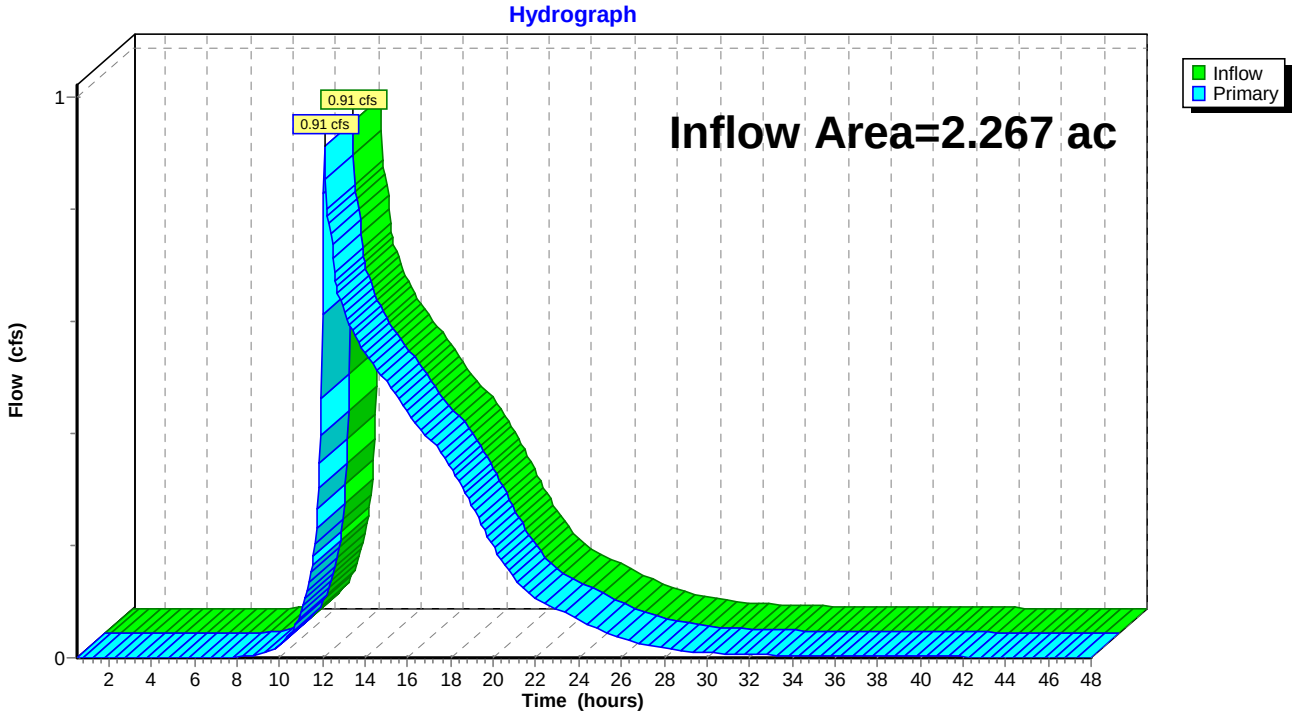


Summary for Link DP#2: DP#2 - Rear Wetlands

Inflow Area = 2.267 ac, 52.82% Impervious, Inflow Depth > 2.00" for 2-YR event
Inflow = 0.91 cfs @ 12.10 hrs, Volume= 0.377 af
Primary = 0.91 cfs @ 12.10 hrs, Volume= 0.377 af, Atten= 0%, Lag= 0.0 min
Routed to Pond 2P : Ex-Wetlands Area

Primary outflow = Inflow, Time Span= 0.50-48.00 hrs, dt= 0.05 hrs

Link DP#2: DP#2 - Rear Wetlands



Summary for Subcatchment 1S: Flow to PCB#1

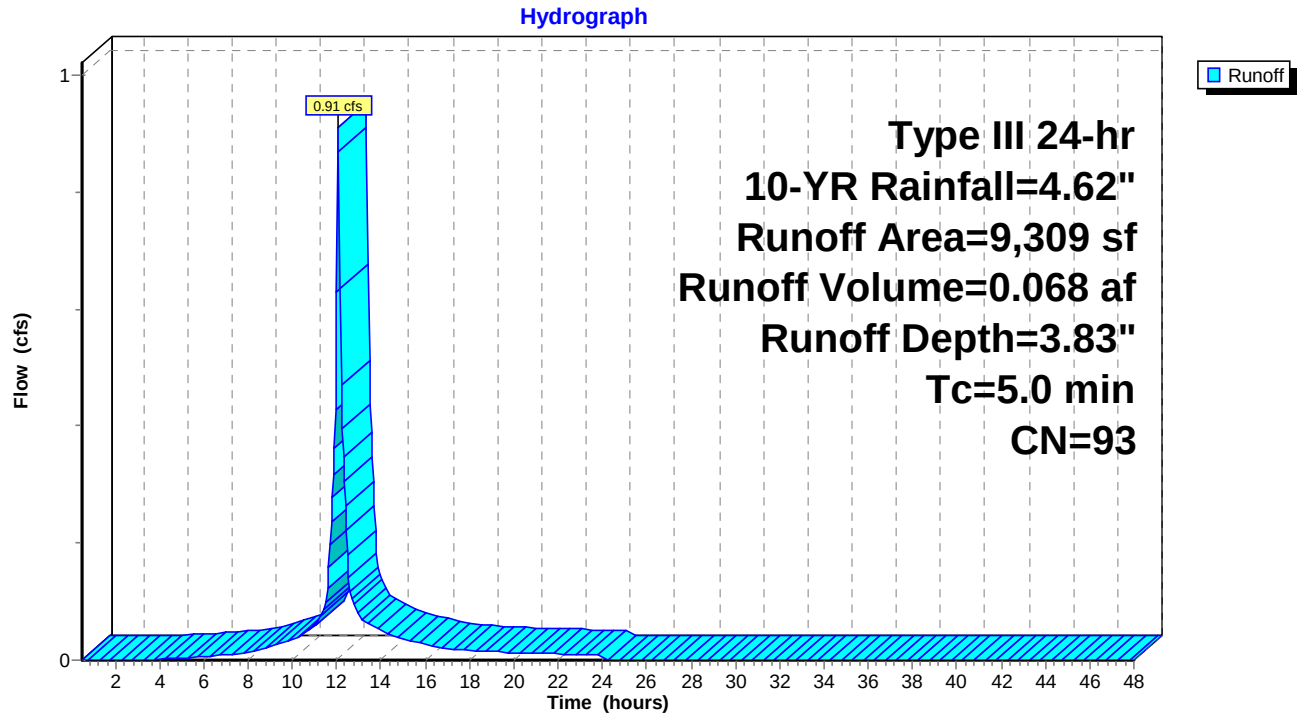
Runoff = 0.91 cfs @ 12.07 hrs, Volume= 0.068 af, Depth= 3.83"
Routed to Pond 1P : ADS 36" Pipe Det Basin

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.50-48.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-YR Rainfall=4.62"

	Area (sf)	CN	Description
	3,640	98	Paved parking, HSG D
	2,814	98	Roofs, HSG D
*	380	98	Walkways
	2,475	80	>75% Grass cover, Good, HSG D
	9,309	93	Weighted Average
	2,475		26.59% Pervious Area
	6,834		73.41% Impervious Area

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

Subcatchment 1S: Flow to PCB#1



Summary for Subcatchment 3S: Flow to PCB#2

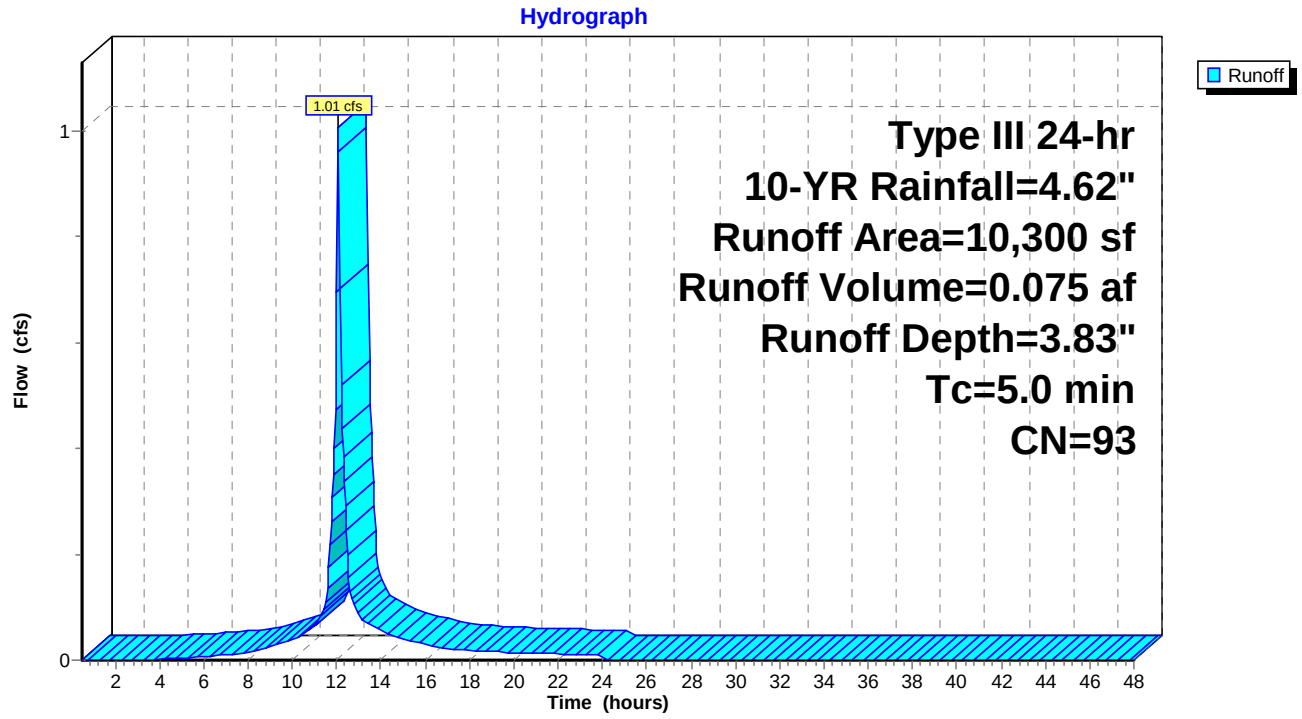
Runoff = 1.01 cfs @ 12.07 hrs, Volume= 0.075 af, Depth= 3.83"
Routed to Pond 1P : ADS 36" Pipe Det Basin

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.50-48.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-YR Rainfall=4.62"

	Area (sf)	CN	Description
	3,906	98	Paved parking, HSG D
	2,936	98	Roofs, HSG D
*	380	98	Walkways, HSG D
	3,078	80	>75% Grass cover, Good, HSG D
	10,300	93	Weighted Average
	3,078		29.88% Pervious Area
	7,222		70.12% Impervious Area

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

Subcatchment 3S: Flow to PCB#2



Summary for Subcatchment 4S: Remaining Ex Neighborhood WS Area

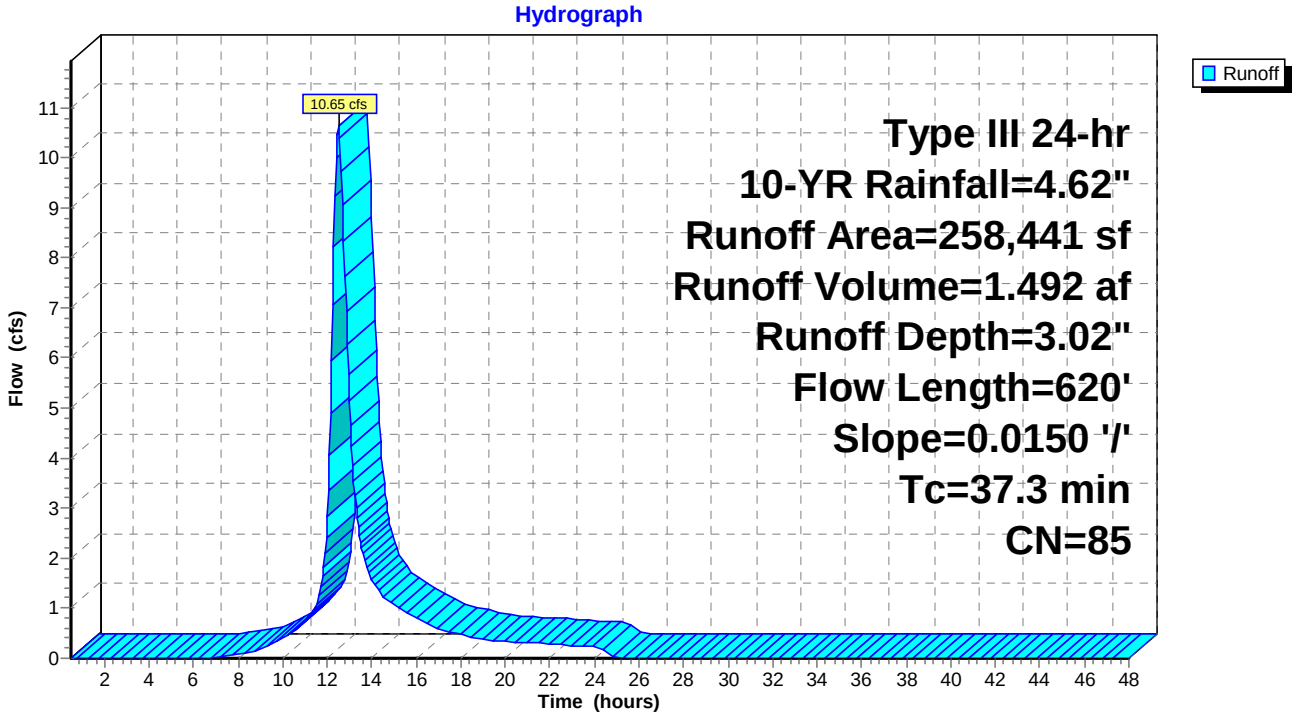
Runoff = 10.65 cfs @ 12.51 hrs, Volume= 1.492 af, Depth= 3.02"
Routed to Pond 2P : Ex-Wetlands Area

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.50-48.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-YR Rainfall=4.62"

Area (sf)	CN	Description
258,441	85	1/2 acre lots, 25% imp, HSG D
193,831		75.00% Pervious Area
64,610		25.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.3	50	0.0150	0.13		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.20"
31.0	570	0.0150	0.31		**Shallow Concentrated Flow,** Forest w/Heavy Litter Kv= 2.5 fps
37.3	620	Total			

Subcatchment 4S: Remaining Ex Neighborhood WS Area



Summary for Subcatchment 5S: Landscape Area To Sed Forebay

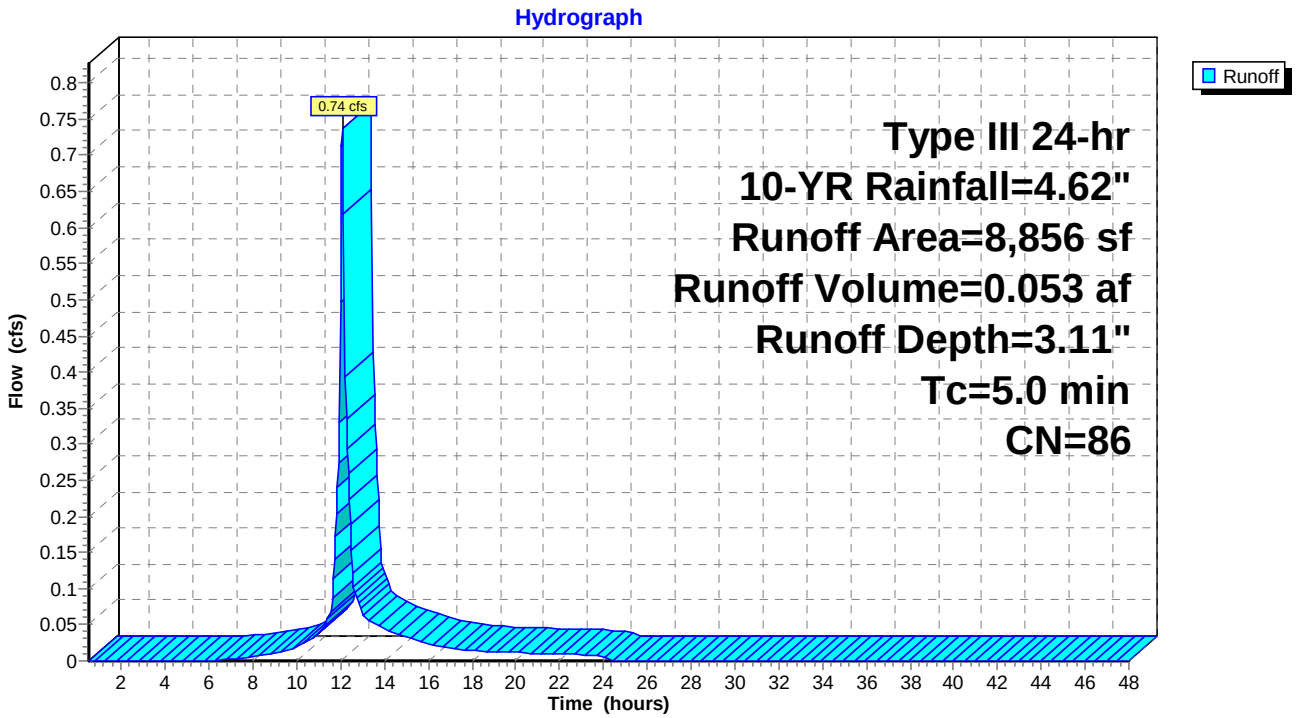
Runoff = 0.74 cfs @ 12.07 hrs, Volume= 0.053 af, Depth= 3.11"
Routed to Reach 10R : PFD#1

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.50-48.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-YR Rainfall=4.62"

	Area (sf)	CN	Description
	5,671	80	>75% Grass cover, Good, HSG D
*	1,160	98	Patios, HSG D
	2,025	98	Roofs, HSG D
	8,856	86	Weighted Average
	5,671		64.04% Pervious Area
	3,185		35.96% Impervious Area

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

Subcatchment 5S: Landscape Area To Sed Forebay



Summary for Subcatchment 6S: Undetained Flow to Wetlands

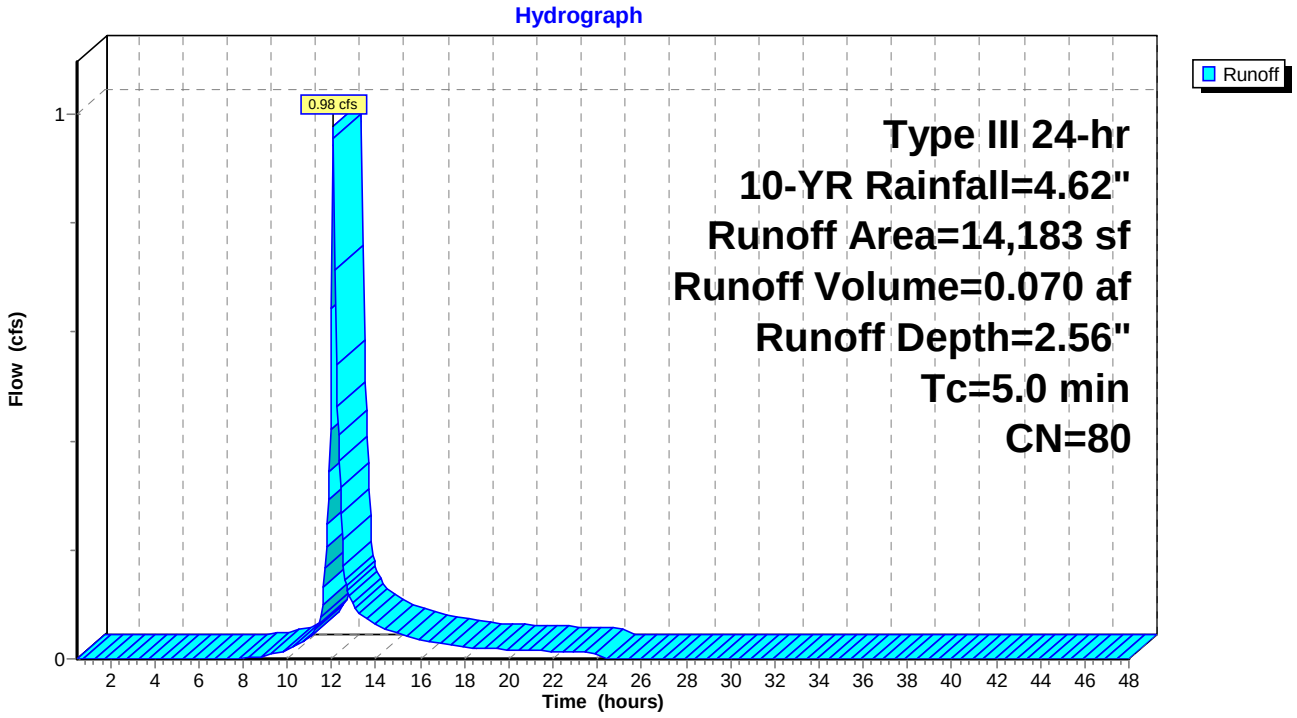
Runoff = 0.98 cfs @ 12.08 hrs, Volume= 0.070 af, Depth= 2.56"
Routed to Link DP#2 : DP#2 - Rear Wetlands

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.50-48.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-YR Rainfall=4.62"

Area (sf)	CN	Description
14,183	80	>75% Grass cover, Good, HSG D
14,183		100.00% Pervious Area

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

Subcatchment 6S: Undetained Flow to Wetlands



Summary for Subcatchment 7S: Flow to PCB#3

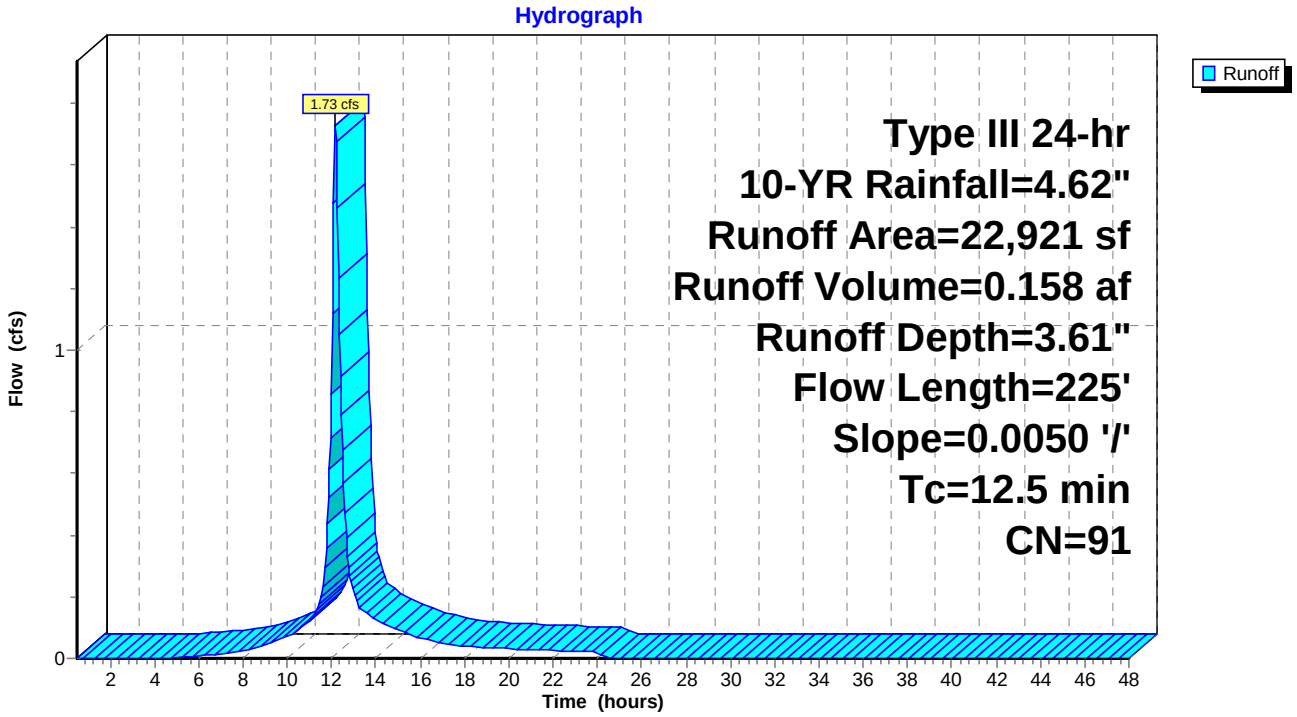
Runoff = 1.73 cfs @ 12.17 hrs, Volume= 0.158 af, Depth= 3.61"
Routed to Pond 1P : ADS 36" Pipe Det Basin

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.50-48.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-YR Rainfall=4.62"

	Area (sf)	CN	Description
	6,527	98	Paved parking, HSG D
*	2,886	98	Roofs, HSG D (Front Units 6-13)
*	140	98	Walkways, HSG D
	615	80	>75% Grass cover, Good, HSG D
*	3,060	98	Roofs, HSG D (Rear Units 5-13)
	7,731	80	>75% Grass cover, Good, HSG D
*	1,962	98	Patios, HSG D
	22,921	91	Weighted Average
	8,346		36.41% Pervious Area
	14,575		63.59% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
9.8	50	0.0050	0.09		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.20"
2.7	175	0.0050	1.06		**Shallow Concentrated Flow,** Grassed Waterway Kv= 15.0 fps
12.5	225	Total			

Subcatchment 7S: Flow to PCB#3



Summary for Subcatchment 8S: Flow to PCB#4

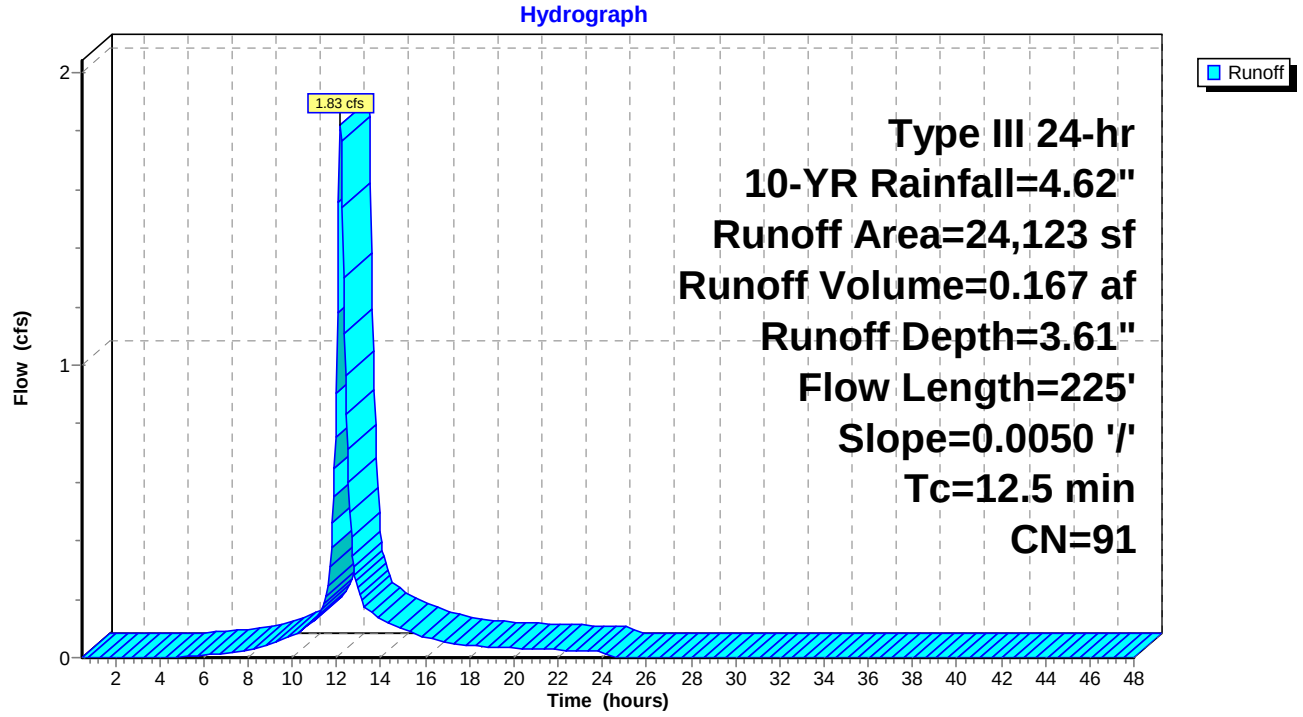
Runoff = 1.83 cfs @ 12.17 hrs, Volume= 0.167 af, Depth= 3.61"
Routed to Pond 1P : ADS 36" Pipe Det Basin

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.50-48.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-YR Rainfall=4.62"

	Area (sf)	CN	Description
	6,532	98	Paved parking, HSG D
	5,760	98	Roofs, HSG D
*	140	98	Walkways, HSG D
	9,729	80	>75% Grass cover, Good, HSG D
*	1,962	98	Patios, HSG D
	24,123	91	Weighted Average
	9,729		40.33% Pervious Area
	14,394		59.67% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
9.8	50	0.0050	0.09		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.20"
2.7	175	0.0050	1.06		**Shallow Concentrated Flow,** Grassed Waterway Kv= 15.0 fps
12.5	225	Total			

Subcatchment 8S: Flow to PCB#4



Summary for Subcatchment 9S: Undetained Flow to Greenmont Ave - DP#1

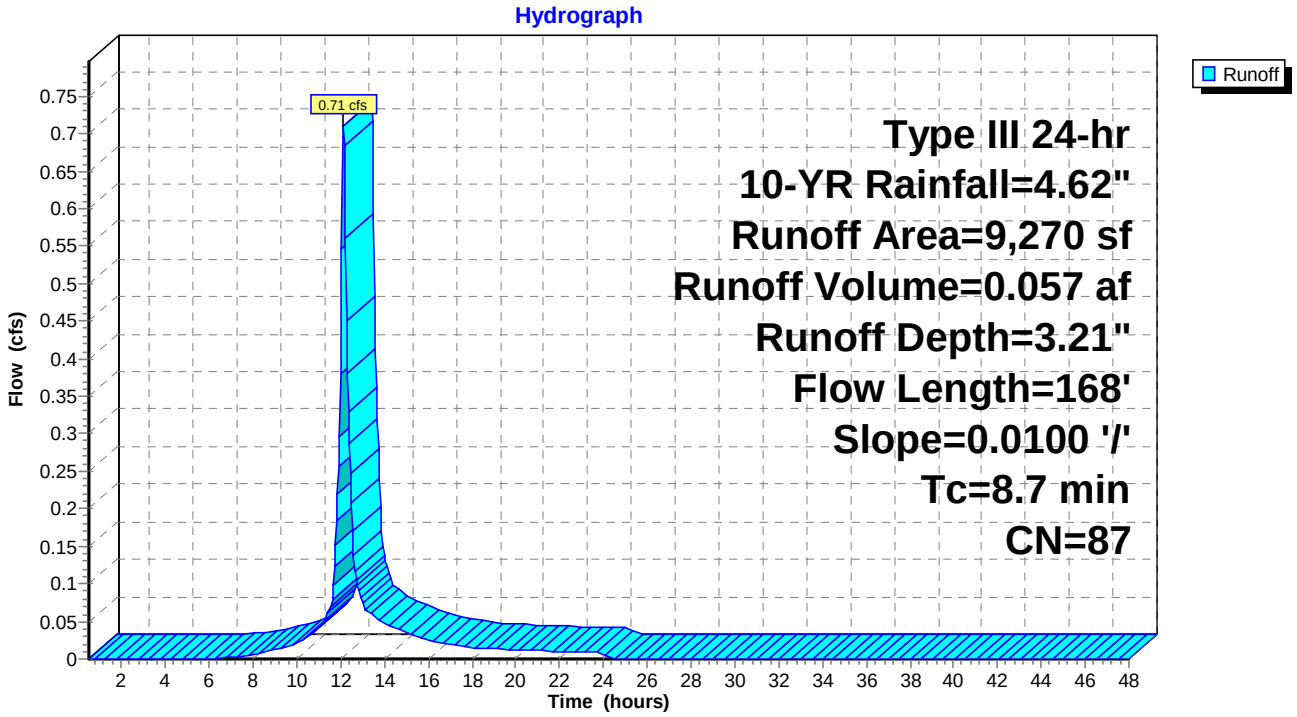
Runoff = 0.71 cfs @ 12.12 hrs, Volume= 0.057 af, Depth= 3.21"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.50-48.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-YR Rainfall=4.62"

Area (sf)	CN	Description
5,908	80	>75% Grass cover, Good, HSG D
3,362	98	Roofs, HSG D
9,270	87	Weighted Average
5,908		63.73% Pervious Area
3,362		36.27% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.4	50	0.0100	0.11		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.20"
1.3	118	0.0100	1.50		**Shallow Concentrated Flow,** Grassed Waterway Kv= 15.0 fps
8.7	168	Total			

Subcatchment 9S: Undetained Flow to Greenmont Ave - DP#1



Summary for Subcatchment 11S: Sediment Forebay Basin

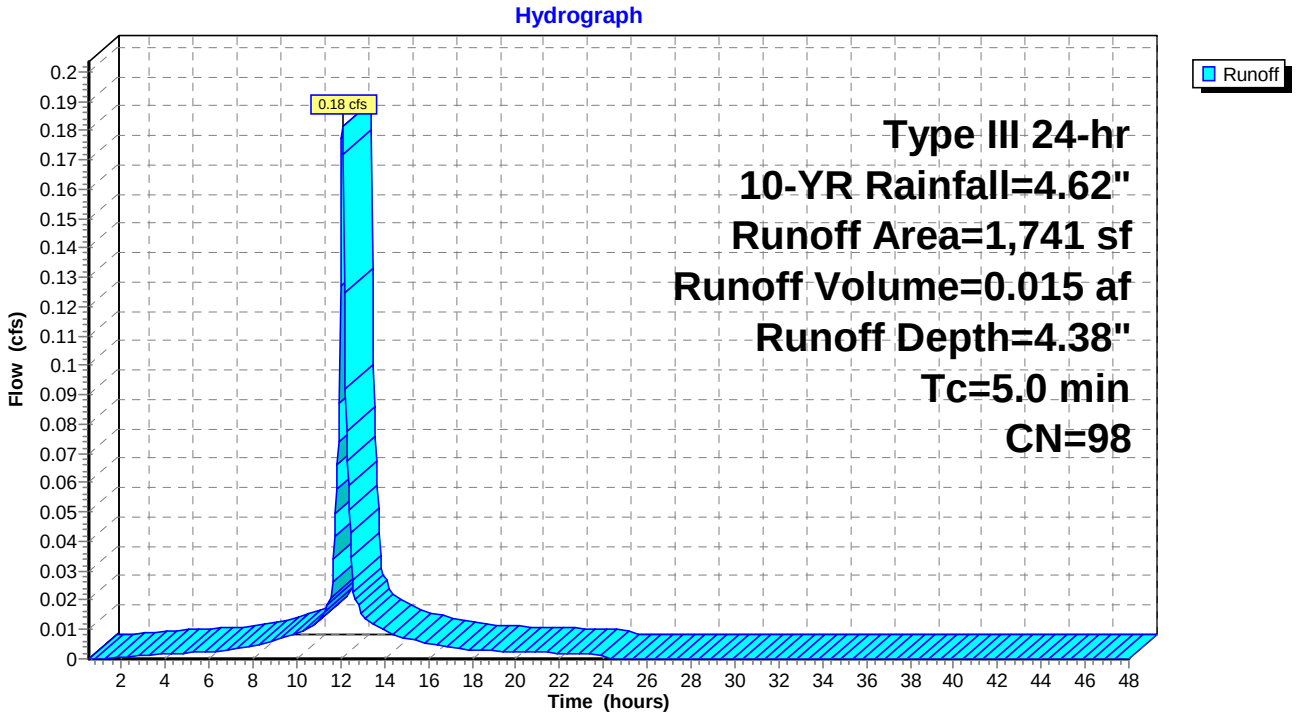
Runoff = 0.18 cfs @ 12.07 hrs, Volume= 0.015 af, Depth= 4.38"
Routed to Pond 11P : Sediment Forebay

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.50-48.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-YR Rainfall=4.62"

	Area (sf)	CN	Description
*	1,741	98	Sed Bas Wet Surface
	1,741		100.00% Impervious Area

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

Subcatchment 11S: Sediment Forebay Basin



Summary for Subcatchment 36S: Extended Detention Wet Basin

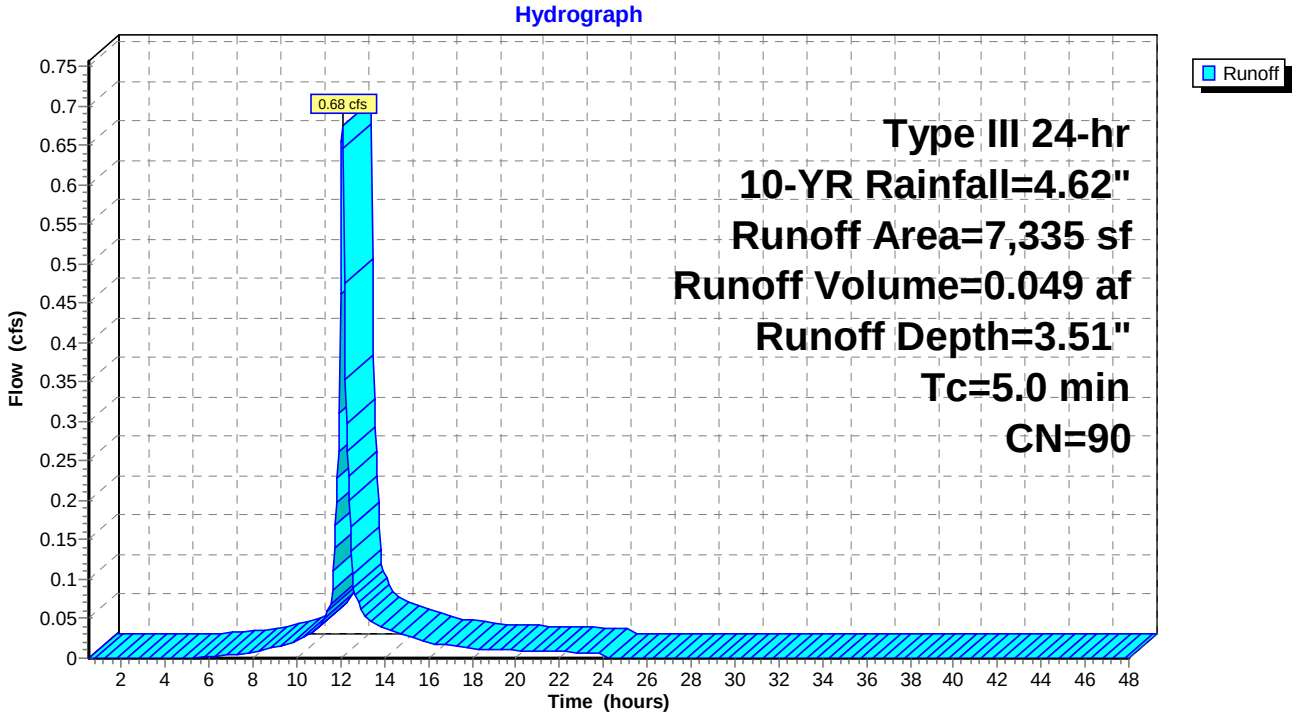
Runoff = 0.68 cfs @ 12.07 hrs, Volume= 0.049 af, Depth= 3.51"
Routed to Pond 12P : Outlet Det Pond

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.50-48.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-YR Rainfall=4.62"

	Area (sf)	CN	Description
	3,120	80	>75% Grass cover, Good, HSG D
*	4,215	98	Wet Basin Surface Water
	7,335	90	Weighted Average
	3,120		42.54% Pervious Area
	4,215		57.46% Impervious Area

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

Subcatchment 36S: Extended Detention Wet Basin



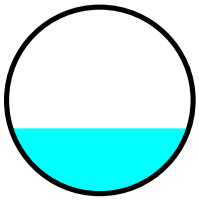
Summary for Reach 10R: PFD#1

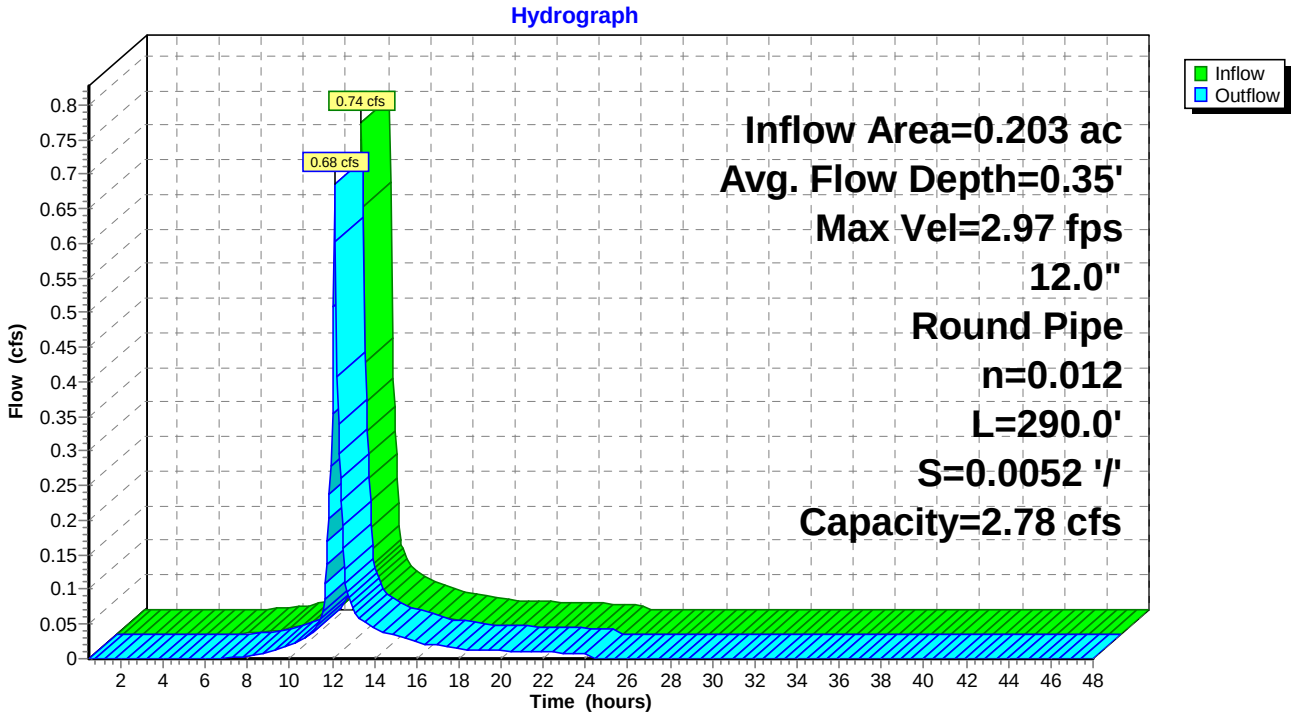
Inflow Area = 0.203 ac, 35.96% Impervious, Inflow Depth = 3.11" for 10-YR event
Inflow = 0.74 cfs @ 12.07 hrs, Volume= 0.053 af
Outflow = 0.68 cfs @ 12.13 hrs, Volume= 0.053 af, Atten= 7%, Lag= 3.1 min
Routed to Pond 11P : Sediment Forebay

Routing by Stor-Ind+Trans method, Time Span= 0.50-48.00 hrs, dt= 0.05 hrs
Max. Velocity= 2.97 fps, Min. Travel Time= 1.6 min
Avg. Velocity = 0.99 fps, Avg. Travel Time= 4.9 min

Peak Storage= 70 cf @ 12.10 hrs
Average Depth at Peak Storage= 0.35' , Surface Width= 0.95'
Bank-Full Depth= 1.00' Flow Area= 0.8 sf, Capacity= 2.78 cfs

12.0" Round Pipe
n= 0.012 Corrugated PP, smooth interior
Length= 290.0' Slope= 0.0052 '/'
Inlet Invert= 158.00', Outlet Invert= 156.50'





Summary for Pond 1P: ADS 36" Pipe Det Basin

Inflow Area = 1.530 ac, 64.55% Impervious, Inflow Depth = 3.68" for 10-YR event
Inflow = 4.95 cfs @ 12.12 hrs, Volume= 0.469 af
Outflow = 0.57 cfs @ 13.05 hrs, Volume= 0.468 af, Atten= 89%, Lag= 55.4 min
Primary = 0.57 cfs @ 13.05 hrs, Volume= 0.468 af
Routed to Pond 11P : Sediment Forebay

Routing by Stor-Ind method, Time Span= 0.50-48.00 hrs, dt= 0.05 hrs
Peak Elev= 158.49' @ 13.05 hrs Surf.Area= 7,550 sf Storage= 9,769 cf

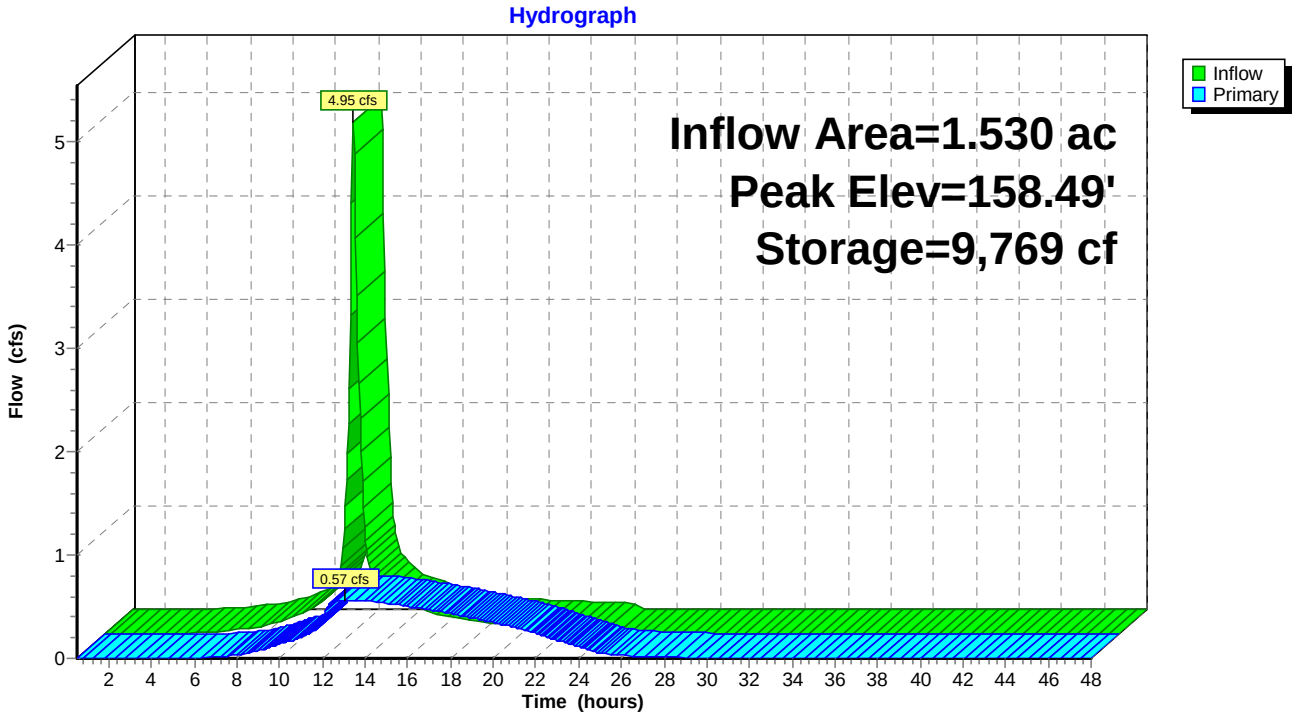
Plug-Flow detention time= 203.5 min calculated for 0.468 af (100% of inflow)
Center-of-Mass det. time= 202.9 min (993.6 - 790.7)

Volume	Invert	Avail.Storage	Storage Description
#1	157.00'	12,723 cf	**36.0" Round Pipe Storage** x 6 Inside #2 L= 300.0'
#2	156.50'	6,991 cf	**25.00'W x 302.00'L x 4.00'H Prismatoid** 30,200 cf Overall - 12,723 cf Embedded = 17,477 cf x 40.0% Voids
		19,714 cf	Total Available Storage

Device	Routing	Invert	Outlet Devices
#1	Primary	159.00'	**12.0" Vert. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#2	Primary	156.50'	**4.0" Vert. Orifice/Grate** C= 0.600 Limited to weir flow at low heads

Primary OutFlow Max=0.57 cfs @ 13.05 hrs HW=158.49' (Free Discharge)
1=Orifice/Grate (Controls 0.00 cfs)
2=Orifice/Grate (Orifice Controls 0.57 cfs @ 6.49 fps)

Pond 1P: ADS 36" Pipe Det Basin



Summary for Pond 2P: Ex-Wetlands Area

Inflow Area = 8.200 ac, 32.69% Impervious, Inflow Depth = 3.14" for 10-YR event
Inflow = 11.92 cfs @ 12.50 hrs, Volume= 2.146 af
Outflow = 4.63 cfs @ 13.16 hrs, Volume= 2.145 af, Atten= 61%, Lag= 39.9 min
Primary = 4.63 cfs @ 13.16 hrs, Volume= 2.145 af

Routing by Stor-Ind method, Time Span= 0.50-48.00 hrs, dt= 0.05 hrs
Peak Elev= 152.59' @ 13.16 hrs Surf.Area= 28,674 sf Storage= 18,715 cf

Plug-Flow detention time= 28.2 min calculated for 2.145 af (100% of inflow)
Center-of-Mass det. time= 27.1 min (912.2 - 885.1)

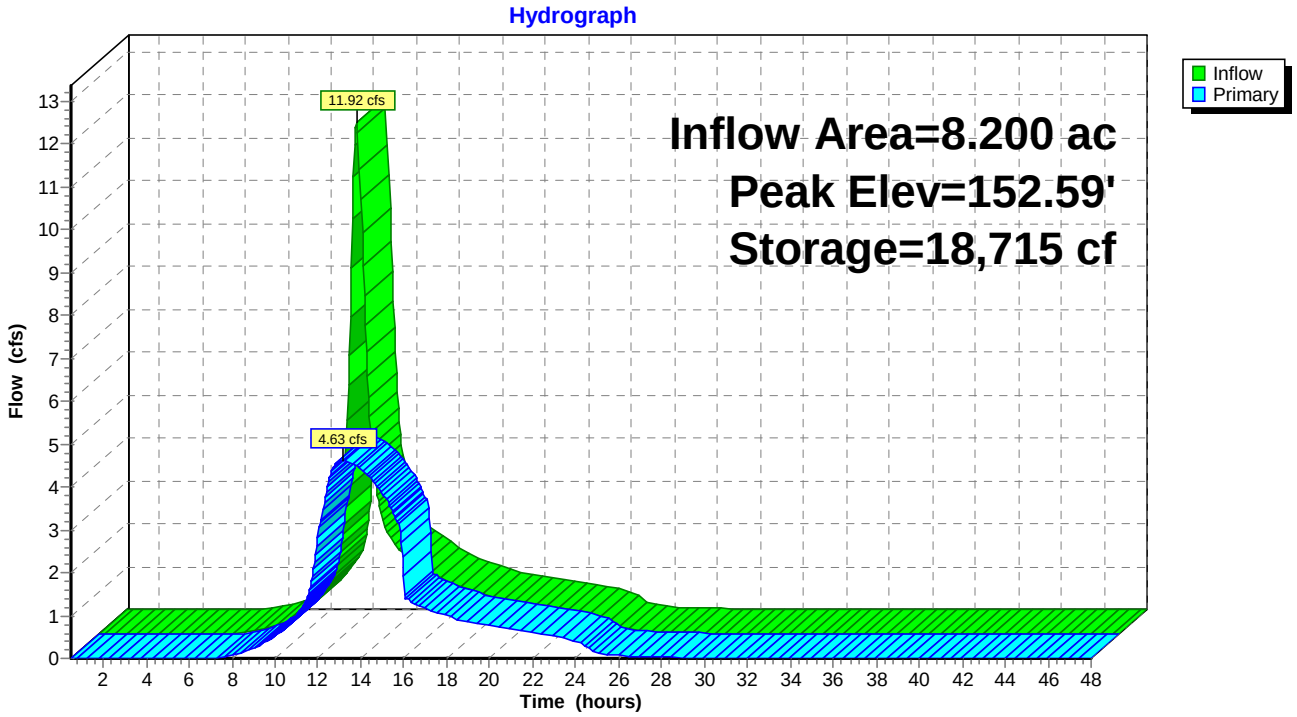
Volume	Invert	Avail.Storage	Storage Description
#1	150.00'	184,747 cf	**Custom Stage Data (Irregular)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
150.00	208	75.0	0	0	208
151.00	328	94.0	266	266	477
152.00	14,780	1,138.0	5,770	6,036	102,832
153.00	40,797	1,192.0	26,711	32,747	112,912
154.00	69,661	1,810.0	54,589	87,336	260,555
155.00	128,105	2,354.0	97,411	184,747	440,827

Device	Routing	Invert	Outlet Devices
#1	Primary	150.25'	**12.0" Round Culvert** L= 83.0' RCP, groove end projecting, Ke= 0.200 Inlet / Outlet Invert= 150.25' / 149.75' S= 0.0060 '/' Cc= 0.900 n= 0.012 Concrete pipe, finished, Flow Area= 0.79 sf
#2	Primary	153.07'	**2.0" x 2.0" Horiz. Orifice/Grate X 6.00 columns** X 6 rows C= 0.600 Limited to weir flow at low heads

Primary OutFlow Max=4.63 cfs @ 13.16 hrs HW=152.59' (Free Discharge)
└**1=Culvert** (Barrel Controls 4.63 cfs @ 5.89 fps)
└**2=Orifice/Grate** (Controls 0.00 cfs)

Pond 2P: Ex-Wetlands Area



Summary for Pond 11P: Sediment Forebay

Inflow Area = 1.773 ac, 62.07% Impervious, Inflow Depth > 3.63" for 10-YR event
Inflow = 1.28 cfs @ 12.12 hrs, Volume= 0.536 af
Outflow = 0.93 cfs @ 12.30 hrs, Volume= 0.535 af, Atten= 27%, Lag= 11.0 min
Primary = 0.93 cfs @ 12.30 hrs, Volume= 0.535 af
Routed to Pond 12P : Outlet Det Pond

Routing by Stor-Ind method, Time Span= 0.50-48.00 hrs, dt= 0.05 hrs
Starting Elev= 156.00' Surf.Area= 1,059 sf Storage= 868 cf
Peak Elev= 157.07' @ 12.30 hrs Surf.Area= 1,532 sf Storage= 2,265 cf (1,396 cf above start)

Plug-Flow detention time= 79.5 min calculated for 0.515 af (96% of inflow)
Center-of-Mass det. time= 37.3 min (1,006.3 - 969.0)

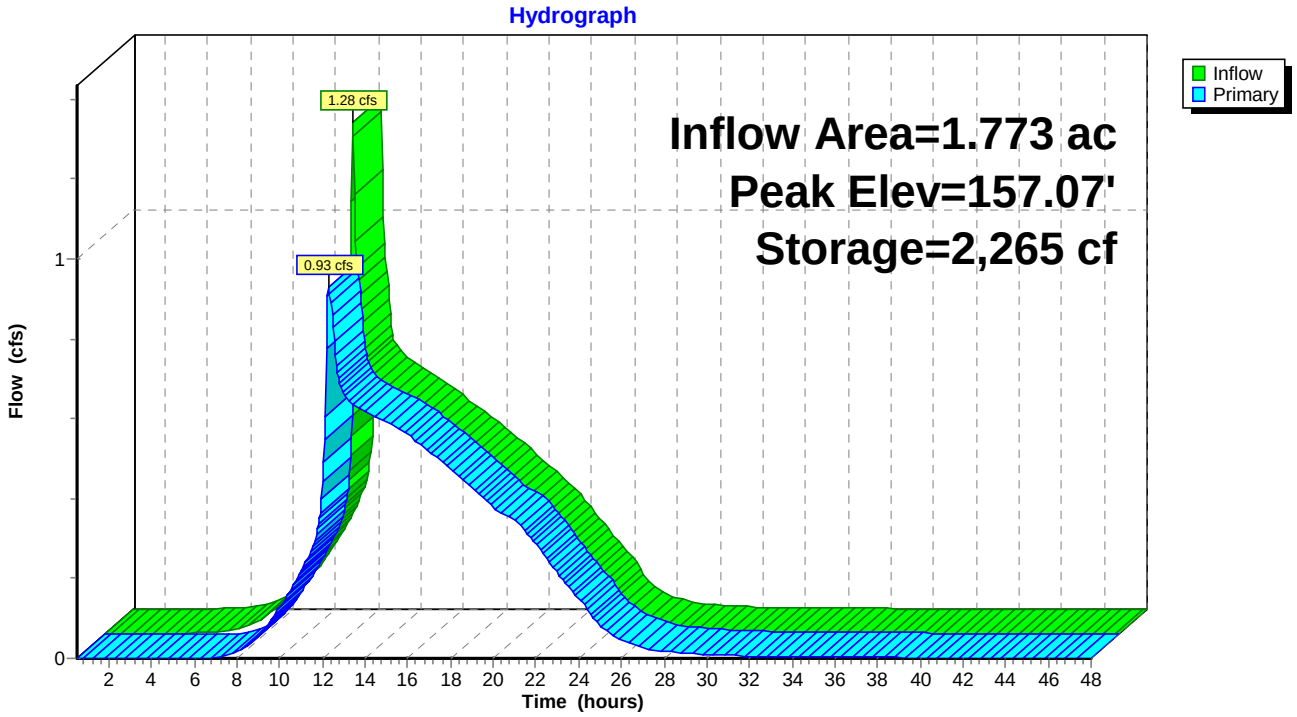
Volume	Invert	Avail.Storage	Storage Description
#1	155.00'	3,718 cf	**Custom Stage Data (Irregular)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
155.00	691	110.0	0	0	691
156.00	1,059	130.0	868	868	1,091
157.00	1,527	162.0	1,286	2,154	1,849
158.00	1,601	162.0	1,564	3,718	2,011

Device	Routing	Invert	Outlet Devices
#1	Primary	156.00'	**6.0" Round Culvert** L= 18.0' CPP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 156.00' / 156.00' S= 0.0000 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.20 sf
#2	Primary	157.00'	**6.0' long x 6.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 3.50 4.00 4.50 5.00 5.50 Coef. (English) 2.37 2.51 2.70 2.68 2.68 2.67 2.65 2.65 2.65 2.65 2.66 2.66 2.67 2.69 2.72 2.76 2.83

Primary OutFlow Max=0.93 cfs @ 12.30 hrs HW=157.07' (Free Discharge)
1=Culvert (Barrel Controls 0.65 cfs @ 3.33 fps)
2=Broad-Crested Rectangular Weir (Weir Controls 0.27 cfs @ 0.64 fps)

Pond 11P: Sediment Forebay



Summary for Pond 12P: Outlet Det Pond

Inflow Area = 1.942 ac, 61.67% Impervious, Inflow Depth > 3.61" for 10-YR event
Inflow = 1.21 cfs @ 12.27 hrs, Volume= 0.584 af
Outflow = 1.08 cfs @ 12.41 hrs, Volume= 0.584 af, Atten= 11%, Lag= 8.5 min
Primary = 1.08 cfs @ 12.41 hrs, Volume= 0.584 af
Routed to Link DP#2 : DP#2 - Rear Wetlands

Routing by Stor-Ind method, Time Span= 0.50-48.00 hrs, dt= 0.05 hrs
Starting Elev= 155.50' Surf.Area= 5,255 sf Storage= 5,215 cf
Peak Elev= 155.68' @ 12.41 hrs Surf.Area= 5,656 sf Storage= 6,192 cf (978 cf above start)

Plug-Flow detention time= 198.8 min calculated for 0.464 af (79% of inflow)
Center-of-Mass det. time= 20.1 min (1,008.3 - 988.2)

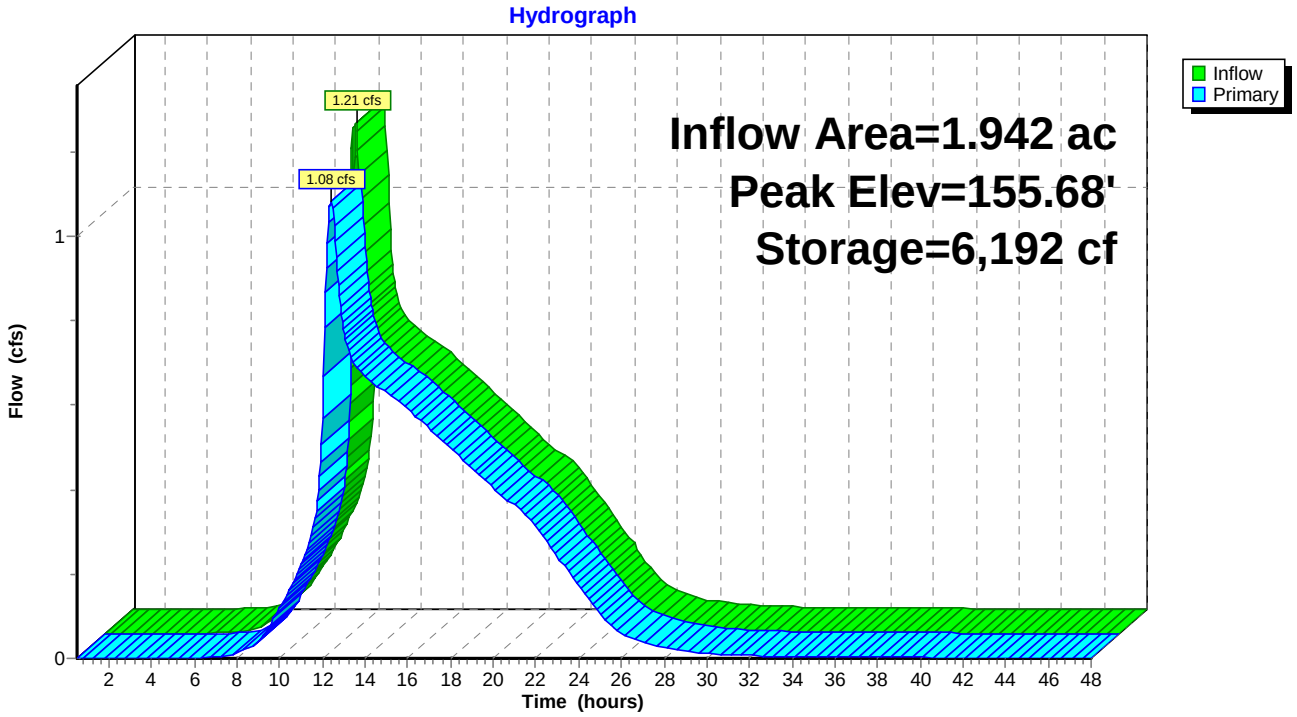
Volume	Invert	Avail.Storage	Storage Description
#1	154.00'	11,493 cf	**Custom Stage Data (Irregular)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
154.00	1,680	368.0	0	0	1,680
155.00	4,215	676.0	2,852	2,852	27,274
156.00	6,410	526.0	5,274	8,126	41,634
156.50	7,063	568.0	3,367	11,493	45,301

Device	Routing	Invert	Outlet Devices
#1	Primary	155.50'	**6.0' long x 6.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 3.50 4.00 4.50 5.00 5.50 Coef. (English) 2.37 2.51 2.70 2.68 2.68 2.67 2.65 2.65 2.65 2.65 2.66 2.66 2.67 2.69 2.72 2.76 2.83

Primary OutFlow Max=1.08 cfs @ 12.41 hrs HW=155.68' (Free Discharge)
1=Broad-Crested Rectangular Weir (Weir Controls 1.08 cfs @ 1.00 fps)

Pond 12P: Outlet Det Pond

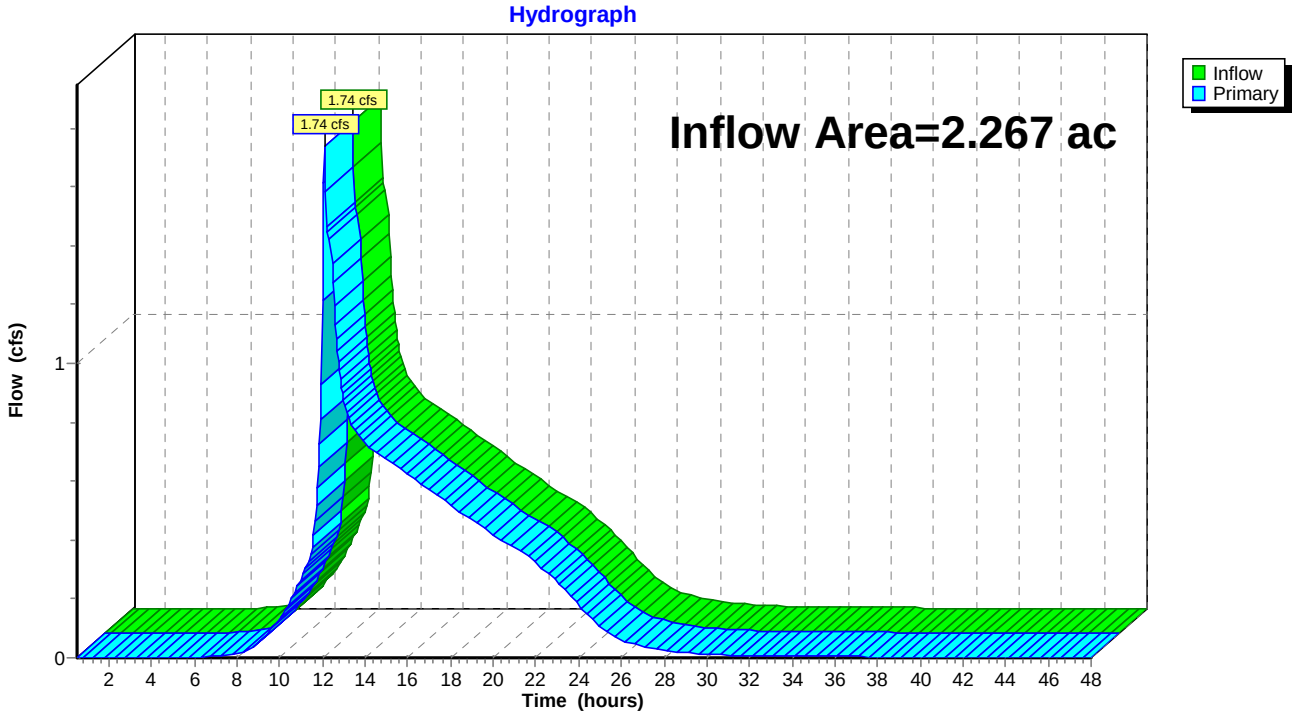


Summary for Link DP#2: DP#2 - Rear Wetlands

Inflow Area = 2.267 ac, 52.82% Impervious, Inflow Depth > 3.46" for 10-YR event
Inflow = 1.74 cfs @ 12.10 hrs, Volume= 0.654 af
Primary = 1.74 cfs @ 12.10 hrs, Volume= 0.654 af, Atten= 0%, Lag= 0.0 min
Routed to Pond 2P : Ex-Wetlands Area

Primary outflow = Inflow, Time Span= 0.50-48.00 hrs, dt= 0.05 hrs

Link DP#2: DP#2 - Rear Wetlands



Summary for Subcatchment 1S: Flow to PCB#1

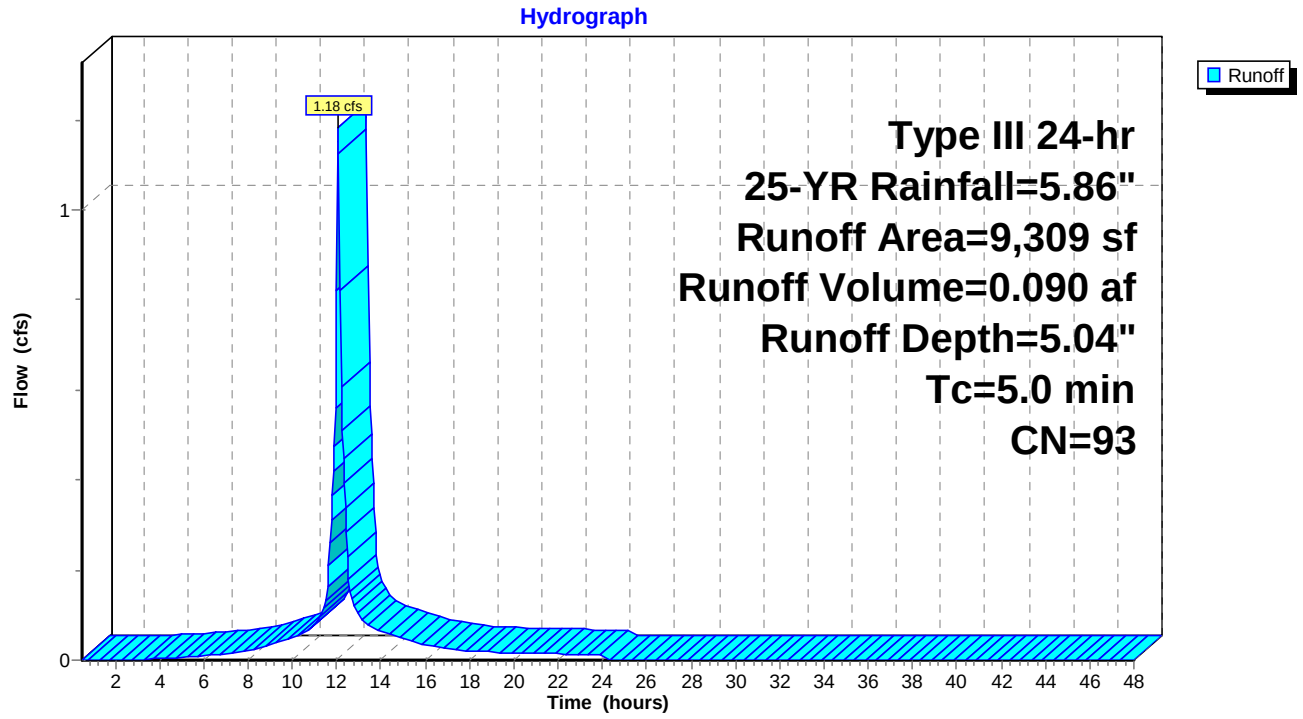
Runoff = 1.18 cfs @ 12.07 hrs, Volume= 0.090 af, Depth= 5.04"
Routed to Pond 1P : ADS 36" Pipe Det Basin

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.50-48.00 hrs, dt= 0.05 hrs
Type III 24-hr 25-YR Rainfall=5.86"

	Area (sf)	CN	Description
	3,640	98	Paved parking, HSG D
	2,814	98	Roofs, HSG D
*	380	98	Walkways
	2,475	80	>75% Grass cover, Good, HSG D
	9,309	93	Weighted Average
	2,475		26.59% Pervious Area
	6,834		73.41% Impervious Area

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

Subcatchment 1S: Flow to PCB#1



Summary for Subcatchment 3S: Flow to PCB#2

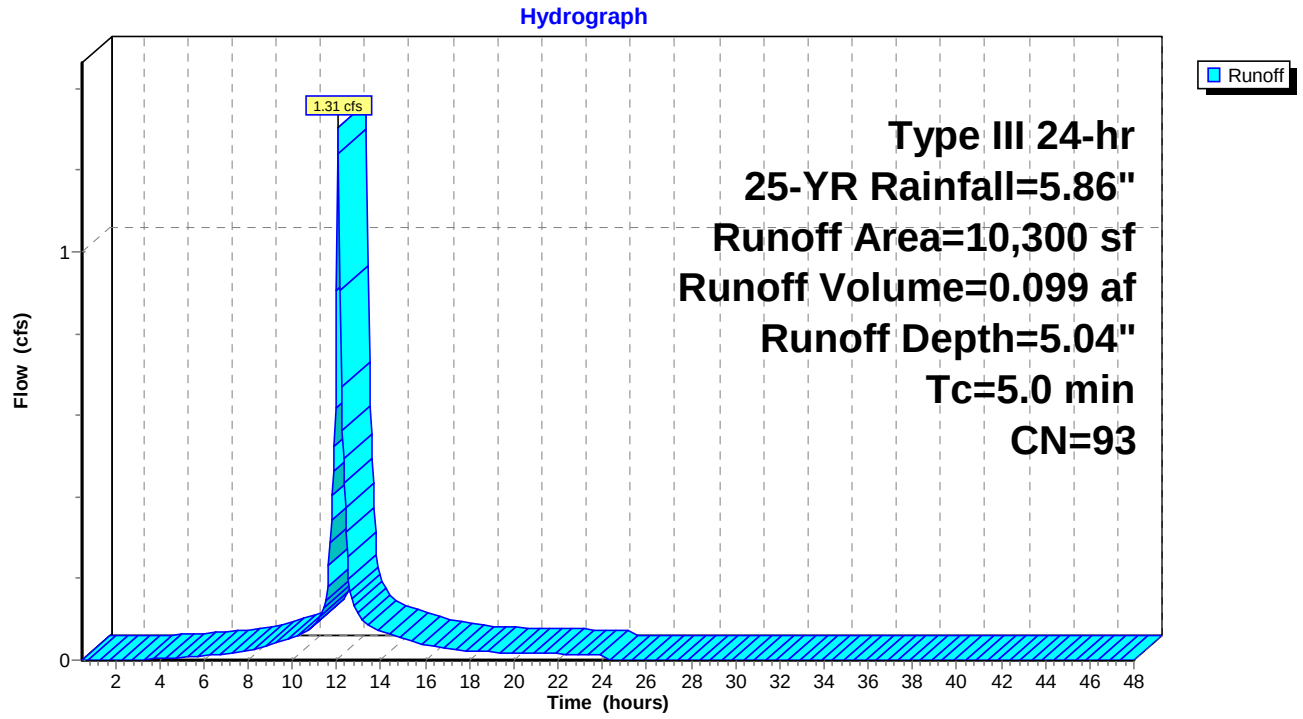
Runoff = 1.31 cfs @ 12.07 hrs, Volume= 0.099 af, Depth= 5.04"
Routed to Pond 1P : ADS 36" Pipe Det Basin

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.50-48.00 hrs, dt= 0.05 hrs
Type III 24-hr 25-YR Rainfall=5.86"

	Area (sf)	CN	Description
	3,906	98	Paved parking, HSG D
	2,936	98	Roofs, HSG D
*	380	98	Walkways, HSG D
	3,078	80	>75% Grass cover, Good, HSG D
	10,300	93	Weighted Average
	3,078		29.88% Pervious Area
	7,222		70.12% Impervious Area

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

Subcatchment 3S: Flow to PCB#2



Summary for Subcatchment 4S: Remaining Ex Neighborhood WS Area

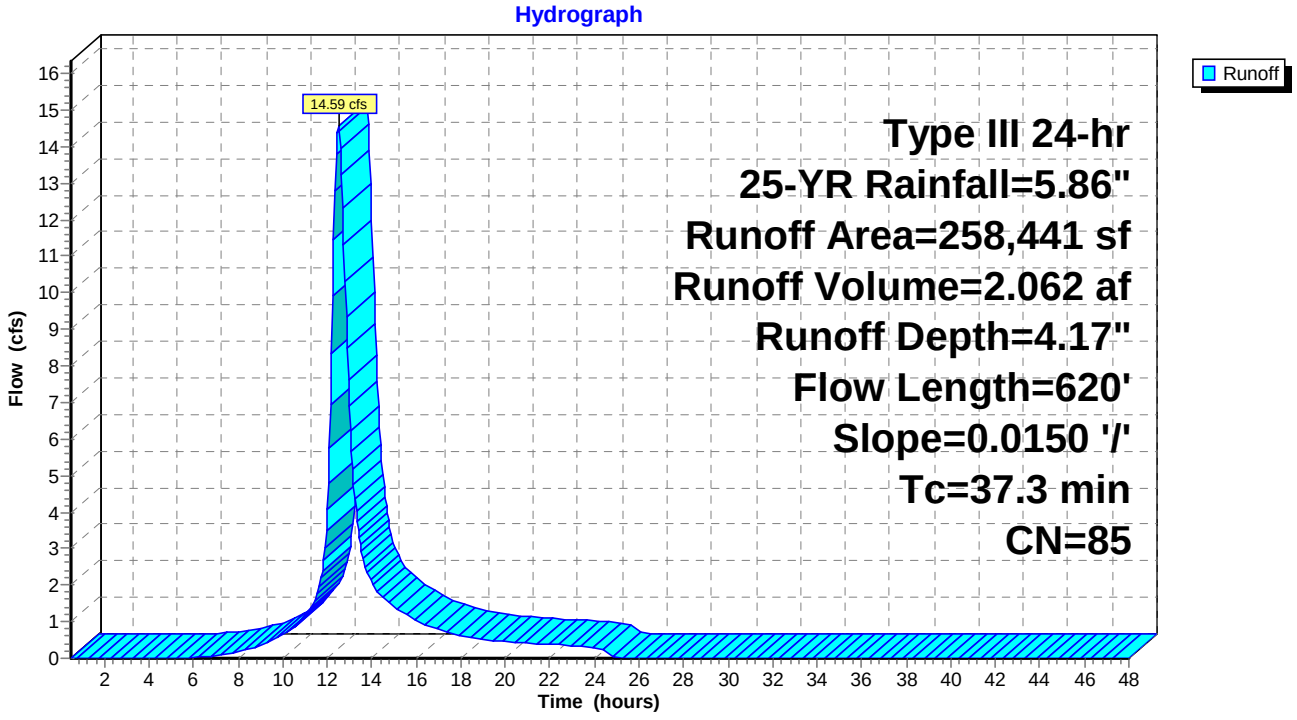
Runoff = 14.59 cfs @ 12.50 hrs, Volume= 2.062 af, Depth= 4.17"
Routed to Pond 2P : Ex-Wetlands Area

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.50-48.00 hrs, dt= 0.05 hrs
Type III 24-hr 25-YR Rainfall=5.86"

Area (sf)	CN	Description
258,441	85	1/2 acre lots, 25% imp, HSG D
193,831		75.00% Pervious Area
64,610		25.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.3	50	0.0150	0.13		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.20"
31.0	570	0.0150	0.31		**Shallow Concentrated Flow,** Forest w/Heavy Litter Kv= 2.5 fps
37.3	620	Total			

Subcatchment 4S: Remaining Ex Neighborhood WS Area



Summary for Subcatchment 5S: Landscape Area To Sed Forebay

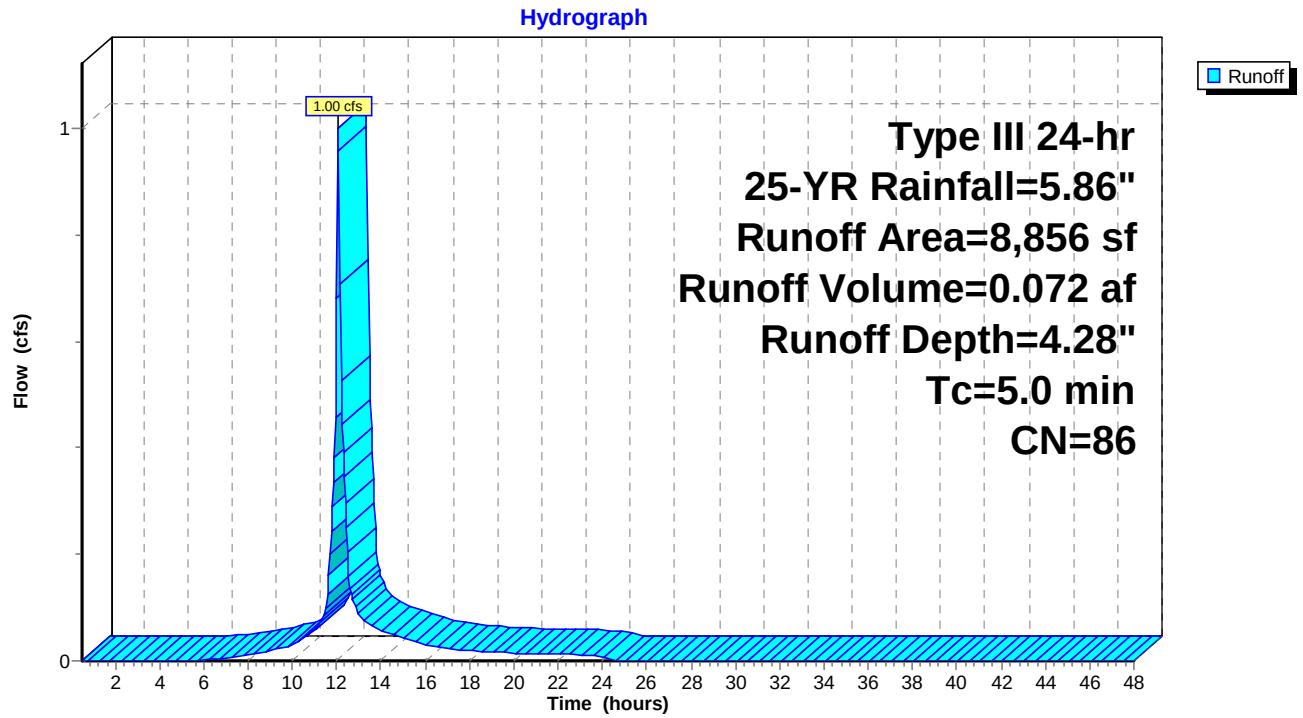
Runoff = 1.00 cfs @ 12.07 hrs, Volume= 0.072 af, Depth= 4.28"
Routed to Reach 10R : PFD#1

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.50-48.00 hrs, dt= 0.05 hrs
Type III 24-hr 25-YR Rainfall=5.86"

	Area (sf)	CN	Description
	5,671	80	>75% Grass cover, Good, HSG D
*	1,160	98	Patios, HSG D
	2,025	98	Roofs, HSG D
	8,856	86	Weighted Average
	5,671		64.04% Pervious Area
	3,185		35.96% Impervious Area

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

Subcatchment 5S: Landscape Area To Sed Forebay



Summary for Subcatchment 6S: Undetained Flow to Wetlands

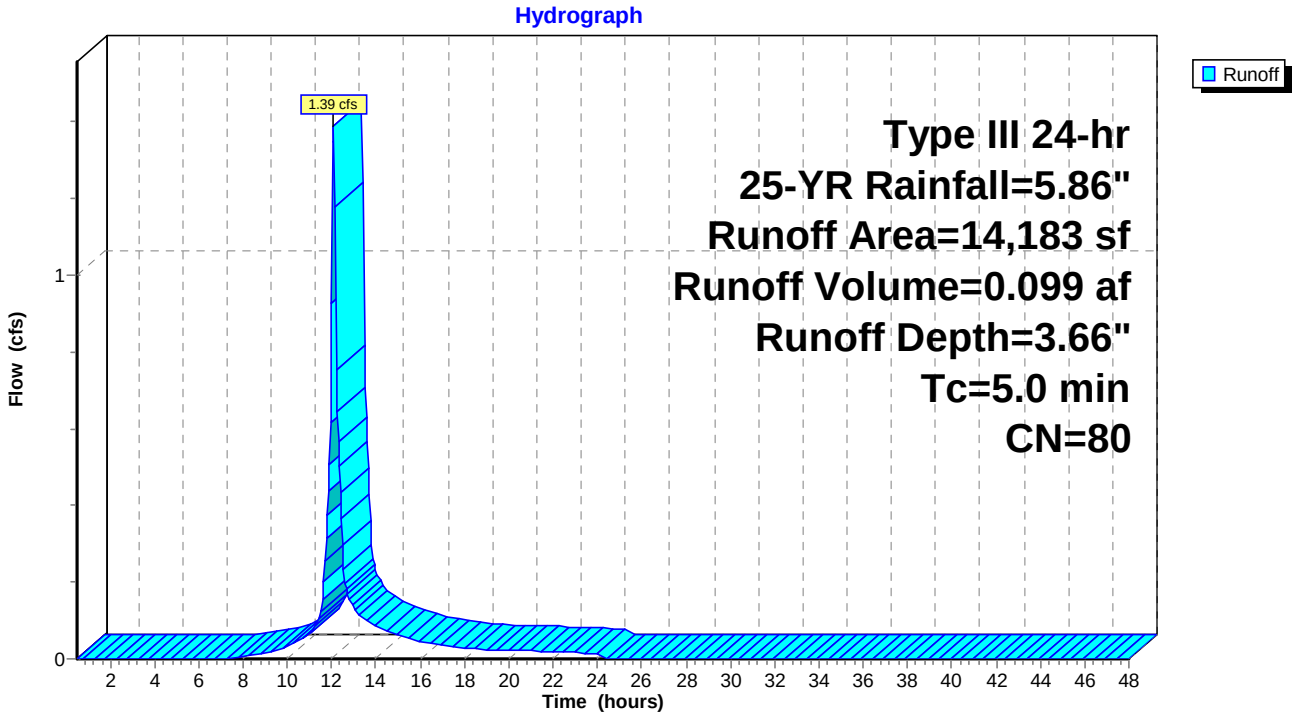
Runoff = 1.39 cfs @ 12.08 hrs, Volume= 0.099 af, Depth= 3.66"
Routed to Link DP#2 : DP#2 - Rear Wetlands

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.50-48.00 hrs, dt= 0.05 hrs
Type III 24-hr 25-YR Rainfall=5.86"

Area (sf)	CN	Description
14,183	80	>75% Grass cover, Good, HSG D
14,183		100.00% Pervious Area

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

Subcatchment 6S: Undetained Flow to Wetlands



Summary for Subcatchment 7S: Flow to PCB#3

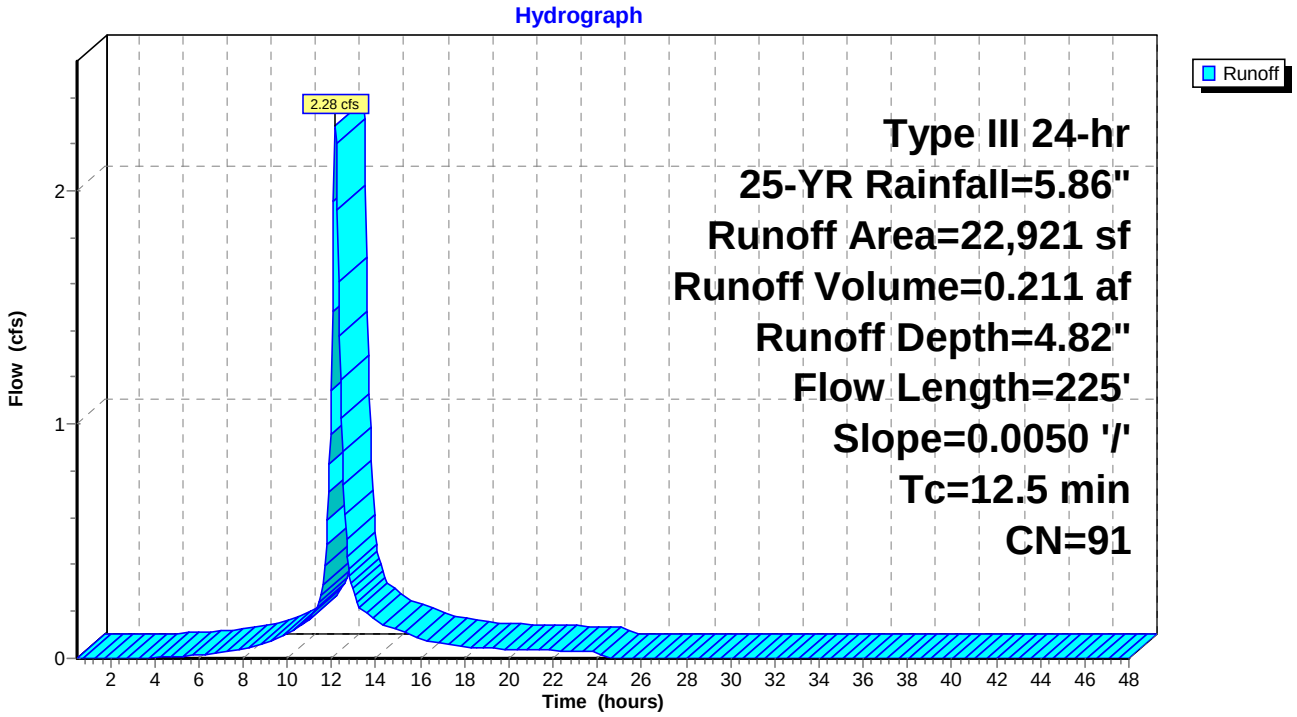
Runoff = 2.28 cfs @ 12.17 hrs, Volume= 0.211 af, Depth= 4.82"
Routed to Pond 1P : ADS 36" Pipe Det Basin

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.50-48.00 hrs, dt= 0.05 hrs
Type III 24-hr 25-YR Rainfall=5.86"

	Area (sf)	CN	Description
	6,527	98	Paved parking, HSG D
*	2,886	98	Roofs, HSG D (Front Units 6-13)
*	140	98	Walkways, HSG D
	615	80	>75% Grass cover, Good, HSG D
*	3,060	98	Roofs, HSG D (Rear Units 5-13)
	7,731	80	>75% Grass cover, Good, HSG D
*	1,962	98	Patios, HSG D
	22,921	91	Weighted Average
	8,346		36.41% Pervious Area
	14,575		63.59% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
9.8	50	0.0050	0.09		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.20"
2.7	175	0.0050	1.06		**Shallow Concentrated Flow,** Grassed Waterway Kv= 15.0 fps
12.5	225	Total			

Subcatchment 7S: Flow to PCB#3



Summary for Subcatchment 8S: Flow to PCB#4

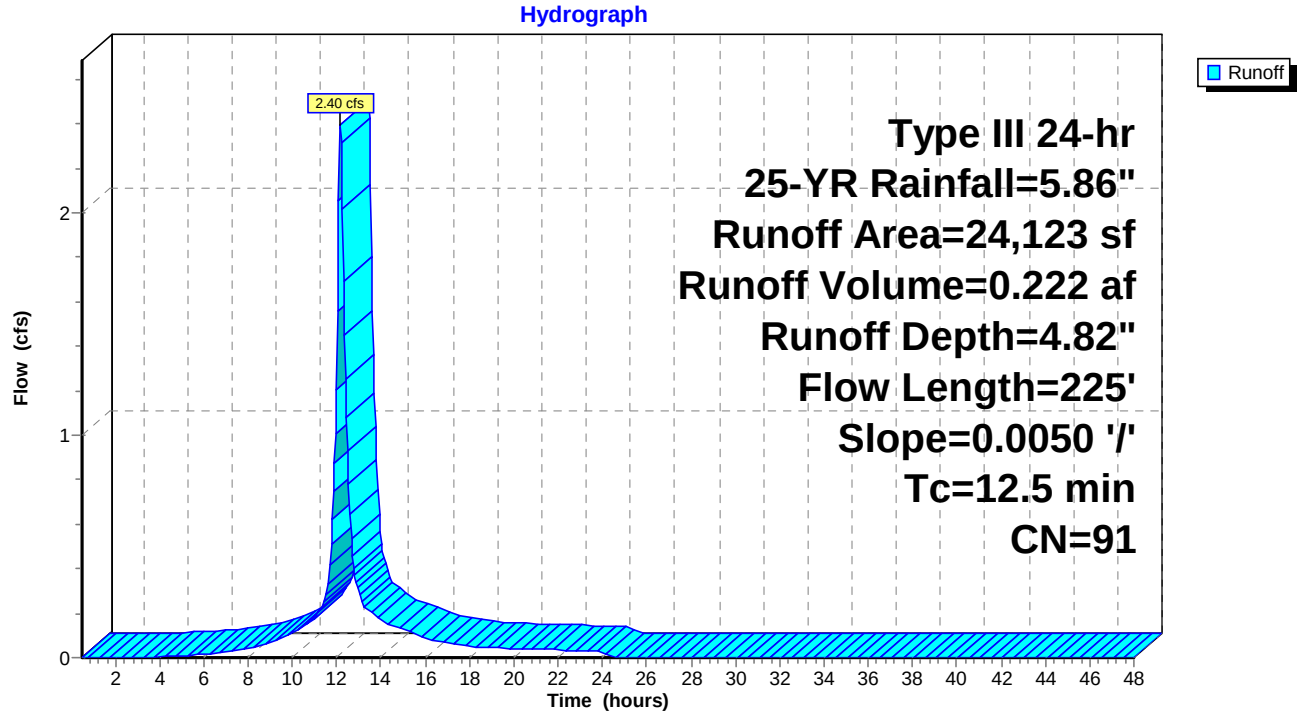
Runoff = 2.40 cfs @ 12.17 hrs, Volume= 0.222 af, Depth= 4.82"
Routed to Pond 1P : ADS 36" Pipe Det Basin

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.50-48.00 hrs, dt= 0.05 hrs
Type III 24-hr 25-YR Rainfall=5.86"

	Area (sf)	CN	Description
	6,532	98	Paved parking, HSG D
	5,760	98	Roofs, HSG D
*	140	98	Walkways, HSG D
	9,729	80	>75% Grass cover, Good, HSG D
*	1,962	98	Patios, HSG D
	24,123	91	Weighted Average
	9,729		40.33% Pervious Area
	14,394		59.67% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
9.8	50	0.0050	0.09		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.20"
2.7	175	0.0050	1.06		**Shallow Concentrated Flow,** Grassed Waterway Kv= 15.0 fps
12.5	225	Total			

Subcatchment 8S: Flow to PCB#4



Summary for Subcatchment 9S: Undetained Flow to Greenmont Ave - DP#1

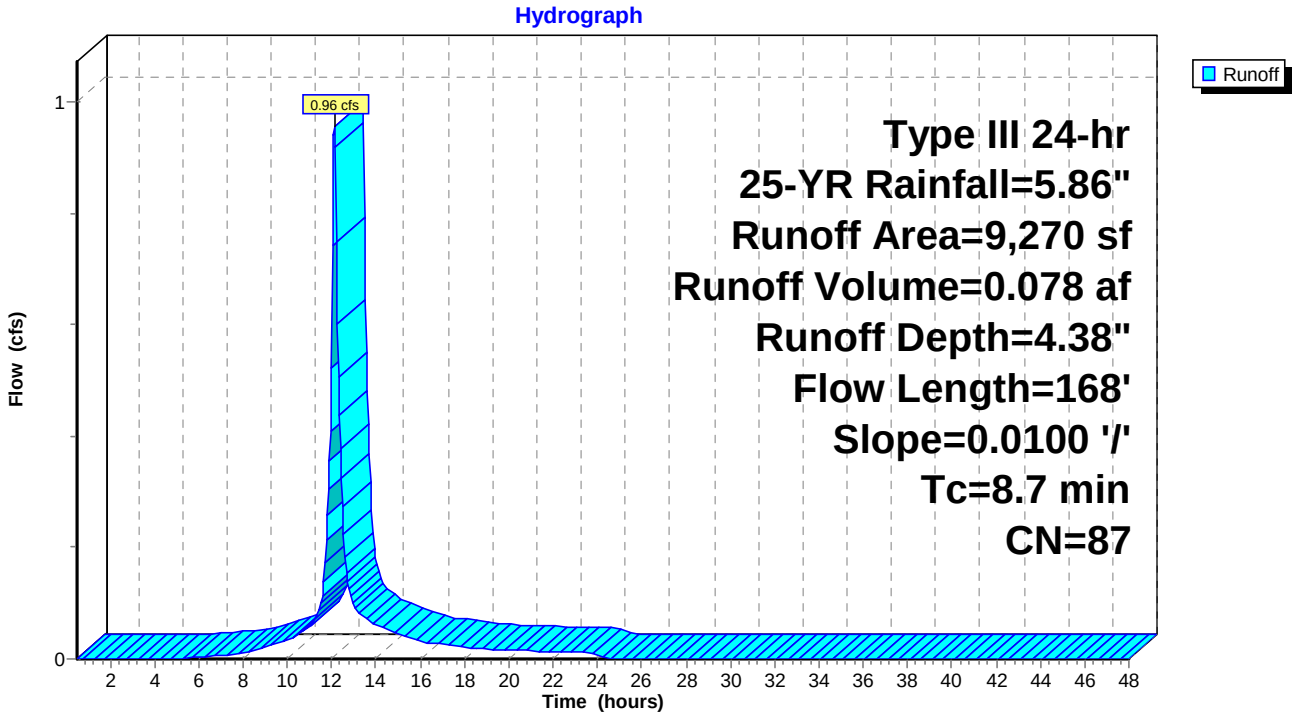
Runoff = 0.96 cfs @ 12.12 hrs, Volume= 0.078 af, Depth= 4.38"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.50-48.00 hrs, dt= 0.05 hrs
Type III 24-hr 25-YR Rainfall=5.86"

Area (sf)	CN	Description
5,908	80	>75% Grass cover, Good, HSG D
3,362	98	Roofs, HSG D
9,270	87	Weighted Average
5,908		63.73% Pervious Area
3,362		36.27% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.4	50	0.0100	0.11		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.20"
1.3	118	0.0100	1.50		**Shallow Concentrated Flow,** Grassed Waterway Kv= 15.0 fps
8.7	168	Total			

Subcatchment 9S: Undetained Flow to Greenmont Ave - DP#1



Summary for Subcatchment 11S: Sediment Forebay Basin

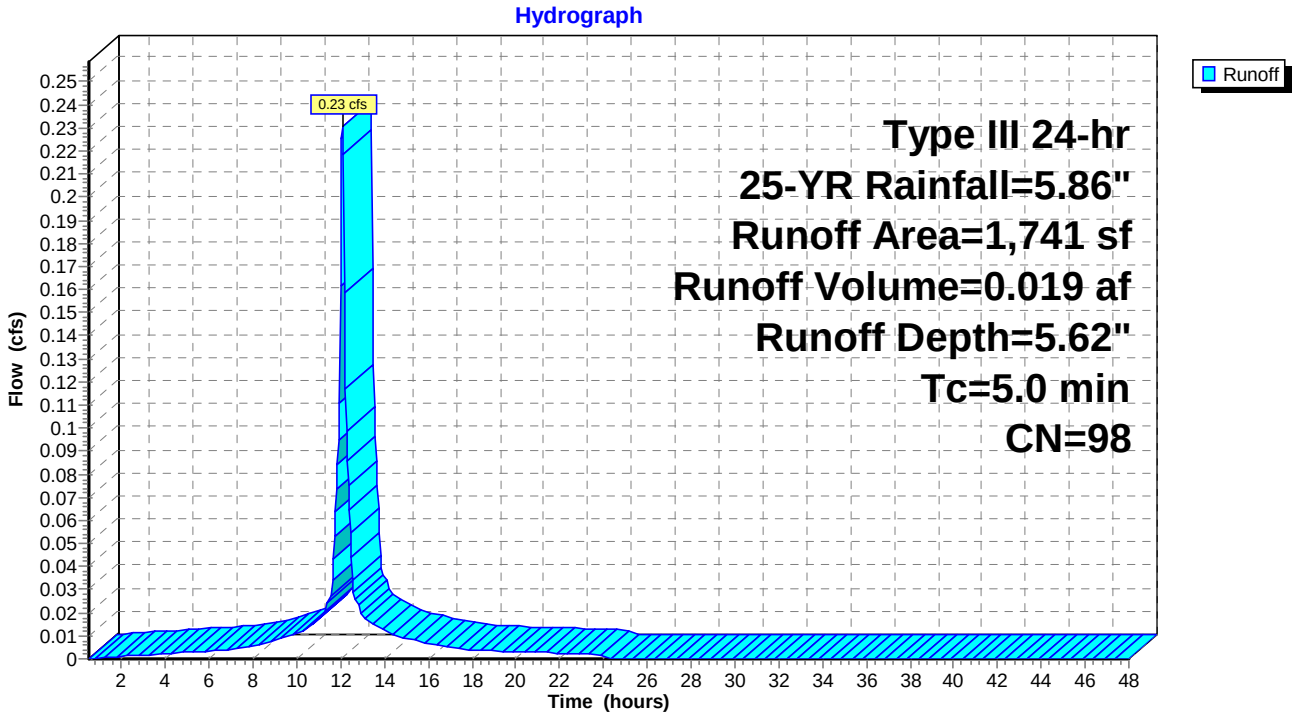
Runoff = 0.23 cfs @ 12.07 hrs, Volume= 0.019 af, Depth= 5.62"
Routed to Pond 11P : Sediment Forebay

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.50-48.00 hrs, dt= 0.05 hrs
Type III 24-hr 25-YR Rainfall=5.86"

	Area (sf)	CN	Description
*	1,741	98	Sed Bas Wet Surface
	1,741		100.00% Impervious Area

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

Subcatchment 11S: Sediment Forebay Basin



Summary for Subcatchment 36S: Extended Detention Wet Basin

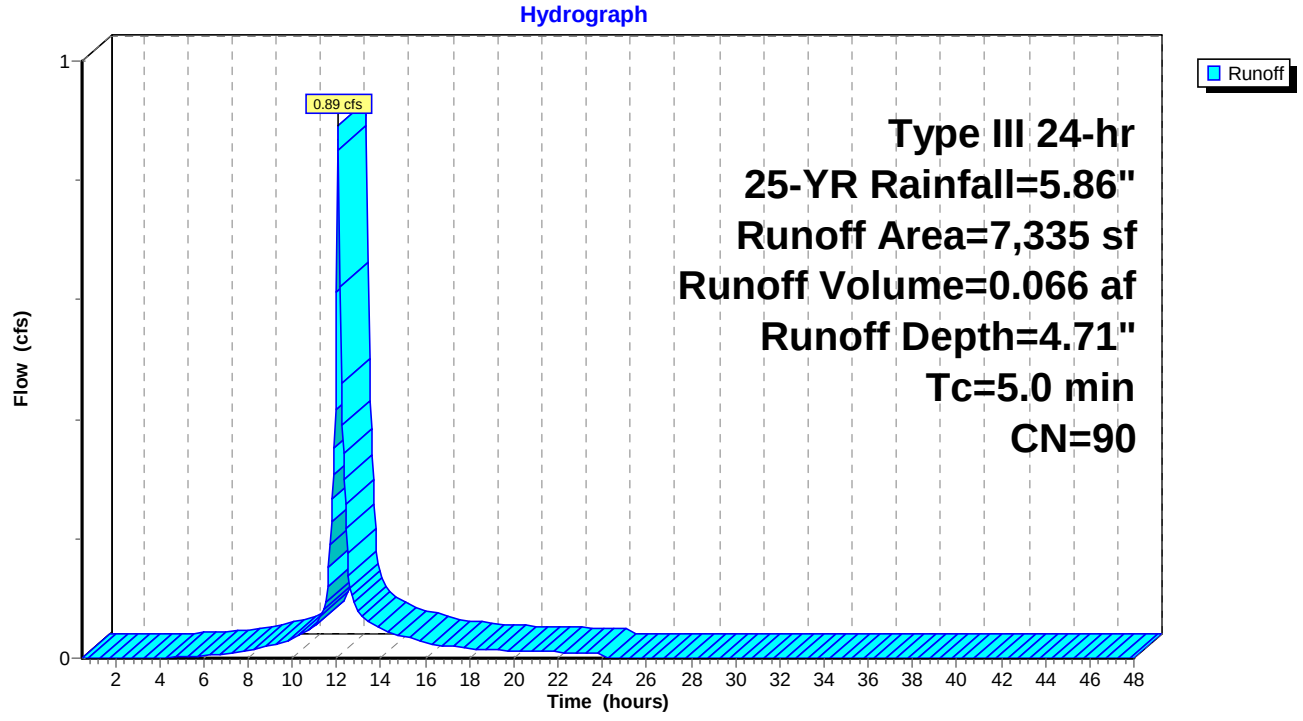
Runoff = 0.89 cfs @ 12.07 hrs, Volume= 0.066 af, Depth= 4.71"
Routed to Pond 12P : Outlet Det Pond

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.50-48.00 hrs, dt= 0.05 hrs
Type III 24-hr 25-YR Rainfall=5.86"

	Area (sf)	CN	Description
	3,120	80	>75% Grass cover, Good, HSG D
*	4,215	98	Wet Basin Surface Water
	7,335	90	Weighted Average
	3,120		42.54% Pervious Area
	4,215		57.46% Impervious Area

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

Subcatchment 36S: Extended Detention Wet Basin



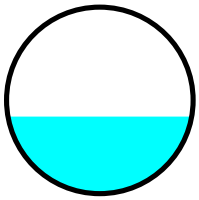
Summary for Reach 10R: PFD#1

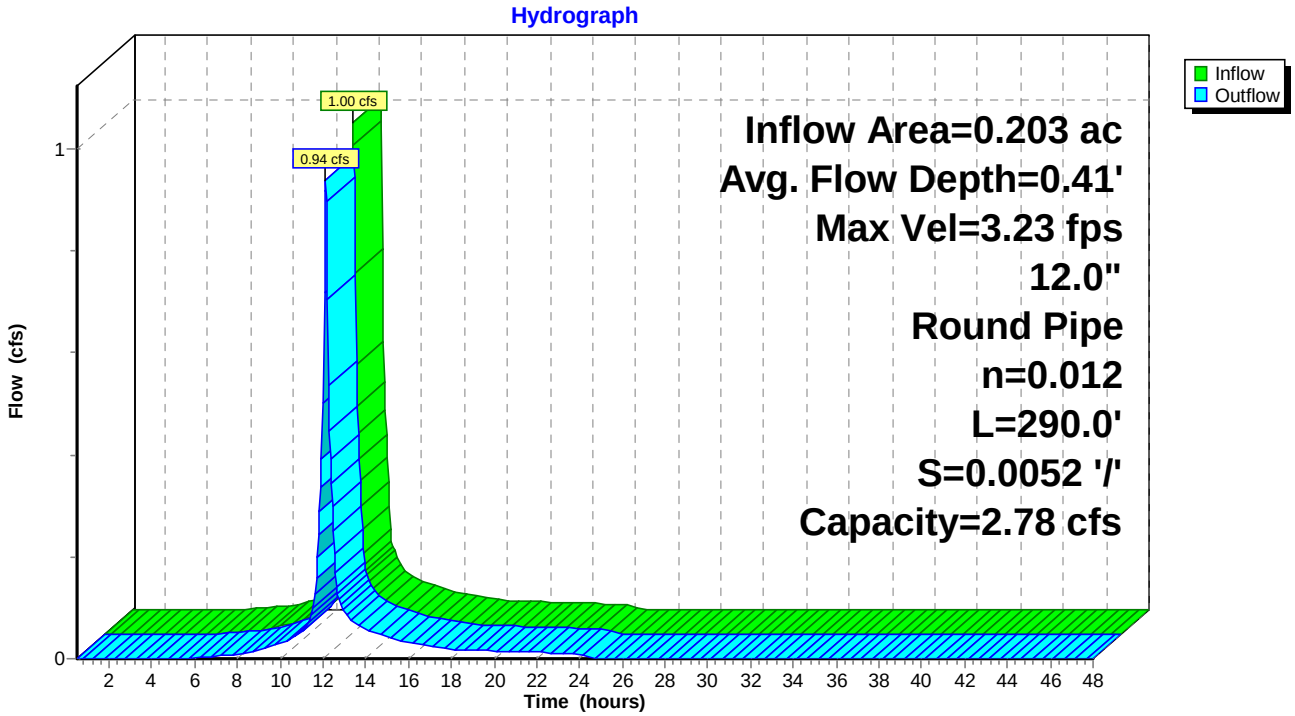
Inflow Area = 0.203 ac, 35.96% Impervious, Inflow Depth = 4.28" for 25-YR event
Inflow = 1.00 cfs @ 12.07 hrs, Volume= 0.072 af
Outflow = 0.94 cfs @ 12.12 hrs, Volume= 0.072 af, Atten= 7%, Lag= 2.8 min
Routed to Pond 11P : Sediment Forebay

Routing by Stor-Ind+Trans method, Time Span= 0.50-48.00 hrs, dt= 0.05 hrs
Max. Velocity= 3.23 fps, Min. Travel Time= 1.5 min
Avg. Velocity = 1.06 fps, Avg. Travel Time= 4.6 min

Peak Storage= 88 cf @ 12.10 hrs
Average Depth at Peak Storage= 0.41' , Surface Width= 0.98'
Bank-Full Depth= 1.00' Flow Area= 0.8 sf, Capacity= 2.78 cfs

12.0" Round Pipe
n= 0.012 Corrugated PP, smooth interior
Length= 290.0' Slope= 0.0052 '/'
Inlet Invert= 158.00', Outlet Invert= 156.50'





Summary for Pond 1P: ADS 36" Pipe Det Basin

Inflow Area = 1.530 ac, 64.55% Impervious, Inflow Depth = 4.89" for 25-YR event
Inflow = 6.48 cfs @ 12.12 hrs, Volume= 0.623 af
Outflow = 0.68 cfs @ 13.13 hrs, Volume= 0.623 af, Atten= 90%, Lag= 60.3 min
Primary = 0.68 cfs @ 13.13 hrs, Volume= 0.623 af
Routed to Pond 11P : Sediment Forebay

Routing by Stor-Ind method, Time Span= 0.50-48.00 hrs, dt= 0.05 hrs
Peak Elev= 159.07' @ 13.13 hrs Surf.Area= 7,550 sf Storage= 13,400 cf

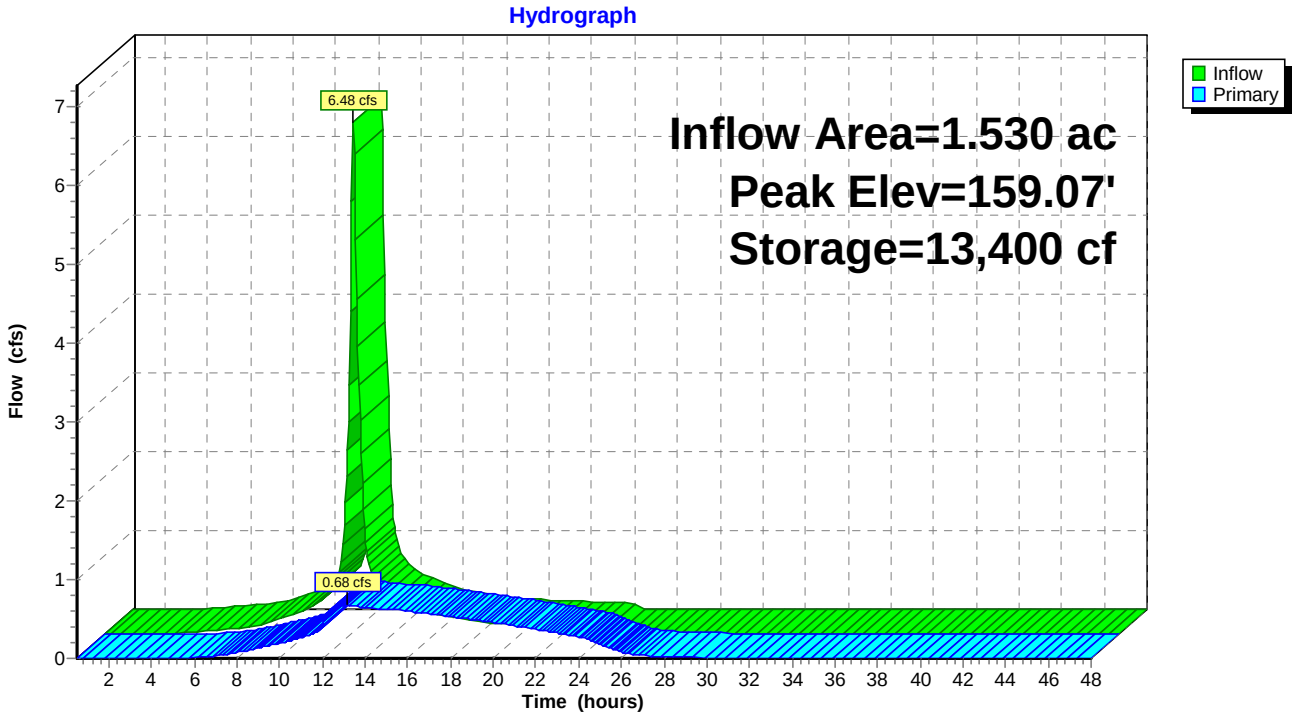
Plug-Flow detention time= 238.1 min calculated for 0.622 af (100% of inflow)
Center-of-Mass det. time= 238.6 min (1,021.9 - 783.2)

Volume	Invert	Avail.Storage	Storage Description
#1	157.00'	12,723 cf	**36.0" Round Pipe Storage** x 6 Inside #2 L= 300.0'
#2	156.50'	6,991 cf	**25.00'W x 302.00'L x 4.00'H Prismatoid** 30,200 cf Overall - 12,723 cf Embedded = 17,477 cf x 40.0% Voids
		19,714 cf	Total Available Storage

Device	Routing	Invert	Outlet Devices
#1	Primary	159.00'	**12.0" Vert. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#2	Primary	156.50'	**4.0" Vert. Orifice/Grate** C= 0.600 Limited to weir flow at low heads

Primary OutFlow Max=0.68 cfs @ 13.13 hrs HW=159.07' (Free Discharge)
└**1=Orifice/Grate** (Orifice Controls 0.02 cfs @ 0.92 fps)
└**2=Orifice/Grate** (Orifice Controls 0.65 cfs @ 7.47 fps)

Pond 1P: ADS 36" Pipe Det Basin



Summary for Pond 2P: Ex-Wetlands Area

Inflow Area = 8.200 ac, 32.69% Impervious, Inflow Depth = 4.30" for 25-YR event
Inflow = 16.29 cfs @ 12.48 hrs, Volume= 2.940 af
Outflow = 5.06 cfs @ 13.29 hrs, Volume= 2.939 af, Atten= 69%, Lag= 48.6 min
Primary = 5.06 cfs @ 13.29 hrs, Volume= 2.939 af

Routing by Stor-Ind method, Time Span= 0.50-48.00 hrs, dt= 0.05 hrs
Peak Elev= 152.96' @ 13.29 hrs Surf.Area= 39,430 sf Storage= 31,044 cf

Plug-Flow detention time= 44.9 min calculated for 2.939 af (100% of inflow)
Center-of-Mass det. time= 44.1 min (925.7 - 881.6)

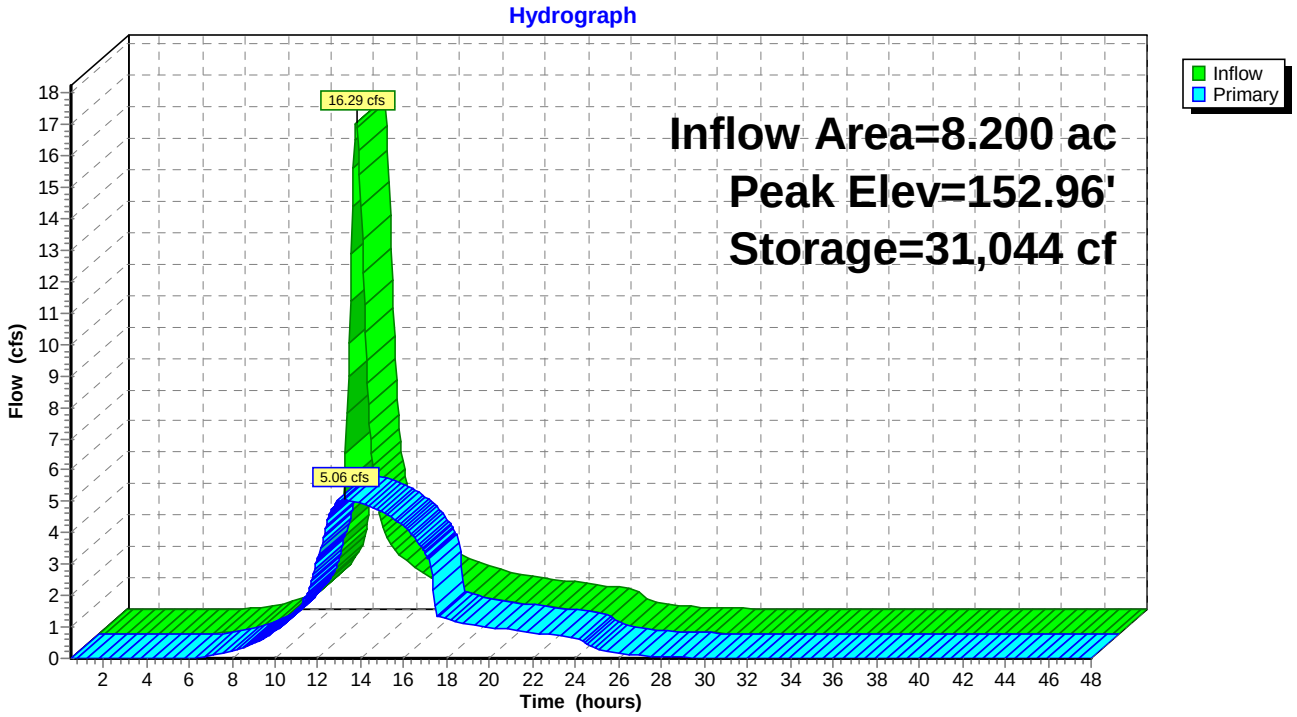
Volume	Invert	Avail.Storage	Storage Description
#1	150.00'	184,747 cf	**Custom Stage Data (Irregular)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
150.00	208	75.0	0	0	208
151.00	328	94.0	266	266	477
152.00	14,780	1,138.0	5,770	6,036	102,832
153.00	40,797	1,192.0	26,711	32,747	112,912
154.00	69,661	1,810.0	54,589	87,336	260,555
155.00	128,105	2,354.0	97,411	184,747	440,827

Device	Routing	Invert	Outlet Devices
#1	Primary	150.25'	**12.0" Round Culvert** L= 83.0' RCP, groove end projecting, Ke= 0.200 Inlet / Outlet Invert= 150.25' / 149.75' S= 0.0060 '/' Cc= 0.900 n= 0.012 Concrete pipe, finished, Flow Area= 0.79 sf
#2	Primary	153.07'	**2.0" x 2.0" Horiz. Orifice/Grate X 6.00 columns** X 6 rows C= 0.600 Limited to weir flow at low heads

Primary OutFlow Max=5.06 cfs @ 13.29 hrs HW=152.96' (Free Discharge)
└**1=Culvert** (Barrel Controls 5.06 cfs @ 6.45 fps)
└**2=Orifice/Grate** (Controls 0.00 cfs)

Pond 2P: Ex-Wetlands Area



Summary for Pond 11P: Sediment Forebay

Inflow Area = 1.773 ac, 62.07% Impervious, Inflow Depth > 4.83" for 25-YR event
Inflow = 1.64 cfs @ 12.12 hrs, Volume= 0.714 af
Outflow = 1.43 cfs @ 12.20 hrs, Volume= 0.713 af, Atten= 12%, Lag= 4.8 min
Primary = 1.43 cfs @ 12.20 hrs, Volume= 0.713 af
Routed to Pond 12P : Outlet Det Pond

Routing by Stor-Ind method, Time Span= 0.50-48.00 hrs, dt= 0.05 hrs
Starting Elev= 156.00' Surf.Area= 1,059 sf Storage= 868 cf
Peak Elev= 157.14' @ 12.20 hrs Surf.Area= 1,537 sf Storage= 2,368 cf (1,499 cf above start)

Plug-Flow detention time= 69.2 min calculated for 0.692 af (97% of inflow)
Center-of-Mass det. time= 34.7 min (1,027.0 - 992.3)

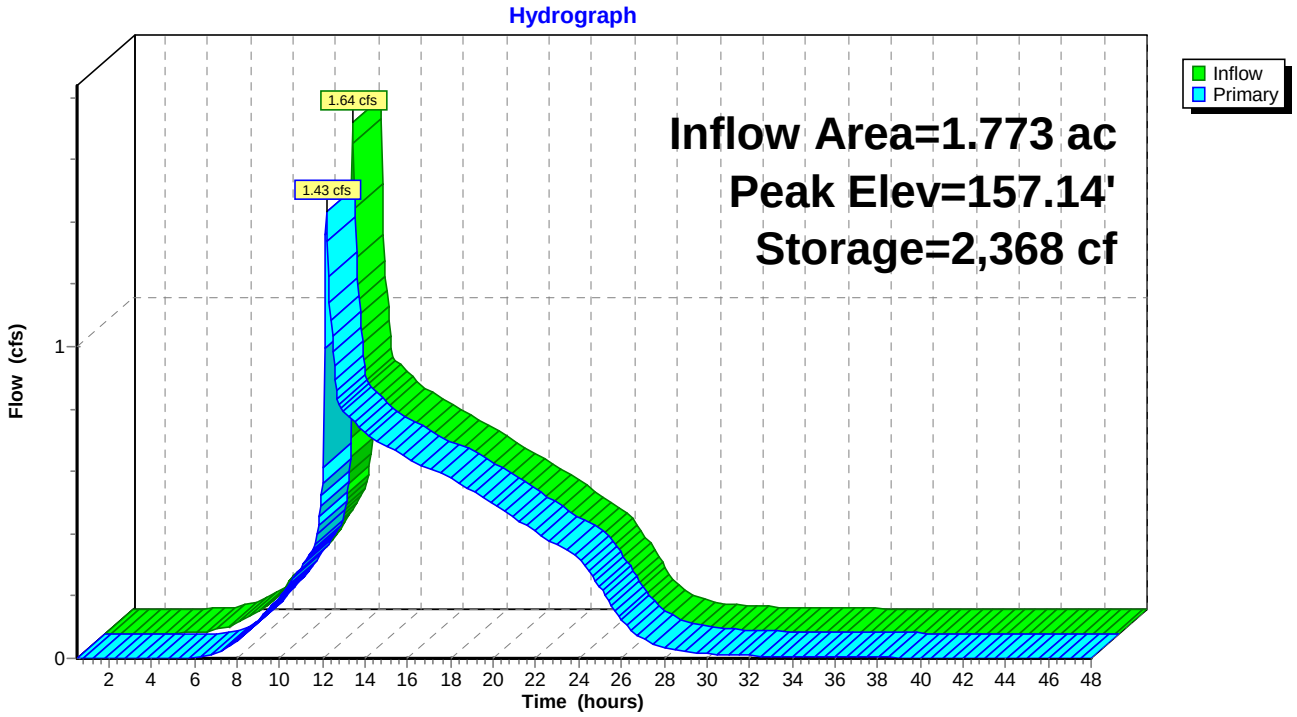
Volume	Invert	Avail.Storage	Storage Description
#1	155.00'	3,718 cf	**Custom Stage Data (Irregular)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
155.00	691	110.0	0	0	691
156.00	1,059	130.0	868	868	1,091
157.00	1,527	162.0	1,286	2,154	1,849
158.00	1,601	162.0	1,564	3,718	2,011

Device	Routing	Invert	Outlet Devices
#1	Primary	156.00'	**6.0" Round Culvert** L= 18.0' CPP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 156.00' / 156.00' S= 0.0000 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.20 sf
#2	Primary	157.00'	**6.0' long x 6.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 3.50 4.00 4.50 5.00 5.50 Coef. (English) 2.37 2.51 2.70 2.68 2.68 2.67 2.65 2.65 2.65 2.65 2.66 2.66 2.67 2.69 2.72 2.76 2.83

Primary OutFlow Max=1.42 cfs @ 12.20 hrs HW=157.14' (Free Discharge)
└**1=Culvert** (Barrel Controls 0.69 cfs @ 3.52 fps)
└**2=Broad-Crested Rectangular Weir** (Weir Controls 0.73 cfs @ 0.88 fps)

Pond 11P: Sediment Forebay



Summary for Pond 12P: Outlet Det Pond

Inflow Area = 1.942 ac, 61.67% Impervious, Inflow Depth > 4.81" for 25-YR event
Inflow = 1.98 cfs @ 12.16 hrs, Volume= 0.779 af
Outflow = 1.59 cfs @ 12.30 hrs, Volume= 0.779 af, Atten= 20%, Lag= 8.6 min
Primary = 1.59 cfs @ 12.30 hrs, Volume= 0.779 af
Routed to Link DP#2 : DP#2 - Rear Wetlands

Routing by Stor-Ind method, Time Span= 0.50-48.00 hrs, dt= 0.05 hrs
Starting Elev= 155.50' Surf.Area= 5,255 sf Storage= 5,215 cf
Peak Elev= 155.73' @ 12.30 hrs Surf.Area= 5,774 sf Storage= 6,486 cf (1,271 cf above start)

Plug-Flow detention time= 170.9 min calculated for 0.659 af (85% of inflow)
Center-of-Mass det. time= 19.0 min (1,025.5 - 1,006.4)

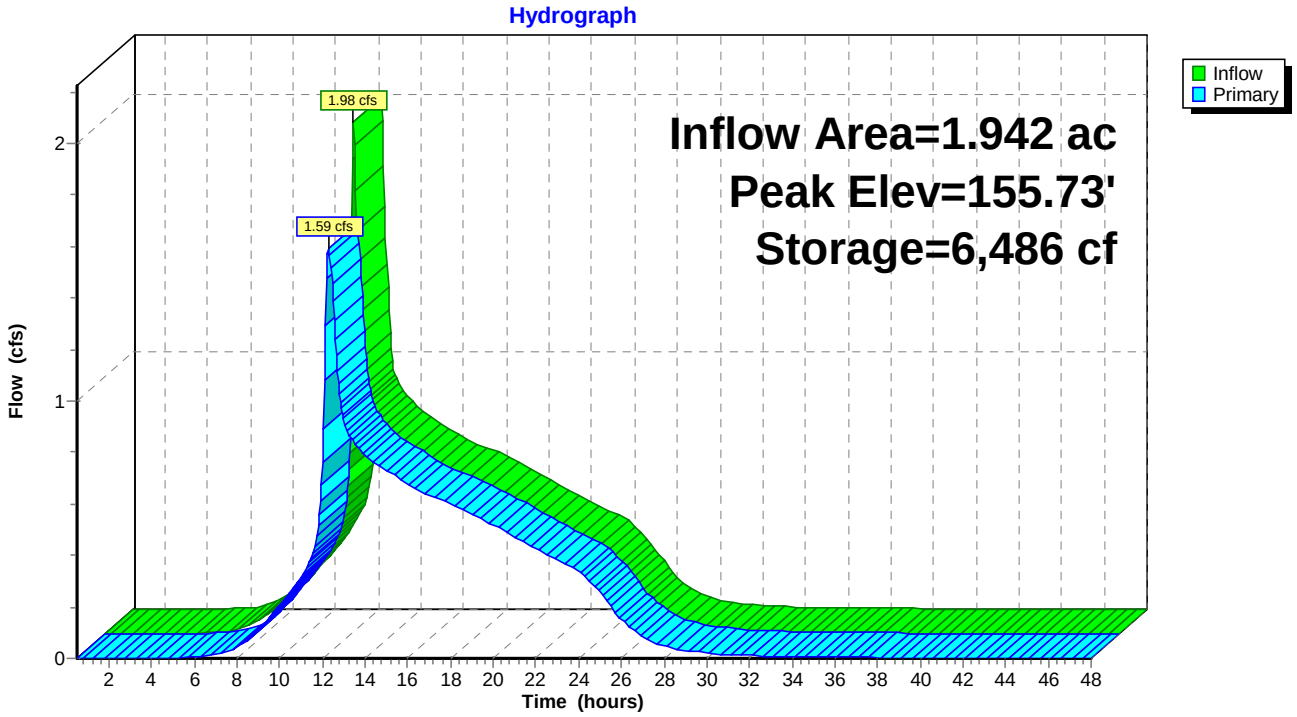
Volume	Invert	Avail.Storage	Storage Description
#1	154.00'	11,493 cf	**Custom Stage Data (Irregular)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
154.00	1,680	368.0	0	0	1,680
155.00	4,215	676.0	2,852	2,852	27,274
156.00	6,410	526.0	5,274	8,126	41,634
156.50	7,063	568.0	3,367	11,493	45,301

Device	Routing	Invert	Outlet Devices
#1	Primary	155.50'	**6.0' long x 6.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 3.50 4.00 4.50 5.00 5.50 Coef. (English) 2.37 2.51 2.70 2.68 2.68 2.67 2.65 2.65 2.65 2.65 2.66 2.66 2.67 2.69 2.72 2.76 2.83

Primary OutFlow Max=1.59 cfs @ 12.30 hrs HW=155.73' (Free Discharge)
1=Broad-Crested Rectangular Weir (Weir Controls 1.59 cfs @ 1.15 fps)

Pond 12P: Outlet Det Pond

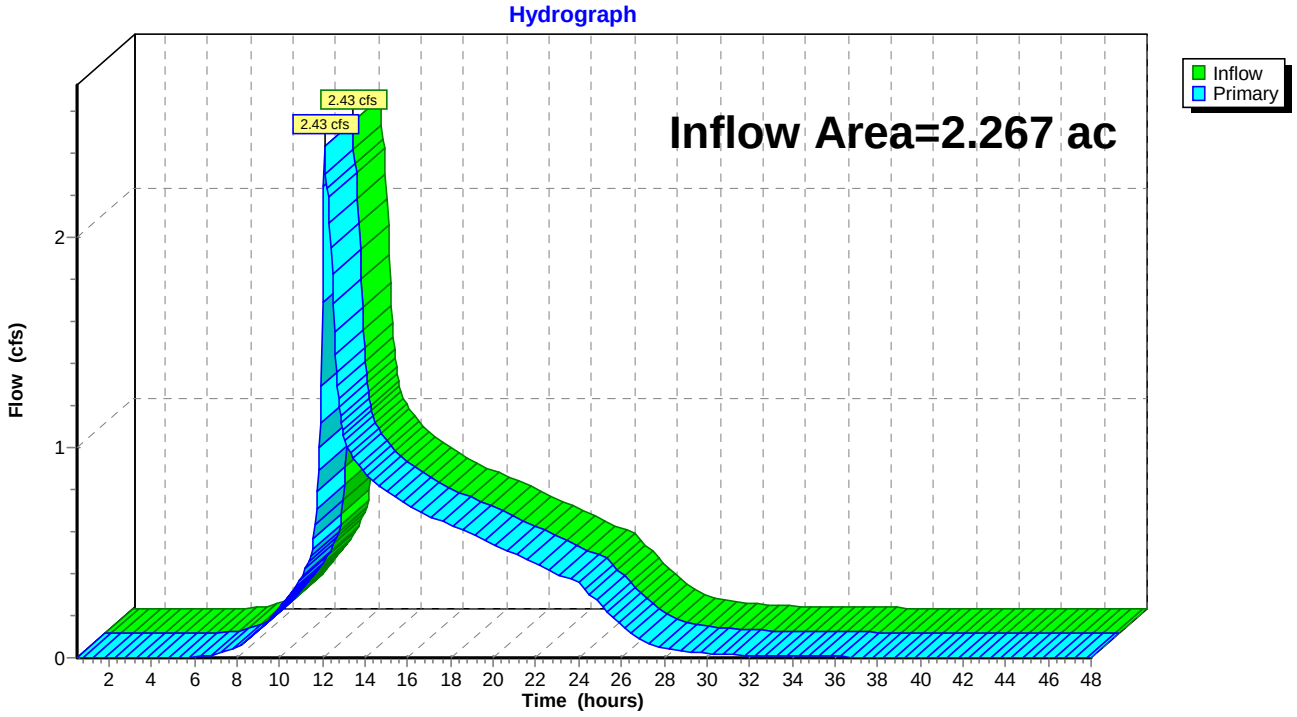


Summary for Link DP#2: DP#2 - Rear Wetlands

Inflow Area = 2.267 ac, 52.82% Impervious, Inflow Depth > 4.65" for 25-YR event
Inflow = 2.43 cfs @ 12.10 hrs, Volume= 0.878 af
Primary = 2.43 cfs @ 12.10 hrs, Volume= 0.878 af, Atten= 0%, Lag= 0.0 min
Routed to Pond 2P : Ex-Wetlands Area

Primary outflow = Inflow, Time Span= 0.50-48.00 hrs, dt= 0.05 hrs

Link DP#2: DP#2 - Rear Wetlands



Summary for Subcatchment 1S: Flow to PCB#1

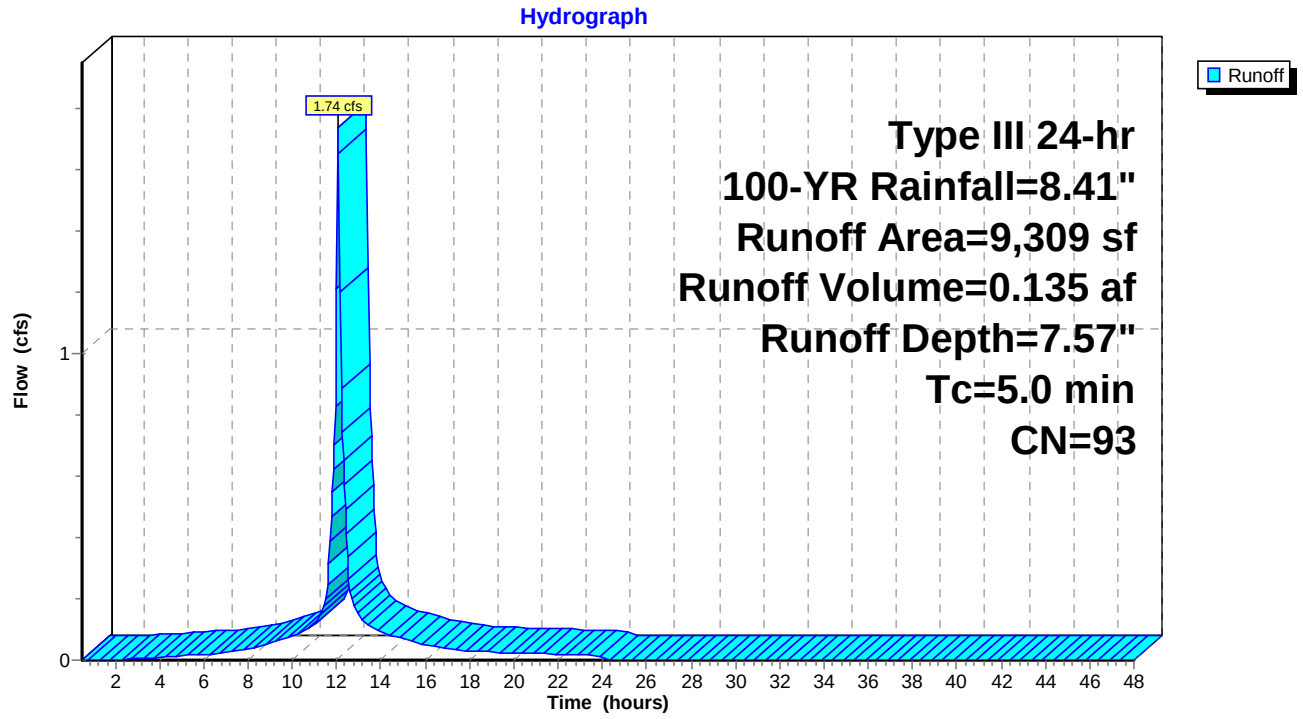
Runoff = 1.74 cfs @ 12.07 hrs, Volume= 0.135 af, Depth= 7.57"
Routed to Pond 1P : ADS 36" Pipe Det Basin

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.50-48.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-YR Rainfall=8.41"

	Area (sf)	CN	Description
	3,640	98	Paved parking, HSG D
	2,814	98	Roofs, HSG D
*	380	98	Walkways
	2,475	80	>75% Grass cover, Good, HSG D
	9,309	93	Weighted Average
	2,475		26.59% Pervious Area
	6,834		73.41% Impervious Area

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

Subcatchment 1S: Flow to PCB#1



Summary for Subcatchment 3S: Flow to PCB#2

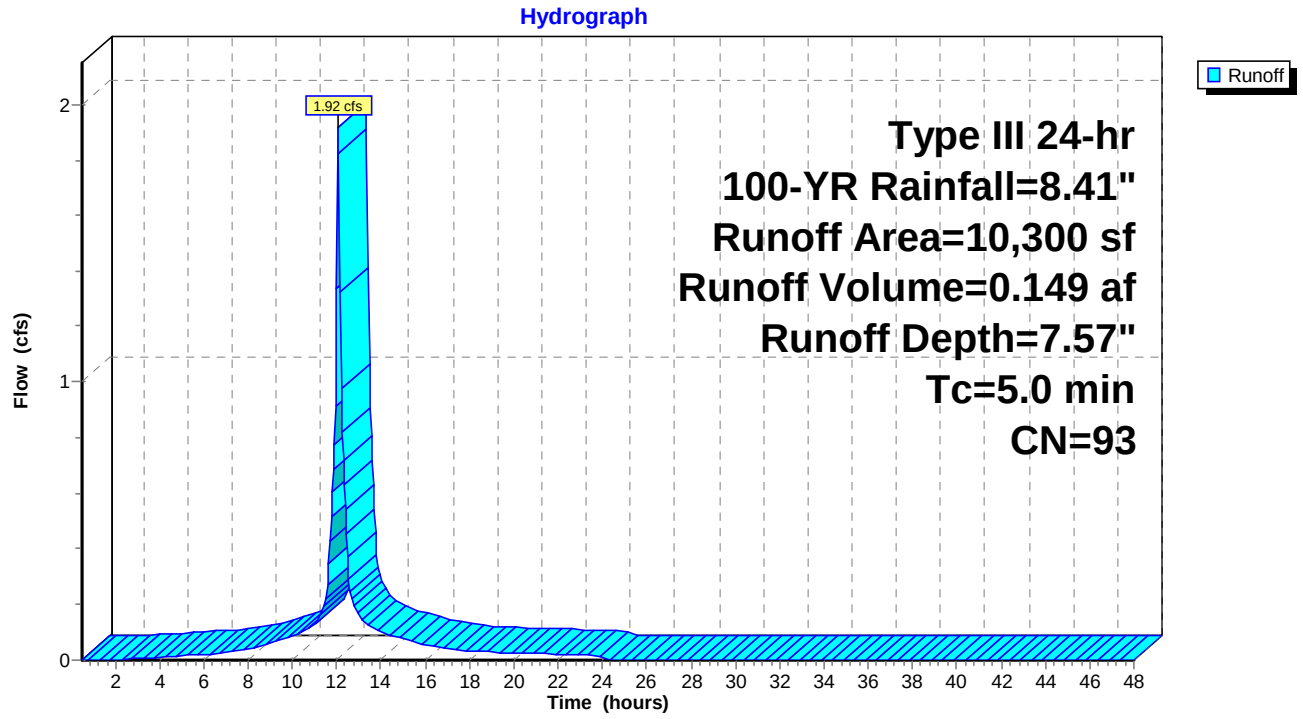
Runoff = 1.92 cfs @ 12.07 hrs, Volume= 0.149 af, Depth= 7.57"
Routed to Pond 1P : ADS 36" Pipe Det Basin

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.50-48.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-YR Rainfall=8.41"

	Area (sf)	CN	Description
	3,906	98	Paved parking, HSG D
	2,936	98	Roofs, HSG D
*	380	98	Walkways, HSG D
	3,078	80	>75% Grass cover, Good, HSG D
	10,300	93	Weighted Average
	3,078		29.88% Pervious Area
	7,222		70.12% Impervious Area

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

Subcatchment 3S: Flow to PCB#2



Summary for Subcatchment 4S: Remaining Ex Neighborhood WS Area

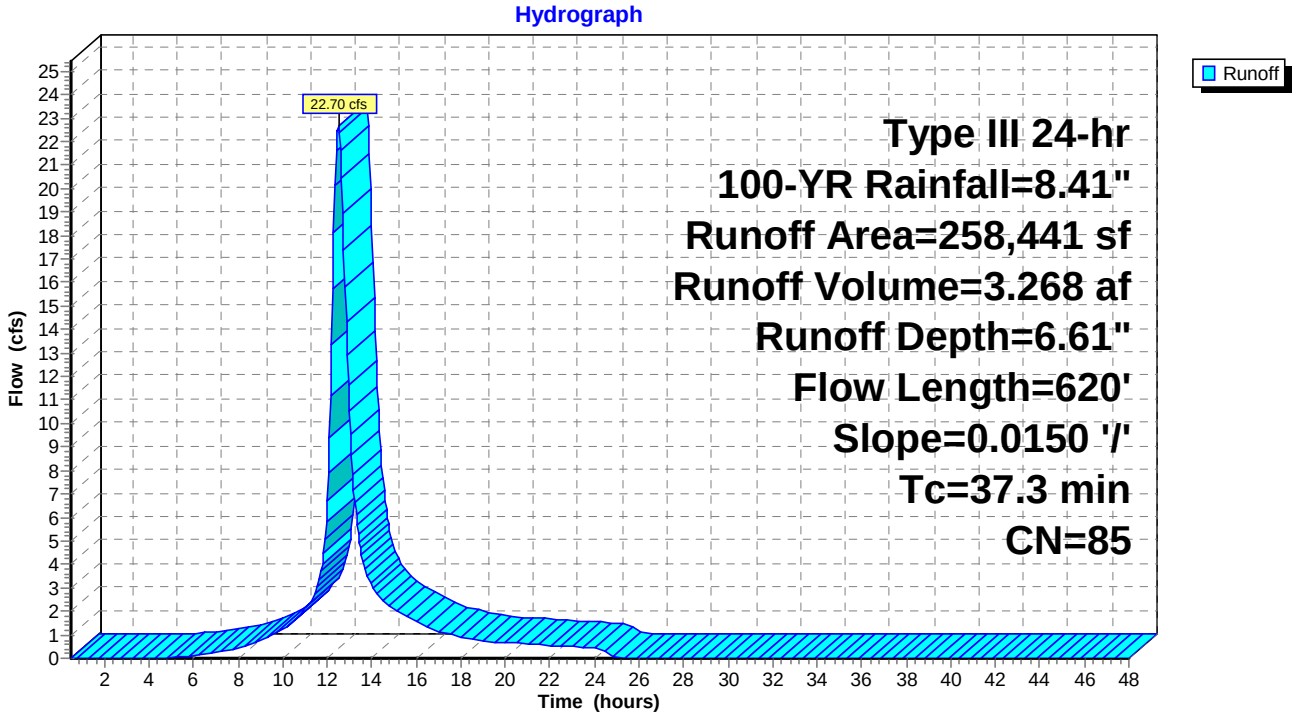
Runoff = 22.70 cfs @ 12.50 hrs, Volume= 3.268 af, Depth= 6.61"
Routed to Pond 2P : Ex-Wetlands Area

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.50-48.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-YR Rainfall=8.41"

Area (sf)	CN	Description
258,441	85	1/2 acre lots, 25% imp, HSG D
193,831		75.00% Pervious Area
64,610		25.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.3	50	0.0150	0.13		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.20"
31.0	570	0.0150	0.31		**Shallow Concentrated Flow,** Forest w/Heavy Litter Kv= 2.5 fps
37.3	620	Total			

Subcatchment 4S: Remaining Ex Neighborhood WS Area



Summary for Subcatchment 5S: Landscape Area To Sed Forebay

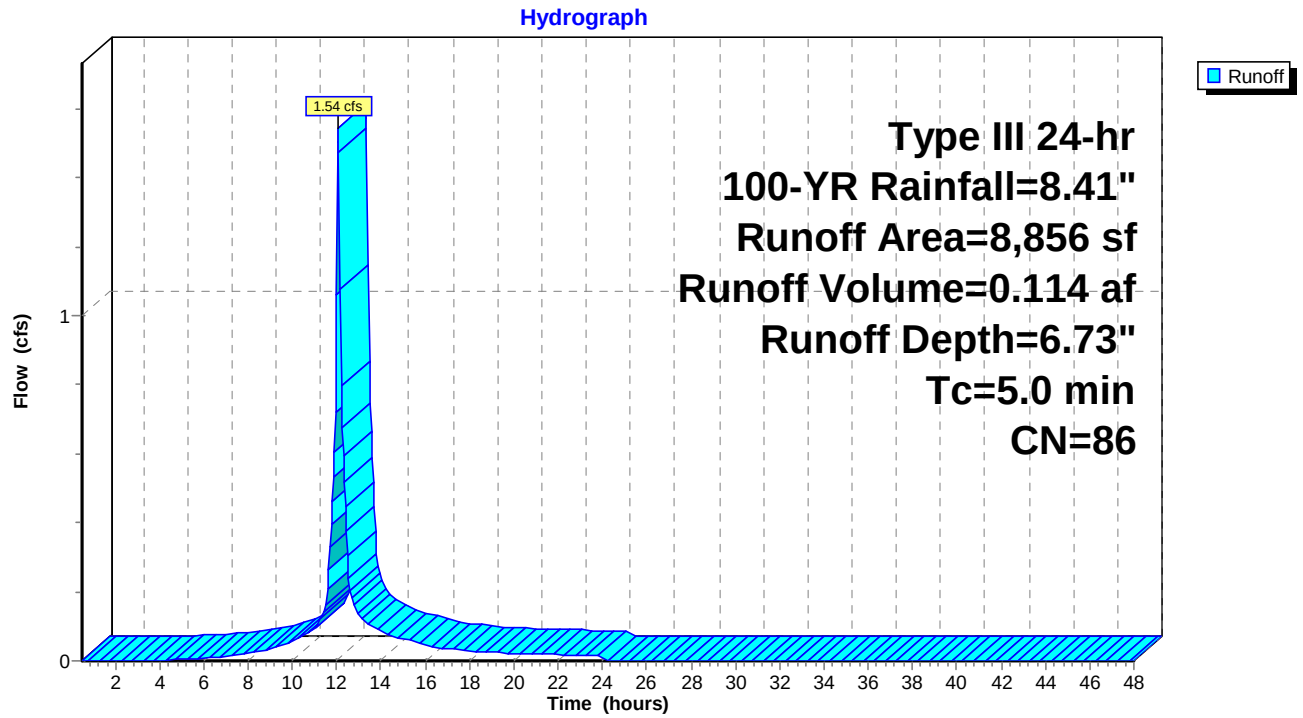
Runoff = 1.54 cfs @ 12.07 hrs, Volume= 0.114 af, Depth= 6.73"
Routed to Reach 10R : PFD#1

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.50-48.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-YR Rainfall=8.41"

	Area (sf)	CN	Description
	5,671	80	>75% Grass cover, Good, HSG D
*	1,160	98	Patios, HSG D
	2,025	98	Roofs, HSG D
	8,856	86	Weighted Average
	5,671		64.04% Pervious Area
	3,185		35.96% Impervious Area

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

Subcatchment 5S: Landscape Area To Sed Forebay



Summary for Subcatchment 6S: Undetained Flow to Wetlands

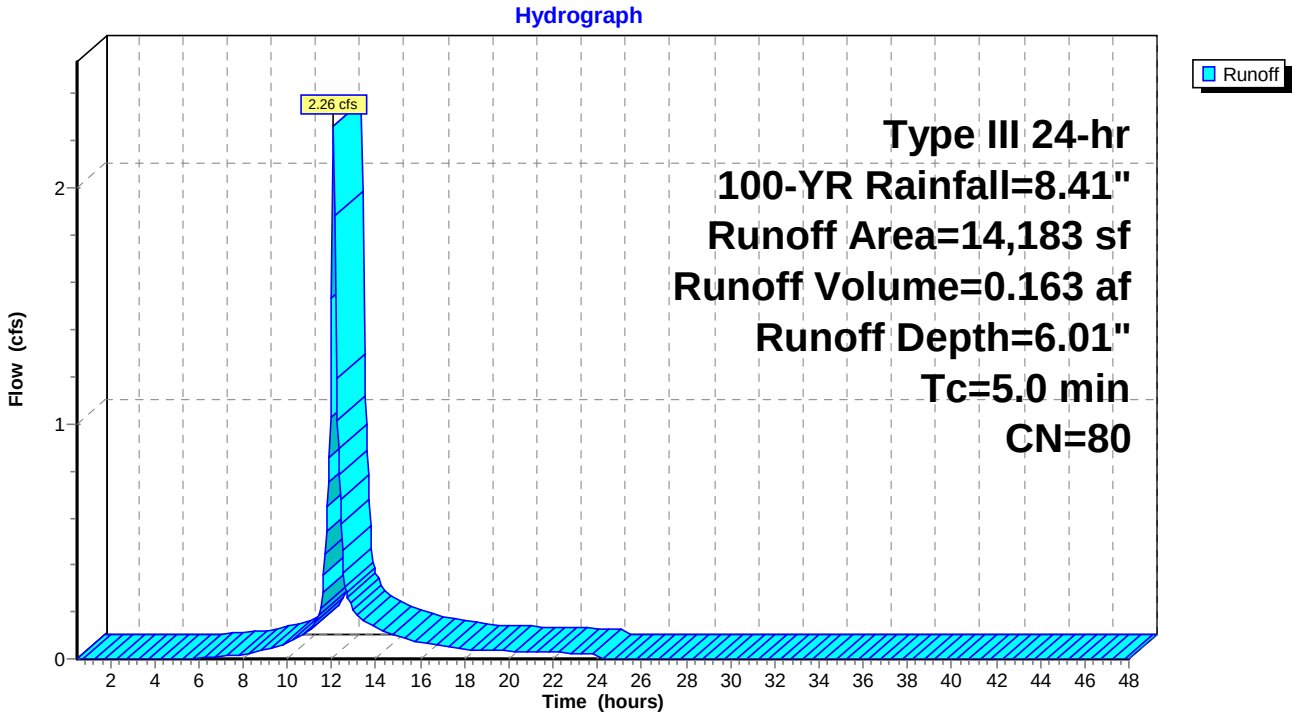
Runoff = 2.26 cfs @ 12.07 hrs, Volume= 0.163 af, Depth= 6.01"
Routed to Link DP#2 : DP#2 - Rear Wetlands

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.50-48.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-YR Rainfall=8.41"

Area (sf)	CN	Description
14,183	80	>75% Grass cover, Good, HSG D
14,183		100.00% Pervious Area

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

Subcatchment 6S: Undetained Flow to Wetlands



Summary for Subcatchment 7S: Flow to PCB#3

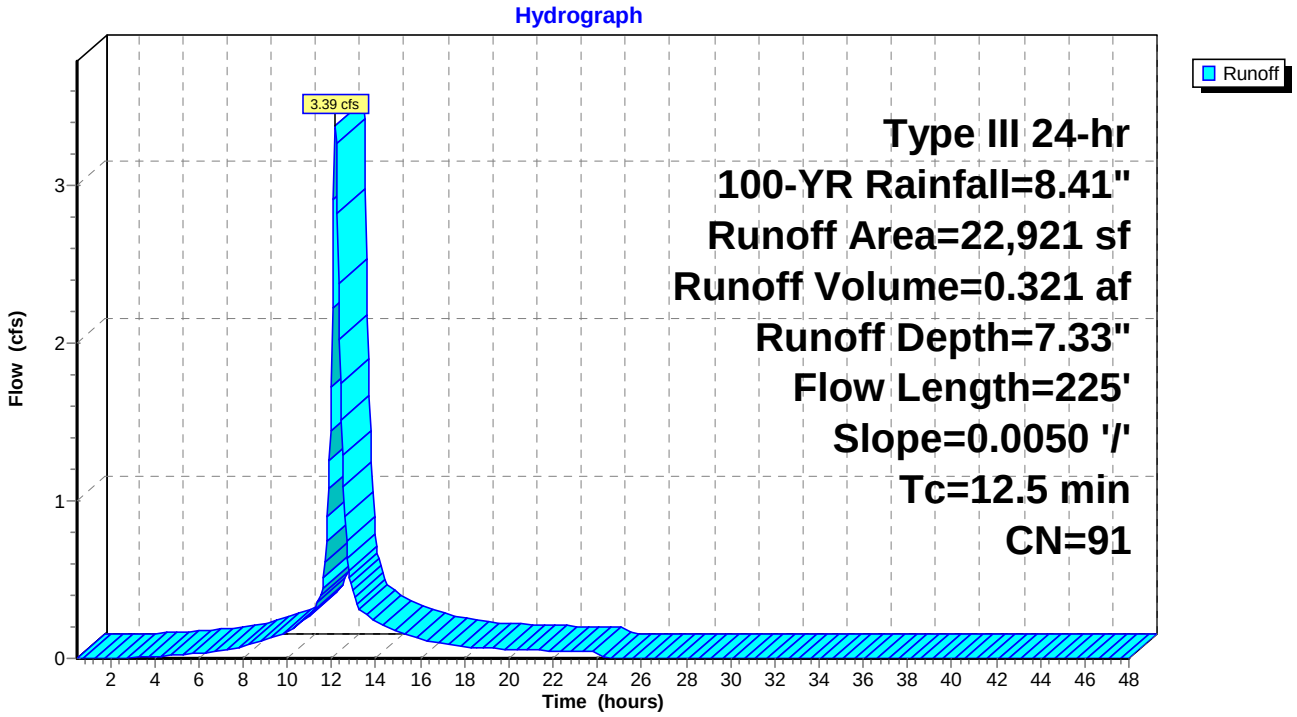
Runoff = 3.39 cfs @ 12.17 hrs, Volume= 0.321 af, Depth= 7.33"
Routed to Pond 1P : ADS 36" Pipe Det Basin

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.50-48.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-YR Rainfall=8.41"

	Area (sf)	CN	Description
	6,527	98	Paved parking, HSG D
*	2,886	98	Roofs, HSG D (Front Units 6-13)
*	140	98	Walkways, HSG D
	615	80	>75% Grass cover, Good, HSG D
*	3,060	98	Roofs, HSG D (Rear Units 5-13)
	7,731	80	>75% Grass cover, Good, HSG D
*	1,962	98	Patios, HSG D
	22,921	91	Weighted Average
	8,346		36.41% Pervious Area
	14,575		63.59% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
9.8	50	0.0050	0.09		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.20"
2.7	175	0.0050	1.06		**Shallow Concentrated Flow,** Grassed Waterway Kv= 15.0 fps
12.5	225	Total			

Subcatchment 7S: Flow to PCB#3



Summary for Subcatchment 8S: Flow to PCB#4

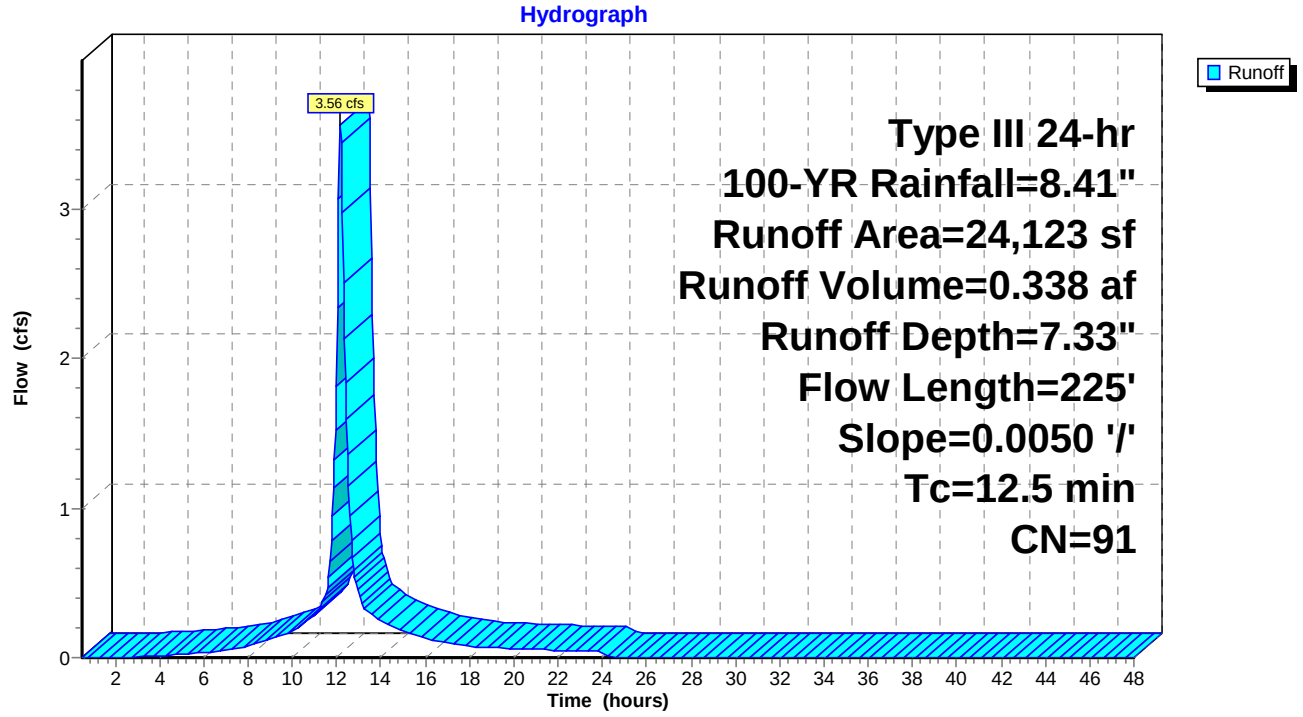
Runoff = 3.56 cfs @ 12.17 hrs, Volume= 0.338 af, Depth= 7.33"
Routed to Pond 1P : ADS 36" Pipe Det Basin

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.50-48.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-YR Rainfall=8.41"

	Area (sf)	CN	Description
	6,532	98	Paved parking, HSG D
	5,760	98	Roofs, HSG D
*	140	98	Walkways, HSG D
	9,729	80	>75% Grass cover, Good, HSG D
*	1,962	98	Patios, HSG D
	24,123	91	Weighted Average
	9,729		40.33% Pervious Area
	14,394		59.67% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
9.8	50	0.0050	0.09		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.20"
2.7	175	0.0050	1.06		**Shallow Concentrated Flow,** Grassed Waterway Kv= 15.0 fps
12.5	225	Total			

Subcatchment 8S: Flow to PCB#4



Summary for Subcatchment 9S: Undetained Flow to Greenmont Ave - DP#1

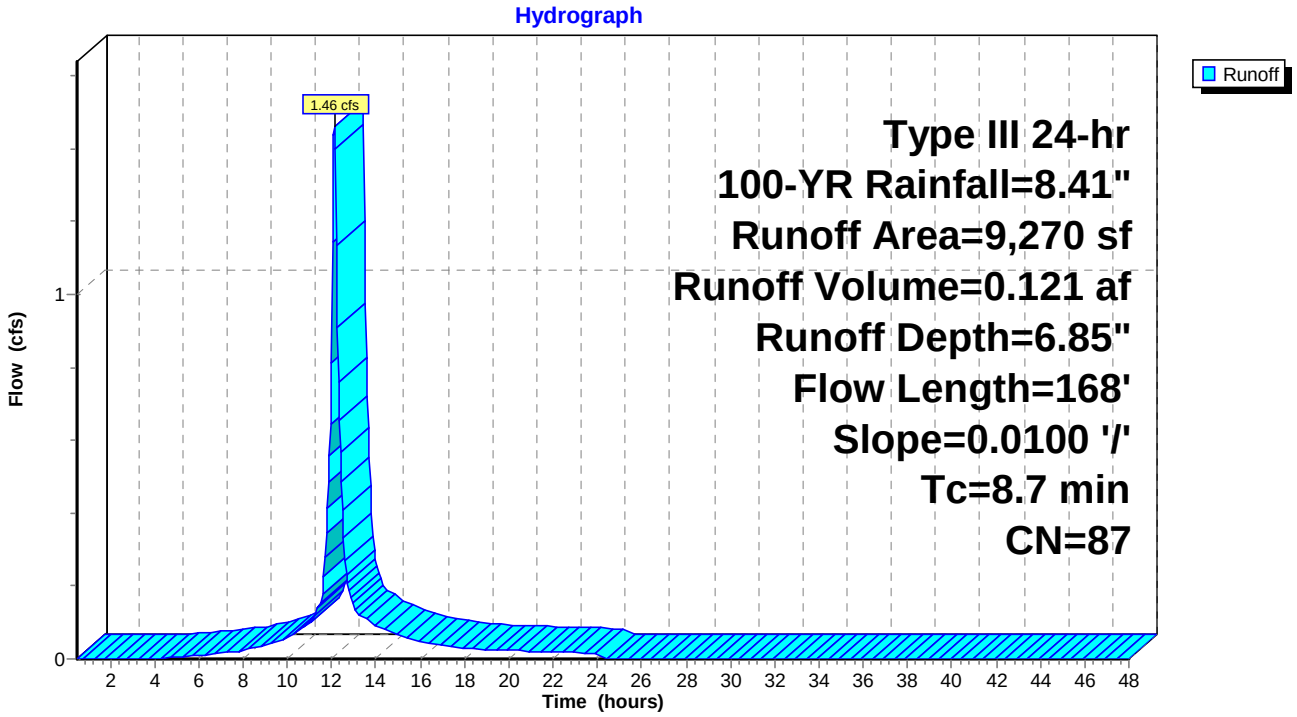
Runoff = 1.46 cfs @ 12.12 hrs, Volume= 0.121 af, Depth= 6.85"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.50-48.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-YR Rainfall=8.41"

Area (sf)	CN	Description
5,908	80	>75% Grass cover, Good, HSG D
3,362	98	Roofs, HSG D
9,270	87	Weighted Average
5,908		63.73% Pervious Area
3,362		36.27% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.4	50	0.0100	0.11		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.20"
1.3	118	0.0100	1.50		**Shallow Concentrated Flow,** Grassed Waterway Kv= 15.0 fps
8.7	168	Total			

Subcatchment 9S: Undetained Flow to Greenmont Ave - DP#1



Summary for Subcatchment 11S: Sediment Forebay Basin

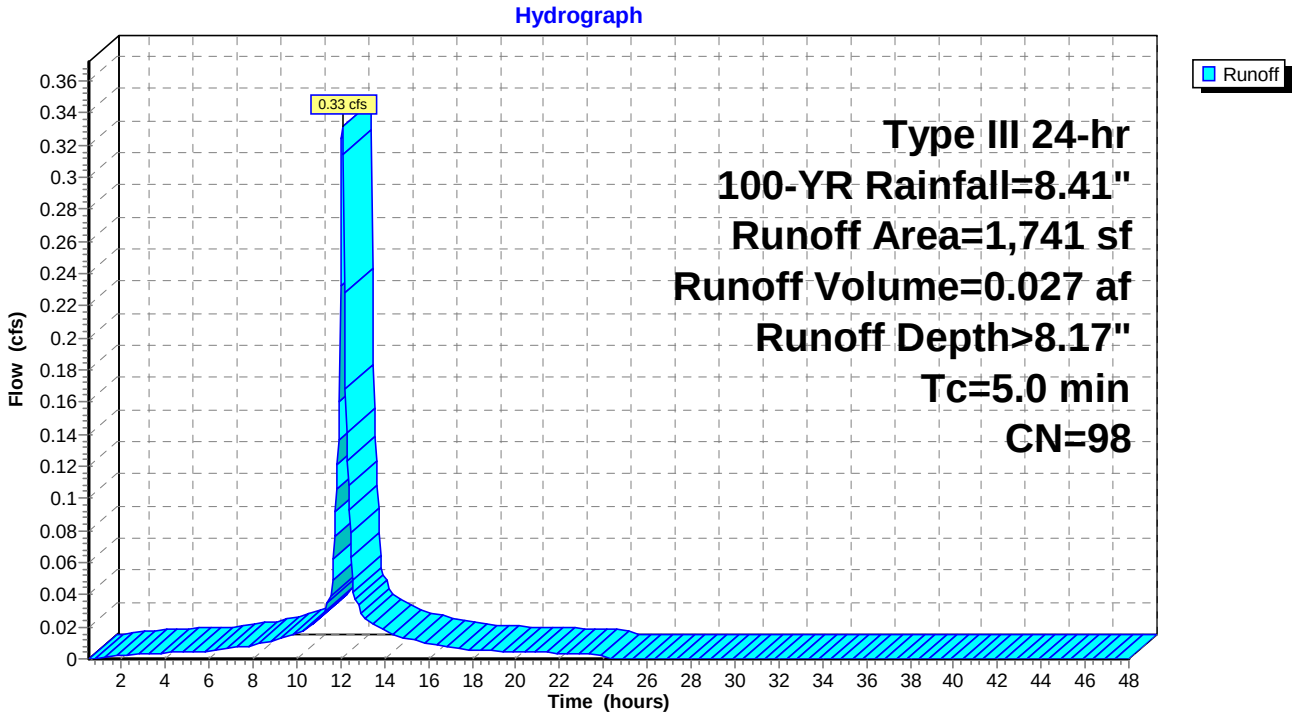
Runoff = 0.33 cfs @ 12.07 hrs, Volume= 0.027 af, Depth> 8.17"
Routed to Pond 11P : Sediment Forebay

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.50-48.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-YR Rainfall=8.41"

	Area (sf)	CN	Description
*	1,741	98	Sed Bas Wet Surface
	1,741		100.00% Impervious Area

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

Subcatchment 11S: Sediment Forebay Basin



Summary for Subcatchment 36S: Extended Detention Wet Basin

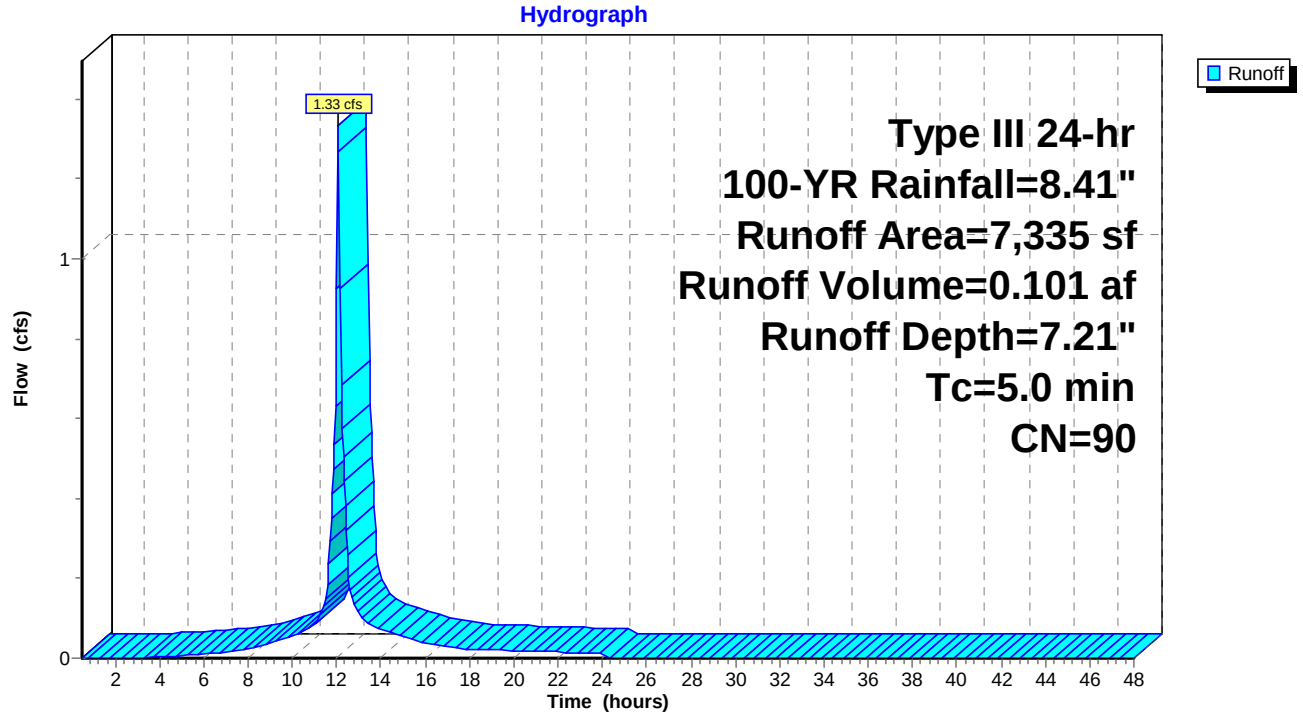
Runoff = 1.33 cfs @ 12.07 hrs, Volume= 0.101 af, Depth= 7.21"
Routed to Pond 12P : Outlet Det Pond

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.50-48.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-YR Rainfall=8.41"

	Area (sf)	CN	Description
	3,120	80	>75% Grass cover, Good, HSG D
*	4,215	98	Wet Basin Surface Water
	7,335	90	Weighted Average
	3,120		42.54% Pervious Area
	4,215		57.46% Impervious Area

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

Subcatchment 36S: Extended Detention Wet Basin



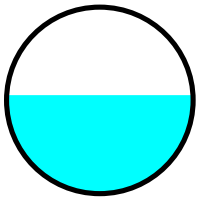
Summary for Reach 10R: PFD#1

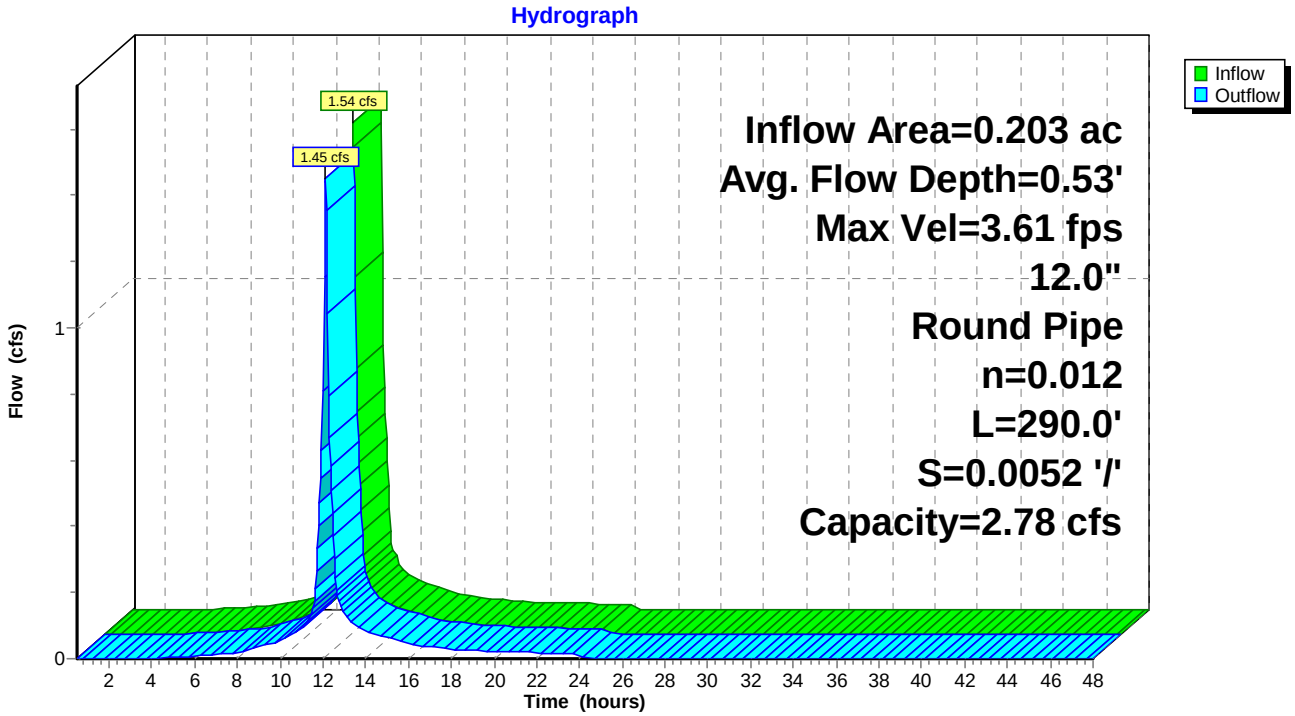
Inflow Area = 0.203 ac, 35.96% Impervious, Inflow Depth = 6.73" for 100-YR event
Inflow = 1.54 cfs @ 12.07 hrs, Volume= 0.114 af
Outflow = 1.45 cfs @ 12.11 hrs, Volume= 0.114 af, Atten= 6%, Lag= 2.5 min
Routed to Pond 11P : Sediment Forebay

Routing by Stor-Ind+Trans method, Time Span= 0.50-48.00 hrs, dt= 0.05 hrs
Max. Velocity= 3.61 fps, Min. Travel Time= 1.3 min
Avg. Velocity = 1.19 fps, Avg. Travel Time= 4.1 min

Peak Storage= 122 cf @ 12.09 hrs
Average Depth at Peak Storage= 0.53' , Surface Width= 1.00'
Bank-Full Depth= 1.00' Flow Area= 0.8 sf, Capacity= 2.78 cfs

12.0" Round Pipe
n= 0.012 Corrugated PP, smooth interior
Length= 290.0' Slope= 0.0052 '/'
Inlet Invert= 158.00', Outlet Invert= 156.50'





Summary for Pond 1P: ADS 36" Pipe Det Basin

Inflow Area = 1.530 ac, 64.55% Impervious, Inflow Depth = 7.40" for 100-YR event
Inflow = 9.60 cfs @ 12.12 hrs, Volume= 0.944 af
Outflow = 3.12 cfs @ 12.52 hrs, Volume= 0.943 af, Atten= 67%, Lag= 23.9 min
Primary = 3.12 cfs @ 12.52 hrs, Volume= 0.943 af
Routed to Pond 11P : Sediment Forebay

Routing by Stor-Ind method, Time Span= 0.50-48.00 hrs, dt= 0.05 hrs
Peak Elev= 159.89' @ 12.52 hrs Surf.Area= 7,550 sf Storage= 17,781 cf

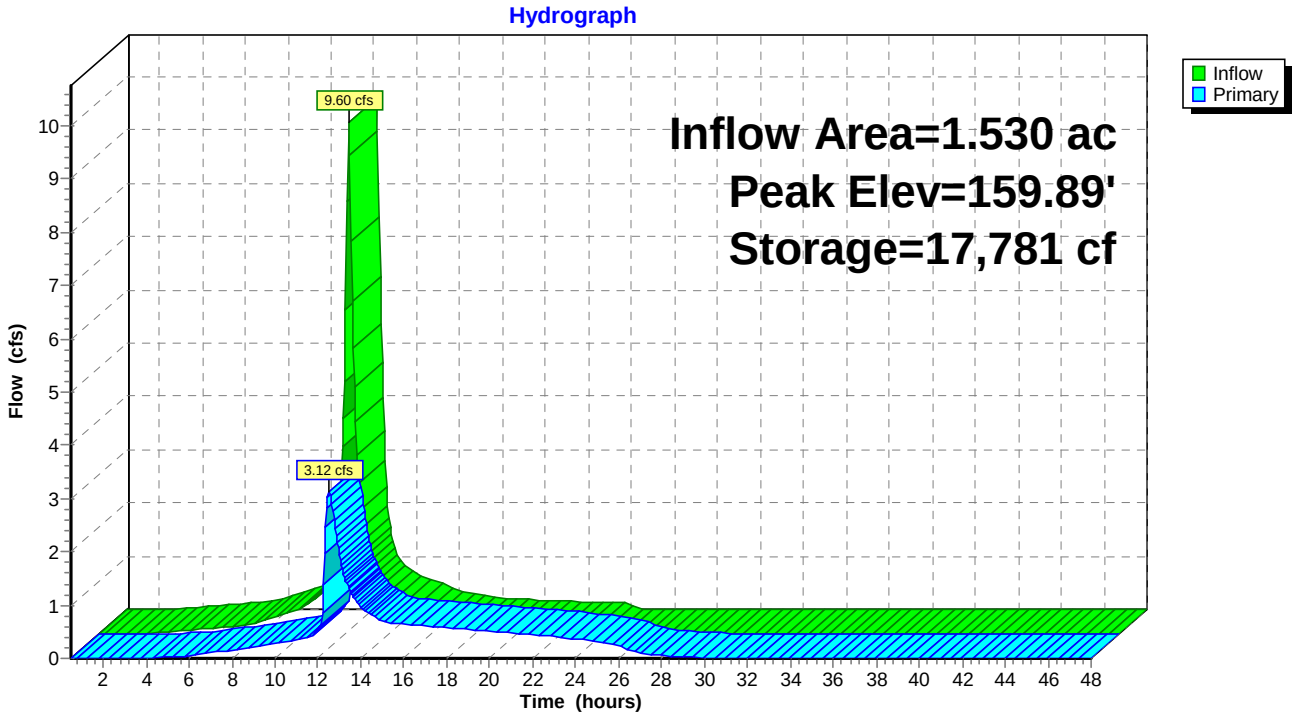
Plug-Flow detention time= 207.2 min calculated for 0.943 af (100% of inflow)
Center-of-Mass det. time= 206.8 min (979.8 - 773.0)

Volume	Invert	Avail.Storage	Storage Description
#1	157.00'	12,723 cf	**36.0" Round Pipe Storage** x 6 Inside #2 L= 300.0'
#2	156.50'	6,991 cf	**25.00'W x 302.00'L x 4.00'H Prismatoid** 30,200 cf Overall - 12,723 cf Embedded = 17,477 cf x 40.0% Voids
		19,714 cf	Total Available Storage

Device	Routing	Invert	Outlet Devices
#1	Primary	159.00'	**12.0" Vert. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#2	Primary	156.50'	**4.0" Vert. Orifice/Grate** C= 0.600 Limited to weir flow at low heads

Primary OutFlow Max=3.11 cfs @ 12.52 hrs HW=159.89' (Free Discharge)
└**1=Orifice/Grate** (Orifice Controls 2.36 cfs @ 3.21 fps)
└**2=Orifice/Grate** (Orifice Controls 0.75 cfs @ 8.64 fps)

Pond 1P: ADS 36" Pipe Det Basin



Summary for Pond 2P: Ex-Wetlands Area

Inflow Area = 8.200 ac, 32.69% Impervious, Inflow Depth = 6.75" for 100-YR event
Inflow = 26.63 cfs @ 12.50 hrs, Volume= 4.615 af
Outflow = 8.88 cfs @ 13.25 hrs, Volume= 4.614 af, Atten= 67%, Lag= 45.1 min
Primary = 8.88 cfs @ 13.25 hrs, Volume= 4.614 af

Routing by Stor-Ind method, Time Span= 0.50-48.00 hrs, dt= 0.05 hrs
Peak Elev= 153.52' @ 13.25 hrs Surf.Area= 54,730 sf Storage= 57,301 cf

Plug-Flow detention time= 63.5 min calculated for 4.614 af (100% of inflow)
Center-of-Mass det. time= 62.8 min (921.6 - 858.9)

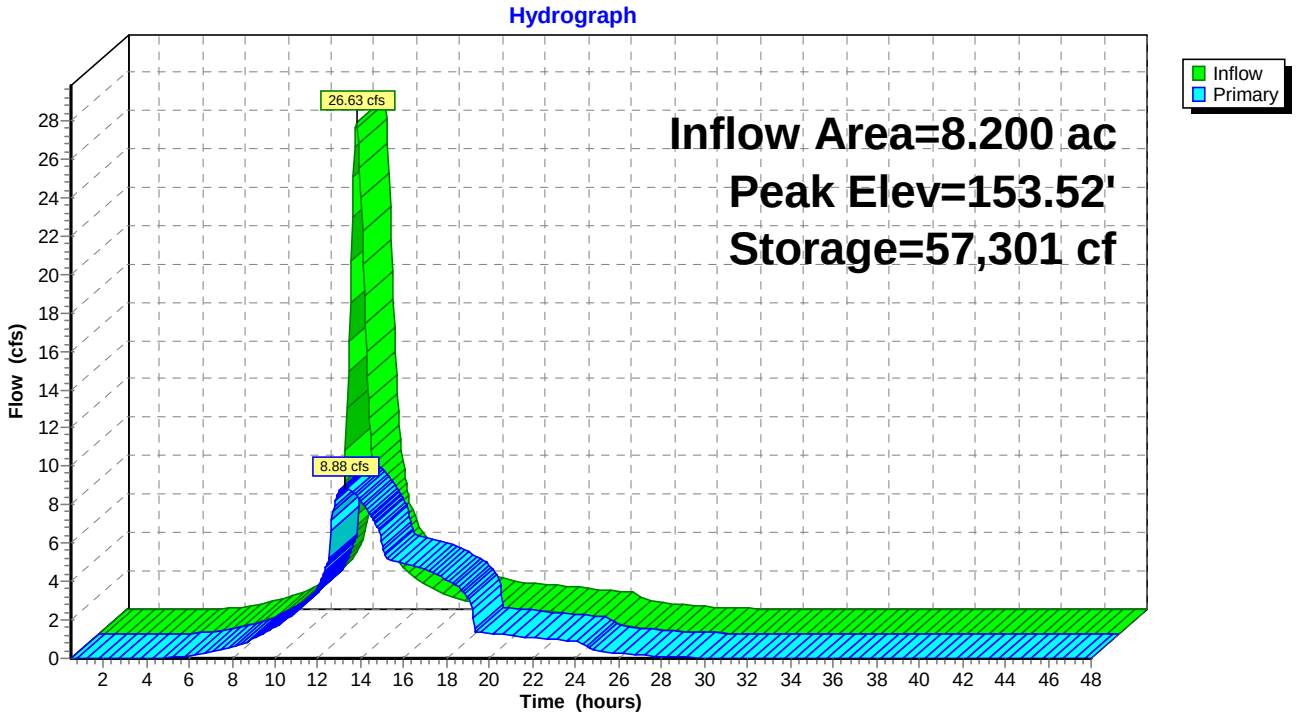
Volume	Invert	Avail.Storage	Storage Description
#1	150.00'	184,747 cf	**Custom Stage Data (Irregular)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
150.00	208	75.0	0	0	208
151.00	328	94.0	266	266	477
152.00	14,780	1,138.0	5,770	6,036	102,832
153.00	40,797	1,192.0	26,711	32,747	112,912
154.00	69,661	1,810.0	54,589	87,336	260,555
155.00	128,105	2,354.0	97,411	184,747	440,827

Device	Routing	Invert	Outlet Devices
#1	Primary	150.25'	**12.0" Round Culvert** L= 83.0' RCP, groove end projecting, Ke= 0.200 Inlet / Outlet Invert= 150.25' / 149.75' S= 0.0060 '/' Cc= 0.900 n= 0.012 Concrete pipe, finished, Flow Area= 0.79 sf
#2	Primary	153.07'	**2.0" x 2.0" Horiz. Orifice/Grate X 6.00 columns** X 6 rows C= 0.600 Limited to weir flow at low heads

Primary OutFlow Max=8.88 cfs @ 13.25 hrs HW=153.52' (Free Discharge)
└**1=Culvert** (Barrel Controls 5.67 cfs @ 7.22 fps)
└**2=Orifice/Grate** (Orifice Controls 3.22 cfs @ 3.22 fps)

Pond 2P: Ex-Wetlands Area



Summary for Pond 11P: Sediment Forebay

Inflow Area = 1.773 ac, 62.07% Impervious, Inflow Depth > 7.34" for 100-YR event
Inflow = 3.56 cfs @ 12.48 hrs, Volume= 1.084 af
Outflow = 3.54 cfs @ 12.51 hrs, Volume= 1.083 af, Atten= 1%, Lag= 2.1 min
Primary = 3.54 cfs @ 12.51 hrs, Volume= 1.083 af
Routed to Pond 12P : Outlet Det Pond

Routing by Stor-Ind method, Time Span= 0.50-48.00 hrs, dt= 0.05 hrs
Starting Elev= 156.00' Surf.Area= 1,059 sf Storage= 868 cf
Peak Elev= 157.33' @ 12.51 hrs Surf.Area= 1,551 sf Storage= 2,658 cf (1,790 cf above start)

Plug-Flow detention time= 53.0 min calculated for 1.062 af (98% of inflow)
Center-of-Mass det. time= 27.5 min (981.2 - 953.7)

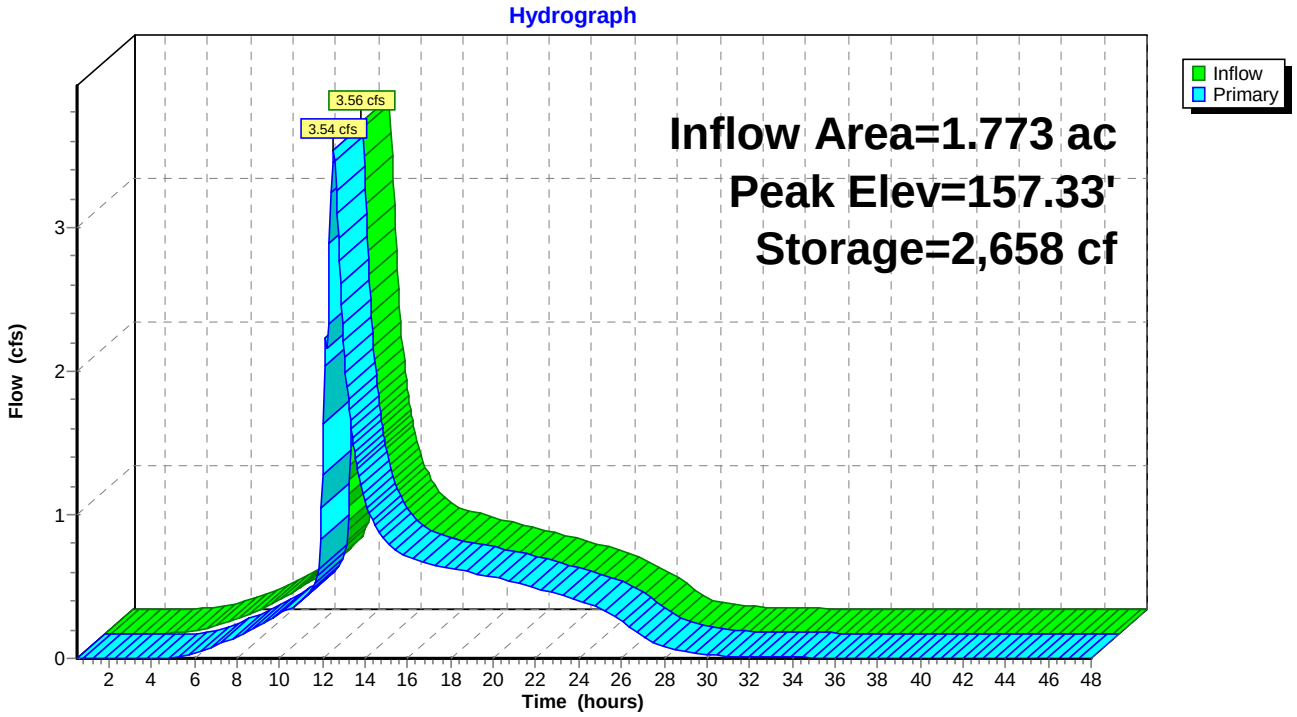
Volume	Invert	Avail.Storage	Storage Description
#1	155.00'	3,718 cf	**Custom Stage Data (Irregular)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
155.00	691	110.0	0	0	691
156.00	1,059	130.0	868	868	1,091
157.00	1,527	162.0	1,286	2,154	1,849
158.00	1,601	162.0	1,564	3,718	2,011

Device	Routing	Invert	Outlet Devices
#1	Primary	156.00'	**6.0" Round Culvert** L= 18.0' CPP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 156.00' / 156.00' S= 0.0000 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.20 sf
#2	Primary	157.00'	**6.0' long x 6.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 3.50 4.00 4.50 5.00 5.50 Coef. (English) 2.37 2.51 2.70 2.68 2.68 2.67 2.65 2.65 2.65 2.65 2.66 2.66 2.67 2.69 2.72 2.76 2.83

Primary OutFlow Max=3.53 cfs @ 12.51 hrs HW=157.33' (Free Discharge)
1=Culvert (Inlet Controls 0.77 cfs @ 3.94 fps)
2=Broad-Crested Rectangular Weir (Weir Controls 2.75 cfs @ 1.40 fps)

Pond 11P: Sediment Forebay



Summary for Pond 12P: Outlet Det Pond

Inflow Area = 1.942 ac, 61.67% Impervious, Inflow Depth > 7.32" for 100-YR event
Inflow = 3.80 cfs @ 12.48 hrs, Volume= 1.184 af
Outflow = 3.60 cfs @ 12.59 hrs, Volume= 1.184 af, Atten= 5%, Lag= 6.6 min
Primary = 3.60 cfs @ 12.59 hrs, Volume= 1.184 af
Routed to Link DP#2 : DP#2 - Rear Wetlands

Routing by Stor-Ind method, Time Span= 0.50-48.00 hrs, dt= 0.05 hrs
Starting Elev= 155.50' Surf.Area= 5,255 sf Storage= 5,215 cf
Peak Elev= 155.89' @ 12.59 hrs Surf.Area= 6,137 sf Storage= 7,411 cf (2,196 cf above start)

Plug-Flow detention time= 128.2 min calculated for 1.065 af (90% of inflow)
Center-of-Mass det. time= 16.7 min (980.2 - 963.5)

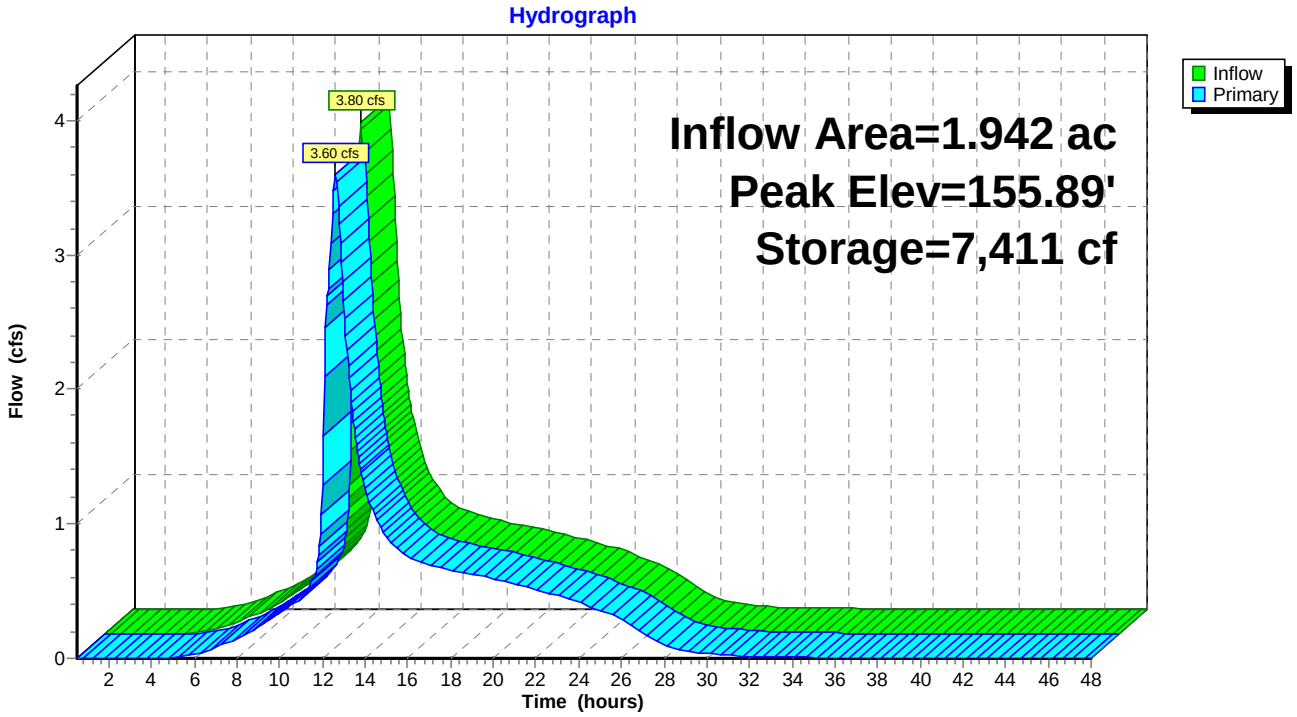
Volume	Invert	Avail.Storage	Storage Description
#1	154.00'	11,493 cf	**Custom Stage Data (Irregular)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
154.00	1,680	368.0	0	0	1,680
155.00	4,215	676.0	2,852	2,852	27,274
156.00	6,410	526.0	5,274	8,126	41,634
156.50	7,063	568.0	3,367	11,493	45,301

Device	Routing	Invert	Outlet Devices
#1	Primary	155.50'	**6.0' long x 6.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 3.50 4.00 4.50 5.00 5.50 Coef. (English) 2.37 2.51 2.70 2.68 2.68 2.67 2.65 2.65 2.65 2.65 2.66 2.66 2.67 2.69 2.72 2.76 2.83

Primary OutFlow Max=3.59 cfs @ 12.59 hrs HW=155.89' (Free Discharge)
1=Broad-Crested Rectangular Weir (Weir Controls 3.59 cfs @ 1.55 fps)

Pond 12P: Outlet Det Pond



Summary for Link DP#2: DP#2 - Rear Wetlands

Inflow Area = 2.267 ac, 52.82% Impervious, Inflow Depth > 7.13" for 100-YR event
Inflow = 4.27 cfs @ 12.11 hrs, Volume= 1.347 af
Primary = 4.27 cfs @ 12.11 hrs, Volume= 1.347 af, Atten= 0%, Lag= 0.0 min
Routed to Pond 2P : Ex-Wetlands Area

Primary outflow = Inflow, Time Span= 0.50-48.00 hrs, dt= 0.05 hrs

Link DP#2: DP#2 - Rear Wetlands