9. Stormwater Management Plan (TIR)

Oak Village Apartments

Preliminary Stormwater Technical Information Report

Date: June 2021

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Certificate of the Engineer

Oak Village Apartments
City of Woodland, Washington
Preliminary Technical Information Report

This Technical Information Report and the data contained herein were prepared by the undersigned, whose seal, as a Professional Engineer licensed to practice as such, is affixed below. All information required by the City of Woodland Municipal Code (WMC) Chapter 15.10, Erosion Control Ordinance, and Chapter 15.12, Stormwater Management, is included in the Stormwater Plan. This project complies with Best Management Practices as identified by the State Department of Ecology 1992 *Stormwater Management Manual for the Puget Sound Basin*.

6/23/2021

BRYCE D HANSON
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References

1992 Stormwater Management Manual for the Puget Sound Basin – “SMMPSB”

City of Woodland Comprehensive Flood Hazard and Drainage Management Plan, prepared by R-W-Beck, January 2000

Preliminary Stormwater Technical Information Report (TIR)

OAK VILLAGE APARTMENTS
WOODLAND, WASHINGTON

Section A – Project Overview

The 34.7-acre site is divided into two zones: 9.8-acre zoned Medium Density Residential (MDR) in the multifamily district located on parcel 5086301000; 24.9-acres zone Highway Commercial (C-2) located on several parcels south of 5086301000 in Woodland, WA. The project site is located within Section 12, Township 5 North, Range 1 West, Willamette Meridian, Cowlitz County, Washington. More specifically, the site fronts Green Mountain Road and Green Mountain Loop Road to the east and Old Pacific Highway (OPH) to the west. The site will be accessed via a proposed new road “Burris Lane”, which will initiate from the west near the intersection of Old Pacific Highway (OPH) and Belmont Loop. The site is located within subbasin 7 of the “City of Woodland Comprehensive Flood Hazard and Drainage Management Plan”, prepared by R-W-Beck, dated January 2000. A project vicinity map is included in Appendix A.

The residential site is a ridge that sits above and extends downslope towards wetlands and a stream to the north and west and Burris Creek to the south, which is characterized by moderate to steep slopes with more gentle sloping areas on top. The site is currently partially timbered with a mix of Oregon White Oak, Oregon Ash, Douglas-fir and other native tree species along with large areas overgrown with Himalayan Blackberries. There are no existing buildings or structures on site; however, there is debris and remnants from a potential structure in the past that was situated on top of the ridge.

The commercial site sits below and south of the residential site and is characterized by an open low-lying hayfield with drainage ditches that flow from east to west and ultimately south to north along the base of OPH.

Critical Areas exist on site and directly adjacent to the site such as: wetlands and a stream to the north; other wetlands to the west and south; Burris Creek, a fish bearing stream dividing the residential and commercial zones; and the previously mentioned Oregon White Oaks. Stormwater runoff for the residential property generally sheet flows to the north, northwest towards wetlands and a stream and to the south towards wetlands and Burris Creek. Stormwater runoff for the commercial property generally sheet flows towards drainage ditches, then flows westerly until reaching the ditch along OPH, which then flows north/northwesterly towards a wetland in the northwest corner of the site. A culvert exits the wetland and flows into Burris Creek.

The residential project proposes to construct eight apartment buildings, a club house, parking lot, sidewalks, utilities, and stormwater facilities on site. Project also includes half-street improvements of Green Mountain Road and Green Mountain Loop Road. The project also proposes to construct Burris Lane, or a portion of it, to access the residential site from the south. This also requires a private access/driveway to cross Burris Creek with a bridge structure. The proposed Burris Lane will be constructed on property also owned by the same organization. Grading to elevate the commercial site for future improvements, along with some stockpiling of aggregate is also proposed on the commercial properties. Overall proposed land disturbances consist of grading and excavation for construction of the proposed buildings, parking lot, roadway improvements, sidewalks, utilities, stormwater facilities, and landscape features. Due to the amount of proposed impervious surfaces (greater than 5,000 square feet) and the amount of disturbed area (greater than 1 acre), the project is required to meet Minimum Requirements 1-11 of the Department of Ecology (ECY) 1992 *Stormwater Management Manual for the Puget Sound Basin* (SMMPSB) (See Appendix B).

The surface water (Burris Creek) will be protected by implementing Best Management Practices (BMPs) adjacent to the creek and installing a bridge to span the ordinary high water. Adjacent wetlands will be protected with an approved mitigation plan as portions of buffers will be impacted by the development. Oregon White Oaks will be protected to the maximum extent feasible, with impact mitigation to be approved by the City and Washington Department of Fish and Wildlife. Appropriate implementation of stormwater and erosion control BMPs will limit impact to adjacent critical areas (within ¼ mile). Adjacent developments will not be negatively affected by the project. Stormwater runoff from neighboring properties (Green Mountain Road and Green Mountain Loop Road) to the west appears to not impact the site; however, these half-street areas will be addressed with this report and proposed site improvements. Off-site drainage from the west near parcel 508720100 will be maintained through the site. Runoff from OPH will not be obstructed. Stormwater runoff quantity and quality impacts from the developed site are proposed to be mitigated by a combination of bioretention facilities, detention ponds, and wet ponds.

Section B – Approval Conditions Summary

An approval conditions summary will be provided during final engineering.

Section C – Downstream Analysis

Stormwater runoff for the residential site generally flows in two directions, split by the ridgeline that bisects the site with the majority sloping to the south. The north slopes towards a smaller stream with an associated wetland that drains westerly towards a larger wetland that is positioned on a large city parcel (#508610101) immediately adjacent to the west of the project. The south part of the ridge slopes towards two small, degraded wetlands that lay within the riparian management zone of Burris Creek. These wetlands drain to Burris Creek, which also flows into the same larger wetland on the city parcel. The large wetland and associated Burris Creek then pass under parcel 508580100 through a round conveyance pipe, which then flows under a private driveway and into another wetland prior to passing under Interstate 5. Even though the different discharge points converge within a quarter mile downstream of the site, there are four different points of compliance being considered for the project as described below. The soils are classified as hydrologic group C and D soils with limited or essentially no infiltration. The apartment site is also situated above steeper slopes; therefore, infiltration is assumed to be infeasible, and the stormwater design accounts for this constraint. The commercial site is on the lowlands in group D soils with no measurable infiltration.

Point of Compliance 1 (POC1): The perennial stream with associated wetland to the north drops in elevation across the northern property line at approximately 5% from east to west. The stream terminates into the larger wetland on the city property. For analysis purposes, we assumed a Point of Compliance discharging into the stream and are analyzing the quantity control from a streambank erosion control (SBEC) perspective, not from a wetland quantity control perspective. This approach should also help regulate flows entering the conveyance pipe that extends under parcel 508580100.

Point of Compliance 2 (POC2): The south side of the ridge and adjacent roadway improvements discharge to the two smaller (+/-2000 & +/-300 square feet) degraded wetlands prior to natural overland flow towards Burris Creek. These wetlands are proposed to be cleaned up (refuse/inorganic debris removed, invasive plant species removed, installation of plantings, etc.). Since the natural flow path from the south side of the ridge is towards and through these wetlands, this flow path will be maintained through construction of bioretention facilities for water quality treatment and detention ponds for water quantity control. Since these wetlands are small and have a natural overflow path towards Burris Creek, Point of Compliance modeling was completed from the SBEC perspective as well. There is approximately 1.8-feet of natural runoff storage potential in the first receiving wetland depression, which is the +/-2000 square-feet wetland. This wetland currently holds standing water and based on the modeling, should not experience an increase or significant decrease in flows that will alter the wetland hydrology. The +/-300 square-feet wetland, down slope of the larger wetland, also has approximately 1.8-feet of potential runoff storage. Based on the design standards, this wetland also should not experience any significant changes in hydrology as a result of the development.

Point of Compliance 3 (POC3): A portion of Burris Lane, the private driveway, and Green Mountain Road frontage improvements cannot be routed to any of the site's other proposed stormwater facilities due to grade limitations. This area will be managed in a separate facility and discharged towards Burris Creek following the quality and quantity control standards.

Point of Compliance 4 (POC4): Runoff from the proposed Burris Lane from the intersection with Old Pacific Highway (OPH), extending east to the new private driveway will be collected and managed in a separate stormwater facility which will discharge towards a wetland on parcel 508610100. This wetland is located adjacent to OPH and discharges through a 48" diameter culvert that flows northwesterly towards the same outfall on parcel 508580100 as described with the introduction to Section C of this report. Since the wetland on parcel 508610100 drains through an existing pipe that discharges into Burris Creek, the same analysis methodology is applied for meeting the SBEC quantity standards following water quality treatment. This should satisfy concerns with further downstream analysis. Full buildout of this section of Burris Lane will be phased, therefore stormwater facilities for these improvements will be designed as standalone to allow them to function separately, if needed. Also, as the development plans of the property to the south of Burris Lane are still unknown, these facilities may ultimately need to be relocated, but will discharge to the same location. Additional grading in the commercial site area will also occur to elevate the site for future development. An aggregate stockpile will also be placed just south of Burris Lane for future development use.

Table C.1: Rainfall Event

24-hr Peak Rainfall Event	Adjusted Average Rainfall (in.)
2-yr	2.26
10-yr	3.56
25-yr	4.17
100-yr	6.30

Values based on the City of Woodland Comprehensive Flood Hazard and Drainage Management Plan (Jan. 2000) for Subbasin 7 "Lower Middle Burris".

The existing runoff characteristics are tabulated in Table D.3. Proposed runoff characteristics are tabulated in Table D.4. Information provided in these tables were utilized to calculate the 24-hr peak pre-developed and developed runoff flows, which are tabulated in Table C.2 for each basin. See section D of this report and the HydroCAD analysis report in Appendix F for more information. Note that there is a difference of approximately 4.5-acres of total site area and modeled area. This area is comprised of critical areas and critical areas buffers, which are not proposed to be impacted by the development.

Table C.2: Peak Flows

Existing Basin	Peak Flow Event	Existing Flow (cfs)	Developed Basin	Peak Flow Event	Developed Flow (cfs)	Notes
1X (1.8 ac)	2-yr	0.06	1S (1.0 ac)	2-yr	0.06	
	10-yr	0.33		10-yr	0.24	
	25-yr	0.49		25-yr	0.48	
	100-yr	1.13		100-yr	1.12	
[A]2X-A+2X-B +2X-C (1.3+3.9+ 0.5 = 5.7 ac)	2-yr	0.25	[B]2S (6.5 ac)	2-yr	0.25	A portion of Basin 1X is diverted to Basin 2S.
	10-yr	0.94		10-yr	0.75	
	25-yr	1.36		25-yr	1.09	
	100-yr	3.09		100-yr	2.95	
3X (1.00 ac)	2-yr	0.23	3S (1.00 ac)	2-yr	0.23	
	10-yr	0.52		10-yr	0.47	
	25-yr	0.66		25-yr	0.61	
	100-yr	1.19		100-yr	1.08	
4X-A + 4X-B (2.50+7.50 =10.00 ac)	2-yr	1.09	4S (10.30)	2-yr	1.02	Burris Ln., commercial site grading & stockpile
	10-yr	2.57		10-yr	2.35	
	25-yr	3.34		25-yr	3.09	
	100-yr	6.16		100-yr	5.90	
5X (11.70 ac)	2-yr	0.66	5S (11.70)	2-yr	0.63	Commercial site grading
	10-yr	1.87		10-yr	1.79	
	25-yr	2.54		25-yr	2.43	
	100-yr	5.17		100-yr	4.92	

[A] *Existing Basin 2X was split into subbasin to more closely match existing runoff time of concentration.*

[B] *Developed Basin 2S was split into subbasins to aid with separate pond designs.*

The designed stormwater runoff matches or is less than the modeled predeveloped runoff; therefore, runoff from the project should not impact the downstream system capacity. Also, based on conversations with city officials, off-site flooding may back up towards the project's point of compliance #4. Therefore, improvements will be elevated to the maximum extent feasible to limit any potential backwatering from the off-site flooding concerns.

Section D – Quantity Control Analysis and Design

The project proposes to utilize detention ponds and wet ponds to meet flow control requirements since site infiltration is not feasible. The Geotechnical Report (see Appendix G.1) suggests limited infiltration may be present near the stream, on the north side by the private driveway; however, groundwater separation cannot be adequately achieved due to site constraints such as topography and relative proximity to the wetlands and the stream. Infiltration on the ridge, where the apartments are proposed, is not advisable due to the proximity to the steeper slopes. The facilities for Burris Lane and the commercial site area (Basin 3S, 4S & 5S) have no measurable infiltration in the native soils.

Plans for the development of the site are included in Appendix C, and stormwater basin delineation maps are included in Appendix D. See Tables D.1 and D.2 below for tabulated areas of hard surfaces and landscaping within each pre-developed and post-developed basin.

Table D.1: Existing Hard Surface and Landscaping

Basin	Landscape Area	Asphalt /Gravel Area	Sidewalk Area	Roof Area	Total Impervious Area	Total Area
1X	1.78	0.02	0	0	0.02	1.80
2X	5.52	0.18	0	0	0.18	5.70
3X	0.88	0.12	0	0	0.12	1.00
4X	9.50	0.80	0	0	0.80	10.30
5X	11.62	0.08	0	0	0.08	11.70

Note: Areas listed here are in acres.

Table D.2: Proposed Hard Surface and Landscaping

Basin	Landscape Area	Asphalt /Gravel Area[1]	Pond Area[2]	Roof Area	Total Impervious Area	Total Area
1S	0.20	0.28	0.05	0.37	0.70	0.90
2S	1.15	3.31	0.33	1.71	5.35	6.50
3S	0.35	0.50	0.15	0	0.65	1.00
4S	5.60	3.90[3]	0.80	0	4.70	10.30
5S	11.62	0.08	0.00	0	0.08	11.70

Note: Areas listed here are in acres.

[1] *Sidewalk areas mix w/asphalt; therefore, are not differentiated.*

[2] *Pond surface area at 100-yr stage storage level.*

[3] *Include gravel stockpile.*

Tables D.3 and D.4 below show the pre-development and post-development runoff curve numbers (CN) that were used in the HydroCAD v10.0 software analyses (Appendix F). These curve numbers are based on the site soils per the NRCS Soils Report (Appendix G.2) and site conditions. It is also assumed that the developed conditions of the commercial site will have slightly better pervious curve numbers than existing due to raising the elevations further above groundwater and potential backwater conditions and the imported soil (topsoil layer) can be classified as “good” rather than “fair”. See Appendix I for SMMPSB runoff curve number table.

Table D.3: Pre-Development Curve Numbers

Basin	Soil Type	Land Cover	Curve Number (CN)	Time of Concentration (minutes)	Notes
1X	HSG C	Woods, Fair Cond. (1.78 ac)	73	19.0	
		Impervious (0.02 ac)	98		
2X-A	HSG C	Woods, Fair Cond. (1.30 ac)	73	25.1	
2X-B	HSG C	Woods, Fair Cond. (3.90 ac)	73	42.8	
2X-C	HSG C	Woods, Fair Cond. (0.32 ac)	73	5.0	
		Impervious (0.18 ac)	98		
3X	HSG D	Pasture, Fair Cond. (0.88 ac)	84	5.0	
		Impervious (0.12 ac)	98		
4X-A	HSG D	Pasture, Fair Cond. (2.00 ac)	84	67.1	
		Impervious (0.50 ac)	98		
4X-B	HSG D	Pasture, Fair Cond. (7.50 ac)	84	65.9	
		Impervious (0.30 ac)	98		
5X	HSG D	Pasture, Fair Cond. (11.62 ac)	84	88.5	
		Impervious (0.08 ac)	98		

Table D.4: Post-Development Curve Numbers

Basin	Soil Type	Land Cover	Curve Number (CN)	Time of Concentration (minutes)	Notes
1S-A	HSG C	Grass, 50-75%, Fair Cond. (0.20 ac)	79	5.0	
		Impervious (0.65 ac)	98		
1S-B	HSG C	Landscape (0.0 ac)		5.0	
		Impervious, Pond (0.05 ac)	98		
2S-A1	HSG C	Landscape (0.0 ac)		5.0	
		Impervious (1.14 ac)	98		
2S-A2	HSG C	Grass, 50-75%, Fair Cond. (0.24 ac)	79	5.0	
		Impervious (0.58 ac)	98		
2S-B1	HSG C	Grass, 50-75%, Fair Cond. (0.69 ac)	79	5.0	
		Impervious (2.93 ac)	98		
2S-B2	HSG C	Grass, >75%, Good Cond. (0.22 ac)	74	5.0	
		Impervious, Pond (0.20 ac)	98		
2S-C	HSG C	Landscape (0.0 ac)		5.0	
		Impervious (0.50 ac)	98		
3S	HSG D	Grass, >75%, Good Cond. (0.35 ac)	80	5.0	
		Impervious (0.65 ac)	98		
4S-A	HSG D	Grass, >75%, Good Cond. (0.60 ac)	80	5.0	
		Impervious (1.90 ac)	98		
4S-B	HSG D	Grass, >75%, Good Cond. (5.0 ac)	80	87.5	Site Grading
		Impervious (2.0 ac)	98		Aggregate Stockpile
4S-C	HSG D	Landscape (0.0 ac)		5.0	
		Impervious (0.80 ac)	98		Wet pond
5S	HSG D	Grass, > 75%, Good Cond. (11.62 ac)	80	97.7	Site Grading
		Impervious (0.08 ac)	98		

See Table C.2 for the existing and developed peak flows for the design storms for all subbasins. All stormwater quantity facilities for the site have been designed in conformance with the SMMPSB. The facilities were analyzed using the HydroCAD program and show that the proposed facilities can detain and provide a metered stormwater runoff release rate equal to or less than pre-developed conditions for the 2-yr, 10-yr, 25-yr, and 100-yr peak 24-hr storm events. Table D.5 tabulates each pond's dimensions, stage-storage elevations, flow control details and peak flow rates. Due to the percentage of impervious area at the site (+/-80%), a minimum pond volume correction factor of 42% has been applied to the proposed ponds per figure III-1.1 of chapter III-1 of the SMMPSB. When the pond is uniformly shaped and trapezoidal, the correction factor can be applied to the pond bottom dimensions. When the pond is irregularly shaped, such as with the wet ponds, the correction factor needs to be applied to the volume and the pond dimensions adjusted accordingly. Grading within Basin 5S is effectively self-mitigating since the proposed graded conditions will be temporarily vegetated with an erosion control seed mix, with no additional impervious area; therefore, no quantity control measures will be necessary.

Table D.5: SBEC Pond Details

Pond	Pond Bottom Dimensions/ volume	Storage Height (ft)	Orifice diam. /El.[2]	Rect. Notch width/I.E.[2,4]	Riser Diameter (in)/I.E.[2]	Peak Flow Event	Developed Flow (cfs)[1]	Peak Elevation (ft)[1]
1P	450sf (modeled)	4.5	1.25” /0.0	12”/2.8’	24”/3.50’	2-yr	0.06	2.40
	775sf (proposed)					10-yr	0.24	2.94
						25-yr	0.48	3.05
						100-	1.12	3.28
2P	1,875sf (modeled)	6.0	0.875” (7/8”)/0.0	9”/4.5’	24”/5.0’	2-yr	0.04	3.52
	2,850sf (proposed)					10-yr	0.17	4.64
						25-yr	0.25	4.69
						100-	0.73	4.93
3P	3,600sf (modeled)	6.5	2.1”/0.0	3”/3.5’	24”/5.5’	2-yr	0.21	3.24
	5,250sf (proposed)					10-yr	0.58	4.07
						25-yr	0.84	4.33
						100-	2.22	5.31
4P	5,158cf (modeled)	2.0	4.0”/0.0	10”/0.50’	18”/2.0’	2-yr	0.23	0.46
	8,200cf (proposed)[3]					10-yr	0.47	0.66
						25-yr	0.61	0.73
						100-	1.08	0.91
5P	27,450 cf (modeled)	2.0	8.0”/0.0	24”/0.75’	24”/2.0’	2-yr	1.02	0.70
						10-yr	2.35	1.03
	44,850 cf (proposed)[3]					25-yr	3.09	1.14
						100-	5.90	1.49

[1] Flow rates (released) and peak elevations based on modeled, uncorrected pond dimensions.

[2] Elevations are relative to the bottom of the live storage elevation, set at 0.0.

[3] Volume of wet pond at top of riser. Refer to the HydroCAD elements 6P & 10P for the corrected volumes.

[4] Slight discrepancies in orifice dimensions due to HydroCAD displaying lower precision.

Additional pond elements are included in the HydroCAD model to represent the calculated dead storage and corrected live storage volumes. These are labeled accordingly in the report located in Appendix F.

Section E – Conveyance Systems Analysis and Design

A basic stormwater layout was designed at this time, without detailed hydraulic analysis of all proposed conveyance systems. A shallow conveyance swale was modeled to direct discharge from wet pond (4P) to a downstream location, otherwise a detailed hydraulic analysis will be provided during final engineering.

Section F –Water Quality Design

Stormwater treatment will be provided by wet ponds for nutrient control per BMP RD.06 and the SMMPSB, and bioretention facilities per the Department of Ecology 2012 Stormwater Management Manual for Western Washington (SMMWW) BMP T5.14B.

Stormwater in the bioretention facilities will percolate through amended soils for a 91% treatment rate of the water quality storm event. Since these facilities are more current than the 1992 SMMPSB, they are modeled separately in the Western Washington Hydrology Model (WWHM). See the analysis in Appendix H for the results. Note that the basin areas used in the WWHM analysis differ from those in this report's tables and the HydroCAD analysis due to exclusion of the facility and some roof areas. The percolation process will remove pollutants from stormwater prior to being directed to the designed detention facilities. Specifications for the amended soil will be detailed with final engineering.

Wet ponds were designed with the required minimum permanent pool (dead storage) per RD0.5, with approximately 30% of the area being less than two feet in depth to meet the shallow marsh conditions requirement of RD0.6. The 6-month 24-hour design storm event volume was calculated for each basin (3S, 4S & 5S) as shown in the HydroCAD analysis. Each wet pond has two cells of similar size and a minimum length to width ratio of three. The soils where the wet ponds are proposed do not infiltrate so no liner is proposed. Groundwater and discharge elevations are constraining features so each wet pond is designed to be as shallow as possible with a minimum three-foot deep permanent pool (first cell) and a live storage depth as shown in Table D.5, which equates to less than the 4.8-feet average maximum depth. The inlets and outlets are proposed at opposite sides of each facility. Each facility has a flat bottom with an internal baffle and internal side slopes no steeper than 3H:1V. Each facility will also have an emergency overflow, which will be designed/detailed during final engineering.

Table F.1: Wet Pond Data

Basin	Wet pond	Required WQ runoff volume (acre-feet)	Provided WQ runoff volume (acre-feet)[1]	Length (ft)	Width (ft)	Surface Area Req. (sf)	Surface Area Provided (sf)
3S	4P	0.074	0.109	130	26	1,075	2,750
4S	5P	[2]0.505	0.411	360	45	7,333	19,000

Note: Dimensions and volumes are for the dead storage component of the wet pond, with dimensions/areas provided at the top of the permanent pool, bottom of live storage. Surface area provided demonstrates acceptable pond correction factor as previously described in this report (42%).

[1] Volume may be less than required to provide up to 30% of the surface area at 0'-2' depth per RD0.6.

[2] Pond area was excluded for required WQ volume calculations.

Spill control type oil/water separators will be provided for the apartment site per WMC15.12.070(D)(2).

Water quality design will meet all requirements per WMC 15.12.070.

Section G – Soils Evaluation

According to the Natural Resources Conservation Service (NRCS) Web Soil Survey (NRCS, 2014 website), on-site soils mainly consist of Stella silt loam (residential site) and Godfrey silt loam (commercial site) with some small areas of similar soils. The Stella silt loam is hydrologic group C, and the Godfrey silt loam is hydrologic group D. Hydrologic group C soils are characterized by slow infiltration. Hydrologic group D soils have very slow infiltration rates, high runoff potential, and a high-water table (Appendix G.2). The Geotechnical Report contains additional information about site conditions (Appendix G.1).

Section H – Special Reports and Studies

A geotechnical investigation was conducted by Strata Design. Findings are consistent with the soils information found through the NRCS; therefore on-site infiltration is not feasible. (Appendix G.1).

A critical areas investigation has been performed by Ecological Land Services (ELS) to investigate on-site wetlands, and other critical areas such as the Oregon White Oaks. ELS has prepared a Mitigation Plan (June 2021) addressing impacts and mitigation related to critical areas on and adjacent to the site.

Section I – Other Permits

The following permits will be required:

(1) Hydraulic Project Approval (HPA) through WDFW for the fish stream crossing. It is not anticipated that a Joint Aquatics Resource Permit Application (JARPA) will be needed since the bridge will span the stream without encroaching on the ordinary highwater.
(2) A Washington Department of Ecology General Construction Stormwater Permit will be required for this project.
(3) City of Woodland Grading Permit
(4) City of Woodland Critical Areas Permit

No other additional permits are required that would affect the stormwater design.

Section J – Groundwater Monitoring Program

The project is not expected to require groundwater monitoring based on the following conditions: soils have very little infiltrating capacity, excavation into existing ground is minimal in the lower portion of the site (commercial area); however, if deemed necessary the project will adhere to WMC 15.12.070 requirements regarding water quality treatment and groundwater monitoring.

Section K – Operation and Maintenance Manual

A site-specific stormwater facility operation and maintenance manual will be provided during final engineering.

Section L –Technical Appendix

Appendix A: Map Submittals
Appendix B: New Development Flow Chart
Appendix C: Development Plans
Appendix D: Basin Delineation Maps
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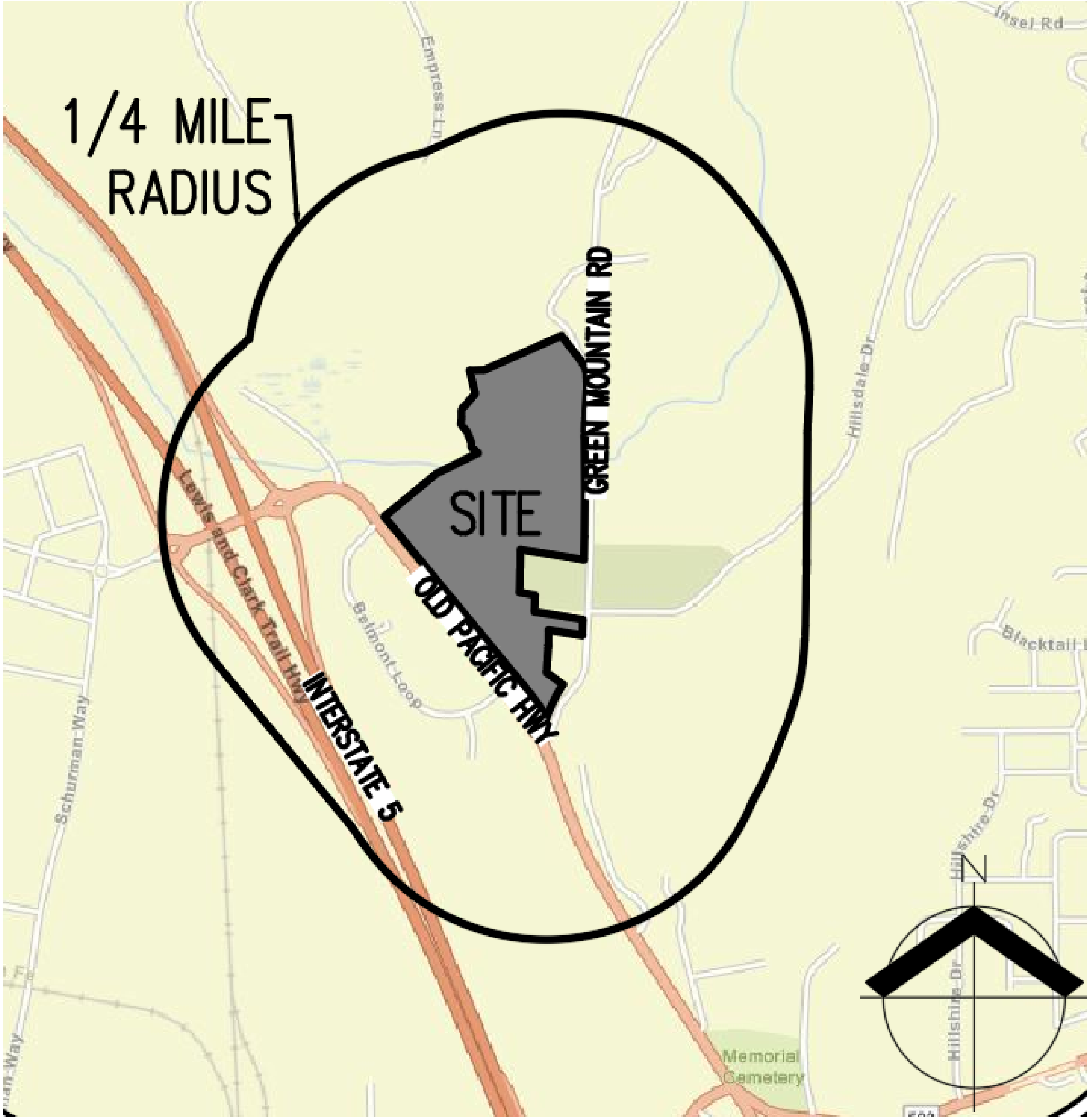
Appendix F: HydroCAD Analysis
Appendix G.1: Geotechnical Report
Appendix G.2: NRCS Soils Report
Appendix H: WWHM Analysis
Appendix I: Curve Numbers & Volume Correction Chart
Appendix J: Rainfall Data

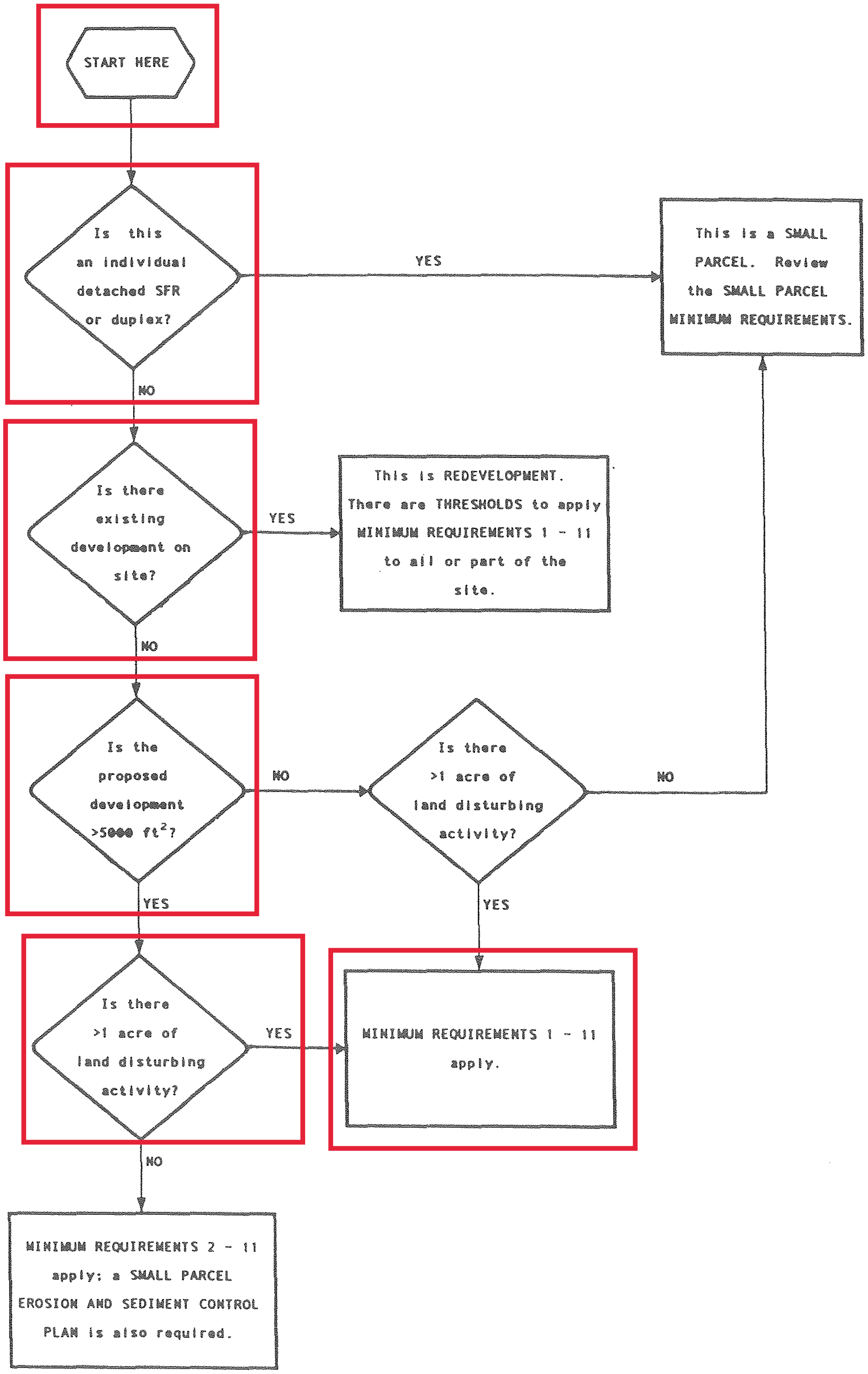
Appendix A: Map Submittals

VICINITY MAP

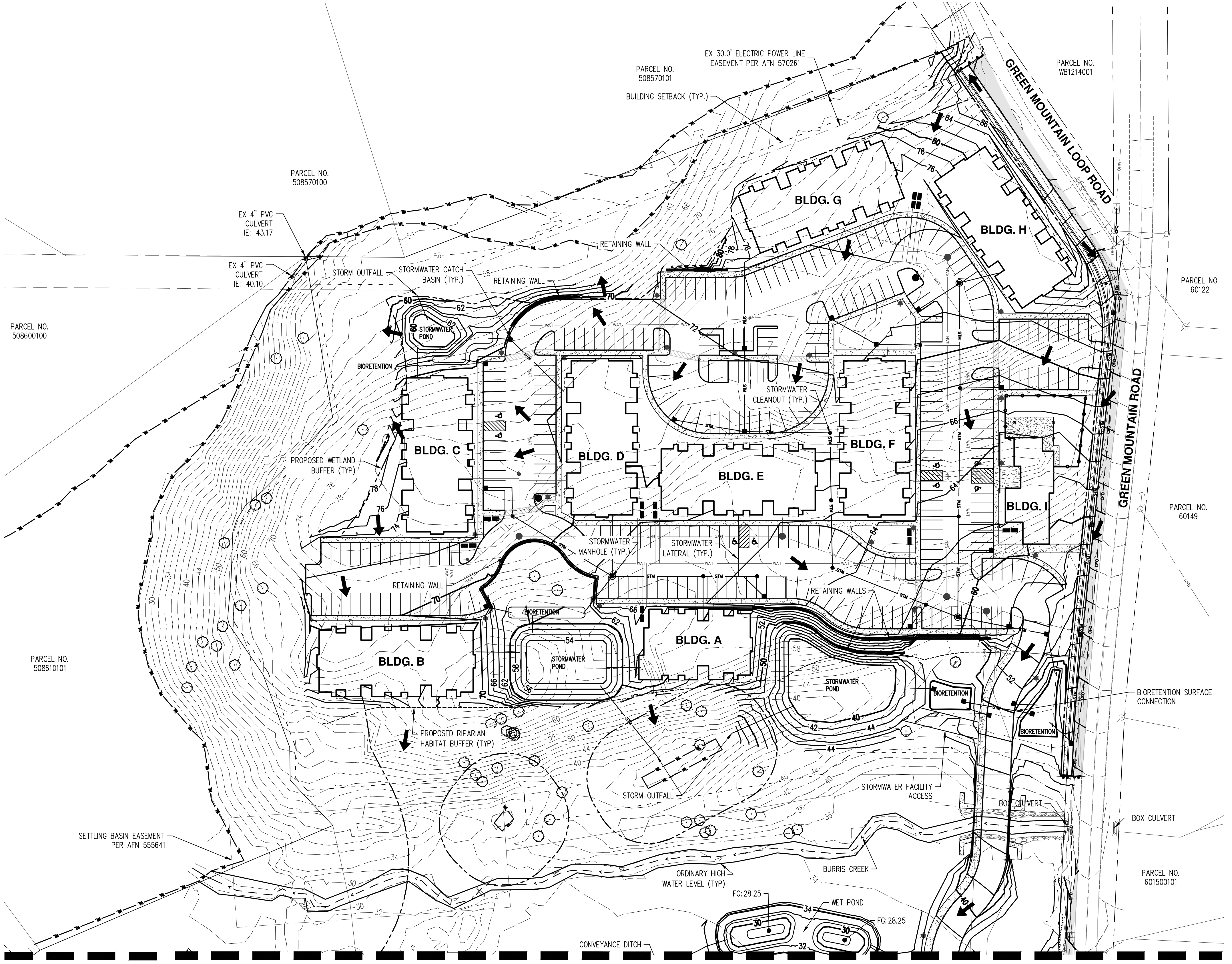


Appendix B: New Development Flow Chart

Figure I-2.1 Flowchart Demonstrating Minimum Requirements



Appendix C: Development Plans



GENERAL NOTES

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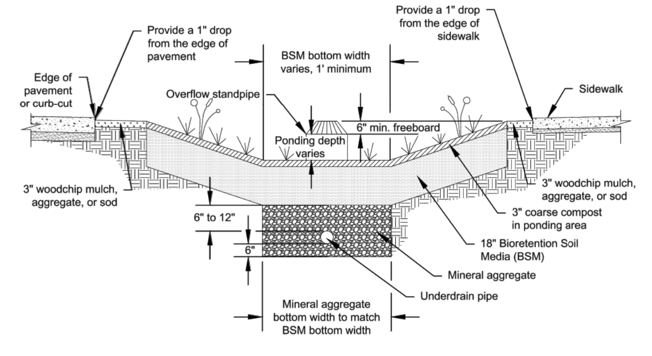

BIORETENTION
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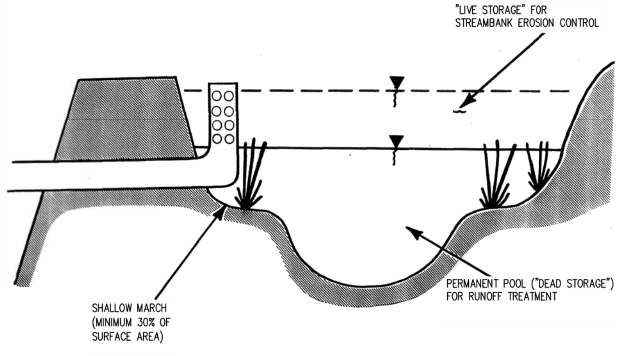

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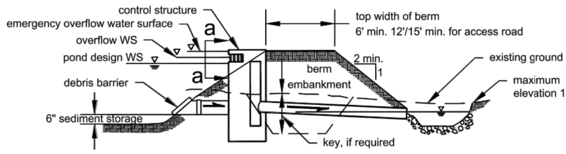

DETENTION POND
NTS

LEGEND

EXISTING GROUND CONTOUR (2 FT)	- - -102- - -
EXISTING GROUND CONTOUR (10 FT)	— — -110- — —
FINISHED GRADE CONTOUR (2 FT)	——102——
FINISHED GRADE CONTOUR (10 FT)	——110——
DRAINAGE FLOW DIRECTION	➔

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CHECKED BY:	BDH

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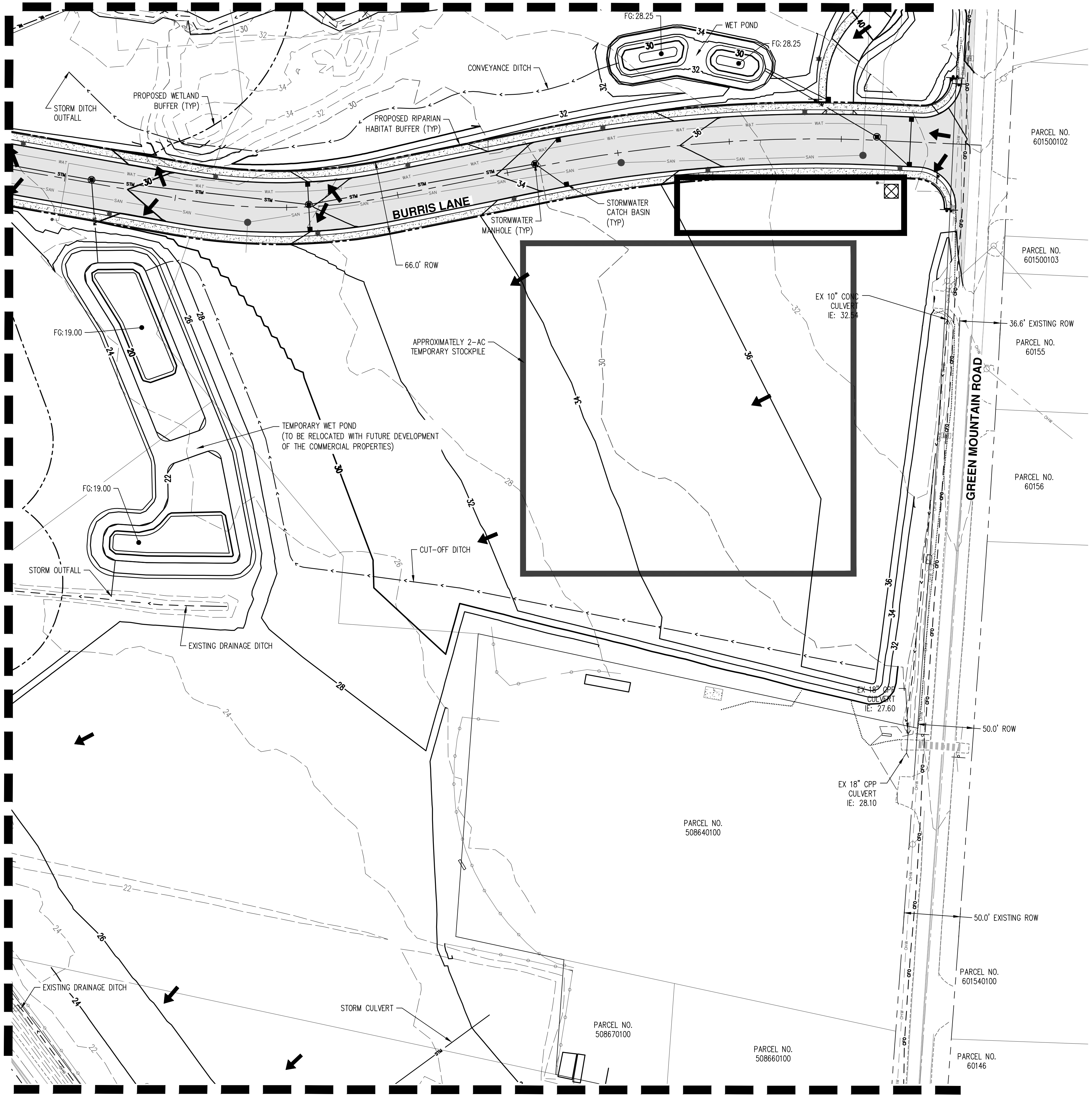
SEE SHEET P7.0



SEE SHEET P7.2

SEE SHEETP7.3

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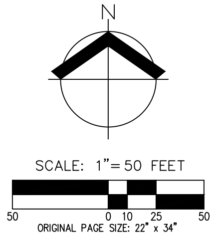

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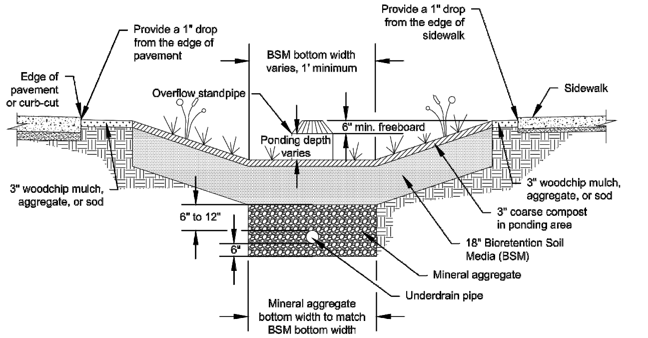

BIORETENTION

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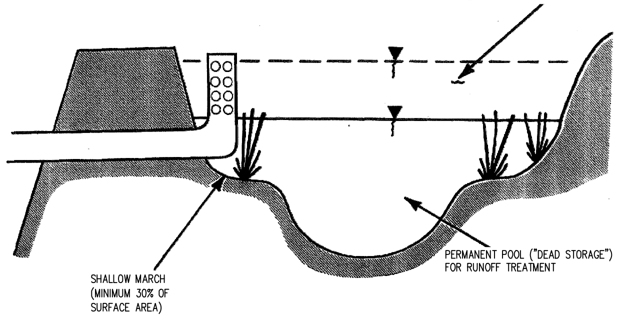
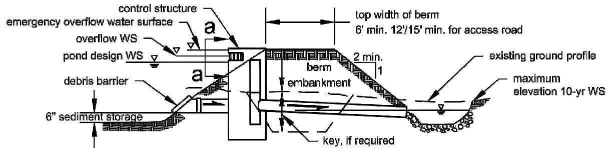


WET POND

NTS



DETENTION POND

NTS

LEGEND

EXISTING GROUND CONTOUR (2 FT)	- - -102- - -
EXISTING GROUND CONTOUR (10 FT)	- - -110- - -
FINISHED GRADE CONTOUR (2 FT)	——102——
FINISHED GRADE CONTOUR (10 FT)	——110——
DRAINAGE FLOW DIRECTION	→

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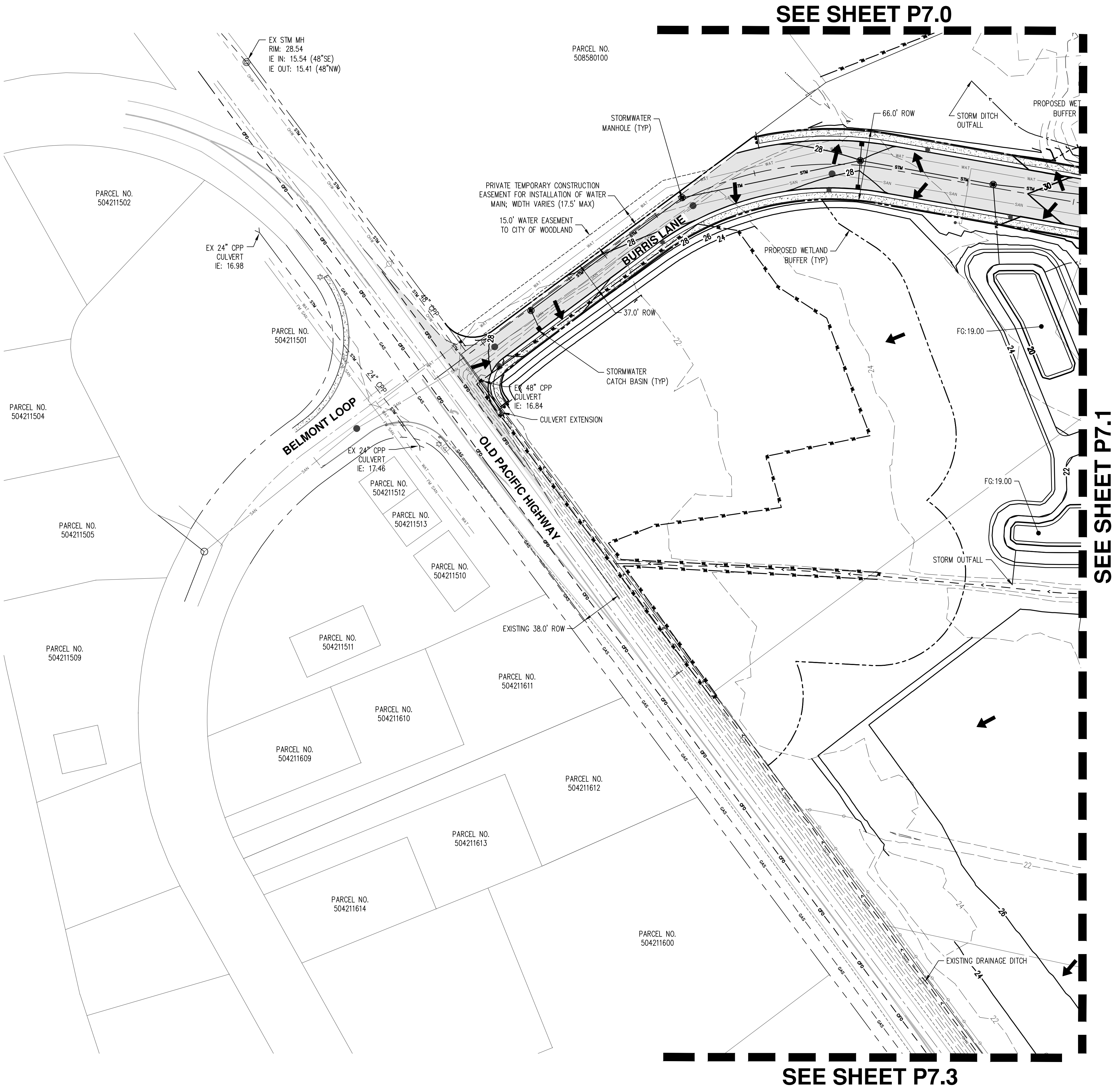

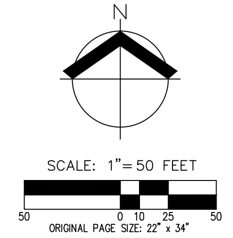

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LEGEND

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EXISTING GROUND CONTOUR (10 FT)	— — ·110· — —
FINISHED GRADE CONTOUR (2 FT)	——102——
FINISHED GRADE CONTOUR (10 FT)	——110——
DRAINAGE FLOW DIRECTION	➡

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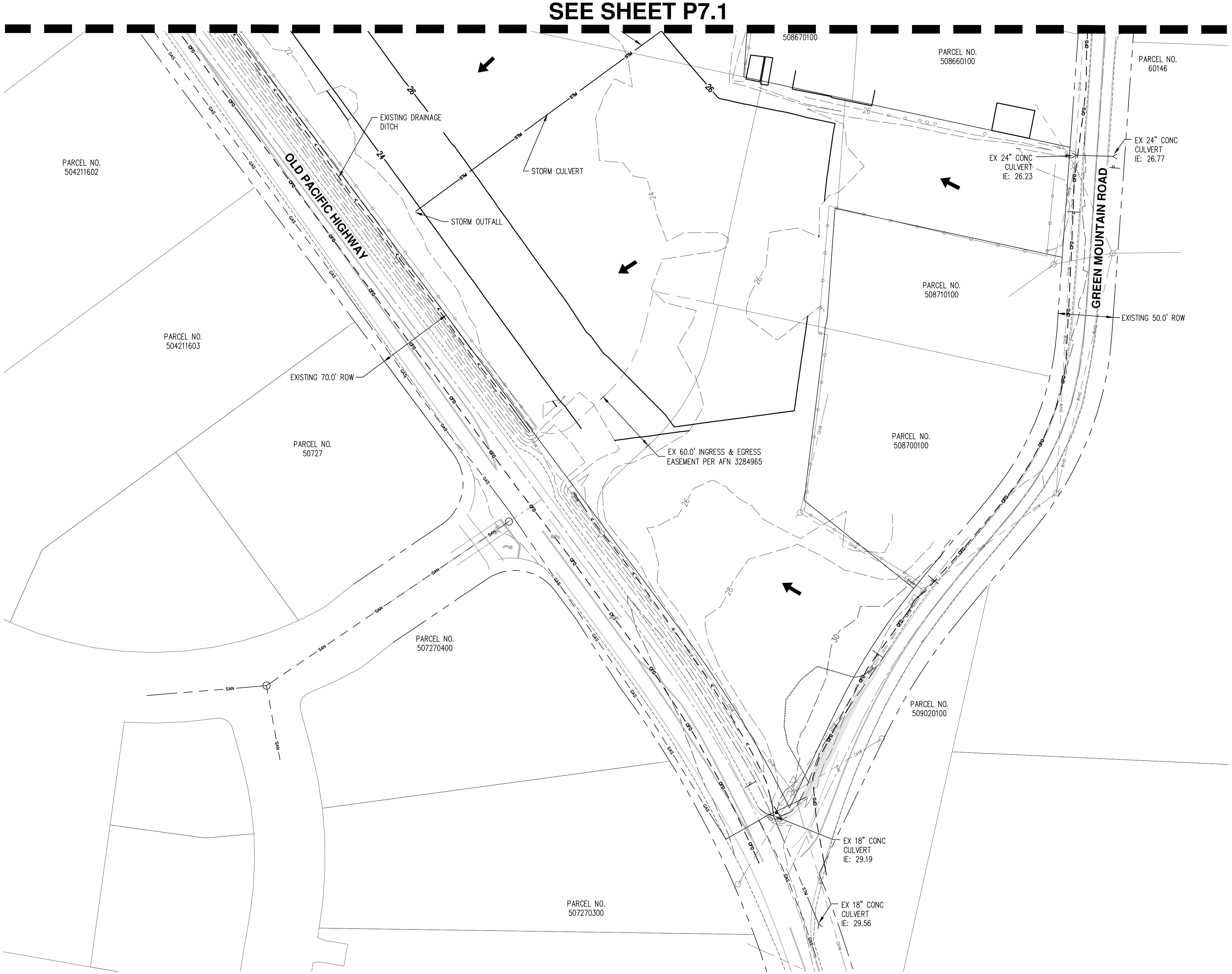

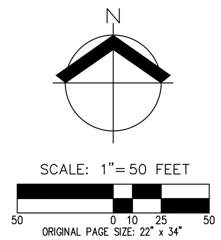

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EXISTING GROUND CONTOUR (10 FT)	— — -110- — —
FINISHED GRADE CONTOUR (2 FT)	——102——
FINISHED GRADE CONTOUR (10 FT)	——110——
DRAINAGE FLOW DIRECTION	→

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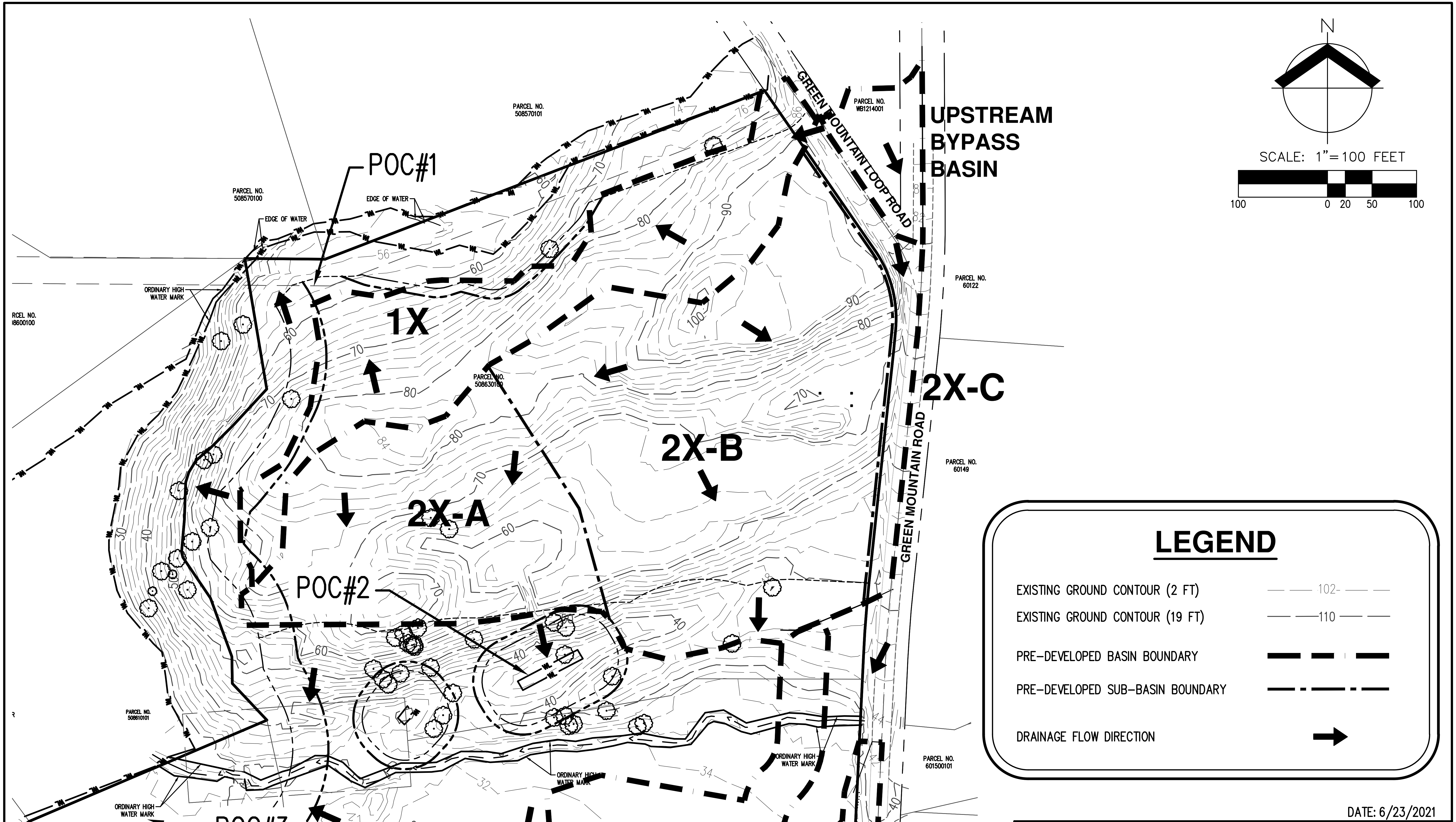
AKS DRAWING FILE: 8344 P7 STM.DWG | LAYOUT: P7.3

Appendix D: Basin Delineation Maps



LEGEND

EXISTING GROUND CONTOUR (2 FT)	— — 102- — —
EXISTING GROUND CONTOUR (19 FT)	— —110 — —
PRE-DEVELOPED BASIN BOUNDARY	▬ ▬ ▬
PRE-DEVELOPED SUB-BASIN BOUNDARY	—·—·—
DRAINAGE FLOW DIRECTION	➡

DATE: 6/23/2021

PRE-DEVELOPED BASIN MAP

EXHIBIT
A

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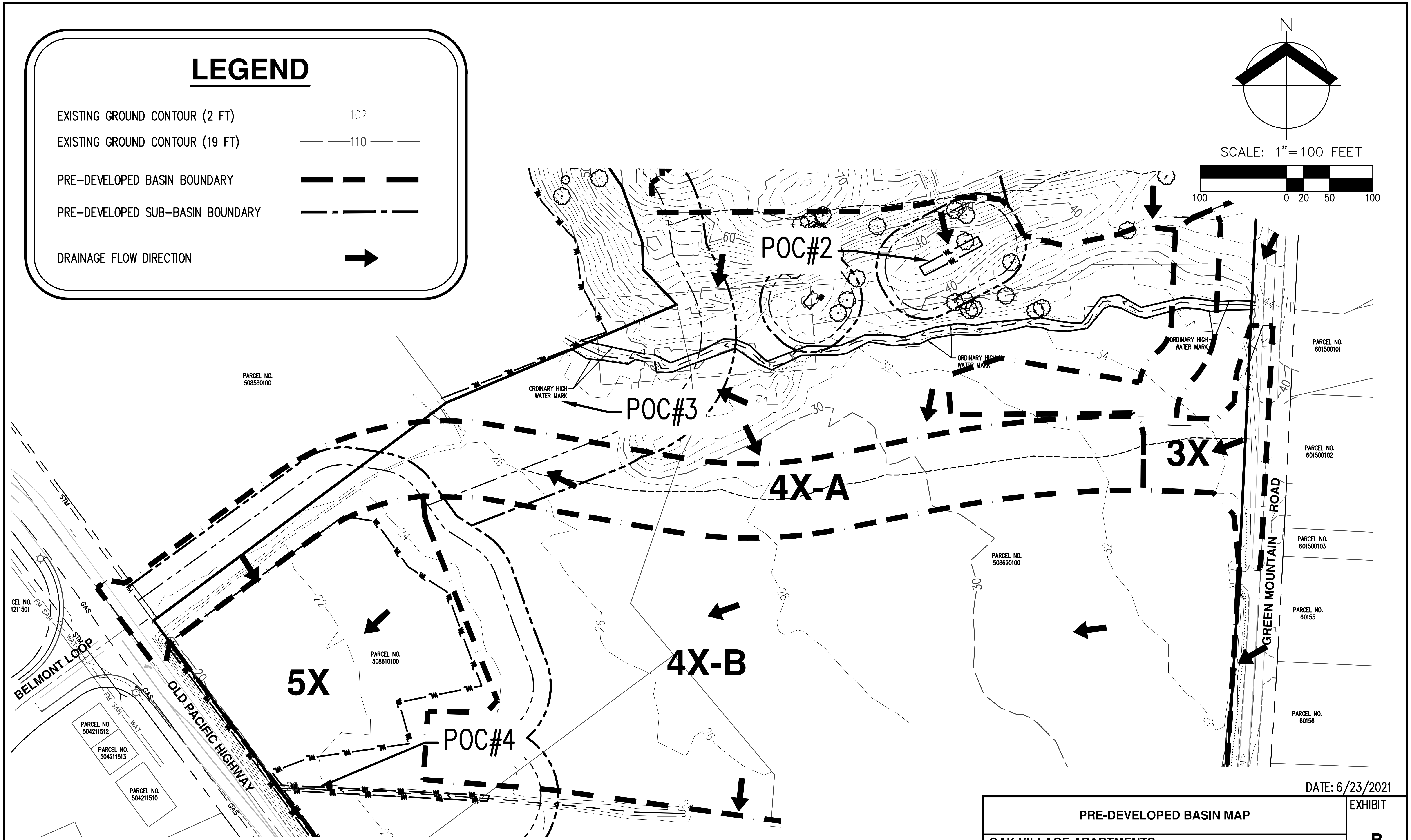
DWG: 8344 BASIN MAPS | PRE-DEV 1



LEGEND

EXISTING GROUND CONTOUR (2 FT) — — 102- — —
EXISTING GROUND CONTOUR (19 FT) — —110 — —
PRE-DEVELOPED BASIN BOUNDARY
PRE-DEVELOPED SUB-BASIN BOUNDARY
DRAINAGE FLOW DIRECTION

DATE: 6/23/2021

PRE-DEVELOPED BASIN MAP

EXHIBIT
B

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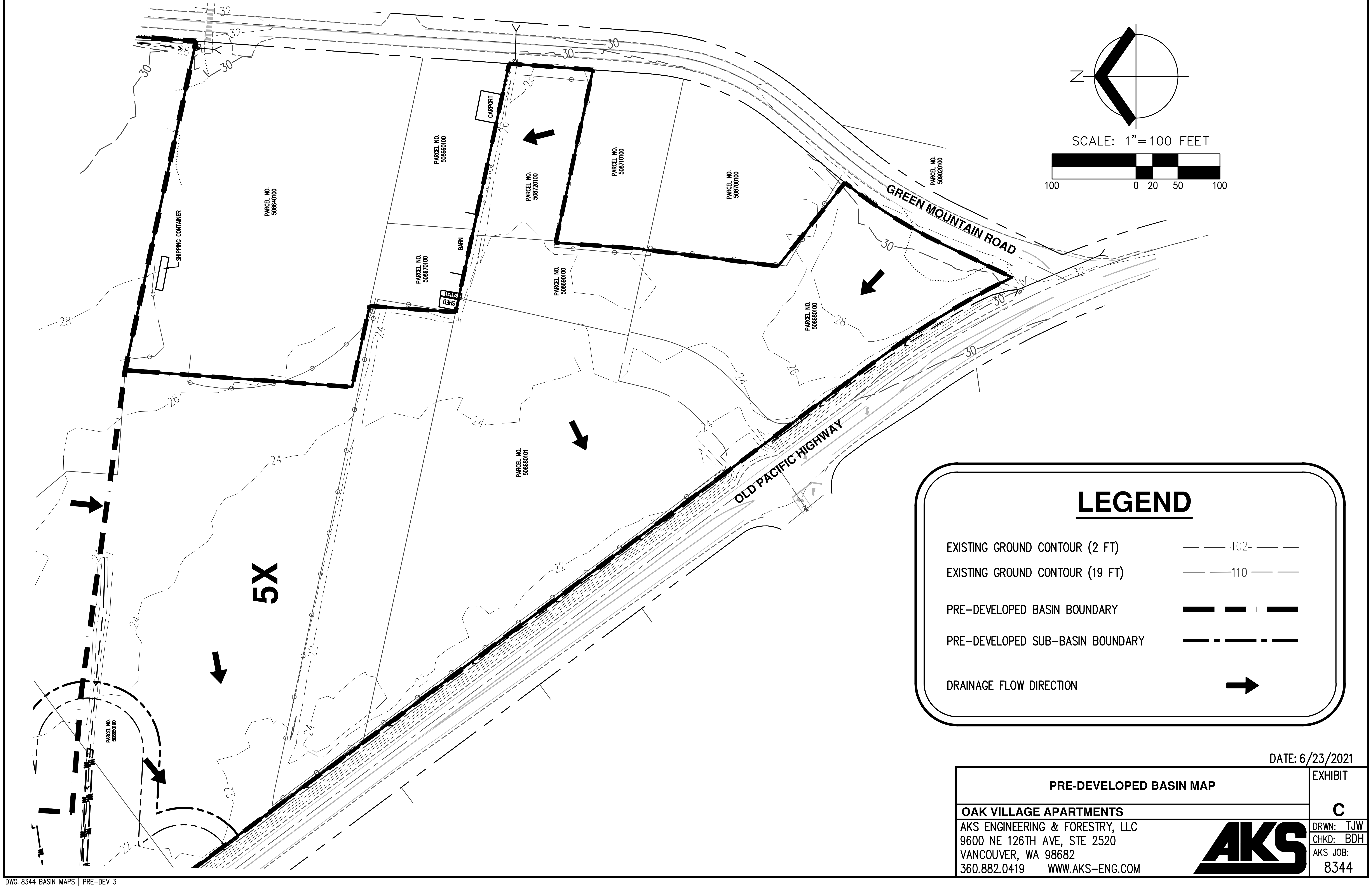
DWG: 8344 BASIN MAPS | PRE-DEV 2



LEGEND

EXISTING GROUND CONTOUR (2 FT)	102
EXISTING GROUND CONTOUR (19 FT)	110
PRE-DEVELOPED BASIN BOUNDARY	▬ ▬ ▬
PRE-DEVELOPED SUB-BASIN BOUNDARY	— - —
DRAINAGE FLOW DIRECTION	➡

DATE: 6/23/2021

PRE-DEVELOPED BASIN MAP

EXHIBIT
C

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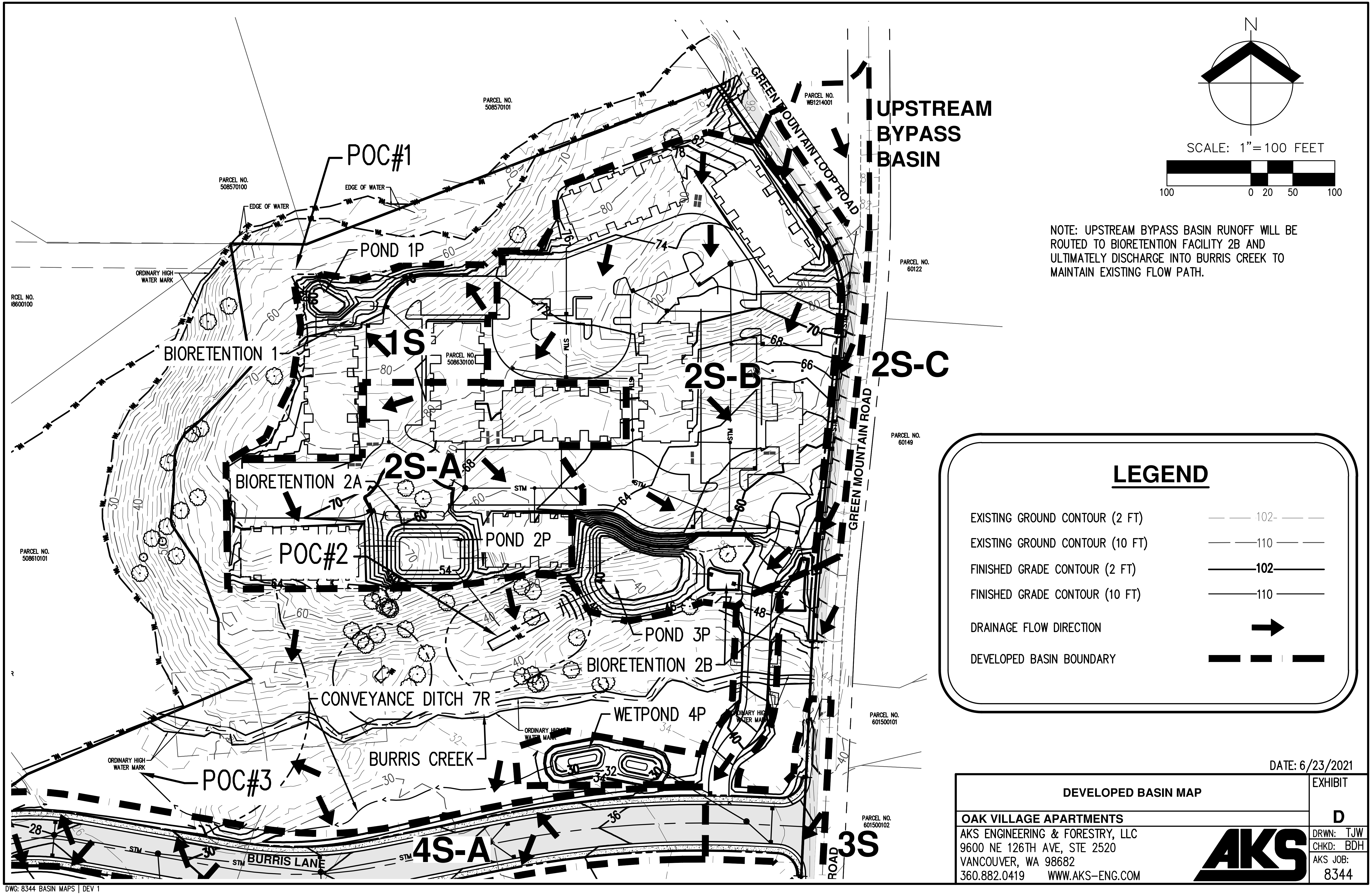
DWG: 8344 BASIN MAPS | PRE-DEV 3



NOTE: UPSTREAM BYPASS BASIN RUNOFF WILL BE ROUTED TO BIORETENTION FACILITY 2B AND ULTIMATELY DISCHARGE INTO BURRIS CREEK TO MAINTAIN EXISTING FLOW PATH.

LEGEND

EXISTING GROUND CONTOUR (2 FT)	— — 102 — —
EXISTING GROUND CONTOUR (10 FT)	— — 110 — —
FINISHED GRADE CONTOUR (2 FT)	—— **102** ——
FINISHED GRADE CONTOUR (10 FT)	—— 110 ——
DRAINAGE FLOW DIRECTION	➡
DEVELOPED BASIN BOUNDARY	▬ ▬ ▬

DATE: 6/23/2021

DEVELOPED BASIN MAP

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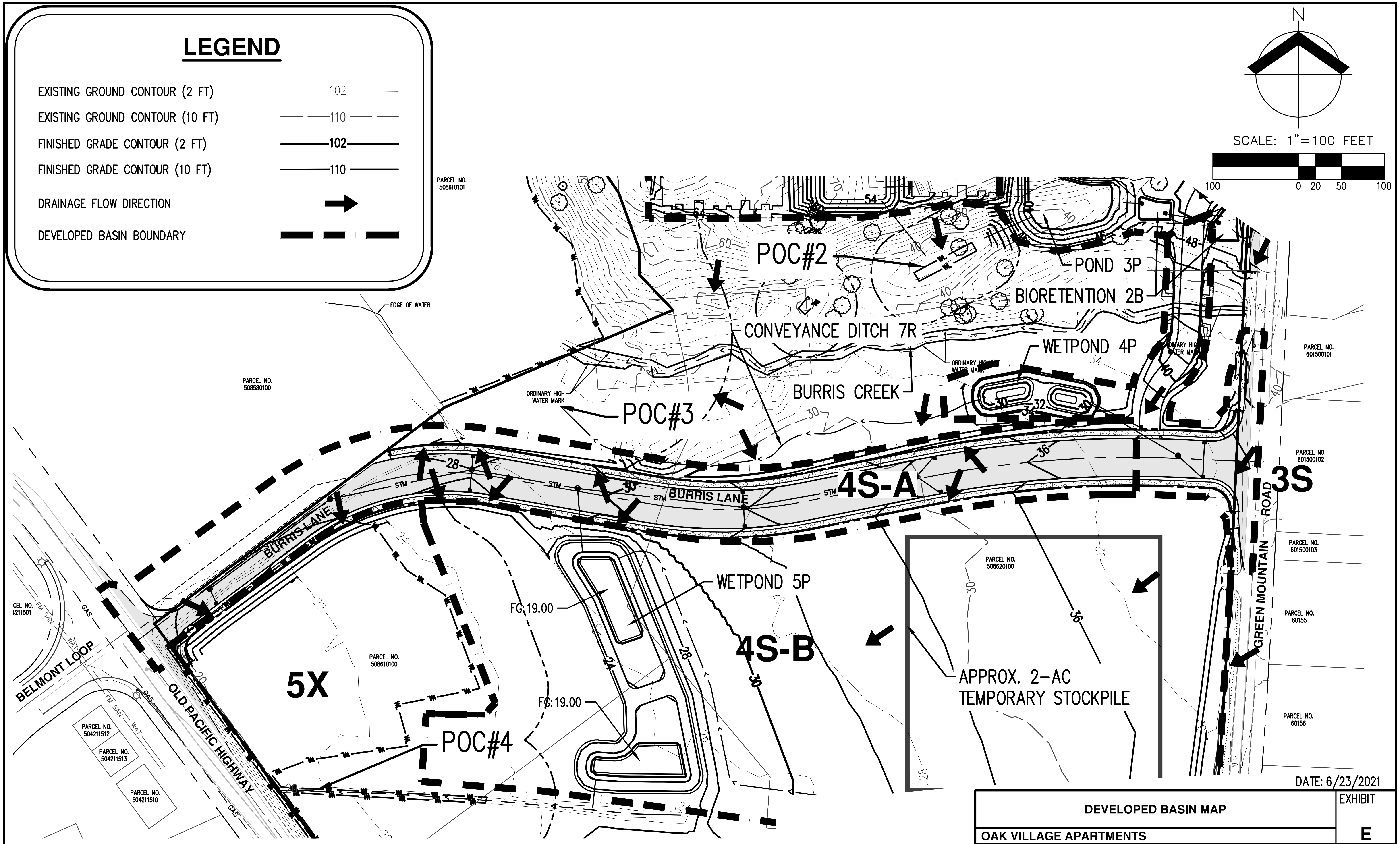
DWG: 8344 BASIN MAPS | DEV 1



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DEVELOPED BASIN MAP

EXHIBIT

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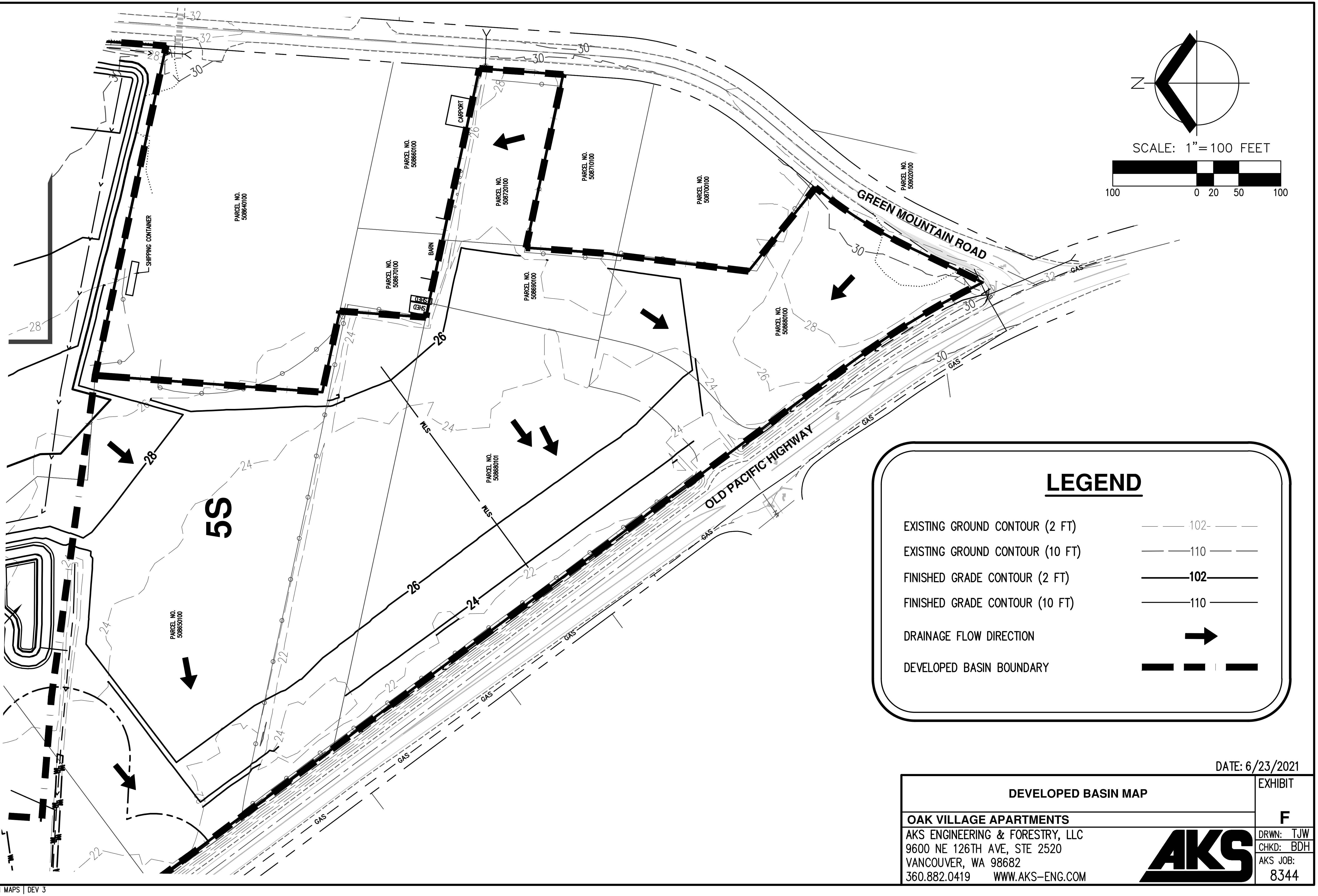
DWG: 8344 BASIN MAPS | DEV 2



LEGEND

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EXISTING GROUND CONTOUR (10 FT)	— —110 — —
FINISHED GRADE CONTOUR (2 FT)	——**102**——
FINISHED GRADE CONTOUR (10 FT)	——110 ——
DRAINAGE FLOW DIRECTION	➡
DEVELOPED BASIN BOUNDARY	▬ ▬ · ▬

DATE: 6/23/2021

DEVELOPED BASIN MAP

OAK VILLAGE APARTMENTS

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Appendix E: BMP Details

III-4.4 STANDARDS AND SPECIFICATIONS FOR DETENTION PONDS

III-4.4.1 BMP RD.05 Wet Pond (Conventional Pollutants)

Purpose and Definition

This BMP is designed to provide runoff treatment for conventional pollutants but not nutrients. It may also be designed to provide streambank erosion control. A wet pond is an open pond which treats runoff using a permanent pool of water ("dead storage"). As an option, a shallow marsh area can be created within the permanent pool volume to provide additional treatment (see BMP RD.06, Wet Pond for Nutrient Control). Streambank erosion control is provided in the "live storage" area above the permanent pool. Figure III-4.1 illustrates a typical wet pond BMP.

Planning Considerations

Wet ponds require careful planning in order to function correctly. Throughout the design process the designer should be committed to considering the potential impacts of the completed facility. Such impacts can be positive or negative and can be as broadly classified as social, economic, political, and environmental. Designers can often influence the positive or negative aspects of these impacts by their careful evaluation of decisions made in the design process. Generally speaking, the completed facility must provide for safety to people as well as protection of real property, water quality, and wildlife habitats.

Multiple Uses

Multi-purpose use of the facility and aesthetic enhancement of the general area should also be major considerations. Above all, the facility should function in such a manner as to be compatible with overall stormwater systems both upstream and downstream to promote a watershed approach to providing stormwater management as well as local flood control and erosion protection.

If the facility is planned as an artificial lake to enhance property values and promote the aesthetic value of the land, pretreatment in the form of landscape retention areas or perimeter swales should be incorporated into the stormwater management facility. If possible, catchbasins should be located in grassed areas. By incorporating this "treatment train" concept into the overall collection and conveyance system, the engineer can prolong the utility of these permanently wet installations and improve their appearance. Any amount of runoff waters, regardless how small, that is filtered or percolated along its way to the final detention area can remove oil and grease, metals, and sediment. In addition, this will reduce the annual nutrient load to prevent the wet detention lake from eutrophying.

Detention system site selection should consider both the natural topography of the area and property boundaries. Aesthetic and water quality considerations may also dictate locations. For example, ponds with wetland vegetation are more aesthetically pleasing than ponds without vegetation. Ponds containing wetland vegetation also provide better conditions for pollutant capture and treatment.

A storage facility is an integral part of the environment and therefore should serve as an aesthetic improvement to the area if possible. Use of good landscaping principles is encouraged. The planting and preservation of desirable trees and other vegetation should be an integral part of the storage facility design.

Water Quality Considerations

In planning new detention facilities, it should be kept in mind that the goal of improved water quality downstream may conflict with certain desired uses of the facility. It is only logical that if the basin is used to remove pollutants, the *water quality within the basin itself will be lowered, thus reducing the applicability for uses such as water supply, recreation, and aesthetics. In planning the facility the engineer or planner should have a good knowledge of site-specific runoff constituents and an understanding of the possible effects on the quality of the stored water.*

Basin Planning

The design of urban detention facilities should be coordinated with a basin plan for managing stormwater runoff. In a localized situation, an individual property owner can, of course, by his or her actions alone, provide effective assistance to the next owner downstream if no other areas contribute to that owner's problems. However, uncontrolled proliferation of impoundments within a watershed can severely alter natural flow conditions, causing compounded flow peaks or increased flow duration which can contribute to downstream degradation. In addition, upstream impacts due to future land use changes should be considered when designing the structure. Land use planning and regulation may be necessary to preserve the intended function of the impoundment. See Minimum Requirement #9 (Basin Planning) and the appendix in Volume I for a further discussion of basin planning.

Sediment and Debris

More often than not, detention ponds serve primarily as sedimentation basins during construction when erosion rates are particularly high. In and of itself, this situation does not present a problem. Unfortunately, these facilities are often installed without the benefit of the designer having evaluated the capacity of either the initial or the final (post-construction) design configuration to perform this type of function.

If a facility is to be used as the principal means to avoid having excessive levels of turbidity discharged from the site during construction, the engineer should evaluate the pond geometry in conjunction with the rate of outflow and grain size distribution of the soils and design the temporary sediment basin according to BMPs E3.35 or E3.40 in Volume II.

Heavy Metal Contamination

Studies have shown high accumulation rates of lead, zinc, and copper on and near heavily traveled highways and streets. Runoff from highways and streets can be expected to carry significant concentrations of these heavy metals. If a significant portion of the drainage area into a pond consists of highways, streets, or parking areas or other known sources of heavy metal contamination, there is a potential environmental health hazard. In such cases the multiple use functions of the pond should be limited and accessibility should be restricted. Additionally, liners may be required in order to prevent these types of pollutants from migrating into the underlying soil and ground water system.

This may require that sediment dredged out of the basins during maintenance cleaning be treated as a Dangerous Waste. Investigations of sediments removed from detention ponds to date have found that many pollutants are tightly bound with only a slight possibility of leaching. To be safe, sediments to be removed should be analyzed and elutriate tests performed to verify that the sediment can be safely disposed of by conventional methods (see Volume IV, Catchbasin Sediment Disposal Policy (to be written) which deals with disposal procedures).

Overflows

Detention facility design must take into consideration overflows and secondary overflow. Overflows include all facilities designed to bypass flows over or around the restrictor system. Overflow may result from higher intensity or longer duration storms than the design storm or result from plugged orifices or inadequate storage *due to sediment buildup in the facility.*

Secondary overflow occurs when the capacities of all conveyance facilities, and all overflow facilities are exceeded or are not functioning. In such instances, stormwater will often exit the conveyance system through catchbasin grates and flow down the corridor of least resistance. Careful consideration must be given to the impact of secondary overflows on public health, safety and welfare, property, and wildlife habitat. When secondary overflow occurs, design of secondary drainage facilities following careful analysis and planning can significantly reduce impacts. Street alignments and grades are the key components in developing secondary drainage design, and consideration should be given early in the planning stages to their use as secondary overflow facilities.

Site Constraints and Setbacks

Site constraints are any manmade restrictions such as property lines, easements, structures, etc. that impose constraints on development. Constraints may also be imposed from <u>natural</u> features such as requirements of the local government's Sensitive Areas Ordinance and Rules (if adopted). These should also be reviewed for specific application to the proposed development.

All facilities shall be a minimum of 20 feet from any structure, property line, and any vegetative buffer required by the local government, and 100 feet from any septic tank/drainfield (except wet vaults shall be a minimum of 20 feet).

All facilities shall be a minimum of 50 feet from any steep (greater than 15%) slope. A geotechnical report must address the potential impact of a wet pond on a steep slope.

Dam Safety

In urban or urbanizing areas, failure of an impoundment structure can cause significant property damage and even loss of life. Such structures should be designed only by professional engineers registered in the State of Washington who are qualified and experienced in impoundment design. Wherever they exist, local safety standards for impoundment design shall be followed. Where no such criteria exist, widely recognized design criteria such as those used by the USDA Soil Conservation Service, Ecology Dam Safety Standards, or U.S. Army Corps of Engineers are recommended.

Safety, Signage and Fencing

Ponds which are readily accessible to populated areas should incorporate all possible safety precautions. Steep side slopes (steeper than 3H:1V) at the perimeter shall be avoided and dangerous outlet facilities shall be protected by enclosure. Warning signs for deep water and potential health risks shall be used wherever appropriate. Signs should be placed so that at least one is clearly visible and legible from all adjacent streets, sidewalks or paths. A notice should be posted warning residents of potential waterborne disease that may be associated with body contact recreation such as swimming in these facilities.

If the pond surface exceeds 20,000 sq. feet, include a safety bench around the basin with a width of 5 feet, and with a depth not exceeding 1 foot during non-storm periods. Emergent vegetation such as cattails should be placed on the bench to inhibit entry by unauthorized people.

A fence is required at the maximum water surface elevation, or higher, when a pond slope is a wall. Local governments and Homeowners Associations may also require appropriate fencing as an additional safety requirement in any event.

Design Criteria

Sizing Wet Ponds

Wet ponds designed for treatment of conventional pollutants utilize a permanent pool of water to provide treatment and are to be designed using the hydrologic analysis methods presented in Chapter III-1.

Permanent Pool Volume

The permanent pool volume shall be equal to the runoff volume of the 6-month, 24-hour design storm. It is not necessary to vegetate the permanent pool, but establishment of a shallow marsh system can provide additional pollutant removal capabilities.

Surface Area-Pool Depth Relationships

The pond surface area is found by dividing the permanent pool volume by the depth, with a maximum depth of six (6) feet recommended. A minimum depth of three (3) feet is recommended so that resuspension of trapped pollutants is inhibited. Permanent pools deeper than six (6) feet could potentially contaminate ground water (should they intersect the existing ground water level). Also, deeper ponds can stratify and create anaerobic condition that can cause pollutants which are normally bound in the sediment (e.g., metals and phosphorus) to resolubilize; their release back to the water column can seriously affect the effectiveness of the BMP and also create nuisance conditions.

See Table III-4.2 for the surface area-pool depth relationship. Table III-4.3 illustrates typical surface area-to-drainage area ratios for this and other detention BMPs.

If the wet pond is also designed to provide streambank erosion control, then additional surface area and depth will be required for the "live storage" volume located above the permanent pool. There is no specific surface area-pool depth relationship for the "live storage" volume.

Ponds designed to provide streambank erosion control may be deeper than six feet as long as the permanent pool volume provided for runoff treatment does not exceed six feet.

Outlet Structure

The outlet structure must be designed to accomplish an extended detention time so that runoff can be released at the flow rates established by Minimum Requirement #5, Streambank Erosion Control (see Chapter I-2). Figure III-4.3 illustrates methods for extending detention time in wet ponds.

Pond Configuration and Geometry

Wet ponds shall be multi-celled with a least two cells, and preferably three. The cells should be approximately equal in size. The first cell should be three feet deep in order to effectively trap coarser sediments and reduce turbulence which can resuspend sediments. It should be easily accessible for maintenance purposes.

Long, narrow, and irregularly shaped ponds are preferred, as these configurations are less prone to short-circuiting and tend to maximize available treatment area. The length-to-width ratio should be at least 3:1 and preferably 5:1. Irregularly shaped ponds may perform more effectively and will have a more natural appearance.

The inlet and outlet should be at opposite ends of the pond where feasible. If this is not possible, then baffles can be installed to increase the flow path and water residence time (see BMP RD.10, Presettling Basin, for details).

Interior side slopes up to the maximum water surface shall be no steeper than 3H:1V. Exterior side slopes shall be no steeper than 2H:1V.

The pond bottom shall be level to facilitate sedimentation.

Pond walls may be retaining walls, provided that the design is prepared and stamped by a structural engineer registered in the State of Washington, that they are constructed of reinforced concrete per Section III-4.6.1, that a fence is provided along the top of the wall, and that at least 25 percent of the pond perimeter will be a vegetated soil slope of not greater than 3H:1V.

Other Design Considerations

Liner to Prevent Infiltration

Detention BMPs should have negligible infiltration rates through the bottom of the pond. Infiltration will impair the proper functioning of detention BMPs and can contaminate ground water. If infiltration is anticipated, then a detention facility must either **not** be used and an infiltration BMP used instead (see Chapter III-3) or a liner should be installed to prevent infiltration. If a liner is used, the specifications provided in Section III-3.7 (Filtration BMPs) can be used. When using a liner the following are recommended:

- A layer of (track) compacted top soil (minimum 18" thick shall be placed over the liner prior to seeding with an appropriate seed mixture (see BMP E1.35 in Chapter II-5).
- Other liners may be used provided the design engineer can supply support documentation that the material will provide the required performance.

Overflow and Emergency Spillway

If streambank erosion control is not required, a pond overflow system must provide controlled discharge of the 100-year, 24-hour design storm event for developed site conditions without overtopping any part of the pond embankment or exceeding the capacity of the emergency spillway. The design must provide controlled discharge directly into the downstream conveyance system. This assumes the pond will be full due to plugged control structure inflow pipe and/or plugged restrictor/orifices conditions.

Open Type 2 catchbasins can function as weirs when used as pond overflow structures to control overtopping. The overflow structure, as shown in Figure III-4.5, may be required in some circumstances to protect embankments from overtopping.

In addition to the above overflow requirements, an emergency overflow spillway (secondary overflow) must be provided to safely pass the 100-year, 24-hour design storm event (for developed site conditions and assuming the pond is full to the crest of the spillway) over the pond embankment in the event of control structure failure or for storm/runoff events exceeding design. The spillway must be located to direct overflows safely towards the downstream conveyance system and shall be located in existing soil wherever feasible. The emergency overflow spill shall be armored with riprap in conformance with Table III-2.4 and shall extend to the toe of each face of the berm embankment.

- Design of emergency overflow spillways requires the analysis of a broad-crested trapezoidal weir. The following weir section is required for the emergency overflow spillway, as per Figure III-4.4.

Figure III-4.2 Methods for Extending Detention Time in Wet Ponds

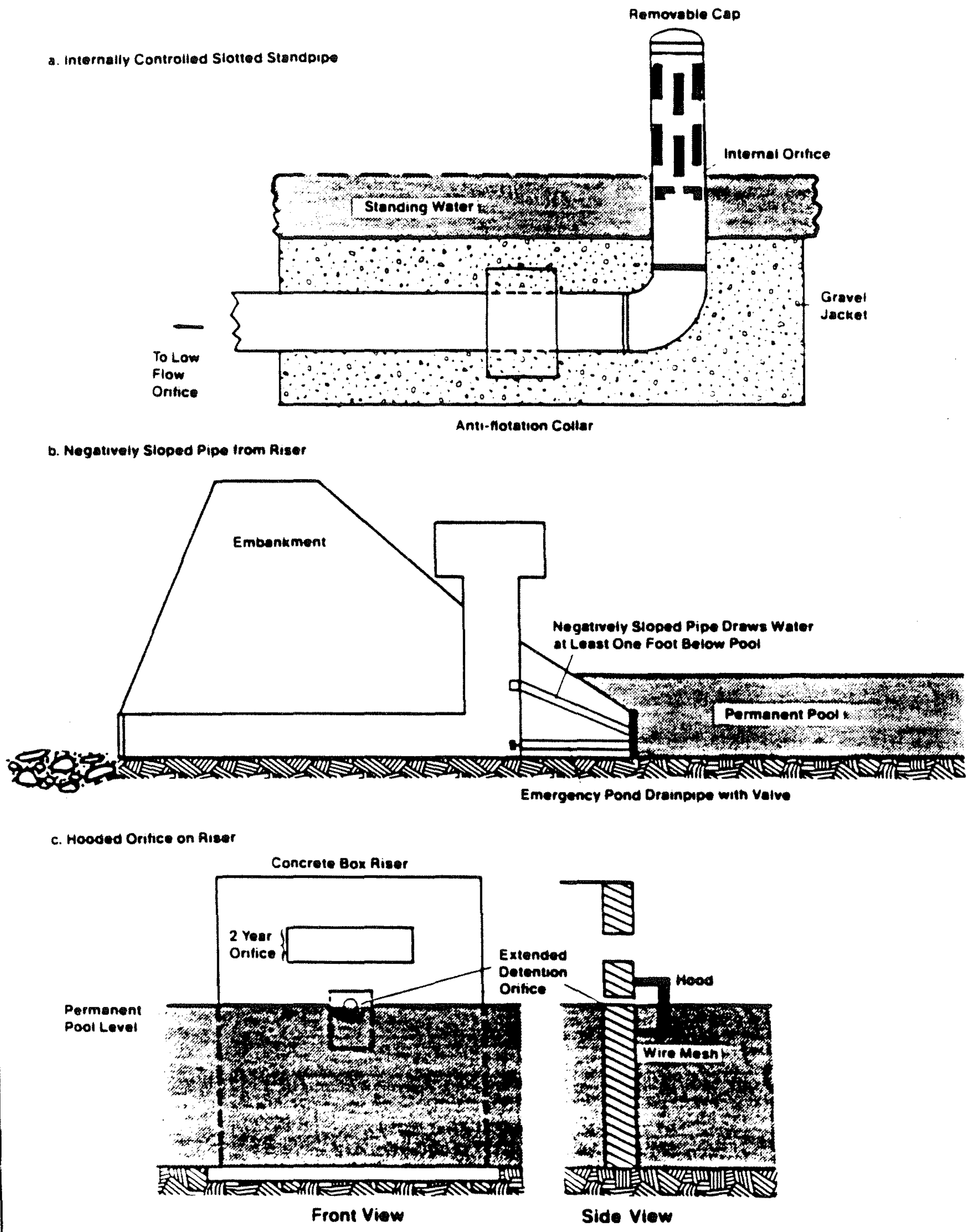
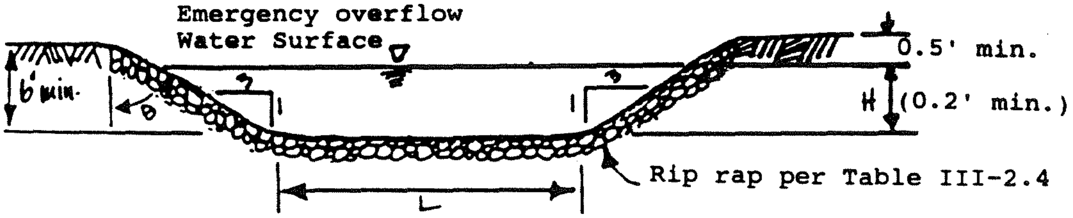


Figure III-4.3 Weir Section for Emergency Overflow Spillway



- The emergency overflow spillway weir section can be designed to pass the 100-year, 24-hour design storm event for developed conditions as follows:

  For this weir, $Q_{100} = C\ (2g)^{1/2}[(2/3)LH^{3/2} + 8/15\ \mathrm{Tan}\ \Theta\ H^{5/2}]$

  using: $C = 0.6$ (discharge coefficient);
  $\mathrm{Tan}\ \Theta = 3$ (for 3:1 slopes);
  $\Theta = 72°$;

  The equation becomes: $Q_{100} = 3.21\ (LH^{3/2} + 2.4H^{5/2})$

  To find width L, the equation is rearranged to use the computed Q_{100} (peak flow for the 100-year, 24-hour design storm) and trial values of H (0.2 feet minimum).

  $L = (Q_{100}/(3.21H^{3/2})) - (2.4H^2)$;
  $=$ 6 feet minimum

Berm Embankment/Slope Stabilization

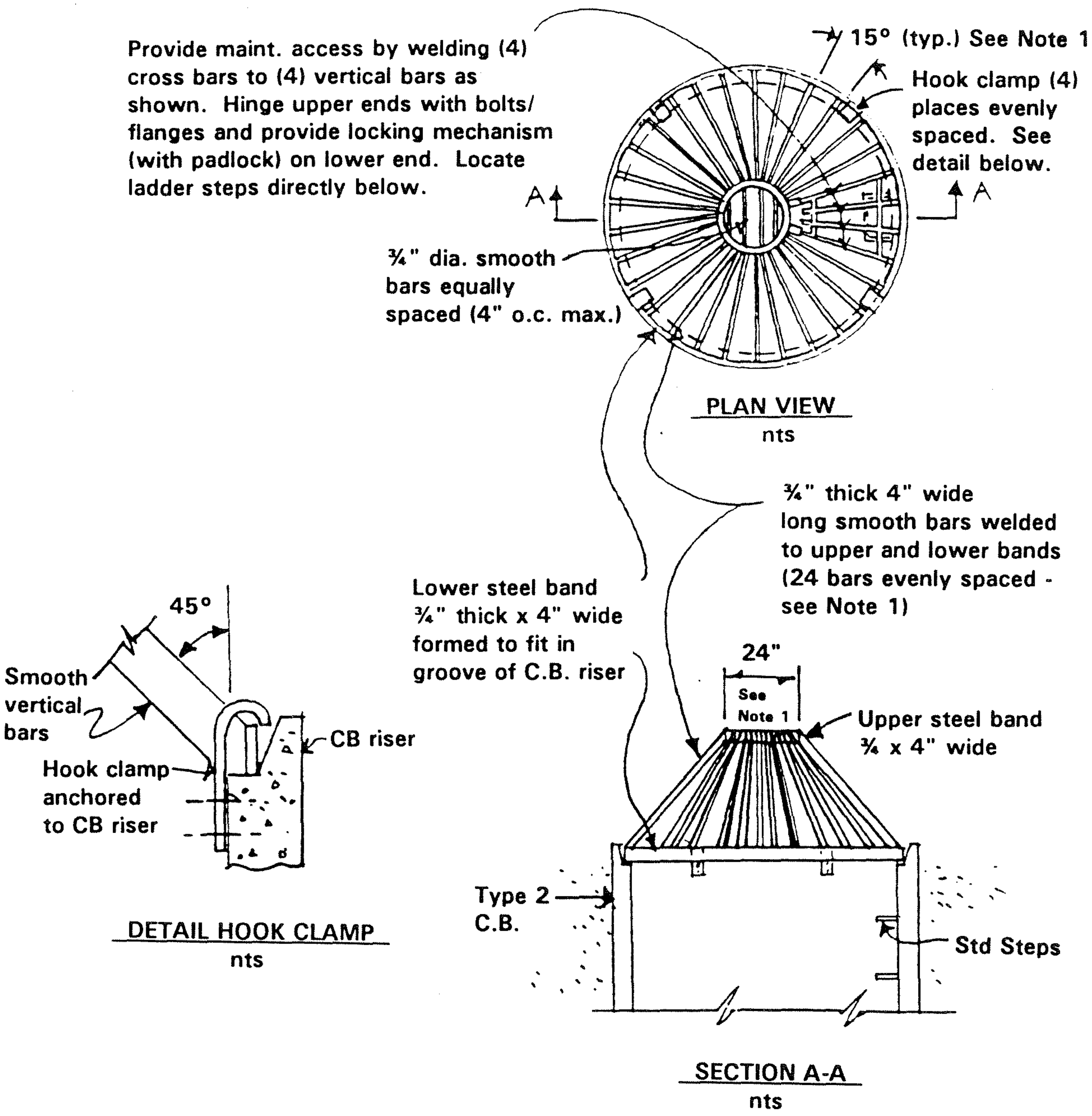
Pond embankments higher than 6 feet shall require design by a geotechnical-civil engineer licensed in the State of Washington. The embankment shall have a minimum 15 foot top width where necessary for maintenance access; otherwise, top width may vary as recommended by the geotechnical-civil engineer.

The berm dividing the pond into cells shall have a 5 foot minimum top width, a top elevation set one foot lower than the design water surface, maximum 3:1 side slopes, and a quarry spall and gravel filter "window" between the cells (see Figure III-4.5).

For berm embankments of 6 feet or less than (including 1 foot freeboard), the minimum top width shall be 6 feet or as recommended by the geotechnical-civil engineer.

The toe of the exterior slope of pond berm embankment must be no closer than 5 feet from the tract or easement property line.

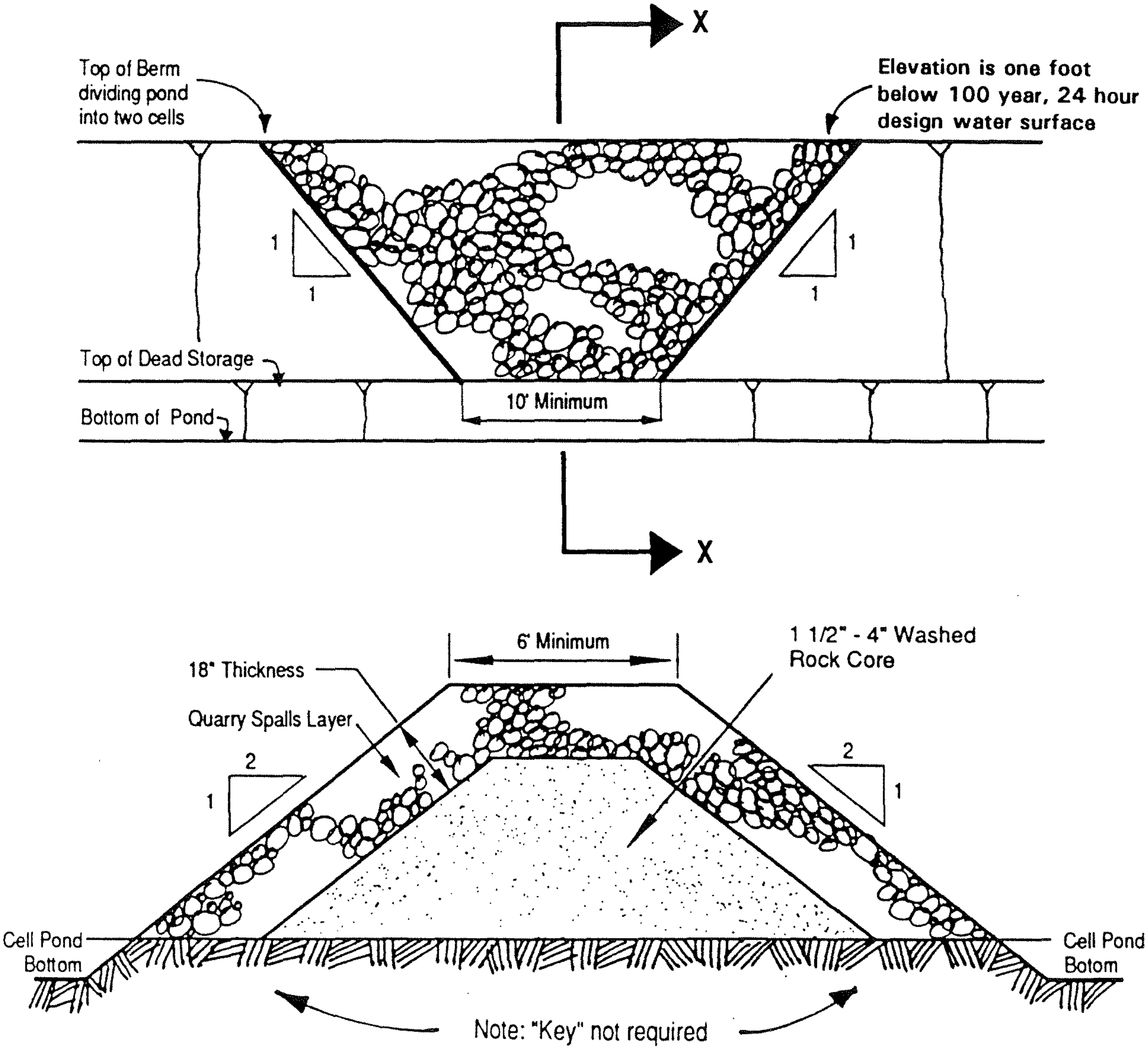
Figure III-4.4 Detention Pond Overflow Structure



Notes:

1. Dimensions are for installation on 54" dia. C.B. For different dia.C.B.'s adjust dimensions to maintain 45° angle on "vertical" bars and 7" O.C. max. spacing of bars around lower steel band.
2. Metal parts: corrosion resistant.
3. This debris barrier is also recommended for use on the inlet to roadway cross-culverts with high potential for debris collection (except on Class 2 streams).

Figure III-4.5 Quarry Spall and Gravel Filter "Window"



Pond berm embankments must be constructed on native consolidated soil (or adequately compacted and stable fill soils analyzed by a geotechnical report) free of loose surface soil materials, roots and other organic debris.

Pond berm embankments must be constructed by excavating a "key" equal to 50 percent of the berm embankment cross-sectional height and width (except on highly compacted till soils where the "key" minimum depth can be reduced to 1 foot of excavation into the till).

The berm embankment shall be constructed on compacted soil (95 percent minimum dry density, standard proctor method per ASTM D1557), placed in 6-inch lifts, with the following soil characteristics per the United States Department of Agriculture's Textural Triangle: a minimum of 30 percent clay, a maximum of 60 percent sand, a maximum of 60 percent silt, with nominal gravel and cable content (Note, in general, excavated glacial till will be well-suited for berm embankment material).

Anti-seepage collars must be placed on outflow pipes in berm embankments impounding water greater than 8 feet in depth at the design water surface.

Exposed earth on the pond bottom and side slopes shall be sodded or seeded with the appropriate seed mixture as soon as is practicable (see Erosion and Sediment Control BMP E1.35 in Volume II). Establishment of protective vegetative cover shall be ensured with jute mesh or other protection and reseeded as necessary (see Erosion and Sediment Control BMPs E1.15 and E1.35 in Volume II).

Gravity Drain

A gravity drain for maintenance shall provide an outlet invert of one foot above the bottom of the facility and shall be sized to drain the facility in four hours or less.

Erosion and Sediment

Bank erosion is often a significant problem during the initial stages of development. Stabilization with sod down to the permanent pool and preventing undue sediment deposition is required for the planting to survive.

Erosion and sediment control BMPs must be used to retain sediment on-site during construction (see Erosion and Sediment Control in Volume II). BMPs must be shown on the design plans and the engineer must provide instructions for proper O&M. Permanently stabilize all areas above the normal water level of ponds to prevent erosion and sedimentation of plantings (see Chapter II-5).

Littoral Zone Planting

For treating conventional pollutants a wet pond does not require the establishment of vegetation in its shallow areas, or "littoral zones." However, a shallow marsh system can provide additional treatment of runoff and be aesthetically pleasing (see BMP RD.06, Wet Pond for Nutrient Control, for details). If littoral zone vegetation is planned it shall be planted according to the advice of a wetlands specialist. Nursery sources are recommended wherever possible. Small (2-4 inch) containers are encouraged to avoid transporting large amounts of potting soil to the pond. White roots and active basal budding indicate a healthy stock.

Most wetlands specialists prefer to have someone on-site during the construction phase to ensure that the littoral shelf is located and graded properly. Knowing exactly where the normal water level of the facility will reside after construction is absolutely essential to the success of this element of the system.

Construction and Maintenance Criteria

Construction

Widely acceptable construction standards and specifications such as those developed by the USDA - Soil Conservation Service or the U.S. Army Corps of Engineers for embankment ponds and reservoirs should be followed to build the impoundment.

Chapter 17 of the SCS Engineering Field Manual provides guidance on construction methods for the various elements of a pond or reservoir. Specifications for the work should conform to methods and procedures for installing earthwork, concrete, reinforcing steel, pipe, water gates, metal work, woodwork, and masonry, that are applicable to the site and the purpose of the structure, and satisfy all requirements of the local government.

Maintenance

General

Maintenance is of primary importance if detention ponds are to continue to function as originally designed. A local government, a designated group such as a homeowners' association, or some individual shall accept the responsibility for maintaining the structures and the impoundment area. A specific maintenance plan shall be formulated outlining the schedule and scope of maintenance operations. Debris removal in detention basins can be achieved through the use of trash racks or other screening devices.

Design with maintenance in mind. Good maintenance will be crucial to successful use of the impoundment. Hence, provisions to facilitate maintenance operations must be built into the project when it is installed. Maintenance must be a basic consideration in design and in determination of first cost. See Table III-4.4 for specific maintenance requirements.

Any standing water removed during the maintenance operation must be disposed of to a sanitary sewer at an approved discharge location. Residuals must be disposed in accordance with current health department requirements of the local government.

Vegetation

If a shallow marsh is established, then periodic removal of dead vegetation will be necessary. The frequency of removal has not been established and Ecology requests comments on this issue. Since decomposing vegetation can release pollutants captured in the wet pond, especially nutrients, it may be necessary to harvest dead vegetation annually prior to the winter wet season. Otherwise the decaying vegetation can export pollutants out of the pond and also can cause nuisance conditions to occur. If harvesting is to be done in the wetland, a written harvesting procedure shall be prepared by a wetland scientist and will be submitted with the drainage design to the local government.

Sediment

Maintenance of sediment forebays and attention to sediment accumulation within the pond is extremely important. Sediment deposition should be continually monitored in the basin. Owners, operators, and maintenance authorities should be aware that significant concentrations of heavy metals (e.g., lead, zinc, and cadmium) as well as some organics such as pesticides, may be expected to accumulate at the bottom of these treatment facilities. Testing of sediment, especially near points of inflow, should be conducted regularly to determine the leaching potential and level of accumulation of hazardous material before disposal. For disposal procedures, refer to Volume IV - disposal requirements for catchbasin and pond sediments (to be written).

Access

Pond access tracts and roads are required when ponds do not abut public right-of-way. Road(s) shall provide access to the control structure and along side(s) of the pond as necessary for vehicular maintenance. For ponds with bottom widths of 15 feet or more, the access road shall extend to the pond bottom and an access pad provided to facilitate cleaning. For ponds less than 15 feet in width, an access road must extend along one side.

Roads and pads shall meet the following criteria:

- Maximum Grade: 15 percent to control structure, 20 percent into pond.
- Provide 40 foot minimum outside radius on the access road to the control structure and the turn around to the pond bottom.
- Fence gates shall be provided for access roads at "straight" sections of road.
- Access roads shall be 15 feet in width.
- Access pads shall be 15 feet in width and 25 feet in length.
- Manhole and catchbasin lids must be at either edge of an access road or pad and be at least 3 feet from a property line.

Access shall be limited by a double-posted gate if a fence is required or by bollards. Bollards shall consist of two fixed bollards on each side of the access road and two removable bollards equally located between the fixed bollards.

Access roads and pads shall be constructed by utilizing one of the following techniques:

- Construct an asphalt surface meeting the same standard as residential minor access streets, as required by the local government.
- Construct a gravel surface road by removing all unsuitable material, laying a geotextile fabric over the native soil, placing quarry spalls (2"-4") six inches thick then providing a two-inch thick crushed gravel surface.
- Construct a landscape block (24"x24"x 6") surface by removing all unsuitable material, laying a geotextile fabric over the native soil, placing landscape blocks, filling the honeycombs with soil particles, and planting grass.

Nuisance Conditions

The presence of wet ponds and marshes in established urban areas is perceived by many people to be undesirable. They are often thought of as mud holes where mosquitoes and other insects breed. If the wet pond has a shallow marsh established (more likely in the cases of BMP RD.06 and BMP RD.09), the pond can become a welcomed addition to an urban community. Constructed fresh water marshes can provide miniature wildlife refuges, and while insect populations are increased, insect predators also increase, often reducing the problem to a tolerable level. Advice from the University of Washington (Rick Sugg, personal communication) suggests that in the Puget Sound lowlands, the extra breeding habitat provided by any wetponds would not be significant. Nevertheless, local governments and homeowners associations may wish to temporarily drain wet ponds during late spring (May) and summer if there is sufficient concern. **However, it is imperative that vegetation in shallow marsh areas not die off during draindown periods. Otherwise, the pollutant removal effectiveness of the wet pond can be severely impacted. In addition, the decaying vegetation can create nuisance conditions.**

Table III-4.4 Specific Maintenance Requirements for Detention Ponds

Maintenance Component	Defect	Conditions When Maintenance is Needed	Results Expected When Maintenance is Performed
I. Ponds - General	Trash and debris	Any trash or debris which exceeds 1 ft^3/1000 ft^2 (equal to the volume of a standard size office garbage can). In general, there should be no evidence of dumping.	Trash and debris cleared from site.
	Poisonous vegetation	Any poisonous vegetation which may constitute a hazard to maintenance personnel or the public, e.g. tansy, poison oak, stinging nettles, devils club.	No danger of poisonous vegetation where maintenance personnel or the public might normally be. Coordinate with the local county health dept.
	Pollution	1 gallon or more of oil, gas or other contaminants or any amount found that could: 1) cause damage to plant, animal or marine life, 2) constitute a fire hazard, 3) be flushed downstream during storms or 4) contaminate ground water.	No contaminants present other than a surface film. Coordinate with the local county health dept.
	Unmowed grass/ground cover	In residential areas, mowing is needed when the cover exceeds 18 inches in height. Otherwise, match facility cover with adjacent ground cover and terrain as long as there is no decrease in facility function.	When mowing is needed, grass or ground cover should be mowed down to 2 inches. A dense grass cover must be maintained on slopes, and in dry ponds on the bottom as well.
	Rodent holes	Any evidence of rodent holes if facility is acting as a dam or berm, or any evidence of water piping through dam or berm via rodent holes.	Rodents destroyed and dam or berm repaired. Coordinate with the local county health dept.
	Insects	When insects such as wasps or hornets interfere with maintenance activities.	Insects destroyed or removed from site. Coordinate with people who remove wasps for anti-venom production.
	Tree growth	Tree growth does not allow maintenance access or interferes with maintenance activity. If trees are not interfering with access, leave trees alone.	Trees do not hinder maintenance activities. Selectively cultivate trees such as alders for firewood.
Side Slopes of Pond	Erosion	Eroded damage >2 inches deep where cause of damage is still present or where there is potential for continued erosion.	Slopes should be stabilized with appropriate erosion control BMPs e.g. seeding, plastic covers, riprap.
Storage Area, Forebay	Sediment	Accumulated sediment that exceeds 10% of the designed forebay depth, or every three years.	Sediment cleaned out to designed pond shape and depth; reseeded if necessary to control erosion.
Pond Dikes	Settling	Any part of dike which has settled 4 inches lower than the design elevation.	Dike should be built back to the design elevation.
Emergency Overflow, Spillway	Rock missing	Only 1 layer of rock above native soil in an area ≥ 5 ft^2 or any exposure of native soil.	Replace rock to design standards.
II. Debris Barriers - General	Trash and debris	Trash or debris that is plugging ≥20% of the openings in the barrier.	Barrier clear to receive capacity flow.

Maintenance Component	Defect	Conditions When Maintenance is Needed	Results Expected When Maintenance is Performed
Metal	Damaged/missing bars	Bars are bent out of shape ≥ 3 inches.	Bars in place with no bend ≥ 3/4".
		Bars or entire barrier is missing.	Bars in place according to design.
		Bars are loose and rust is causing 50% deterioration to any part of the barrier.	Repair or replace barrier to standards.
III. Fencing - General	Missing or broken parts	Any defect in the fence that permits easy entrance to the facility.	Parts in place to provide adequate security.
		Parts broken or missing.	Broken or missing parts replaced.
	Erosion	Erosion ≥ 4 inches deep and 12 - 18 inches wide permitting an opening under the fence.	No opening under the fence ≥ 4 inches in depth.
Wire Fences	Damaged parts	Posts out of plumb more than 6 inches.	Posts plumb within 1½ inches.
		Top rails bent more than 6 inches.	Top rail free of bends ≥ 1 inch.
		Any part of fence (including posts, top rails and fabric) ≥ 1 foot out of design alignment.	Fence is aligned and meets design standards.
		Missing or loose tension wire.	Tension wire in place & holding fabric.
		Missing or loose barbed wire sagging more than 2½ inches between posts.	Barbed wire in place with < 3/4 inch sag between posts.
		Extension arm missing, broken or bent out of shape more than 1½ inches.	Extension arm in place with no bends larger than 3/4 inch.
	Deteriorated paint or protective coating	Part(s) that have a rusting or scaling condition which has affected structural adequacy.	Structurally adequate posts or parts with a uniform protective coating.
	Openings in fabric	Openings in fabric are such that an 8 inch diameter ball could fit through.	No openings in fence.
IV. Gates - General	Damaged or missing members	Missing gate or locking device.	Gates and locking devices in place.
		Broken or missing hinges such that gate cannot be easily opened and closed by maintenance personnel.	Hinges intact & lubed, gate working freely.
		Gate is out of plumb ≥ 6 inches and ≥ 1 foot out of design alignment.	Gate is aligned & vertical.
		Missing stretcher bar, stretcher bands and ties.	Stretcher bar, bands & ties in place.
		See "Fencing" standard, above.	See "Fencing" standard, above.
V. Access Roads, Easements - General	Trash and debris	Exceeds 1 $ft^3/1000\ ft^2$ or the amount that would fill a standard size garbage can.	Trash & debris cleared from site.
	Blocked roadway	Debris which could damage vehicle tires.	Roadway free of such debris.
		Obstructions which reduce clearance above road surface to < 14 feet.	Roadway overhead clear to 14 feet high.

Maintenance Component	Defect	Conditions When Maintenance is Needed	Results Expected When Maintenance is Performed
V. Access Roads, Easements, continued	Blocked roadway, continued	Any obstructions restricting access to a 10 - 12 foot width for a distance of $\geq$ 12 feet or any point restricting access to a < 10 foot width.	Obstruction moved to allow at least a 12 foot access route.
	Settlement, potholes, mushy spots, ruts	When any surface exceeds 6 inches in depth and 6 ft^2 in area. In general, any surface defect which prevents or hinders maintenance access.	Road surface uniformly smooth with no evidence of potholes, settlement, mushy spots or ruts.
	Vegetation in surface	Weeds growing in the road surface that are $\geq$ 6 inches tall and < 6 inches apart within a 400 ft^2 area.	Road surface free of weeds taller than 2 inches.
	Erosion damage	Erosion within 1 foot of the roadway $\geq$ 8 inches wide & 6 inches deep.	Shoulder free of erosion & matching the surrounding road.
	Weeds and brush	Weeds and brush exceed 18 inches in height or hinder maintenance access.	Weeds and brush cut to 2 inches in height or cleared in such a way as to allow maintenance access.

III-4.4.2 BMP RD.06 Wet Pond (Nutrient Control)

Purpose and Definition

This BMP is similar to BMP RD.05 (Wet Pond for treatment of conventional pollutants) but has a shallow marsh area which provides additional treatment of pollutants, especially nutrients. The shallow marsh area is contained within the "permanent pool" volume. Streambank erosion control can be provided by detaining runoff in the "live storage" area above the permanent pool. Figure III-4.6 illustrates a wet pond for nutrient control.

Planning Considerations

See BMP RD.05, Wet Pond (Conventional Pollutants). The primary difference is that this BMP requires the establishment of a shallow marsh in order to provide additional treatment of runoff, particularly nutrients.

Marsh Establishment

Establishment of fresh water marshes in ponds can aid in water quality improvement. Marsh areas create a sink for many pollutants with a high degree of water treatment or purification, depending upon the runoff detention time and the availability of wetland plants and aquatic life to assimilate pollutants.

Wetland-associated plants will establish themselves naturally in shallow, wet ponds. It may be beneficial, however, to accelerate marsh establishment by planting appropriate native vegetation in shallow areas. Certain wetland plant species have a greater capacity for pollutant assimilation and are less maintenance intensive than others.

Marsh establishment for stormwater treatment is still in the investigational stages in Washington. One particular limitation is the fact that the major plant growing season (April - October) is largely out of phase with the times of greatest stormwater runoff. However, preliminary indications show that such measures can be appropriate for the following applications:

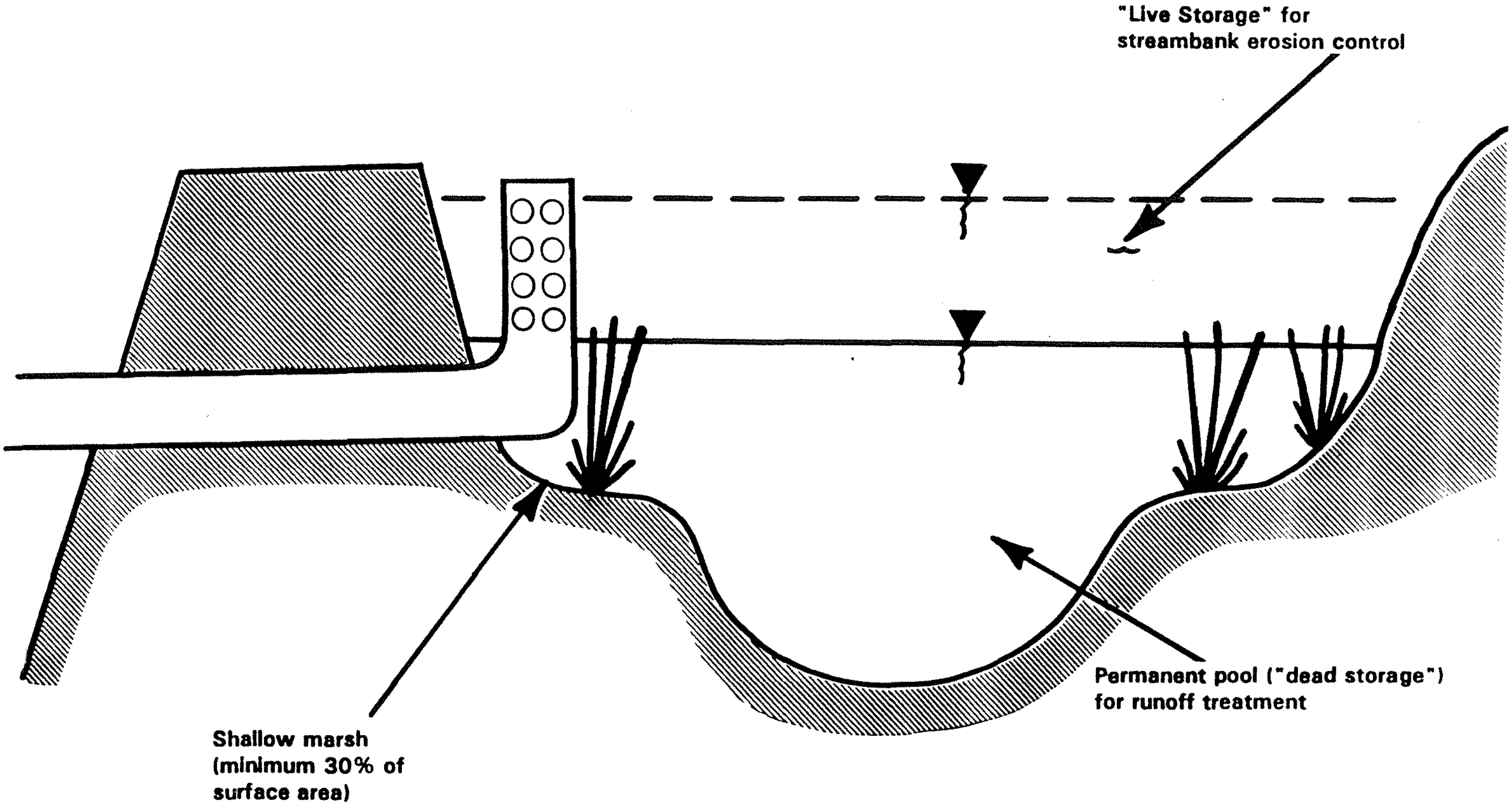
1. *At the perimeter of deep detention facilities to filter direct sheet flow runoff from the adjacent drainage area.*
2. *On shallow sills or shelves separating in-line tandem ponds or forebays to filter runoff before it enters the major impoundment from tributaries or storm drain inlets.*
3. *Surrounding the outflow of detention facilities to promote assimilation of dissolved pollutants before water exits the primary impoundment.*

Note: In any event, the value of the plant communities will depend upon how much untreated stormwater flows through them.

Marsh establishment in facilities that also serve as temporary sediment basins may be difficult during construction due to the need for frequent clean-out of accumulated sediment. Wet ponds should be designed with the need for periodic sediment removal in mind. To continue functioning, marshes also require periodic sediment removal. Sediment should be removed from the deepest parts of the basin where vegetation is sparse. Heavily vegetated areas should be disturbed as little as possible. Overhead scooping equipment works well for dredging selected portions of marsh areas.

The presence of marshes in established urban areas is perceived by many people to be undesirable. They are often thought of as mud holes where mosquitoes and other insects breed. Actually, once a marsh becomes fully established, it can become a

Figure III-4.6
BMP RD.06 Wet Pond for Nutrient Control



welcomed addition to an urban community. Constructed fresh water marshes can provide miniature wildlife refuges, and while insect populations are increased, insect predators also increase, often reducing the problem to a tolerable level. However, allowance should be made to periodically drain the pond to help control mosquitoes (see Maintenance details). Also, ponds that are stocked with fish should also aid in control (2).

Design Criteria

See BMP RD.05, Wet Pond (Conventional Pollutants). The primary difference between this BMP and BMP RD.05 is that a larger surface area is required in order to establish a shallow marsh system in the littoral zone. Important design criteria, including the pond configuration and geometry, and other considerations are discussed above in BMP RD.05.

Sizing Wet Ponds for Nutrient Control

Wet ponds designed for treatment of nutrients utilize a permanent pool of water which has a shallow marsh established. Hydrologic analysis methods presented in Chapter III-1 are to be used for design purposes.

Permanent Pool Volume

The permanent pool volume shall be equal to the runoff volume of the 6-month, 24-hour design storm.

Surface Area-Pool Depth Relationships

The pond should be designed using the following surface area-depth relationship (for the permanent pool volume):

- 70% of the area @ 2 - 6 feet
- 30% of the area @ 0 - 2 feet

The maximum depth of the permanent pool should be six feet. Permanent pools deeper than six feet may contaminate ground water (should they intersect the existing ground water level). Also, deeper ponds can stratify and create anaerobic conditions that can cause pollutants which are normally bound in the sediment (e.g., metals and phosphorus) to resolubilize; their release back to the water column can seriously affect the effectiveness of the BMP and also create nuisance conditions.

The *maximum average* depth of this BMP is 4.8 feet. See Table III-4.2 for surface area-pool depth relationships for this and other detention BMPs and Table III-4.3 for typical surface area-to-drainage area ratios.

If the wet pond is also designed to provide streambank erosion control, then additional surface area and depth will be required for the "live storage" volume located above the permanent pool. There is no specific surface area-pool depth relationship for the "live storage" volume. Ponds designed to provide streambank erosion control may be deeper than six feet as long as the permanent pool volume provided for runoff treatment does not exceed six feet.

Pond Configuration and Geometry

See BMP RD.05, Wet Pond (Conventional Pollutants).

Littoral Zone Planting

Littoral zones shall be planted according to the advice of a wetlands specialist.

Nursery sources are recommended wherever possible. Small (2-4 inch) containers are encouraged to avoid transporting large amounts of potting soil to the pond. White roots and active basal budding indicate a healthy stock.

Most wetlands specialists prefer to have someone on-site during the construction phase to ensure that the littoral shelf is located and graded properly. Knowing exactly where the normal water level of the facility will reside after construction is absolutely essential to the success of this element of the system.

Bank erosion is often a significant problem during the initial stages of development. Stabilization with sod down to the permanent pool and preventing undue sediment deposition is required for the planting to survive.

Other Design Considerations

See BMP RD.05, Wet Pond (Conventional Pollutants).

Construction and Maintenance Criteria

See BMP RD.05, Wet Pond (Conventional Pollutants).

III-4.4.5 BMP RD.11 Extended Detention Dry Pond

Purpose and Definition

An Extended Detention Dry Pond is designed to provide both pretreatment and streambank erosion control. It is similar to BMP RD.10 (Presettling Basin) except that it has an additional storage volume which provides an extended period of detention to control streambank erosion. Unlike the presettling basin, an extended detention dry pond will always be located "on-line" with the primary conveyance/detention system.

Planning Considerations

See BMP RD.10, Presettling Basin, for the following planning considerations:

- *Sediment and Debris*
- *Heavy Metal Contamination*
- *Site Constraints and Setbacks*
- *Dam Safety*
- *Safety, Signage and Fencing*

Other planning considerations are:

Multiple Uses

Multi-purpose use of the facility and aesthetic enhancement of the general area should also be major considerations. Above all, the facility should function in such a manner as to be compatible with overall stormwater systems both upstream and downstream to promote a watershed approach to providing stormwater management as well as local flood control and erosion protection.

If the facility is planned as an artificial lake to enhance property values and promote the aesthetic value of the land, pretreatment in the form of landscape retention areas or perimeter swales should be incorporated into the stormwater management facility. If possible, catchbasins should be located in grassed areas. By incorporating this "treatment train" concept into the overall collection and conveyance system, the engineer can prolong the utility of these permanently wet installations and improve their appearance. Any amount of runoff waters, regardless how small, that is filtered or percolated along its way to the final detention area can remove oil and grease, metals, and sediment. In addition, this will reduce the annual nutrient load to prevent the wet detention lake from eutrophying.

Detention system site selection should consider both the natural topography of the area and property boundaries. Aesthetic and water quality considerations may also dictate locations. For example, ponds with wetland vegetation are more aesthetically pleasing than ponds without vegetation. Ponds containing wetland vegetation also provide better conditions for pollutant capture and treatment.

A storage facility is an integral part of the environment and therefore should serve as an aesthetic improvement to the area if possible. Use of good landscaping principles is encouraged. The planting and preservation of desirable trees and other vegetation should be an integral part of the storage facility design.

Basin Planning

The design of urban detention facilities should be coordinated with a basin plan for managing stormwater runoff. In a localized situation, an individual property owner can, of course, by his or her actions alone, provide effective assistance to the next owner downstream if no other areas contribute to that owner's problems. However, uncontrolled proliferation of impoundments within a watershed can severely *alter natural flow conditions, causing compounded flow peaks or increased flow duration which can contribute to downstream degradation. In addition, upstream impacts due to future land use changes should be considered when designing the structure. Land use planning and regulation may be necessary to preserve the intended function of the impoundment. See Minimum Requirement #9 (Basin Planning) and the appendix in Volume I for a further discussion of basin planning.*

Overflows

Detention facility design must take into consideration overflows and secondary overflow. Overflows include all facilities designed to bypass flows over or around the restrictor system. Overflow may result from higher intensity or longer duration storms than the design storm or result from plugged orifices or inadequate storage due to sediment buildup in the facility.

Secondary overflow occurs when the capacities of all conveyance facilities, and all overflow facilities are exceeded or are not functioning. In such instances, stormwater will often exit the conveyance system through catchbasin grates and flow down the corridor of least resistance. Careful consideration must be given to the impact of secondary overflows on public health, safety and welfare, property, and wildlife habitat. When secondary overflow occurs, design of secondary drainage facilities following careful analysis and planning can significantly reduce impacts. Street alignments and grades are the key components in developing secondary drainage design, and consideration should be given early in the planning stages to their use as secondary overflow facilities.

Design Criteria

See BMP RD.10, Presettling Basin, for the following design criteria:

- Pond Configuration and Geometry
- Outlet Structure
- Liner
- Berm Embankment/Slope Stabilization
- Erosion and Sediment

Sizing Extended Detention Dry Basins

For pretreating runoff, see BMP RD.10, Presettling Basin. Pretreatment should be provided for a range of runoff volumes, up to the 6-month, 24-hour design storm.

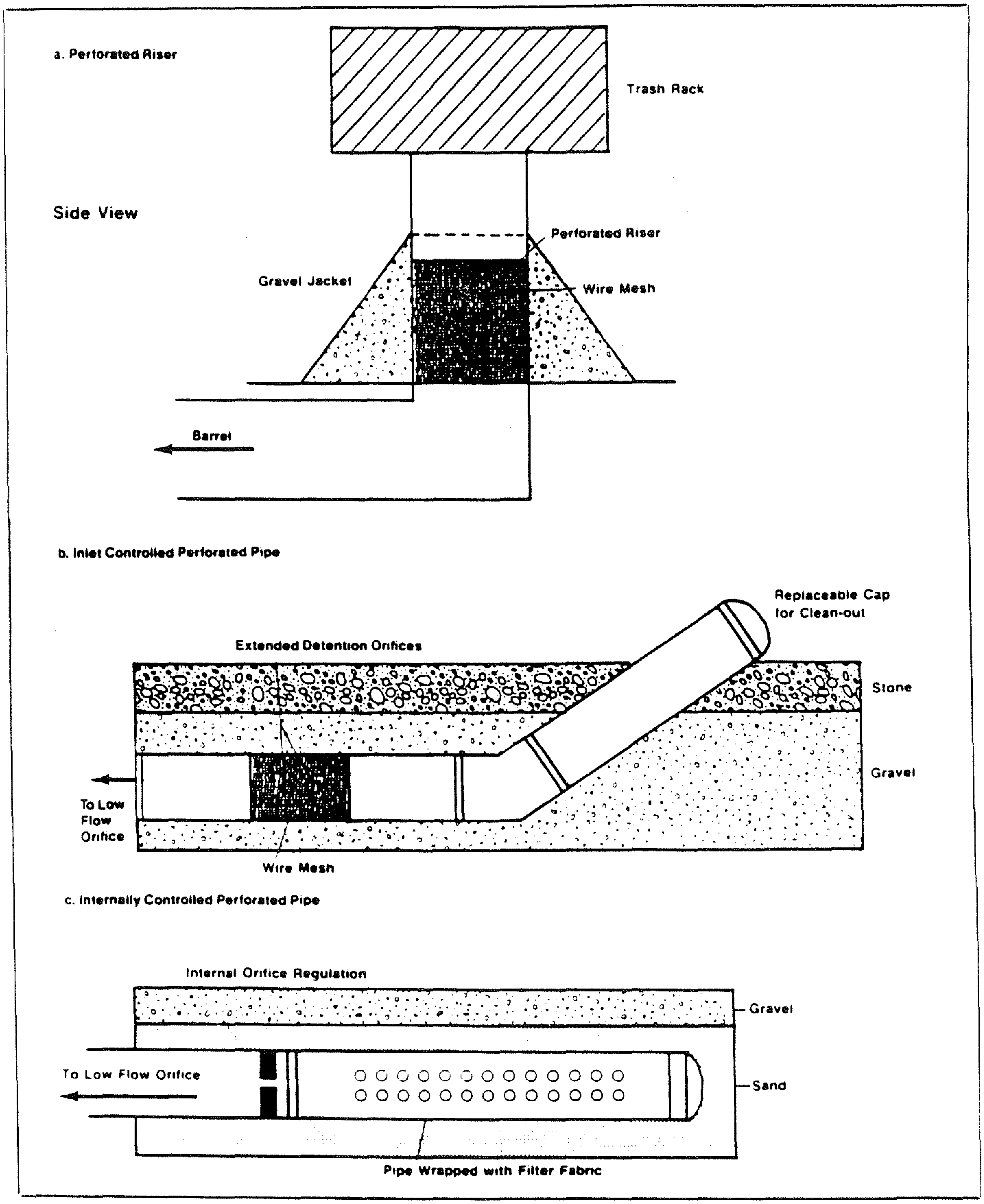
For streambank erosion control, use the design methods and procedures provided in Chapter III-1. A multiple orifice design will be necessary in order to meet the three release requirements, i.e., 50% of the existing condition 2-year, 24-hour peak flow; maintain existing condition peak flow rates for the 10-year and 100-year, 24-hour events. A correction factor must be applied to the calculated detention volume, as discussed in Section III-1.2, in order to account for weaknesses in current hydrologic analysis methods.

Figure III-4.16 illustrates methods to provide extended detention for this BMP.

Construction and Maintenance Criteria

See BMP RD.05, Wet Pond (Conventional Pollutants).

Figure III-4.16 Methods for Extending Detention Times for Dry Detention Ponds



BMP T7.20: Infiltration Trenches

The design criteria and design procedures for infiltration trenches for treatment are in III-3.3 Infiltration Facilities for Flow Control and for Treatment (p.512). III-3.3.1 Purpose (p.512) through III-3.3.9 General Design, Maintenance, and Construction Criteria for Infiltration Facilities (p.538) provide information pertinent to all infiltration facilities. III-3.3.11 Infiltration Trenches (p.543) provides information specific to infiltration trenches.

BMP T7.30: Bioretention Cells, Swales, and Planter Boxes

Purpose

To provide effective removal of many stormwater pollutants, and provide reductions in stormwater runoff quantity and surface runoff flow rates. Where the surrounding native soils have adequate infiltration rates, bioretention can help comply with flow control and treatment requirements. Where the native soils have low infiltration rates, underdrain systems can be installed and the facility used to filter pollutants and detain flows that exceed infiltration capacity of the surrounding soil. However, designs utilizing underdrains provide less flow control benefits.

Description

Bioretention areas are shallow landscaped depressions, with a designed soil mix and plants adapted to the local climate and soil moisture conditions, that receive stormwater from a contributing area.

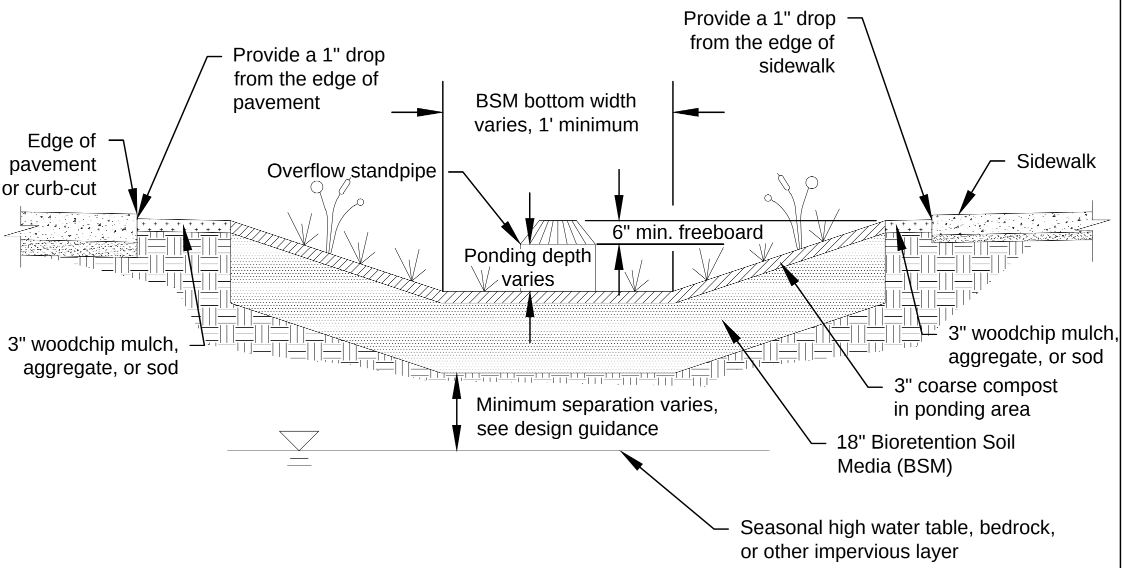
The term, bioretention, is used to describe various designs using soil and plant complexes to manage stormwater. The following terminology is used in this manual:

- *Bioretention cells:* Shallow depressions with a designed planting soil mix and a variety of plant material, including trees, shrubs, grasses, and/or other herbaceous plants. Bioretention cells may or may not have an underdrain and are not designed as a conveyance system. (See Figure V-7.4.1a Typical Bioretention (p.961), Figure V-7.4.1b Typical Bioretention w/Underdrain (p.962), and Figure V-7.4.1c Typical Bioretention w/Liner (Not LID) (p.963))
- *Bioretention swales:* Incorporate the same design features as bioretention cells; however, bioretention swales are designed as part of a system that can convey stormwater when maximum ponding depth is exceeded. Bioretention swales have relatively gentle side slopes and ponding depths that are typically 6 to 12 inches. (See Figure V-7.4.1a Typical Bioretention (p.961), Figure V-7.4.1b Typical Bioretention w/Underdrain (p.962), and Figure V-7.4.1c Typical Bioretention w/Liner (Not LID) (p.963))

- *Bioretention planters and planter boxes:* Designed soil mix and a variety of plant material including trees, shrubs, grasses, and/or other herbaceous plants within a vertical walled container usually constructed from formed concrete, but could include other materials. Planter boxes are completely impervious and include a bottom (must include an underdrain). Planters have an open bottom and allow infiltration to the subgrade. These designs are often used in ultra-urban settings. (See Figure V-7.4.2 Example of a Bioretention Planter (p.964))

Note: Ecology has approved use of certain patented treatment systems that use specific, high rate media for treatment. Such systems are not considered LID BMPs and are not options for meeting the requirements of I-2.5.5 Minimum Requirement #5: On-site Stormwater Management (p.55). The Ecology approval is meant to be used for I-2.5.6 Minimum Requirement #6: Runoff Treatment (p.61), where appropriate.

Figure V-7.4.1a Typical Bioretention



Notes:

1. Scarify subgrade 3" min. before bioretention soil installation
2. Compact BSM to 85% per ASTM 1577

NOT TO SCALE

DEPARTMENT OF ECOLOGY
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Figure V-7.4.1a
Typical Bioretention

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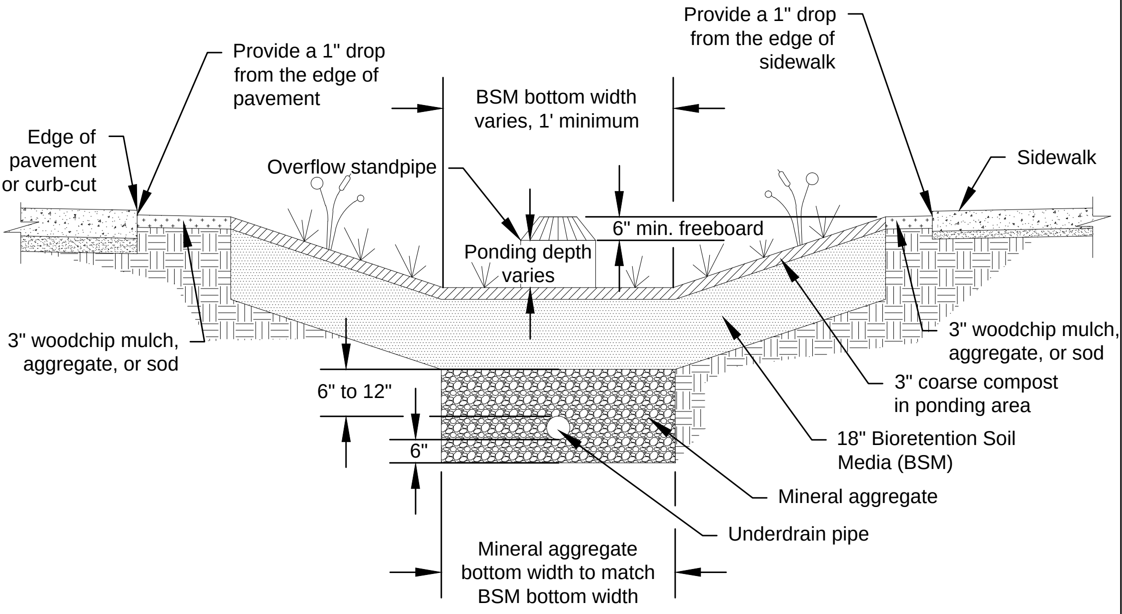
Figure V-7.4.1b Typical Bioretention w/Underdrain



Notes:
1. Scarify subgrade 3" min. before bioretention soil installation
2. Compact BSM to 85% per ASTM 1577

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Figure V-7.4.1b
Typical Bioretention w/Underdrain

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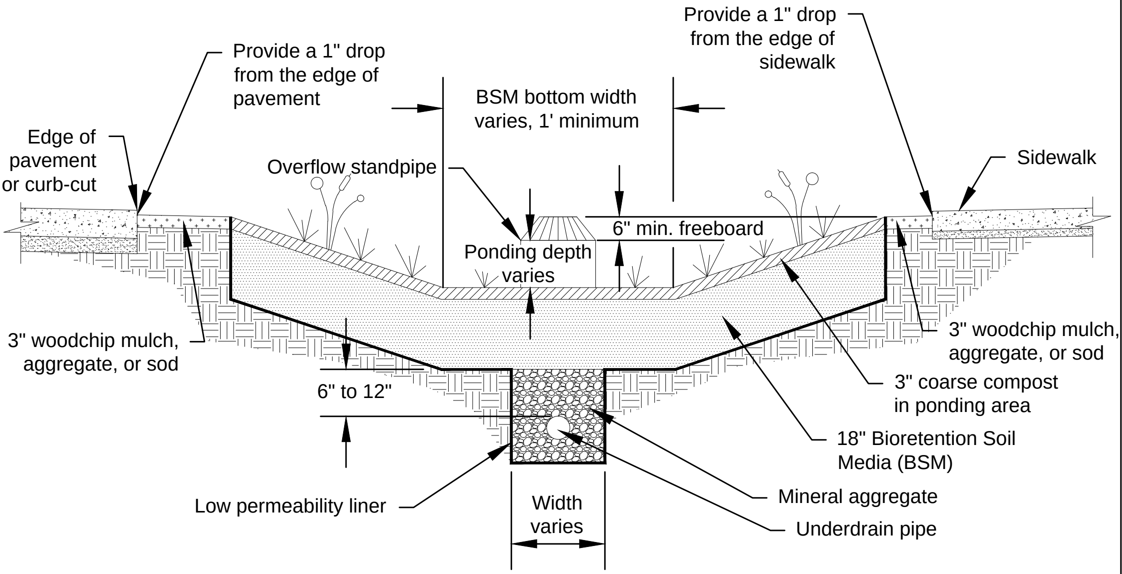
Figure V-7.4.1c Typical Bioretention w/Liner (Not LID)



Notes:

1. Scarify subgrade 3" min. before bioretention soil installation
2. Compact BSM to 85% per ASTM 1577

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Figure V-7.4.1c
Typical Bioretention w/Liner (Not LID)

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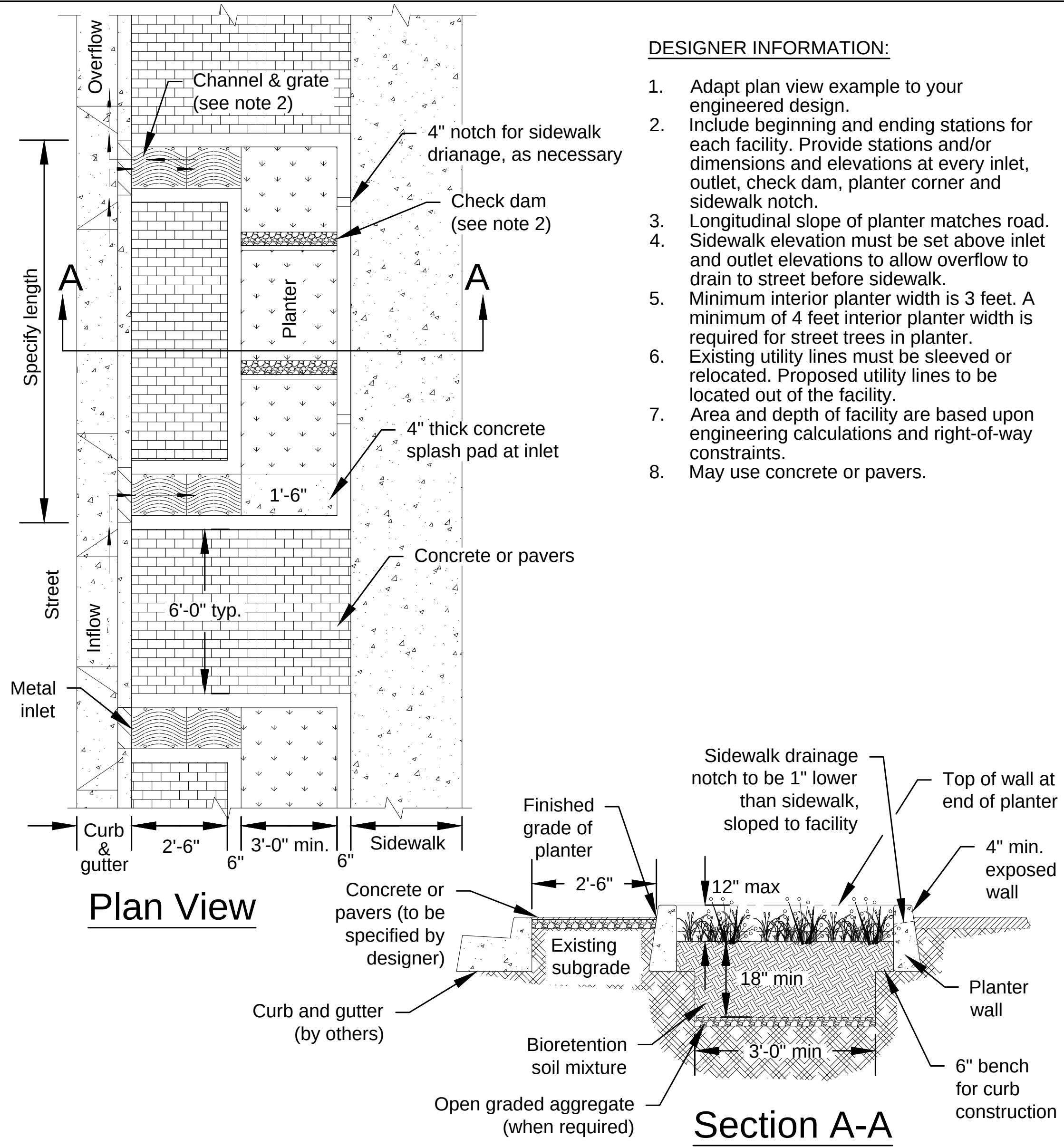
Figure V-7.4.2 Example of a Bioretention Planter



DESIGNER INFORMATION:

1. Adapt plan view example to your engineered design.
2. Include beginning and ending stations for each facility. Provide stations and/or dimensions and elevations at every inlet, outlet, check dam, planter corner and sidewalk notch.
3. Longitudinal slope of planter matches road.
4. Sidewalk elevation must be set above inlet and outlet elevations to allow overflow to drain to street before sidewalk.
5. Minimum interior planter width is 3 feet. A minimum of 4 feet interior planter width is required for street trees in planter.
6. Existing utility lines must be sleeved or relocated. Proposed utility lines to be located out of the facility.
7. Area and depth of facility are based upon engineering calculations and right-of-way constraints.
8. May use concrete or pavers.

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Figure V-7.4.2
Example of a Bioretention Planter

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Applications and Limitations

Because bioretention facilities use an imported soil mix that has a moderate design infiltration rate, they are best applied for small drainages, and near the source of the stormwater. Cells may be scattered throughout a subdivision; a swale may run alongside the access road; or a series of planter boxes may serve the road. In these situations, they can but are not required to fully meet the requirement to treat 91% of the stormwater runoff file from pollution-generating surfaces. But the amount of stormwater that is predicted to pass through the soil profile may be estimated and subtracted from the 91% volume that must be treated. Downstream treatment facilities may be significantly smaller as a result.

Bioretention facilities that infiltrate into the ground can also serve a significant flow reduction function. They can, but are not required to fully meet the flow control duration standard of I-2.5.7 Minimum Requirement #7: Flow Control (p.64). Because they typically do not have an orifice restricting overflow or underflow discharge rates, they typically don’t fully meet I-2.5.7 Minimum Requirement #7: Flow Control (p.64). However, their performance contributes to meeting the standard, and that can result in much smaller flow control facilities at the bottom of the project site. When used in combination with other low impact development techniques, they can also help achieve compliance with the Performance Standard option of I-2.5.5 Minimum Requirement #5: On-site Stormwater Management (p.55).

Bioretention constructed with imported composted material should not be used within one-quarter mile of phosphorus-sensitive waterbodies if the underlying native soil does not meet the soil suitability criteria for treatment in Chapter III-3 - Flow Control Design (p.449). Preliminary monitoring indicates that new bioretention facilities can add phosphorus to stormwater. Therefore, they should also not be used with an underdrain when the underdrain water would be routed to a phosphorus-sensitive receiving water.

Applications with or without underdrains vary extensively and can be applied in new development, redevelopment and retrofits. Typical applications include:

- Individual lots for rooftop, driveway, and other on-lot impervious surface.
- Shared facilities located in common areas for individual lots.
- Areas within loop roads or cul-de-sacs.
- Landscaped parking lot islands.
- Within right-of-ways along roads (often linear bioretention swales and cells).
- Common landscaped areas in apartment complexes or other multifamily housing designs.
- Planters on building roofs, patios, and as part of streetscapes.

Infeasibility Criteria:

The following criteria describe conditions that make bioretention or rain gardens not required. If a project proponent wishes to use a bioretention or rain garden BMP though not required to because of these feasibility criteria, they may propose a functional design to the local government.

Note: Criteria with setback distances are as measured from the bottom edge of the bioretention soil mix.

Citation of any of the following infeasibility criteria must be based on an evaluation of site-specific conditions and a written recommendation from an appropriate licensed professional (e.g., engineer, geologist, hydrogeologist):

- Where professional geotechnical evaluation recommends infiltration not be used due to reasonable concerns about erosion, slope failure, or down gradient flooding.
- Within an area whose ground water drains into an erosion hazard, or landslide hazard area.
- Where the only area available for siting would threaten the safety or reliability of pre-existing underground utilities, pre-existing underground storage tanks, pre-existing structures, or pre-existing road or parking lot surfaces.
- Where the only area available for siting does not allow for a safe overflow pathway to the municipal separate storm sewer system or private storm sewer system.
- Where there is a lack of usable space for rain garden/bioretention facilities at re-development sites, or where there is insufficient space within the existing public right-of-way on public road projects.
- Where infiltrating water would threaten existing below grade basements.
- Where infiltrating water would threaten shoreline structures such as bulkheads.

The following criteria can be cited as reasons for a finding of infeasibility without further justification (though some require professional services):

- Within setbacks from structures as established by the local government with jurisdiction.
- Where they are not compatible with surrounding drainage system as determined by the local government with jurisdiction (e.g., project drains to an existing stormwater collection system whose elevation or location precludes connection to a properly functioning bioretention facility).
- Where land for bioretention is within area designated as an erosion hazard, or landslide hazard.

- Where the site cannot be reasonably designed to locate bioretention facilities on slopes less than 8%.
- Within 50 feet from the top of slopes that are greater than 20% and over 10 feet of vertical relief.
- For properties with known soil or ground water contamination (typically federal Superfund sites or state cleanup sites under the Model Toxics Control Act (MTCA)):
  - Within 100 feet of an area known to have deep soil contamination;
  - Where ground water modeling indicates infiltration will likely increase or change the direction of the migration of pollutants in the ground water;
  - Wherever surface soils have been found to be contaminated unless those soils are removed within 10 horizontal feet from the infiltration area;
  - Any area where these facilities are prohibited by an approved cleanup plan under the state Model Toxics Control Act or Federal Superfund Law, or an environmental covenant under Chapter 64.70 RCW.
- Within 100 feet of a closed or active landfill.
- Within 100 feet of a drinking water well, or a spring used for drinking water supply.
- Within 10 feet of small on-site sewage disposal drainfield, including reserve areas, and grey water reuse systems. For setbacks from a “large on-site sewage disposal system”, see Chapter 246-272B WAC.
- Within 10 feet of an underground storage tank and connecting underground pipes when the capacity of the tank and pipe system is 1100 gallons or less. (As used in these criteria, an underground storage tank means any tank used to store petroleum products, chemicals, or liquid hazardous wastes of which 10% or more of the storage volume (including volume in the connecting piping system) is beneath the ground surface.
- Within 100 feet of an underground storage tank and connecting underground pipes when the capacity of the tank and pipe system is greater than 1100 gallons.
- Where the minimum vertical separation of 1 foot to the seasonal high water table, bedrock, or other impervious layer would not be achieved below bioretention or rain gardens that would serve a drainage area that is: 1) less than 5,000 sq. ft. of pollution-generating impervious surface, and 2) less than 10,000 sq. ft. of impervious surface; and, 3) less than 3/4 acres of pervious surface.
- Where the a minimum vertical separation of 3 feet to the seasonal high water table, bedrock or other impervious layer would not be achieved below bioretention that: 1) would serve a drainage area that meets or exceeds: a) 5,000 square feet of

pollution-generating impervious surface, or b) 10,000 square feet of impervious surface, or c) three-quarter (3/4) acres of pervious surfaces; and 2) cannot reasonably be broken down into amounts smaller than indicated in (1).

- Where the field testing indicates potential bioretention/rain garden sites have a measured (a.k.a., initial) native soil saturated hydraulic conductivity less than 0.30 inches per hour. If the measured native soil infiltration rate is less than 0.30 in/hour, this option should not be used to meet the requirements of I-2.5.5 Minimum Requirement #5: On-site Stormwater Management (p.55). In these slow draining soils, a bioretention facility with an underdrain may be used to treat pollution- generating surfaces to help meet I-2.5.6 Minimum Requirement #6: Runoff Treatment (p.61). If the underdrain is elevated within a base course of gravel, the bioretention facility will also provide some modest flow reduction benefit that will help achieve I-2.5.7 Minimum Requirement #7: Flow Control (p.64).

A local government may designate geographic boundaries within which bioretention cells, swales, or planters may be designated as infeasible due to year-round, seasonal or periodic high groundwater conditions, or due to inadequate infiltration rates. Designations must be based upon a pre-ponderance of field data, collected within the area of concern, that indicate a high likelihood of failure to achieve the minimum groundwater clearance or infiltration rates identified in the above infeasibility criteria. The local government must develop a technical report and make it available upon request to the Dept. of Ecology. The report must be authored by (a) professional(s) with appropriate expertise (e.g., registered engineer, geologist, hydrogeologist, or certified soil scientist), and document the location and the pertinent values/observations of data that were used to recommend the designation and boundaries for the geographic area. The types of pertinent data include, but are not limited to:

- Standing water heights or evidence of recent saturated conditions in observation wells, test pits, test holes, and well logs.
- Observations of areal extent and time of surface ponding, including local government or professional observations of high water tables, frequent or long durations of standing water, springs, wetlands, and/or frequent flooding.
- Results of infiltration tests

In addition, a local government can map areas that meet a specific infeasibility criterion listed above provided they have an adequate data basis. Criteria that are most amenable to mapping are:

- Where land for bioretention is within an area designated by the local government as an erosion hazard, or landslide hazard
- Within 50 feet from the top of slopes that are greater than 20% and over 10 feet ver-

tical relief

- Within 100 feet of a closed or active landfill

Other Site Suitability Factors:

- Utility conflicts: Consult local jurisdiction requirements for horizontal and vertical separation required for publicly-owned utilities, such as water and sewer. Consult the appropriate franchise utility owners for separation requirements from their utilities, which may include communications and gas. When separation requirements cannot be met, designs should include appropriate mitigation measures, such as impermeable liners over the utility, sleeving utilities, fixing known leaky joints or cracked conduits, and/or adding an underdrain to the bioretention.
- Transportation safety: The design configuration and selected plant types should provide adequate sight distances, clear zones, and appropriate setbacks for roadway applications in accordance with local jurisdiction requirements.
- Ponding depth and surface water draw-down: Flow control needs, as well as location in the development, and mosquito breeding cycles will determine draw-down timing. For example, front yards and entrances to residential or commercial developments may require rapid surface dewatering for aesthetics.
- Impacts of surrounding activities: Human activity influences the location of the facility in the development. For example, locate bioretention areas away from traveled areas on individual lots to prevent soil compaction and damage to vegetation or provide elevated or bermed pathways in areas where foot traffic is inevitable. and provide barriers, such as wheel stops, to restrict vehicle access in roadside applications.
- Visual buffering: Bioretention facilities can be used to buffer structures from roads, enhance privacy among residences, and for an aesthetic site feature.
- Site growing characteristics and plant selection: Appropriate plants should be selected for sun exposure, soil moisture, and adjacent plant communities. Native species or hardy cultivars are recommended and can flourish in the properly designed and placed Bioretention Soil Mix with no nutrient or pesticide inputs and 2-3 years irrigation for establishment. Invasive species control may be necessary.

Field and Design Procedures

Geotechnical analysis is an important first step to develop an initial assessment of the variability of site soils, infiltration characteristics and the necessary frequency and depth of infiltration tests. See the Site Planning guidance in Chapter I-3 - Preparation of Stormwater Site Plans (p.77).

See III-3.4 Stormwater-related Site Procedures and Design Guidance for Bioretention and Permeable Pavement (p.554) for more specific guidance regarding required field testing, assignment of infiltration rate correction factors, project submission requirements, and modeling.

Determining subgrade infiltration rates

Determining infiltration rates of the site soils is necessary to determine feasibility of designs that intend to infiltrate stormwater on-site. It is also necessary to estimate flow reduction benefits of such designs when using the Western Washington Hydrologic Model (WWHM) or MGS Flood.

The following provides recommended tests for the soils underlying bioretention areas. The test should be run at the anticipated elevation of the top of the native soil beneath the bioretention facility.

Method 1:

- Small bioretention cells (bioretention facilities receiving water from 1 or 2 individual lots or < 1/4 acre of pavement or other impervious surface): Small-Scale Pilot Infiltration Test (PIT). See III-3.3.6 Design Saturated Hydraulic Conductivity – Guidelines and Criteria (p.523) for small-scale PIT method description. See III-3.4 Stormwater-related Site Procedures and Design Guidance for Bioretention and Permeable Pavement (p.554) for a discussion of the assignment of an appropriate infiltration correction factor.
- Large bioretention cells (bioretention facilities receiving water from several lots or 1/4 acre or more of pavement or other impervious surface): Multiple small or one large-scale PIT. If using the small-scale test, measurements should be taken at several locations within the area of interest. After completing the infiltration test, excavate the test site at least 3 feet if variable soil conditions or seasonal high water tables are suspected. Observe whether water is infiltrating vertically or only spreading horizontally because of ground water or a restrictive soil layer. See III-3.4 Stormwater-related Site Procedures and Design Guidance for Bioretention and Permeable Pavement (p.554) for a discussion of the assignment of an appropriate infiltration correction factor.
- Bioretention swales: approximately 1 small--scale PIT per 200 feet of swale, and within each length of road with significant differences in subsurface characteristics. However, if the site subsurface characterization, including soil borings across the development site, indicate consistent soil characteristics and depths to seasonal high ground water conditions, the number of test locations may be reduced to a frequency recommended by a geotechnical professional. See III-3.4 Stormwater-related Site Procedures and Design Guidance for Bioretention and Permeable Pavement (p.554) for a discussion of the assignment of an appropriate infiltration correction factor.

Method 2: Soil Grain Size Analysis Method:

This method is restricted to sites underlain with soils not consolidated by glacial advance (e.g., recessional outwash soils).

- Small bioretention cells: Use the grain size analysis method described in III-3.3.6 Design Saturated Hydraulic Conductivity – Guidelines and Criteria (p.523) based on the layer(s) identified in results of one soil test pit or boring.
- Large bioretention cells: Use the grain size analysis method based on more than one soil test pit or boring. The more test pits/borings used, and the more evidence of consistency in the soils, the less of a correction factor may be used.
- Bioretention swales: Approximately 1 soil test pit/boring per 200 feet of swale and within each length of road with significant differences in subsurface characteristics. However, if the site subsurface characterization, including soil borings across the development site, indicate consistent soil characteristics and depths to seasonal high ground water conditions, the number of test locations may be reduced to the minimum frequency indicated above.

Determining Bioretention soil mix infiltration rate:

Option 1: If using the Bioretention Soil Mix recommended herein, the WWHM assumes a default infiltration rate of 12 inches per hour (15.24 cm/hr)Option 2: If creating a custom bioretention soil mix, Use ASTM D 2434 Standard Test Method for Permeability of granular Soils (Constant Head) with a compaction rate of 85 percent using ASTM D1557 Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort. See Appendix V-B for specific procedures for conducting ASTM D 2434. The WWHM user must enter the derived value into WWHM using “View/Edit Soil Types” pull down menu and adjusting the Ksat value.

After selecting option 1 or 2 above, determine the appropriate safety factor for the saturated hydraulic conductivity (Ksat). If the contributing area of the bioretention cell or swale is equal to or exceeds any of the following limitations:

5,000 square feet of pollution-generating impervious surface;

10,000 square feet of impervious surface;

¾ acre of lawn and landscape,

use 4 as the infiltration rate (Ksat) safety factor. If the contributing area is less than all of the above areas, or if the design includes a pretreatment device for solids removal, use 2 as the Ksat safety factor.

The WWHM has a field for entering the appropriate safety factor.

Design Criteria for Bioretention

These design criteria are from the *LID Technical Guidance Manual for Puget Sound (2012)*. Refer to that document for additional explanations and background.

Note that the *LID Technical Guidance Manual for Puget Sound (2012)* is for additional information purposes only. You must follow the guidance within this manual if there are any discrepancies between this manual and the *LID Technical Guidance Manual for Puget Sound (2012)*.

Flow entrance and presettling

Flow entrance design will depend on topography, flow velocities and volume entering the pretreatment and bioretention area, adjacent land use and site constraints. Flow velocities entering bioretention should be less than 1.0 ft/second to minimize erosion potential. Five primary types of flow entrances can be used for bioretention:

- *Dispersed, low velocity flow across a landscape area:* Landscape areas and vegetated buffer strips slow incoming flows and provide an initial settling of particulates and are the preferred method of delivering flows to the bioretention cell., Dispersed flow may not be possible given space limitations or if the facility is controlling roadway or parking lot flows where curbs are mandatory.
- *Dispersed or sheet flow across pavement or gravel and past wheel stops for parking areas.*
- *Curb cuts for roadside, driveway or parking lot areas:* Curb cuts should include a rock pad, concrete or other erosion protection material in the channel entrance to dissipate energy. Minimum curb cut width should be 12 inches; however, 18 inches is recommended. Avoid the use of angular rock or quarry spalls and instead use round (river) rock if needed. Removing sediment from angular rock is difficult. Flow entrance should drop 2 to 3 inches from curb line and provide an area for settling and periodic removal of sediment and coarse material before flow dissipates to the remainder of the cell.
- Curb cuts used for bioretention areas in high use parking lots or roadways require increased level of maintenance due to high coarse particulates and trash accumulation in the flow entrance and associated bypass of flows. The following are methods recommended for areas where heavy trash and coarse particulates are anticipated:
    - Curb cut width: 18 inches.
    - At a minimum the flow entrance should drop 2 to 3 inches from gutter line into the bioretention area and provide an area for settling and periodic removal of debris.
    - Anticipate relatively more frequent inspection and maintenance for areas with

    large impervious areas, high traffic loads and larger debris loads.

    - Catch basins or forebays may be necessary at the flow entrance to adequately capture debris and sediment load from large contributing areas and high use areas. Piped flow entrance in this setting can easily clog and catch basins with regular maintenance are necessary to capture coarse and fine debris and sediment.

- *Pipe flow entrance:* Piped entrances should include rock or other erosion protection material in the channel entrance to dissipate energy and disperse flow.
- *Catch basin:* In some locations where road sanding or higher than usual sediment inputs are anticipated, catch basins can be used to settle sediment and release water to the bioretention area through a grate for filtering coarse material.
- *Trench drains:* can be used to cross sidewalks or driveways where a deeper pipe conveyance creates elevation problems. Trench drains tend to clog and may require additional maintenance.

Woody plants can restrict or concentrate flows and can be damaged by erosion around the root ball and should not be placed directly in the entrance flow path.

Bottom area and side slopes

Bioretention areas are highly adaptable and can fit various settings such as rural and urban roadsides, ultra urban streetscapes and parking lots by adjusting bottom area and side slope configuration. Recommended maximum and minimum dimensions include:

- Maximum planted side slope if total cell depth is greater than 3 feet: 3H:1V. If steeper side slopes are necessary rockeries, concrete walls or soil wraps may be effective design options. Local jurisdictions may require bike and/or pedestrian safety features, such as railings or curbs with curb cuts, when steep side slopes are adjacent to sidewalks, walkways, or bike lanes.
- Minimum bottom width for bioretention swales: 2 feet recommended and 1 foot minimum. Carefully consider flow depths and velocities, flow velocity control (check dams) and appropriate vegetation or rock mulch to prevent erosion and channelization at bottom widths less than 2 feet.

Bioretention areas should have a minimum shoulder of 12 inches (30.5 cm) between the road edge and beginning of the bioretention side slope where flush curbs are used. Compaction effort for the shoulder should 90 percent proctor.

Ponding area

Ponding depth recommendations:

- Maximum ponding depth: 12 inches (30.5 cm).
- Surface pool drawdown time: 24 hours

For design on projects subject to I-2.5.5 Minimum Requirement #5: On-site Stormwater Management (p.55), and choosing to use List #1 or List #2 of that requirement, a bioretention facility shall have a horizontally projected surface area below the overflow which is at least 5% of the total impervious surface area draining to it. If lawn/landscape area will also be draining to the bioretention facility, Ecology recommends that the bioretention facility’s horizontally projected surface area below the overflow be increased by 2% of the lawn/landscape area.

The ponding area provides surface storage for storm flows, particulate settling, and the first stages of pollutant treatment within the cell. Pool depth and draw-down rate are recommended to provide surface storage, adequate infiltration capability, and soil moisture conditions that allow for a range of appropriate plant species. Soils must be allowed to dry out periodically in order to: restore hydraulic capacity to receive flows from subsequent storms; maintain infiltration rates; maintain adequate soil oxygen levels for healthy soil biota and vegetation; provide proper soil conditions for biodegradation and retention of pollutants. Maximum designed depth of ponding (before surface overflow to a pipe or ditch) must be considered in light of drawdown time.

For bioretention areas with underdrains, elevating the drain to create a temporary saturated zone beneath the drain is advised to promote denitrification (conversion of nitrate to nitrogen gas) and prolong moist soil conditions for plant survival during dry periods (see Underdrain section below for details).

Surface overflow

Surface overflow can be provided by vertical stand pipes that are connected to underdrain systems, by horizontal drainage pipes or armored overflow channels installed at the designed maximum ponding elevations. Overflow can also be provided by a curb cut at the down-gradient end of the bioretention area to direct overflows back to the street. Overflow conveyance structures are necessary for all bioretention facilities to safely convey flows that exceed the capacity of the facility and to protect downstream natural resources and property.

The minimum freeboard from the invert of the overflow stand pipe, horizontal drainage pipe or earthen channel should be 6 inches unless otherwise specified by the local jurisdiction’s design standards.

Default Bioretention Soil Media (BSM)

Projects which use the following requirements for the bioretention soil media do not have to test the media for it saturated hydraulic conductivity (aka. Infiltration rate). They may assume the rates specified in the subsection titled “Determining Bioretention Soil Mix Infiltration Rate.”

Mineral Aggregate

Percent Fines: A range of 2 to 4 percent passing the #200 sieve is ideal and fines should not be above 5 percent for a proper functioning specification according to ASTM D422.

Aggregate Gradation

The aggregate portion of the BSM should be well-graded. According to ASTM D 2487-98 (Classification of Soils for Engineering Purposes (Unified Soil Classification System)), well-graded sand should have the following gradation coefficients:

- Coefficient of Uniformity ($C_u = D_{60}/D_{10}$) equal to or greater than 4, and
- Coefficient of Curve ($C_c = (D_{30})^2/D_{60} \times D_{10}$) greater than or equal to 1 and less than or equal to 3.

Table V-7.4.1 General Guideline for Mineral Aggregate Gradation (p.975) provides a gradation guideline for the aggregate component of a Bioretention Soil Mix specification in western Washington (Hinman, Robertson, 2007). The sand gradation below is often supplied as a well-graded utility or screened. With compost this blend provides enough fines for adequate water retention, hydraulic conductivity within recommended range (see below), pollutant removal capability, and plant growth characteristics for meeting design guidelines and objectives.

Table V-7.4.1 General Guideline for Mineral Aggregate Gradation

Sieve Size	Percent Passing
3/8"	100
#4	95-100
#10	75-90
#40	25-40
#100	4-10
#200	2-5

Where existing soils meet the above aggregate gradation, those soils may be amended rather than importing mineral aggregate.

Compost to Aggregate Ratio, Organic Matter Content, Cation Exchange Capacity

- Compost to aggregate ratio: 60-65 percent mineral aggregate, 35 – 40 percent compost by volume.
- Organic matter content: 5 – 8 percent by weight.

- Cation Exchange Capacity (CEC) must be > 5 milliequivalents/100 g dry soil Note: Soil mixes meeting the above specifications do not have to be tested for CEC. They will readily meet the minimum CEC.

Compost

To ensure that the BSM will support healthy plant growth and root development, contribute to biofiltration of pollutants, and not restrict infiltration when used in the proportions cited herein, the following compost standards are required.

- Meets the definition of “composted material” in WAC 173-350-100 and complies with testing parameters and other standards in WAC 173-350-220.
- Produced at a composting facility that is permitted by the jurisdictional health authority. Permitted compost facilities in Washington are included on a list available at http://www.ecy.wa.gov/programs/swfa/organics/soil.html
- The compost product must originate a minimum of 65 percent by volume from recycled plant waste comprised of ”yard debris,” “crop residues,” and “bulking agents” as those terms are defined in WAC 173-350-100. A maximum of 35 percent by volume of “post-consumer food waste” as defined in WAC 173-350-100, but not including biosolids, may be substituted for recycled plant waste.
- Stable (low oxygen use and CO_2 generation) and mature (capable of supporting plant growth) by tests shown below. This is critical to plant success in a bioretention soil mixes.
- Moisture content range: no visible free water or dust produced when handling the material.
- Tested in accordance with the U.S. Composting Council “Test Method for the Examination of Compost and Composting” (TMECC), as established in the Composting Council’s “Seal of Testing Assurance” (STA) program. Most Washington compost facilities now use these tests.
- Screened to the following size gradations for Fine Compost when tested in accordance with TMECC test method 02.02-B, Sample Sieving for Aggregate Size Classification.”

  Fine Compost shall meet the following gradation by dry weight

  Minimum percent passing 2”: 100%

  Minimum percent passing 1”: 99%

  Minimum percent passing 5/8”: 90%

  Minimum percent passing ¼”: 75%
- pH between 6.0 and 8.5 (TMECC 04.11-A). “Physical contaminants” (as defined in WAC 173-350-100) content less that 1% by weight (TMECC 03.08-A) total, not to

exceed 0.25 percent film plastic by dry weight.

- Minimum organic matter content of 40% (TMECC 05.07-A “Loss on Ignition)
- Soluble salt content less than 4.0 dS/m (mmhos/cm) (TMECC 04.10-A “Electrical Conductivity, 1:5 Slurry Method, Mass Basis”)
- Maturity indicators from a cucumber bioassay (TMECC 05.05-A “Seedling Emergence and Relative Growth) must be greater than 80%for both emergence and vigor”)
- Stability of 7 mg CO2-C/g OM/day or below (TMECC 05.08-B “Carbon Dioxide Evolution Rate”)
- Carbon to nitrogen ratio (TMECC 05.02A “ Carbon to Nitrogen Ratio” which uses 04.01 “Organic Carbon” and 04.02D “Total Nitrogen by Oxidation”) of less than 25:1. The C:N ratio may be up to 35:1 for plantings composed entirely of Puget Sound Lowland native species and up to 40:1 for coarse compost to be used as a surface mulch (not in a soil mix).

Design Criteria for Custom Bioretention Soil Mixes

Projects which prefer to create a custom Bioretention Soil Mix rather than using the default requirements above must demonstrate compliance with the following criteria using the specified test method:

- CEC ≥ 5 meq/100 grams of dry soil; USEPA 9081
- pH between 5.5 and 7.0
- 5 - 8 percent organic matter content before and after the saturated hydraulic conductivity test; ASTM D2974(Standard Test Method for Moisture, Ash, and Organic Matter of Peat and Other Organic Soils)
- 2-5 percent fines passing the 200 sieve; TMECC 04.11-A
- Measured (Initial) saturated hydraulic conductivity of less than 12 inches per hour; ASTM D 2434 (Standard Test Method for Permeability of Granular Soils (Constant Head)) at 85% compaction per ASTM D 1557 (Standard Test Method s for Laboratory Compaction Characteristics of Soil Using Modified Effort). Also, use Appendix V-B: Recommended Modifications to ASTM D 2434 When Measuring Hydraulic Conductivity for Bioretention Soil Mixes (p.1133).
- Design (long-term) saturated hydraulic conductivity of more than 1 inch per hour. Note: Design saturated hydraulic conductivity is determined by applying the appropriate infiltration correction factors as explained above under “Determining Bioretention soil mix infiltration rate.”
- If compost is used in creating the custom mix, it must meet all of the specifications

listed above for compost except for the gradation specification. An alternative gradation specification must indicate the minimum percent passing for a range of similar particle sizes.

Soil Depth:

Soil depth must be a minimum of 18 inches to provide water quality treatment and good growing conditions for selected plants

Filter Fabrics:

Do not use filter fabrics between the subgrade and the Bioretention Soil Mix. The gradation between existing soils and Bioretention Soil Mix is not great enough to allow significant migration of fines into the Bioretention Soil Mix. Additionally, filter fabrics may clog with downward migration of fines from the Bioretention Soil Mix.

Underdrain (optional):

Where the underlying native soils have an estimated initial infiltration rate between 0.3 and 0.6 inches per hour, bioretention facilities without an underdrain, or with an elevated underdrain directed to a surface outlet, may be used to satisfy List #2 of I-2.5.5 Minimum Requirement #5: On-site Stormwater Management (p.55). Underdrained bioretention facilities that drain to a retention/detention facility must meet the following criteria if they are used to satisfy list #2 of I-2.5.5 Minimum Requirement #5: On-site Stormwater Management (p.55).

- the invert of the underdrain must be elevated 6 inches above the bottom of the aggregate bedding layer. A larger distance between the underdrain and bottom of the bedding layer is desirable, but cannot be used to trigger infeasibility due to inadequate vertical separation to the seasonal high water table, bedrock, or other impermeable layer.
- the distance between the bottom of the bioretention soil mix and the crown of the underdrain pipe must be not less than 6 but not more than 12 inches;
- the aggregate bedding layer must run the full length and the full width of the bottom of the bioretention facility;
- the facility must not be underlain by a low permeability liner that prevents infiltration into the native soil.

Figure V-7.4.1b Typical Bioretention w/Underdrain (p.962) depicts a bioretention facility with an elevated underdrain. Figure V-7.4.1c Typical Bioretention w/Liner (Not LID) (p.963) depicts a bioretention facility with an underdrain and a low permeability liner. The latter is not considered a low impact development BMP. It cannot be used to implement List #2 of I-2.5.5 Minimum Requirement #5: On-site Stormwater Management (p.55).

The volume above an underdrain pipe in a bioretention facility provides pollutant filtering and minor detention. However, only the void volume of the aggregate below the underdrain invert and above the bottom of the bioretention facility (subgrade) can be used in the WWHM or MGSFlood for dead storage volume that provides flow control benefit. Assume a 40% void volume for the Type 26 mineral aggregate specified below.

Underdrain systems should only be installed when the bioretention facility is:

- Located near sensitive infrastructure (e.g., unsealed basements) and potential for flooding is likely.
- Used for filtering storm flows from gas stations or other pollutant hotspots (requires impermeable liner).
- Located above native soils with infiltration rates that are not adequate to meet maximum pool and system dewater rates, or are below a minimum rate allowed by the local government.
- In an area that does not provide the minimum depth to a hydraulic restriction layer, e.g., high seasonal ground water.

The underdrain can be connected to a downstream open conveyance (bioretention swale), to another bioretention cell as part of a connected treatment system, daylight to a dispersion area using an effective flow dispersion practice, or to a storm drain.

Underdrain pipe:

Underdrains shall be slotted, thick-walled plastic pipe. The slot opening should be smaller than the smallest aggregate gradation for the gravel filter bed (see underdrain filter bed below) to prevent migration of material into the drain. This configuration allows for pressurized water cleaning and root cutting if necessary.

Underdrain pipe recommendations:

- Minimum pipe diameter: 4 inches (pipe diameter will depend on hydraulic capacity required, 4 to 8 inches is common).
- Slotted subsurface drain PVC per ASTM D1785 SCH 40.
- Slots should be cut perpendicular to the long axis of the pipe and be 0.04 to 0.069 inches by 1 inch long and be spaced 0.25 inches apart (spaced longitudinally). Slots should be arranged in four rows spaced on 45-degree centers and cover ½ of the circumference of the pipe. See Filter Materials section for aggregate gradation appropriate for this slot size.
- Underdrains should be sloped at a minimum of 0.5 percent unless otherwise specified by an engineer.

Perforated PVC or flexible slotted HDPE pipe cannot be cleaned with pressurized water or root cutting equipment, are less durable and are not recommended. Wrapping the underdrain pipe in filter fabric increases chances of clogging and is not recommended. A 6-inch rigid non-perforated observation pipe or other maintenance access should be connected to the underdrain every 250 to 300 feet to provide a clean-out port, as well as an observation well to monitor dewatering rates.

Underdrain aggregate filter and bedding layer.

Aggregate filter and bedding layers buffer the underdrain system from sediment input and clogging. When properly selected for the soil gradation, geosynthetic filter fabrics can provide adequate protection from the migration of fines. However, aggregate filter and bedding layers, with proper gradations, provide a larger surface area for protecting underdrains and are preferred.

- Guideline for underdrain aggregate filter and bedding layers with heavy walled slotted pipe (see underdrain pipe guideline above):

Sieve size	Percent Passing
¾ inch	100
¼ inch	30-60
US No. 8	20-50
US No. 50	3-12
US No. 200	0-1

  The above gradation is a Type 26 mineral aggregate (gravel backfill for drains, City of Seattle).

- Place underdrain on a bed of the Type 26 aggregate with a minimum thickness of 6 inches and cover with Type 26 aggregate to provide a 1-foot minimum depth around the top and sides of the slotted pipe. See the *LID Technical Guidance Manual for Puget Sound (2012)* for a related figure.

  Note that the *LID Technical Guidance Manual for Puget Sound (2012)* is for additional informational purposes only. You must follow the guidance within this manual if there are any discrepancies between this manual and the *LID Technical Guidance Manual for Puget Sound (2012)*.

Orifice and other flow control structures:

- The minimum orifice diameter should be 0.5 inches to minimize clogging and maintenance requirements.

Check dams and weirs

Check dams are necessary for reducing flow velocity and potential erosion, as well as increasing detention time and infiltration capability on sloped sites. Typical materials include concrete, wood, rock, compacted dense soil covered with vegetation, and vegetated hedge rows. Design depends on flow control goals, local regulations for structures within road right-of-ways and aesthetics. Optimum spacing is determined by flow control benefit (modeling) in relation to cost consideration. See the *LID Technical Guidance Manual for Puget Sound (2012)* for displays of typical designs.

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UIC discharge

Stormwater that has passed through the bioretention soil mix may also discharge to a gravel-filled dug or drilled drain. Underground Injection Control (UIC) regulations are applicable and must be followed (Chapter 173-218 WAC).

Hydraulic restriction layers:

Adjacent roads, foundations or other infrastructure may require that infiltration pathways are restricted to prevent excessive hydrologic loading. Two types of restricting layers can be incorporated into bioretention designs:

- Clay (bentonite) liners are low permeability liners. Where clay liners are used underdrain systems are necessary. See V-4.4.3 Design Criteria for Low Permeability Liner Options (p.804) for guidelines.
- Geomembrane liners completely block infiltration to subgrade soils and are used for ground water protection when bioretention facilities are installed to filter storm flows from pollutant hotspots or on sidewalls of bioretention areas to restrict lateral flows to roadbeds or other sensitive infrastructure. Where geomembrane liners are used to line the entire facility underdrain systems are necessary. The liner should have a minimum thickness of 30 mils and be ultraviolet (UV) resistant.

Plant materials

In general, the predominant plant material utilized in bioretention areas are facultative species adapted to stresses associated with wet and dry conditions. Soil moisture conditions will vary within the facility from saturated (bottom of cell) to relatively dry (rim of cell). Accordingly, wetland plants may be used in the lower areas, if saturated soil conditions exist for appropriate periods, and drought-tolerant species planted on the perimeter of the facility or on mounded areas. See the *LID Technical Guidance Manual for Puget Sound (2012)* for additional guidance and recommended plant species.

Note that the *LID Technical Guidance Manual for Puget Sound (2012)* is for additional informational purposes only. You must follow the guidance within this manual if there are any discrepancies between this manual and the *LID Technical Guidance Manual for Puget Sound (2012)*.

Mulch layer

You can design Bioretention areas with or without a mulch layer. When used, mulch shall be:

- Coarse compost in the bottom of the facilities (compost is less likely to float during cell inundation). Compost shall not include biosolids or manures.
- Shredded or chipped hardwood or softwood on side slopes above ponding elevation and rim area. Arborist mulch is mostly woody trimmings from trees and shrubs and is a good source of mulch material. Wood chip operations are a good source for mulch material that has more control of size distribution and consistency. Do not use shredded construction wood debris or any shredded wood to which preservatives have been added.
- Free of weed seeds, soil, roots and other material that is not bole or branch wood and bark.
- A maximum of 2 to 3 inches thick.

Mulch shall **not** be:

- Grass clippings (decomposing grass clippings are a source of nitrogen and are not recommended for mulch in bioretention areas).
- Pure bark (bark is essentially sterile and inhibits plant establishment).

In bioretention areas where higher flow velocities are anticipated an aggregate mulch may be used to dissipate flow energy and protect underlying Bioretention Soil Mix. Aggregate mulch varies in size and type, but 1 to 1 1/2 inch gravel (rounded) decorative rock is typical.

Installation

Excavation

Soil compaction can lead to facility failure; accordingly, minimizing compaction of the base and sidewalls of the bioretention area is critical. Excavation should never be allowed during wet or saturated conditions (compaction can reach depths of 2-3 feet during wet conditions and mitigation is likely not be possible). Excavation should be performed by machinery operating adjacent to the bioretention facility and no heavy equipment with narrow tracks, narrow tires, or large lugged, high pressure tires should be allowed on the bottom of the bioretention facility. If machinery must operate in the bioretention cell for excavation, use light weight, low ground-contact pressure equipment and rip the base at completion to refracture soil to a minimum of 12 inches. If machinery operates in the facility, subgrade infiltration rates must be field tested and compared to design rates. Failure to meet or exceed the design infiltration rate will require revised engineering designs to verify achievement of treatment and flow control benefits that were estimated in the Stormwater Site Plan.

Prior to placement of the BSM, the finished subgrade shall:

- Be scarified to a minimum depth of 3 inches.
- Have any sediment deposited from construction runoff removed. To remove all introduced sediment, subgrade soil should be removed to a depth of 3-6 inches and replaced with BSM.
- Be inspected by the responsible engineer to verify required subgrade condition.

Sidewalls of the facility, beneath the surface of the BSM, can be vertical if soil stability is adequate. Exposed sidewalls of the completed bioretention area with BSM in place should be no steeper than 3H:1V. The bottom of the facility should be flat.

Soil Placement

On-site soil mixing or placement shall not be performed if Bioretention Soil Mix or subgrade soil is saturated. The bioretention soil mixture should be placed and graded by machinery operating adjacent to the bioretention facility. If machinery must operate in the bioretention cell for soil placement, use light weight equipment with low ground-contact pressure. If machinery operates in the facility, subgrade infiltration rates must be field tested and compared to design rates. Failure to meet or exceed the design infiltration rate will require revised engineering designs to verify achievement of treatment and flow control benefits that were estimated in the Stormwater Site Plan.

The soil mixture shall be placed in horizontal layers not to exceed 6 inches per lift for the entire area of the bioretention facility.

Compact the Bioretention Soil Mix to a relative compaction of 85 percent of modified maximum dry density (ASTM D 1557). Compaction can be achieved by boot packing (simply walking over all areas of each lift), and then apply 0.2 inches (0.5 cm) of water per 1 inch (2.5 cm) of Bioretention Soil Mix depth. Water for settling should be applied by spraying or sprinkling.

Temporary Erosion and Sediment Control (TESC)

Controlling erosion and sediment are most difficult during clearing, grading, and construction; accordingly, minimizing site disturbance to the greatest extent practicable is the most effective sediment management. During construction:

- Bioretention facilities should not be used as sediment control facilities and all drainage should be directed away from bioretention facilities after initial rough grading. Flow can be directed away from the facility with temporary diversion swales or other approved protection. If introduction of construction runoff cannot be avoided see below for guidelines.

- Construction on Bioretention facilities should not begin until all contributing drainage areas are stabilized according to erosion and sediment control BMPs and to the satisfaction of the engineer.
- If the design includes curb and gutter, the curb cuts and inlets should be blocked until Bioretention Soil Mix and mulch have been placed and planting completed (when possible), and dispersion pads are in place.

Every effort during design, construction sequencing and construction should be made to prevent sediment from entering bioretention facilities. However, bioretention areas are often distributed throughout the project area and can present unique challenges during construction. See the *LID Technical Guidance Manual for Puget Sound (2012)* for guidelines if no other options exist and runoff during construction must be directed through the bioretention facilities.

Note that the *LID Technical Guidance Manual for Puget Sound (2012)* is for additional informational purposes only. You must follow the guidance within this manual if there are any discrepancies between this manual and the *LID Technical Guidance Manual for Puget Sound (2012)*.

Erosion and sediment control practices must be inspected and maintained on a regular basis.

Verification

If using the default bioretention soil media, pre-placement laboratory analysis for saturated hydraulic conductivity of the bioretention soil media is not required. Verification of the mineral aggregate gradation, compliance with the compost specifications, and the mix ratio must be provided.

If using a custom bioretention soil media, verification of compliance with the minimum design criteria cited above for such custom mixes must be provided. This will require laboratory testing of the material that will be used in the installation. Testing shall be performed by a Seal of Testing Assurance, AASHTO, ASTM or other standards organization accredited laboratory with current and maintained certification. Samples for testing must be supplied from the BSM that will be placed in the bioretention areas.

If testing infiltration rates is necessary for post-construction verification use the Pilot Infiltration Test (PIT) method or a double ring infiltrometer test (or other small-scale testing allowed by the local government with jurisdiction). If using the PIT method, do not excavate Bioretention Soil Mix (conduct test at level of finished Bioretention Soil Mix elevation), use a maximum of 6 inch ponding depth and conduct test before plants are installed.

Maintenance

Bioretention areas require annual plant, soil, and mulch layer maintenance to ensure optimum infiltration, storage, and pollutant removal capabilities. In general, bioretention maintenance requirements are typical landscape care procedures and include:

- Watering: Plants should be selected to be drought tolerant and not require watering after establishment (2 to 3 years). Watering may be required during prolonged dry periods after plants are established.
- Erosion control: Inspect flow entrances, ponding area, and surface overflow areas periodically, and replace soil, plant material, and/or mulch layer in areas if erosion has occurred. Properly designed facilities with appropriate flow velocities should not have erosion problems except perhaps in extreme events. If erosion problems occur the following should be reassessed: (1) flow volumes from contributing areas and bioretention cell sizing; (2) flow velocities and gradients within the cell; and (3) flow dissipation and erosion protection strategies in the pretreatment area and flow entrance. If sediment is deposited in the bioretention area, immediately determine the source within the contributing area, stabilize, and remove excess surface deposits.
- Sediment removal: Follow the maintenance plan schedule for visual inspection and remove sediment if the volume of the ponding area has been compromised.
- Plant material: Depending on aesthetic requirements, occasional pruning and removing dead plant material may be necessary. Replace all dead plants and if specific plants have a high mortality rate, assess the cause and replace with appropriate species. Periodic weeding is necessary until plants are established.
- Weeding: Invasive or nuisance plants should be removed regularly and not allowed to accumulate and exclude planted species. At a minimum, schedule weeding with inspections to coincide with important horticultural cycles (e.g., prior to major weed varieties dispersing seeds). Weeding should be done manually and without herbicide applications. The weeding schedule should become less frequent if the appropriate plant species and planting density are used and the selected plants grow to capture the site and exclude undesirable weeds.
- Nutrient and pesticides: The soil mix and plants are selected for optimum fertility, plant establishment, and growth. Nutrient and pesticide inputs should not be required and may degrade the pollutant processing capability of the bioretention area, as well as contribute pollutant loads to receiving waters. By design, bioretention facilities are located in areas where phosphorous and nitrogen levels may be elevated and these should not be limiting nutrients. If in question, have soil analyzed for fertility.
- Mulch: Replace mulch annually in bioretention facilities where heavy metal

deposition is high (e.g., contributing areas that include gas stations, ports and roads with high traffic loads). In residential settings or other areas where metals or other pollutant loads are not anticipated to be high, replace or add mulch as needed (likely 3 to 5 years) to maintain a 2 to 3 inch depth.

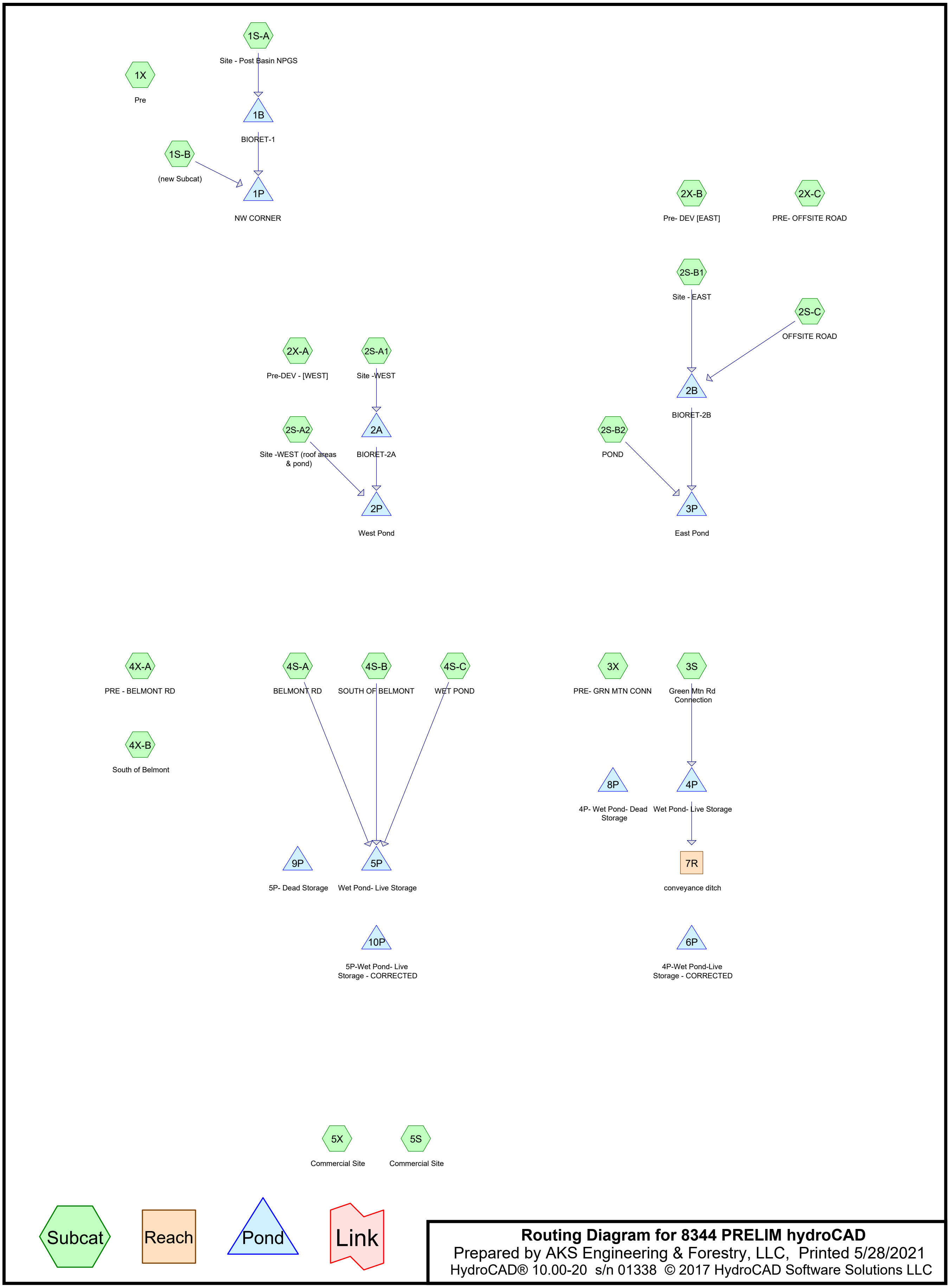
- Soil: Soil mixes for bioretention facilities are designed to maintain long-term fertility and pollutant processing capability. Estimates from metal attenuation research suggest that metal accumulation should not present an environmental concern for at least 20 years in bioretention systems, but this will vary according to pollutant load. Replacing mulch media in bioretention facilities where heavy metal deposition is likely provides an additional level of protection for prolonged performance. If in question, have soil analyzed for fertility and pollutant levels.

BMP T7.40: Compost-amended Vegetated Filter Strips (CAVFS)

Description

The CAVFS is a variation of the basic vegetated filter strip that adds soil amendments to the roadside embankment (See Figure V-7.4.3 Example of a Compost Amended Vegetated Filter Strip (CAVFS) (p.987)). The soil amendments improve infiltration characteristics, increase surface roughness, and improve plant sustainability. Once permanent vegetation is established, the advantages of the CAVFS are higher surface roughness; greater retention and infiltration capacity; improved removal of soluble cationic contaminants through sorption; improved overall vegetative health; and a reduction of invasive weeds. Compost-amended systems have somewhat higher construction costs due to more expensive materials, but require less land area for runoff treatment, which can reduce overall costs.

Appendix F: HydroCAD Analysis



Routing Diagram for 8344 PRELIM hydroCAD
Prepared by AKS Engineering & Forestry, LLC, Printed 5/28/2021
HydroCAD® 10.00-20 s/n 01338 © 2017 HydroCAD Software Solutions LLC

Area Listing (all nodes)

Area (acres)	CN	Description (subcatchment-numbers)
1.130	79	50-75% Grass cover, Fair, HSG C (1S-A, 2S-A2, 2S-B1)
0.220	74	>75% Grass cover, Good, HSG C (2S-B2)
17.570	80	>75% Grass cover, Good, HSG D (3S, 4S-A, 4S-B, 5S)
1.900	98	BELMONT RD (4S-A)
0.500	98	BELMONT RD & PVT RD (3S)
0.080	98	Existing gravel (5S)
0.300	98	Existing gravel access road (4X-B)
0.500	98	GREEN MTN LOOP & RD (2S-C)
0.120	98	GREEN MTN RD (3X)
0.180	98	GREEN MTN RD & LOOP (2X-C)
0.500	98	OPH & PARKING LOT (4X-A)
2.060	98	PARKING AND DRIVE AISLE (2S-B1)
0.950	98	POND (3S, 4S-C)
0.200	98	POND AT Q100 (2S-B2)
0.020	98	PORTION OF GREEN MTN LOOP (1X)
10.380	84	Pasture/grassland/range, Fair, HSG D (3X, 4X-A, 4X-B)
11.620	80	Pasture/grassland/range, Good, HSG D (5X)
2.000	98	ROCK STOCKPILE (4S-B)
7.300	73	Woods, Fair, HSG C (1X, 2X-A, 2X-B, 2X-C)
0.750	98	drive/parking (2S-A1)
0.080	98	existing gravel in south (5X)
0.280	98	parking (1S-A)
0.130	98	pond (2S-A2)
0.050	98	pond surface at Q100 (1S-B)
1.690	98	roof areas (1S-A, 2S-A2, 2S-B1)
0.390	98	roof areas- bldg E, half building (2S-A1)
60.900	**84**	**TOTAL AREA**

Soil Listing (all nodes)

Area (acres)	Soil Group	Subcatchment Numbers
0.000	HSG A	
0.000	HSG B	
8.650	HSG C	1S-A, 1X, 2S-A2, 2S-B1, 2S-B2, 2X-A, 2X-B, 2X-C
39.570	HSG D	3S, 3X, 4S-A, 4S-B, 4X-A, 4X-B, 5S, 5X
12.680	Other	1S-A, 1S-B, 1X, 2S-A1, 2S-A2, 2S-B1, 2S-B2, 2S-C, 2X-C, 3S, 3X, 4S-A, 4S-B, 4S-C, 4X-A, 4X-B, 5S, 5X
60.900		**TOTAL AREA**

Ground Covers (all nodes)

HSG-A (acres)	HSG-B (acres)	HSG-C (acres)	HSG-D (acres)	Other (acres)	Total (acres)	Ground Cover	Subcatchme Numbers
0.000	0.000	1.130	0.000	0.000	1.130	50-75% Grass cover, Fair	
0.000	0.000	0.220	17.570	0.000	17.790	>75% Grass cover, Good	
0.000	0.000	0.000	0.000	1.900	1.900	BELMONT RD	
0.000	0.000	0.000	0.000	0.500	0.500	BELMONT RD & PVT RD	
0.000	0.000	0.000	0.000	0.080	0.080	Existing gravel	
0.000	0.000	0.000	0.000	0.300	0.300	Existing gravel access road	
0.000	0.000	0.000	0.000	0.500	0.500	GREEN MTN LOOP & RD	
0.000	0.000	0.000	0.000	0.120	0.120	GREEN MTN RD	
0.000	0.000	0.000	0.000	0.180	0.180	GREEN MTN RD & LOOP	
0.000	0.000	0.000	0.000	0.500	0.500	OPH & PARKING LOT	
0.000	0.000	0.000	0.000	2.060	2.060	PARKING AND DRIVE AISLE	
0.000	0.000	0.000	0.000	0.950	0.950	POND	
0.000	0.000	0.000	0.000	0.200	0.200	POND AT Q100	
0.000	0.000	0.000	0.000	0.020	0.020	PORTION OF GREEN MTN LOOP	
0.000	0.000	0.000	10.380	0.000	10.380	Pasture/grassland/range, Fair	
0.000	0.000	0.000	11.620	0.000	11.620	Pasture/grassland/range, Good	
0.000	0.000	0.000	0.000	2.000	2.000	ROCK STOCKPILE	
0.000	0.000	7.300	0.000	0.000	7.300	Woods, Fair	
0.000	0.000	0.000	0.000	0.750	0.750	drive/parking	
0.000	0.000	0.000	0.000	0.080	0.080	existing gravel in south	
0.000	0.000	0.000	0.000	0.280	0.280	parking	
0.000	0.000	0.000	0.000	0.130	0.130	pond	
0.000	0.000	0.000	0.000	0.050	0.050	pond surface at Q100	
0.000	0.000	0.000	0.000	1.690	1.690	roof areas	
0.000	0.000	0.000	0.000	0.390	0.390	roof areas- bldg E, half building	
0.000	**0.000**	**8.650**	**39.570**	**12.680**	**60.900**	**TOTAL AREA**	

Time span=0.00-24.00 hrs, dt=0.17 hrs, 142 points
Runoff by SBUH method, Split Pervious/Imperv.
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment1S-A: Site - Post Basin Runoff Area=0.850 ac 76.47% Impervious Runoff Depth>1.71"
Tc=5.0 min CN=79/98 Runoff=0.36 cfs 0.121 af

Subcatchment1S-B: (new Subcat) Runoff Area=0.050 ac 100.00% Impervious Runoff Depth>2.03"
Tc=5.0 min CN=0/98 Runoff=0.03 cfs 0.008 af

Subcatchment1X: Pre Runoff Area=1.800 ac 1.11% Impervious Runoff Depth>0.45"
Tc=19.0 min CN=73/98 Runoff=0.06 cfs 0.068 af

Subcatchment2S-A1: Site -WEST Runoff Area=1.140 ac 100.00% Impervious Runoff Depth>2.03"
Tc=5.0 min CN=0/98 Runoff=0.59 cfs 0.193 af

Subcatchment2S-A2: Site -WEST (roof Runoff Area=0.820 ac 70.73% Impervious Runoff Depth>1.63"
Tc=5.0 min CN=79/98 Runoff=0.33 cfs 0.112 af

Subcatchment2S-B1: Site - EAST Runoff Area=3.620 ac 80.94% Impervious Runoff Depth>1.77"
Tc=5.0 min CN=79/98 Runoff=1.60 cfs 0.534 af

Subcatchment2S-B2: POND Runoff Area=0.420 ac 47.62% Impervious Runoff Depth>1.21"
Tc=5.0 min CN=74/98 Runoff=0.11 cfs 0.043 af

Subcatchment2S-C: OFFSITE ROAD Runoff Area=0.500 ac 100.00% Impervious Runoff Depth>2.03"
Tc=5.0 min CN=0/98 Runoff=0.26 cfs 0.084 af

Subcatchment2X-A: Pre-DEV - [WEST] Runoff Area=1.300 ac 0.00% Impervious Runoff Depth>0.43"
Flow Length=285' Slope=0.1700 '/' Tc=25.1 min CN=73/0 Runoff=0.04 cfs 0.047 af

Subcatchment2X-B: Pre- DEV [EAST] Runoff Area=3.900 ac 0.00% Impervious Runoff Depth>0.43"
Flow Length=750' Tc=42.8 min CN=73/0 Runoff=0.11 cfs 0.139 af

Subcatchment2X-C: PRE- OFFSITE ROAD Runoff Area=0.500 ac 36.00% Impervious Runoff Depth>1.01"
Tc=5.0 min CN=73/98 Runoff=0.10 cfs 0.042 af

Subcatchment3S: Green Mtn Rd Runoff Area=1.000 ac 65.00% Impervious Runoff Depth>1.57"
Tc=5.0 min CN=80/98 Runoff=0.38 cfs 0.131 af

Subcatchment3X: PRE- GRN MTN CONN Runoff Area=1.000 ac 12.00% Impervious Runoff Depth>1.06"
Tc=5.0 min CN=84/98 Runoff=0.23 cfs 0.088 af

Subcatchment4S-A: BELMONT RD Runoff Area=2.500 ac 76.00% Impervious Runoff Depth>1.71"
Tc=5.0 min CN=80/98 Runoff=1.06 cfs 0.357 af

Subcatchment4S-B: SOUTH OF BELMONT Runoff Area=7.000 ac 28.57% Impervious Runoff Depth>1.05"
Flow Length=1,050' Tc=87.5 min CN=80/98 Runoff=0.73 cfs 0.611 af

Subcatchment4S-C: WET POND Runoff Area=0.800 ac 100.00% Impervious Runoff Depth>2.03"
Tc=5.0 min CN=0/98 Runoff=0.42 cfs 0.135 af

```
Subcatchment4X-A: PRE - BELMONT RD   Runoff Area=2.500 ac  20.00% Impervious   Runoff Depth>1.11"
                       Flow Length=850'   Slope=0.0100 '/'   Tc=67.1 min   CN=84/98   Runoff=0.32 cfs  0.231 af

Subcatchment4X-B: South of Belmont     Runoff Area=7.800 ac   3.85% Impervious   Runoff Depth>0.94"
                       Flow Length=800'   Slope=0.0100 '/'   Tc=65.9 min   CN=84/98   Runoff=0.77 cfs  0.609 af

Subcatchment5S: Commercial Site       Runoff Area=11.700 ac   0.68% Impervious   Runoff Depth>0.68"
                                     Flow Length=1,550'   Tc=97.7 min   CN=80/98   Runoff=0.63 cfs  0.668 af

Subcatchment5X: Commercial Site       Runoff Area=11.700 ac   0.68% Impervious   Runoff Depth>0.69"
                                     Flow Length=1,600'   Tc=88.5 min   CN=80/98   Runoff=0.66 cfs  0.673 af

Reach 7R: conveyance ditch             Avg. Flow Depth=0.10'   Max Vel=0.66 fps   Inflow=0.23 cfs  0.128 af
                          n=0.030   L=450.0'   S=0.0044 '/'   Capacity=40.89 cfs   Outflow=0.22 cfs  0.127 af

Pond 1B: BIORET-1                          Peak Elev=7.00'  Storage=0.000 af   Inflow=0.36 cfs  0.121 af
                                                                               Outflow=0.36 cfs  0.121 af

Pond 1P: NW CORNER                         Peak Elev=2.40'  Storage=0.049 af   Inflow=0.39 cfs  0.130 af
                                                                               Outflow=0.06 cfs  0.088 af

Pond 2A: BIORET-2A                         Peak Elev=5.00'  Storage=0.000 af   Inflow=0.59 cfs  0.193 af
                                                                               Outflow=0.59 cfs  0.193 af

Pond 2B: BIORET-2B                         Peak Elev=6.00'  Storage=0.000 af   Inflow=1.86 cfs  0.619 af
                                                                               Outflow=1.86 cfs  0.618 af

Pond 2P: West Pond                         Peak Elev=3.52'  Storage=0.249 af   Inflow=0.92 cfs  0.304 af
                                                                               Outflow=0.04 cfs  0.055 af

Pond 3P: East Pond                        Peak Elev=3.24'  Storage=15,976 cf   Inflow=1.97 cfs  0.661 af
                                                                               Outflow=0.21 cfs  0.296 af

Pond 4P: Wet Pond- Live Storage              Peak Elev=0.46'  Storage=557 cf   Inflow=0.38 cfs  0.131 af
                                                                               Outflow=0.23 cfs  0.128 af

Pond 5P: Wet Pond- Live Storage            Peak Elev=0.70'  Storage=8,348 cf   Inflow=2.07 cfs  1.103 af
                                                                               Outflow=1.02 cfs  1.005 af

Pond 6P: 4P-Wet Pond-Live Storage - CORRECTED                                Peak Elev=0.00'  Storage=0 cf
                                                                               Primary=0.00 cfs  0.000 af

Pond 8P: 4P- Wet Pond- Dead Storage                                      Peak Elev=0.00'  Storage=4,748 cf


Pond 9P: 5P- Dead Storage                                               Peak Elev=0.00'  Storage=17,914 cf


Pond 10P: 5P-Wet Pond- Live Storage - CORRECTED                              Peak Elev=0.00'  Storage=0 cf
                                                                               Primary=0.00 cfs  0.000 af
```

Total Runoff Area = 60.900 ac Runoff Volume = 4.894 af Average Runoff Depth = 0.96"
79.18% Pervious = 48.220 ac 20.82% Impervious = 12.680 ac

Summary for Subcatchment 1S-A: Site - Post Basin NPGS

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

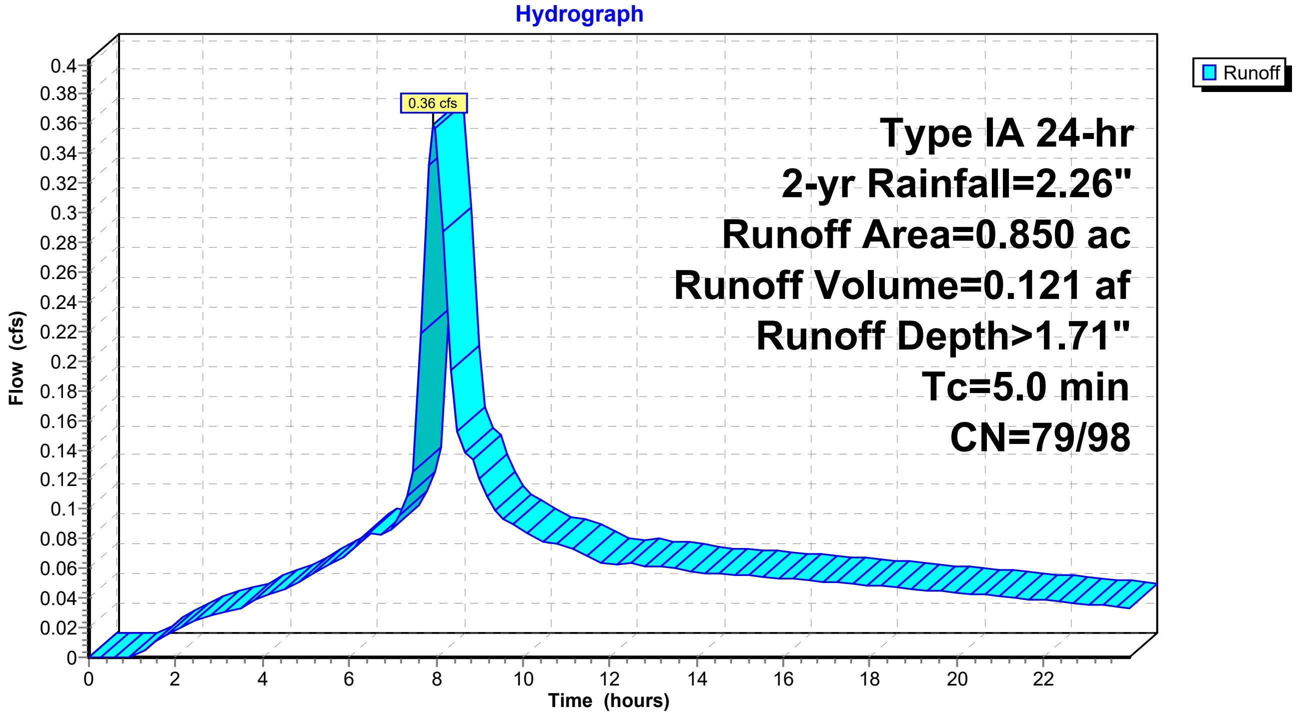
Runoff = 0.36 cfs @ 7.95 hrs, Volume= 0.121 af, Depth> 1.71"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-23.97 hrs, dt= 0.17 hrs
Type IA 24-hr 2-yr Rainfall=2.26"

	Area (ac)	CN	Description
*	0.370	98	roof areas
	0.200	79	50-75% Grass cover, Fair, HSG C
*	0.280	98	parking
	0.850	94	Weighted Average
	0.200	79	23.53% Pervious Area
	0.650	98	76.47% Impervious Area

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

Subcatchment 1S-A: Site - Post Basin NPGS



Summary for Subcatchment 1S-B: (new Subcat)

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

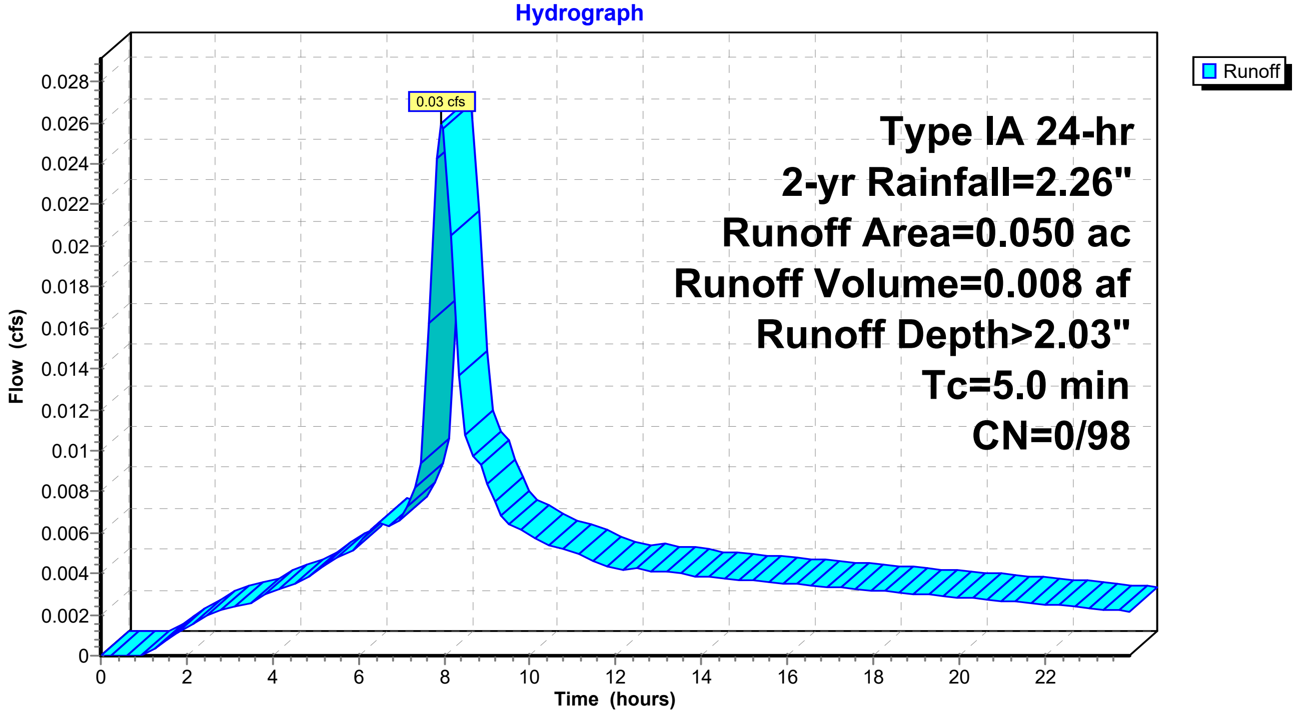
```
Runoff      =        0.03 cfs @    7.94 hrs,  Volume=          0.008 af,  Depth>  2.03"
```

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-23.97 hrs, dt= 0.17 hrs
Type IA 24-hr 2-yr Rainfall=2.26"

	Area (ac)	CN	Description
*	0.050	98	pond surface at Q100
	0.050	98	100.00% Impervious Area

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

Subcatchment 1S-B: (new Subcat)



Summary for Subcatchment 1X: Pre

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

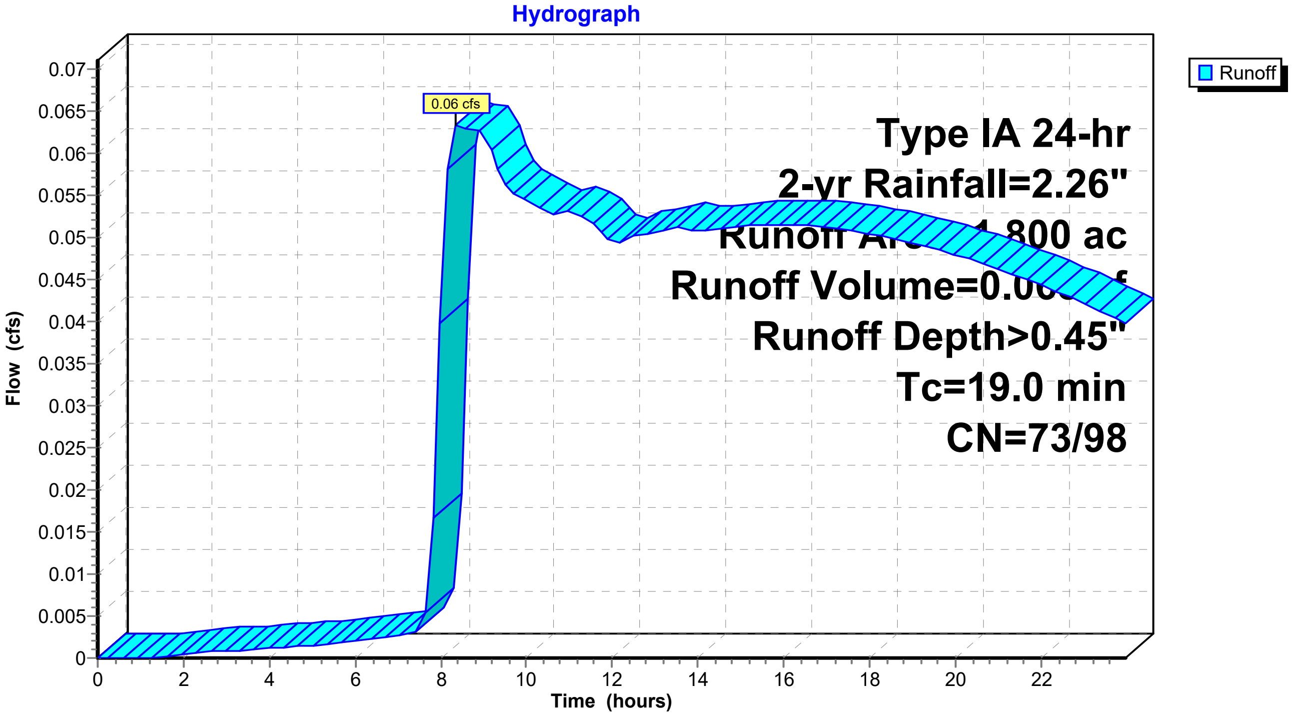
Runoff = 0.06 cfs @ 8.33 hrs, Volume= 0.068 af, Depth> 0.45"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-23.97 hrs, dt= 0.17 hrs
Type IA 24-hr 2-yr Rainfall=2.26"

	Area (ac)	CN	Description
	1.780	73	Woods, Fair, HSG C
*	0.020	98	PORTION OF GREEN MTN LOOP
	1.800	73	Weighted Average
	1.780	73	98.89% Pervious Area
	0.020	98	1.11% Impervious Area

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

Subcatchment 1X: Pre



Summary for Subcatchment 2S-A1: Site -WEST

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

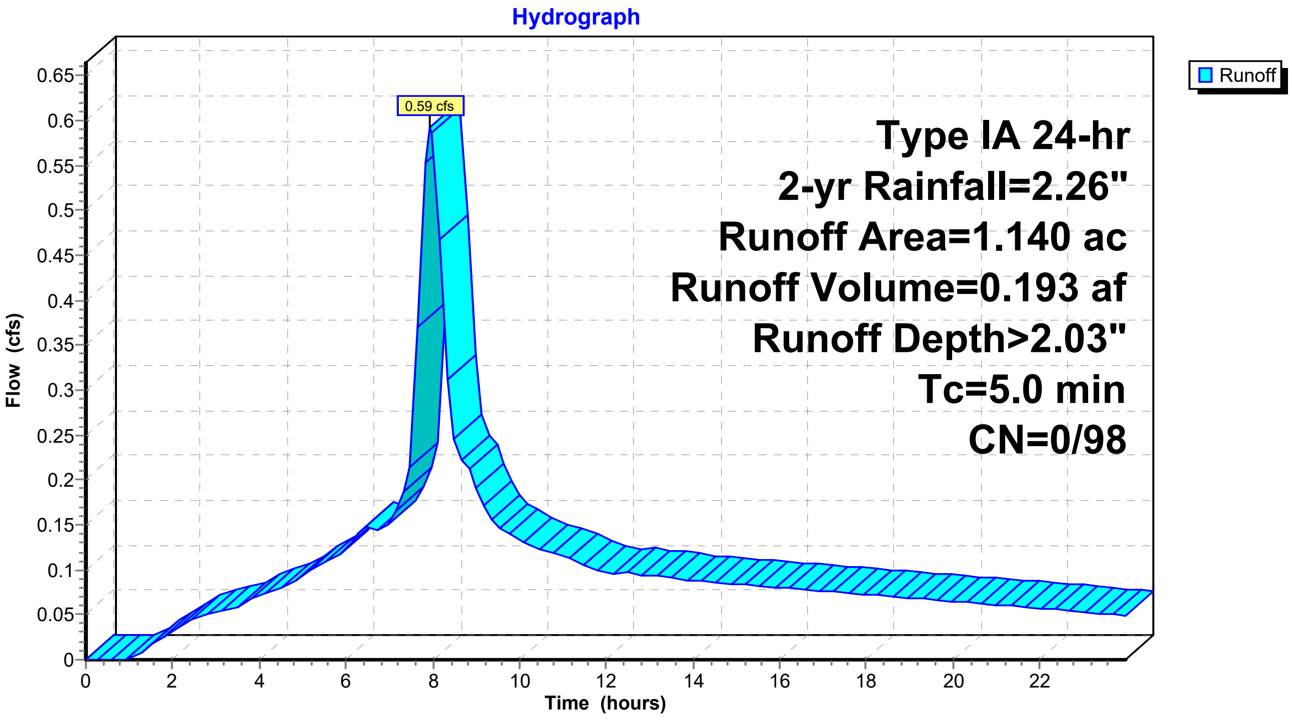
Runoff = 0.59 cfs @ 7.94 hrs, Volume= 0.193 af, Depth> 2.03"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-23.97 hrs, dt= 0.17 hrs
Type IA 24-hr 2-yr Rainfall=2.26"

	Area (ac)	CN	Description
*	0.390	98	roof areas- bldg E, half building
*	0.750	98	drive/parking
	1.140	98	Weighted Average
	1.140	98	100.00% Impervious Area

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

Subcatchment 2S-A1: Site -WEST



Summary for Subcatchment 2S-A2: Site -WEST (roof areas & pond)

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

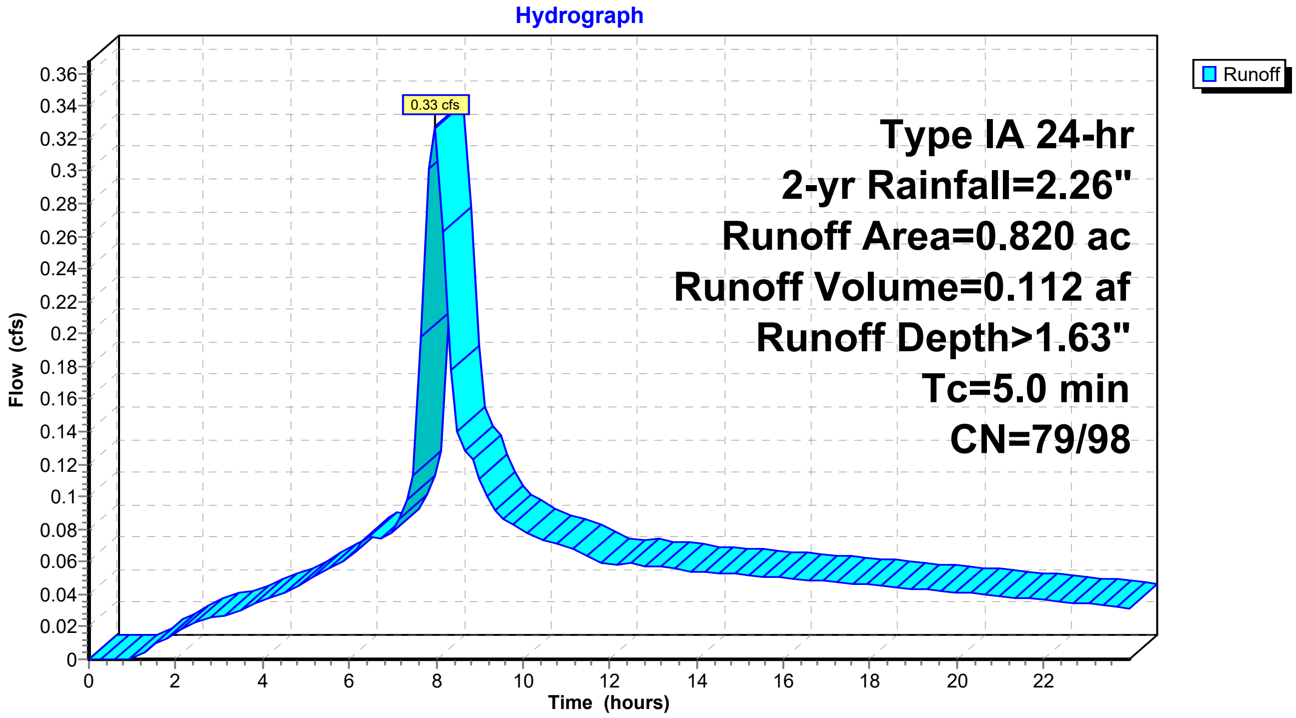
Runoff = 0.33 cfs @ 7.95 hrs, Volume= 0.112 af, Depth> 1.63"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-23.97 hrs, dt= 0.17 hrs
Type IA 24-hr 2-yr Rainfall=2.26"

	Area (ac)	CN	Description
*	0.450	98	roof areas
*	0.130	98	pond
	0.240	79	50-75% Grass cover, Fair, HSG C
	0.820	92	Weighted Average
	0.240	79	29.27% Pervious Area
	0.580	98	70.73% Impervious Area

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

Subcatchment 2S-A2: Site -WEST (roof areas & pond)



Summary for Subcatchment 2S-B1: Site - EAST

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

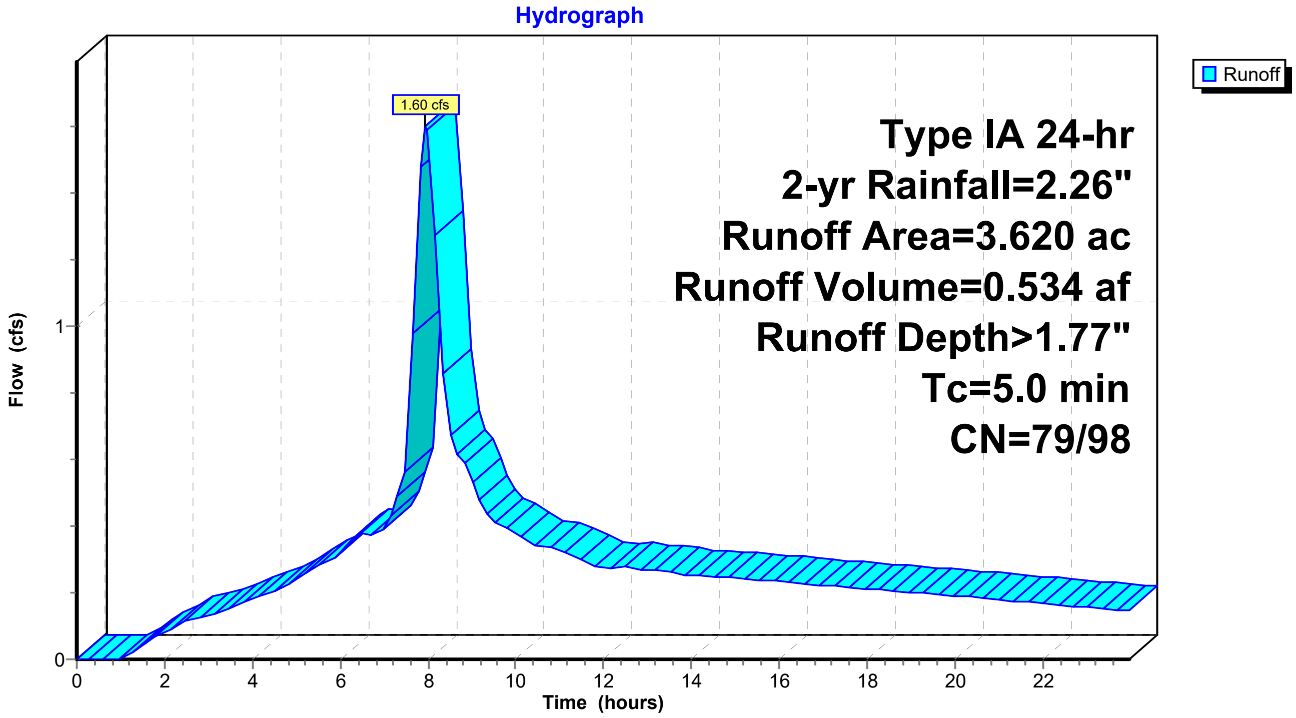
Runoff = 1.60 cfs @ 7.95 hrs, Volume= 0.534 af, Depth> 1.77"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-23.97 hrs, dt= 0.17 hrs
Type IA 24-hr 2-yr Rainfall=2.26"

	Area (ac)	CN	Description
*	0.870	98	roof areas
*	2.060	98	PARKING AND DRIVE AISLE
	0.690	79	50-75% Grass cover, Fair, HSG C
	3.620	94	Weighted Average
	0.690	79	19.06% Pervious Area
	2.930	98	80.94% Impervious Area

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

Subcatchment 2S-B1: Site - EAST



Summary for Subcatchment 2S-B2: POND

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

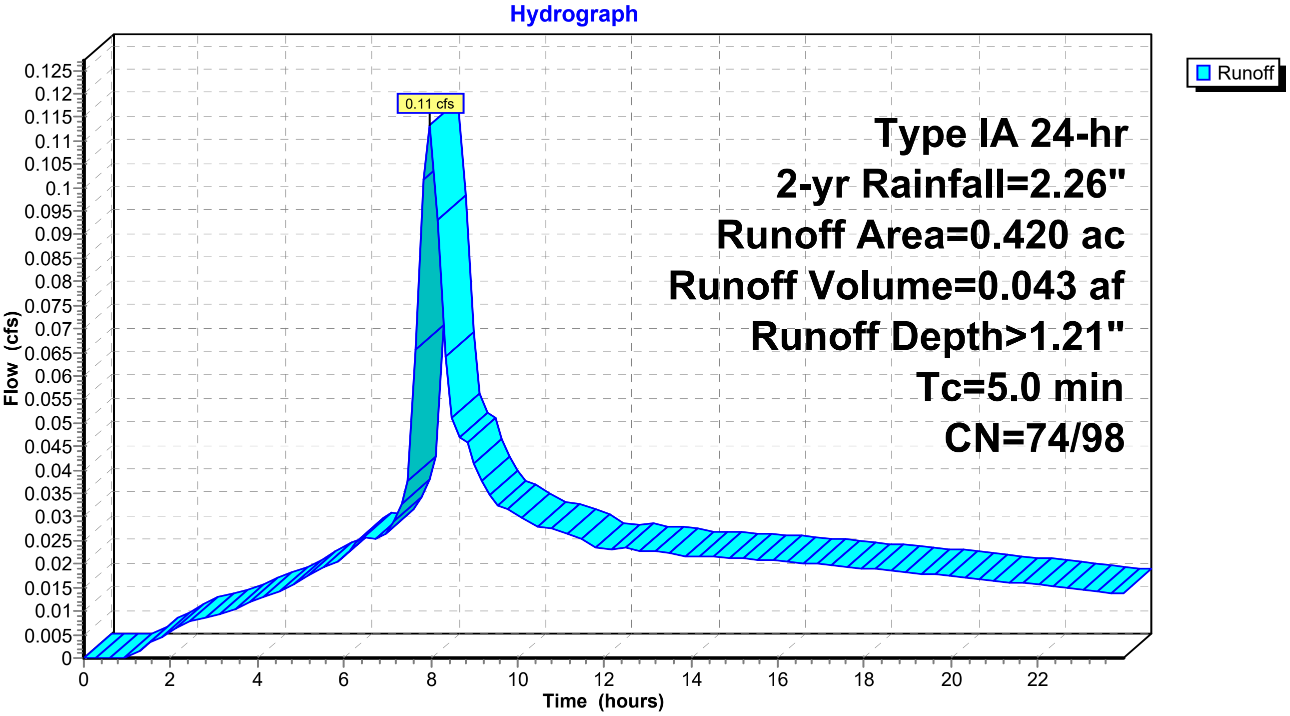
Runoff = 0.11 cfs @ 7.97 hrs, Volume= 0.043 af, Depth> 1.21"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-23.97 hrs, dt= 0.17 hrs
Type IA 24-hr 2-yr Rainfall=2.26"

	Area (ac)	CN	Description
*	0.200	98	POND AT Q100
	0.220	74	>75% Grass cover, Good, HSG C
	0.420	85	Weighted Average
	0.220	74	52.38% Pervious Area
	0.200	98	47.62% Impervious Area

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

Subcatchment 2S-B2: POND



Summary for Subcatchment 2S-C: OFFSITE ROAD

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

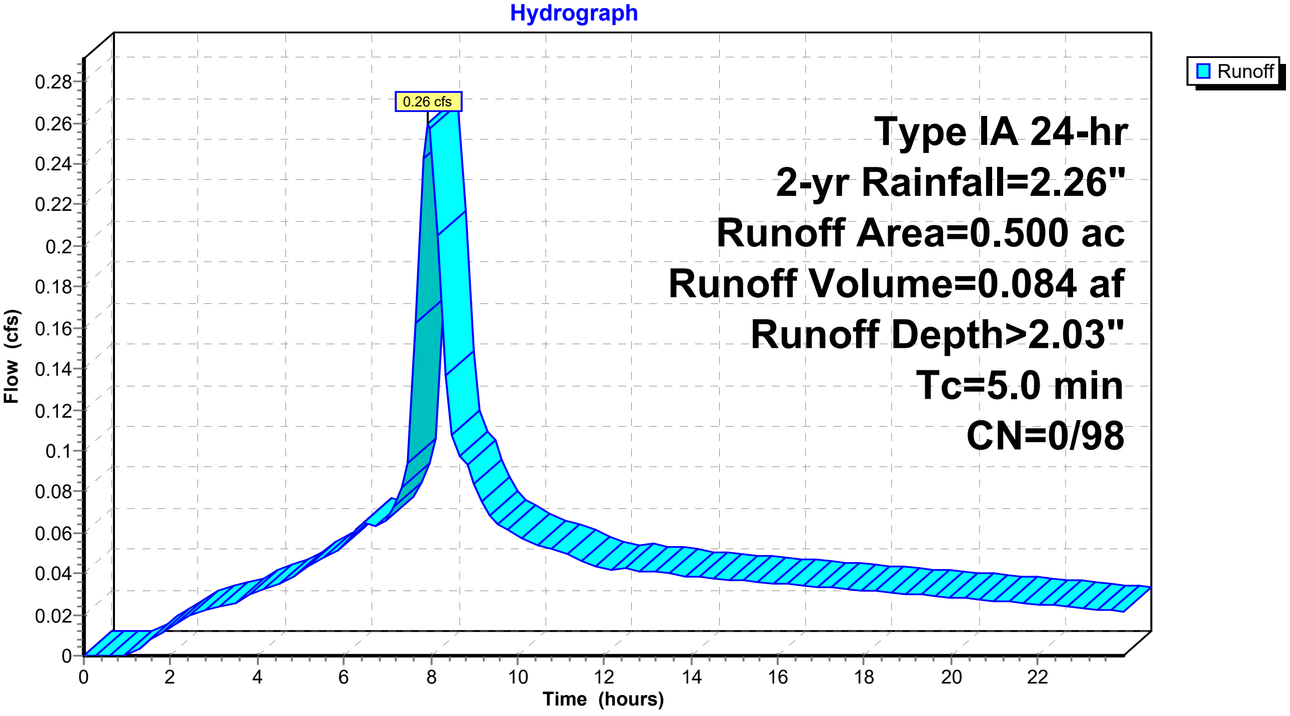
Runoff = 0.26 cfs @ 7.94 hrs, Volume= 0.084 af, Depth> 2.03"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-23.97 hrs, dt= 0.17 hrs
Type IA 24-hr 2-yr Rainfall=2.26"

	Area (ac)	CN	Description
*	0.500	98	GREEN MTN LOOP & RD
	0.500	98	100.00% Impervious Area

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

Subcatchment 2S-C: OFFSITE ROAD



Summary for Subcatchment 2X-A: Pre-DEV - [WEST]

BASIN 30S-A - 1S TO THE NORTH

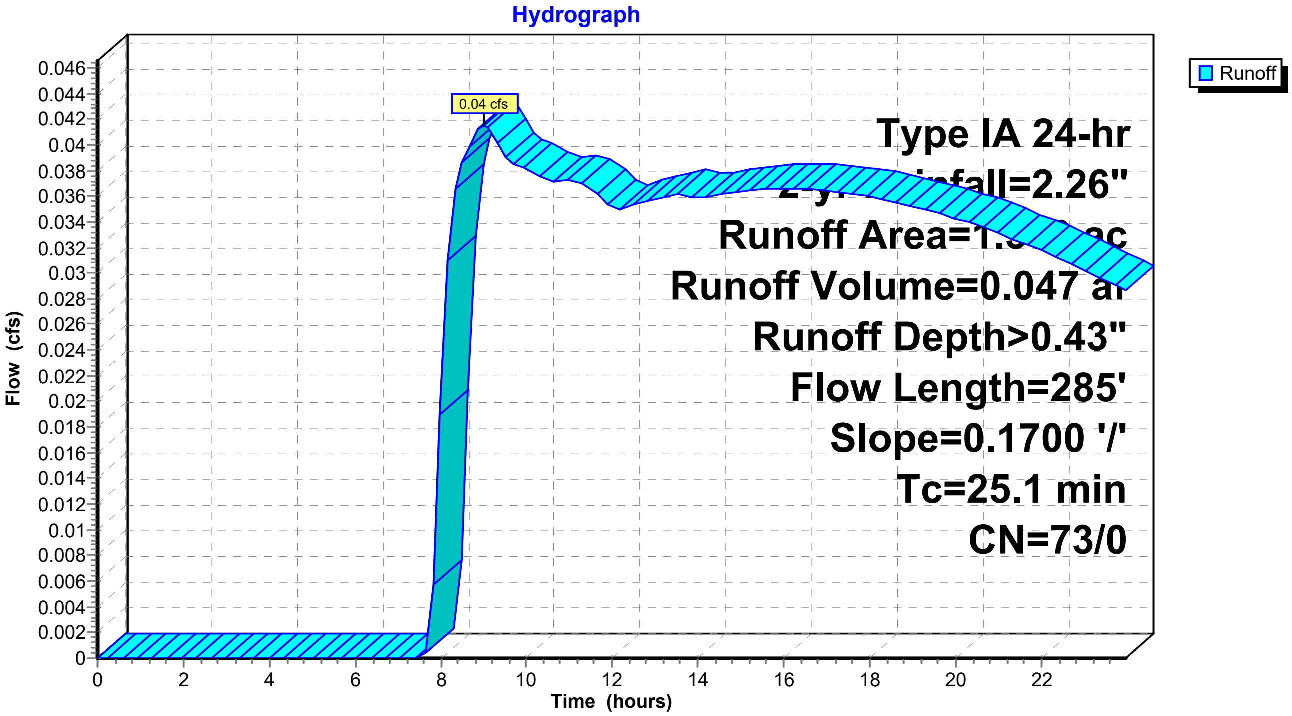
Runoff = 0.04 cfs @ 8.99 hrs, Volume= 0.047 af, Depth> 0.43"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-23.97 hrs, dt= 0.17 hrs
Type IA 24-hr 2-yr Rainfall=2.26"

Area (ac)	CN	Description
1.300	73	Woods, Fair, HSG C
1.300	73	100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
25.1	285	0.1700	0.19		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 2.26"

Subcatchment 2X-A: Pre-DEV - [WEST]



Summary for Subcatchment 2X-B: Pre- DEV [EAST]

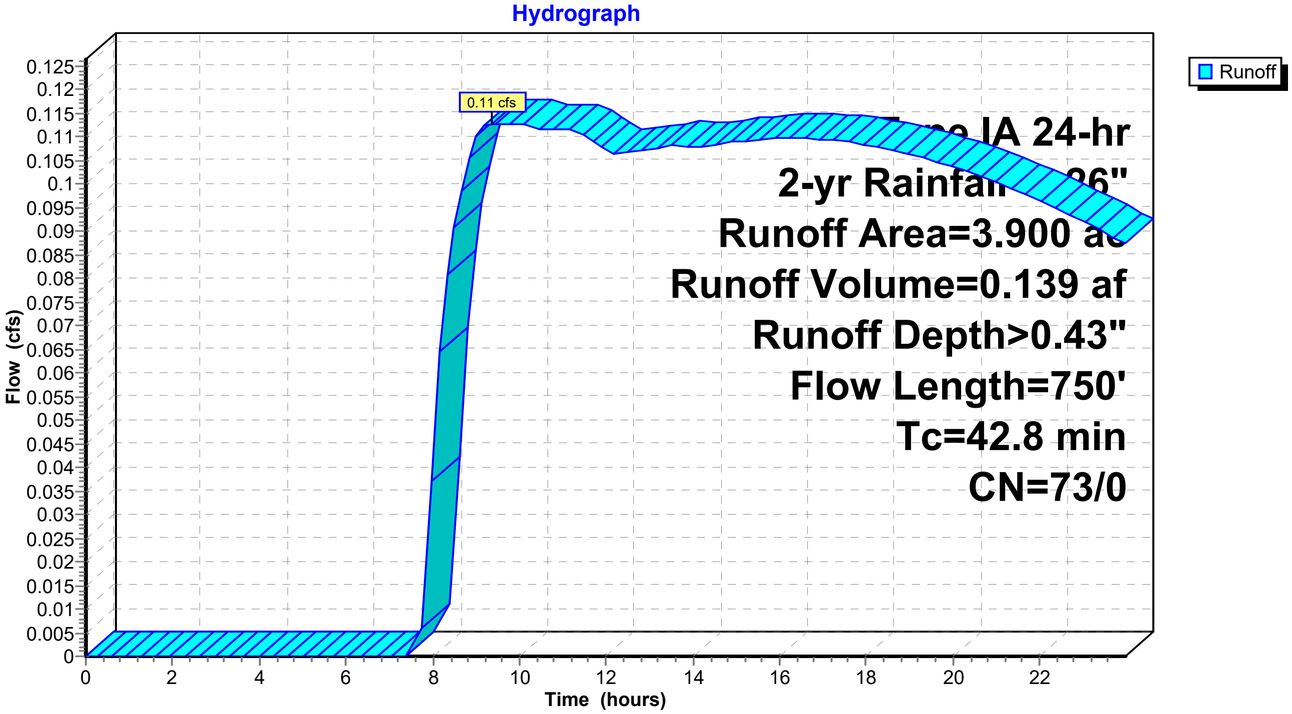
Runoff = 0.11 cfs @ 9.37 hrs, Volume= 0.139 af, Depth> 0.43"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-23.97 hrs, dt= 0.17 hrs
Type IA 24-hr 2-yr Rainfall=2.26"

Area (ac)	CN	Description
3.900	73	Woods, Fair, HSG C
3.900	73	100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
23.8	250	0.1500	0.18		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 2.26"
2.7	200	0.0600	1.22		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
16.3	300	0.0150	0.31		**Shallow Concentrated Flow,** Forest w/Heavy Litter Kv= 2.5 fps
42.8	750	Total			

Subcatchment 2X-B: Pre- DEV [EAST]



Summary for Subcatchment 2X-C: PRE- OFFSITE ROAD

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

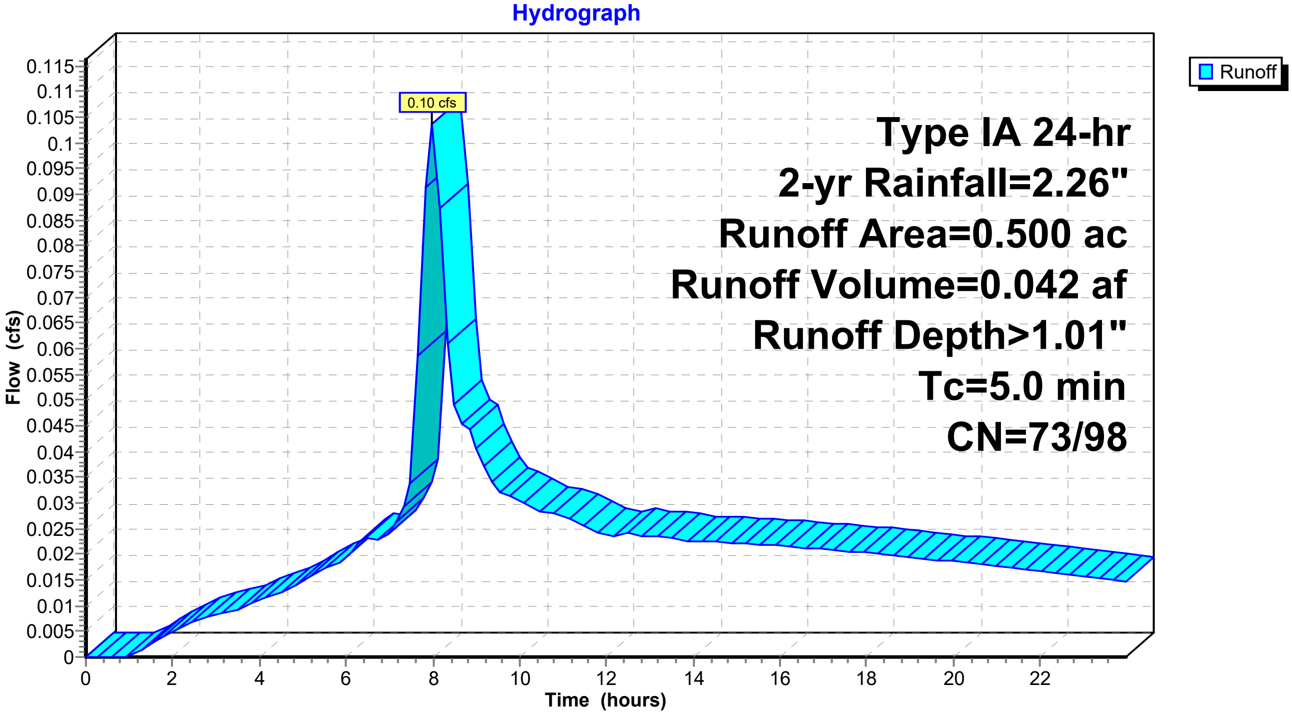
Runoff = 0.10 cfs @ 7.98 hrs, Volume= 0.042 af, Depth> 1.01"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-23.97 hrs, dt= 0.17 hrs
Type IA 24-hr 2-yr Rainfall=2.26"

	Area (ac)	CN	Description
	0.320	73	Woods, Fair, HSG C
*	0.180	98	GREEN MTN RD & LOOP
	0.500	82	Weighted Average
	0.320	73	64.00% Pervious Area
	0.180	98	36.00% Impervious Area

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

Subcatchment 2X-C: PRE- OFFSITE ROAD



Summary for Subcatchment 3S: Green Mtn Rd Connection

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

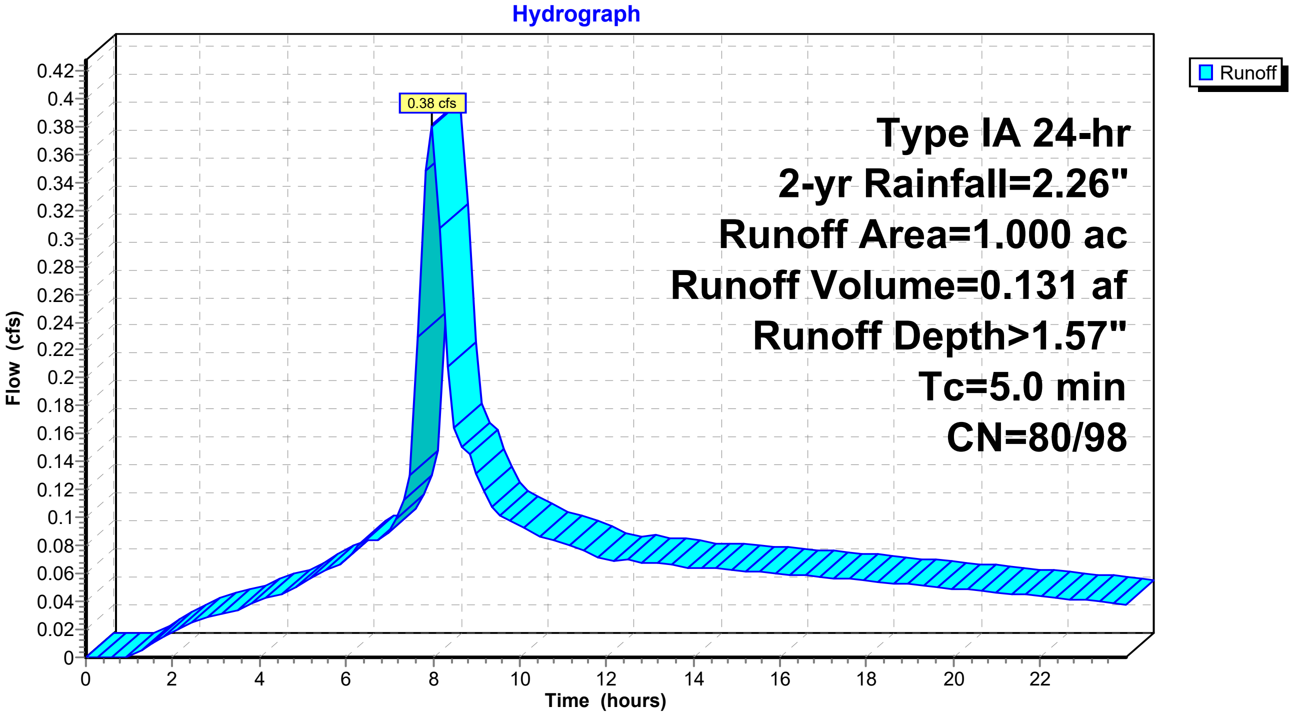
```
Runoff     =        0.38 cfs @    7.96 hrs,  Volume=          0.131 af,  Depth>  1.57"
```

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-23.97 hrs, dt= 0.17 hrs
Type IA 24-hr 2-yr Rainfall=2.26"

	Area (ac)	CN	Description
*	0.500	98	BELMONT RD & PVT RD
	0.350	80	>75% Grass cover, Good, HSG D
*	0.150	98	POND
	1.000	92	Weighted Average
	0.350	80	35.00% Pervious Area
	0.650	98	65.00% Impervious Area

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

Subcatchment 3S: Green Mtn Rd Connection



Summary for Subcatchment 3X: PRE- GRN MTN CONN

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

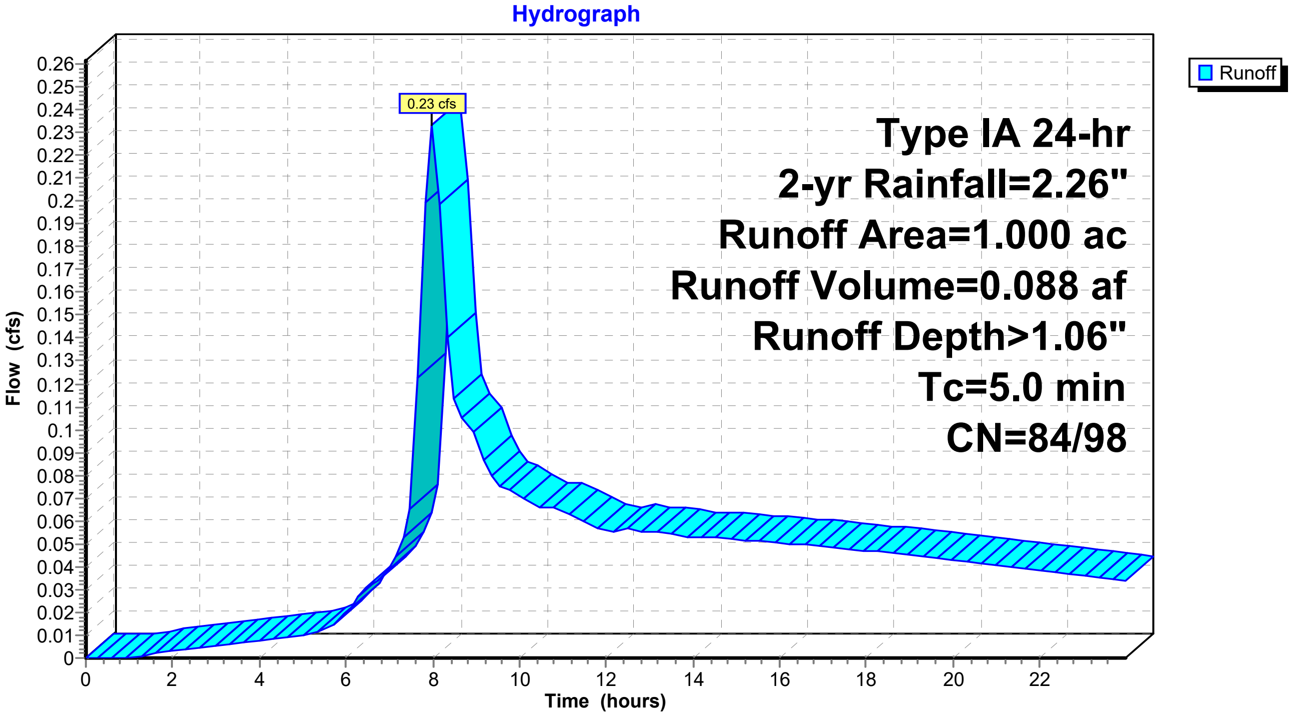
Runoff = 0.23 cfs @ 7.99 hrs, Volume= 0.088 af, Depth> 1.06"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-23.97 hrs, dt= 0.17 hrs
Type IA 24-hr 2-yr Rainfall=2.26"

	Area (ac)	CN	Description
	0.880	84	Pasture/grassland/range, Fair, HSG D
*	0.120	98	GREEN MTN RD
	1.000	86	Weighted Average
	0.880	84	88.00% Pervious Area
	0.120	98	12.00% Impervious Area

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

Subcatchment 3X: PRE- GRN MTN CONN



Summary for Subcatchment 4S-A: BELMONT RD

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

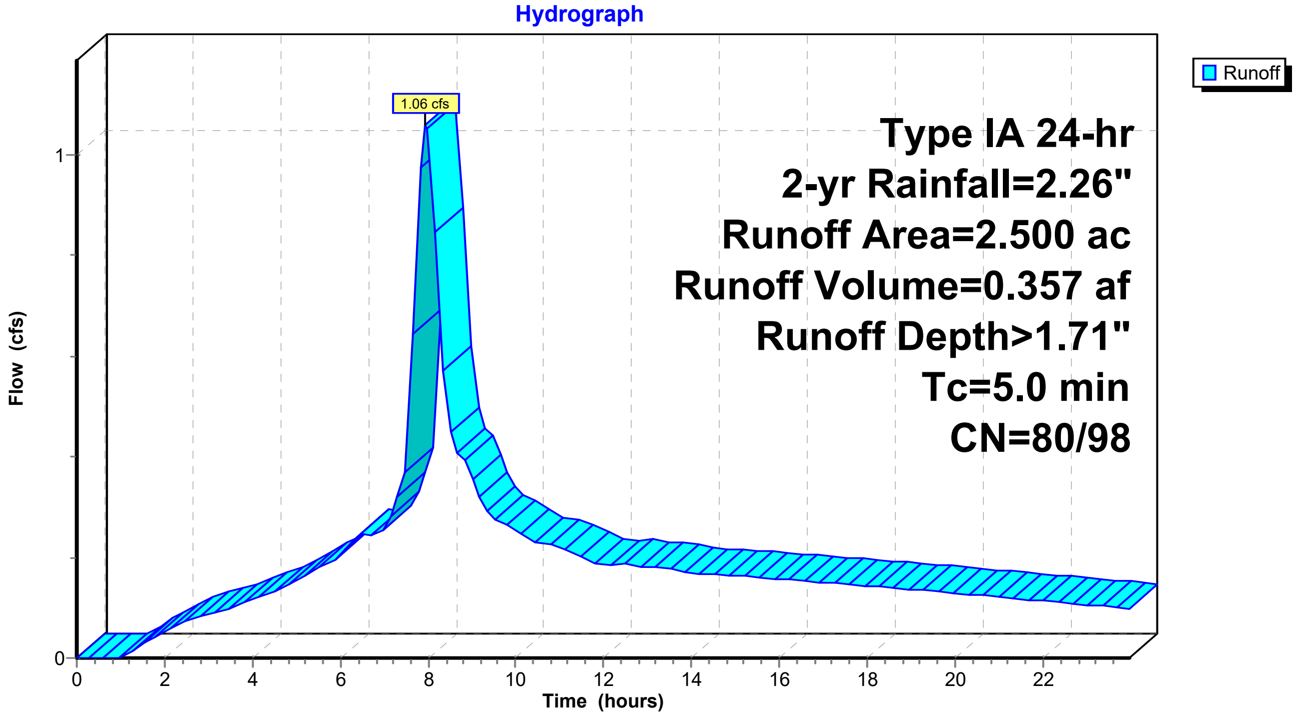
Runoff = 1.06 cfs @ 7.95 hrs, Volume= 0.357 af, Depth> 1.71"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-23.97 hrs, dt= 0.17 hrs
Type IA 24-hr 2-yr Rainfall=2.26"

	Area (ac)	CN	Description
*	1.900	98	BELMONT RD
	0.600	80	>75% Grass cover, Good, HSG D
	2.500	94	Weighted Average
	0.600	80	24.00% Pervious Area
	1.900	98	76.00% Impervious Area

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

Subcatchment 4S-A: BELMONT RD



Summary for Subcatchment 4S-B: SOUTH OF BELMONT

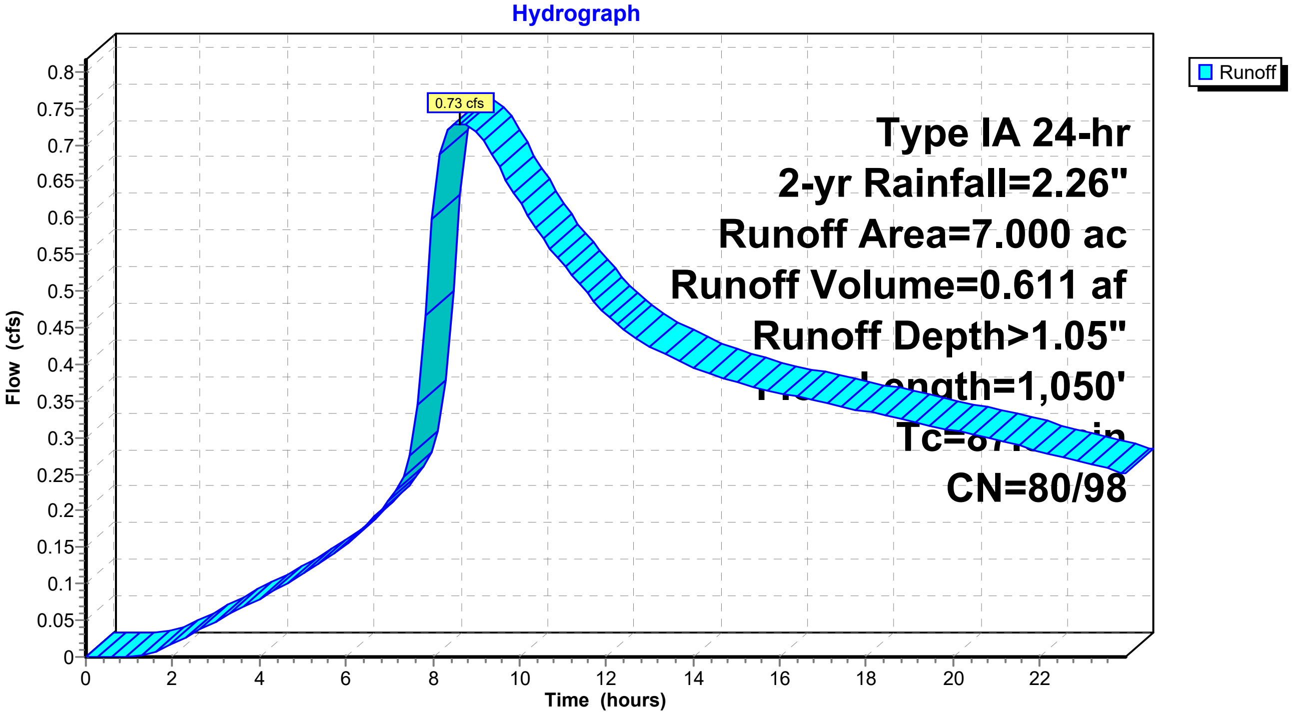
Runoff = 0.73 cfs @ 8.61 hrs, Volume= 0.611 af, Depth> 1.05"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-23.97 hrs, dt= 0.17 hrs
Type IA 24-hr 2-yr Rainfall=2.26"

	Area (ac)	CN	Description
	5.000	80	>75% Grass cover, Good, HSG D
*	2.000	98	ROCK STOCKPILE
	7.000	85	Weighted Average
	5.000	80	71.43% Pervious Area
	2.000	98	28.57% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
71.2	300	0.0050	0.07		**Sheet Flow,** Grass: Dense n= 0.240 P2= 2.26"
15.2	450	0.0050	0.49		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
1.1	300	0.0100	4.71	37.72	**Trap/Vee/Rect Channel Flow,** Bot.W=5.00' D=1.00' Z= 3.0 '/' Top.W=11.00' n= 0.025 Earth, clean & winding
87.5	1,050	Total			

Subcatchment 4S-B: SOUTH OF BELMONT



Summary for Subcatchment 4S-C: WET POND

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

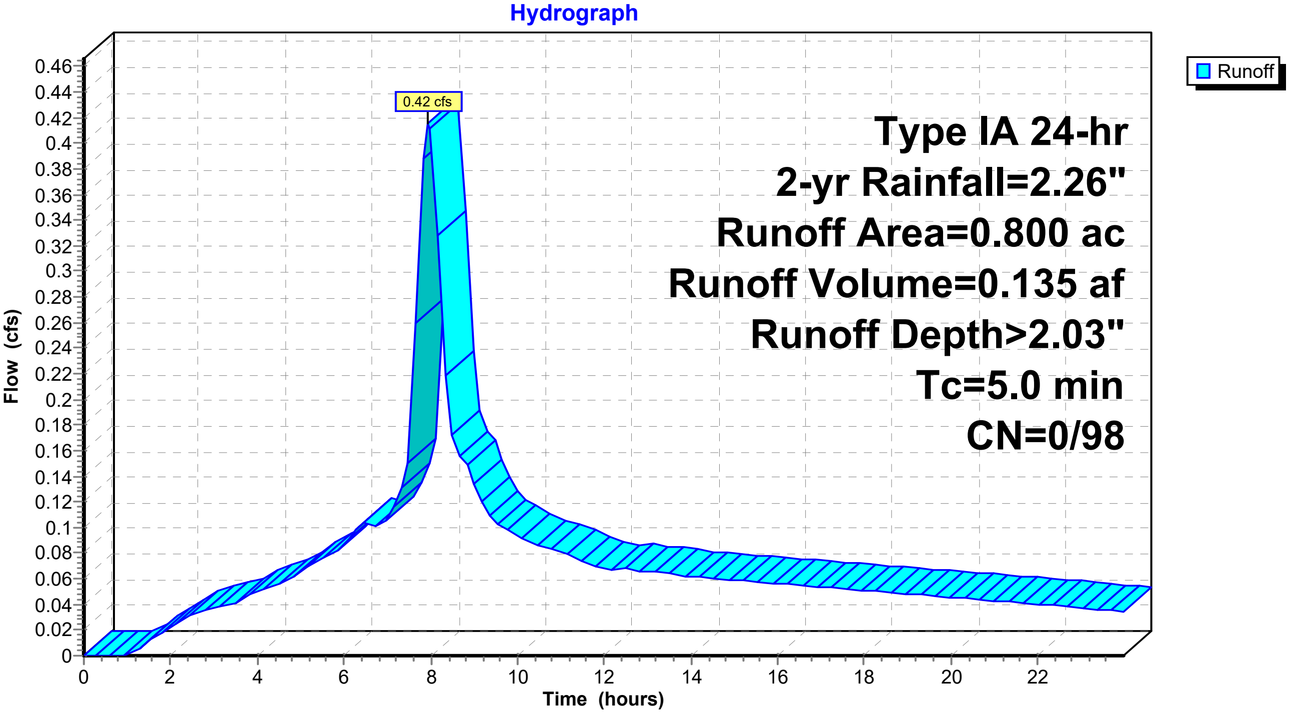
Runoff = 0.42 cfs @ 7.94 hrs, Volume= 0.135 af, Depth> 2.03"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-23.97 hrs, dt= 0.17 hrs
Type IA 24-hr 2-yr Rainfall=2.26"

	Area (ac)	CN	Description
*	0.800	98	POND
	0.800	98	100.00% Impervious Area

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

Subcatchment 4S-C: WET POND



Summary for Subcatchment 4X-A: PRE - BELMONT RD

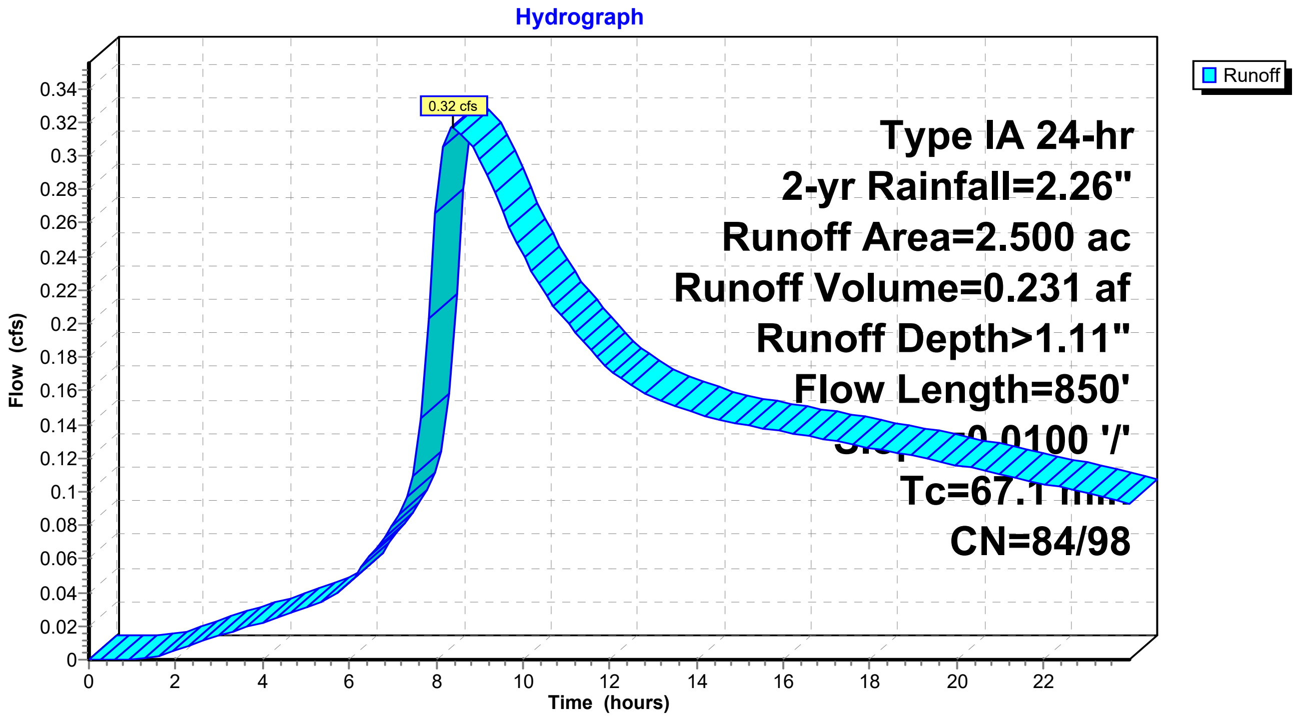
Runoff = 0.32 cfs @ 8.40 hrs, Volume= 0.231 af, Depth> 1.11"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-23.97 hrs, dt= 0.17 hrs
Type IA 24-hr 2-yr Rainfall=2.26"

	Area (ac)	CN	Description
	2.000	84	Pasture/grassland/range, Fair, HSG D
*	0.500	98	OPH & PARKING LOT
	2.500	87	Weighted Average
	2.000	84	80.00% Pervious Area
	0.500	98	20.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
54.0	300	0.0100	0.09		**Sheet Flow,** Grass: Dense n= 0.240 P2= 2.26"
13.1	550	0.0100	0.70		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
67.1	850	Total			

Subcatchment 4X-A: PRE - BELMONT RD



Summary for Subcatchment 4X-B: South of Belmont

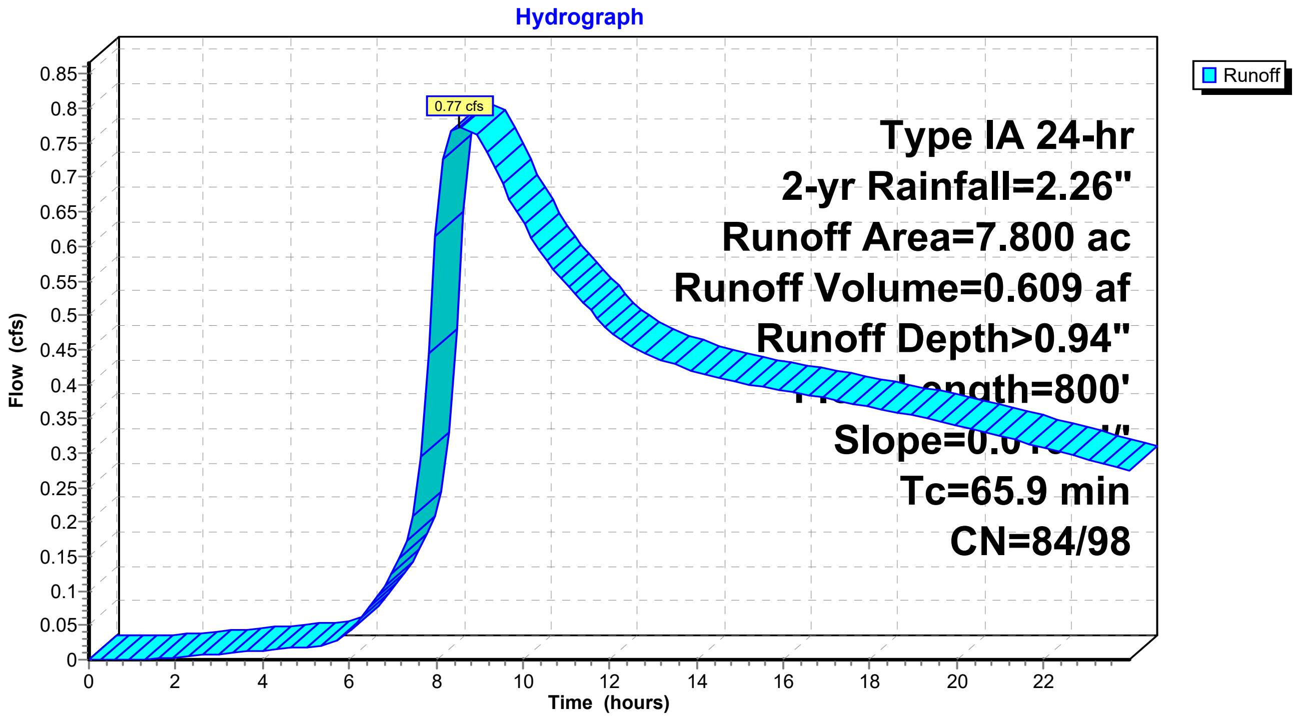
Runoff = 0.77 cfs @ 8.54 hrs, Volume= 0.609 af, Depth> 0.94"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-23.97 hrs, dt= 0.17 hrs
Type IA 24-hr 2-yr Rainfall=2.26"

	Area (ac)	CN	Description
	7.500	84	Pasture/grassland/range, Fair, HSG D
*	0.300	98	Existing gravel access road
	7.800	85	Weighted Average
	7.500	84	96.15% Pervious Area
	0.300	98	3.85% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
54.0	300	0.0100	0.09		**Sheet Flow,** Grass: Dense n= 0.240 P2= 2.26"
11.9	500	0.0100	0.70		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
65.9	800	Total			

Subcatchment 4X-B: South of Belmont



Summary for Subcatchment 5S: Commercial Site

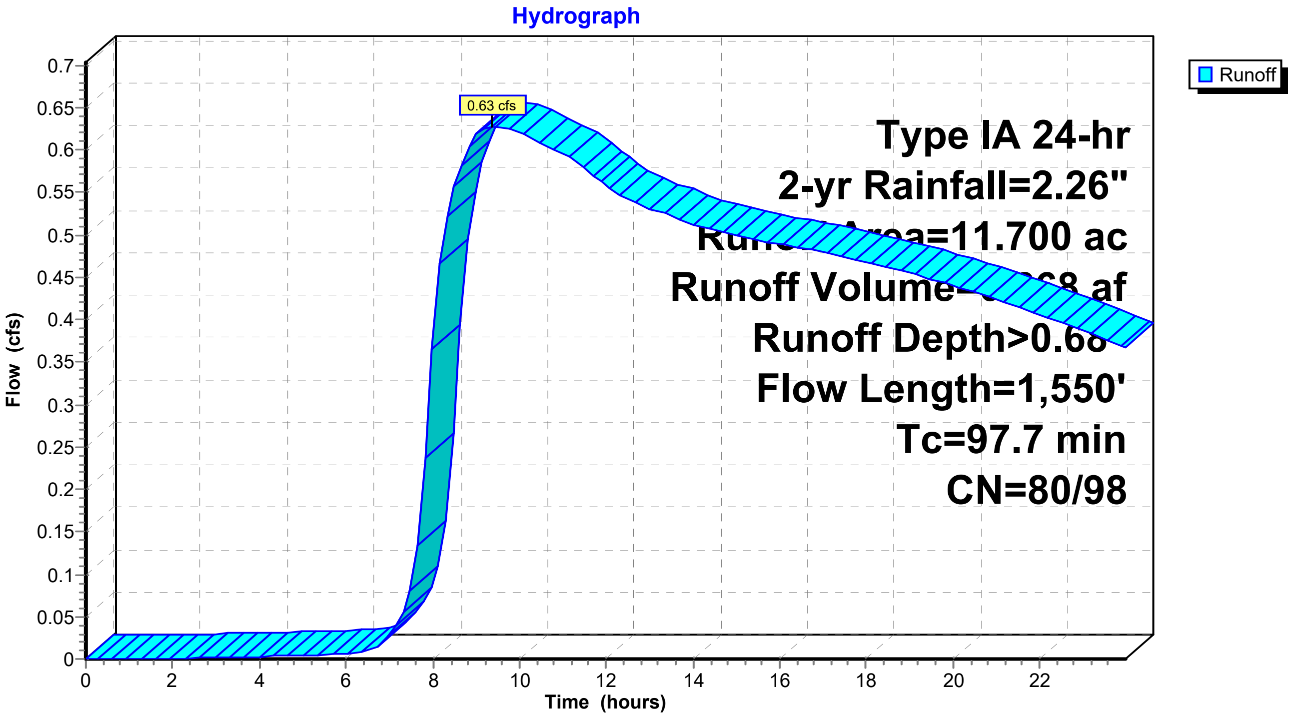
Runoff = 0.63 cfs @ 9.38 hrs, Volume= 0.668 af, Depth> 0.68"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-23.97 hrs, dt= 0.17 hrs
Type IA 24-hr 2-yr Rainfall=2.26"

	Area (ac)	CN	Description
	11.620	80	>75% Grass cover, Good, HSG D
*	0.080	98	Existing gravel
	11.700	80	Weighted Average
	11.620	80	99.32% Pervious Area
	0.080	98	0.68% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
71.2	300	0.0050	0.07		**Sheet Flow,** Grass: Dense n= 0.240 P2= 2.26"
1.6	100	0.0050	1.06		**Shallow Concentrated Flow,** Grassed Waterway Kv= 15.0 fps
24.9	1,150	0.0005	0.77	6.93	**Trap/Vee/Rect Channel Flow,** Bot.W=6.00' D=1.00' Z= 3.0 '/' Top.W=12.00' n= 0.035 High grass
97.7	1,550	Total			

Subcatchment 5S: Commercial Site



Summary for Subcatchment 5X: Commercial Site

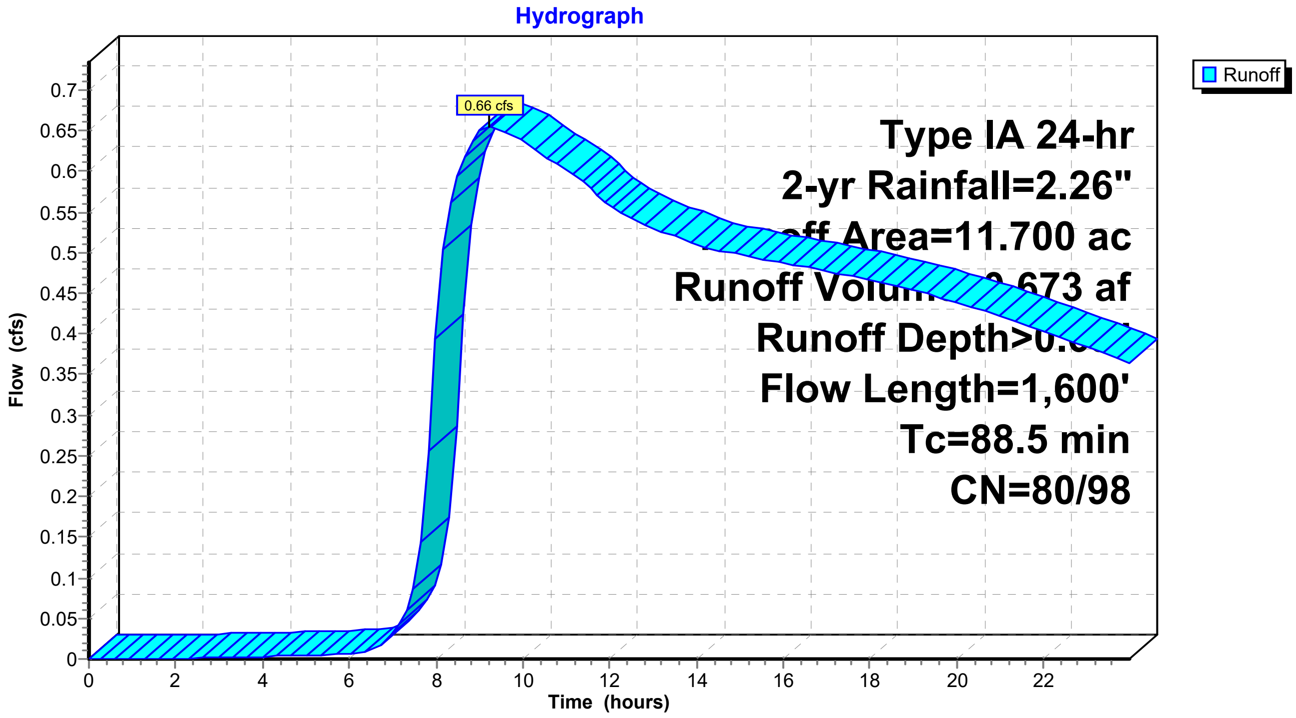
Runoff = 0.66 cfs @ 9.24 hrs, Volume= 0.673 af, Depth> 0.69"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-23.97 hrs, dt= 0.17 hrs
Type IA 24-hr 2-yr Rainfall=2.26"

	Area (ac)	CN	Description
	11.620	80	Pasture/grassland/range, Good, HSG D
*	0.080	98	existing gravel in south
	11.700	80	Weighted Average
	11.620	80	99.32% Pervious Area
	0.080	98	0.68% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
62.2	300	0.0070	0.08		**Sheet Flow,** Grass: Dense n= 0.240 P2= 2.26"
4.7	300	0.0050	1.06		**Shallow Concentrated Flow,** Grassed Waterway Kv= 15.0 fps
21.6	1,000	0.0005	0.77	6.93	**Trap/Vee/Rect Channel Flow,** Bot.W=6.00' D=1.00' Z= 3.0 '/' Top.W=12.00' n= 0.035 High grass
88.5	1,600	Total			

Subcatchment 5X: Commercial Site



Summary for Reach 7R: conveyance ditch

[81] Warning: Exceeded Pond 4P by 30.00' @ 0.00 hrs

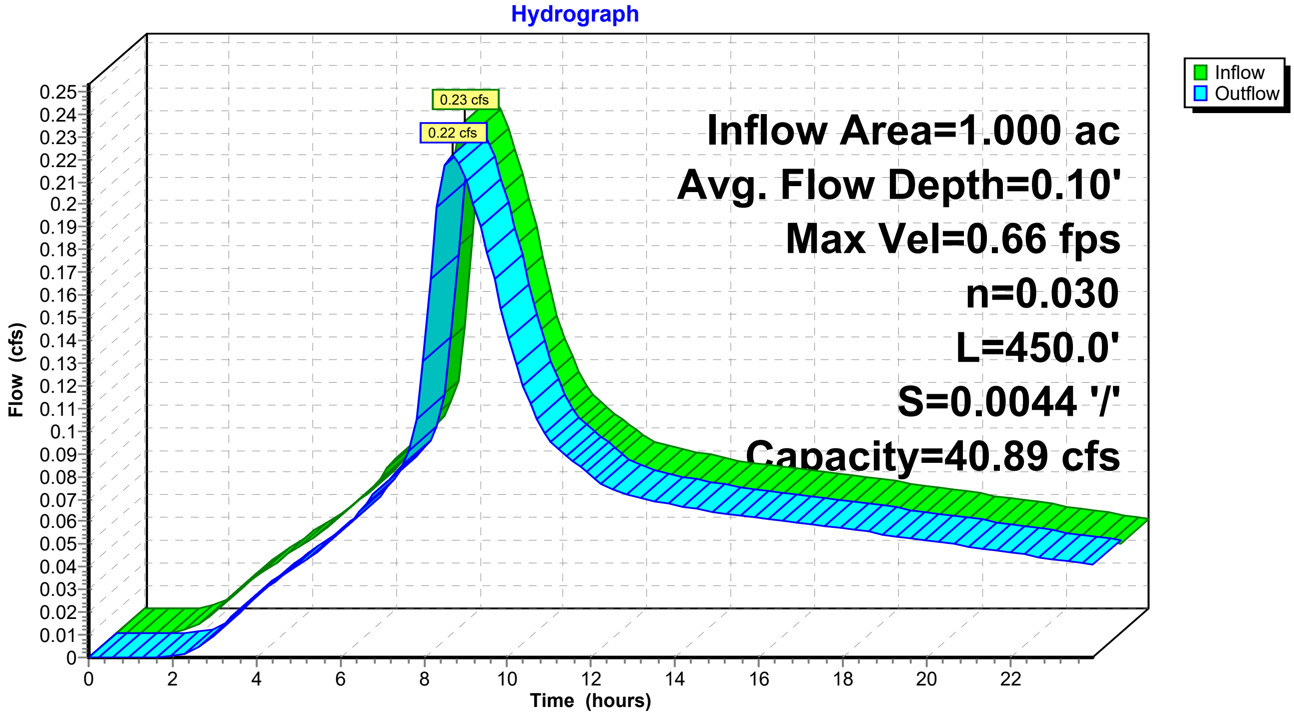
Inflow Area = 1.000 ac, 65.00% Impervious, Inflow Depth > 1.54" for 2-yr event
Inflow = 0.23 cfs @ 8.33 hrs, Volume= 0.128 af
Outflow = 0.22 cfs @ 8.68 hrs, Volume= 0.127 af, Atten= 2%, Lag= 21.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-23.97 hrs, dt= 0.17 hrs
Max. Velocity= 0.66 fps, Min. Travel Time= 11.4 min
Avg. Velocity = 0.41 fps, Avg. Travel Time= 18.3 min

Peak Storage= 152 cf @ 8.48 hrs
Average Depth at Peak Storage= 0.10'
Bank-Full Depth= 1.50' Flow Area= 13.5 sf, Capacity= 40.89 cfs

3.00' x 1.50' deep channel, n= 0.030 Earth, grassed & winding
Side Slope Z-value= 4.0 '/' Top Width= 15.00'
Length= 450.0' Slope= 0.0044 '/'
Inlet Invert= 30.00', Outlet Invert= 28.00'

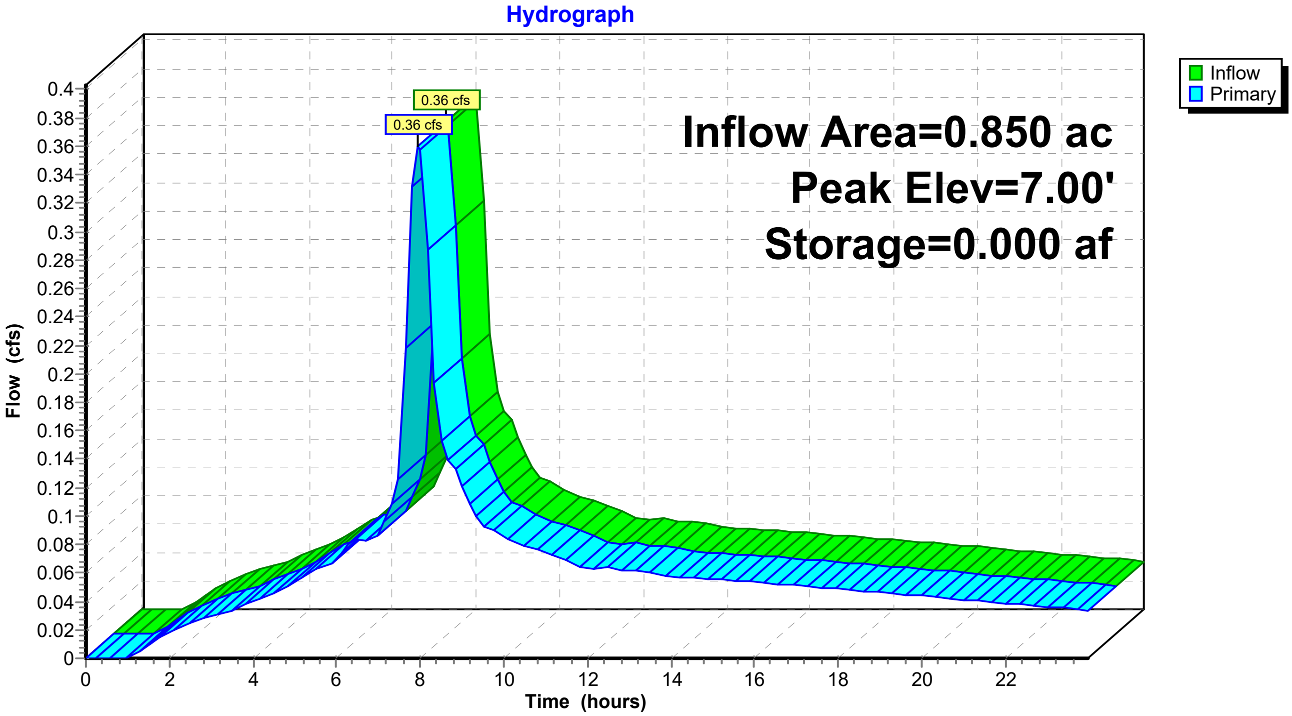
Reach 7R: conveyance ditch



Summary for Pond 1B: BIORET-1

```
Inflow Area =      0.850 ac, 76.47% Impervious, Inflow Depth >  1.71"   for 2-yr event
Inflow      =     0.36 cfs @   7.95 hrs, Volume=          0.121 af
Outflow     =     0.36 cfs @   7.95 hrs, Volume=          0.121 af, Atten= 0%, Lag= 0.0 min
Primary     =     0.36 cfs @   7.95 hrs, Volume=          0.121 af

Routing by Stor-Ind method, Time Span= 0.00-23.97 hrs, dt= 0.17 hrs
Peak Elev= 7.00' @ 7.95 hrs   Surf.Area= 0.010 ac   Storage= 0.000 af

Plug-Flow detention time= 0.0 min calculated for 0.120 af (99% of inflow)
Center-of-Mass det. time= 0.0 min ( 697.3 - 697.3 )

Volume      Invert   Avail.Storage   Storage Description
  #1         7.00'        0.016 af   5.00'W x 85.00'L x 1.00'H Prismatoid  Z=3.0

Device   Routing        Invert   Outlet Devices
  #1     Primary         7.00'   12.00 cfs Exfiltration X 0.25 at all elevations
  #2     Primary         7.50'   50.0' long  x 1.0' breadth Broad-Crested Rectangular Weir
                                 Head (feet)  0.20  0.40  0.60  0.80  1.00  1.20  1.40  1.60  1.80  2.00
                                 2.50  3.00
                                 Coef. (English)  2.69  2.72  2.75  2.85  2.98  3.08  3.20  3.28  3.31
                                 3.30  3.31  3.32

Primary OutFlow Max=3.00 cfs @ 7.95 hrs  HW=7.00'   (Free Discharge)
├─1=Exfiltration (Exfiltration Controls 3.00 cfs)
└─2=Broad-Crested Rectangular Weir( Controls 0.00 cfs)
```

Pond 1B: BIORET-1



Summary for Pond 1P: NW CORNER

Inflow Area = 0.900 ac, 77.78% Impervious, Inflow Depth > 1.73" for 2-yr event
Inflow = 0.39 cfs @ 7.95 hrs, Volume= 0.130 af
Outflow = 0.06 cfs @ 15.62 hrs, Volume= 0.088 af, Atten= 85%, Lag= 459.9 min
Primary = 0.06 cfs @ 15.62 hrs, Volume= 0.088 af

Routing by Stor-Ind method, Time Span= 0.00-23.97 hrs, dt= 0.17 hrs
Peak Elev= 2.40' @ 15.62 hrs Surf.Area= 0.032 ac Storage= 0.049 af

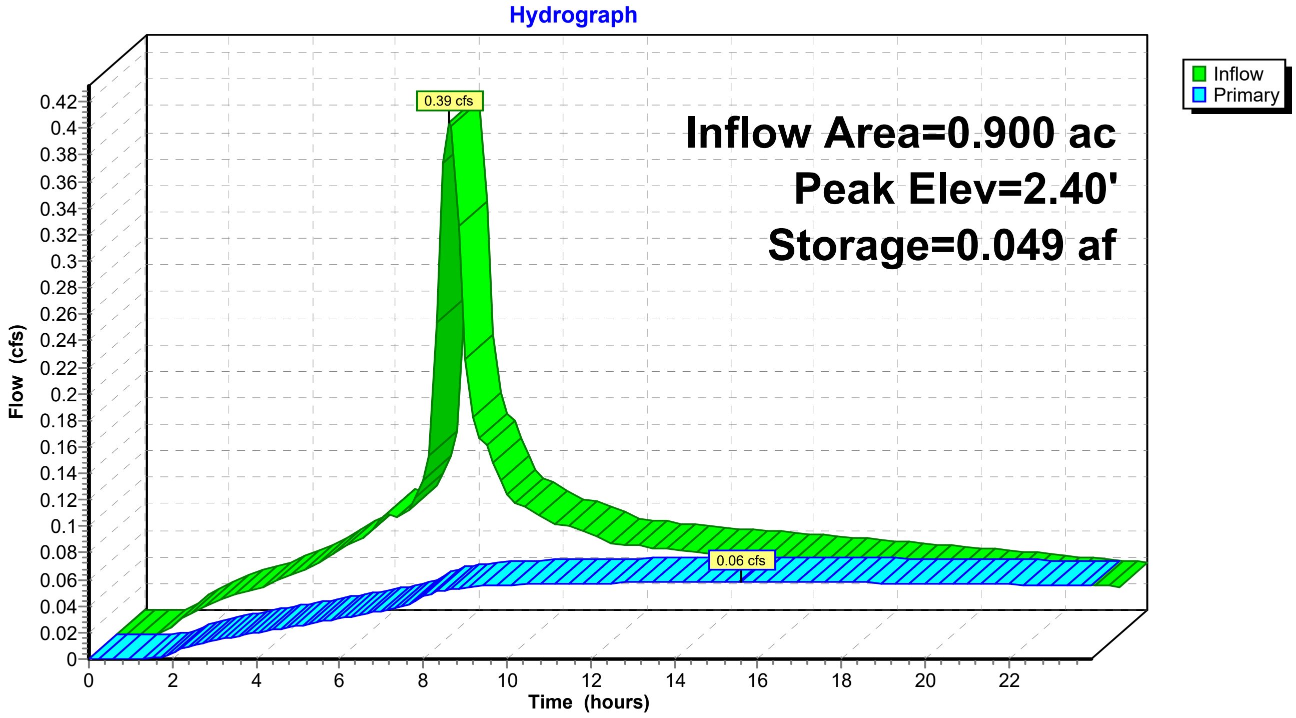
Plug-Flow detention time= 372.2 min calculated for 0.087 af (67% of inflow)
Center-of-Mass det. time= 178.2 min (874.3 - 696.1)

Volume	Invert	Avail.Storage	Storage Description
#1	0.00'	0.141 af	**9.00'W x 50.00'L x 4.50'H Prismatoid Z=2.7**

Device	Routing	Invert	Outlet Devices
#1	Primary	0.00'	**1.2" Vert. Orifice** C= 0.600
#2	Primary	3.50'	**24.0" Horiz. riser** C= 0.600 Limited to weir flow at low heads
#3	Primary	2.80'	**12.0" W x 8.4" H Vert. notch** C= 0.600

Primary OutFlow Max=0.06 cfs @ 15.62 hrs HW=2.40' (Free Discharge)
↑—**1=Orifice** (Orifice Controls 0.06 cfs @ 7.37 fps)
├—**2=riser** (Controls 0.00 cfs)
└—**3=notch** (Controls 0.00 cfs)

Pond 1P: NW CORNER



Summary for Pond 2A: BIORET-2A

Inflow Area = 1.140 ac,100.00% Impervious, Inflow Depth > 2.03" for 2-yr event
Inflow = 0.59 cfs @ 7.94 hrs, Volume= 0.193 af
Outflow = 0.59 cfs @ 7.94 hrs, Volume= 0.193 af, Atten= 0%, Lag= 0.0 min
Primary = 0.59 cfs @ 7.94 hrs, Volume= 0.193 af

Routing by Stor-Ind method, Time Span= 0.00-23.97 hrs, dt= 0.17 hrs
Peak Elev= 5.00' @ 7.94 hrs Surf.Area= 0.016 ac Storage= 0.000 af

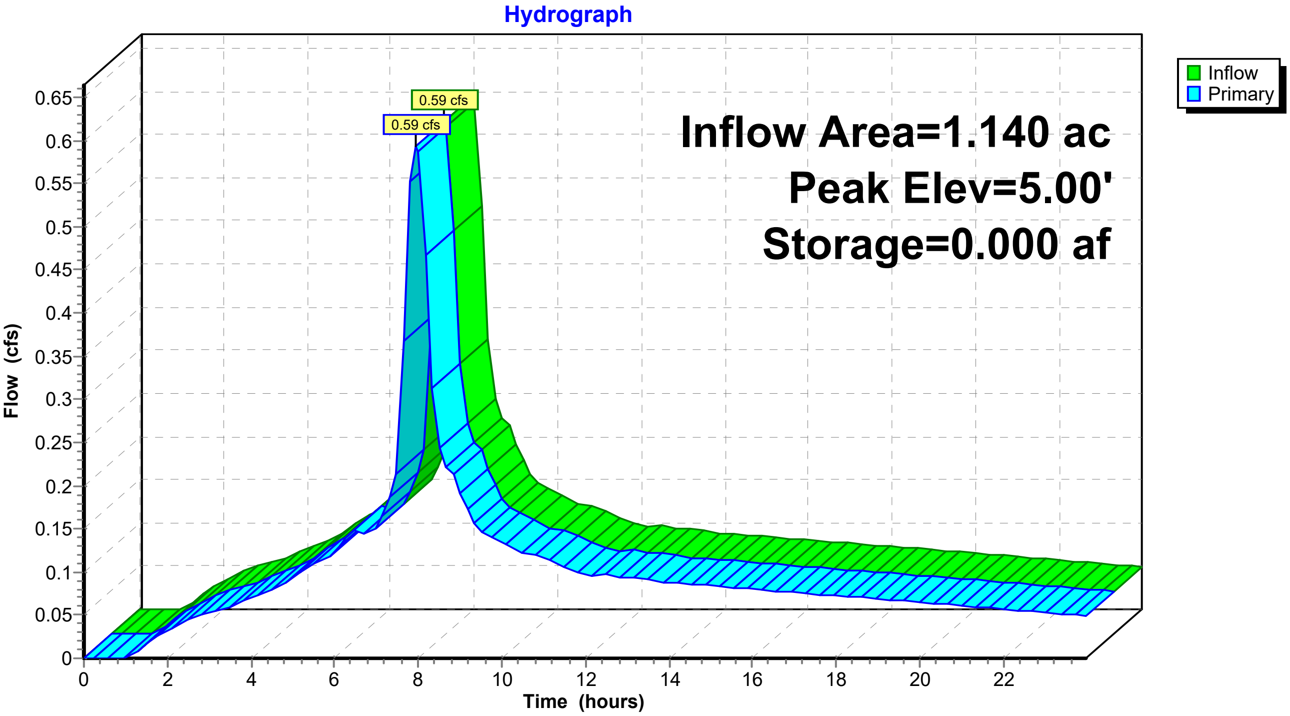
Plug-Flow detention time= 0.0 min calculated for 0.191 af (99% of inflow)
Center-of-Mass det. time= 0.0 min (679.0 - 679.0)

Volume	Invert	Avail.Storage	Storage Description
#1	5.00'	0.022 af	**10.00'W x 70.00'L x 1.00'H Prismatoid Z=3.0**

Device	Routing	Invert	Outlet Devices
#1	Primary	5.00'	**12.00 cfs Exfiltration X 0.25 at all elevations**
#2	Primary	5.50'	**50.0' long x 1.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 Coef. (English) 2.69 2.72 2.75 2.85 2.98 3.08 3.20 3.28 3.31 3.30 3.31 3.32

Primary OutFlow Max=3.00 cfs @ 7.94 hrs HW=5.00' (Free Discharge)
├─**1=Exfiltration** (Exfiltration Controls 3.00 cfs)
└─**2=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond 2A: BIORET-2A



Summary for Pond 2B: BIORET-2B

Inflow Area = 4.120 ac, 83.25% Impervious, Inflow Depth > 1.80" for 2-yr event
Inflow = 1.86 cfs @ 7.95 hrs, Volume= 0.619 af
Outflow = 1.86 cfs @ 7.95 hrs, Volume= 0.618 af, Atten= 0%, Lag= 0.0 min
Primary = 1.86 cfs @ 7.95 hrs, Volume= 0.618 af

Routing by Stor-Ind method, Time Span= 0.00-23.97 hrs, dt= 0.17 hrs
Peak Elev= 6.00' @ 7.95 hrs Surf.Area= 0.046 ac Storage= 0.000 af

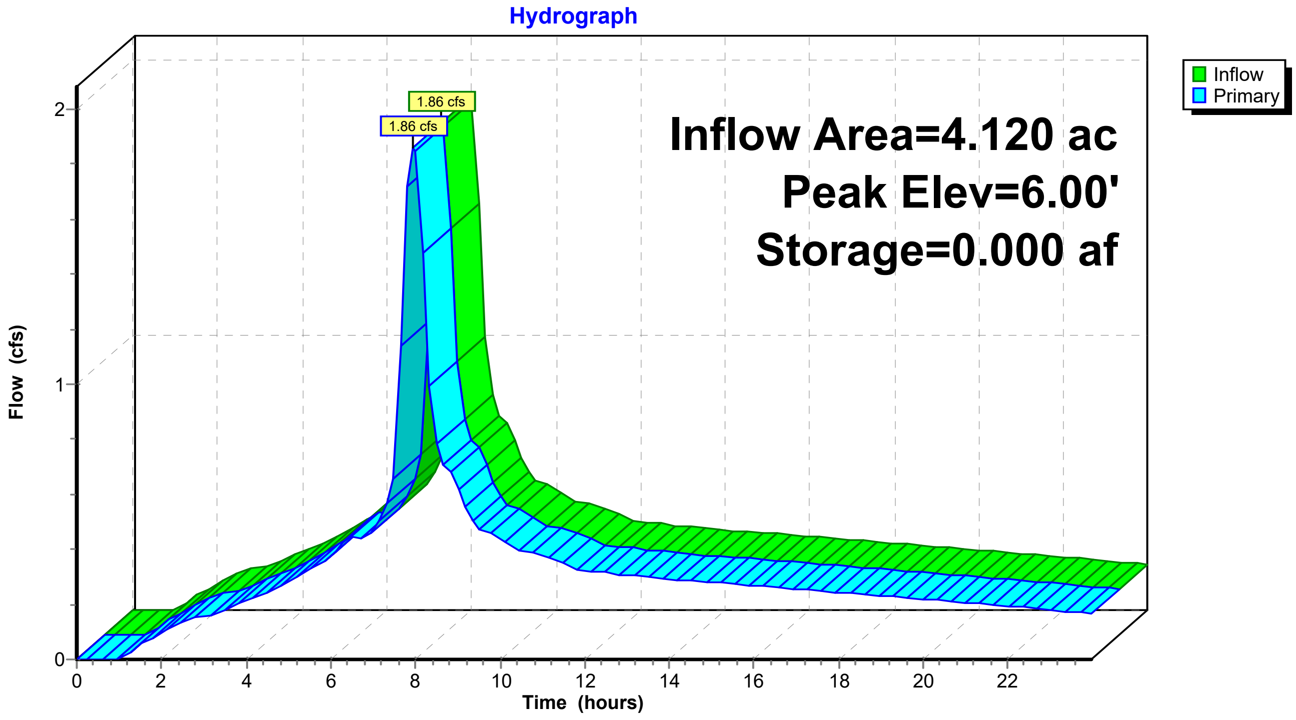
Plug-Flow detention time= 0.0 min calculated for 0.618 af (100% of inflow)
Center-of-Mass det. time= 0.0 min (691.4 - 691.3)

Volume	Invert	Avail.Storage	Storage Description
#1	6.00'	0.086 af	**25.00'W x 80.00'L x 1.50'H Prismatoid Z=3.0**

Device	Routing	Invert	Outlet Devices
#1	Primary	6.00'	**12.00 cfs Exfiltration X 0.25 at all elevations**
#2	Primary	1.00'	**24.0" Horiz. riser** C= 0.600 Limited to weir flow at low heads

Primary OutFlow Max=36.83 cfs @ 7.95 hrs HW=6.00' (Free Discharge)
↑—**1=Exfiltration** (Exfiltration Controls 3.00 cfs)
└—**2=riser** (Orifice Controls 33.83 cfs @ 10.77 fps)

Pond 2B: BIORET-2B



Summary for Pond 2P: West Pond

Inflow Area = 1.960 ac, 87.76% Impervious, Inflow Depth > 1.86" for 2-yr event
Inflow = 0.92 cfs @ 7.95 hrs, Volume= 0.304 af
Outflow = 0.04 cfs @ 23.97 hrs, Volume= 0.055 af, Atten= 96%, Lag= 961.4 min
Primary = 0.04 cfs @ 23.97 hrs, Volume= 0.055 af

Routing by Stor-Ind method, Time Span= 0.00-23.97 hrs, dt= 0.17 hrs
Peak Elev= 3.52' @ 23.97 hrs Surf.Area= 0.102 ac Storage= 0.249 af

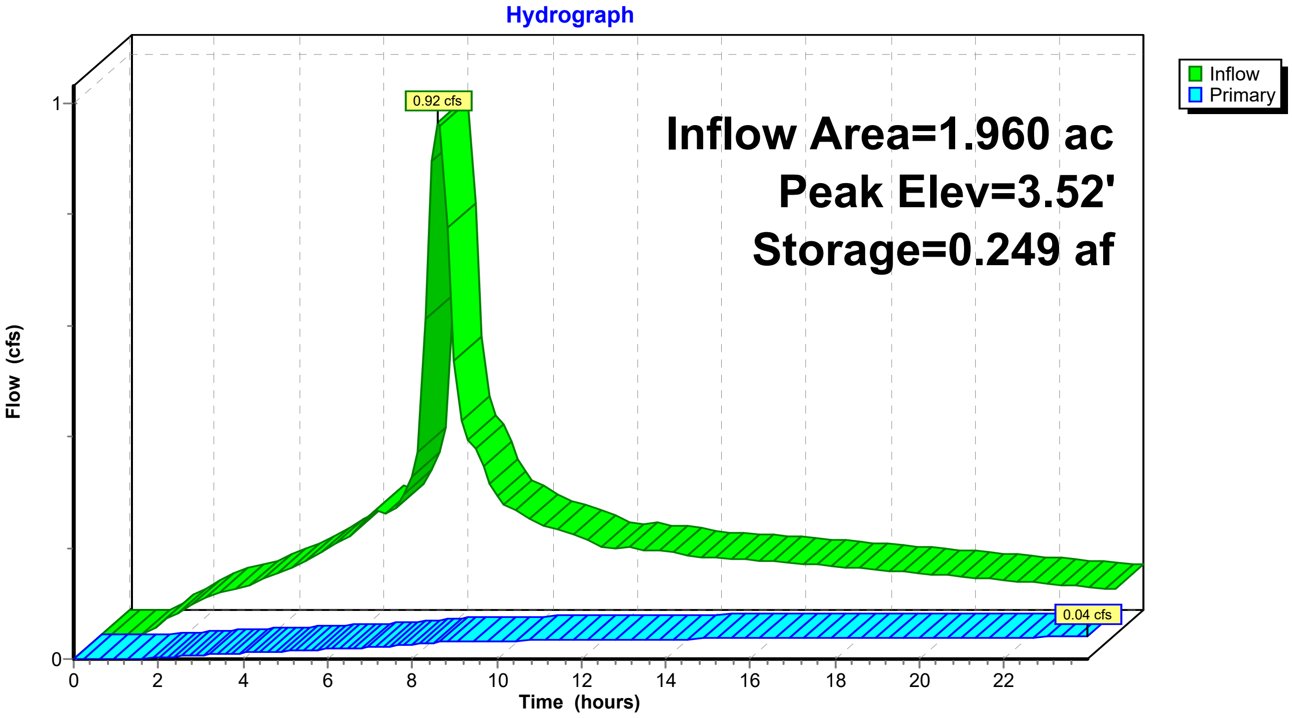
Plug-Flow detention time= 601.7 min calculated for 0.055 af (18% of inflow)
Center-of-Mass det. time= 212.6 min (900.4 - 687.7)

Volume	Invert	Avail.Storage	Storage Description
#1	0.00'	0.566 af	**25.00'W x 75.00'L x 6.00'H Prismatoid Z=3.0**

Device	Routing	Invert	Outlet Devices
#1	Primary	0.00'	**0.9" Vert. Orifice/Grate** C= 0.600
#2	Primary	4.50'	**9.0" W x 6.0" H Vert. notch** C= 0.600
#3	Primary	5.00'	**24.0" Horiz. riser** C= 0.600 Limited to weir flow at low heads

Primary OutFlow Max=0.04 cfs @ 23.97 hrs HW=3.52' (Free Discharge)
1=Orifice/Grate (Orifice Controls 0.04 cfs @ 8.98 fps)
2=notch (Controls 0.00 cfs)
3=riser (Controls 0.00 cfs)

Pond 2P: West Pond



Summary for Pond 3P: East Pond

[79] Warning: Submerged Pond 2B Primary device # 2 by 2.24'

```
Inflow Area =        4.540 ac, 79.96% Impervious, Inflow Depth >   1.75"    for  2-yr event
Inflow      =       1.97 cfs @    7.95 hrs,  Volume=          0.661 af
Outflow     =       0.21 cfs @   22.18 hrs,  Volume=          0.296 af,  Atten= 90%,  Lag= 853.9 min
Primary     =       0.21 cfs @   22.18 hrs,  Volume=          0.296 af
```

Routing by Stor-Ind method, Time Span= 0.00-23.97 hrs, dt= 0.17 hrs
Peak Elev= 3.24' @ 22.18 hrs Surf.Area= 6,374 sf Storage= 15,976 cf

Plug-Flow detention time= 490.8 min calculated for 0.296 af (45% of inflow)
Center-of-Mass det. time= 206.3 min (900.1 - 693.8)

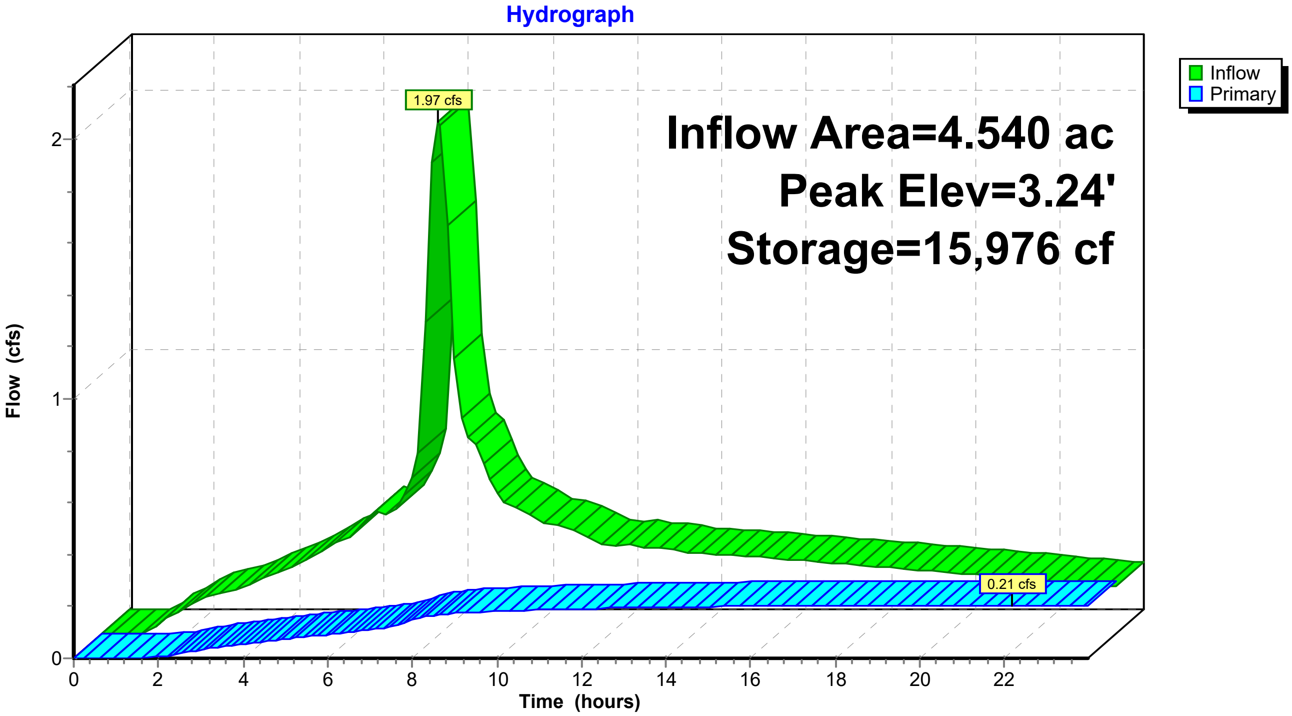
Volume	Invert	Avail.Storage	Storage Description
#1	0.00'	42,286 cf	**48.00'W x 75.00'L x 6.50'H Prismatoid Z=3.0**

Device	Routing	Invert	Outlet Devices
#1	Primary	0.00'	**2.1" Vert. Orifice** C= 0.600
#2	Primary	3.50'	**3.0" W x 24.0" H Vert. notch** C= 0.600
#3	Primary	5.50'	**24.0" Horiz. riser** C= 0.600 Limited to weir flow at low heads

Primary OutFlow Max=0.21 cfs @ 22.18 hrs HW=3.24' (Free Discharge)

```
↑─1=Orifice  (Orifice Controls 0.21 cfs @ 8.56 fps)
├─2=notch  ( Controls 0.00 cfs)
└─3=riser  ( Controls 0.00 cfs)
```

Pond 3P: East Pond



Summary for Pond 4P: Wet Pond- Live Storage

Inflow Area = 1.000 ac, 65.00% Impervious, Inflow Depth > 1.57" for 2-yr event
Inflow = 0.38 cfs @ 7.96 hrs, Volume= 0.131 af
Outflow = 0.23 cfs @ 8.33 hrs, Volume= 0.128 af, Atten= 41%, Lag= 22.3 min
Primary = 0.23 cfs @ 8.33 hrs, Volume= 0.128 af

Routing by Stor-Ind method, Time Span= 0.00-23.97 hrs, dt= 0.17 hrs
Peak Elev= 0.46' @ 8.33 hrs Surf.Area= 1,739 sf Storage= 557 cf

Plug-Flow detention time= 39.6 min calculated for 0.127 af (97% of inflow)
Center-of-Mass det. time= 25.7 min (734.9 - 709.2)

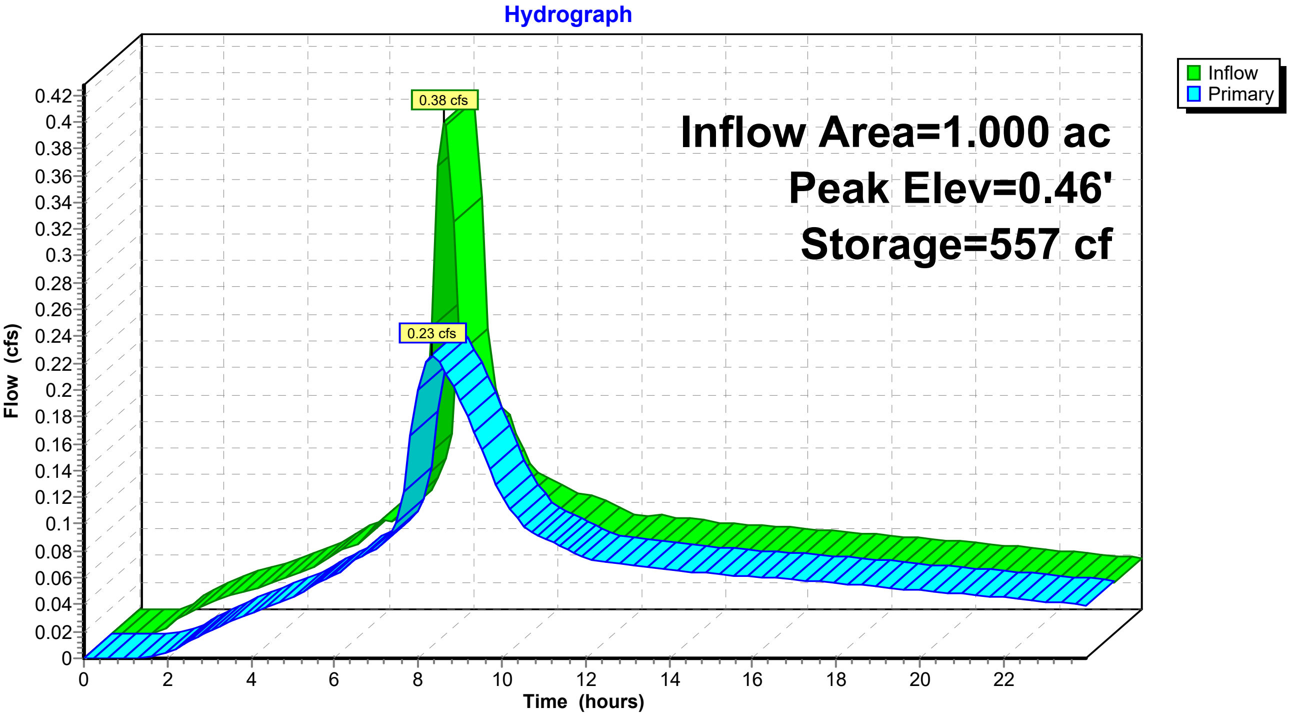
Volume	Invert	Avail.Storage	Storage Description
#1	0.00'	9,172 cf	**Live Storage (Prismatic)**Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
0.00	704	0	0
1.00	2,975	1,840	1,840
2.00	3,662	3,319	5,158
3.00	4,366	4,014	9,172

Device	Routing	Invert	Outlet Devices
#1	Primary	0.00'	**4.0" Vert. Orifice** C= 0.600
#2	Primary	0.50'	**10.0" W x 18.0" H Vert. Notch** C= 0.600
#3	Primary	2.00'	**18.0" Horiz. Riser** C= 0.600 Limited to weir flow at low heads

Primary OutFlow Max=0.23 cfs @ 8.33 hrs HW=0.46' (Free Discharge)
├─**1=Orifice** (Orifice Controls 0.23 cfs @ 2.59 fps)
├─**2=Notch** (Controls 0.00 cfs)
└─**3=Riser** (Controls 0.00 cfs)

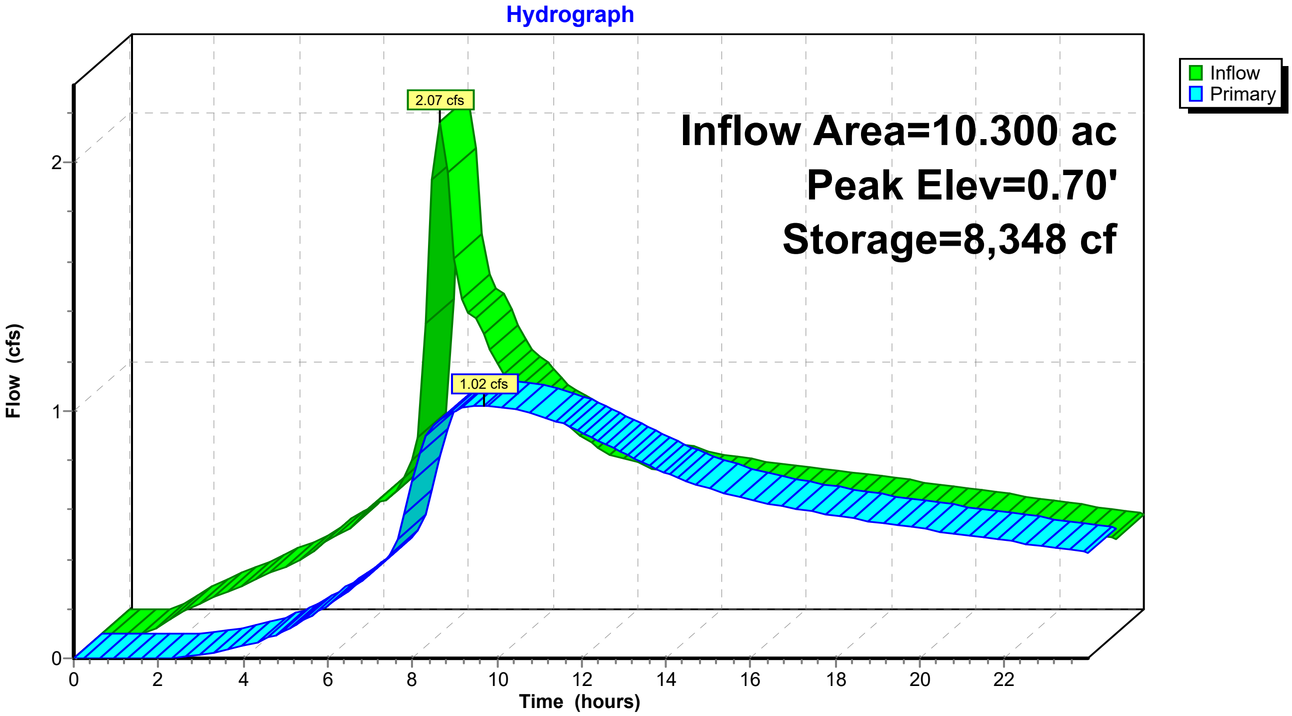
Pond 4P: Wet Pond- Live Storage



Summary for Pond 5P: Wet Pond- Live Storage

```
Inflow Area =      10.300 ac, 45.63% Impervious, Inflow Depth >  1.29"   for 2-yr event
Inflow      =       2.07 cfs @   8.00 hrs, Volume=         1.103 af
Outflow     =       1.02 cfs @   9.69 hrs, Volume=         1.005 af, Atten= 51%, Lag= 101.5 min
Primary     =       1.02 cfs @   9.69 hrs, Volume=         1.005 af

Routing by Stor-Ind method, Time Span= 0.00-23.97 hrs, dt= 0.17 hrs
Peak Elev= 0.70' @ 9.69 hrs  Surf.Area= 12,977 sf  Storage= 8,348 cf

Plug-Flow detention time= 141.1 min calculated for 1.005 af (91% of inflow)
Center-of-Mass det. time= 83.3 min ( 845.5 - 762.2 )

Volume     Invert    Avail.Storage  Storage Description
   #1       0.00'       44,950 cf  Live Storage (Prismatic)Listed below (Recalc)

 Elevation     Surf.Area     Inc.Store     Cum.Store
    (feet)       (sq-ft)  (cubic-feet)  (cubic-feet)
      0.00        10,800             0             0
      1.00        13,900        12,350        12,350
      2.00        16,300        15,100        27,450
      3.00        18,700        17,500        44,950

Device  Routing          Invert  Outlet Devices
   #1   Primary           0.00'  8.0" Vert. Orifice/Grate  C= 0.600
   #2   Primary           0.75'  24.0" W x 15.0" H Vert. Notch  C= 0.600
   #3   Primary           2.00'  24.0" Horiz. Riser  C= 0.600  Limited to weir flow at low heads

Primary OutFlow Max=1.02 cfs @ 9.69 hrs  HW=0.70'  (Free Discharge)
 ├─1=Orifice/Grate (Orifice Controls 1.02 cfs @ 2.92 fps)
 ├─2=Notch ( Controls 0.00 cfs)
 └─3=Riser ( Controls 0.00 cfs)
```

Pond 5P: Wet Pond- Live Storage



Summary for Pond 6P: 4P-Wet Pond-Live Storage - CORRECTED

[43] Hint: Has no inflow (Outflow=Zero)

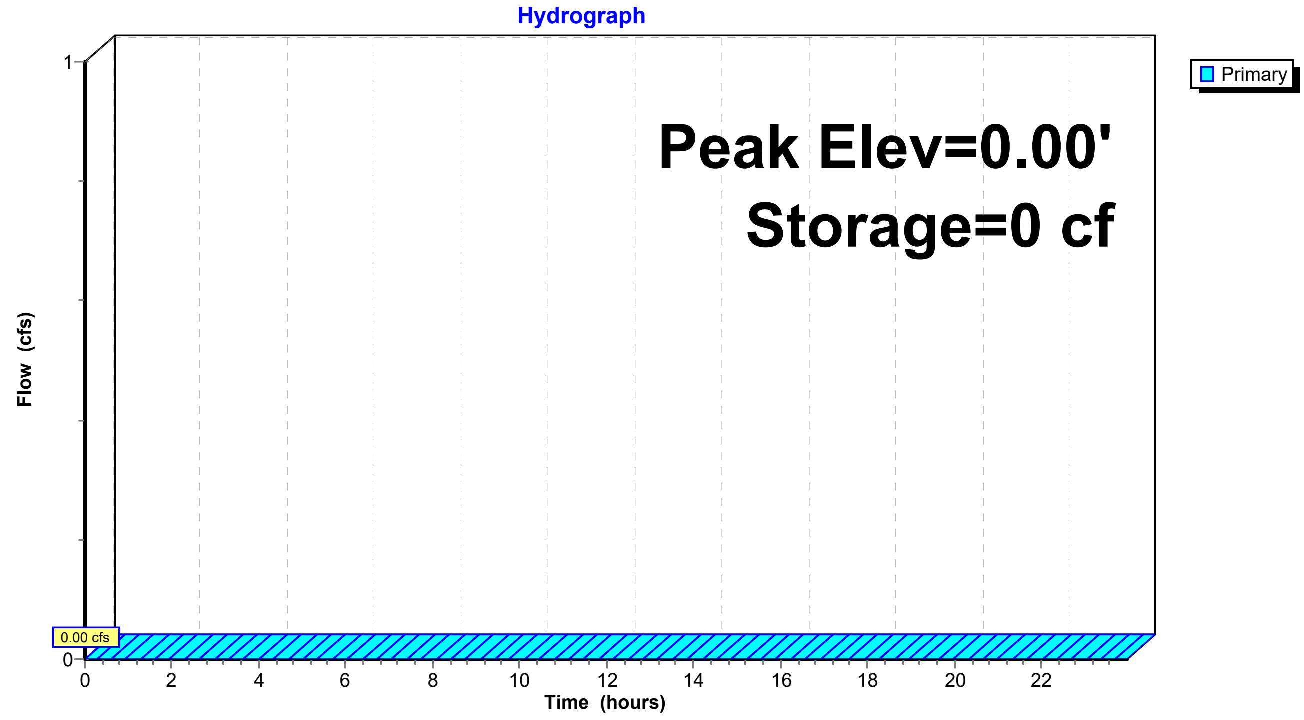
Volume	Invert	Avail.Storage	Storage Description
#1	0.00'	13,900 cf	**Live Storage (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
0.00	2,750	0	0
1.00	4,225	3,488	3,488
2.00	5,200	4,713	8,200
3.00	6,200	5,700	13,900

Device	Routing	Invert	Outlet Devices
#1	Primary	0.00'	**4.0" Vert. Orifice** C= 0.600
#2	Primary	0.50'	**10.0" W x 18.0" H Vert. Notch** C= 0.600
#3	Primary	2.00'	**18.0" Horiz. Riser** C= 0.600 Limited to weir flow at low heads

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=0.00' (Free Discharge)
1=Orifice (Controls 0.00 cfs)
2=Notch (Controls 0.00 cfs)
3=Riser (Controls 0.00 cfs)

Pond 6P: 4P-Wet Pond-Live Storage - CORRECTED



Summary for Pond 8P: 4P- Wet Pond- Dead Storage

[43] Hint: Has no inflow (Outflow=Zero)

Volume	Invert	Avail.Storage	Storage Description
#1	-3.00'	4,748 cf	**Dead Storage (Prismatic)**Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
-3.00	457	0	0
-2.00	1,213	835	835
-1.00	1,928	1,571	2,406
0.00	2,756	2,342	4,748

Summary for Pond 9P: 5P- Dead Storage

[43] Hint: Has no inflow (Outflow=Zero)

Volume	Invert	Avail.Storage	Storage Description
#1	-3.00'	17,914 cf	**Live Storage (Prismatic)**Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
-3.00	3,156	0	0
-2.00	4,660	3,908	3,908
-1.00	6,276	5,468	9,376
0.00	10,800	8,538	17,914

Summary for Pond 10P: 5P-Wet Pond- Live Storage - CORRECTED

[43] Hint: Has no inflow (Outflow=Zero)

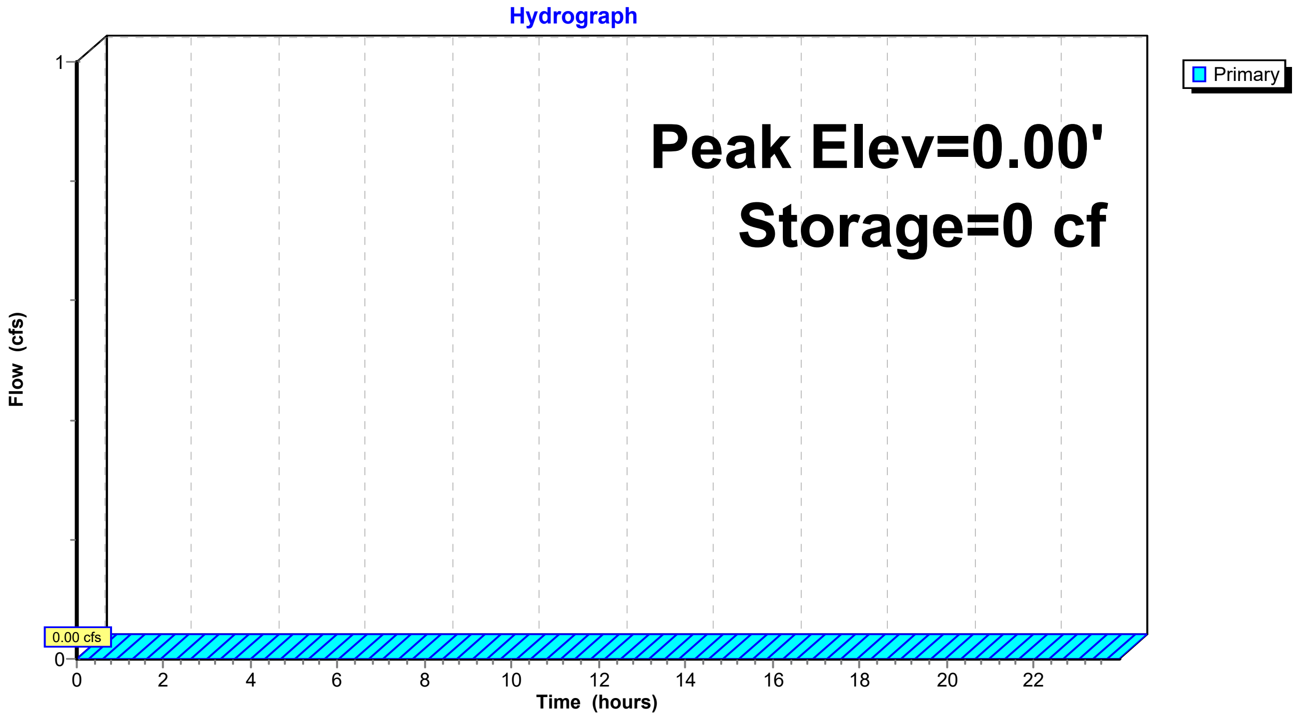
Volume	Invert	Avail.Storage	Storage Description
#1	0.00'	71,500 cf	**Live Storage (Prismatic)**Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
0.00	19,000	0	0
1.00	22,700	20,850	20,850
2.00	25,300	24,000	44,850
3.00	28,000	26,650	71,500

Device	Routing	Invert	Outlet Devices
#1	Primary	0.00'	**8.0" Vert. Orifice/Grate** C= 0.600
#2	Primary	0.75'	**24.0" W x 15.0" H Vert. Notch** C= 0.600
#3	Primary	2.00'	**24.0" Horiz. Riser** C= 0.600 Limited to weir flow at low heads

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=0.00' (Free Discharge)
1=Orifice/Grate (Controls 0.00 cfs)
2=Notch (Controls 0.00 cfs)
3=Riser (Controls 0.00 cfs)

Pond 10P: 5P-Wet Pond- Live Storage - CORRECTED



Time span=0.00-24.00 hrs, dt=0.17 hrs, 142 points
Runoff by SBUH method, Split Pervious/Imperv.
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment1S-A: Site - Post Basin Runoff Area=0.850 ac 76.47% Impervious Runoff Depth>2.92"
Tc=5.0 min CN=79/98 Runoff=0.61 cfs 0.207 af

Subcatchment1S-B: (new Subcat) Runoff Area=0.050 ac 100.00% Impervious Runoff Depth>3.32"
Tc=5.0 min CN=0/98 Runoff=0.04 cfs 0.014 af

Subcatchment1X: Pre Runoff Area=1.800 ac 1.11% Impervious Runoff Depth>1.23"
Tc=19.0 min CN=73/98 Runoff=0.33 cfs 0.184 af

Subcatchment2S-A1: Site -WEST Runoff Area=1.140 ac 100.00% Impervious Runoff Depth>3.32"
Tc=5.0 min CN=0/98 Runoff=0.96 cfs 0.315 af

Subcatchment2S-A2: Site -WEST (roof Runoff Area=0.820 ac 70.73% Impervious Runoff Depth>2.82"
Tc=5.0 min CN=79/98 Runoff=0.57 cfs 0.193 af

Subcatchment2S-B1: Site - EAST Runoff Area=3.620 ac 80.94% Impervious Runoff Depth>2.99"
Tc=5.0 min CN=79/98 Runoff=2.70 cfs 0.903 af

Subcatchment2S-B2: POND Runoff Area=0.420 ac 47.62% Impervious Runoff Depth>2.25"
Tc=5.0 min CN=74/98 Runoff=0.22 cfs 0.079 af

Subcatchment2S-C: OFFSITE ROAD Runoff Area=0.500 ac 100.00% Impervious Runoff Depth>3.32"
Tc=5.0 min CN=0/98 Runoff=0.42 cfs 0.138 af

Subcatchment2X-A: Pre-DEV - [WEST] Runoff Area=1.300 ac 0.00% Impervious Runoff Depth>1.20"
Flow Length=285' Slope=0.1700 '/' Tc=25.1 min CN=73/0 Runoff=0.21 cfs 0.130 af

Subcatchment2X-B: Pre- DEV [EAST] Runoff Area=3.900 ac 0.00% Impervious Runoff Depth>1.18"
Flow Length=750' Tc=42.8 min CN=73/0 Runoff=0.51 cfs 0.385 af

Subcatchment2X-C: PRE- OFFSITE ROAD Runoff Area=0.500 ac 36.00% Impervious Runoff Depth>1.97"
Tc=5.0 min CN=73/98 Runoff=0.22 cfs 0.082 af

Subcatchment3S: Green Mtn Rd Runoff Area=1.000 ac 65.00% Impervious Runoff Depth>2.74"
Tc=5.0 min CN=80/98 Runoff=0.68 cfs 0.229 af

Subcatchment3X: PRE- GRN MTN CONN Runoff Area=1.000 ac 12.00% Impervious Runoff Depth>2.14"
Tc=5.0 min CN=84/98 Runoff=0.52 cfs 0.178 af

Subcatchment4S-A: BELMONT RD Runoff Area=2.500 ac 76.00% Impervious Runoff Depth>2.92"
Tc=5.0 min CN=80/98 Runoff=1.82 cfs 0.609 af

Subcatchment4S-B: SOUTH OF BELMONT Runoff Area=7.000 ac 28.57% Impervious Runoff Depth>2.06"
Flow Length=1,050' Tc=87.5 min CN=80/98 Runoff=1.56 cfs 1.201 af

Subcatchment4S-C: WET POND Runoff Area=0.800 ac 100.00% Impervious Runoff Depth>3.32"
Tc=5.0 min CN=0/98 Runoff=0.67 cfs 0.221 af

```
Subcatchment4X-A: PRE - BELMONT RD   Runoff Area=2.500 ac  20.00% Impervious   Runoff Depth>2.18"
                     Flow Length=850'   Slope=0.0100 '/'   Tc=67.1 min   CN=84/98   Runoff=0.68 cfs  0.455 af

Subcatchment4X-B: South of Belmont      Runoff Area=7.800 ac   3.85% Impervious   Runoff Depth>1.97"
                     Flow Length=800'   Slope=0.0100 '/'   Tc=65.9 min   CN=84/98   Runoff=1.89 cfs  1.280 af

Subcatchment5S: Commercial Site        Runoff Area=11.700 ac   0.68% Impervious   Runoff Depth>1.60"
                                     Flow Length=1,550'   Tc=97.7 min   CN=80/98   Runoff=1.79 cfs  1.556 af

Subcatchment5X: Commercial Site        Runoff Area=11.700 ac   0.68% Impervious   Runoff Depth>1.61"
                                     Flow Length=1,600'   Tc=88.5 min   CN=80/98   Runoff=1.87 cfs  1.566 af

Reach 7R: conveyance ditch          Avg. Flow Depth=0.15'   Max Vel=0.84 fps   Inflow=0.47 cfs  0.225 af
                      n=0.030   L=450.0'   S=0.0044 '/'   Capacity=40.89 cfs   Outflow=0.45 cfs  0.223 af

Pond 1B: BIORET-1                    Peak Elev=7.00'  Storage=0.000 af   Inflow=0.61 cfs  0.207 af
                                                                    Outflow=0.61 cfs  0.207 af

Pond 1P: NW CORNER                   Peak Elev=2.94'  Storage=0.068 af   Inflow=0.66 cfs  0.220 af
                                                                    Outflow=0.24 cfs  0.158 af

Pond 2A: BIORET-2A                   Peak Elev=5.00'  Storage=0.000 af   Inflow=0.96 cfs  0.315 af
                                                                    Outflow=0.96 cfs  0.315 af

Pond 2B: BIORET-2B                   Peak Elev=6.00'  Storage=0.000 af   Inflow=3.12 cfs  1.041 af
                                                                    Outflow=3.12 cfs  1.041 af

Pond 2P: West Pond                   Peak Elev=4.64'  Storage=0.376 af   Inflow=1.53 cfs  0.508 af
                                                                    Outflow=0.17 cfs  0.135 af

Pond 3P: East Pond                  Peak Elev=4.07'  Storage=21,596 cf   Inflow=3.34 cfs  1.120 af
                                                                    Outflow=0.58 cfs  0.669 af

Pond 4P: Wet Pond- Live Storage        Peak Elev=0.66'  Storage=968 cf   Inflow=0.68 cfs  0.229 af
                                                                    Outflow=0.47 cfs  0.225 af

Pond 5P: Wet Pond- Live Storage     Peak Elev=1.03'  Storage=12,768 cf   Inflow=3.79 cfs  2.032 af
                                                                    Outflow=2.35 cfs  1.888 af

Pond 6P: 4P-Wet Pond-Live Storage - CORRECTED                       Peak Elev=0.00'  Storage=0 cf
                                                                    Primary=0.00 cfs  0.000 af

Pond 8P: 4P- Wet Pond- Dead Storage                             Peak Elev=0.00'  Storage=4,748 cf

Pond 9P: 5P- Dead Storage                                      Peak Elev=0.00'  Storage=17,914 cf

Pond 10P: 5P-Wet Pond- Live Storage - CORRECTED                     Peak Elev=0.00'  Storage=0 cf
                                                                    Primary=0.00 cfs  0.000 af
```

Total Runoff Area = 60.900 ac Runoff Volume = 9.925 af Average Runoff Depth = 1.96"
79.18% Pervious = 48.220 ac 20.82% Impervious = 12.680 ac

Summary for Subcatchment 1S-A: Site - Post Basin NPGS

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

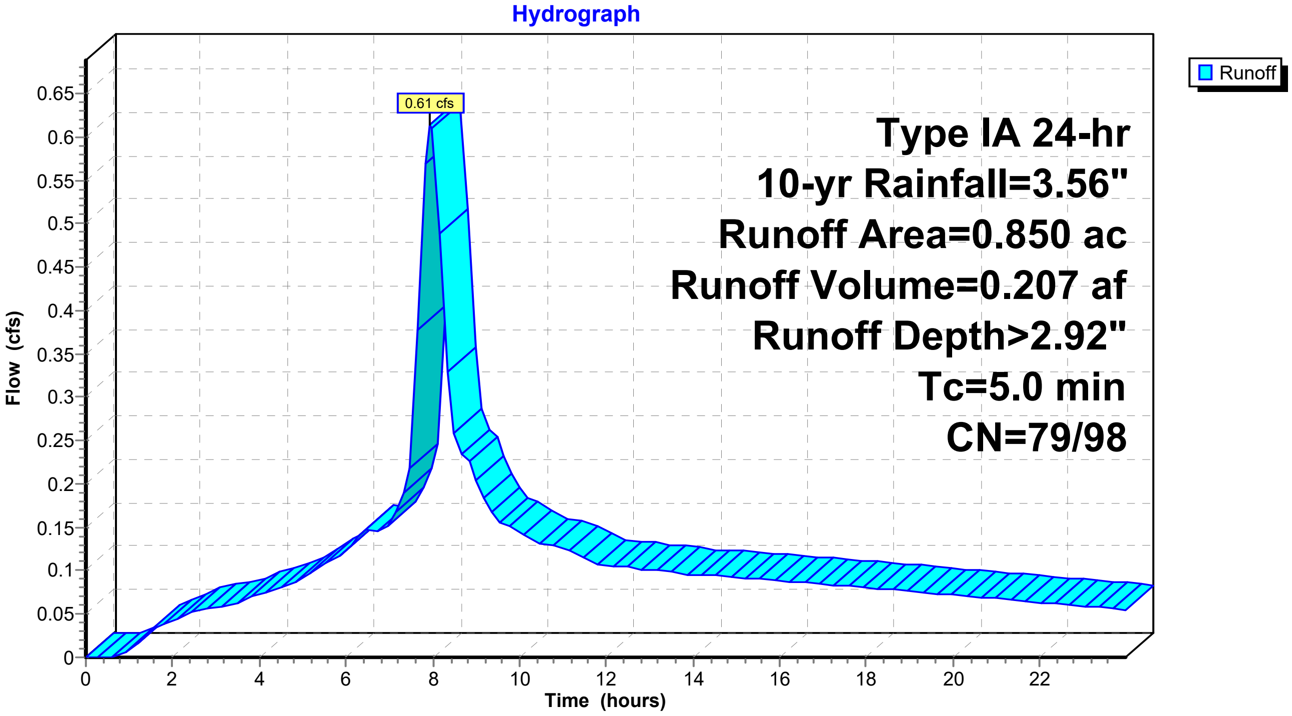
Runoff = 0.61 cfs @ 7.95 hrs, Volume= 0.207 af, Depth> 2.92"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-23.97 hrs, dt= 0.17 hrs
Type IA 24-hr 10-yr Rainfall=3.56"

	Area (ac)	CN	Description
*	0.370	98	roof areas
	0.200	79	50-75% Grass cover, Fair, HSG C
*	0.280	98	parking
	0.850	94	Weighted Average
	0.200	79	23.53% Pervious Area
	0.650	98	76.47% Impervious Area

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

Subcatchment 1S-A: Site - Post Basin NPGS



Summary for Subcatchment 1S-B: (new Subcat)

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

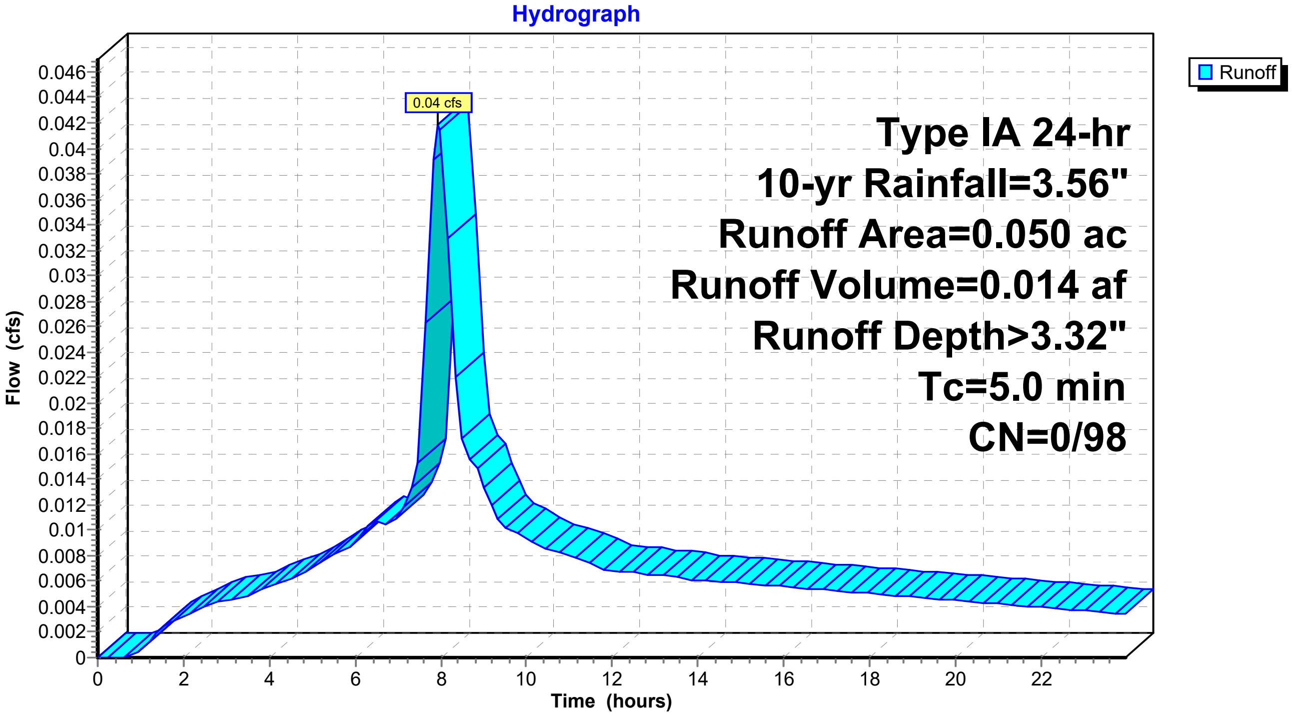
Runoff = 0.04 cfs @ 7.94 hrs, Volume= 0.014 af, Depth> 3.32"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-23.97 hrs, dt= 0.17 hrs
Type IA 24-hr 10-yr Rainfall=3.56"

	Area (ac)	CN	Description
*	0.050	98	pond surface at Q100
	0.050	98	100.00% Impervious Area

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

Subcatchment 1S-B: (new Subcat)



Summary for Subcatchment 1X: Pre

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

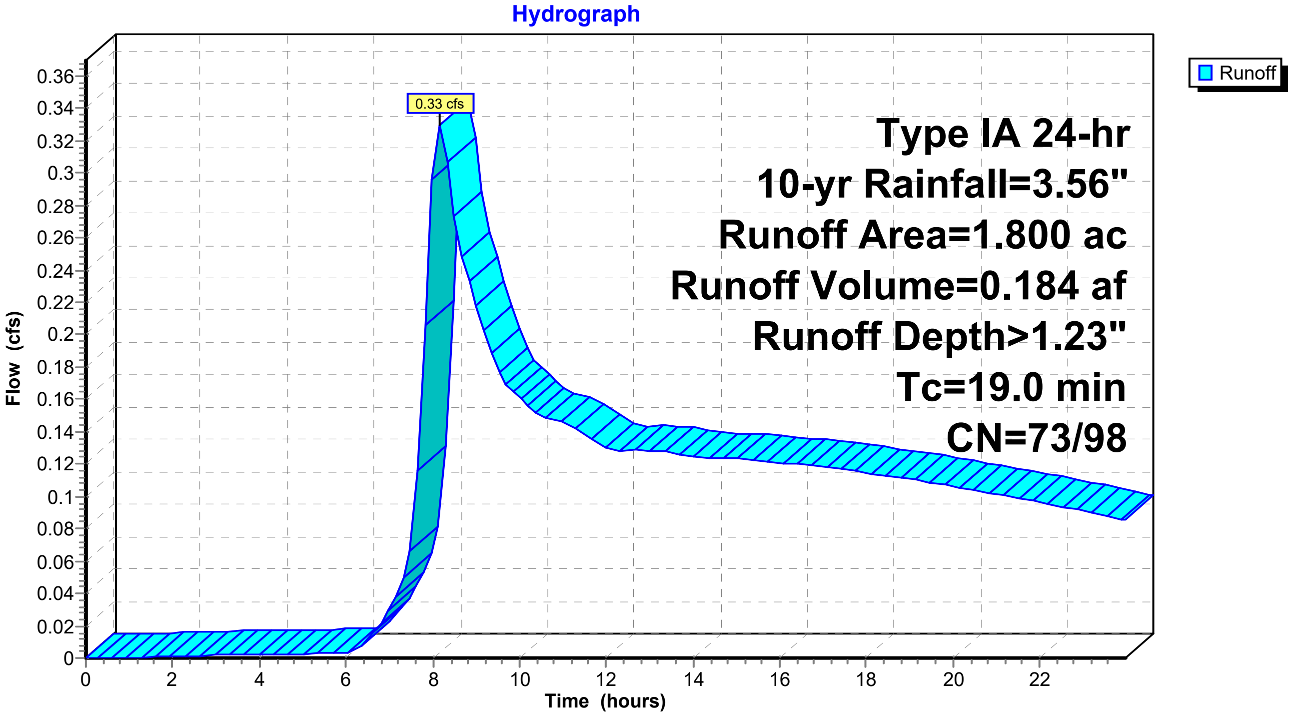
Runoff = 0.33 cfs @ 8.18 hrs, Volume= 0.184 af, Depth> 1.23"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-23.97 hrs, dt= 0.17 hrs
Type IA 24-hr 10-yr Rainfall=3.56"

	Area (ac)	CN	Description
	1.780	73	Woods, Fair, HSG C
*	0.020	98	PORTION OF GREEN MTN LOOP
	1.800	73	Weighted Average
	1.780	73	98.89% Pervious Area
	0.020	98	1.11% Impervious Area

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

Subcatchment 1X: Pre



Summary for Subcatchment 2S-A1: Site -WEST

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

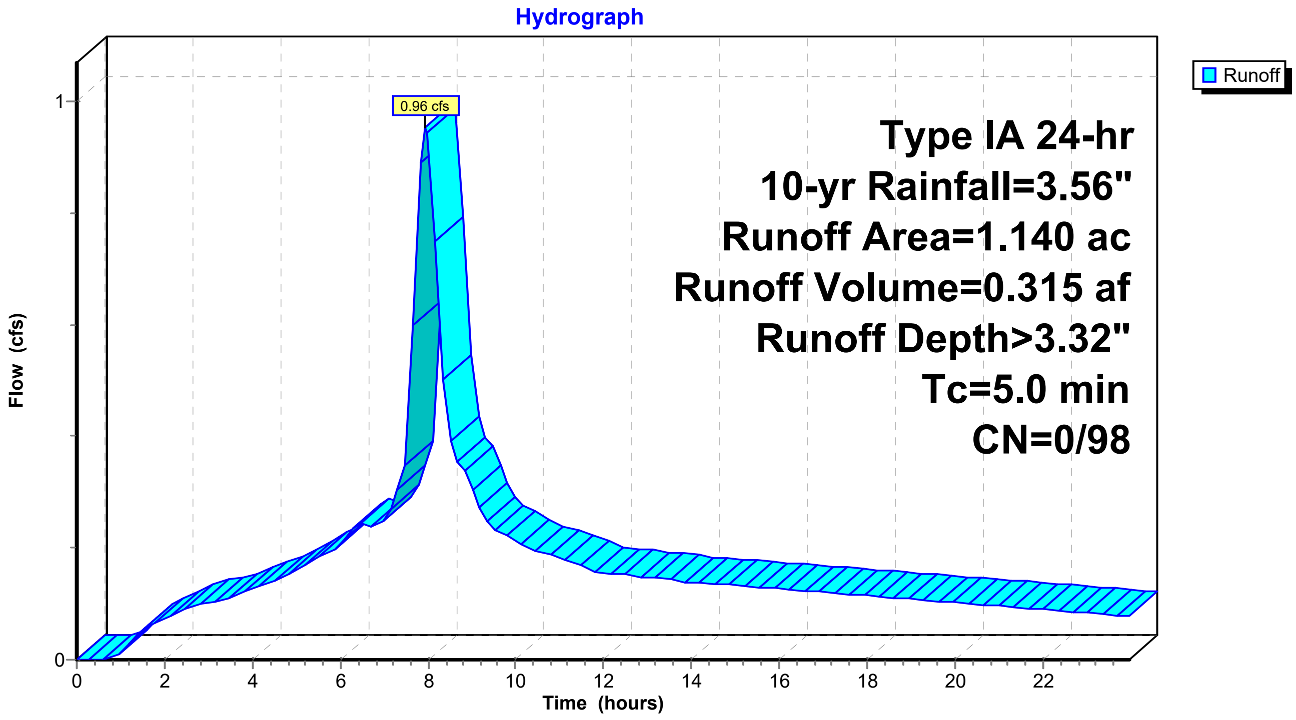
```
Runoff      =        0.96 cfs @     7.94 hrs,  Volume=          0.315 af,  Depth>  3.32"
```

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-23.97 hrs, dt= 0.17 hrs
Type IA 24-hr 10-yr Rainfall=3.56"

	Area (ac)	CN	Description
*	0.390	98	roof areas- bldg E, half building
*	0.750	98	drive/parking
	1.140	98	Weighted Average
	1.140	98	100.00% Impervious Area

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

Subcatchment 2S-A1: Site -WEST



Summary for Subcatchment 2S-A2: Site -WEST (roof areas & pond)

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

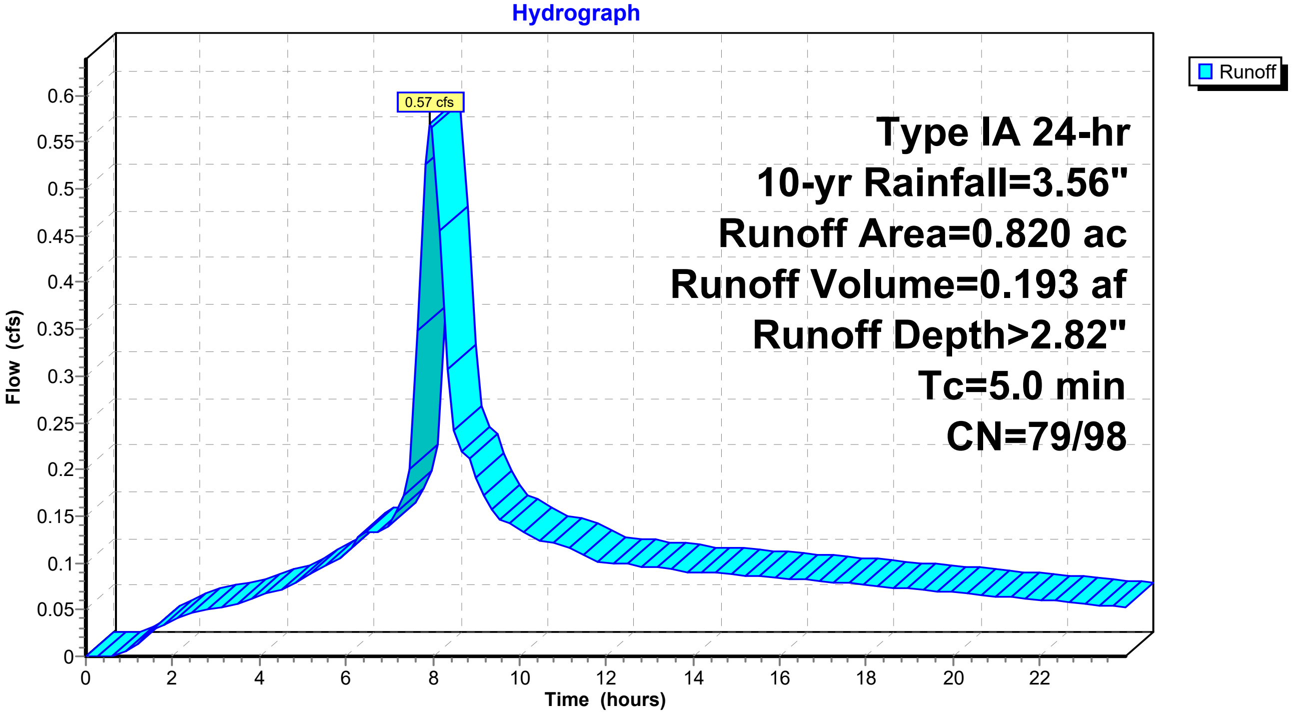
Runoff = 0.57 cfs @ 7.95 hrs, Volume= 0.193 af, Depth> 2.82"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-23.97 hrs, dt= 0.17 hrs
Type IA 24-hr 10-yr Rainfall=3.56"

	Area (ac)	CN	Description
*	0.450	98	roof areas
*	0.130	98	pond
	0.240	79	50-75% Grass cover, Fair, HSG C
	0.820	92	Weighted Average
	0.240	79	29.27% Pervious Area
	0.580	98	70.73% Impervious Area

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

Subcatchment 2S-A2: Site -WEST (roof areas & pond)



Summary for Subcatchment 2S-B1: Site - EAST

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

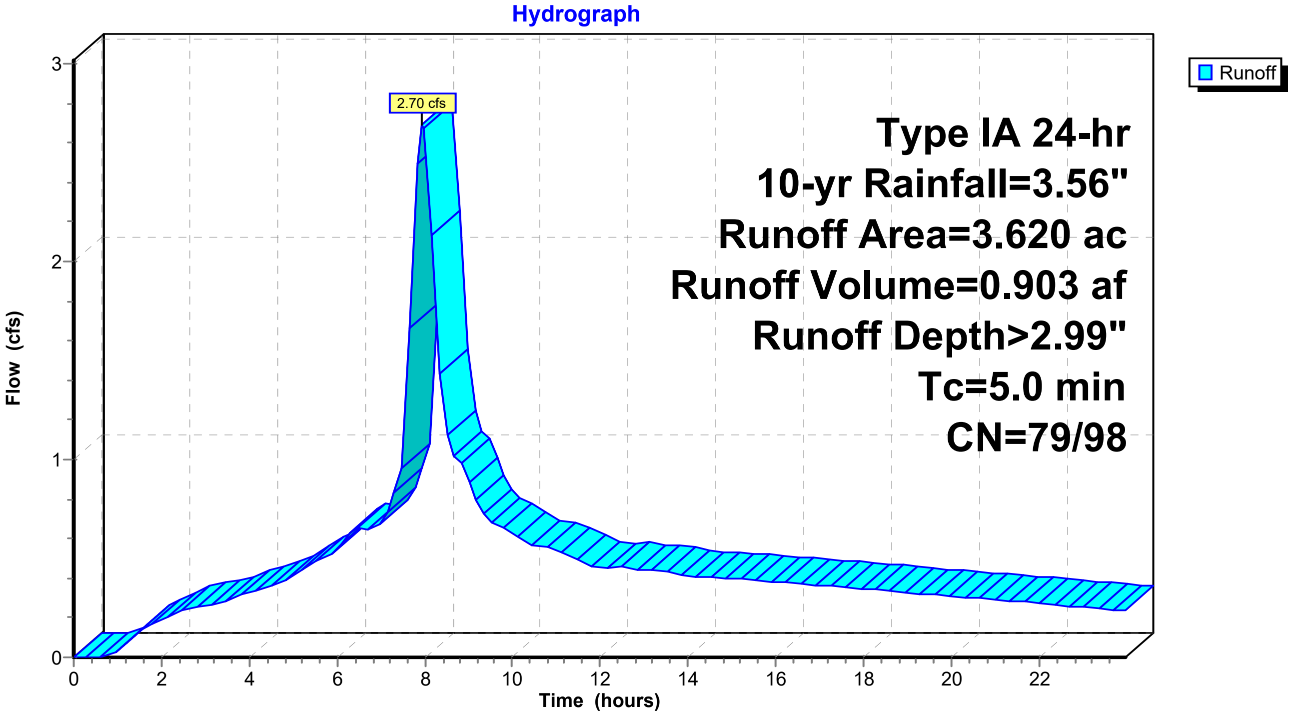
Runoff = 2.70 cfs @ 7.95 hrs, Volume= 0.903 af, Depth> 2.99"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-23.97 hrs, dt= 0.17 hrs
Type IA 24-hr 10-yr Rainfall=3.56"

	Area (ac)	CN	Description
*	0.870	98	roof areas
*	2.060	98	PARKING AND DRIVE AISLE
	0.690	79	50-75% Grass cover, Fair, HSG C
	3.620	94	Weighted Average
	0.690	79	19.06% Pervious Area
	2.930	98	80.94% Impervious Area

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

Subcatchment 2S-B1: Site - EAST



Summary for Subcatchment 2S-B2: POND

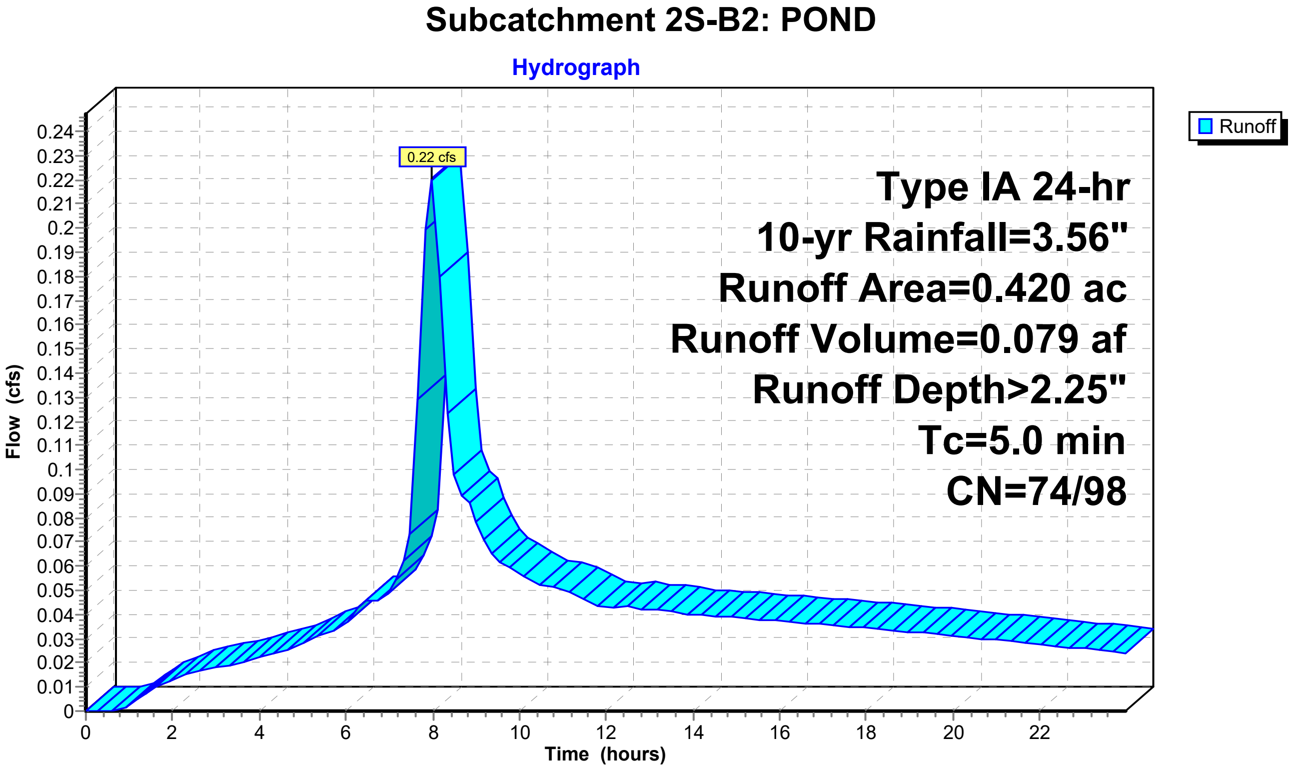
[49] Hint: Tc<2dt may require smaller dt

Runoff = 0.22 cfs @ 7.96 hrs, Volume= 0.079 af, Depth> 2.25"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-23.97 hrs, dt= 0.17 hrs
Type IA 24-hr 10-yr Rainfall=3.56"

	Area (ac)	CN	Description
*	0.200	98	POND AT Q100
	0.220	74	>75% Grass cover, Good, HSG C
	0.420	85	Weighted Average
	0.220	74	52.38% Pervious Area
	0.200	98	47.62% Impervious Area

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



Summary for Subcatchment 2S-C: OFFSITE ROAD

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

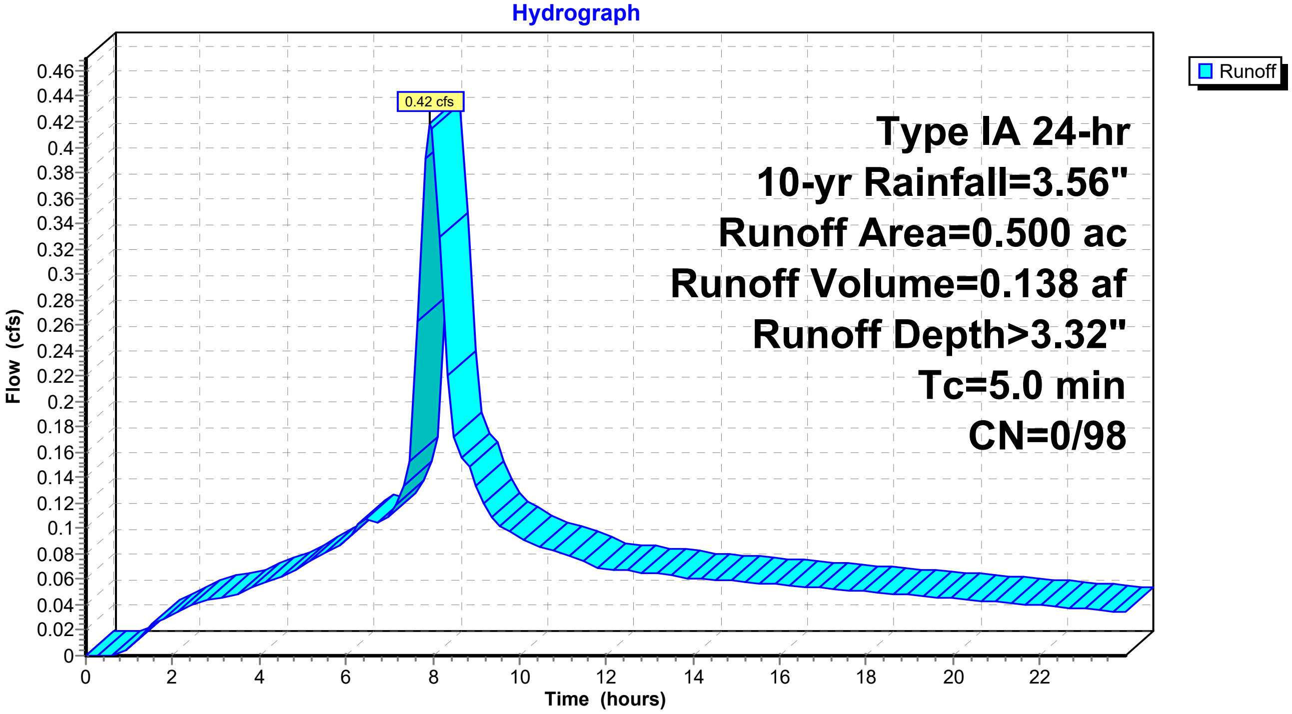
Runoff = 0.42 cfs @ 7.94 hrs, Volume= 0.138 af, Depth> 3.32"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-23.97 hrs, dt= 0.17 hrs
Type IA 24-hr 10-yr Rainfall=3.56"

	Area (ac)	CN	Description
*	0.500	98	GREEN MTN LOOP & RD
	0.500	98	100.00% Impervious Area

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

Subcatchment 2S-C: OFFSITE ROAD



Summary for Subcatchment 2X-A: Pre-DEV - [WEST]

BASIN 30S-A - 1S TO THE NORTH

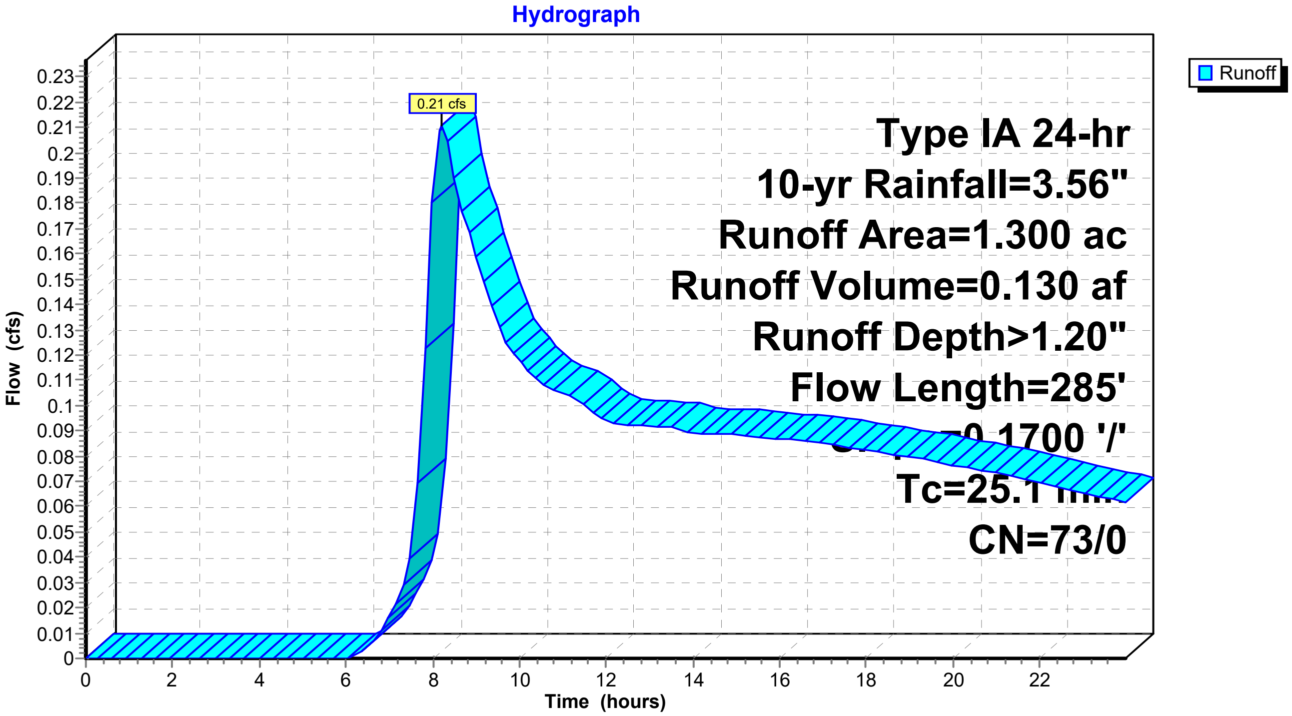
Runoff = 0.21 cfs @ 8.22 hrs, Volume= 0.130 af, Depth> 1.20"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-23.97 hrs, dt= 0.17 hrs
Type IA 24-hr 10-yr Rainfall=3.56"

Area (ac)	CN	Description
1.300	73	Woods, Fair, HSG C
1.300	73	100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
25.1	285	0.1700	0.19		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 2.26"

Subcatchment 2X-A: Pre-DEV - [WEST]



Summary for Subcatchment 2X-B: Pre- DEV [EAST]

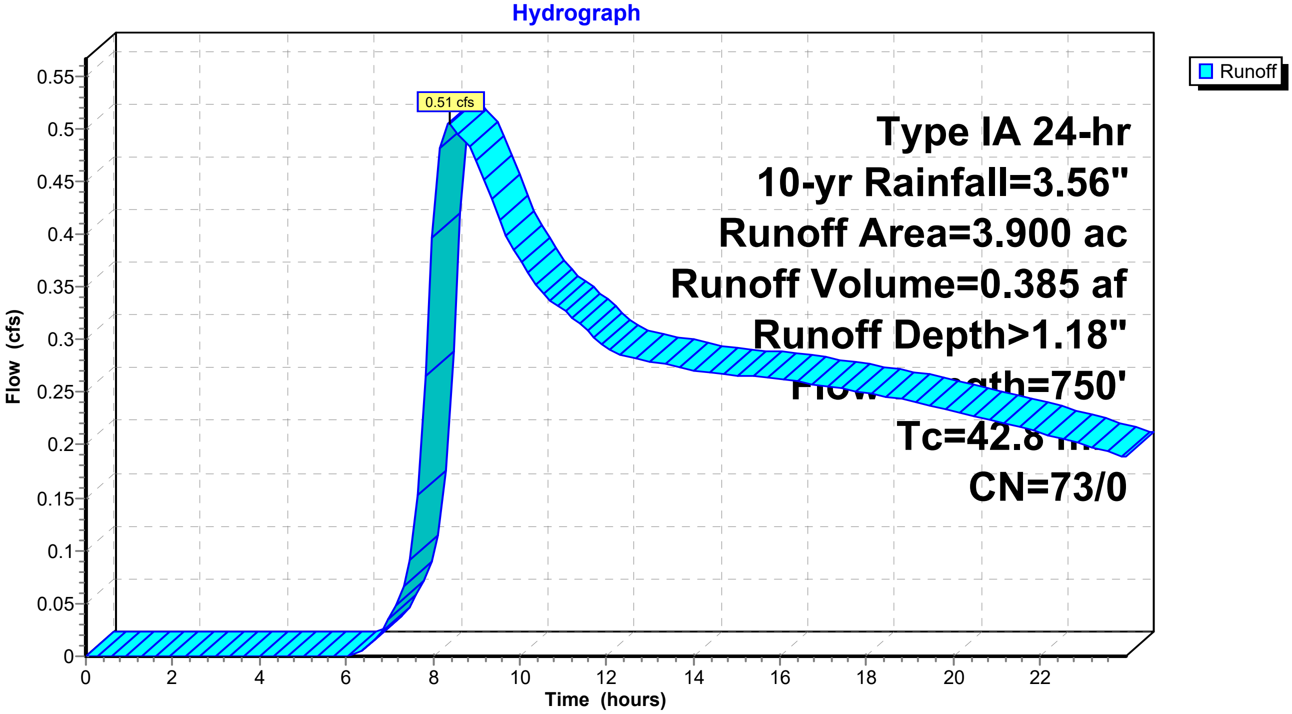
Runoff = 0.51 cfs @ 8.39 hrs, Volume= 0.385 af, Depth> 1.18"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-23.97 hrs, dt= 0.17 hrs
Type IA 24-hr 10-yr Rainfall=3.56"

Area (ac)	CN	Description
3.900	73	Woods, Fair, HSG C
3.900	73	100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
23.8	250	0.1500	0.18		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 2.26"
2.7	200	0.0600	1.22		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
16.3	300	0.0150	0.31		**Shallow Concentrated Flow,** Forest w/Heavy Litter Kv= 2.5 fps
42.8	750	Total			

Subcatchment 2X-B: Pre- DEV [EAST]



Summary for Subcatchment 2X-C: PRE- OFFSITE ROAD

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

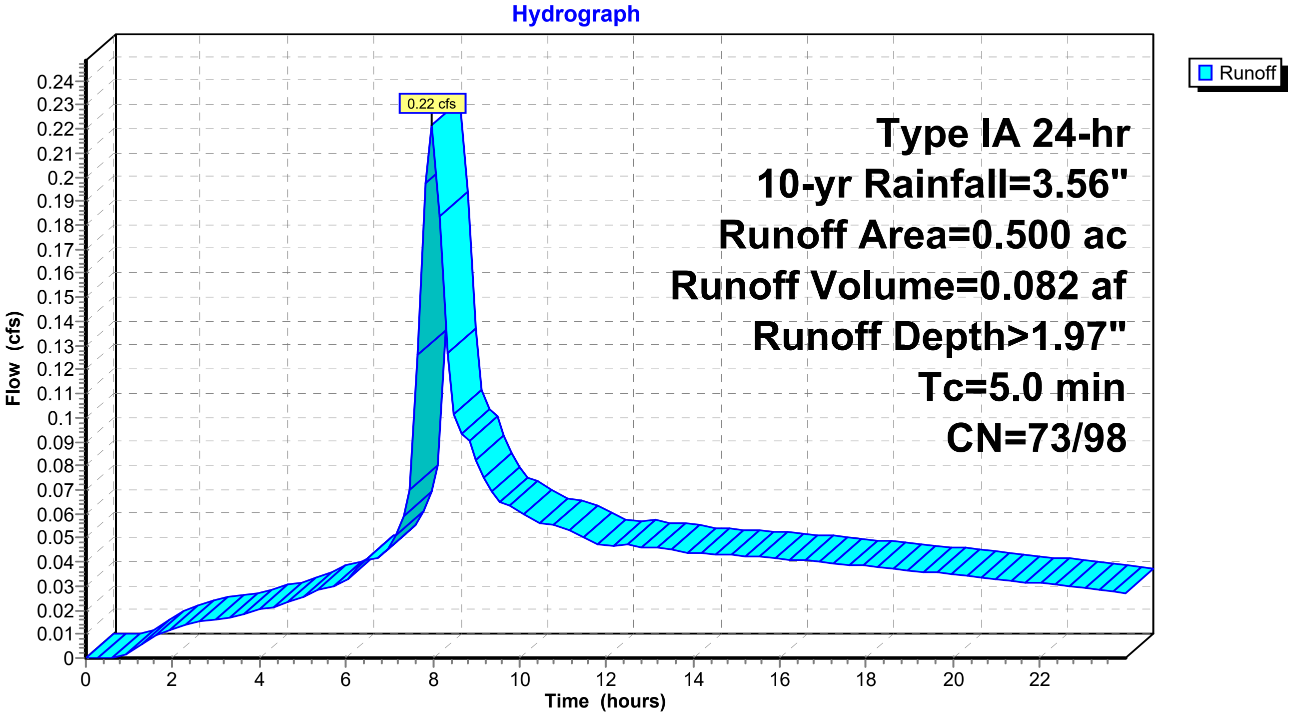
Runoff = 0.22 cfs @ 7.97 hrs, Volume= 0.082 af, Depth> 1.97"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-23.97 hrs, dt= 0.17 hrs
Type IA 24-hr 10-yr Rainfall=3.56"

	Area (ac)	CN	Description
	0.320	73	Woods, Fair, HSG C
*	0.180	98	GREEN MTN RD & LOOP
	0.500	82	Weighted Average
	0.320	73	64.00% Pervious Area
	0.180	98	36.00% Impervious Area

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

Subcatchment 2X-C: PRE- OFFSITE ROAD



Summary for Subcatchment 3S: Green Mtn Rd Connection

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

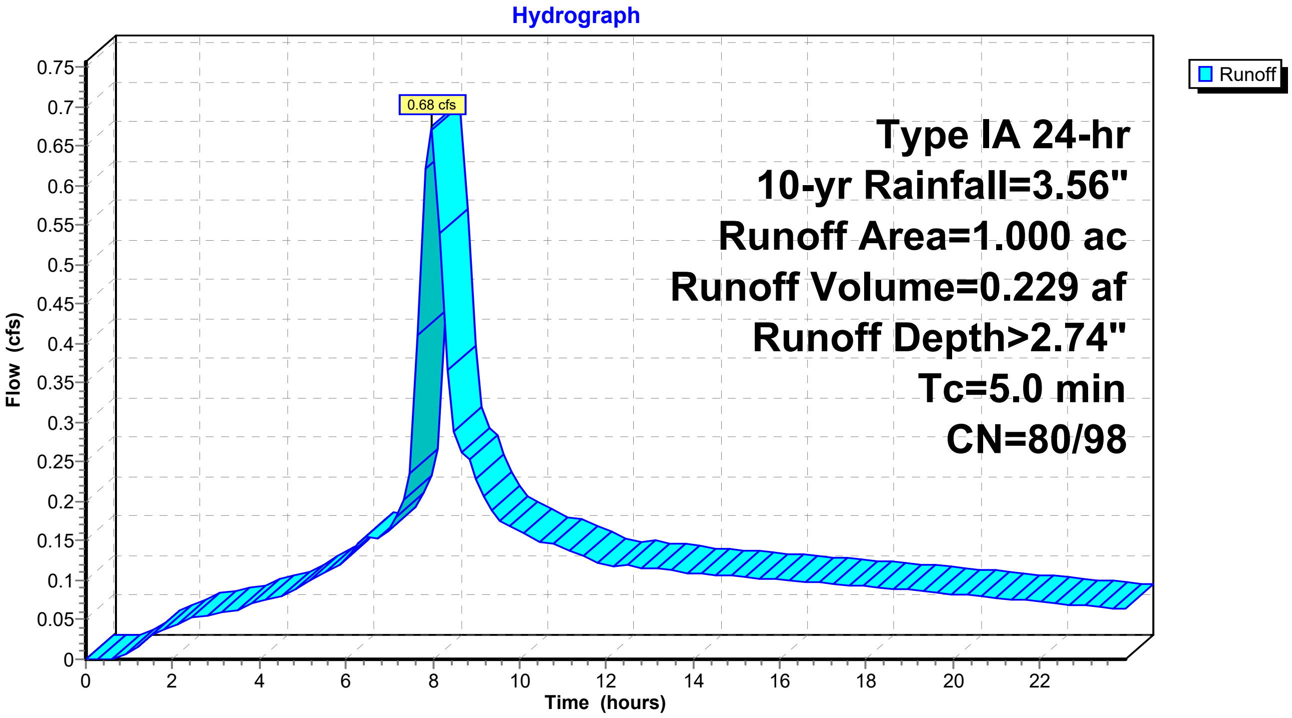
Runoff = 0.68 cfs @ 7.95 hrs, Volume= 0.229 af, Depth> 2.74"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-23.97 hrs, dt= 0.17 hrs
Type IA 24-hr 10-yr Rainfall=3.56"

	Area (ac)	CN	Description
*	0.500	98	BELMONT RD & PVT RD
	0.350	80	>75% Grass cover, Good, HSG D
*	0.150	98	POND
	1.000	92	Weighted Average
	0.350	80	35.00% Pervious Area
	0.650	98	65.00% Impervious Area

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

Subcatchment 3S: Green Mtn Rd Connection



Summary for Subcatchment 3X: PRE- GRN MTN CONN

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

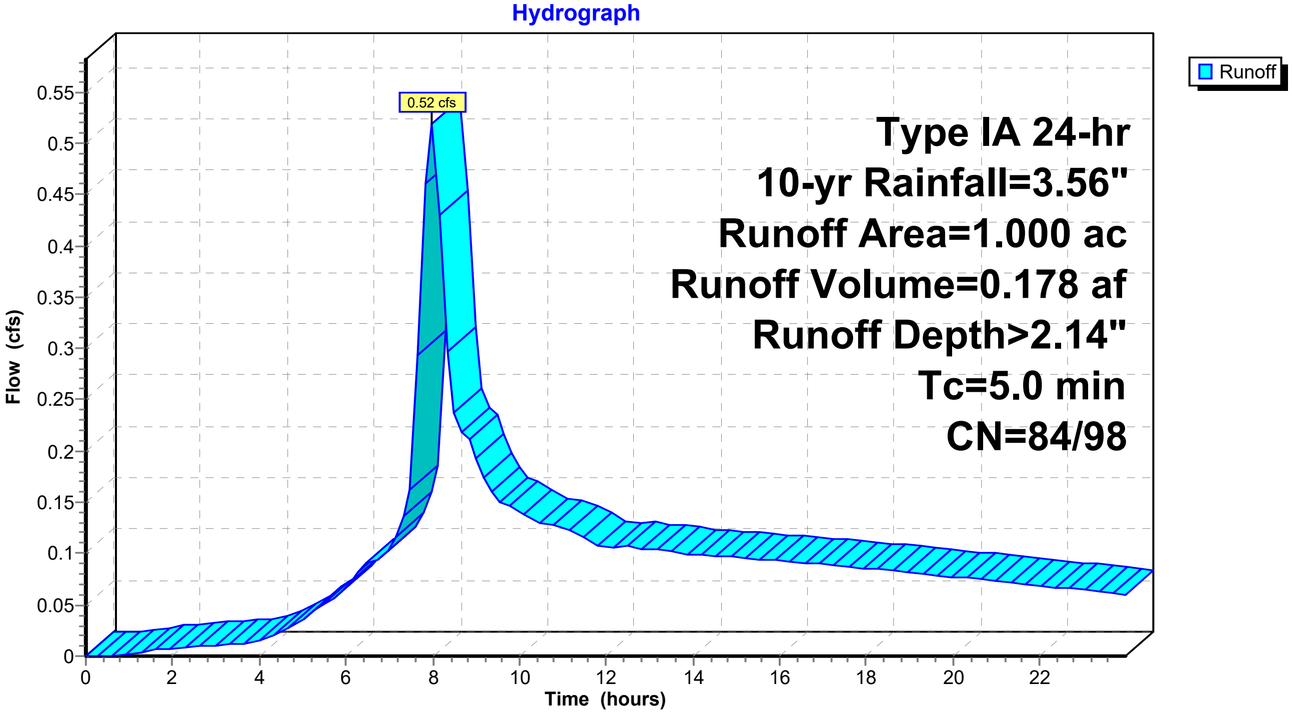
Runoff = 0.52 cfs @ 7.97 hrs, Volume= 0.178 af, Depth> 2.14"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-23.97 hrs, dt= 0.17 hrs
Type IA 24-hr 10-yr Rainfall=3.56"

	Area (ac)	CN	Description
	0.880	84	Pasture/grassland/range, Fair, HSG D
*	0.120	98	GREEN MTN RD
	1.000	86	Weighted Average
	0.880	84	88.00% Pervious Area
	0.120	98	12.00% Impervious Area

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

Subcatchment 3X: PRE- GRN MTN CONN



Summary for Subcatchment 4S-A: BELMONT RD

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

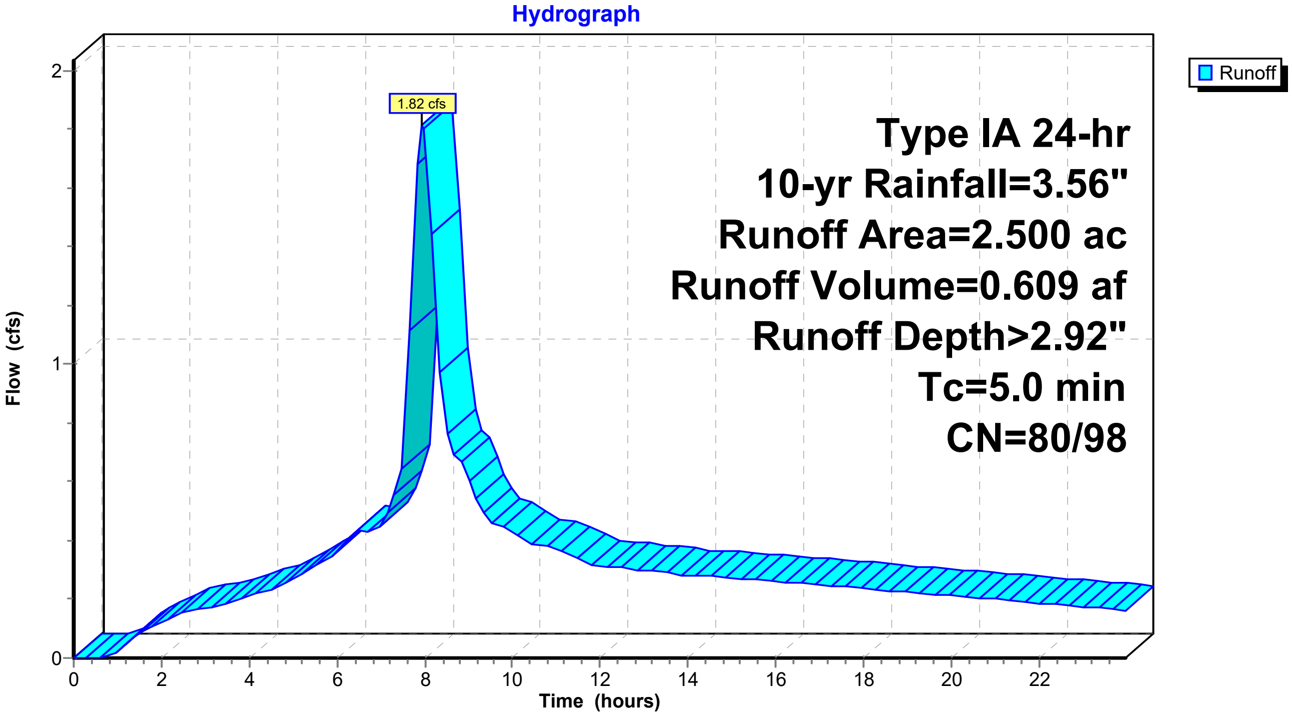
Runoff = 1.82 cfs @ 7.95 hrs, Volume= 0.609 af, Depth> 2.92"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-23.97 hrs, dt= 0.17 hrs
Type IA 24-hr 10-yr Rainfall=3.56"

	Area (ac)	CN	Description
*	1.900	98	BELMONT RD
	0.600	80	>75% Grass cover, Good, HSG D
	2.500	94	Weighted Average
	0.600	80	24.00% Pervious Area
	1.900	98	76.00% Impervious Area

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

Subcatchment 4S-A: BELMONT RD



Summary for Subcatchment 4S-B: SOUTH OF BELMONT

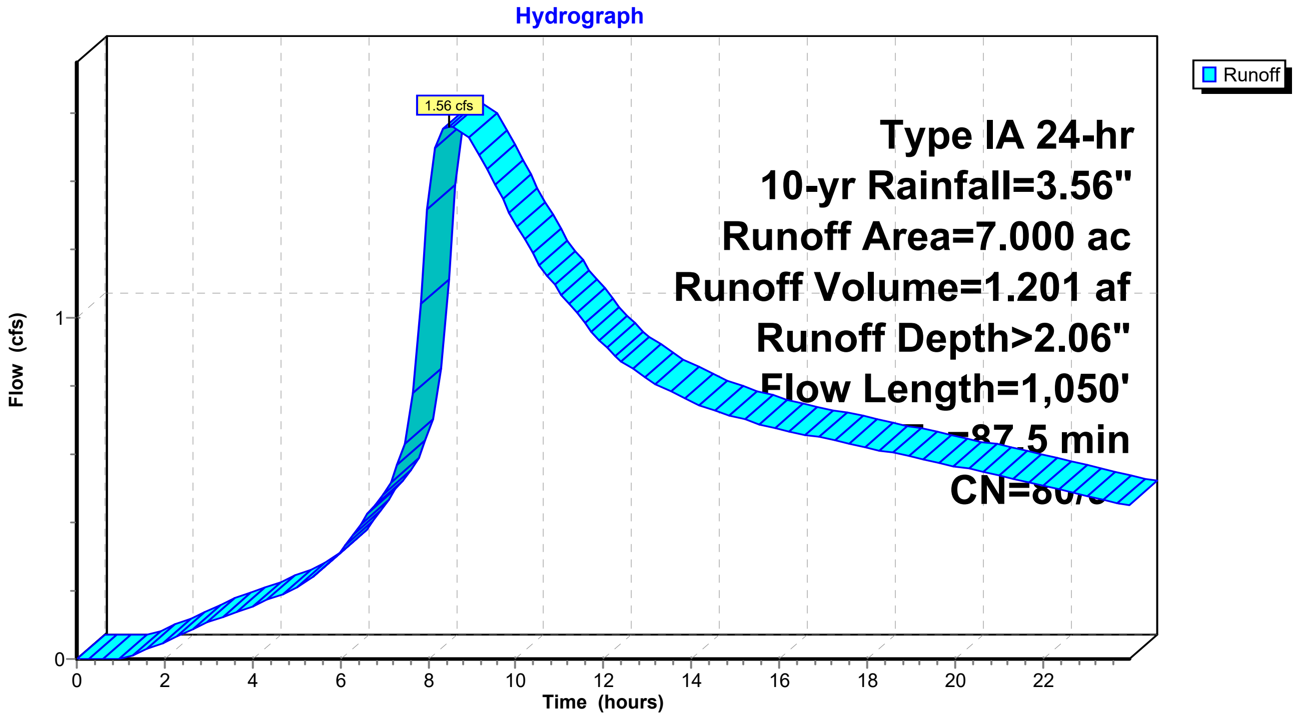
Runoff = 1.56 cfs @ 8.49 hrs, Volume= 1.201 af, Depth> 2.06"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-23.97 hrs, dt= 0.17 hrs
Type IA 24-hr 10-yr Rainfall=3.56"

	Area (ac)	CN	Description
	5.000	80	>75% Grass cover, Good, HSG D
*	2.000	98	ROCK STOCKPILE
	7.000	85	Weighted Average
	5.000	80	71.43% Pervious Area
	2.000	98	28.57% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
71.2	300	0.0050	0.07		**Sheet Flow,** Grass: Dense n= 0.240 P2= 2.26"
15.2	450	0.0050	0.49		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
1.1	300	0.0100	4.71	37.72	**Trap/Vee/Rect Channel Flow,** Bot.W=5.00' D=1.00' Z= 3.0 '/' Top.W=11.00' n= 0.025 Earth, clean & winding
87.5	1,050	Total			

Subcatchment 4S-B: SOUTH OF BELMONT



Summary for Subcatchment 4S-C: WET POND

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

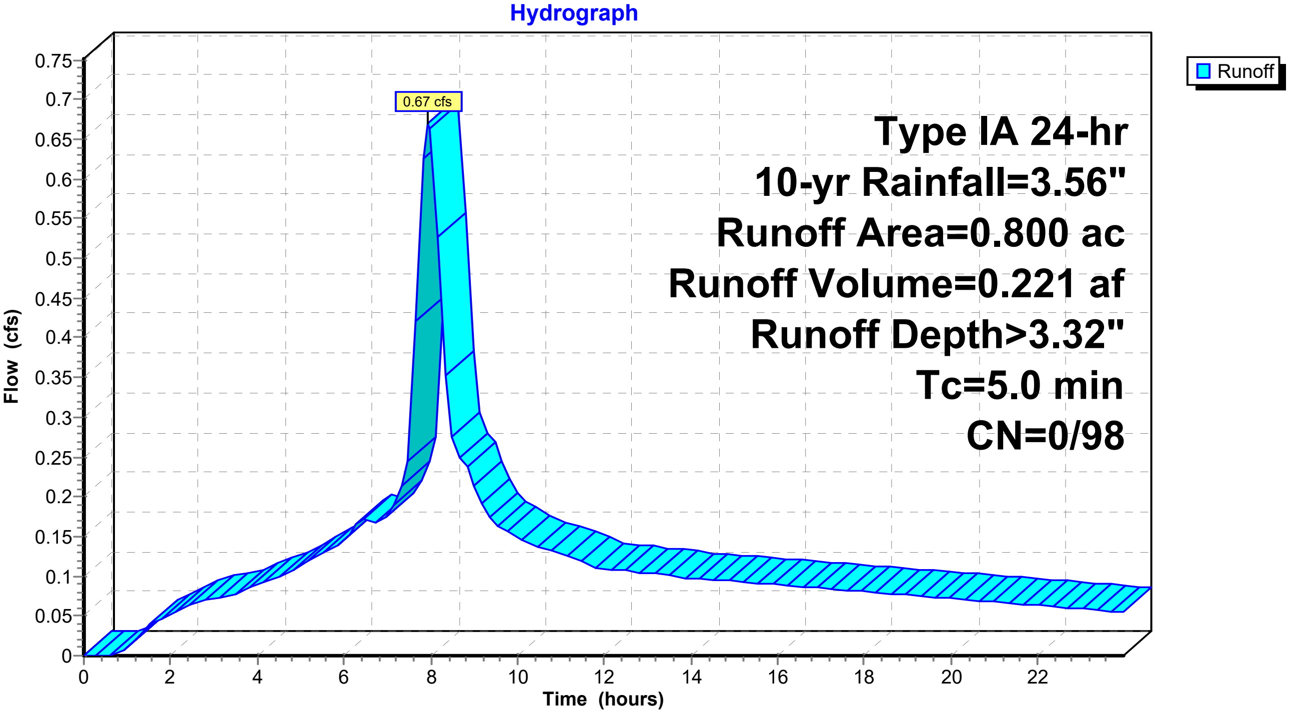
Runoff = 0.67 cfs @ 7.94 hrs, Volume= 0.221 af, Depth> 3.32"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-23.97 hrs, dt= 0.17 hrs
Type IA 24-hr 10-yr Rainfall=3.56"

	Area (ac)	CN	Description
*	0.800	98	POND
	0.800	98	100.00% Impervious Area

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

Subcatchment 4S-C: WET POND



Summary for Subcatchment 4X-A: PRE - BELMONT RD

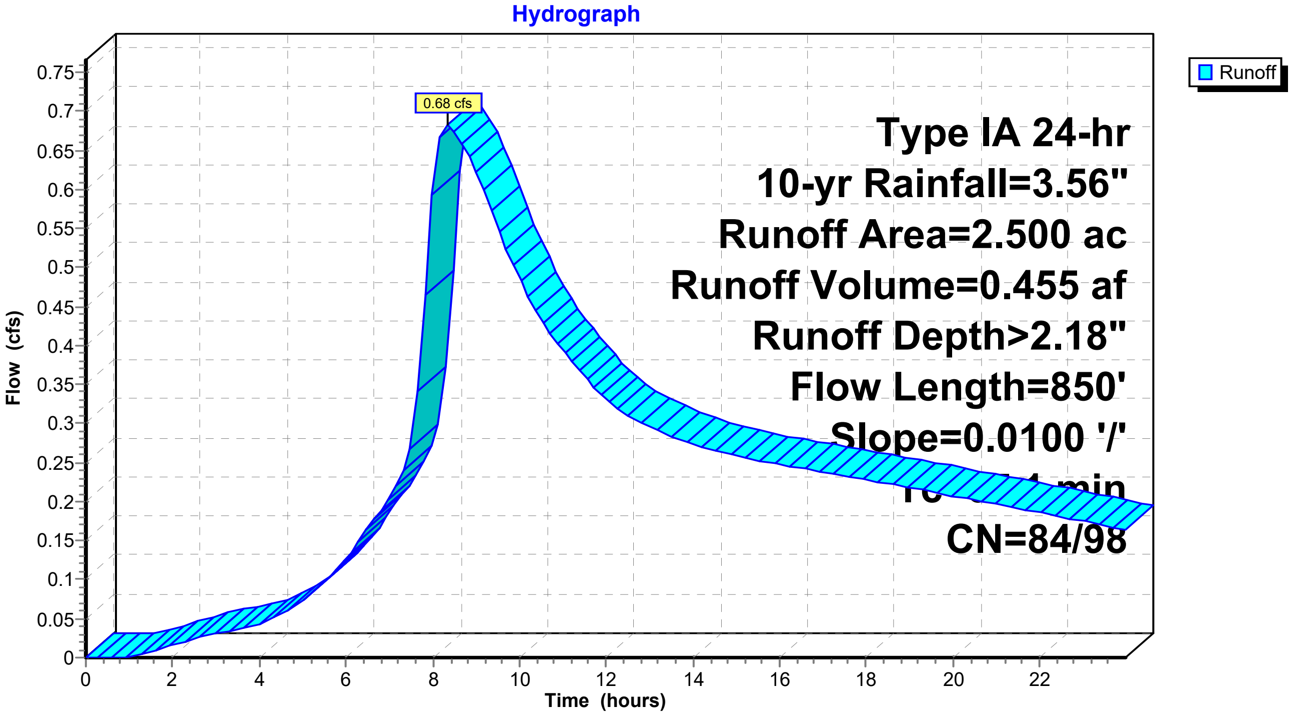
Runoff = 0.68 cfs @ 8.35 hrs, Volume= 0.455 af, Depth> 2.18"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-23.97 hrs, dt= 0.17 hrs
Type IA 24-hr 10-yr Rainfall=3.56"

	Area (ac)	CN	Description
	2.000	84	Pasture/grassland/range, Fair, HSG D
*	0.500	98	OPH & PARKING LOT
	2.500	87	Weighted Average
	2.000	84	80.00% Pervious Area
	0.500	98	20.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
54.0	300	0.0100	0.09		**Sheet Flow,** Grass: Dense n= 0.240 P2= 2.26"
13.1	550	0.0100	0.70		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
67.1	850	Total			

Subcatchment 4X-A: PRE - BELMONT RD



Summary for Subcatchment 4X-B: South of Belmont

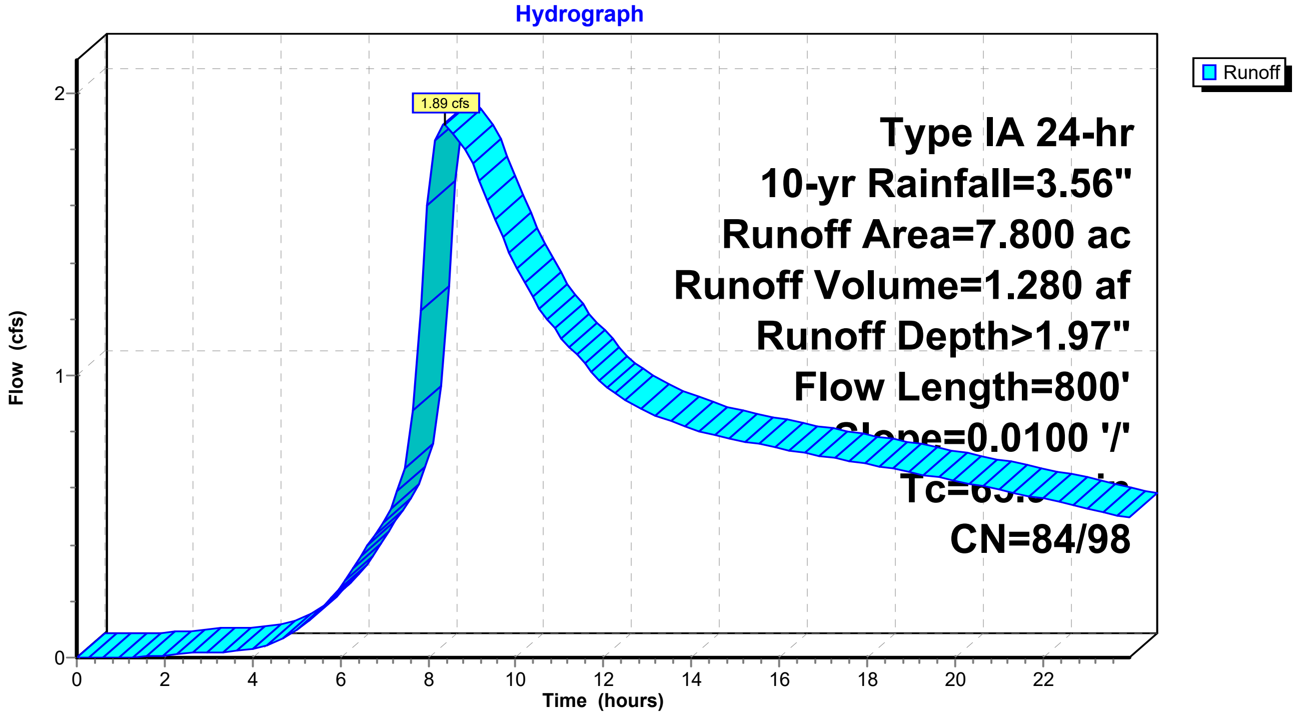
Runoff = 1.89 cfs @ 8.38 hrs, Volume= 1.280 af, Depth> 1.97"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-23.97 hrs, dt= 0.17 hrs
Type IA 24-hr 10-yr Rainfall=3.56"

	Area (ac)	CN	Description
	7.500	84	Pasture/grassland/range, Fair, HSG D
*	0.300	98	Existing gravel access road
	7.800	85	Weighted Average
	7.500	84	96.15% Pervious Area
	0.300	98	3.85% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
54.0	300	0.0100	0.09		**Sheet Flow,** Grass: Dense n= 0.240 P2= 2.26"
11.9	500	0.0100	0.70		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
65.9	800	Total			

Subcatchment 4X-B: South of Belmont



Summary for Subcatchment 5S: Commercial Site

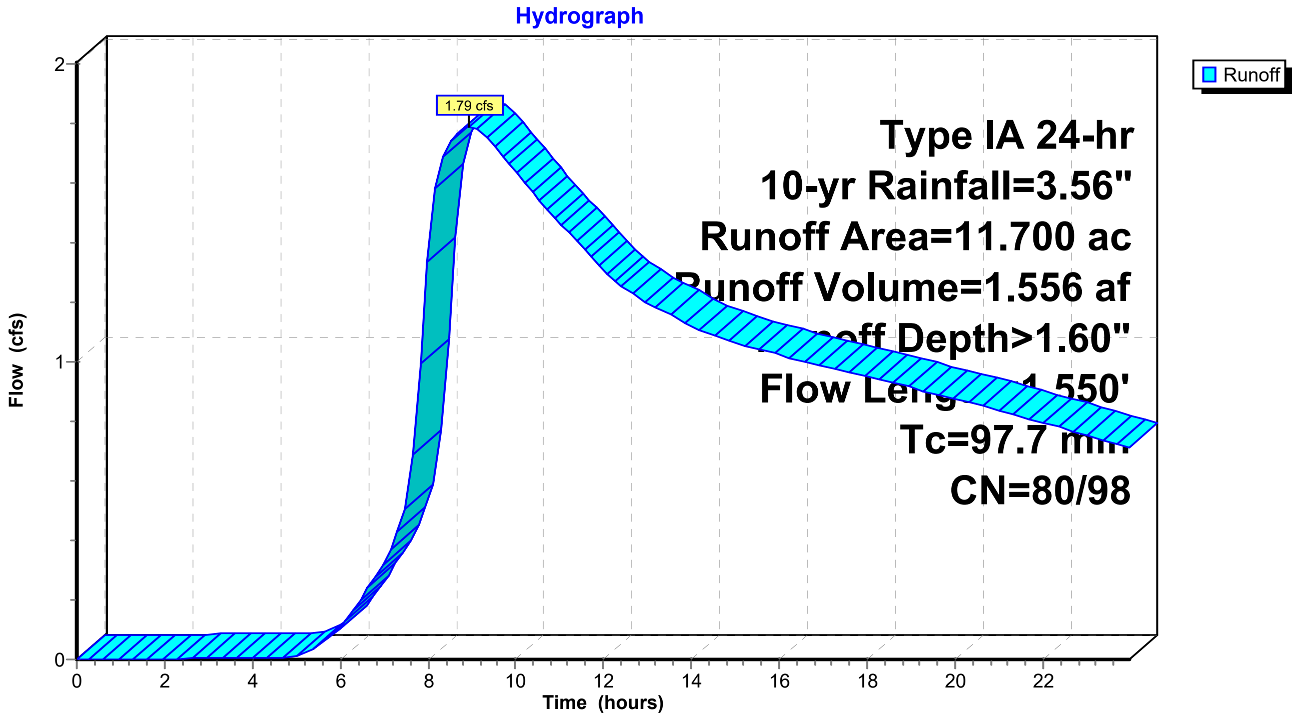
Runoff = 1.79 cfs @ 8.95 hrs, Volume= 1.556 af, Depth> 1.60"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-23.97 hrs, dt= 0.17 hrs
Type IA 24-hr 10-yr Rainfall=3.56"

	Area (ac)	CN	Description
	11.620	80	>75% Grass cover, Good, HSG D
*	0.080	98	Existing gravel
	11.700	80	Weighted Average
	11.620	80	99.32% Pervious Area
	0.080	98	0.68% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
71.2	300	0.0050	0.07		**Sheet Flow,** Grass: Dense n= 0.240 P2= 2.26"
1.6	100	0.0050	1.06		**Shallow Concentrated Flow,** Grassed Waterway Kv= 15.0 fps
24.9	1,150	0.0005	0.77	6.93	**Trap/Vee/Rect Channel Flow,** Bot.W=6.00' D=1.00' Z= 3.0 '/' Top.W=12.00' n= 0.035 High grass
97.7	1,550	Total			

Subcatchment 5S: Commercial Site



Summary for Subcatchment 5X: Commercial Site

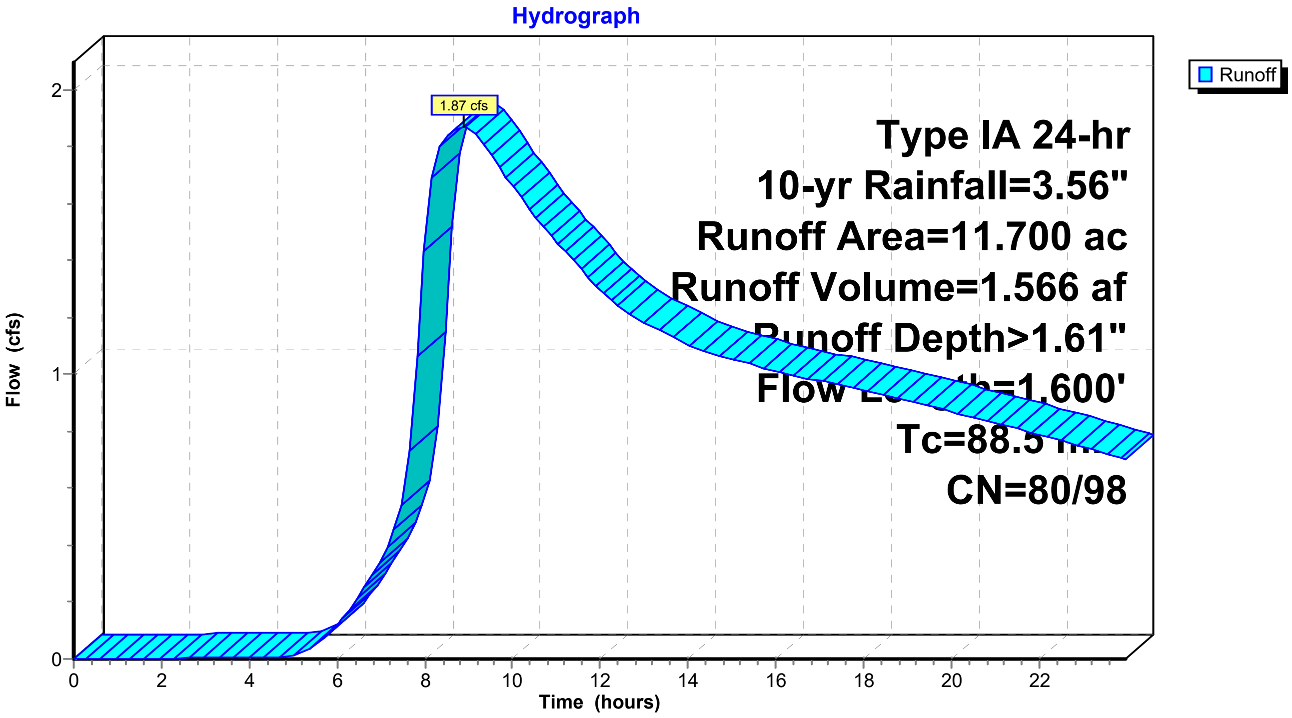
Runoff = 1.87 cfs @ 8.87 hrs, Volume= 1.566 af, Depth> 1.61"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-23.97 hrs, dt= 0.17 hrs
Type IA 24-hr 10-yr Rainfall=3.56"

	Area (ac)	CN	Description
	11.620	80	Pasture/grassland/range, Good, HSG D
*	0.080	98	existing gravel in south
	11.700	80	Weighted Average
	11.620	80	99.32% Pervious Area
	0.080	98	0.68% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
62.2	300	0.0070	0.08		**Sheet Flow,** Grass: Dense n= 0.240 P2= 2.26"
4.7	300	0.0050	1.06		**Shallow Concentrated Flow,** Grassed Waterway Kv= 15.0 fps
21.6	1,000	0.0005	0.77	6.93	**Trap/Vee/Rect Channel Flow,** Bot.W=6.00' D=1.00' Z= 3.0 '/' Top.W=12.00' n= 0.035 High grass
88.5	1,600	Total			

Subcatchment 5X: Commercial Site



Summary for Reach 7R: conveyance ditch

[81] Warning: Exceeded Pond 4P by 30.00' @ 0.00 hrs

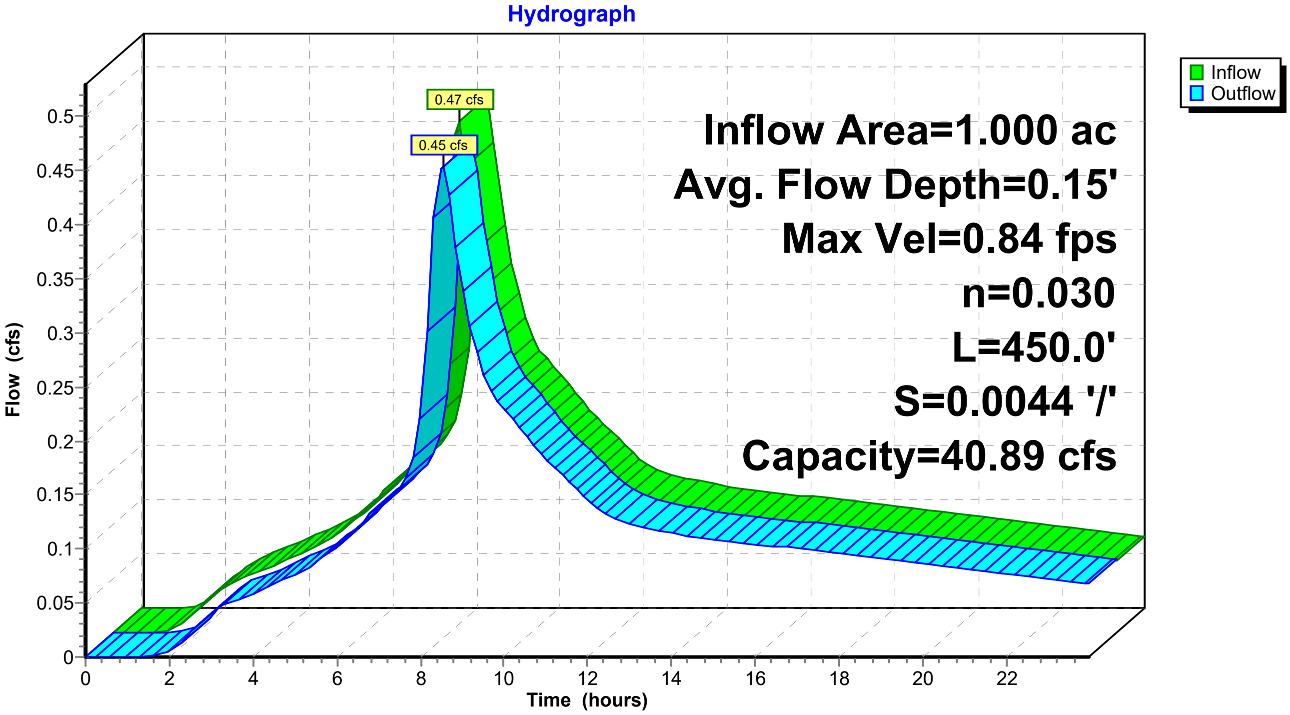
Inflow Area =	1.000 ac,	65.00% Impervious,	Inflow Depth >	2.70"	for 10-yr event
Inflow =	0.47 cfs @	8.24 hrs,	Volume=	0.225 af	
Outflow =	0.45 cfs @	8.53 hrs,	Volume=	0.223 af,	Atten= 4%, Lag= 17.3 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-23.97 hrs, dt= 0.17 hrs
Max. Velocity= 0.84 fps, Min. Travel Time= 8.9 min
Avg. Velocity = 0.50 fps, Avg. Travel Time= 15.1 min

Peak Storage= 245 cf @ 8.37 hrs
Average Depth at Peak Storage= 0.15'
Bank-Full Depth= 1.50' Flow Area= 13.5 sf, Capacity= 40.89 cfs

3.00' x 1.50' deep channel, n= 0.030 Earth, grassed & winding
Side Slope Z-value= 4.0 '/' Top Width= 15.00'
Length= 450.0' Slope= 0.0044 '/'
Inlet Invert= 30.00', Outlet Invert= 28.00'

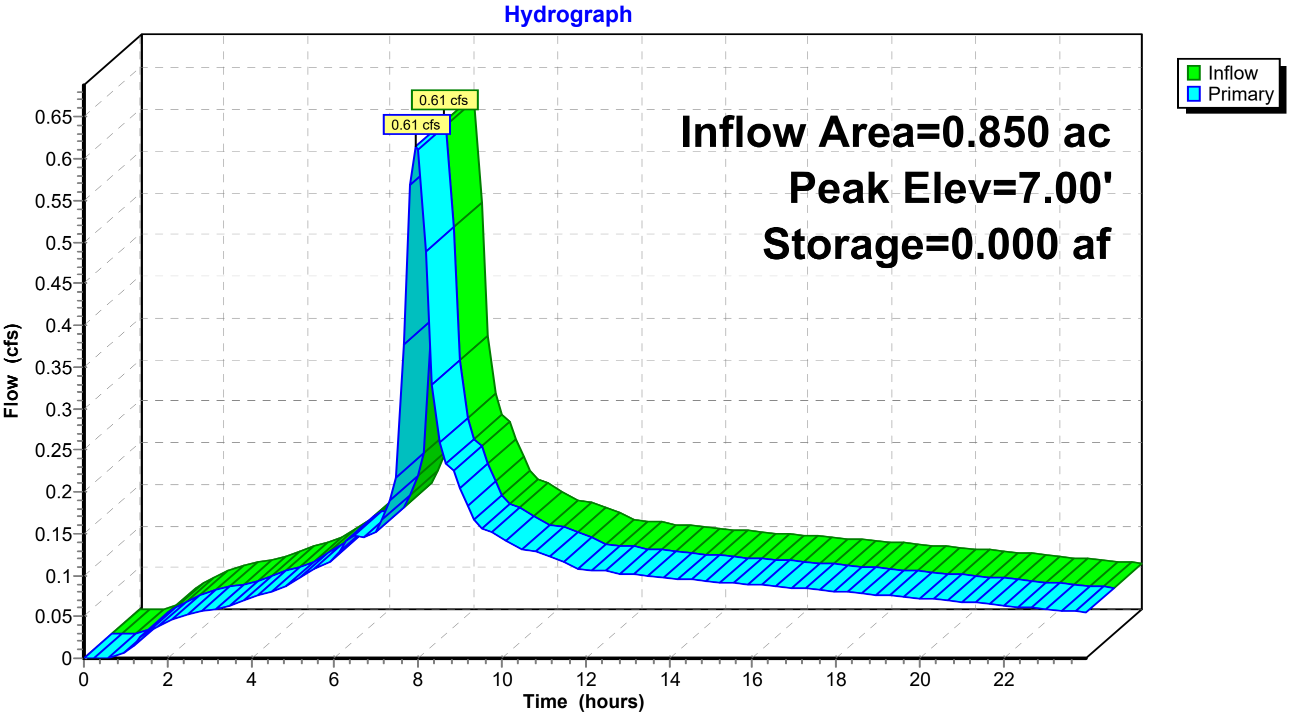
Reach 7R: conveyance ditch



Summary for Pond 1B: BIORET-1

```
Inflow Area =        0.850 ac, 76.47% Impervious, Inflow Depth >   2.92"   for  10-yr event
Inflow      =       0.61 cfs @   7.95 hrs, Volume=          0.207 af
Outflow     =       0.61 cfs @   7.95 hrs, Volume=          0.207 af,  Atten= 0%,  Lag= 0.0 min
Primary     =       0.61 cfs @   7.95 hrs, Volume=          0.207 af

Routing by Stor-Ind method, Time Span= 0.00-23.97 hrs, dt= 0.17 hrs
Peak Elev= 7.00' @ 7.95 hrs   Surf.Area= 0.010 ac   Storage= 0.000 af

Plug-Flow detention time= 0.0 min calculated for 0.207 af (100% of inflow)
Center-of-Mass det. time= 0.0 min ( 685.2 - 685.2 )

Volume       Invert   Avail.Storage   Storage Description
   #1         7.00'        0.016 af   5.00'W x 85.00'L x 1.00'H Prismatoid  Z=3.0

Device   Routing          Invert   Outlet Devices
   #1    Primary           7.00'   12.00 cfs Exfiltration X 0.25 at all elevations
   #2    Primary           7.50'   50.0' long  x 1.0' breadth Broad-Crested Rectangular Weir
                                   Head (feet)  0.20  0.40  0.60  0.80  1.00  1.20  1.40  1.60  1.80  2.00
                                   2.50  3.00
                                   Coef. (English)  2.69  2.72  2.75  2.85  2.98  3.08  3.20  3.28  3.31
                                   3.30  3.31  3.32

Primary OutFlow  Max=3.00 cfs @ 7.95 hrs  HW=7.00'   (Free Discharge)
├─1=Exfiltration  (Exfiltration Controls 3.00 cfs)
└─2=Broad-Crested Rectangular Weir( Controls 0.00 cfs)
```

Pond 1B: BIORET-1



Summary for Pond 1P: NW CORNER

Inflow Area = 0.900 ac, 77.78% Impervious, Inflow Depth > 2.94" for 10-yr event
Inflow = 0.66 cfs @ 7.95 hrs, Volume= 0.220 af
Outflow = 0.24 cfs @ 8.87 hrs, Volume= 0.158 af, Atten= 64%, Lag= 55.6 min
Primary = 0.24 cfs @ 8.87 hrs, Volume= 0.158 af

Routing by Stor-Ind method, Time Span= 0.00-23.97 hrs, dt= 0.17 hrs
Peak Elev= 2.94' @ 8.87 hrs Surf.Area= 0.038 ac Storage= 0.068 af

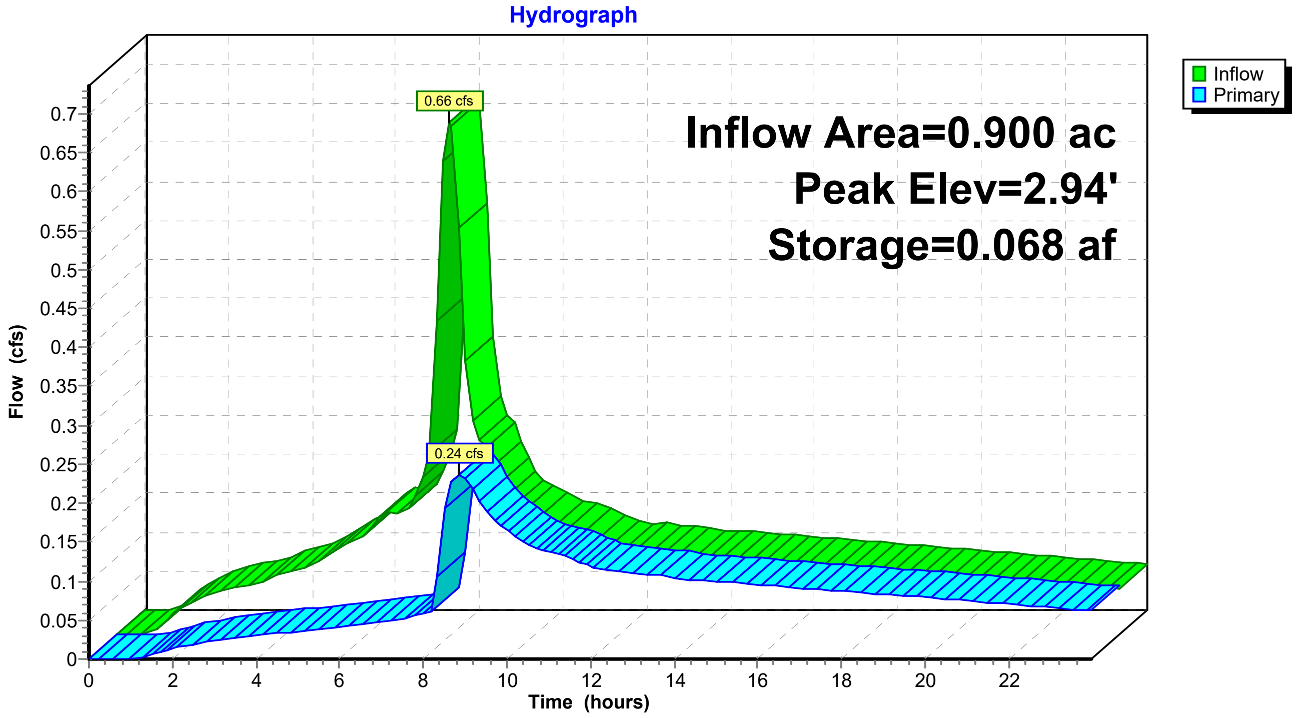
Plug-Flow detention time= 306.2 min calculated for 0.158 af (72% of inflow)
Center-of-Mass det. time= 128.8 min (812.8 - 684.0)

Volume	Invert	Avail.Storage	Storage Description
#1	0.00'	0.141 af	**9.00'W x 50.00'L x 4.50'H Prismatoid Z=2.7**

Device	Routing	Invert	Outlet Devices
#1	Primary	0.00'	**1.2" Vert. Orifice** C= 0.600
#2	Primary	3.50'	**24.0" Horiz. riser** C= 0.600 Limited to weir flow at low heads
#3	Primary	2.80'	**12.0" W x 8.4" H Vert. notch** C= 0.600

Primary OutFlow Max=0.23 cfs @ 8.87 hrs HW=2.94' (Free Discharge)
1=Orifice (Orifice Controls 0.06 cfs @ 8.19 fps)
2=riser (Controls 0.00 cfs)
3=notch (Orifice Controls 0.17 cfs @ 1.20 fps)

Pond 1P: NW CORNER



Summary for Pond 2A: BIORET-2A

Inflow Area = 1.140 ac,100.00% Impervious, Inflow Depth > 3.32" for 10-yr event
Inflow = 0.96 cfs @ 7.94 hrs, Volume= 0.315 af
Outflow = 0.96 cfs @ 7.94 hrs, Volume= 0.315 af, Atten= 0%, Lag= 0.0 min
Primary = 0.96 cfs @ 7.94 hrs, Volume= 0.315 af

Routing by Stor-Ind method, Time Span= 0.00-23.97 hrs, dt= 0.17 hrs
Peak Elev= 5.00' @ 7.94 hrs Surf.Area= 0.016 ac Storage= 0.000 af

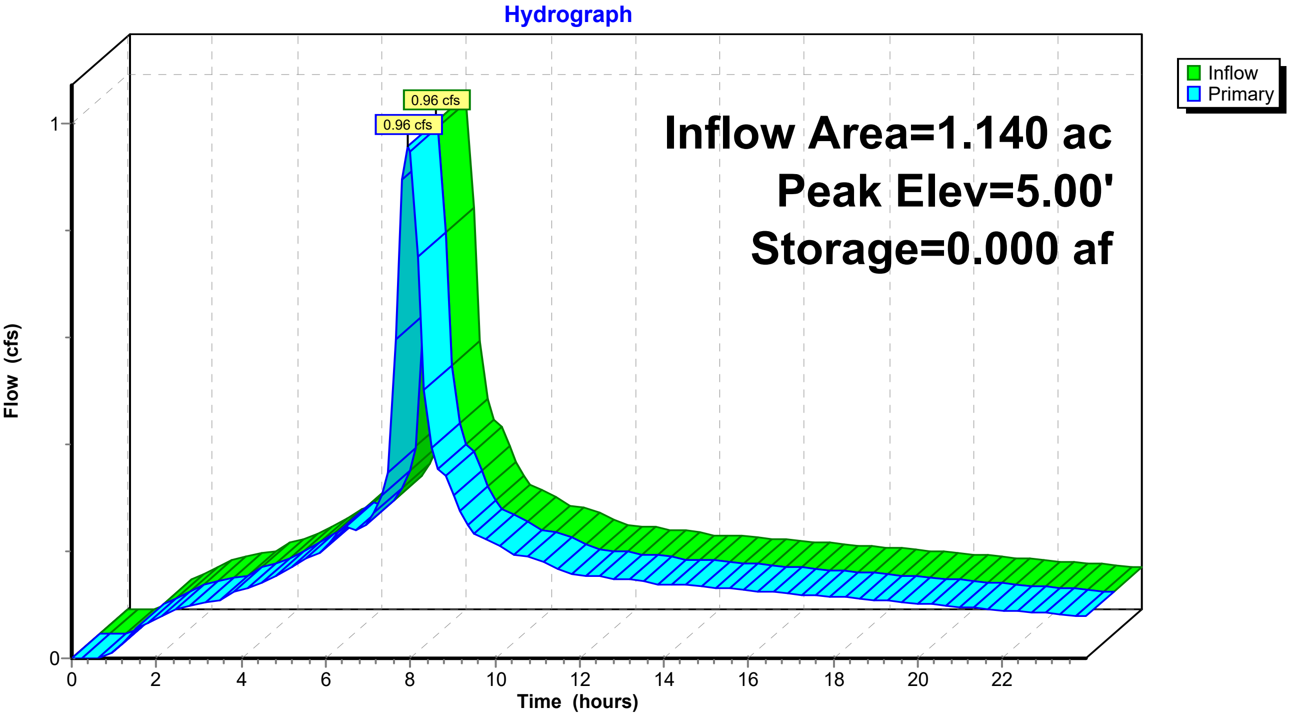
Plug-Flow detention time= 0.0 min calculated for 0.313 af (99% of inflow)
Center-of-Mass det. time= 0.0 min (665.4 - 665.4)

Volume	Invert	Avail.Storage	Storage Description
#1	5.00'	0.022 af	**10.00'W x 70.00'L x 1.00'H Prismatoid Z=3.0**

Device	Routing	Invert	Outlet Devices
#1	Primary	5.00'	**12.00 cfs Exfiltration X 0.25 at all elevations**
#2	Primary	5.50'	**50.0' long x 1.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 Coef. (English) 2.69 2.72 2.75 2.85 2.98 3.08 3.20 3.28 3.31 3.30 3.31 3.32

Primary OutFlow Max=3.00 cfs @ 7.94 hrs HW=5.00' (Free Discharge)
↑—**1=Exfiltration** (Exfiltration Controls 3.00 cfs)
└—**2=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond 2A: BIORET-2A



Summary for Pond 2B: BIORET-2B

```
Inflow Area =      4.120 ac, 83.25% Impervious, Inflow Depth >   3.03"    for  10-yr event
Inflow      =      3.12 cfs @    7.95 hrs,  Volume=          1.041 af
Outflow     =      3.12 cfs @    7.95 hrs,  Volume=          1.041 af,  Atten= 0%,  Lag= 0.0 min
Primary     =      3.12 cfs @    7.95 hrs,  Volume=          1.041 af
```

Routing by Stor-Ind method, Time Span= 0.00-23.97 hrs, dt= 0.17 hrs
Peak Elev= 6.00' @ 7.95 hrs Surf.Area= 0.046 ac Storage= 0.000 af

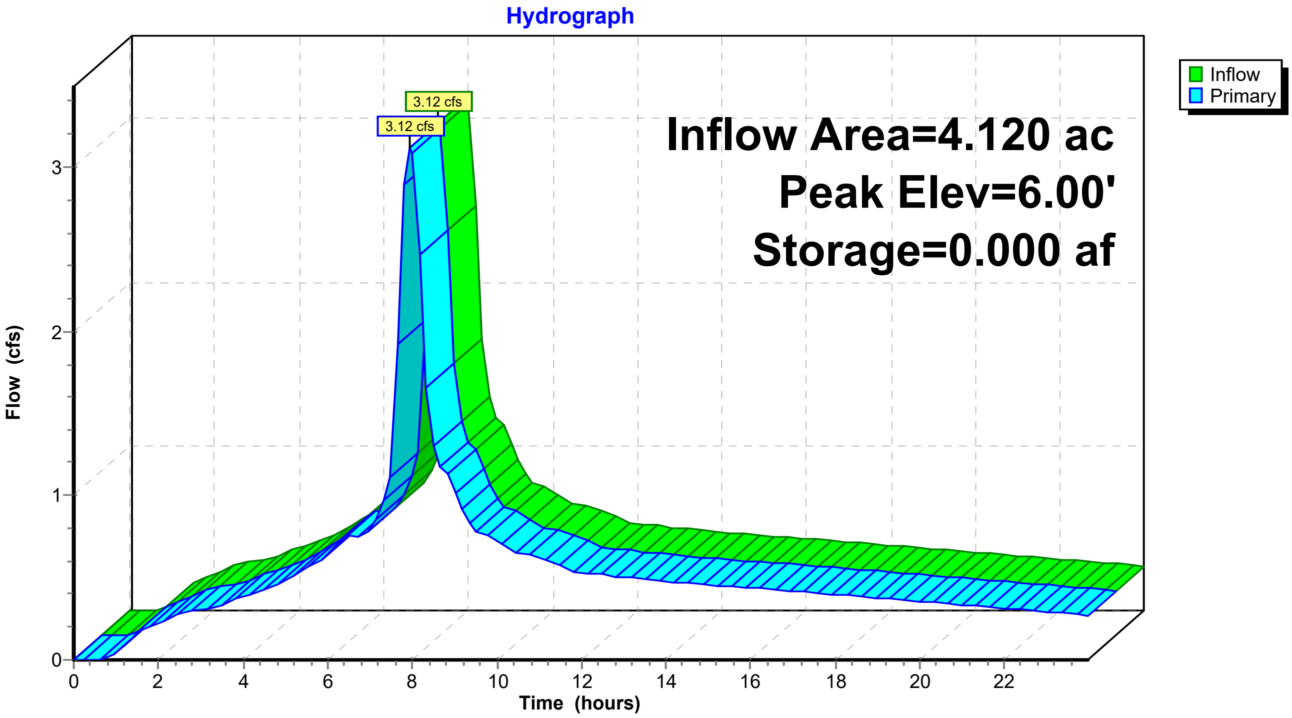
Plug-Flow detention time= 0.0 min calculated for 1.034 af (99% of inflow)
Center-of-Mass det. time= 0.0 min (679.0 - 679.0)

Volume	Invert	Avail.Storage	Storage Description
#1	6.00'	0.086 af	**25.00'W x 80.00'L x 1.50'H Prismatoid Z=3.0**

Device	Routing	Invert	Outlet Devices
#1	Primary	6.00'	**12.00 cfs Exfiltration X 0.25 at all elevations**
#2	Primary	1.00'	**24.0" Horiz. riser** C= 0.600 Limited to weir flow at low heads

Primary OutFlow Max=36.83 cfs @ 7.95 hrs HW=6.00' (Free Discharge)
├─**1=Exfiltration** (Exfiltration Controls 3.00 cfs)
└─**2=riser** (Orifice Controls 33.83 cfs @ 10.77 fps)

Pond 2B: BIORET-2B



Summary for Pond 2P: West Pond

Inflow Area = 1.960 ac, 87.76% Impervious, Inflow Depth > 3.11" for 10-yr event
Inflow = 1.53 cfs @ 7.94 hrs, Volume= 0.508 af
Outflow = 0.17 cfs @ 19.66 hrs, Volume= 0.135 af, Atten= 89%, Lag= 703.0 min
Primary = 0.17 cfs @ 19.66 hrs, Volume= 0.135 af

Routing by Stor-Ind method, Time Span= 0.00-23.97 hrs, dt= 0.17 hrs
Peak Elev= 4.64' @ 19.66 hrs Surf.Area= 0.125 ac Storage= 0.376 af

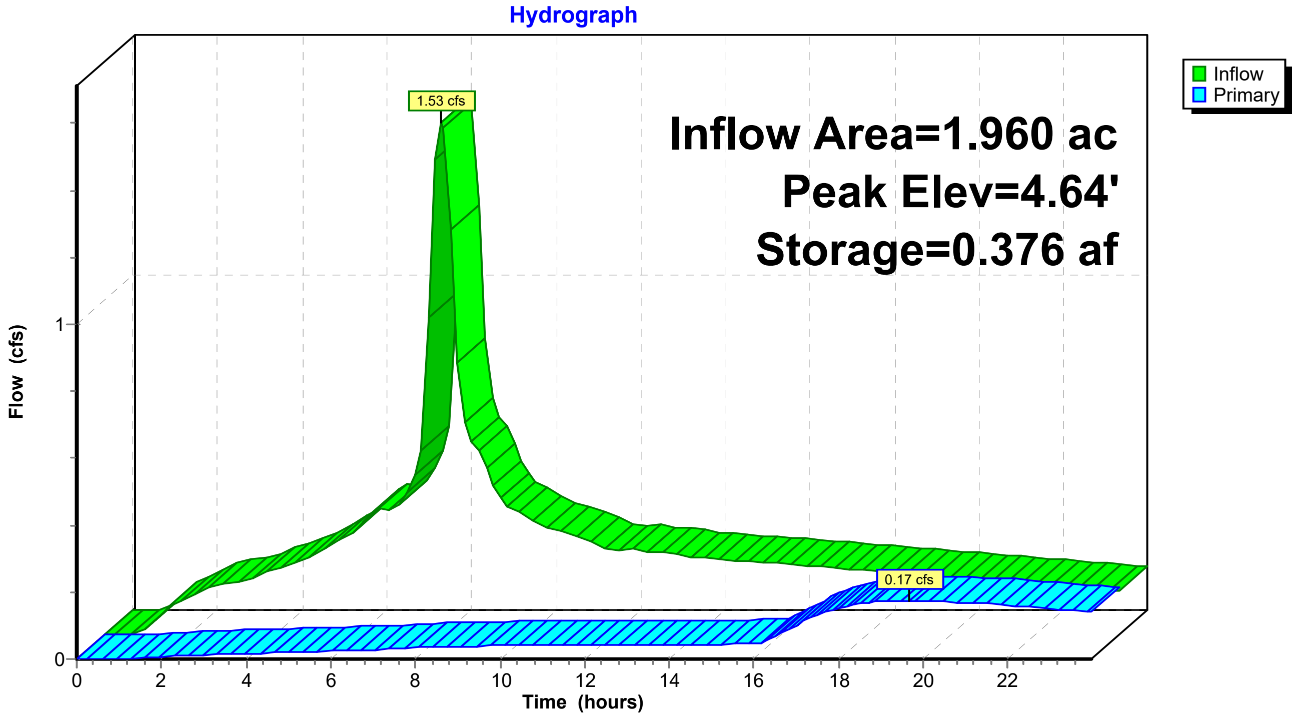
Plug-Flow detention time= 725.7 min calculated for 0.134 af (26% of inflow)
Center-of-Mass det. time= 377.9 min (1,053.0 - 675.1)

Volume	Invert	Avail.Storage	Storage Description
#1	0.00'	0.566 af	**25.00'W x 75.00'L x 6.00'H Prismatoid Z=3.0**

Device	Routing	Invert	Outlet Devices
#1	Primary	0.00'	**0.9" Vert. Orifice/Grate** C= 0.600
#2	Primary	4.50'	**9.0" W x 6.0" H Vert. notch** C= 0.600
#3	Primary	5.00'	**24.0" Horiz. riser** C= 0.600 Limited to weir flow at low heads

Primary OutFlow Max=0.17 cfs @ 19.66 hrs HW=4.64' (Free Discharge)
—**1=Orifice/Grate** (Orifice Controls 0.05 cfs @ 10.33 fps)
—**2=notch** (Orifice Controls 0.13 cfs @ 1.20 fps)
—**3=riser** (Controls 0.00 cfs)

Pond 2P: West Pond



Summary for Pond 3P: East Pond

[79] Warning: Submerged Pond 2B Primary device # 2 by 3.07'

```
Inflow Area =        4.540 ac, 79.96% Impervious, Inflow Depth >  2.96"   for 10-yr event
Inflow      =        3.34 cfs @   7.95 hrs, Volume=          1.120 af
Outflow     =        0.58 cfs @  11.79 hrs, Volume=          0.669 af, Atten= 83%, Lag= 230.6 min
Primary     =        0.58 cfs @  11.79 hrs, Volume=          0.669 af
```

Routing by Stor-Ind method, Time Span= 0.00-23.97 hrs, dt= 0.17 hrs
Peak Elev= 4.07' @ 11.79 hrs Surf.Area= 7,203 sf Storage= 21,596 cf

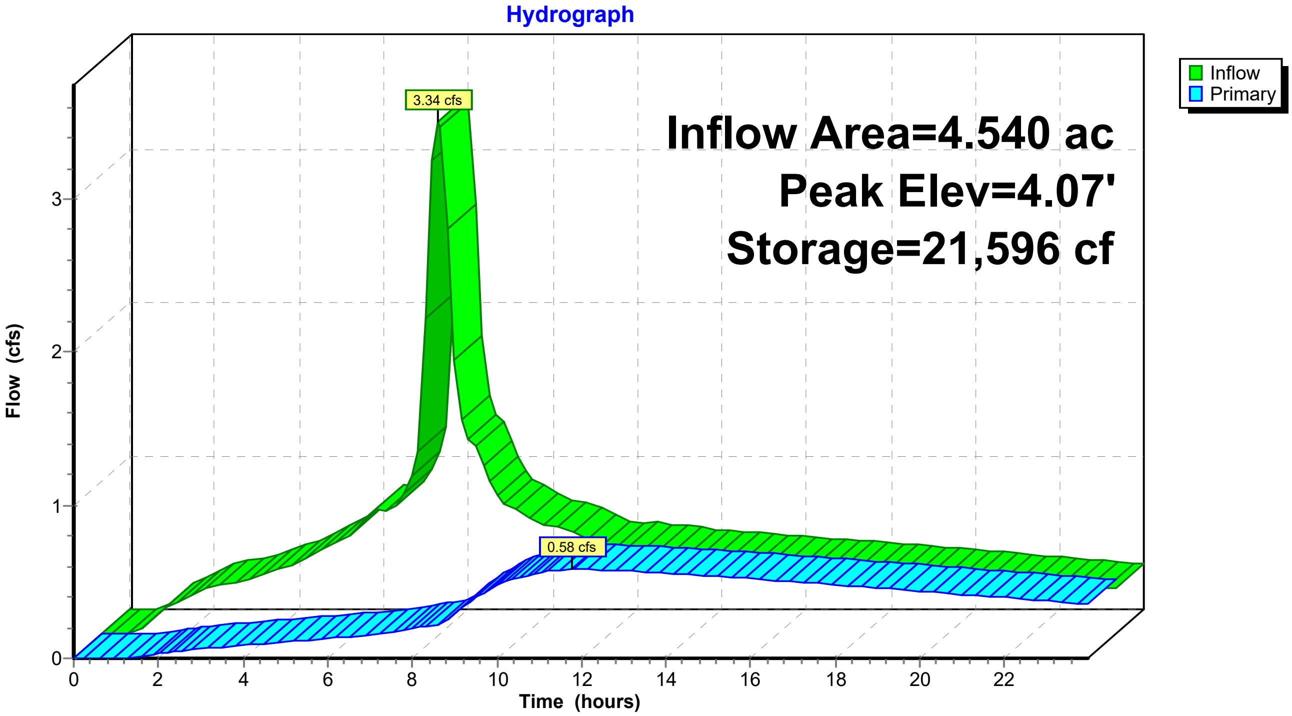
Plug-Flow detention time= 451.4 min calculated for 0.664 af (59% of inflow)
Center-of-Mass det. time= 221.1 min (903.0 - 681.9)

Volume	Invert	Avail.Storage	Storage Description
#1	0.00'	42,286 cf	**48.00'W x 75.00'L x 6.50'H Prismatoid Z=3.0**

Device	Routing	Invert	Outlet Devices
#1	Primary	0.00'	**2.1" Vert. Orifice** C= 0.600
#2	Primary	3.50'	**3.0" W x 24.0" H Vert. notch** C= 0.600
#3	Primary	5.50'	**24.0" Horiz. riser** C= 0.600 Limited to weir flow at low heads

Primary OutFlow Max=0.58 cfs @ 11.79 hrs HW=4.07' (Free Discharge)
├─**1=Orifice** (Orifice Controls 0.23 cfs @ 9.61 fps)
├─**2=notch** (Orifice Controls 0.35 cfs @ 2.43 fps)
└─**3=riser** (Controls 0.00 cfs)

Pond 3P: East Pond



Summary for Pond 4P: Wet Pond- Live Storage

```
Inflow Area =      1.000 ac, 65.00% Impervious, Inflow Depth >  2.74"   for 10-yr event
Inflow     =      0.68 cfs @   7.95 hrs, Volume=        0.229 af
Outflow    =      0.47 cfs @   8.24 hrs, Volume=        0.225 af, Atten= 30%, Lag= 17.2 min
Primary    =      0.47 cfs @   8.24 hrs, Volume=        0.225 af

Routing by Stor-Ind method, Time Span= 0.00-23.97 hrs, dt= 0.17 hrs
Peak Elev= 0.66' @ 8.24 hrs  Surf.Area= 2,212 sf  Storage= 968 cf

Plug-Flow detention time= 36.8 min calculated for 0.224 af (98% of inflow)
Center-of-Mass det. time= 25.3 min ( 722.0 - 696.7 )
```

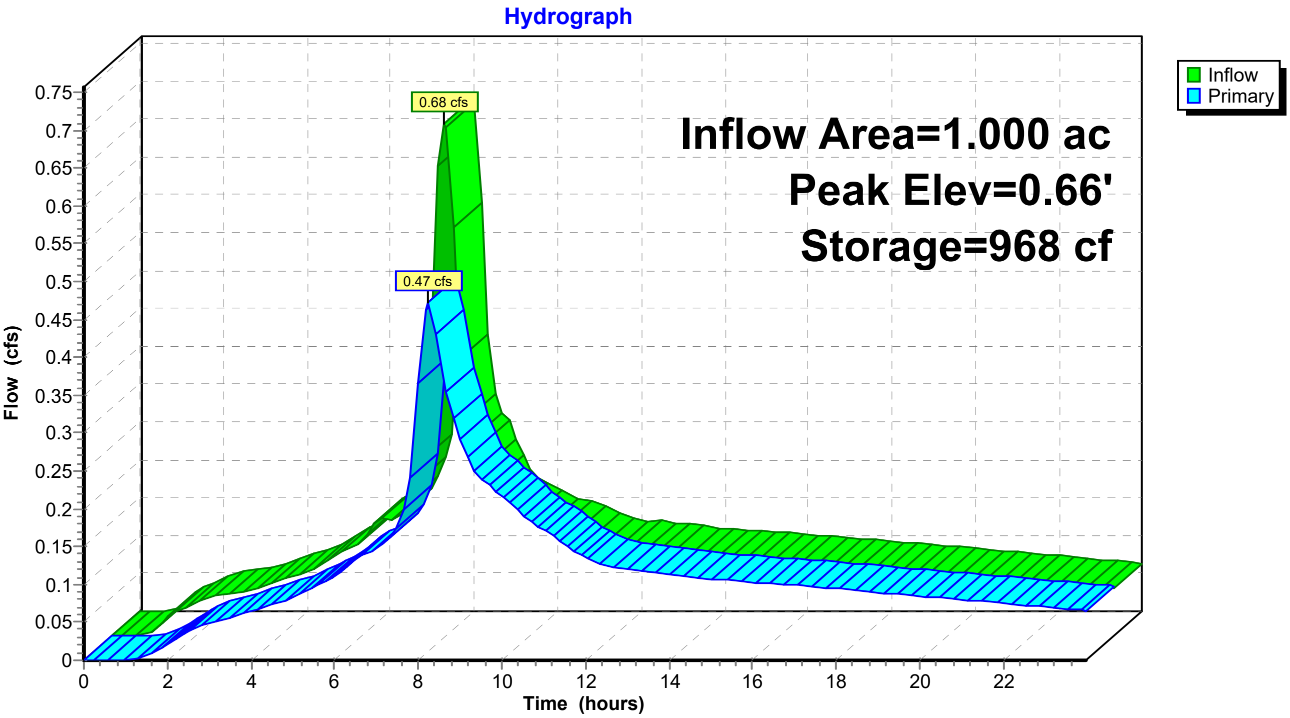
Volume	Invert	Avail.Storage	Storage Description
#1	0.00'	9,172 cf	**Live Storage (Prismatic)**Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
0.00	704	0	0
1.00	2,975	1,840	1,840
2.00	3,662	3,319	5,158
3.00	4,366	4,014	9,172

Device	Routing	Invert	Outlet Devices
#1	Primary	0.00'	**4.0" Vert. Orifice** C= 0.600
#2	Primary	0.50'	**10.0" W x 18.0" H Vert. Notch** C= 0.600
#3	Primary	2.00'	**18.0" Horiz. Riser** C= 0.600 Limited to weir flow at low heads

```
Primary OutFlow Max=0.46 cfs @ 8.24 hrs  HW=0.66'  (Free Discharge)
├─1=Orifice  (Orifice Controls 0.29 cfs @ 3.37 fps)
├─2=Notch  (Orifice Controls 0.17 cfs @ 1.27 fps)
└─3=Riser  ( Controls 0.00 cfs)
```

Pond 4P: Wet Pond- Live Storage



Summary for Pond 5P: Wet Pond- Live Storage

Inflow Area = 10.300 ac, 45.63% Impervious, Inflow Depth > 2.37" for 10-yr event
Inflow = 3.79 cfs @ 8.00 hrs, Volume= 2.032 af
Outflow = 2.35 cfs @ 8.98 hrs, Volume= 1.888 af, Atten= 38%, Lag= 58.7 min
Primary = 2.35 cfs @ 8.98 hrs, Volume= 1.888 af

Routing by Stor-Ind method, Time Span= 0.00-23.97 hrs, dt= 0.17 hrs
Peak Elev= 1.03' @ 8.98 hrs Surf.Area= 13,972 sf Storage= 12,768 cf

Plug-Flow detention time= 118.9 min calculated for 1.875 af (92% of inflow)
Center-of-Mass det. time= 72.3 min (823.1 - 750.8)

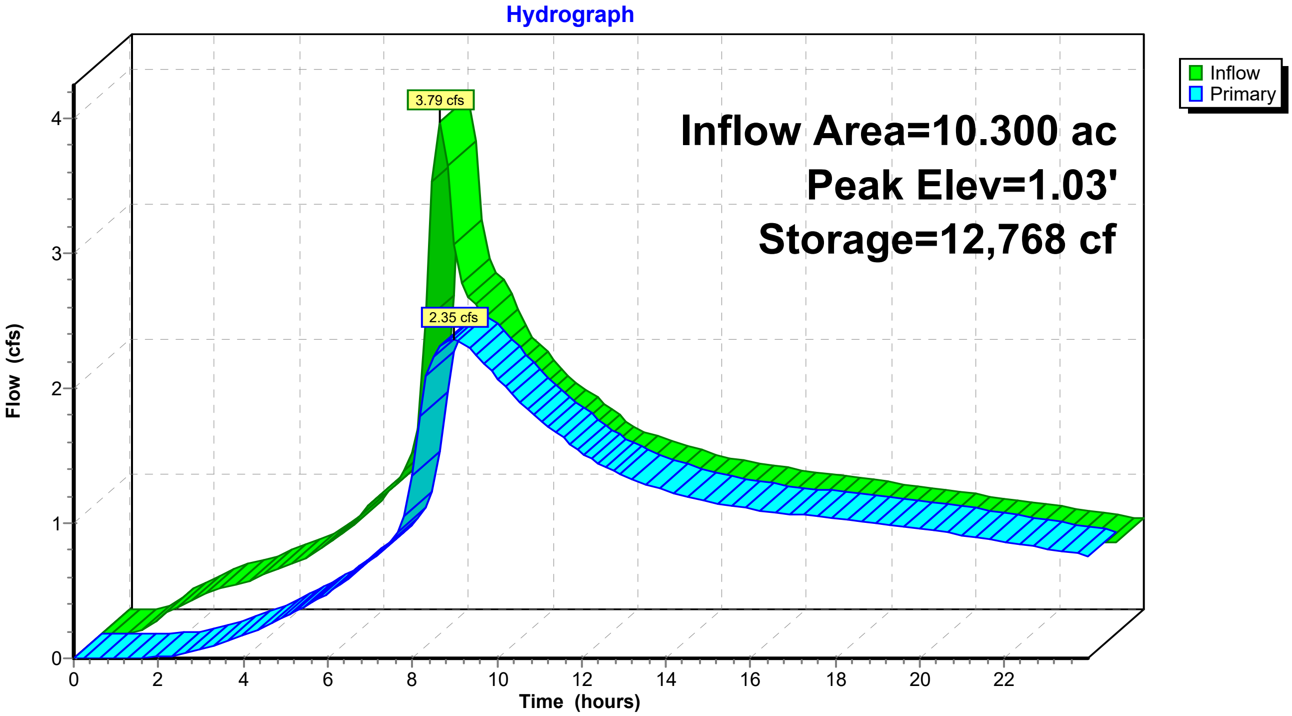
Volume	Invert	Avail.Storage	Storage Description
#1	0.00'	44,950 cf	**Live Storage (Prismatic)**Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
0.00	10,800	0	0
1.00	13,900	12,350	12,350
2.00	16,300	15,100	27,450
3.00	18,700	17,500	44,950

Device	Routing	Invert	Outlet Devices
#1	Primary	0.00'	**8.0" Vert. Orifice/Grate** C= 0.600
#2	Primary	0.75'	**24.0" W x 15.0" H Vert. Notch** C= 0.600
#3	Primary	2.00'	**24.0" Horiz. Riser** C= 0.600 Limited to weir flow at low heads

Primary OutFlow Max=2.35 cfs @ 8.98 hrs HW=1.03' (Free Discharge)
├─**1=Orifice/Grate** (Orifice Controls 1.40 cfs @ 4.02 fps)
├─**2=Notch** (Orifice Controls 0.95 cfs @ 1.70 fps)
└─**3=Riser** (Controls 0.00 cfs)

Pond 5P: Wet Pond- Live Storage



Summary for Pond 6P: 4P-Wet Pond-Live Storage - CORRECTED

[43] Hint: Has no inflow (Outflow=Zero)

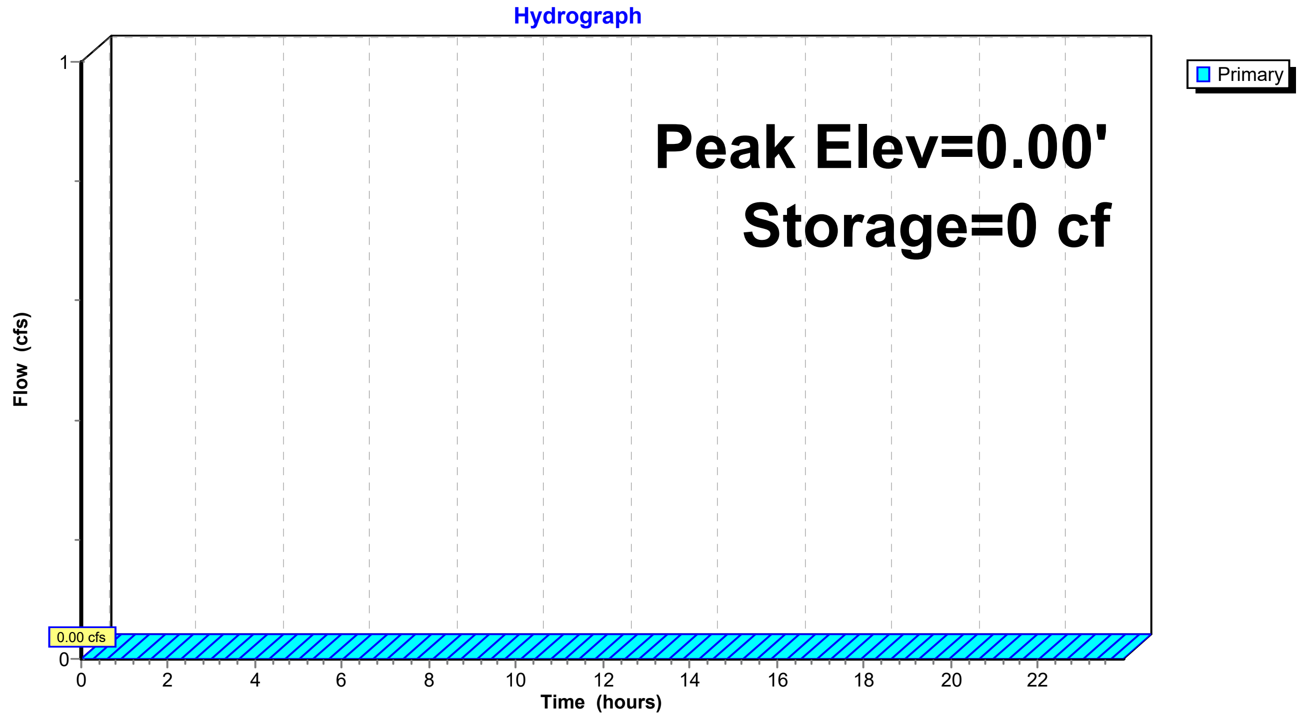
Volume	Invert	Avail.Storage	Storage Description
#1	0.00'	13,900 cf	**Live Storage (Prismatic)**Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
0.00	2,750	0	0
1.00	4,225	3,488	3,488
2.00	5,200	4,713	8,200
3.00	6,200	5,700	13,900

Device	Routing	Invert	Outlet Devices
#1	Primary	0.00'	**4.0" Vert. Orifice** C= 0.600
#2	Primary	0.50'	**10.0" W x 18.0" H Vert. Notch** C= 0.600
#3	Primary	2.00'	**18.0" Horiz. Riser** C= 0.600 Limited to weir flow at low heads

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=0.00' (Free Discharge)
1=Orifice (Controls 0.00 cfs)
2=Notch (Controls 0.00 cfs)
3=Riser (Controls 0.00 cfs)

Pond 6P: 4P-Wet Pond-Live Storage - CORRECTED



Summary for Pond 8P: 4P- Wet Pond- Dead Storage

[43] Hint: Has no inflow (Outflow=Zero)

Volume	Invert	Avail.Storage	Storage Description
#1	-3.00'	4,748 cf	**Dead Storage (Prismatic)**Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
-3.00	457	0	0
-2.00	1,213	835	835
-1.00	1,928	1,571	2,406
0.00	2,756	2,342	4,748

Summary for Pond 9P: 5P- Dead Storage

[43] Hint: Has no inflow (Outflow=Zero)

Volume	Invert	Avail.Storage	Storage Description
#1	-3.00'	17,914 cf	**Live Storage (Prismatic)**Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
-3.00	3,156	0	0
-2.00	4,660	3,908	3,908
-1.00	6,276	5,468	9,376
0.00	10,800	8,538	17,914

Summary for Pond 10P: 5P-Wet Pond- Live Storage - CORRECTED

[43] Hint: Has no inflow (Outflow=Zero)

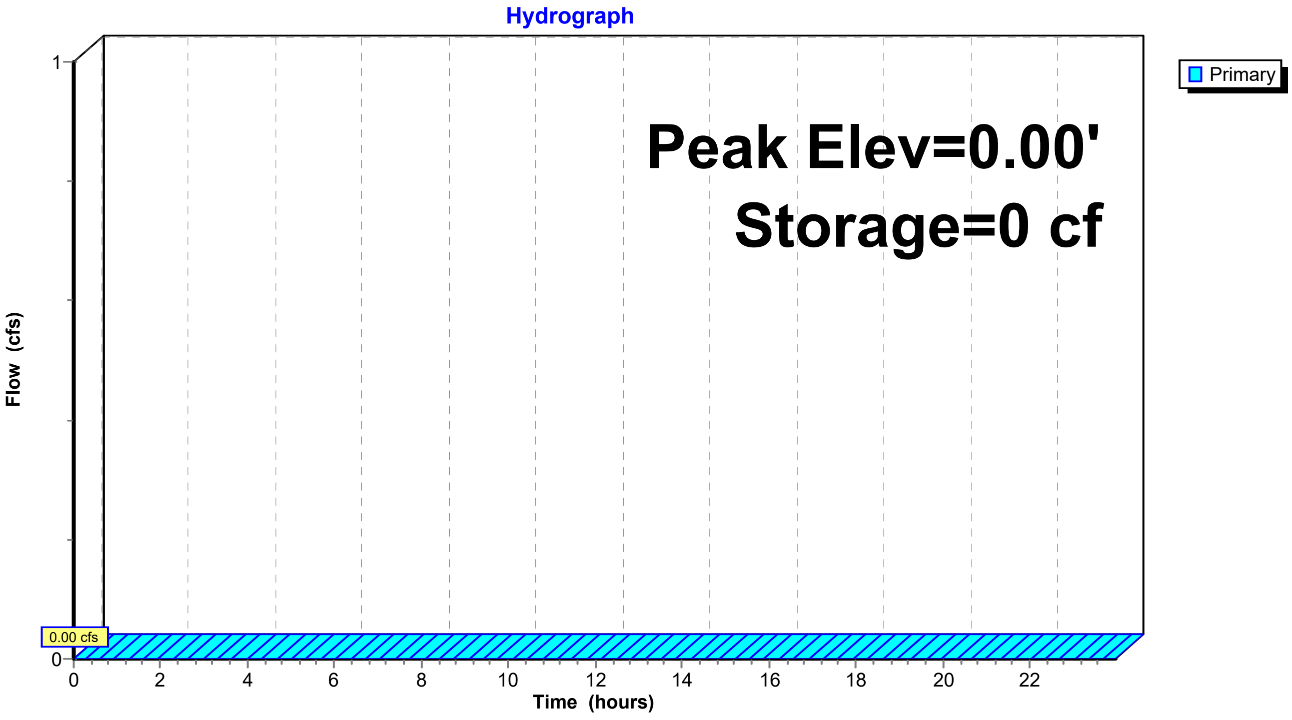
Volume	Invert	Avail.Storage	Storage Description
#1	0.00'	71,500 cf	**Live Storage (Prismatic)**Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
0.00	19,000	0	0
1.00	22,700	20,850	20,850
2.00	25,300	24,000	44,850
3.00	28,000	26,650	71,500

Device	Routing	Invert	Outlet Devices
#1	Primary	0.00'	**8.0" Vert. Orifice/Grate** C= 0.600
#2	Primary	0.75'	**24.0" W x 15.0" H Vert. Notch** C= 0.600
#3	Primary	2.00'	**24.0" Horiz. Riser** C= 0.600 Limited to weir flow at low heads

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=0.00' (Free Discharge)
↑**1=Orifice/Grate** (Controls 0.00 cfs)
2=Notch (Controls 0.00 cfs)
3=Riser (Controls 0.00 cfs)

Pond 10P: 5P-Wet Pond- Live Storage - CORRECTED



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                    Time span=0.00-24.00 hrs, dt=0.17 hrs, 142 points
                      Runoff by SBUH method, Split Pervious/Imperv.
          Reach routing by Stor-Ind+Trans method  -  Pond routing by Stor-Ind method

Subcatchment1S-A: Site - Post Basin       Runoff Area=0.850 ac   76.47% Impervious   Runoff Depth>3.50"
                                                    Tc=5.0 min   CN=79/98   Runoff=0.74 cfs  0.248 af

Subcatchment1S-B: (new Subcat)           Runoff Area=0.050 ac   100.00% Impervious   Runoff Depth>3.93"
                                                     Tc=5.0 min   CN=0/98   Runoff=0.05 cfs  0.016 af

Subcatchment1X: Pre                        Runoff Area=1.800 ac   1.11% Impervious   Runoff Depth>1.66"
                                                   Tc=19.0 min   CN=73/98   Runoff=0.49 cfs  0.248 af

Subcatchment2S-A1: Site -WEST            Runoff Area=1.140 ac   100.00% Impervious   Runoff Depth>3.93"
                                                     Tc=5.0 min   CN=0/98   Runoff=1.13 cfs  0.373 af

Subcatchment2S-A2: Site -WEST (roof       Runoff Area=0.820 ac   70.73% Impervious   Runoff Depth>3.39"
                                                    Tc=5.0 min   CN=79/98   Runoff=0.69 cfs  0.232 af

Subcatchment2S-B1: Site - EAST            Runoff Area=3.620 ac   80.94% Impervious   Runoff Depth>3.58"
                                                    Tc=5.0 min   CN=79/98   Runoff=3.22 cfs  1.079 af

Subcatchment2S-B2: POND                   Runoff Area=0.420 ac   47.62% Impervious   Runoff Depth>2.77"
                                                    Tc=5.0 min   CN=74/98   Runoff=0.28 cfs  0.097 af

Subcatchment2S-C: OFFSITE ROAD           Runoff Area=0.500 ac   100.00% Impervious   Runoff Depth>3.93"
                                                     Tc=5.0 min   CN=0/98   Runoff=0.49 cfs  0.164 af

Subcatchment2X-A: Pre-DEV - [WEST]         Runoff Area=1.300 ac   0.00% Impervious   Runoff Depth>1.62"
                     Flow Length=285'   Slope=0.1700 '/'   Tc=25.1 min   CN=73/0   Runoff=0.32 cfs  0.176 af

Subcatchment2X-B: Pre- DEV [EAST]          Runoff Area=3.900 ac   0.00% Impervious   Runoff Depth>1.61"
                                 Flow Length=750'   Tc=42.8 min   CN=73/0   Runoff=0.76 cfs  0.522 af

Subcatchment2X-C: PRE- OFFSITE ROAD Runoff Area=0.500 ac   36.00% Impervious   Runoff Depth>2.47"
                                                    Tc=5.0 min   CN=73/98   Runoff=0.28 cfs  0.103 af

Subcatchment3S: Green Mtn Rd              Runoff Area=1.000 ac   65.00% Impervious   Runoff Depth>3.31"
                                                    Tc=5.0 min   CN=80/98   Runoff=0.82 cfs  0.276 af

Subcatchment3X: PRE- GRN MTN CONN         Runoff Area=1.000 ac   12.00% Impervious   Runoff Depth>2.68"
                                                    Tc=5.0 min   CN=84/98   Runoff=0.66 cfs  0.224 af

Subcatchment4S-A: BELMONT RD              Runoff Area=2.500 ac   76.00% Impervious   Runoff Depth>3.51"
                                                    Tc=5.0 min   CN=80/98   Runoff=2.18 cfs  0.730 af

Subcatchment4S-B: SOUTH OF BELMONT Runoff Area=7.000 ac   28.57% Impervious   Runoff Depth>2.57"
                               Flow Length=1,050'   Tc=87.5 min   CN=80/98   Runoff=2.00 cfs  1.499 af

Subcatchment4S-C: WET POND               Runoff Area=0.800 ac   100.00% Impervious   Runoff Depth>3.93"
                                                     Tc=5.0 min   CN=0/98   Runoff=0.79 cfs  0.262 af
```

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Subcatchment4X-A: PRE - BELMONT RD   Runoff Area=2.500 ac  20.00% Impervious   Runoff Depth>2.72"
                        Flow Length=850'   Slope=0.0100 '/'   Tc=67.1 min   CN=84/98   Runoff=0.87 cfs  0.566 af

Subcatchment4X-B: South of Belmont     Runoff Area=7.800 ac   3.85% Impervious   Runoff Depth>2.49"
                        Flow Length=800'   Slope=0.0100 '/'   Tc=65.9 min   CN=84/98   Runoff=2.47 cfs  1.619 af

Subcatchment5S: Commercial Site       Runoff Area=11.700 ac   0.68% Impervious   Runoff Depth>2.07"
                                   Flow Length=1,550'   Tc=97.7 min   CN=80/98   Runoff=2.43 cfs  2.021 af

Subcatchment5X: Commercial Site       Runoff Area=11.700 ac   0.68% Impervious   Runoff Depth>2.09"
                                   Flow Length=1,600'   Tc=88.5 min   CN=80/98   Runoff=2.54 cfs  2.033 af

Reach 7R: conveyance ditch            Avg. Flow Depth=0.17'   Max Vel=0.91 fps   Inflow=0.61 cfs  0.272 af
                     n=0.030   L=450.0'   S=0.0044 '/'   Capacity=40.89 cfs   Outflow=0.58 cfs  0.269 af

Pond 1B: BIORET-1                       Peak Elev=7.00'  Storage=0.000 af   Inflow=0.74 cfs  0.248 af
                                                                           Outflow=0.74 cfs  0.248 af

Pond 1P: NW CORNER                      Peak Elev=3.05'  Storage=0.072 af   Inflow=0.79 cfs  0.264 af
                                                                           Outflow=0.48 cfs  0.201 af

Pond 2A: BIORET-2A                      Peak Elev=5.00'  Storage=0.000 af   Inflow=1.13 cfs  0.373 af
                                                                           Outflow=1.12 cfs  0.373 af

Pond 2B: BIORET-2B                      Peak Elev=6.00'  Storage=0.000 af   Inflow=3.72 cfs  1.243 af
                                                                           Outflow=3.72 cfs  1.243 af

Pond 2P: West Pond                      Peak Elev=4.69'  Storage=0.382 af   Inflow=1.81 cfs  0.605 af
                                                                           Outflow=0.25 cfs  0.230 af

Pond 3P: East Pond                     Peak Elev=4.33'  Storage=23,466 cf   Inflow=3.99 cfs  1.339 af
                                                                           Outflow=0.84 cfs  0.876 af

Pond 4P: Wet Pond- Live Storage         Peak Elev=0.73'  Storage=1,120 cf   Inflow=0.82 cfs  0.276 af
                                                                           Outflow=0.61 cfs  0.272 af

Pond 5P: Wet Pond- Live Storage        Peak Elev=1.14'  Storage=14,360 cf   Inflow=4.65 cfs  2.491 af
                                                                           Outflow=3.09 cfs  2.319 af

Pond 6P: 4P-Wet Pond-Live Storage - CORRECTED                          Peak Elev=0.00'  Storage=0 cf
                                                                           Primary=0.00 cfs  0.000 af

Pond 8P: 4P- Wet Pond- Dead Storage                                 Peak Elev=0.00'  Storage=4,748 cf


Pond 9P: 5P- Dead Storage                                          Peak Elev=0.00'  Storage=17,914 cf


Pond 10P: 5P-Wet Pond- Live Storage - CORRECTED                        Peak Elev=0.00'  Storage=0 cf
                                                                           Primary=0.00 cfs  0.000 af
```

Total Runoff Area = 60.900 ac Runoff Volume = 12.486 af Average Runoff Depth = 2.46"
79.18% Pervious = 48.220 ac 20.82% Impervious = 12.680 ac

Summary for Subcatchment 1S-A: Site - Post Basin NPGS

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

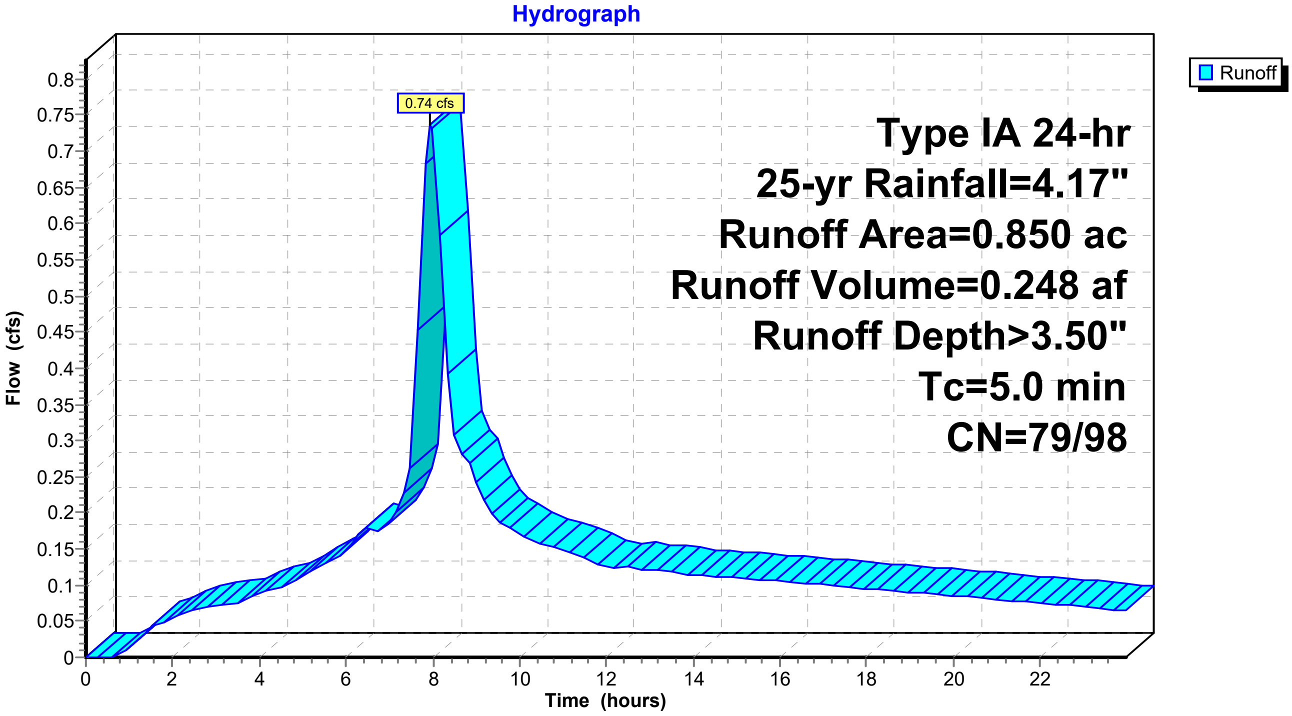
Runoff = 0.74 cfs @ 7.95 hrs, Volume= 0.248 af, Depth> 3.50"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-23.97 hrs, dt= 0.17 hrs
Type IA 24-hr 25-yr Rainfall=4.17"

	Area (ac)	CN	Description
*	0.370	98	roof areas
	0.200	79	50-75% Grass cover, Fair, HSG C
*	0.280	98	parking
	0.850	94	Weighted Average
	0.200	79	23.53% Pervious Area
	0.650	98	76.47% Impervious Area

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

Subcatchment 1S-A: Site - Post Basin NPGS



Summary for Subcatchment 1S-B: (new Subcat)

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

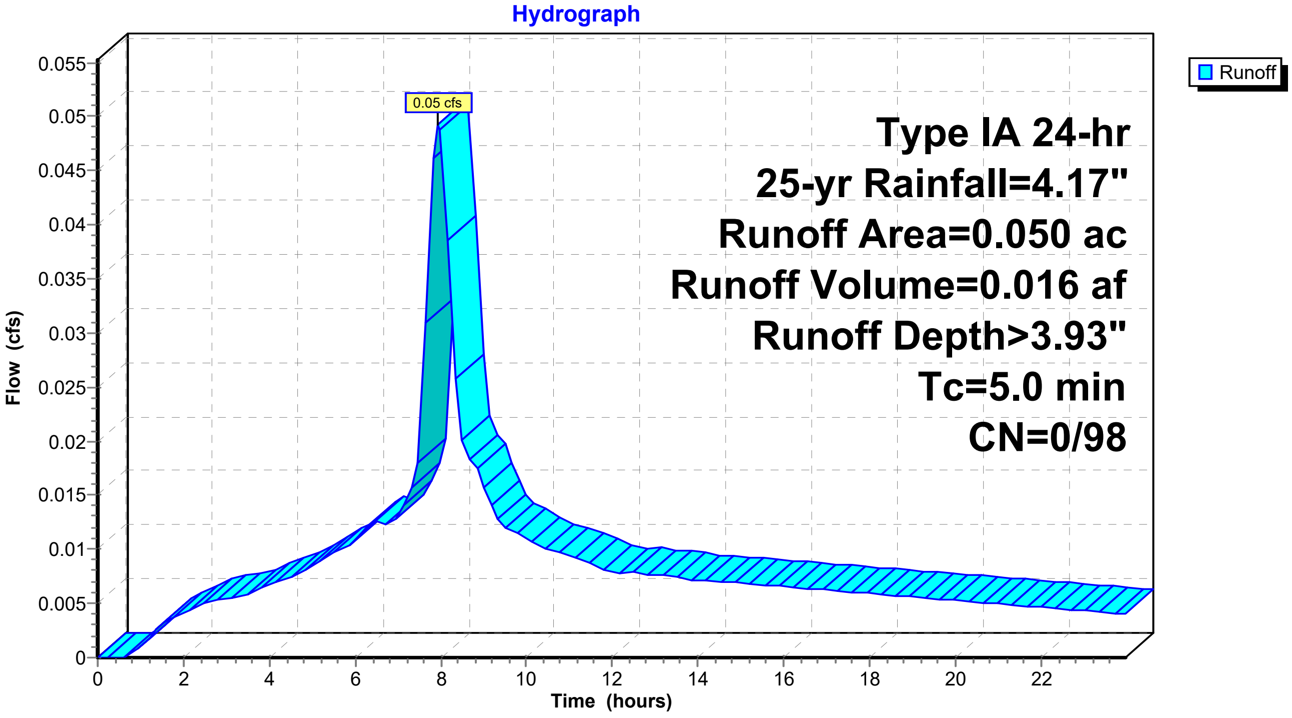
Runoff = 0.05 cfs @ 7.94 hrs, Volume= 0.016 af, Depth> 3.93"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-23.97 hrs, dt= 0.17 hrs
Type IA 24-hr 25-yr Rainfall=4.17"

	Area (ac)	CN	Description
*	0.050	98	pond surface at Q100
	0.050	98	100.00% Impervious Area

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

Subcatchment 1S-B: (new Subcat)



Summary for Subcatchment 1X: Pre

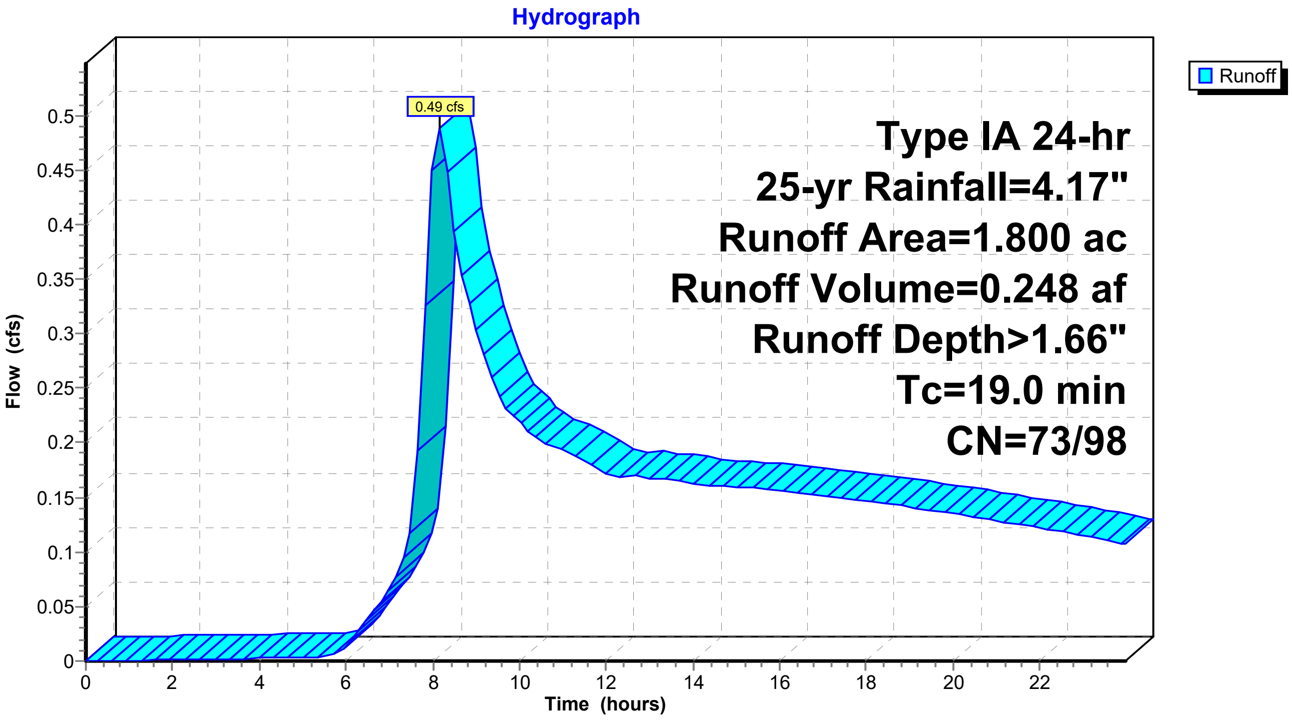
[49] Hint: Tc<2dt may require smaller dt

Runoff = 0.49 cfs @ 8.16 hrs, Volume= 0.248 af, Depth> 1.66"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-23.97 hrs, dt= 0.17 hrs
Type IA 24-hr 25-yr Rainfall=4.17"

	Area (ac)	CN	Description
	1.780	73	Woods, Fair, HSG C
*	0.020	98	PORTION OF GREEN MTN LOOP
	1.800	73	Weighted Average
	1.780	73	98.89% Pervious Area
	0.020	98	1.11% Impervious Area

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



Summary for Subcatchment 2S-A1: Site -WEST

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

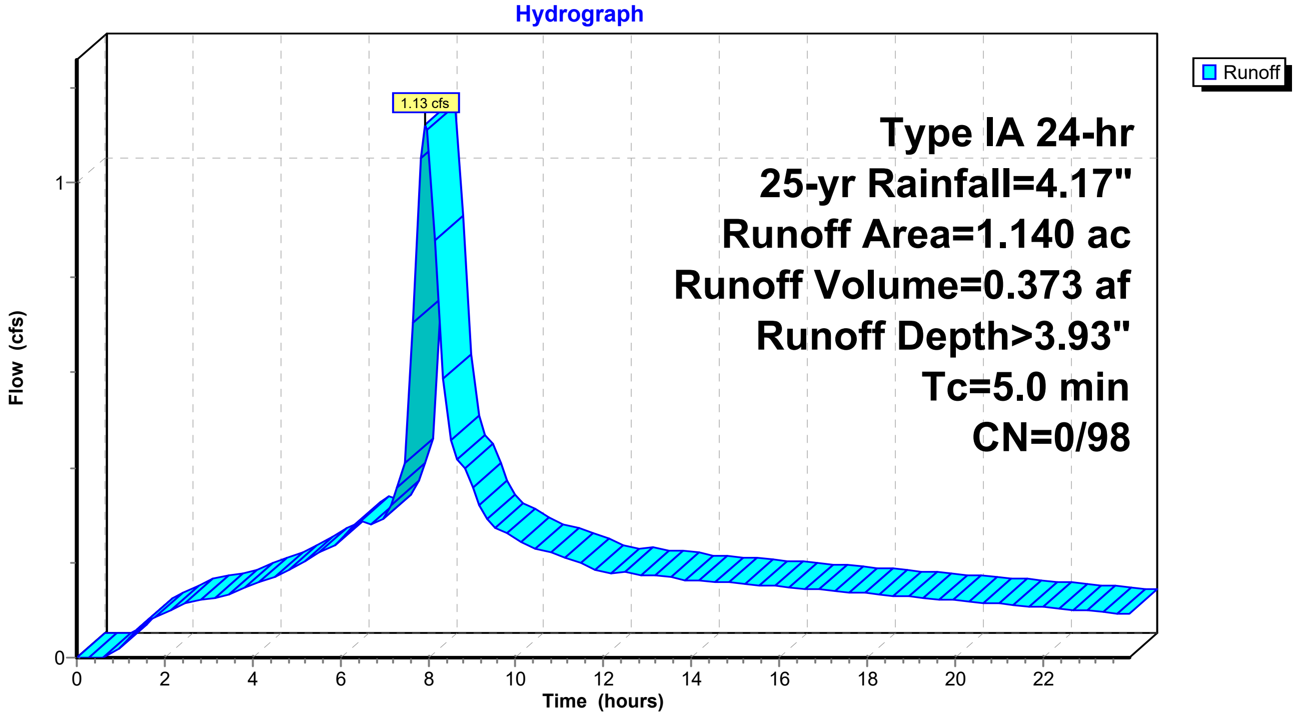
Runoff = 1.13 cfs @ 7.94 hrs, Volume= 0.373 af, Depth> 3.93"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-23.97 hrs, dt= 0.17 hrs
Type IA 24-hr 25-yr Rainfall=4.17"

	Area (ac)	CN	Description
*	0.390	98	roof areas- bldg E, half building
*	0.750	98	drive/parking
	1.140	98	Weighted Average
	1.140	98	100.00% Impervious Area

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

Subcatchment 2S-A1: Site -WEST



Summary for Subcatchment 2S-A2: Site -WEST (roof areas & pond)

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

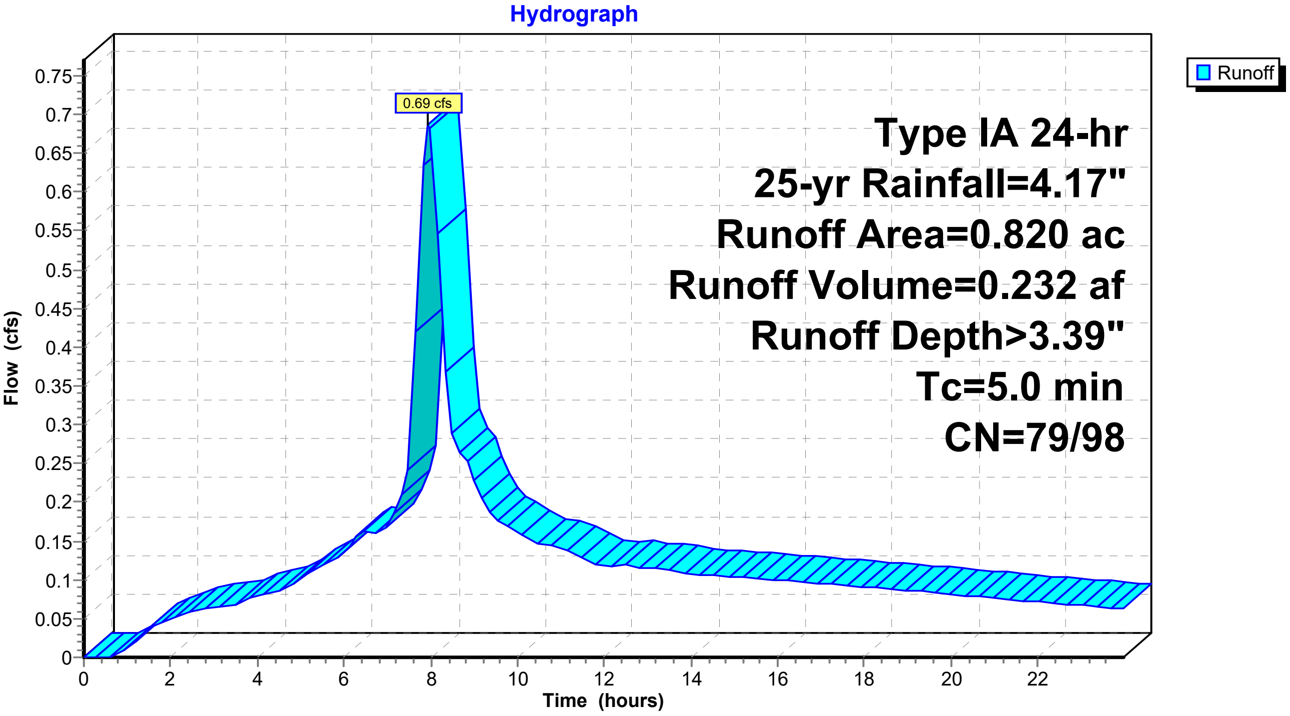
Runoff = 0.69 cfs @ 7.95 hrs, Volume= 0.232 af, Depth> 3.39"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-23.97 hrs, dt= 0.17 hrs
Type IA 24-hr 25-yr Rainfall=4.17"

	Area (ac)	CN	Description
*	0.450	98	roof areas
*	0.130	98	pond
	0.240	79	50-75% Grass cover, Fair, HSG C
	0.820	92	Weighted Average
	0.240	79	29.27% Pervious Area
	0.580	98	70.73% Impervious Area

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

Subcatchment 2S-A2: Site -WEST (roof areas & pond)



Summary for Subcatchment 2S-B1: Site - EAST

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

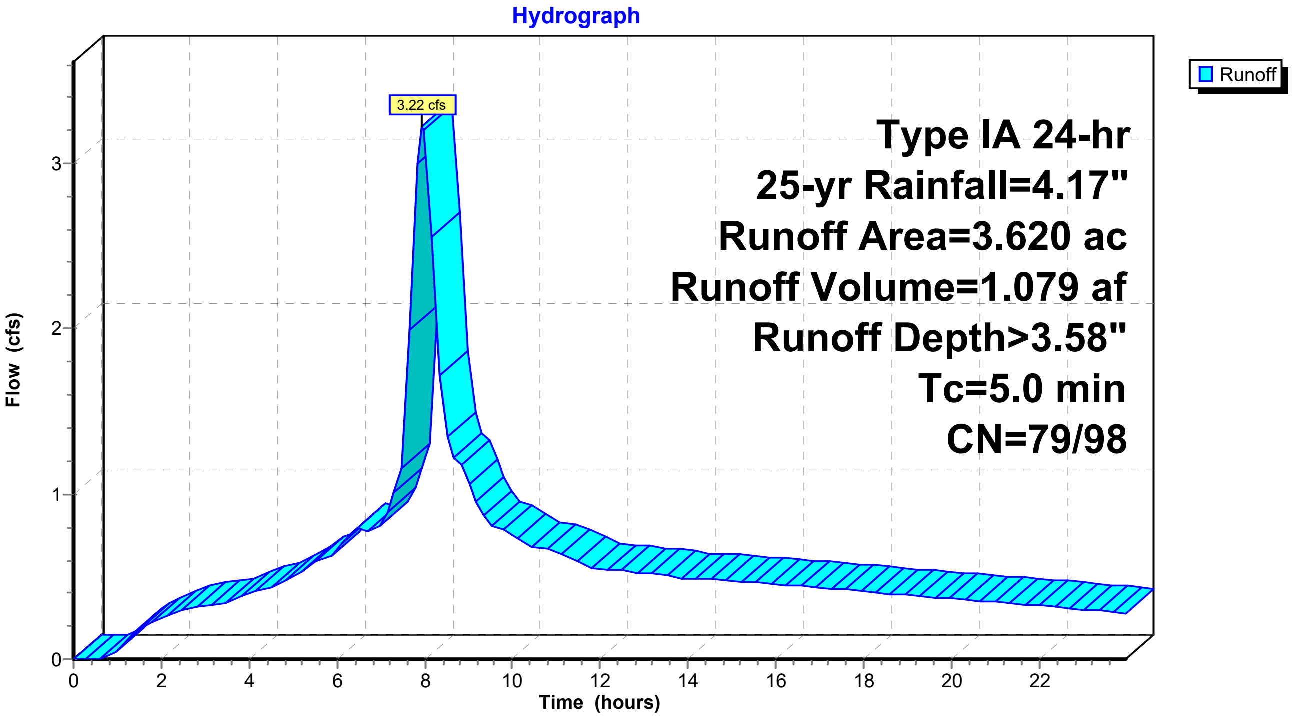
Runoff = 3.22 cfs @ 7.95 hrs, Volume= 1.079 af, Depth> 3.58"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-23.97 hrs, dt= 0.17 hrs
Type IA 24-hr 25-yr Rainfall=4.17"

	Area (ac)	CN	Description
*	0.870	98	roof areas
*	2.060	98	PARKING AND DRIVE AISLE
	0.690	79	50-75% Grass cover, Fair, HSG C
	3.620	94	Weighted Average
	0.690	79	19.06% Pervious Area
	2.930	98	80.94% Impervious Area

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

Subcatchment 2S-B1: Site - EAST



Summary for Subcatchment 2S-B2: POND

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

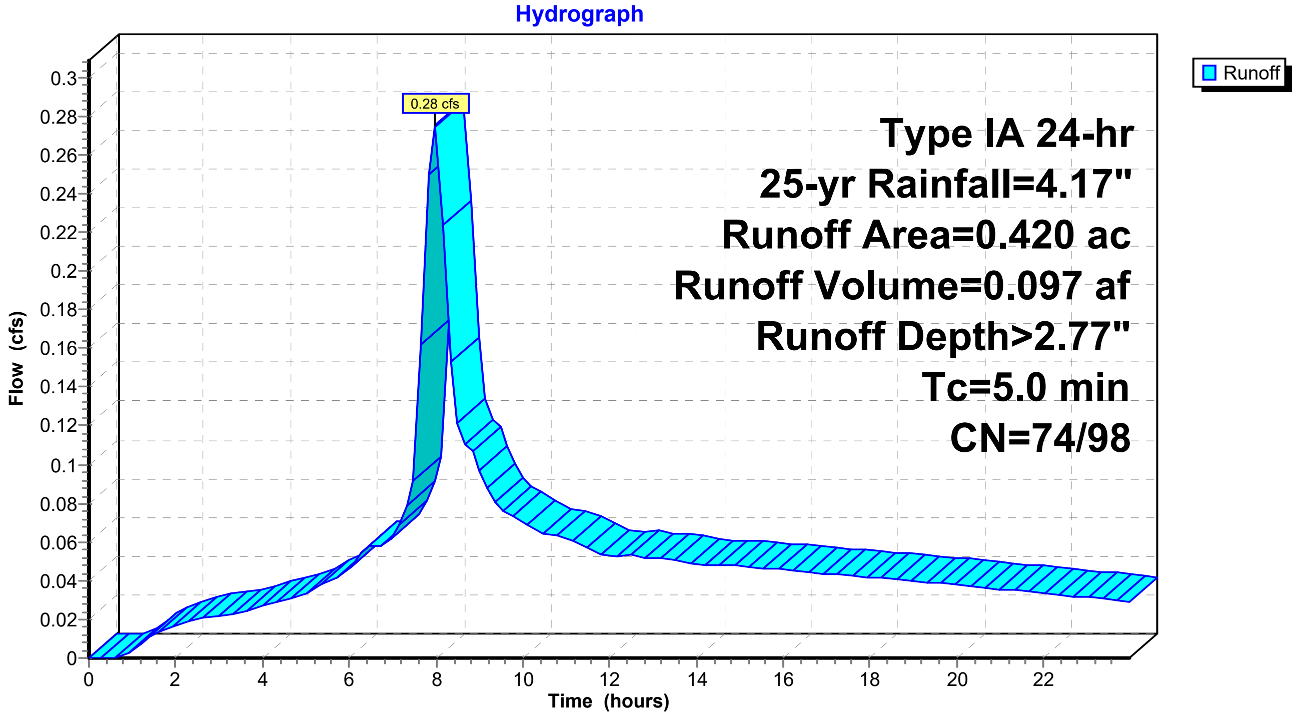
Runoff = 0.28 cfs @ 7.96 hrs, Volume= 0.097 af, Depth> 2.77"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-23.97 hrs, dt= 0.17 hrs
Type IA 24-hr 25-yr Rainfall=4.17"

	Area (ac)	CN	Description
*	0.200	98	POND AT Q100
	0.220	74	>75% Grass cover, Good, HSG C
	0.420	85	Weighted Average
	0.220	74	52.38% Pervious Area
	0.200	98	47.62% Impervious Area

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

Subcatchment 2S-B2: POND



Summary for Subcatchment 2S-C: OFFSITE ROAD

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

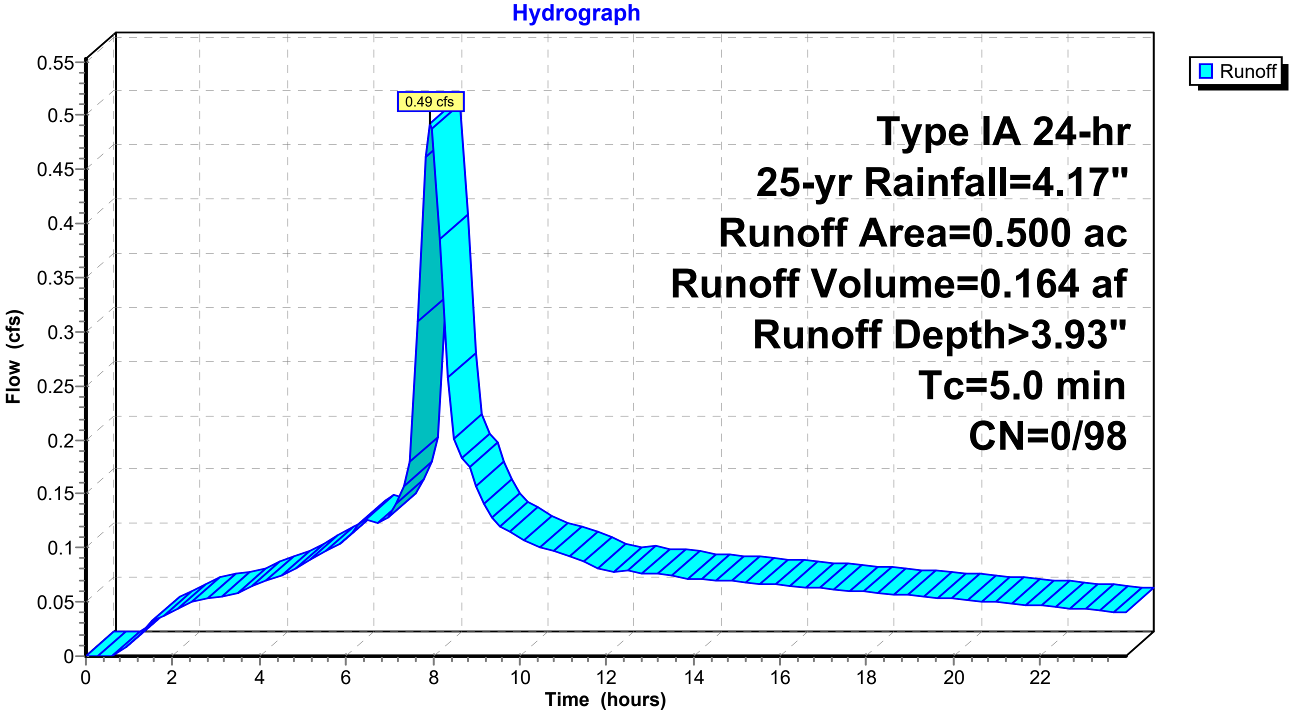
Runoff = 0.49 cfs @ 7.94 hrs, Volume= 0.164 af, Depth> 3.93"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-23.97 hrs, dt= 0.17 hrs
Type IA 24-hr 25-yr Rainfall=4.17"

	Area (ac)	CN	Description
*	0.500	98	GREEN MTN LOOP & RD
	0.500	98	100.00% Impervious Area

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

Subcatchment 2S-C: OFFSITE ROAD



Summary for Subcatchment 2X-A: Pre-DEV - [WEST]

BASIN 30S-A - 1S TO THE NORTH

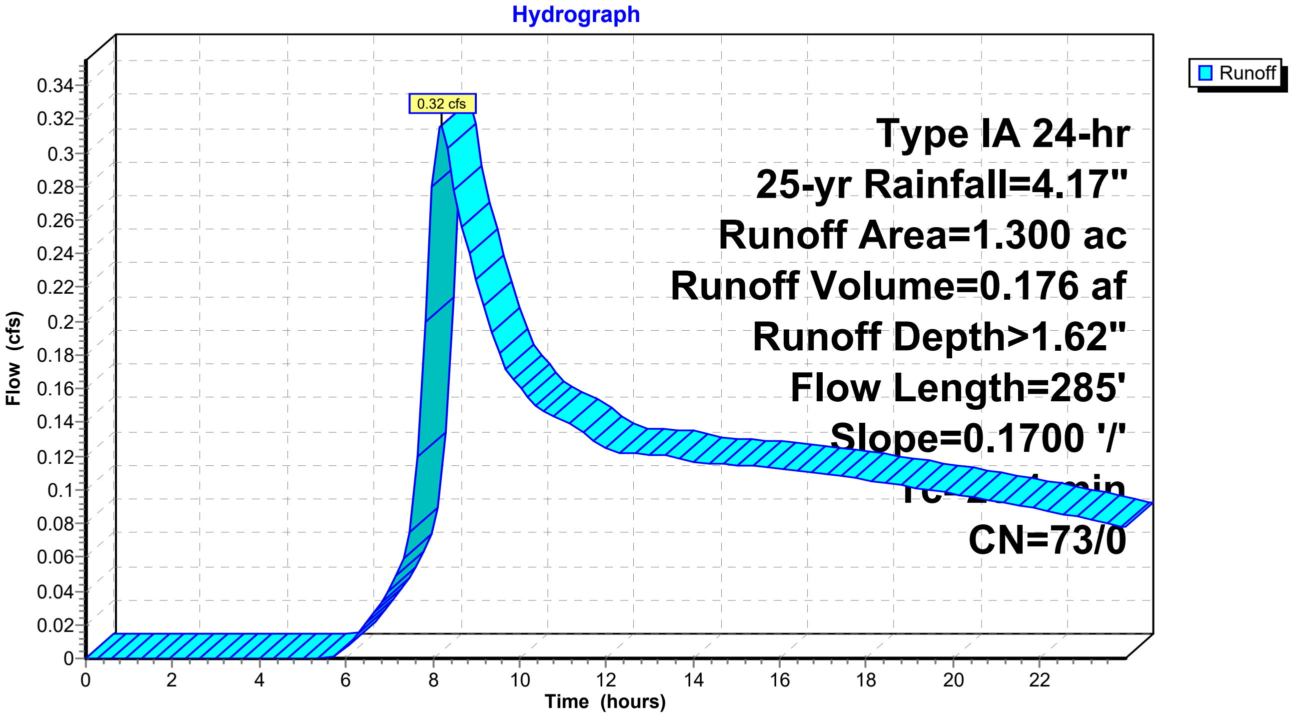
Runoff = 0.32 cfs @ 8.20 hrs, Volume= 0.176 af, Depth> 1.62"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-23.97 hrs, dt= 0.17 hrs
Type IA 24-hr 25-yr Rainfall=4.17"

Area (ac)	CN	Description
1.300	73	Woods, Fair, HSG C
1.300	73	100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
25.1	285	0.1700	0.19		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 2.26"

Subcatchment 2X-A: Pre-DEV - [WEST]



Summary for Subcatchment 2X-B: Pre- DEV [EAST]

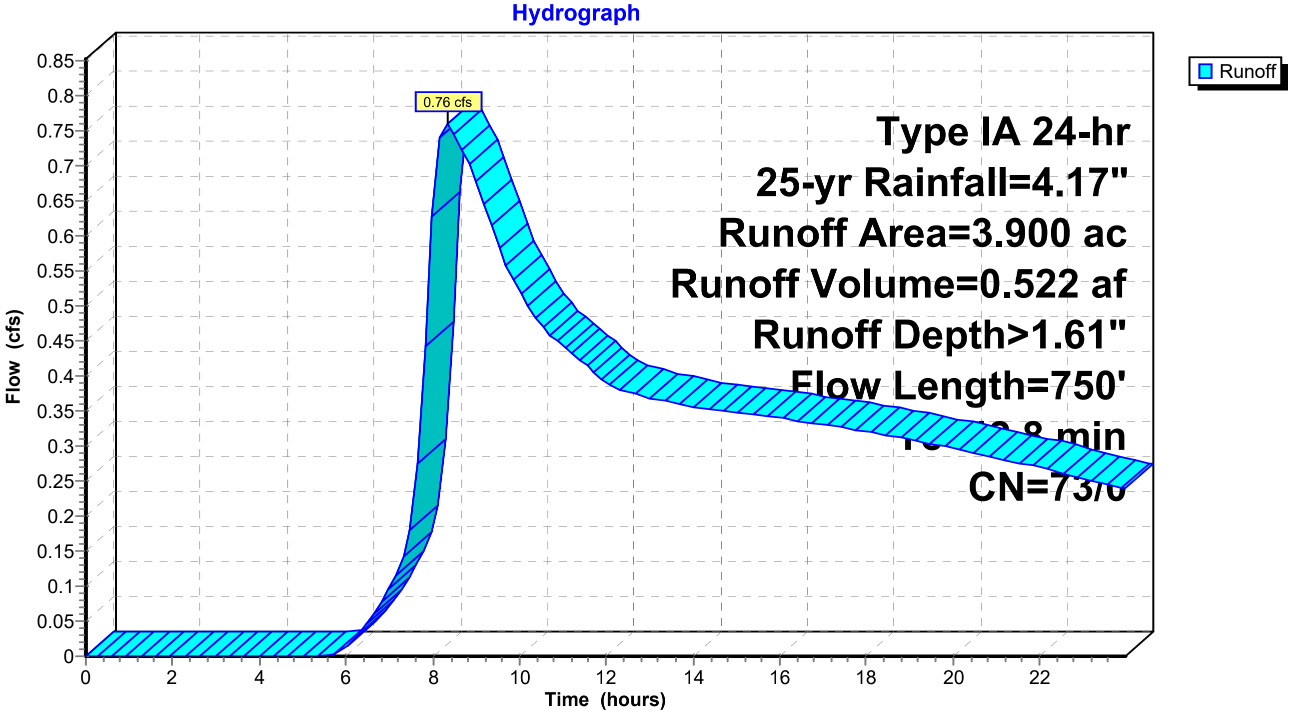
Runoff = 0.76 cfs @ 8.34 hrs, Volume= 0.522 af, Depth> 1.61"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-23.97 hrs, dt= 0.17 hrs
Type IA 24-hr 25-yr Rainfall=4.17"

Area (ac)	CN	Description
3.900	73	Woods, Fair, HSG C
3.900	73	100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
23.8	250	0.1500	0.18		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 2.26"
2.7	200	0.0600	1.22		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
16.3	300	0.0150	0.31		**Shallow Concentrated Flow,** Forest w/Heavy Litter Kv= 2.5 fps
42.8	750	Total			

Subcatchment 2X-B: Pre- DEV [EAST]



Summary for Subcatchment 2X-C: PRE- OFFSITE ROAD

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

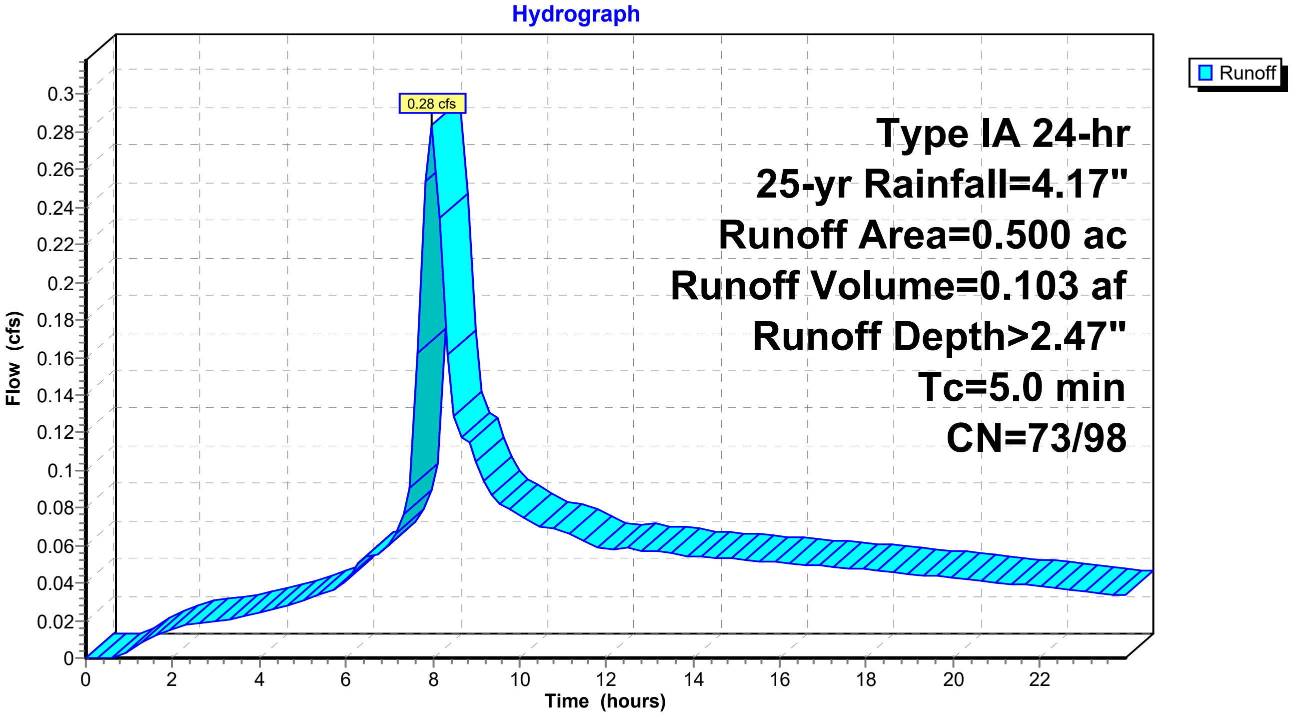
Runoff = 0.28 cfs @ 7.97 hrs, Volume= 0.103 af, Depth> 2.47"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-23.97 hrs, dt= 0.17 hrs
Type IA 24-hr 25-yr Rainfall=4.17"

	Area (ac)	CN	Description
	0.320	73	Woods, Fair, HSG C
*	0.180	98	GREEN MTN RD & LOOP
	0.500	82	Weighted Average
	0.320	73	64.00% Pervious Area
	0.180	98	36.00% Impervious Area

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

Subcatchment 2X-C: PRE- OFFSITE ROAD



Summary for Subcatchment 3S: Green Mtn Rd Connection

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

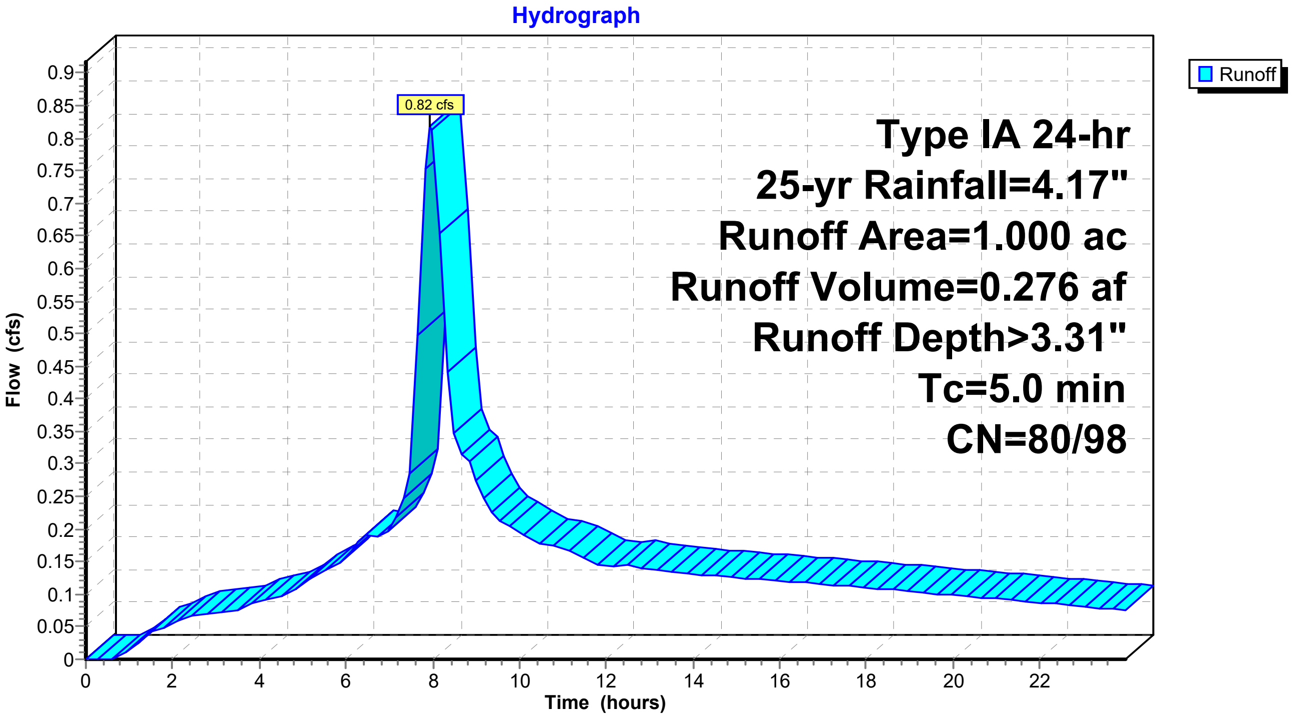
Runoff = 0.82 cfs @ 7.95 hrs, Volume= 0.276 af, Depth> 3.31"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-23.97 hrs, dt= 0.17 hrs
Type IA 24-hr 25-yr Rainfall=4.17"

	Area (ac)	CN	Description
*	0.500	98	BELMONT RD & PVT RD
	0.350	80	>75% Grass cover, Good, HSG D
*	0.150	98	POND
	1.000	92	Weighted Average
	0.350	80	35.00% Pervious Area
	0.650	98	65.00% Impervious Area

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

Subcatchment 3S: Green Mtn Rd Connection



Summary for Subcatchment 3X: PRE- GRN MTN CONN

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

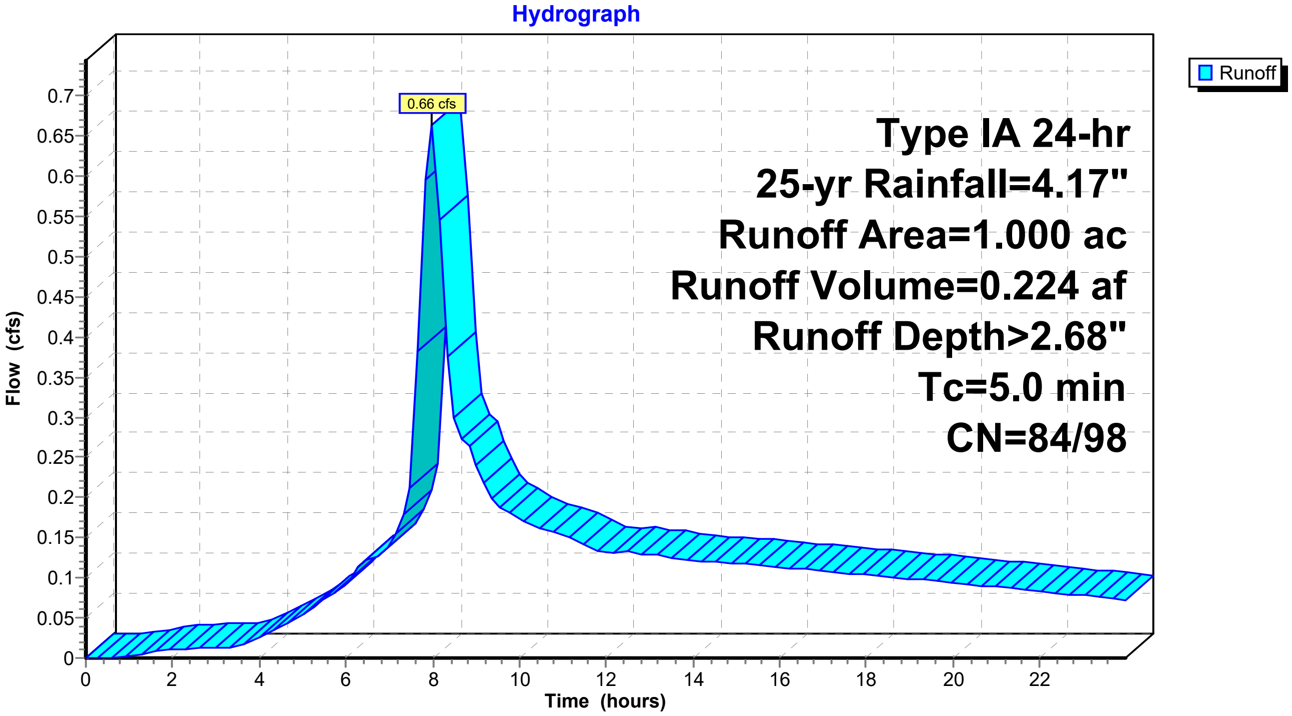
Runoff = 0.66 cfs @ 7.97 hrs, Volume= 0.224 af, Depth> 2.68"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-23.97 hrs, dt= 0.17 hrs
Type IA 24-hr 25-yr Rainfall=4.17"

	Area (ac)	CN	Description
	0.880	84	Pasture/grassland/range, Fair, HSG D
*	0.120	98	GREEN MTN RD
	1.000	86	Weighted Average
	0.880	84	88.00% Pervious Area
	0.120	98	12.00% Impervious Area

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

Subcatchment 3X: PRE- GRN MTN CONN



Summary for Subcatchment 4S-A: BELMONT RD

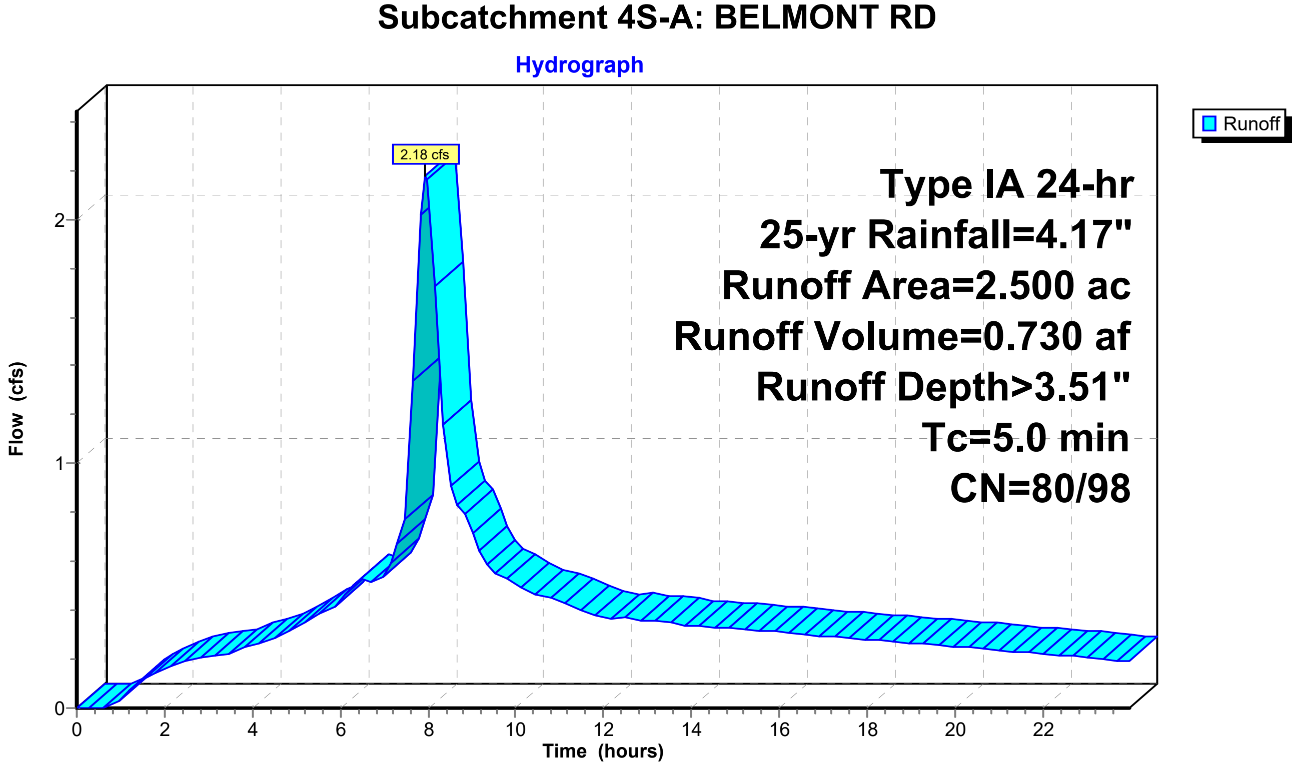
[49] Hint: Tc<2dt may require smaller dt

Runoff = 2.18 cfs @ 7.95 hrs, Volume= 0.730 af, Depth> 3.51"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-23.97 hrs, dt= 0.17 hrs
Type IA 24-hr 25-yr Rainfall=4.17"

	Area (ac)	CN	Description
*	1.900	98	BELMONT RD
	0.600	80	>75% Grass cover, Good, HSG D
	2.500	94	Weighted Average
	0.600	80	24.00% Pervious Area
	1.900	98	76.00% Impervious Area

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



Summary for Subcatchment 4S-B: SOUTH OF BELMONT

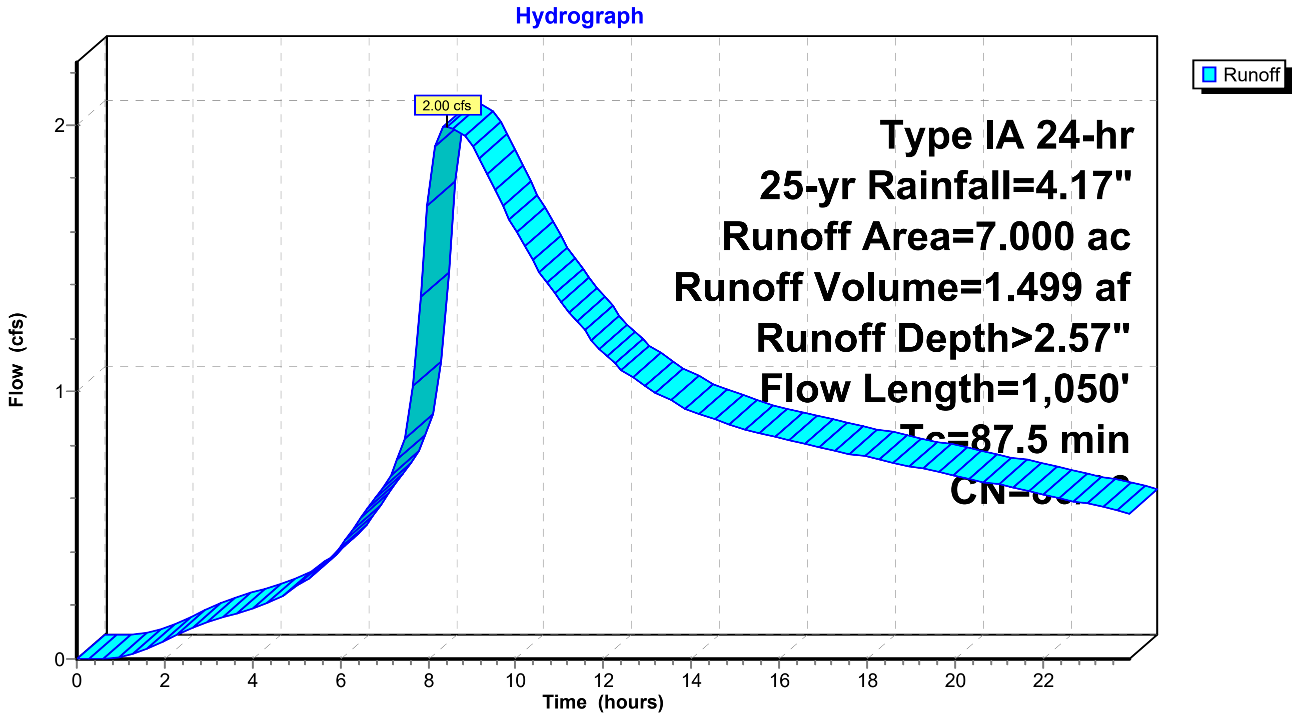
Runoff = 2.00 cfs @ 8.45 hrs, Volume= 1.499 af, Depth> 2.57"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-23.97 hrs, dt= 0.17 hrs
Type IA 24-hr 25-yr Rainfall=4.17"

	Area (ac)	CN	Description
	5.000	80	>75% Grass cover, Good, HSG D
*	2.000	98	ROCK STOCKPILE
	7.000	85	Weighted Average
	5.000	80	71.43% Pervious Area
	2.000	98	28.57% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
71.2	300	0.0050	0.07		**Sheet Flow,** Grass: Dense n= 0.240 P2= 2.26"
15.2	450	0.0050	0.49		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
1.1	300	0.0100	4.71	37.72	**Trap/Vee/Rect Channel Flow,** Bot.W=5.00' D=1.00' Z= 3.0 '/' Top.W=11.00' n= 0.025 Earth, clean & winding
87.5	1,050	Total			

Subcatchment 4S-B: SOUTH OF BELMONT



Summary for Subcatchment 4S-C: WET POND

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

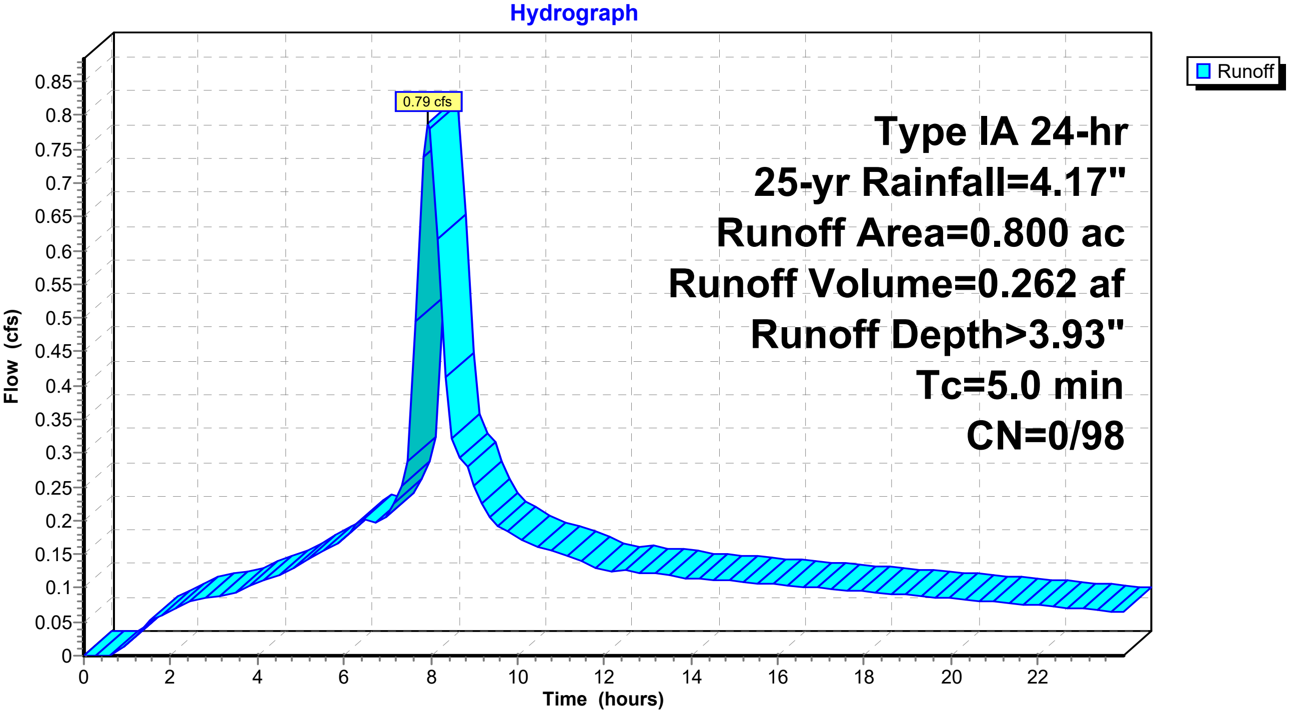
Runoff = 0.79 cfs @ 7.94 hrs, Volume= 0.262 af, Depth> 3.93"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-23.97 hrs, dt= 0.17 hrs
Type IA 24-hr 25-yr Rainfall=4.17"

	Area (ac)	CN	Description
*	0.800	98	POND
	0.800	98	100.00% Impervious Area

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

Subcatchment 4S-C: WET POND



Summary for Subcatchment 4X-A: PRE - BELMONT RD

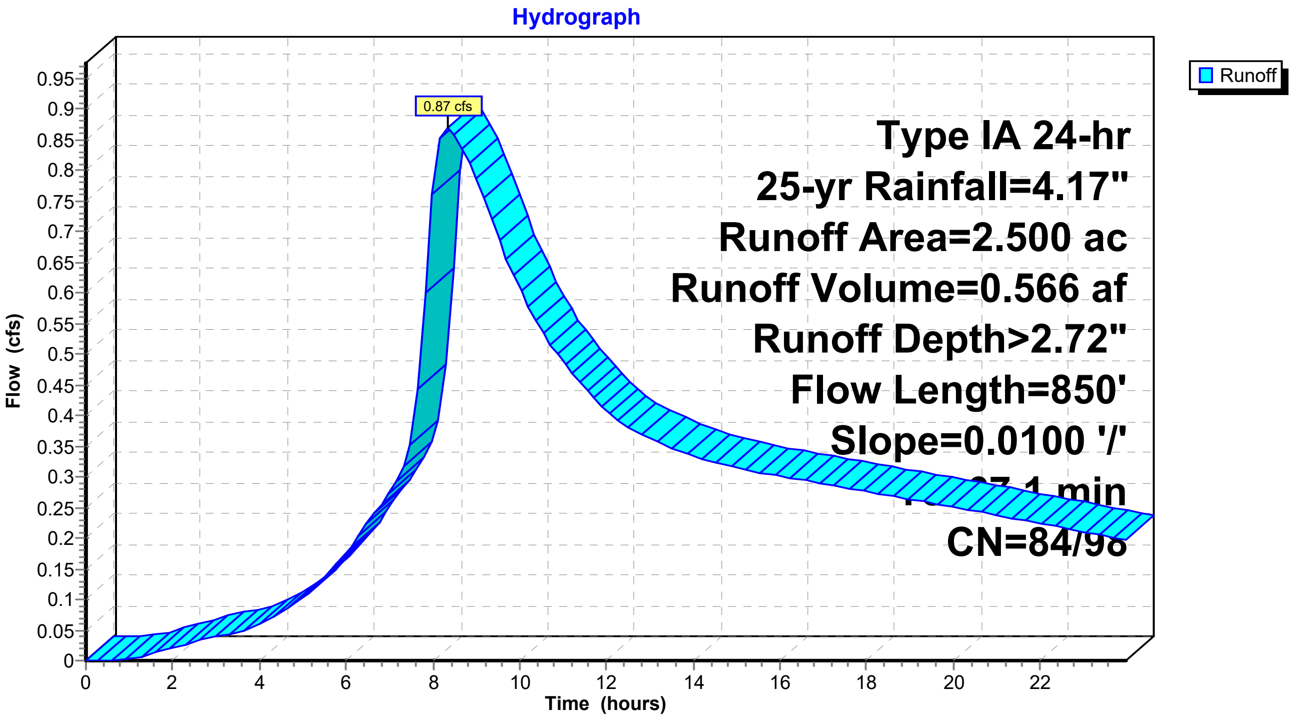
Runoff = 0.87 cfs @ 8.34 hrs, Volume= 0.566 af, Depth> 2.72"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-23.97 hrs, dt= 0.17 hrs
Type IA 24-hr 25-yr Rainfall=4.17"

	Area (ac)	CN	Description
	2.000	84	Pasture/grassland/range, Fair, HSG D
*	0.500	98	OPH & PARKING LOT
	2.500	87	Weighted Average
	2.000	84	80.00% Pervious Area
	0.500	98	20.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
54.0	300	0.0100	0.09		**Sheet Flow,**
					Grass: Dense n= 0.240 P2= 2.26"
13.1	550	0.0100	0.70		**Shallow Concentrated Flow,**
					Short Grass Pasture Kv= 7.0 fps
67.1	850	Total			

Subcatchment 4X-A: PRE - BELMONT RD



Summary for Subcatchment 4X-B: South of Belmont

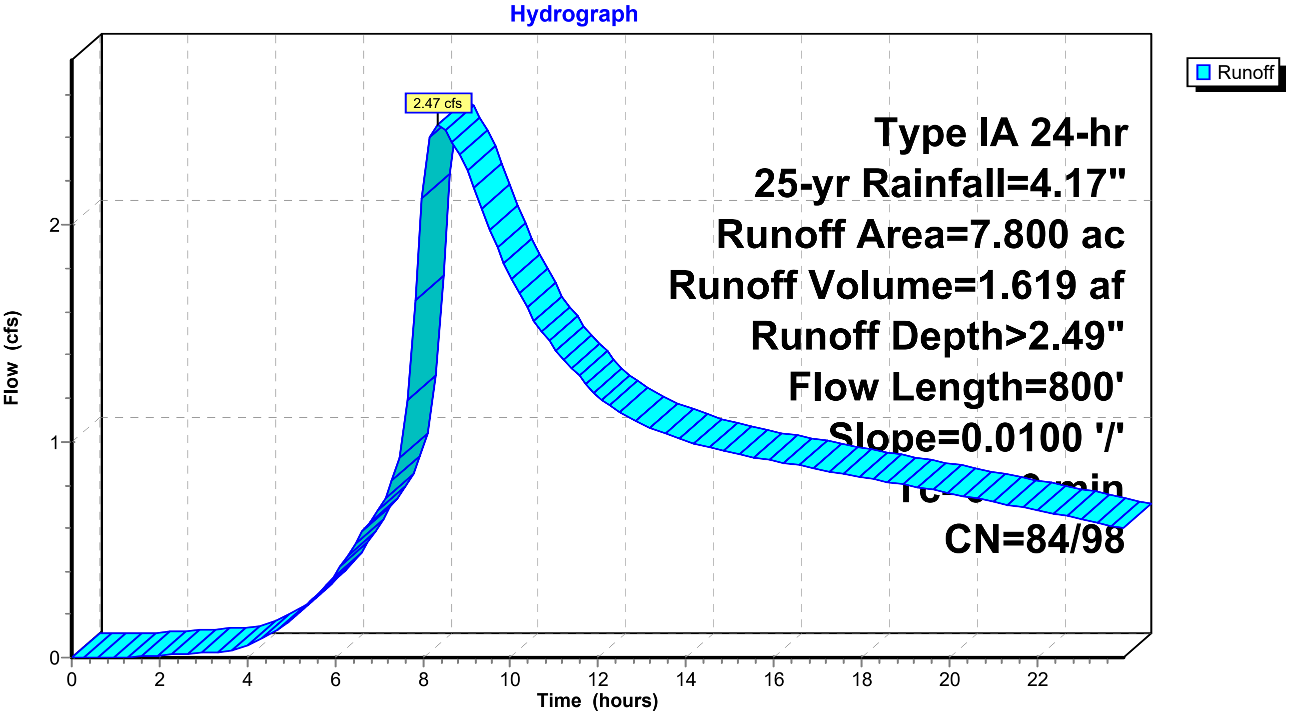
Runoff = 2.47 cfs @ 8.36 hrs, Volume= 1.619 af, Depth> 2.49"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-23.97 hrs, dt= 0.17 hrs
Type IA 24-hr 25-yr Rainfall=4.17"

	Area (ac)	CN	Description
	7.500	84	Pasture/grassland/range, Fair, HSG D
*	0.300	98	Existing gravel access road
	7.800	85	Weighted Average
	7.500	84	96.15% Pervious Area
	0.300	98	3.85% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
54.0	300	0.0100	0.09		**Sheet Flow,** Grass: Dense n= 0.240 P2= 2.26"
11.9	500	0.0100	0.70		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
65.9	800	Total			

Subcatchment 4X-B: South of Belmont



Summary for Subcatchment 5S: Commercial Site

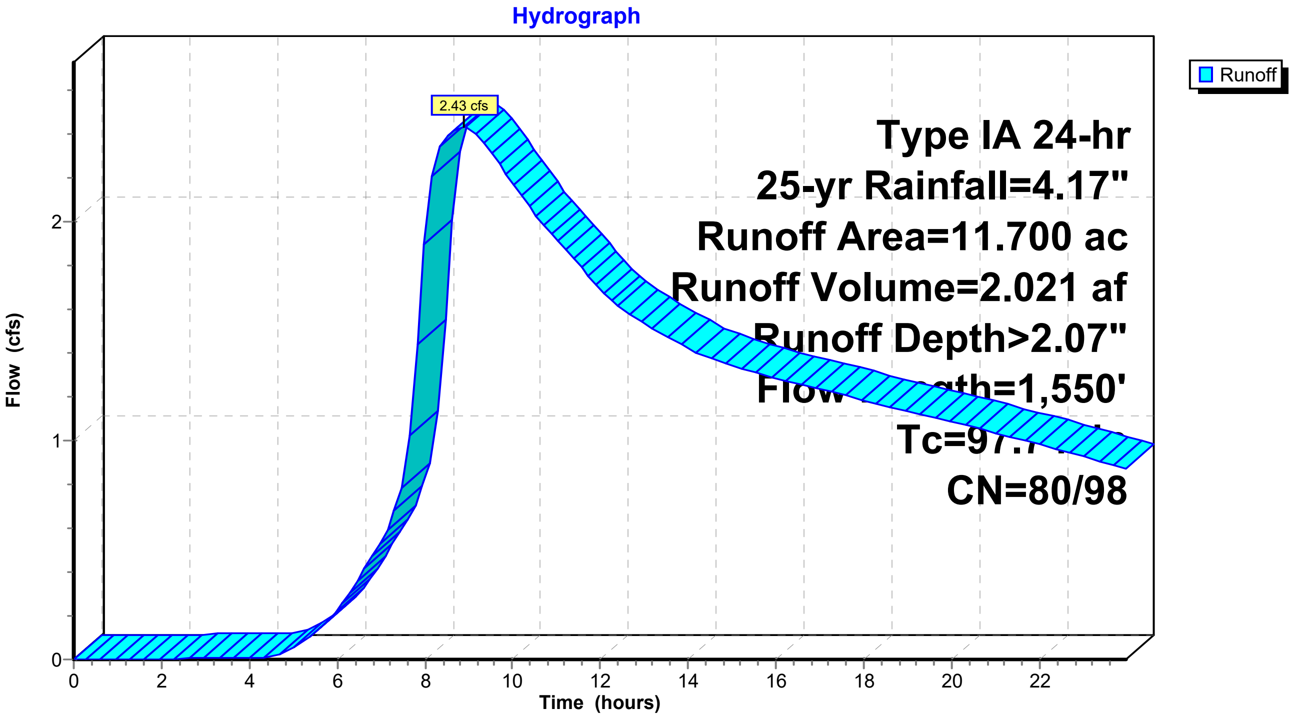
Runoff = 2.43 cfs @ 8.87 hrs, Volume= 2.021 af, Depth> 2.07"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-23.97 hrs, dt= 0.17 hrs
Type IA 24-hr 25-yr Rainfall=4.17"

	Area (ac)	CN	Description
	11.620	80	>75% Grass cover, Good, HSG D
*	0.080	98	Existing gravel
	11.700	80	Weighted Average
	11.620	80	99.32% Pervious Area
	0.080	98	0.68% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
71.2	300	0.0050	0.07		**Sheet Flow,** Grass: Dense n= 0.240 P2= 2.26"
1.6	100	0.0050	1.06		**Shallow Concentrated Flow,** Grassed Waterway Kv= 15.0 fps
24.9	1,150	0.0005	0.77	6.93	**Trap/Vee/Rect Channel Flow,** Bot.W=6.00' D=1.00' Z= 3.0 '/' Top.W=12.00' n= 0.035 High grass
97.7	1,550	Total			

Subcatchment 5S: Commercial Site



Summary for Subcatchment 5X: Commercial Site

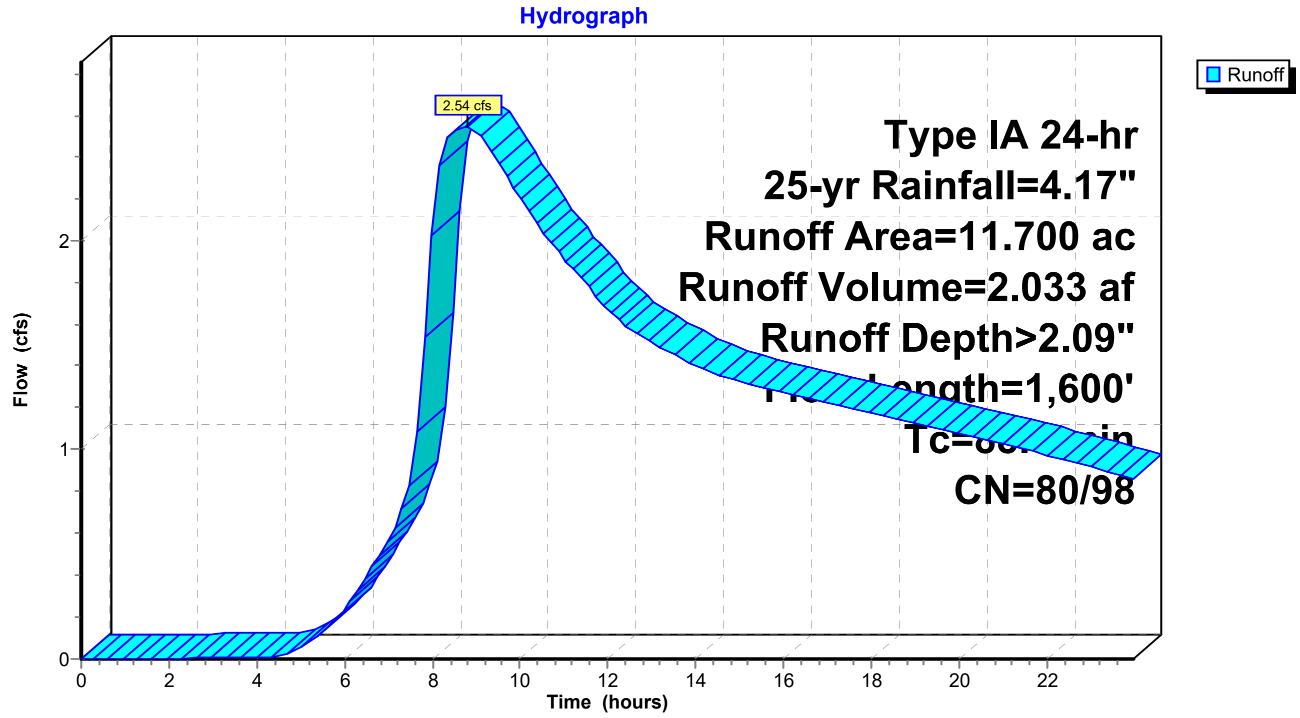
Runoff = 2.54 cfs @ 8.78 hrs, Volume= 2.033 af, Depth> 2.09"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-23.97 hrs, dt= 0.17 hrs
Type IA 24-hr 25-yr Rainfall=4.17"

	Area (ac)	CN	Description
	11.620	80	Pasture/grassland/range, Good, HSG D
*	0.080	98	existing gravel in south
	11.700	80	Weighted Average
	11.620	80	99.32% Pervious Area
	0.080	98	0.68% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
62.2	300	0.0070	0.08		**Sheet Flow,** Grass: Dense n= 0.240 P2= 2.26"
4.7	300	0.0050	1.06		**Shallow Concentrated Flow,** Grassed Waterway Kv= 15.0 fps
21.6	1,000	0.0005	0.77	6.93	**Trap/Vee/Rect Channel Flow,** Bot.W=6.00' D=1.00' Z= 3.0 '/' Top.W=12.00' n= 0.035 High grass
88.5	1,600	Total			

Subcatchment 5X: Commercial Site



Summary for Reach 7R: conveyance ditch

[81] Warning: Exceeded Pond 4P by 30.00' @ 0.00 hrs

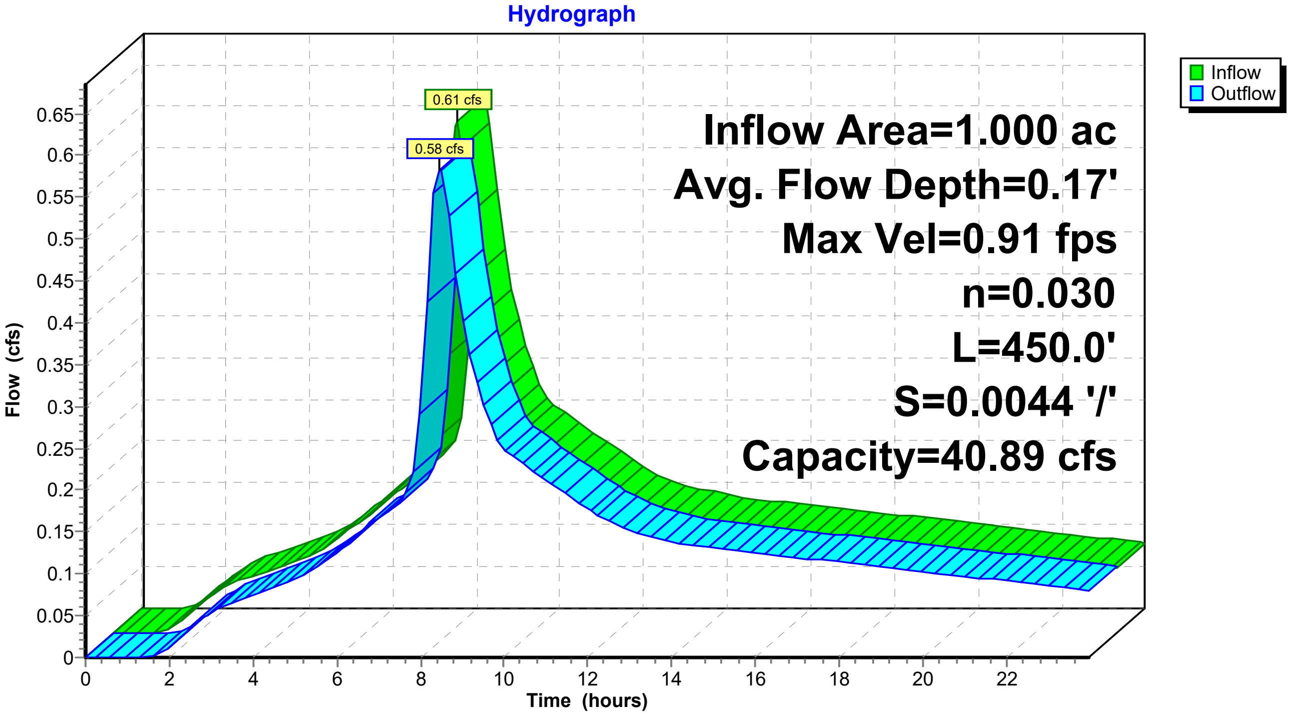
Inflow Area =	1.000 ac,	65.00% Impervious,	Inflow Depth > 3.26"	for 25-yr event	
Inflow =	0.61 cfs @	8.21 hrs,	Volume=	0.272 af	
Outflow =	0.58 cfs @	8.47 hrs,	Volume=	0.269 af,	Atten= 5%, Lag= 15.8 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-23.97 hrs, dt= 0.17 hrs
Max. Velocity= 0.91 fps, Min. Travel Time= 8.2 min
Avg. Velocity = 0.53 fps, Avg. Travel Time= 14.2 min

Peak Storage= 291 cf @ 8.33 hrs
Average Depth at Peak Storage= 0.17'
Bank-Full Depth= 1.50' Flow Area= 13.5 sf, Capacity= 40.89 cfs

3.00' x 1.50' deep channel, n= 0.030 Earth, grassed & winding
Side Slope Z-value= 4.0 '/' Top Width= 15.00'
Length= 450.0' Slope= 0.0044 '/'
Inlet Invert= 30.00', Outlet Invert= 28.00'

Reach 7R: conveyance ditch



Summary for Pond 1B: BIORET-1

```
Inflow Area =      0.850 ac, 76.47% Impervious, Inflow Depth >   3.50"   for 25-yr event
Inflow      =      0.74 cfs @   7.95 hrs, Volume=        0.248 af
Outflow     =      0.74 cfs @   7.95 hrs, Volume=        0.248 af, Atten= 0%, Lag= 0.0 min
Primary     =      0.74 cfs @   7.95 hrs, Volume=        0.248 af
```

Routing by Stor-Ind method, Time Span= 0.00-23.97 hrs, dt= 0.17 hrs
Peak Elev= 7.00' @ 7.95 hrs Surf.Area= 0.010 ac Storage= 0.000 af

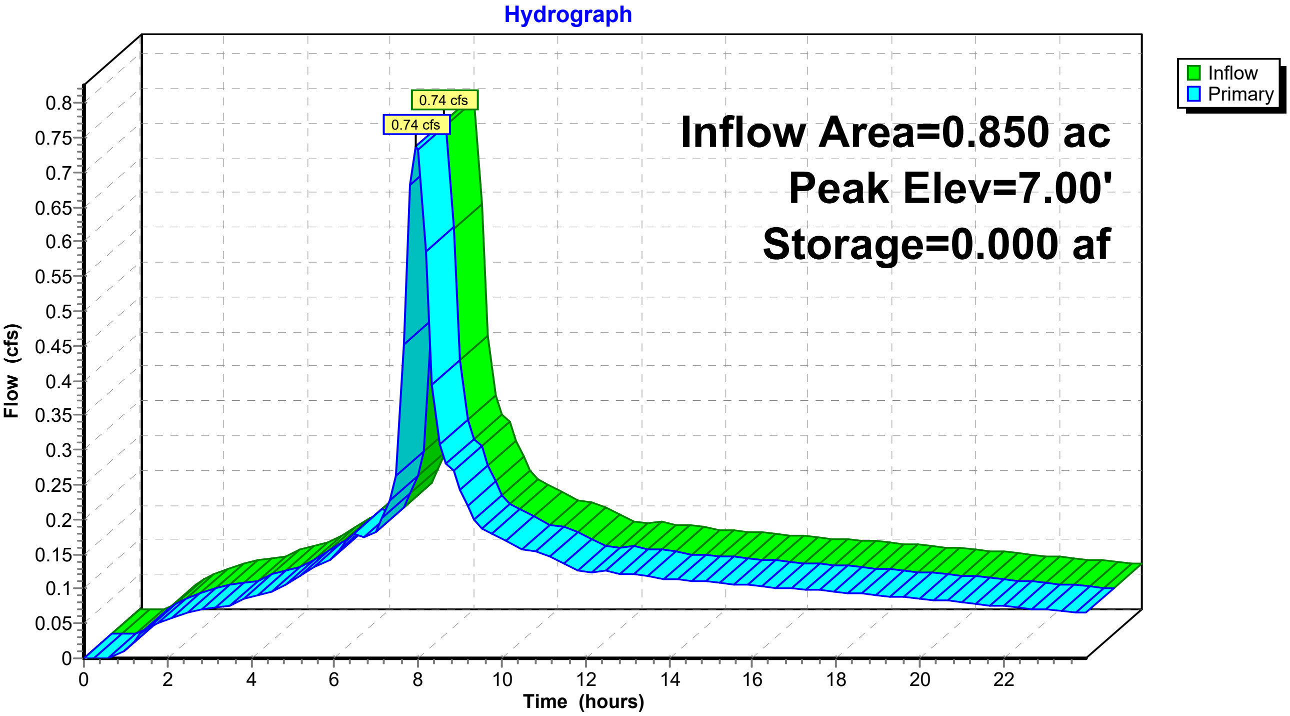
Plug-Flow detention time= 0.0 min calculated for 0.248 af (100% of inflow)
Center-of-Mass det. time= 0.0 min (681.4 - 681.4)

Volume	Invert	Avail.Storage	Storage Description
#1	7.00'	0.016 af	**5.00'W x 85.00'L x 1.00'H Prismatoid Z=3.0**

Device	Routing	Invert	Outlet Devices
#1	Primary	7.00'	**12.00 cfs Exfiltration X 0.25 at all elevations**
#2	Primary	7.50'	**50.0' long x 1.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 Coef. (English) 2.69 2.72 2.75 2.85 2.98 3.08 3.20 3.28 3.31 3.30 3.31 3.32

```
Primary OutFlow Max=3.00 cfs @ 7.95 hrs HW=7.00'  (Free Discharge)
├─1=Exfiltration (Exfiltration Controls 3.00 cfs)
└─2=Broad-Crested Rectangular Weir( Controls 0.00 cfs)
```

Pond 1B: BIORET-1



Summary for Pond 1P: NW CORNER

Inflow Area = 0.900 ac, 77.78% Impervious, Inflow Depth > 3.52" for 25-yr event
Inflow = 0.79 cfs @ 7.95 hrs, Volume= 0.264 af
Outflow = 0.48 cfs @ 8.33 hrs, Volume= 0.201 af, Atten= 39%, Lag= 23.1 min
Primary = 0.48 cfs @ 8.33 hrs, Volume= 0.201 af

Routing by Stor-Ind method, Time Span= 0.00-23.97 hrs, dt= 0.17 hrs
Peak Elev= 3.05' @ 8.33 hrs Surf.Area= 0.039 ac Storage= 0.072 af

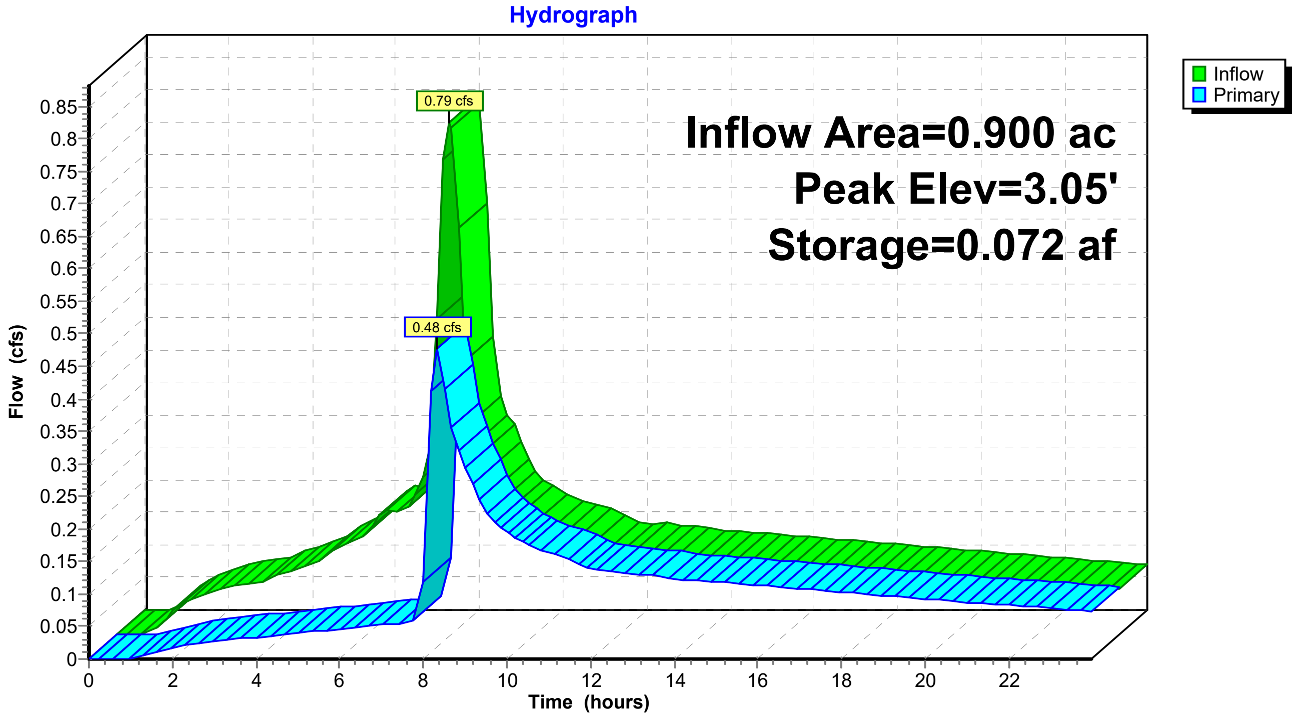
Plug-Flow detention time= 263.2 min calculated for 0.199 af (76% of inflow)
Center-of-Mass det. time= 110.5 min (790.6 - 680.2)

Volume	Invert	Avail.Storage	Storage Description
#1	0.00'	0.141 af	**9.00'W x 50.00'L x 4.50'H Prismatoid Z=2.7**

Device	Routing	Invert	Outlet Devices
#1	Primary	0.00'	**1.2" Vert. Orifice** C= 0.600
#2	Primary	3.50'	**24.0" Horiz. riser** C= 0.600 Limited to weir flow at low heads
#3	Primary	2.80'	**12.0" W x 8.4" H Vert. notch** C= 0.600

Primary OutFlow Max=0.48 cfs @ 8.33 hrs HW=3.05' (Free Discharge)
└**1=Orifice** (Orifice Controls 0.07 cfs @ 8.35 fps)
└**2=riser** (Controls 0.00 cfs)
└**3=notch** (Orifice Controls 0.41 cfs @ 1.62 fps)

Pond 1P: NW CORNER



Summary for Pond 2A: BIORET-2A

Inflow Area = 1.140 ac,100.00% Impervious, Inflow Depth > 3.93" for 25-yr event
Inflow = 1.13 cfs @ 7.94 hrs, Volume= 0.373 af
Outflow = 1.12 cfs @ 7.94 hrs, Volume= 0.373 af, Atten= 0%, Lag= 0.0 min
Primary = 1.12 cfs @ 7.94 hrs, Volume= 0.373 af

Routing by Stor-Ind method, Time Span= 0.00-23.97 hrs, dt= 0.17 hrs
Peak Elev= 5.00' @ 7.94 hrs Surf.Area= 0.016 ac Storage= 0.000 af

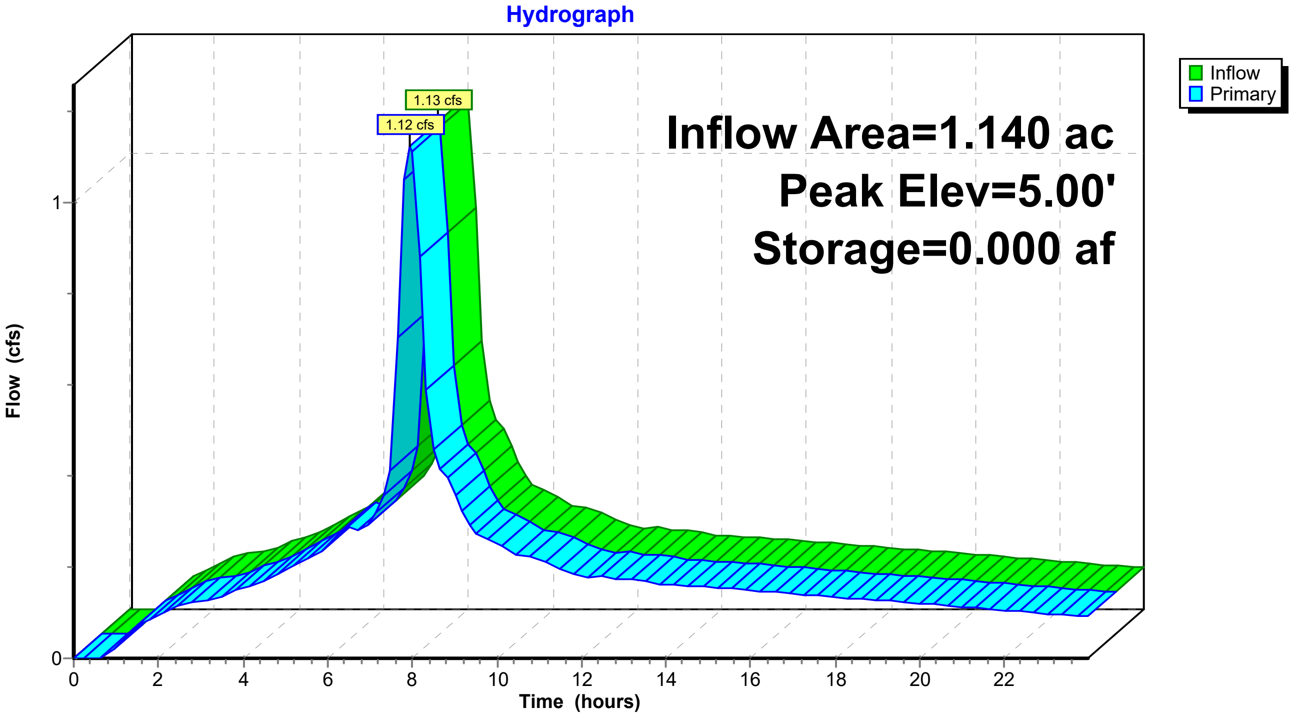
Plug-Flow detention time= 0.0 min calculated for 0.373 af (100% of inflow)
Center-of-Mass det. time= 0.0 min (661.6 - 661.6)

Volume	Invert	Avail.Storage	Storage Description
#1	5.00'	0.022 af	**10.00'W x 70.00'L x 1.00'H Prismatoid Z=3.0**

Device	Routing	Invert	Outlet Devices
#1	Primary	5.00'	**12.00 cfs Exfiltration X 0.25 at all elevations**
#2	Primary	5.50'	**50.0' long x 1.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 Coef. (English) 2.69 2.72 2.75 2.85 2.98 3.08 3.20 3.28 3.31 3.30 3.31 3.32

Primary OutFlow Max=3.00 cfs @ 7.94 hrs HW=5.00' (Free Discharge)
↑—**1=Exfiltration** (Exfiltration Controls 3.00 cfs)
└—**2=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond 2A: BIORET-2A



Summary for Pond 2B: BIORET-2B

Inflow Area =	4.120 ac,	83.25% Impervious,	Inflow Depth > 3.62"	for 25-yr event	
Inflow =	3.72 cfs @	7.94 hrs,	Volume=	1.243 af	
Outflow =	3.72 cfs @	7.95 hrs,	Volume=	1.243 af,	Atten= 0%, Lag= 0.0 min
Primary =	3.72 cfs @	7.95 hrs,	Volume=	1.243 af	

Routing by Stor-Ind method, Time Span= 0.00-23.97 hrs, dt= 0.17 hrs
Peak Elev= 6.00' @ 7.95 hrs Surf.Area= 0.046 ac Storage= 0.000 af

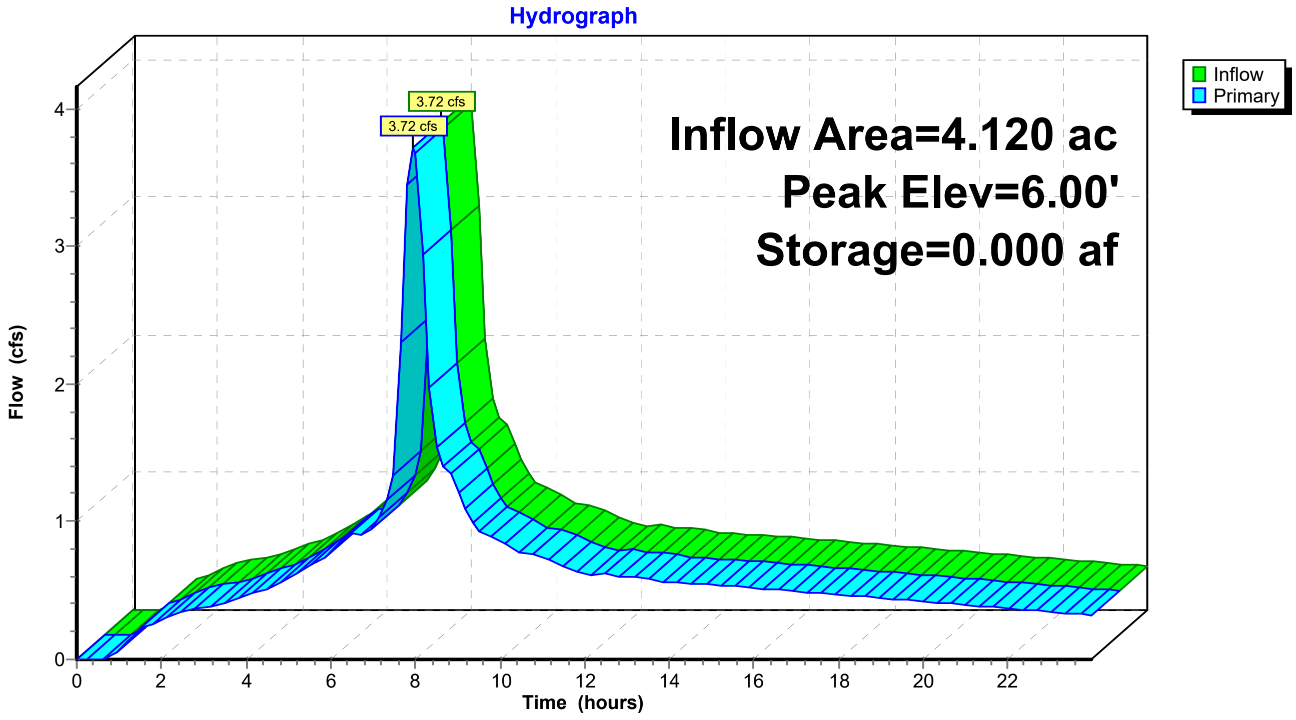
Plug-Flow detention time= 0.0 min calculated for 1.243 af (100% of inflow)
Center-of-Mass det. time= 0.0 min (675.2 - 675.2)

Volume	Invert	Avail.Storage	Storage Description
#1	6.00'	0.086 af	**25.00'W x 80.00'L x 1.50'H Prismatoid Z=3.0**

Device	Routing	Invert	Outlet Devices
#1	Primary	6.00'	**12.00 cfs Exfiltration X 0.25 at all elevations**
#2	Primary	1.00'	**24.0" Horiz. riser** C= 0.600 Limited to weir flow at low heads

Primary OutFlow Max=36.83 cfs @ 7.95 hrs HW=6.00' (Free Discharge)
↑—**1=Exfiltration** (Exfiltration Controls 3.00 cfs)
└—**2=riser** (Orifice Controls 33.83 cfs @ 10.77 fps)

Pond 2B: BIORET-2B



Summary for Pond 2P: West Pond

Inflow Area =	1.960 ac,	87.76% Impervious,	Inflow Depth > 3.70"	for 25-yr event	
Inflow =	1.81 cfs @	7.94 hrs,	Volume=	0.605 af	
Outflow =	0.25 cfs @	15.61 hrs,	Volume=	0.230 af,	Atten= 86%, Lag= 460.1 min
Primary =	0.25 cfs @	15.61 hrs,	Volume=	0.230 af	

Routing by Stor-Ind method, Time Span= 0.00-23.97 hrs, dt= 0.17 hrs
Peak Elev= 4.69' @ 15.61 hrs Surf.Area= 0.126 ac Storage= 0.382 af

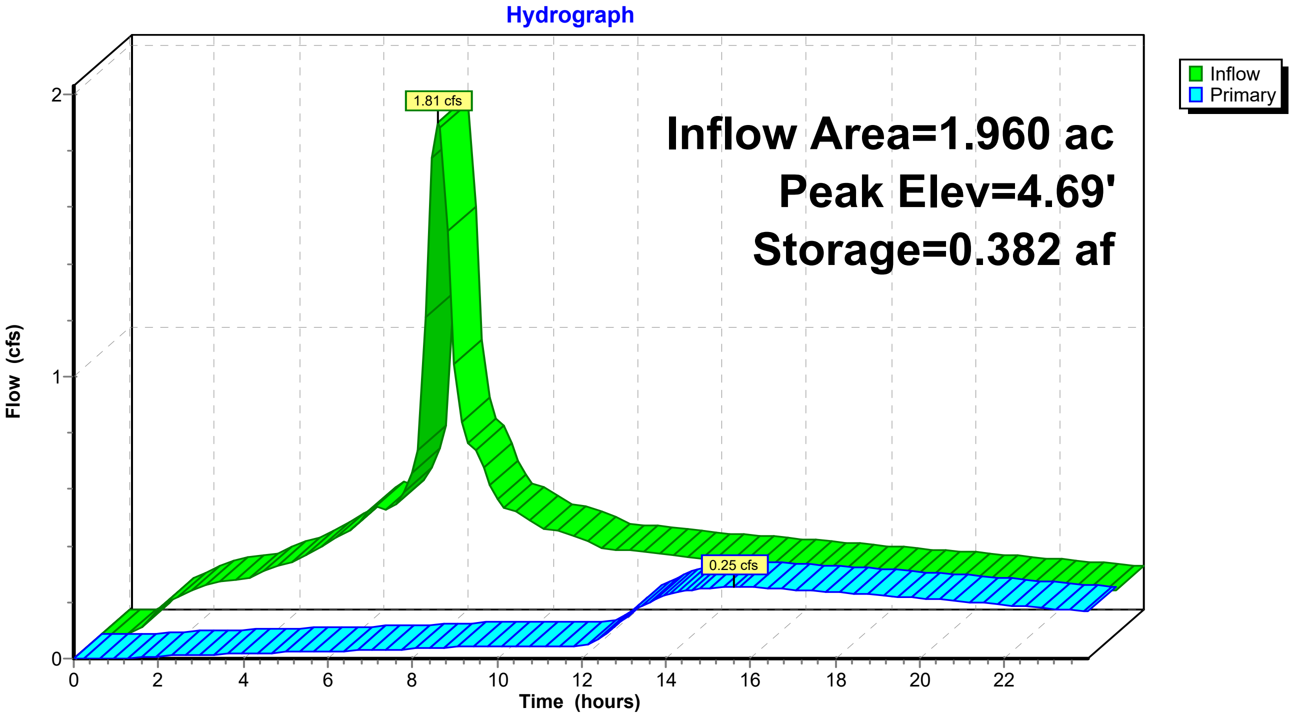
Plug-Flow detention time= 652.2 min calculated for 0.230 af (38% of inflow)
Center-of-Mass det. time= 347.6 min (1,018.9 - 671.3)

Volume	Invert	Avail.Storage	Storage Description
#1	0.00'	0.566 af	**25.00'W x 75.00'L x 6.00'H Prismatoid Z=3.0**

Device	Routing	Invert	Outlet Devices
#1	Primary	0.00'	**0.9" Vert. Orifice/Grate** C= 0.600
#2	Primary	4.50'	**9.0" W x 6.0" H Vert. notch** C= 0.600
#3	Primary	5.00'	**24.0" Horiz. riser** C= 0.600 Limited to weir flow at low heads

Primary OutFlow Max=0.25 cfs @ 15.61 hrs HW=4.69' (Free Discharge)
- **1=Orifice/Grate** (Orifice Controls 0.05 cfs @ 10.39 fps)
- **2=notch** (Orifice Controls 0.21 cfs @ 1.42 fps)
- **3=riser** (Controls 0.00 cfs)

Pond 2P: West Pond



Summary for Pond 3P: East Pond

[79] Warning: Submerged Pond 2B Primary device # 2 by 3.33'

Inflow Area = 4.540 ac, 79.96% Impervious, Inflow Depth > 3.54" for 25-yr event
Inflow = 3.99 cfs @ 7.95 hrs, Volume= 1.339 af
Outflow = 0.84 cfs @ 10.44 hrs, Volume= 0.876 af, Atten= 79%, Lag= 149.9 min
Primary = 0.84 cfs @ 10.44 hrs, Volume= 0.876 af

Routing by Stor-Ind method, Time Span= 0.00-23.97 hrs, dt= 0.17 hrs
Peak Elev= 4.33' @ 10.44 hrs Surf.Area= 7,468 sf Storage= 23,466 cf

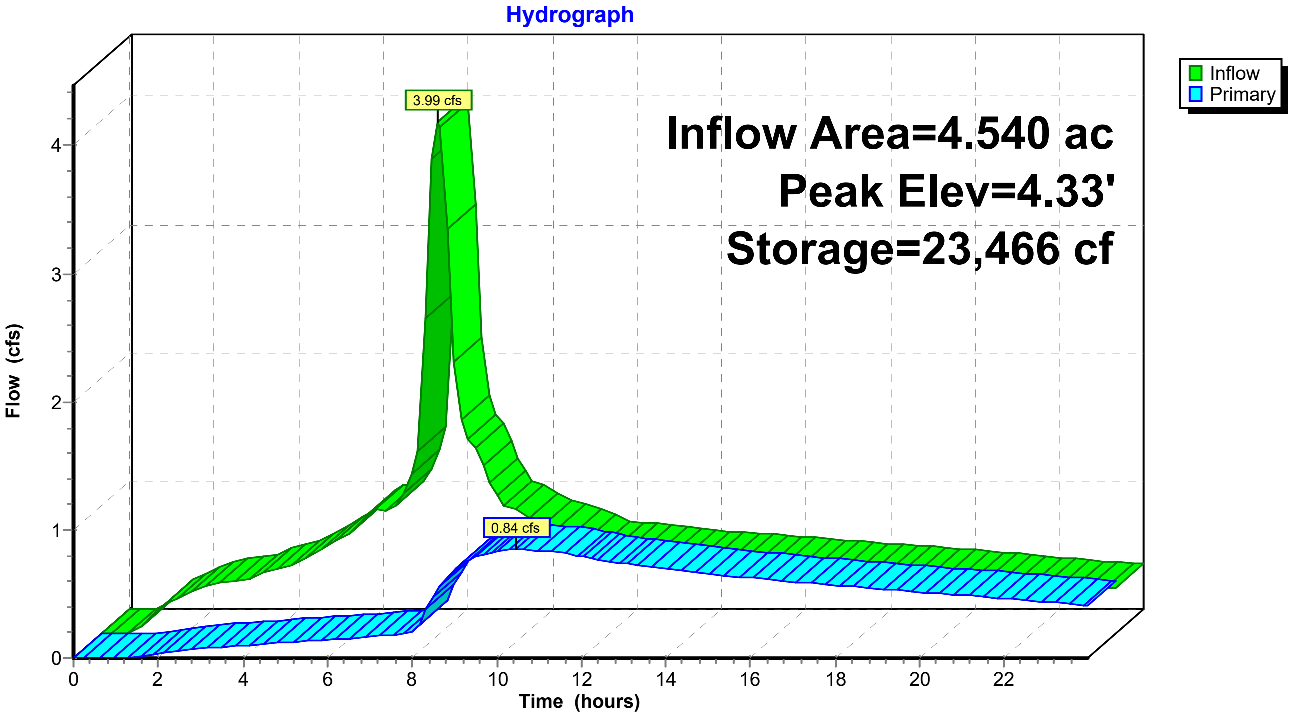
Plug-Flow detention time= 404.8 min calculated for 0.869 af (65% of inflow)
Center-of-Mass det. time= 198.4 min (876.7 - 678.2)

Volume	Invert	Avail.Storage	Storage Description
#1	0.00'	42,286 cf	**48.00'W x 75.00'L x 6.50'H Prismatoid Z=3.0**

Device	Routing	Invert	Outlet Devices
#1	Primary	0.00'	**2.1" Vert. Orifice** C= 0.600
#2	Primary	3.50'	**3.0" W x 24.0" H Vert. notch** C= 0.600
#3	Primary	5.50'	**24.0" Horiz. riser** C= 0.600 Limited to weir flow at low heads

Primary OutFlow Max=0.84 cfs @ 10.44 hrs HW=4.33' (Free Discharge)
├─**1=Orifice** (Orifice Controls 0.24 cfs @ 9.91 fps)
├─**2=notch** (Orifice Controls 0.60 cfs @ 2.92 fps)
└─**3=riser** (Controls 0.00 cfs)

Pond 3P: East Pond



Summary for Pond 4P: Wet Pond- Live Storage

```
Inflow Area =      1.000 ac, 65.00% Impervious, Inflow Depth >  3.31"   for 25-yr event
Inflow      =     0.82 cfs @   7.95 hrs, Volume=        0.276 af
Outflow     =     0.61 cfs @   8.21 hrs, Volume=        0.272 af, Atten= 25%, Lag= 15.5 min
Primary     =     0.61 cfs @   8.21 hrs, Volume=        0.272 af
```

Routing by Stor-Ind method, Time Span= 0.00-23.97 hrs, dt= 0.17 hrs
Peak Elev= 0.73' @ 8.21 hrs Surf.Area= 2,363 sf Storage= 1,120 cf

Plug-Flow detention time= 35.9 min calculated for 0.272 af (99% of inflow)
Center-of-Mass det. time= 25.1 min (717.6 - 692.5)

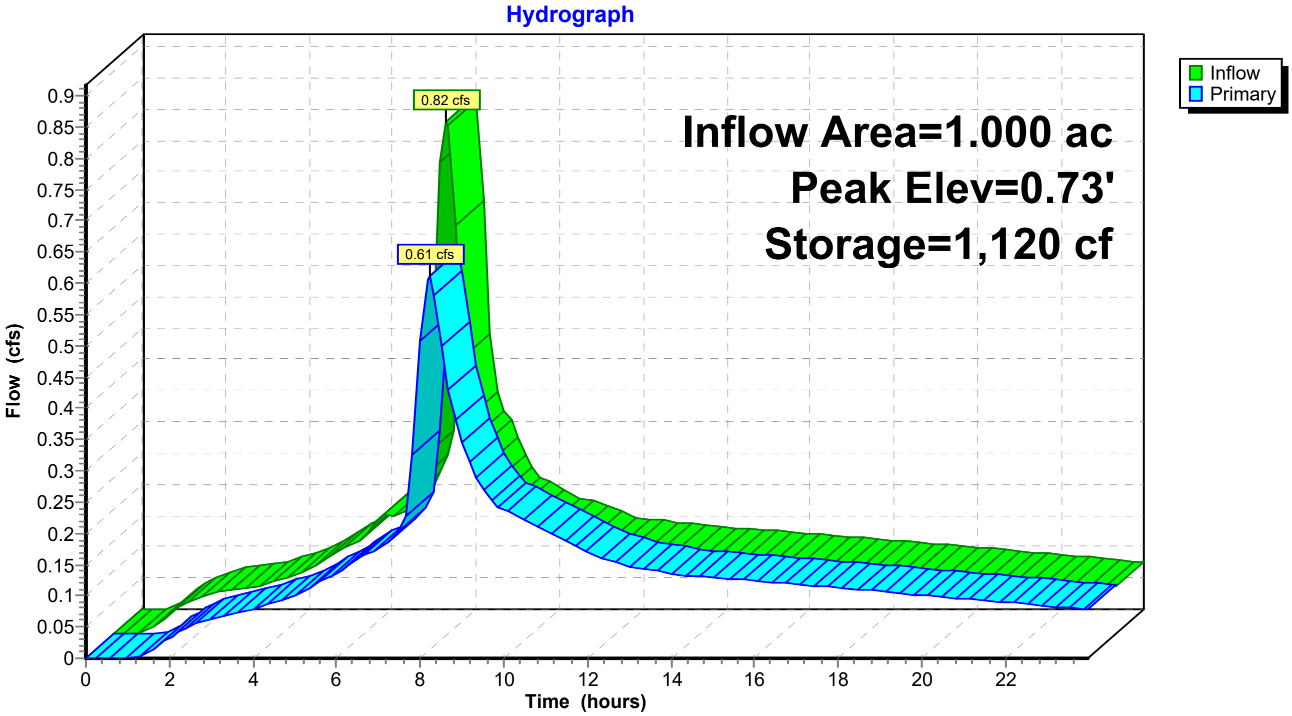
Volume	Invert	Avail.Storage	Storage Description
#1	0.00'	9,172 cf	**Live Storage (Prismatic)**Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
0.00	704	0	0
1.00	2,975	1,840	1,840
2.00	3,662	3,319	5,158
3.00	4,366	4,014	9,172

Device	Routing	Invert	Outlet Devices
#1	Primary	0.00'	**4.0" Vert. Orifice** C= 0.600
#2	Primary	0.50'	**10.0" W x 18.0" H Vert. Notch** C= 0.600
#3	Primary	2.00'	**18.0" Horiz. Riser** C= 0.600 Limited to weir flow at low heads

```
Primary OutFlow Max=0.60 cfs @ 8.21 hrs  HW=0.72'   (Free Discharge)
├─1=Orifice  (Orifice Controls 0.31 cfs @ 3.60 fps)
├─2=Notch  (Orifice Controls 0.28 cfs @ 1.52 fps)
└─3=Riser  ( Controls 0.00 cfs)
```

Pond 4P: Wet Pond- Live Storage



Summary for Pond 5P: Wet Pond- Live Storage

Inflow Area = 10.300 ac, 45.63% Impervious, Inflow Depth > 2.90" for 25-yr event
Inflow = 4.65 cfs @ 8.00 hrs, Volume= 2.491 af
Outflow = 3.09 cfs @ 8.72 hrs, Volume= 2.319 af, Atten= 33%, Lag= 43.0 min
Primary = 3.09 cfs @ 8.72 hrs, Volume= 2.319 af

Routing by Stor-Ind method, Time Span= 0.00-23.97 hrs, dt= 0.17 hrs
Peak Elev= 1.14' @ 8.72 hrs Surf.Area= 14,243 sf Storage= 14,360 cf

Plug-Flow detention time= 109.4 min calculated for 2.303 af (92% of inflow)
Center-of-Mass det. time= 63.9 min (810.2 - 746.4)

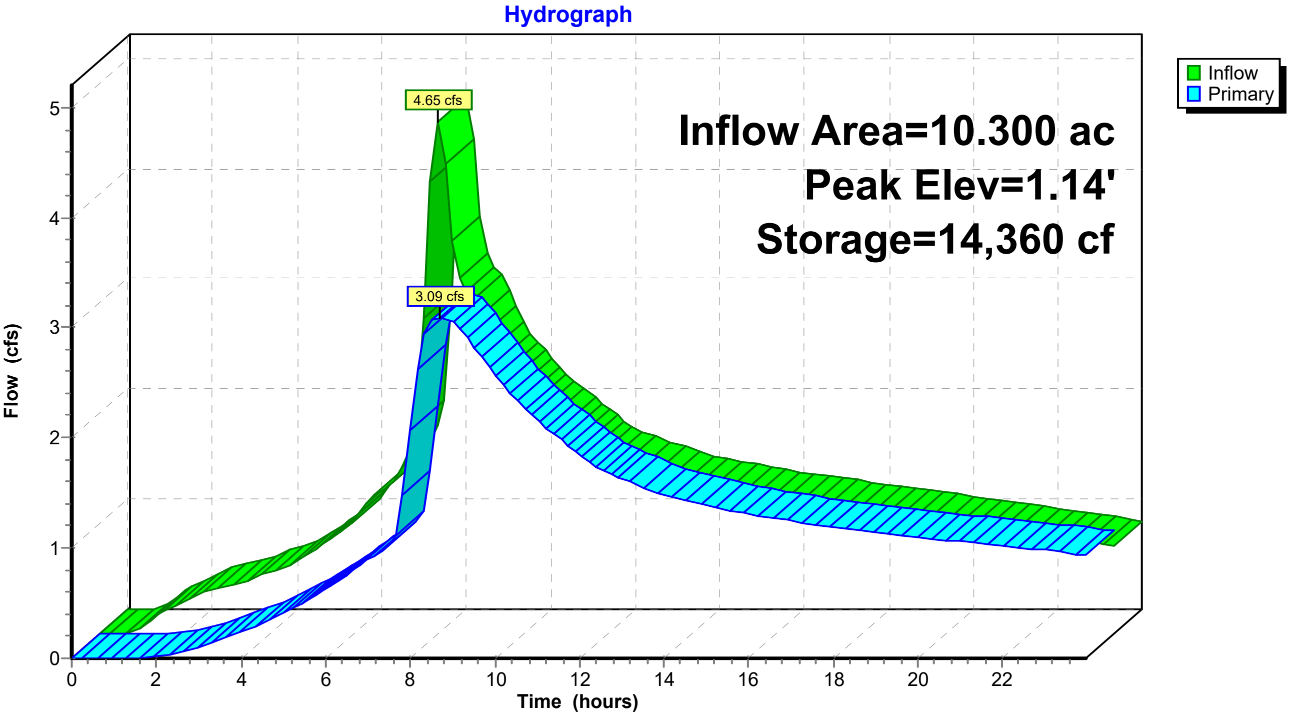
Volume	Invert	Avail.Storage	Storage Description
#1	0.00'	44,950 cf	**Live Storage (Prismatic)**Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
0.00	10,800	0	0
1.00	13,900	12,350	12,350
2.00	16,300	15,100	27,450
3.00	18,700	17,500	44,950

Device	Routing	Invert	Outlet Devices
#1	Primary	0.00'	**8.0" Vert. Orifice/Grate** C= 0.600
#2	Primary	0.75'	**24.0" W x 15.0" H Vert. Notch** C= 0.600
#3	Primary	2.00'	**24.0" Horiz. Riser** C= 0.600 Limited to weir flow at low heads

Primary OutFlow Max=3.09 cfs @ 8.72 hrs HW=1.14' (Free Discharge)
├─**1=Orifice/Grate** (Orifice Controls 1.51 cfs @ 4.33 fps)
├─**2=Notch** (Orifice Controls 1.58 cfs @ 2.01 fps)
└─**3=Riser** (Controls 0.00 cfs)

Pond 5P: Wet Pond- Live Storage



Summary for Pond 6P: 4P-Wet Pond-Live Storage - CORRECTED

[43] Hint: Has no inflow (Outflow=Zero)

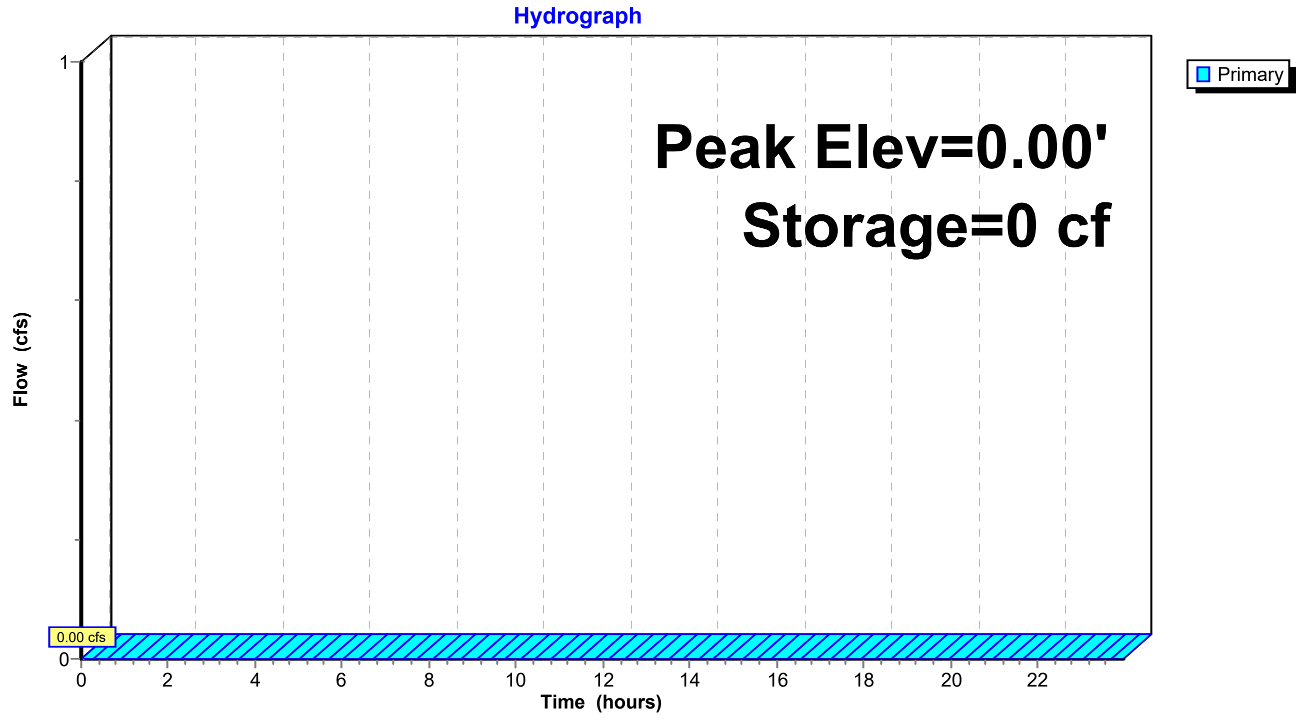
Volume	Invert	Avail.Storage	Storage Description
#1	0.00'	13,900 cf	**Live Storage (Prismatic)**Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
0.00	2,750	0	0
1.00	4,225	3,488	3,488
2.00	5,200	4,713	8,200
3.00	6,200	5,700	13,900

Device	Routing	Invert	Outlet Devices
#1	Primary	0.00'	**4.0" Vert. Orifice** C= 0.600
#2	Primary	0.50'	**10.0" W x 18.0" H Vert. Notch** C= 0.600
#3	Primary	2.00'	**18.0" Horiz. Riser** C= 0.600 Limited to weir flow at low heads

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=0.00' (Free Discharge)
1=Orifice (Controls 0.00 cfs)
2=Notch (Controls 0.00 cfs)
3=Riser (Controls 0.00 cfs)

Pond 6P: 4P-Wet Pond-Live Storage - CORRECTED



Summary for Pond 8P: 4P- Wet Pond- Dead Storage

[43] Hint: Has no inflow (Outflow=Zero)

Volume	Invert	Avail.Storage	Storage Description
#1	-3.00'	4,748 cf	**Dead Storage (Prismatic)**Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
-3.00	457	0	0
-2.00	1,213	835	835
-1.00	1,928	1,571	2,406
0.00	2,756	2,342	4,748

Summary for Pond 9P: 5P- Dead Storage

[43] Hint: Has no inflow (Outflow=Zero)

Volume	Invert	Avail.Storage	Storage Description
#1	-3.00'	17,914 cf	**Live Storage (Prismatic)**Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
-3.00	3,156	0	0
-2.00	4,660	3,908	3,908
-1.00	6,276	5,468	9,376
0.00	10,800	8,538	17,914

Summary for Pond 10P: 5P-Wet Pond- Live Storage - CORRECTED

[43] Hint: Has no inflow (Outflow=Zero)

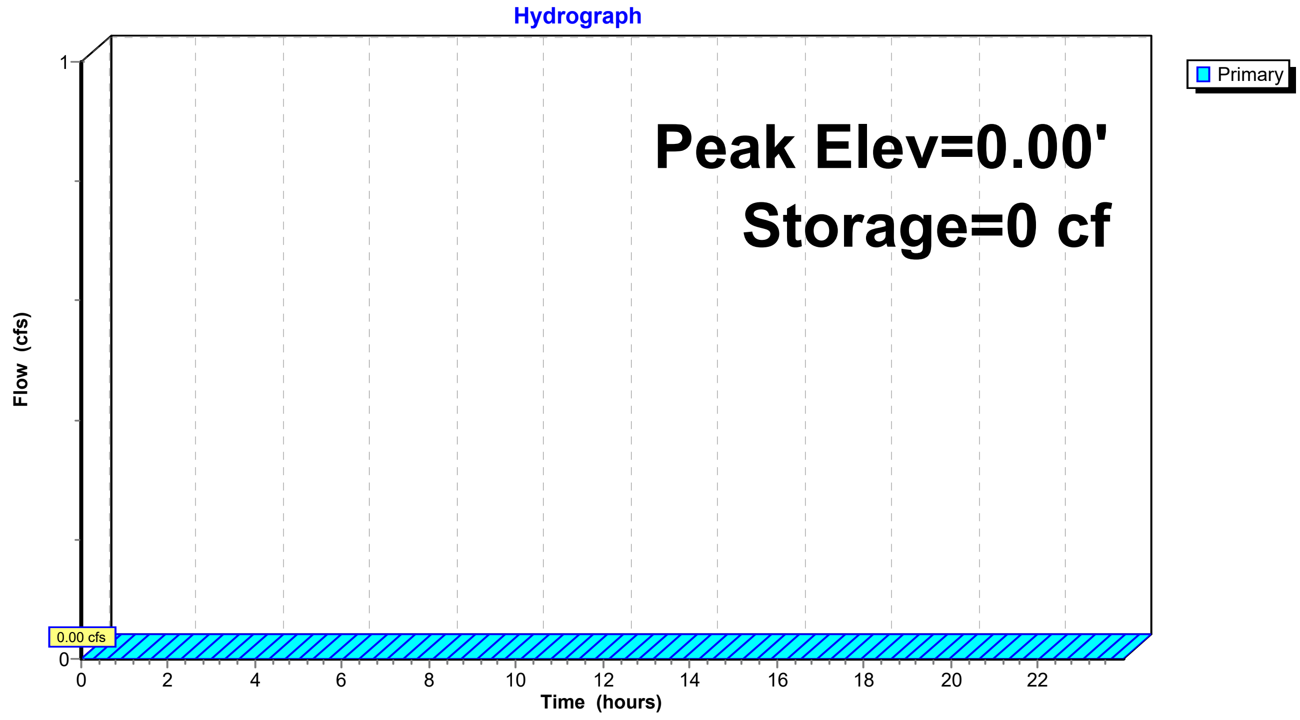
Volume	Invert	Avail.Storage	Storage Description
#1	0.00'	71,500 cf	**Live Storage (Prismatic)**Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
0.00	19,000	0	0
1.00	22,700	20,850	20,850
2.00	25,300	24,000	44,850
3.00	28,000	26,650	71,500

Device	Routing	Invert	Outlet Devices
#1	Primary	0.00'	**8.0" Vert. Orifice/Grate** C= 0.600
#2	Primary	0.75'	**24.0" W x 15.0" H Vert. Notch** C= 0.600
#3	Primary	2.00'	**24.0" Horiz. Riser** C= 0.600 Limited to weir flow at low heads

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=0.00' (Free Discharge)
↑**1=Orifice/Grate** (Controls 0.00 cfs)
2=Notch (Controls 0.00 cfs)
3=Riser (Controls 0.00 cfs)

Pond 10P: 5P-Wet Pond- Live Storage - CORRECTED



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                    Time span=0.00-24.00 hrs, dt=0.17 hrs, 142 points
                     Runoff by SBUH method, Split Pervious/Imperv.
          Reach routing by Stor-Ind+Trans method  -  Pond routing by Stor-Ind method

Subcatchment1S-A: Site - Post Basin      Runoff Area=0.850 ac   76.47% Impervious   Runoff Depth>5.55"
                                                   Tc=5.0 min   CN=79/98   Runoff=1.17 cfs  0.393 af

Subcatchment1S-B: (new Subcat)          Runoff Area=0.050 ac   100.00% Impervious   Runoff Depth>6.05"
                                                    Tc=5.0 min   CN=0/98   Runoff=0.08 cfs  0.025 af

Subcatchment1X: Pre                      Runoff Area=1.800 ac    1.11% Impervious   Runoff Depth>3.33"
                                                  Tc=19.0 min   CN=73/98   Runoff=1.13 cfs  0.500 af

Subcatchment2S-A1: Site -WEST           Runoff Area=1.140 ac   100.00% Impervious   Runoff Depth>6.05"
                                                    Tc=5.0 min   CN=0/98   Runoff=1.71 cfs  0.575 af

Subcatchment2S-A2: Site -WEST (roof      Runoff Area=0.820 ac   70.73% Impervious   Runoff Depth>5.43"
                                                   Tc=5.0 min   CN=79/98   Runoff=1.11 cfs  0.371 af

Subcatchment2S-B1: Site - EAST           Runoff Area=3.620 ac   80.94% Impervious   Runoff Depth>5.65"
                                                   Tc=5.0 min   CN=79/98   Runoff=5.08 cfs  1.703 af

Subcatchment2S-B2: POND                  Runoff Area=0.420 ac   47.62% Impervious   Runoff Depth>4.68"
                                                   Tc=5.0 min   CN=74/98   Runoff=0.48 cfs  0.164 af

Subcatchment2S-C: OFFSITE ROAD          Runoff Area=0.500 ac   100.00% Impervious   Runoff Depth>6.05"
                                                    Tc=5.0 min   CN=0/98   Runoff=0.75 cfs  0.252 af

Subcatchment2X-A: Pre-DEV - [WEST]        Runoff Area=1.300 ac   0.00% Impervious   Runoff Depth>3.29"
                     Flow Length=285'   Slope=0.1700 '/'   Tc=25.1 min   CN=73/0   Runoff=0.75 cfs  0.357 af

Subcatchment2X-B: Pre- DEV [EAST]         Runoff Area=3.900 ac   0.00% Impervious   Runoff Depth>3.26"
                                Flow Length=750'   Tc=42.8 min   CN=73/0   Runoff=1.82 cfs  1.060 af

Subcatchment2X-C: PRE- OFFSITE ROAD      Runoff Area=0.500 ac   36.00% Impervious   Runoff Depth>4.31"
                                                   Tc=5.0 min   CN=73/98   Runoff=0.52 cfs  0.179 af

Subcatchment3S: Green Mtn Rd             Runoff Area=1.000 ac   65.00% Impervious   Runoff Depth>5.35"
                                                   Tc=5.0 min   CN=80/98   Runoff=1.33 cfs  0.445 af

Subcatchment3X: PRE- GRN MTN CONN        Runoff Area=1.000 ac   12.00% Impervious   Runoff Depth>4.66"
                                                   Tc=5.0 min   CN=84/98   Runoff=1.19 cfs  0.388 af

Subcatchment4S-A: BELMONT RD             Runoff Area=2.500 ac   76.00% Impervious   Runoff Depth>5.57"
                                                   Tc=5.0 min   CN=80/98   Runoff=3.46 cfs  1.160 af

Subcatchment4S-B: SOUTH OF BELMONT Runoff Area=7.000 ac   28.57% Impervious   Runoff Depth>4.44"
                              Flow Length=1,050'   Tc=87.5 min   CN=80/98   Runoff=3.63 cfs  2.592 af

Subcatchment4S-C: WET POND              Runoff Area=0.800 ac   100.00% Impervious   Runoff Depth>6.05"
                                                    Tc=5.0 min   CN=0/98   Runoff=1.20 cfs  0.403 af
```

Subcatchment 4X-A: PRE - BELMONT RD Runoff Area=2.500 ac 20.00% Impervious Runoff Depth>4.65"
Flow Length=850' Slope=0.0100 '/' Tc=67.1 min CN=84/98 Runoff=1.55 cfs 0.970 af

Subcatchment 4X-B: South of Belmont Runoff Area=7.800 ac 3.85% Impervious Runoff Depth>4.40"
Flow Length=800' Slope=0.0100 '/' Tc=65.9 min CN=84/98 Runoff=4.61 cfs 2.861 af

Subcatchment 5S: Commercial Site Runoff Area=11.700 ac 0.68% Impervious Runoff Depth>3.87"
Flow Length=1,550' Tc=97.7 min CN=80/98 Runoff=4.92 cfs 3.769 af

Subcatchment 5X: Commercial Site Runoff Area=11.700 ac 0.68% Impervious Runoff Depth>3.89"
Flow Length=1,600' Tc=88.5 min CN=80/98 Runoff=5.17 cfs 3.789 af

Reach 7R: conveyance ditch Avg. Flow Depth=0.24' Max Vel=1.09 fps Inflow=1.08 cfs 0.440 af
n=0.030 L=450.0' S=0.0044 '/' Capacity=40.89 cfs Outflow=1.04 cfs 0.436 af

Pond 1B: BIORET-1 Peak Elev=7.00' Storage=0.000 af Inflow=1.17 cfs 0.393 af
Outflow=1.17 cfs 0.393 af

Pond 1P: NW CORNER Peak Elev=3.28' Storage=0.081 af Inflow=1.25 cfs 0.418 af
Outflow=1.12 cfs 0.354 af

Pond 2A: BIORET-2A Peak Elev=5.01' Storage=0.000 af Inflow=1.71 cfs 0.575 af
Outflow=1.71 cfs 0.575 af

Pond 2B: BIORET-2B Peak Elev=6.00' Storage=0.000 af Inflow=5.83 cfs 1.955 af
Outflow=5.83 cfs 1.955 af

Pond 2P: West Pond Peak Elev=4.93' Storage=0.413 af Inflow=2.82 cfs 0.946 af
Outflow=0.73 cfs 0.564 af

Pond 3P: East Pond Peak Elev=5.31' Storage=31,316 cf Inflow=6.31 cfs 2.119 af
Outflow=2.22 cfs 1.616 af

Pond 4P: Wet Pond- Live Storage Peak Elev=0.91' Storage=1,594 cf Inflow=1.33 cfs 0.445 af
Outflow=1.08 cfs 0.440 af

Pond 5P: Wet Pond- Live Storage Peak Elev=1.49' Storage=19,453 cf Inflow=7.77 cfs 4.155 af
Outflow=5.90 cfs 3.923 af

Pond 6P: 4P-Wet Pond-Live Storage - CORRECTED Peak Elev=0.00' Storage=0 cf
Primary=0.00 cfs 0.000 af

Pond 8P: 4P- Wet Pond- Dead Storage Peak Elev=0.00' Storage=4,748 cf

Pond 9P: 5P- Dead Storage Peak Elev=0.00' Storage=17,914 cf

Pond 10P: 5P-Wet Pond- Live Storage - CORRECTED Peak Elev=0.00' Storage=0 cf
Primary=0.00 cfs 0.000 af

Total Runoff Area = 60.900 ac Runoff Volume = 21.956 af Average Runoff Depth = 4.33"
79.18% Pervious = 48.220 ac 20.82% Impervious = 12.680 ac

Summary for Subcatchment 1S-A: Site - Post Basin NPGS

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

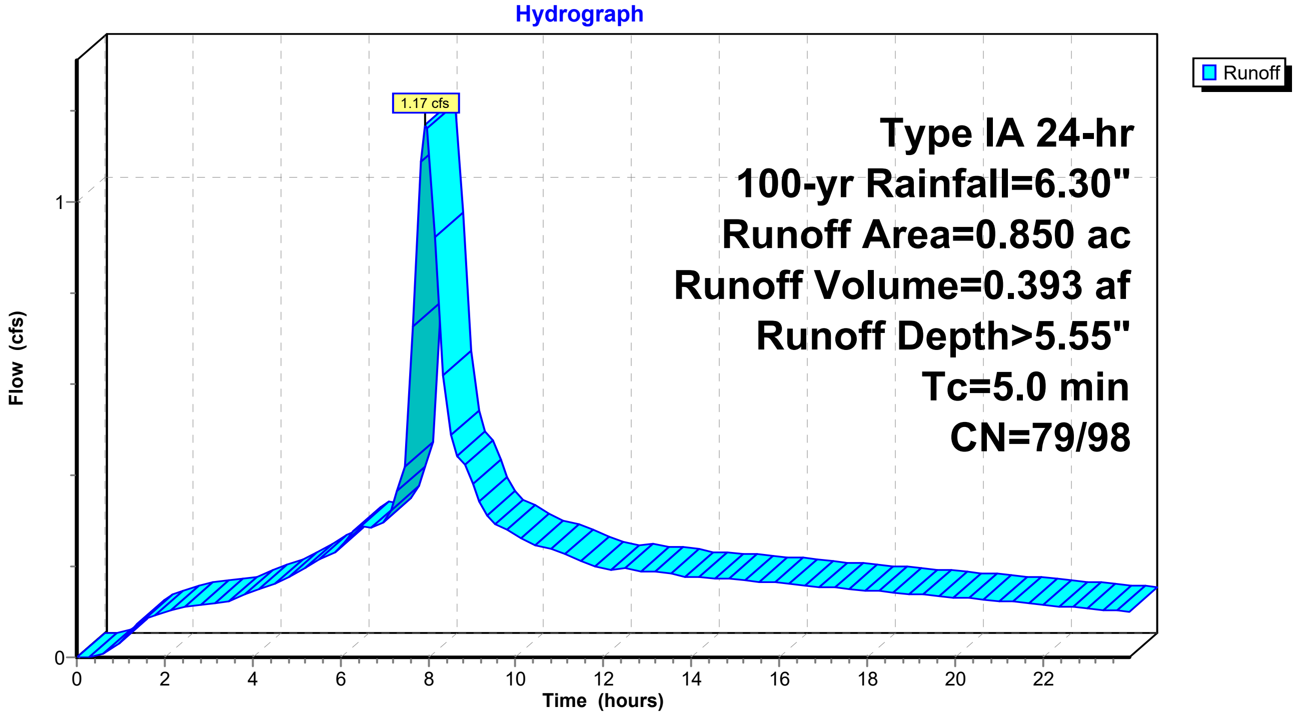
Runoff = 1.17 cfs @ 7.95 hrs, Volume= 0.393 af, Depth> 5.55"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-23.97 hrs, dt= 0.17 hrs
Type IA 24-hr 100-yr Rainfall=6.30"

	Area (ac)	CN	Description
*	0.370	98	roof areas
	0.200	79	50-75% Grass cover, Fair, HSG C
*	0.280	98	parking
	0.850	94	Weighted Average
	0.200	79	23.53% Pervious Area
	0.650	98	76.47% Impervious Area

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

Subcatchment 1S-A: Site - Post Basin NPGS



Summary for Subcatchment 1S-B: (new Subcat)

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

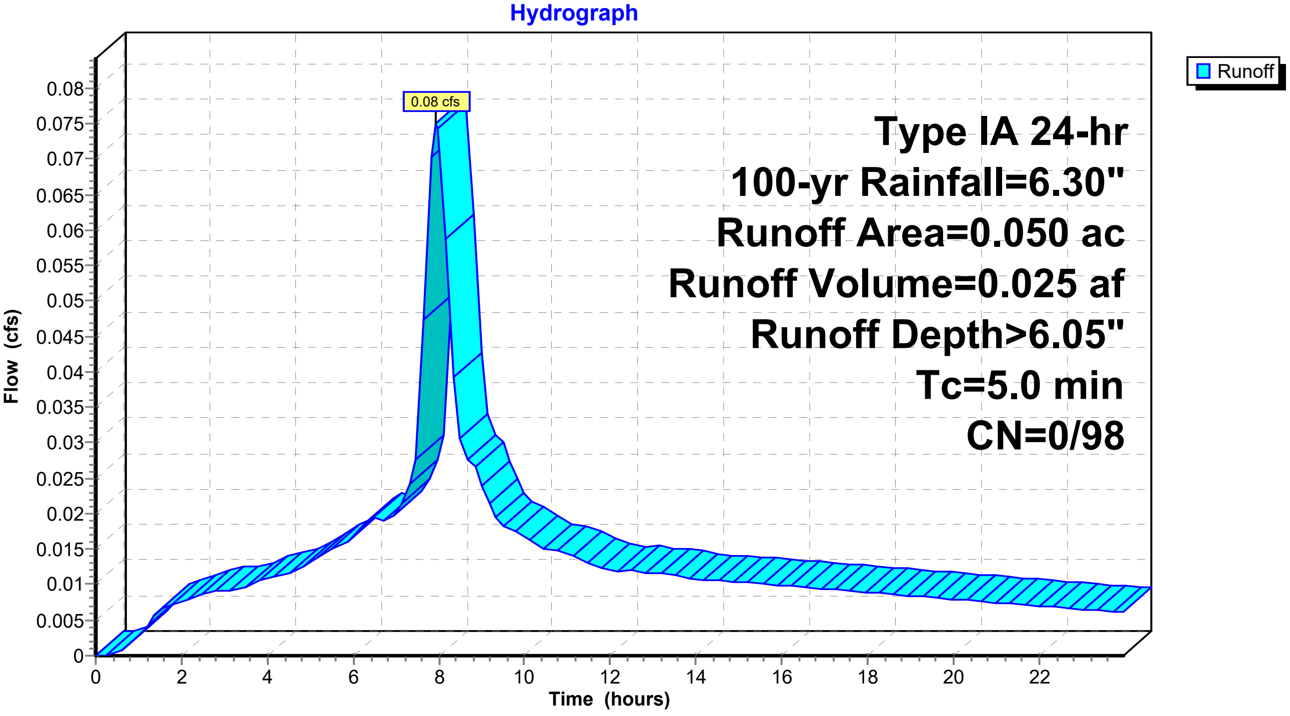
Runoff = 0.08 cfs @ 7.94 hrs, Volume= 0.025 af, Depth> 6.05"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-23.97 hrs, dt= 0.17 hrs
Type IA 24-hr 100-yr Rainfall=6.30"

	Area (ac)	CN	Description
*	0.050	98	pond surface at Q100
	0.050	98	100.00% Impervious Area

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

Subcatchment 1S-B: (new Subcat)



Summary for Subcatchment 1X: Pre

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

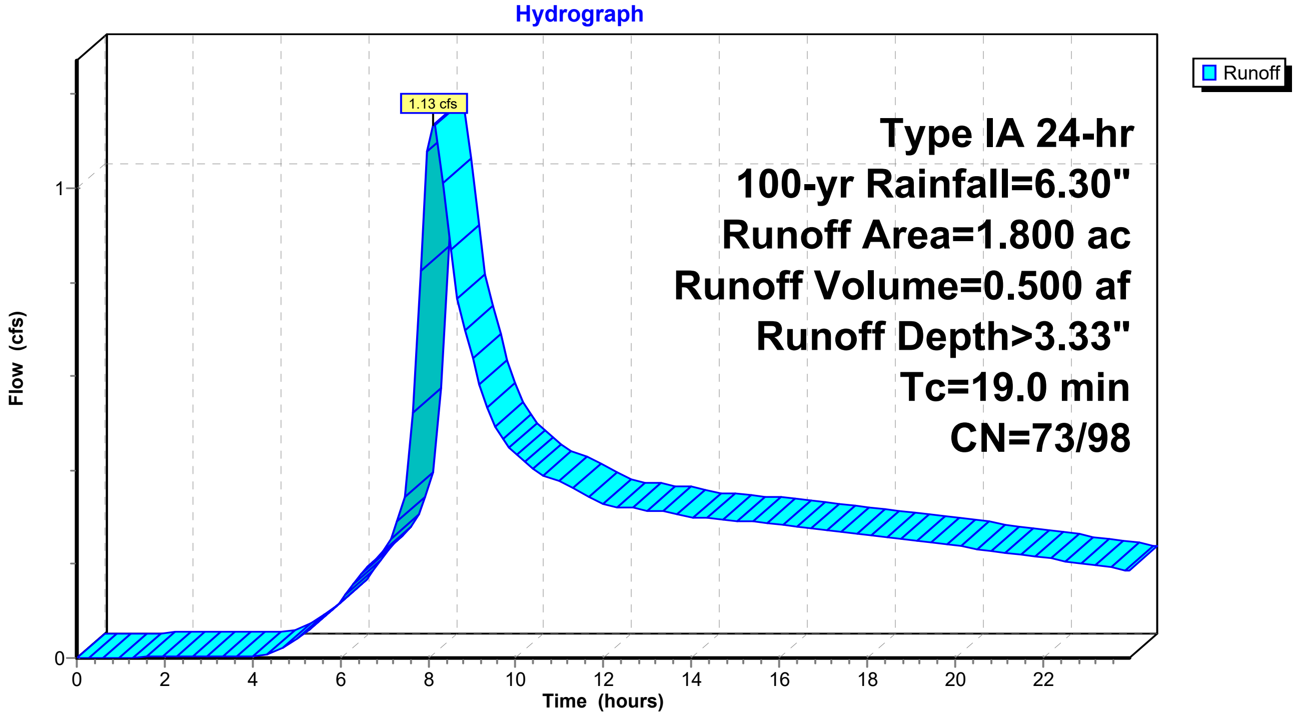
Runoff = 1.13 cfs @ 8.13 hrs, Volume= 0.500 af, Depth> 3.33"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-23.97 hrs, dt= 0.17 hrs
Type IA 24-hr 100-yr Rainfall=6.30"

	Area (ac)	CN	Description
	1.780	73	Woods, Fair, HSG C
*	0.020	98	PORTION OF GREEN MTN LOOP
	1.800	73	Weighted Average
	1.780	73	98.89% Pervious Area
	0.020	98	1.11% Impervious Area

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

Subcatchment 1X: Pre



Summary for Subcatchment 2S-A1: Site -WEST

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

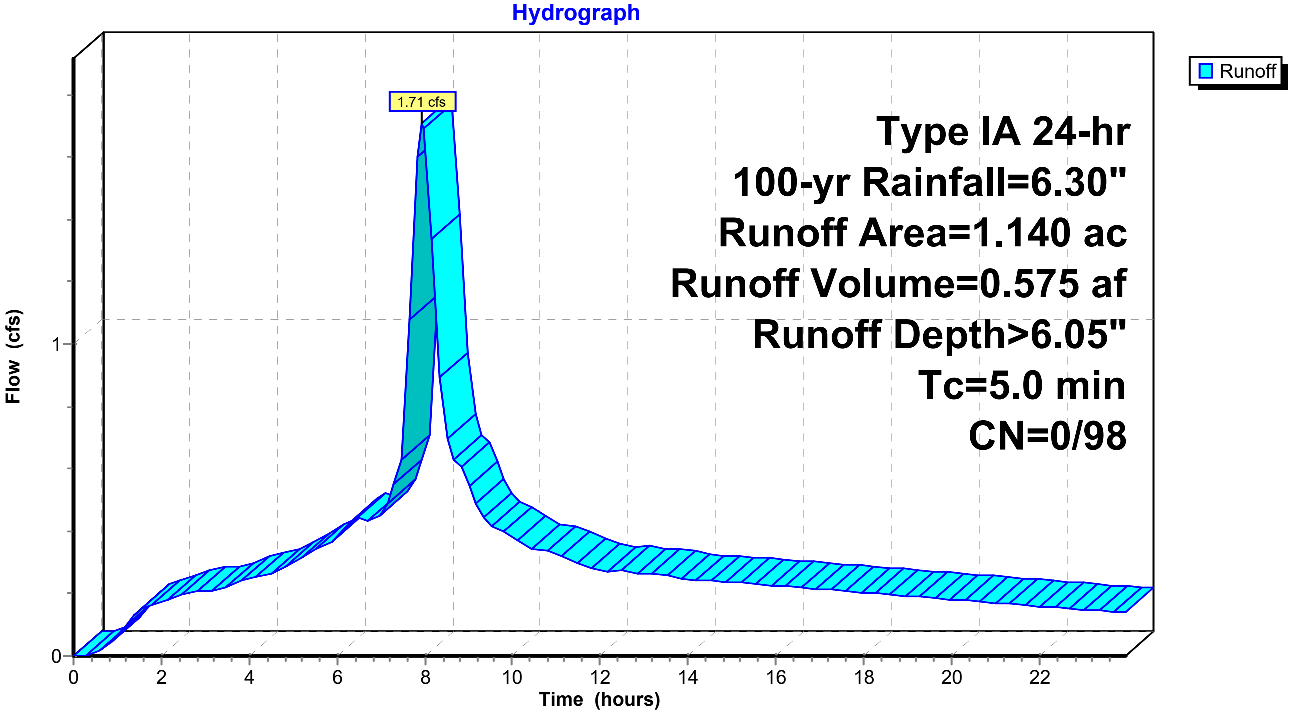
Runoff = 1.71 cfs @ 7.94 hrs, Volume= 0.575 af, Depth> 6.05"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-23.97 hrs, dt= 0.17 hrs
Type IA 24-hr 100-yr Rainfall=6.30"

	Area (ac)	CN	Description
*	0.390	98	roof areas- bldg E, half building
*	0.750	98	drive/parking
	1.140	98	Weighted Average
	1.140	98	100.00% Impervious Area

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

Subcatchment 2S-A1: Site -WEST



Summary for Subcatchment 2S-A2: Site -WEST (roof areas & pond)

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

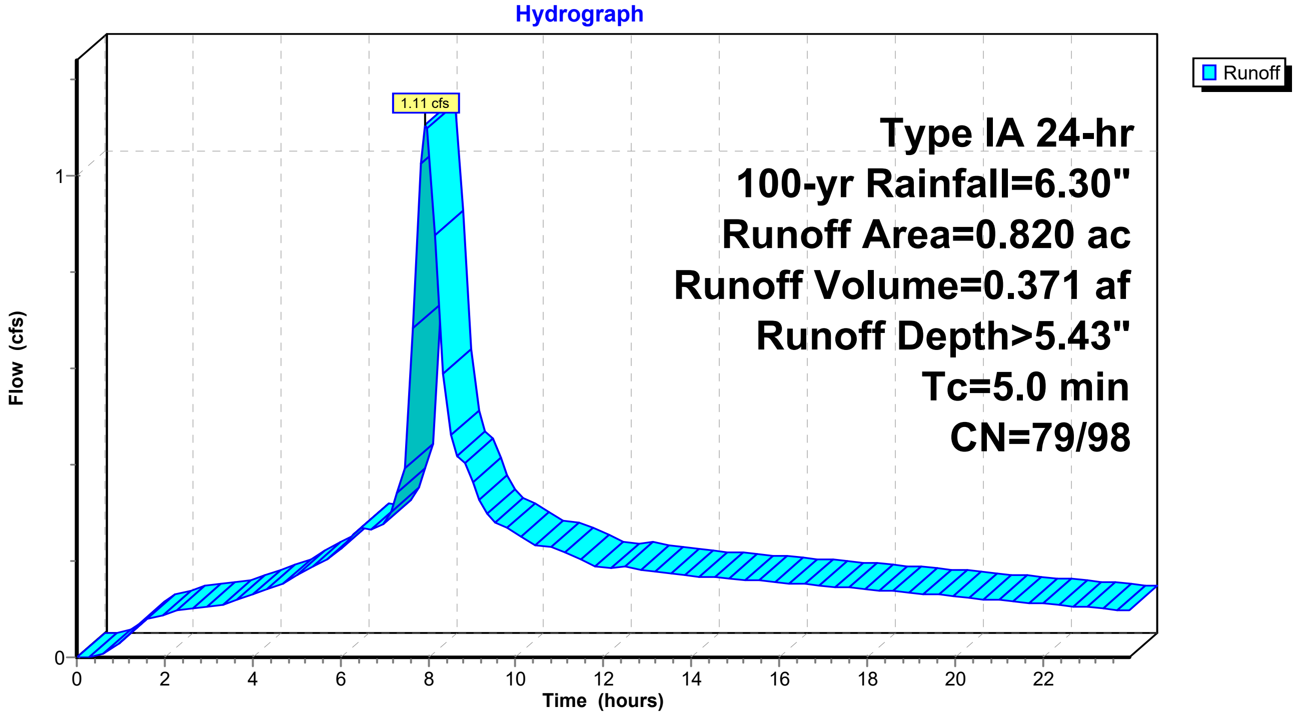
Runoff = 1.11 cfs @ 7.95 hrs, Volume= 0.371 af, Depth> 5.43"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-23.97 hrs, dt= 0.17 hrs
Type IA 24-hr 100-yr Rainfall=6.30"

	Area (ac)	CN	Description
*	0.450	98	roof areas
*	0.130	98	pond
	0.240	79	50-75% Grass cover, Fair, HSG C
	0.820	92	Weighted Average
	0.240	79	29.27% Pervious Area
	0.580	98	70.73% Impervious Area

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

Subcatchment 2S-A2: Site -WEST (roof areas & pond)



Summary for Subcatchment 2S-B1: Site - EAST

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

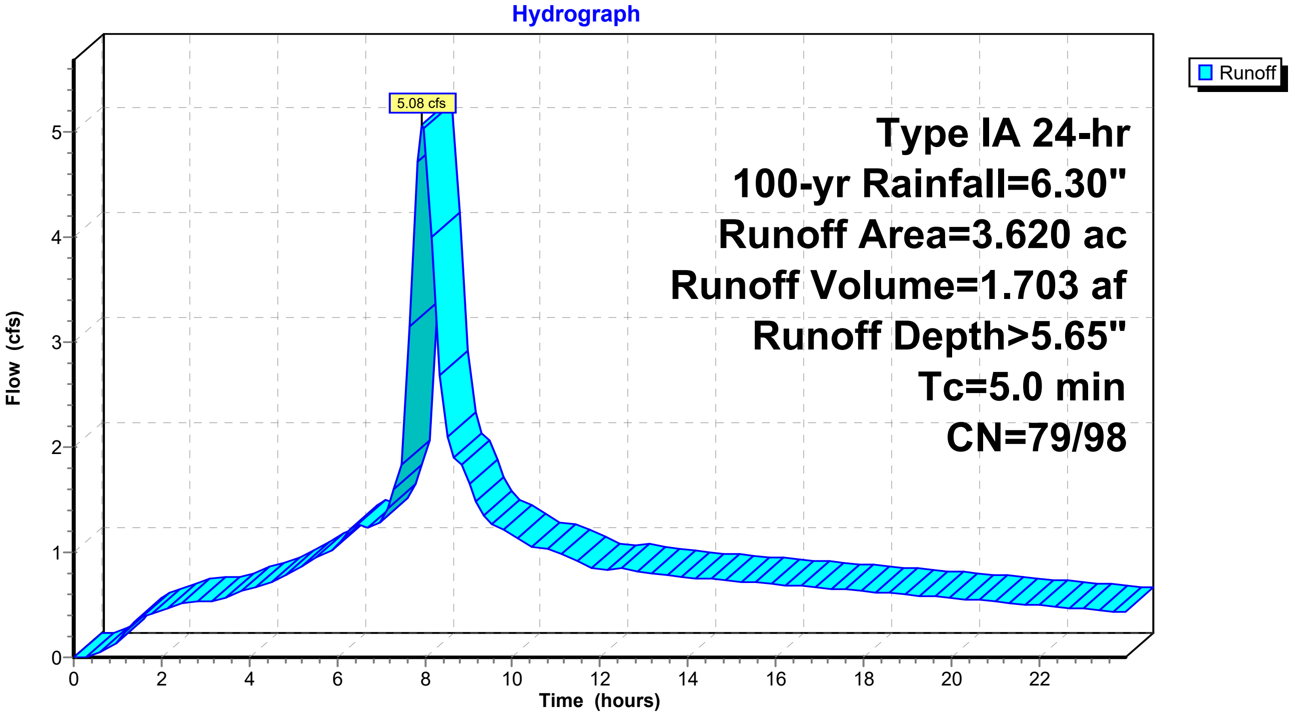
Runoff = 5.08 cfs @ 7.94 hrs, Volume= 1.703 af, Depth> 5.65"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-23.97 hrs, dt= 0.17 hrs
Type IA 24-hr 100-yr Rainfall=6.30"

	Area (ac)	CN	Description
*	0.870	98	roof areas
*	2.060	98	PARKING AND DRIVE AISLE
	0.690	79	50-75% Grass cover, Fair, HSG C
	3.620	94	Weighted Average
	0.690	79	19.06% Pervious Area
	2.930	98	80.94% Impervious Area

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

Subcatchment 2S-B1: Site - EAST



Summary for Subcatchment 2S-B2: POND

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

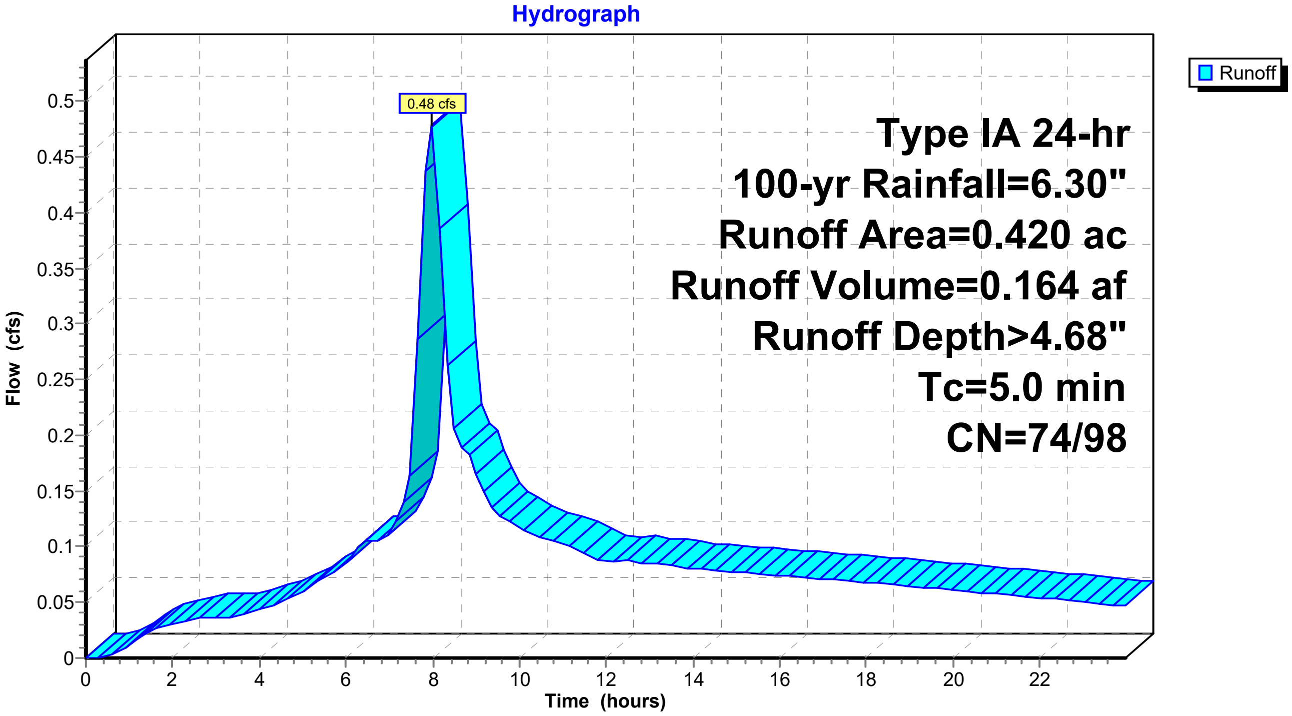
Runoff = 0.48 cfs @ 7.96 hrs, Volume= 0.164 af, Depth> 4.68"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-23.97 hrs, dt= 0.17 hrs
Type IA 24-hr 100-yr Rainfall=6.30"

	Area (ac)	CN	Description
*	0.200	98	POND AT Q100
	0.220	74	>75% Grass cover, Good, HSG C
	0.420	85	Weighted Average
	0.220	74	52.38% Pervious Area
	0.200	98	47.62% Impervious Area

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

Subcatchment 2S-B2: POND



Summary for Subcatchment 2S-C: OFFSITE ROAD

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

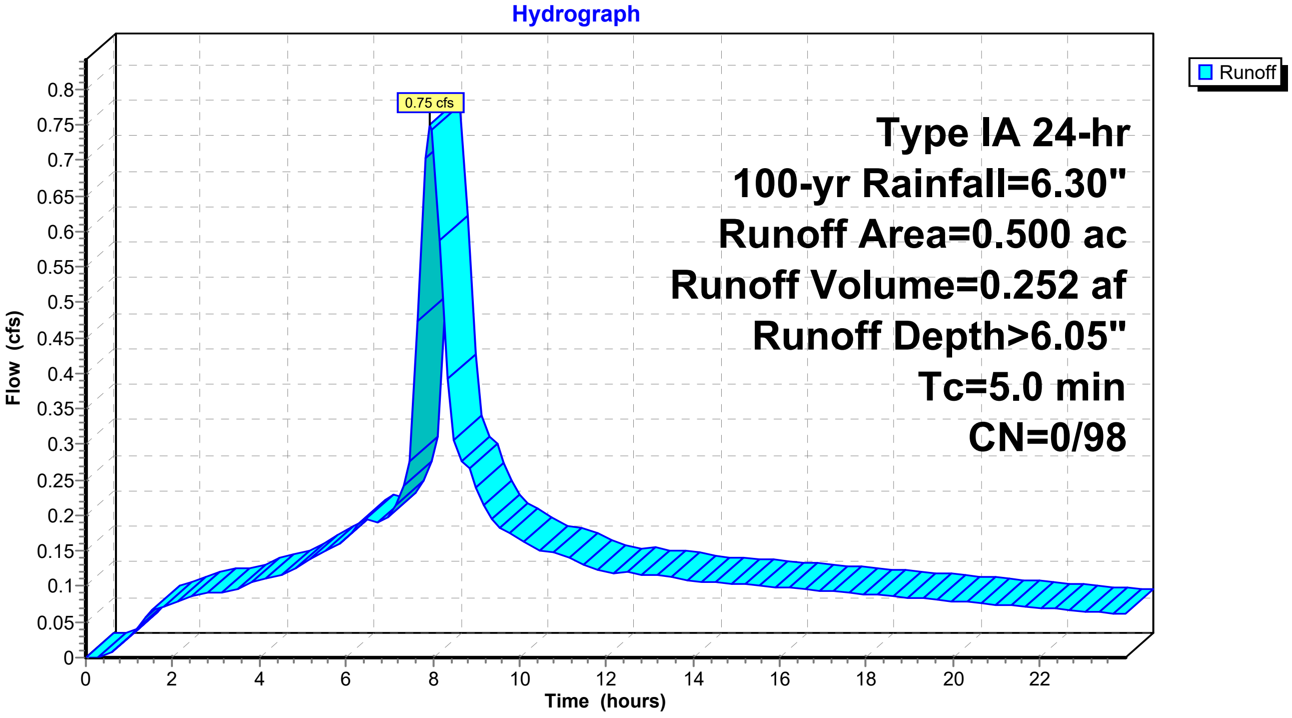
Runoff = 0.75 cfs @ 7.94 hrs, Volume= 0.252 af, Depth> 6.05"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-23.97 hrs, dt= 0.17 hrs
Type IA 24-hr 100-yr Rainfall=6.30"

	Area (ac)	CN	Description
*	0.500	98	GREEN MTN LOOP & RD
	0.500	98	100.00% Impervious Area

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

Subcatchment 2S-C: OFFSITE ROAD



Summary for Subcatchment 2X-A: Pre-DEV - [WEST]

BASIN 30S-A - 1S TO THE NORTH

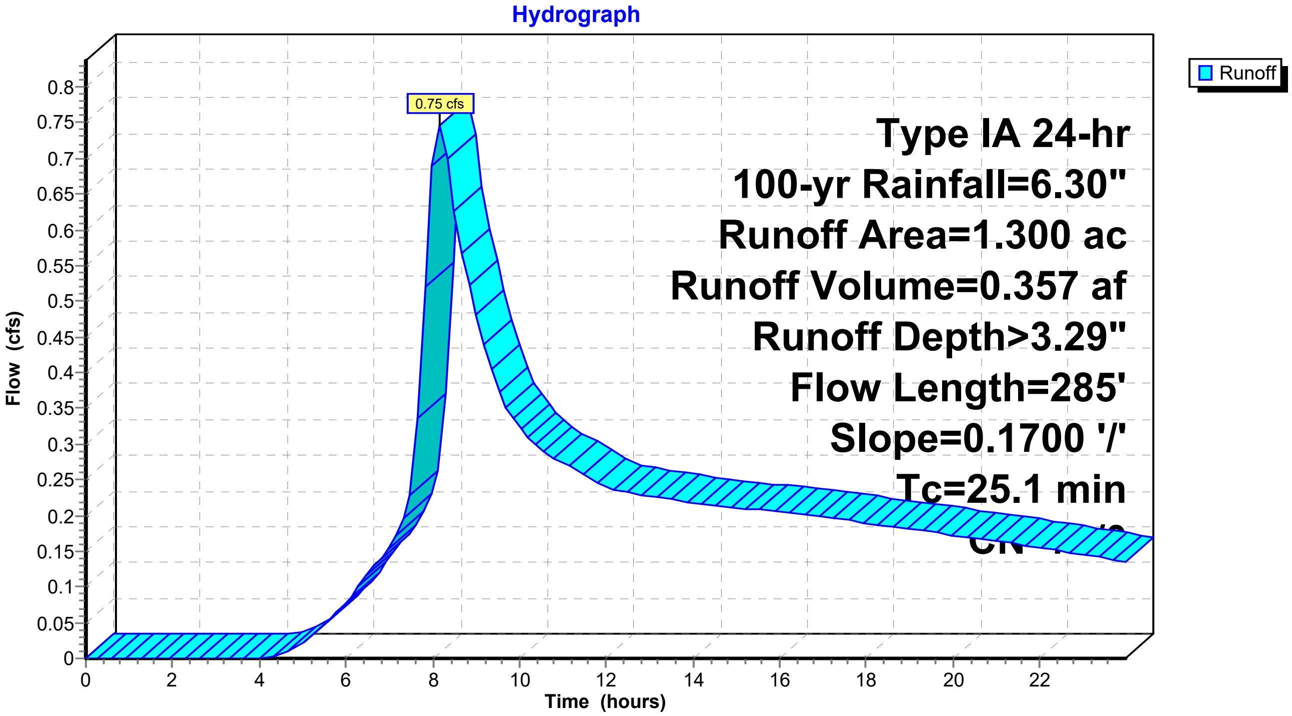
Runoff = 0.75 cfs @ 8.17 hrs, Volume= 0.357 af, Depth> 3.29"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-23.97 hrs, dt= 0.17 hrs
Type IA 24-hr 100-yr Rainfall=6.30"

Area (ac)	CN	Description
1.300	73	Woods, Fair, HSG C
1.300	73	100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
25.1	285	0.1700	0.19		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 2.26"

Subcatchment 2X-A: Pre-DEV - [WEST]



Summary for Subcatchment 2X-B: Pre- DEV [EAST]

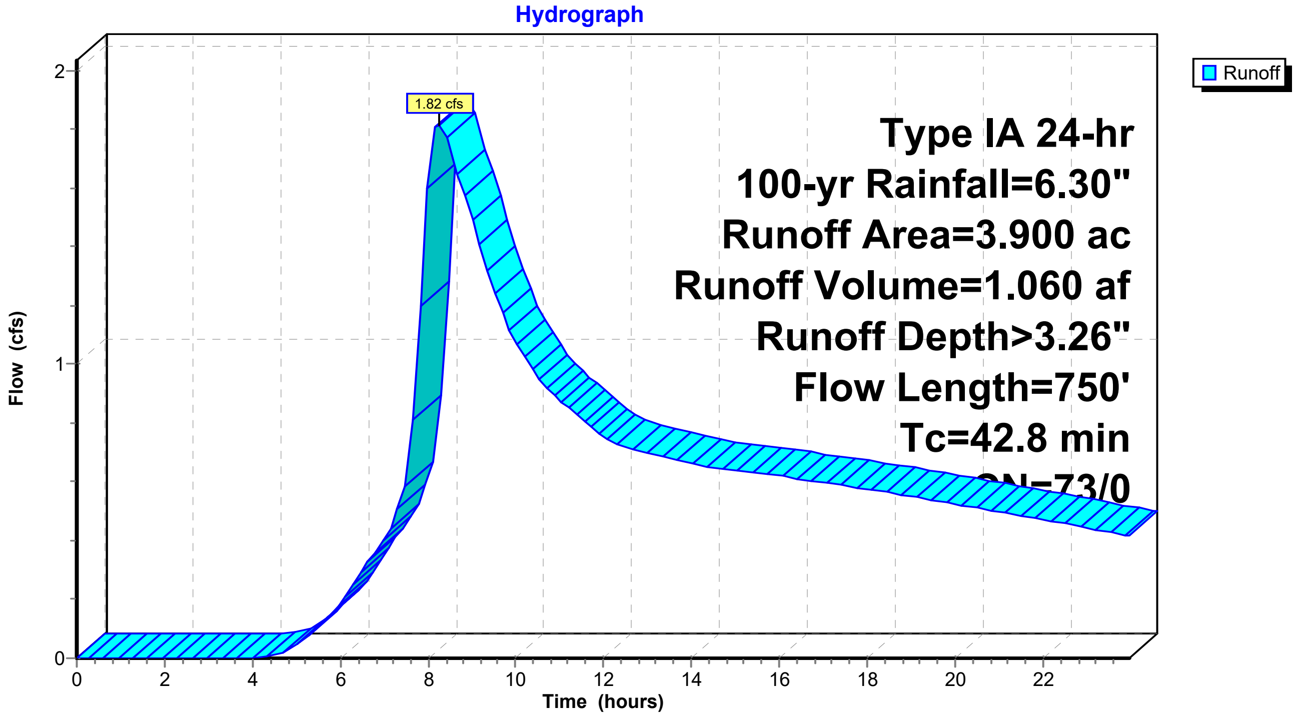
Runoff = 1.82 cfs @ 8.25 hrs, Volume= 1.060 af, Depth> 3.26"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-23.97 hrs, dt= 0.17 hrs
Type IA 24-hr 100-yr Rainfall=6.30"

Area (ac)	CN	Description
3.900	73	Woods, Fair, HSG C
3.900	73	100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
23.8	250	0.1500	0.18		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 2.26"
2.7	200	0.0600	1.22		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
16.3	300	0.0150	0.31		**Shallow Concentrated Flow,** Forest w/Heavy Litter Kv= 2.5 fps
42.8	750	Total			

Subcatchment 2X-B: Pre- DEV [EAST]



Summary for Subcatchment 2X-C: PRE- OFFSITE ROAD

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

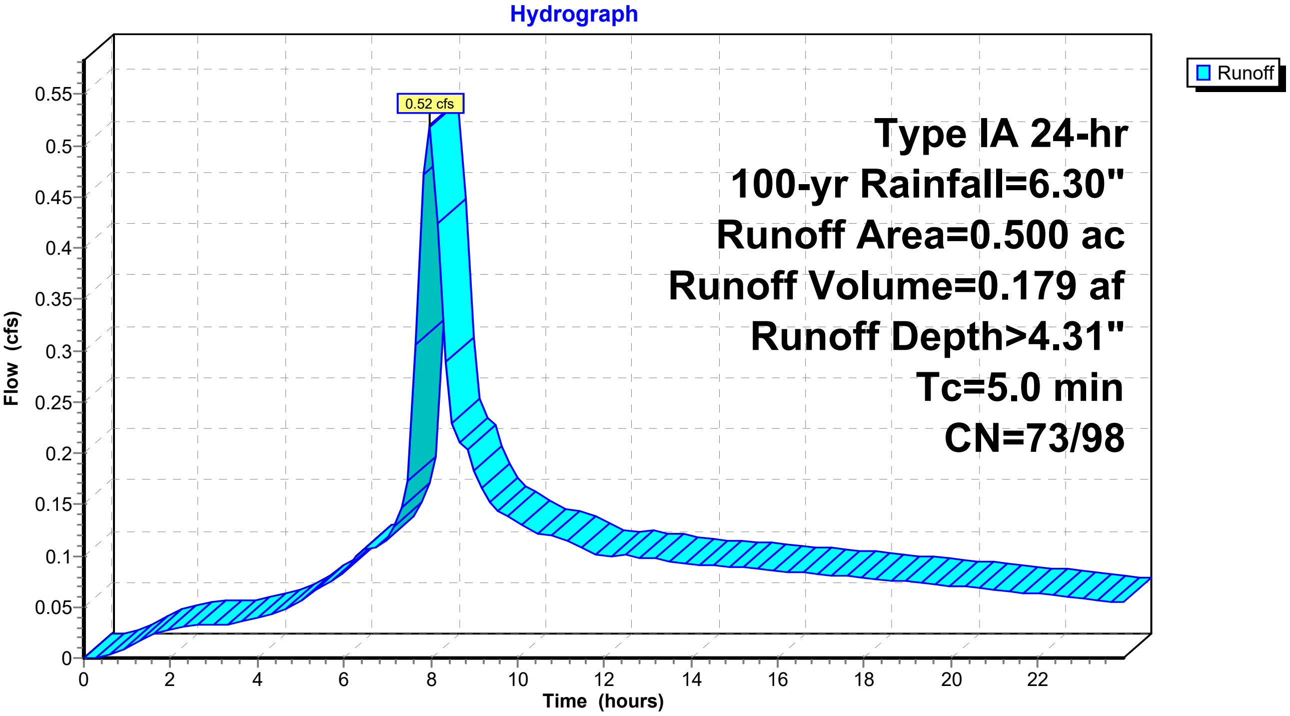
Runoff = 0.52 cfs @ 7.96 hrs, Volume= 0.179 af, Depth> 4.31"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-23.97 hrs, dt= 0.17 hrs
Type IA 24-hr 100-yr Rainfall=6.30"

	Area (ac)	CN	Description
	0.320	73	Woods, Fair, HSG C
*	0.180	98	GREEN MTN RD & LOOP
	0.500	82	Weighted Average
	0.320	73	64.00% Pervious Area
	0.180	98	36.00% Impervious Area

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

Subcatchment 2X-C: PRE- OFFSITE ROAD



Summary for Subcatchment 3S: Green Mtn Rd Connection

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

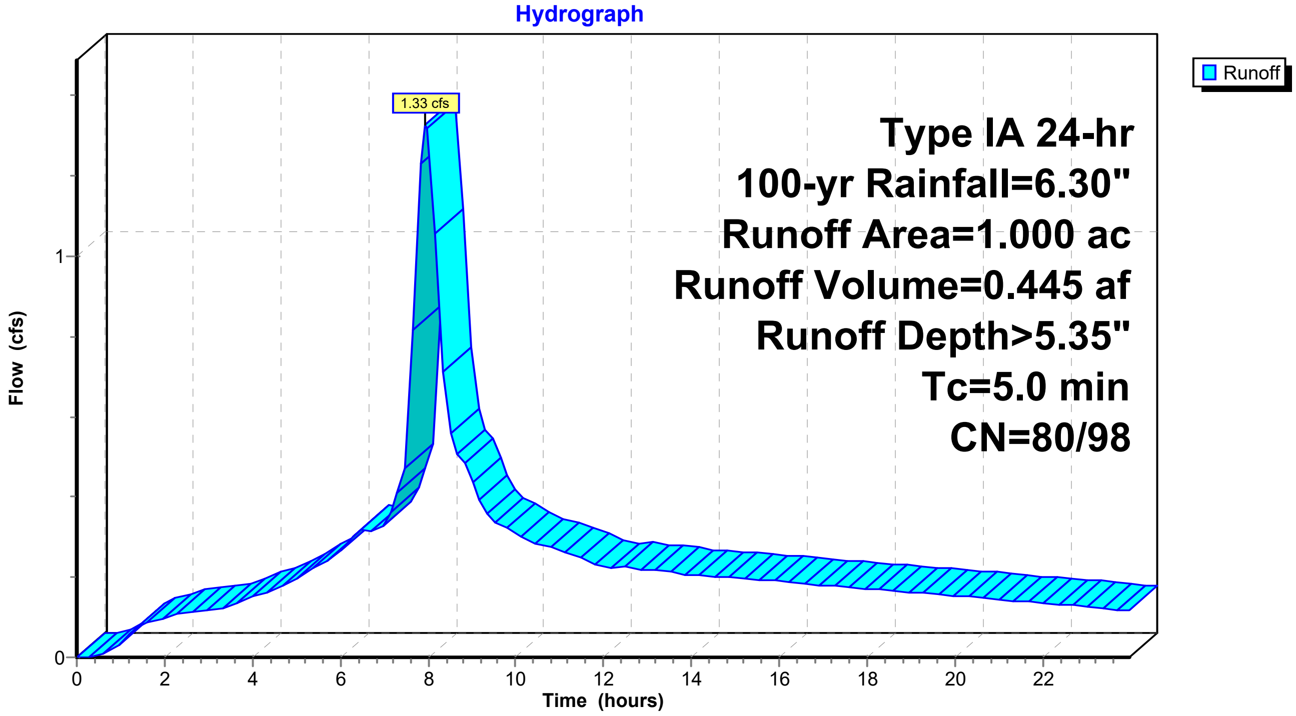
Runoff = 1.33 cfs @ 7.95 hrs, Volume= 0.445 af, Depth> 5.35"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-23.97 hrs, dt= 0.17 hrs
Type IA 24-hr 100-yr Rainfall=6.30"

	Area (ac)	CN	Description
*	0.500	98	BELMONT RD & PVT RD
	0.350	80	>75% Grass cover, Good, HSG D
*	0.150	98	POND
	1.000	92	Weighted Average
	0.350	80	35.00% Pervious Area
	0.650	98	65.00% Impervious Area

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

Subcatchment 3S: Green Mtn Rd Connection



Summary for Subcatchment 3X: PRE- GRN MTN CONN

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

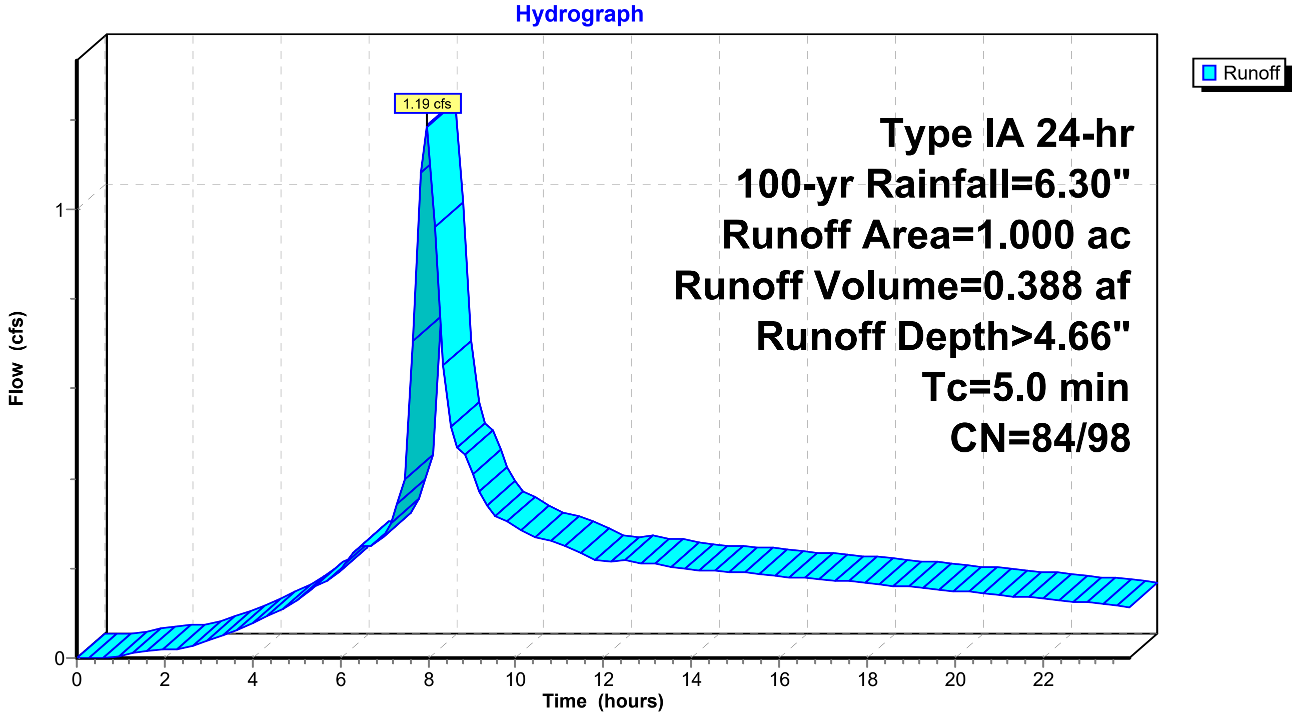
Runoff = 1.19 cfs @ 7.96 hrs, Volume= 0.388 af, Depth> 4.66"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-23.97 hrs, dt= 0.17 hrs
Type IA 24-hr 100-yr Rainfall=6.30"

	Area (ac)	CN	Description
	0.880	84	Pasture/grassland/range, Fair, HSG D
*	0.120	98	GREEN MTN RD
	1.000	86	Weighted Average
	0.880	84	88.00% Pervious Area
	0.120	98	12.00% Impervious Area

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

Subcatchment 3X: PRE- GRN MTN CONN



Summary for Subcatchment 4S-A: BELMONT RD

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

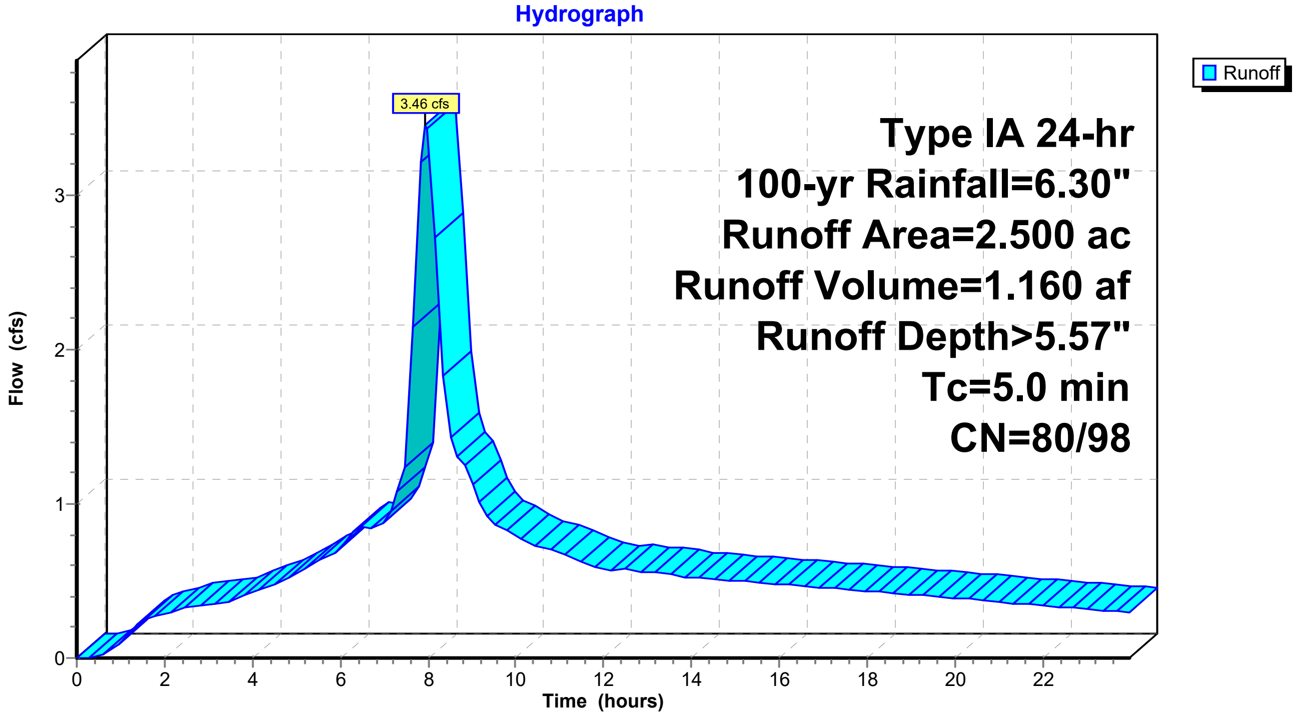
Runoff = 3.46 cfs @ 7.94 hrs, Volume= 1.160 af, Depth> 5.57"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-23.97 hrs, dt= 0.17 hrs
Type IA 24-hr 100-yr Rainfall=6.30"

	Area (ac)	CN	Description
*	1.900	98	BELMONT RD
	0.600	80	>75% Grass cover, Good, HSG D
	2.500	94	Weighted Average
	0.600	80	24.00% Pervious Area
	1.900	98	76.00% Impervious Area

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

Subcatchment 4S-A: BELMONT RD



Summary for Subcatchment 4S-B: SOUTH OF BELMONT

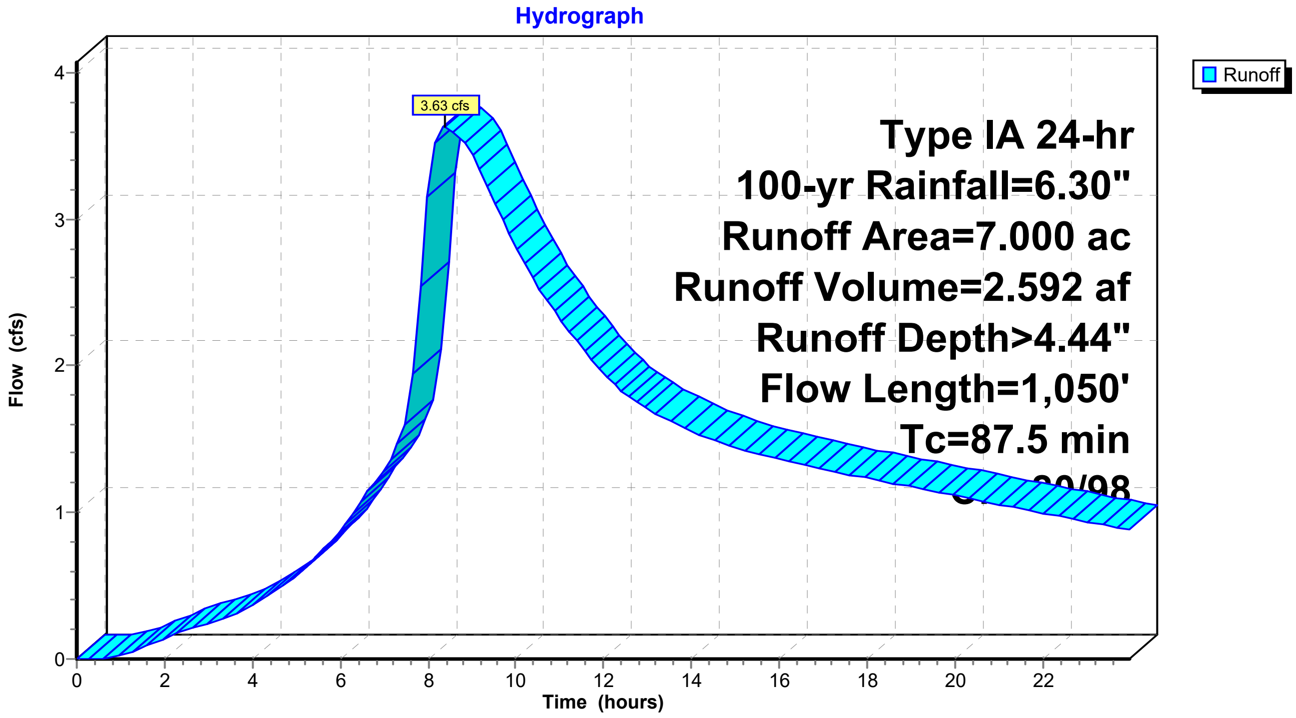
Runoff = 3.63 cfs @ 8.40 hrs, Volume= 2.592 af, Depth> 4.44"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-23.97 hrs, dt= 0.17 hrs
Type IA 24-hr 100-yr Rainfall=6.30"

	Area (ac)	CN	Description
	5.000	80	>75% Grass cover, Good, HSG D
*	2.000	98	ROCK STOCKPILE
	7.000	85	Weighted Average
	5.000	80	71.43% Pervious Area
	2.000	98	28.57% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
71.2	300	0.0050	0.07		**Sheet Flow,** Grass: Dense n= 0.240 P2= 2.26"
15.2	450	0.0050	0.49		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
1.1	300	0.0100	4.71	37.72	**Trap/Vee/Rect Channel Flow,** Bot.W=5.00' D=1.00' Z= 3.0 '/' Top.W=11.00' n= 0.025 Earth, clean & winding
87.5	1,050	Total			

Subcatchment 4S-B: SOUTH OF BELMONT



Summary for Subcatchment 4S-C: WET POND

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

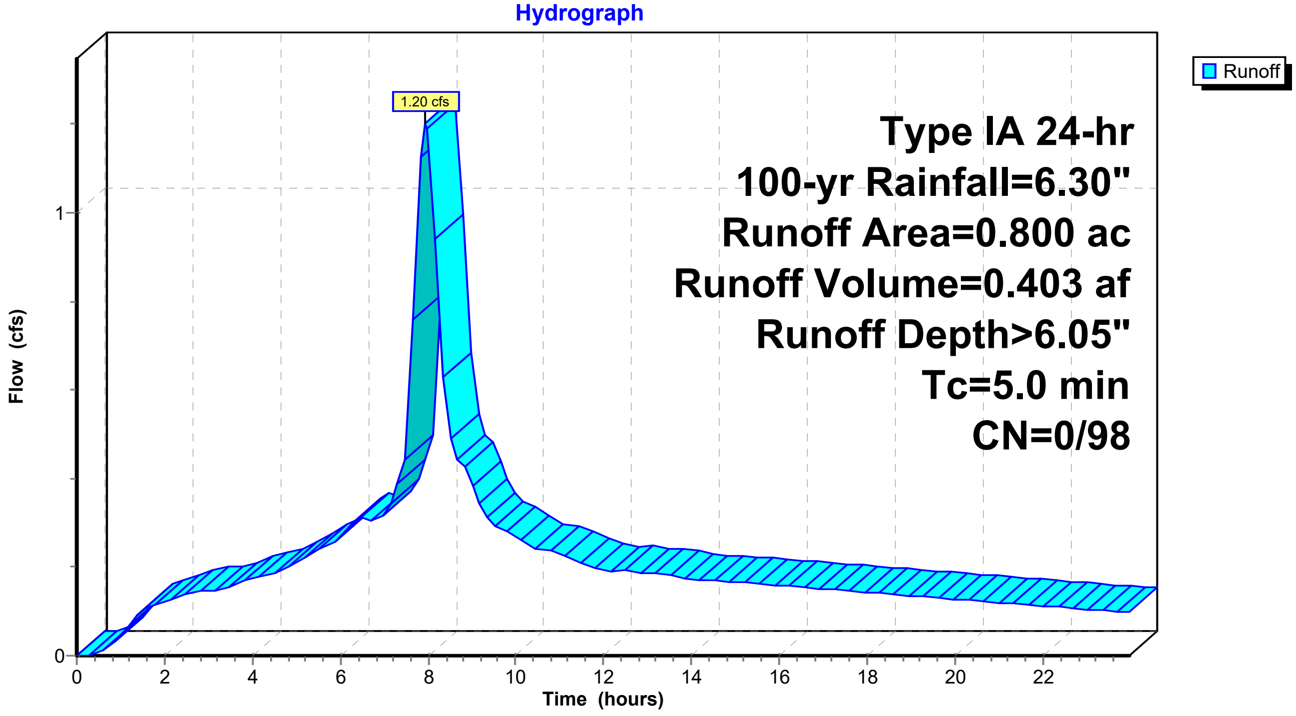
Runoff = 1.20 cfs @ 7.94 hrs, Volume= 0.403 af, Depth> 6.05"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-23.97 hrs, dt= 0.17 hrs
Type IA 24-hr 100-yr Rainfall=6.30"

	Area (ac)	CN	Description
*	0.800	98	POND
	0.800	98	100.00% Impervious Area

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

Subcatchment 4S-C: WET POND



Summary for Subcatchment 4X-A: PRE - BELMONT RD

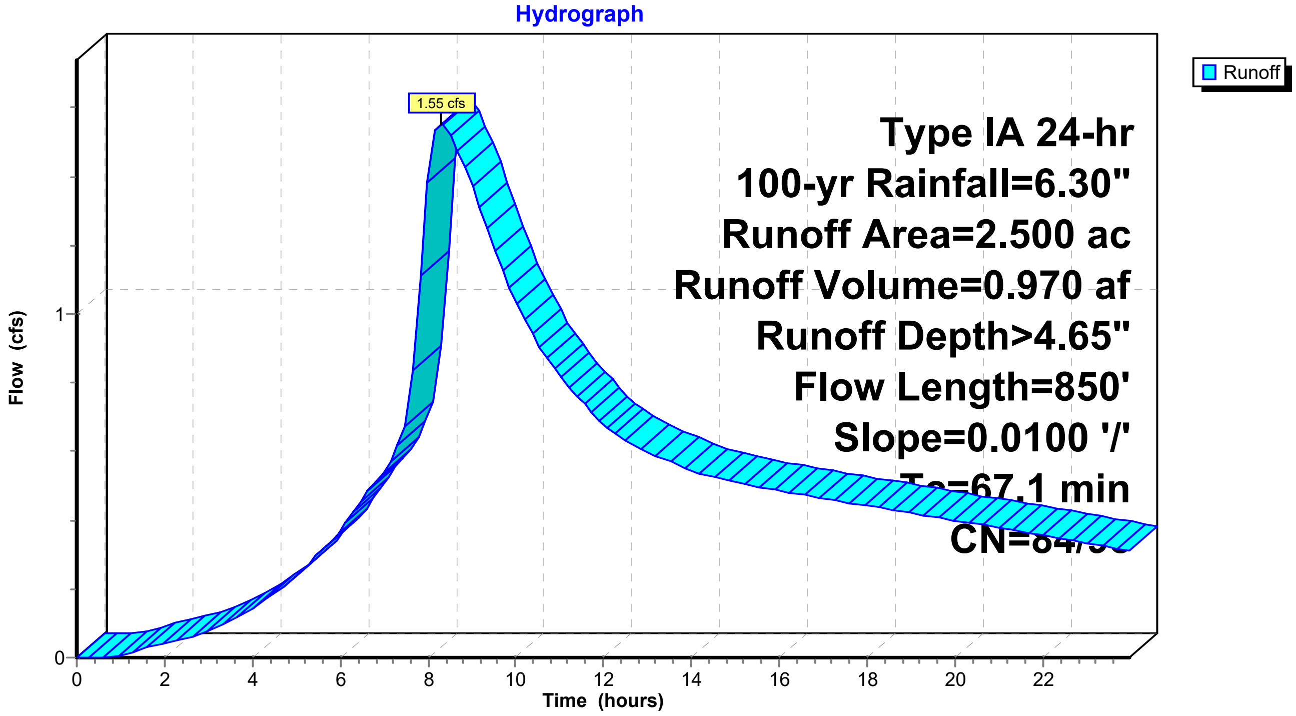
Runoff = 1.55 cfs @ 8.31 hrs, Volume= 0.970 af, Depth> 4.65"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-23.97 hrs, dt= 0.17 hrs
Type IA 24-hr 100-yr Rainfall=6.30"

	Area (ac)	CN	Description
	2.000	84	Pasture/grassland/range, Fair, HSG D
*	0.500	98	OPH & PARKING LOT
	2.500	87	Weighted Average
	2.000	84	80.00% Pervious Area
	0.500	98	20.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
54.0	300	0.0100	0.09		**Sheet Flow,** Grass: Dense n= 0.240 P2= 2.26"
13.1	550	0.0100	0.70		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
67.1	850	Total			

Subcatchment 4X-A: PRE - BELMONT RD



Summary for Subcatchment 4X-B: South of Belmont

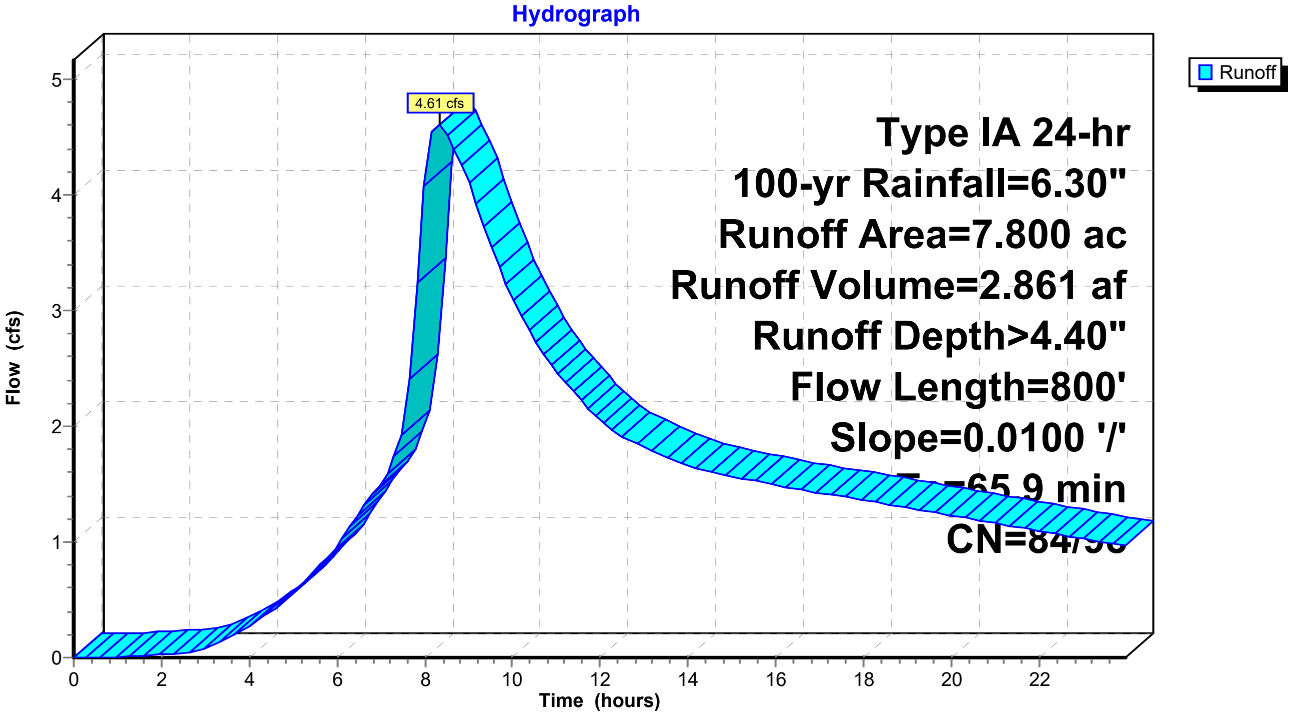
Runoff = 4.61 cfs @ 8.32 hrs, Volume= 2.861 af, Depth> 4.40"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-23.97 hrs, dt= 0.17 hrs
Type IA 24-hr 100-yr Rainfall=6.30"

	Area (ac)	CN	Description
	7.500	84	Pasture/grassland/range, Fair, HSG D
*	0.300	98	Existing gravel access road
	7.800	85	Weighted Average
	7.500	84	96.15% Pervious Area
	0.300	98	3.85% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
54.0	300	0.0100	0.09		**Sheet Flow,** Grass: Dense n= 0.240 P2= 2.26"
11.9	500	0.0100	0.70		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
65.9	800	Total			

Subcatchment 4X-B: South of Belmont



Summary for Subcatchment 5S: Commercial Site

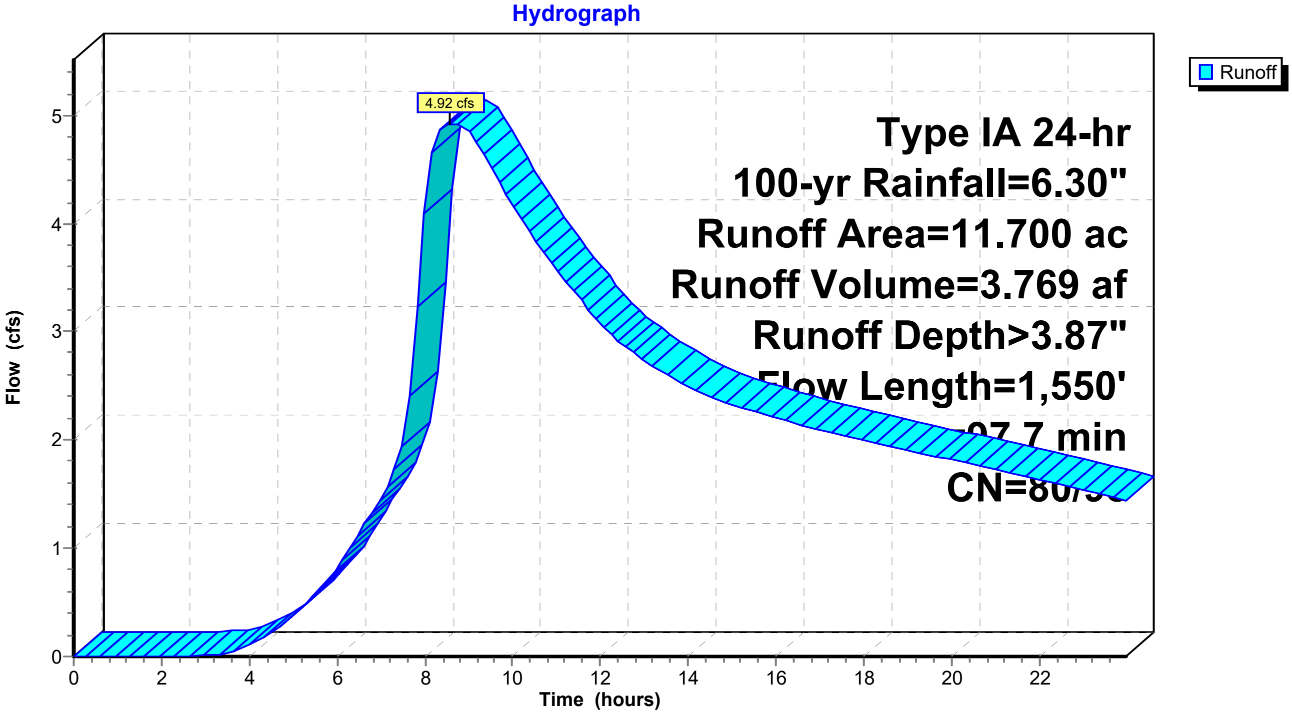
Runoff = 4.92 cfs @ 8.58 hrs, Volume= 3.769 af, Depth> 3.87"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-23.97 hrs, dt= 0.17 hrs
Type IA 24-hr 100-yr Rainfall=6.30"

	Area (ac)	CN	Description
	11.620	80	>75% Grass cover, Good, HSG D
*	0.080	98	Existing gravel
	11.700	80	Weighted Average
	11.620	80	99.32% Pervious Area
	0.080	98	0.68% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
71.2	300	0.0050	0.07		**Sheet Flow,** Grass: Dense n= 0.240 P2= 2.26"
1.6	100	0.0050	1.06		**Shallow Concentrated Flow,** Grassed Waterway Kv= 15.0 fps
24.9	1,150	0.0005	0.77	6.93	**Trap/Vee/Rect Channel Flow,** Bot.W=6.00' D=1.00' Z= 3.0 '/' Top.W=12.00' n= 0.035 High grass
97.7	1,550	Total			

Subcatchment 5S: Commercial Site



Summary for Subcatchment 5X: Commercial Site

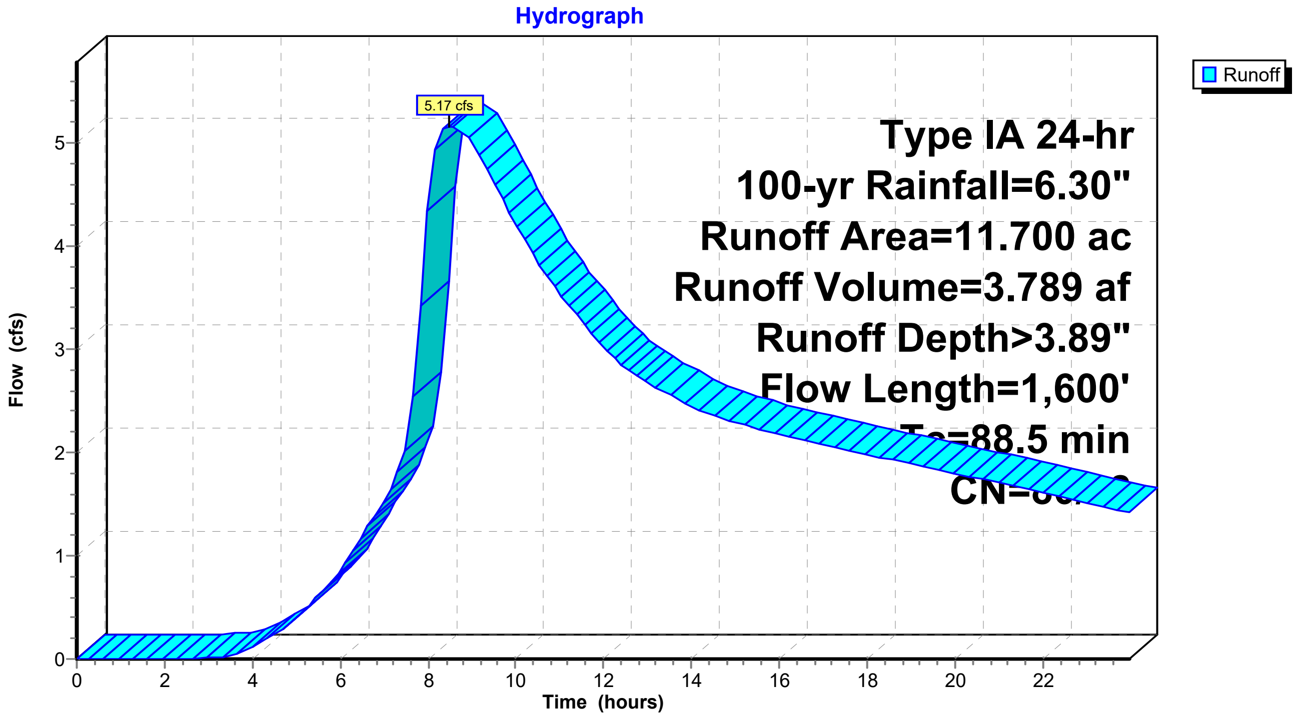
Runoff = 5.17 cfs @ 8.49 hrs, Volume= 3.789 af, Depth> 3.89"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-23.97 hrs, dt= 0.17 hrs
Type IA 24-hr 100-yr Rainfall=6.30"

	Area (ac)	CN	Description
	11.620	80	Pasture/grassland/range, Good, HSG D
*	0.080	98	existing gravel in south
	11.700	80	Weighted Average
	11.620	80	99.32% Pervious Area
	0.080	98	0.68% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
62.2	300	0.0070	0.08		**Sheet Flow,** Grass: Dense n= 0.240 P2= 2.26"
4.7	300	0.0050	1.06		**Shallow Concentrated Flow,** Grassed Waterway Kv= 15.0 fps
21.6	1,000	0.0005	0.77	6.93	**Trap/Vee/Rect Channel Flow,** Bot.W=6.00' D=1.00' Z= 3.0 '/' Top.W=12.00' n= 0.035 High grass
88.5	1,600	Total			

Subcatchment 5X: Commercial Site



Summary for Reach 7R: conveyance ditch

[81] Warning: Exceeded Pond 4P by 30.00' @ 0.00 hrs

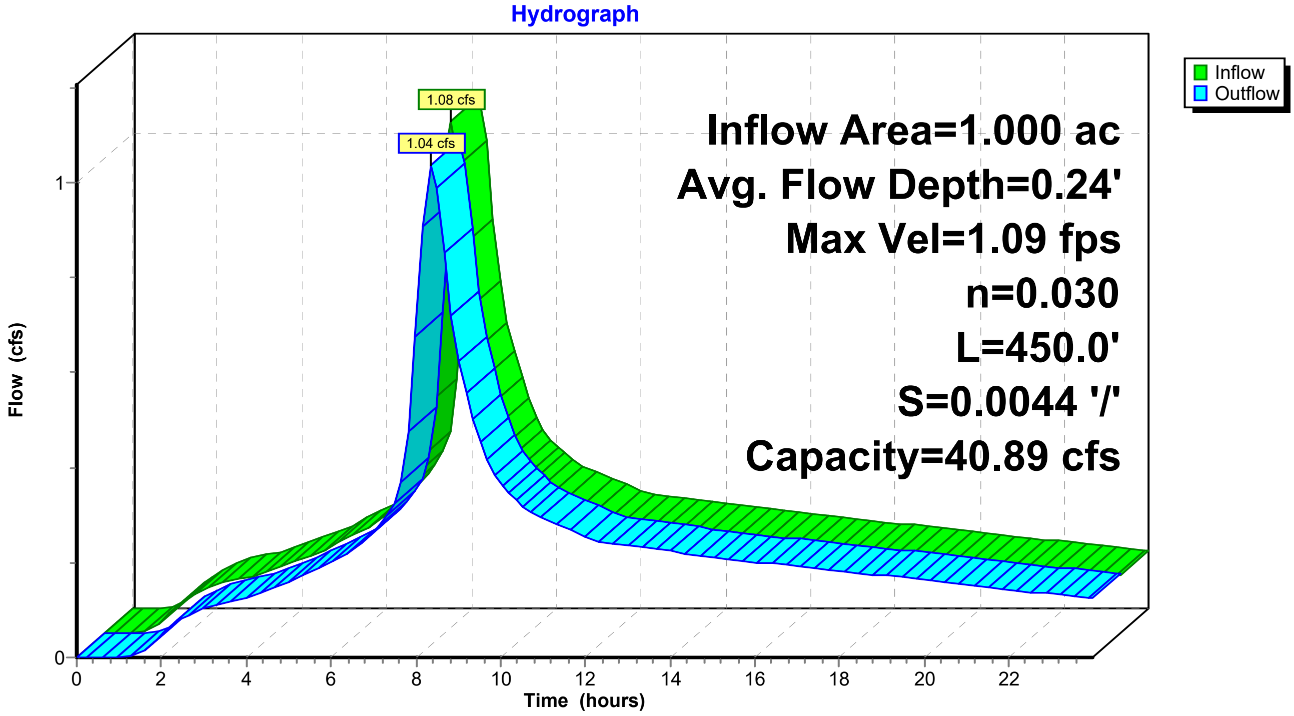
Inflow Area =	1.000 ac,	65.00% Impervious,	Inflow Depth >	5.28"	for 100-yr event
Inflow =	1.08 cfs @	8.16 hrs,	Volume=	0.440 af	
Outflow =	1.04 cfs @	8.37 hrs,	Volume=	0.436 af,	Atten= 4%, Lag= 12.5 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-23.97 hrs, dt= 0.17 hrs
Max. Velocity= 1.09 fps, Min. Travel Time= 6.9 min
Avg. Velocity = 0.62 fps, Avg. Travel Time= 12.0 min

Peak Storage= 432 cf @ 8.24 hrs
Average Depth at Peak Storage= 0.24'
Bank-Full Depth= 1.50' Flow Area= 13.5 sf, Capacity= 40.89 cfs

3.00' x 1.50' deep channel, n= 0.030 Earth, grassed & winding
Side Slope Z-value= 4.0 '/' Top Width= 15.00'
Length= 450.0' Slope= 0.0044 '/'
Inlet Invert= 30.00', Outlet Invert= 28.00'

Reach 7R: conveyance ditch



Summary for Pond 1B: BIORET-1

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Inflow Area =       0.850 ac, 76.47% Impervious, Inflow Depth >  5.55"   for  100-yr event
Inflow      =       1.17 cfs @   7.95 hrs,  Volume=         0.393 af
Outflow     =       1.17 cfs @   7.95 hrs,  Volume=         0.393 af,  Atten= 0%,  Lag= 0.0 min
Primary     =       1.17 cfs @   7.95 hrs,  Volume=         0.393 af

Routing by Stor-Ind method, Time Span= 0.00-23.97 hrs, dt= 0.17 hrs
Peak Elev= 7.00' @ 7.95 hrs   Surf.Area= 0.010 ac   Storage= 0.000 af

Plug-Flow detention time= 0.0 min calculated for 0.393 af (100% of inflow)
Center-of-Mass det. time= 0.0 min ( 672.1 - 672.1 )

Volume     Invert   Avail.Storage  Storage Description
   #1       7.00'       0.016 af   5.00'W x 85.00'L x 1.00'H Prismatoid  Z=3.0

Device  Routing        Invert  Outlet Devices
   #1   Primary         7.00'  12.00 cfs Exfiltration X 0.25 at all elevations
   #2   Primary         7.50'  50.0' long  x 1.0' breadth Broad-Crested Rectangular Weir
                               Head (feet)  0.20  0.40  0.60  0.80  1.00  1.20  1.40  1.60  1.80  2.00
                               2.50  3.00
                               Coef. (English)  2.69  2.72  2.75  2.85  2.98  3.08  3.20  3.28  3.31
                               3.30  3.31  3.32

Primary OutFlow  Max=3.00 cfs @ 7.95 hrs  HW=7.00'   (Free Discharge)
 ├─1=Exfiltration  (Exfiltration Controls 3.00 cfs)
 └─2=Broad-Crested Rectangular Weir( Controls 0.00 cfs)
```
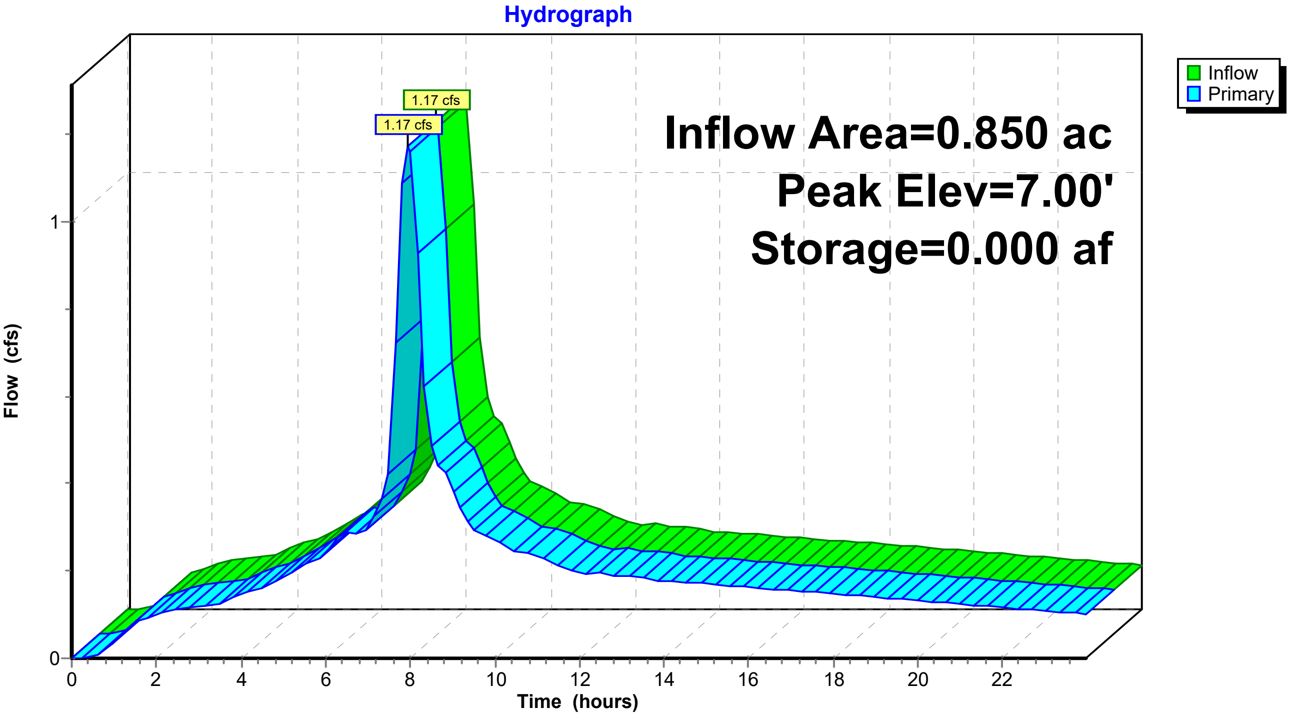

Pond 1B: BIORET-1



Summary for Pond 1P: NW CORNER

Inflow Area = 0.900 ac, 77.78% Impervious, Inflow Depth > 5.58" for 100-yr event
Inflow = 1.25 cfs @ 7.94 hrs, Volume= 0.418 af
Outflow = 1.12 cfs @ 8.09 hrs, Volume= 0.354 af, Atten= 10%, Lag= 8.8 min
Primary = 1.12 cfs @ 8.09 hrs, Volume= 0.354 af

Routing by Stor-Ind method, Time Span= 0.00-23.97 hrs, dt= 0.17 hrs
Peak Elev= 3.28' @ 8.09 hrs Surf.Area= 0.041 ac Storage= 0.081 af

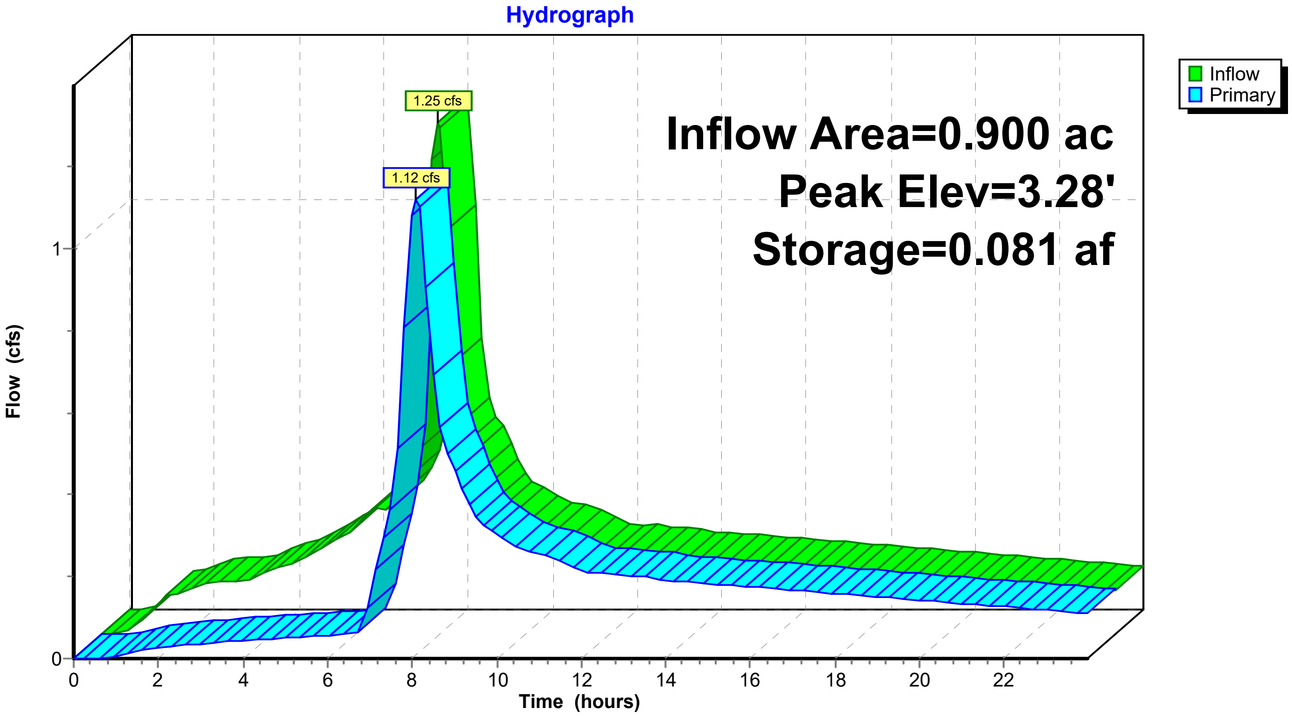
Plug-Flow detention time= 185.8 min calculated for 0.354 af (85% of inflow)
Center-of-Mass det. time= 79.7 min (750.7 - 671.0)

Volume	Invert	Avail.Storage	Storage Description
#1	0.00'	0.141 af	**9.00'W x 50.00'L x 4.50'H Prismatoid Z=2.7**

Device	Routing	Invert	Outlet Devices
#1	Primary	0.00'	**1.2" Vert. Orifice** C= 0.600
#2	Primary	3.50'	**24.0" Horiz. riser** C= 0.600 Limited to weir flow at low heads
#3	Primary	2.80'	**12.0" W x 8.4" H Vert. notch** C= 0.600

Primary OutFlow Max=1.09 cfs @ 8.09 hrs HW=3.27' (Free Discharge)
↑—**1=Orifice** (Orifice Controls 0.07 cfs @ 8.64 fps)
├—**2=riser** (Controls 0.00 cfs)
└—**3=notch** (Orifice Controls 1.02 cfs @ 2.19 fps)

Pond 1P: NW CORNER



Summary for Pond 2A: BIORET-2A

Inflow Area = 1.140 ac,100.00% Impervious, Inflow Depth > 6.05" for 100-yr event
Inflow = 1.71 cfs @ 7.94 hrs, Volume= 0.575 af
Outflow = 1.71 cfs @ 7.94 hrs, Volume= 0.575 af, Atten= 0%, Lag= 0.0 min
Primary = 1.71 cfs @ 7.94 hrs, Volume= 0.575 af

Routing by Stor-Ind method, Time Span= 0.00-23.97 hrs, dt= 0.17 hrs
Peak Elev= 5.01' @ 7.94 hrs Surf.Area= 0.016 ac Storage= 0.000 af

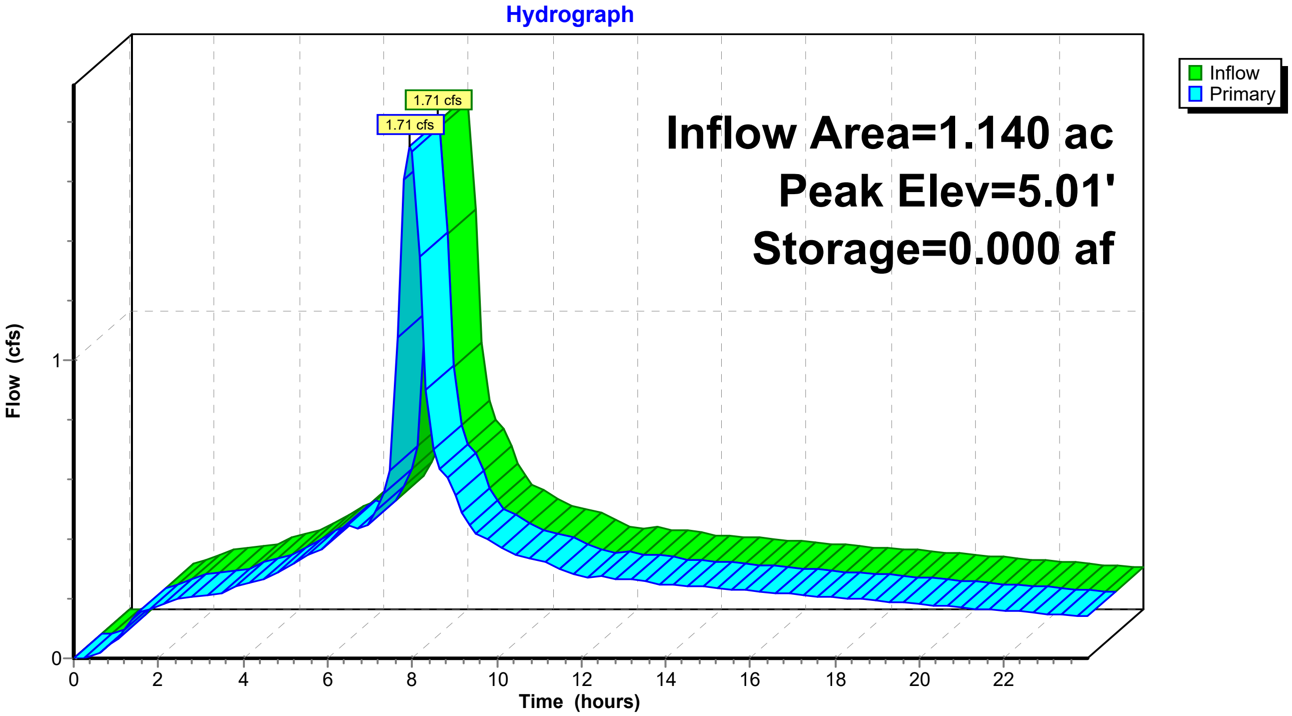
Plug-Flow detention time= 0.0 min calculated for 0.575 af (100% of inflow)
Center-of-Mass det. time= 0.0 min (653.5 - 653.5)

Volume	Invert	Avail.Storage	Storage Description
#1	5.00'	0.022 af	**10.00'W x 70.00'L x 1.00'H Prismatoid Z=3.0**

Device	Routing	Invert	Outlet Devices
#1	Primary	5.00'	**12.00 cfs Exfiltration X 0.25 at all elevations**
#2	Primary	5.50'	**50.0' long x 1.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 Coef. (English) 2.69 2.72 2.75 2.85 2.98 3.08 3.20 3.28 3.31 3.30 3.31 3.32

Primary OutFlow Max=3.00 cfs @ 7.94 hrs HW=5.01' (Free Discharge)
↑—**1=Exfiltration** (Exfiltration Controls 3.00 cfs)
└—**2=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond 2A: BIORET-2A



Summary for Pond 2B: BIORET-2B

Inflow Area =	4.120 ac,	83.25% Impervious,	Inflow Depth > 5.69"	for 100-yr event	
Inflow =	5.83 cfs @	7.94 hrs,	Volume=	1.955 af	
Outflow =	5.83 cfs @	7.94 hrs,	Volume=	1.955 af,	Atten= 0%, Lag= 0.0 min
Primary =	5.83 cfs @	7.94 hrs,	Volume=	1.955 af	

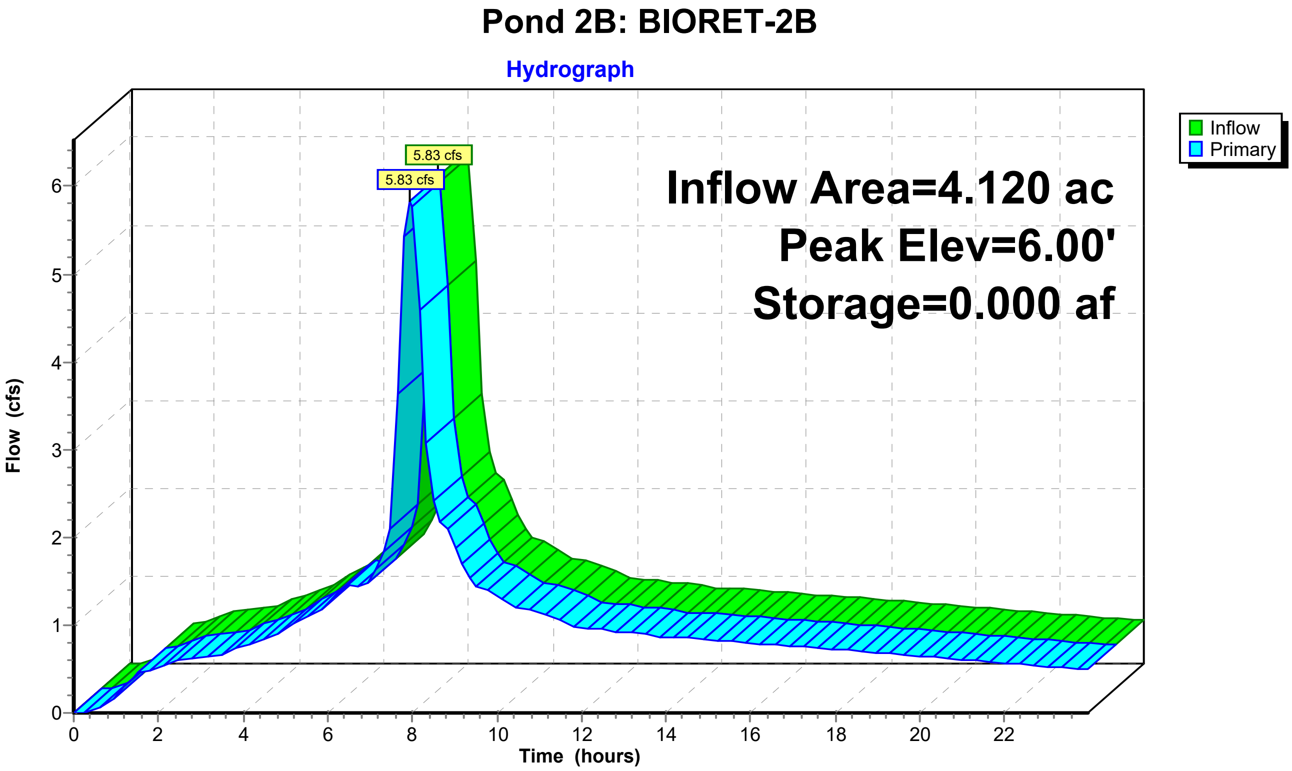
Routing by Stor-Ind method, Time Span= 0.00-23.97 hrs, dt= 0.17 hrs
Peak Elev= 6.00' @ 7.94 hrs Surf.Area= 0.046 ac Storage= 0.000 af

Plug-Flow detention time= 0.0 min calculated for 1.941 af (99% of inflow)
Center-of-Mass det. time= 0.0 min (666.4 - 666.4)

Volume	Invert	Avail.Storage	Storage Description
#1	6.00'	0.086 af	**25.00'W x 80.00'L x 1.50'H Prismatoid Z=3.0**

Device	Routing	Invert	Outlet Devices
#1	Primary	6.00'	**12.00 cfs Exfiltration X 0.25 at all elevations**
#2	Primary	1.00'	**24.0" Horiz. riser** C= 0.600 Limited to weir flow at low heads

Primary OutFlow Max=36.83 cfs @ 7.94 hrs HW=6.00' (Free Discharge)
↑—**1=Exfiltration** (Exfiltration Controls 3.00 cfs)
└—**2=riser** (Orifice Controls 33.83 cfs @ 10.77 fps)



Summary for Pond 2P: West Pond

```
Inflow Area =      1.960 ac, 87.76% Impervious, Inflow Depth >  5.79"   for 100-yr event
Inflow      =     2.82 cfs @    7.94 hrs, Volume=          0.946 af
Outflow     =     0.73 cfs @    9.40 hrs, Volume=          0.564 af, Atten= 74%, Lag= 87.5 min
Primary     =     0.73 cfs @    9.40 hrs, Volume=          0.564 af
```

Routing by Stor-Ind method, Time Span= 0.00-23.97 hrs, dt= 0.17 hrs
Peak Elev= 4.93' @ 9.40 hrs Surf.Area= 0.131 ac Storage= 0.413 af

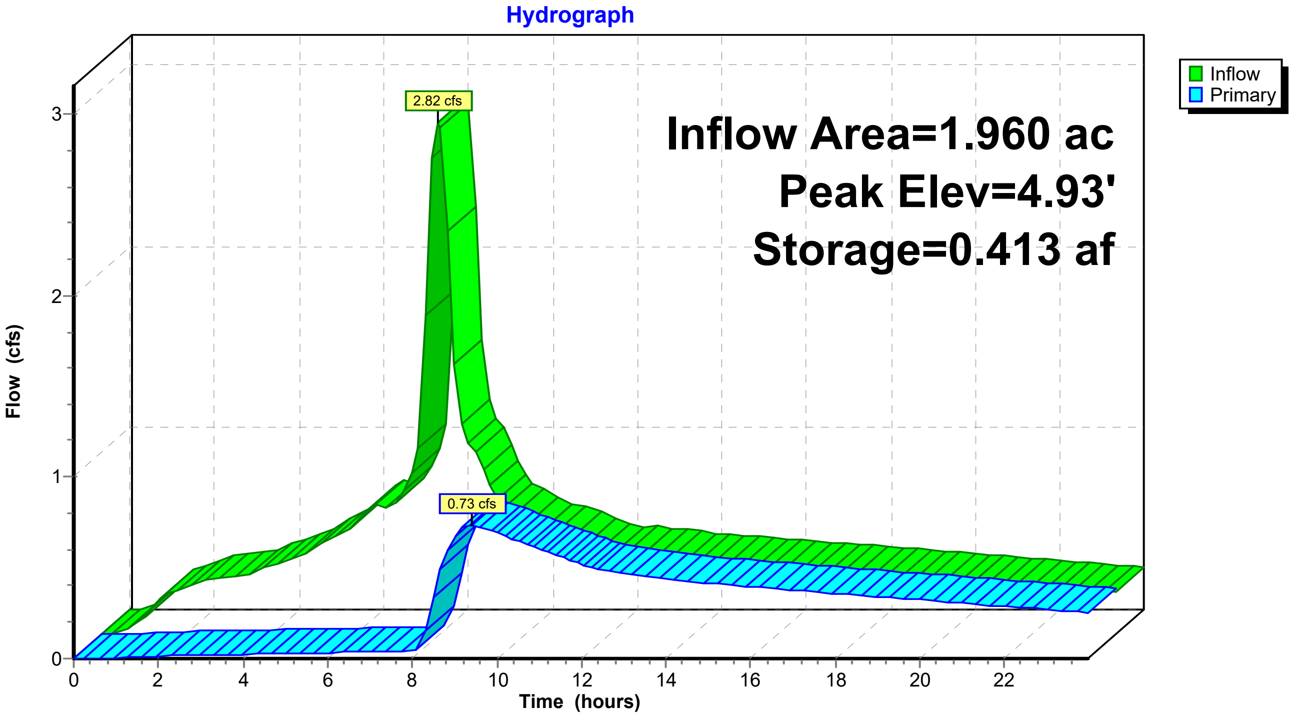
Plug-Flow detention time= 450.5 min calculated for 0.564 af (60% of inflow)
Center-of-Mass det. time= 217.4 min (880.2 - 662.8)

Volume	Invert	Avail.Storage	Storage Description
#1	0.00'	0.566 af	**25.00'W x 75.00'L x 6.00'H Prismatoid Z=3.0**

Device	Routing	Invert	Outlet Devices
#1	Primary	0.00'	**0.9" Vert. Orifice/Grate** C= 0.600
#2	Primary	4.50'	**9.0" W x 6.0" H Vert. notch** C= 0.600
#3	Primary	5.00'	**24.0" Horiz. riser** C= 0.600 Limited to weir flow at low heads

Primary OutFlow Max=0.73 cfs @ 9.40 hrs HW=4.93' (Free Discharge)
↑—**1=Orifice/Grate** (Orifice Controls 0.05 cfs @ 10.65 fps)
—**2=notch** (Orifice Controls 0.68 cfs @ 2.11 fps)
└—**3=riser** (Controls 0.00 cfs)

Pond 2P: West Pond



Summary for Pond 3P: East Pond

[79] Warning: Submerged Pond 2B Primary device # 2 by 4.31'

```
Inflow Area =         4.540 ac,  79.96% Impervious,  Inflow Depth >   5.60"    for  100-yr event
Inflow      =         6.31 cfs @    7.94 hrs,  Volume=           2.119 af
Outflow     =         2.22 cfs @    8.87 hrs,  Volume=           1.616 af,  Atten= 65%,  Lag= 55.5 min
Primary     =         2.22 cfs @    8.87 hrs,  Volume=           1.616 af
```

Routing by Stor-Ind method, Time Span= 0.00-23.97 hrs, dt= 0.17 hrs
Peak Elev= 5.31' @ 8.87 hrs Surf.Area= 8,534 sf Storage= 31,316 cf

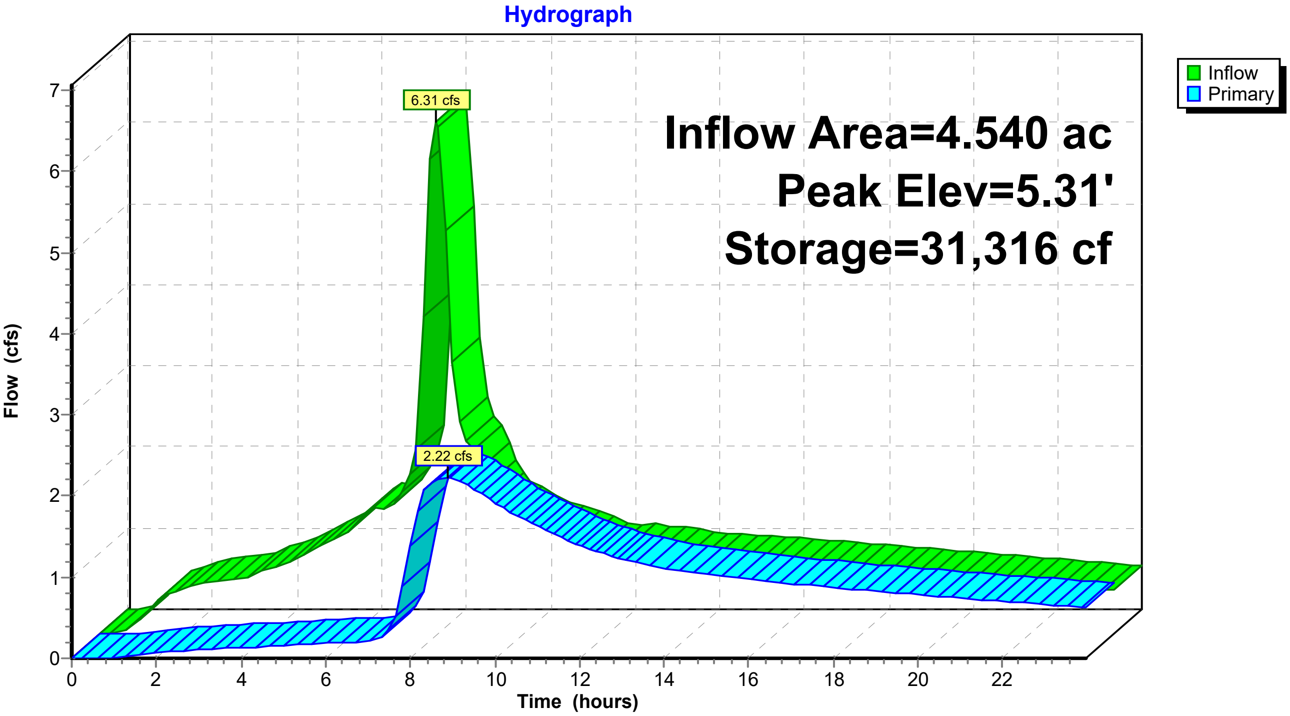
Plug-Flow detention time= 307.9 min calculated for 1.605 af (76% of inflow)
Center-of-Mass det. time= 155.0 min (824.4 - 669.4)

Volume	Invert	Avail.Storage	Storage Description
#1	0.00'	42,286 cf	**48.00'W x 75.00'L x 6.50'H Prismatoid Z=3.0**

Device	Routing	Invert	Outlet Devices
#1	Primary	0.00'	**2.1" Vert. Orifice** C= 0.600
#2	Primary	3.50'	**3.0" W x 24.0" H Vert. notch** C= 0.600
#3	Primary	5.50'	**24.0" Horiz. riser** C= 0.600 Limited to weir flow at low heads

Primary OutFlow Max=2.22 cfs @ 8.87 hrs HW=5.31' (Free Discharge)
├─**1=Orifice** (Orifice Controls 0.26 cfs @ 11.00 fps)
├─**2=notch** (Orifice Controls 1.95 cfs @ 4.32 fps)
└─**3=riser** (Controls 0.00 cfs)

Pond 3P: East Pond



Summary for Pond 4P: Wet Pond- Live Storage

```
Inflow Area =        1.000 ac, 65.00% Impervious, Inflow Depth >   5.35"    for  100-yr event
Inflow      =        1.33 cfs @    7.95 hrs,  Volume=          0.445 af
Outflow     =        1.08 cfs @    8.16 hrs,  Volume=          0.440 af,  Atten= 19%,  Lag= 12.9 min
Primary     =        1.08 cfs @    8.16 hrs,  Volume=          0.440 af
```

Routing by Stor-Ind method, Time Span= 0.00-23.97 hrs, dt= 0.17 hrs
Peak Elev= 0.91' @ 8.16 hrs Surf.Area= 2,781 sf Storage= 1,594 cf

Plug-Flow detention time= 35.5 min calculated for 0.437 af (98% of inflow)
Center-of-Mass det. time= 25.9 min (707.6 - 681.7)

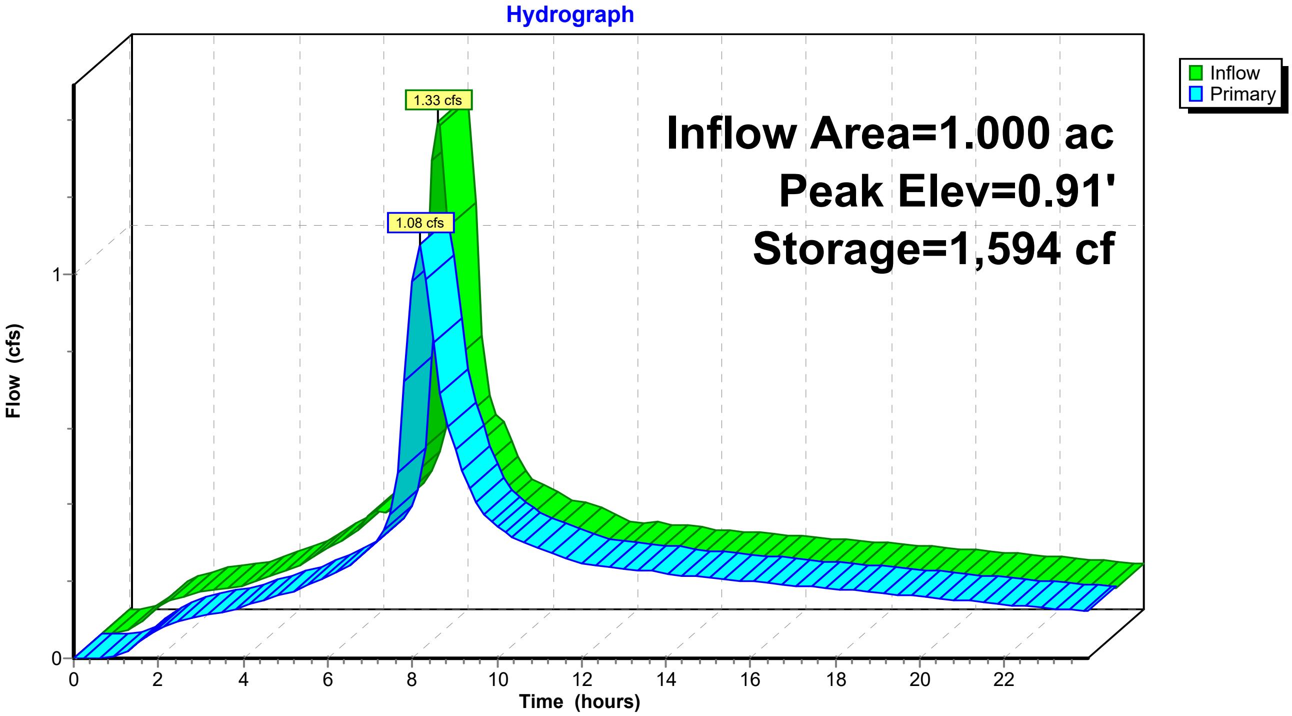
Volume	Invert	Avail.Storage	Storage Description
#1	0.00'	9,172 cf	**Live Storage (Prismatic)**Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
0.00	704	0	0
1.00	2,975	1,840	1,840
2.00	3,662	3,319	5,158
3.00	4,366	4,014	9,172

Device	Routing	Invert	Outlet Devices
#1	Primary	0.00'	**4.0" Vert. Orifice** C= 0.600
#2	Primary	0.50'	**10.0" W x 18.0" H Vert. Notch** C= 0.600
#3	Primary	2.00'	**18.0" Horiz. Riser** C= 0.600 Limited to weir flow at low heads

```
Primary OutFlow Max=1.08 cfs @ 8.16 hrs  HW=0.91'   (Free Discharge)
 ├─1=Orifice  (Orifice Controls 0.36 cfs @ 4.16 fps)
 ├─2=Notch  (Orifice Controls 0.71 cfs @ 2.07 fps)
 └─3=Riser  ( Controls 0.00 cfs)
```

Pond 4P: Wet Pond- Live Storage



Summary for Pond 5P: Wet Pond- Live Storage

Inflow Area = 10.300 ac, 45.63% Impervious, Inflow Depth > 4.84" for 100-yr event
Inflow = 7.77 cfs @ 8.01 hrs, Volume= 4.155 af
Outflow = 5.90 cfs @ 8.41 hrs, Volume= 3.923 af, Atten= 24%, Lag= 24.0 min
Primary = 5.90 cfs @ 8.41 hrs, Volume= 3.923 af

Routing by Stor-Ind method, Time Span= 0.00-23.97 hrs, dt= 0.17 hrs
Peak Elev= 1.49' @ 8.41 hrs Surf.Area= 15,077 sf Storage= 19,453 cf

Plug-Flow detention time= 84.9 min calculated for 3.923 af (94% of inflow)
Center-of-Mass det. time= 47.1 min (781.3 - 734.2)

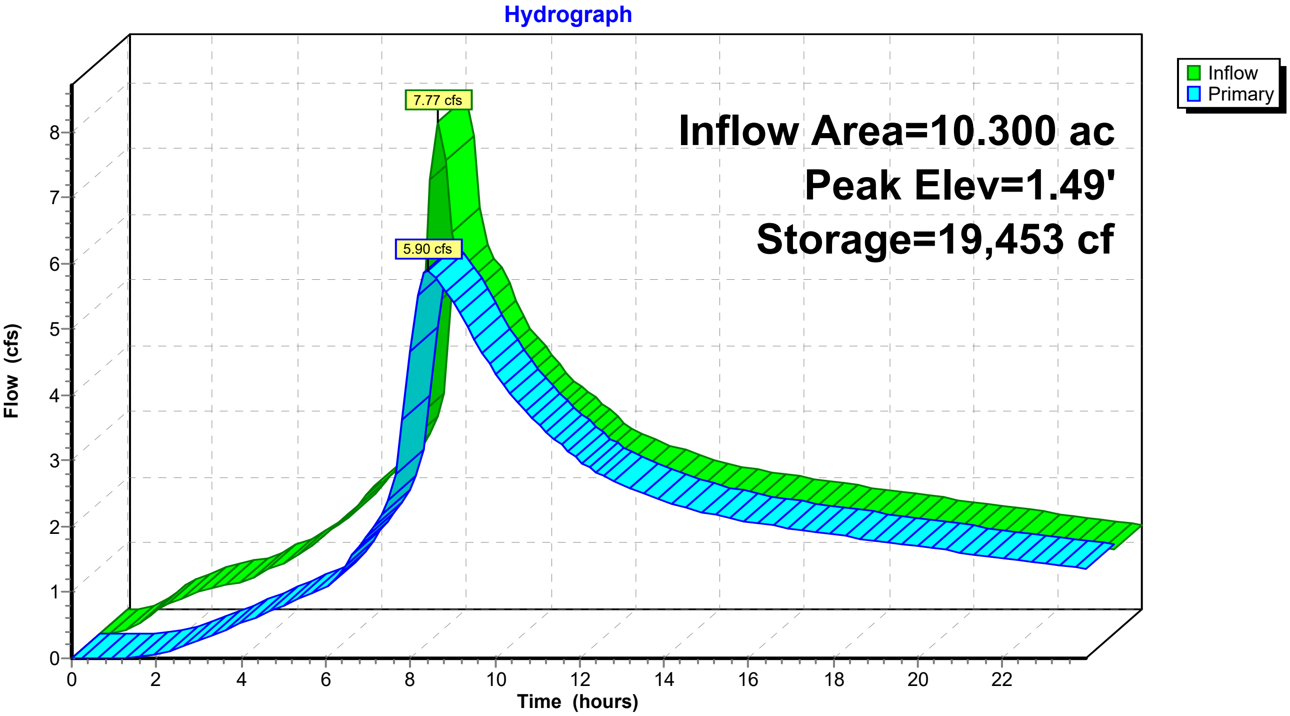
Volume	Invert	Avail.Storage	Storage Description
#1	0.00'	44,950 cf	**Live Storage (Prismatic)**Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
0.00	10,800	0	0
1.00	13,900	12,350	12,350
2.00	16,300	15,100	27,450
3.00	18,700	17,500	44,950

Device	Routing	Invert	Outlet Devices
#1	Primary	0.00'	**8.0" Vert. Orifice/Grate** C= 0.600
#2	Primary	0.75'	**24.0" W x 15.0" H Vert. Notch** C= 0.600
#3	Primary	2.00'	**24.0" Horiz. Riser** C= 0.600 Limited to weir flow at low heads

Primary OutFlow Max=5.85 cfs @ 8.41 hrs HW=1.49' (Free Discharge)
├—**1=Orifice/Grate** (Orifice Controls 1.80 cfs @ 5.17 fps)
├—**2=Notch** (Orifice Controls 4.05 cfs @ 2.75 fps)
└—**3=Riser** (Controls 0.00 cfs)

Pond 5P: Wet Pond- Live Storage



Summary for Pond 6P: 4P-Wet Pond-Live Storage - CORRECTED

[43] Hint: Has no inflow (Outflow=Zero)

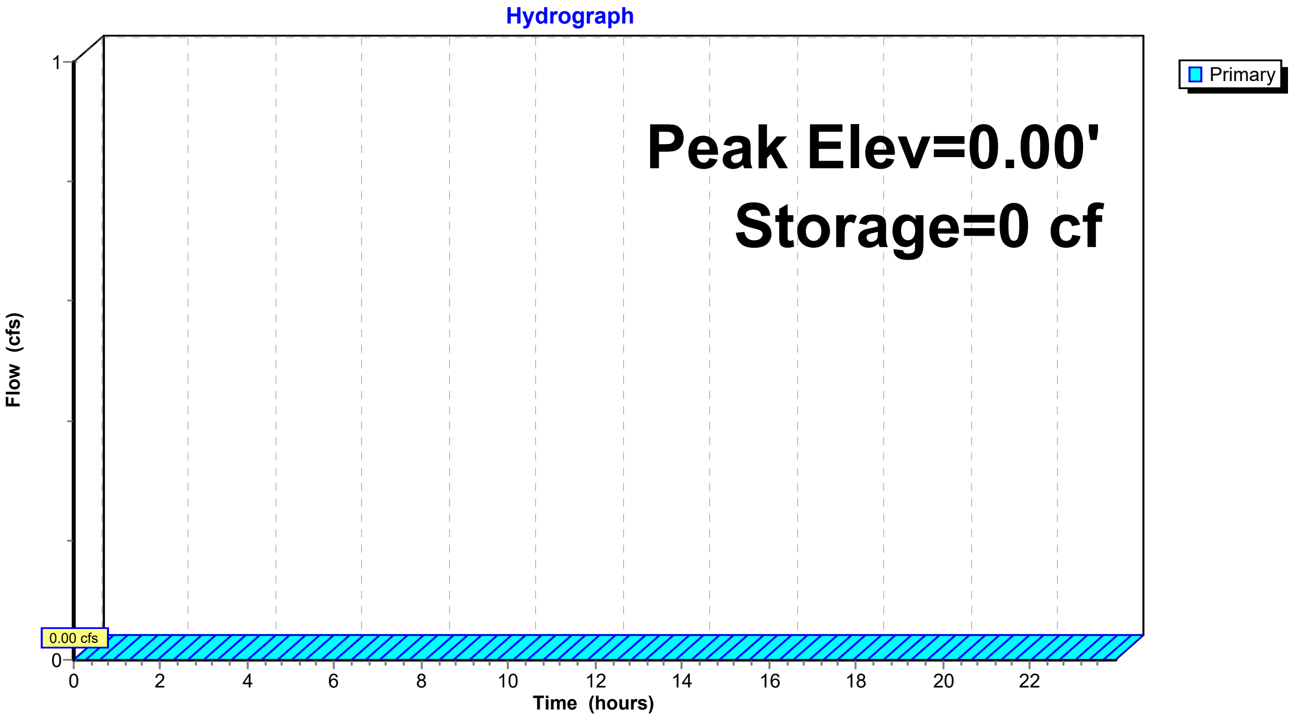
Volume	Invert	Avail.Storage	Storage Description
#1	0.00'	13,900 cf	**Live Storage (Prismatic)**Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
0.00	2,750	0	0
1.00	4,225	3,488	3,488
2.00	5,200	4,713	8,200
3.00	6,200	5,700	13,900

Device	Routing	Invert	Outlet Devices
#1	Primary	0.00'	**4.0" Vert. Orifice** C= 0.600
#2	Primary	0.50'	**10.0" W x 18.0" H Vert. Notch** C= 0.600
#3	Primary	2.00'	**18.0" Horiz. Riser** C= 0.600 Limited to weir flow at low heads

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=0.00' (Free Discharge)
1=Orifice (Controls 0.00 cfs)
2=Notch (Controls 0.00 cfs)
3=Riser (Controls 0.00 cfs)

Pond 6P: 4P-Wet Pond-Live Storage - CORRECTED



Summary for Pond 8P: 4P- Wet Pond- Dead Storage

[43] Hint: Has no inflow (Outflow=Zero)

Volume	Invert	Avail.Storage	Storage Description
#1	-3.00'	4,748 cf	**Dead Storage (Prismatic)**Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
-3.00	457	0	0
-2.00	1,213	835	835
-1.00	1,928	1,571	2,406
0.00	2,756	2,342	4,748

Summary for Pond 9P: 5P- Dead Storage

[43] Hint: Has no inflow (Outflow=Zero)

Volume	Invert	Avail.Storage	Storage Description
#1	-3.00'	17,914 cf	**Live Storage (Prismatic)**Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
-3.00	3,156	0	0
-2.00	4,660	3,908	3,908
-1.00	6,276	5,468	9,376
0.00	10,800	8,538	17,914

Summary for Pond 10P: 5P-Wet Pond- Live Storage - CORRECTED

[43] Hint: Has no inflow (Outflow=Zero)

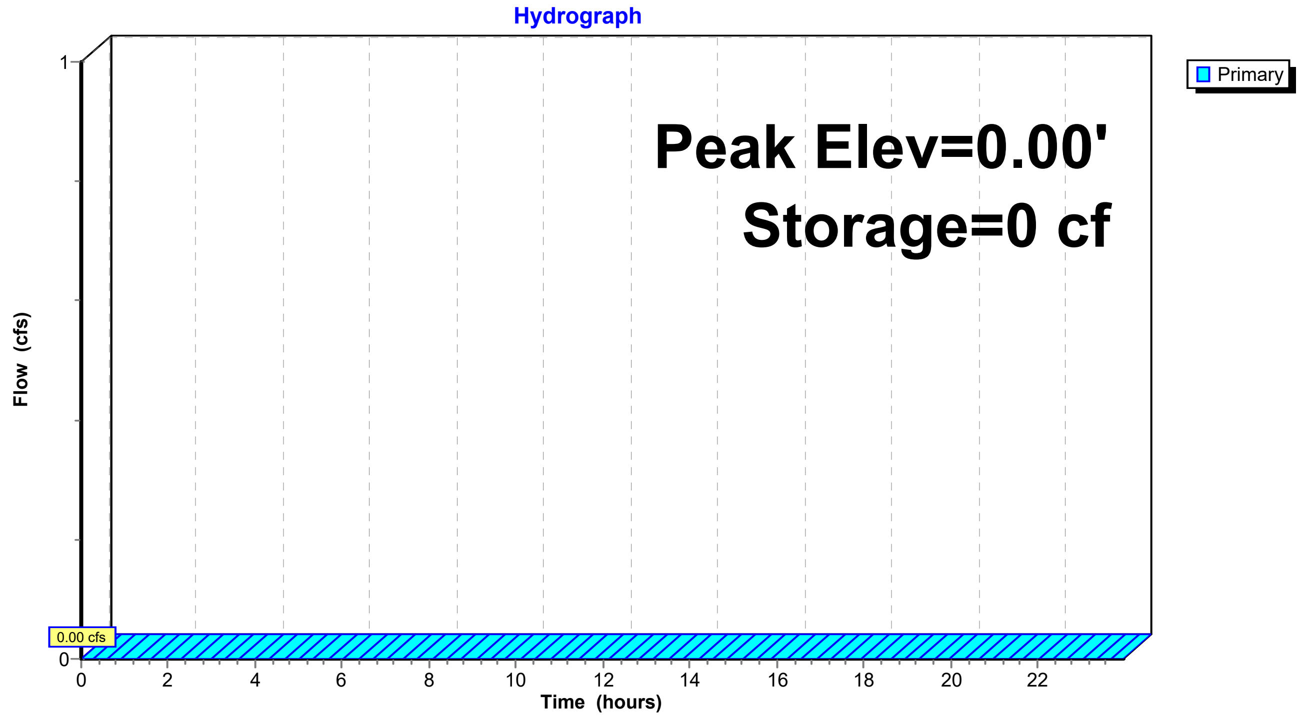
Volume	Invert	Avail.Storage	Storage Description
#1	0.00'	71,500 cf	**Live Storage (Prismatic)**Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
0.00	19,000	0	0
1.00	22,700	20,850	20,850
2.00	25,300	24,000	44,850
3.00	28,000	26,650	71,500

Device	Routing	Invert	Outlet Devices
#1	Primary	0.00'	**8.0" Vert. Orifice/Grate** C= 0.600
#2	Primary	0.75'	**24.0" W x 15.0" H Vert. Notch** C= 0.600
#3	Primary	2.00'	**24.0" Horiz. Riser** C= 0.600 Limited to weir flow at low heads

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=0.00' (Free Discharge)
↑—**1=Orifice/Grate** (Controls 0.00 cfs)
├—**2=Notch** (Controls 0.00 cfs)
└—**3=Riser** (Controls 0.00 cfs)

Pond 10P: 5P-Wet Pond- Live Storage - CORRECTED



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                    Time span=0.00-24.00 hrs, dt=0.17 hrs, 142 points
                        Runoff by SBUH method, Split Pervious/Imperv.
           Reach routing by Stor-Ind+Trans method  -  Pond routing by Stor-Ind method

Subcatchment1S-A: Site - Post Basin          Runoff Area=0.850 ac   76.47% Impervious   Runoff Depth>0.99"
                                                       Tc=5.0 min   CN=79/98   Runoff=0.21 cfs  0.070 af

Subcatchment1S-B: (new Subcat)              Runoff Area=0.050 ac   100.00% Impervious   Runoff Depth>1.23"
                                                        Tc=5.0 min   CN=0/98   Runoff=0.02 cfs  0.005 af

Subcatchment1X: Pre                           Runoff Area=1.800 ac   1.11% Impervious   Runoff Depth>0.12"
                                                      Tc=19.0 min   CN=73/98   Runoff=0.02 cfs  0.019 af

Subcatchment2S-A1: Site -WEST               Runoff Area=1.140 ac   100.00% Impervious   Runoff Depth>1.23"
                                                        Tc=5.0 min   CN=0/98   Runoff=0.36 cfs  0.117 af

Subcatchment2S-A2: Site -WEST (roof         Runoff Area=0.820 ac   70.73% Impervious   Runoff Depth>0.94"
                                                       Tc=5.0 min   CN=79/98   Runoff=0.19 cfs  0.064 af

Subcatchment2S-B1: Site - EAST               Runoff Area=3.620 ac   80.94% Impervious   Runoff Depth>1.04"
                                                       Tc=5.0 min   CN=79/98   Runoff=0.94 cfs  0.313 af

Subcatchment2S-B2: POND                      Runoff Area=0.420 ac   47.62% Impervious   Runoff Depth>0.65"
                                                       Tc=5.0 min   CN=74/98   Runoff=0.06 cfs  0.023 af

Subcatchment2S-C: OFFSITE ROAD              Runoff Area=0.500 ac   100.00% Impervious   Runoff Depth>1.23"
                                                        Tc=5.0 min   CN=0/98   Runoff=0.16 cfs  0.051 af

Subcatchment2X-A: Pre-DEV - [WEST]            Runoff Area=1.300 ac   0.00% Impervious   Runoff Depth>0.11"
                     Flow Length=285'   Slope=0.1700 '/'   Tc=25.1 min   CN=73/0   Runoff=0.01 cfs  0.012 af

Subcatchment2X-B: Pre- DEV [EAST]             Runoff Area=3.900 ac   0.00% Impervious   Runoff Depth>0.11"
                                        Flow Length=750'   Tc=42.8 min   CN=73/0   Runoff=0.04 cfs  0.035 af

Subcatchment2X-C: PRE- OFFSITE ROAD  Runoff Area=0.500 ac   36.00% Impervious   Runoff Depth>0.51"
                                                       Tc=5.0 min   CN=73/98   Runoff=0.06 cfs  0.021 af

Subcatchment3S: Green Mtn Rd                 Runoff Area=1.000 ac   65.00% Impervious   Runoff Depth>0.89"
                                                       Tc=5.0 min   CN=80/98   Runoff=0.21 cfs  0.074 af

Subcatchment3X: PRE- GRN MTN CONN         Runoff Area=1.000 ac   12.00% Impervious   Runoff Depth>0.48"
                                                       Tc=5.0 min   CN=84/98   Runoff=0.09 cfs  0.040 af

Subcatchment4S-A: BELMONT RD                 Runoff Area=2.500 ac   76.00% Impervious   Runoff Depth>1.00"
                                                       Tc=5.0 min   CN=80/98   Runoff=0.61 cfs  0.207 af

Subcatchment4S-B: SOUTH OF BELMONT Runoff Area=7.000 ac   28.57% Impervious   Runoff Depth>0.51"
                                      Flow Length=1,050'   Tc=87.5 min   CN=80/98   Runoff=0.33 cfs  0.298 af

Subcatchment4S-C: WET POND                  Runoff Area=0.800 ac   100.00% Impervious   Runoff Depth>1.23"
                                                        Tc=5.0 min   CN=0/98   Runoff=0.26 cfs  0.082 af
```

```
Subcatchment4X-A: PRE - BELMONT RD   Runoff Area=2.500 ac  20.00% Impervious   Runoff Depth>0.53"
                   Flow Length=850'   Slope=0.0100 '/'   Tc=67.1 min   CN=84/98   Runoff=0.13 cfs  0.111 af

Subcatchment4X-B: South of Belmont      Runoff Area=7.800 ac   3.85% Impervious   Runoff Depth>0.40"
                   Flow Length=800'   Slope=0.0100 '/'   Tc=65.9 min   CN=84/98   Runoff=0.25 cfs  0.258 af

Subcatchment5S: Commercial Site         Runoff Area=11.700 ac   0.68% Impervious   Runoff Depth>0.24"
                                  Flow Length=1,550'   Tc=97.7 min   CN=80/98   Runoff=0.20 cfs  0.239 af

Subcatchment5X: Commercial Site         Runoff Area=11.700 ac   0.68% Impervious   Runoff Depth>0.25"
                                  Flow Length=1,600'   Tc=88.5 min   CN=80/98   Runoff=0.20 cfs  0.241 af

Reach 7R: conveyance ditch          Avg. Flow Depth=0.08'   Max Vel=0.56 fps   Inflow=0.15 cfs  0.072 af
                     n=0.030   L=450.0'   S=0.0044 '/'   Capacity=40.89 cfs   Outflow=0.14 cfs  0.071 af

Pond 1B: BIORET-1                      Peak Elev=7.00'  Storage=0.000 af   Inflow=0.21 cfs  0.070 af
                                                                        Outflow=0.21 cfs  0.070 af

Pond 1P: NW CORNER                     Peak Elev=1.41'  Storage=0.022 af   Inflow=0.22 cfs  0.076 af
                                                                        Outflow=0.04 cfs  0.063 af

Pond 2A: BIORET-2A                     Peak Elev=5.00'  Storage=0.000 af   Inflow=0.36 cfs  0.117 af
                                                                        Outflow=0.36 cfs  0.117 af

Pond 2B: BIORET-2B                     Peak Elev=6.00'  Storage=0.000 af   Inflow=1.10 cfs  0.364 af
                                                                        Outflow=1.10 cfs  0.364 af

Pond 2P: West Pond                     Peak Elev=2.28'  Storage=0.137 af   Inflow=0.55 cfs  0.181 af
                                                                        Outflow=0.03 cfs  0.043 af

Pond 3P: East Pond                     Peak Elev=1.81'  Storage=7,792 cf   Inflow=1.16 cfs  0.387 af
                                                                        Outflow=0.15 cfs  0.217 af

Pond 4P: Wet Pond- Live Storage          Peak Elev=0.29'  Storage=301 cf   Inflow=0.21 cfs  0.074 af
                                                                        Outflow=0.15 cfs  0.072 af

Pond 5P: Wet Pond- Live Storage        Peak Elev=0.43'  Storage=4,965 cf   Inflow=1.13 cfs  0.587 af
                                                                        Outflow=0.54 cfs  0.517 af

Pond 6P: 4P-Wet Pond-Live Storage - CORRECTED                       Peak Elev=0.00'  Storage=0 cf
                                                                        Primary=0.00 cfs  0.000 af

Pond 8P: 4P- Wet Pond- Dead Storage                            Peak Elev=0.00'  Storage=4,748 cf

Pond 9P: 5P- Dead Storage                                     Peak Elev=0.00'  Storage=17,914 cf

Pond 10P: 5P-Wet Pond- Live Storage - CORRECTED                     Peak Elev=0.00'  Storage=0 cf
                                                                        Primary=0.00 cfs  0.000 af
```

Total Runoff Area = 60.900 ac Runoff Volume = 2.280 af Average Runoff Depth = 0.45"
79.18% Pervious = 48.220 ac 20.82% Impervious = 12.680 ac

Summary for Subcatchment 1S-A: Site - Post Basin NPGS

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

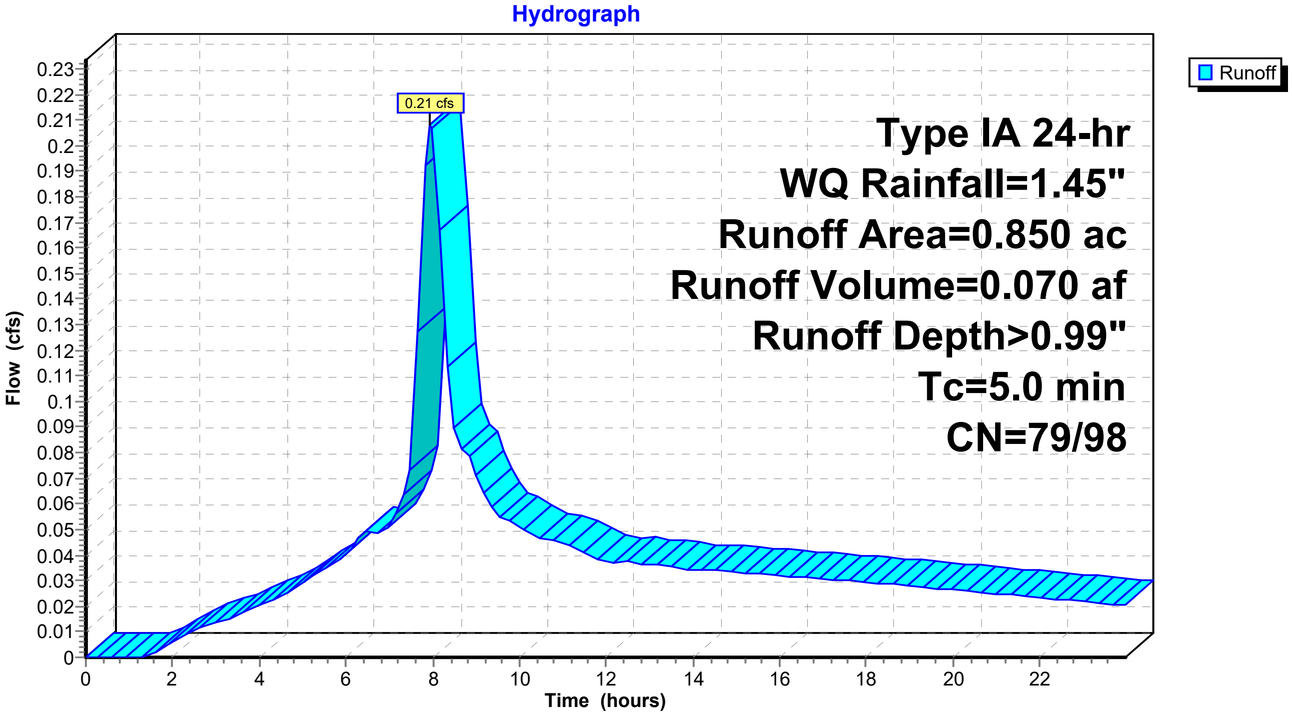
Runoff = 0.21 cfs @ 7.95 hrs, Volume= 0.070 af, Depth> 0.99"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-23.97 hrs, dt= 0.17 hrs
Type IA 24-hr WQ Rainfall=1.45"

	Area (ac)	CN	Description
*	0.370	98	roof areas
	0.200	79	50-75% Grass cover, Fair, HSG C
*	0.280	98	parking
	0.850	94	Weighted Average
	0.200	79	23.53% Pervious Area
	0.650	98	76.47% Impervious Area

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

Subcatchment 1S-A: Site - Post Basin NPGS



Summary for Subcatchment 1S-B: (new Subcat)

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

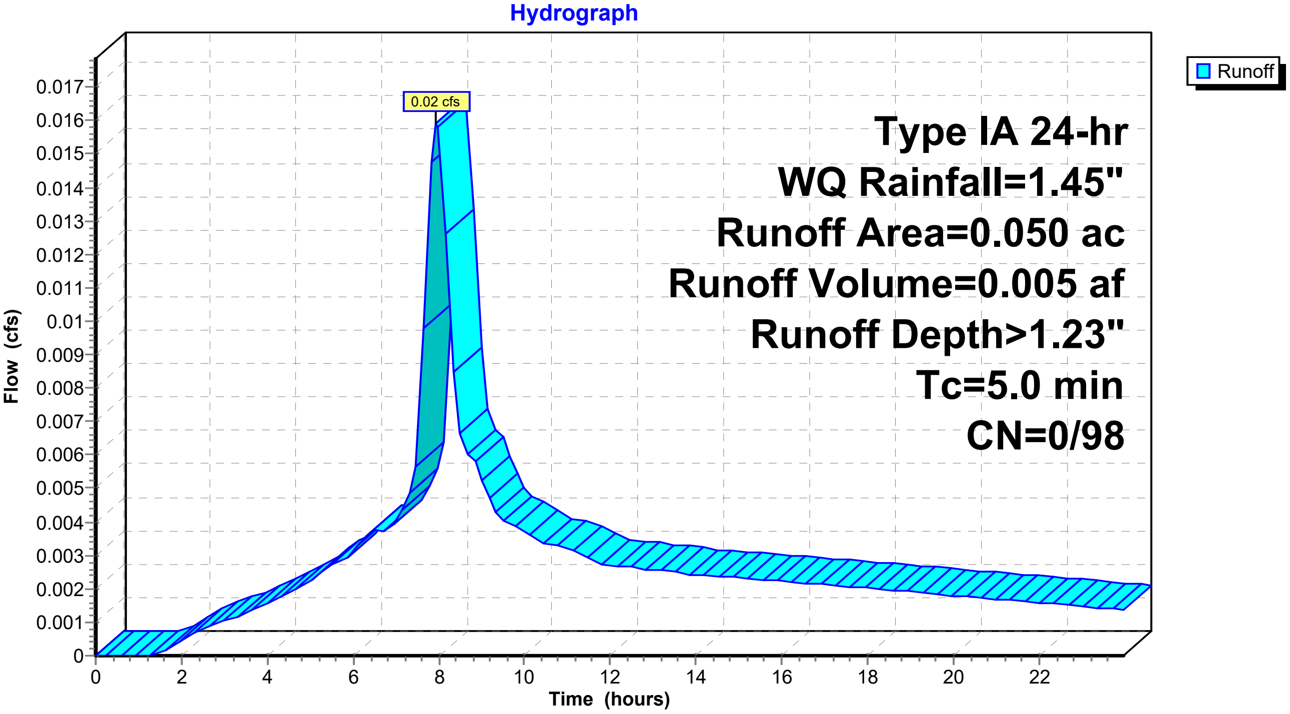
Runoff = 0.02 cfs @ 7.95 hrs, Volume= 0.005 af, Depth> 1.23"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-23.97 hrs, dt= 0.17 hrs
Type IA 24-hr WQ Rainfall=1.45"

	Area (ac)	CN	Description
*	0.050	98	pond surface at Q100
	0.050	98	100.00% Impervious Area

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

Subcatchment 1S-B: (new Subcat)



Summary for Subcatchment 1X: Pre

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

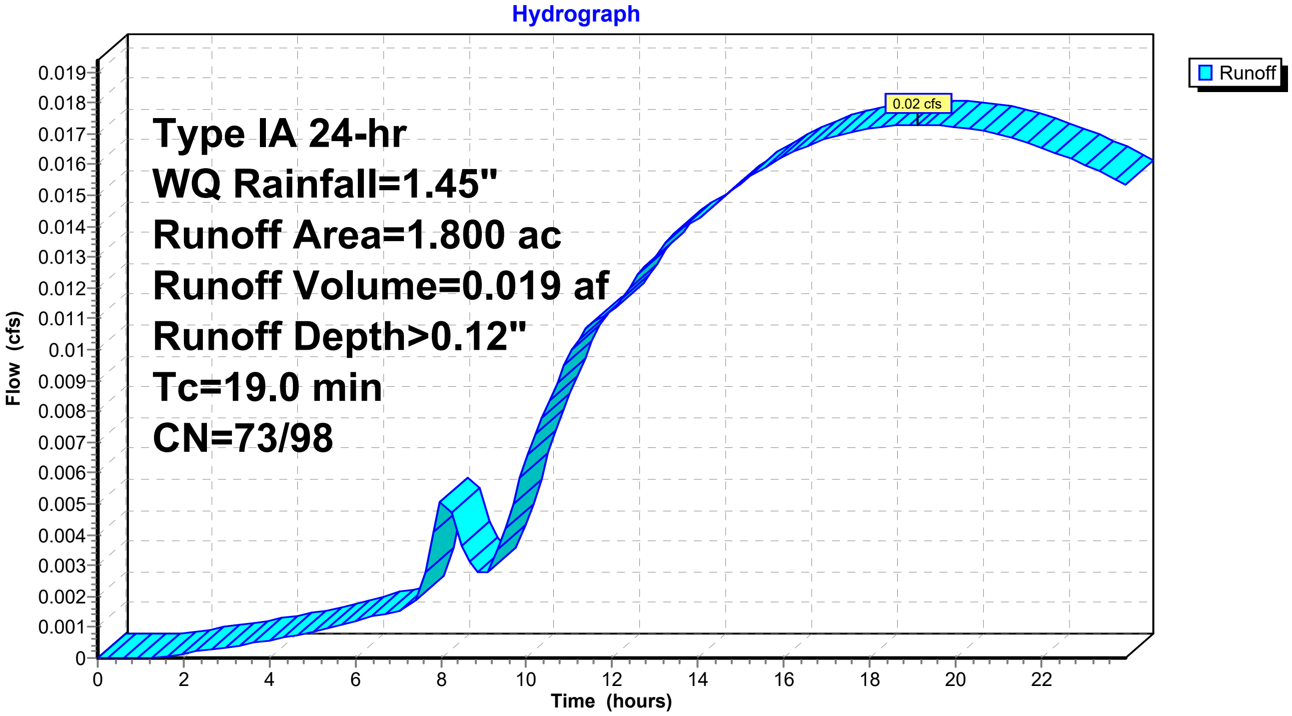
Runoff = 0.02 cfs @ 19.12 hrs, Volume= 0.019 af, Depth> 0.12"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-23.97 hrs, dt= 0.17 hrs
Type IA 24-hr WQ Rainfall=1.45"

	Area (ac)	CN	Description
	1.780	73	Woods, Fair, HSG C
*	0.020	98	PORTION OF GREEN MTN LOOP
	1.800	73	Weighted Average
	1.780	73	98.89% Pervious Area
	0.020	98	1.11% Impervious Area

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

Subcatchment 1X: Pre



Summary for Subcatchment 2S-A1: Site -WEST

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

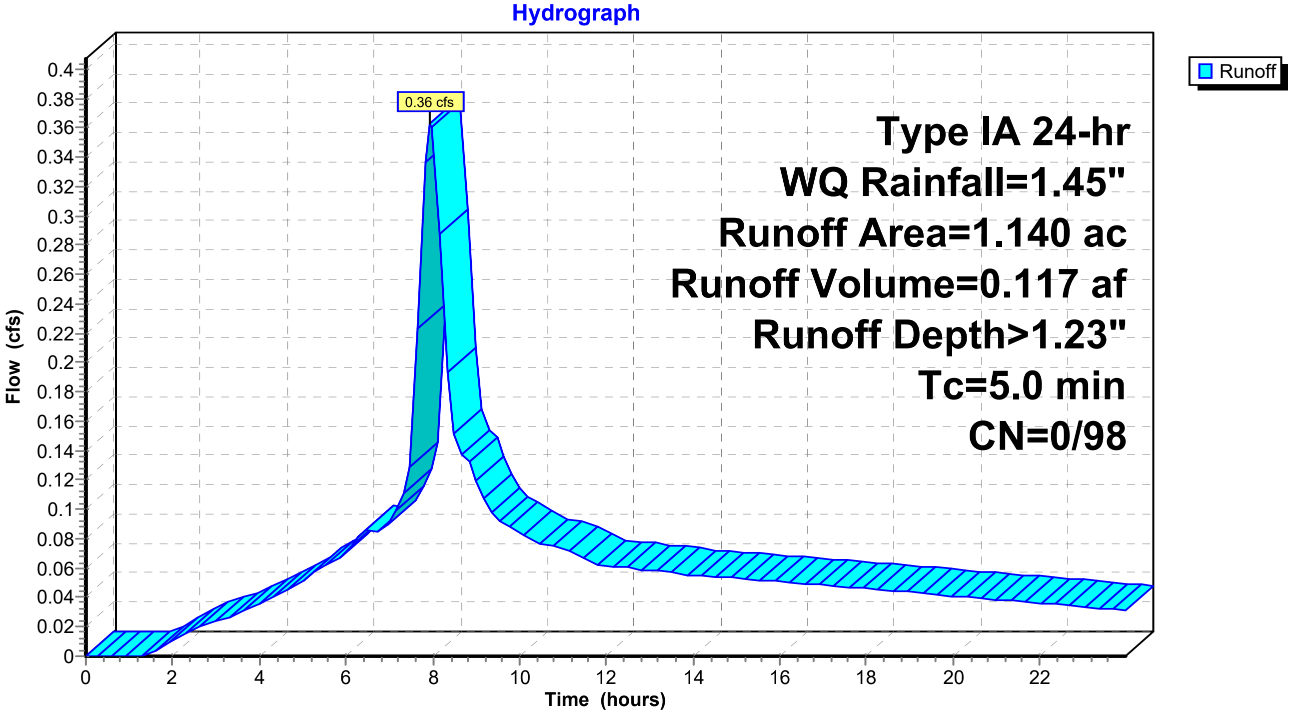
Runoff = 0.36 cfs @ 7.95 hrs, Volume= 0.117 af, Depth> 1.23"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-23.97 hrs, dt= 0.17 hrs
Type IA 24-hr WQ Rainfall=1.45"

	Area (ac)	CN	Description
*	0.390	98	roof areas- bldg E, half building
*	0.750	98	drive/parking
	1.140	98	Weighted Average
	1.140	98	100.00% Impervious Area

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

Subcatchment 2S-A1: Site -WEST



Summary for Subcatchment 2S-A2: Site -WEST (roof areas & pond)

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

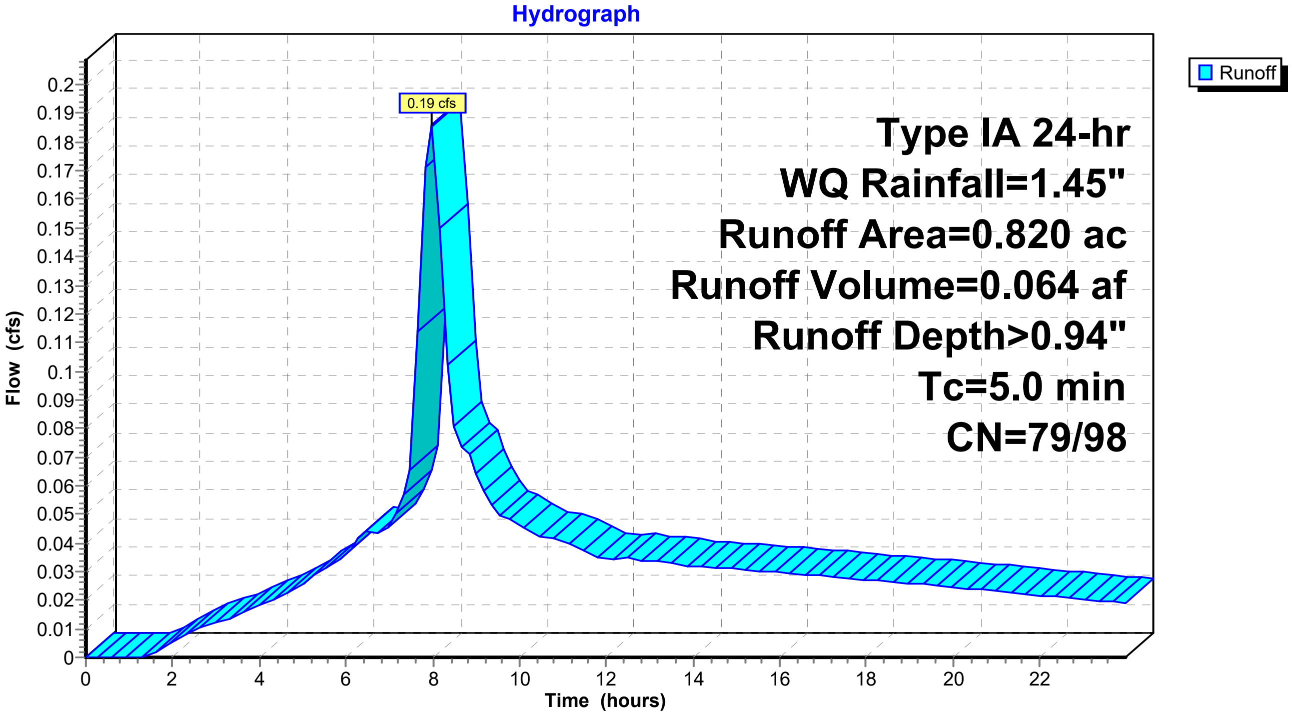
Runoff = 0.19 cfs @ 7.95 hrs, Volume= 0.064 af, Depth> 0.94"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-23.97 hrs, dt= 0.17 hrs
Type IA 24-hr WQ Rainfall=1.45"

	Area (ac)	CN	Description
*	0.450	98	roof areas
*	0.130	98	pond
	0.240	79	50-75% Grass cover, Fair, HSG C
	0.820	92	Weighted Average
	0.240	79	29.27% Pervious Area
	0.580	98	70.73% Impervious Area

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

Subcatchment 2S-A2: Site -WEST (roof areas & pond)



Summary for Subcatchment 2S-B1: Site - EAST

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

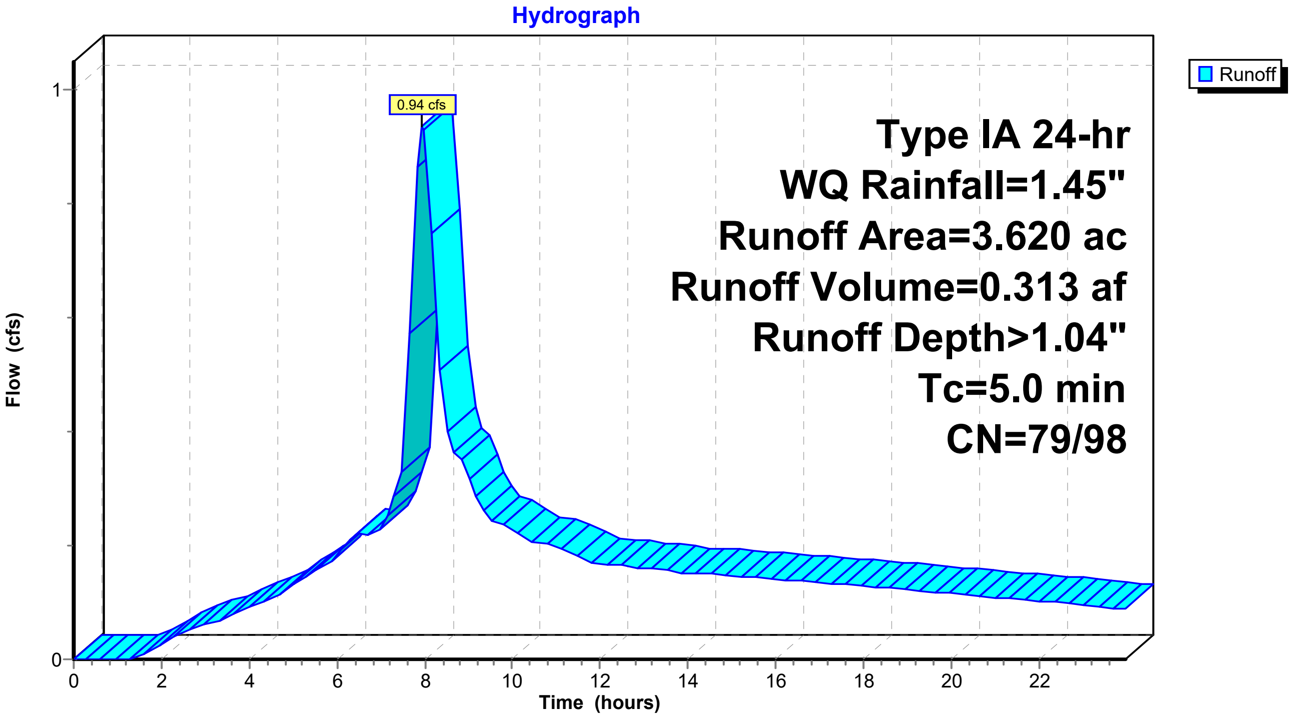
Runoff = 0.94 cfs @ 7.95 hrs, Volume= 0.313 af, Depth> 1.04"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-23.97 hrs, dt= 0.17 hrs
Type IA 24-hr WQ Rainfall=1.45"

	Area (ac)	CN	Description
*	0.870	98	roof areas
*	2.060	98	PARKING AND DRIVE AISLE
	0.690	79	50-75% Grass cover, Fair, HSG C
	3.620	94	Weighted Average
	0.690	79	19.06% Pervious Area
	2.930	98	80.94% Impervious Area

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

Subcatchment 2S-B1: Site - EAST



Summary for Subcatchment 2S-B2: POND

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

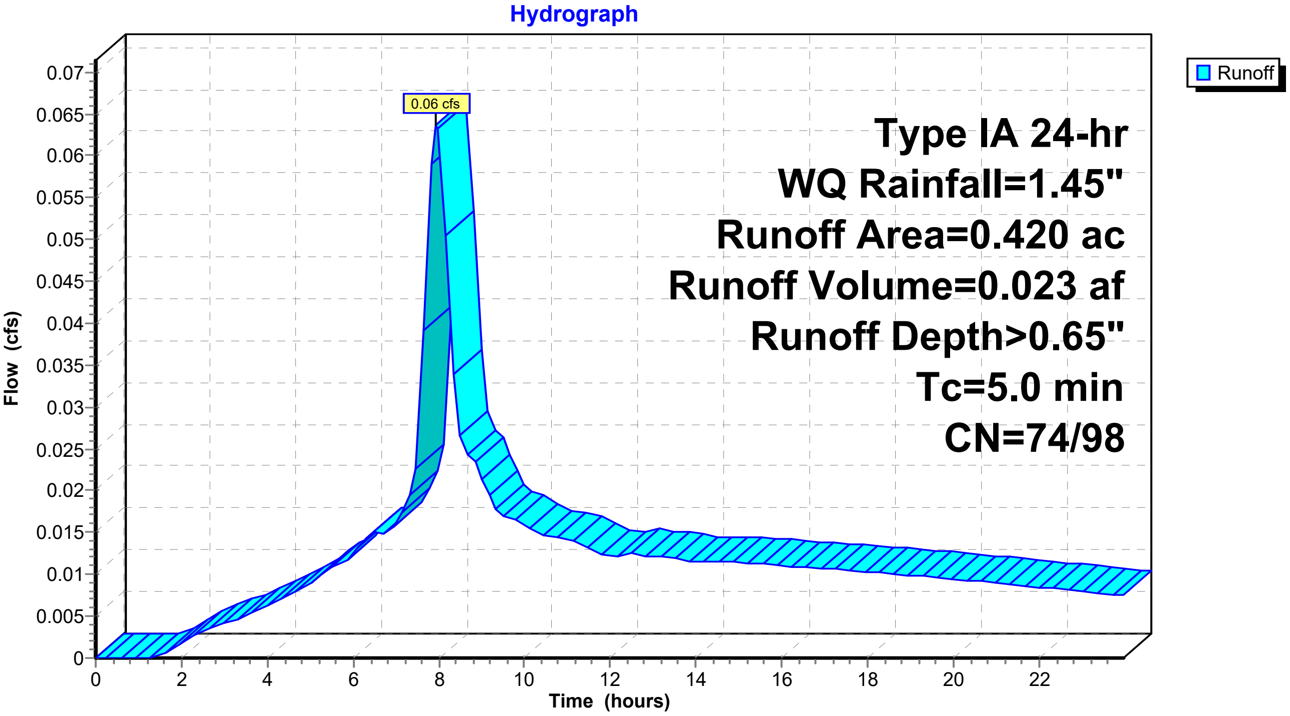
Runoff = 0.06 cfs @ 7.95 hrs, Volume= 0.023 af, Depth> 0.65"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-23.97 hrs, dt= 0.17 hrs
Type IA 24-hr WQ Rainfall=1.45"

	Area (ac)	CN	Description
*	0.200	98	POND AT Q100
	0.220	74	>75% Grass cover, Good, HSG C
	0.420	85	Weighted Average
	0.220	74	52.38% Pervious Area
	0.200	98	47.62% Impervious Area

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

Subcatchment 2S-B2: POND



Summary for Subcatchment 2S-C: OFFSITE ROAD

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

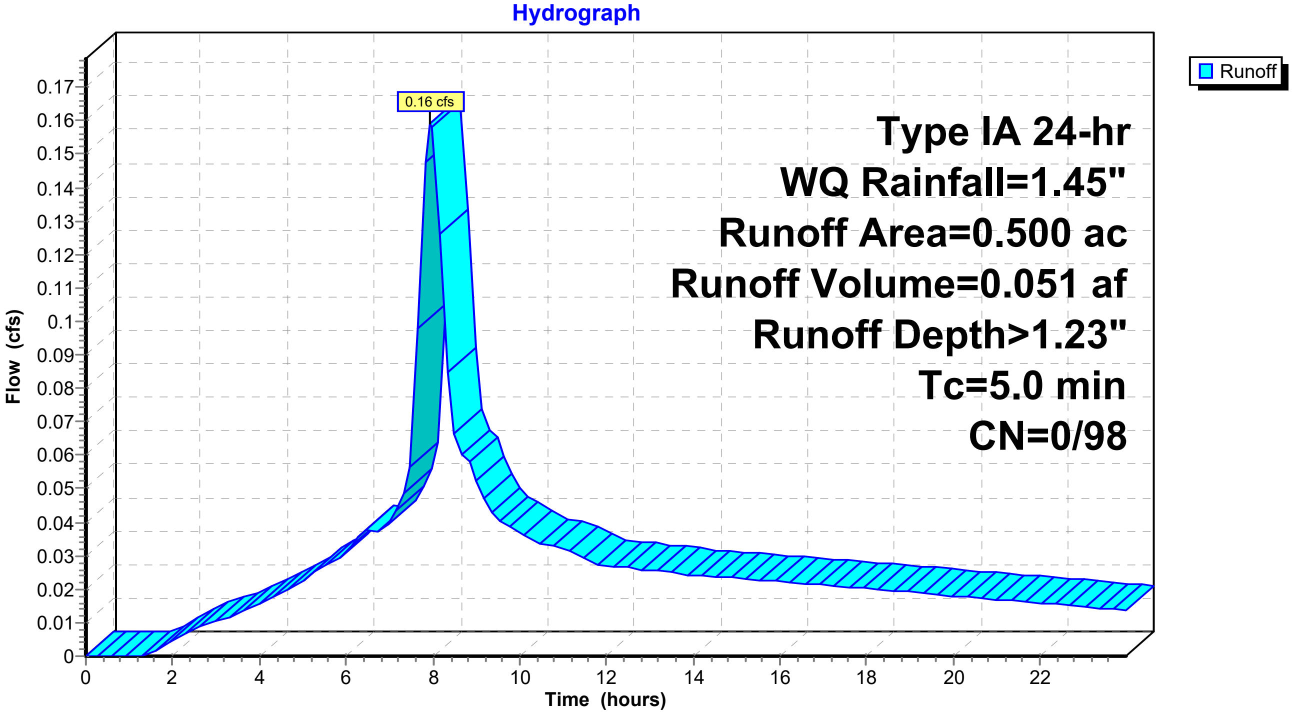
Runoff = 0.16 cfs @ 7.95 hrs, Volume= 0.051 af, Depth> 1.23"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-23.97 hrs, dt= 0.17 hrs
Type IA 24-hr WQ Rainfall=1.45"

	Area (ac)	CN	Description
*	0.500	98	GREEN MTN LOOP & RD
	0.500	98	100.00% Impervious Area

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

Subcatchment 2S-C: OFFSITE ROAD



Summary for Subcatchment 2X-A: Pre-DEV - [WEST]

BASIN 30S-A - 1S TO THE NORTH

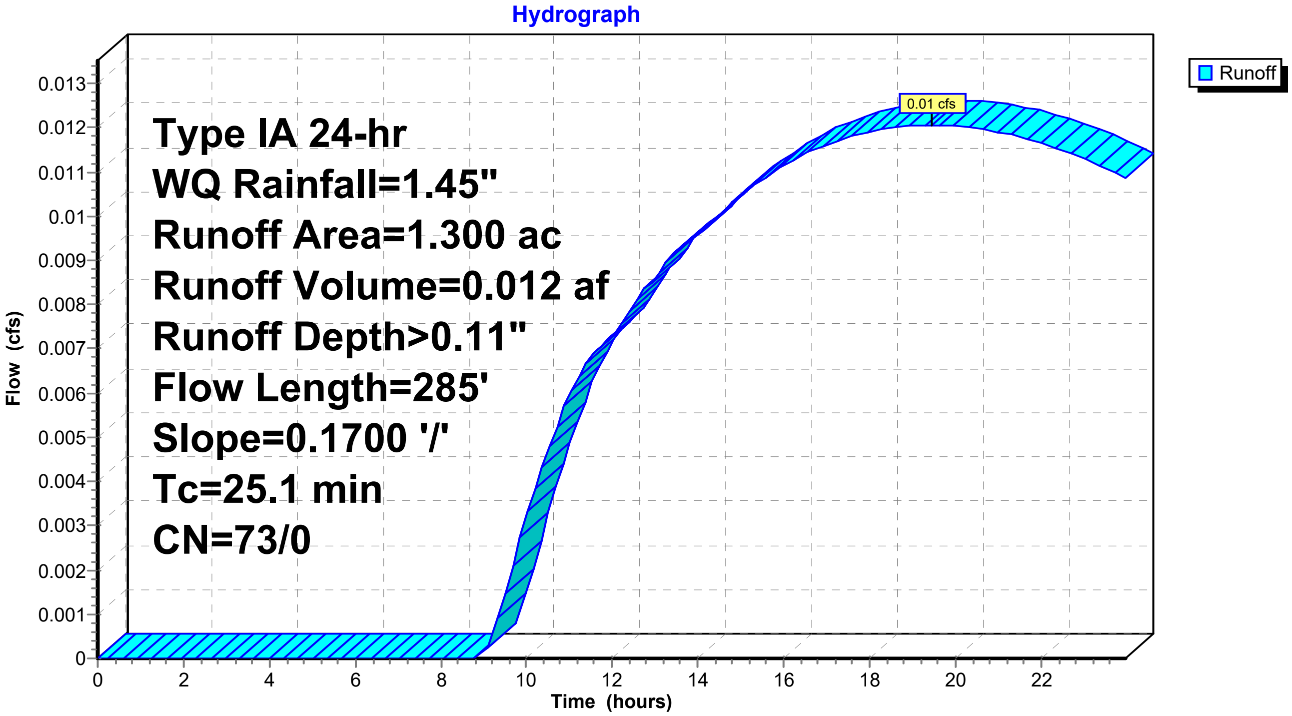
Runoff = 0.01 cfs @ 19.45 hrs, Volume= 0.012 af, Depth> 0.11"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-23.97 hrs, dt= 0.17 hrs
Type IA 24-hr WQ Rainfall=1.45"

Area (ac)	CN	Description
1.300	73	Woods, Fair, HSG C
1.300	73	100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
25.1	285	0.1700	0.19		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 2.26"

Subcatchment 2X-A: Pre-DEV - [WEST]



Summary for Subcatchment 2X-B: Pre- DEV [EAST]

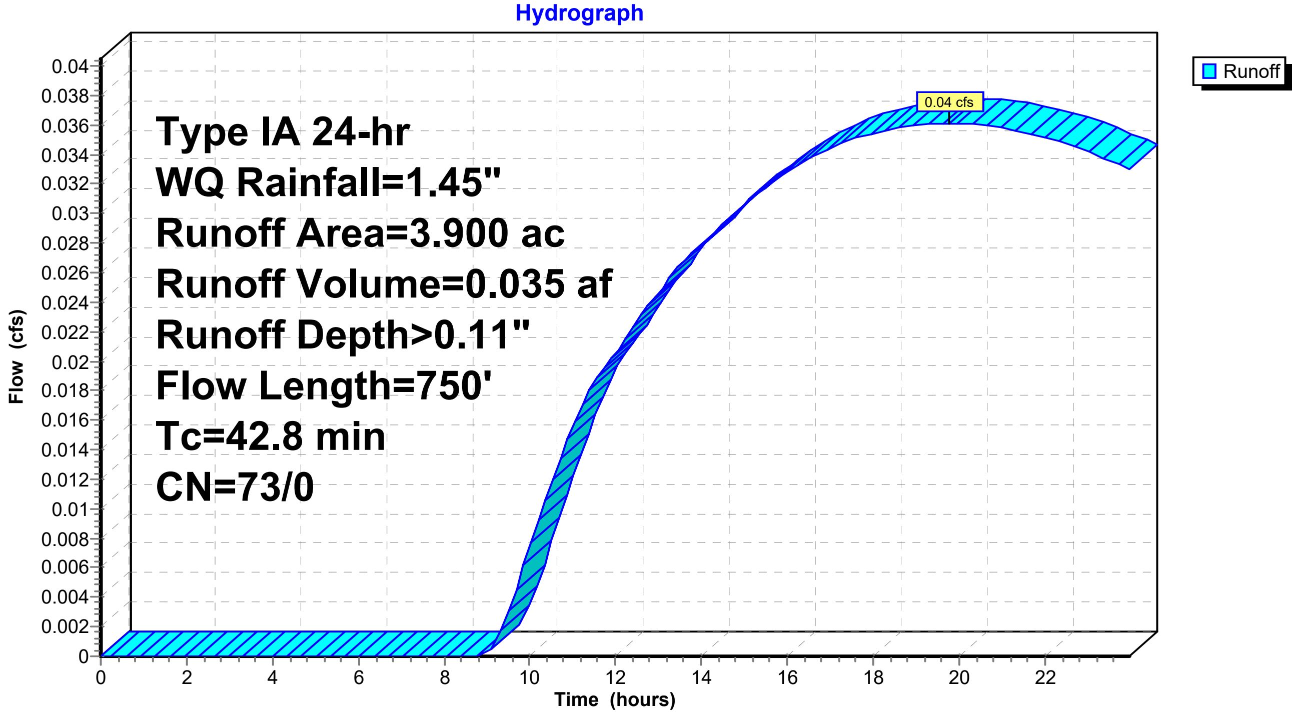
Runoff = 0.04 cfs @ 19.76 hrs, Volume= 0.035 af, Depth> 0.11"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-23.97 hrs, dt= 0.17 hrs
Type IA 24-hr WQ Rainfall=1.45"

Area (ac)	CN	Description
3.900	73	Woods, Fair, HSG C
3.900	73	100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
23.8	250	0.1500	0.18		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 2.26"
2.7	200	0.0600	1.22		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
16.3	300	0.0150	0.31		**Shallow Concentrated Flow,** Forest w/Heavy Litter Kv= 2.5 fps
42.8	750	Total			

Subcatchment 2X-B: Pre- DEV [EAST]



Summary for Subcatchment 2X-C: PRE- OFFSITE ROAD

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

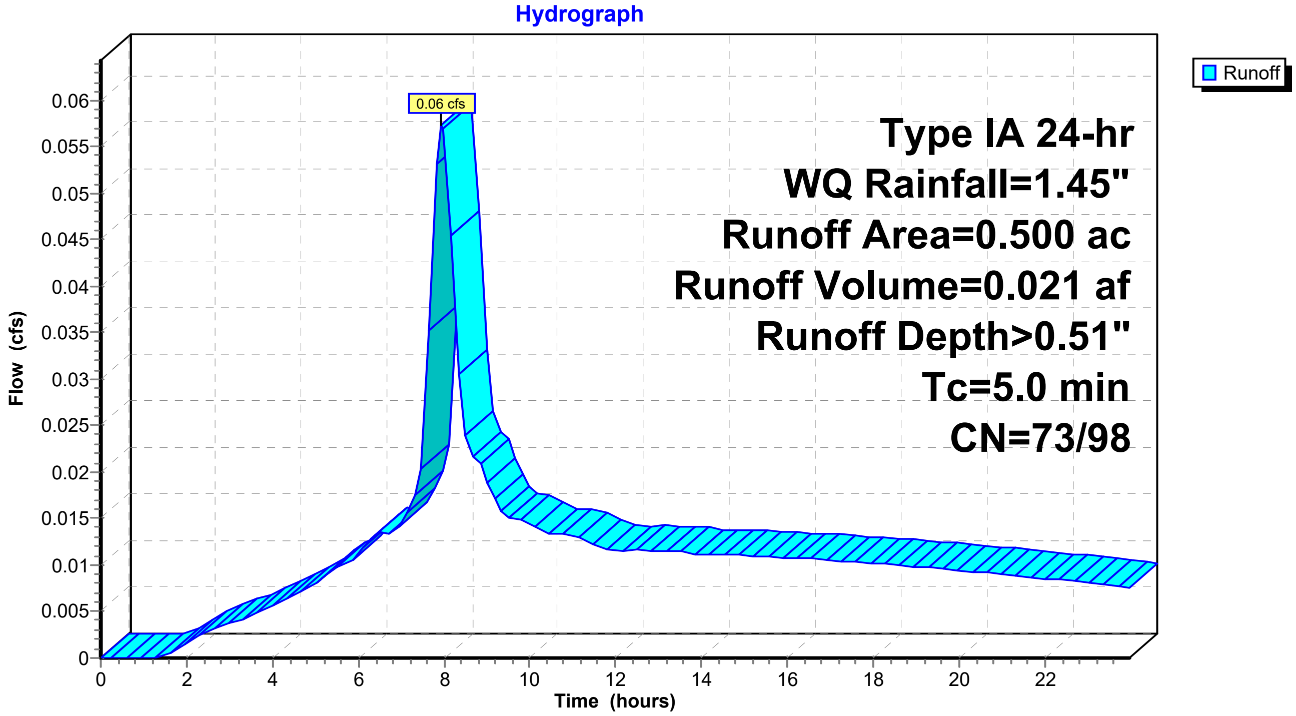
```
Runoff      =        0.06 cfs @    7.95 hrs,  Volume=           0.021 af,  Depth>  0.51"
```

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-23.97 hrs, dt= 0.17 hrs
Type IA 24-hr WQ Rainfall=1.45"

	Area (ac)	CN	Description
	0.320	73	Woods, Fair, HSG C
*	0.180	98	GREEN MTN RD & LOOP
	0.500	82	Weighted Average
	0.320	73	64.00% Pervious Area
	0.180	98	36.00% Impervious Area

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

Subcatchment 2X-C: PRE- OFFSITE ROAD



Summary for Subcatchment 3S: Green Mtn Rd Connection

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

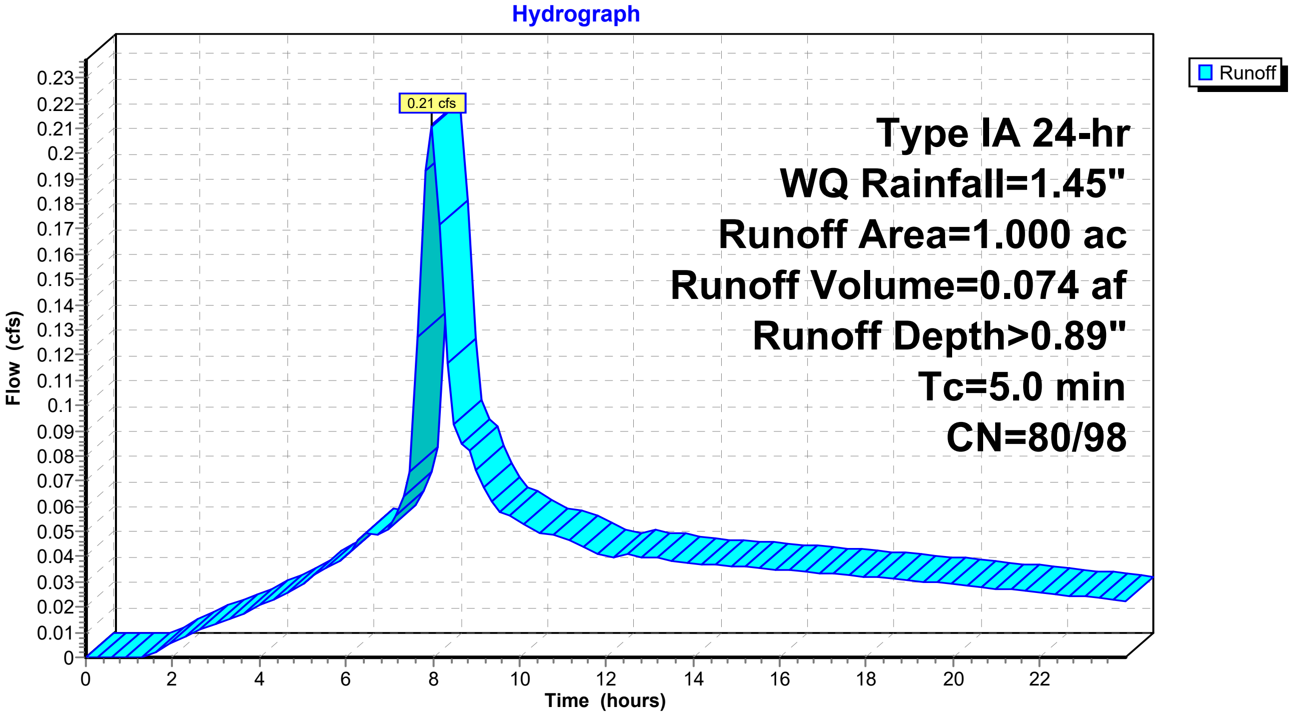
Runoff = 0.21 cfs @ 7.96 hrs, Volume= 0.074 af, Depth> 0.89"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-23.97 hrs, dt= 0.17 hrs
Type IA 24-hr WQ Rainfall=1.45"

	Area (ac)	CN	Description
*	0.500	98	BELMONT RD & PVT RD
	0.350	80	>75% Grass cover, Good, HSG D
*	0.150	98	POND
	1.000	92	Weighted Average
	0.350	80	35.00% Pervious Area
	0.650	98	65.00% Impervious Area

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

Subcatchment 3S: Green Mtn Rd Connection



Summary for Subcatchment 3X: PRE- GRN MTN CONN

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

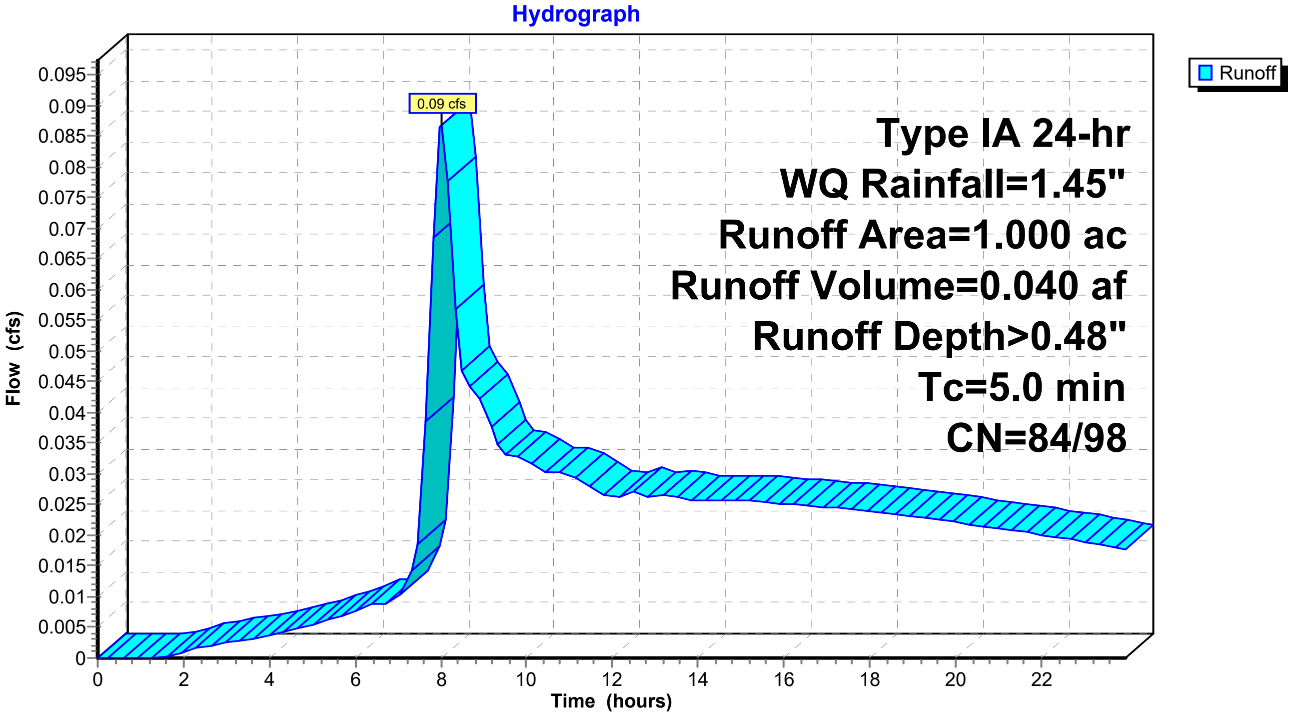
Runoff = 0.09 cfs @ 8.02 hrs, Volume= 0.040 af, Depth> 0.48"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-23.97 hrs, dt= 0.17 hrs
Type IA 24-hr WQ Rainfall=1.45"

	Area (ac)	CN	Description
	0.880	84	Pasture/grassland/range, Fair, HSG D
*	0.120	98	GREEN MTN RD
	1.000	86	Weighted Average
	0.880	84	88.00% Pervious Area
	0.120	98	12.00% Impervious Area

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

Subcatchment 3X: PRE- GRN MTN CONN



Summary for Subcatchment 4S-A: BELMONT RD

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

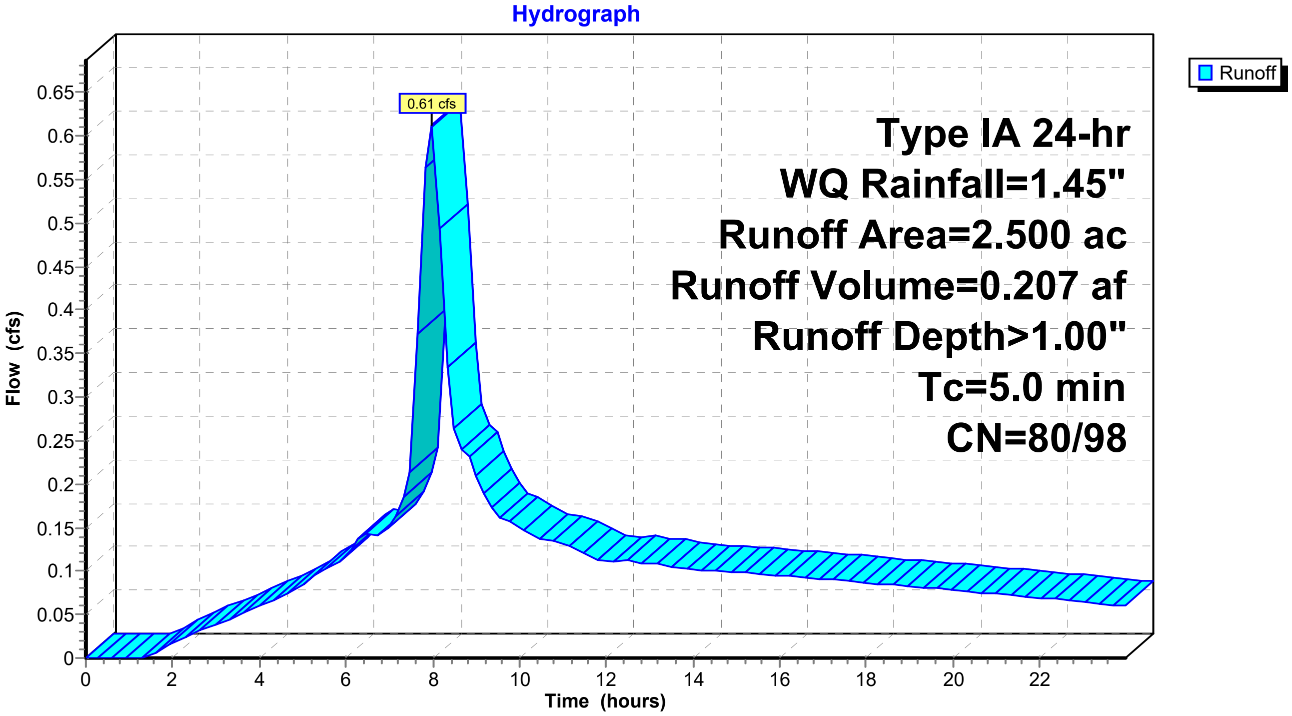
Runoff = 0.61 cfs @ 7.95 hrs, Volume= 0.207 af, Depth> 1.00"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-23.97 hrs, dt= 0.17 hrs
Type IA 24-hr WQ Rainfall=1.45"

	Area (ac)	CN	Description
*	1.900	98	BELMONT RD
	0.600	80	>75% Grass cover, Good, HSG D
	2.500	94	Weighted Average
	0.600	80	24.00% Pervious Area
	1.900	98	76.00% Impervious Area

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

Subcatchment 4S-A: BELMONT RD



Summary for Subcatchment 4S-B: SOUTH OF BELMONT

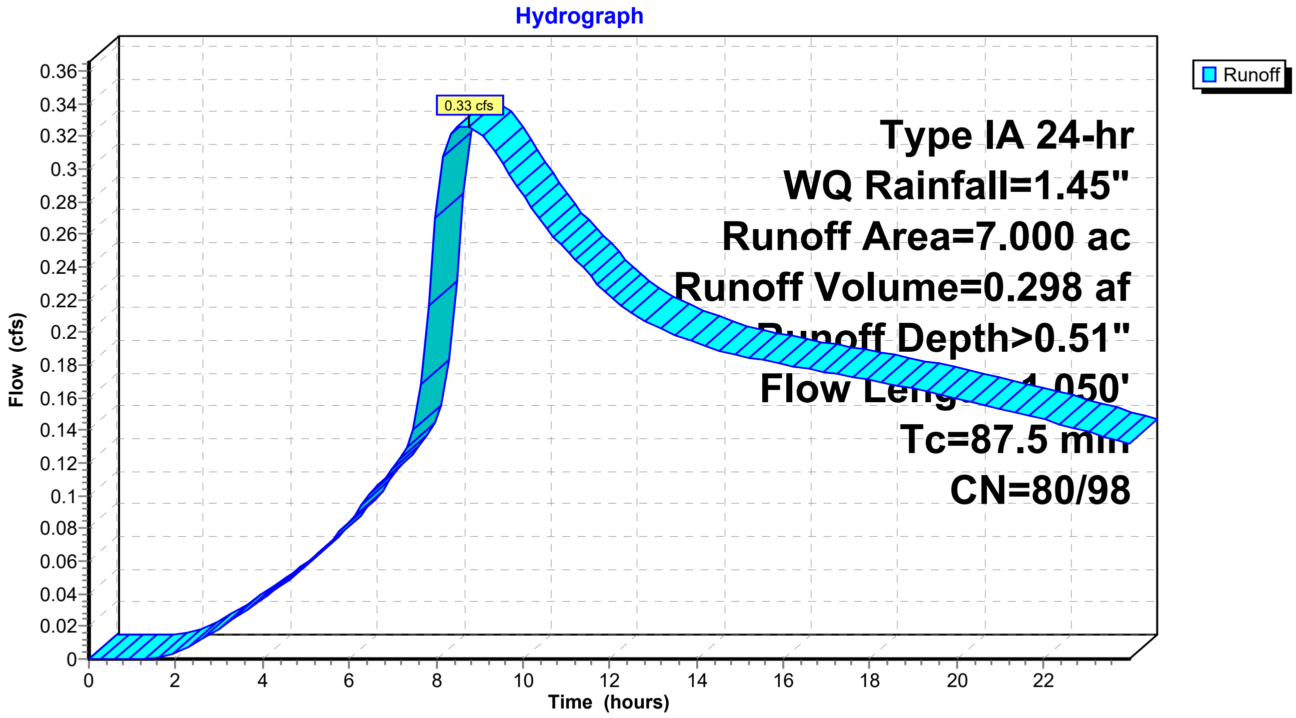
Runoff = 0.33 cfs @ 8.75 hrs, Volume= 0.298 af, Depth> 0.51"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-23.97 hrs, dt= 0.17 hrs
Type IA 24-hr WQ Rainfall=1.45"

	Area (ac)	CN	Description
	5.000	80	>75% Grass cover, Good, HSG D
*	2.000	98	ROCK STOCKPILE
	7.000	85	Weighted Average
	5.000	80	71.43% Pervious Area
	2.000	98	28.57% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
71.2	300	0.0050	0.07		**Sheet Flow,** Grass: Dense n= 0.240 P2= 2.26"
15.2	450	0.0050	0.49		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
1.1	300	0.0100	4.71	37.72	**Trap/Vee/Rect Channel Flow,** Bot.W=5.00' D=1.00' Z= 3.0 '/' Top.W=11.00' n= 0.025 Earth, clean & winding
87.5	1,050	Total			

Subcatchment 4S-B: SOUTH OF BELMONT



Summary for Subcatchment 4S-C: WET POND

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

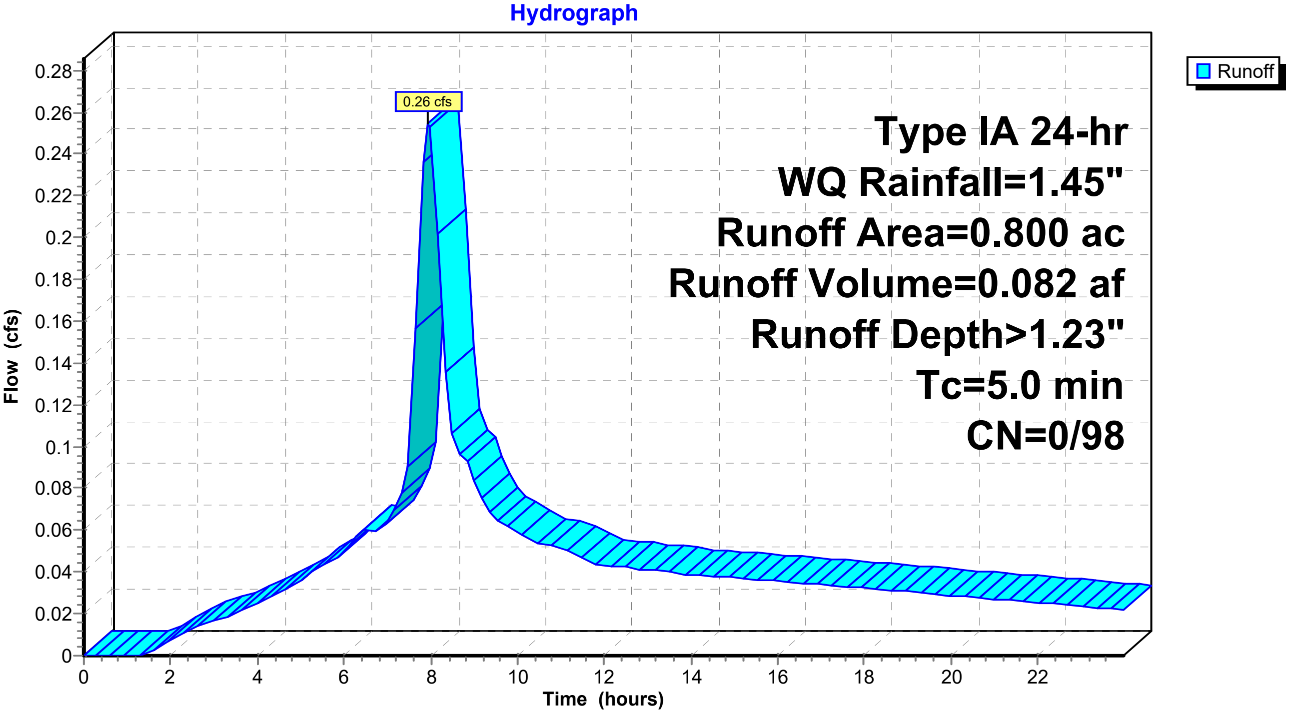
Runoff = 0.26 cfs @ 7.95 hrs, Volume= 0.082 af, Depth> 1.23"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-23.97 hrs, dt= 0.17 hrs
Type IA 24-hr WQ Rainfall=1.45"

	Area (ac)	CN	Description
*	0.800	98	POND
	0.800	98	100.00% Impervious Area

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

Subcatchment 4S-C: WET POND



Summary for Subcatchment 4X-A: PRE - BELMONT RD

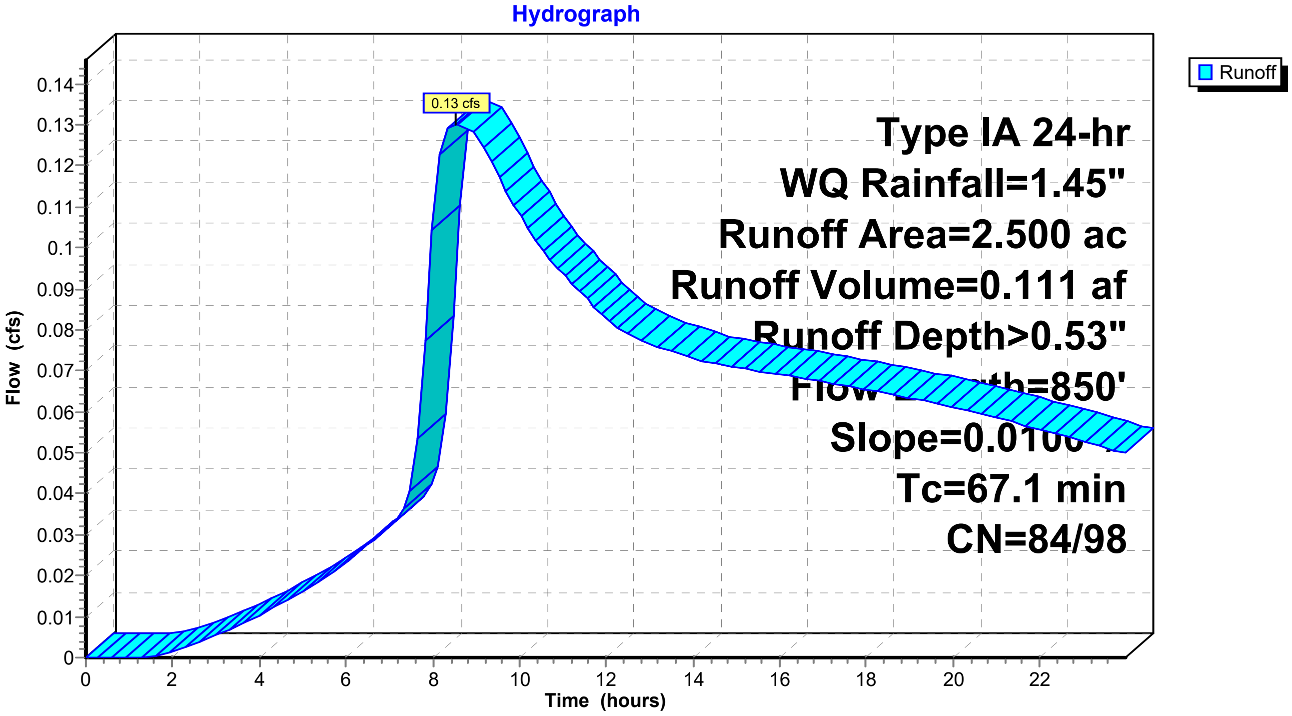
Runoff = 0.13 cfs @ 8.55 hrs, Volume= 0.111 af, Depth> 0.53"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-23.97 hrs, dt= 0.17 hrs
Type IA 24-hr WQ Rainfall=1.45"

	Area (ac)	CN	Description
	2.000	84	Pasture/grassland/range, Fair, HSG D
*	0.500	98	OPH & PARKING LOT
	2.500	87	Weighted Average
	2.000	84	80.00% Pervious Area
	0.500	98	20.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
54.0	300	0.0100	0.09		**Sheet Flow,** Grass: Dense n= 0.240 P2= 2.26"
13.1	550	0.0100	0.70		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
67.1	850	Total			

Subcatchment 4X-A: PRE - BELMONT RD



Summary for Subcatchment 4X-B: South of Belmont

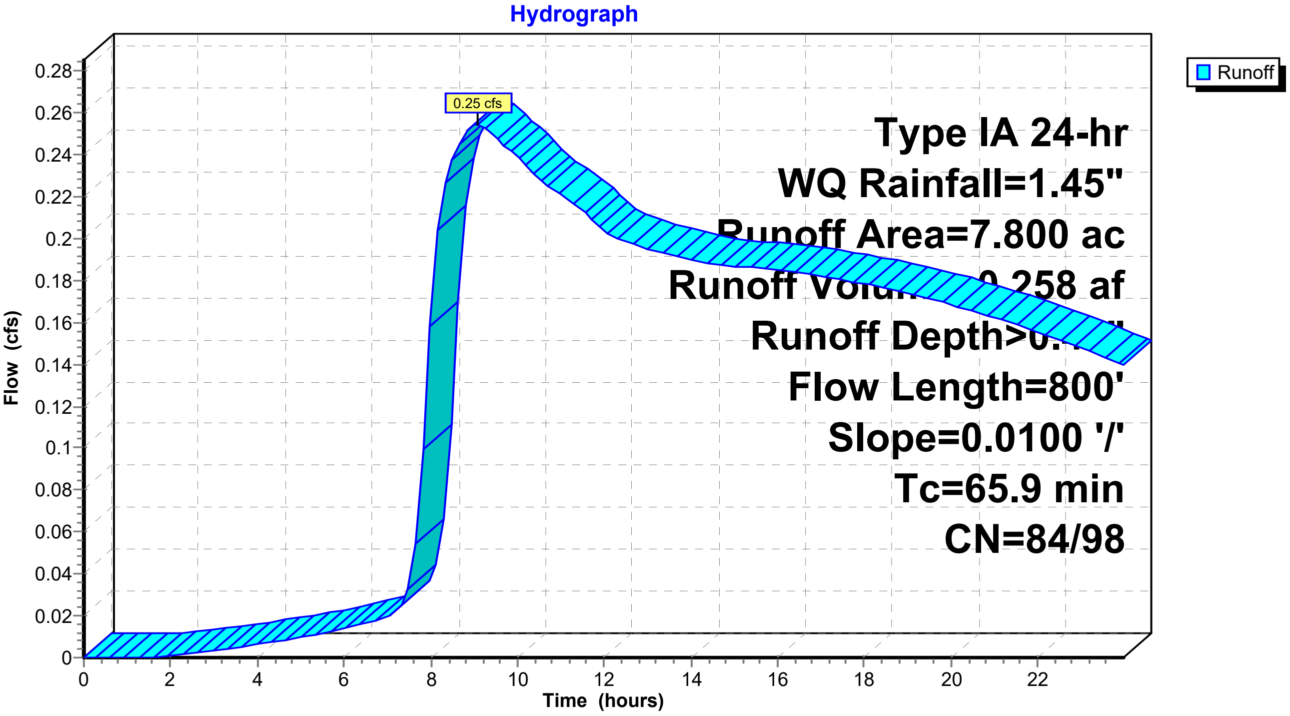
Runoff = 0.25 cfs @ 9.07 hrs, Volume= 0.258 af, Depth> 0.40"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-23.97 hrs, dt= 0.17 hrs
Type IA 24-hr WQ Rainfall=1.45"

	Area (ac)	CN	Description
	7.500	84	Pasture/grassland/range, Fair, HSG D
*	0.300	98	Existing gravel access road
	7.800	85	Weighted Average
	7.500	84	96.15% Pervious Area
	0.300	98	3.85% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
54.0	300	0.0100	0.09		**Sheet Flow,** Grass: Dense n= 0.240 P2= 2.26"
11.9	500	0.0100	0.70		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
65.9	800	Total			

Subcatchment 4X-B: South of Belmont



Summary for Subcatchment 5S: Commercial Site

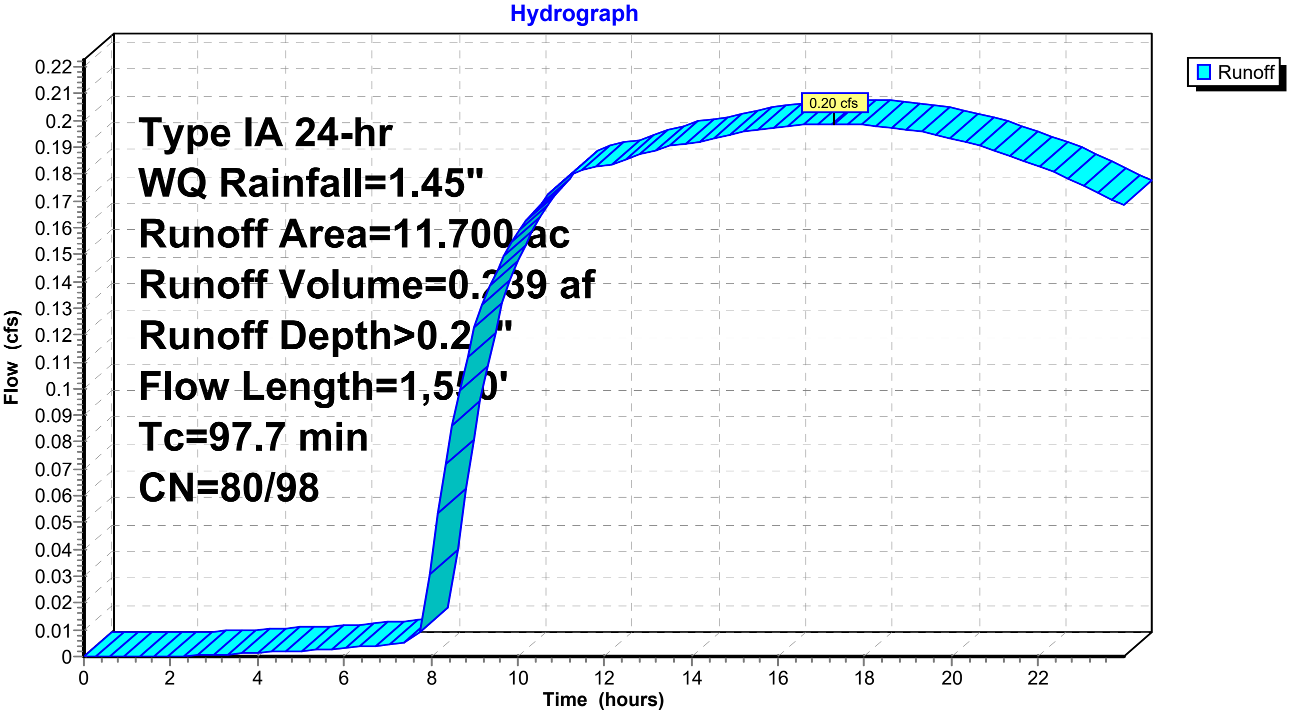
Runoff = 0.20 cfs @ 17.29 hrs, Volume= 0.239 af, Depth> 0.24"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-23.97 hrs, dt= 0.17 hrs
Type IA 24-hr WQ Rainfall=1.45"

	Area (ac)	CN	Description
	11.620	80	>75% Grass cover, Good, HSG D
*	0.080	98	Existing gravel
	11.700	80	Weighted Average
	11.620	80	99.32% Pervious Area
	0.080	98	0.68% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
71.2	300	0.0050	0.07		**Sheet Flow,** Grass: Dense n= 0.240 P2= 2.26"
1.6	100	0.0050	1.06		**Shallow Concentrated Flow,** Grassed Waterway Kv= 15.0 fps
24.9	1,150	0.0005	0.77	6.93	**Trap/Vee/Rect Channel Flow,** Bot.W=6.00' D=1.00' Z= 3.0 '/' Top.W=12.00' n= 0.035 High grass
97.7	1,550	Total			

Subcatchment 5S: Commercial Site



Summary for Subcatchment 5X: Commercial Site

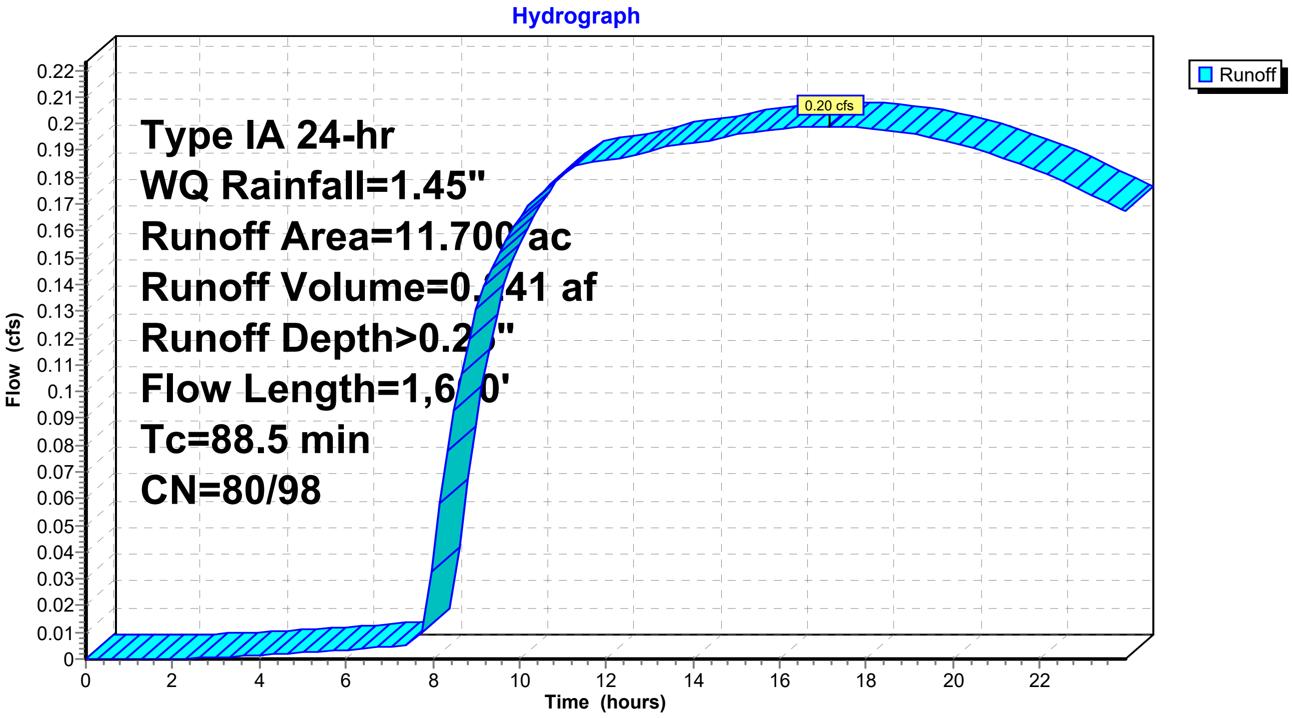
Runoff = 0.20 cfs @ 17.14 hrs, Volume= 0.241 af, Depth> 0.25"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-23.97 hrs, dt= 0.17 hrs
Type IA 24-hr WQ Rainfall=1.45"

	Area (ac)	CN	Description
	11.620	80	Pasture/grassland/range, Good, HSG D
*	0.080	98	existing gravel in south
	11.700	80	Weighted Average
	11.620	80	99.32% Pervious Area
	0.080	98	0.68% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
62.2	300	0.0070	0.08		**Sheet Flow,** Grass: Dense n= 0.240 P2= 2.26"
4.7	300	0.0050	1.06		**Shallow Concentrated Flow,** Grassed Waterway Kv= 15.0 fps
21.6	1,000	0.0005	0.77	6.93	**Trap/Vee/Rect Channel Flow,** Bot.W=6.00' D=1.00' Z= 3.0 '/' Top.W=12.00' n= 0.035 High grass
88.5	1,600	Total			

Subcatchment 5X: Commercial Site



Summary for Reach 7R: conveyance ditch

[81] Warning: Exceeded Pond 4P by 30.00' @ 0.00 hrs

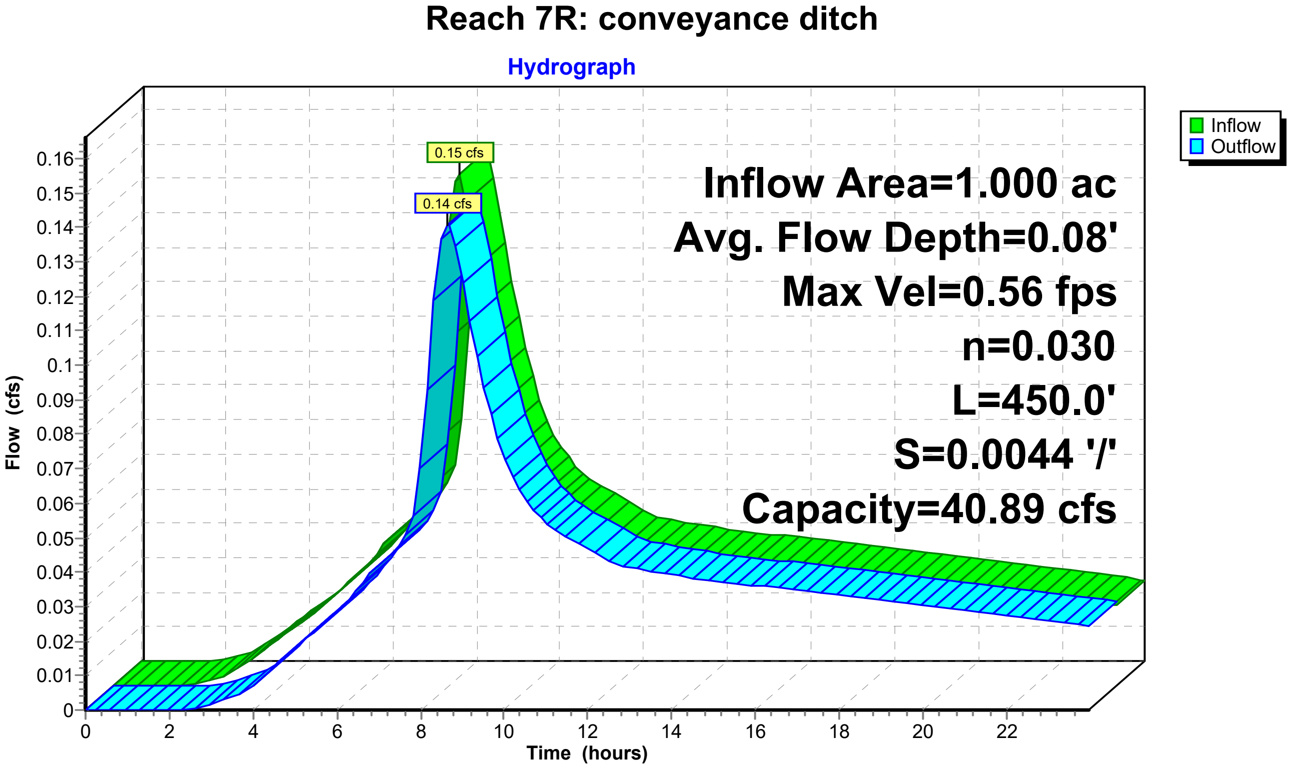
Inflow Area = 1.000 ac, 65.00% Impervious, Inflow Depth > 0.87" for WQ event
Inflow = 0.15 cfs @ 8.24 hrs, Volume= 0.072 af
Outflow = 0.14 cfs @ 8.65 hrs, Volume= 0.071 af, Atten= 5%, Lag= 24.7 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-23.97 hrs, dt= 0.17 hrs
Max. Velocity= 0.56 fps, Min. Travel Time= 13.4 min
Avg. Velocity = 0.34 fps, Avg. Travel Time= 22.4 min

Peak Storage= 114 cf @ 8.41 hrs
Average Depth at Peak Storage= 0.08'
Bank-Full Depth= 1.50' Flow Area= 13.5 sf, Capacity= 40.89 cfs

3.00' x 1.50' deep channel, n= 0.030 Earth, grassed & winding
Side Slope Z-value= 4.0 '/' Top Width= 15.00'
Length= 450.0' Slope= 0.0044 '/'
Inlet Invert= 30.00', Outlet Invert= 28.00'

‡



Summary for Pond 1B: BIORET-1

Inflow Area = 0.850 ac, 76.47% Impervious, Inflow Depth > 0.99" for WQ event
Inflow = 0.21 cfs @ 7.95 hrs, Volume= 0.070 af
Outflow = 0.21 cfs @ 7.95 hrs, Volume= 0.070 af, Atten= 0%, Lag= 0.0 min
Primary = 0.21 cfs @ 7.95 hrs, Volume= 0.070 af

Routing by Stor-Ind method, Time Span= 0.00-23.97 hrs, dt= 0.17 hrs
Peak Elev= 7.00' @ 7.95 hrs Surf.Area= 0.010 ac Storage= 0.000 af

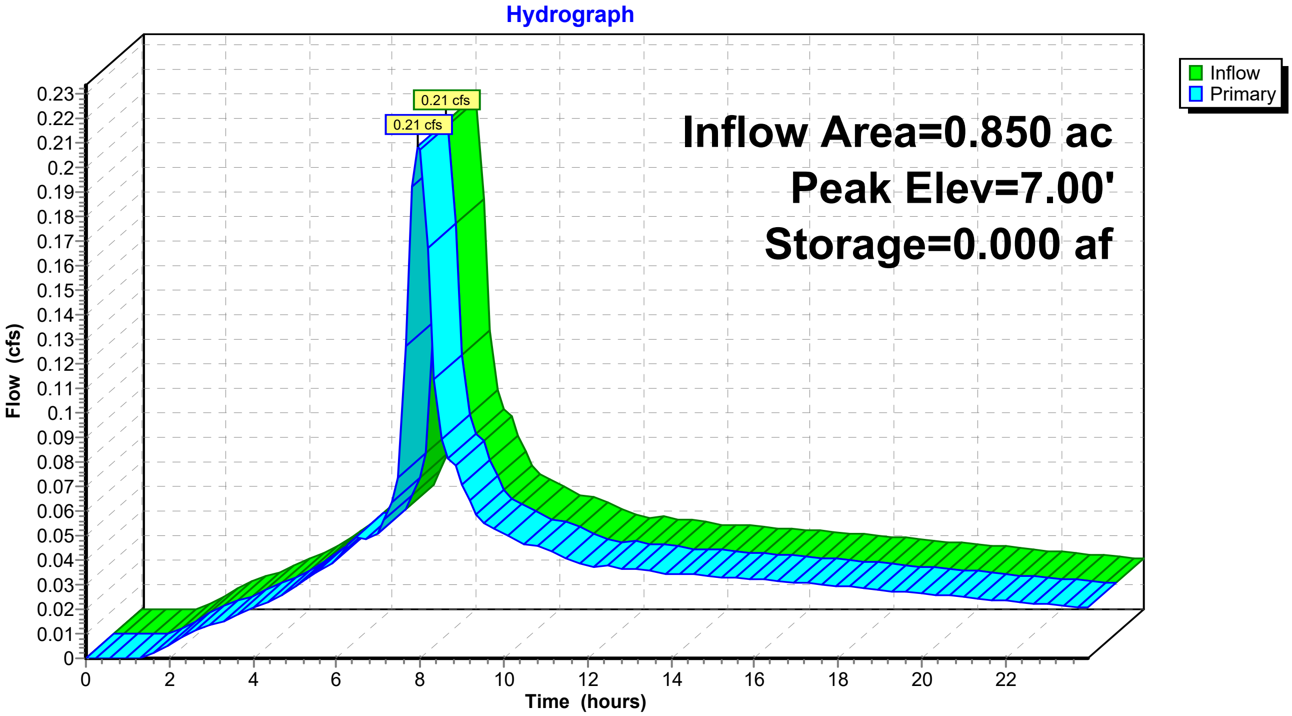
Plug-Flow detention time= 0.0 min calculated for 0.070 af (100% of inflow)
Center-of-Mass det. time= 0.0 min (711.1 - 711.1)

Volume	Invert	Avail.Storage	Storage Description
#1	7.00'	0.016 af	**5.00'W x 85.00'L x 1.00'H Prismatoid Z=3.0**

Device	Routing	Invert	Outlet Devices
#1	Primary	7.00'	**12.00 cfs Exfiltration X 0.25 at all elevations**
#2	Primary	7.50'	**50.0' long x 1.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 Coef. (English) 2.69 2.72 2.75 2.85 2.98 3.08 3.20 3.28 3.31 3.30 3.31 3.32

Primary OutFlow Max=3.00 cfs @ 7.95 hrs HW=7.00' (Free Discharge)
1=Exfiltration (Exfiltration Controls 3.00 cfs)
2=Broad-Crested Rectangular Weir (Controls 0.00 cfs)

Pond 1B: BIORET-1



Summary for Pond 1P: NW CORNER

Inflow Area = 0.900 ac, 77.78% Impervious, Inflow Depth > 1.01" for WQ event
Inflow = 0.22 cfs @ 7.95 hrs, Volume= 0.076 af
Outflow = 0.04 cfs @ 11.46 hrs, Volume= 0.063 af, Atten= 80%, Lag= 210.3 min
Primary = 0.04 cfs @ 11.46 hrs, Volume= 0.063 af

Routing by Stor-Ind method, Time Span= 0.00-23.97 hrs, dt= 0.17 hrs
Peak Elev= 1.41' @ 11.46 hrs Surf.Area= 0.022 ac Storage= 0.022 af

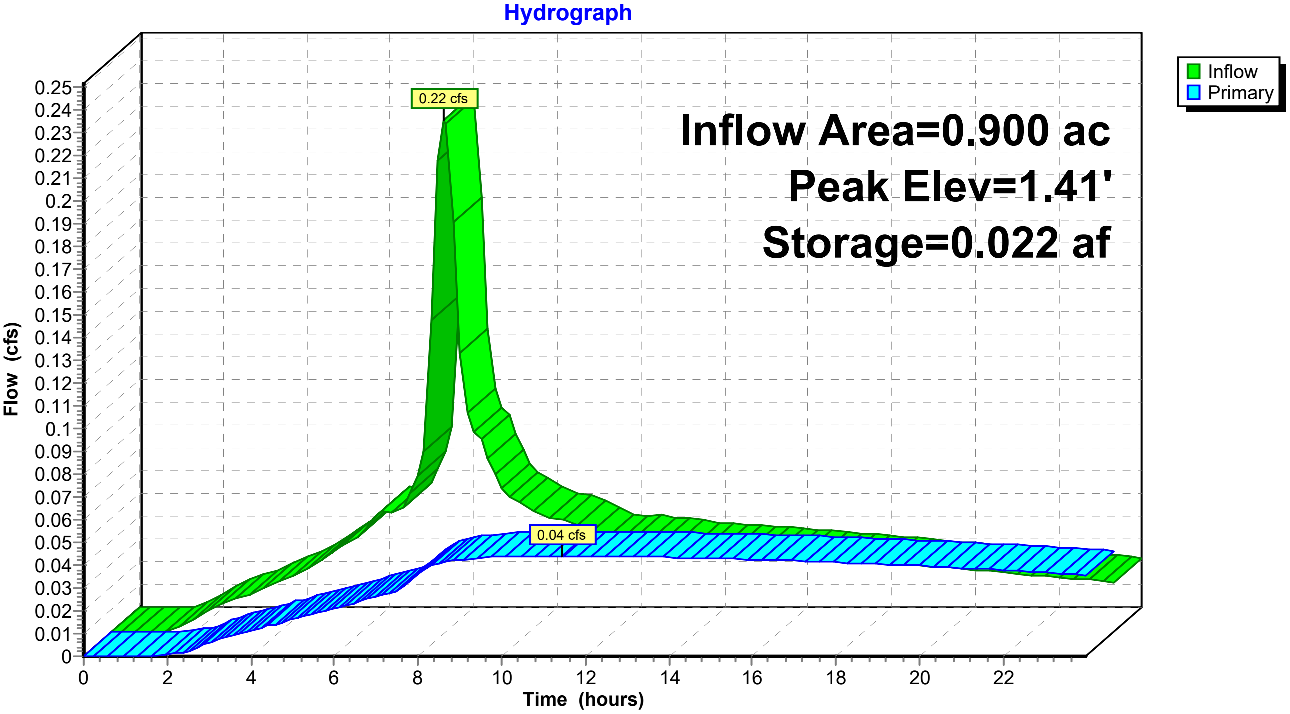
Plug-Flow detention time= 273.1 min calculated for 0.062 af (82% of inflow)
Center-of-Mass det. time= 162.3 min (872.4 - 710.1)

Volume	Invert	Avail.Storage	Storage Description
#1	0.00'	0.141 af	**9.00'W x 50.00'L x 4.50'H Prismatoid Z=2.7**

Device	Routing	Invert	Outlet Devices
#1	Primary	0.00'	**1.2" Vert. Orifice** C= 0.600
#2	Primary	3.50'	**24.0" Horiz. riser** C= 0.600 Limited to weir flow at low heads
#3	Primary	2.80'	**12.0" W x 8.4" H Vert. notch** C= 0.600

Primary OutFlow Max=0.04 cfs @ 11.46 hrs HW=1.41' (Free Discharge)
1=Orifice (Orifice Controls 0.04 cfs @ 5.61 fps)
2=riser (Controls 0.00 cfs)
3=notch (Controls 0.00 cfs)

Pond 1P: NW CORNER



Summary for Pond 2A: BIORET-2A

Inflow Area = 1.140 ac,100.00% Impervious, Inflow Depth > 1.23" for WQ event
Inflow = 0.36 cfs @ 7.95 hrs, Volume= 0.117 af
Outflow = 0.36 cfs @ 7.95 hrs, Volume= 0.117 af, Atten= 0%, Lag= 0.0 min
Primary = 0.36 cfs @ 7.95 hrs, Volume= 0.117 af

Routing by Stor-Ind method, Time Span= 0.00-23.97 hrs, dt= 0.17 hrs
Peak Elev= 5.00' @ 7.95 hrs Surf.Area= 0.016 ac Storage= 0.000 af

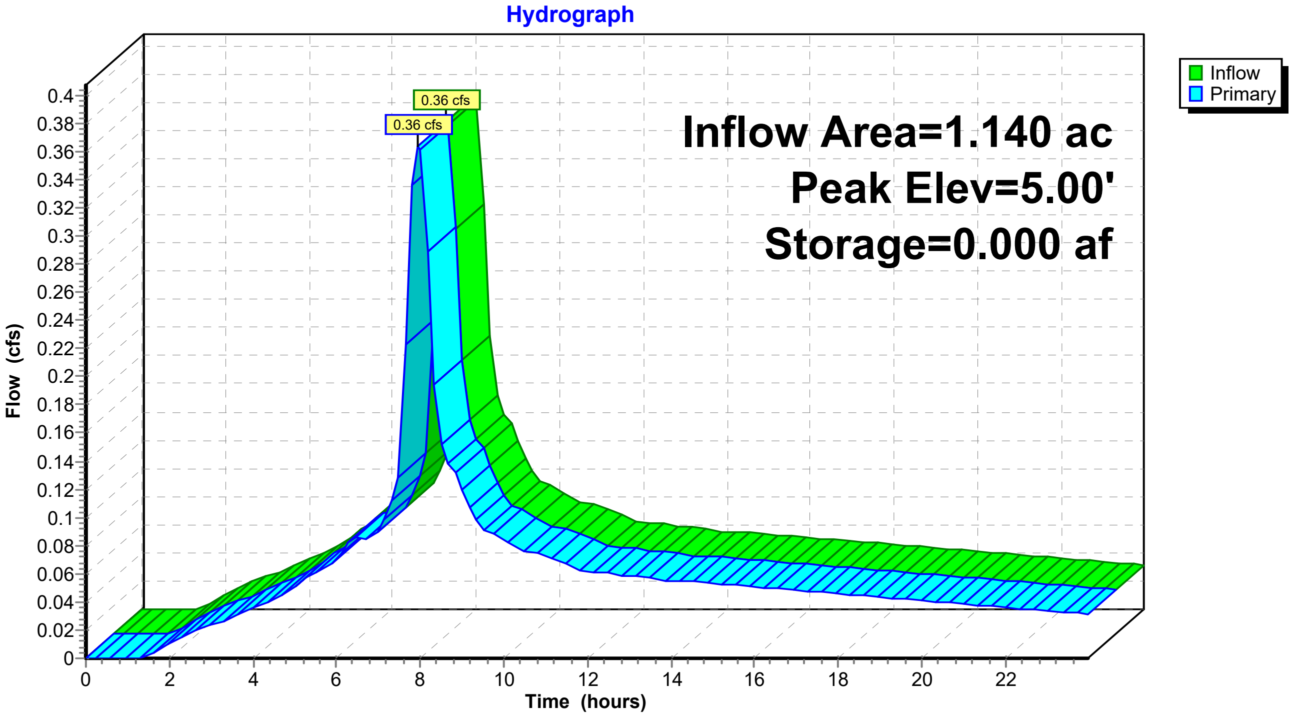
Plug-Flow detention time= 0.0 min calculated for 0.117 af (100% of inflow)
Center-of-Mass det. time= 0.0 min (696.7 - 696.7)

Volume	Invert	Avail.Storage	Storage Description
#1	5.00'	0.022 af	**10.00'W x 70.00'L x 1.00'H Prismatoid Z=3.0**

Device	Routing	Invert	Outlet Devices
#1	Primary	5.00'	**12.00 cfs Exfiltration X 0.25 at all elevations**
#2	Primary	5.50'	**50.0' long x 1.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 Coef. (English) 2.69 2.72 2.75 2.85 2.98 3.08 3.20 3.28 3.31 3.30 3.31 3.32

Primary OutFlow Max=3.00 cfs @ 7.95 hrs HW=5.00' (Free Discharge)
├─**1=Exfiltration** (Exfiltration Controls 3.00 cfs)
└─**2=Broad-Crested Rectangular Weir**(Controls 0.00 cfs)

Pond 2A: BIORET-2A



Summary for Pond 2B: BIORET-2B

Inflow Area = 4.120 ac, 83.25% Impervious, Inflow Depth > 1.06" for WQ event
Inflow = 1.10 cfs @ 7.95 hrs, Volume= 0.364 af
Outflow = 1.10 cfs @ 7.95 hrs, Volume= 0.364 af, Atten= 0%, Lag= 0.0 min
Primary = 1.10 cfs @ 7.95 hrs, Volume= 0.364 af

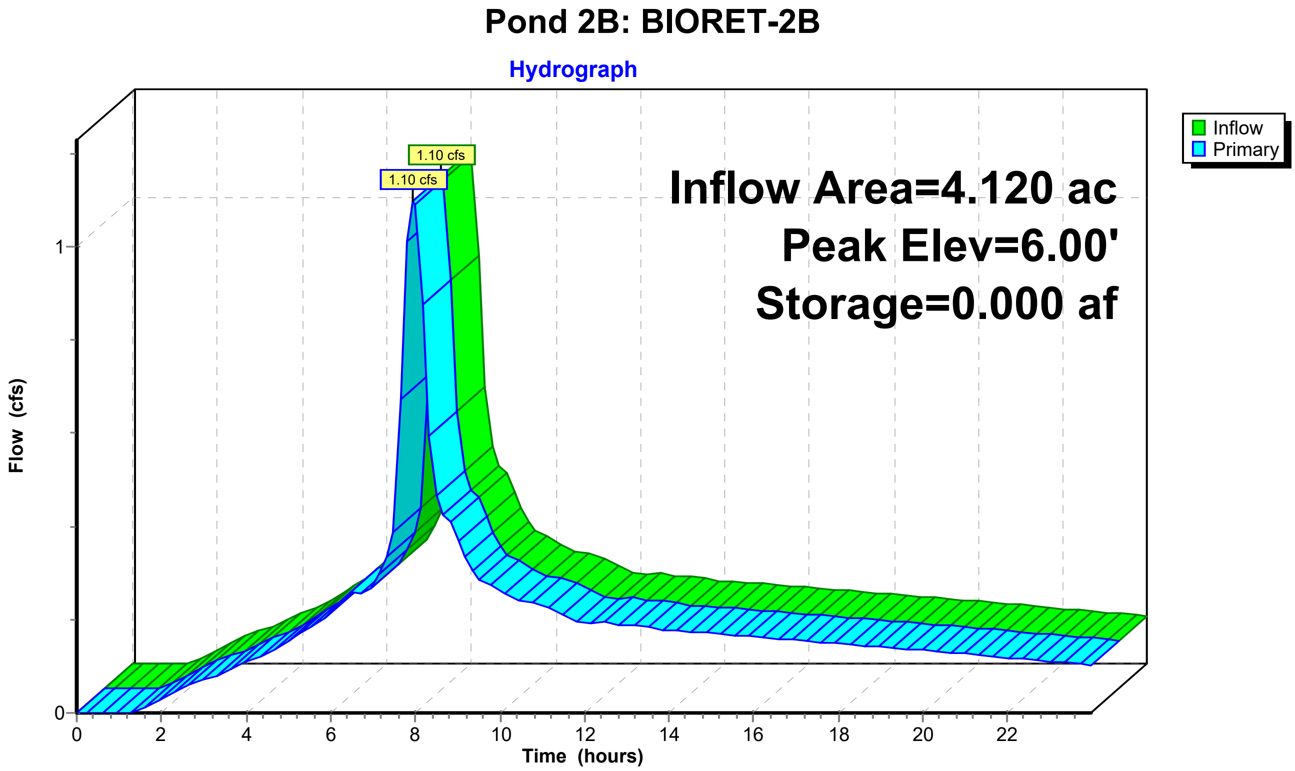
Routing by Stor-Ind method, Time Span= 0.00-23.97 hrs, dt= 0.17 hrs
Peak Elev= 6.00' @ 7.95 hrs Surf.Area= 0.046 ac Storage= 0.000 af

Plug-Flow detention time= 0.0 min calculated for 0.364 af (100% of inflow)
Center-of-Mass det. time= 0.0 min (706.3 - 706.3)

Volume	Invert	Avail.Storage	Storage Description
#1	6.00'	0.086 af	**25.00'W x 80.00'L x 1.50'H Prismatoid Z=3.0**

Device	Routing	Invert	Outlet Devices
#1	Primary	6.00'	**12.00 cfs Exfiltration X 0.25 at all elevations**
#2	Primary	1.00'	**24.0" Horiz. riser** C= 0.600 Limited to weir flow at low heads

Primary OutFlow Max=36.83 cfs @ 7.95 hrs HW=6.00' (Free Discharge)
↑—**1=Exfiltration** (Exfiltration Controls 3.00 cfs)
└—**2=riser** (Orifice Controls 33.83 cfs @ 10.77 fps)



Summary for Pond 2P: West Pond

Inflow Area = 1.960 ac, 87.76% Impervious, Inflow Depth > 1.11" for WQ event
Inflow = 0.55 cfs @ 7.95 hrs, Volume= 0.181 af
Outflow = 0.03 cfs @ 23.97 hrs, Volume= 0.043 af, Atten= 94%, Lag= 961.2 min
Primary = 0.03 cfs @ 23.97 hrs, Volume= 0.043 af

Routing by Stor-Ind method, Time Span= 0.00-23.97 hrs, dt= 0.17 hrs
Peak Elev= 2.28' @ 23.97 hrs Surf.Area= 0.079 ac Storage= 0.137 af

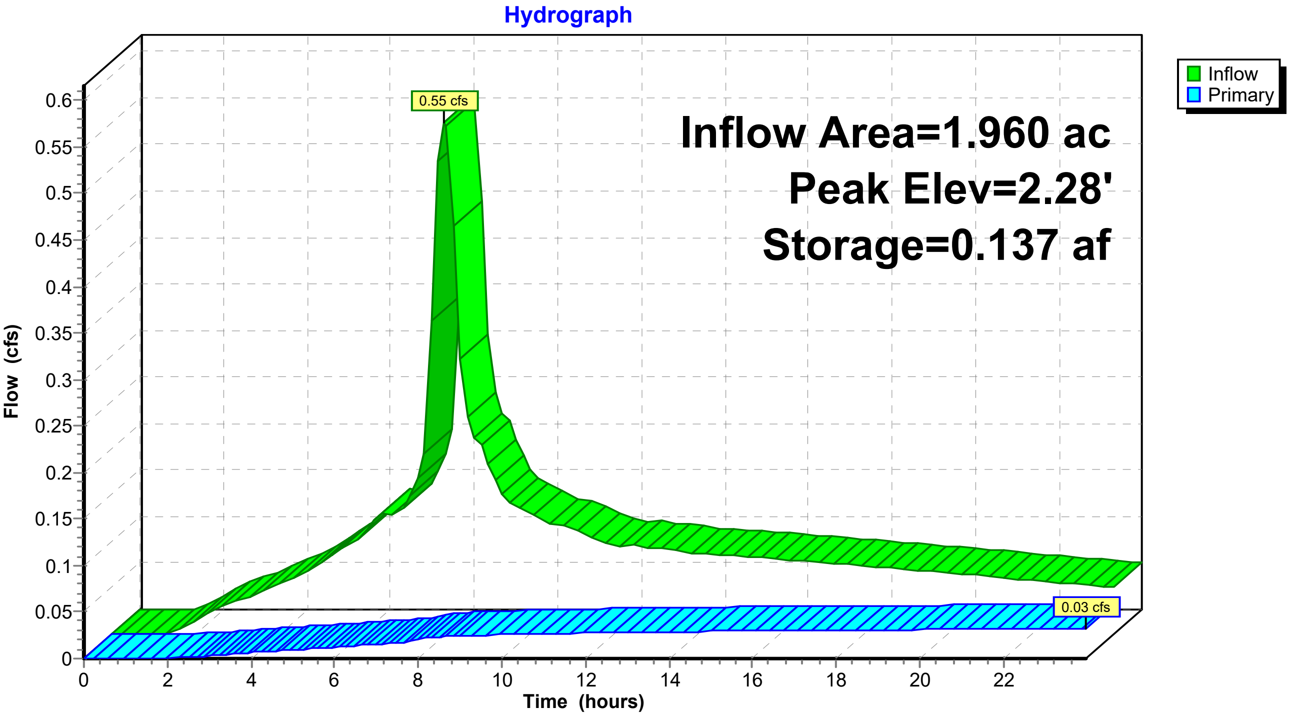
Plug-Flow detention time= 560.0 min calculated for 0.043 af (24% of inflow)
Center-of-Mass det. time= 213.6 min (917.1 - 703.4)

Volume	Invert	Avail.Storage	Storage Description
#1	0.00'	0.566 af	**25.00'W x 75.00'L x 6.00'H Prismatoid Z=3.0**

Device	Routing	Invert	Outlet Devices
#1	Primary	0.00'	**0.9" Vert. Orifice/Grate** C= 0.600
#2	Primary	4.50'	**9.0" W x 6.0" H Vert. notch** C= 0.600
#3	Primary	5.00'	**24.0" Horiz. riser** C= 0.600 Limited to weir flow at low heads

Primary OutFlow Max=0.03 cfs @ 23.97 hrs HW=2.28' (Free Discharge)
↑—**1=Orifice/Grate** (Orifice Controls 0.03 cfs @ 7.21 fps)
├—**2=notch** (Controls 0.00 cfs)
└—**3=riser** (Controls 0.00 cfs)

Pond 2P: West Pond



Summary for Pond 3P: East Pond

[79] Warning: Submerged Pond 2B Primary device # 2 by 0.81'

Inflow Area = 4.540 ac, 79.96% Impervious, Inflow Depth > 1.02" for WQ event
Inflow = 1.16 cfs @ 7.95 hrs, Volume= 0.387 af
Outflow = 0.15 cfs @ 18.93 hrs, Volume= 0.217 af, Atten= 87%, Lag= 658.8 min
Primary = 0.15 cfs @ 18.93 hrs, Volume= 0.217 af

Routing by Stor-Ind method, Time Span= 0.00-23.97 hrs, dt= 0.17 hrs
Peak Elev= 1.81' @ 18.93 hrs Surf.Area= 5,053 sf Storage= 7,792 cf

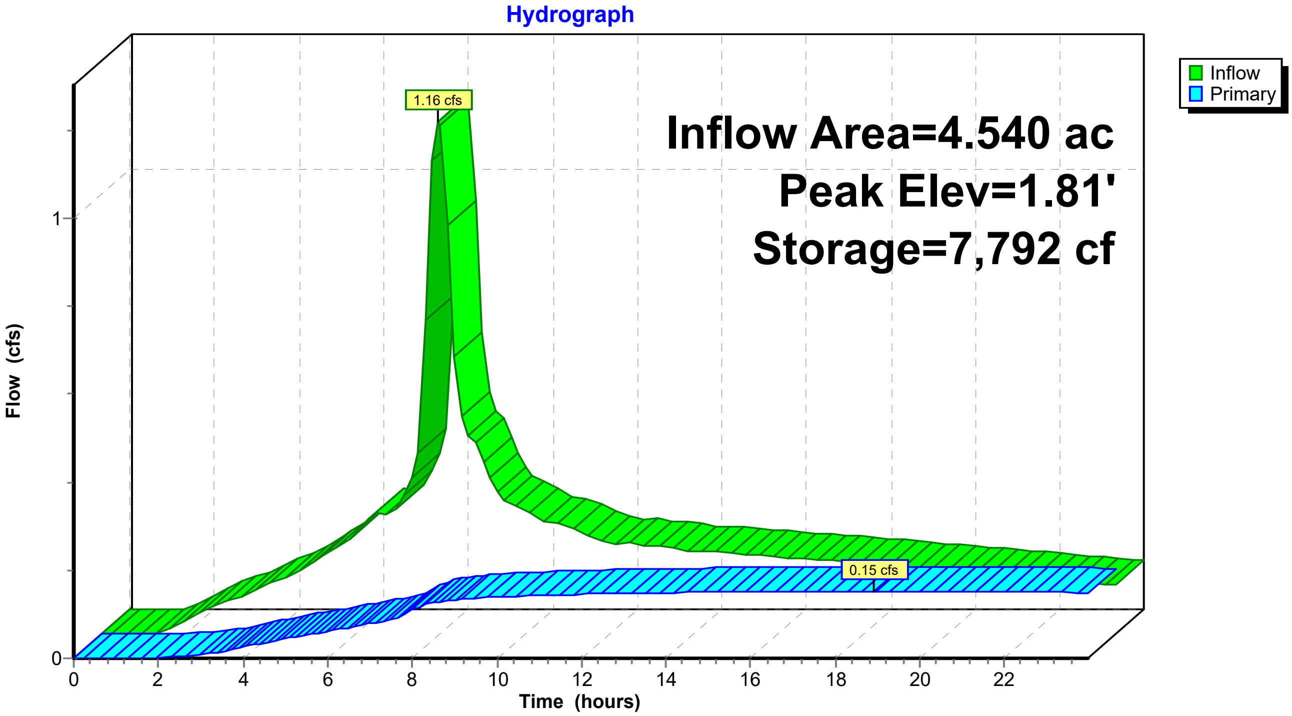
Plug-Flow detention time= 445.9 min calculated for 0.215 af (56% of inflow)
Center-of-Mass det. time= 203.1 min (910.9 - 707.8)

Volume	Invert	Avail.Storage	Storage Description
#1	0.00'	42,286 cf	**48.00'W x 75.00'L x 6.50'H Prismatoid Z=3.0**

Device	Routing	Invert	Outlet Devices
#1	Primary	0.00'	**2.1" Vert. Orifice** C= 0.600
#2	Primary	3.50'	**3.0" W x 24.0" H Vert. notch** C= 0.600
#3	Primary	5.50'	**24.0" Horiz. riser** C= 0.600 Limited to weir flow at low heads

Primary OutFlow Max=0.15 cfs @ 18.93 hrs HW=1.81' (Free Discharge)
├─**1=Orifice** (Orifice Controls 0.15 cfs @ 6.32 fps)
├─**2=notch** (Controls 0.00 cfs)
└─**3=riser** (Controls 0.00 cfs)

Pond 3P: East Pond



Summary for Pond 4P: Wet Pond- Live Storage

```
Inflow Area =        1.000 ac,  65.00% Impervious,  Inflow Depth >   0.89"    for  WQ event
Inflow      =       0.21 cfs @    7.96 hrs,  Volume=          0.074 af
Outflow     =       0.15 cfs @    8.24 hrs,  Volume=          0.072 af,  Atten= 30%,  Lag= 16.9 min
Primary     =       0.15 cfs @    8.24 hrs,  Volume=          0.072 af
```

Routing by Stor-Ind method, Time Span= 0.00-23.97 hrs, dt= 0.17 hrs
Peak Elev= 0.29' @ 8.24 hrs Surf.Area= 1,365 sf Storage= 301 cf

Plug-Flow detention time= 44.9 min calculated for 0.072 af (97% of inflow)
Center-of-Mass det. time= 27.5 min (749.4 - 721.9)

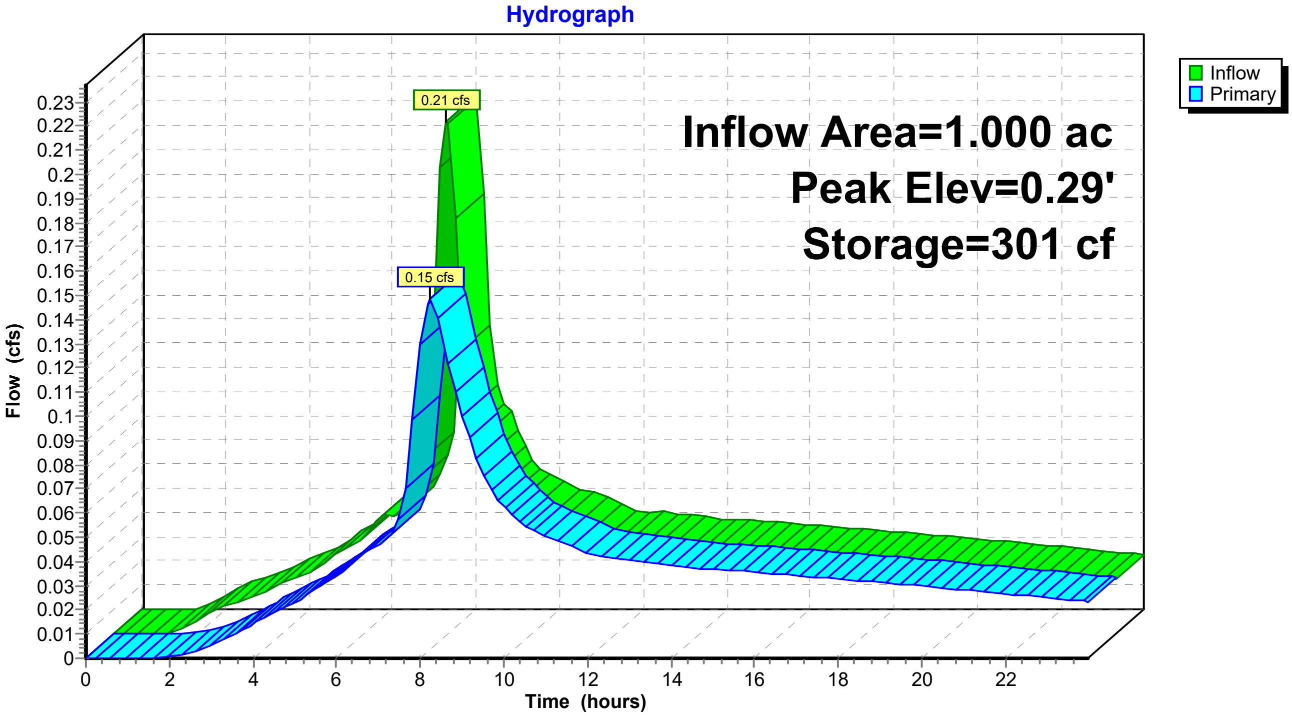
Volume	Invert	Avail.Storage	Storage Description
#1	0.00'	9,172 cf	**Live Storage (Prismatic)**Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
0.00	704	0	0
1.00	2,975	1,840	1,840
2.00	3,662	3,319	5,158
3.00	4,366	4,014	9,172

Device	Routing	Invert	Outlet Devices
#1	Primary	0.00'	**4.0" Vert. Orifice** C= 0.600
#2	Primary	0.50'	**10.0" W x 18.0" H Vert. Notch** C= 0.600
#3	Primary	2.00'	**18.0" Horiz. Riser** C= 0.600 Limited to weir flow at low heads

Primary OutFlow Max=0.15 cfs @ 8.24 hrs HW=0.29' (Free Discharge)
├─**1=Orifice** (Orifice Controls 0.15 cfs @ 1.83 fps)
├─**2=Notch** (Controls 0.00 cfs)
└─**3=Riser** (Controls 0.00 cfs)

Pond 4P: Wet Pond- Live Storage



Summary for Pond 5P: Wet Pond- Live Storage

Inflow Area = 10.300 ac, 45.63% Impervious, Inflow Depth > 0.68" for WQ event
Inflow = 1.13 cfs @ 7.99 hrs, Volume= 0.587 af
Outflow = 0.54 cfs @ 9.47 hrs, Volume= 0.517 af, Atten= 53%, Lag= 89.4 min
Primary = 0.54 cfs @ 9.47 hrs, Volume= 0.517 af

Routing by Stor-Ind method, Time Span= 0.00-23.97 hrs, dt= 0.17 hrs
Peak Elev= 0.43' @ 9.47 hrs Surf.Area= 12,142 sf Storage= 4,965 cf

Plug-Flow detention time= 170.3 min calculated for 0.513 af (87% of inflow)
Center-of-Mass det. time= 94.7 min (864.9 - 770.2)

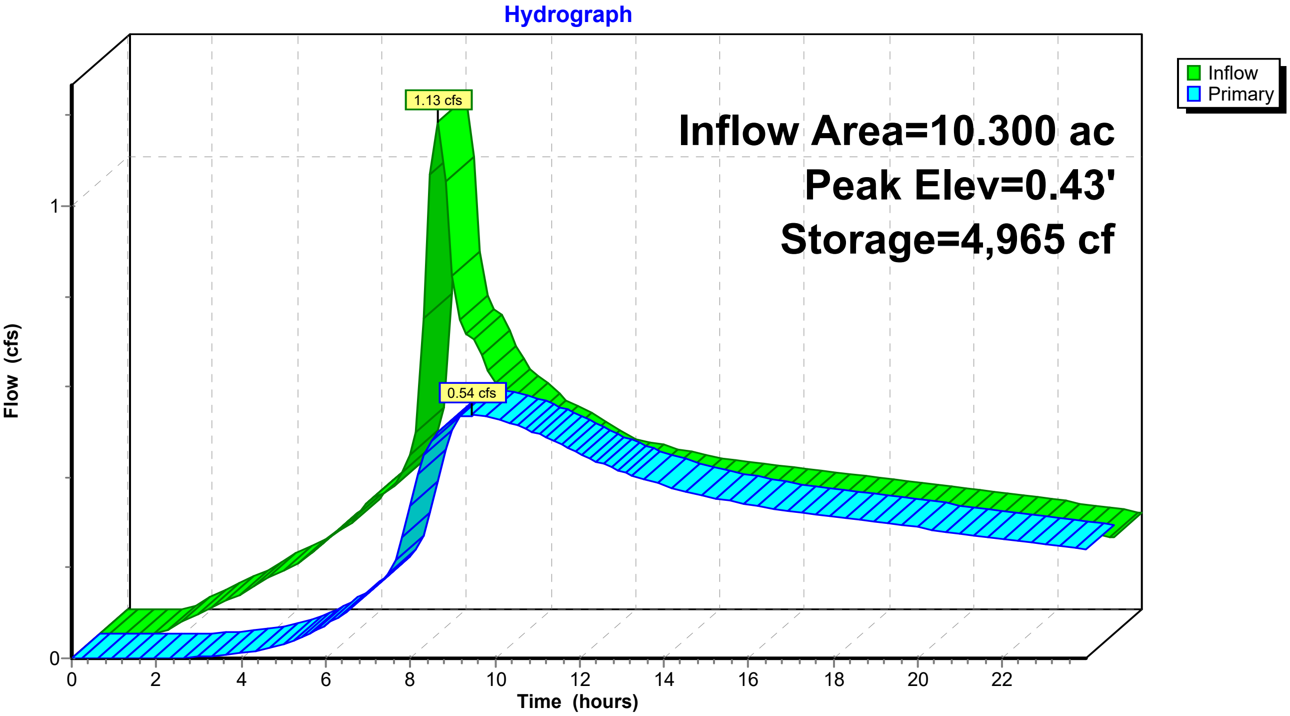
Volume	Invert	Avail.Storage	Storage Description
#1	0.00'	44,950 cf	**Live Storage (Prismatic)**Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
0.00	10,800	0	0
1.00	13,900	12,350	12,350
2.00	16,300	15,100	27,450
3.00	18,700	17,500	44,950

Device	Routing	Invert	Outlet Devices
#1	Primary	0.00'	**8.0" Vert. Orifice/Grate** C= 0.600
#2	Primary	0.75'	**24.0" W x 15.0" H Vert. Notch** C= 0.600
#3	Primary	2.00'	**24.0" Horiz. Riser** C= 0.600 Limited to weir flow at low heads

Primary OutFlow Max=0.54 cfs @ 9.47 hrs HW=0.43' (Free Discharge)
—**1=Orifice/Grate** (Orifice Controls 0.54 cfs @ 2.24 fps)
—**2=Notch** (Controls 0.00 cfs)
—**3=Riser** (Controls 0.00 cfs)

Pond 5P: Wet Pond- Live Storage



Summary for Pond 6P: 4P-Wet Pond-Live Storage - CORRECTED

[43] Hint: Has no inflow (Outflow=Zero)

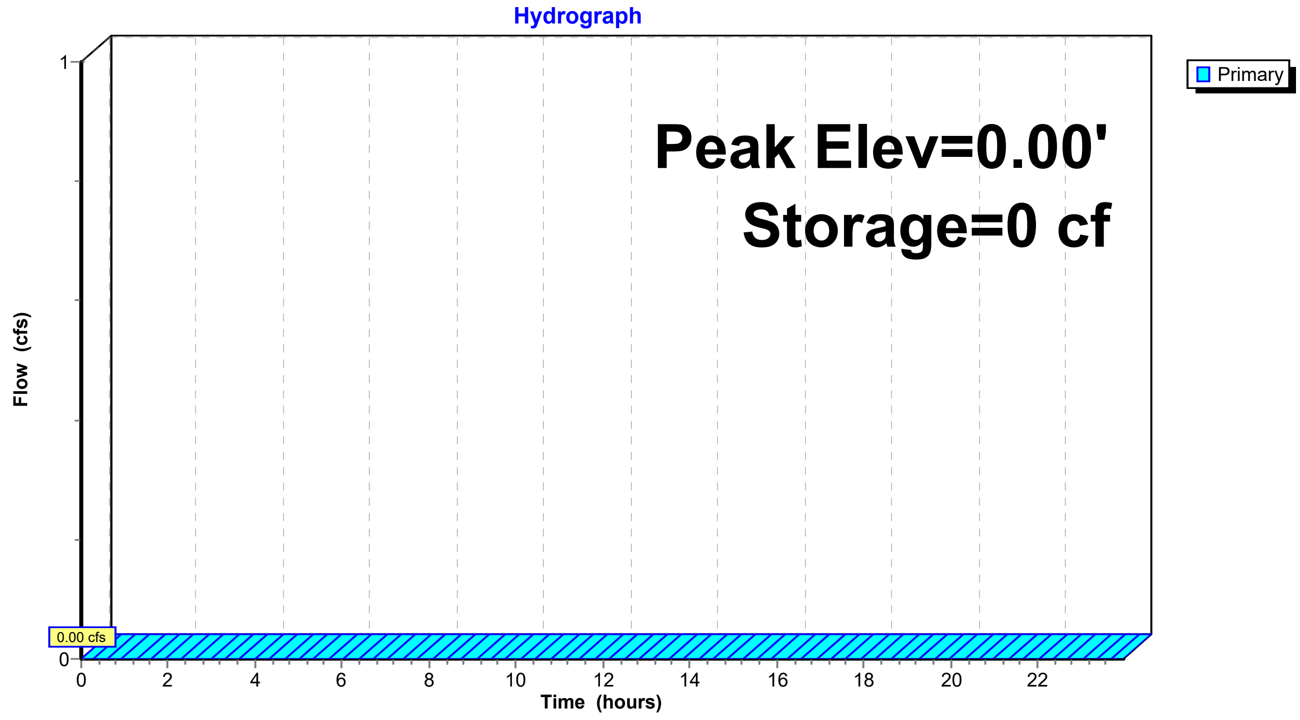
Volume	Invert	Avail.Storage	Storage Description
#1	0.00'	13,900 cf	**Live Storage (Prismatic)**Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
0.00	2,750	0	0
1.00	4,225	3,488	3,488
2.00	5,200	4,713	8,200
3.00	6,200	5,700	13,900

Device	Routing	Invert	Outlet Devices
#1	Primary	0.00'	**4.0" Vert. Orifice** C= 0.600
#2	Primary	0.50'	**10.0" W x 18.0" H Vert. Notch** C= 0.600
#3	Primary	2.00'	**18.0" Horiz. Riser** C= 0.600 Limited to weir flow at low heads

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=0.00' (Free Discharge)
1=Orifice (Controls 0.00 cfs)
2=Notch (Controls 0.00 cfs)
3=Riser (Controls 0.00 cfs)

Pond 6P: 4P-Wet Pond-Live Storage - CORRECTED



Summary for Pond 8P: 4P- Wet Pond- Dead Storage

[43] Hint: Has no inflow (Outflow=Zero)

Volume	Invert	Avail.Storage	Storage Description
#1	-3.00'	4,748 cf	**Dead Storage (Prismatic)**Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
-3.00	457	0	0
-2.00	1,213	835	835
-1.00	1,928	1,571	2,406
0.00	2,756	2,342	4,748

Summary for Pond 9P: 5P- Dead Storage

[43] Hint: Has no inflow (Outflow=Zero)

Volume	Invert	Avail.Storage	Storage Description
#1	-3.00'	17,914 cf	**Live Storage (Prismatic)**Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
-3.00	3,156	0	0
-2.00	4,660	3,908	3,908
-1.00	6,276	5,468	9,376
0.00	10,800	8,538	17,914

Summary for Pond 10P: 5P-Wet Pond- Live Storage - CORRECTED

[43] Hint: Has no inflow (Outflow=Zero)

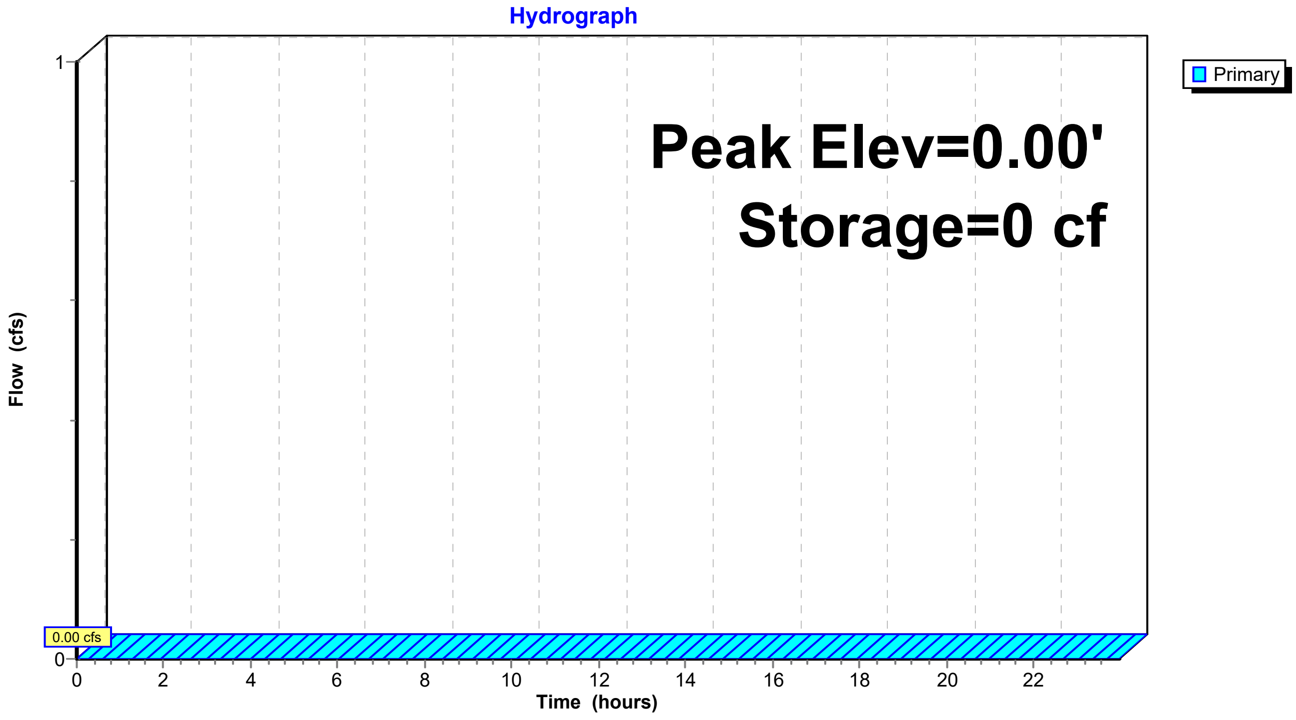
Volume	Invert	Avail.Storage	Storage Description
#1	0.00'	71,500 cf	**Live Storage (Prismatic)**Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
0.00	19,000	0	0
1.00	22,700	20,850	20,850
2.00	25,300	24,000	44,850
3.00	28,000	26,650	71,500

Device	Routing	Invert	Outlet Devices
#1	Primary	0.00'	**8.0" Vert. Orifice/Grate** C= 0.600
#2	Primary	0.75'	**24.0" W x 15.0" H Vert. Notch** C= 0.600
#3	Primary	2.00'	**24.0" Horiz. Riser** C= 0.600 Limited to weir flow at low heads

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=0.00' (Free Discharge)
1=Orifice/Grate (Controls 0.00 cfs)
2=Notch (Controls 0.00 cfs)
3=Riser (Controls 0.00 cfs)

Pond 10P: 5P-Wet Pond- Live Storage - CORRECTED



Appendix G.1: Geotechnical Report

Geotechnical Engineering Report

New Bridge Foundation – Adjacent to Green Mountain Road
Woodland, WA

Prepared for:
Mark and Patrick Jeffries, Owners
18518 NW 41st Avenue
Ridgefield, WA 98642

May 10, 2021
Strata Design Project No. 21-0379

STRATA DESIGN
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1 INTRODUCTION

1.1 General

Strata Design (STRATA) completed a geotechnical investigation for the proposed bridge across Burris Creek adjacent to Green Mountain Road in Woodland, Washington. The purpose of our investigation was to evaluate subsurface conditions at the site and develop geotechnical conclusions and recommendations for the design and construction of foundations for the proposed bridge. The general site location is shown on the Vicinity Map, Figure 1. The approximate locations of STRATA's explorations in relation to existing and proposed site features are shown on the Site Plan, Figure 2. This report describes the work accomplished and provides our geotechnical-related conclusions and recommendations for design and construction of the bridge foundations and associated earthwork.

We informally completed test pit explorations of the uplands and lower portions of the terrain surrounding the bridge site on August 24, 2020 (results transmitted to client verbally in consultation with Mark and Patrick Jeffries). Several of the logs are pertinent to the bridge explorations and were reviewed as part of our analysis for development of the recommendations and conclusions in this report.

1.2 Project Understanding

Based on review of available preliminary site plans provided by AKS and our discussions with the project team, we understand the project includes construction of a new approximately 32-foot-wide by 30-foot-long bridge over Burris Creek, located approximately 70 feet west of Green Mountain Road in Woodland, Washington (Figure 2). We understand that in the short term the bridge will need to carry loaded off-highway trucks for grading between the uplands and lowland site areas. We also understand that the bridge will be converted for residential use and that the maximum loadings (after construction) will likely be for fire access.

Additionally, we understand paved access roads will be constructed south and north of the proposed bridge to connect parcel 508620100 (south of the bridge) to parcel 508630100 (north of the bridge). We understand that geotechnical information for the connecting roads will be completed later. Our work is focused on the approach fills, abutments, and the bridge structure foundations.

Grading plans and anticipated structural loading for the proposed bridge and pavement features are not available at this time, and STRATA should be consulted to provide updated recommendations when grading plans and additional information are made available. We understand that you are contemplating a steel structure supporting the bridge deck. We are not aware of the clearance requirements based on Burris Creek rise analysis, but we assume that the bridge will be a single span with no intermediate vertical supports. Thus, our explorations were conducted at the north and south ends of the proposed bridge location as indicated on Figure 2. Due to the presence of relatively soft, compressible soils at the site, the new bridge will likely be supported by deep foundation elements that extend into the underlying weathered basalt at depth.

We understand the bridge will be designed in general accordance with the current American Association of State Highway and Transportation Officials (AASHTO) Load and Resistance Factor

Bridge Design Specifications (LRFD BDS) and Washington Department of Transportation (WSDOT) design requirements, except as superseded by Cowlitz County (County).

2 SITE CONDITIONS

2.1 Topography and Surface Description

Based on our ground-based reconnaissance and review of available topographic information, we understand the ground surface adjacent to Burris Creek in the location of the proposed bridge, as well as immediately south of the bridge, is relatively flat with elevations ranging from about 36 feet to 37 feet. The Burris Creek channel bottom has an elevation that ranges from about 34.5 feet on the downstream side of the bridge to about 35 feet on the upstream side of the bridge. The ground surface north of the bridge slopes gently upward to the north with a slope of about 5H:1V (Horizontal to Vertical).

All elevations noted in this report reference the North American Datum of 1983 (NAD 83) unless otherwise noted.

2.2 Geologic Setting and Landslides

The site lies in the Western Cascades geologic province near the northern margin of the Portland Basin, which forms the southern portion of the Puget Lowlands. Following mild folding, faulting and erosion, the bedrock units in the Western Cascade Range volcanic arc formed a low-relief terrain within which the Portland Basin began to develop. Basaltic lavas of the Miocene-age Columbia River Basalt Group and fluvial deposits of the ancestral Columbia River were deposited on the older Paleogene bedrock within the subsiding or ‘pull-apart’ Portland basin. Erosion during the geologically recent (late Pleistocene-age, +/- 14,000 ya) Missoula Catastrophic Floods, caused by periodic failure of the ice dam that impounded water in glacial Lake Missoula, is interpreted to have created a flow-through channel or terrace that is present below an elevation of about 300 feet. In the area around the town of Kalama, Washington, this flood-terrace feature is approximately ½ to ¾ miles wide and extends to the south for a distance of approximately four (4) miles. The stripped flood terraces can be identified by the wide, level and gently sloping ground surfaces with the occasional basalt bedrock ridges or buttes protruding above the flood plain surface. Basaltic and andesitic rock outcrops and flat-topped depositional surfaces with thin deposits of micaceous and pumiceous sands along their bases, indicate stripping by the rising and peak floodwaters and sedimentation by slack and receding floodwaters. Throughout the hillside regions of the Columbia River corridor region of Cowlitz County, larger ancient landslides occurred hundreds or even thousands of years ago as evolving geologic equilibrium activity during repeated cycles of heavy, sustained rainfall events and seismic activity. The majority of landslide activity of recent times stems from development impacts to land such as deforestation and earthwork.

As shown in Figure 2, we understand slopes are present within or near the proposed locations of development which are mapped within an overlay zone of “ancient-inactive, deep seated landslide“. According to the Washington Department of Natural Resources (DNR)-published report on landslides in the area, which produced a geologic hazard study of the Cowlitz County Urban Corridor (Wegmann, 2006), there is an ancient deep-seated landslide that is depicted on GIS mapping abutting the northeastern edge of the property, but not extending into the 10 acre site north of the bridge more than about 5 to 10 feet. The DNR publication cites the ancient landslide located nearby to the west as 'dormant-relict', originating as a slide-rotational, and provides a general description of the landslide mass as fluvial sediments of the Troutdale Formation (QTtd). The publication narrative indicates this large scale ancient landslide (GIS Slide #78) as not exhibiting indications of recent movement, except at a distant upgradient location that is about 500 feet from the study site. According to the geologic quadrangle map (R.C. Evarts, 2004), the site area is interpreted as Holocene alluvial fan deposits (map unit Qaf). The deposit is described as moderately to poorly sorted sand and gravel, composed of well rounded pebble and cobble. The far west extents of the site will also be comprised of a volcanic tuff unit (Tt).

2.3 Subsurface Conditions

The site was explored on March 20, 2021 by drilling two borings, designated B-1 and B-2, to depths of 20 feet and to 12.5 feet below ground surface (bgs). The drilling was performed by Geoservices Northwest using a crawler style rubber-tired drill rig and hollow-stem auger drilling techniques. Encased falling head infiltration testing was also performed at a depth of 5 feet bgs in the location of infiltration test I-1, as shown on Figures 2 and 3.

STRATA has summarized the subsurface units as follows:

Topsoil	Topsoil consisting of clayey silt with variable percentages of sand was encountered at the ground surface and extends to a depth of about 1 foot in borings B-1 and B-2. The topsoil is typically dark brown and contains abundant fine roots and organics. Based on SPT N-values, the relative consistency of the topsoil is very soft.
Clayey SILT:	Clayey silt was encountered below the topsoil in borings B-1 and B-2 and extends to depths of about 5.5 and 11.5 feet bgs, respectively, in these borings. The clayey silt is typically gray brown. Based on SPT N-values, the relative consistency of the clayey silt is soft to medium stiff.
Sandy Silty CLAY	Sandy silty clay was encountered below the clayey silt in boring B-1 and extends to a depth of about 13 feet bgs. The clay is typically grey and contains fine- to coarse-grained sand. Based on SPT N-values, the relative consistency of the clay is very soft.
Sandy SILT with Gravel (Decomposed Basalt):	Sandy silt containing variable percentages of gravel identified as decomposed basalt was encountered below the clay in boring B-1 and extends to a depth of about 19 feet bgs in this boring. The decomposed basalt is typically red-brown and contains fine- to coarse-grained sand and subangular to subrounded gravel. Based on SPT N-values, the relative consistency of the decomposed basalt is very stiff to hard.

Basalt:	Weathered basalt was encountered below the decomposed basalt in boring B-1, and below the clayey silt in boring B-2 and extends to the maximum depths of exploration. The basalt is typically gray, slightly weathered, and soft (R2 by rock description). We consider the weathered basalt to be the foundation zone.

2.4 Groundwater

Groundwater was observed at the time of drilling using hollow-stem auger techniques. Groundwater was observed at depths of 8.5 feet and 5 feet bgs in borings B-1 and B-2, respectively. However, we anticipate groundwater closely reflects water levels in the nearby Burris Creek, and shallow perched-groundwater conditions may approach the ground surface in response to extended wet periods or heavy/flooding creek flows. There is also a "lake/pond" to the west of the site which may influence the groundwater levels.

3 CONCLUSIONS AND RECOMMENDATIONS

3.1 General

The proposed bridge construction at this site is feasible. We understand that bridge loadings, span length, bridge deck elevation and scour potential has not yet been determined and are currently under consideration and design by others. This information is typically used by us to determine approach fill extent and thickness (for consolidation), type and foundation requirements for the abutments, and foundation requirements to support the bridge under static and seismic loadings. We have made reasonable assumptions for the above indicated items in the production of this document.

Subsurface explorations completed for this investigation indicate the site is mantled with clay and silt soils to depths ranging from about 11.5 to 20 feet bgs. The silt encountered below a depth of about 13 feet bgs in boring B-1 was identified as decomposed basalt and contains gravel. The clay and silt soils at the site are underlain by weathered basalt. We anticipate the basalt will becomes less weathered with depth and will likely become harder immediately beneath the weathered basalt unit.

We anticipate groundwater at the site is near the water level of Burris Creek and will fluctuate in response to water levels in the creek. Groundwater levels may approach the ground surface during periods of intense or prolonged precipitation or flooding. The fine-grained soils encountered in the borings overlying the decomposed or weathered basalt are compressible. As discussed, the character of the grading and approach fills, are not known at this time; however, we anticipate placement of new fills will cause settlement that will require time to consolidate. Some type of preloading of the approach fills (particularly on the south abutment) should be contemplated. An alternative would be to construct the bridge and keep a gravel pavement during heavy off road truck use during grading operations and refresh as it settles during construction. Repair and relevel before paving for long term residential use.

We also estimate a risk of seismically induced strain softening of the very soft to medium-stiff silt and clay soils following the code-based earthquake. Soil strain softening would result in reduced soil strength and significant seismic settlement potentially cutting off access to the proposed residential units. Due to static and seismic settlement, conventional spread footings are not considered appropriate for foundation support of the bridge. In our opinion, driven steel pin piles will likely be the most feasible foundation type for bridge support from a cost and construction standpoint and will reduce the risk of post-construction settlement of the bridge. Additionally, the presence of moisture-sensitive fine-grained soils near the ground surface will be a significant construction consideration. Recommendations for protection of the subgrade from construction traffic loading are provided in the Site Preparation and Grading section of this report.

As mentioned, the depth and extent of scour is unknown at this time. The scour depth will potentially affect the type, depth and support of the north and south abutment structures and the functioning of the deep foundation bridge supports.

As noted above, we understand the grading and final development plans for the project had not been completed when this report was prepared. Once completed, STRATA should be engaged to review the project plans and update our recommendations for earthwork, temporary excavation support and dewatering, foundation support, and additional geotechnical concerns, as necessary.

The following sections of this report provide our recommendations for planning and preliminary design of the proposed bridge foundations and associated earthwork.

3.2 Site Preparation and Grading

The ground surface in the locations of all bridge foundations, pavements, and areas to receive structural fill should be stripped of existing vegetation, surface organics, and loose surface soils. We estimate stripping will generally be necessary to a depth of about 12 inches. Deeper excavations may be necessary to remove roots larger than about 1 inch in diameter. Strippings should be removed from the site or stockpiled for use in landscaped areas.

Underground utility lines or other abandoned structural elements in the location of the planned improvements should also be removed. The voids resulting from removal of existing features should be backfilled with compacted structural fill in accordance with the structural fill recommendations in this report. The base of these excavations should be excavated to firm native subgrade before filling. Materials generated during demolition should be transported off site or stockpiled in areas designated by the owner’s representative.

To minimize disturbance of the near-surface, silt and clay subgrade soils, we recommend demolition, site stripping, and all excavations be completed with excavators equipped with smooth-edged buckets. Upon completion of demolition, site stripping, and excavation to subgrade level, the resulting subgrade should be observed by a qualified member of STRATA’s geotechnical engineering staff. Any soft areas or areas of unsuitable material should be overexcavated to undisturbed soil and to the satisfaction of STRATA’s geotechnical engineering staff and backfilled with structural fill.

The on-site soils consist of fine-grained silt and clay soils that are moisture sensitive. When these soils exceed 3% to 4% of their optimum moisture content, they typically become weak and unstable when disturbed and remolded by construction traffic. For this reason, we recommend, if possible, all site preparation and earthwork be accomplished during the dry summer months, typically extending from mid-May to mid-October. If construction is to proceed during the wet months of the year or if the moisture content of subgrade soils is significantly above optimum, we recommend construction equipment not traffic the fine-grained subgrade soils. Site earthwork and subgrade preparation should not be completed during freezing conditions, except for mass excavation to the subgrade design elevations. Protection of the subgrade is the responsibility of the contractor. Construction of granular haul roads to the project site entrance may help reduce further damage to the pavement and disturbance of site soils. In our opinion, a 12-inch-thick granular work pad should be sufficient to prevent disturbance of the subgrade by lighter construction equipment. A granular work pad on the order of 18 inches to 24 inches thick is typically required to protect silty subgrade soils from disturbance by repetitive heavy construction loads. The imported granular material should be placed in one lift over the prepared undisturbed subgrade and compacted using a smooth-drum, non-vibratory roller. A geotextile fabric should be used to separate the subgrade from the imported granular material in areas of repeated construction traffic. Depending on site conditions, the geotextile should meet Washington State Department of Transportation (WSDOT) SS 9-33.2 Geosynthetic Properties for soil separation or stabilization. The geotextile should be installed in conformance with WSDOT SS 2-12.3 Construction Geosynthetic (Construction Requirements) and, as applicable, WSDOT SS 2-12.3(2) Separation or WSDOT SS 2-12.3(3) Stabilization. If the subgrade is disturbed during construction, soft, disturbed soils should be overexcavated to firm soil and backfilled with granular structural fill.

3.3 Temporary Excavation

Construction of temporary cut slopes in the adjacent soft soils may be problematic and should be shored or carefully carried out. Cuts on the north abutment may be into non-excavatable rock. Permanent cut and fill slopes should be constructed at 2H:1V or flatter. The near-surface soils on the south abutment of the site can be excavated with conventional earthwork equipment. Rock excavation may be encountered on the north abutment depending on the ultimate bridge abutment location and grading plans. Sloughing and caving should be anticipated. Excavation below the water table will be difficult without dewatering or shoring installed. Excavation adjacent to the active creek channel will likely be problematic. The creek flows should be captured and channelized or piped through the construction zone to prevent a potential washout.

All excavations should be made in accordance with applicable Occupational Safety and Health Administration (OSHA) and state regulations. The contractor is solely responsible for adherence to the OSHA requirements. Trench cuts should stand relatively vertical to a depth of approximately 4 feet bgs, provided no groundwater seepage is present in the trench walls. Open excavation techniques may be used provided the excavation is configured in accordance with the OSHA requirements, groundwater seepage is not present, and with the understanding that some sloughing may occur. Trenches/excavations should be flattened if sloughing occurs or seepage is present. Use of a trench shield or other approved temporary shoring is recommended if vertical walls are desired for cuts deeper than 4 feet bgs. The method of excavation and design of excavation support are the responsibilities of the contractor and should conform to applicable local, state, and federal regulations. If dewatering is used, we recommend that the type and design of the dewatering system be the responsibility of the contractor, who is in the best position to choose systems that fit the overall plan of operation.

3.4 Infiltration Testing

Encased falling-head infiltration testing was conducted at a depth of 5 feet bgs, designated I-1 in the approximate locations shown on the Site Plan, Figures 2. This test location was requested by the designers. The test was conducted in general conformance with the 2017 Cowlitz County Stormwater Drainage Manual. A more detailed description of the testing is provided in Appendix A. The results of the field infiltration testing was analyzed, and the falling-head infiltration rate was calculated from the field-test data. The recommended field infiltration rate for the test location, I-1, is 37 inches per hour. We also understand that the groundwater needs to be a minimum of 5 feet below the ground surface at the indicated location. Although free water was not encountered in the boring at the time of testing, there is a lake nearby the surface of which is at or very near the 5-foot-deep threshold as discussed with the designers.

Compaction of the subgrade soils beneath the infiltration facility could reduce the field permeability to values significantly less than reported above. Reduction of permeability due to compaction of subgrade soils may be a significant consideration in the design of permeable pavements, if used. Based on the soils encountered in borings B-1 and B-2, we anticipate lower-permeability materials may be encountered on the site. Additional explorations and infiltration testing can be completed in these areas if requested by the project team.

It should be noted the proposed locations and depths of the stormwater facilities had not been determined at the time testing was completed. STRATA should review the actual locations and depths with respect to the field-test results when that information becomes available. Additional testing may be required if subsurface conditions at the proposed facility locations are substantially different than those encountered during the testing.

3.5 Structural Fill

3.5.1 General

The extent of site grading is currently unknown; however, STRATA estimates that cuts and fills will be on the order of up to 5 feet deep as part of the bridge abutment and wingwall construction. Note that excavation into or near the groundwater level will be difficult. Structural fill should be placed over subgrade that has been prepared in conformance with the Site Preparation section of this report. Structural fill material should consist of relatively well-graded soil, or an approved rock product that is free of organic material and debris and contains particles not greater than 1.5 inches nominal dimension.

The suitability of soil for use as compacted structural fill will depend on the gradation and moisture content of the soil when it is placed. As the amount of fines (material finer than the US Standard No. 200 Sieve) increases, soil becomes increasingly sensitive to small changes in moisture content and compaction becomes more difficult to achieve. Soils containing more than about 5 percent fines cannot consistently be compacted to a dense, non-yielding condition when the water content is significantly greater (or significantly less) than optimum.

If fill and excavated material will be placed on soil slopes steeper than 5H:1V, these must be keyed/benched into the existing slopes and installed in horizontal lifts. Vertical steps between benches should be approximately 2 feet.

3.5.2 On-Site Soil

On-site soils encountered in our explorations are not suitable for placement as structural fill for general site grading without significant moisture conditioning treatment. A suitable borrow site from the upland areas to the north may be identified based on our previous test pit work.

Fill placement should take place during moderate, dry weather when moisture content can be maintained by air drying and/or addition of water. The fine-grained fraction of the site soils are moisture sensitive, and during wet weather, may become unworkable because of excess moisture content. In order to reduce moisture content, some aerating and drying of fine-grained soils may be required. The material should be placed in lifts with a maximum uncompacted thickness of approximately 6 inches and compacted to at least 95 percent of the maximum dry density, as determined by ASTM D698 (standard Proctor).

3.5.3 Select Granular Fill

Imported granular material used during periods of wet weather or for haul roads and staging areas should be pit or quarry run rock, crushed rock, or crushed gravel and sand, and should meet the specifications provided in WSDOT SS 9-03.14(2) – Select Borrow. In addition, the imported granular material should be well graded between coarse and fine, and of the fraction passing the US Standard No. 4 Sieve, less than 5 percent by dry weight should pass the US Standard No. 200 Sieve.

Imported granular material should be placed in lifts with a maximum uncompacted thickness of 9 inches and be compacted to not less than 95 percent of the maximum dry density, as determined by ASTM D698.

During wet conditions, where imported granular material is placed over potentially soft-soil subgrades, we recommend a geotextile be placed between the subgrade and imported granular material. Depending on site conditions, the geotextile should meet WSDOT SS 9-33.2 – Geosynthetic Properties for soil separation or stabilization. The geotextile should be installed in conformance with WSDOT SS 2-12.3 – Construction Geosynthetic (Construction Requirements) and, as applicable, WSDOT SS 2-12.3(2) – Separation or WSDOT SS 2-12.3(3) – Stabilization.

3.5.4 Abutment and Wingwall Structural Backfill and Drainage

Backfilling behind the abutments and wingwalls should conform to Section 6-11.3 of the WSDOT Standard Specifications (SS). Compaction techniques can significantly affect the actual lateral earth pressure against a wall and over compaction of the backfill behind walls should be avoided. Backfill within about 3 feet of the wall should be compacted using lightweight compaction equipment to about 95% of the maximum dry density as determined by ASTM D698 (AASHTO T-99). Beyond 3 feet of the wall, the backfill should be compacted to at least 95% of the maximum dry density as determined by ASTM D698 (AASHTO T-99).

The abutments and wingwalls should have a minimum-12-inch-wide drainage zone of free-draining granular material conforming to Section 2-09.3(1)E of the WSDOT SS and should be provided with a perforated drainpipe or weepholes at the bottom of the backfill. A non-woven geotextile filter fabric, meeting the requirements of WSDOT SS Section 9-33.2 for drainage geotextile, should be placed between the drainage blanket and general wall backfill. Section 7-01.3 of the WSDOT SS also provides guidelines for appropriate drainpipe materials and construction.

3.6 Seismic Considerations

3.6.1 General

We anticipate the proposed bridge will be seismically designed in accordance with current AASHTO LRFD BDS and WSDOT requirements. The current WSDOT *Bridge Design Manual* (BDM) and the WSDOT *Geotechnical Design Manual* (GDM) require bridges to be designed to withstand seismic loading in accordance with the 2011 AASHTO *Guide Specification for LRFD Seismic Bridge Design* (AASHTO SBD) except as modified by the WSDOT BDM. These standards consider a Life Safety design criteria. Based on the AASHTO LRFD BDS, bridges must be designed for a “low probability of collapse but may suffer significant damage and disruption to service” in response to a 1,000-year return-interval earthquake (7% probability of exceedance in 75 years). The 1,000-year return-interval “No Collapse” or “Life-Safety” criteria requires bridge foundation and approach fills to withstand the forces and soil displacements caused by the earthquake without collapse of any portion of the bridge structure.

Ground-motion parameters for the 1,000-year (Life Safety) hazard level is based on the 2014 U.S. Geological Survey (USGS) seismic-hazard maps (Petersen et al., 2014). The 1,000-year acceleration response spectrum is based on three spectral response parameters: peak ground acceleration (PGA), S_S, and S_1, corresponding to periods of 0.0 seconds, 0.2 second, and 1.0 second. The appropriate site class factors, designated F_{PGA}, F_a, and F_v, can be used to adjust the bedrock spectral accelerations to ground-surface spectral accelerations. Based on review of the soil conditions at the site relative to site class definitions provided in Section 3.10.3 of the AASHTO LRFD BDS, the bridge structure can be designed using Site Class D. Section 3.10.2 of AASHTO LRFD BDS requires a site-specific procedure for projects located in a region where long-duration earthquakes are expected or within 6 miles of an active fault. We have assumed the bridge will be a single span with a short fundamental period of vibration, and in our opinion, Site Class D is appropriate for seismic design of the bridge. Therefore, a ground-motion hazard analysis was not completed for the project. A summary of the seismic parameters, including the zero-period peak ground-surface spectral acceleration, the 0.2- and 1.0-second coefficients for the 1,000-year/Life Safety Event hazard level adjusted for Site Class D condition are provided for the project site (i.e., site coordinates of 45.9285° N and 122.7479° W) in Table 3-1 below.

Table 3-1: Recommended 1000-year Earthquake Seismic Design Parameters (Site Class D)

Parameter	0 Second	Short Period	1 Second
Mapped Acceleration (B/C Boundary)	PGA = 0.26 g	S_s = 0.57 g	S_1 = 0.22 g
Site Class	D		
Site Coefficient	F_{PGA} = 1.34	F_a = 1.31	F_v = 2.16

g= Acceleration due to gravity

3.6.2 Cyclic Softening

Cyclic softening is a term that describes a relatively gradual and progressive increase in shear strain with load cycles. Excess pore pressures may increase due to cyclic loading but will generally not approach the total overburden stress. Shear strains accumulate with additional loading cycles, but an abrupt or sudden decrease in shear stiffness is not typically expected. Settlement due to post-seismic consolidation can occur, particularly in lower-plasticity silts. Large shear strains can develop, and strength loss related to soil sensitivity may be a concern. The potential for cyclic softening is typically estimated using a simplified method that compares the cyclic shear stresses induced by the earthquake (demand) to the cyclic shear strength of the soil available to resist these stresses (resistance).

The potential for cyclic softening at the site was estimated based on our observations of subsurface conditions at the site and experience with similar materials. 2014 USGS Probabilistic Seismic Hazard Analysis (PSHA) deaggregation data for the 1,000-year return period indicate the Cascadia Subduction Zone Earthquake (CSZE) generally controls the seismic hazards at the site. Our evaluation indicates the very soft to medium-stiff silt and clay soils overlying the decomposed or weathered basalt to a depth of about 13 feet bgs are susceptible to minor cyclic softening during ground motions associated with the code-level earthquake.

3.6.3 Other Seismic Design Considerations

Based on our review of the Quaternary Fault and Fold Database for the United States published by the U.S. Geological Survey (USGS 2006), the nearest fault zone is the Portland Hills fault zone, which is located about 13 miles from the project site. Therefore, due to the absence of mapped crustal faults near the site, it is our opinion the potential for surface rupture to affect the project site following a seismic event is low.

Based on the subsurface conditions, topography, and site location, it is our opinion the risk of earthquake-induced liquefaction and lateral spreading at the site is low. In our opinion, the risk of seiche at the site is low and the risk of tsunami at the site is absent.

3.7 Bridge Foundation Support

3.7.1 General

Considering the relatively soft soil that mantles the site, the risk of significant static and seismic settlement, spread footings are not considered appropriate for this site. Due to this risk, we recommend that the new bridge abutments and wingwalls be supported on a system of deep foundations. The estimated maximum factored pile loads for the Service, Strength and Extreme limit states for the abutments are not known at this time.

Based on our experience and discussions with local contractors and based on the site conditions as we understand it, it is our opinion that pin piles would provide the least cost option for the bridge support. The following subsections provide preliminary design and construction criteria for steel pin pile foundations based on our subsurface investigation and understanding of the project site.

3.7.2 Pin Piles

We anticipate open-end, steel, 8-inch-diameter pin piles will develop the nominal resistances provided in the table below within about 2 to 5 feet of embedment into the underlying weathered basalt unit. The degree of weathering of the siltstone is variable and the actual penetrations required to achieve the design capacities could be more or less than estimated due to variation in the subsurface materials and conditions.

Table 3-2: Preliminary Estimated Nominal Pile Resistances and Downdrag Loads for Open-Ended Steel Pin Piles Driven a Minimum of 2 Feet into Underlying Weathered Basalt

	Nominal Resistance, kips		Downdrag Load, kips	
Pin Pile Diameter, in.	Strength Limit State	Extreme Limit State	Strength Limit State	Extreme Limit State
8	90	90	5	5

The nominal resistance in Table 3-2 is based on the factored loads provided for the piles. Larger nominal resistances for piles bearing on the weathered basalt could be achieved if necessary. The steel pin piles will develop supporting capacity from a combination of skin friction and tip resistance. Based on Table 10.5.5.2.3-1 of the AASHTO BDS, a resistance factor of 0.45 is appropriate for piles with end bearing in rock. Based on Subsection 10.5.5.3.3 of AASHTO BDS, a resistance factor of 1.0 is appropriate for design of pile foundations in compression for the Extreme Limit State. STRATA recommends center-to-center pile spacing be at minimum 4D, where D is the pile diameter.

The maximum fill heights associated with construction of the bridge abutments are not known at this time. However, settlement of the soft silt soils due to placement of new fills will induce static downdrag loads on the pin piles. Fill associated with construction of the abutments and wing walls will also impose lateral loading on the pin pile caps due to lateral earth pressures on the walls. In addition, the very soft to medium-stiff silt and clay soils above the decomposed and weathered basalt could soften during a design-level earthquake and induce down drag loads on the piles during the Extreme Limit State. The estimated nominal resistances for the Strength and Extreme limit states shown in Table 3-2 do not include contribution from side resistance in the potential zone of static settlements or soil softening because of the potential downward movement of the soil.

Downdrag loads and wall loads on the piles will need to be included in the pile load combinations. Based on guidelines in Section 8.6.2 of the WSDOT GDM, load factors of 1.1 and 1.0 should be applied to the down drag load for the Strength and Extreme limit states, respectively, provided in Table 3-2. The pile down drag load does not need to be subtracted from the resistance side of the equation because nominal side resistance in the zone of potential settlement or soil softening was not included in the estimated nominal capacity.

We understand a pile-supported abutment wall will be used to retain the embankment fills. The static- and seismically induced down drag loads provided in Table 3-2 do not consider down drag load on the abutment wall due to settlement caused by fill placement. Based on our understanding of the project, it is our opinion these loads will be insignificant.

3.7.3 Settlement

Settlement of the steel pin piles driven into the weathered basalt and designed based on the nominal resistances provided in Table 3-2 are anticipated to be limited to the elastic shortening of the pile plus about ¼ inch for Service Limit State loads. To avoid damage to the pile during installation, driving stresses should not exceed 0.9 fy for steel piles. We recommend open-ended pin piles, if selected, be fitted with tip protection. The pin pile installation equipment and methods of installation proposed by the contractor should be reviewed and approved by the project team prior to pile installation. We do not anticipate existing utilities to be present in the planned location of the bridge. However, if existing utilities are present near the new piles, the piles can be pre-bored below the bottom of the utilities to reduce potential damage from lateral pressure developed by soil displacement around the pile. If preboring is used, the prebored hole should not exceed the diameter of the pile.

For preliminary design recommendations, we have assumed the bridge wingwalls will be constructed as part of the bridge abutment walls. If the bridge wingwalls are constructed separately from the abutment walls, significant static and seismic settlement could occur at the wingwalls if not supported by a deep foundation system. STRATA should be consulted to provide additional recommendations once final grading and structural plans are made available. Additionally, we have assumed the bridge will be single span.

As discussed, the bridge will function as an aid to construction while supporting heavily loaded off highway trucks over a construction season. After that the design load would by typical residential which is likely limited to potential fire truck traffic which is approximately half the loading of a loaded off-highway truck. As a cost savings based on significantly lower support requirements, temporary mid-span bents supported by temporary pin piles may be contemplated to support the anticipated heavy truck traffic. The temporary piles can be removed for long term bridge operations.

Subgrade for abutment and wingwall pile caps should be prepared in conformance with our recommendations provided in the Site Preparation and Grading section of this report.

3.7.4 Lateral Loading

Lateral forces in the longitudinal direction can be provided partially or fully by passive earth pressure against the pile cap/abutment. We anticipate the passive earth pressure and modulus values used in design will be for the most extreme loading case, which occurs during a seismic event. In our opinion, the methods described in Section 4.2.11.2 of the WSDOT BDM are appropriate for computing resistance to lateral forces during the seismic event and are suitable for rapid, short-term, transient loading. Alternatively or additionally, pin piles or micropiles can be battered to partially resist lateral forces during the extreme loading case.

4 ADDITIONAL SERVICES AND CONSTRUCTION OBSERVATIONS

In most cases, other services beyond completion of a final geotechnical engineering report are necessary or desirable to complete the project. Occasionally, conditions or circumstances arise that require additional work that was not anticipated when the geotechnical report was written. Strata offers a range of environmental, geological, geotechnical, and construction services to suit the varying needs of our clients.

STRATA should be retained to review the plans and specifications for this project before they are finalized. Such a review allows us to verify that our recommendations and concerns have been adequately addressed in the design.

Satisfactory earthwork performance depends on the quality of construction. Sufficient observation of the contractor's activities is a key part of determining that the work is completed in accordance with the construction drawings and specifications. We recommend that Strata be retained to observe general excavation, stripping, fill placement, footing subgrades, and/or pile installation. Subsurface conditions observed during construction should be compared with those encountered during the subsurface explorations. Recognition of changed conditions requires experience; therefore, qualified personnel should visit the site with sufficient frequency to detect whether subsurface conditions change significantly from those anticipated.

5 LIMITATIONS

This report has been prepared for the exclusive use of the addressee, and their architects and engineers, for aiding in the design and construction of the proposed development and is not to be relied upon by other parties. It is not to be photographed, photocopied, or similarly reproduced, in total or in part, without express written consent of the client and Strata. It is the addressee's responsibility to provide this report to the appropriate design professionals, building officials, and contractors to ensure correct implementation of the recommendations.

The opinions, comments, and conclusions presented in this report are based upon information derived from our literature review, field explorations, laboratory testing, and engineering analyses. It is possible that soil, rock, or groundwater conditions could vary between or beyond the points explored. If soil, rock, or groundwater conditions are encountered during construction that differ from those described herein, the client is responsible for ensuring that Strata is notified immediately so that we may reevaluate the recommendations of this report.

Unanticipated fill, soil and rock conditions, and seasonal soil moisture and groundwater variations are commonly encountered and cannot be fully determined by merely taking soil samples or completing explorations such as soil borings or test pits. Such variations may result in changes to our recommendations and may require additional funds for expenses to attain a properly constructed project; therefore, we recommend a contingency fund to accommodate such potential extra costs.

The scope of work for this subsurface exploration and geotechnical report did not include environmental assessments or evaluations regarding the presence or absence of wetlands or hazardous substances in the soil, surface water, or groundwater at this site.

If there is a substantial lapse of time between the submission of this report and the start of work at the site, if conditions have changed due to natural causes or construction operations at or adjacent to the site, or if the basic project scheme is significantly modified from that assumed, this report should be reviewed to determine the applicability of the conclusions and recommendations presented herein. Land use, site conditions (both on and off site), or other factors may change over time and could materially affect our findings; therefore, this report should not be relied upon after three years from its issue, or if the site conditions change.

6 REFERENCES

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Geotechnical Engineering Report
New Bridge Foundation – Adjacent to Green Mountain Road
Woodland, WA

Prepared for:
Mark and Patrick Jeffries, Owners
18518 NW 41st Avenue
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Prepared by:
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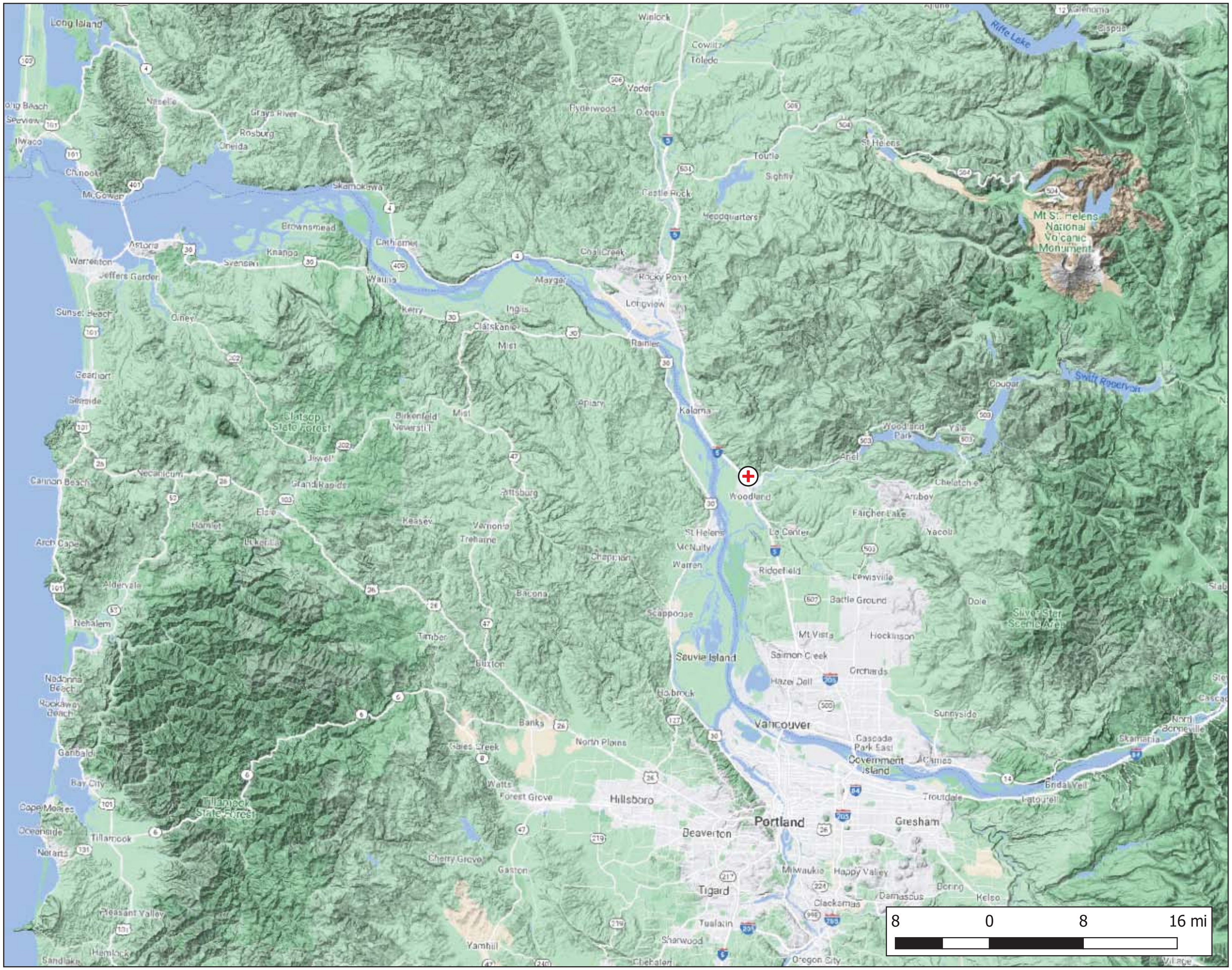
Senior Geotechnical Engineer

Reviewed by:
Strata Design, LLC

FREDERICK G. THRALL
23278

Frederick G. Thrall, PE, GE
Senior Geotechnical Engineer

FIGURES



VICINITY MAP

NEW BRIDGE FOUNDATION - ADJACENT TO GREEN MOUNTAIN ROAD, WOODLAND, WA

Legend

⊕ Site Location

Job #21-0379

Figure 1

AKS SITE PLAN

NEW BRIDGE FOUNDATION - ADJACENT TO GREEN MOUNTAIN ROAD, WOODLAND, WA

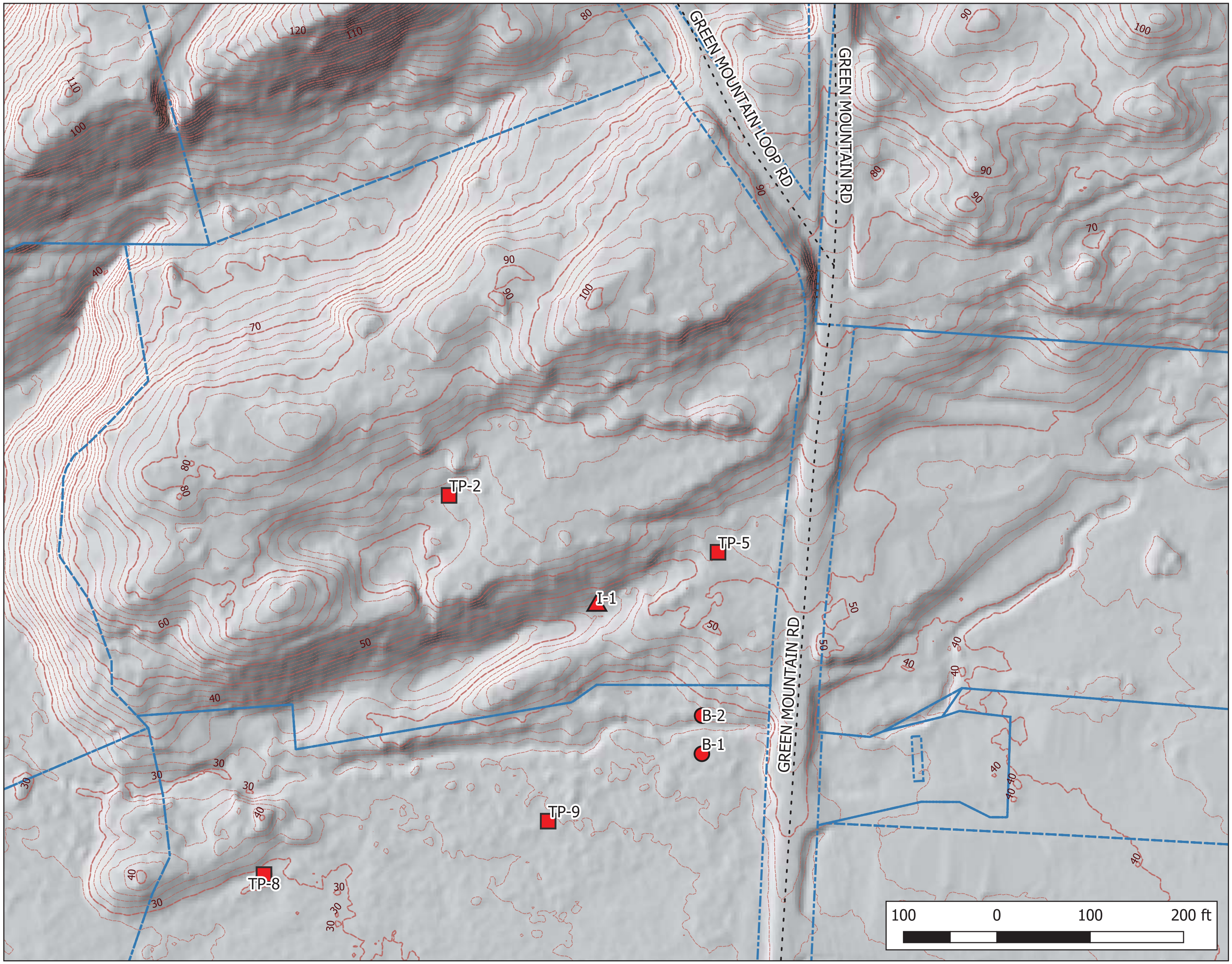
STRATA DESIGN

Legend

🟥 Test Pit Locations
● Boring Locations
▲ Infiltration Locations

Job #21-0379

Figure 2



LIDAR TOPOGRAPHY SITE PLAN

NEW BRIDGE FOUNDATION - ADJACENT TO GREEN MOUNTAIN ROAD, WOODLAND, WA

Contours derived from 2019 LiDAR (WA-DNR)

STRATA DESIGN

Legend

Contours
- --- 10-ft
- ---- 2-ft

Test Sites
- 🟥 Test Pit Locations
- ● Boring Locations
- ▲ Infiltration Locations

Cowlitz County GIS
- - - - Cowlitz Road Centerlines
- ⬚ Cowlitz County Parcels

Lot lines shown are from Cowlitz County GIS

Figure 3

APPENDIX A

Field Explorations

APPENDIX A: FIELD EXPLORATIONS

A1 GENERAL

STRATA explored subsurface conditions at the project site by advancing two borings. The borings were advanced to depths of up to approximately 12.5 to 20 feet bgs on March 20, 2021. The approximate locations of the explorations are shown on the Site Plan, Figure 2. The procedures used to advance the borings, collect samples, and other field techniques are described in detail in the following paragraphs. Unless otherwise noted, all soil sampling and classification procedures followed engineering practices in general accordance with relevant ASTM procedures. "General accordance" means that certain local drilling/excavation and descriptive practices and methodologies have been followed.

A2 BORINGS

A2.1 Drilling

Borings were advanced using a small, crawler style rubber-tired drill rig provided and operated by Geoservices Northwest . Borings B-1 and B-2 were advanced using hollow-stem auger techniques. The borings were observed by a member of the STRATA geotechnical staff, who maintained a log of the subsurface conditions and materials encountered during the course of the work.

A2.2 Sampling

Disturbed soil samples were taken in the borings at selected depth intervals. The samples were obtained using a standard 2-inch outside diameter (OD), split-spoon sampler following procedures prescribed for the standard penetration test (SPT). Using the SPT, the sampler is driven 18 inches into the soil using a 140-pound hammer dropped 30 inches. The number of blows required to drive the sampler the last 12 inches is defined as the standard penetration resistance (N-value). The N-value provides a measure of the relative density of granular soils such as sands and gravels, and the consistency of cohesive soils such as clays and plastic silts. The disturbed soil samples were examined by a member of the STRATA geotechnical staff and then sealed in plastic bags for further examination and physical testing in our laboratory.

A2.3 Boring Logs

The boring logs show the various types of materials that were encountered in the borings and the depths where the materials and/or characteristics of these materials changed, although the changes may be gradual. Where material types and descriptions changed between samples, the contacts were interpreted. The types of samples taken during drilling, along with their sample identification number, are shown to the right of the classification of materials. The N-values are shown further to the right.

A.3 MATERIAL DESCRIPTION

Initially, samples were classified visually in the field. Consistency, color, relative moisture, degree of plasticity, and other distinguishing characteristics of the soil samples were noted. Afterward, the samples were reexamined in the STRATA laboratory and the field classifications were modified where necessary. The terminology used in the soil classifications and other modifiers are defined in Table A-1, Guidelines for Classification of Soil.

A.4 Falling-Head Infiltration Testing

Falling-head infiltration tests were conducted at a depth of 5 feet in the approximate locations shown on the Site Plan, Figure 2, designated I-1. The testing was conducted in general conformance with the

2017 Cowlitz County Stormwater Drainage Manual. The infiltration tests were conducted using a 4-inch-diameter, hollow-stem auger installed by Geoservices Northwest. The infiltration test was conducted by filling the auger with water to have about 12 inches of head and conducting a falling-head infiltration test through the auger. The bottom of the auger is installed into the soil at the bottom of the hole using a track-mounted drill rig to prevent flow of water below the auger. Prior to conducting the tests, the bottom of each auger was soaked by maintaining an approximate 12- to 24-inch head of water for a minimum of two hours. The infiltration test holes were backfilled with bentonite chips after removing the augers. Results of the infiltration testing are provided in the Infiltration Testing section of this report.

Table 1A

GUIDELINES FOR CLASSIFICATION OF SOIL

Description of Relative Density for Granular Soil

Relative Density	Standard Penetration Resistance (N-values), blows/ft
Very Loose	0 - 4
Loose	4 - 10
Medium Dense	10 - 30
Dense	30 - 50
Very Dense	over 50

Description of Consistency for Fine-Grained (Cohesive) Soils

Consistency	Standard Penetration Resistance (N-values), blows/ft	Torvane or Undrained Shear Strength, tsf
Very Soft	0 - 2	less than 0.125
Soft	2 - 4	0.125 - 0.25
Medium Stiff	4 - 8	0.25 - 0.50
Stiff	8 - 15	0.50 - 1.0
Very Stiff	15 - 30	1.0 - 2.0
Hard	over 30	over 2.0

Grain-Size Classification
Boulders: >12 in.
Cobbles: 3-12 in.
Gravel: ¼ - ¾ in. (fine) ¾ - 3 in. (coarse)
Sand: No. 200 - No. 40 sieve (fine) No. 40 - No. 10 sieve (medium) No. 10 - No. 4 sieve (coarse)
Silt/Clay: Pass No. 200 sieve

Modifier for Subclassification		
	Primary Constituent SAND or GRAVEL	Primary Constituent SILT or CLAY
Adjective	Percentage of Other Material (By Weight)	
trace:	5 - 15 (sand, gravel)	5 - 15 (sand, gravel)
some:	15 - 30 (sand, gravel)	15 - 30 (sand, gravel)
sandy, gravelly:	30 - 50 (sand, gravel)	30 - 50 (sand, gravel)
trace:	<5 (silt, clay)	*Relationship of clay and silt determined by plasticity index test*
some:	5 - 12 (silt, clay)	
silty, clayey:	12 - 50 (silt, clay)	

Borehole: B-1 South Sitde of Creek

Project: New Bridge Foundation - Adjacent to Green Mtn. Rd.
Project ID: Field Drilling
Location: South Side of Creek
Client: Jeffries
Drilling Co.: GSNW
Method of drilling: HSA
Logged by: rgt
Checked by:
Notes:

Date start: 3/20/2021
Date end: 3/20/2021
Easting: 1068443.82
Northing: 225174.82
Ground Elevation: 36.00 (Approximate)
Altitude system:
Scale:

Depth [ft]	Samples and GWT	Recovery [%]	RQD [%]	Number of Blows [BL/12 in]	USCS Classification	Graphical log	Layers description	Environmental Data - Vapor
						▼ 36.00		
0.00 1.00	3" ◢	100.0		1	OL	▤	Brown to black, Clayey SILT (OL), very soft, contains organics	
2.00 3.00 4.00 5.00	12.5" ◢			4	ML-CL	🟧	Grey-brown, clayey SILT (ML-CL), moist, soft to medium stiff	
6.00 7.00 8.00 9.00 10.00 11.00 12.00 13.00	8.50 during drilling ▽ 13" ◢ 18" ◢			1		▨	Gray, sandy silty CLAY (ML-CL), moist, very soft, fine- to coarse-grained sand	
14.00 15.00 16.00 17.00 18.00 19.00	12" ◢			30	Basalt	▦	Red-brown, sandy SILT with some gravel (Decomposed Basalt), fine- to coarse-grained sand, subangular to subrounded gravel	
20.00	6" ◢			50		■	Gray, BASALT, slightly weathered, very soft to soft (R1 to R2)	

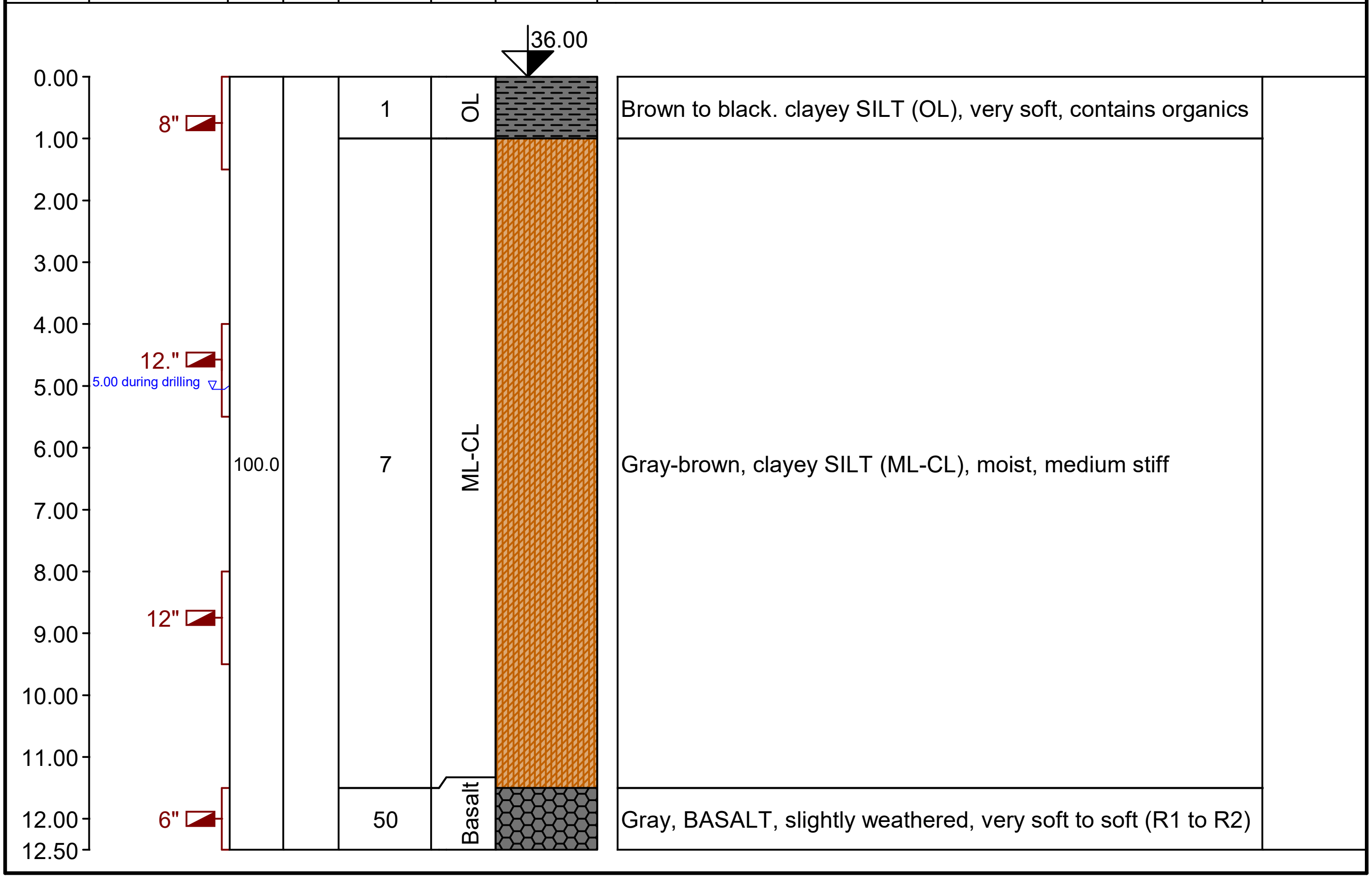
Key:

▽ GWT bored ◢ disturbed

Borehole: B-2 North Sitde of Creek (2)

Project: New Bridge Foundation - Adjacent to Green Mtn. Rd.
Project ID: Field Drilling
Location: North Side of Creek
Client: Jeffries
Drilling Co.: GSNW
Method of drilling: HSA
Logged by: rgt
Checked by:
Notes:

Date start: 3/20/2021
Date end: 3/20/2021
Easting: 1068448.53
Northing: 225206.06
Ground Elevation: 36.00 (Approximate)
Altitude system:
Scale:



Depth [ft]	Samples and GWT	Recovery [%]	RQD [%]	Number of Blows [BL/12 in]	USCS Classification	Graphical log	Layers description	Environmental Data - Vapor
0.00–1.00	8"			1	OL	▤	Brown to black. clayey SILT (OL), very soft, contains organics	
1.00–11.50	12." 5.00 during drilling 12"	100.0		7	ML-CL	▨	Gray-brown, clayey SILT (ML-CL), moist, medium stiff	
11.50–12.50	6"			50	Basalt	⬢	Gray, BASALT, slightly weathered, very soft to soft (R1 to R2)	

Key:
▽ GWT bored ◪ disturbed

APPENDIX B

August 2020 Draft Test Pit Logs (close to bridge site)

DEPTH (feet bgs)	GRAPHIC LOG	USCS SYMBOL	SOIL DESCRIPTION	SAMPLE	WATER CONTENT (%)	GROUND WATER	FIELD TESTING	TESTING AND LABORATORY DATA
0	🟩	ML	Stiff, brown SILT (TOPSOIL) with organics (roots); moist. (6-inch thick heavily rooted zone at the ground surface)					
	🟨	ML	Stiff, brown, fine SANDY SILT with trace clay, rounded gravel and cobbles; moist.					
	🟩	ML	Stiff, brown SILT; moist.					
5			End at 5 feet in stiff silt. No caving and no groundwater to the depth explored.					
10								
15								
20								

Station:

LOGGED BY: Rick Thrall, PE

Approximate Elevation: 65 +/-

Excavator: TB-1140 Trackhoe

Excavation Started: 8/24/20

Excavation Completed: 8/24/20

20-0262 Jeffries

2117 NE Oregon Street #502
Portland OR 97232
Tel 503-819-4423

STRATA DESIGN

LOG OF TEST PIT

TP-2

Page 1 of 1

DEPTH (feet bgs)	GRAPHIC LOG	USCS SYMBOL	SOIL DESCRIPTION	SAMPLE	WATER CONTENT (%)	GROUND WATER	FIELD TESTING	TESTING AND LABORATORY DATA
0	🟩	ML	Stiff, brown-black SILT with gravel; moist.(up to 12-inch thick heavily rooted zone at the ground surface)					
	🟨	ML	Stiff, brown, fine to coarse SANDY SILT with fine to medium gravel; moist.	1				
				2				
5	🟥	RK	Hard, weathered SILTSTONE; moist.					
			End at 10 feet in hard siltstone bedrock. No caving and no groundwater to the depth explored.					
10								
15								
20								

Station:

LOGGED BY: Rick Thrall, PE

Approximate Elevation: 52 +/-

Excavator: TB-1140 Trackhoe

Excavation Started: 8/24/20

Excavation Completed: 8/24/20

20-0262 Jeffries

2117 NE Oregon Street #502
Portland OR 97232
Tel 503-819-4423

STRATA DESIGN

LOG OF TEST PIT

TP-5

DEPTH (feet bgs)	GRAPHIC LOG	USCS SYMBOL	SOIL DESCRIPTION	SAMPLE	WATER CONTENT (%)	GROUND WATER	FIELD TESTING	TESTING AND LABORATORY DATA
0	🟩	ML	Stiff, brown SILT; moist. (8-inch thick heavily rooted zone at the ground surface)					
5	🟨	ML	Stiff, mottled brown, fine to medium SANDY SILT; moist.	1		▼		
	🟩	ML	Soft, gray SILTY CLAY with fine to coarse sand; wet.	2				
10			End at 9 feet in soft silty clay. Severe caving observed at 8 feet. Groundwater observed at 8 feet					
15								
20								

Station:

Approximate Elevation: 30 +/-

Excavation Started: 8/24/20

LOGGED BY: Rick Thrall, PE

Excavator: TB-1140 Trackhoe

Excavation Completed: 8/24/20

20-0262 Jeffries

2117 NE Oregon Street #502
Portland OR 97232
Tel 503-819-4423

STRATA DESIGN

LOG OF TEST PIT

TP-8

DEPTH (feet bgs)	GRAPHIC LOG	USCS SYMBOL	SOIL DESCRIPTION	SAMPLE	WATER CONTENT (%)	GROUND WATER	FIELD TESTING	TESTING AND LABORATORY DATA
0	🟩	ML	Stiff, brown SILT (TOPSOIL) with organics(roots), moist ; up to 12- inch thick heavily rooted zone at the ground surface)					
	🟨	ML	Stiff, brown, fine SANDY SILT with trace clay; moist.	1				
5	▨	SC	Medium dense, mottled gray, fine to coarse CLAYEY SAND; wet.	2		▼		
10			End at 8 feet in medium dense clayey sand. No caving observed during exploration. Groundwater observed at 7 feet during site exploration. Standing water at 7 feet.					
15								
20								

Station:

LOGGED BY: Rick Thrall, PE

Approximate Elevation: 36 +/-

Excavator: TB-1140 Trackhoe

Excavation Started: 8/24/20

Excavation Completed: 8/24/20

20-0262 Jeffries

2117 NE Oregon Street #502
Portland OR 97232
Tel 503-819-4423

STRATA DESIGN

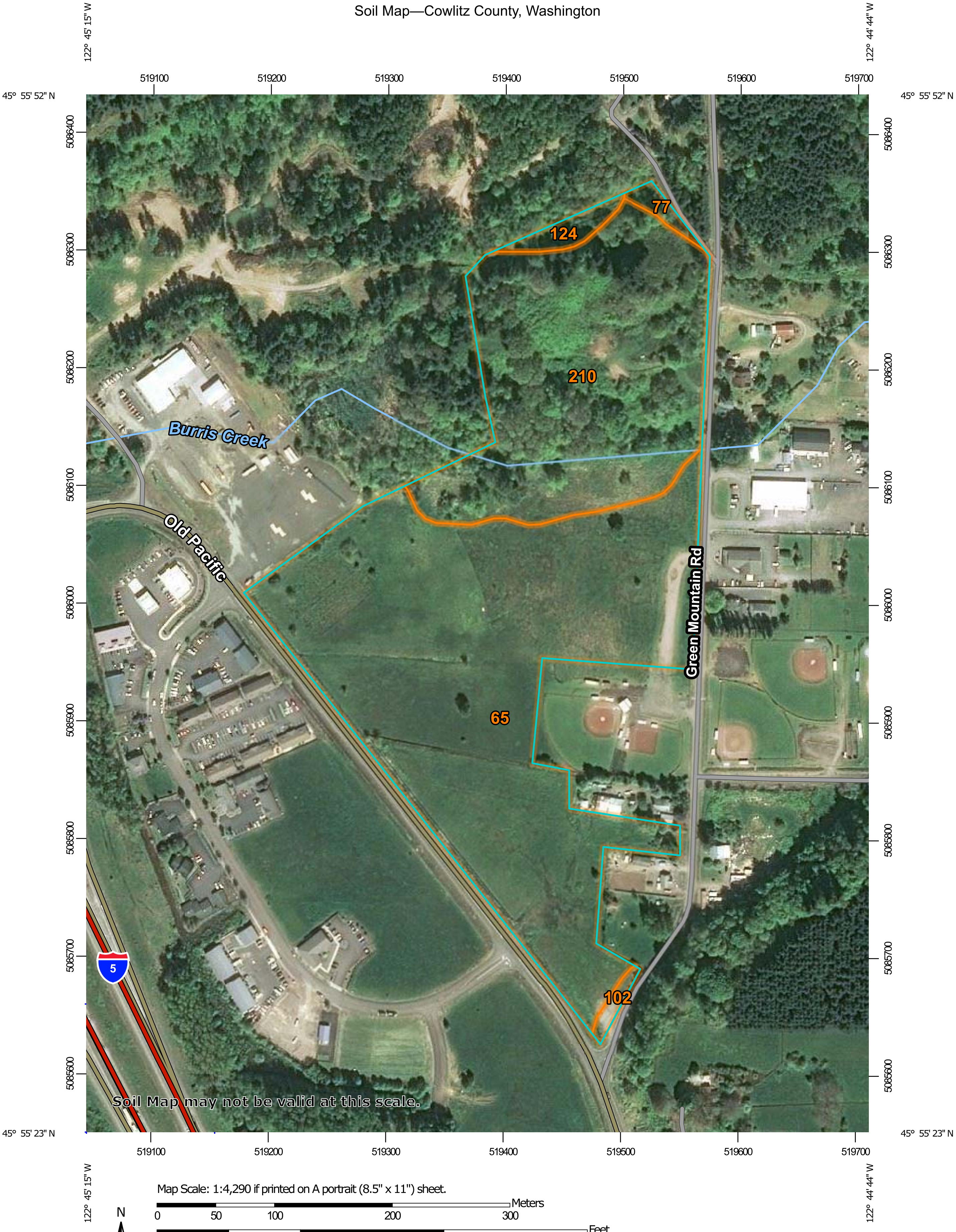
LOG OF TEST PIT

TP-9

Page 1 of 1

Appendix G.2: NRCS Soils Report

Soil Map—Cowlitz County, Washington



Map Scale: 1:4,290 if printed on A portrait (8.5" x 11") sheet.

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 1:24,000.

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: Cowlitz County, Washington
Survey Area Data: Version 21, Jun 4, 2020

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

Date(s) aerial images were photographed: Apr 26, 2019—Jun 11, 2019

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

Map Unit Legend

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
65	Godfrey silt loam, 0 to 3 percent slopes	20.9	62.5%
77	Hazeldell gravelly silt loam, 20 to 30 percent slopes	0.3	0.8%
102	Kelso silt loam, 15 to 30 percent slopes	0.2	0.6%
124	Mart silt loam, 8 to 20 percent slopes	0.5	1.4%
210	Stella silt loam, 15 to 30 percent slopes	11.6	34.8%
Totals for Area of Interest		**33.4**	**100.0%**

Engineering Properties

This table gives the engineering classifications and the range of engineering properties for the layers of each soil in the survey area.

Hydrologic soil group is a group of soils having similar runoff potential under similar storm and cover conditions. The criteria for determining Hydrologic soil group is found in the National Engineering Handbook, Chapter 7 issued May 2007(http://directives.sc.egov.usda.gov/OpenNonWebContent.aspx?content=17757.wba). Listing HSGs by soil map unit component and not by soil series is a new concept for the engineers. Past engineering references contained lists of HSGs by soil series. Soil series are continually being defined and redefined, and the list of soil series names changes so frequently as to make the task of maintaining a single national list virtually impossible. Therefore, the criteria is now used to calculate the HSG using the component soil properties and no such national series lists will be maintained. All such references are obsolete and their use should be discontinued. Soil properties that influence runoff potential are those that influence the minimum rate of infiltration for a bare soil after prolonged wetting and when not frozen. These properties are depth to a seasonal high water table, saturated hydraulic conductivity after prolonged wetting, and depth to a layer with a very slow water transmission rate. Changes in soil properties caused by land management or climate changes also cause the hydrologic soil group to change. The influence of ground cover is treated independently. There are four hydrologic soil groups, A, B, C, and D, and three dual groups, A/D, B/D, and C/D. In the dual groups, the first letter is for drained areas and the second letter is for undrained areas.

The four hydrologic soil groups are described in the following paragraphs:

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

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

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

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

Depth to the upper and lower boundaries of each layer is indicated.

Texture is given in the standard terms used by the U.S. Department of Agriculture. These terms are defined according to percentages of sand, silt, and clay in the fraction of the soil that is less than 2 millimeters in diameter. "Loam," for example, is soil that is 7 to 27 percent clay, 28 to 50 percent silt, and less than 52 percent sand. If the content of particles coarser than sand is 15 percent or more, an appropriate modifier is added, for example, "gravelly."

Classification of the soils is determined according to the Unified soil classification system (ASTM, 2005) and the system adopted by the American Association of State Highway and Transportation Officials (AASHTO, 2004).

The Unified system classifies soils according to properties that affect their use as construction material. Soils are classified according to particle-size distribution of the fraction less than 3 inches in diameter and according to plasticity index, liquid limit, and organic matter content. Sandy and gravelly soils are identified as GW, GP, GM, GC, SW, SP, SM, and SC; silty and clayey soils as ML, CL, OL, MH, CH, and OH; and highly organic soils as PT. Soils exhibiting engineering properties of two groups can have a dual classification, for example, CL-ML.

The AASHTO system classifies soils according to those properties that affect roadway construction and maintenance. In this system, the fraction of a mineral soil that is less than 3 inches in diameter is classified in one of seven groups from A-1 through A-7 on the basis of particle-size distribution, liquid limit, and plasticity index. Soils in group A-1 are coarse grained and low in content of fines (silt and clay). At the other extreme, soils in group A-7 are fine grained. Highly organic soils are classified in group A-8 on the basis of visual inspection.

If laboratory data are available, the A-1, A-2, and A-7 groups are further classified as A-1-a, A-1-b, A-2-4, A-2-5, A-2-6, A-2-7, A-7-5, or A-7-6. As an additional refinement, the suitability of a soil as subgrade material can be indicated by a group index number. Group index numbers range from 0 for the best subgrade material to 20 or higher for the poorest.

Percentage of rock fragments larger than 10 inches in diameter and 3 to 10 inches in diameter are indicated as a percentage of the total soil on a dry-weight basis. The percentages are estimates determined mainly by converting volume percentage in the field to weight percentage. Three values are provided to identify the expected Low (L), Representative Value (R), and High (H).

Percentage (of soil particles) passing designated sieves is the percentage of the soil fraction less than 3 inches in diameter based on an ovendry weight. The sieves, numbers 4, 10, 40, and 200 (USA Standard Series), have openings of 4.76, 2.00, 0.420, and 0.074 millimeters, respectively. Estimates are based on laboratory tests of soils sampled in the survey area and in nearby areas and on estimates made in the field. Three values are provided to identify the expected Low (L), Representative Value (R), and High (H).

Liquid limit and *plasticity index* (Atterberg limits) indicate the plasticity characteristics of a soil. The estimates are based on test data from the survey area or from nearby areas and on field examination. Three values are provided to identify the expected Low (L), Representative Value (R), and High (H).

References:

American Association of State Highway and Transportation Officials (AASHTO). 2004. Standard specifications for transportation materials and methods of sampling and testing. 24th edition.

American Society for Testing and Materials (ASTM). 2005. Standard classification of soils for engineering purposes. ASTM Standard D2487-00.

Report—Engineering Properties

Absence of an entry indicates that the data were not estimated. The asterisk '*' denotes the representative texture; other possible textures follow the dash. The criteria for determining the hydrologic soil group for individual soil components is found in the National Engineering Handbook, Chapter 7 issued May 2007(http://directives.sc.egov.usda.gov/OpenNonWebContent.aspx?content=17757.wba). Three values are provided to identify the expected Low (L), Representative Value (R), and High (H).

Engineering Properties–Cowlitz County, Washington

Map unit symbol and soil name	Pct. of map unit	Hydrologic group	Depth	USDA texture	Classification		Pct Fragments		Percentage passing sieve number—				Liquid limit	Plasticity index
					Unified	AASHTO	>10 inches	3-10 inches	4	10	40	200		
			In				*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*
65—Godfrey silt loam, 0 to 3 percent slopes														
Godfrey	85	D	0-5	Silt loam	CL, CL-ML	A-4, A-6	0- 0- 0	0- 0- 0	100-100-100	100-100-100	90-95-100	80-88-95	25-30-35	5-10-15
			5-27	Silty clay loam, silty clay, clay	MH, ML	A-7	0- 0- 0	0- 0- 0	100-100-100	100-100-100	90-95-100	80-88-95	40-48-55	15-20-25
			27-60	Sandy clay, silty clay, clay	MH, ML	A-7	0- 0- 0	0- 0- 0	100-100-100	100-100-100	80-88-95	50-70-90	40-48-55	15-20-25
77—Hazeldell gravelly silt loam, 20 to 30 percent slopes														
Hazeldell	80	B	0-7	Gravelly silt loam	CL, ML	A-6, A-7	0- 0- 0	0- 0- 0	70-78-85	60-68-75	55-65-75	50-58-65	30-40-50	10-15-20
			7-28	Gravelly clay loam, gravelly loam	CL, ML, SC	A-6, A-7	0- 0- 0	0- 8- 15	75-80-85	60-68-75	55-63-70	40-45-50	30-40-50	10-15-20
			28-40	Gravelly clay loam, gravelly loam, very gravelly clay loam	SC, SM, GC	A-4, A-5, A-6, A-7	0- 3- 5	0- 8- 15	50-68-85	45-60-75	40-55-70	35-43-50	30-40-45	5-15-20
			40-60	Gravelly clay loam, gravelly clay, very gravelly clay loam	CL, GC, ML, SC	A-4, A-5, A-6, A-7	0- 0- 0	0- 3- 5	50-65-80	45-60-75	40-55-70	35-48-60	45-50-55	20-25-25

Engineering Properties–Cowlitz County, Washington

Map unit symbol and soil name	Pct. of map unit	Hydrologic group	Depth	USDA texture	Classification		Pct Fragments		Percentage passing sieve number—				Liquid limit	Plasticity index
					Unified	AASHTO	>10 inches	3-10 inches	4	10	40	200		
			In				*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*
124—Mart silt loam, 8 to 20 percent slopes														
Mart	80	C	0-11	Silt loam	CL, CL-ML	A-4, A-6	0- 0- 0	0- 0- 0	90-95-100	85-93-100	85-90-95	85-90-95	25-30-35	5-10-15
			11-20	Silt loam, silty clay loam	CL, CL-ML	A-4, A-6	0- 0- 0	0- 0- 0	90-95-100	85-93-100	85-90-95	80-85-90	25-30-35	5-10-15
			20-40	Silty clay loam	CL	A-6, A-7	0- 0- 0	0- 0- 0	90-95-100	85-93-100	85-93-100	80-85-90	30-38-45	10-15-20
			40-72	Silty clay loam, silt loam	CL, CL-ML	A-4, A-6	0- 0- 0	0- 0- 0	90-95-100	85-93-100	85-90-95	80-85-90	25-30-35	5-10-15
210—Stella silt loam, 15 to 30 percent slopes														
Stella	80	C	0-11	Silt loam	CL	A-6	0- 0- 0	0- 0- 0	100-100-100	100-100-100	90-95-100	75-85-95	25-30-35	10-15-20
			11-25	Silt loam	CL	A-6	0- 0- 0	0- 0- 0	100-100-100	100-100-100	95-98-100	90-95-100	25-30-35	10-15-20
			25-48	Silty clay loam, silt loam	CL	A-6, A-7	0- 0- 0	0- 0- 0	100-100-100	100-100-100	90-95-100	85-90-95	35-40-45	15-18-20
			48-60	Silty clay, silty clay loam	CH, CL	A-7	0- 0- 0	0- 0- 0	100-100-100	100-100-100	95-98-100	90-95-100	45-60-75	20-33-45

Data Source Information

Soil Survey Area: Cowlitz County, Washington
Survey Area Data: Version 21, Jun 4, 2020

Physical Soil Properties

This table shows estimates of some physical characteristics and features that affect soil behavior. These estimates are given for the layers of each soil in the survey area. The estimates are based on field observations and on test data for these and similar soils.

Depth to the upper and lower boundaries of each layer is indicated.

Particle size is the effective diameter of a soil particle as measured by sedimentation, sieving, or micrometric methods. Particle sizes are expressed as classes with specific effective diameter class limits. The broad classes are sand, silt, and clay, ranging from the larger to the smaller.

Sand as a soil separate consists of mineral soil particles that are 0.05 millimeter to 2 millimeters in diameter. In this table, the estimated sand content of each soil layer is given as a percentage, by weight, of the soil material that is less than 2 millimeters in diameter.

Silt as a soil separate consists of mineral soil particles that are 0.002 to 0.05 millimeter in diameter. In this table, the estimated silt content of each soil layer is given as a percentage, by weight, of the soil material that is less than 2 millimeters in diameter.

Clay as a soil separate consists of mineral soil particles that are less than 0.002 millimeter in diameter. In this table, the estimated clay content of each soil layer is given as a percentage, by weight, of the soil material that is less than 2 millimeters in diameter.

The content of sand, silt, and clay affects the physical behavior of a soil. Particle size is important for engineering and agronomic interpretations, for determination of soil hydrologic qualities, and for soil classification.

The amount and kind of clay affect the fertility and physical condition of the soil and the ability of the soil to adsorb cations and to retain moisture. They influence shrink-swell potential, saturated hydraulic conductivity (Ksat), plasticity, the ease of soil dispersion, and other soil properties. The amount and kind of clay in a soil also affect tillage and earthmoving operations.

Moist bulk density is the weight of soil (ovendry) per unit volume. Volume is measured when the soil is at field moisture capacity, that is, the moisture content at 1/3- or 1/10-bar (33kPa or 10kPa) moisture tension. Weight is determined after the soil is dried at 105 degrees C. In the table, the estimated moist bulk density of each soil horizon is expressed in grams per cubic centimeter of soil material that is less than 2 millimeters in diameter. Bulk density data are used to compute linear extensibility, shrink-swell potential, available water capacity, total pore space, and other soil properties. The moist bulk density of a soil indicates the pore space available for water and roots. Depending on soil texture, a bulk density of more than 1.4 can restrict water storage and root penetration. Moist bulk density is influenced by texture, kind of clay, content of organic matter, and soil structure.

Saturated hydraulic conductivity (Ksat) refers to the ease with which pores in a saturated soil transmit water. The estimates in the table are expressed in terms of micrometers per second. They are based on soil characteristics observed in the field, particularly structure, porosity, and texture. Saturated hydraulic conductivity (Ksat) is considered in the design of soil drainage systems and septic tank absorption fields.

Available water capacity refers to the quantity of water that the soil is capable of storing for use by plants. The capacity for water storage is given in inches of water per inch of soil for each soil layer. The capacity varies, depending on soil properties that affect retention of water. The most important properties are the content of organic matter, soil texture, bulk density, and soil structure. Available water capacity is an important factor in the choice of plants or crops to be grown and in the design and management of irrigation systems. Available water capacity is not an estimate of the quantity of water actually available to plants at any given time.

Linear extensibility refers to the change in length of an unconfined clod as moisture content is decreased from a moist to a dry state. It is an expression of the volume change between the water content of the clod at 1/3- or 1/10-bar tension (33kPa or 10kPa tension) and oven dryness. The volume change is reported in the table as percent change for the whole soil. The amount and type of clay minerals in the soil influence volume change.

Linear extensibility is used to determine the shrink-swell potential of soils. The shrink-swell potential is low if the soil has a linear extensibility of less than 3 percent; moderate if 3 to 6 percent; high if 6 to 9 percent; and very high if more than 9 percent. If the linear extensibility is more than 3, shrinking and swelling can cause damage to buildings, roads, and other structures and to plant roots. Special design commonly is needed.

Organic matter is the plant and animal residue in the soil at various stages of decomposition. In this table, the estimated content of organic matter is expressed as a percentage, by weight, of the soil material that is less than 2 millimeters in diameter. The content of organic matter in a soil can be maintained by returning crop residue to the soil.

Organic matter has a positive effect on available water capacity, water infiltration, soil organism activity, and tilth. It is a source of nitrogen and other nutrients for crops and soil organisms.

Erosion factors are shown in the table as the K factor (Kw and Kf) and the T factor. Erosion factor K indicates the susceptibility of a soil to sheet and rill erosion by water. Factor K is one of six factors used in the Universal Soil Loss Equation (USLE) and the Revised Universal Soil Loss Equation (RUSLE) to predict the average annual rate of soil loss by sheet and rill erosion in tons per acre per year. The estimates are based primarily on percentage of silt, sand, and organic matter and on soil structure and Ksat. Values of K range from 0.02 to 0.69. Other factors being equal, the higher the value, the more susceptible the soil is to sheet and rill erosion by water.

Erosion factor Kw indicates the erodibility of the whole soil. The estimates are modified by the presence of rock fragments.

Erosion factor Kf indicates the erodibility of the fine-earth fraction, or the material less than 2 millimeters in size.

Erosion factor T is an estimate of the maximum average annual rate of soil erosion by wind and/or water that can occur without affecting crop productivity over a sustained period. The rate is in tons per acre per year.

Wind erodibility groups are made up of soils that have similar properties affecting their susceptibility to wind erosion in cultivated areas. The soils assigned to group 1 are the most susceptible to wind erosion, and those assigned to group 8 are the least susceptible. The groups are described in the "National Soil Survey Handbook."

Wind erodibility index is a numerical value indicating the susceptibility of soil to wind erosion, or the tons per acre per year that can be expected to be lost to wind erosion. There is a close correlation between wind erosion and the texture of the surface layer, the size and durability of surface clods, rock fragments, organic matter, and a calcareous reaction. Soil moisture and frozen soil layers also influence wind erosion.

Reference:
United States Department of Agriculture, Natural Resources Conservation Service. National soil survey handbook, title 430-VI. (http://soils.usda.gov)

Report—Physical Soil Properties

Three values are provided to identify the expected Low (L), Representative Value (R), and High (H).

Physical Soil Properties–Cowlitz County, Washington

Map symbol and soil name	Depth	Sand	Silt	Clay	Moist bulk density	Saturated hydraulic conductivity	Available water capacity	Linear extensibility	Organic matter	Erosion factors			Wind erodibility group	Wind erodibility index
										Kw	Kf	T		
	In	*Pct*	*Pct*	*Pct*	*g/cc*	*micro m/sec*	*In/In*	*Pct*	*Pct*					
65—Godfrey silt loam, 0 to 3 percent slopes														
Godfrey	0-5	-25-	-53-	18-23- 27	1.15-1.25-1.35	4.00-9.00-14.00	0.20-0.22-0.24	0.0- 1.5- 2.9	0.5- 1.3- 2.0	.49	.49	4	6	48
	5-27	- 7-	-51-	35-43- 50	1.15-1.28-1.40	0.42-0.91-1.40	0.14-0.16-0.18	6.0- 7.5- 8.9	0.5- 0.8- 1.0	.32	.32			
	27-60	-48-	- 7-	40-45- 50	1.15-1.28-1.40	0.01-0.22-0.42	0.13-0.14-0.15	6.0- 7.5- 8.9	0.5- 0.8- 1.0	.20	.20			
77—Hazeldell gravelly silt loam, 20 to 30 percent slopes														
Hazeldell	0-7	-25-	-52-	20-24- 27	1.10-1.23-1.35	4.00-9.00-14.00	0.19-0.22-0.24	3.0- 4.5- 5.9	5.0- 7.5-10.0	.17	.28	5	7	38
	7-28	-36-	-39-	20-25- 30	1.10-1.23-1.35	4.00-9.00-14.00	0.18-0.21-0.24	3.0- 4.5- 5.9	1.0- 1.5- 2.0	.20	.32			
	28-40	-35-	-38-	20-28- 35	1.10-1.28-1.45	4.00-9.00-14.00	0.13-0.17-0.21	3.0- 4.5- 5.9	0.0- 0.5- 1.0	.15	.32			
	40-60	-30-	-31-	35-39- 70	1.25-1.35-1.45	4.00-9.00-14.00	0.13-0.17-0.20	3.0- 4.5- 5.9	0.0- 0.3- 0.5	.10	.24			

Physical Soil Properties–Cowlitz County, Washington

Map symbol and soil name	Depth	Sand	Silt	Clay	Moist bulk density	Saturated hydraulic conductivity	Available water capacity	Linear extensibility	Organic matter	Erosion factors			Wind erodibility group	Wind erodibility index
										Kw	Kf	T		
	In	*Pct*	*Pct*	*Pct*	*g/cc*	*micro m/sec*	*In/In*	*Pct*	*Pct*					
124—Mart silt loam, 8 to 20 percent slopes														
Mart	0-11	-25-	-52-	20-24- 27	1.15-1.25 -1.35	4.00-9.00-14.00	0.18-0.20-0. 21	3.0- 4.5- 5.9	1.0- 3.0- 5.0	.28	.28	5	6	48
	11-20	-24-	-51-	20-25- 30	1.20-1.30 -1.40	4.00-9.00-14.00	0.18-0.20-0. 21	3.0- 4.5- 5.9	1.0- 1.5- 2.0	.43	.43			
	20-40	-17-	-48-	30-35- 40	1.20-1.30 -1.40	1.40-3.00-4.00	0.17-0.19-0. 20	3.0- 4.5- 5.9	0.0- 0.5- 1.0	.37	.37			
	40-72	-20-	-54-	25-26- 40	1.20-1.30 -1.40	1.40-3.00-4.00	0.09-0.11-0. 12	3.0- 4.5- 5.9	0.0- 0.3- 0.5	.49	.49			
210—Stella silt loam, 15 to 30 percent slopes														
Stella	0-11	-11-	-68-	15-21- 27	1.15-1.25 -1.35	4.00-9.00-14.00	0.19-0.20-0. 21	0.0- 1.5- 2.9	1.0- 3.0- 5.0	.37	.37	5	6	48
	11-25	- 9-	-67-	20-24- 27	1.30-1.38 -1.45	4.00-9.00-14.00	0.18-0.19-0. 20	0.0- 1.5- 2.9	1.0- 1.5- 2.0	.49	.49			
	25-48	- 7-	-65-	20-28- 35	1.20-1.25 -1.30	1.40-3.00-4.00	0.18-0.19-0. 20	3.0- 4.5- 5.9	0.0- 0.5- 1.0	.49	.49			
	48-60	- 7-	-48-	30-45- 60	1.15-1.25 -1.35	0.01-0.91-1.40	0.17-0.18-0. 19	3.0- 4.5- 5.9	0.0- 0.3- 0.5	.32	.32			

Data Source Information

Soil Survey Area: Cowlitz County, Washington
Survey Area Data: Version 21, Jun 4, 2020

Appendix H: WWHM Analysis

WWHM2012

PROJECT REPORT

General Model Information

Project Name:	8344 prelim
Site Name:	Jeffries Woodland Apt
Site Address:	
City:	
Report Date:	5/5/2021
Gage:	Longview
Data Start:	1955/10/01
Data End:	2009/09/30
Timestep:	15 Minute
Precip Scale:	1.000
Version Date:	2017/04/17
Version:	4.2.13

POC Thresholds

Low Flow Threshold for POC1:	8 Percent of the 2 Year
High Flow Threshold for POC1:	50 Year
Low Flow Threshold for POC2:	50 Percent of the 2 Year
High Flow Threshold for POC2:	50 Year

Landuse Basin Data

Predeveloped Land Use

Basin 2X-B

Bypass:	No
GroundWater:	No
Pervious Land Use	acre
C, Forest, Mod	4.12
Pervious Total	4.12
Impervious Land Use	acre
Impervious Total	0
Basin Total	4.12

Element Flows To:

Surface	Interflow	Groundwater

Basin 2X-A

Bypass:	No
GroundWater:	No
Pervious Land Use	acre
C, Forest, Mod	1.14
Pervious Total	1.14
Impervious Land Use	acre
Impervious Total	0
Basin Total	1.14

Element Flows To:

Surface	Interflow	Groundwater

Basin 1X

Bypass:	No
GroundWater:	No
Pervious Land Use	acre
C, Forest, Mod	0.903
Pervious Total	0.903
Impervious Land Use	acre
Impervious Total	0
Basin Total	0.903

Element Flows To:

Surface	Interflow	Groundwater

Mitigated Land Use

Basin 2S-B1

Bypass:	No
GroundWater:	No
Pervious Land Use	acre
C, Lawn, Flat	0.69
Pervious Total	0.69
Impervious Land Use	acre
ROOF TOPS FLAT	0.87
PARKING FLAT	2.06
Impervious Total	2.93
Basin Total	3.62

Element Flows To:

Surface	Interflow	Groundwater
Surface etention 2B	Surface etention 2B	

Basin 2S-A1

Bypass:	No
GroundWater:	No
Pervious Land Use	acre
Pervious Total	0
Impervious Land Use	acre
ROOF TOPS FLAT	0.39
PARKING FLAT	0.75
Impervious Total	1.14
Basin Total	1.14

Element Flows To:

Surface	Interflow	Groundwater
Surface etention 2A	Surface etention 2A	

Basin 1S-A

Bypass:	No
GroundWater:	No
Pervious Land Use	acre
C, Lawn, Flat	0.2
Pervious Total	0.2
Impervious Land Use	acre
PARKING FLAT	0.65
Impervious Total	0.65
Basin Total	0.85

Element Flows To:

Surface	Interflow	Groundwater
Surface retention 1	Surface retention 1	

Basin 2S-C

Bypass:	No
GroundWater:	No
Pervious Land Use	acre
Pervious Total	0
Impervious Land Use	acre
ROADS MOD	0.5
Impervious Total	0.5
Basin Total	0.5

Element Flows To:

Surface	Interflow	Groundwater
Surface etention 2B	Surface etention 2B	

Routing Elements

Predeveloped Routing

Mitigated Routing

Bioretention 2B

Bottom Length:	80.00 ft.
Bottom Width:	25.00 ft.
Material thickness of first layer:	1.5
Material type for first layer:	SMMWW 12 in/hr
Material thickness of second layer:	1
Material type for second layer:	GRAVEL
Material thickness of third layer:	0
Material type for third layer:	GRAVEL
Underdrain used	
Underdrain Diameter (feet):	0.5
Orifice Diameter (in.):	6
Offset (in.):	1
Flow Through Underdrain (ac-ft.):	563.85
Total Outflow (ac-ft.):	608.735
Percent Through Underdrain:	92.63

Discharge Structure

Riser Height:	1 ft.
Riser Diameter:	18 in.

Element Flows To:

Outlet 1 Outlet 2

Bioretention Hydraulic Table

Stage(feet)	**Area(ac.)**	**Volume(ac-ft.)**	**Discharge(cfs)**	**Infilt(cfs)**
0.0000	0.0872	0.0000	0.0000	0.0000
0.0440	0.0865	0.0009	0.0000	0.0000
0.0879	0.0857	0.0019	0.0000	0.0000
0.1319	0.0849	0.0028	0.0000	0.0000
0.1758	0.0841	0.0038	0.0000	0.0000
0.2198	0.0833	0.0048	0.0000	0.0000
0.2637	0.0825	0.0058	0.0004	0.0000
0.3077	0.0817	0.0068	0.0005	0.0000
0.3516	0.0809	0.0078	0.0009	0.0000
0.3956	0.0801	0.0088	0.0015	0.0000
0.4396	0.0793	0.0099	0.0023	0.0000
0.4835	0.0785	0.0109	0.0033	0.0000
0.5275	0.0778	0.0120	0.0044	0.0000
0.5714	0.0770	0.0131	0.0058	0.0000
0.6154	0.0762	0.0142	0.0074	0.0000
0.6593	0.0754	0.0153	0.0093	0.0000
0.7033	0.0747	0.0164	0.0115	0.0000
0.7473	0.0739	0.0176	0.0139	0.0000
0.7912	0.0731	0.0187	0.0165	0.0000
0.8352	0.0724	0.0199	0.0195	0.0000
0.8791	0.0716	0.0211	0.0228	0.0000
0.9231	0.0709	0.0223	0.0264	0.0000
0.9670	0.0701	0.0235	0.0303	0.0000
1.0110	0.0694	0.0247	0.0345	0.0000
1.0549	0.0686	0.0260	0.0391	0.0000
1.0989	0.0679	0.0272	0.0440	0.0000
1.1429	0.0672	0.0285	0.0493	0.0000
1.1868	0.0664	0.0298	0.0549	0.0000
1.2308	0.0657	0.0311	0.0609	0.0000

1.2747	0.0650	0.0324	0.0673	0.0000
1.3187	0.0642	0.0337	0.0706	0.0000
1.3626	0.0635	0.0351	0.0741	0.0000
1.4066	0.0628	0.0364	0.0812	0.0000
1.4505	0.0621	0.0378	0.0888	0.0000
1.4945	0.0614	0.0392	0.0967	0.0000
1.5385	0.0607	0.0405	0.1051	0.0000
1.5824	0.0600	0.0417	0.1139	0.0000
1.6264	0.0593	0.0430	0.1231	0.0000
1.6703	0.0586	0.0444	0.1243	0.0000
1.7143	0.0579	0.0457	0.1327	0.0000
1.7582	0.0572	0.0470	0.1389	0.0000
1.8022	0.0565	0.0484	0.1389	0.0000
1.8462	0.0558	0.0497	0.1389	0.0000
1.8901	0.0551	0.0511	0.1389	0.0000
1.9341	0.0544	0.0525	0.1389	0.0000
1.9780	0.0538	0.0539	0.1389	0.0000
2.0220	0.0531	0.0554	0.1389	0.0000
2.0659	0.0524	0.0568	0.1389	0.0000
2.1099	0.0518	0.0583	0.1389	0.0000
2.1538	0.0511	0.0597	0.1389	0.0000
2.1978	0.0504	0.0612	0.1389	0.0000
2.2418	0.0498	0.0627	0.1389	0.0000
2.2857	0.0491	0.0642	0.1389	0.0000
2.3297	0.0485	0.0657	0.1389	0.0000
2.3736	0.0478	0.0673	0.1389	0.0000
2.4176	0.0472	0.0688	0.1389	0.0000
2.4615	0.0466	0.0704	0.1389	0.0000
2.5000	0.0459	0.0718	0.1389	0.0000

Bioretention Hydraulic Table

Stage(feet)	Area(ac.)	Volume(ac-ft.)	Discharge(cfs)	To Amended(cfs)	Infilt(cfs)
2.5000	0.0872	0.0718	0.0000	0.5718	0.0000
2.5440	0.0881	0.0757	0.0000	0.5718	0.0000
2.5879	0.0889	0.0795	0.0000	0.5881	0.0000
2.6319	0.0897	0.0835	0.0000	0.6044	0.0000
2.6758	0.0905	0.0874	0.0000	0.6207	0.0000
2.7198	0.0914	0.0914	0.0000	0.6370	0.0000
2.7637	0.0922	0.0955	0.0000	0.6532	0.0000
2.8077	0.0930	0.0995	0.0000	0.6695	0.0000
2.8516	0.0939	0.1036	0.0000	0.6858	0.0000
2.8956	0.0947	0.1078	0.0000	0.7021	0.0000
2.9396	0.0956	0.1120	0.0000	0.7184	0.0000
2.9835	0.0964	0.1162	0.0000	0.7346	0.0000
3.0275	0.0973	0.1204	0.0000	0.7509	0.0000
3.0714	0.0981	0.1247	0.0000	0.7672	0.0000
3.1154	0.0990	0.1291	0.0000	0.7835	0.0000
3.1593	0.0999	0.1334	0.0000	0.7998	0.0000
3.2033	0.1007	0.1379	0.0000	0.8160	0.0000
3.2473	0.1016	0.1423	0.0000	0.8323	0.0000
3.2912	0.1025	0.1468	0.0000	0.8486	0.0000
3.3352	0.1033	0.1513	0.0000	0.8649	0.0000
3.3791	0.1042	0.1559	0.0000	0.8812	0.0000
3.4231	0.1051	0.1605	0.0000	0.8974	0.0000
3.4670	0.1060	0.1651	0.0000	0.9137	0.0000
3.5110	0.1069	0.1698	0.0183	0.9300	0.0000
3.5549	0.1078	0.1745	0.2049	0.9463	0.0000
3.5989	0.1087	0.1793	0.4939	0.9626	0.0000

3.6429	0.1096	0.1841	0.8548	0.9788	0.0000
3.6868	0.1105	0.1889	1.2709	0.9951	0.0000
3.7308	0.1114	0.1938	1.7286	1.0114	0.0000
3.7747	0.1123	0.1987	2.2144	1.0277	0.0000
3.8187	0.1132	0.2036	2.7149	1.0440	0.0000
3.8626	0.1141	0.2086	3.2160	1.0602	0.0000
3.9066	0.1150	0.2137	3.7040	1.0765	0.0000
3.9505	0.1159	0.2187	4.1657	1.0928	0.0000
3.9945	0.1169	0.2239	4.5893	1.1091	0.0000
4.0000	0.1170	0.2245	4.9654	1.1111	0.0000

Surface etention 2B

Element Flows To:

Outlet 1	Outlet 2
	Bioretention 2B

Bioretention 2A

Bottom Length:	70.00 ft.
Bottom Width:	10.00 ft.
Material thickness of first layer:	1.5
Material type for first layer:	SMMWW 12 in/hr
Material thickness of second layer:	1
Material type for second layer:	GRAVEL
Material thickness of third layer:	0
Material type for third layer:	GRAVEL
Underdrain used	
Underdrain Diameter (feet):	0.5
Orifice Diameter (in.):	6
Offset (in.):	1
Flow Through Underdrain (ac-ft.):	170.414
Total Outflow (ac-ft.):	182.11
Percent Through Underdrain:	93.58

Discharge Structure

Riser Height:	0.5 ft.
Riser Diameter:	18 in.

Element Flows To:

Outlet 1	Outlet 2

Bioretention Hydraulic Table

Stage(feet)	Area(ac.)	Volume(ac-ft.)	Discharge(cfs)	Infilt(cfs)
0.0000	0.0488	0.0000	0.0000	0.0000
0.0385	0.0488	0.0003	0.0000	0.0000
0.0769	0.0482	0.0006	0.0000	0.0000
0.1154	0.0476	0.0009	0.0000	0.0000
0.1538	0.0470	0.0012	0.0000	0.0000
0.1923	0.0465	0.0015	0.0000	0.0000
0.2308	0.0459	0.0018	0.0000	0.0000
0.2692	0.0453	0.0022	0.0002	0.0000
0.3077	0.0448	0.0025	0.0002	0.0000
0.3462	0.0442	0.0029	0.0004	0.0000
0.3846	0.0436	0.0032	0.0006	0.0000
0.4231	0.0431	0.0036	0.0008	0.0000
0.4615	0.0425	0.0039	0.0011	0.0000
0.5000	0.0420	0.0043	0.0015	0.0000
0.5385	0.0414	0.0047	0.0019	0.0000
0.5769	0.0409	0.0051	0.0023	0.0000
0.6154	0.0403	0.0055	0.0029	0.0000
0.6538	0.0398	0.0059	0.0035	0.0000
0.6923	0.0392	0.0063	0.0042	0.0000
0.7308	0.0387	0.0068	0.0049	0.0000
0.7692	0.0382	0.0072	0.0057	0.0000
0.8077	0.0376	0.0076	0.0066	0.0000
0.8462	0.0371	0.0081	0.0076	0.0000
0.8846	0.0366	0.0086	0.0087	0.0000
0.9231	0.0360	0.0090	0.0098	0.0000
0.9615	0.0355	0.0095	0.0110	0.0000
1.0000	0.0350	0.0100	0.0124	0.0000
1.0385	0.0345	0.0105	0.0138	0.0000
1.0769	0.0339	0.0110	0.0153	0.0000
1.1154	0.0334	0.0115	0.0169	0.0000
1.1538	0.0329	0.0120	0.0184	0.0000

1.1923	0.0324	0.0126	0.0186	0.0000
1.2308	0.0319	0.0131	0.0204	0.0000
1.2692	0.0314	0.0136	0.0223	0.0000
1.3077	0.0309	0.0142	0.0243	0.0000
1.3462	0.0304	0.0148	0.0264	0.0000
1.3846	0.0299	0.0153	0.0286	0.0000
1.4231	0.0294	0.0159	0.0309	0.0000
1.4615	0.0289	0.0165	0.0321	0.0000
1.5000	0.0284	0.0171	0.0333	0.0000
1.5385	0.0279	0.0176	0.0359	0.0000
1.5769	0.0274	0.0182	0.0385	0.0000
1.6154	0.0269	0.0187	0.0413	0.0000
1.6538	0.0265	0.0193	0.0441	0.0000
1.6923	0.0260	0.0199	0.0471	0.0000
1.7308	0.0255	0.0205	0.0486	0.0000
1.7692	0.0250	0.0211	0.0486	0.0000
1.8077	0.0246	0.0217	0.0486	0.0000
1.8462	0.0241	0.0224	0.0486	0.0000
1.8846	0.0236	0.0230	0.0486	0.0000
1.9231	0.0232	0.0236	0.0486	0.0000
1.9615	0.0227	0.0243	0.0486	0.0000
2.0000	0.0222	0.0249	0.0486	0.0000
2.0385	0.0218	0.0256	0.0486	0.0000
2.0769	0.0213	0.0263	0.0486	0.0000
2.1154	0.0209	0.0269	0.0486	0.0000
2.1538	0.0204	0.0276	0.0486	0.0000
2.1923	0.0200	0.0283	0.0486	0.0000
2.2308	0.0195	0.0291	0.0486	0.0000
2.2692	0.0191	0.0298	0.0486	0.0000
2.3077	0.0187	0.0305	0.0486	0.0000
2.3462	0.0182	0.0312	0.0486	0.0000
2.3846	0.0178	0.0320	0.0486	0.0000
2.4231	0.0174	0.0327	0.0486	0.0000
2.4615	0.0169	0.0335	0.0486	0.0000
2.5000	0.0165	0.0343	0.0486	0.0000
2.5000	0.0161	0.0343	0.0486	0.0000

Bioretention Hydraulic Table

Stage(feet)	**Area(ac.)**	**Volume(ac-ft.)**	**Discharge(cfs)**	**To Amended(cfs)**	**Infilt(cfs)**
2.5000	0.0488	0.0343	0.0000	0.1994	0.0000
2.5385	0.0494	0.0362	0.0000	0.1994	0.0000
2.5769	0.0500	0.0381	0.0000	0.2044	0.0000
2.6154	0.0505	0.0400	0.0000	0.2094	0.0000
2.6538	0.0511	0.0420	0.0000	0.2144	0.0000
2.6923	0.0517	0.0439	0.0000	0.2194	0.0000
2.7308	0.0523	0.0459	0.0000	0.2244	0.0000
2.7692	0.0529	0.0480	0.0000	0.2293	0.0000
2.8077	0.0535	0.0500	0.0000	0.2343	0.0000
2.8462	0.0541	0.0521	0.0000	0.2393	0.0000
2.8846	0.0547	0.0542	0.0000	0.2443	0.0000
2.9231	0.0553	0.0563	0.0000	0.2493	0.0000
2.9615	0.0560	0.0584	0.0000	0.2543	0.0000
3.0000	0.0566	0.0606	0.0000	0.2593	0.0000
3.0385	0.0572	0.0628	0.1200	0.2642	0.0000
3.0769	0.0578	0.0650	0.3391	0.2692	0.0000
3.1154	0.0584	0.0672	0.6219	0.2742	0.0000
3.1538	0.0590	0.0695	0.9542	0.2792	0.0000
3.1923	0.0597	0.0718	1.3261	0.2842	0.0000

3.2308	0.0603	0.0741	1.7286	0.2892	0.0000
3.2692	0.0609	0.0764	2.1526	0.2942	0.0000
3.3077	0.0616	0.0788	2.5891	0.2991	0.0000
3.3462	0.0622	0.0811	3.0289	0.3041	0.0000
3.3846	0.0628	0.0836	3.4625	0.3091	0.0000
3.4231	0.0635	0.0860	3.8809	0.3141	0.0000
3.4615	0.0641	0.0884	4.2756	0.3191	0.0000
3.5000	0.0648	0.0909	4.6391	0.3241	0.0000

Surface etention 2A

Element Flows To:

Outlet 1	Outlet 2
	Bioretention 2A

Bioretention 1

Bottom Length: 25.00 ft.
Bottom Width: 17.00 ft.
Material thickness of first layer: 1.5
Material type for first layer: SMMWW 12 in/hr
Material thickness of second layer: 1
Material type for second layer: GRAVEL
Material thickness of third layer: 0
Material type for third layer: GRAVEL
Underdrain used
Underdrain Diameter (feet): 0.5
Orifice Diameter (in.): 6
Offset (in.): 1
Flow Through Underdrain (ac-ft.): 114.05
Total Outflow (ac-ft.): 121.753
Percent Through Underdrain: 93.67
Discharge Structure
Riser Height: 0.5 ft.
Riser Diameter: 18 in.
Element Flows To:
Outlet 1 Outlet 2

Bioretention Hydraulic Table

Stage(feet)	**Area(ac.)**	**Volume(ac-ft.)**	**Discharge(cfs)**	**Infilt(cfs)**
0.0000	0.0294	0.0000	0.0000	0.0000
0.0385	0.0294	0.0002	0.0000	0.0000
0.0769	0.0290	0.0004	0.0000	0.0000
0.1154	0.0286	0.0005	0.0000	0.0000
0.1538	0.0283	0.0007	0.0000	0.0000
0.1923	0.0279	0.0009	0.0000	0.0000
0.2308	0.0275	0.0011	0.0000	0.0000
0.2692	0.0271	0.0013	0.0001	0.0000
0.3077	0.0268	0.0015	0.0001	0.0000
0.3462	0.0264	0.0017	0.0002	0.0000
0.3846	0.0261	0.0019	0.0004	0.0000
0.4231	0.0257	0.0021	0.0005	0.0000
0.4615	0.0253	0.0024	0.0007	0.0000
0.5000	0.0250	0.0026	0.0009	0.0000
0.5385	0.0246	0.0028	0.0011	0.0000
0.5769	0.0243	0.0030	0.0014	0.0000
0.6154	0.0239	0.0033	0.0017	0.0000
0.6538	0.0236	0.0035	0.0021	0.0000
0.6923	0.0233	0.0038	0.0025	0.0000
0.7308	0.0229	0.0040	0.0030	0.0000
0.7692	0.0226	0.0043	0.0035	0.0000
0.8077	0.0222	0.0045	0.0040	0.0000
0.8462	0.0219	0.0048	0.0046	0.0000
0.8846	0.0216	0.0051	0.0053	0.0000
0.9231	0.0213	0.0053	0.0060	0.0000
0.9615	0.0209	0.0056	0.0067	0.0000
1.0000	0.0206	0.0059	0.0075	0.0000
1.0385	0.0203	0.0062	0.0084	0.0000
1.0769	0.0200	0.0065	0.0093	0.0000
1.1154	0.0197	0.0068	0.0103	0.0000
1.1538	0.0194	0.0071	0.0112	0.0000

1.1923	0.0190	0.0074	0.0113	0.0000
1.2308	0.0187	0.0077	0.0124	0.0000
1.2692	0.0184	0.0081	0.0135	0.0000
1.3077	0.0181	0.0084	0.0147	0.0000
1.3462	0.0178	0.0087	0.0160	0.0000
1.3846	0.0175	0.0090	0.0174	0.0000
1.4231	0.0172	0.0094	0.0188	0.0000
1.4615	0.0169	0.0097	0.0195	0.0000
1.5000	0.0167	0.0101	0.0202	0.0000
1.5385	0.0164	0.0104	0.0218	0.0000
1.5769	0.0161	0.0107	0.0234	0.0000
1.6154	0.0158	0.0111	0.0251	0.0000
1.6538	0.0155	0.0114	0.0268	0.0000
1.6923	0.0152	0.0117	0.0286	0.0000
1.7308	0.0150	0.0121	0.0295	0.0000
1.7692	0.0147	0.0125	0.0295	0.0000
1.8077	0.0144	0.0128	0.0295	0.0000
1.8462	0.0142	0.0132	0.0295	0.0000
1.8846	0.0139	0.0136	0.0295	0.0000
1.9231	0.0136	0.0139	0.0295	0.0000
1.9615	0.0134	0.0143	0.0295	0.0000
2.0000	0.0131	0.0147	0.0295	0.0000
2.0385	0.0129	0.0151	0.0295	0.0000
2.0769	0.0126	0.0155	0.0295	0.0000
2.1154	0.0124	0.0159	0.0295	0.0000
2.1538	0.0121	0.0163	0.0295	0.0000
2.1923	0.0119	0.0168	0.0295	0.0000
2.2308	0.0116	0.0172	0.0295	0.0000
2.2692	0.0114	0.0176	0.0295	0.0000
2.3077	0.0111	0.0180	0.0295	0.0000
2.3462	0.0109	0.0185	0.0295	0.0000
2.3846	0.0107	0.0189	0.0295	0.0000
2.4231	0.0104	0.0194	0.0295	0.0000
2.4615	0.0102	0.0198	0.0295	0.0000
2.5000	0.0100	0.0203	0.0295	0.0000
2.5000	0.0098	0.0203	0.0295	0.0000

Bioretention Hydraulic Table

Stage(feet)	Area(ac.)	Volume(ac-ft.)	Discharge(cfs)	To Amended(cfs)	Infilt(cfs)
2.5000	0.0294	0.0203	0.0000	0.1211	0.0000
2.5385	0.0298	0.0215	0.0000	0.1211	0.0000
2.5769	0.0302	0.0226	0.0000	0.1241	0.0000
2.6154	0.0305	0.0238	0.0000	0.1271	0.0000
2.6538	0.0309	0.0250	0.0000	0.1302	0.0000
2.6923	0.0313	0.0261	0.0000	0.1332	0.0000
2.7308	0.0317	0.0274	0.0000	0.1362	0.0000
2.7692	0.0321	0.0286	0.0000	0.1392	0.0000
2.8077	0.0325	0.0298	0.0000	0.1423	0.0000
2.8462	0.0329	0.0311	0.0000	0.1453	0.0000
2.8846	0.0333	0.0324	0.0000	0.1483	0.0000
2.9231	0.0337	0.0337	0.0000	0.1514	0.0000
2.9615	0.0341	0.0350	0.0000	0.1544	0.0000
3.0000	0.0346	0.0363	0.0000	0.1574	0.0000
3.0385	0.0350	0.0376	0.1200	0.1604	0.0000
3.0769	0.0354	0.0390	0.3391	0.1635	0.0000
3.1154	0.0358	0.0403	0.6219	0.1665	0.0000
3.1538	0.0362	0.0417	0.9542	0.1695	0.0000
3.1923	0.0366	0.0431	1.3261	0.1725	0.0000

3.2308	0.0371	0.0445	1.7286	0.1756	0.0000
3.2692	0.0375	0.0460	2.1526	0.1786	0.0000
3.3077	0.0379	0.0474	2.5891	0.1816	0.0000
3.3462	0.0384	0.0489	3.0289	0.1847	0.0000
3.3846	0.0388	0.0504	3.4625	0.1877	0.0000
3.4231	0.0392	0.0519	3.8809	0.1907	0.0000
3.4615	0.0397	0.0534	4.2756	0.1937	0.0000
3.5000	0.0401	0.0549	4.6391	0.1968	0.0000

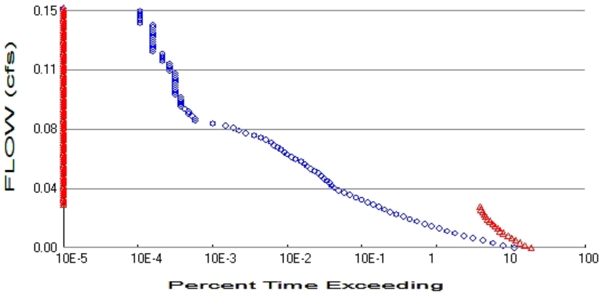
Surface retention 1

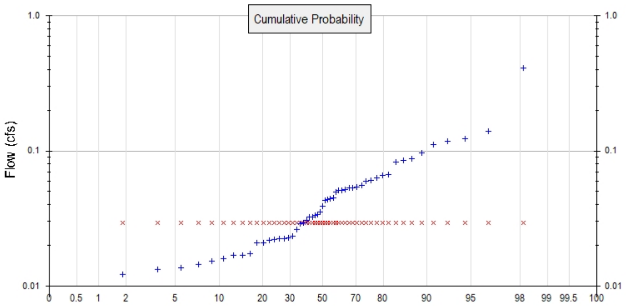
Element Flows To:

Outlet 1	Outlet 2
	Bioretention 1

Analysis Results

POC 1





+ Predeveloped   x Mitigated

Predeveloped Landuse Totals for POC #1
Total Pervious Area: 0.903
Total Impervious Area: 0

Mitigated Landuse Totals for POC #1
Total Pervious Area: 0.2
Total Impervious Area: 0.65

Flow Frequency Method: Log Pearson Type III 17B

Flow Frequency Return Periods for Predeveloped. POC #1

Return Period	**Flow(cfs)**
2 year	0.042041
5 year	0.080886
10 year	0.105184
25 year	0.131948
50 year	0.148763
100 year	0.163072

Flow Frequency Return Periods for Mitigated. POC #1

Return Period	**Flow(cfs)**
2 year	0.029514
5 year	0.029514
10 year	0.029514
25 year	0.029514
50 year	0.029514
100 year	0.029514

Annual Peaks

Annual Peaks for Predeveloped and Mitigated. POC #1

Year	**Predeveloped**	**Mitigated**
1956	0.066	0.030
1957	0.051	0.030
1958	0.060	0.030
1959	0.034	0.030
1960	0.063	0.030
1961	0.065	0.030
1962	0.124	0.030
1963	0.083	0.030
1964	0.044	0.030
1965	0.033	0.030

1966	0.022	0.030
1967	0.022	0.030
1968	0.014	0.030
1969	0.023	0.030
1970	0.022	0.030
1971	0.053	0.030
1972	0.043	0.030
1973	0.029	0.030
1974	0.045	0.030
1975	0.140	0.030
1976	0.088	0.030
1977	0.015	0.030
1978	0.118	0.030
1979	0.029	0.030
1980	0.024	0.030
1981	0.026	0.030
1982	0.053	0.030
1983	0.032	0.030
1984	0.054	0.030
1985	0.014	0.030
1986	0.096	0.030
1987	0.032	0.030
1988	0.022	0.030
1989	0.013	0.030
1990	0.060	0.030
1991	0.035	0.030
1992	0.017	0.030
1993	0.017	0.030
1994	0.017	0.030
1995	0.051	0.030
1996	0.085	0.030
1997	0.031	0.030
1998	0.049	0.030
1999	0.021	0.030
2000	0.021	0.030
2001	0.000	0.030
2002	0.112	0.030
2003	0.012	0.030
2004	0.016	0.030
2005	0.408	0.030
2006	0.039	0.030
2007	0.044	0.030
2008	0.052	0.030
2009	0.056	0.030

Ranked Annual Peaks

Ranked Annual Peaks for Predeveloped and Mitigated. POC #1

Rank	**Predeveloped**	**Mitigated**
1	0.4083	0.0295
2	0.1401	0.0295
3	0.1236	0.0295
4	0.1176	0.0295
5	0.1117	0.0295
6	0.0964	0.0295
7	0.0877	0.0295
8	0.0850	0.0295
9	0.0829	0.0295
10	0.0664	0.0295

11	0.0655	0.0295
12	0.0634	0.0295
13	0.0605	0.0295
14	0.0596	0.0295
15	0.0558	0.0295
16	0.0539	0.0295
17	0.0530	0.0295
18	0.0529	0.0295
19	0.0521	0.0295
20	0.0511	0.0295
21	0.0508	0.0295
22	0.0493	0.0295
23	0.0451	0.0295
24	0.0443	0.0295
25	0.0437	0.0295
26	0.0429	0.0295
27	0.0392	0.0295
28	0.0352	0.0295
29	0.0340	0.0295
30	0.0333	0.0295
31	0.0324	0.0295
32	0.0324	0.0295
33	0.0308	0.0295
34	0.0294	0.0295
35	0.0290	0.0295
36	0.0262	0.0295
37	0.0235	0.0295
38	0.0228	0.0295
39	0.0224	0.0295
40	0.0223	0.0295
41	0.0221	0.0295
42	0.0217	0.0295
43	0.0209	0.0295
44	0.0207	0.0295
45	0.0174	0.0295
46	0.0168	0.0295
47	0.0168	0.0295
48	0.0160	0.0295
49	0.0152	0.0295
50	0.0144	0.0295
51	0.0136	0.0295
52	0.0133	0.0295
53	0.0123	0.0295
54	0.0004	0.0295

Duration Flows

Flow(cfs)	Predev	Mit	Percentage	Pass/Fail
0.0034	208475	353517	169	Fail
0.0048	147390	291032	197	Fail
0.0063	108176	248238	229	Fail
0.0078	79148	216806	273	Fail
0.0092	58774	192948	328	Fail
0.0107	44119	173388	393	Fail
0.0122	33723	148072	439	Fail
0.0136	26168	135064	516	Fail
0.0151	20620	124441	603	Fail
0.0166	16294	115390	708	Fail
0.0181	13111	107665	821	Fail
0.0195	10333	98462	952	Fail
0.0210	8311	91002	1094	Fail
0.0225	6769	86438	1276	Fail
0.0239	5485	82481	1503	Fail
0.0254	4556	78940	1732	Fail
0.0269	3834	75702	1974	Fail
0.0283	3234	72427	2239	Fail
0.0298	2693	0	0	Pass
0.0313	2268	0	0	Pass
0.0327	1863	0	0	Pass
0.0342	1566	0	0	Pass
0.0357	1294	0	0	Pass
0.0371	1088	0	0	Pass
0.0386	920	0	0	Pass
0.0401	804	0	0	Pass
0.0415	758	0	0	Pass
0.0430	700	0	0	Pass
0.0445	639	0	0	Pass
0.0460	591	0	0	Pass
0.0474	539	0	0	Pass
0.0489	492	0	0	Pass
0.0504	439	0	0	Pass
0.0518	387	0	0	Pass
0.0533	352	0	0	Pass
0.0548	326	0	0	Pass
0.0562	290	0	0	Pass
0.0577	244	0	0	Pass
0.0592	216	0	0	Pass
0.0606	187	0	0	Pass
0.0621	172	0	0	Pass
0.0636	155	0	0	Pass
0.0650	141	0	0	Pass
0.0665	125	0	0	Pass
0.0680	115	0	0	Pass
0.0695	98	0	0	Pass
0.0709	84	0	0	Pass
0.0724	68	0	0	Pass
0.0739	53	0	0	Pass
0.0753	43	0	0	Pass
0.0768	36	0	0	Pass
0.0783	28	0	0	Pass
0.0797	19	0	0	Pass
0.0812	11	0	0	Pass

0.0827	11	0	0	Pass
0.0841	10	0	0	Pass
0.0856	9	0	0	Pass
0.0871	9	0	0	Pass
0.0885	8	0	0	Pass
0.0900	7	0	0	Pass
0.0915	7	0	0	Pass
0.0930	7	0	0	Pass
0.0944	7	0	0	Pass
0.0959	7	0	0	Pass
0.0974	6	0	0	Pass
0.0988	6	0	0	Pass
0.1003	6	0	0	Pass
0.1018	6	0	0	Pass
0.1032	6	0	0	Pass
0.1047	6	0	0	Pass
0.1062	6	0	0	Pass
0.1076	6	0	0	Pass
0.1091	6	0	0	Pass
0.1106	6	0	0	Pass
0.1120	5	0	0	Pass
0.1135	5	0	0	Pass
0.1150	5	0	0	Pass
0.1165	5	0	0	Pass
0.1179	4	0	0	Pass
0.1194	4	0	0	Pass
0.1209	4	0	0	Pass
0.1223	4	0	0	Pass
0.1238	3	0	0	Pass
0.1253	3	0	0	Pass
0.1267	3	0	0	Pass
0.1282	3	0	0	Pass
0.1297	3	0	0	Pass
0.1311	3	0	0	Pass
0.1326	3	0	0	Pass
0.1341	3	0	0	Pass
0.1355	3	0	0	Pass
0.1370	3	0	0	Pass
0.1385	3	0	0	Pass
0.1400	3	0	0	Pass
0.1414	2	0	0	Pass
0.1429	2	0	0	Pass
0.1444	2	0	0	Pass
0.1458	2	0	0	Pass
0.1473	2	0	0	Pass
0.1488	2	0	0	Pass

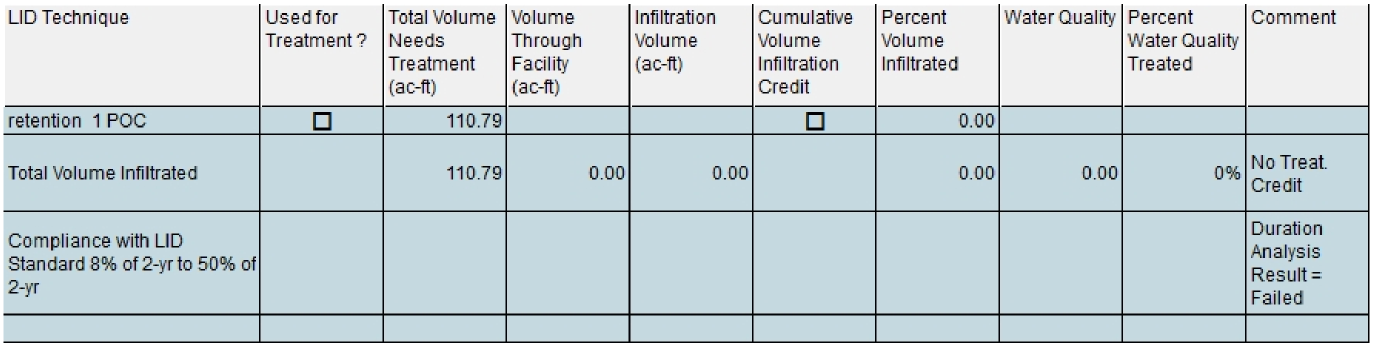
The development has an increase in flow durations from 1/2 Predeveloped 2 year flow to the 2 year flow or more than a 10% increase from the 2 year to the 50 year flow.

Water Quality

Water Quality BMP Flow and Volume for POC #1

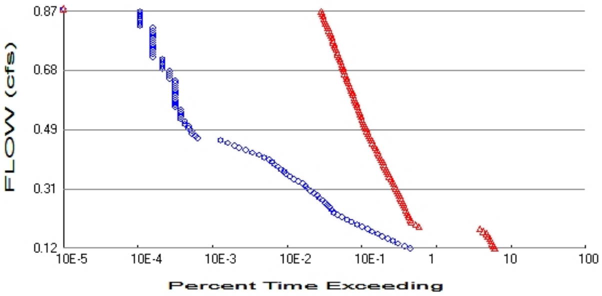
On-line facility volume:	0.0878 acre-feet
On-line facility target flow:	0.1119 cfs.
Adjusted for 15 min:	0.1119 cfs.
Off-line facility target flow:	0.0616 cfs.
Adjusted for 15 min:	0.0616 cfs.

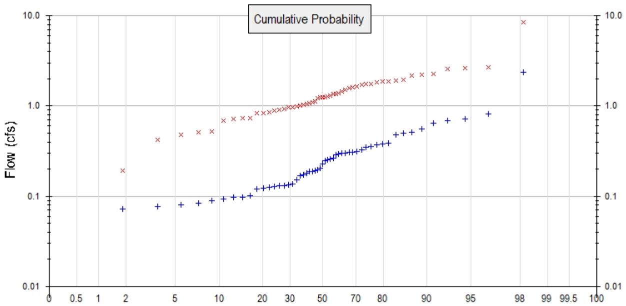
LID Report



LID Technique	Used for Treatment ?	Total Volume Needs Treatment (ac-ft)	Volume Through Facility (ac-ft)	Infiltration Volume (ac-ft)	Cumulative Volume Infiltration Credit	Percent Volume Infiltrated	Water Quality	Percent Water Quality Treated	Comment
retention 1 POC	☐	110.79			☐	0.00			
Total Volume Infiltrated		110.79	0.00	0.00		0.00	0.00	0%	No Treat. Credit
Compliance with LID Standard 8% of 2-yr to 50% of 2-yr									Duration Analysis Result = Failed

POC 2





+ Predeveloped x Mitigated

Predeveloped Landuse Totals for POC #2
Total Pervious Area: 5.26
Total Impervious Area: 0

Mitigated Landuse Totals for POC #2
Total Pervious Area: 0.69
Total Impervious Area: 4.57

Flow Frequency Method: Log Pearson Type III 17B

Flow Frequency Return Periods for Predeveloped. POC #2

Return Period	**Flow(cfs)**
2 year	0.244892
5 year	0.471165
10 year	0.612698
25 year	0.768602
50 year	0.866549
100 year	0.949897

Flow Frequency Return Periods for Mitigated. POC #2

Return Period	**Flow(cfs)**
2 year	1.213208
5 year	2.002413
10 year	2.557897
25 year	3.279364
50 year	3.824241
100 year	4.37161

Annual Peaks

Annual Peaks for Predeveloped and Mitigated. POC #2

Year	**Predeveloped**	**Mitigated**
1956	0.387	1.745
1957	0.298	1.909
1958	0.352	1.856
1959	0.198	1.272
1960	0.370	1.883
1961	0.381	1.504
1962	0.720	1.637
1963	0.483	2.575
1964	0.258	1.241
1965	0.194	1.002
1966	0.126	0.481

1967	0.130	0.997
1968	0.084	0.854
1969	0.133	0.683
1970	0.130	0.964
1971	0.309	1.130
1972	0.250	1.029
1973	0.169	1.059
1974	0.263	1.356
1975	0.816	2.658
1976	0.511	1.394
1977	0.089	0.834
1978	0.685	1.736
1979	0.171	0.975
1980	0.137	0.738
1981	0.153	1.101
1982	0.308	1.446
1983	0.189	1.588
1984	0.314	1.361
1985	0.079	0.729
1986	0.561	1.933
1987	0.189	1.626
1988	0.129	0.425
1989	0.077	0.193
1990	0.347	1.236
1991	0.205	0.715
1992	0.098	0.514
1993	0.098	0.928
1994	0.101	0.837
1995	0.296	2.235
1996	0.495	2.279
1997	0.179	1.084
1998	0.287	2.624
1999	0.122	0.913
2000	0.121	1.306
2001	0.002	0.188
2002	0.651	2.165
2003	0.071	0.893
2004	0.093	0.523
2005	2.378	8.515
2006	0.228	1.233
2007	0.255	1.831
2008	0.303	1.246
2009	0.325	1.743

Ranked Annual Peaks

Ranked Annual Peaks for Predeveloped and Mitigated. POC #2

Rank	Predeveloped	Mitigated
1	2.3783	8.5146
2	0.8158	2.6578
3	0.7202	2.6238
4	0.6848	2.5752
5	0.6505	2.2794
6	0.5613	2.2348
7	0.5111	2.1649
8	0.4953	1.9333
9	0.4827	1.9089
10	0.3866	1.8826
11	0.3815	1.8559

12	0.3695	1.8312
13	0.3523	1.7449
14	0.3474	1.7433
15	0.3249	1.7357
16	0.3138	1.6367
17	0.3087	1.6259
18	0.3081	1.5880
19	0.3033	1.5037
20	0.2979	1.4465
21	0.2961	1.3942
22	0.2873	1.3614
23	0.2627	1.3564
24	0.2583	1.3064
25	0.2546	1.2723
26	0.2496	1.2461
27	0.2281	1.2414
28	0.2053	1.2360
29	0.1979	1.2332
30	0.1938	1.1303
31	0.1886	1.1011
32	0.1885	1.0843
33	0.1794	1.0587
34	0.1712	1.0287
35	0.1690	1.0019
36	0.1527	0.9967
37	0.1370	0.9749
38	0.1330	0.9641
39	0.1304	0.9284
40	0.1298	0.9126
41	0.1287	0.8926
42	0.1262	0.8538
43	0.1218	0.8365
44	0.1207	0.8341
45	0.1015	0.7379
46	0.0979	0.7293
47	0.0976	0.7149
48	0.0931	0.6830
49	0.0887	0.5230
50	0.0840	0.5142
51	0.0794	0.4806
52	0.0775	0.4251
53	0.0714	0.1932
54	0.0022	0.1875

Duration Flows

Flow(cfs)	Predev	Mit	Percentage	Pass/Fail
0.1224	8350	113724	1361	Fail
0.1300	7050	109653	1555	Fail
0.1375	5804	105620	1819	Fail
0.1450	4921	102136	2075	Fail
0.1525	4194	98216	2341	Fail
0.1600	3583	93085	2597	Fail
0.1675	3107	88199	2838	Fail
0.1751	2613	80114	3065	Fail
0.1826	2274	71593	3148	Fail
0.1901	1891	10994	581	Fail
0.1976	1638	9911	605	Fail
0.2051	1379	8792	637	Fail
0.2126	1190	8460	710	Fail
0.2202	1018	8110	796	Fail
0.2277	881	7850	891	Fail
0.2352	793	7599	958	Fail
0.2427	758	7368	972	Fail
0.2502	701	7099	1012	Fail
0.2577	653	6909	1058	Fail
0.2653	607	6686	1101	Fail
0.2728	565	6493	1149	Fail
0.2803	517	6243	1207	Fail
0.2878	482	6063	1257	Fail
0.2953	432	5821	1347	Fail
0.3028	387	5612	1450	Fail
0.3104	353	5402	1530	Fail
0.3179	332	5218	1571	Fail
0.3254	304	5031	1654	Fail
0.3329	268	4863	1814	Fail
0.3404	231	4628	2003	Fail
0.3479	206	4454	2162	Fail
0.3554	182	4298	2361	Fail
0.3630	172	4147	2411	Fail
0.3705	155	3992	2575	Fail
0.3780	143	3872	2707	Fail
0.3855	129	3730	2891	Fail
0.3930	118	3590	3042	Fail
0.4005	108	3465	3208	Fail
0.4081	93	3338	3589	Fail
0.4156	80	3227	4033	Fail
0.4231	65	3103	4773	Fail
0.4306	53	2997	5654	Fail
0.4381	43	2871	6676	Fail
0.4456	37	2770	7486	Fail
0.4532	30	2655	8850	Fail
0.4607	24	2552	10633	Fail
0.4682	12	2452	20433	Fail
0.4757	11	2361	21463	Fail
0.4832	10	2284	22840	Fail
0.4907	10	2212	22120	Fail
0.4983	9	2147	23855	Fail
0.5058	9	2083	23144	Fail
0.5133	8	2015	25187	Fail
0.5208	8	1964	24550	Fail

0.5283	7	1897	27100	Fail
0.5358	7	1846	26371	Fail
0.5434	7	1795	25642	Fail
0.5509	7	1758	25114	Fail
0.5584	7	1701	24300	Fail
0.5659	6	1658	27633	Fail
0.5734	6	1615	26916	Fail
0.5809	6	1573	26216	Fail
0.5884	6	1529	25483	Fail
0.5960	6	1483	24716	Fail
0.6035	6	1442	24033	Fail
0.6110	6	1414	23566	Fail
0.6185	6	1377	22950	Fail
0.6260	6	1335	22250	Fail
0.6335	6	1288	21466	Fail
0.6411	6	1252	20866	Fail
0.6486	6	1215	20250	Fail
0.6561	5	1184	23680	Fail
0.6636	5	1165	23300	Fail
0.6711	5	1115	22300	Fail
0.6786	5	1092	21840	Fail
0.6862	4	1063	26575	Fail
0.6937	4	1040	26000	Fail
0.7012	4	1013	25325	Fail
0.7087	4	987	24675	Fail
0.7162	4	959	23975	Fail
0.7237	3	932	31066	Fail
0.7313	3	897	29900	Fail
0.7388	3	882	29400	Fail
0.7463	3	853	28433	Fail
0.7538	3	829	27633	Fail
0.7613	3	805	26833	Fail
0.7688	3	792	26400	Fail
0.7764	3	773	25766	Fail
0.7839	3	752	25066	Fail
0.7914	3	731	24366	Fail
0.7989	3	710	23666	Fail
0.8064	3	684	22800	Fail
0.8139	3	665	22166	Fail
0.8215	2	648	32400	Fail
0.8290	2	622	31100	Fail
0.8365	2	606	30300	Fail
0.8440	2	587	29350	Fail
0.8515	2	572	28600	Fail
0.8590	2	554	27700	Fail
0.8665	2	542	27100	Fail

The development has an increase in flow durations from 1/2 Predeveloped 2 year flow to the 2 year flow or more than a 10% increase from the 2 year to the 50 year flow.
The development has an increase in flow durations for more than 50% of the flows for the range of the duration analysis.

Water Quality

Water Quality BMP Flow and Volume for POC #2

On-line facility volume:	0.6021 acre-feet
On-line facility target flow:	0.8027 cfs.
Adjusted for 15 min:	0.8027 cfs.
Off-line facility target flow:	0.4411 cfs.
Adjusted for 15 min:	0.4411 cfs.

LID Report

LID Technique	Used for Treatment ?	Total Volume Needs Treatment (ac-ft)	Volume Through Facility (ac-ft)	Infiltration Volume (ac-ft)	Cumulative Volume Infiltration Credit	Percent Volume Infiltrated	Water Quality	Percent Water Quality Treated	Comment
etention 2B POC	☐	553.95			☐	0.00			
etention 2A POC	☐	165.72			☐	0.00			
Total Volume Infiltrated		719.67	0.00	0.00		0.00	0.00	0%	No Treat. Credit
Compliance with LID Standard 8% of 2-yr to 50% of 2-yr									Duration Analysis Result = Failed

POC 3

POC #3 was not reported because POC must exist in both scenarios and both scenarios must have been run.

Model Default Modifications

Total of 0 changes have been made.

PERLND Changes

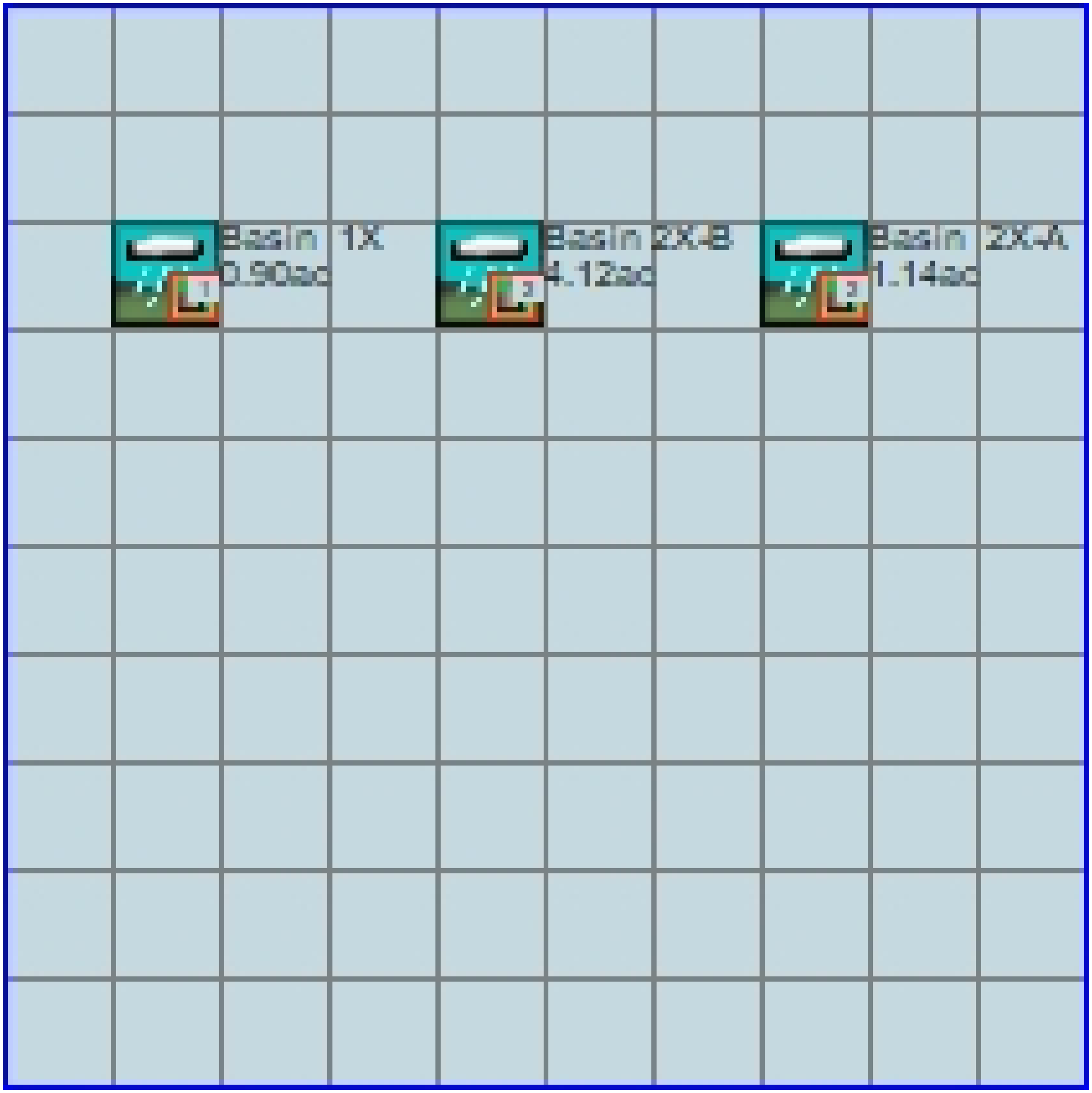
No PERLND changes have been made.

IMPLND Changes

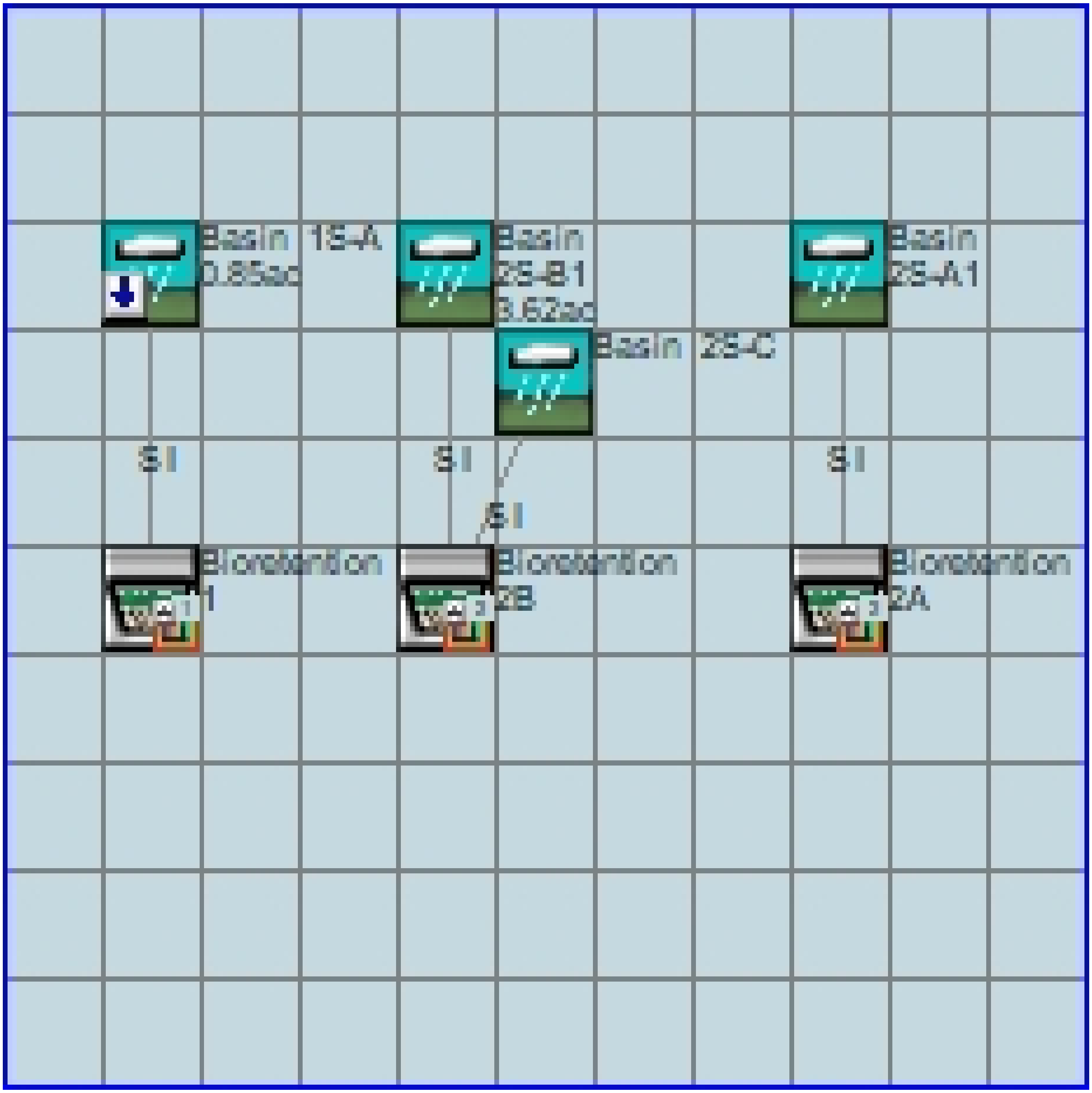
No IMPLND changes have been made.

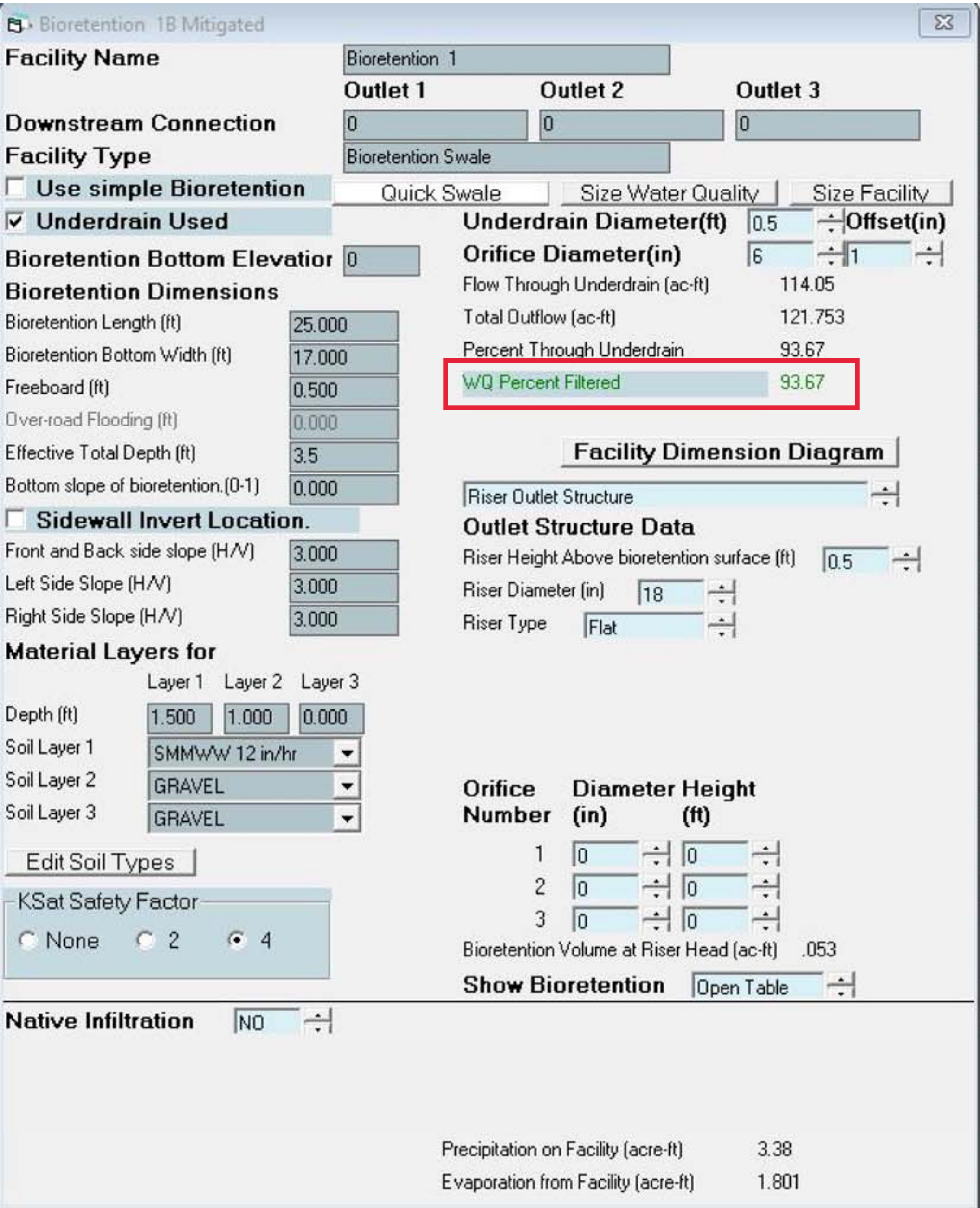
Appendix

Predeveloped Schematic



Mitigated Schematic





Facility Name	Bioretention 1		
	Outlet 1	**Outlet 2**	**Outlet 3**
Downstream Connection	0	0	0
Facility Type	Bioretention Swale		

☐ **Use simple Bioretention**

☑ **Underdrain Used**

Underdrain Diameter(ft) 0.5 **Offset(in)**

Orifice Diameter(in) 6 1

Bioretention Bottom Elevatior 0

Flow Through Underdrain (ac-ft)	114.05
Total Outflow (ac-ft)	121.753
Percent Through Underdrain	93.67
WQ Percent Filtered	93.67

Bioretention Dimensions

Bioretention Length (ft)	25.000
Bioretention Bottom Width (ft)	17.000
Freeboard (ft)	0.500
Over-road Flooding (ft)	0.000
Effective Total Depth (ft)	3.5
Bottom slope of bioretention.(0-1)	0.000

Riser Outlet Structure

☐ **Sidewall Invert Location.**

Front and Back side slope (H/V)	3.000
Left Side Slope (H/V)	3.000
Right Side Slope (H/V)	3.000

Outlet Structure Data

Riser Height Above bioretention surface (ft)	0.5
Riser Diameter (in)	18
Riser Type	Flat

Material Layers for

	Layer 1	Layer 2	Layer 3
Depth (ft)	1.500	1.000	0.000

Soil Layer 1	SMMWW 12 in/hr
Soil Layer 2	GRAVEL
Soil Layer 3	GRAVEL

KSat Safety Factor

○ None ○ 2 ● 4

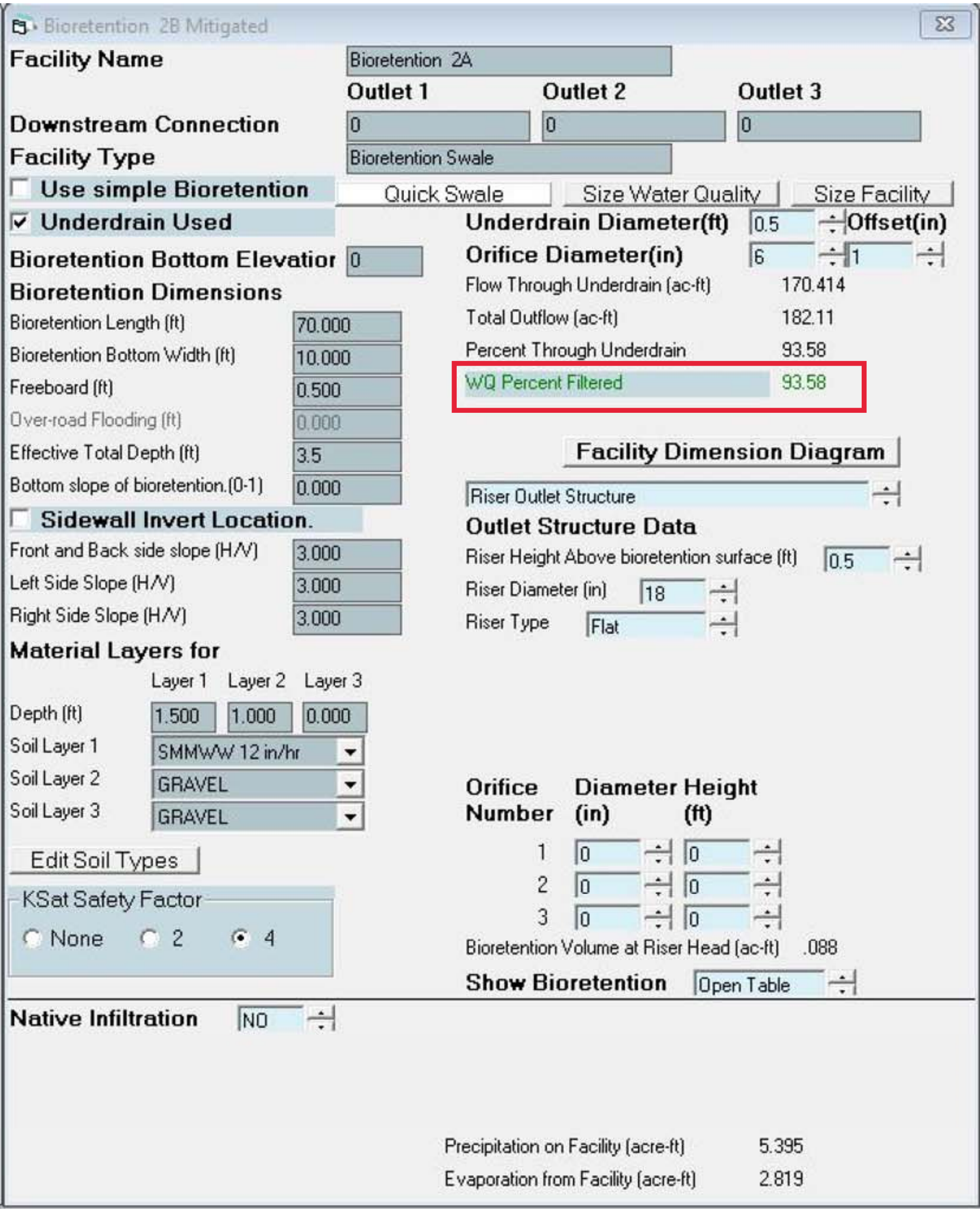
Orifice Number	Diameter (in)	Height (ft)
1	0	0
2	0	0
3	0	0

Bioretention Volume at Riser Head (ac-ft) .053

Show Bioretention Open Table

Native Infiltration NO

Precipitation on Facility (acre-ft)	3.38
Evaporation from Facility (acre-ft)	1.801



Facility Name	Bioretention 2A		
	Outlet 1	**Outlet 2**	**Outlet 3**
Downstream Connection	0	0	0
Facility Type	Bioretention Swale		

☐ **Use simple Bioretention**

☑ **Underdrain Used**

Underdrain Diameter(ft) 0.5 **Offset(in)**

Orifice Diameter(in) 6 1

Bioretention Bottom Elevatior 0

Flow Through Underdrain (ac-ft)	170.414
Total Outflow (ac-ft)	182.11
Percent Through Underdrain	93.58
WQ Percent Filtered	93.58

Bioretention Dimensions

Bioretention Length (ft)	70.000
Bioretention Bottom Width (ft)	10.000
Freeboard (ft)	0.500
Over-road Flooding (ft)	0.000
Effective Total Depth (ft)	3.5
Bottom slope of bioretention.(0-1)	0.000

Riser Outlet Structure

☐ **Sidewall Invert Location.**

Front and Back side slope (H/V)	3.000
Left Side Slope (H/V)	3.000
Right Side Slope (H/V)	3.000

Outlet Structure Data

Riser Height Above bioretention surface (ft)	0.5
Riser Diameter (in)	18
Riser Type	Flat

Material Layers for

	Layer 1	Layer 2	Layer 3
Depth (ft)	1.500	1.000	0.000

Soil Layer 1	SMMWW 12 in/hr
Soil Layer 2	GRAVEL
Soil Layer 3	GRAVEL

KSat Safety Factor

○ None ○ 2 ● 4

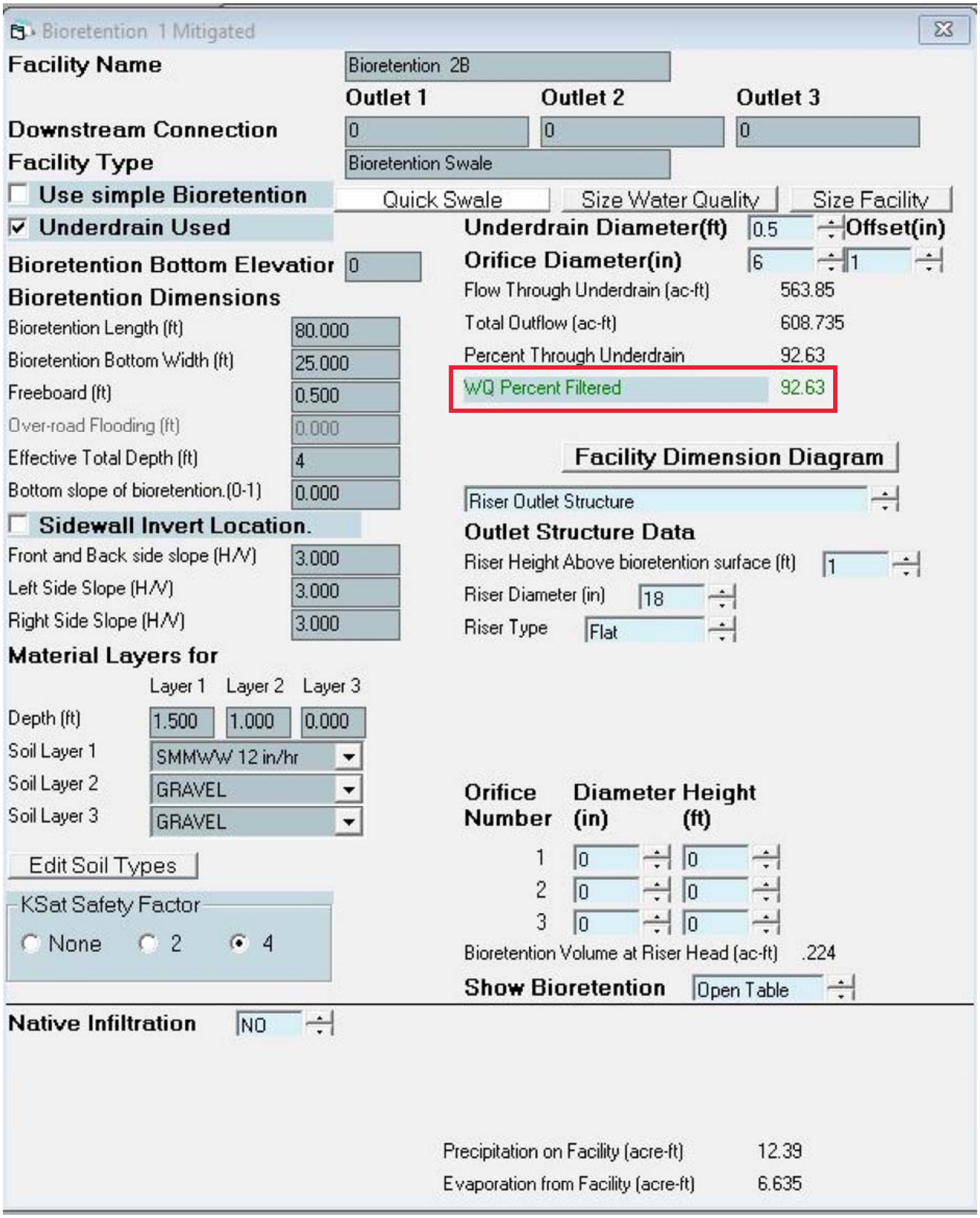
Orifice Number	Diameter (in)	Height (ft)
1	0	0
2	0	0
3	0	0

Bioretention Volume at Riser Head (ac-ft) .088

Show Bioretention Open Table

Native Infiltration NO

Precipitation on Facility (acre-ft)	5.395
Evaporation from Facility (acre-ft)	2.819



Facility Name Bioretention 2B

	Outlet 1	Outlet 2	Outlet 3
Downstream Connection	0	0	0

Facility Type Bioretention Swale

☐ **Use simple Bioretention**

☑ **Underdrain Used**

Underdrain Diameter(ft) 0.5 **Offset(in)**

Orifice Diameter(in) 6 1

Flow Through Underdrain (ac-ft) 563.85

Total Outflow (ac-ft) 608.735

Percent Through Underdrain 92.63

WQ Percent Filtered 92.63

Bioretention Bottom Elevatior 0

Bioretention Dimensions

Bioretention Length (ft) 80.000

Bioretention Bottom Width (ft) 25.000

Freeboard (ft) 0.500

Over-road Flooding (ft) 0.000

Effective Total Depth (ft) 4

Bottom slope of bioretention.(0-1) 0.000

☐ **Sidewall Invert Location.**

Front and Back side slope (H/V) 3.000

Left Side Slope (H/V) 3.000

Right Side Slope (H/V) 3.000

Riser Outlet Structure

Outlet Structure Data

Riser Height Above bioretention surface (ft) 1

Riser Diameter (in) 18

Riser Type Flat

Material Layers for

	Layer 1	Layer 2	Layer 3
Depth (ft)	1.500	1.000	0.000

Soil Layer 1 SMMWW 12 in/hr

Soil Layer 2 GRAVEL

Soil Layer 3 GRAVEL

Orifice Number	**Diameter (in)**	**Height (ft)**
1	0	0
2	0	0
3	0	0

KSat Safety Factor

○ None ○ 2 ● 4

Bioretention Volume at Riser Head (ac-ft) .224

Show Bioretention Open Table

Native Infiltration NO

Precipitation on Facility (acre-ft) 12.39

Evaporation from Facility (acre-ft) 6.635

Predeveloped UCI File

```
RUN

GLOBAL
  WWHM4 model simulation
  START       1955 10 01        END    2009 09 30
  RUN INTERP OUTPUT LEVEL    3    0
  RESUME     0 RUN     1                   UNIT SYSTEM     1
END GLOBAL

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MESSU      25   Pre8344 prelim.MES
           27   Pre8344 prelim.L61
           28   Pre8344 prelim.L62
           31   POC8344 prelim2.dat
           30   POC8344 prelim1.dat
END FILES

OPN SEQUENCE
    INGRP              INDELT 00:15
      PERLND      11
      COPY       502
      COPY       501
      DISPLY       2
      DISPLY       1
    END INGRP
END OPN SEQUENCE
DISPLY
  DISPLY-INFO1
    # -  #<----------Title----------->***TRAN PIVL DIG1 FIL1  PYR DIG2 FIL2 YRND
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    1        Basin  1X                   MAX                     1    2   30    9
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END DISPLY
COPY
  TIMESERIES
    # -  #  NPT  NMN ***
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  502         1    1
  501         1    1
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END COPY
GENER
  OPCODE
    #    # OPCD ***
  END OPCODE
  PARM
    #    #         K ***
  END PARM
END GENER
PERLND
  GEN-INFO
    <PLS ><-------Name------->NBLKS   Unit-systems   Printer ***
    # -  #                          User  t-series Engl Metr ***
                                          in  out           ***
   11     C, Forest, Mod          1    1    1    1   27    0
  END GEN-INFO
  *** Section PWATER***

  ACTIVITY
    <PLS > ************* Active Sections *****************************
    # -  # ATMP SNOW PWAT  SED  PST  PWG PQAL MSTL PEST NITR PHOS TRAC ***
   11         0    0    1    0    0    0    0    0    0    0    0    0
  END ACTIVITY

  PRINT-INFO
```

```
    <PLS > ***************** Print-flags ***************************** PIVL  PYR
    # -  # ATMP SNOW PWAT  SED  PST  PWG PQAL MSTL PEST NITR PHOS TRAC  *********
   11         0    0    4    0    0    0    0    0    0    0    0    0    1    9
  END PRINT-INFO

  PWAT-PARM1
    <PLS >  PWATER variable monthly parameter value flags  ***
    # -  # CSNO RTOP UZFG  VCS  VUZ  VNN VIFW VIRC  VLE INFC  HWT ***
   11         0    0    0    0    0    0    0    0    0    0    0
  END PWAT-PARM1

  PWAT-PARM2
    <PLS >      PWATER input info: Part 2         ***
    # -  # ***FOREST      LZSN    INFILT      LSUR     SLSUR     KVARY     AGWRC
   11             0       4.5      0.08       400       0.1       0.5     0.996
  END PWAT-PARM2

  PWAT-PARM3
    <PLS >      PWATER input info: Part 3         ***
    # -  # ***PETMAX    PETMIN    INFEXP    INFILD    DEEPFR    BASETP    AGWETP
   11             0         0         2         2         0         0         0
  END PWAT-PARM3
  PWAT-PARM4
    <PLS >     PWATER input info: Part 4                               ***
    # -  #     CEPSC      UZSN      NSUR     INTFW       IRC     LZETP ***
   11           0.2       0.5      0.35         6       0.5       0.7
  END PWAT-PARM4

  PWAT-STATE1
    <PLS > *** Initial conditions at start of simulation
              ran from 1990 to end of 1992 (pat 1-11-95) RUN 21 ***
    # -  # ***  CEPS      SURS       UZS      IFWS       LZS      AGWS      GWVS
   11             0         0         0         0       2.5         1         0
  END PWAT-STATE1

END PERLND

IMPLND
  GEN-INFO
    <PLS ><-------Name------->   Unit-systems   Printer ***
    # -  #                    User  t-series Engl Metr ***
                                      in  out           ***
  END GEN-INFO
  *** Section IWATER***

  ACTIVITY
    <PLS > ************* Active Sections *****************************
    # -  # ATMP SNOW IWAT  SLD  IWG IQAL   ***
  END ACTIVITY

  PRINT-INFO
    <ILS > ******** Print-flags ******** PIVL  PYR
    # -  # ATMP SNOW IWAT  SLD  IWG IQAL    *********
  END PRINT-INFO

  IWAT-PARM1
    <PLS >  IWATER variable monthly parameter value flags  ***
    # -  # CSNO RTOP  VRS  VNN RTLI     ***
  END IWAT-PARM1

  IWAT-PARM2
    <PLS >      IWATER input info: Part 2         ***
    # -  # ***  LSUR     SLSUR      NSUR     RETSC
  END IWAT-PARM2

  IWAT-PARM3
    <PLS >      IWATER input info: Part 3         ***
    # -  # ***PETMAX    PETMIN
  END IWAT-PARM3
```

```
  IWAT-STATE1
    <PLS > *** Initial conditions at start of simulation
    # -  # ***  RETS      SURS
  END IWAT-STATE1

END IMPLND

SCHEMATIC
<-Source->                  <--Area-->     <-Target->   MBLK   ***
<Name>   #                  <-factor->     <Name>   #   Tbl#   ***
Basin 2X-B***
PERLND  11                        4.12     COPY   502     12
PERLND  11                        4.12     COPY   502     13
Basin  2X-A***
PERLND  11                        1.14     COPY   502     12
PERLND  11                        1.14     COPY   502     13
Basin  1X***
PERLND  11                       0.903     COPY   501     12
PERLND  11                       0.903     COPY   501     13

******Routing******
END SCHEMATIC

NETWORK
<-Volume-> <-Grp> <-Member-><--Mult-->Tran <-Target vols> <-Grp> <-Member->  ***
<Name>   #        <Name> # #<-factor->strg <Name>   #   #        <Name> # #  ***
COPY   502 OUTPUT MEAN   1 1   48.4        DISPLY   2     INPUT  TIMSER 1
COPY   501 OUTPUT MEAN   1 1   48.4        DISPLY   1     INPUT  TIMSER 1



<-Volume-> <-Grp> <-Member-><--Mult-->Tran <-Target vols> <-Grp> <-Member->  ***
<Name>   #        <Name> # #<-factor->strg <Name>   #   #        <Name> # #  ***
END NETWORK

RCHRES
  GEN-INFO
    RCHRES       Name        Nexits   Unit Systems   Printer                 ***
    # -  #<------------------><---> User T-series  Engl Metr LKFG            ***
                                           in  out                           ***
  END GEN-INFO
  *** Section RCHRES***

  ACTIVITY
    <PLS > ************* Active Sections *****************************
    # -  # HYFG ADFG CNFG HTFG SDFG GQFG OXFG NUFG PKFG PHFG ***
  END ACTIVITY

  PRINT-INFO
    <PLS > ***************** Print-flags ******************* PIVL  PYR
    # -  # HYDR ADCA CONS HEAT  SED  GQL OXRX NUTR PLNK PHCB PIVL  PYR  *********
  END PRINT-INFO

  HYDR-PARM1
    RCHRES  Flags for each HYDR Section                                      ***
    # -  #  VC A1 A2 A3  ODFVFG for each *** ODGTFG for each     FUNCT  for each
            FG FG FG FG  possible  exit  *** possible  exit      possible  exit
             *  *  *  *    *  *  *  *  *       *  *  *  *  *         ***
  END HYDR-PARM1

  HYDR-PARM2
    # -  #    FTABNO       LEN     DELTH     STCOR        KS      DB50       ***
  <------><--------><--------><--------><--------><--------><-------->       ***
  END HYDR-PARM2
  HYDR-INIT
    RCHRES  Initial conditions for each HYDR section                         ***
    # -  # ***   VOL     Initial  value  of COLIND     Initial  value  of OUTDGT
          *** ac-ft     for each possible exit        for each possible exit
  <------><-------->     <---><---><---><---><---> *** <---><---><---><---><--->
  END HYDR-INIT
```

```
END RCHRES

SPEC-ACTIONS
END SPEC-ACTIONS
FTABLES
END FTABLES

EXT SOURCES
<-Volume-> <Member> SsysSgap<--Mult-->Tran <-Target vols> <-Grp> <-Member->  ***
<Name>   # <Name> # tem strg<-factor->strg <Name>   #   #        <Name> # #  ***
WDM      2 PREC     ENGL    1              PERLND   1 999 EXTNL  PREC
WDM      2 PREC     ENGL    1              IMPLND   1 999 EXTNL  PREC
WDM      1 EVAP     ENGL    0.76           PERLND   1 999 EXTNL  PETINP
WDM      1 EVAP     ENGL    0.76           IMPLND   1 999 EXTNL  PETINP

END EXT SOURCES

EXT TARGETS
<-Volume-> <-Grp> <-Member-><--Mult-->Tran <-Volume-> <Member> Tsys Tgap Amd ***
<Name>   #        <Name> # #<-factor->strg <Name>   # <Name>    tem strg strg***
COPY   502 OUTPUT MEAN   1 1     48.4      WDM    502 FLOW     ENGL      REPL
COPY   501 OUTPUT MEAN   1 1     48.4      WDM    501 FLOW     ENGL      REPL
END EXT TARGETS

MASS-LINK
<Volume>   <-Grp> <-Member-><--Mult-->     <Target>       <-Grp> <-Member->***
<Name>            <Name> # #<-factor->     <Name>                <Name> # #***
  MASS-LINK       12
PERLND     PWATER SURO       0.083333      COPY           INPUT  MEAN
  END MASS-LINK   12

  MASS-LINK       13
PERLND     PWATER IFWO       0.083333      COPY           INPUT  MEAN
  END MASS-LINK   13


END MASS-LINK

END RUN
```

Mitigated UCI File

```
RUN

GLOBAL
  WWHM4 model simulation
  START       1955 10 01        END    2009 09 30
  RUN INTERP OUTPUT LEVEL    3    0
  RESUME     0 RUN     1                   UNIT SYSTEM     1
END GLOBAL

FILES
<File>  <Un#>   <-----------File Name------------------------------>***
<-ID->                                                              ***
WDM        26   8344 prelim.wdm
MESSU      25   Mit8344 prelim.MES
           27   Mit8344 prelim.L61
           28   Mit8344 prelim.L62
           31   POC8344 prelim2.dat
           30   POC8344 prelim1.dat
END FILES

OPN SEQUENCE
    INGRP              INDELT 00:15
      PERLND      16
      IMPLND       4
      IMPLND      11
      IMPLND       2
      GENER        2
      RCHRES       1
      RCHRES       2
      GENER        4
      RCHRES       3
      RCHRES       4
      GENER        6
      RCHRES       5
      RCHRES       6
      COPY         2
      COPY       502
      COPY         1
      COPY       501
      DISPLY       2
      DISPLY       1
    END INGRP
END OPN SEQUENCE
DISPLY
  DISPLY-INFO1
    # -  #<----------Title----------->***TRAN PIVL DIG1 FIL1  PYR DIG2 FIL2 YRND
    2        Surface etention  2A        MAX                     1    2   31    9
    1        Surface retention  1        MAX                     1    2   30    9
  END DISPLY-INFO1
END DISPLY
COPY
  TIMESERIES
    # -  #  NPT  NMN ***
    1         1    1
    2         1    1
  502         1    1
  501         1    1
  END TIMESERIES
END COPY
GENER
  OPCODE
    #    # OPCD ***
    2        24
    4        24
    6        24
  END OPCODE
  PARM
    #    #         K ***
```

```
    2             0.
    4             0.
    6             0.
  END PARM
END GENER
PERLND
  GEN-INFO
    <PLS ><-------Name------->NBLKS   Unit-systems   Printer ***
    # -  #                          User  t-series Engl Metr ***
                                           in  out           ***
   16     C, Lawn, Flat           1    1    1    1   27    0
  END GEN-INFO
  *** Section PWATER***

  ACTIVITY
    <PLS > ************* Active Sections *****************************
    # -  # ATMP SNOW PWAT  SED  PST  PWG PQAL MSTL PEST NITR PHOS TRAC ***
   16         0    0    1    0    0    0    0    0    0    0    0    0
  END ACTIVITY

  PRINT-INFO
    <PLS > ***************** Print-flags ***************************** PIVL  PYR
    # -  # ATMP SNOW PWAT  SED  PST  PWG PQAL MSTL PEST NITR PHOS TRAC  *********
   16         0    0    4    0    0    0    0    0    0    0    0    0    1    9
  END PRINT-INFO

  PWAT-PARM1
    <PLS >  PWATER variable monthly parameter value flags  ***
    # -  # CSNO RTOP UZFG  VCS  VUZ  VNN VIFW VIRC  VLE INFC  HWT ***
   16         0    0    0    0    0    0    0    0    0    0    0
  END PWAT-PARM1

  PWAT-PARM2
    <PLS >      PWATER input info: Part 2         ***
    # -  # ***FOREST      LZSN    INFILT      LSUR     SLSUR     KVARY     AGWRC
   16              0       4.5      0.03       400      0.05       0.5     0.996
  END PWAT-PARM2

  PWAT-PARM3
    <PLS >      PWATER input info: Part 3         ***
    # -  # ***PETMAX    PETMIN    INFEXP    INFILD    DEEPFR    BASETP    AGWETP
   16              0         0         2         2         0         0         0
  END PWAT-PARM3
  PWAT-PARM4
    <PLS >     PWATER input info: Part 4                               ***
    # -  #     CEPSC      UZSN      NSUR     INTFW       IRC     LZETP ***
   16            0.1      0.25      0.25         6       0.5      0.25
  END PWAT-PARM4

  PWAT-STATE1
    <PLS > *** Initial conditions at start of simulation
              ran from 1990 to end of 1992 (pat 1-11-95) RUN 21 ***
    # -  # ***  CEPS      SURS       UZS      IFWS       LZS      AGWS      GWVS
   16              0         0         0         0       2.5         1         0
  END PWAT-STATE1

END PERLND

IMPLND
  GEN-INFO
    <PLS ><-------Name------->   Unit-systems   Printer ***
    # -  #                     User  t-series Engl Metr ***
                                      in  out           ***
    4      ROOF TOPS/FLAT         1    1    1   27    0
   11      PARKING/FLAT           1    1    1   27    0
    2      ROADS/MOD              1    1    1   27    0
  END GEN-INFO
  *** Section IWATER***

  ACTIVITY
```

```
    <PLS > ************* Active Sections *****************************
    # -  # ATMP SNOW IWAT  SLD  IWG IQAL   ***
    4         0    0    1    0    0    0
   11         0    0    1    0    0    0
    2         0    0    1    0    0    0
  END ACTIVITY

  PRINT-INFO
    <ILS > ******** Print-flags ******** PIVL  PYR
    # -  # ATMP SNOW IWAT  SLD  IWG IQAL    *********
    4         0    0    4    0    0    0    1    9
   11         0    0    4    0    0    0    1    9
    2         0    0    4    0    0    0    1    9
  END PRINT-INFO

  IWAT-PARM1
    <PLS >  IWATER variable monthly parameter value flags  ***
    # -  # CSNO RTOP  VRS  VNN RTLI     ***
    4         0    0    0    0    0
   11         0    0    0    0    0
    2         0    0    0    0    0
  END IWAT-PARM1

  IWAT-PARM2
    <PLS >      IWATER input info: Part 2         ***
    # -  # ***  LSUR     SLSUR      NSUR     RETSC
    4            400      0.01       0.1       0.1
   11            400      0.01       0.1       0.1
    2            400      0.05       0.1      0.08
  END IWAT-PARM2

  IWAT-PARM3
    <PLS >      IWATER input info: Part 3         ***
    # -  # ***PETMAX    PETMIN
    4              0         0
   11              0         0
    2              0         0
  END IWAT-PARM3

  IWAT-STATE1
    <PLS > *** Initial conditions at start of simulation
    # -  # ***  RETS      SURS
    4              0         0
   11              0         0
    2              0         0
  END IWAT-STATE1

END IMPLND

SCHEMATIC
<-Source->                 <--Area-->     <-Target->   MBLK   ***
<Name>   #                 <-factor->     <Name>   #   Tbl#   ***
Basin  2S-B1***
PERLND  16                       0.69     RCHRES   5      2
PERLND  16                       0.69     RCHRES   5      3
IMPLND   4                       0.87     RCHRES   5      5
IMPLND  11                       2.06     RCHRES   5      5
Basin  2S-A1***
IMPLND   4                       0.39     RCHRES   1      5
IMPLND  11                       0.75     RCHRES   1      5
Basin  1S-A***
PERLND  16                        0.2     RCHRES   3      2
PERLND  16                        0.2     RCHRES   3      3
IMPLND  11                       0.65     RCHRES   3      5
Basin  2S-C***
IMPLND   2                        0.5     RCHRES   5      5

******Routing******
PERLND  16                       0.69     COPY     2     12
IMPLND   4                       0.87     COPY     2     15
```

```
IMPLND  11                        2.06     COPY     2     15
PERLND  16                        0.69     COPY     2     13
RCHRES   5                           1     RCHRES   6      8
IMPLND   4                        0.39     COPY     2     15
IMPLND  11                        0.75     COPY     2     15
RCHRES   1                           1     RCHRES   2      8
PERLND  16                         0.2     COPY     1     12
IMPLND  11                        0.65     COPY     1     15
PERLND  16                         0.2     COPY     1     13
RCHRES   3                           1     RCHRES   4      8
IMPLND   2                         0.5     COPY     2     15
RCHRES   6                           1     COPY   502     16
RCHRES   5                           1     COPY   502     17
RCHRES   2                           1     COPY   502     16
RCHRES   4                           1     COPY   501     16
END SCHEMATIC

NETWORK
<-Volume-> <-Grp> <-Member-><--Mult-->Tran <-Target vols> <-Grp> <-Member->  ***
<Name>   #        <Name> # #<-factor->strg <Name>   #   #        <Name> # #  ***
COPY   502 OUTPUT MEAN   1 1   48.4        DISPLY   2     INPUT  TIMSER 1
COPY   501 OUTPUT MEAN   1 1   48.4        DISPLY   1     INPUT  TIMSER 1
GENER    2 OUTPUT TIMSER      .0011111     RCHRES   1     EXTNL  OUTDGT 1
GENER    4 OUTPUT TIMSER      .0011111     RCHRES   3     EXTNL  OUTDGT 1
GENER    6 OUTPUT TIMSER      .0011111     RCHRES   5     EXTNL  OUTDGT 1



<-Volume-> <-Grp> <-Member-><--Mult-->Tran <-Target vols> <-Grp> <-Member->  ***
<Name>   #        <Name> # #<-factor->strg <Name>   #   #        <Name> # #  ***
END NETWORK

RCHRES
  GEN-INFO
    RCHRES       Name        Nexits   Unit Systems   Printer                 ***
    # -  #<------------------><---> User T-series  Engl Metr LKFG            ***
                                          in  out                            ***
    1     Surface etention-012    3    1    1    1   28    0    1
    2     Bioretention  2A-011    1    1    1    1   28    0    1
    3     Surface retentio-016    3    1    1    1   28    0    1
    4     Bioretention  1         1    1    1    1   28    0    1
    5     Surface etention-008    3    1    1    1   28    0    1
    6     Bioretention  2B-007    1    1    1    1   28    0    1
  END GEN-INFO
  *** Section RCHRES***

  ACTIVITY
    <PLS > ************* Active Sections *****************************
    # -  # HYFG ADFG CNFG HTFG SDFG GQFG OXFG NUFG PKFG PHFG ***
    1         1    0    0    0    0    0    0    0    0    0
    2         1    0    0    0    0    0    0    0    0    0
    3         1    0    0    0    0    0    0    0    0    0
    4         1    0    0    0    0    0    0    0    0    0
    5         1    0    0    0    0    0    0    0    0    0
    6         1    0    0    0    0    0    0    0    0    0
  END ACTIVITY

  PRINT-INFO
    <PLS > ***************** Print-flags ******************* PIVL  PYR
    # -  # HYDR ADCA CONS HEAT  SED  GQL OXRX NUTR PLNK PHCB PIVL  PYR  *********
    1         4    0    0    0    0    0    0    0    0    0    1    9
    2         4    0    0    0    0    0    0    0    0    0    1    9
    3         4    0    0    0    0    0    0    0    0    0    1    9
    4         4    0    0    0    0    0    0    0    0    0    1    9
    5         4    0    0    0    0    0    0    0    0    0    1    9
    6         4    0    0    0    0    0    0    0    0    0    1    9
  END PRINT-INFO

  HYDR-PARM1
    RCHRES  Flags for each HYDR Section                                      ***
```

```
    # -  #  VC A1 A2 A3  ODFVFG for each *** ODGTFG for each     FUNCT  for each
            FG FG FG FG  possible  exit  *** possible  exit      possible  exit
             *  *  *  *    *  *  *  *  *       *  *  *  *  *         ***
    1        0  1  0  0    4  5  6  0  0       0  1  0  0  0       2  1  2  2  2
    2        0  1  0  0    4  0  0  0  0       0  0  0  0  0       2  2  2  2  2
    3        0  1  0  0    4  5  6  0  0       0  1  0  0  0       2  1  2  2  2
    4        0  1  0  0    4  0  0  0  0       0  0  0  0  0       2  2  2  2  2
    5        0  1  0  0    4  5  6  0  0       0  1  0  0  0       2  1  2  2  2
    6        0  1  0  0    4  0  0  0  0       0  0  0  0  0       2  2  2  2  2
  END HYDR-PARM1

  HYDR-PARM2
    # -  #    FTABNO       LEN     DELTH     STCOR        KS      DB50       ***
  <------><--------><--------><--------><--------><--------><-------->       ***
    1             1      0.01       0.0       0.0       0.5       0.0
    2             2      0.01       0.0       0.0       0.5       0.0
    3             3      0.01       0.0       0.0       0.5       0.0
    4             4      0.01       0.0       0.0       0.5       0.0
    5             5      0.01       0.0       0.0       0.5       0.0
    6             6      0.02       0.0       0.0       0.5       0.0
  END HYDR-PARM2
  HYDR-INIT
    RCHRES  Initial conditions for each HYDR section                             ***
    # -  # ***   VOL     Initial  value  of COLIND     Initial  value  of OUTDGT
          *** ac-ft     for each possible exit       for each possible exit
  <------><-------->     <---><---><---><---><---> *** <---><---><---><---><--->
    1            0         4.0  5.0  6.0  0.0  0.0       0.0  0.0  0.0  0.0  0.0
    2            0         4.0  0.0  0.0  0.0  0.0       0.0  0.0  0.0  0.0  0.0
    3            0         4.0  5.0  6.0  0.0  0.0       0.0  0.0  0.0  0.0  0.0
    4            0         4.0  0.0  0.0  0.0  0.0       0.0  0.0  0.0  0.0  0.0
    5            0         4.0  5.0  6.0  0.0  0.0       0.0  0.0  0.0  0.0  0.0
    6            0         4.0  0.0  0.0  0.0  0.0       0.0  0.0  0.0  0.0  0.0
  END HYDR-INIT
END RCHRES

SPEC-ACTIONS
*** User-Defined Variable Quantity Lines
***                          addr
***                        <------>
*** kwd  varnam optyp  opn  vari  s1 s2 s3 tp multiply  lc ls ac as agfn ***
  <****> <----> <----> <-> <----><-><-><-><-><--------> <><-> <><-> <--> ***
  UVQUAN vol2   RCHRES   2 VOL              4
  UVQUAN v2m2   GLOBAL     WORKSP  1        3
  UVQUAN vpo2   GLOBAL     WORKSP  2        3
  UVQUAN v2d2   GENER    2 K       1        3
*** User-Defined Variable Quantity Lines
***                          addr
***                        <------>
*** kwd  varnam optyp  opn  vari  s1 s2 s3 tp multiply  lc ls ac as agfn ***
  <****> <----> <----> <-> <----><-><-><-><-><--------> <><-> <><-> <--> ***
  UVQUAN vol4   RCHRES   4 VOL              4
  UVQUAN v2m4   GLOBAL     WORKSP  3        3
  UVQUAN vpo4   GLOBAL     WORKSP  4        3
  UVQUAN v2d4   GENER    4 K       1        3
*** User-Defined Variable Quantity Lines
***                          addr
***                        <------>
*** kwd  varnam optyp  opn  vari  s1 s2 s3 tp multiply  lc ls ac as agfn ***
  <****> <----> <----> <-> <----><-><-><-><-><--------> <><-> <><-> <--> ***
  UVQUAN vol6   RCHRES   6 VOL              4
  UVQUAN v2m6   GLOBAL     WORKSP  5        3
  UVQUAN vpo6   GLOBAL     WORKSP  6        3
  UVQUAN v2d6   GENER    6 K       1        3
*** User-Defined Target Variable Names
***                  addr or                       addr or
***                <------>                      <------>
*** kwd   varnam ct  vari  s1 s2 s3  frac oper     vari  s1 s2 s3  frac oper
  <****>  <----><-> <----><-><-><-> <---> <-->    <----><-><-><-> <---> <-->
  UVNAME  v2m2    1 WORKSP  1         1.0 QUAN
  UVNAME  vpo2    1 WORKSP  2         1.0 QUAN
```

```
  UVNAME  v2d2    1 K       1         1.0 QUAN
*** User-Defined Target Variable Names
***                  addr or                       addr or
***                 <------>                      <------>
*** kwd   varnam ct  vari  s1 s2 s3  frac oper     vari  s1 s2 s3  frac oper
  <****>  <----><-> <----><-><-><-> <---> <-->    <----><-><-><-> <---> <-->
  UVNAME  v2m4    1 WORKSP  3         1.0 QUAN
  UVNAME  vpo4    1 WORKSP  4         1.0 QUAN
  UVNAME  v2d4    1 K       1         1.0 QUAN
*** User-Defined Target Variable Names
***                  addr or                       addr or
***                 <------>                      <------>
*** kwd   varnam ct  vari  s1 s2 s3  frac oper     vari  s1 s2 s3  frac oper
  <****>  <----><-> <----><-><-><-> <---> <-->    <----><-><-><-> <---> <-->
  UVNAME  v2m6    1 WORKSP  5         1.0 QUAN
  UVNAME  vpo6    1 WORKSP  6         1.0 QUAN
  UVNAME  v2d6    1 K       1         1.0 QUAN
*** opt foplop dcdts  yr mo dy hr mn d t   vnam  s1 s2 s3 ac quantity  tc  ts rp
  <****><-><--><><-><--> <> <> <> <><><>  <----><-><-><-><-><--------> <> <-><->
  GENER   2                               v2m2            =  1418.
*** Compute remaining available pore space
  GENER   2                               vpo2            =  v2m2
  GENER   2                               vpo2           -=  vol2
*** Check to see if VPORA goes negative; if so set VPORA = 0.0
IF (vpo2 < 0.0) THEN
  GENER   2                               vpo2            =  0.0
END IF
*** Infiltration volume
  GENER   2                               v2d2            =  vpo2
*** opt foplop dcdts  yr mo dy hr mn d t   vnam  s1 s2 s3 ac quantity  tc  ts rp
  <****><-><--><><-><--> <> <> <> <><><>  <----><-><-><-><-><--------> <> <-><->
  GENER   4                               v2m4            =  840.
*** Compute remaining available pore space
  GENER   4                               vpo4            =  v2m4
  GENER   4                               vpo4           -=  vol4
*** Check to see if VPORA goes negative; if so set VPORA = 0.0
IF (vpo4 < 0.0) THEN
  GENER   4                               vpo4            =  0.0
END IF
*** Infiltration volume
  GENER   4                               v2d4            =  vpo4
*** opt foplop dcdts  yr mo dy hr mn d t   vnam  s1 s2 s3 ac quantity  tc  ts rp
  <****><-><--><><-><--> <> <> <> <><><>  <----><-><-><-><-><--------> <> <-><->
  GENER   6                               v2m6            =  2914.
*** Compute remaining available pore space
  GENER   6                               vpo6            =  v2m6
  GENER   6                               vpo6           -=  vol6
*** Check to see if VPORA goes negative; if so set VPORA = 0.0
IF (vpo6 < 0.0) THEN
  GENER   6                               vpo6            =  0.0
END IF
*** Infiltration volume
  GENER   6                               v2d6            =  vpo6
END SPEC-ACTIONS
FTABLES
  FTABLE      6
   58    4
     Depth      Area    Volume  Outflow1 Velocity  Travel Time***
      (ft)   (acres) (acre-ft)   (cfs)   (ft/sec)    (Minutes)***
  0.000000  0.087236  0.000000  0.000000
  0.043956  0.086522  0.000929  0.000000
  0.087912  0.085709  0.001871  0.000000
  0.131868  0.084899  0.002827  0.000000
  0.175824  0.084093  0.003795  0.000000
  0.219780  0.083289  0.004776  0.000000
  0.263736  0.082489  0.005770  0.000368
  0.307692  0.081692  0.006777  0.000525
  0.351648  0.080898  0.007798  0.000949
  0.395604  0.080108  0.008832  0.001534
  0.439560  0.079320  0.009879  0.002299
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  0.483516  0.078536  0.010939  0.003258
  0.527473  0.077755  0.012014  0.004427
  0.571429  0.076977  0.013101  0.005818
  0.615385  0.076202  0.014203  0.007444
  0.659341  0.075431  0.015318  0.009319
  0.703297  0.074663  0.016446  0.011452
  0.747253  0.073898  0.017589  0.013855
  0.791209  0.073136  0.018745  0.016539
  0.835165  0.072377  0.019915  0.019515
  0.879121  0.071622  0.021100  0.022790
  0.923077  0.070869  0.022298  0.026377
  0.967033  0.070120  0.023511  0.030282
  1.010989  0.069374  0.024737  0.034517
  1.054945  0.068632  0.025978  0.039088
  1.098901  0.067892  0.027234  0.044005
  1.142857  0.067156  0.028503  0.049277
  1.186813  0.066423  0.029787  0.054910
  1.230769  0.065693  0.031086  0.060913
  1.274725  0.064966  0.032399  0.067294
  1.318681  0.064242  0.033727  0.070563
  1.362637  0.063522  0.035070  0.074060
  1.406593  0.062805  0.036427  0.081218
  1.450549  0.062091  0.037799  0.088775
  1.494505  0.061380  0.039186  0.096738
  1.538462  0.060673  0.040458  0.105113
  1.582418  0.059968  0.041744  0.113905
  1.626374  0.059267  0.043044  0.123118
  1.670330  0.058569  0.044357  0.124265
  1.714286  0.057874  0.045684  0.132746
  1.758242  0.057183  0.047026  0.138889
  1.802198  0.056494  0.048381  0.138889
  1.846154  0.055809  0.049750  0.138889
  1.890110  0.055127  0.051133  0.138889
  1.934066  0.054448  0.052530  0.138889
  1.978022  0.053772  0.053941  0.138889
  2.021978  0.053100  0.055367  0.138889
  2.065934  0.052431  0.056806  0.138889
  2.109890  0.051765  0.058260  0.138889
  2.153846  0.051102  0.059729  0.138889
  2.197802  0.050442  0.061212  0.138889
  2.241758  0.049786  0.062709  0.138889
  2.285714  0.049132  0.064221  0.138889
  2.329670  0.048482  0.065748  0.138889
  2.373626  0.047835  0.067289  0.138889
  2.417582  0.047192  0.068846  0.138889
  2.461538  0.046551  0.070416  0.138889
  2.500000  0.045914  0.150787  0.138889
  END FTABLE  6
  FTABLE      5
   36    6
     Depth      Area    Volume  Outflow1  Outflow2  outflow 3 Velocity  Travel
Time***
      (ft)   (acres) (acre-ft)   (cfs)      (cfs)     (cfs)   (ft/sec)
(Minutes)***
  0.000000  0.045914  0.000000  0.000000  0.000000  0.000000
  0.043956  0.088055  0.003853  0.000000  0.571836  0.000000
  0.087912  0.088877  0.007741  0.000000  0.588116  0.000000
  0.131868  0.089702  0.011666  0.000000  0.604396  0.000000
  0.175824  0.090531  0.015627  0.000000  0.620676  0.000000
  0.219780  0.091363  0.019625  0.000000  0.636956  0.000000
  0.263736  0.092198  0.023659  0.000000  0.653236  0.000000
  0.307692  0.093036  0.027730  0.000000  0.669516  0.000000
  0.351648  0.093877  0.031838  0.000000  0.685796  0.000000
  0.395604  0.094722  0.035983  0.000000  0.702076  0.000000
  0.439560  0.095569  0.040165  0.000000  0.718356  0.000000
  0.483516  0.096420  0.044385  0.000000  0.734636  0.000000
  0.527473  0.097274  0.048642  0.000000  0.750916  0.000000
  0.571429  0.098132  0.052937  0.000000  0.767196  0.000000
  0.615385  0.098992  0.057269  0.000000  0.783476  0.000000
  0.659341  0.099856  0.061639  0.000000  0.799756  0.000000
```

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0.703297  0.100723  0.066048  0.000000  0.816036  0.000000
0.747253  0.101593  0.070494  0.000000  0.832316  0.000000
0.791209  0.102466  0.074979  0.000000  0.848597  0.000000
0.835165  0.103342  0.079502  0.000000  0.864877  0.000000
0.879121  0.104222  0.084064  0.000000  0.881157  0.000000
0.923077  0.105105  0.088665  0.000000  0.897437  0.000000
0.967033  0.105991  0.093304  0.000000  0.913717  0.000000
1.010989  0.106880  0.097983  0.018346  0.929997  0.000000
1.054945  0.107773  0.102700  0.204851  0.946277  0.000000
1.098901  0.108668  0.107457  0.493950  0.962557  0.000000
1.142857  0.109567  0.112254  0.854840  0.978837  0.000000
1.186813  0.110469  0.117089  1.270936  0.995117  0.000000
1.230769  0.111374  0.121965  1.728554  1.011397  0.000000
1.274725  0.112282  0.126881  2.214396  1.027677  0.000000
1.318681  0.113194  0.131836  2.714853  1.043957  0.000000
1.362637  0.114109  0.136832  3.216016  1.060237  0.000000
1.406593  0.115027  0.141868  3.704036  1.076517  0.000000
1.450549  0.115948  0.146944  4.165725  1.092797  0.000000
1.494505  0.116872  0.152061  4.589323  1.109077  0.000000
1.500000  0.116988  0.152704  4.965389  1.111112  0.000000
END FTABLE  5
FTABLE      2
 67    4
   Depth      Area    Volume  Outflow1 Velocity  Travel Time***
    (ft)   (acres) (acre-ft)   (cfs)   (ft/sec)    (Minutes)***
0.000000  0.048783  0.000000  0.000000
0.038462  0.048783  0.000286  0.000000
0.076923  0.048202  0.000580  0.000000
0.115385  0.047623  0.000882  0.000000
0.153846  0.047046  0.001191  0.000000
0.192308  0.046472  0.001507  0.000000
0.230769  0.045900  0.001832  0.000000
0.269231  0.045331  0.002164  0.000184
0.307692  0.044764  0.002503  0.000242
0.346154  0.044200  0.002851  0.000390
0.384615  0.043638  0.003206  0.000582
0.423077  0.043078  0.003570  0.000824
0.461538  0.042521  0.003941  0.001117
0.500000  0.041966  0.004320  0.001467
0.538462  0.041414  0.004707  0.001875
0.576923  0.040864  0.005102  0.002346
0.615385  0.040317  0.005506  0.002882
0.653846  0.039772  0.005917  0.003485
0.692308  0.039230  0.006337  0.004159
0.730769  0.038690  0.006765  0.004905
0.769231  0.038152  0.007201  0.005727
0.807692  0.037617  0.007646  0.006627
0.846154  0.037085  0.008098  0.007607
0.884615  0.036554  0.008560  0.008669
0.923077  0.036027  0.009029  0.009816
0.961538  0.035501  0.009508  0.011049
1.000000  0.034979  0.009994  0.012372
1.038462  0.034458  0.010490  0.013785
1.076923  0.033940  0.010994  0.015291
1.115385  0.033425  0.011506  0.016891
1.153846  0.032912  0.012027  0.018389
1.192308  0.032401  0.012557  0.018589
1.230769  0.031893  0.013096  0.020384
1.269231  0.031387  0.013644  0.022280
1.307692  0.030884  0.014200  0.024278
1.346154  0.030383  0.014766  0.026380
1.384615  0.029885  0.015340  0.028587
1.423077  0.029389  0.015923  0.030902
1.461538  0.028895  0.016516  0.032144
1.500000  0.028404  0.017062  0.033325
1.538462  0.027916  0.017616  0.035858
1.576923  0.027429  0.018178  0.038502
1.615385  0.026946  0.018749  0.041259
1.653846  0.026464  0.019329  0.044129
1.692308  0.025986  0.019916  0.047108
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  1.730769  0.025509  0.020512  0.048611
  1.769231  0.025035  0.021117  0.048611
  1.807692  0.024564  0.021730  0.048611
  1.846154  0.024095  0.022352  0.048611
  1.884615  0.023628  0.022983  0.048611
  1.923077  0.023164  0.023622  0.048611
  1.961538  0.022702  0.024270  0.048611
  2.000000  0.022243  0.024926  0.048611
  2.038462  0.021786  0.025592  0.048611
  2.076923  0.021332  0.026266  0.048611
  2.115385  0.020880  0.026949  0.048611
  2.153846  0.020430  0.027641  0.048611
  2.192308  0.019983  0.028342  0.048611
  2.230769  0.019539  0.029052  0.048611
  2.269231  0.019096  0.029771  0.048611
  2.307692  0.018657  0.030499  0.048611
  2.346154  0.018219  0.031237  0.048611
  2.384615  0.017785  0.031983  0.048611
  2.423077  0.017352  0.032739  0.048611
  2.461538  0.016922  0.033503  0.048611
  2.500000  0.016495  0.034277  0.048611
  2.500000  0.016070  0.071982  0.048611
  END FTABLE  2
  FTABLE      1
   27    6
     Depth      Area    Volume  Outflow1  Outflow2  outflow 3 Velocity  Travel
Time***
      (ft)   (acres) (acre-ft)   (cfs)      (cfs)     (cfs)   (ft/sec)
(Minutes)***
  0.000000  0.016070  0.000000  0.000000  0.000000  0.000000
  0.038462  0.049367  0.001888  0.000000  0.199430  0.000000
  0.076923  0.049954  0.003798  0.000000  0.204416  0.000000
  0.115385  0.050543  0.005730  0.000000  0.209402  0.000000
  0.153846  0.051134  0.007685  0.000000  0.214388  0.000000
  0.192308  0.051728  0.009664  0.000000  0.219373  0.000000
  0.230769  0.052324  0.011665  0.000000  0.224359  0.000000
  0.269231  0.052922  0.013689  0.000000  0.229345  0.000000
  0.307692  0.053524  0.015736  0.000000  0.234331  0.000000
  0.346154  0.054127  0.017806  0.000000  0.239316  0.000000
  0.384615  0.054733  0.019899  0.000000  0.244302  0.000000
  0.423077  0.055341  0.022016  0.000000  0.249288  0.000000
  0.461538  0.055952  0.024156  0.000000  0.254274  0.000000
  0.500000  0.056566  0.026320  0.000000  0.259259  0.000000
  0.538462  0.057181  0.028508  0.120025  0.264245  0.000000
  0.576923  0.057800  0.030719  0.339117  0.269231  0.000000
  0.615385  0.058420  0.032954  0.621878  0.274217  0.000000
  0.653846  0.059043  0.035213  0.954243  0.279203  0.000000
  0.692308  0.059669  0.037496  1.326139  0.284188  0.000000
  0.730769  0.060297  0.039803  1.728554  0.289174  0.000000
  0.769231  0.060927  0.042134  2.152583  0.294160  0.000000
  0.807692  0.061560  0.044489  2.589127  0.299146  0.000000
  0.846154  0.062196  0.046869  3.028884  0.304131  0.000000
  0.884615  0.062833  0.049274  3.462517  0.309117  0.000000
  0.923077  0.063473  0.051703  3.880926  0.314103  0.000000
  0.961538  0.064116  0.054156  4.275612  0.319089  0.000000
  1.000000  0.064761  0.056635  4.639092  0.324074  0.000000
  END FTABLE  1
  FTABLE      4
   67    4
     Depth      Area    Volume  Outflow1 Velocity  Travel Time***
      (ft)   (acres) (acre-ft)   (cfs)   (ft/sec)    (Minutes)***
  0.000000  0.029385  0.000000  0.000000
  0.038462  0.029385  0.000174  0.000000
  0.076923  0.029005  0.000351  0.000000
  0.115385  0.028627  0.000533  0.000000
  0.153846  0.028251  0.000718  0.000000
  0.192308  0.027879  0.000908  0.000000
  0.230769  0.027508  0.001102  0.000000
  0.269231  0.027140  0.001300  0.000112
  0.307692  0.026775  0.001502  0.000147
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  0.346154  0.026412  0.001708  0.000237
  0.384615  0.026051  0.001919  0.000354
  0.423077  0.025693  0.002134  0.000500
  0.461538  0.025337  0.002353  0.000678
  0.500000  0.024984  0.002577  0.000891
  0.538462  0.024633  0.002806  0.001139
  0.576923  0.024284  0.003039  0.001424
  0.615385  0.023938  0.003276  0.001750
  0.653846  0.023595  0.003518  0.002116
  0.692308  0.023254  0.003765  0.002525
  0.730769  0.022915  0.004016  0.002978
  0.769231  0.022579  0.004272  0.003477
  0.807692  0.022245  0.004533  0.004023
  0.846154  0.021914  0.004799  0.004618
  0.884615  0.021585  0.005069  0.005263
  0.923077  0.021258  0.005345  0.005960
  0.961538  0.020934  0.005625  0.006709
  1.000000  0.020613  0.005911  0.007511
  1.038462  0.020294  0.006201  0.008369
  1.076923  0.019977  0.006496  0.009284
  1.115385  0.019663  0.006797  0.010255
  1.153846  0.019351  0.007103  0.011165
  1.192308  0.019042  0.007414  0.011286
  1.230769  0.018735  0.007730  0.012376
  1.269231  0.018431  0.008052  0.013527
  1.307692  0.018129  0.008378  0.014740
  1.346154  0.017829  0.008711  0.016016
  1.384615  0.017532  0.009048  0.017357
  1.423077  0.017237  0.009391  0.018762
  1.461538  0.016945  0.009740  0.019516
  1.500000  0.016656  0.010061  0.020233
  1.538462  0.016368  0.010388  0.021771
  1.576923  0.016083  0.010719  0.023376
  1.615385  0.015801  0.011056  0.025050
  1.653846  0.015521  0.011398  0.026793
  1.692308  0.015243  0.011745  0.028601
  1.730769  0.014968  0.012098  0.029514
  1.769231  0.014696  0.012455  0.029514
  1.807692  0.014426  0.012818  0.029514
  1.846154  0.014158  0.013187  0.029514
  1.884615  0.013893  0.013561  0.029514
  1.923077  0.013630  0.013940  0.029514
  1.961538  0.013369  0.014325  0.029514
  2.000000  0.013111  0.014715  0.029514
  2.038462  0.012856  0.015111  0.029514
  2.076923  0.012603  0.015513  0.029514
  2.115385  0.012352  0.015920  0.029514
  2.153846  0.012104  0.016333  0.029514
  2.192308  0.011858  0.016752  0.029514
  2.230769  0.011615  0.017176  0.029514
  2.269231  0.011374  0.017607  0.029514
  2.307692  0.011136  0.018043  0.029514
  2.346154  0.010900  0.018485  0.029514
  2.384615  0.010666  0.018933  0.029514
  2.423077  0.010435  0.019387  0.029514
  2.461538  0.010207  0.019847  0.029514
  2.500000  0.009980  0.020313  0.029514
  2.500000  0.009757  0.042656  0.029514
  END FTABLE  4
  FTABLE      3
   27    6
     Depth       Area    Volume  Outflow1  Outflow2  outflow 3 Velocity  Travel
Time***
      (ft)   (acres) (acre-ft)   (cfs)      (cfs)     (cfs)   (ft/sec)
(Minutes)***
  0.000000  0.009757  0.000000  0.000000  0.000000  0.000000
  0.038462  0.029767  0.001138  0.000000  0.121083  0.000000
  0.076923  0.030153  0.002290  0.000000  0.124110  0.000000
  0.115385  0.030540  0.003457  0.000000  0.127137  0.000000
  0.153846  0.030930  0.004639  0.000000  0.130164  0.000000
```

```
  0.192308  0.031323  0.005836  0.000000  0.133191  0.000000
  0.230769  0.031717  0.007049  0.000000  0.136218  0.000000
  0.269231  0.032115  0.008276  0.000000  0.139245  0.000000
  0.307692  0.032514  0.009519  0.000000  0.142272  0.000000
  0.346154  0.032917  0.010777  0.000000  0.145299  0.000000
  0.384615  0.033321  0.012051  0.000000  0.148326  0.000000
  0.423077  0.033728  0.013341  0.000000  0.151353  0.000000
  0.461538  0.034138  0.014646  0.000000  0.154380  0.000000
  0.500000  0.034550  0.015967  0.000000  0.157408  0.000000
  0.538462  0.034964  0.017303  0.120025  0.160435  0.000000
  0.576923  0.035381  0.018656  0.339117  0.163462  0.000000
  0.615385  0.035801  0.020025  0.621878  0.166489  0.000000
  0.653846  0.036222  0.021410  0.954243  0.169516  0.000000
  0.692308  0.036647  0.022811  1.326139  0.172543  0.000000
  0.730769  0.037073  0.024229  1.728554  0.175570  0.000000
  0.769231  0.037503  0.025663  2.152583  0.178597  0.000000
  0.807692  0.037934  0.027114  2.589127  0.181624  0.000000
  0.846154  0.038368  0.028581  3.028884  0.184651  0.000000
  0.884615  0.038805  0.030065  3.462517  0.187678  0.000000
  0.923077  0.039243  0.031566  3.880926  0.190705  0.000000
  0.961538  0.039685  0.033084  4.275612  0.193732  0.000000
  1.000000  0.040129  0.034619  4.639092  0.196759  0.000000
  END FTABLE  3
END FTABLES

EXT SOURCES
<-Volume-> <Member> SsysSgap<--Mult-->Tran <-Target vols> <-Grp> <-Member->  ***
<Name>   # <Name> # tem strg<-factor->strg <Name>   #   #        <Name> # #  ***
WDM      2 PREC     ENGL    1               PERLND   1 999 EXTNL  PREC
WDM      2 PREC     ENGL    1               IMPLND   1 999 EXTNL  PREC
WDM      1 EVAP     ENGL    0.76            PERLND   1 999 EXTNL  PETINP
WDM      1 EVAP     ENGL    0.76            IMPLND   1 999 EXTNL  PETINP
WDM      2 PREC     ENGL    1               RCHRES   1     EXTNL  PREC
WDM      2 PREC     ENGL    1               RCHRES   3     EXTNL  PREC
WDM      2 PREC     ENGL    1               RCHRES   5     EXTNL  PREC
WDM      1 EVAP     ENGL    0.5             RCHRES   1     EXTNL  POTEV
WDM      1 EVAP     ENGL    0.76            RCHRES   2     EXTNL  POTEV
WDM      1 EVAP     ENGL    0.5             RCHRES   3     EXTNL  POTEV
WDM      1 EVAP     ENGL    0.76            RCHRES   4     EXTNL  POTEV
WDM      1 EVAP     ENGL    0.5             RCHRES   5     EXTNL  POTEV
WDM      1 EVAP     ENGL    0.76            RCHRES   6     EXTNL  POTEV

END EXT SOURCES

EXT TARGETS
<-Volume-> <-Grp> <-Member-><--Mult-->Tran <-Volume-> <Member> Tsys Tgap Amd ***
<Name>   #        <Name> # #<-factor->strg <Name>   # <Name>    tem strg strg***
RCHRES   6 HYDR   RO      1 1         1      WDM   1002 FLOW     ENGL      REPL
RCHRES   6 HYDR   STAGE   1 1         1      WDM   1003 STAG     ENGL      REPL
RCHRES   5 HYDR   STAGE   1 1         1      WDM   1004 STAG     ENGL      REPL
RCHRES   5 HYDR   O       1 1         1      WDM   1005 FLOW     ENGL      REPL
COPY     2 OUTPUT MEAN    1 1      48.4      WDM    702 FLOW     ENGL      REPL
COPY   502 OUTPUT MEAN    1 1      48.4      WDM    802 FLOW     ENGL      REPL
RCHRES   2 HYDR   RO      1 1         1      WDM   1006 FLOW     ENGL      REPL
RCHRES   2 HYDR   STAGE   1 1         1      WDM   1007 STAG     ENGL      REPL
RCHRES   1 HYDR   STAGE   1 1         1      WDM   1008 STAG     ENGL      REPL
RCHRES   1 HYDR   O       1 1         1      WDM   1009 FLOW     ENGL      REPL
RCHRES   4 HYDR   RO      1 1         1      WDM   1010 FLOW     ENGL      REPL
RCHRES   4 HYDR   STAGE   1 1         1      WDM   1011 STAG     ENGL      REPL
RCHRES   3 HYDR   STAGE   1 1         1      WDM   1012 STAG     ENGL      REPL
RCHRES   3 HYDR   O       1 1         1      WDM   1013 FLOW     ENGL      REPL
COPY     1 OUTPUT MEAN    1 1      48.4      WDM    701 FLOW     ENGL      REPL
COPY   501 OUTPUT MEAN    1 1      48.4      WDM    801 FLOW     ENGL      REPL
END EXT TARGETS

MASS-LINK
<Volume>   <-Grp> <-Member-><--Mult-->     <Target>       <-Grp> <-Member->***
<Name>            <Name> # #<-factor->     <Name>                <Name> # #***
  MASS-LINK        2
PERLND     PWATER SURO       0.083333      RCHRES         INFLOW IVOL
```

```
  END MASS-LINK    2

  MASS-LINK        3
PERLND     PWATER IFWO       0.083333      RCHRES         INFLOW IVOL
  END MASS-LINK    3

  MASS-LINK        5
IMPLND     IWATER SURO       0.083333      RCHRES         INFLOW IVOL
  END MASS-LINK    5

  MASS-LINK        8
RCHRES     OFLOW  OVOL   2                 RCHRES         INFLOW IVOL
  END MASS-LINK    8

  MASS-LINK       12
PERLND     PWATER SURO       0.083333      COPY           INPUT  MEAN
  END MASS-LINK   12

  MASS-LINK       13
PERLND     PWATER IFWO       0.083333      COPY           INPUT  MEAN
  END MASS-LINK   13

  MASS-LINK       15
IMPLND     IWATER SURO       0.083333      COPY           INPUT  MEAN
  END MASS-LINK   15

  MASS-LINK       16
RCHRES     ROFLOW                          COPY           INPUT  MEAN
  END MASS-LINK   16

  MASS-LINK       17
RCHRES     OFLOW  OVOL   1                 COPY           INPUT  MEAN
  END MASS-LINK   17


END MASS-LINK

END RUN
```

Predeveloped HSPF Message File

Mitigated HSPF Message File

```
ERROR/WARNING ID:   341   6

DATE/TIME: 2005/ 4/29  9:45

RCHRES:     5

The volume of water in this reach/mixed reservoir is greater than the value
in the "volume" column of the last row of RCHTAB().  To continue the
simulation the table has been extrapolated, based on information contained
in the last two rows.  This will usually result in some loss of accuracy.
If depth is being calculated it will also cause an error condition.
Relevant data are:

NROWS         V1         V2        VOL
36 6.6238E+03 6651.8     6968.9
```

```
ERROR/WARNING ID:   341   5

DATE/TIME: 2005/ 4/29  9:45

RCHRES:     5

Calculation of relative depth, using Newton's method of successive
approximations, converged to an invalid value (not in range 0.0 to 1.0).
Probably ftable was extrapolated.  If extrapolation was small, no problem.
Remedy; extend ftable.  Relevant data are:

A          B          C      RDEP1      RDEP2  COUNT
5.0532E+00 1.0182E+04 -1.255E+05   12.254   1.2254E+01      3
```

```
ERROR/WARNING ID:   341   6

DATE/TIME: 2005/ 4/29 10: 0

RCHRES:     5

The volume of water in this reach/mixed reservoir is greater than the value
in the "volume" column of the last row of RCHTAB().  To continue the
simulation the table has been extrapolated, based on information contained
in the last two rows.  This will usually result in some loss of accuracy.
If depth is being calculated it will also cause an error condition.
Relevant data are:

NROWS         V1         V2        VOL
36 6.6238E+03 6651.8     6836.4
```

```
ERROR/WARNING ID:   341   5

DATE/TIME: 2005/ 4/29 10: 0

RCHRES:     5

Calculation of relative depth, using Newton's method of successive
approximations, converged to an invalid value (not in range 0.0 to 1.0).
Probably ftable was extrapolated.  If extrapolation was small, no problem.
Remedy; extend ftable.  Relevant data are:

A          B          C      RDEP1      RDEP2  COUNT
5.0532E+00 1.0182E+04 -7.735E+04    7.5680     7.5680       3
```

Disclaimer

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Local (360)943-0304

www.clearcreeksolutions.com

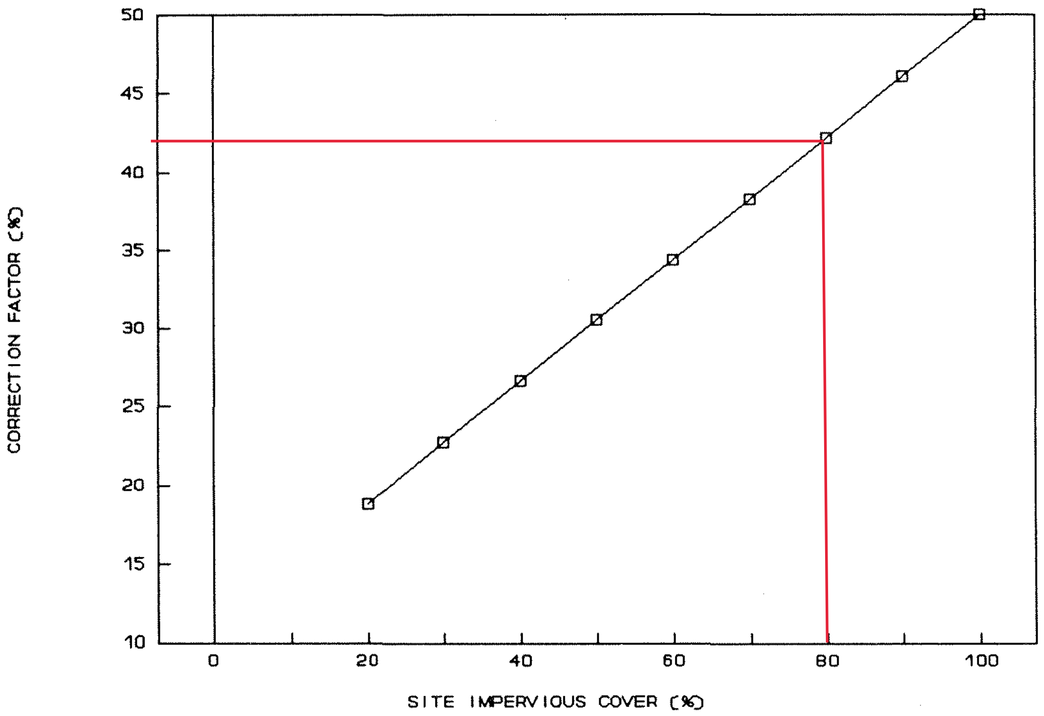
Appendix I: Curve Numbers & Volume Correction Chart

Table III-1.3 SCS Western Washington Runoff Curve Numbers
(Published by SCS in 1982) Runoff curve numbers for selected agricultural, suburban and urban
land use for Type 1A rainfall distribution, 24-hour storm duration.

LAND USE DESCRIPTION		CURVE NUMBERS BY HYDROLOGIC SOIL GROUP			
		A	B	C	D
Cultivated land(1):	winter condition	86	91	94	95
Mountain open areas:	low growing brush & grasslands	74	82	89	92
Meadow or pasture:		65	78	85	89
Wood or forest land:	undisturbed	42	64	76	81
Wood or forest land:	young second growth or brush	55	72	81	86
Orchard:	with cover crop	81	88	92	94
Open spaces, lawns, parks, golf courses, cemeteries, landscaping.					
Good condition:	grass cover on ≥75% of the area	68	80	86	90
Fair condition:	grass cover on 50-75% of the area	77	85	90	92
Gravel roads & parking lots:		76	85	89	91
Dirt roads & parking lots:		72	82	87	89
Impervious surfaces, pavement, roofs etc.		98	98	98	98
Open water bodies:	lakes, wetlands, ponds etc.	100	100	100	100
Single family residential(2):					
Dwelling Unit/Gross Acre	%Impervious(3)	Separate curve number shall be selected for pervious & impervious portions of the site or basin			
1.0 DU/GA	15				
1.5 DU/GA	20				
2.0 DU/GA	25				
2.5 DU/GA	30				
3.0 DU/GA	34				
3.5 DU/GA	38				
4.0 DU/GA	42				
4.5 DU/GA	46				
5.0 DU/GA	48				
5.5 DU/GA	50				
6.0 DU/GA	52				
6.5 DU/GA	54				
7.0 DU/GA	56				
PUD's, condos, apartments, commercial businesses & industrial areas	%impervious must be computed				

(1) For a more detailed description of agricultural land use curve numbers refer to National Engineering Handbook, Sec. 4, Hydrology, Chapter 9, August 1972.
(2) Assumes roof and driveway runoff is directed into street/storm system.
(3) The remaining pervious areas (lawn) are considered to be in good condition for these curve numbers.

FIGURE III-1.1
Volume Correction Factor to be Applied to
Streambank Erosion Control BMPs
Based on Site Impervious Cover



Appendix J: Rainfall Data

Table 5-1

City of Woodland
Comprehensive Flood Hazard and Drainage Management Plan
Subbasin Summary - Areas and 24-Hour Precipitation Frequency Data

Subbasin Number	Description	Drainage Path or Outlet	Drainage Area (sq.mi.)	Drainage Area (acres)	Unadjusted Average Rain (in.) (1) 2-yr	10-yr	25-yr	100-yr	Adjusted Average Rain (in.) (2) 2-yr	10-yr	25-yr	100-yr
1	Upper Robinson Creek	Lewis River	1.86	1,192	3.25	4.45	5.10	6.30	3.06	4.41	5.46	7.94
2	Lower Robinson Creek	Lewis River	0.89	570	2.80	4.10	4.60	5.75	2.63	4.06	4.92	7.25
3	Upper Burris Creek	Burris/PS #1	0.97	621	3.20	4.40	5.00	6.20	3.01	4.36	5.35	7.81
4	Upper Middle Burris	Burris/PS #1	1.13	725	2.80	4.10	4.50	5.60	2.63	4.06	4.82	7.06
5	Unnamed Creek between Burris and Burke Creeks	PS #1/Columbia	0.57	363	2.50	3.70	4.10	5.25	2.35	3.66	4.39	6.62
6	Tributary to I-5 Median	Burris/PS #1	0.24	152	2.40	3.60	4.10	5.20	2.26	3.56	4.39	6.55
7	Lower Middle Burris	Burris/PS #1	0.97	620	2.40	3.60	3.90	5.00	2.26	3.56	4.17	6.30
8	Unnamed small creek	Lewis River	0.49	314	2.50	3.60	4.00	5.00	2.35	3.56	4.28	6.30
9	South and east of SR 503	Lewis River	0.30	192	2.25	3.25	3.75	4.50	2.12	3.22	4.01	5.67
10	North and west of SR 503	Infiltration	0.29	183	2.25	3.25	3.75	4.50	2.12	3.22	4.01	5.67
11	Farm lowland	PS #1/Columbia	2.39	1,529	2.25	3.25	3.75	4.50	2.12	3.22	4.01	5.67
12	Mostly storm sewers	Lewis River	0.15	93	2.25	3.25	3.75	4.50	2.12	3.22	4.01	5.67
13	Downtown Woodland	Horseshoe Lake	0.08	50	2.25	3.25	3.75	4.50	2.12	3.22	4.01	5.67
14	SW corner of study area	PS #2/Columbia	0.83	533	2.25	3.25	3.75	4.50	2.12	3.22	4.01	5.67
15	East railroad	Burris/PS #1	0.50	319	2.25	3.25	3.75	4.50	2.12	3.22	4.01	5.67
16	West of I-5	Infiltration	0.12	77	2.25	3.25	3.75	4.50	2.12	3.22	4.01	5.67
17	Horseshoe Lake vicinity	Horseshoe Lake	0.15	93	2.25	3.25	3.75	4.50	2.12	3.22	4.01	5.67
18	Adjacent to Lewis River	Infiltration	0.13	81	2.25	3.25	3.75	4.50	2.12	3.22	4.01	5.67
19	Tributary to subbasin 11	PS #1/Columbia	0.26	169	2.25	3.25	3.75	4.50	2.12	3.22	4.01	5.67
		Total Area	12.31	7,875								

Notes

(1) Based on maps in NOAA Atlas 2, 1973.

(2) Adjustments to NOAA Atlas 2 data: 100-year rain increased by 26%; 25-year rain increased by 7%; 10-yr decreased by 1%; 2-yr rain decreased by 6%.

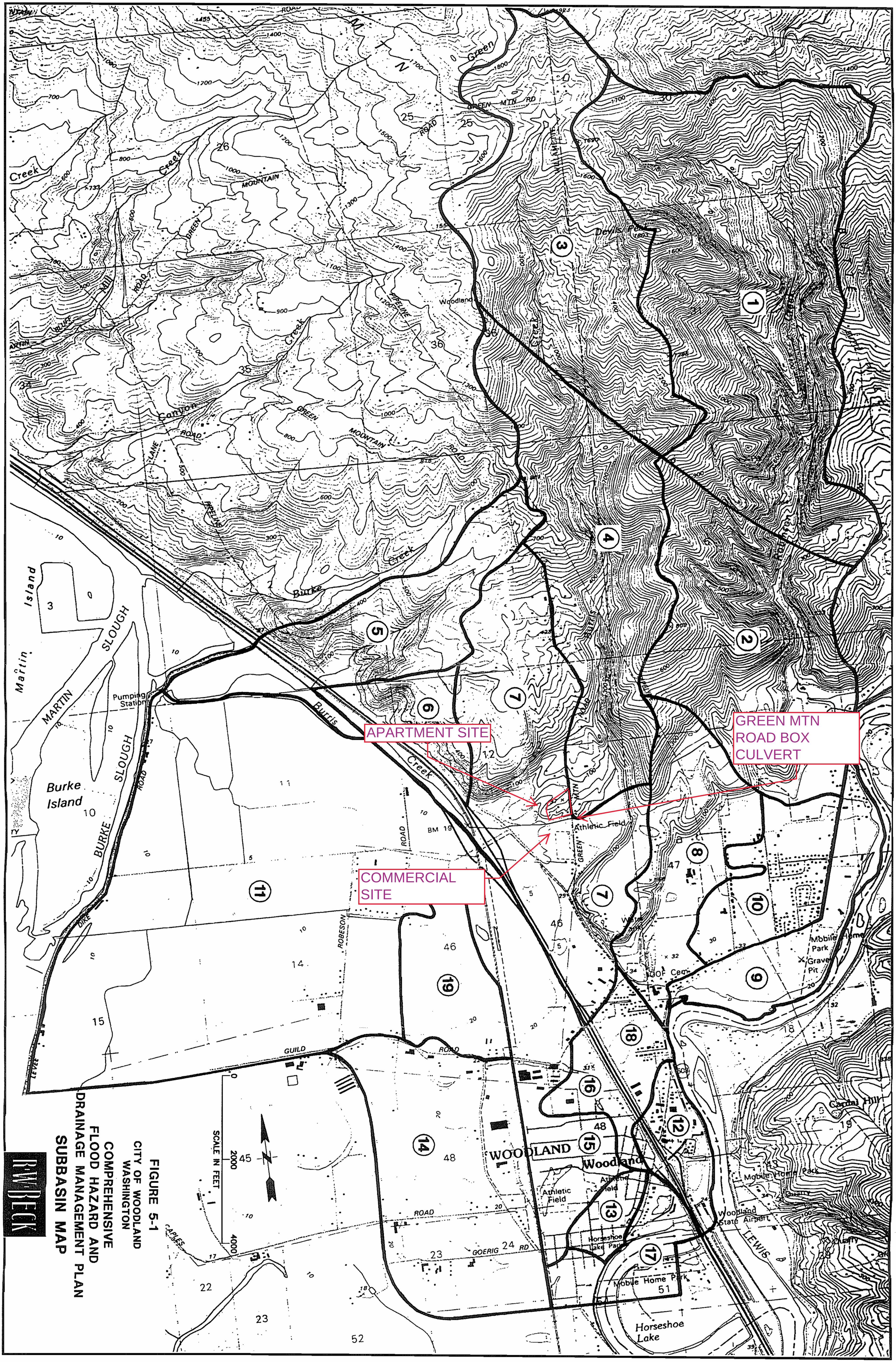


FIGURE 5-1
CITY OF WOODLAND
WASHINGTON
COMPREHENSIVE
FLOOD HAZARD AND
DRAINAGE MANAGEMENT PLAN
SUBBASIN MAP