EXHIBIT J

Preliminary Stormwater Report

Cascade Creek Apartments

38272 OR-11
Sandy, OR 97055

Prepared by BCRA

December 2022

bcra
2106 Pacific Avenue, Suite 300
Tacoma, WA 98402

PRELIMINARY STORMWATER REPORT

December 2022

PROJECT:
Cascade Creek Apartments
38272 OR-11
Sandy, OR 97055

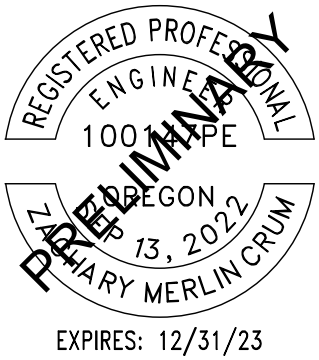
OWNER:
DPS, LLC
1911 65th Ave W
Tacoma, WA 98466

ENGINEER:
BCRA Civil Engineering
2106 Pacific Avenue, Suite 300
Tacoma, WA 98402

PREPARED BY:
Sam Morman
smorman@bcradesign.com

REVIEWED BY:
Zachary Crum, PE
zcrum@bcradesign.com

I hereby certify that this Stormwater Report for Cascade Creek Apartments has been prepared by me or under my supervision and meets minimum standards of the City of Portland and normal standards of engineering practice. I hereby acknowledge and agree that the jurisdiction does not and will not assume liability for the sufficiency, suitability, or performance of drainage facilities designed by me.



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Section A – Project Overview and Description

The Cascade Creek Apartments project is located at 38272 and 38330 OR-11 Sandy, OR 97055. The project site is bordered by residences across Highway 211 on the north, residences on the east and west, and Bornstedt Park on the south. Generally, the site slopes toward a low point one located in the center of the western border. The site in the current condition consists of two parcels, with a total area of 8.84 acres. The parcel numbers are 00677173 and 00677164. The land will be divided into three new parcels. The northernmost parcel is zoned as Village Commercial. The parcel directly south of this is zoned mostly as Village Commercial, with a small section of Medium Density Residential on the southern portion of the parcel. The southernmost parcel is primarily zoned as Medium Density Residential, with a small zone around the southeast corner being zoned as Low Density Residential.

The existing site consists of two residences on the northern side of the site, with some cleared areas surrounding the residences, and the rest of the land in a natural vegetated condition with dense shrubbery and occasional trees. The site has slopes of 5-10%.

Improvements

Frontage improvements for this project include half-street improvements along Highway 211, Village Boulevard, and Pine Street where they border the project site. In addition, a new portion of Cascadia Village Drive will be constructed between the south border of parcel 2, and the north border of parcel 3. This new portion of Cascadia Village Drive will connect with existing offsite intersections between the existing Cascadia Village Drive and SE Village Boulevard on the west, and the existing Cascadia Village Drive and the new Pine Street on the east.

The only on-site improvements being made to the northernmost parcel includes the installation of a new driveway so that the site is accessible, and a new sewer connection to be used instead of the existing on-site septic system. Improvements to the parcel directly south of this include two new buildings that contain both offices and apartments. There will be 5 offices and 16 apartments in each building, resulting in a total of 10 offices and 32 apartments on this parcel. Surrounding the buildings are a new parking lot, an open space, and a public plaza with connections to the right of way. On the parcel south of Cascade Village Drive, four new apartment buildings will be constructed. These buildings will contain a total of 46 apartments. Surrounding these buildings are parking lots and a large open space.

Existing Drainage Basins

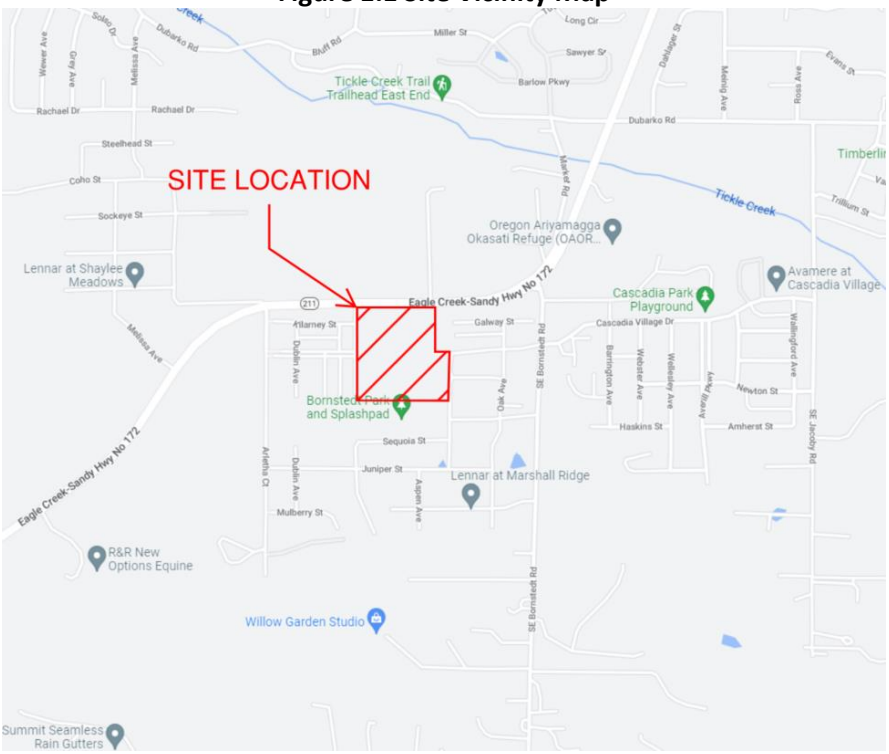
In the existing condition, the site has three separate drainage basins. The first basin is located on the north side of the site and consists mostly of Highway 211. Runoff from the highway runs into a series of catch basins located in the public right-of-way that runs off-site to the west. The runoff is then conveyed further west, turning south at the intersection of through the existing system until being dispersed across a forested area which likely connects to Tickle Creek. This basin is labeled as Basin 1 in Figure 1.2.

The second basin spans over the majority of the project site. It consists of two residences on the northern side, with some cleared areas surrounding the residences, and the rest of the land in a natural vegetated condition with dense shrubbery and occasional trees. The site has slopes of 5-10% to the west. It is labeled as Basin 2 in Figure 1.2. Runoff drains to a catch basin that is a part of a privately owned storm system located on the west border of the site, roughly 75 feet north of the intersection between Cascadia Village Drive and SE Village Boulevard. From here it is conveyed further west and combines with the runoff from Basin 1 around 1,000 feet downstream before being dispersed across a forested area and likely connecting to Tickle Creek.

The final basin is on the southeast corner of the site. It has slopes ranging mostly from 0-5%, with occasional slopes ranging from 5-10%. The land cover is a natural vegetated condition with dense shrubbery. Runoff from this basin drains toward a catch basin that is a part of a privately owned storm system to the east of the site, located in the intersection of Pine Street and Limerick Street. From here, runoff is sent east off-site and ends up in a separate branch of Tickle Creek than the previous two basins. This basin is labeled as Basin 3 in Figure 1.2. The two branches of Tickle Creek being discharged to, do not converge until around 3 miles downstream.

Due to the site discharging to two separate locations is the existing condition, the developed condition will match the flow rates of each discharge location in addition to matching the flow rates of the site as a whole. In the existing condition, basins 1 and 2 connect to conveyance systems that discharge to a forested area that likely connects to a branch of Tickle Creek to the west of the site. Throughout this report, the total area discharging to this location is referred to as Threshold Discharge Area (TDA) 1. Basin 3 connects to a conveyance system that discharges to a separate branch of Tickle Creek. Throughout this report, the total area discharging to this location is referred to as Threshold Discharge Area (TDA) 2.

Figure 1.1 Site Vicinity Map

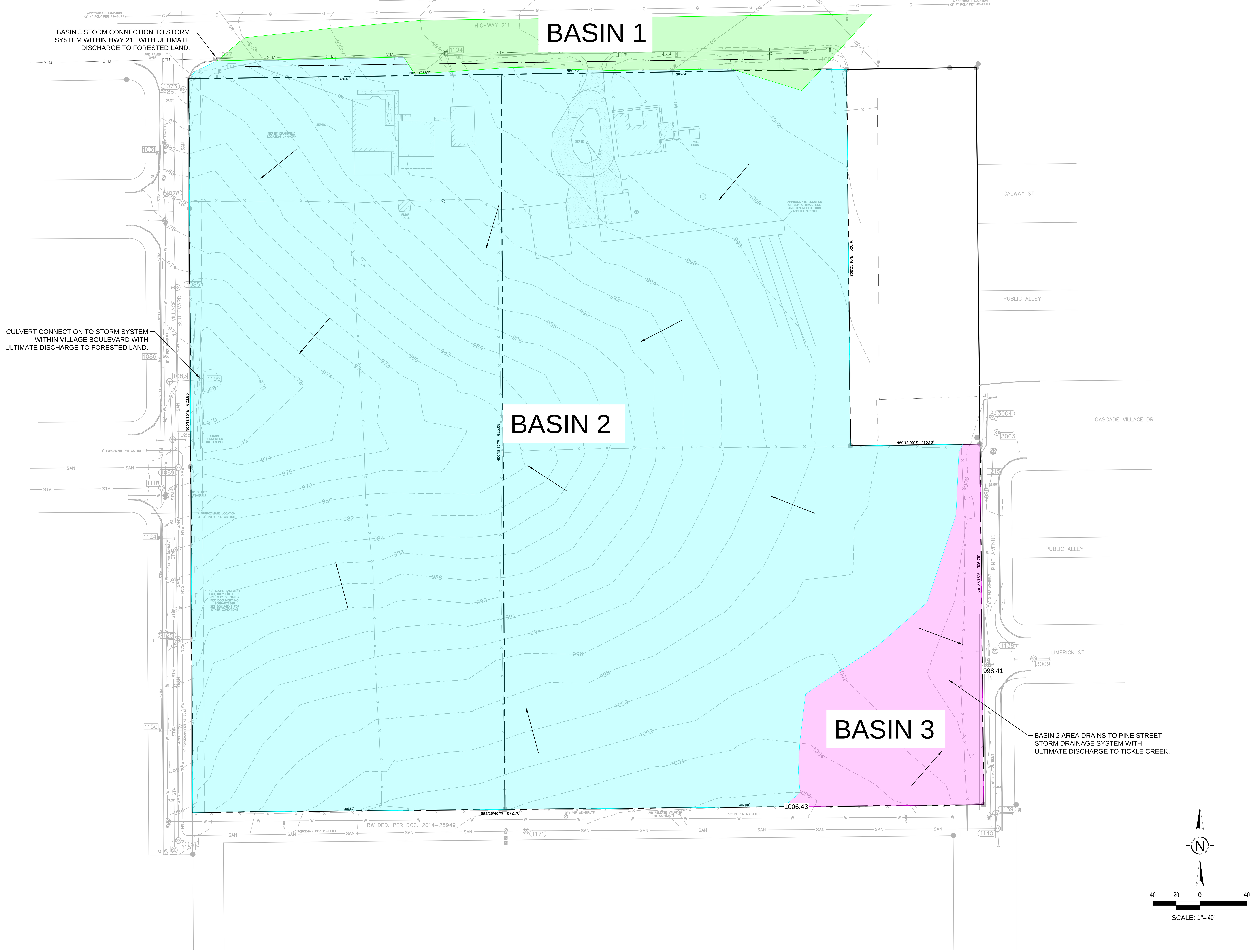


The intent of this preliminary report is to communicate the feasibility of the stormwater facility design to meet the minimum requirements of the City of Portland's Stormwater Management Manual, 2020 in support of the project's design review and tentative partition submittal.

DECEMBER 2022 / CASCADE CREEK

BASIN MAP

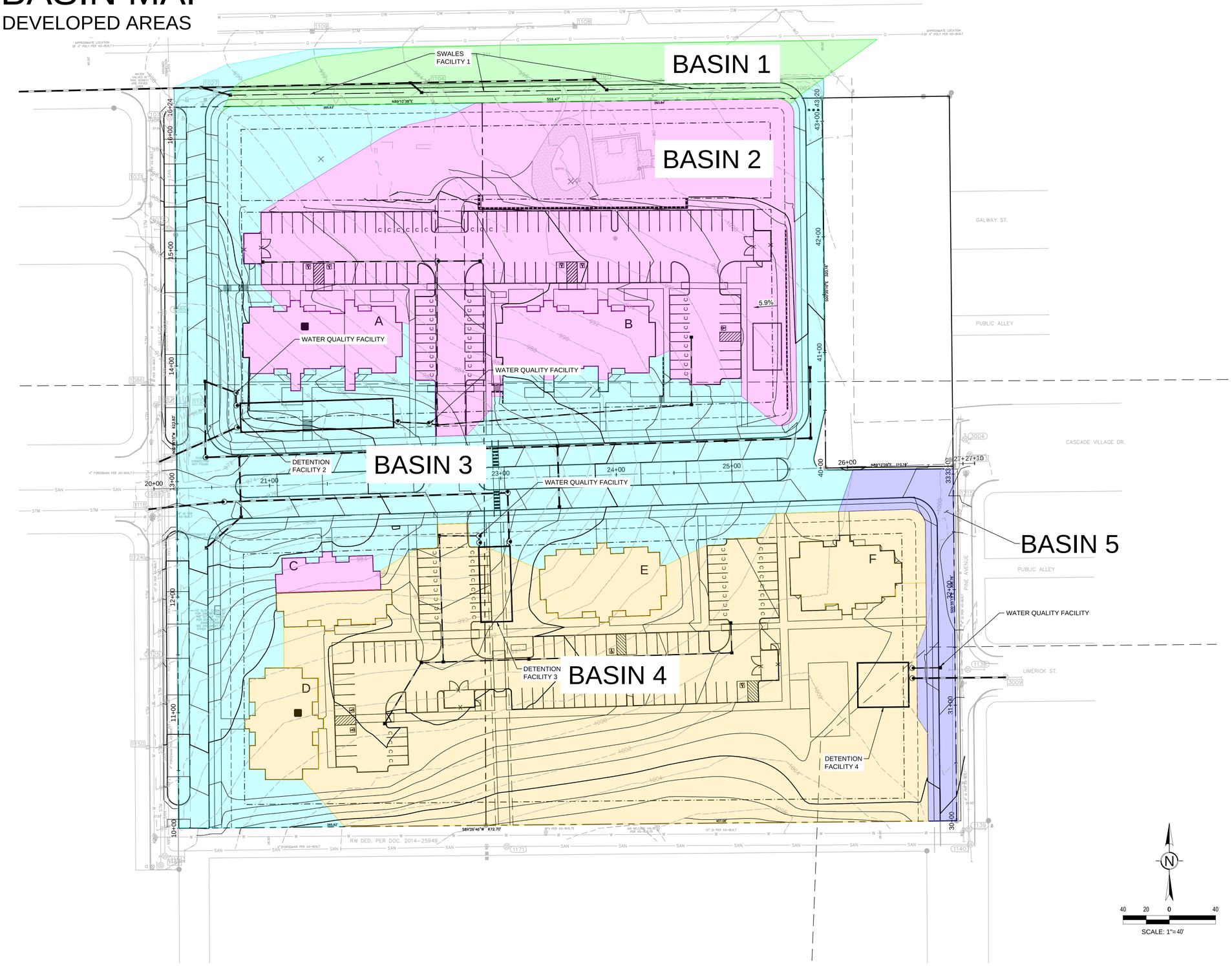
PREDEVELOPED AREAS



DECEMBER 2022 / CASCADE CREEK

BASIN MAP

DEVELOPED AREAS



Section B – Methodology

Soils

A Geotechnical Engineering Report was prepared by Gill Group, Inc., dated 05/04/2021.
Gill found stiff to very stiff clay throughout the site. No groundwater was encountered in any of their explorations. Gill did not provide information about the infiltration rate for the site soils. The geotechnical report can be found in Appendix A of this document.

A soils report has been generated using the Web Soils Survey, showing that the soils on-site are type B. This report can be found in Appendix B of this document.

Infiltration and Discharge Hierarchy

Although infiltration testing has not been conducted, infiltration rates are assumed to be less than 2 in/hr due to the soils being still to very still clay. Because of this, Level 1: Full Onsite Infiltration is not practicable per section 1.3.3 of the City of Portland 2020 Stormwater Management Manual. Level 2: Offsite Discharge to the Separated Stormwater System is practicable and will be followed for this project.

Stormwater Management Techniques

Because this project falls under Level 2 in the infiltration and discharge hierarchy, it must follow pollution reduction and flow control requirements specified in Table 1-2 of the City of Portland Stormwater Management Manual. For pollution reduction, this project is required to remove 70% of the total suspended solids from 90% of the average annual rainfall. The project will meet this through the use of four Stormtech Jellyfish facilities. See Section C, subsection “Water Quality Design” of this report for further detail. For flow control, the project will be following the “smaller surface water bodies (hydromodification)” category specified in the Portland SWMM because it is not discharging to a major body of water. TDA 1 of the project site connects to a conveyance system that discharges to forested area that likely connects to Tickle Creek. TDA 2 of the project site connects to a conveyance system that discharges into Tickle Creek. The project must limit post-development peak runoff rates to pre-development rates for one-half of the 2-year event, and for the 5-, 10-, and 25-year design storm events. The project will meet this requirement through the use of three underground detention systems. The sizing of these systems can be found in Section C, subsection “Flow Control Facility Sizing” of this report.

Section C – Analysis

Design Assumptions

For this project, the presumptive approach has been used for analysis. The software selected to be used is HydroCAD. Tables summarizing the calculations and outputs from the HydroCAD software can be found throughout this section below. Full HydroCAD reports have been generated and attached to this report in Appendix C.

Rainfall

The following rainfall numbers are taken from the City of Sandy Stormwater Website (https://www.ci.sandy.or.us/publicworks/page/stormwater), to be used for calculations:

Table 3.1 24-Hour Rainfall Data

Storm Recurrence Interval	Rainfall (inches)
2-year	3.50
5-year	4.50
10-year	4.80
25-year	5.50

Basin Areas

The following basin areas are based on the basins shown in the Tables 3.2 and 3.3.

Table 3.2 Existing Basin Areas

Existing Basins		
	SF	Acres
TDA 1 Basin 1 (Highway 211)		
Roof	0	0
Paved	15,191	0.349
Pervious	5,791	0.133
Basin 2 Total	20,982	0.482
Basin 2 (On-site Draining West)		
Roof	6,892	0.158
Paved	6,565	0.151
Pervious	348,054	7.990
Basin 1 Total	361,511	8.299
TDA 2 Basin 3 (On-site Draining East)		
Roof	0	0
Paved	0	0
Pervious	25,882	0.594
Basin 2 Total	25,882	0.594

Table 3.3 Proposed Basin Areas

Proposed Basins		
	SF	Acres
TDA 1		
Basin 1 (Highway 211)		
Roof	0	0
Paved	20,624	0.473
Pervious	3,694	0.085
Basin 1 Total	24,318	0.558
Basin 2 (North Lot)		
Roof	18,844	0.433
Paved	46,939	1.078
Pervious	42,608	0.978
Basin 2 Total	108,391	2.488
Basin 3 (Right-of-Way)		
Roof	0	0
Paved	58,584	1.345
Pervious	75,049	1.723
Basin 3 Total	133,633	3.068
Basin 4 (South Lot)		
Roof	18,639	0.428
Paved	45,226	1.038
Pervious	70,076	1.609
Basin 4 Total	133,941	3.075
TDA 2		
Basin 5 (Southeast Area)		
Roof	0	0
Paved	9,134	0.210
Pervious	1,418	0.033
Basin 5 Total	10,552	0.242

Curve Numbers

The following curve numbers were taken from the City of Portland Stormwater Management Manual, and the City of Portland Sewer and Drainage Facilities Design Manual.

Table 3.4 Curve Number Table

Description	CN	Land Use Description
Pre-Developed Pervious	72	Soil Type “B” Portland SWMM Table A-8
Pre-Developed Impervious	98	Roofs, Pavement
Developed Pervious	56	Grass Lawn, Soil Group B Portland SDFDM Table 6-5
Developed Impervious	98	Roofs, Pavement

Flow Control Facility Sizing

Hydrographs for the drainage basins were determined using HydroCAD, which uses the Santa Barbara Urban Hydrograph (SBUH) method. The flow control facilities and control structures were sized and designed to release water to match the pre-developed rates for half of the 2-year, and the 5-, 10-, and 25-year storm events as prescribed by the 2020 Portland Stormwater Management Manual, Chapter 1.3.5 under the section "Level 2 Flow Control Requirements", subsection "Smaller surface water bodies (hydromodification)". These values are specified in Table 3.1 of this document.

There are 4 flow control facilities being utilized in this project.

Facility 1:

Facility 1 consists of a series of 3 bioswales running parallel to Highway 211 on the northern border of the site. Swales are designed with 8 ft top width, 2 ft bottom width, and 3:1 side slopes. The length of each swale is 150 feet. The area contributing to this swale is described in Table 3.3 as Basin 1.

Facility 2:

Facility 2 is a detention system located at the southwest corner of parcel 2. The detention system used is a detention vault. The vault has internal storage dimensions of 119 ft L x 24 ft W x 7.5ft D. The walls, lid, and base all have a thickness of 1 foot. The vault has 6" of dead storage, 6ft of live storage, and 12" of freeboard. The vault has a total live capacity of 17,136 cf. The areas contributing to this facility are Basin 2 and 3 of Table 3.3.

Facility 3:

Facility 3 is a detention system located on the north side of parcel 3. The detention system used is a detention vault. The vault has a length of 58 ft L x 26 ft W x 7.5ft D. The walls, lid, and base all have a thickness of 1 foot. The vault has 6" of dead storage and 12" of freeboard. The vault has a total live capacity of 9,060 cf. The area contributing to this facility is Basin 4 of Table 3.3.

Facility 4:

Facility 4 is a detention system located on the east side of parcel 3. The detention system used is ADS StormTech SC-160LP underground chambers. The facility has 13 rows of chambers, with 4 chambers per row and has a total system capacity of 933 cf. The chambers are 12" in height, and have 6" of stone above and below, giving a total system depth of 2 feet. The area contributing to this facility is Basin 5 of Table 3.3.

Facilities 2-4 have been shown on the plans with minimum of 10% additional storage volume above what is necessary, as this project is still early in design. This 10% increase is reflected in the facility footprints and associated volume callouts on the plans. See Table 3.5 below for calculations. Tables 3.6 and 3.7 show the site's predeveloped outflow rates. Tables 3.8 and 3.9 show a summary of flows from the proposed facilities compared to the predeveloped outflow rates. Table 3.10 gives a summary of the orifices designed for each proposed facility. See Appendix C for a more detailed system analysis.

Table 3.5 Detention Facility Volumes With 10% Increase

Detention Facility	Volume Required (cf)	Volume with ~10% Increase (cf)
Facility 2	17,136	19,000
Facility 3	9,060	10,000
Facility 4	993	1,100

Table 3.6 TDA 1 Predeveloped Outflows

Recurrence Interval	Basin 1 Predeveloped Outflow (cfs)	Basin 2 Predeveloped Outflow (cfs)	TDA 1 Predeveloped Outflow (cfs)
½ of 2-year	0.32	1.75	1.035
5-year	0.43	3.18	3.61
10-year	0.46	3.65	4.11
25-year	0.54	4.79	5.33

Table 3.7 TDA 2 Predeveloped Outflows

Recurrence Interval	Basin 3 Predeveloped Outflow (cfs)	TDA 2 Predeveloped Outflow (cfs)
½ of 2-year	0.055	0.055
5-year	0.21	0.21
10-year	0.24	0.24
25-year	0.32	0.32

Table 3.8 TDA 1 Proposed System Outflows

Recurrence Interval	Facility 1 Proposed Outflow (cfs)	Facility 2 Proposed Outflow (cfs)	Facility 3 Proposed Outflow (cfs)	Proposed TDA 1 Total (cfs)	Predeveloped Outflow (cfs)
½ of 2-year	0.25	0.50	0.21	0.96	1.035
5-year	0.32	0.87	0.39	1.58	3.61
10-year	0.34	0.97	0.45	1.76	4.11
25-year	0.39	1.19	0.59	2.17	5.33

Table 3.9 TDA 2 Proposed System Outflows

Recurrance Interval	Facility 4 Proposed Outflow (cfs)	Proposed TDA 2 Total (cfs)	Predeveloped Outflow(cfs)
½ of 2-year	0.05	0.05	0.055
5-year	0.06	0.06	0.21
10-year	0.07	0.07	0.34
25-year	0.08	0.08	0.32

Table 3.10 Proposed System Orifices

Orifice	Height (ft)	Diameter (inches)
Facility 1 (Highway 211 Bioswales)		
Bottom	0	4
Facility 2 (North Lot Detention)		
Bottom	0	2
Middle	3.25	3
Top	4	4
Overflow Riser	6	12
Facility 3 (South Lot Detention)		
Bottom	0	1.5
Middle	4	1.75
Top	4.75	2.5
Overflow Riser	6	12
Facility 4 (Southeast Area Detention)		
Bottom	0	1.5
Overflow Riser	1.92	12

Water Quality Design

Basin 1:

Due to no new pollution-generating hard surfaces being added within Basin 1, water quality treatment is not applicable.

Basin 2-5:

Four Jellyfish manholes by Contech Stormwater Solutions will be designed for water quality for this site, with one manhole being used for each of the remaining basins (Basins 2-5). The areas contributing to the water quality systems are the "paved" and "pervious" areas from Table 3.3. Areas from the roofs are conveyed separately to the detention system and do not mix with polluted runoff, therefore they do not need to receive treatment. The rational method was used for sizing the water quality systems where:

Q = flow (cfs)
C = runoff coefficient (from Table 6-3 of the Portland SDFDM)
I = Intensity = 0.11 in/hr (per SMC Section 13.18.60 for off-line facilities)
A = Drainage Area (acres)

Table 3.11 Water Quality Flowrates

Rational Method Flow Calculation				
Basin	Q (cfs)	C	I (in/hr)	A (acres)
2	0.16	0.58	0.11	2.488
3	0.22	0.64	0.11	3.068
4	0.24	0.72	0.11	3.075
5	0.01	0.37	0.11	0.242

The Contech Jellyfish JF4 model has a treatment capacity of 0.45 cfs, which is larger than any flow contributing in the "Q" column of Table 3.11.

Section D – Engineering Conclusions

The design for on-site detention and water quality systems are in accordance with the City of Sandy requirements. For flow control, the four facilities (one series of bioswales, three detention tanks) have been designed for half of the 2-year design storm up to the 25-year storm as shown in tables 3.8 and 3.9. For water quality, the Highway 211 Basin does not require water quality treatment, as no pollution generating surfaces are being added. The remaining basins all receive treatment from Contech Jellyfish JF4 systems. Each system receives flow below the treatment flow capacity, as shown in Table 3.11.

Detailed calculations will be completed with the final engineering plans as needed. Stormwater facility details/exhibits and Manufactured Stormwater Treatment Technology Data will be provided under the engineering permit submittal.

Appendix A – Geotechnical Report

GILL GROUP

May 4, 2021

Vaughn Bay Construction
1911 65th Avenue West
Tacoma, WA 98466

Attention: Zac Baker
Subject: Geotechnical Report
Bornstedt Village
38272 SE Highway 211
Sandy, Oregon
Gill Project No. ET237V1028

Dear Mr. Baker,

Gill Group, Inc. (Gill) is pleased to provide you with this Geotechnical Report for the above referenced site. This report includes a summary of the activities conducted, a summary of the findings, and recommendations. We appreciate the opportunity to provide the above services. If you have any questions or comments, please contact the undersigned Gill Group participant at (800) 428-3320.

Sincerely,

Gill Group, Inc.

Jacob G. Epperson

Jacob G. Epperson, P.G.

Director of Environmental Services

Foundation Engineering, Inc.
Professional Geotechnical Services

Memorandum

Date: May 4, 2021

To: Jake Epperson, P.G.
Gill Group

From: Nathan M. Villeneuve, C.E.G.
Timothy J. Pfeiffer, P.E., G.E.

Subject: Preliminary Geotechnical Investigation - DRAFT

Project: Sandy Housing Development
Project No. 2211038

We have completed the requested preliminary geotechnical investigation for the above-referenced project in Sandy, Oregon. This report provides a description of our work and a discussion of site conditions.

BACKGROUND

Gill Group is assisting with the purchase of two parcels in Sandy, Oregon. The site is located south of Highway 211 (Eagle Creek-Sandy Highway), between Village Boulevard and Pine Avenue and is currently occupied by two residential homes and pasture. The site location is shown on Figure 1A (Appendix A). Should the purchase proceed, we understand a housing development consisting of 3-story buildings will be constructed on the properties. Some of the buildings may have daylight basements.

Gill Group is the lead designer for the project. The subject property is in the process of being purchased. Gill Group retained Foundation Engineering to complete a preliminary geotechnical investigation as part the pre-purchase due-diligence process. After the properties are purchased and the site plan is developed, Phase 2 geotechnical work will be needed to provide specific geotechnical recommendations for site grading and for the design and construction of foundations and pavements. Details of our current, Phase 1 scope of work were provided in a proposal dated March 30, 2021 and authorized by a signed agreement dated April 6, 2021.

FIELD EXPLORATION

We excavated twelve (12) exploratory test pits (TP-1 through TP-12) at the site on April 27, 2021 using a CAT 306 excavator provided and operated by Wapiti Pacific Construction. The northwest quadrant of the site was not accessible during the preliminary investigation, so test pits were not excavated in this area. The approximate locations of the test pits are shown in Figure 2A (Appendix A) The test pits extended to maximum depths ranging from ±6 to 10 feet.

The soil profiles were continuously logged during excavation and samples were collected where appropriate. Undrained shear strength measurements were made on the side walls of the test pits using a field vane shear device. The soil profile,

sampling depths, and strength measurements are shown on the test pit logs (Appendix B). The surface and subsurface conditions are discussed below.

SITE AND SUBSURFACE CONDITIONS

Surface Conditions

The site consists of sloping topography with the high elevations to the north and south and lowest elevations in the middle of the properties. The low elevations form a small drainage to the west where it intersects a road embankment. The lots are bordered on the north by Highway 211, on the east by Pine Avenue, on the south by Bornstedt Park, and on the west by Village Boulevard. Surface conditions at the time of our field exploration are shown in Photos 1 and 2 (Appendix A).

Subsurface Conditions

A general discussion of the soil conditions encountered in the test pits is provided below. More detailed descriptions of conditions encountered in each test pit are provided on the test pit logs (Appendix B).

Topsoil. A topsoil layer was encountered in all the test pits, typically extending to depths of ±6 to 18 inches. The topsoil consists of low to medium plasticity silty clay and silt with some organics. The organics consisted of roots up to 1/2 inch in diameter.

Residual Soil. Residual soil consisting of stiff to very stiff, high plasticity clay with scattered organics was encountered in all the test pits beneath the topsoil. The residual soil extended to the bottom of each test pit. In TP-1 to TP-5, the residual soil graded to a clay with some sand and a relict rock texture.

Groundwater

No groundwater was encountered in the test pits. We anticipate perched water conditions may develop within a few feet of the ground surface during periods of prolonged rainfall based on the presence of low permeability, fine-grained soils encountered at shallow depths across the site.

PRELIMINARY CONCLUSIONS

Based on the results of our field explorations, in our opinion the site is suitable for the planned development. We anticipate the new housing units can be supported on shallow foundations (e.g., spread and continuous wall footings). Preliminary considerations for site grading and construction are discussed below.

Site preparation should include stripping the upper ±6 to 18 inches of topsoil and removing it from structural foundation areas. The native soil is typically stiff to very stiff and will be suitable to support new structures, foundations, and pavements.

The foundation soil is primarily fine-grained and sensitive to moisture. Site grading and earthwork should be performed during the dry season (typically June through September) when aeration, moisture conditioning, and compaction are possible. Construction during the wet season will require removal of soft soil and construction of thick rock sections underlain by a separation geotextile for the building pads, pavement areas, and haul roads to support construction traffic.

As discussed above, the surficial soil is predominantly fine-grained. During dry weather the excavated soils may be reused for general site grading under pavements and landscaping areas or reworked and used as general site fill outside building areas.

ADDITIONAL GEOTECHNICAL WORK

A second phase of geotechnical work should be completed after the property is purchased and the site layout and grading plan has been established. Phase 2 will consist of developing detailed recommendations for foundation design and construction, and new pavements.

VARIATION OF SUBSURFACE CONDITIONS, USE OF THIS REPORT, AND WARRANTY

The preliminary conclusions contained herein assume the soil profiles and groundwater conditions encountered in the test pits are representative of the overall site conditions. The current scope of work does not include recommendations for site grading or for foundation and pavement design. We assume a more detailed geotechnical investigation will be conducted prior to design and construction.

No changes in the enclosed recommendations should be made without our approval. We will assume no responsibility or liability for any engineering judgment, inspection or testing performed by others.

This report was prepared for the exclusive use of Gill Group for their due diligence investigation of the Sandy Housing Development project. Information contained herein should not be used for other sites or for unanticipated design or construction without our written consent. This report is intended solely for the stated purpose. Contractors using this information to estimate construction quantities or costs do so at their own risk. Our services do not include any survey or assessment of potential surface contamination or contamination of the soil or ground water by hazardous or toxic materials. We assume that those services, if needed, have been completed by others.

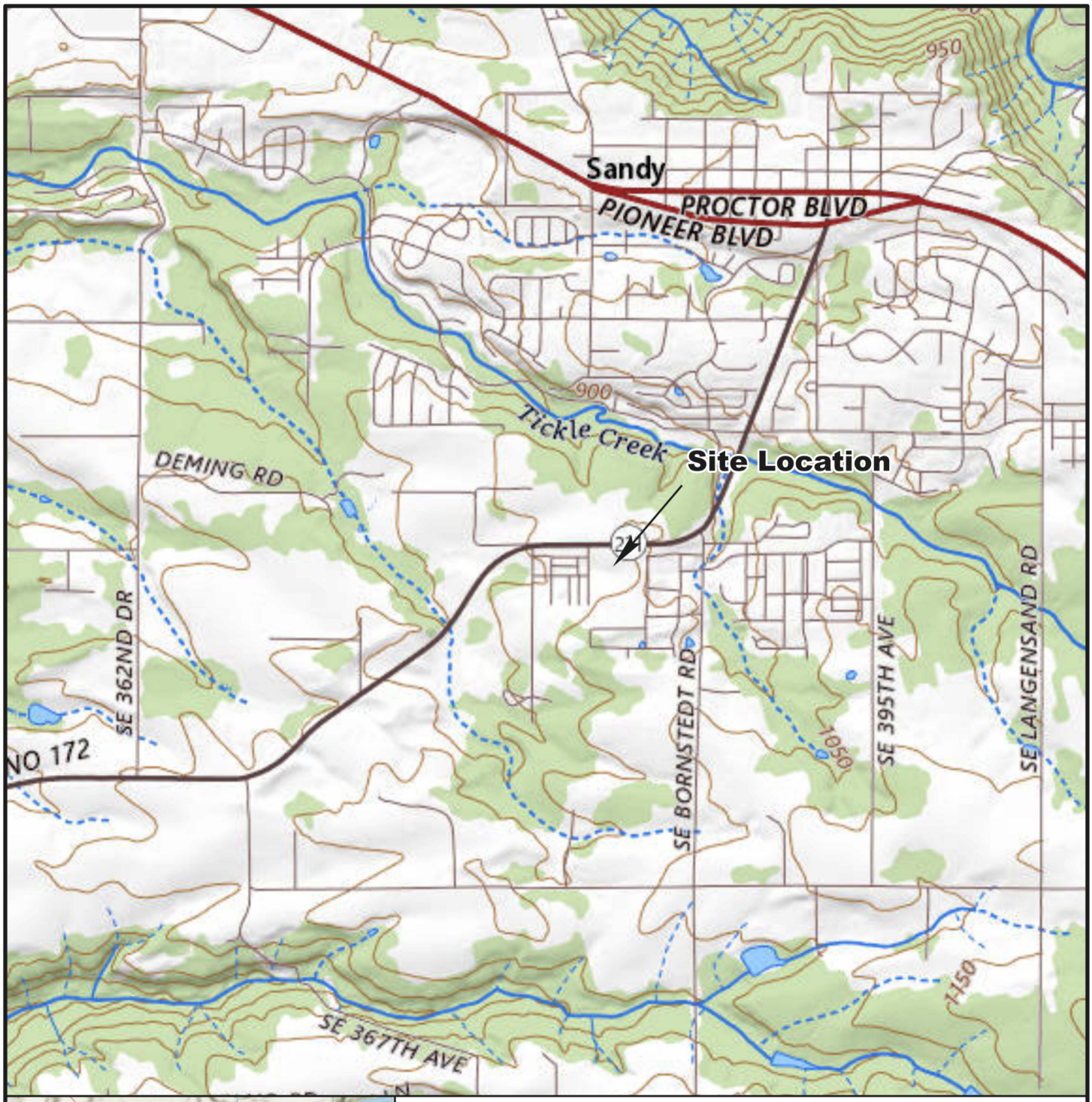
Our work was done in accordance with generally accepted soil and foundation engineering practices. No other warranty, expressed or implied, is made.

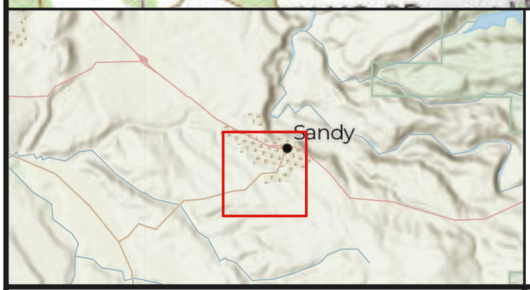
Attachments

Appendix A

Figures

Foundation Engineering, Inc.
Professional Geotechnical Services





NOTES:
1. Base map and contours from ESRI and USGS

N

SCALE: 1" =2,400'

0 1,200 2,400

Foundation Engineering, Inc.
Professional Geotechnical Services

PROJECT NO.	DATE:	DRAWN BY:
2211038	5/3/2021	NMV

VICINITY MAP

Sandy Housing Development
Sandy, Oregon

FIGURE NO.

1A

LEGEND

Approximate Test Pit Location

NOTES:
1. Test pit locations were collected with mobile GPS and are approximate.
2. Base map provided by ESRI.

N

SCALE: 1" =160'

0 80 160

Foundation Engineering, Inc.
Professional Geotechnical Services

PROJECT NO.	DATE:	DRAWN BY:
2211038	5/3/2021	NMV

SITE PLAN

Sandy Housing Development
Sandy, Oregon

FIGURE NO.

2A

Photo 1: West side of the property, looking southwest.

Photo 2: East side of the property, looking north.

Foundation Engineering, Inc. Professional Geotechnical Services	PHOTOGRAPHS	FIGURE NO.:
	Sandy Housing Development Sandy, Oregon	3A

PROJECT NO.:	DATE:	DRAWN BY:
2211038	May 3, 2021	NMV

Appendix B

Test Pit Logs

Foundation Engineering, Inc.
Professional Geotechnical Services

DISTINCTION BETWEEN FIELD LOGS AND FINAL LOGS

A field log is prepared for each boring or test pit by our field representative. The log contains information concerning sampling depths and the presence of various materials such as gravel, cobbles, and fill, and observations of ground water. It also contains our interpretation of the soil conditions between samples. The final logs presented in this report represent our interpretation of the contents of the field logs and the results of the sample examinations and laboratory test results. Our recommendations are based on the contents of the final logs and the information contained therein and not on the field logs.

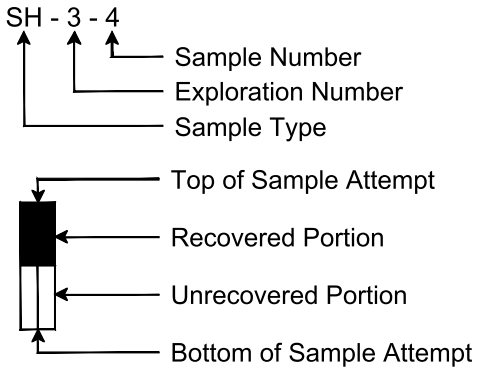
VARIATION IN SOILS BETWEEN TEST PITS AND BORINGS

The final log and related information depict subsurface conditions only at the specific location and on the date indicated. Those using the information contained herein should be aware that soil conditions at other locations or on other dates may differ. Actual foundation or subgrade conditions should be confirmed by us during construction.

TRANSITION BETWEEN SOIL OR ROCK TYPES

The lines designating the interface between soil, fill or rock on the final logs and on subsurface profiles presented in the report are determined by interpolation and are therefore approximate. The transition between the materials may be abrupt or gradual. Only at boring or test pit locations should profiles be considered as reasonably accurate and then only to the degree implied by the notes thereon.

SAMPLE OR TEST SYMBOLS



C - Pavement Core Sample
CS - Rock Core Sample
OS - Oversize Sample (3-inch O.D. split-spoon)
S - Grab Sample
SH - Thin-walled Shelby Tube Sample
SS - Standard Penetration Test Sample (2-inch O.D. split-spoon)

▲ Standard Penetration Test Resistance equals the number of blows a 140 lb. weight falling 30 in. is required to drive a standard split-spoon sampler 1 ft. Practical refusal is equal to 50 or more blows per 6 in. of sampler penetration.

● Water Content (%)

FIELD SHEAR STRENGTH TEST

Shear strength measurements on test pit side walls, blocks of soil or Shelby tube samples are typically made with Torvane or Field Vane shear devices.

WATER TABLE

▼ Water Table Location

(1/31/16) Date of Measurement

TYPICAL SOIL/ROCK SYMBOLS

Concrete
Organics
Clay
Silt
Sand
Gravel
Basalt
Sandstone
Siltstone

UNIFIED SOIL CLASSIFICATION SYMBOLS

G - Gravel
S - Sand
M - Silt
C - Clay
Pt - Peat
W - Well Graded
P - Poorly Graded
L - Low Plasticity
H - High Plasticity
O - Organic

Foundation Engineering, Inc.
Professional Geotechnical Services

SYMBOL KEY

EXPLORATION LOGS

Explanation of Common Terms Used in Soil Descriptions

Field Identification	Cohesive Soils			Granular Soils	
	SPT*	S_u** (tsf)	Term	SPT*	Term
Easily penetrated several inches by fist.	0 - 2	< 0.125	Very Soft	0 - 4	Very Loose
Easily penetrated several inches by thumb.	2 - 4	0.125 - 0.25	Soft	4 - 10	Loose
Can be penetrated several inches by thumb with moderate effort.	4 - 8	0.25 - 0.50	Medium Stiff	10 - 30	Medium Dense
Readily indented by thumb but penetrated only with great effort.	8 - 15	0.50 - 1.0	Stiff	30 - 50	Dense
Readily indented by thumbnail.	15 - 30	1.0 - 2.0	Very Stiff	> 50	Very Dense
Indented with difficulty by thumbnail.	> 30	> 2.0	Hard		

* SPT N-value in blows per foot (bpf)
** Undrained shear strength

Term	Soil Moisture Field Description
Dry	Absence of moisture. Dusty. Dry to the touch.
Damp	Soil has moisture. Cohesive soils are below plastic limit and usually moldable.
Moist	Grains appear darkened, but no visible water. Silt/clay will clump. Sand will bulk. Soils are often at or near plastic limit.
Wet	Visible water on larger grain surfaces. Sand and cohesionless silt exhibit dilatancy. Cohesive soil can be readily remolded. Soil leaves wetness on the hand when squeezed. Soil is wetter than the optimum moisture content and above the plastic limit.

Term	PI	Plasticity Field Test
Non-plastic	0 - 3	Cannot be rolled into a thread at any moisture.
Low Plasticity	3 - 15	Can be rolled into a thread with some difficulty.
Medium Plasticity	15 - 30	Easily rolled into thread.
High Plasticity	> 30	Easily rolled and re-rolled into thread.

Term	Soil Structure Criteria
Stratified	Alternating layers at least ¼ inch thick.
Laminated	Alternating layers less than ¼ inch thick.
Fissured	Contains shears and partings along planes of weakness.
Slickensided	Partings appear glossy or striated.
Blocky	Breaks into small lumps that resist further breakdown.
Lensed	Contains pockets of different soils.

Term	Soil Cementation Criteria
Weak	Breaks under light finger pressure.
Moderate	Breaks under hard finger pressure.
Strong	Will not break with finger pressure.

Comments	Depth, Feet	Sample #	Location	C, TSF	Elev. Depth	Symbol	Soil and Rock Description
	0	S-1-1		0.70			Medium stiff to stiff silty CLAY, some organics, trace sand (CL); brown, dry to damp, low to medium plasticity, fine sand, organics consist of roots up to 1/2-inch diameter, (topsoil).
	1				1.0		Stiff to very stiff CLAY, trace sand, scattered organics (CH); red-brown, dry to damp, high plasticity, fine sand, organics consist of black wood fragments and fine roots, (residual soil).
	2						
	3	S-1-2		0.90 >1.00			
	4						
	5			±1.00			
	6	S-1-3			6.0		Very stiff to hard CLAY, some sand (CH); red-brown mottled light brown, moist, high plasticity, fine to medium sand, blocky structure, relict rock texture, (residual soil).
No seepage or groundwater encountered to the limit of exploration.	7						
	8						
	9				9.0		BOTTOM OF EXPLORATION

Project No.: 2211038

Surface Elevation: N/A (Approx.)

Date of Test Pit: April 27, 2021

Test Pit Log: TP- 1

Sandy Housing Development

Sandy, Oregon

Comments	Depth, Feet	Sample #	Location	C, TSF	Elev. Depth	Symbol	Soil and Rock Description
	0	S-2-1		0.86			Medium stiff to stiff silty CLAY, some organics, trace sand (CL); brown, dry to damp, low to medium plasticity, fine sand, organics consist of roots up to ±1/2-inch diameter, (topsoil).
	1				1.0		Stiff to very stiff CLAY, trace sand, scattered organics (CH); red-brown, dry to damp, high plasticity, fine sand, organics consist of black wood fragments and fine roots, (residual soil).
	2			0.90			
	3	S-2-2		±1.00			
	4			>1.00			
	5						
	6						
	7						
	8	S-2-3			8.0		Very stiff to hard CLAY, some sand (CH); red-brown mottled light brown, moist, high plasticity, fine to medium sand, blocky structure, relict rock texture, (residual soil).
No seepage or groundwater encountered to the limit of exploration.	9						
	10				10.0		BOTTOM OF EXPLORATION

Project No.: 2211038

Surface Elevation: N/A (Approx.)

Date of Test Pit: April 27, 2021

Test Pit Log: TP- 2

Sandy Housing Development

Sandy, Oregon

Comments	Depth, Feet	Sample #	Location	C, TSF	Elev. Depth	Symbol	Soil and Rock Description
	1			0.56			Medium stiff to stiff silty CLAY, some organics, trace sand (CL); brown, dry to damp, low to medium plasticity, fine sand, organics consist of roots up to ±1/2-inch diameter, (topsoil).
					1.0		Stiff to very stiff CLAY, trace sand, scattered organics (CH); red-brown, dry to damp, high plasticity, fine sand, organics consist of black wood fragments and fine roots, (residual soil).
	2			±1.00			
	3			±1.00			
	4			>1.00			
	5						
	6						
	7						
	8	S-3-1			8.0		Very stiff to hard CLAY, some sand (CH); red-brown mottled light brown, moist, high plasticity, fine to medium sand, blocky structure, relict rock texture, (residual soil).
No seepage or groundwater encountered to the limit of exploration.	9						
	10				10.0		BOTTOM OF EXPLORATION

Project No.: 2211038

Surface Elevation: N/A (Approx.)

Date of Test Pit: April 27, 2021

Test Pit Log: TP- 3

Sandy Housing Development

Sandy, Oregon

Comments	Depth, Feet	Sample #	Location	C, TSF	Elev. Depth	Symbol	Soil and Rock Description
		S-4-1		0.50			Medium stiff to stiff silty CLAY, some organics, trace sand (CL); brown, dry to damp, low to medium plasticity, fine sand, organics consist of roots up to ±1/2-inch diameter, (topsoil).
	1				1.5		Stiff to very stiff CLAY, trace sand, scattered organics (CH); red-brown, dry to damp, high plasticity, fine sand, organics consist of black wood fragments and fine roots, blocky structure, (residual soil).
	2			0.84			
	3			0.92			
		S-4-2					
	4			0.90			
	5						
	6				6.0		Very stiff to hard CLAY, some sand (CH); red-brown mottled light brown, moist, high plasticity, fine to medium sand, blocky structure, relict rock texture, (residual soil).
	7	S-4-3					
No seepage or groundwater encountered to the limit of exploration.	8						
	9				9.0		BOTTOM OF EXPLORATION

Project No.: 2211038

Surface Elevation: N/A (Approx.)

Date of Test Pit: April 27, 2021

Test Pit Log: TP- 4

Sandy Housing Development

Sandy, Oregon

Comments	Depth, Feet	Sample #	Location	C, TSF	Elev. Depth	Symbol	Soil and Rock Description
		S-5-1		0.40			Medium stiff to stiff silty CLAY, some organics, trace sand (CL); brown, dry to damp, low to medium plasticity, fine sand, organics consist of roots up to ±1/2-inch diameter, (topsoil).
	1				0.6		Stiff to very stiff CLAY, trace sand, scattered organics (CH); red-brown, dry to damp, high plasticity, fine sand, organics consist of black wood fragments and fine roots, blocky structure, (residual soil).
	2	S-5-2		±1.00			
	3			±1.00			
	4			>1.00			
	5						
	6						
	7	S-5-3					
					7.5		Very stiff to hard CLAY, some sand (CH); red-brown mottled light brown, moist, high plasticity, fine to medium sand, blocky structure, relict rock texture, (residual soil).
No seepage or groundwater encountered to the limit of exploration.	8						
	9				9.0		BOTTOM OF EXPLORATION

Project No.: 2211038

Surface Elevation: N/A (Approx.)

Date of Test Pit: April 27, 2021

Test Pit Log: TP- 5

Sandy Housing Development

Sandy, Oregon

Comments	Depth, Feet	Sample #	Location	C, TSF	Elev. Depth	Symbol	Soil and Rock Description
		S-6-1		0.50			Medium stiff to stiff silty CLAY, trace sand, scattered organics, (CL); brown, dry to damp, low to medium plasticity, fine sand, organics consist of roots up to ±1/2-inch diameter, (topsoil).
	1				1.0		Stiff to very stiff CLAY, trace sand, scattered organics (CH); red-brown, dry to damp, high plasticity, fine sand, organics consist of black wood fragments and fine roots, lenses of brown clay, blocky structure, (residual soil).
	2	S-6-2		0.84			
	3			0.70			
	4			±1.00			
	5						
	6	S-6-3					
	7						
No seepage or groundwater encountered to the limit of exploration.	8						
					8.5		BOTTOM OF EXPLORATION
	9						

Project No.: 2211038

Surface Elevation: N/A (Approx.)

Date of Test Pit: April 27, 2021

Test Pit Log: TP- 6

Sandy Housing Development

Sandy, Oregon

Comments	Depth, Feet	Sample #	Location	C, TSF	Elev. Depth	Symbol	Soil and Rock Description
		S-7-1		0.46			Medium stiff to stiff silty CLAY, some organics, trace sand (CL); brown, dry to damp, low to medium plasticity, fine sand, organics consist of roots up to ±1/2-inch diameter, (topsoil).
	1				1.0		Stiff to very stiff CLAY, trace sand, scattered organics (CH); red-brown, dry to damp, high plasticity, fine sand, organics consist of black wood fragments and fine roots, lenses of brown clay, blocky structure (residual soil).
	2			0.88			
	3	S-7-2		0.94			
	4						
	5						
	6						
No seepage or groundwater encountered to the limit of exploration.	7	S-7-3					
	8				8.0		BOTTOM OF EXPLORATION

Project No.: 2211038

Surface Elevation: N/A (Approx.)

Date of Test Pit: April 27, 2021

Test Pit Log: TP- 7

Sandy Housing Development

Sandy, Oregon

Comments	Depth, Feet	Sample #	Location	C, TSF	Elev. Depth	Symbol	Soil and Rock Description
		S-8-1		0.38			Medium stiff to stiff silty CLAY, trace sand, scattered organics (CL); brown, dry to damp, low to medium plasticity, fine sand, organics consist of fine roots, (topsoil).
	1				1.3		Stiff to very stiff CLAY, trace sand, scattered organics (CH); red-brown, dry to damp, high plasticity, fine sand, organics consist of black wood fragments and fine roots, lenses of brown clay, blocky structure, (residual soil).
	2	S-8-2		±1.00			
	3			0.88			
	4						
	5						
	6						
	7	S-8-3					
No seepage or groundwater encountered to the limit of exploration.	8						
	9				9.0		BOTTOM OF EXPLORATION

Project No.: 2211038

Surface Elevation: N/A (Approx.)

Date of Test Pit: April 27, 2021

Test Pit Log: TP- 8

Sandy Housing Development

Sandy, Oregon

Comments	Depth, Feet	Sample #	Location	C, TSF	Elev. Depth	Symbol	Soil and Rock Description
	1	S-9-1		0.40			Medium stiff to stiff silty CLAY, trace sand, scattered organics (CL); brown, damp, low to medium plasticity, fine sand, organics consist of fine roots, (topsoil).
	2				1.5		Stiff to very stiff CLAY, trace sand, scattered organics (CH); red-brown, dry to damp, high plasticity, fine sand, organics consist of black wood fragments and fine roots, lenses of brown clay, blocky structure, (residual soil).
	3	S-9-2		0.72			
	4			±1.00			
	5						
	6	S-9-3					
	7						
No seepage or groundwater encountered to the limit of exploration.	8	S-9-4					
	9				9.0		BOTTOM OF EXPLORATION

Project No.: 2211038

Surface Elevation: N/A (Approx.)

Date of Test Pit: April 27, 2021

Test Pit Log: TP- 9

Sandy Housing Development

Sandy, Oregon

Comments	Depth, Feet	Sample #	Location	C, TSF	Elev. Depth	Symbol	Soil and Rock Description
	1	S-10-1		0.42			Medium stiff to stiff silty CLAY, trace sand, scattered organics (CL); brown, dry to damp, low to medium plasticity, fine sand, organics consist of fine roots, (topsoil).
	2			0.48	1.0		Stiff to very stiff CLAY, trace sand, scattered organics (CH); red-brown, dry to damp, high plasticity, fine sand, organics consist of black wood fragments and fine roots, lenses of brown clay, blocky structure, (residual soil).
	3	S-10-2		0.70			
	4			±1.00			
	5	S-10-3					
No seepage or groundwater encountered to the limit of exploration.	6						
	7				6.5		BOTTOM OF EXPLORATION

Project No.: 2211038

Surface Elevation: N/A (Approx.)

Date of Test Pit: April 27, 2021

Test Pit Log: TP-10

Sandy Housing Development

Sandy, Oregon

Comments	Depth, Feet	Sample #	Location	C, TSF	Elev. Depth	Symbol	Soil and Rock Description
	1	S-11-1		0.40			Medium stiff to stiff silty CLAY, trace sand, scattered organics (CL); brown, dry to damp, low to medium plasticity, fine sand, organics consist of fine roots, (topsoil).
					1.0		Stiff to very stiff CLAY, trace sand, scattered organics (CH); red-brown, dry to damp, high plasticity, fine sand, organics consist of black wood fragments and fine roots, lenses of brown clay, blocky structure, (residual soil).
	2	S-11-2		±1.00			
	3			0.74			
	4			>1.00			
	5						
	6	S-11-3					
	7						
No seepage or groundwater encountered to the limit of exploration.	8	S-11-4					
					8.5		BOTTOM OF EXPLORATION
	9						

Project No.: 2211038

Surface Elevation: N/A (Approx.)

Date of Test Pit: April 27, 2021

Test Pit Log: TP-11

Sandy Housing Development

Sandy, Oregon

Comments	Depth, Feet	Sample #	Location	C, TSF	Elev. Depth	Symbol	Soil and Rock Description
	1	S-12-1		0.38			Medium stiff to stiff silty CLAY, trace sand, scattered organics (CL); brown, dry to damp, low to medium plasticity, fine sand, organics consist of fine roots, (topsoil).
					1.3		Stiff to very stiff CLAY, trace sand, scattered organics (CH); red-brown, dry to damp, high plasticity, fine sand, organics consist of black wood fragments and fine roots, lenses of brown clay, blocky structure, (residual soil).
	2			±1.00			
	3	S-12-2		>1.00			
	4			>1.00			
	5						
	6						
	7						
	8						
No seepage or groundwater encountered to the limit of exploration.	9	S-12-3					
					9.5		BOTTOM OF EXPLORATION
	10						

Project No.: 2211038

Surface Elevation: N/A (Approx.)

Date of Test Pit: April 27, 2021

Test Pit Log: TP-12

Sandy Housing Development

Sandy, Oregon

Appendix B – Soil Survey Report

Soil Map—Clackamas County Area, Oregon
(Cascade Creek Soils Report)

Map Scale: 1:1,650 if printed on A landscape (11" x 8.5") sheet.

N

Meters
0 20 40 80 120

Feet
0 50 100 200 300

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 10N WGS84

MAP LEGEND

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

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

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

Water Features
- Streams and Canals

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

Background
- Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:20,000.

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

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

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

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

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

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

Soil Survey Area: Clackamas County Area, Oregon
Survey Area Data: Version 18, Oct 27, 2021

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

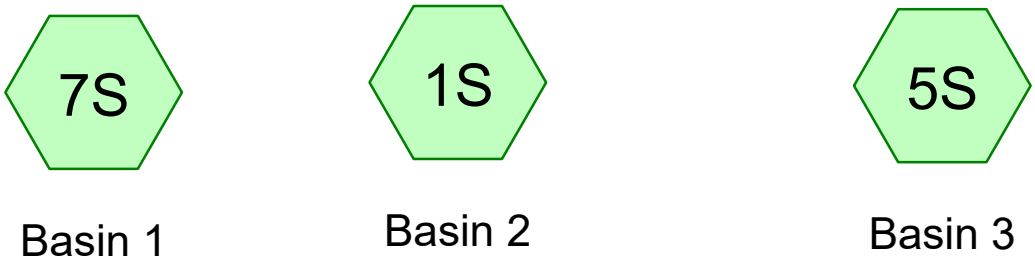
Date(s) aerial images were photographed: Jun 22, 2020—Jun 26, 2020

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

Map Unit Legend

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
15B	Cazadero silty clay loam, 0 to 7 percent slopes	9.1	100.0%
Totals for Area of Interest		**9.1**	**100.0%**

Appendix C – Basin Analysis, Data, and Detention Sizing



Subcat Reach Pond Link

Routing Diagram for Cascade Creek Predeveloped
Prepared by BCRA, Inc, Printed 12/21/2022

Rainfall Events Listing

Event#	Event Name	Storm Type	Curve	Mode	Duration (hours)	B/B	Depth (inches)	AMC
1	2-year	Type IA 24-hr		Default	24.00	1	3.50	2
2	5-year	Type IA 24-hr		Default	24.00	1	4.50	2
3	10-year	Type IA 24-hr		Default	24.00	1	4.80	2
4	25-year	Type IA 24-hr		Default	24.00	1	5.50	2

Area Listing (all nodes)

Area (acres)	CN	Description (subcatchment-numbers)
0.658	98	Paved roads w/curbs & sewers, HSG B (1S, 7S)
0.594	72	Pre-Developed Pervious (5S)
8.123	72	Predeveloped Pervious (1S, 7S)
9.375	**74**	**TOTAL AREA**

Soil Listing (all nodes)

Area (acres)	Soil Group	Subcatchment Numbers
0.000	HSG A	
0.658	HSG B	1S, 7S
0.000	HSG C	
0.000	HSG D	
8.717	Other	1S, 5S, 7S
9.375		**TOTAL AREA**

Ground Covers (all nodes)

HSG-A (acres)	HSG-B (acres)	HSG-C (acres)	HSG-D (acres)	Other (acres)	Total (acres)	Ground Cover	Subcatchment Numbers
0.000	0.658	0.000	0.000	0.000	0.658	Paved roads w/curbs & sewers	1S, 7S
0.000	0.000	0.000	0.000	0.594	0.594	Pre-Developed Pervious	5S
0.000	0.000	0.000	0.000	8.123	8.123	Predeveloped Pervious	1S, 7S
0.000	**0.658**	**0.000**	**0.000**	**8.717**	**9.375**	**TOTAL AREA**	

Time span=5.00-20.00 hrs, dt=0.05 hrs, 301 points
Runoff by SBUH method, Split Pervious/Imperv.
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment1S: Basin 2 Runoff Area=8.299 ac 3.72% Impervious Runoff Depth>0.98"
Flow Length=685' Slope=0.0511 '/' Tc=10.1 min CN=72/98 Runoff=1.75 cfs 0.678 af

Subcatchment5S: Basin 3 Runoff Area=0.594 ac 0.00% Impervious Runoff Depth>0.92"
Flow Length=217' Slope=0.0370 '/' Tc=12.1 min CN=72/0 Runoff=0.11 cfs 0.045 af

Subcatchment7S: Basin 1 Runoff Area=0.482 ac 72.41% Impervious Runoff Depth>2.15"
Flow Length=565' Slope=0.0280 '/' Tc=2.8 min CN=72/98 Runoff=0.32 cfs 0.086 af

Total Runoff Area = 9.375 ac Runoff Volume = 0.809 af Average Runoff Depth = 1.04"
92.98% Pervious = 8.717 ac 7.02% Impervious = 0.658 ac

Summary for Subcatchment 1S: Basin 2

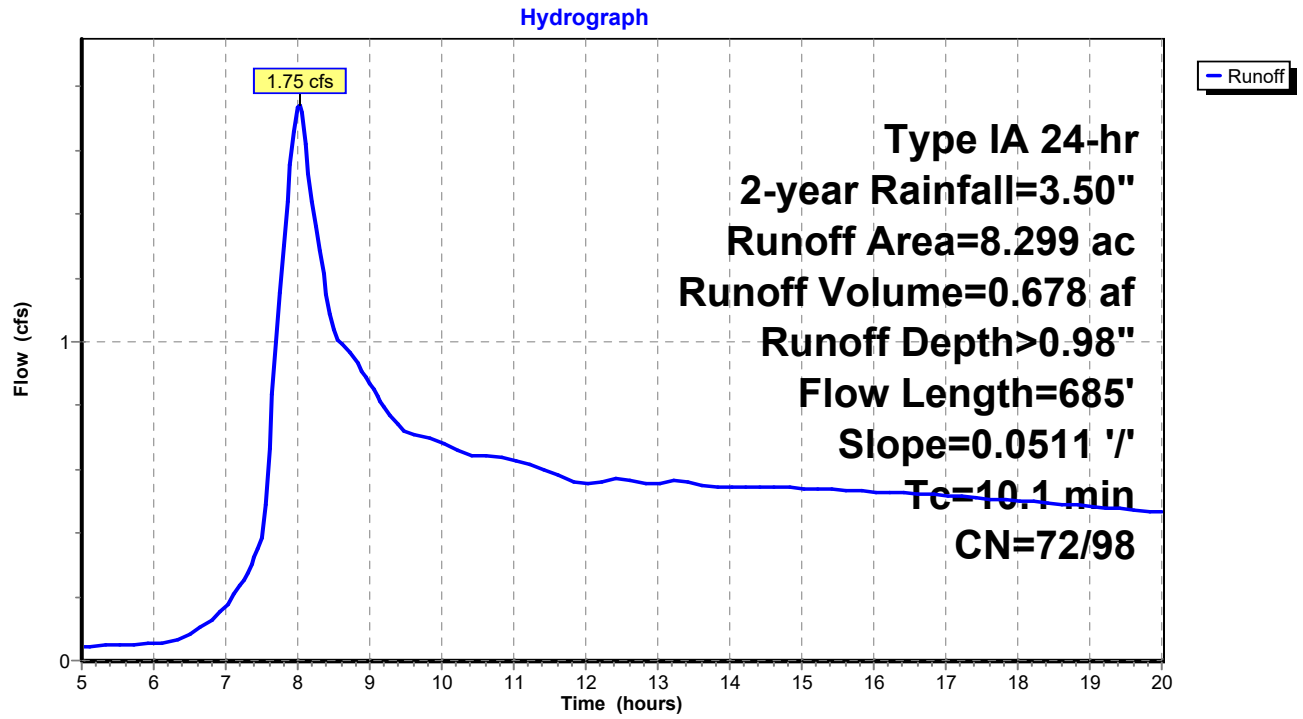
Runoff = 1.75 cfs @ 8.02 hrs, Volume= 0.678 af, Depth> 0.98"
Routed to nonexistent node 6P

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type IA 24-hr 2-year Rainfall=3.50"

	Area (ac)	CN	Description
	0.309	98	Paved roads w/curbs & sewers, HSG B
*	7.990	72	Predeveloped Pervious
	8.299	73	Weighted Average
	7.990	72	96.28% Pervious Area
	0.309	98	3.72% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.1	685	0.0511	1.13		**Shallow Concentrated Flow, Northeast to "pond"** Woodland Kv= 5.0 fps

Subcatchment 1S: Basin 2



Summary for Subcatchment 5S: Basin 3

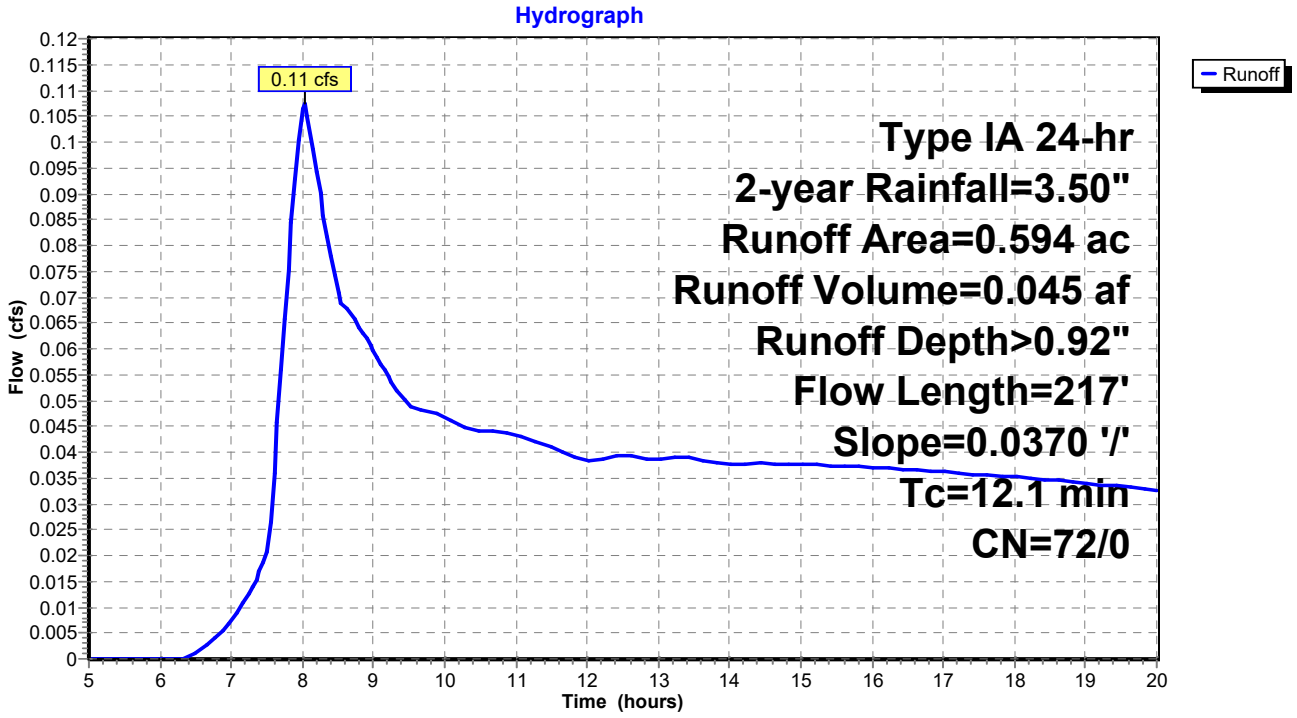
Runoff = 0.11 cfs @ 8.03 hrs, Volume= 0.045 af, Depth> 0.92"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type IA 24-hr 2-year Rainfall=3.50"

	Area (ac)	CN	Description
*	0.594	72	Pre-Developed Pervious
	0.594	72	100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
12.1	217	0.0370	0.30		**Sheet Flow, South high point to East exit point** Range n= 0.130 P2= 3.50"

Subcatchment 5S: Basin 3



Summary for Subcatchment 7S: Basin 1

[49] Hint: Tc<2dt may require smaller dt

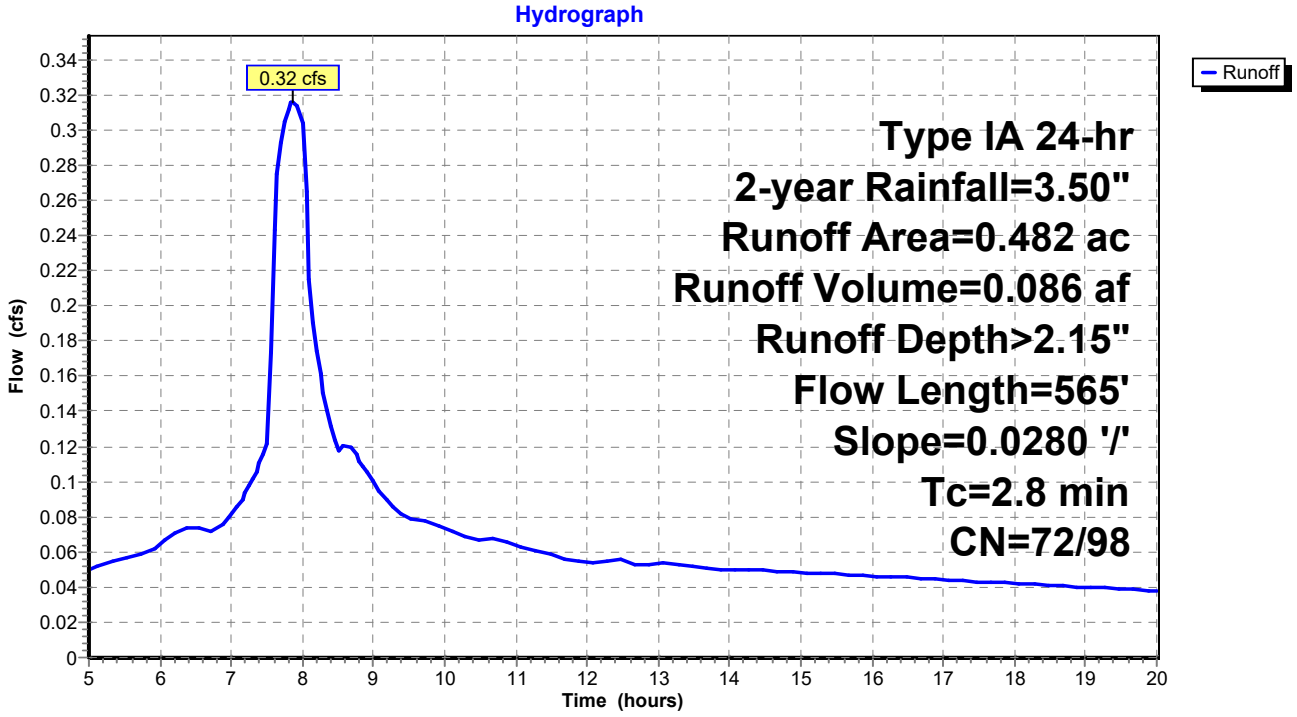
Runoff = 0.32 cfs @ 7.87 hrs, Volume= 0.086 af, Depth> 2.15"
Routed to nonexistent node 6P

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type IA 24-hr 2-year Rainfall=3.50"

	Area (ac)	CN	Description
	0.349	98	Paved roads w/curbs & sewers, HSG B
*	0.133	72	Predeveloped Pervious
	0.482	91	Weighted Average
	0.133	72	27.59% Pervious Area
	0.349	98	72.41% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
2.8	565	0.0280	3.40		**Shallow Concentrated Flow, Roadway** Paved Kv= 20.3 fps

Subcatchment 7S: Basin 1



Time span=5.00-20.00 hrs, dt=0.05 hrs, 301 points
Runoff by SBUH method, Split Pervious/Imperv.
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment1S: Basin 2 Runoff Area=8.299 ac 3.72% Impervious Runoff Depth>1.59"
Flow Length=685' Slope=0.0511 '/' Tc=10.1 min CN=72/98 Runoff=3.18 cfs 1.101 af

Subcatchment5S: Basin 3 Runoff Area=0.594 ac 0.00% Impervious Runoff Depth>1.52"
Flow Length=217' Slope=0.0370 '/' Tc=12.1 min CN=72/0 Runoff=0.21 cfs 0.075 af

Subcatchment7S: Basin 1 Runoff Area=0.482 ac 72.41% Impervious Runoff Depth>2.87"
Flow Length=565' Slope=0.0280 '/' Tc=2.8 min CN=72/98 Runoff=0.43 cfs 0.115 af

Total Runoff Area = 9.375 ac Runoff Volume = 1.291 af Average Runoff Depth = 1.65"
92.98% Pervious = 8.717 ac 7.02% Impervious = 0.658 ac

Summary for Subcatchment 1S: Basin 2

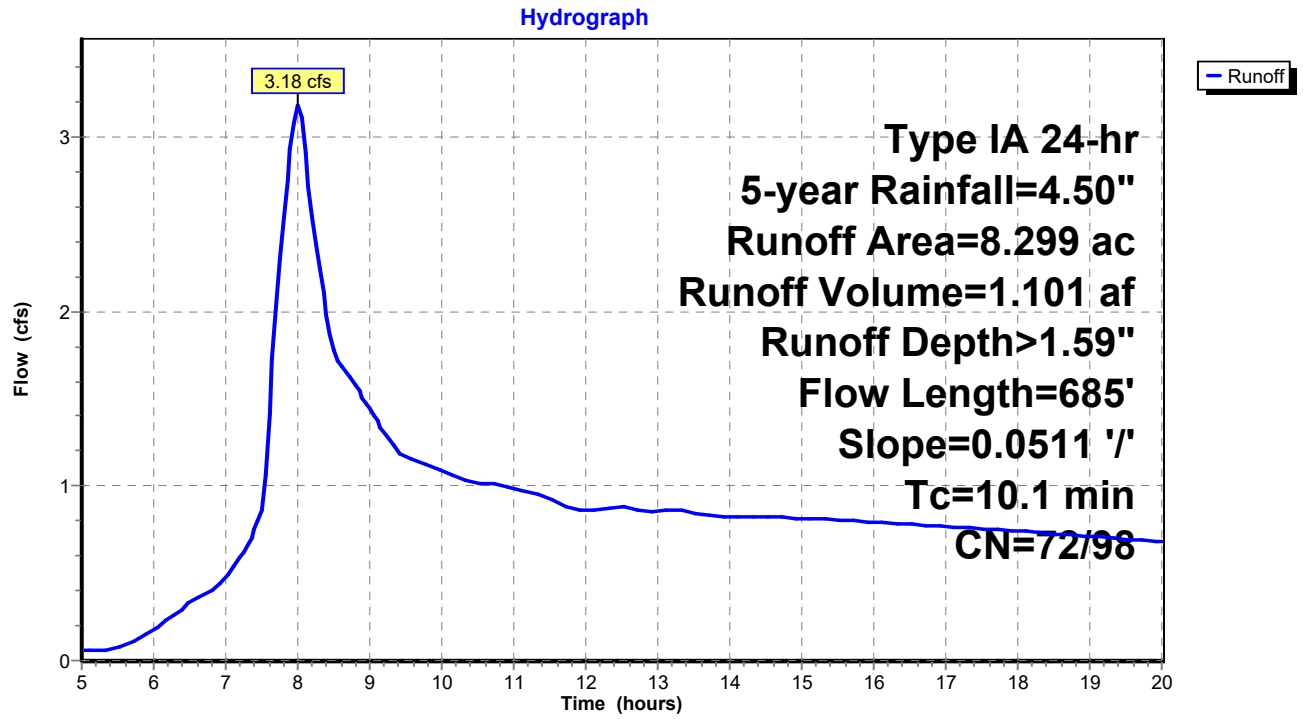
Runoff = 3.18 cfs @ 8.01 hrs, Volume= 1.101 af, Depth> 1.59"
Routed to nonexistent node 6P

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type IA 24-hr 5-year Rainfall=4.50"

	Area (ac)	CN	Description
	0.309	98	Paved roads w/curbs & sewers, HSG B
*	7.990	72	Predeveloped Pervious
	8.299	73	Weighted Average
	7.990	72	96.28% Pervious Area
	0.309	98	3.72% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.1	685	0.0511	1.13		**Shallow Concentrated Flow, Northeast to "pond"** Woodland Kv= 5.0 fps

Subcatchment 1S: Basin 2



Summary for Subcatchment 5S: Basin 3

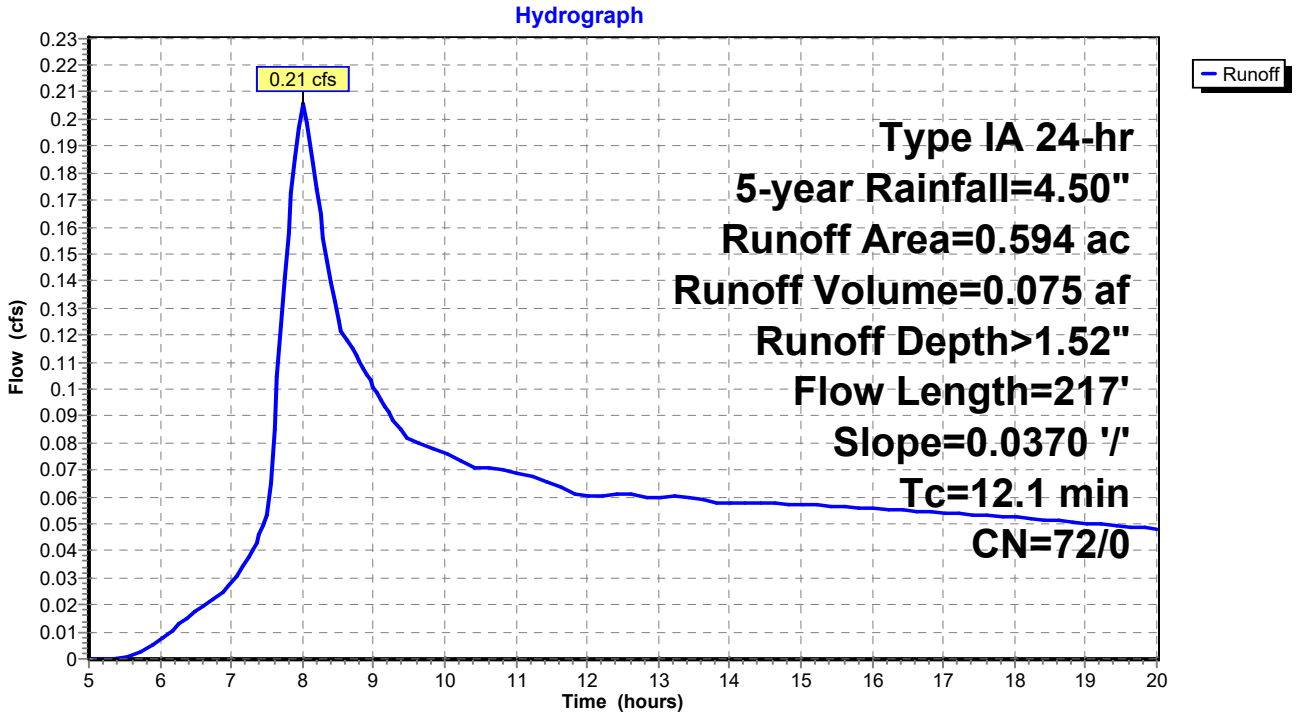
Runoff = 0.21 cfs @ 8.02 hrs, Volume= 0.075 af, Depth> 1.52"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type IA 24-hr 5-year Rainfall=4.50"

	Area (ac)	CN	Description
*	0.594	72	Pre-Developed Pervious
	0.594	72	100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
12.1	217	0.0370	0.30		**Sheet Flow, South high point to East exit point** Range n= 0.130 P2= 3.50"

Subcatchment 5S: Basin 3



Summary for Subcatchment 7S: Basin 1

[49] Hint: Tc<2dt may require smaller dt

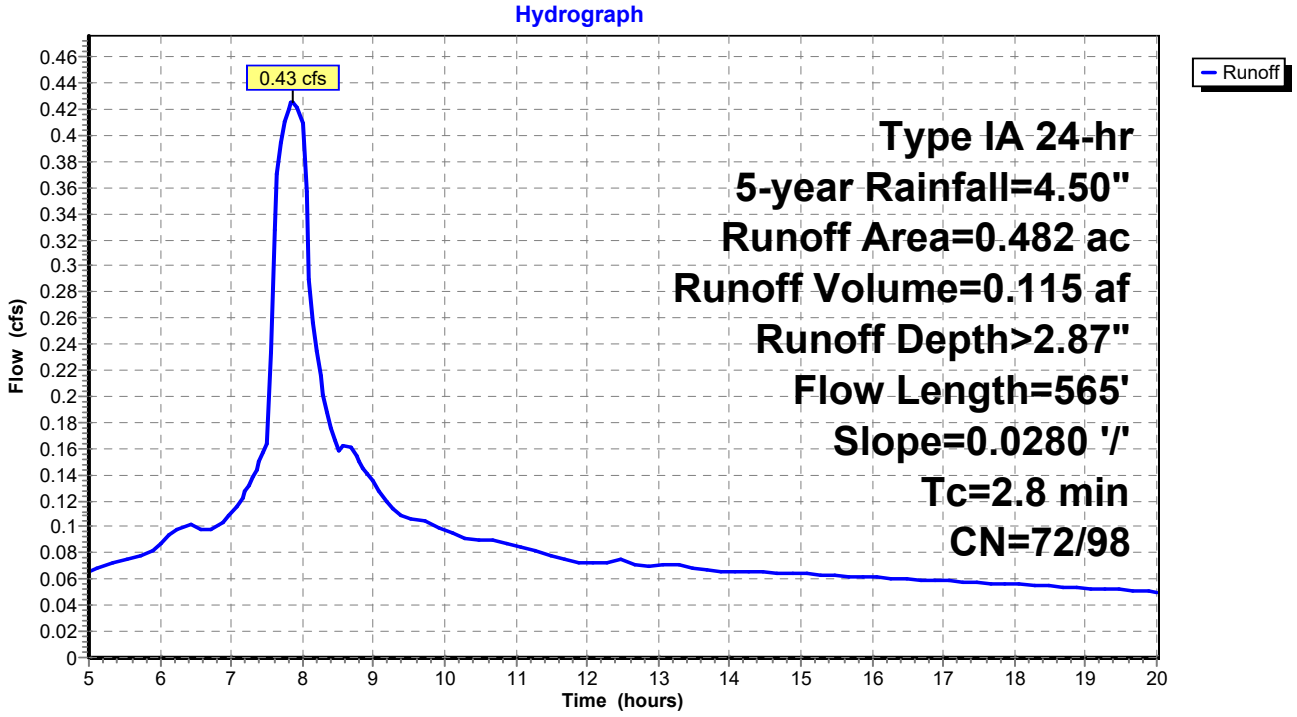
Runoff = 0.43 cfs @ 7.87 hrs, Volume= 0.115 af, Depth> 2.87"
Routed to nonexistent node 6P

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type IA 24-hr 5-year Rainfall=4.50"

	Area (ac)	CN	Description
	0.349	98	Paved roads w/curbs & sewers, HSG B
*	0.133	72	Predeveloped Pervious
	0.482	91	Weighted Average
	0.133	72	27.59% Pervious Area
	0.349	98	72.41% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
2.8	565	0.0280	3.40		**Shallow Concentrated Flow, Roadway** Paved Kv= 20.3 fps

Subcatchment 7S: Basin 1



Time span=5.00-20.00 hrs, dt=0.05 hrs, 301 points
Runoff by SBUH method, Split Pervious/Imperv.
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment1S: Basin 2 Runoff Area=8.299 ac 3.72% Impervious Runoff Depth>1.79"
Flow Length=685' Slope=0.0511 '/' Tc=10.1 min CN=72/98 Runoff=3.65 cfs 1.237 af

Subcatchment5S: Basin 3 Runoff Area=0.594 ac 0.00% Impervious Runoff Depth>1.71"
Flow Length=217' Slope=0.0370 '/' Tc=12.1 min CN=72/0 Runoff=0.24 cfs 0.085 af

Subcatchment7S: Basin 1 Runoff Area=0.482 ac 72.41% Impervious Runoff Depth>3.09"
Flow Length=565' Slope=0.0280 '/' Tc=2.8 min CN=72/98 Runoff=0.46 cfs 0.124 af

Total Runoff Area = 9.375 ac Runoff Volume = 1.446 af Average Runoff Depth = 1.85"
92.98% Pervious = 8.717 ac 7.02% Impervious = 0.658 ac

Summary for Subcatchment 1S: Basin 2

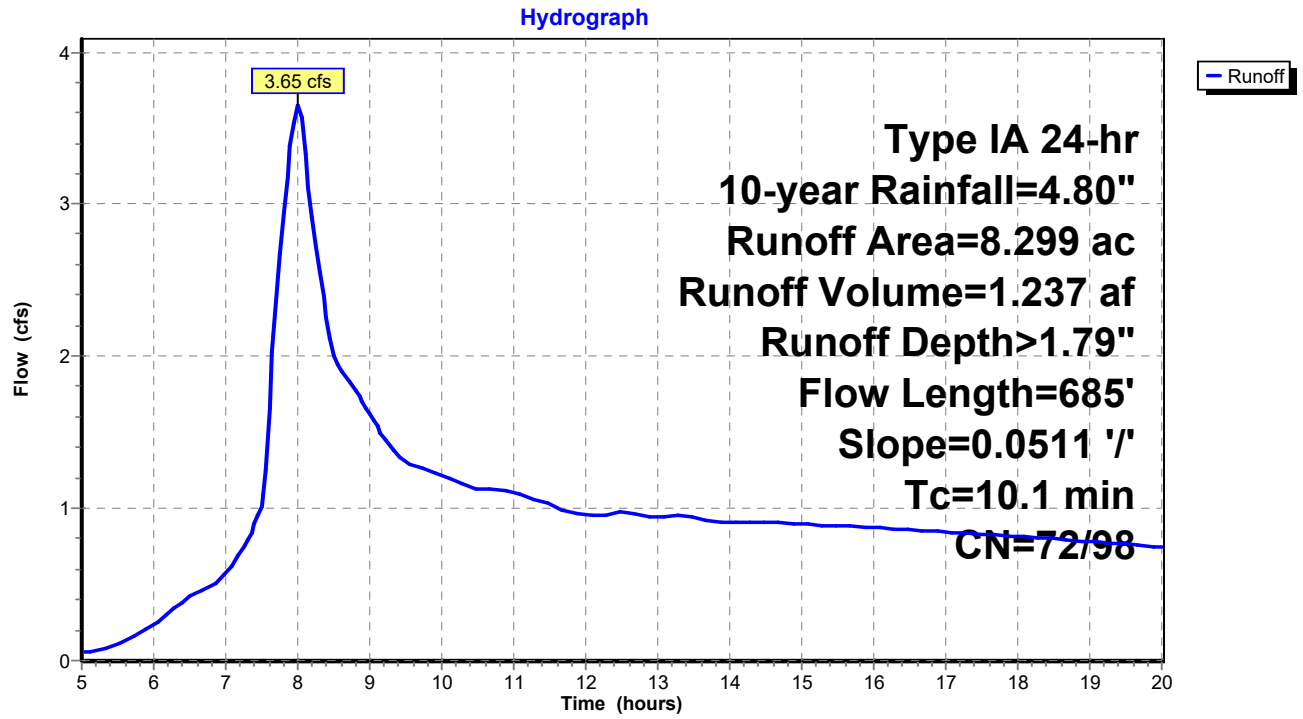
Runoff = 3.65 cfs @ 8.00 hrs, Volume= 1.237 af, Depth> 1.79"
Routed to nonexistent node 6P

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type IA 24-hr 10-year Rainfall=4.80"

	Area (ac)	CN	Description
	0.309	98	Paved roads w/curbs & sewers, HSG B
*	7.990	72	Predeveloped Pervious
	8.299	73	Weighted Average
	7.990	72	96.28% Pervious Area
	0.309	98	3.72% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.1	685	0.0511	1.13		**Shallow Concentrated Flow, Northeast to "pond"** Woodland Kv= 5.0 fps

Subcatchment 1S: Basin 2



Summary for Subcatchment 5S: Basin 3

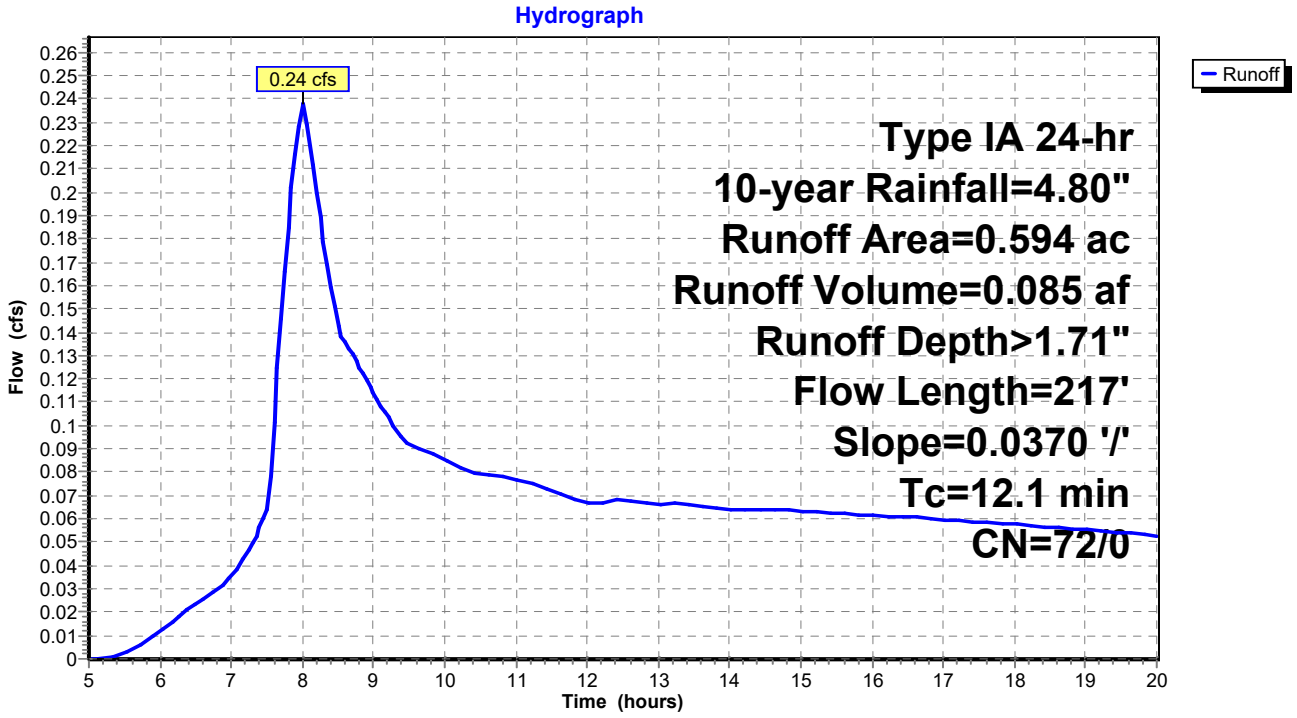
Runoff = 0.24 cfs @ 8.02 hrs, Volume= 0.085 af, Depth> 1.71"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type IA 24-hr 10-year Rainfall=4.80"

	Area (ac)	CN	Description
*	0.594	72	Pre-Developed Pervious
	0.594	72	100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
12.1	217	0.0370	0.30		**Sheet Flow, South high point to East exit point** Range n= 0.130 P2= 3.50"

Subcatchment 5S: Basin 3



Summary for Subcatchment 7S: Basin 1

[49] Hint: Tc<2dt may require smaller dt

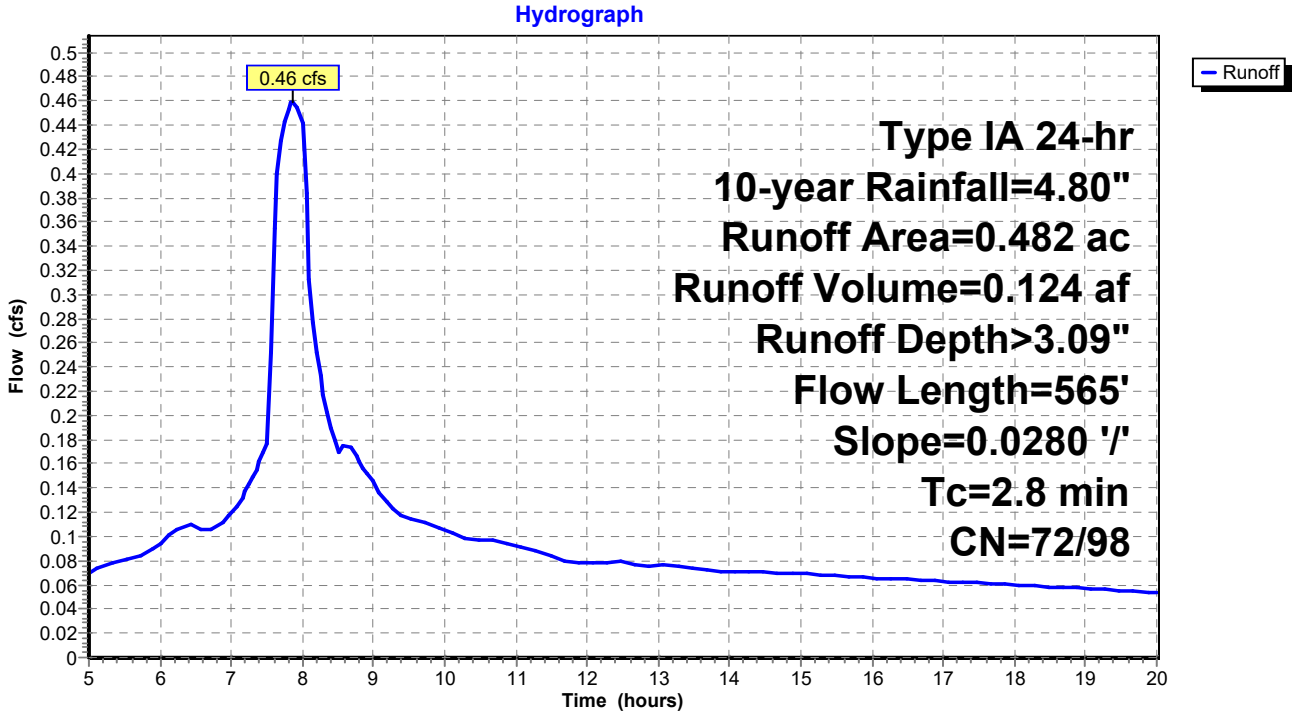
Runoff = 0.46 cfs @ 7.87 hrs, Volume= 0.124 af, Depth> 3.09"
Routed to nonexistent node 6P

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type IA 24-hr 10-year Rainfall=4.80"

	Area (ac)	CN	Description
	0.349	98	Paved roads w/curbs & sewers, HSG B
*	0.133	72	Predeveloped Pervious
	0.482	91	Weighted Average
	0.133	72	27.59% Pervious Area
	0.349	98	72.41% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
2.8	565	0.0280	3.40		**Shallow Concentrated Flow, Roadway** Paved Kv= 20.3 fps

Subcatchment 7S: Basin 1



Time span=5.00-20.00 hrs, dt=0.05 hrs, 301 points
Runoff by SBUH method, Split Pervious/Imperv.
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment1S: Basin 2 Runoff Area=8.299 ac 3.72% Impervious Runoff Depth>2.27"
Flow Length=685' Slope=0.0511 '/' Tc=10.1 min CN=72/98 Runoff=4.79 cfs 1.568 af

Subcatchment5S: Basin 3 Runoff Area=0.594 ac 0.00% Impervious Runoff Depth>2.19"
Flow Length=217' Slope=0.0370 '/' Tc=12.1 min CN=72/0 Runoff=0.32 cfs 0.108 af

Subcatchment7S: Basin 1 Runoff Area=0.482 ac 72.41% Impervious Runoff Depth>3.61"
Flow Length=565' Slope=0.0280 '/' Tc=2.8 min CN=72/98 Runoff=0.54 cfs 0.145 af

Total Runoff Area = 9.375 ac Runoff Volume = 1.822 af Average Runoff Depth = 2.33"
92.98% Pervious = 8.717 ac 7.02% Impervious = 0.658 ac

Summary for Subcatchment 1S: Basin 2

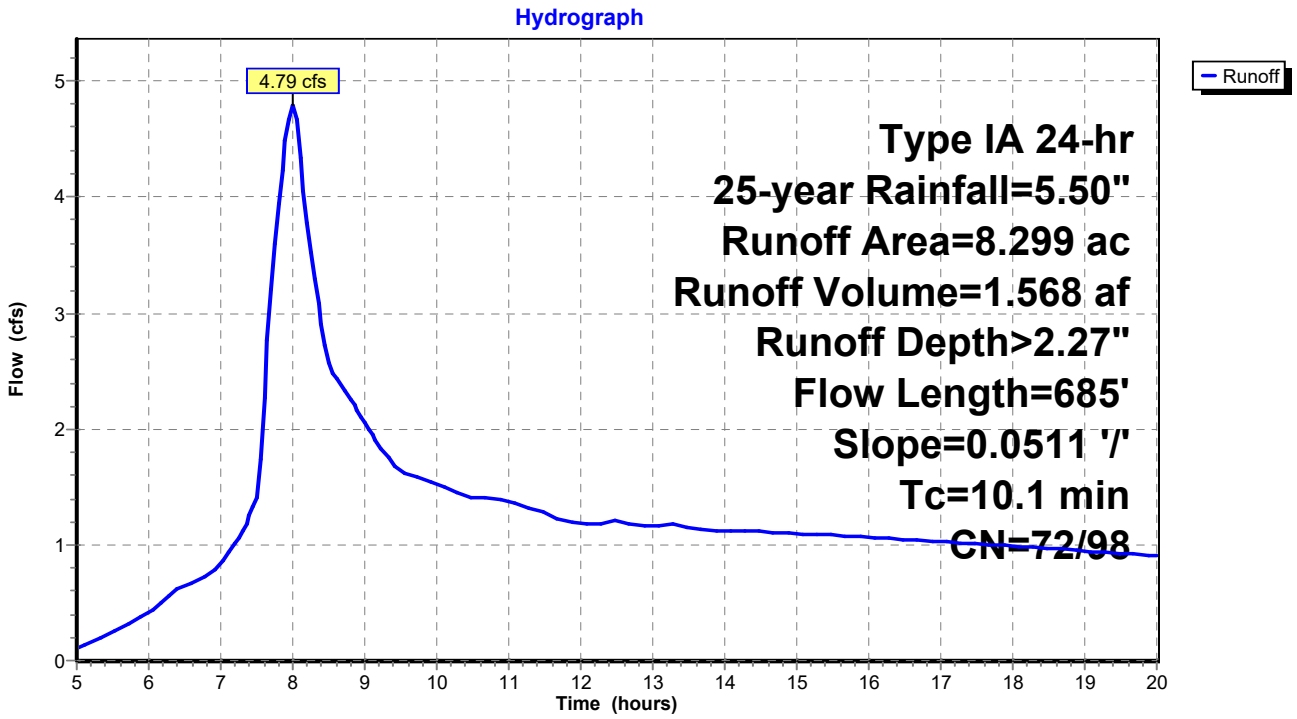
Runoff = 4.79 cfs @ 8.00 hrs, Volume= 1.568 af, Depth> 2.27"
Routed to nonexistent node 6P

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type IA 24-hr 25-year Rainfall=5.50"

	Area (ac)	CN	Description
	0.309	98	Paved roads w/curbs & sewers, HSG B
*	7.990	72	Predeveloped Pervious
	8.299	73	Weighted Average
	7.990	72	96.28% Pervious Area
	0.309	98	3.72% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.1	685	0.0511	1.13		**Shallow Concentrated Flow, Northeast to "pond"** Woodland Kv= 5.0 fps

Subcatchment 1S: Basin 2



Summary for Subcatchment 5S: Basin 3

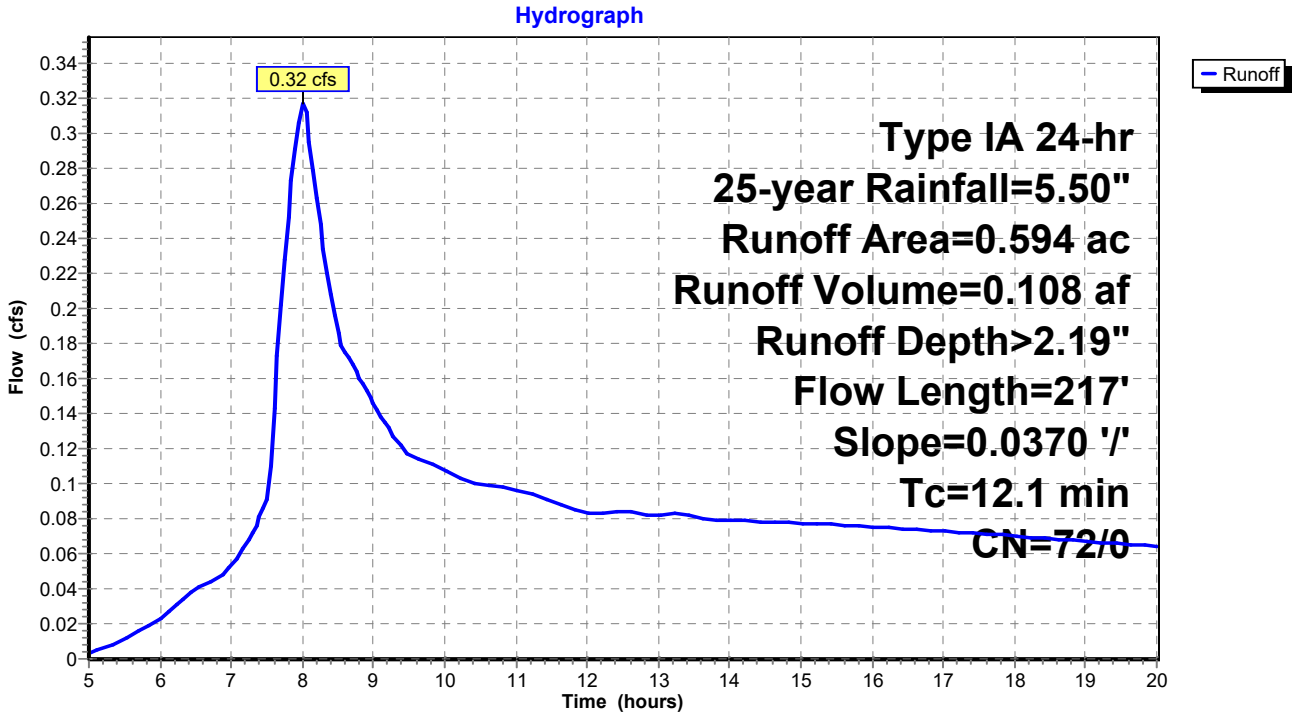
Runoff = 0.32 cfs @ 8.01 hrs, Volume= 0.108 af, Depth> 2.19"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type IA 24-hr 25-year Rainfall=5.50"

	Area (ac)	CN	Description
*	0.594	72	Pre-Developed Pervious
	0.594	72	100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
12.1	217	0.0370	0.30		**Sheet Flow, South high point to East exit point** Range n= 0.130 P2= 3.50"

Subcatchment 5S: Basin 3



Summary for Subcatchment 7S: Basin 1

[49] Hint: Tc<2dt may require smaller dt

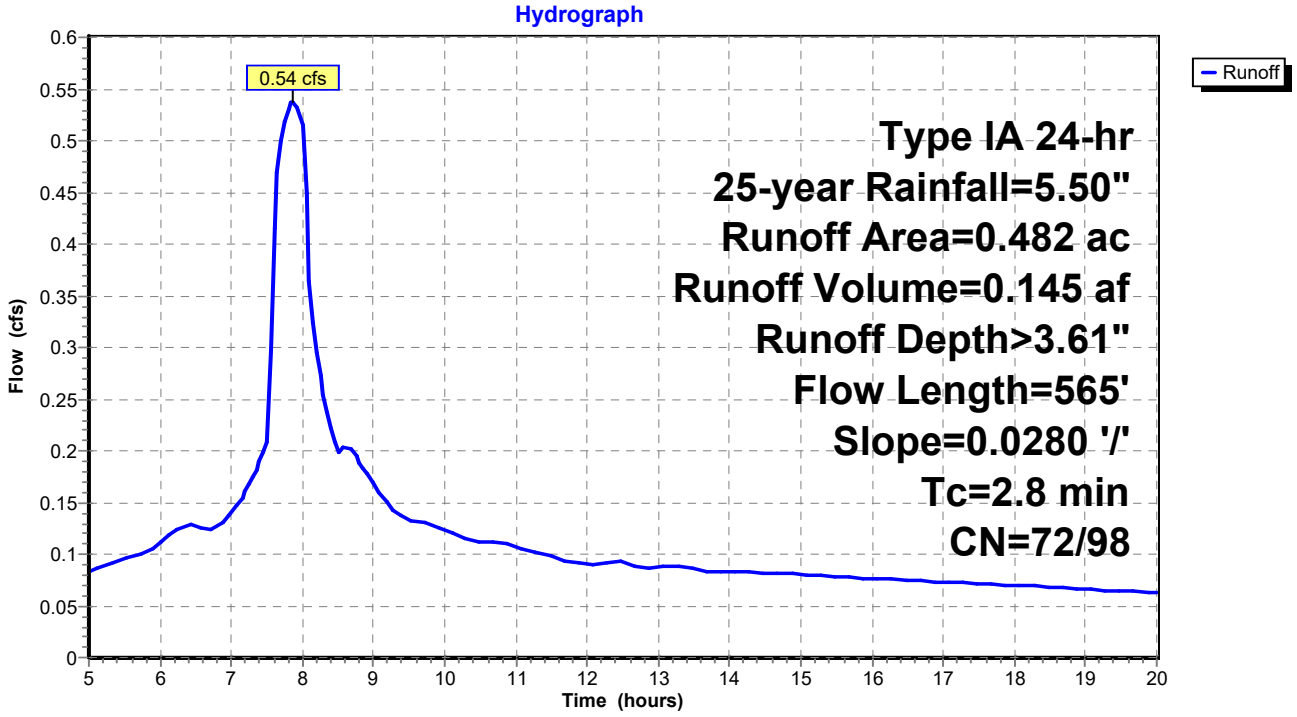
Runoff = 0.54 cfs @ 7.87 hrs, Volume= 0.145 af, Depth> 3.61"
Routed to nonexistent node 6P

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type IA 24-hr 25-year Rainfall=5.50"

	Area (ac)	CN	Description
	0.349	98	Paved roads w/curbs & sewers, HSG B
*	0.133	72	Predeveloped Pervious
	0.482	91	Weighted Average
	0.133	72	27.59% Pervious Area
	0.349	98	72.41% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
2.8	565	0.0280	3.40		**Shallow Concentrated Flow, Roadway** Paved Kv= 20.3 fps

Subcatchment 7S: Basin 1



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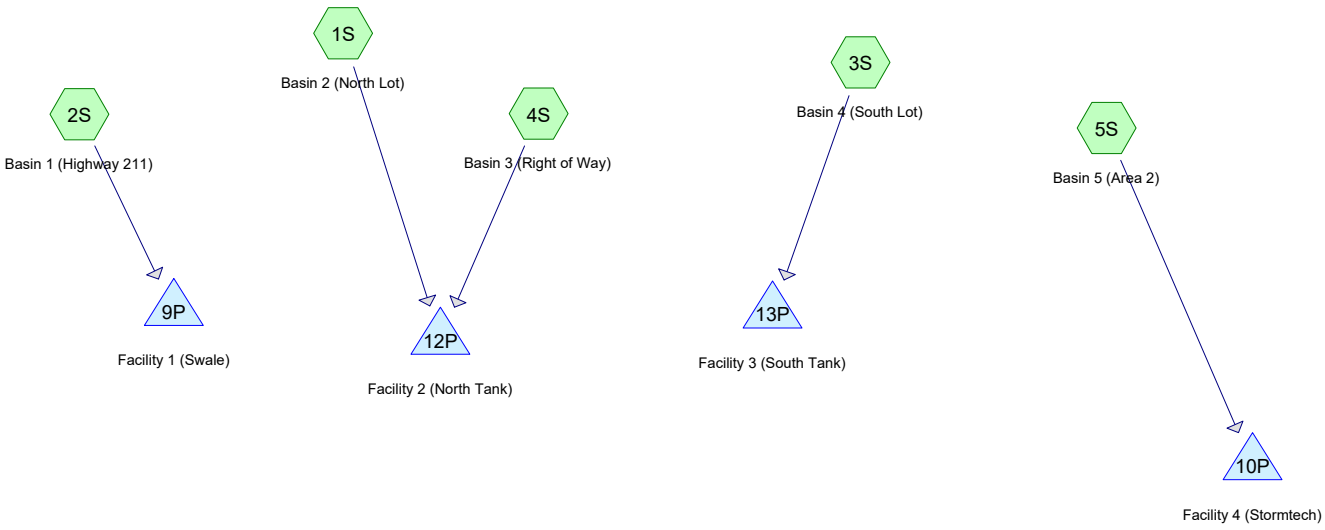


Subcat Reach Pond Link

Routing Diagram for Cascade Creek
Prepared by BCRA, Inc, Printed 12/21/2022

Rainfall Events Listing

Event#	Event Name	Storm Type	Curve	Mode	Duration (hours)	B/B	Depth (inches)	AMC
1	2-year	Type IA 24-hr		Default	24.00	1	3.50	2
2	5-year	Type IA 24-hr		Default	24.00	1	4.50	2
3	10-year	Type IA 24-hr		Default	24.00	1	4.80	2
4	25-year	Type IA 24-hr		Default	24.00	1	5.50	2

Area Listing (all nodes)

Area (acres)	CN	Description (subcatchment-numbers)
0.085	56	>75% Grass cover, Good, HSG B (2S)
4.343	56	Lawn (1S, 3S, 4S, 5S)
1.288	98	Paved parking, HSG B (1S, 5S)
2.383	98	Paved roads w/curbs & sewers, HSG B (3S, 4S)
0.473	98	Paved roads w/open ditches, 50% imp, HSG B (2S)
0.433	98	Roofs, HSG B (1S)
0.428	98	Unconnected roofs, HSG B (3S)
9.433	**78**	**TOTAL AREA**

Soil Listing (all nodes)

Area (acres)	Soil Group	Subcatchment Numbers
0.000	HSG A	
5.090	HSG B	1S, 2S, 3S, 4S, 5S
0.000	HSG C	
0.000	HSG D	
4.343	Other	1S, 3S, 4S, 5S
9.433		**TOTAL AREA**

Ground Covers (all nodes)

HSG-A (acres)	HSG-B (acres)	HSG-C (acres)	HSG-D (acres)	Other (acres)	Total (acres)	Ground Cover	Subcatch Numbers
0.000	0.085	0.000	0.000	0.000	0.085	>75% Grass cover, Good	
0.000	0.000	0.000	0.000	4.343	4.343	Lawn	
0.000	1.288	0.000	0.000	0.000	1.288	Paved parking	
0.000	2.383	0.000	0.000	0.000	2.383	Paved roads w/curbs & sewers	
0.000	0.473	0.000	0.000	0.000	0.473	Paved roads w/open ditches, 50% imp	
0.000	0.433	0.000	0.000	0.000	0.433	Roofs	
0.000	0.428	0.000	0.000	0.000	0.428	Unconnected roofs	
0.000	**5.090**	**0.000**	**0.000**	**4.343**	**9.433**	**TOTAL AREA**	

Pipe Listing (all nodes)

Line#	Node Number	In-Invert (feet)	Out-Invert (feet)	Length (feet)	Slope (ft/ft)	n	Width (inches)	Diam/Height (inches)	Inside-Fill (inches)
1	1S	0.00	0.00	230.0	0.0300	0.013	0.0	12.0	0.0
2	3S	0.00	0.00	365.0	0.0200	0.013	0.0	12.0	0.0
3	4S	0.00	0.00	25.0	0.0200	0.013	0.0	12.0	0.0
4	5S	0.00	0.00	36.0	0.0200	0.013	0.0	12.0	0.0

Time span=5.00-20.00 hrs, dt=0.05 hrs, 301 points
Runoff by SBUH method, Split Pervious/Imperv.
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment1S: Basin 2 (North Lot) Runoff Area=2.489 ac 60.71% Impervious Runoff Depth>1.70"
Flow Length=544' Tc=13.0 min CN=56/98 Runoff=1.13 cfs 0.352 af

Subcatchment2S: Basin 1 (Highway 211) Runoff Area=0.558 ac 42.38% Impervious Runoff Depth>2.19"
Flow Length=549' Slope=0.0250 '/' Tc=7.8 min CN=87/98 Runoff=0.36 cfs 0.102 af

Subcatchment3S: Basin 4 (South Lot) Runoff Area=3.075 ac 47.67% Impervious Runoff Depth>1.39"
Flow Length=543' Tc=6.8 min CN=56/98 Runoff=1.18 cfs 0.356 af

Subcatchment4S: Basin 3 (Right of Way) Runoff Area=3.068 ac 43.84% Impervious Runoff Depth>1.30"
Flow Length=365' Tc=10.1 min CN=56/98 Runoff=1.05 cfs 0.333 af

Subcatchment5S: Basin 5 (Area 2) Runoff Area=0.243 ac 86.42% Impervious Runoff Depth>2.29"
Flow Length=116' Tc=0.9 min CN=56/98 Runoff=0.18 cfs 0.046 af

Pond 9P: Facility 1 (Swale) Peak Elev=-1.31' Storage=0.007 af Inflow=0.36 cfs 0.102 af
Outflow=0.30 cfs 0.099 af

Pond 10P: Facility 4 (Stormtech) Peak Elev=0.91' Storage=0.010 af Inflow=0.18 cfs 0.046 af
Outflow=0.05 cfs 0.045 af

Pond 12P: Facility 2 (North Tank) Peak Elev=4.19' Storage=0.275 af Inflow=2.18 cfs 0.684 af
Outflow=0.50 cfs 0.430 af

Pond 13P: Facility 3 (South Tank) Peak Elev=4.03' Storage=0.139 af Inflow=1.18 cfs 0.356 af
Outflow=0.21 cfs 0.223 af

Total Runoff Area = 9.433 ac Runoff Volume = 1.189 af Average Runoff Depth = 1.51"
49.45% Pervious = 4.665 ac 50.55% Impervious = 4.769 ac

Summary for Subcatchment 1S: Basin 2 (North Lot)

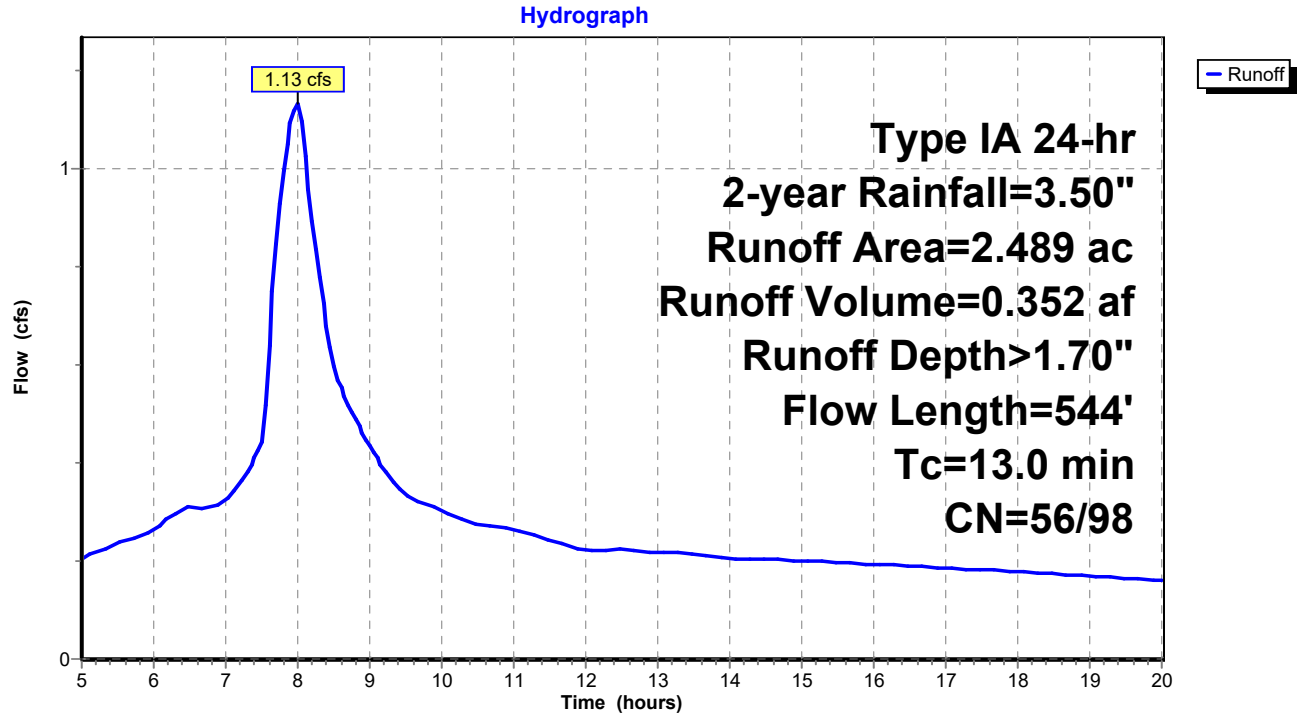
Runoff = 1.13 cfs @ 7.99 hrs, Volume= 0.352 af, Depth> 1.70"
Routed to Pond 12P : Facility 2 (North Tank)

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type IA 24-hr 2-year Rainfall=3.50"

	Area (ac)	CN	Description
	0.433	98	Roofs, HSG B
	1.078	98	Paved parking, HSG B
*	0.978	56	Lawn
	2.489	81	Weighted Average
	0.978	56	39.29% Pervious Area
	1.511	98	60.71% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
11.2	146	0.0273	0.22		**Sheet Flow, Lawn** Grass: Short n= 0.150 P2= 3.50"
1.3	168	0.0420	2.15		**Sheet Flow, Lot** Smooth surfaces n= 0.011 P2= 3.50"
0.5	230	0.0300	7.86	6.17	**Pipe Channel, Conveyance** 12.0" Round Area= 0.8 sf Perim= 3.1' r= 0.25' n= 0.013 Corrugated PE, smooth interior
13.0	544	Total			

Subcatchment 1S: Basin 2 (North Lot)



Summary for Subcatchment 2S: Basin 1 (Highway 211)

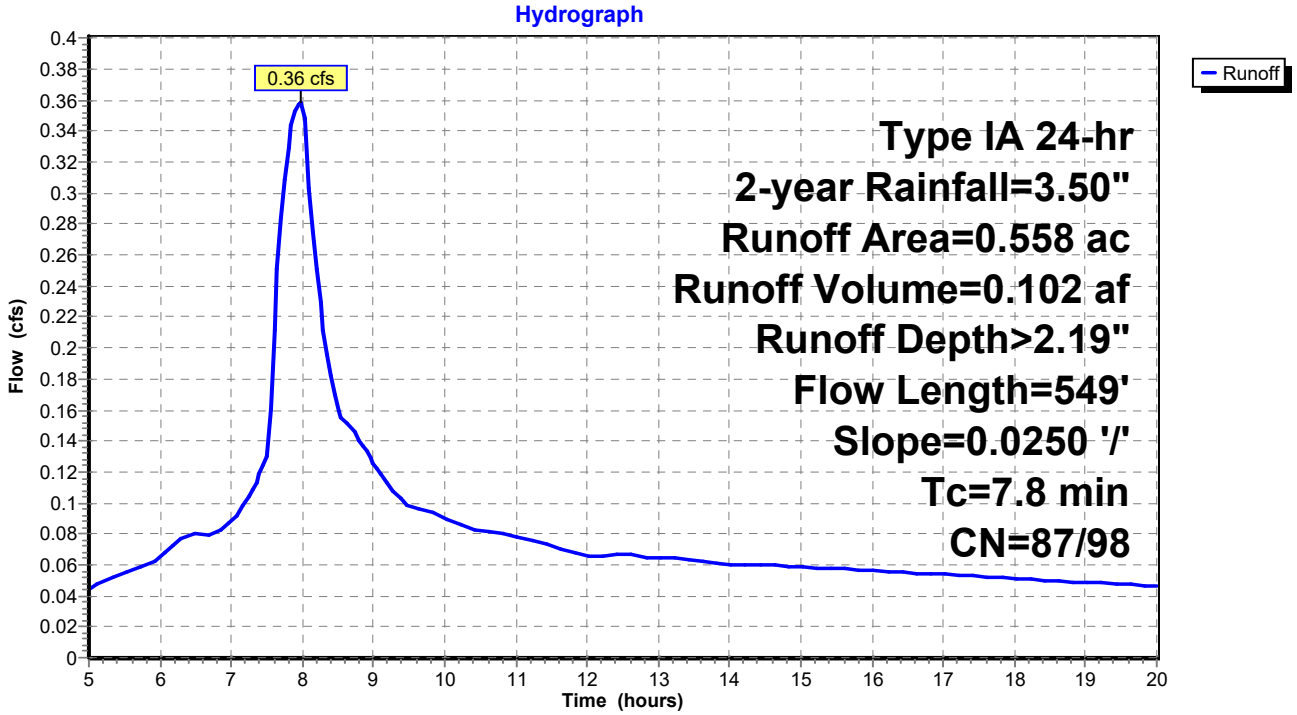
Runoff = 0.36 cfs @ 7.97 hrs, Volume= 0.102 af, Depth> 2.19"
Routed to Pond 9P : Facility 1 (Swale)

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type IA 24-hr 2-year Rainfall=3.50"

	Area (ac)	CN	Description
*	0.473	98	Paved roads w/open ditches, 50% imp, HSG B
*	0.085	56	>75% Grass cover, Good, HSG B
	0.558	92	Weighted Average
	0.322	87	57.62% Pervious Area
	0.237	98	42.38% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.8	65	0.0250	1.44		**Sheet Flow, Road** Smooth surfaces n= 0.011 P2= 3.50"
7.0	484	0.0250	1.15	5.73	**Channel Flow, Swale** Area= 5.0 sf Perim= 8.0' r= 0.63' n= 0.150 Sheet flow over Short Grass
7.8	549	Total			

Subcatchment 2S: Basin 1 (Highway 211)



Summary for Subcatchment 3S: Basin 4 (South Lot)

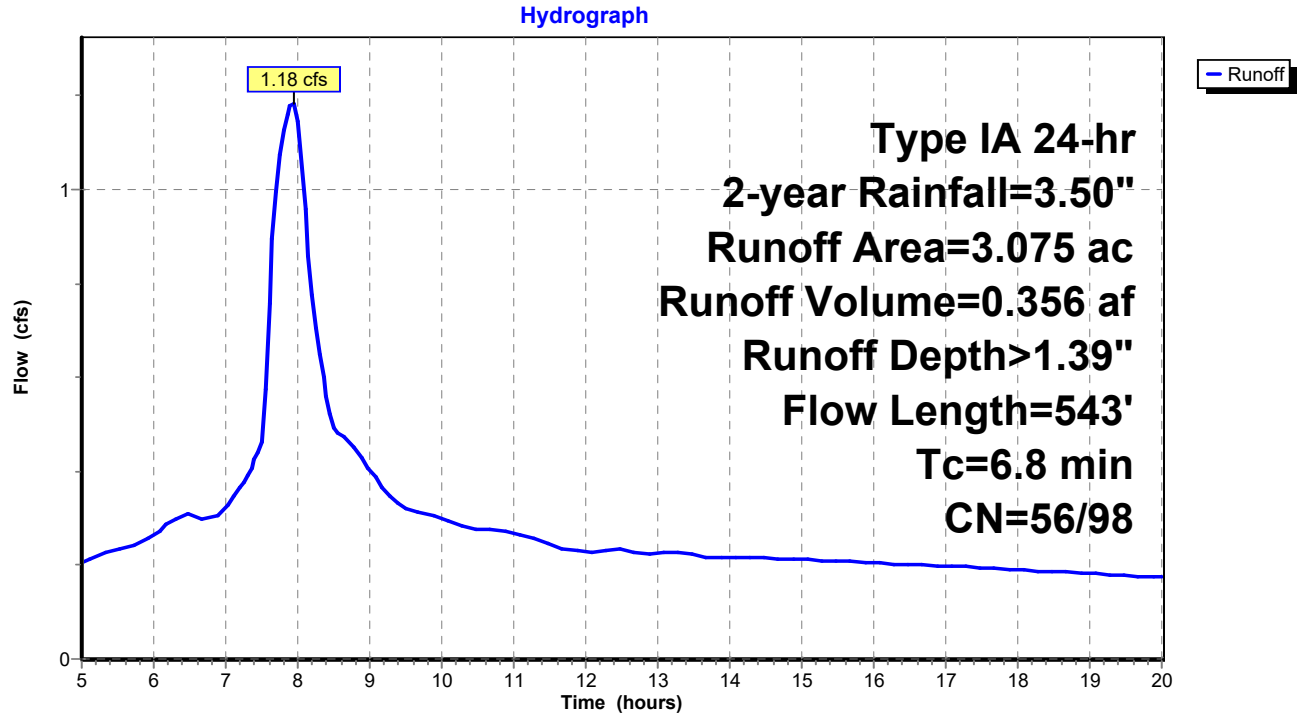
Runoff = 1.18 cfs @ 7.93 hrs, Volume= 0.356 af, Depth> 1.39"
Routed to Pond 13P : Facility 3 (South Tank)

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type IA 24-hr 2-year Rainfall=3.50"

	Area (ac)	CN	Description
	1.038	98	Paved roads w/curbs & sewers, HSG B
	0.428	98	Unconnected roofs, HSG B
*	1.609	56	Lawn
	3.075	76	Weighted Average
	1.609	56	52.33% Pervious Area
	1.466	98	47.67% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.4	124	0.1200	0.38		**Sheet Flow, Lawn** Grass: Short n= 0.150 P2= 3.50"
0.5	54	0.0500	1.83		**Sheet Flow, Pavement** Smooth surfaces n= 0.011 P2= 3.50"
0.9	365	0.0200	6.42	5.04	**Pipe Channel, Conveyance** 12.0" Round Area= 0.8 sf Perim= 3.1' r= 0.25' n= 0.013 Corrugated PE, smooth interior
6.8	543	Total			

Subcatchment 3S: Basin 4 (South Lot)



Summary for Subcatchment 4S: Basin 3 (Right of Way)

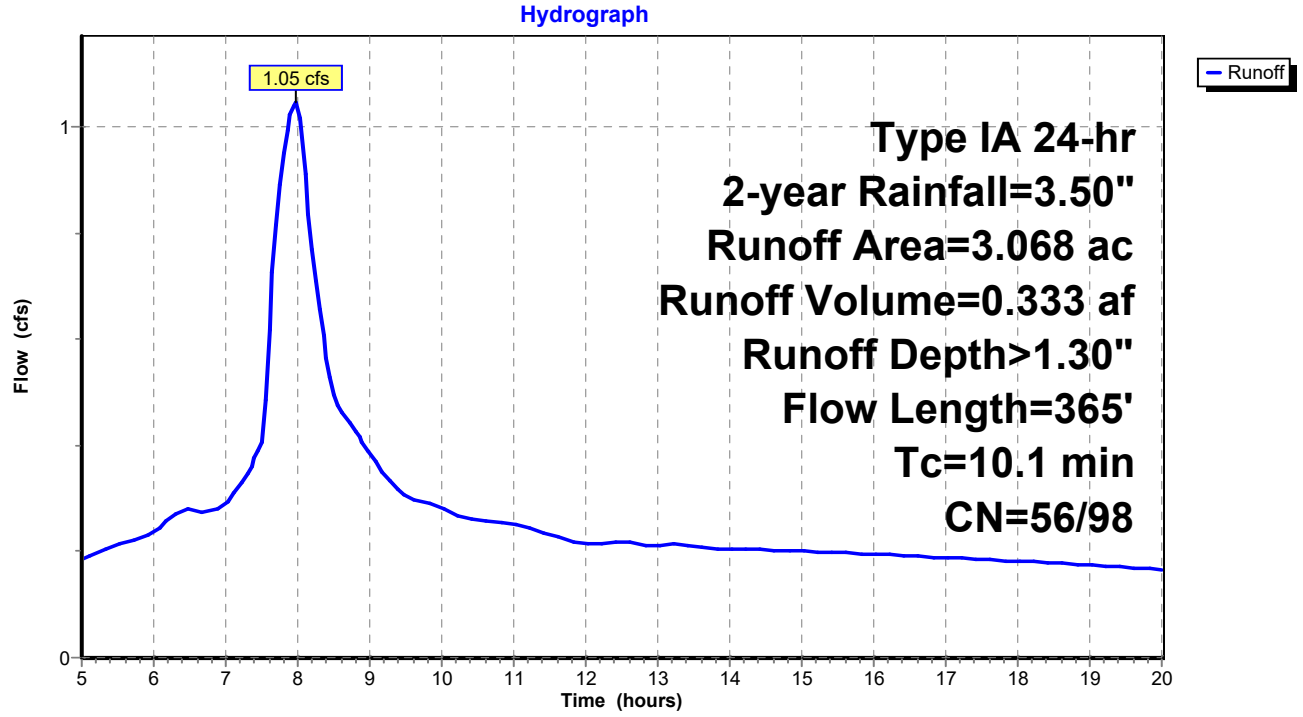
Runoff = 1.05 cfs @ 7.98 hrs, Volume= 0.333 af, Depth> 1.30"
Routed to Pond 12P : Facility 2 (North Tank)

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type IA 24-hr 2-year Rainfall=3.50"

	Area (ac)	CN	Description
	1.345	98	Paved roads w/curbs & sewers, HSG B
*	1.723	56	Lawn
	3.068	74	Weighted Average
	1.723	56	56.16% Pervious Area
	1.345	98	43.84% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
9.1	200	0.0866	0.37		**Sheet Flow, Lawn** Grass: Short n= 0.150 P2= 3.50"
0.9	140	0.0800	2.68		**Sheet Flow, Pavement** Smooth surfaces n= 0.011 P2= 3.50"
0.1	25	0.0200	6.42	5.04	**Pipe Channel, Conveyance** 12.0" Round Area= 0.8 sf Perim= 3.1' r= 0.25' n= 0.013 Corrugated PE, smooth interior
10.1	365	Total			

Subcatchment 4S: Basin 3 (Right of Way)



Summary for Subcatchment 5S: Basin 5 (Area 2)

[49] Hint: Tc<2dt may require smaller dt

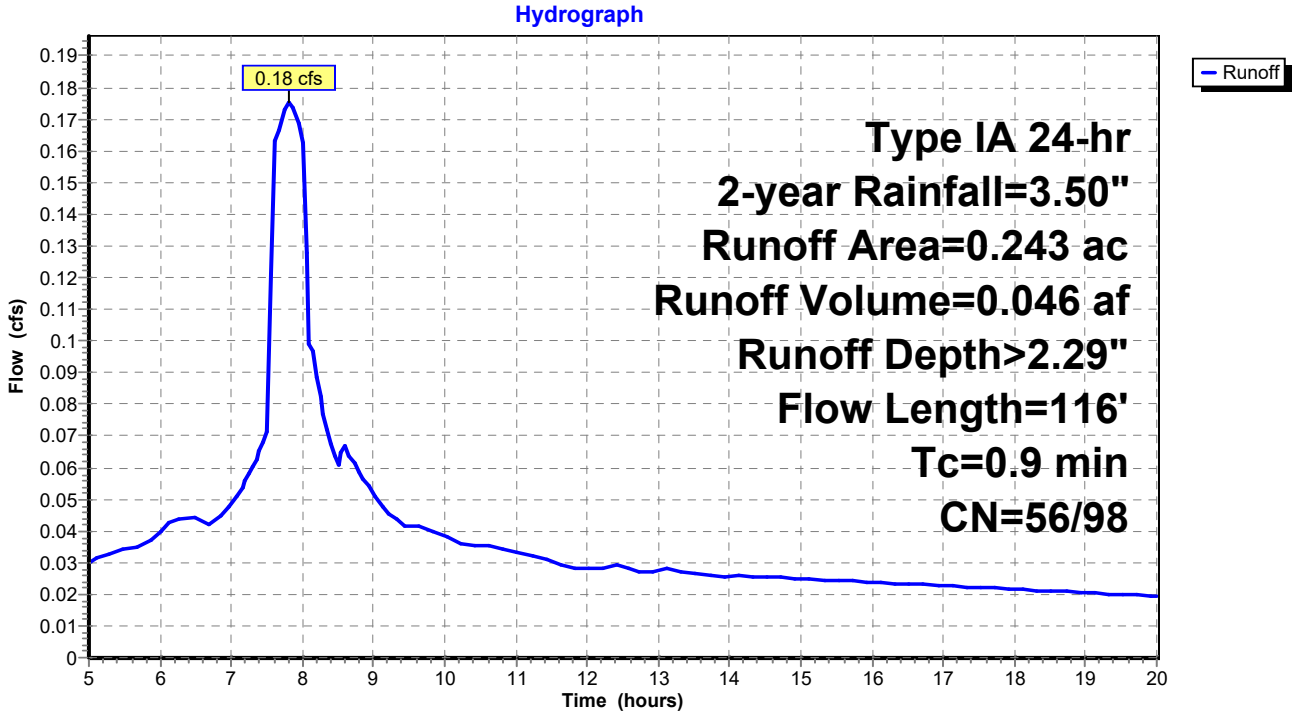
Runoff = 0.18 cfs @ 7.82 hrs, Volume= 0.046 af, Depth> 2.29"
Routed to Pond 10P : Facility 4 (Stormtech)

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type IA 24-hr 2-year Rainfall=3.50"

	Area (ac)	CN	Description
	0.210	98	Paved parking, HSG B
*	0.033	56	Lawn
	0.243	92	Weighted Average
	0.033	56	13.58% Pervious Area
	0.210	98	86.42% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.8	80	0.0280	1.57		**Sheet Flow, Pavement** Smooth surfaces n= 0.011 P2= 3.50"
0.1	36	0.0200	6.42	5.04	**Pipe Channel, Conveyance** 12.0" Round Area= 0.8 sf Perim= 3.1' r= 0.25' n= 0.013 Corrugated PE, smooth interior
0.9	116	Total			

Subcatchment 5S: Basin 5 (Area 2)



Summary for Pond 9P: Facility 1 (Swale)

[82] Warning: Early inflow requires earlier time span

Inflow Area = 0.558 ac, 42.38% Impervious, Inflow Depth > 2.19" for 2-year event
Inflow = 0.36 cfs @ 7.97 hrs, Volume= 0.102 af
Outflow = 0.30 cfs @ 8.11 hrs, Volume= 0.099 af, Atten= 16%, Lag= 7.8 min
Primary = 0.30 cfs @ 8.11 hrs, Volume= 0.099 af

Routing by Stor-Ind method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Peak Elev= -1.31' @ 8.11 hrs Surf.Area= 0.031 ac Storage= 0.007 af

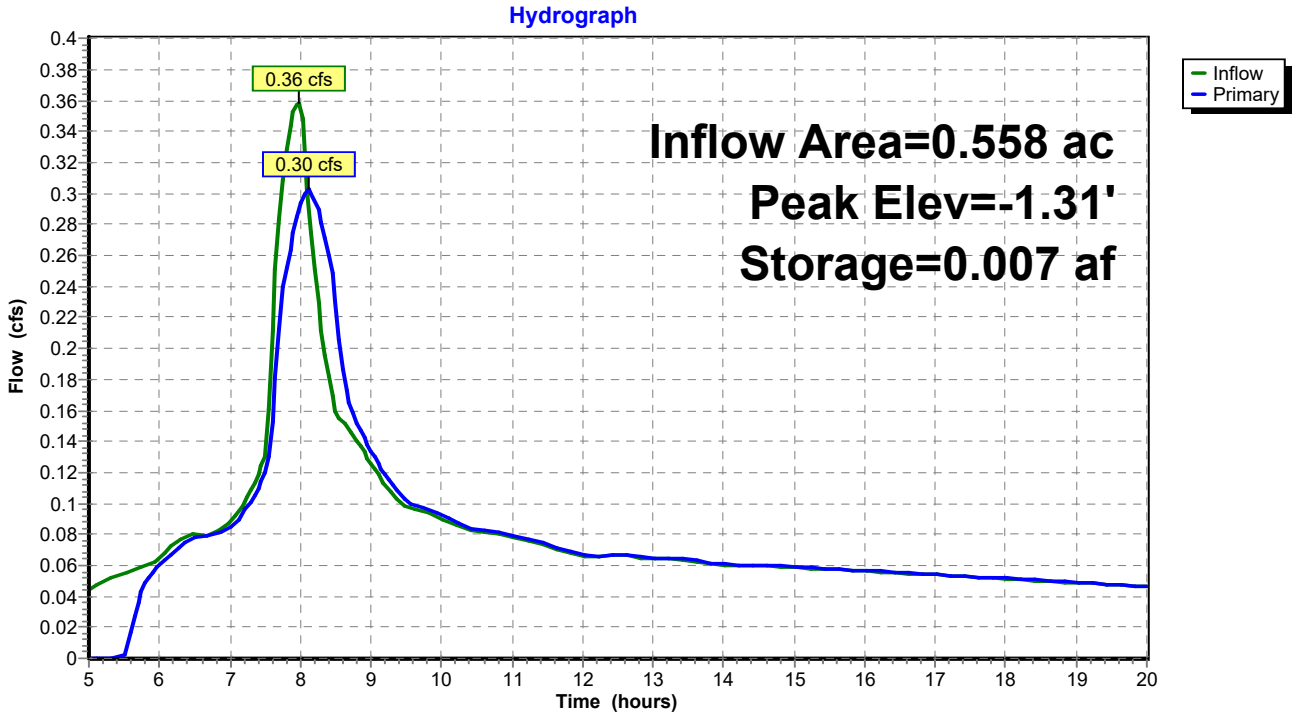
Plug-Flow detention time= 29.4 min calculated for 0.098 af (97% of inflow)
Center-of-Mass det. time= 13.6 min (682.6 - 669.0)

Volume	Invert	Avail.Storage	Storage Description
#1	-1.00'	0.053 af	**2.00'W x 455.00'L x 1.00'H Swale Z=3.0**
#2	-1.50'	0.005 af	**2.00'W x 455.00'L x 0.50'H Prismatoid** 0.010 af Overall x 46.6% Voids
#3	-2.00'	0.001 af	**4.0" Round Pipe Storage** Inside #4 L= 455.0'
#4	-2.50'	0.004 af	**1.00'W x 455.00'L x 1.00'H Prismatoid** 0.010 af Overall - 0.001 af Embedded = 0.010 af x 40.0% Voids
		0.062 af	Total Available Storage

Device	Routing	Invert	Outlet Devices
#1	Primary	-2.00'	**4.0" Vert. Orifice/Grate** C= 0.600 Limited to weir flow at low heads

Primary OutFlow Max=0.30 cfs @ 8.11 hrs HW=-1.32' (Free Discharge)
↑**1=Orifice/Grate** (Orifice Controls 0.30 cfs @ 3.47 fps)

Pond 9P: Facility 1 (Swale)



Summary for Pond 10P: Facility 4 (Stormtech)

[82] Warning: Early inflow requires earlier time span

Inflow Area = 0.243 ac, 86.42% Impervious, Inflow Depth > 2.29" for 2-year event
Inflow = 0.18 cfs @ 7.82 hrs, Volume= 0.046 af
Outflow = 0.05 cfs @ 8.91 hrs, Volume= 0.045 af, Atten= 69%, Lag= 65.6 min
Primary = 0.05 cfs @ 8.91 hrs, Volume= 0.045 af

Routing by Stor-Ind method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Peak Elev= 0.91' @ 8.91 hrs Surf.Area= 0.021 ac Storage= 0.010 af

Plug-Flow detention time= 95.0 min calculated for 0.045 af (96% of inflow)
Center-of-Mass det. time= 75.3 min (723.9 - 648.6)

Volume	Invert	Avail.Storage	Storage Description
#1A	0.00'	0.013 af	**29.08'W x 30.95'L x 2.00'H Field A** 0.041 af Overall - 0.008 af Embedded = 0.033 af x 40.0% Voids
#2A	0.50'	0.008 af	**ADS_StormTech SC-160LP +Cap**x 52 Inside #1 Effective Size= 18.0"W x 12.0"H => 0.96 sf x 7.12'L = 6.8 cf Overall Size= 25.0"W x 12.0"H x 7.56'L with 0.44' Overlap 52 Chambers in 13 Rows
		0.021 af	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Primary	0.00'	**1.5" Vert. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#2	Primary	1.92'	**12.0" Vert. Overflow Riser** C= 0.600 Limited to weir flow at low heads

Primary OutFlow Max=0.05 cfs @ 8.91 hrs HW=0.91' (Free Discharge)
1=Orifice/Grate (Orifice Controls 0.05 cfs @ 4.44 fps)
2=Overflow Riser (Controls 0.00 cfs)

Pond 10P: Facility 4 (Stormtech) - Chamber Wizard Field A

Chamber Model = ADS_StormTechSC-160LP +Cap (ADS StormTech® SC-160LP with cap length)
Effective Size= 18.0"W x 12.0"H => 0.96 sf x 7.12'L = 6.8 cf
Overall Size= 25.0"W x 12.0"H x 7.56'L with 0.44' Overlap

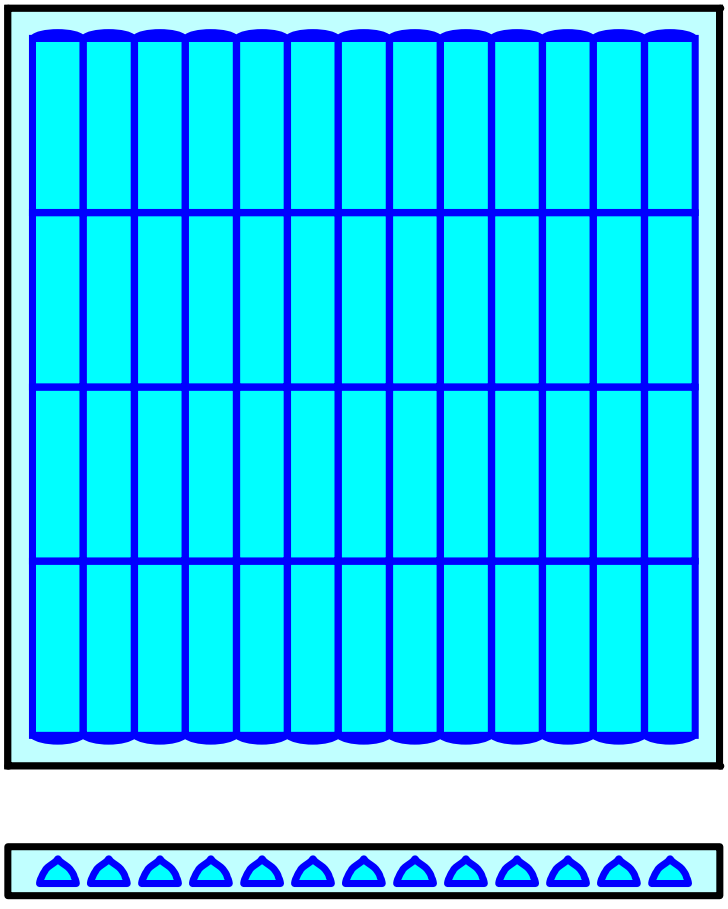
4 Chambers/Row x 7.12' Long +0.23' Cap Length x 2 = 28.95' Row Length +12.0" End Stone x 2 = 30.95' Base Length
13 Rows x 25.0" Wide + 12.0" Side Stone x 2 = 29.08' Base Width
6.0" Stone Base + 12.0" Chamber Height + 6.0" Stone Cover = 2.00' Field Height

52 Chambers x 6.8 cf = 355.5 cf Chamber Storage

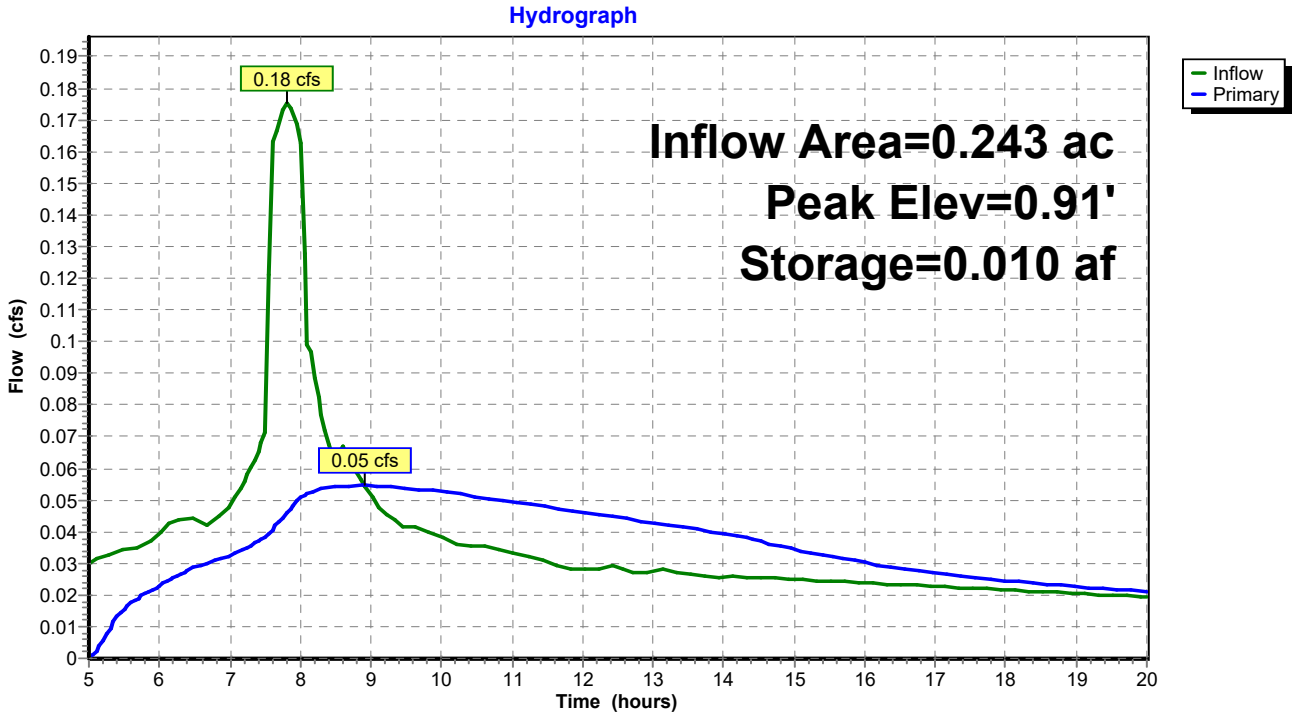
1,800.1 cf Field - 355.5 cf Chambers = 1,444.5 cf Stone x 40.0% Voids = 577.8 cf Stone Storage

Chamber Storage + Stone Storage = 933.3 cf = 0.021 af
Overall Storage Efficiency = 51.9%
Overall System Size = 30.95' x 29.08' x 2.00'

52 Chambers
66.7 cy Field
53.5 cy Stone



Pond 10P: Facility 4 (Stormtech)



Summary for Pond 12P: Facility 2 (North Tank)

[82] Warning: Early inflow requires earlier time span
[92] Warning: Device #4 is above defined storage

Inflow Area = 5.557 ac, 51.39% Impervious, Inflow Depth > 1.48" for 2-year event
Inflow = 2.18 cfs @ 7.98 hrs, Volume= 0.684 af
Outflow = 0.50 cfs @ 11.16 hrs, Volume= 0.430 af, Atten= 77%, Lag= 190.4 min
Primary = 0.50 cfs @ 11.16 hrs, Volume= 0.430 af

Routing by Stor-Ind method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Peak Elev= 4.19' @ 11.16 hrs Surf.Area= 0.066 ac Storage= 0.275 af

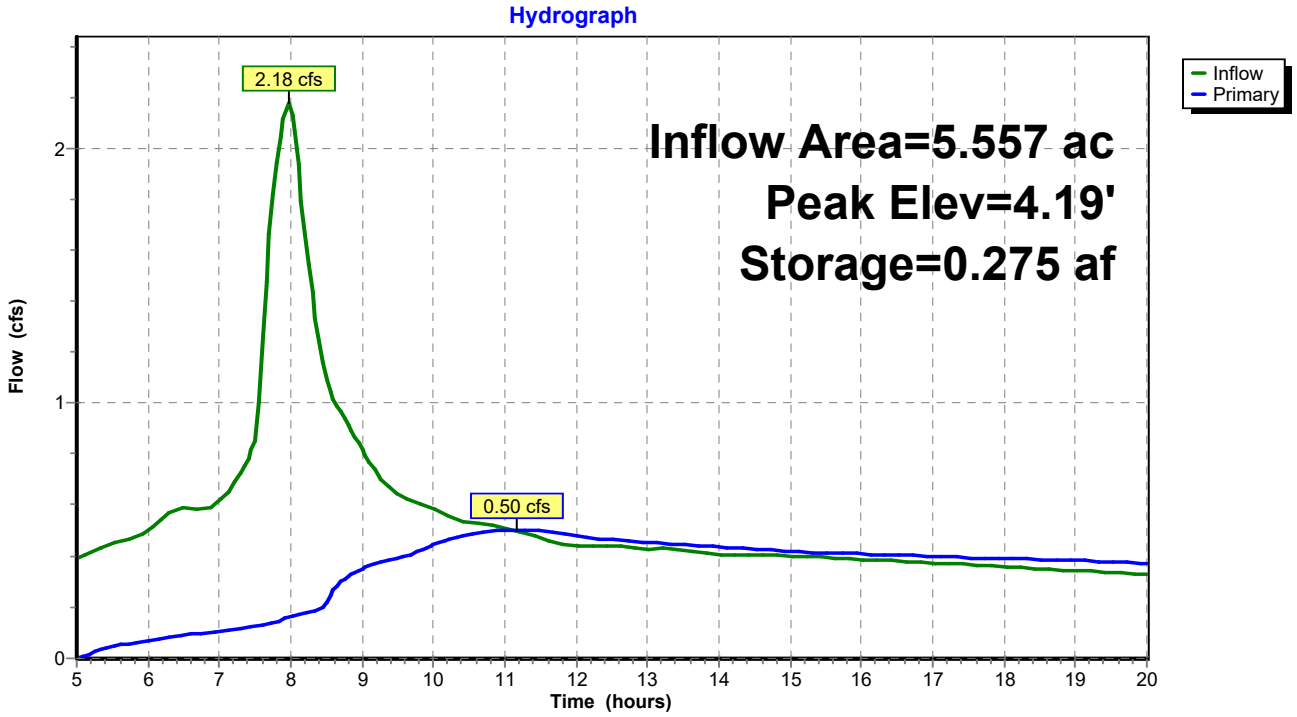
Plug-Flow detention time= 316.4 min calculated for 0.428 af (62% of inflow)
Center-of-Mass det. time= 149.9 min (820.6 - 670.7)

Volume	Invert	Avail.Storage	Storage Description
#1	0.00'	0.393 af	**24.00'W x 119.00'L x 6.00'H Prismatoid**

Device	Routing	Invert	Outlet Devices
#1	Primary	0.00'	**2.0" Vert. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#2	Primary	3.25'	**3.0" Vert. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#3	Primary	4.00'	**4.0" Vert. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#4	Primary	6.00'	**12.0" Vert. Overflow Riser** C= 0.600 Limited to weir flow at low heads

Primary OutFlow Max=0.50 cfs @ 11.16 hrs HW=4.19' (Free Discharge)
- **1=Orifice/Grate** (Orifice Controls 0.21 cfs @ 9.76 fps)
- **2=Orifice/Grate** (Orifice Controls 0.21 cfs @ 4.34 fps)
- **3=Orifice/Grate** (Orifice Controls 0.08 cfs @ 1.48 fps)
- **4=Overflow Riser** (Controls 0.00 cfs)

Pond 12P: Facility 2 (North Tank)



Summary for Pond 13P: Facility 3 (South Tank)

[82] Warning: Early inflow requires earlier time span
[92] Warning: Device #4 is above defined storage

Inflow Area = 3.075 ac, 47.67% Impervious, Inflow Depth > 1.39" for 2-year event
Inflow = 1.18 cfs @ 7.93 hrs, Volume= 0.356 af
Outflow = 0.21 cfs @ 14.99 hrs, Volume= 0.223 af, Atten= 82%, Lag= 423.5 min
Primary = 0.21 cfs @ 14.99 hrs, Volume= 0.223 af

Routing by Stor-Ind method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Peak Elev= 4.03' @ 14.99 hrs Surf.Area= 0.035 ac Storage= 0.139 af

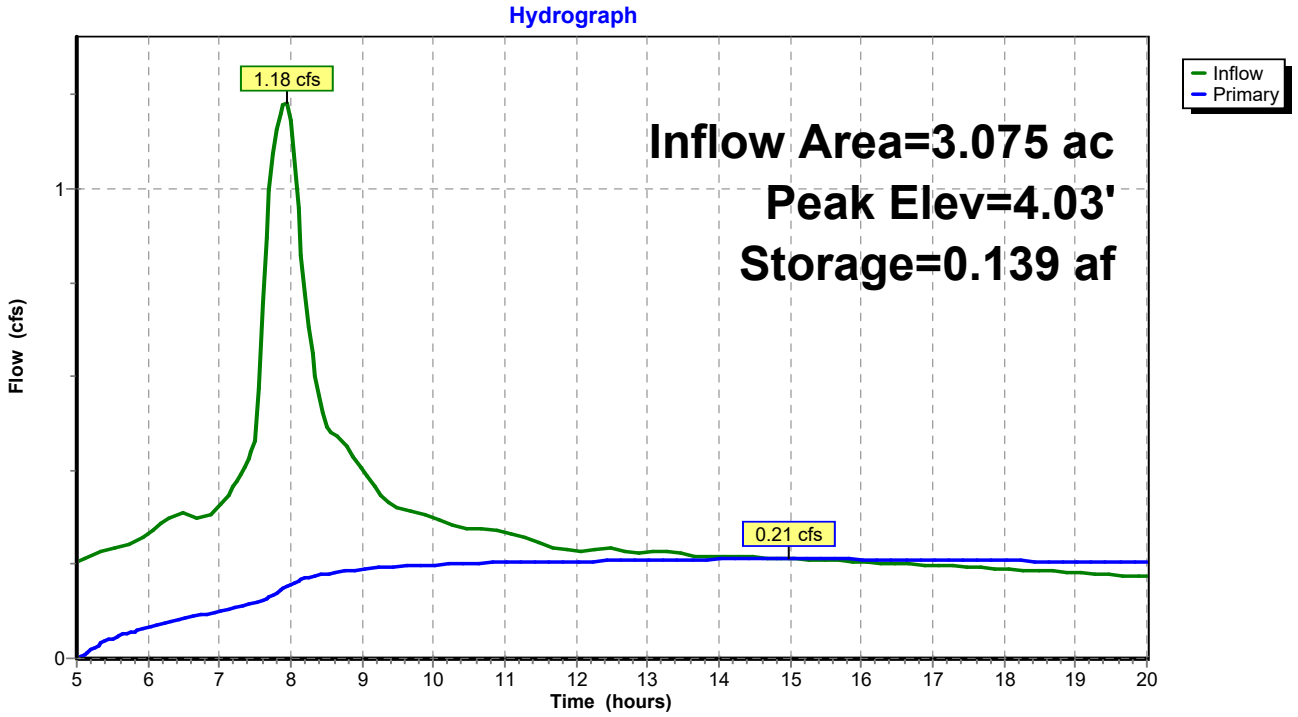
Plug-Flow detention time= 304.1 min calculated for 0.222 af (62% of inflow)
Center-of-Mass det. time= 135.4 min (807.5 - 672.1)

Volume	Invert	Avail.Storage	Storage Description
#1	0.00'	0.208 af	**26.00'W x 58.00'L x 6.00'H Prismatoid**

Device	Routing	Invert	Outlet Devices
#1	Primary	0.00'	**2.0" Vert. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#2	Primary	4.00'	**1.7" Vert. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#3	Primary	4.75'	**3.0" Vert. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#4	Primary	6.00'	**12.0" Vert. Overflow Riser** C= 0.600 Limited to weir flow at low heads

Primary OutFlow Max=0.21 cfs @ 14.99 hrs HW=4.03' (Free Discharge)
- **1=Orifice/Grate** (Orifice Controls 0.21 cfs @ 9.56 fps)
- **2=Orifice/Grate** (Orifice Controls 0.00 cfs @ 0.58 fps)
- **3=Orifice/Grate** (Controls 0.00 cfs)
- **4=Overflow Riser** (Controls 0.00 cfs)

Pond 13P: Facility 3 (South Tank)



Time span=5.00-20.00 hrs, dt=0.05 hrs, 301 points
Runoff by SBUH method, Split Pervious/Imperv.
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment1S: Basin 2 (North Lot) Runoff Area=2.489 ac 60.71% Impervious Runoff Depth>2.30"
Flow Length=544' Tc=13.0 min CN=56/98 Runoff=1.50 cfs 0.476 af

Subcatchment2S: Basin 1 (Highway 211) Runoff Area=0.558 ac 42.38% Impervious Runoff Depth>2.96"
Flow Length=549' Slope=0.0250 '/' Tc=7.8 min CN=87/98 Runoff=0.49 cfs 0.138 af

Subcatchment3S: Basin 4 (South Lot) Runoff Area=3.075 ac 47.67% Impervious Runoff Depth>1.93"
Flow Length=543' Tc=6.8 min CN=56/98 Runoff=1.60 cfs 0.496 af

Subcatchment4S: Basin 3 (Right of Way) Runoff Area=3.068 ac 43.84% Impervious Runoff Depth>1.83"
Flow Length=365' Tc=10.1 min CN=56/98 Runoff=1.43 cfs 0.467 af

Subcatchment5S: Basin 5 (Area 2) Runoff Area=0.243 ac 86.42% Impervious Runoff Depth>3.00"
Flow Length=116' Tc=0.9 min CN=56/98 Runoff=0.23 cfs 0.061 af

Pond 9P: Facility 1 (Swale) Peak Elev=-1.00' Storage=0.010 af Inflow=0.49 cfs 0.138 af
Outflow=0.38 cfs 0.135 af

Pond 10P: Facility 4 (Stormtech) Peak Elev=1.26' Storage=0.015 af Inflow=0.23 cfs 0.061 af
Outflow=0.06 cfs 0.058 af

Pond 12P: Facility 2 (North Tank) Peak Elev=4.87' Storage=0.320 af Inflow=2.93 cfs 0.944 af
Outflow=0.87 cfs 0.671 af

Pond 13P: Facility 3 (South Tank) Peak Elev=5.00' Storage=0.173 af Inflow=1.60 cfs 0.496 af
Outflow=0.39 cfs 0.336 af

Total Runoff Area = 9.433 ac Runoff Volume = 1.638 af Average Runoff Depth = 2.08"
49.45% Pervious = 4.665 ac 50.55% Impervious = 4.769 ac

Summary for Subcatchment 1S: Basin 2 (North Lot)

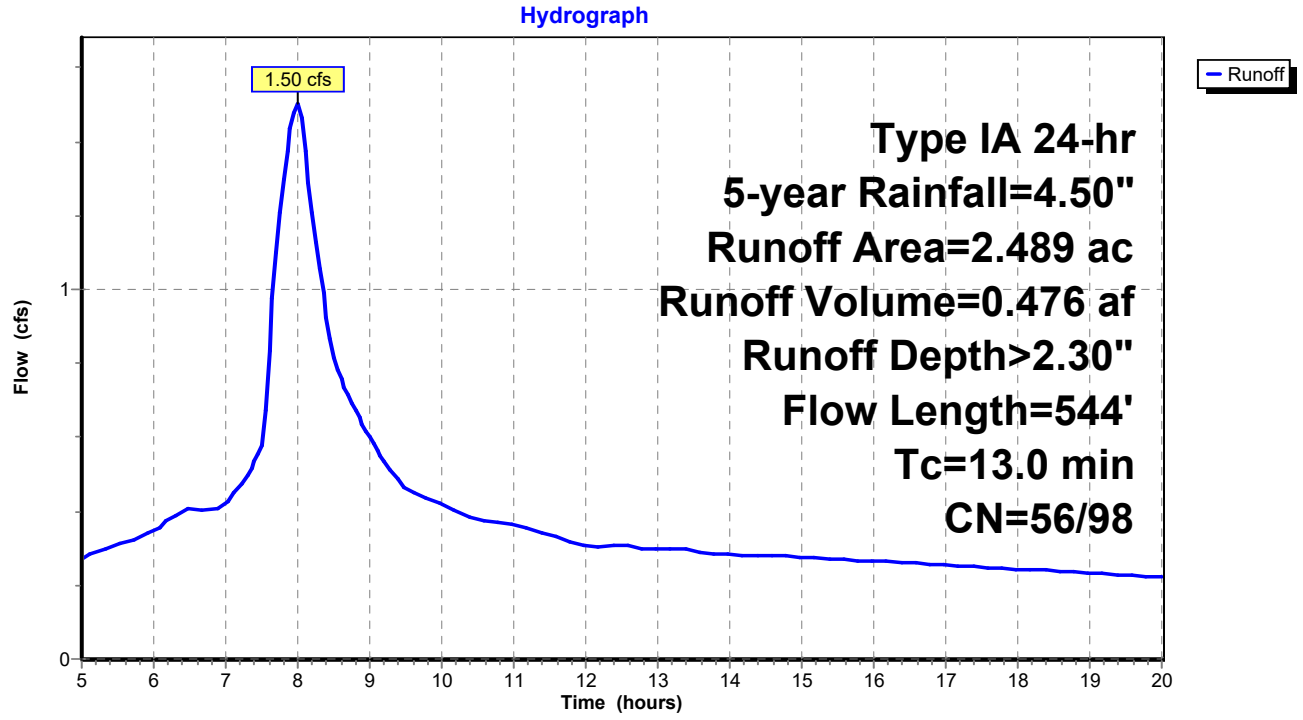
Runoff = 1.50 cfs @ 7.99 hrs, Volume= 0.476 af, Depth> 2.30"
Routed to Pond 12P : Facility 2 (North Tank)

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type IA 24-hr 5-year Rainfall=4.50"

	Area (ac)	CN	Description
	0.433	98	Roofs, HSG B
	1.078	98	Paved parking, HSG B
*	0.978	56	Lawn
	2.489	81	Weighted Average
	0.978	56	39.29% Pervious Area
	1.511	98	60.71% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
11.2	146	0.0273	0.22		**Sheet Flow, Lawn** Grass: Short n= 0.150 P2= 3.50"
1.3	168	0.0420	2.15		**Sheet Flow, Lot** Smooth surfaces n= 0.011 P2= 3.50"
0.5	230	0.0300	7.86	6.17	**Pipe Channel, Conveyance** 12.0" Round Area= 0.8 sf Perim= 3.1' r= 0.25' n= 0.013 Corrugated PE, smooth interior
13.0	544	Total			

Subcatchment 1S: Basin 2 (North Lot)



Summary for Subcatchment 2S: Basin 1 (Highway 211)

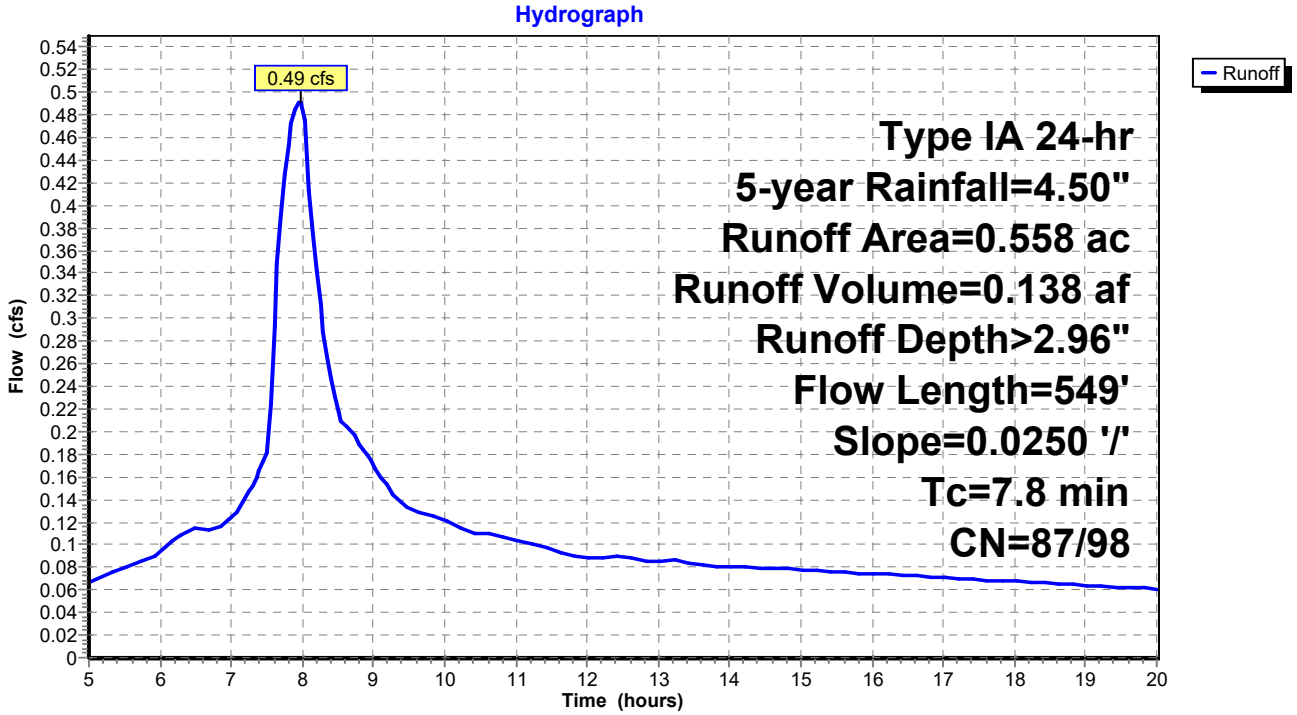
Runoff = 0.49 cfs @ 7.97 hrs, Volume= 0.138 af, Depth> 2.96"
Routed to Pond 9P : Facility 1 (Swale)

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type IA 24-hr 5-year Rainfall=4.50"

	Area (ac)	CN	Description
*	0.473	98	Paved roads w/open ditches, 50% imp, HSG B
*	0.085	56	>75% Grass cover, Good, HSG B
	0.558	92	Weighted Average
	0.322	87	57.62% Pervious Area
	0.237	98	42.38% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.8	65	0.0250	1.44		**Sheet Flow, Road** Smooth surfaces n= 0.011 P2= 3.50"
7.0	484	0.0250	1.15	5.73	**Channel Flow, Swale** Area= 5.0 sf Perim= 8.0' r= 0.63' n= 0.150 Sheet flow over Short Grass
7.8	549	Total			

Subcatchment 2S: Basin 1 (Highway 211)



Summary for Subcatchment 3S: Basin 4 (South Lot)

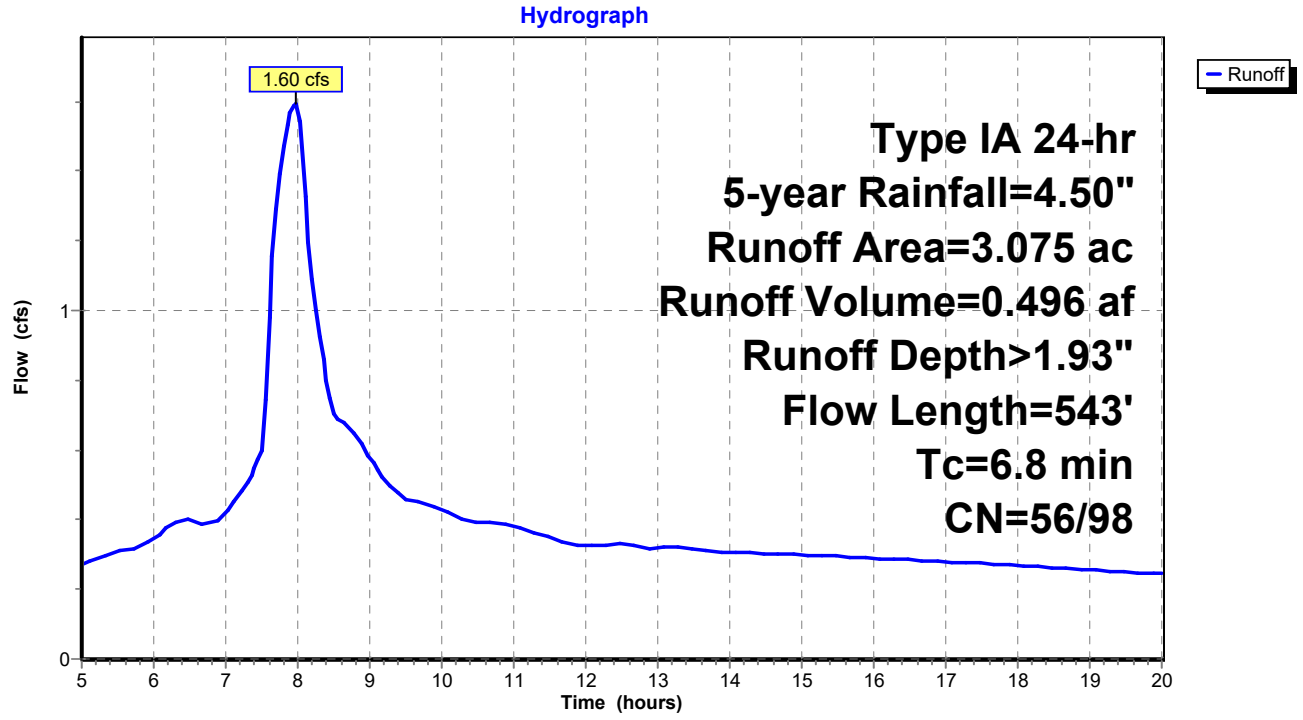
Runoff = 1.60 cfs @ 7.97 hrs, Volume= 0.496 af, Depth> 1.93"
Routed to Pond 13P : Facility 3 (South Tank)

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type IA 24-hr 5-year Rainfall=4.50"

	Area (ac)	CN	Description
	1.038	98	Paved roads w/curbs & sewers, HSG B
	0.428	98	Unconnected roofs, HSG B
*	1.609	56	Lawn
	3.075	76	Weighted Average
	1.609	56	52.33% Pervious Area
	1.466	98	47.67% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.4	124	0.1200	0.38		**Sheet Flow, Lawn** Grass: Short n= 0.150 P2= 3.50"
0.5	54	0.0500	1.83		**Sheet Flow, Pavement** Smooth surfaces n= 0.011 P2= 3.50"
0.9	365	0.0200	6.42	5.04	**Pipe Channel, Conveyance** 12.0" Round Area= 0.8 sf Perim= 3.1' r= 0.25' n= 0.013 Corrugated PE, smooth interior
6.8	543	Total			

Subcatchment 3S: Basin 4 (South Lot)



Summary for Subcatchment 4S: Basin 3 (Right of Way)

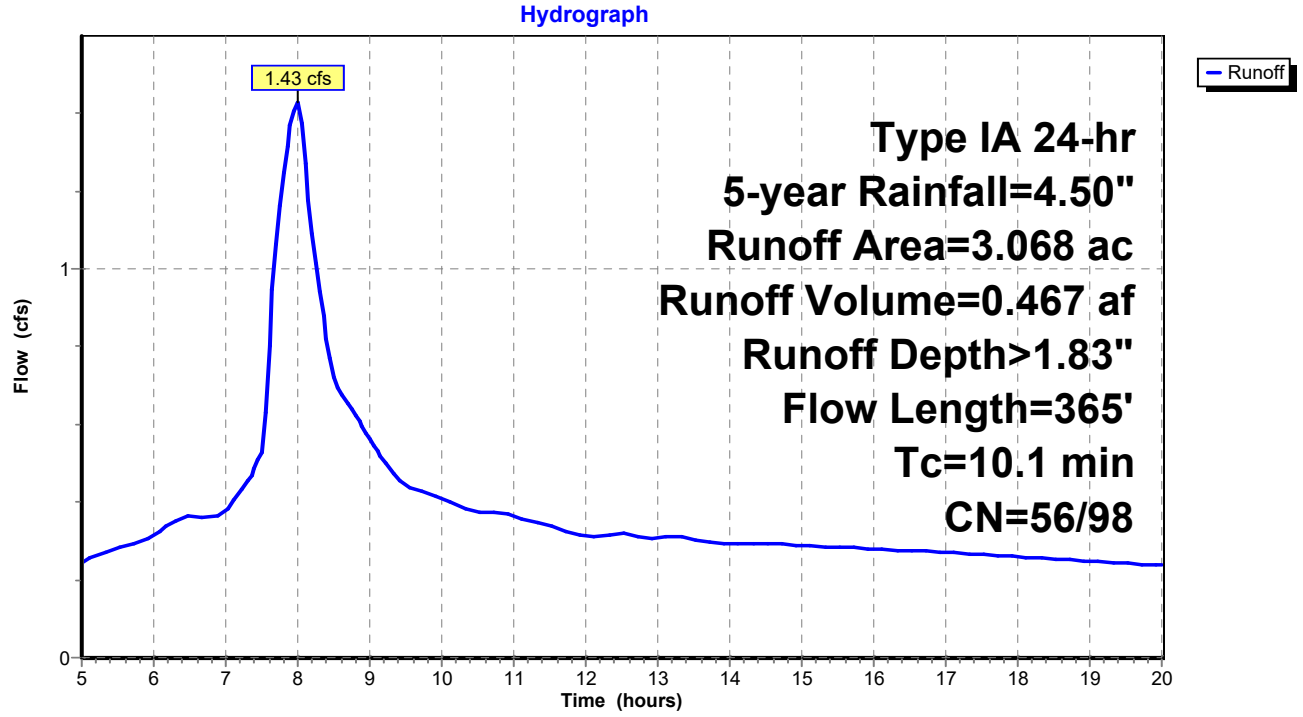
Runoff = 1.43 cfs @ 7.99 hrs, Volume= 0.467 af, Depth> 1.83"
Routed to Pond 12P : Facility 2 (North Tank)

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type IA 24-hr 5-year Rainfall=4.50"

	Area (ac)	CN	Description
	1.345	98	Paved roads w/curbs & sewers, HSG B
*	1.723	56	Lawn
	3.068	74	Weighted Average
	1.723	56	56.16% Pervious Area
	1.345	98	43.84% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
9.1	200	0.0866	0.37		**Sheet Flow, Lawn** Grass: Short n= 0.150 P2= 3.50"
0.9	140	0.0800	2.68		**Sheet Flow, Pavement** Smooth surfaces n= 0.011 P2= 3.50"
0.1	25	0.0200	6.42	5.04	**Pipe Channel, Conveyance** 12.0" Round Area= 0.8 sf Perim= 3.1' r= 0.25' n= 0.013 Corrugated PE, smooth interior
10.1	365	Total			

Subcatchment 4S: Basin 3 (Right of Way)



Summary for Subcatchment 5S: Basin 5 (Area 2)

[49] Hint: Tc<2dt may require smaller dt

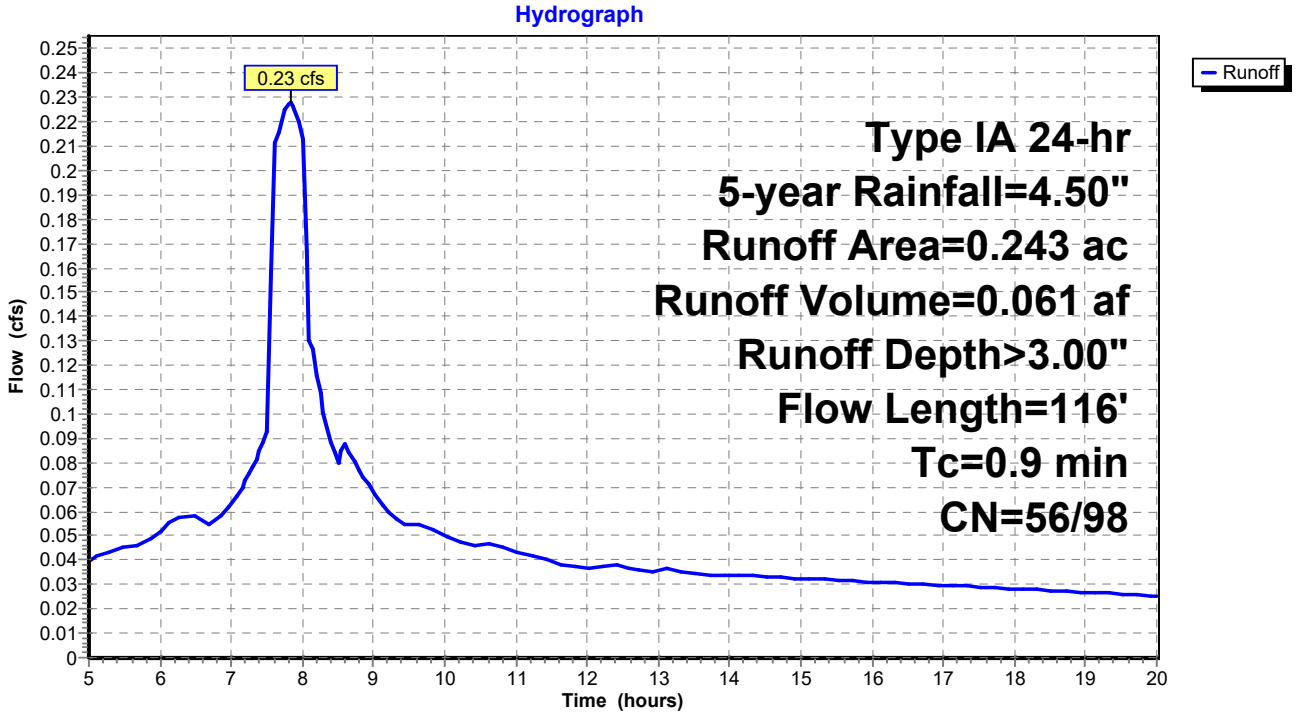
Runoff = 0.23 cfs @ 7.83 hrs, Volume= 0.061 af, Depth> 3.00"
Routed to Pond 10P : Facility 4 (Stormtech)

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type IA 24-hr 5-year Rainfall=4.50"

	Area (ac)	CN	Description
	0.210	98	Paved parking, HSG B
*	0.033	56	Lawn
	0.243	92	Weighted Average
	0.033	56	13.58% Pervious Area
	0.210	98	86.42% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.8	80	0.0280	1.57		**Sheet Flow, Pavement** Smooth surfaces n= 0.011 P2= 3.50"
0.1	36	0.0200	6.42	5.04	**Pipe Channel, Conveyance** 12.0" Round Area= 0.8 sf Perim= 3.1' r= 0.25' n= 0.013 Corrugated PE, smooth interior
0.9	116	Total			

Subcatchment 5S: Basin 5 (Area 2)



Summary for Pond 9P: Facility 1 (Swale)

[82] Warning: Early inflow requires earlier time span

Inflow Area = 0.558 ac, 42.38% Impervious, Inflow Depth > 2.96" for 5-year event
Inflow = 0.49 cfs @ 7.97 hrs, Volume= 0.138 af
Outflow = 0.38 cfs @ 8.14 hrs, Volume= 0.135 af, Atten= 22%, Lag= 10.4 min
Primary = 0.38 cfs @ 8.14 hrs, Volume= 0.135 af

Routing by Stor-Ind method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Peak Elev= -1.00' @ 8.14 hrs Surf.Area= 0.031 ac Storage= 0.010 af

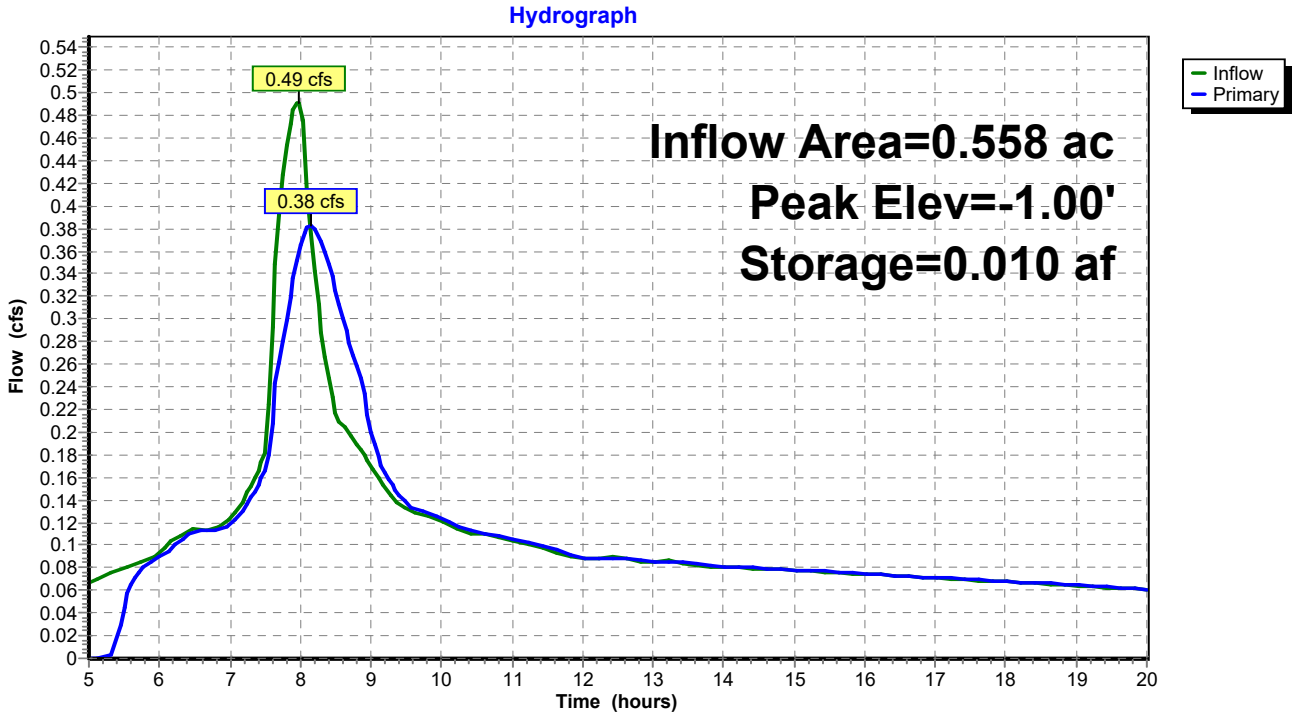
Plug-Flow detention time= 24.6 min calculated for 0.134 af (98% of inflow)
Center-of-Mass det. time= 12.0 min (675.5 - 663.6)

Volume	Invert	Avail.Storage	Storage Description
#1	-1.00'	0.053 af	**2.00'W x 455.00'L x 1.00'H Swale Z=3.0**
#2	-1.50'	0.005 af	**2.00'W x 455.00'L x 0.50'H Prismatoid** 0.010 af Overall x 46.6% Voids
#3	-2.00'	0.001 af	**4.0" Round Pipe Storage** Inside #4 L= 455.0'
#4	-2.50'	0.004 af	**1.00'W x 455.00'L x 1.00'H Prismatoid** 0.010 af Overall - 0.001 af Embedded = 0.010 af x 40.0% Voids
		0.062 af	Total Available Storage

Device	Routing	Invert	Outlet Devices
#1	Primary	-2.00'	**4.0" Vert. Orifice/Grate** C= 0.600 Limited to weir flow at low heads

Primary OutFlow Max=0.38 cfs @ 8.14 hrs HW=-1.00' (Free Discharge)
↑—**1=Orifice/Grate** (Orifice Controls 0.38 cfs @ 4.39 fps)

Pond 9P: Facility 1 (Swale)



Summary for Pond 10P: Facility 4 (Stormtech)

[82] Warning: Early inflow requires earlier time span

Inflow Area = 0.243 ac, 86.42% Impervious, Inflow Depth > 3.00" for 5-year event
Inflow = 0.23 cfs @ 7.83 hrs, Volume= 0.061 af
Outflow = 0.06 cfs @ 9.07 hrs, Volume= 0.058 af, Atten= 72%, Lag= 74.7 min
Primary = 0.06 cfs @ 9.07 hrs, Volume= 0.058 af

Routing by Stor-Ind method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Peak Elev= 1.26' @ 9.07 hrs Surf.Area= 0.021 ac Storage= 0.015 af

Plug-Flow detention time= 122.4 min calculated for 0.058 af (95% of inflow)
Center-of-Mass det. time= 96.1 min (744.9 - 648.8)

Volume	Invert	Avail.Storage	Storage Description
#1A	0.00'	0.013 af	**29.08'W x 30.95'L x 2.00'H Field A** 0.041 af Overall - 0.008 af Embedded = 0.033 af x 40.0% Voids
#2A	0.50'	0.008 af	**ADS_StormTech SC-160LP +Cap**x 52 Inside #1 Effective Size= 18.0"W x 12.0"H => 0.96 sf x 7.12'L = 6.8 cf Overall Size= 25.0"W x 12.0"H x 7.56'L with 0.44' Overlap 52 Chambers in 13 Rows
		0.021 af	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Primary	0.00'	**1.5" Vert. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#2	Primary	1.92'	**12.0" Vert. Overflow Riser** C= 0.600 Limited to weir flow at low heads

Primary OutFlow Max=0.06 cfs @ 9.07 hrs HW=1.26' (Free Discharge)
1=Orifice/Grate (Orifice Controls 0.06 cfs @ 5.28 fps)
2=Overflow Riser (Controls 0.00 cfs)

Pond 10P: Facility 4 (Stormtech) - Chamber Wizard Field A

Chamber Model = ADS_StormTechSC-160LP +Cap (ADS StormTech® SC-160LP with cap length)
Effective Size= 18.0"W x 12.0"H => 0.96 sf x 7.12'L = 6.8 cf
Overall Size= 25.0"W x 12.0"H x 7.56'L with 0.44' Overlap

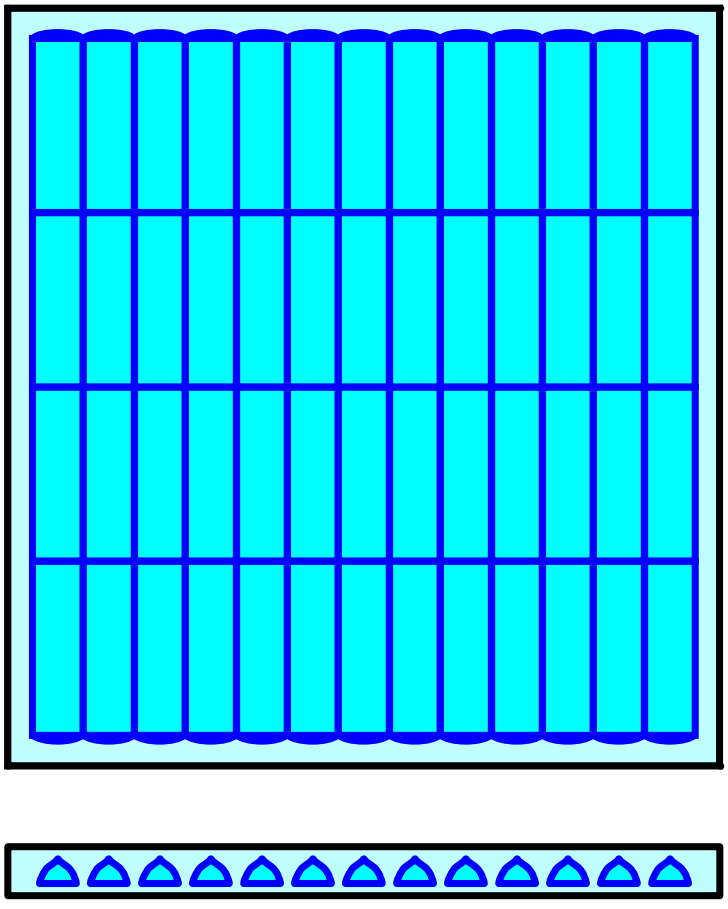
4 Chambers/Row x 7.12' Long +0.23' Cap Length x 2 = 28.95' Row Length +12.0" End Stone x 2 = 30.95' Base Length
13 Rows x 25.0" Wide + 12.0" Side Stone x 2 = 29.08' Base Width
6.0" Stone Base + 12.0" Chamber Height + 6.0" Stone Cover = 2.00' Field Height

52 Chambers x 6.8 cf = 355.5 cf Chamber Storage

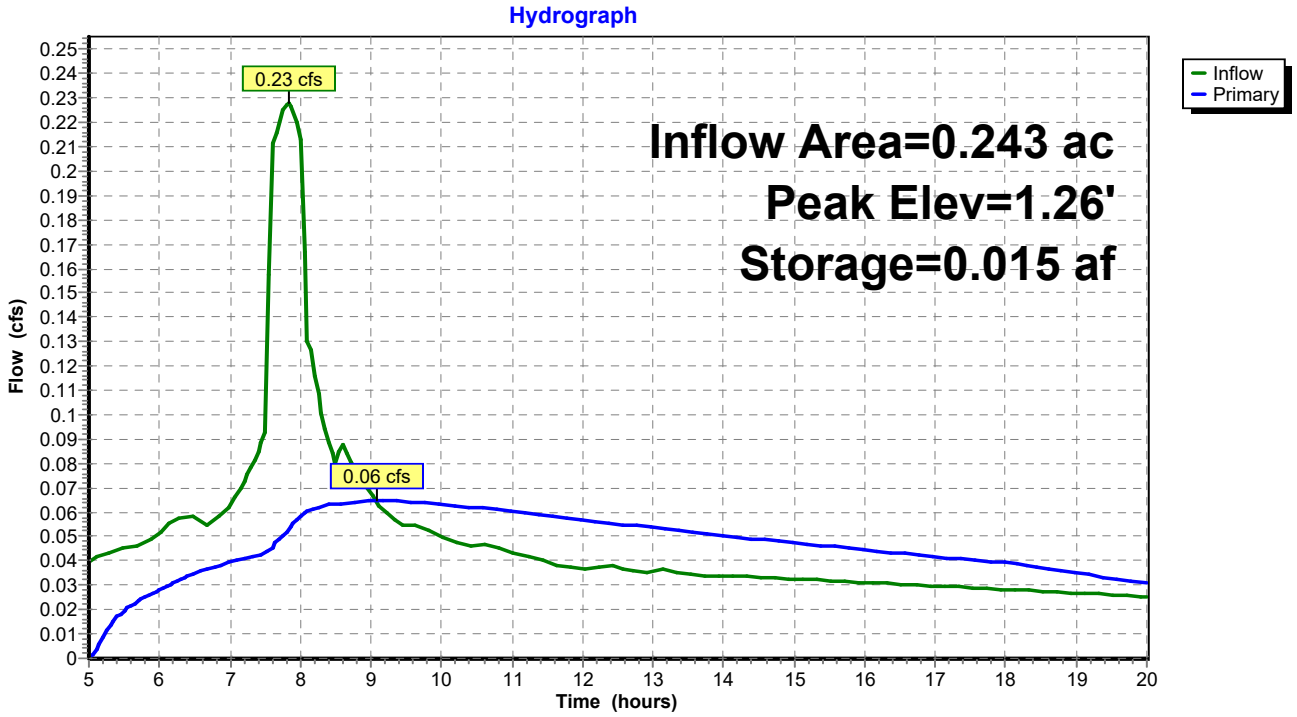
1,800.1 cf Field - 355.5 cf Chambers = 1,444.5 cf Stone x 40.0% Voids = 577.8 cf Stone Storage

Chamber Storage + Stone Storage = 933.3 cf = 0.021 af
Overall Storage Efficiency = 51.9%
Overall System Size = 30.95' x 29.08' x 2.00'

52 Chambers
66.7 cy Field
53.5 cy Stone



Pond 10P: Facility 4 (Stormtech)



Summary for Pond 12P: Facility 2 (North Tank)

[82] Warning: Early inflow requires earlier time span
[92] Warning: Device #4 is above defined storage

Inflow Area = 5.557 ac, 51.39% Impervious, Inflow Depth > 2.04" for 5-year event
Inflow = 2.93 cfs @ 7.99 hrs, Volume= 0.944 af
Outflow = 0.87 cfs @ 9.70 hrs, Volume= 0.671 af, Atten= 70%, Lag= 102.3 min
Primary = 0.87 cfs @ 9.70 hrs, Volume= 0.671 af

Routing by Stor-Ind method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Peak Elev= 4.87' @ 9.70 hrs Surf.Area= 0.066 ac Storage= 0.320 af

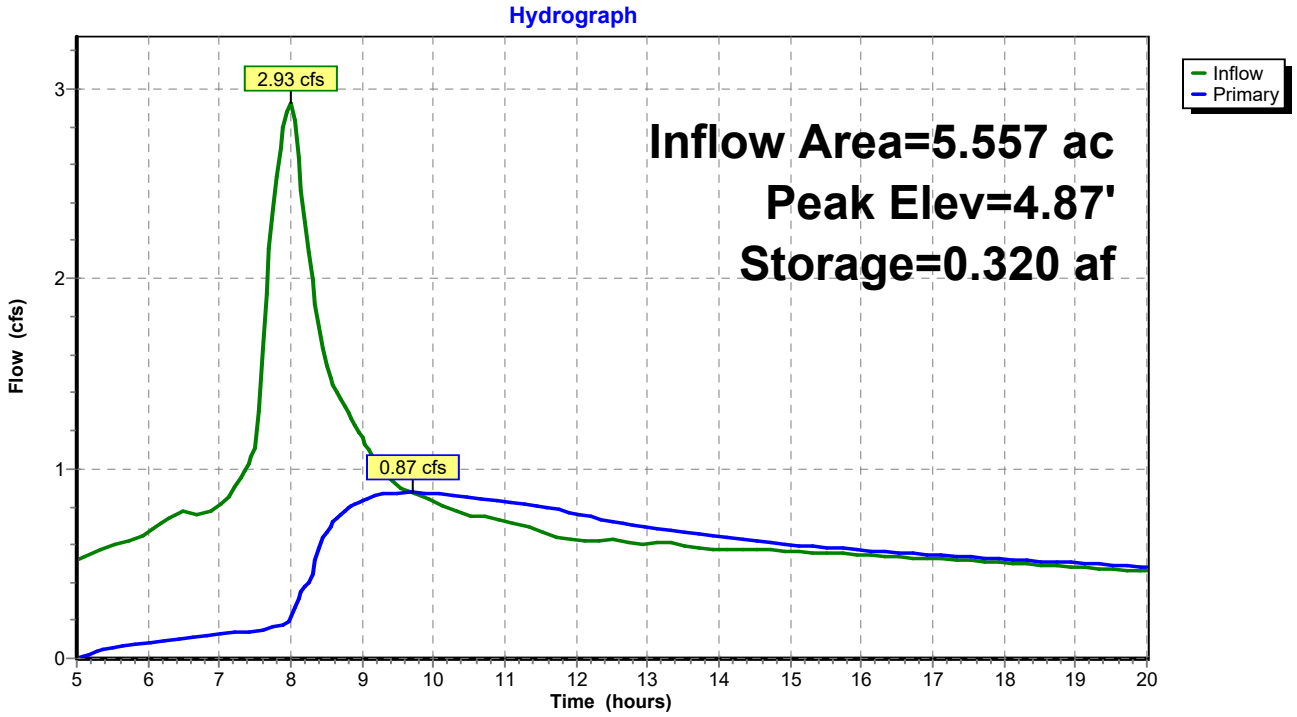
Plug-Flow detention time= 253.7 min calculated for 0.668 af (71% of inflow)
Center-of-Mass det. time= 118.9 min (794.2 - 675.3)

Volume	Invert	Avail.Storage	Storage Description
#1	0.00'	0.393 af	**24.00'W x 119.00'L x 6.00'H Prismatoid**

Device	Routing	Invert	Outlet Devices
#1	Primary	0.00'	**2.0" Vert. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#2	Primary	3.25'	**3.0" Vert. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#3	Primary	4.00'	**4.0" Vert. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#4	Primary	6.00'	**12.0" Vert. Overflow Riser** C= 0.600 Limited to weir flow at low heads

Primary OutFlow Max=0.87 cfs @ 9.70 hrs HW=4.87' (Free Discharge)
- **1=Orifice/Grate** (Orifice Controls 0.23 cfs @ 10.54 fps)
- **2=Orifice/Grate** (Orifice Controls 0.29 cfs @ 5.90 fps)
- **3=Orifice/Grate** (Orifice Controls 0.35 cfs @ 4.05 fps)
- **4=Overflow Riser** (Controls 0.00 cfs)

Pond 12P: Facility 2 (North Tank)



Summary for Pond 13P: Facility 3 (South Tank)

[82] Warning: Early inflow requires earlier time span
[92] Warning: Device #4 is above defined storage

Inflow Area = 3.075 ac, 47.67% Impervious, Inflow Depth > 1.93" for 5-year event
Inflow = 1.60 cfs @ 7.97 hrs, Volume= 0.496 af
Outflow = 0.39 cfs @ 10.81 hrs, Volume= 0.336 af, Atten= 76%, Lag= 170.0 min
Primary = 0.39 cfs @ 10.81 hrs, Volume= 0.336 af

Routing by Stor-Ind method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Peak Elev= 5.00' @ 10.81 hrs Surf.Area= 0.035 ac Storage= 0.173 af

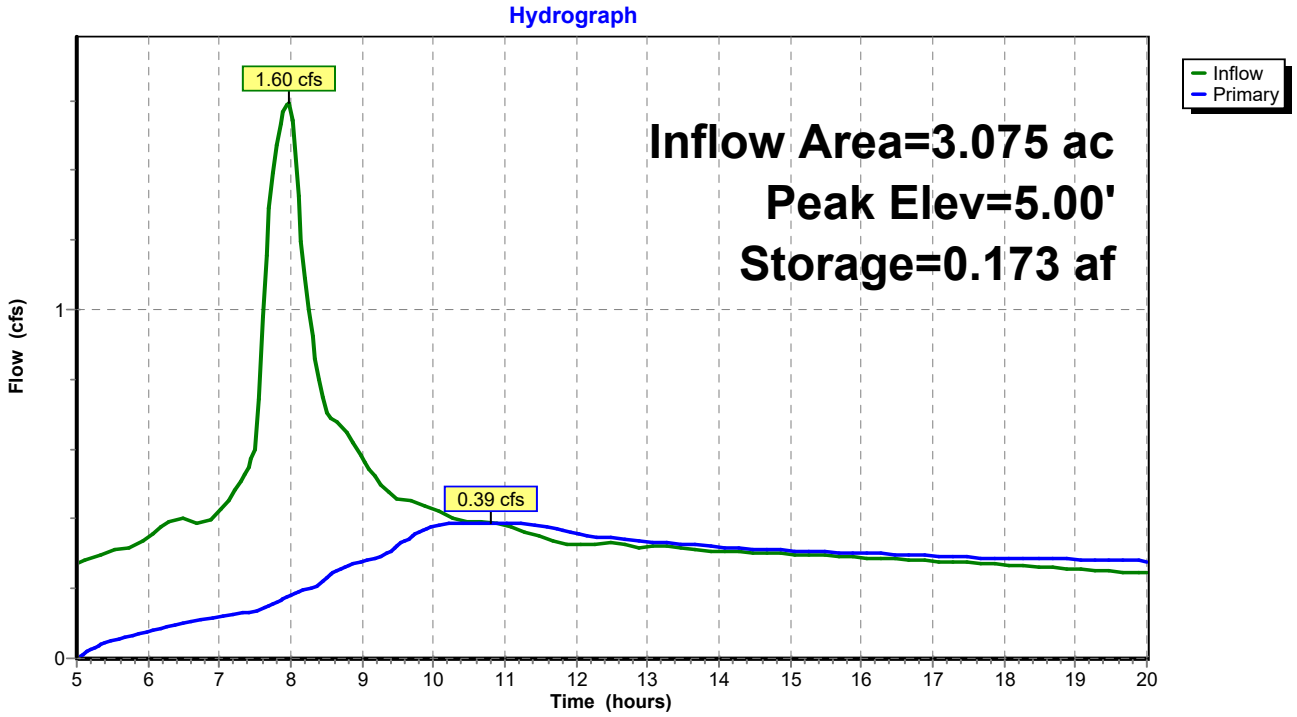
Plug-Flow detention time= 273.9 min calculated for 0.335 af (68% of inflow)
Center-of-Mass det. time= 125.8 min (803.1 - 677.2)

Volume	Invert	Avail.Storage	Storage Description
#1	0.00'	0.208 af	**26.00'W x 58.00'L x 6.00'H Prismatoid**

Device	Routing	Invert	Outlet Devices
#1	Primary	0.00'	**2.0" Vert. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#2	Primary	4.00'	**1.7" Vert. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#3	Primary	4.75'	**3.0" Vert. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#4	Primary	6.00'	**12.0" Vert. Overflow Riser** C= 0.600 Limited to weir flow at low heads

Primary OutFlow Max=0.39 cfs @ 10.81 hrs HW=5.00' (Free Discharge)
- **1=Orifice/Grate** (Orifice Controls 0.23 cfs @ 10.68 fps)
- **2=Orifice/Grate** (Orifice Controls 0.07 cfs @ 4.65 fps)
- **3=Orifice/Grate** (Orifice Controls 0.08 cfs @ 1.72 fps)
- **4=Overflow Riser** (Controls 0.00 cfs)

Pond 13P: Facility 3 (South Tank)



Time span=5.00-20.00 hrs, dt=0.05 hrs, 301 points
Runoff by SBUH method, Split Pervious/Imperv.
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment1S: Basin 2 (North Lot) Runoff Area=2.489 ac 60.71% Impervious Runoff Depth>2.48"
Flow Length=544' Tc=13.0 min CN=56/98 Runoff=1.63 cfs 0.515 af

Subcatchment2S: Basin 1 (Highway 211) Runoff Area=0.558 ac 42.38% Impervious Runoff Depth>3.19"
Flow Length=549' Slope=0.0250 '/' Tc=7.8 min CN=87/98 Runoff=0.53 cfs 0.149 af

Subcatchment3S: Basin 4 (South Lot) Runoff Area=3.075 ac 47.67% Impervious Runoff Depth>2.11"
Flow Length=543' Tc=6.8 min CN=56/98 Runoff=1.76 cfs 0.540 af

Subcatchment4S: Basin 3 (Right of Way) Runoff Area=3.068 ac 43.84% Impervious Runoff Depth>2.00"
Flow Length=365' Tc=10.1 min CN=56/98 Runoff=1.57 cfs 0.510 af

Subcatchment5S: Basin 5 (Area 2) Runoff Area=0.243 ac 86.42% Impervious Runoff Depth>3.22"
Flow Length=116' Tc=0.9 min CN=56/98 Runoff=0.24 cfs 0.065 af

Pond 9P: Facility 1 (Swale) Peak Elev=-0.95' Storage=0.011 af Inflow=0.53 cfs 0.149 af
Outflow=0.39 cfs 0.145 af

Pond 10P: Facility 4 (Stormtech) Peak Elev=1.40' Storage=0.016 af Inflow=0.24 cfs 0.065 af
Outflow=0.07 cfs 0.062 af

Pond 12P: Facility 2 (North Tank) Peak Elev=5.16' Storage=0.339 af Inflow=3.19 cfs 1.026 af
Outflow=0.97 cfs 0.750 af

Pond 13P: Facility 3 (South Tank) Peak Elev=5.20' Storage=0.180 af Inflow=1.76 cfs 0.540 af
Outflow=0.45 cfs 0.376 af

Total Runoff Area = 9.433 ac Runoff Volume = 1.779 af Average Runoff Depth = 2.26"
49.45% Pervious = 4.665 ac 50.55% Impervious = 4.769 ac

Summary for Subcatchment 1S: Basin 2 (North Lot)

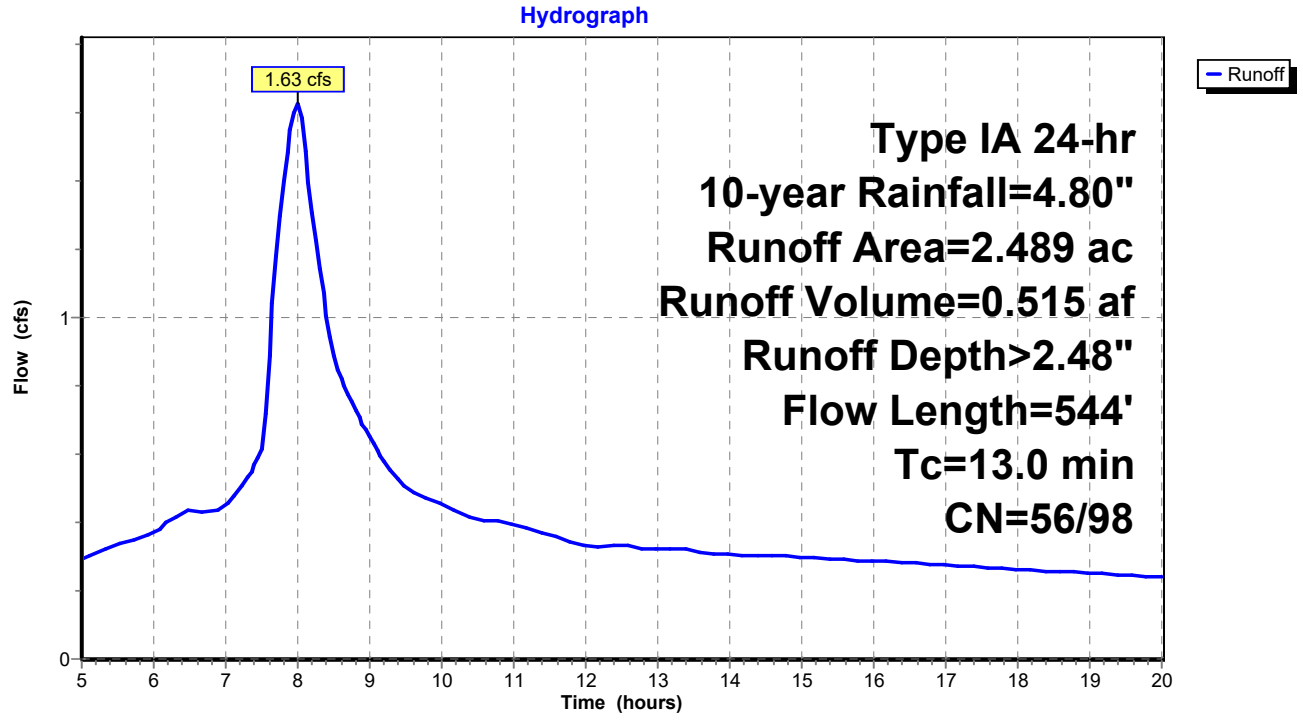
Runoff = 1.63 cfs @ 8.00 hrs, Volume= 0.515 af, Depth> 2.48"
Routed to Pond 12P : Facility 2 (North Tank)

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type IA 24-hr 10-year Rainfall=4.80"

	Area (ac)	CN	Description
	0.433	98	Roofs, HSG B
	1.078	98	Paved parking, HSG B
*	0.978	56	Lawn
	2.489	81	Weighted Average
	0.978	56	39.29% Pervious Area
	1.511	98	60.71% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
11.2	146	0.0273	0.22		**Sheet Flow, Lawn** Grass: Short n= 0.150 P2= 3.50"
1.3	168	0.0420	2.15		**Sheet Flow, Lot** Smooth surfaces n= 0.011 P2= 3.50"
0.5	230	0.0300	7.86	6.17	**Pipe Channel, Conveyance** 12.0" Round Area= 0.8 sf Perim= 3.1' r= 0.25' n= 0.013 Corrugated PE, smooth interior
13.0	544	Total			

Subcatchment 1S: Basin 2 (North Lot)



Summary for Subcatchment 2S: Basin 1 (Highway 211)

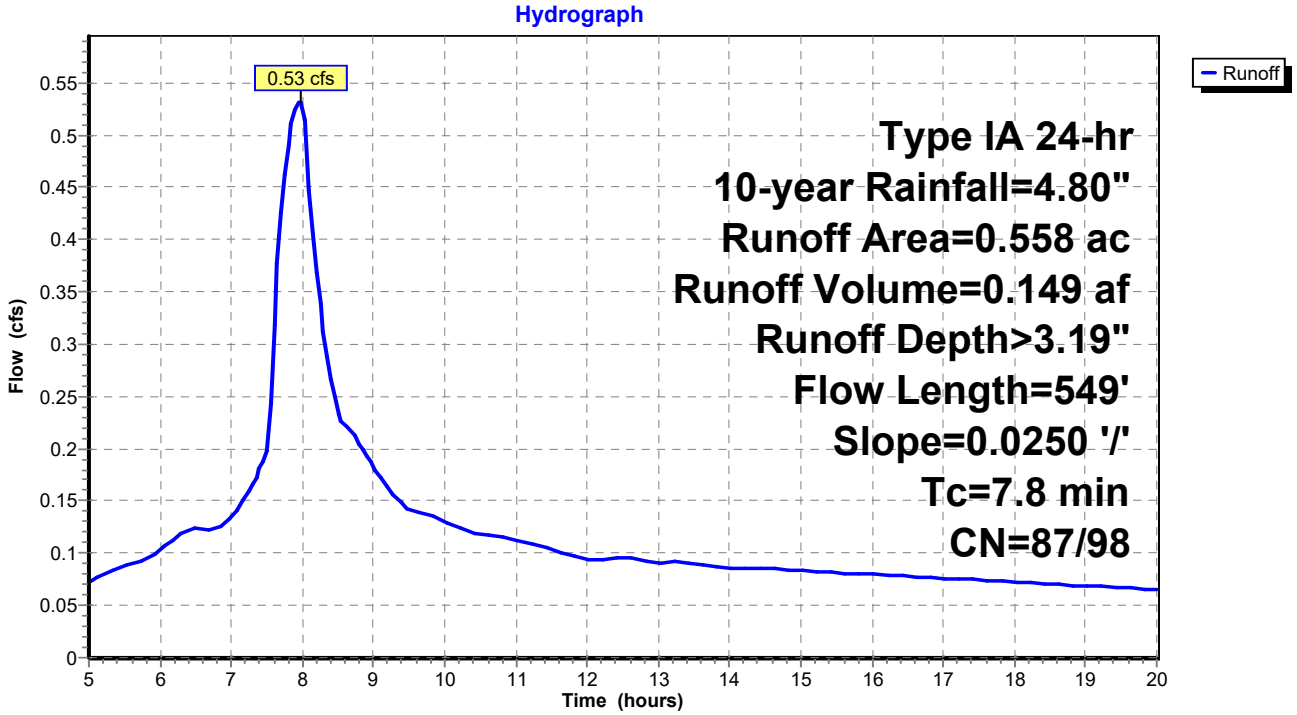
Runoff = 0.53 cfs @ 7.97 hrs, Volume= 0.149 af, Depth> 3.19"
Routed to Pond 9P : Facility 1 (Swale)

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type IA 24-hr 10-year Rainfall=4.80"

	Area (ac)	CN	Description
*	0.473	98	Paved roads w/open ditches, 50% imp, HSG B
*	0.085	56	>75% Grass cover, Good, HSG B
	0.558	92	Weighted Average
	0.322	87	57.62% Pervious Area
	0.237	98	42.38% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.8	65	0.0250	1.44		**Sheet Flow, Road** Smooth surfaces n= 0.011 P2= 3.50"
7.0	484	0.0250	1.15	5.73	**Channel Flow, Swale** Area= 5.0 sf Perim= 8.0' r= 0.63' n= 0.150 Sheet flow over Short Grass
7.8	549	Total			

Subcatchment 2S: Basin 1 (Highway 211)



Summary for Subcatchment 3S: Basin 4 (South Lot)

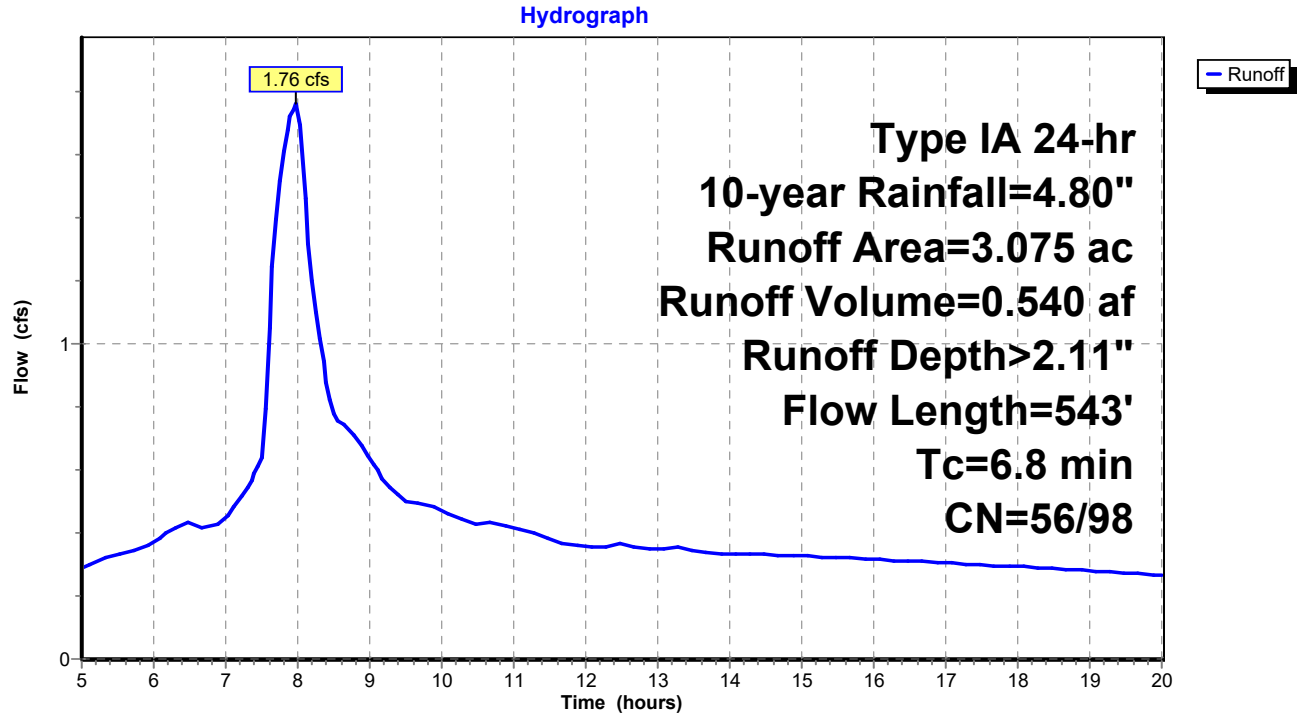
Runoff = 1.76 cfs @ 7.98 hrs, Volume= 0.540 af, Depth> 2.11"
Routed to Pond 13P : Facility 3 (South Tank)

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type IA 24-hr 10-year Rainfall=4.80"

	Area (ac)	CN	Description
	1.038	98	Paved roads w/curbs & sewers, HSG B
	0.428	98	Unconnected roofs, HSG B
*	1.609	56	Lawn
	3.075	76	Weighted Average
	1.609	56	52.33% Pervious Area
	1.466	98	47.67% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.4	124	0.1200	0.38		**Sheet Flow, Lawn** Grass: Short n= 0.150 P2= 3.50"
0.5	54	0.0500	1.83		**Sheet Flow, Pavement** Smooth surfaces n= 0.011 P2= 3.50"
0.9	365	0.0200	6.42	5.04	**Pipe Channel, Conveyance** 12.0" Round Area= 0.8 sf Perim= 3.1' r= 0.25' n= 0.013 Corrugated PE, smooth interior
6.8	543	Total			

Subcatchment 3S: Basin 4 (South Lot)



Summary for Subcatchment 4S: Basin 3 (Right of Way)

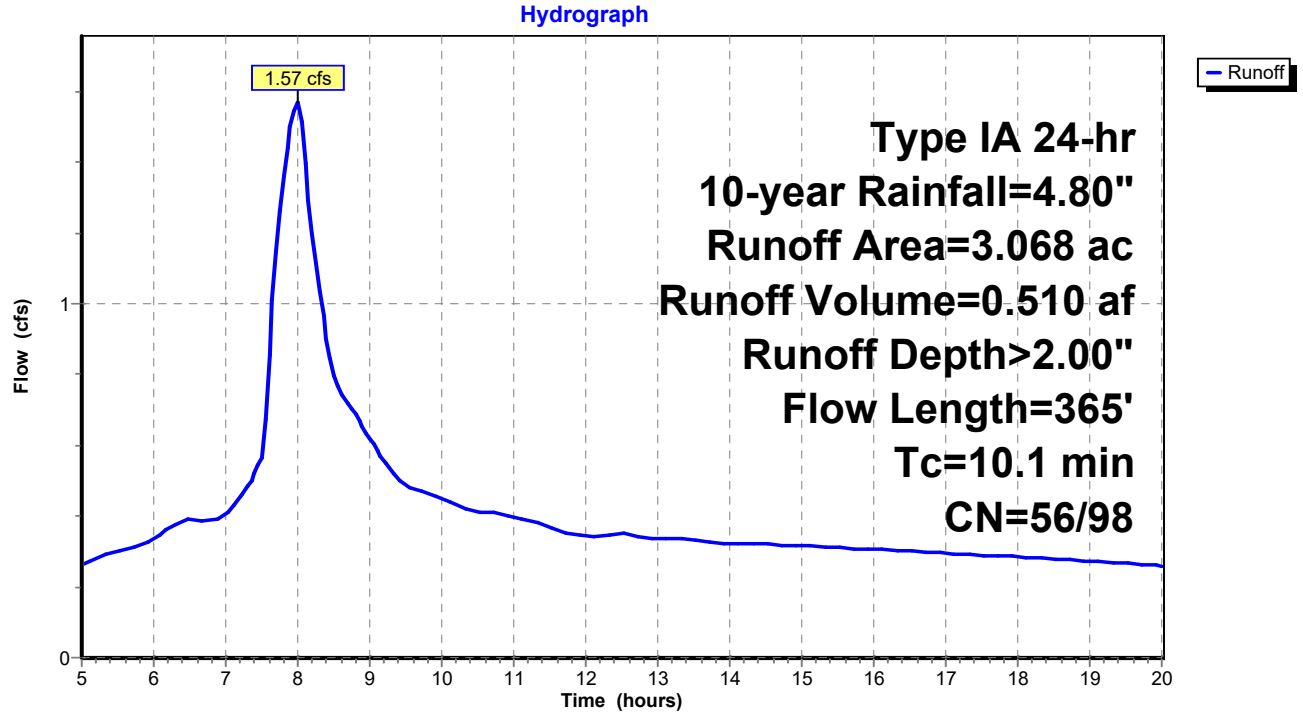
Runoff = 1.57 cfs @ 7.99 hrs, Volume= 0.510 af, Depth> 2.00"
Routed to Pond 12P : Facility 2 (North Tank)

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type IA 24-hr 10-year Rainfall=4.80"

	Area (ac)	CN	Description
	1.345	98	Paved roads w/curbs & sewers, HSG B
*	1.723	56	Lawn
	3.068	74	Weighted Average
	1.723	56	56.16% Pervious Area
	1.345	98	43.84% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
9.1	200	0.0866	0.37		**Sheet Flow, Lawn** Grass: Short n= 0.150 P2= 3.50"
0.9	140	0.0800	2.68		**Sheet Flow, Pavement** Smooth surfaces n= 0.011 P2= 3.50"
0.1	25	0.0200	6.42	5.04	**Pipe Channel, Conveyance** 12.0" Round Area= 0.8 sf Perim= 3.1' r= 0.25' n= 0.013 Corrugated PE, smooth interior
10.1	365	Total			

Subcatchment 4S: Basin 3 (Right of Way)



Summary for Subcatchment 5S: Basin 5 (Area 2)

[49] Hint: Tc<2dt may require smaller dt

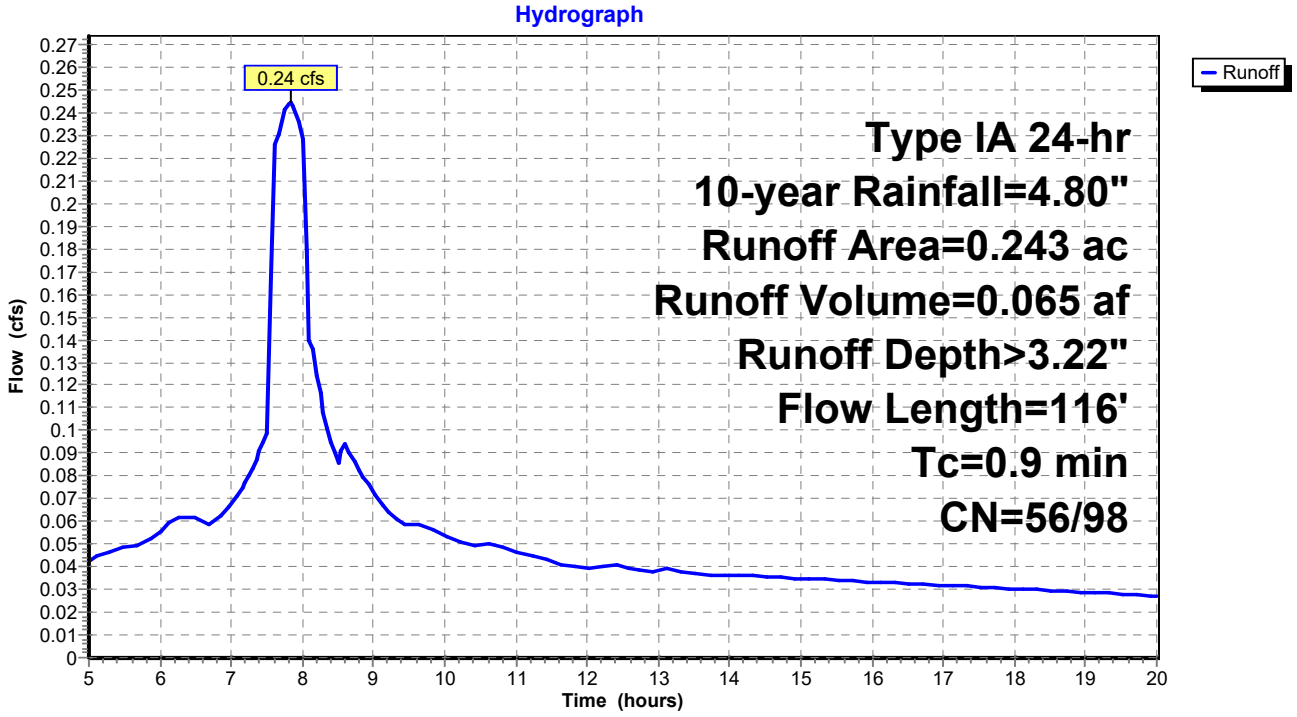
Runoff = 0.24 cfs @ 7.83 hrs, Volume= 0.065 af, Depth> 3.22"
Routed to Pond 10P : Facility 4 (Stormtech)

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type IA 24-hr 10-year Rainfall=4.80"

	Area (ac)	CN	Description
	0.210	98	Paved parking, HSG B
*	0.033	56	Lawn
	0.243	92	Weighted Average
	0.033	56	13.58% Pervious Area
	0.210	98	86.42% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.8	80	0.0280	1.57		**Sheet Flow, Pavement** Smooth surfaces n= 0.011 P2= 3.50"
0.1	36	0.0200	6.42	5.04	**Pipe Channel, Conveyance** 12.0" Round Area= 0.8 sf Perim= 3.1' r= 0.25' n= 0.013 Corrugated PE, smooth interior
0.9	116	Total			

Subcatchment 5S: Basin 5 (Area 2)



Summary for Pond 9P: Facility 1 (Swale)

[82] Warning: Early inflow requires earlier time span

Inflow Area = 0.558 ac, 42.38% Impervious, Inflow Depth > 3.19" for 10-year event
Inflow = 0.53 cfs @ 7.97 hrs, Volume= 0.149 af
Outflow = 0.39 cfs @ 8.17 hrs, Volume= 0.145 af, Atten= 26%, Lag= 11.9 min
Primary = 0.39 cfs @ 8.17 hrs, Volume= 0.145 af

Routing by Stor-Ind method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Peak Elev= -0.95' @ 8.17 hrs Surf.Area= 0.055 ac Storage= 0.011 af

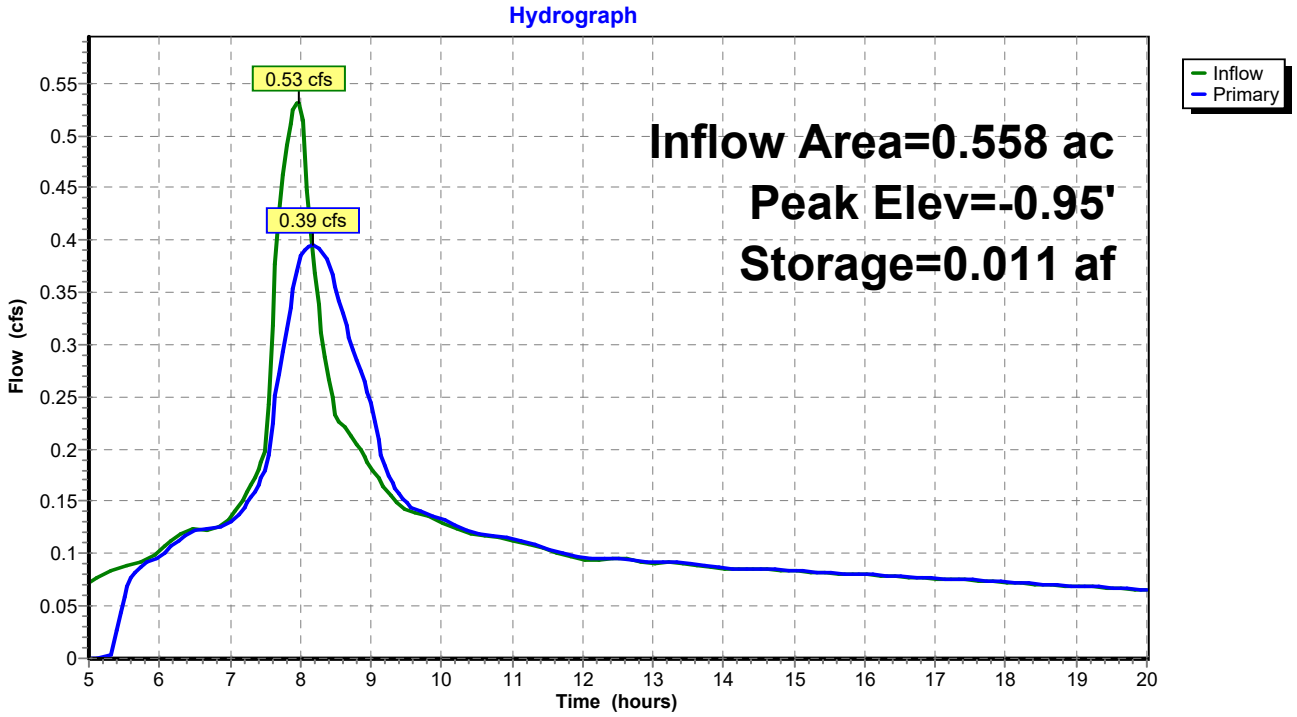
Plug-Flow detention time= 23.7 min calculated for 0.145 af (97% of inflow)
Center-of-Mass det. time= 11.8 min (674.1 - 662.3)

Volume	Invert	Avail.Storage	Storage Description
#1	-1.00'	0.053 af	**2.00'W x 455.00'L x 1.00'H Swale Z=3.0**
#2	-1.50'	0.005 af	**2.00'W x 455.00'L x 0.50'H Prismatoid** 0.010 af Overall x 46.6% Voids
#3	-2.00'	0.001 af	**4.0" Round Pipe Storage** Inside #4 L= 455.0'
#4	-2.50'	0.004 af	**1.00'W x 455.00'L x 1.00'H Prismatoid** 0.010 af Overall - 0.001 af Embedded = 0.010 af x 40.0% Voids
		0.062 af	Total Available Storage

Device	Routing	Invert	Outlet Devices
#1	Primary	-2.00'	**4.0" Vert. Orifice/Grate** C= 0.600 Limited to weir flow at low heads

Primary OutFlow Max=0.39 cfs @ 8.17 hrs HW=-0.95' (Free Discharge)
↑**1=Orifice/Grate** (Orifice Controls 0.39 cfs @ 4.52 fps)

Pond 9P: Facility 1 (Swale)



Summary for Pond 10P: Facility 4 (Stormtech)

[82] Warning: Early inflow requires earlier time span

Inflow Area = 0.243 ac, 86.42% Impervious, Inflow Depth > 3.22" for 10-year event
Inflow = 0.24 cfs @ 7.83 hrs, Volume= 0.065 af
Outflow = 0.07 cfs @ 9.10 hrs, Volume= 0.062 af, Atten= 72%, Lag= 76.1 min
Primary = 0.07 cfs @ 9.10 hrs, Volume= 0.062 af

Routing by Stor-Ind method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Peak Elev= 1.40' @ 9.10 hrs Surf.Area= 0.021 ac Storage= 0.016 af

Plug-Flow detention time= 130.1 min calculated for 0.061 af (94% of inflow)
Center-of-Mass det. time= 99.9 min (748.8 - 648.9)

Volume	Invert	Avail.Storage	Storage Description
#1A	0.00'	0.013 af	**29.08'W x 30.95'L x 2.00'H Field A** 0.041 af Overall - 0.008 af Embedded = 0.033 af x 40.0% Voids
#2A	0.50'	0.008 af	**ADS_StormTech SC-160LP +Cap**x 52 Inside #1 Effective Size= 18.0"W x 12.0"H => 0.96 sf x 7.12'L = 6.8 cf Overall Size= 25.0"W x 12.0"H x 7.56'L with 0.44' Overlap 52 Chambers in 13 Rows
		0.021 af	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Primary	0.00'	**1.5" Vert. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#2	Primary	1.92'	**12.0" Vert. Overflow Riser** C= 0.600 Limited to weir flow at low heads

Primary OutFlow Max=0.07 cfs @ 9.10 hrs HW=1.40' (Free Discharge)
1=Orifice/Grate (Orifice Controls 0.07 cfs @ 5.58 fps)
2=Overflow Riser (Controls 0.00 cfs)

Pond 10P: Facility 4 (Stormtech) - Chamber Wizard Field A

Chamber Model = ADS_StormTechSC-160LP +Cap (ADS StormTech® SC-160LP with cap length)
Effective Size= 18.0"W x 12.0"H => 0.96 sf x 7.12'L = 6.8 cf
Overall Size= 25.0"W x 12.0"H x 7.56'L with 0.44' Overlap

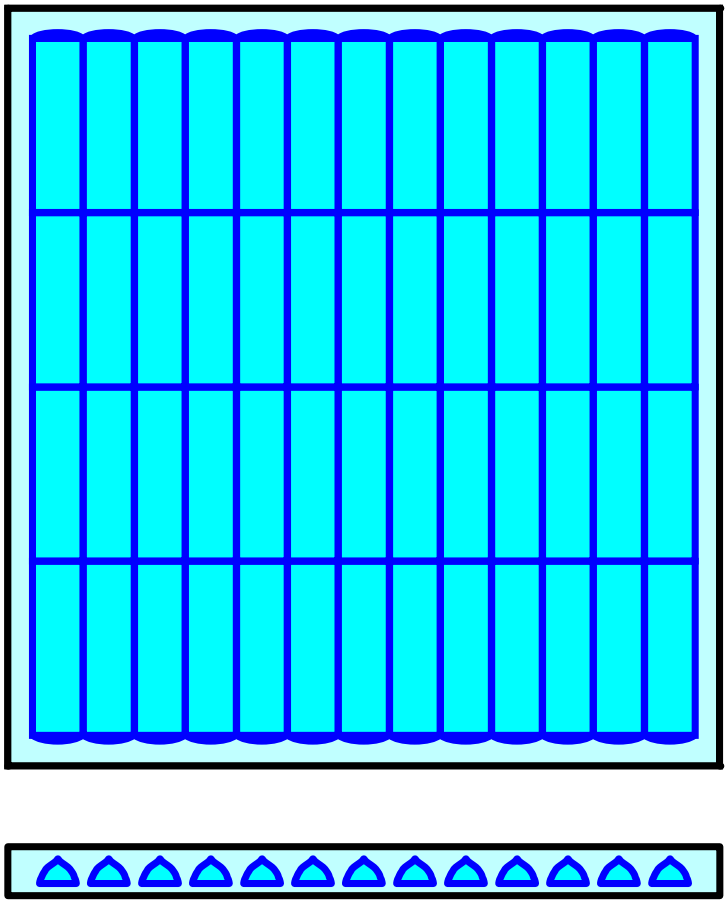
4 Chambers/Row x 7.12' Long +0.23' Cap Length x 2 = 28.95' Row Length +12.0" End Stone x 2 = 30.95' Base Length
13 Rows x 25.0" Wide + 12.0" Side Stone x 2 = 29.08' Base Width
6.0" Stone Base + 12.0" Chamber Height + 6.0" Stone Cover = 2.00' Field Height

52 Chambers x 6.8 cf = 355.5 cf Chamber Storage

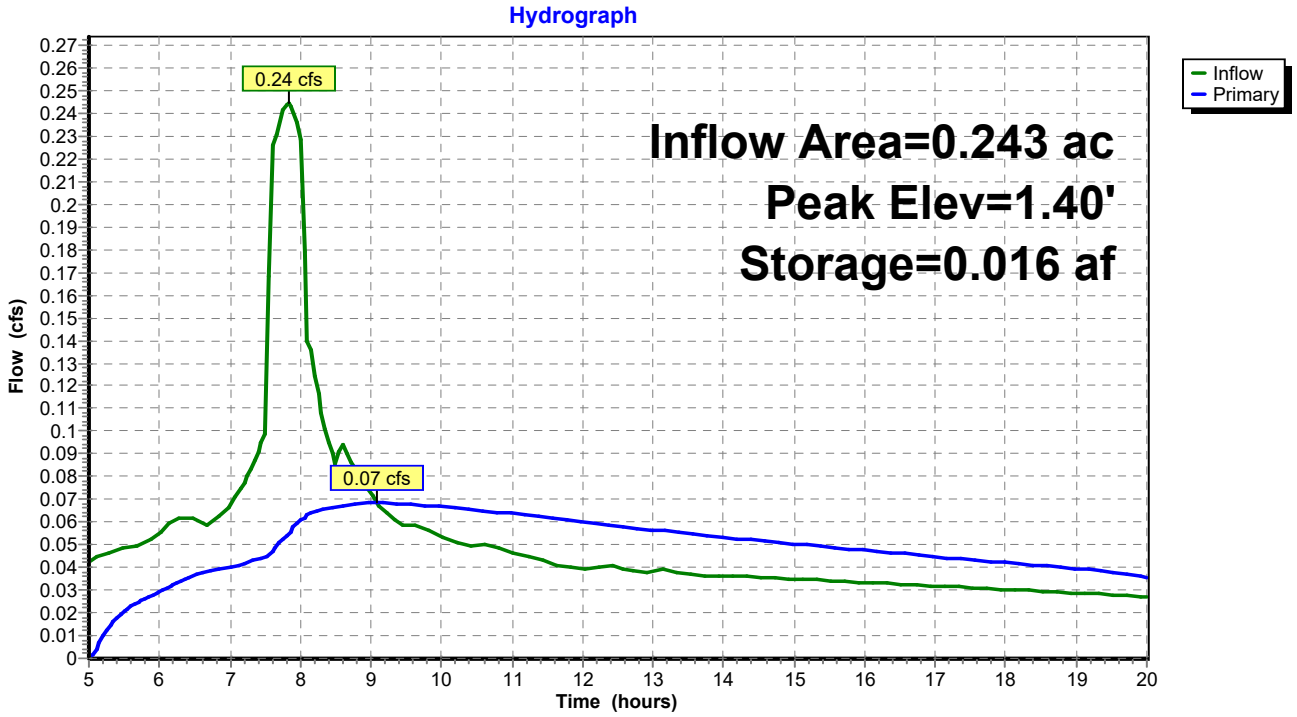
1,800.1 cf Field - 355.5 cf Chambers = 1,444.5 cf Stone x 40.0% Voids = 577.8 cf Stone Storage

Chamber Storage + Stone Storage = 933.3 cf = 0.021 af
Overall Storage Efficiency = 51.9%
Overall System Size = 30.95' x 29.08' x 2.00'

52 Chambers
66.7 cy Field
53.5 cy Stone



Pond 10P: Facility 4 (Stormtech)



Summary for Pond 12P: Facility 2 (North Tank)

[82] Warning: Early inflow requires earlier time span
[92] Warning: Device #4 is above defined storage

Inflow Area = 5.557 ac, 51.39% Impervious, Inflow Depth > 2.21" for 10-year event
Inflow = 3.19 cfs @ 7.99 hrs, Volume= 1.026 af
Outflow = 0.97 cfs @ 9.57 hrs, Volume= 0.750 af, Atten= 70%, Lag= 94.5 min
Primary = 0.97 cfs @ 9.57 hrs, Volume= 0.750 af

Routing by Stor-Ind method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Peak Elev= 5.16' @ 9.57 hrs Surf.Area= 0.066 ac Storage= 0.339 af

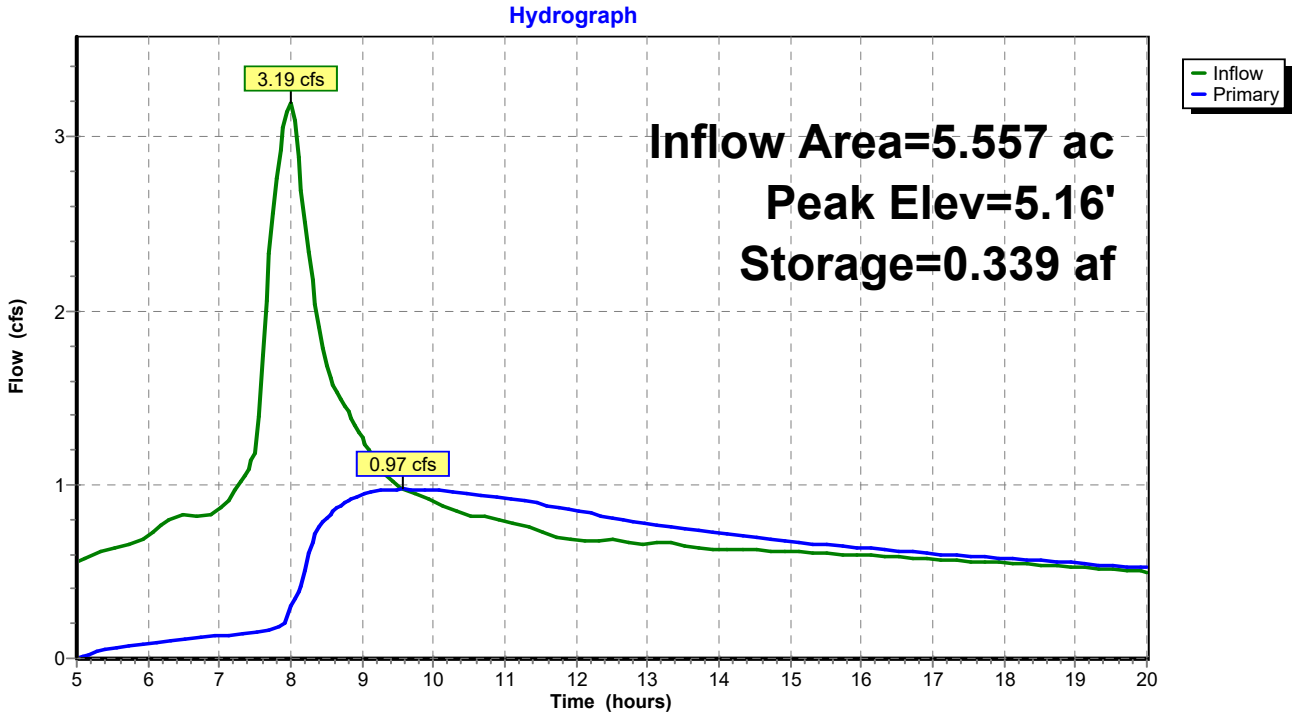
Plug-Flow detention time= 242.5 min calculated for 0.746 af (73% of inflow)
Center-of-Mass det. time= 115.8 min (791.9 - 676.1)

Volume	Invert	Avail.Storage	Storage Description
#1	0.00'	0.393 af	**24.00'W x 119.00'L x 6.00'H Prismatoid**

Device	Routing	Invert	Outlet Devices
#1	Primary	0.00'	**2.0" Vert. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#2	Primary	3.25'	**3.0" Vert. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#3	Primary	4.00'	**4.0" Vert. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#4	Primary	6.00'	**12.0" Vert. Overflow Riser** C= 0.600 Limited to weir flow at low heads

Primary OutFlow Max=0.97 cfs @ 9.57 hrs HW=5.16' (Free Discharge)
- **1=Orifice/Grate** (Orifice Controls 0.24 cfs @ 10.85 fps)
- **2=Orifice/Grate** (Orifice Controls 0.32 cfs @ 6.44 fps)
- **3=Orifice/Grate** (Orifice Controls 0.42 cfs @ 4.81 fps)
- **4=Overflow Riser** (Controls 0.00 cfs)

Pond 12P: Facility 2 (North Tank)



Summary for Pond 13P: Facility 3 (South Tank)

[82] Warning: Early inflow requires earlier time span
[92] Warning: Device #4 is above defined storage

Inflow Area = 3.075 ac, 47.67% Impervious, Inflow Depth > 2.11" for 10-year event
Inflow = 1.76 cfs @ 7.98 hrs, Volume= 0.540 af
Outflow = 0.45 cfs @ 10.15 hrs, Volume= 0.376 af, Atten= 74%, Lag= 130.5 min
Primary = 0.45 cfs @ 10.15 hrs, Volume= 0.376 af

Routing by Stor-Ind method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Peak Elev= 5.20' @ 10.15 hrs Surf.Area= 0.035 ac Storage= 0.180 af

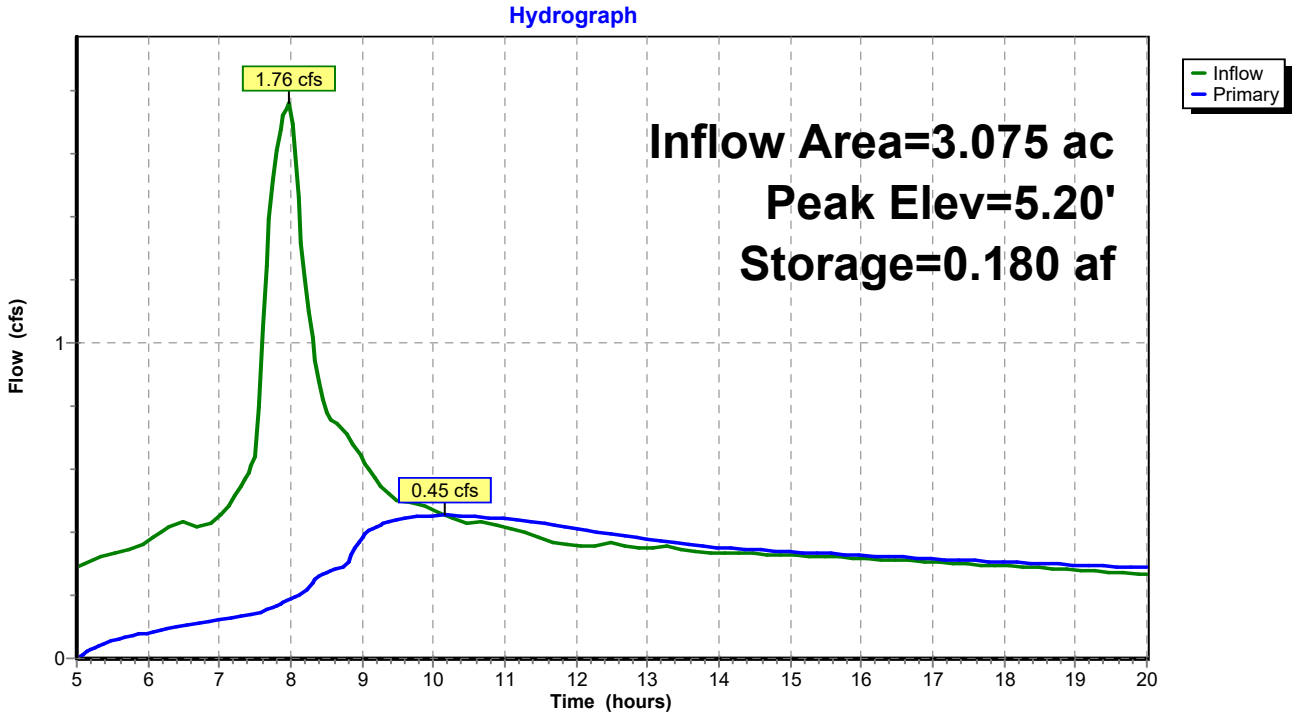
Plug-Flow detention time= 258.2 min calculated for 0.375 af (69% of inflow)
Center-of-Mass det. time= 116.8 min (794.9 - 678.0)

Volume	Invert	Avail.Storage	Storage Description
#1	0.00'	0.208 af	**26.00'W x 58.00'L x 6.00'H Prismatoid**

Device	Routing	Invert	Outlet Devices
#1	Primary	0.00'	**2.0" Vert. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#2	Primary	4.00'	**1.7" Vert. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#3	Primary	4.75'	**3.0" Vert. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#4	Primary	6.00'	**12.0" Vert. Overflow Riser** C= 0.600 Limited to weir flow at low heads

Primary OutFlow Max=0.45 cfs @ 10.15 hrs HW=5.20' (Free Discharge)
- **1=Orifice/Grate** (Orifice Controls 0.24 cfs @ 10.89 fps)
- **2=Orifice/Grate** (Orifice Controls 0.08 cfs @ 5.12 fps)
- **3=Orifice/Grate** (Orifice Controls 0.14 cfs @ 2.76 fps)
- **4=Overflow Riser** (Controls 0.00 cfs)

Pond 13P: Facility 3 (South Tank)



Time span=5.00-20.00 hrs, dt=0.05 hrs, 301 points
Runoff by SBUH method, Split Pervious/Imperv.
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment1S: Basin 2 (North Lot) Runoff Area=2.489 ac 60.71% Impervious Runoff Depth>2.93"
Flow Length=544' Tc=13.0 min CN=56/98 Runoff=1.93 cfs 0.608 af

Subcatchment2S: Basin 1 (Highway 211) Runoff Area=0.558 ac 42.38% Impervious Runoff Depth>3.74"
Flow Length=549' Slope=0.0250 '/' Tc=7.8 min CN=87/98 Runoff=0.62 cfs 0.174 af

Subcatchment3S: Basin 4 (South Lot) Runoff Area=3.075 ac 47.67% Impervious Runoff Depth>2.52"
Flow Length=543' Tc=6.8 min CN=56/98 Runoff=2.14 cfs 0.647 af

Subcatchment4S: Basin 3 (Right of Way) Runoff Area=3.068 ac 43.84% Impervious Runoff Depth>2.41"
Flow Length=365' Tc=10.1 min CN=56/98 Runoff=1.92 cfs 0.615 af

Subcatchment5S: Basin 5 (Area 2) Runoff Area=0.243 ac 86.42% Impervious Runoff Depth>3.72"
Flow Length=116' Tc=0.9 min CN=56/98 Runoff=0.28 cfs 0.075 af

Pond 9P: Facility 1 (Swale) Peak Elev=-0.84' Storage=0.014 af Inflow=0.62 cfs 0.174 af
Outflow=0.42 cfs 0.171 af

Pond 10P: Facility 4 (Stormtech) Peak Elev=1.80' Storage=0.020 af Inflow=0.28 cfs 0.075 af
Outflow=0.08 cfs 0.070 af

Pond 12P: Facility 2 (North Tank) Peak Elev=5.94' Storage=0.390 af Inflow=3.86 cfs 1.223 af
Outflow=1.19 cfs 0.937 af

Pond 13P: Facility 3 (South Tank) Peak Elev=5.85' Storage=0.202 af Inflow=2.14 cfs 0.647 af
Outflow=0.59 cfs 0.478 af

Total Runoff Area = 9.433 ac Runoff Volume = 2.119 af Average Runoff Depth = 2.70"
49.45% Pervious = 4.665 ac 50.55% Impervious = 4.769 ac

Summary for Subcatchment 1S: Basin 2 (North Lot)

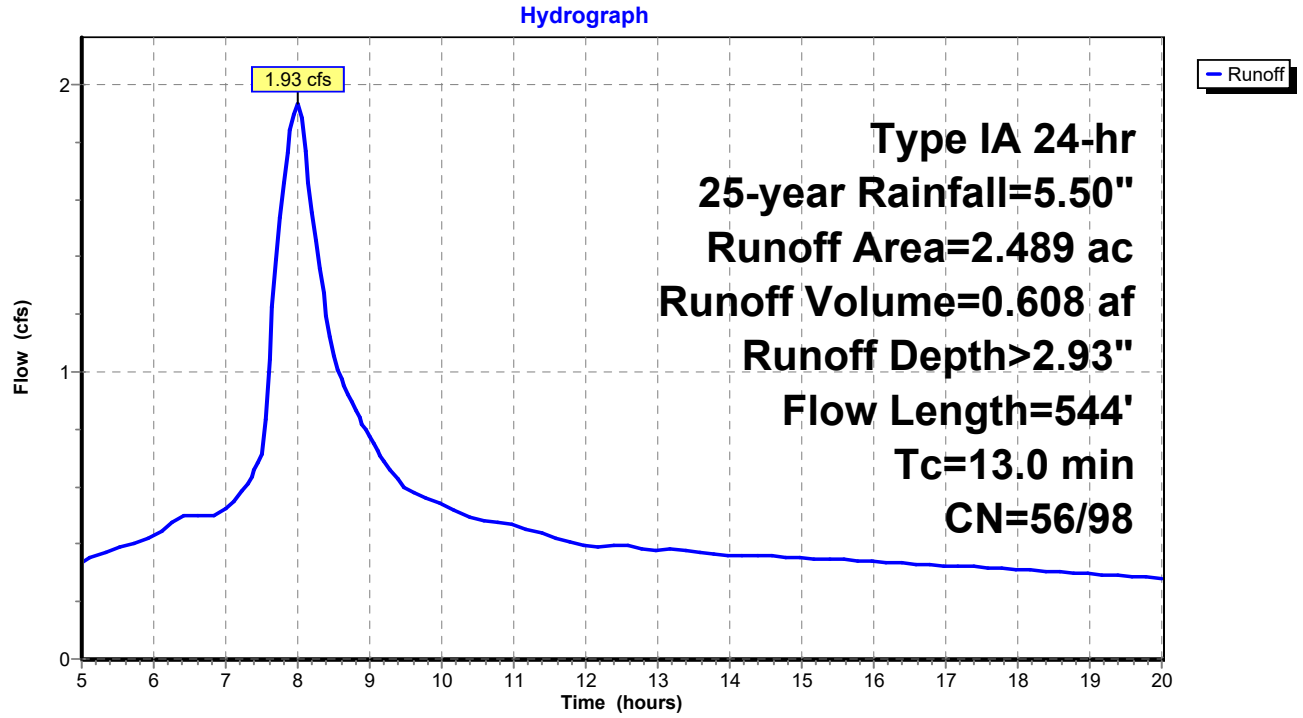
Runoff = 1.93 cfs @ 8.00 hrs, Volume= 0.608 af, Depth> 2.93"
Routed to Pond 12P : Facility 2 (North Tank)

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type IA 24-hr 25-year Rainfall=5.50"

	Area (ac)	CN	Description
	0.433	98	Roofs, HSG B
	1.078	98	Paved parking, HSG B
*	0.978	56	Lawn
	2.489	81	Weighted Average
	0.978	56	39.29% Pervious Area
	1.511	98	60.71% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
11.2	146	0.0273	0.22		**Sheet Flow, Lawn** Grass: Short n= 0.150 P2= 3.50"
1.3	168	0.0420	2.15		**Sheet Flow, Lot** Smooth surfaces n= 0.011 P2= 3.50"
0.5	230	0.0300	7.86	6.17	**Pipe Channel, Conveyance** 12.0" Round Area= 0.8 sf Perim= 3.1' r= 0.25' n= 0.013 Corrugated PE, smooth interior
13.0	544	Total			

Subcatchment 1S: Basin 2 (North Lot)



Summary for Subcatchment 2S: Basin 1 (Highway 211)

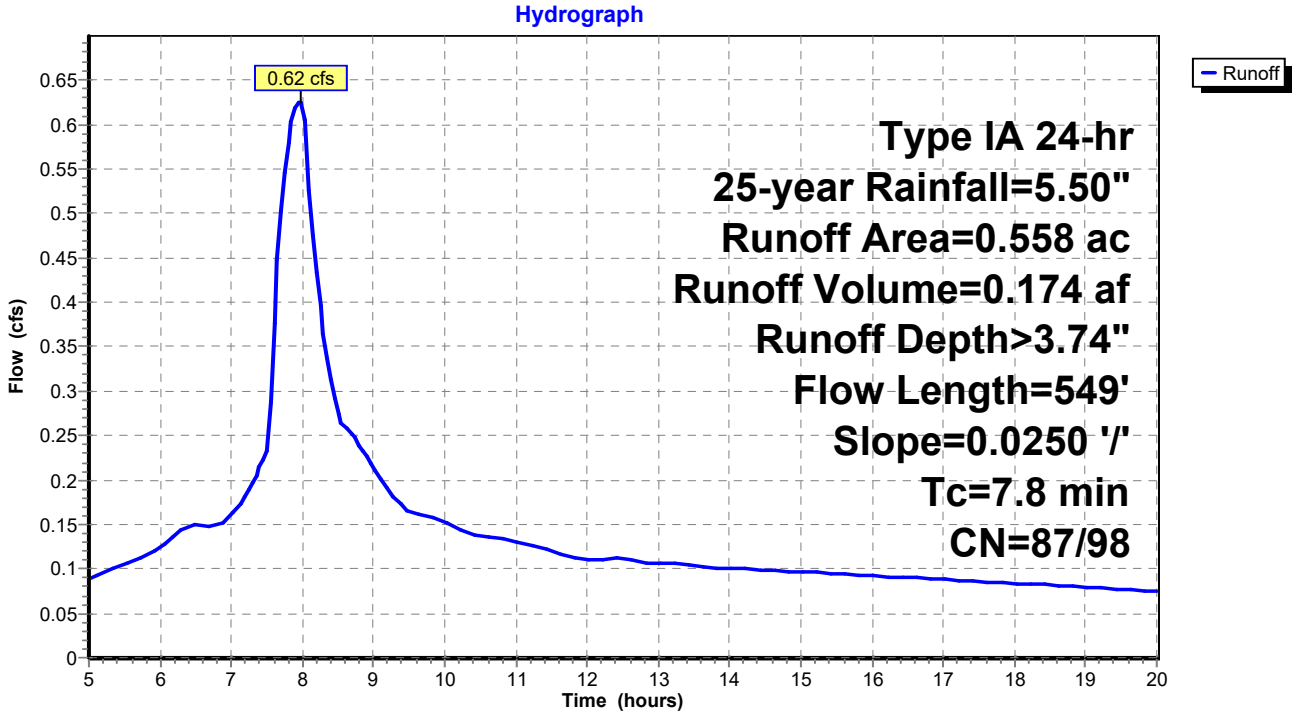
Runoff = 0.62 cfs @ 7.96 hrs, Volume= 0.174 af, Depth> 3.74"
Routed to Pond 9P : Facility 1 (Swale)

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type IA 24-hr 25-year Rainfall=5.50"

	Area (ac)	CN	Description
*	0.473	98	Paved roads w/open ditches, 50% imp, HSG B
*	0.085	56	>75% Grass cover, Good, HSG B
	0.558	92	Weighted Average
	0.322	87	57.62% Pervious Area
	0.237	98	42.38% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.8	65	0.0250	1.44		**Sheet Flow, Road** Smooth surfaces n= 0.011 P2= 3.50"
7.0	484	0.0250	1.15	5.73	**Channel Flow, Swale** Area= 5.0 sf Perim= 8.0' r= 0.63' n= 0.150 Sheet flow over Short Grass
7.8	549	Total			

Subcatchment 2S: Basin 1 (Highway 211)



Summary for Subcatchment 3S: Basin 4 (South Lot)

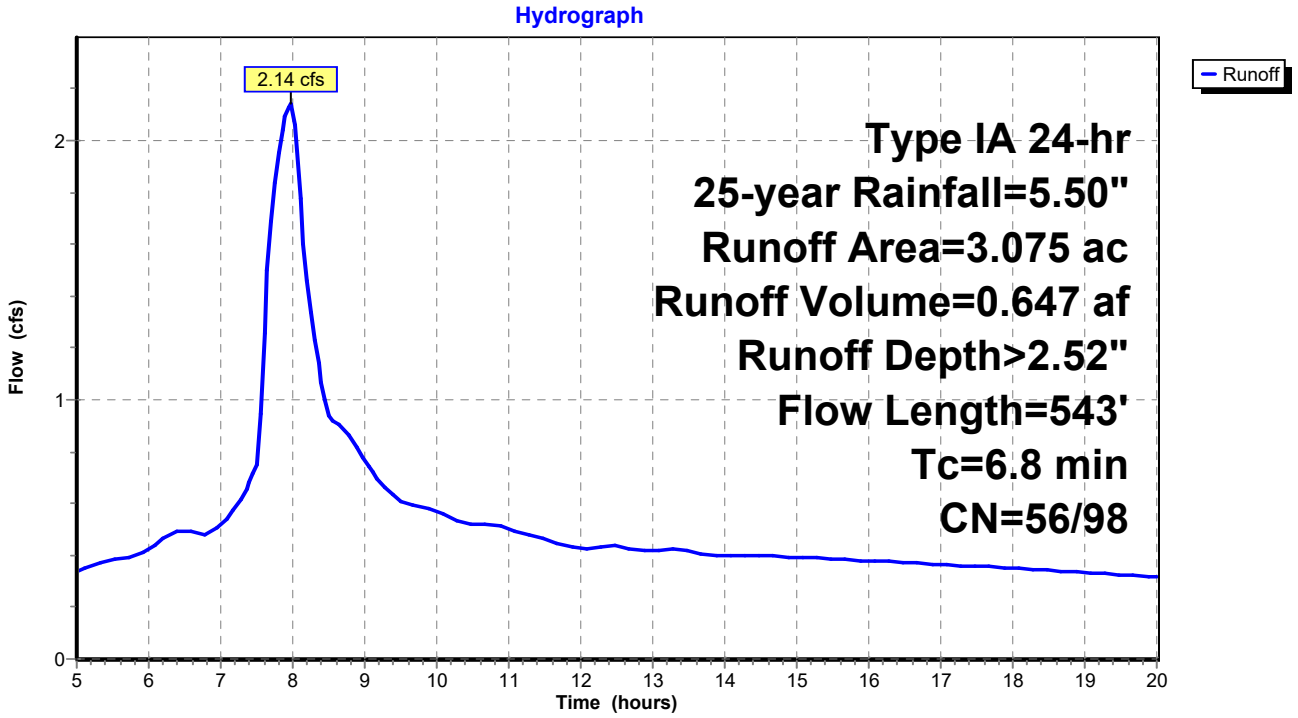
Runoff = 2.14 cfs @ 7.98 hrs, Volume= 0.647 af, Depth> 2.52"
Routed to Pond 13P : Facility 3 (South Tank)

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type IA 24-hr 25-year Rainfall=5.50"

	Area (ac)	CN	Description
	1.038	98	Paved roads w/curbs & sewers, HSG B
	0.428	98	Unconnected roofs, HSG B
*	1.609	56	Lawn
	3.075	76	Weighted Average
	1.609	56	52.33% Pervious Area
	1.466	98	47.67% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.4	124	0.1200	0.38		**Sheet Flow, Lawn** Grass: Short n= 0.150 P2= 3.50"
0.5	54	0.0500	1.83		**Sheet Flow, Pavement** Smooth surfaces n= 0.011 P2= 3.50"
0.9	365	0.0200	6.42	5.04	**Pipe Channel, Conveyance** 12.0" Round Area= 0.8 sf Perim= 3.1' r= 0.25' n= 0.013 Corrugated PE, smooth interior
6.8	543	Total			

Subcatchment 3S: Basin 4 (South Lot)



Summary for Subcatchment 4S: Basin 3 (Right of Way)

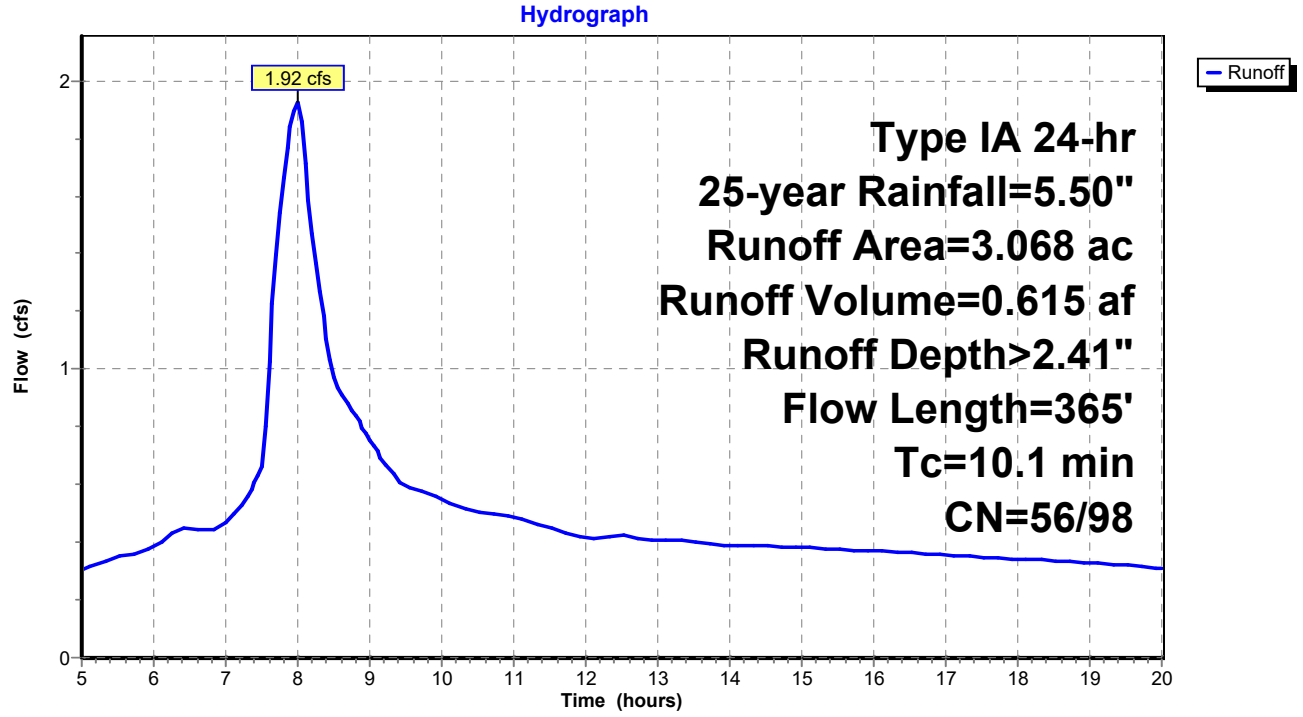
Runoff = 1.92 cfs @ 7.99 hrs, Volume= 0.615 af, Depth> 2.41"
Routed to Pond 12P : Facility 2 (North Tank)

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type IA 24-hr 25-year Rainfall=5.50"

	Area (ac)	CN	Description
	1.345	98	Paved roads w/curbs & sewers, HSG B
*	1.723	56	Lawn
	3.068	74	Weighted Average
	1.723	56	56.16% Pervious Area
	1.345	98	43.84% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
9.1	200	0.0866	0.37		**Sheet Flow, Lawn** Grass: Short n= 0.150 P2= 3.50"
0.9	140	0.0800	2.68		**Sheet Flow, Pavement** Smooth surfaces n= 0.011 P2= 3.50"
0.1	25	0.0200	6.42	5.04	**Pipe Channel, Conveyance** 12.0" Round Area= 0.8 sf Perim= 3.1' r= 0.25' n= 0.013 Corrugated PE, smooth interior
10.1	365	Total			

Subcatchment 4S: Basin 3 (Right of Way)



Summary for Subcatchment 5S: Basin 5 (Area 2)

[49] Hint: Tc<2dt may require smaller dt

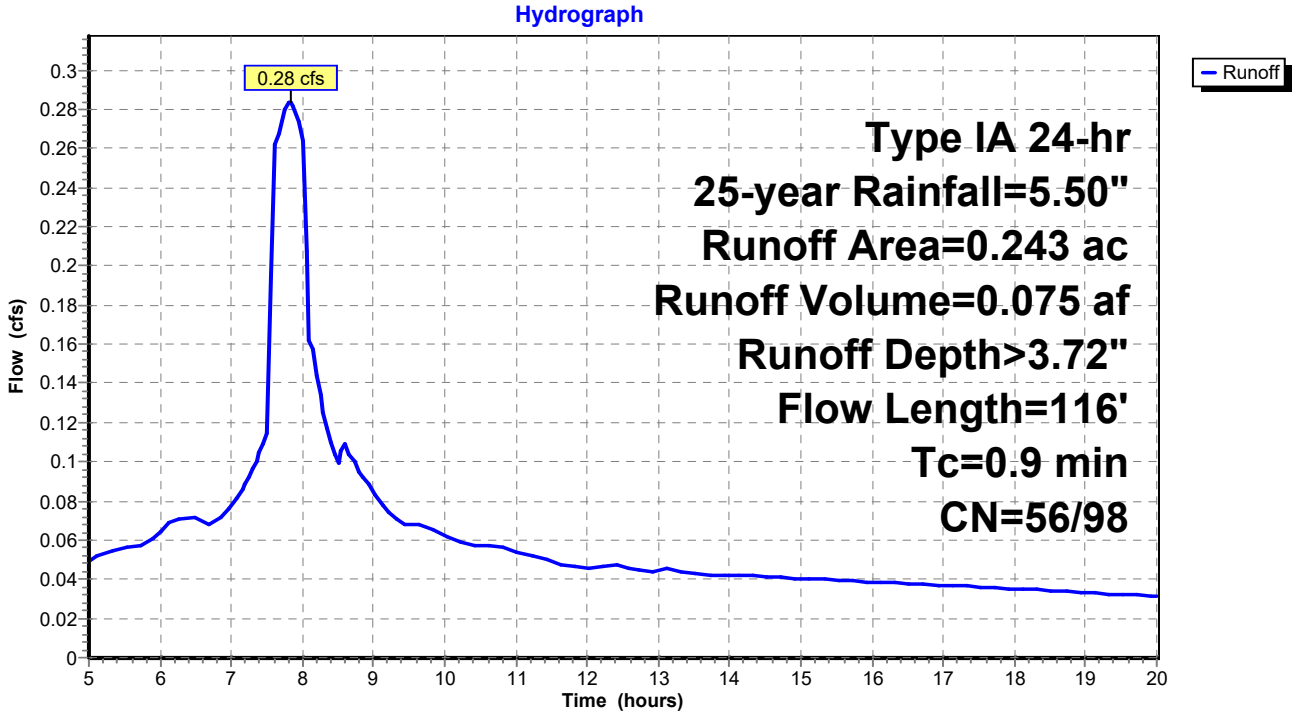
Runoff = 0.28 cfs @ 7.83 hrs, Volume= 0.075 af, Depth> 3.72"
Routed to Pond 10P : Facility 4 (Stormtech)

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type IA 24-hr 25-year Rainfall=5.50"

	Area (ac)	CN	Description
	0.210	98	Paved parking, HSG B
*	0.033	56	Lawn
	0.243	92	Weighted Average
	0.033	56	13.58% Pervious Area
	0.210	98	86.42% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.8	80	0.0280	1.57		**Sheet Flow, Pavement** Smooth surfaces n= 0.011 P2= 3.50"
0.1	36	0.0200	6.42	5.04	**Pipe Channel, Conveyance** 12.0" Round Area= 0.8 sf Perim= 3.1' r= 0.25' n= 0.013 Corrugated PE, smooth interior
0.9	116	Total			

Subcatchment 5S: Basin 5 (Area 2)



Summary for Pond 9P: Facility 1 (Swale)

[82] Warning: Early inflow requires earlier time span

Inflow Area = 0.558 ac, 42.38% Impervious, Inflow Depth > 3.74" for 25-year event
Inflow = 0.62 cfs @ 7.96 hrs, Volume= 0.174 af
Outflow = 0.42 cfs @ 8.22 hrs, Volume= 0.171 af, Atten= 33%, Lag= 15.3 min
Primary = 0.42 cfs @ 8.22 hrs, Volume= 0.171 af

Routing by Stor-Ind method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Peak Elev= -0.84' @ 8.22 hrs Surf.Area= 0.063 ac Storage= 0.014 af

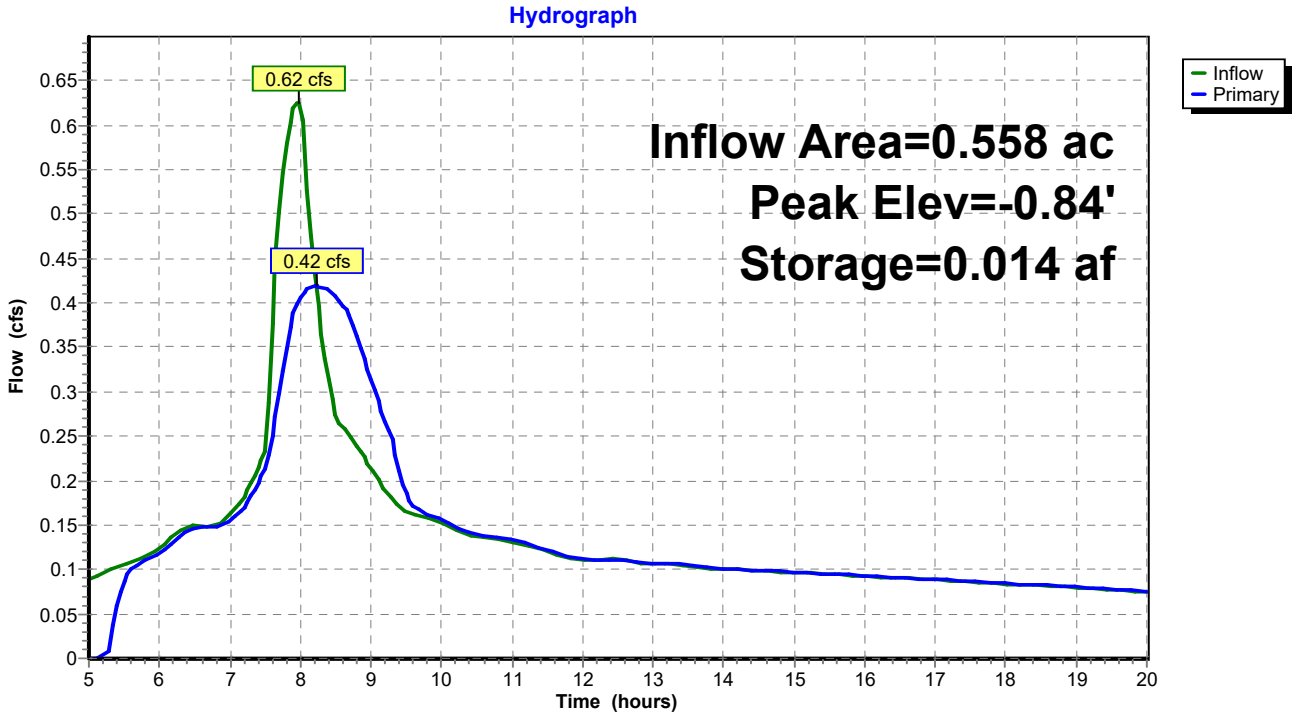
Plug-Flow detention time= 22.6 min calculated for 0.170 af (98% of inflow)
Center-of-Mass det. time= 11.8 min (671.7 - 659.9)

Volume	Invert	Avail.Storage	Storage Description
#1	-1.00'	0.053 af	**2.00'W x 455.00'L x 1.00'H Swale Z=3.0**
#2	-1.50'	0.005 af	**2.00'W x 455.00'L x 0.50'H Prismatoid** 0.010 af Overall x 46.6% Voids
#3	-2.00'	0.001 af	**4.0" Round Pipe Storage** Inside #4 L= 455.0'
#4	-2.50'	0.004 af	**1.00'W x 455.00'L x 1.00'H Prismatoid** 0.010 af Overall - 0.001 af Embedded = 0.010 af x 40.0% Voids
		0.062 af	Total Available Storage

Device	Routing	Invert	Outlet Devices
#1	Primary	-2.00'	**4.0" Vert. Orifice/Grate** C= 0.600 Limited to weir flow at low heads

Primary OutFlow Max=0.42 cfs @ 8.22 hrs HW=-0.84' (Free Discharge)
↑—**1=Orifice/Grate** (Orifice Controls 0.42 cfs @ 4.80 fps)

Pond 9P: Facility 1 (Swale)



Summary for Pond 10P: Facility 4 (Stormtech)

[82] Warning: Early inflow requires earlier time span

Inflow Area = 0.243 ac, 86.42% Impervious, Inflow Depth > 3.72" for 25-year event
Inflow = 0.28 cfs @ 7.83 hrs, Volume= 0.075 af
Outflow = 0.08 cfs @ 9.13 hrs, Volume= 0.070 af, Atten= 73%, Lag= 78.0 min
Primary = 0.08 cfs @ 9.13 hrs, Volume= 0.070 af

Routing by Stor-Ind method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Peak Elev= 1.80' @ 9.13 hrs Surf.Area= 0.021 ac Storage= 0.020 af

Plug-Flow detention time= 144.6 min calculated for 0.070 af (92% of inflow)
Center-of-Mass det. time= 103.1 min (752.1 - 649.0)

Volume	Invert	Avail.Storage	Storage Description
#1A	0.00'	0.013 af	**29.08'W x 30.95'L x 2.00'H Field A** 0.041 af Overall - 0.008 af Embedded = 0.033 af x 40.0% Voids
#2A	0.50'	0.008 af	**ADS_StormTech SC-160LP +Cap**x 52 Inside #1 Effective Size= 18.0"W x 12.0"H => 0.96 sf x 7.12'L = 6.8 cf Overall Size= 25.0"W x 12.0"H x 7.56'L with 0.44' Overlap 52 Chambers in 13 Rows
		0.021 af	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Primary	0.00'	**1.5" Vert. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#2	Primary	1.92'	**12.0" Vert. Overflow Riser** C= 0.600 Limited to weir flow at low heads

Primary OutFlow Max=0.08 cfs @ 9.13 hrs HW=1.80' (Free Discharge)
1=Orifice/Grate (Orifice Controls 0.08 cfs @ 6.35 fps)
2=Overflow Riser (Controls 0.00 cfs)

Pond 10P: Facility 4 (Stormtech) - Chamber Wizard Field A

Chamber Model = ADS_StormTechSC-160LP +Cap (ADS StormTech® SC-160LP with cap length)
Effective Size= 18.0"W x 12.0"H => 0.96 sf x 7.12'L = 6.8 cf
Overall Size= 25.0"W x 12.0"H x 7.56'L with 0.44' Overlap

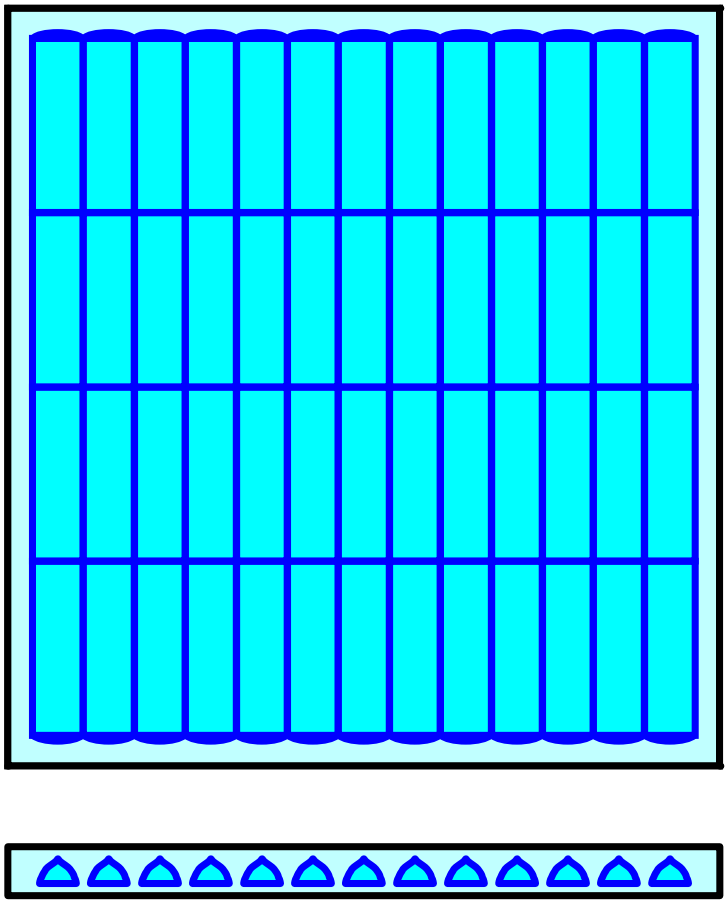
4 Chambers/Row x 7.12' Long +0.23' Cap Length x 2 = 28.95' Row Length +12.0" End Stone x 2 = 30.95' Base Length
13 Rows x 25.0" Wide + 12.0" Side Stone x 2 = 29.08' Base Width
6.0" Stone Base + 12.0" Chamber Height + 6.0" Stone Cover = 2.00' Field Height

52 Chambers x 6.8 cf = 355.5 cf Chamber Storage

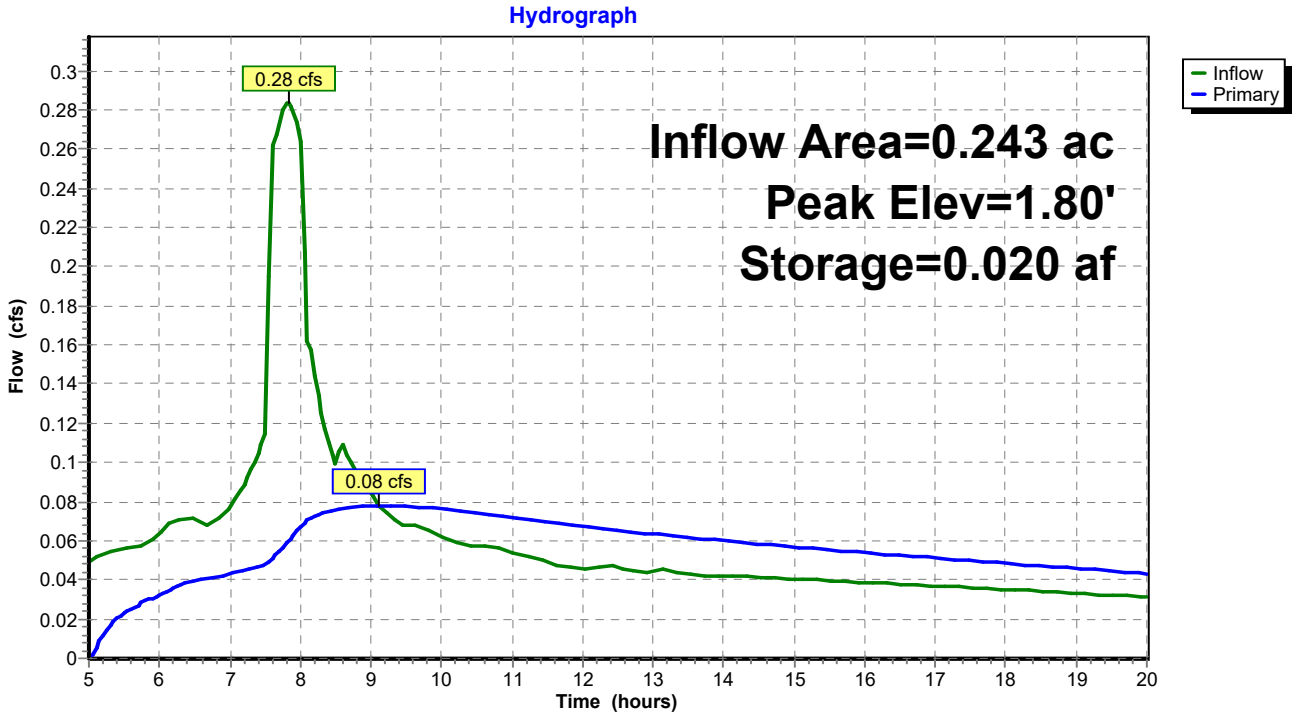
1,800.1 cf Field - 355.5 cf Chambers = 1,444.5 cf Stone x 40.0% Voids = 577.8 cf Stone Storage

Chamber Storage + Stone Storage = 933.3 cf = 0.021 af
Overall Storage Efficiency = 51.9%
Overall System Size = 30.95' x 29.08' x 2.00'

52 Chambers
66.7 cy Field
53.5 cy Stone



Pond 10P: Facility 4 (Stormtech)



Summary for Pond 12P: Facility 2 (North Tank)

[82] Warning: Early inflow requires earlier time span
[92] Warning: Device #4 is above defined storage

Inflow Area = 5.557 ac, 51.39% Impervious, Inflow Depth > 2.64" for 25-year event
Inflow = 3.86 cfs @ 7.99 hrs, Volume= 1.223 af
Outflow = 1.19 cfs @ 9.49 hrs, Volume= 0.937 af, Atten= 69%, Lag= 90.0 min
Primary = 1.19 cfs @ 9.49 hrs, Volume= 0.937 af

Routing by Stor-Ind method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Peak Elev= 5.94' @ 9.49 hrs Surf.Area= 0.066 ac Storage= 0.390 af

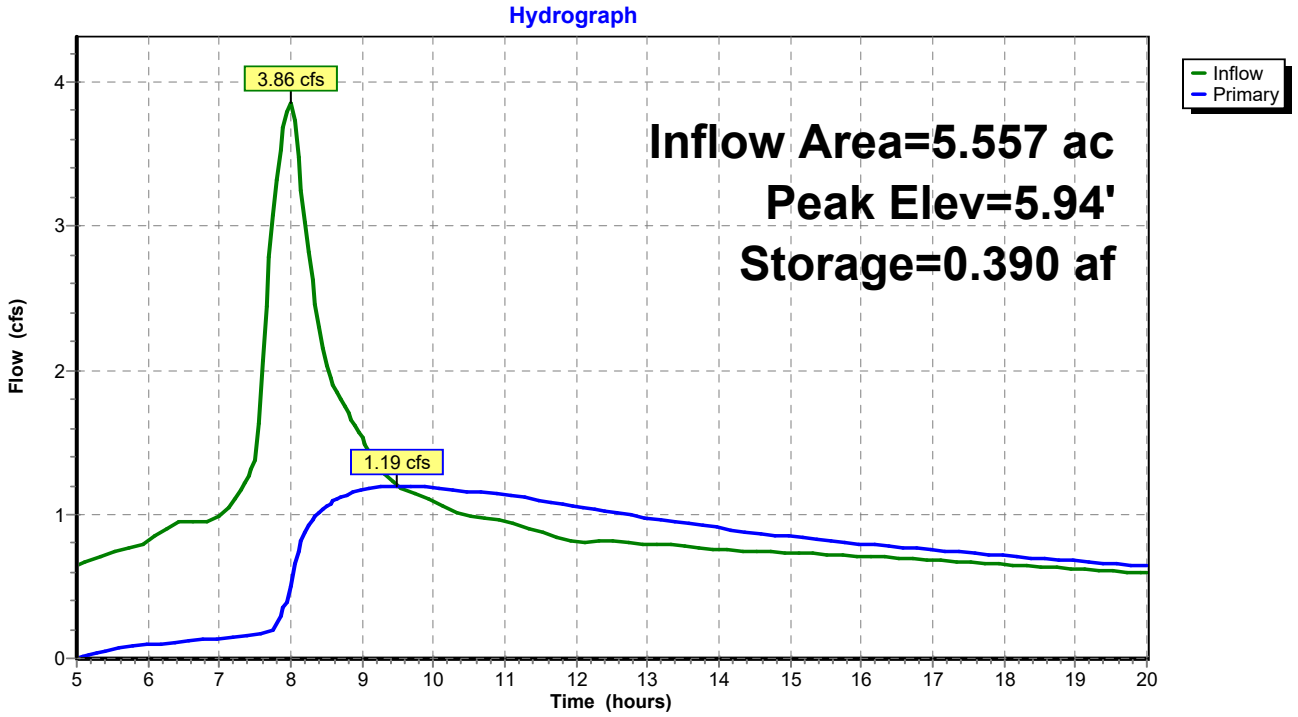
Plug-Flow detention time= 225.8 min calculated for 0.936 af (76% of inflow)
Center-of-Mass det. time= 113.8 min (790.9 - 677.1)

Volume	Invert	Avail.Storage	Storage Description
#1	0.00'	0.393 af	**24.00'W x 119.00'L x 6.00'H Prismatoid**

Device	Routing	Invert	Outlet Devices
#1	Primary	0.00'	**2.0" Vert. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#2	Primary	3.25'	**3.0" Vert. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#3	Primary	4.00'	**4.0" Vert. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#4	Primary	6.00'	**12.0" Vert. Overflow Riser** C= 0.600 Limited to weir flow at low heads

Primary OutFlow Max=1.19 cfs @ 9.49 hrs HW=5.94' (Free Discharge)
- **1=Orifice/Grate** (Orifice Controls 0.25 cfs @ 11.65 fps)
- **2=Orifice/Grate** (Orifice Controls 0.38 cfs @ 7.71 fps)
- **3=Orifice/Grate** (Orifice Controls 0.56 cfs @ 6.41 fps)
- **4=Overflow Riser** (Controls 0.00 cfs)

Pond 12P: Facility 2 (North Tank)



Summary for Pond 13P: Facility 3 (South Tank)

[82] Warning: Early inflow requires earlier time span
[92] Warning: Device #4 is above defined storage

Inflow Area = 3.075 ac, 47.67% Impervious, Inflow Depth > 2.52" for 25-year event
Inflow = 2.14 cfs @ 7.98 hrs, Volume= 0.647 af
Outflow = 0.59 cfs @ 9.83 hrs, Volume= 0.478 af, Atten= 73%, Lag= 111.6 min
Primary = 0.59 cfs @ 9.83 hrs, Volume= 0.478 af

Routing by Stor-Ind method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Peak Elev= 5.85' @ 9.83 hrs Surf.Area= 0.035 ac Storage= 0.202 af

Plug-Flow detention time= 231.8 min calculated for 0.477 af (74% of inflow)
Center-of-Mass det. time= 108.2 min (787.3 - 679.1)

Volume	Invert	Avail.Storage	Storage Description
#1	0.00'	0.208 af	**26.00'W x 58.00'L x 6.00'H Prismatoid**

Device	Routing	Invert	Outlet Devices
#1	Primary	0.00'	**2.0" Vert. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#2	Primary	4.00'	**1.7" Vert. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#3	Primary	4.75'	**3.0" Vert. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#4	Primary	6.00'	**12.0" Vert. Overflow Riser** C= 0.600 Limited to weir flow at low heads

Primary OutFlow Max=0.59 cfs @ 9.83 hrs HW=5.85' (Free Discharge)
- **1=Orifice/Grate** (Orifice Controls 0.25 cfs @ 11.56 fps)
- **2=Orifice/Grate** (Orifice Controls 0.10 cfs @ 6.41 fps)
- **3=Orifice/Grate** (Orifice Controls 0.23 cfs @ 4.74 fps)
- **4=Overflow Riser** (Controls 0.00 cfs)

Pond 13P: Facility 3 (South Tank)