Preliminary
Storm Drainage Report

FOR

Bullfrog – Phase S-1

Cle Elum, Washington

2024-11-14

Prepared for:	Bullfrog Flats, LLC 18300 Redmond Way, Suite 120 Redmond, WA 98052
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1. Project Overview

The Bullfrog project is a mixed-use phased development project located in the western portion of the City of Cle Elum, between Bullfrog Road and SR 903. This report addresses the stormwater design for Phase S-1 of this project. Phase S-1 will consist of single family detached residential development resulting in 103 individual lots. Phase S-1 is located centrally within the overall development, with future phase J to the northeast, future phase P-4 to the southwest, the development spine road to the northwest, and the Washington State Horse Park to the southeast. See Figure 1-1 below for reference.

The existing site of Phase S-1 generally slopes from northwest to southeast at slopes ranging between 1 and 10 percent. Additionally, the area along the northeastern boundary of the phase slopes southeast at slopes up to twenty percent.

All runoff from the site infiltrates prior to leaving the site in the present state, and this will be maintained post development. Basic water quality treatment will be provided by infiltration through bioretention soil mix. Stormwater management and facilities have been designed per the 2024 Stormwater Management Manual for Eastern Washington (SWMMEW).

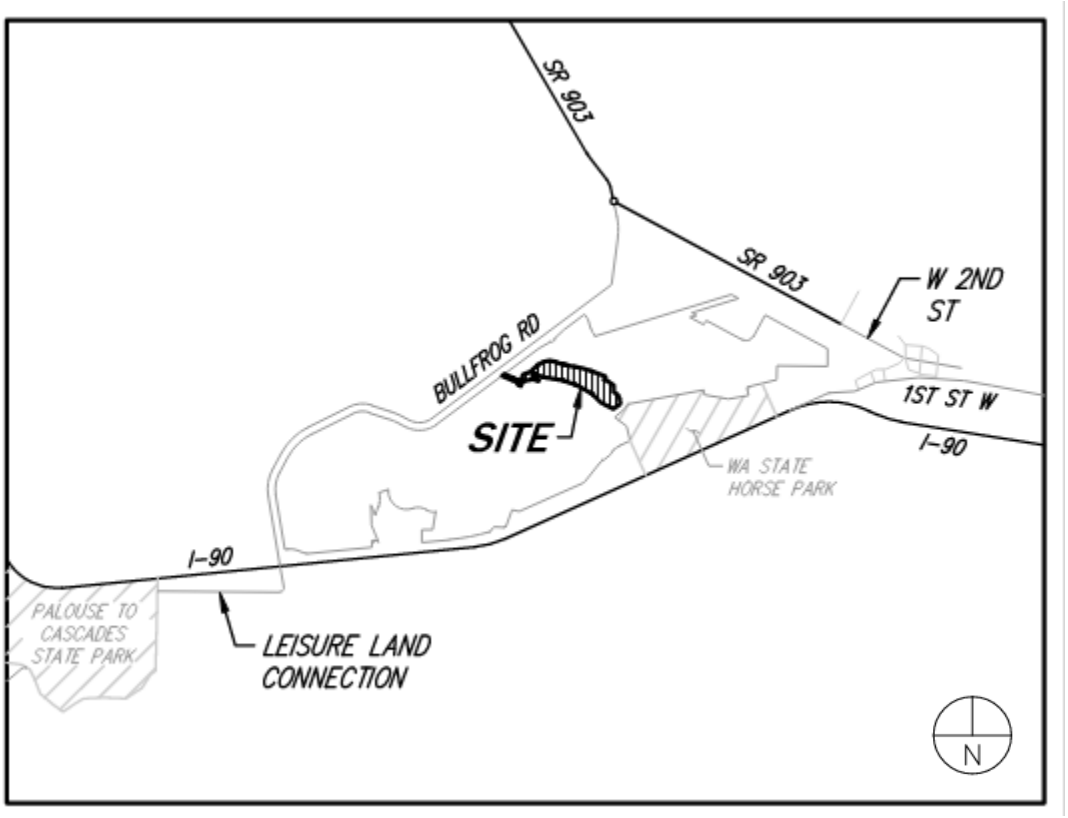


Figure 1-1 Vicinity Map

2. Conditions and Requirement Summary

This project is considered a new development project and proposes greater than 5,000 square feet of new plus replaced hard surfaces; therefore, per Figure 2.1 of the SWMMEW, provided at the end of this section, Phase S-1 is subject to all Core Elements.

2.1 Core Elements

2.1.1 Core Element #1: Preparation of a Stormwater Site Plan

This report, along with the civil plans submitted under separate cover, will satisfy this core element.

2.1.2 Core Element #2: Construction Stormwater Pollution Prevention Plan

In order to reduce the impacts of sediment laden runoff during construction, a Construction Stormwater Pollution Prevention Plan (CSWPPP) will be prepared for this project and included under separate cover at final design. This plan will address the 13 elements of pollution prevention and the appropriate BMPs which will be implemented to ensure the prevention of sediment laden runoff from leaving the site. Section 5 of this report will also provide an overview of the measures being taken to address this element at final design.

2.1.3 Core Element #3: Source Control of Pollution

Development of the project site consists of single family residential development and associated roads and utilities. Per Section 8.1 of the 2024 SWMMEW, this level of development is not required to implement Source Control BMPs. As such, this element is considered to have been addressed.

2.1.4 Core Element #4: Preservation of Natural Drainage Systems

Onsite natural drainage patterns consist of infiltration of runoff. The project proposes to mimic this condition. In doing such, the project will maintain the natural drainage outfall to the maximum extent practicable. See Section 3 of this report for a discussion of the existing outfall.

2.1.5 Core Element #5: Runoff Treatment

Runoff treatment for the project has been evaluated in accordance with the 2024 SWMMEW based on the location of project site discharge. Project site discharge is proposed to be through surface infiltration, and oil control is not required for the proposed level of development. As such, runoff treatment will be accomplished by filtering through bioretention soil mix prior to surface infiltration. This will occur at a bioretention facility for each drainage basin, the design of which is discussed further in Section 4.3 of this report.

2.1.6 Core Element #6: Flow Control

Flow control is required for the project site and will be provided through the use of infiltration BMPs, designed to infiltrate 100 percent of the 25-year, 24-hour Type IA storm. Additional information regarding the proposed facilities in included in Section 4 of this report.

2.1.7 Core Element #7: Operation and Maintenance

Appropriate Operations and Maintenance (O&M) information for the proposed stormwater management BMPs will be provided at final design in Section 6 of this report.

2.1.8 Core Element #8: Wetlands Protection

Stormwater discharge from the project site will be via onsite infiltration, matching the existing condition. Therefore, stormwater discharge from the site does not discharge into a wetland directly or via a conveyance system, and Core Element #8 is not applicable.

2.2 Additional Protective Measures (APMs)

The City of Cle Elum does not require the APMs to be applied to project development. However, the project has reviewed the requirements as discussed below, for applicability and relevance.

2.2.1 APM1: Financial Liability

Bonding for the project will be determined at final design and per instruction from the City at that time.

2.2.2 APM2: Off-Site Analysis Report

Section 3 of this report provides discussion of the natural drainage patterns of the project site. In the existing condition, all runoff infiltrates on site. Therefore, an offsite analysis is not required.

2.2.3 APM3: Local Requirements

No additional Local Requirements per the City of Cle Elum are required.

Figure 2.1: Flow Chart for Determining Requirements for New Development

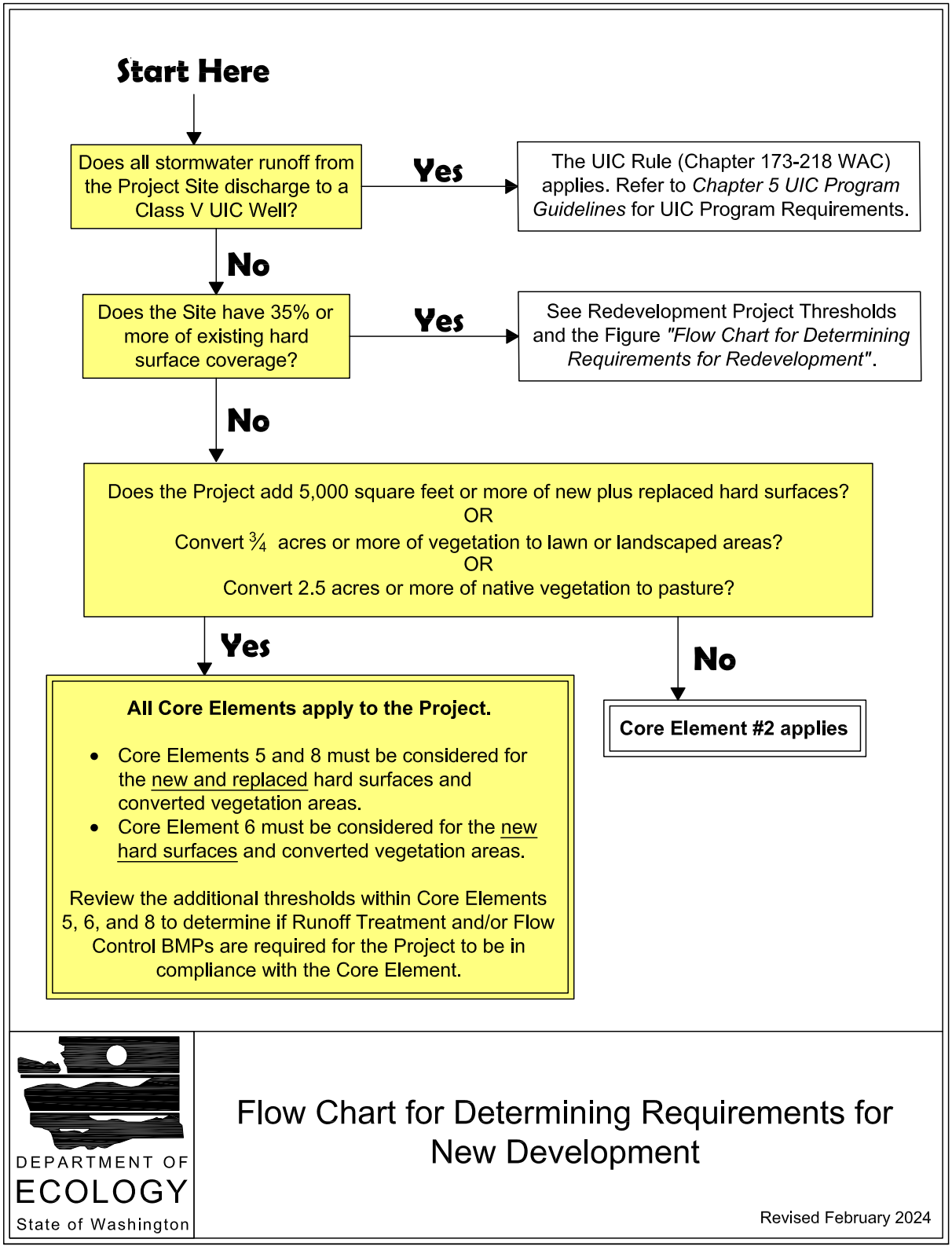
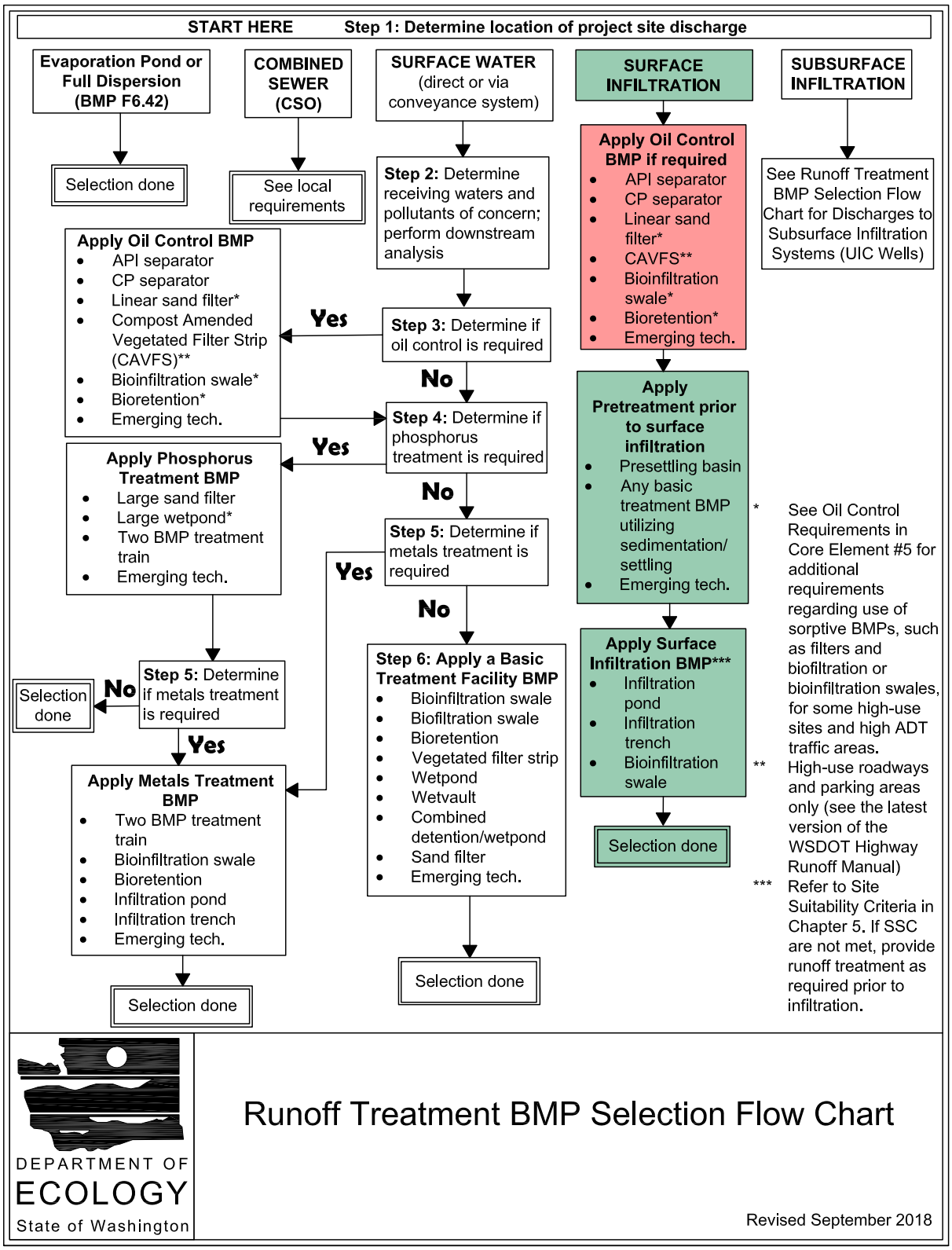
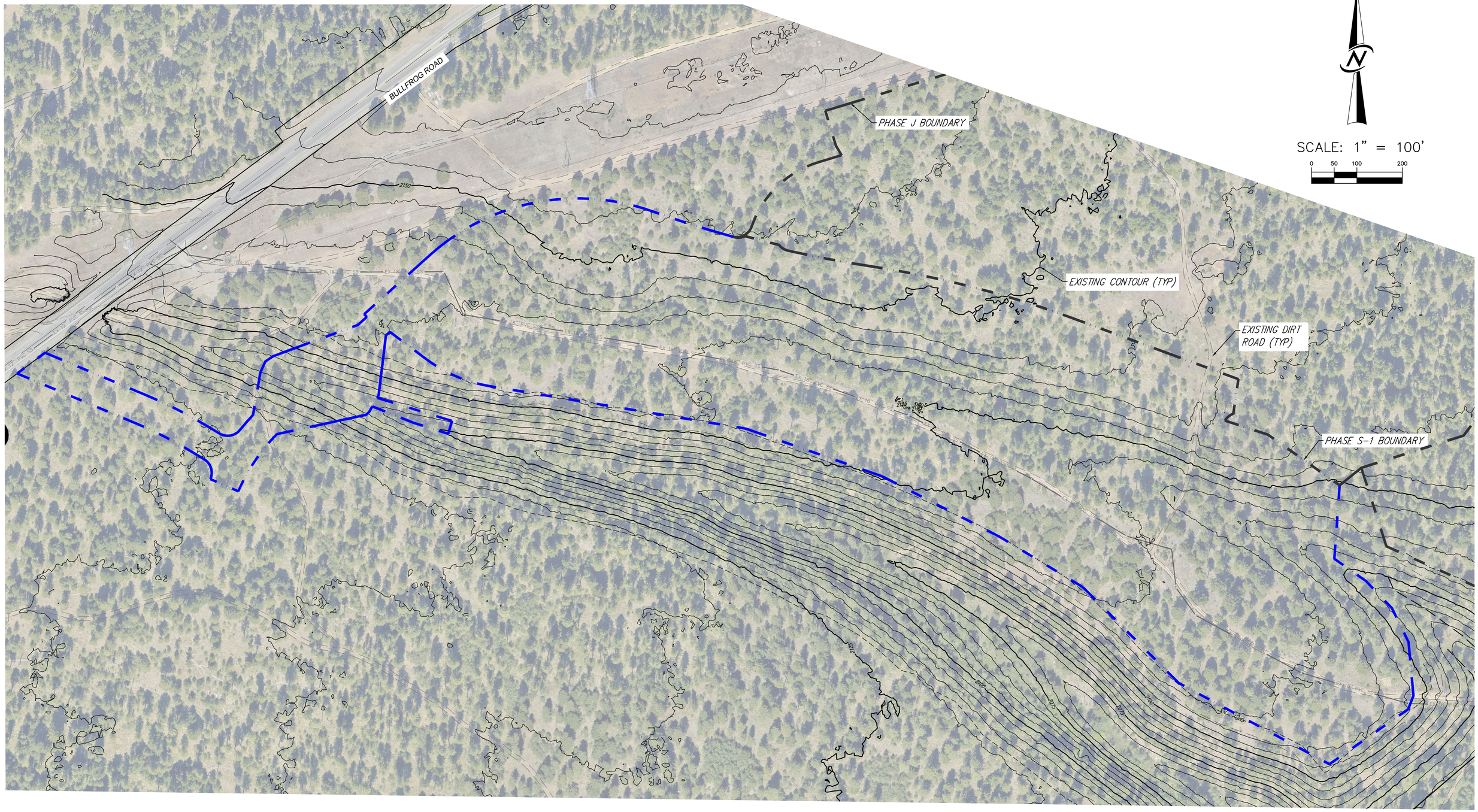


Figure 6.1: Runoff Treatment BMP Selection Flow Chart



3. Off-Site Analysis

Due to the high infiltration rate of onsite soils, this project proposes to infiltrate 100 percent of the 25-year, 24-hour Type IA storm event plus 24-hour snowmelt. Therefore, there is no anticipated discharge from the site. As such, there is no downstream path to analyze. The natural drainage pattern is concluded to be infiltrated through on-site soils, so analysis did not extend off-site. See the Existing Basin Map in the following pages for an overview of the existing site.



BULLFROG - PHASE S-1

EXISTING CONDITIONS EXHIBIT

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4. Permanent Stormwater Control Analysis and Design

In order to mitigate the impacts of increased runoff from the developed site in comparison to the undeveloped site, flow control is required for this project. To meet this requirement, infiltration facilities are proposed to mitigate all impervious surfaces. Undisturbed and disturbed pervious surfaces are assumed to infiltrate all surface runoff, and are not included in the sizing for the infiltration facilities.

4.1 Stormwater Design Overview

This project proposes construction of three bioretention areas and two infiltration ponds. The Center Infiltration Pond is designed to provide infiltration capacity for runoff from a fourth bioretention area, to be constructed under future Phase S-2, in addition to two of the three onsite bioretention areas. The west infiltration pond will provide infiltration capacity for runoff from the third onsite bioretention area. Each proposed bioretention area will provide runoff treatment from PGIS associated with portions of the spine road and internal roads for the project. Infiltration of all NPGIS associated with the individual lots is anticipated to consist of individual infiltration trenches which will be located on each lot and designed once proposed footprints have been determined for all lots.

4.2 Basin Information

As discussed in Section 4.1, the Center infiltration pond will be downstream of three bioretention areas, the Center, South, and East Basins. Similarly, the West Infiltration Pond will be downstream of on bioretention area, the West Basin. The basins defined by each of these bioretention areas are detailed in Table 4-1 below. The boundaries of these basins is also detailed in the Developed Conditions Exhibit, provided at the end of this section.

Table 4-1 Basin Areas

Total Basin	500819 sf	11.50 ac	% of Total
West Basin	81787 sf	1.88 ac	16%
Center Basin	242360 sf	5.56 ac	48%
South Basin	45787 sf	1.05 ac	9%
East Basin	130885 sf	3.00 ac	26%

It should be noted that the East bioretention area and associated Basin will not be constructed with the Bullfrog – Phase S-1 project; however, the Center Infiltration Pond designed under this project has been sized to accommodate these future flows. Exact areas may vary from what is presented for the East Basin area, and additional confirmation of adequate function under the 2024 SWMMEW will be provided during engineering design of the Bullfrog - Phase S-2 project.

4.3 Bioretention Design

The proposed bioretention areas have been designed for treatment based on the 6 month Water Quality 24-hour storm – 1.22 inches, as required under the Cle Elum 2024 Construction Standards.

4.3.1 Modeling Results

All bioretention sizing has been determined utilizing SBUH in HydroCAD, the reports of which are provided in Appendix A of this report, for storms equal to or greater than the water quality design storm noted in Section 4.3 of this report. All four bioretention areas have been designed using an infiltration rate of 3.0 inches per hour across the vertical surface area only. Geometry of the proposed facilities varies, but all provide one foot of freeboard. Overflow for all bioretention facilities will be provided via an overflow structure, which will route all flows which do not infiltrate through the facility to the infiltration pond. See Section 4.4 for additional information regarding the design of the infiltration pond. Table 4-2 below provides the minimum required geometrical design of the bioretention facilities. All proposed bioretention areas will match the required design at minimum. Confirmation of this match will be provided at final design and again at as-builts.

Table 4-2 Bioretention Design Information

Basin	Bottom Length	Bottom Width	Base Area	Maximum Stage	Overflow Stage	Total Depth	Side Slope
West	75.00'	15.00'	1,125 sf	1.00'	2.0'	5.5'	Vertical Rock Wall
Center	53.00'	102.00'	5,406 sf	1.00'	2.0'	2.0'	3H:1V
South	12.00'	90.00'	1,080 sf	1.00'	2.0'	5.2'	Vertical Rock Wall
East	45.00'	70.00'	3,150 sf	1.00'	2.0'	7.8'	Vertical Rock Wall

4.4 Infiltration Pond Design

The proposed infiltration pond has been designed utilizing HydroCAD for the Type IA, 25-year, 24-hour storm event and 24-hour snow melt for the region. The precipitation depth was determined per the 2024 City of Cle Elum Design Standards. The estimated average daily snow depth was determined utilizing the methodology presented in the 2024 SWMMEW based on the data of Table 4.9 within the 2024 SWMMEW. This calculation is provided in Section 4.4.1 of this report for reference.

4.4.1 Snowmelt Adjustment Factor Calculation

According to the 2024 SWMMEW, the project site is located within Climate Region 1. No snowfall data for the project location is provided in the 2024 SWMMEW. As a result, the closest data available in Wenatchee was used to determine the average daily snow depth in Cle Elum.

The average annual precipitation for Wenatchee, per Figure 4.1 of the 2024 SWMMEW, is 10 inches. The average annual precipitation for Cle Elum from the same figure is 26 inches. The estimated average daily snow depth for Cle Elum was determined by multiplying the ratio of average annual precipitation between Cle Elum and Wenatchee against the average daily snow depth and all other adjustment factors.

$$S_{Cle\ Elum} = S_{Wenatchee} * \frac{P_{Cle\ Elum}}{P_{Wenatchee}}$$

Where: S_{City} is the average daily snow depth of that city in inches, and
P_{City} is the average annual precipitation of that city in inches.

The calculated Average Daily Snow Depth of Cle Elum is 6.94 inches. A summary of the values used for this calculation is provided in Table 4-3 below.

Table 4-3 Average Daily Snow Depth Calculation

$P_{Wenatchee}$	10 in
$P_{Cle\ Elum}$	26 in
$P_{Cle\ Elum}$ / $P_{Wenatchee}$	2.6
$S_{Wenatchee}$	2.67 in
$S_{Cle\ Elum}$	6.94 in

The equivalent snowmelt depth was determined utilizing a 20 percent snow moisture content, matching the relationships presented in Table 4.9 of the 2024 SWMMEW. As such, the Cle Elum Snowmelt 24-hour Adjustment utilized in sizing the infiltration pond was found to be 1.39 inches. See Table 4-4 for the referenced and calculated snowmelt factors.

Table 4-4 Snowmelt Adjustment Factors as adopted from the 2024 SWMMEW

Location	Average Daily Snow Depth (inches)	Water Equivalent (inches) 24-Hour Storm Precipitation Adjustment
Wenatchee	2.67	0.53
*Cle Elum**	*6.94*	*1.39*

**Per calculations provided above*

4.4.2 Design Storm

In order to determine the design storm rainfall depth, the Type IA 25-year, 24-hour storm depth was combined with the Cle Elum Snowmelt 24-hour Adjustment. As discussed at the beginning of this section, the 25-year, 24-hour storm depth for the Type IA storm was determined from the 2024 City of Cle Elum Design Standards. This depth is noted as 3.48 inches. Upon combination with the Snowmelt 24-hour Adjustment, the design precipitation depth utilized for Flow Control modeling was determined to be 4.87 inches. See Table 4-6 below for a summary of this calculation.

Table 4-5 Design Storm Calculation

Snowmelt Adjustment	1.39 in
25-yr, 24-hr Depth	3.48 in
Design Storm Depth	4.87 in

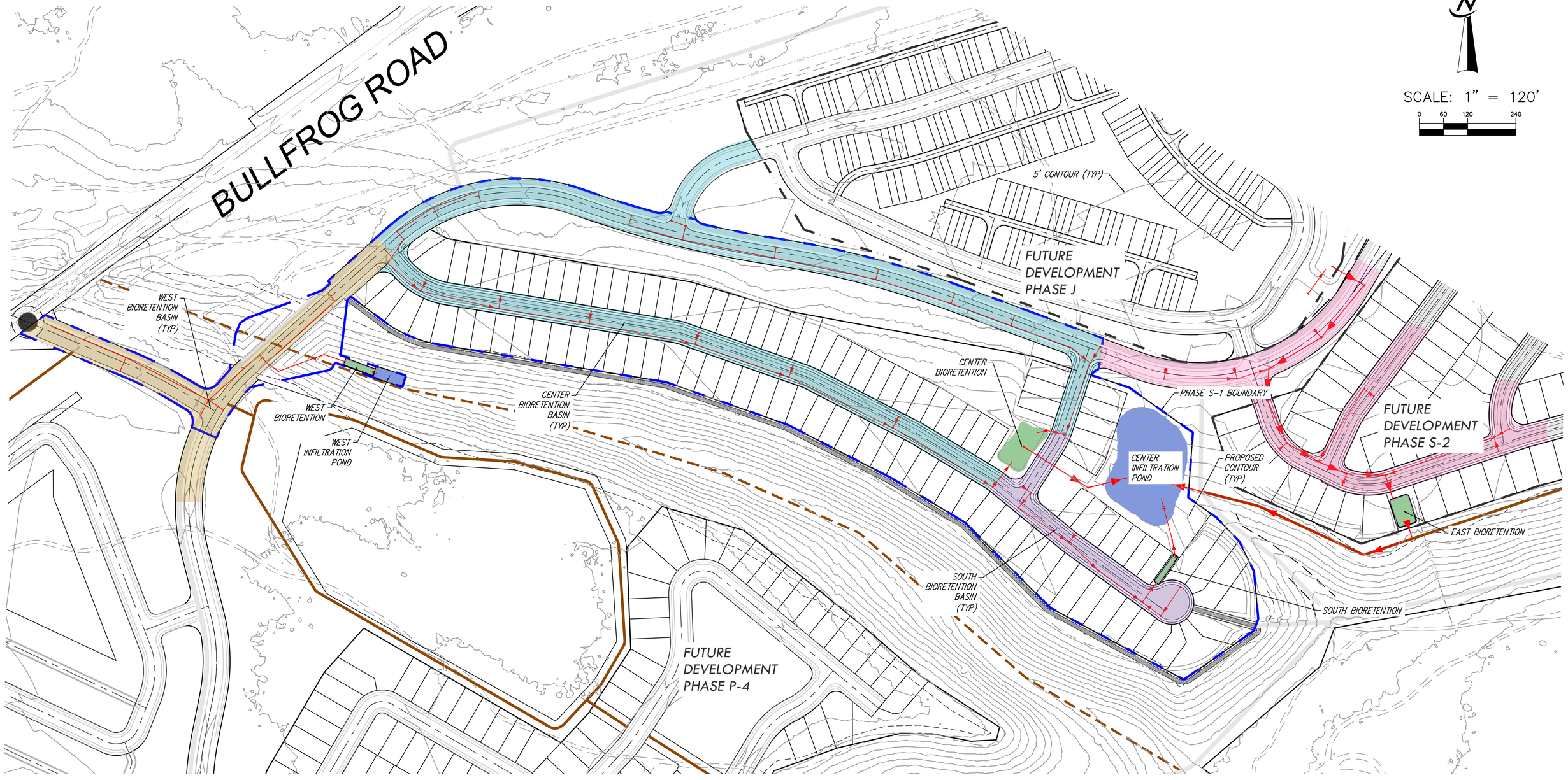
4.4.3 Modeling Results

The proposed infiltration pond sizing has been determined utilizing SBUH in HydroCAD, the report of which is provided in Appendix B of this report. The model has been set up such that the overflows from the tributary bioretention areas, as designed in Section 4.3 of this report, are routed to the proposed infiltration pond. The center infiltration pond has been designed assuming 3 to 1 side slopes and one foot of freeboard. The west infiltration pond has been designed assuming vertical sidewalls and one foot of freeboard. Detailed information regarding the geometry of the proposed pond is provided in Table 4-6 below.

Table 4-6 Infiltration Pond Design Geometry

Basin	Bottom Length	Bottom Width	Base Area	Maximum Stage	Overflow Stage	Storage Volume
West	70.00'	23.00'	1,610 sf	6.00'	7.0'	9,660 cf
Center	85.00'	85.00'	7,225 sf	6.00'	7.0'	68,298 cf

The proposed infiltration pond will match the required design at minimum. Confirmation of this match will be provided at final design and again at as-builts. The hydrograph produced by HydroCAD shows that all runoff routed to the infiltration pond is infiltrated within 40 hours, less than the required 72 hours. As such, the proposed stormwater design will provide treatment and flow control via infiltration for all runoff from the project site through the 25-year storm. See the Hydrograph provided in the HydroCAD report in Appendix B for reference.



BULLFROG - PHASE S-1

DEVELOPED CONDITIONS EXHIBIT

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5. Construction Stormwater Pollution Prevention Analysis

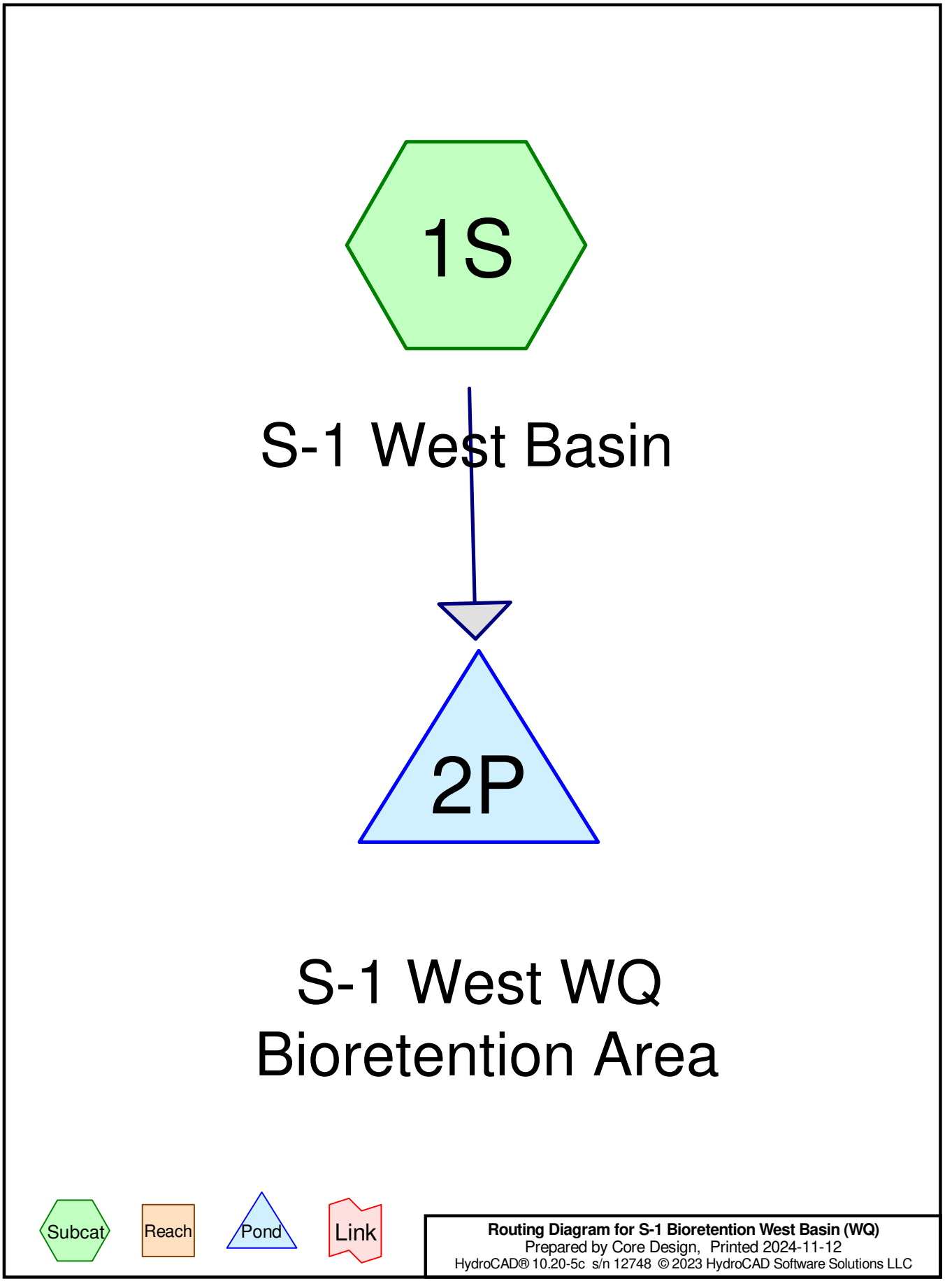
Erosion and sediment control for the project will be provided per the requirements of the 2024 SWMMEW. Additional information and analysis will be provided at final design.

6. Operations and Maintenance Manual

Operations and maintenance details for the applicable proposed stormwater facilities will be provided at final engineering design.

Appendix A

Bioretention Water Quality HydroCAD Reports



Routing Diagram for S-1 Bioretention West Basin (WQ)
Prepared by Core Design, Printed 2024-11-12
HydroCAD® 10.20-5c s/n 12748 © 2023 HydroCAD Software Solutions LLC

Rainfall Events Listing (selected events)

Event#	Event Name	Storm Type	Curve	Mode	Duration (hours)	B/B	Depth (inches)	AMC
1	6 Month	Type IA 24-hr		Default	24.00	1	1.22	2

Area Listing (all nodes)

Area (acres)	CN	Description (subcatchment-numbers)
1.878	98	Roads (1S)
1.878	**98**	**TOTAL AREA**

Soil Listing (all nodes)

Area (acres)	Soil Group	Subcatchment Numbers
0.000	HSG A	
0.000	HSG B	
0.000	HSG C	
0.000	HSG D	
1.878	Other	1S
1.878		**TOTAL AREA**

Ground Covers (all nodes)

HSG-A (acres)	HSG-B (acres)	HSG-C (acres)	HSG-D (acres)	Other (acres)	Total (acres)	Ground Cover	Subcatchment Numbers
0.000	0.000	0.000	0.000	1.878	1.878	Roads	1S
0.000	**0.000**	**0.000**	**0.000**	**1.878**	**1.878**	**TOTAL AREA**	

Time span=0.00-72.00 hrs, dt=0.01 hrs, 7201 points
Runoff by SBUH method, Split Pervious/Imperv.
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 1S: S-1 West Basin Runoff Area=1.878 ac 100.00% Impervious Runoff Depth=1.01"
Tc=5.0 min CN=0/98 Runoff=0.49 cfs 0.157 af

Pond 2P: S-1 West WQ Bioretention Area Peak Elev=100.96' Storage=0.031 af Inflow=0.49 cfs 0.157 af
Discarded=0.12 cfs 0.157 af Primary=0.00 cfs 0.000 af Outflow=0.12 cfs 0.157 af

Total Runoff Area = 1.878 ac Runoff Volume = 0.157 af Average Runoff Depth = 1.01"
0.00% Pervious = 0.000 ac 100.00% Impervious = 1.878 ac

Summary for Subcatchment 1S: S-1 West Basin

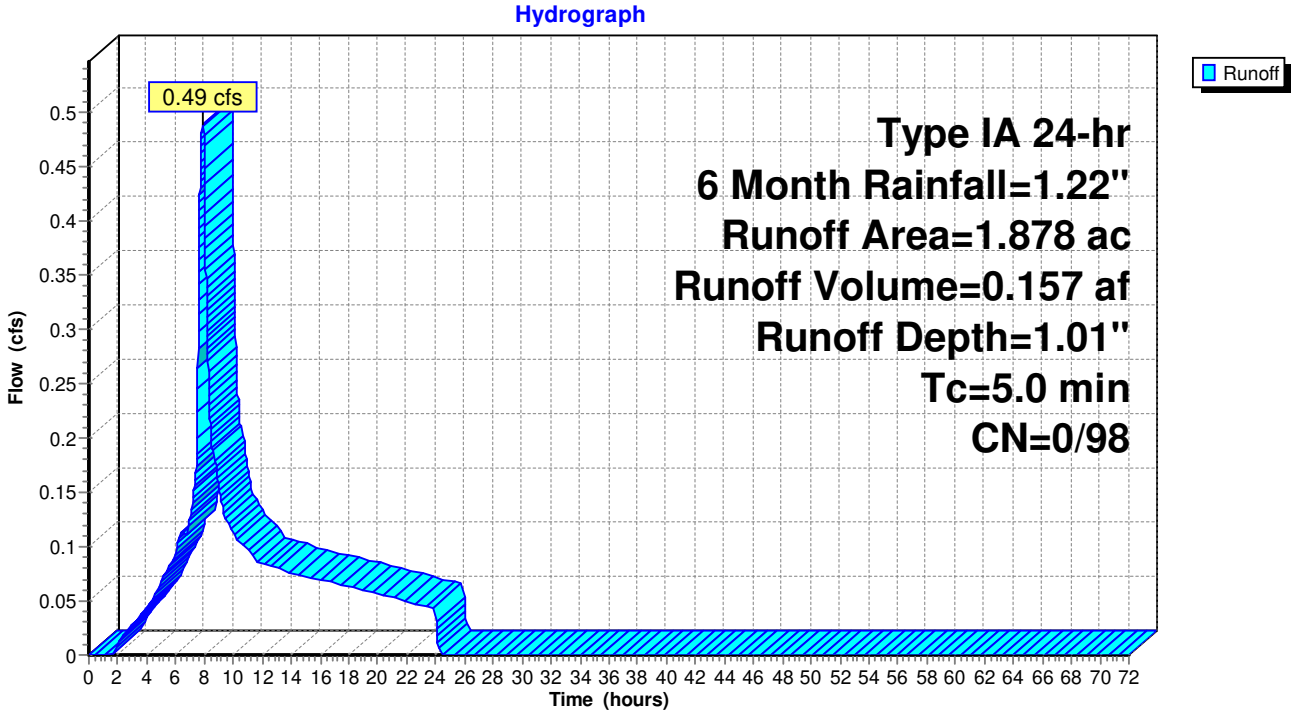
Runoff = 0.49 cfs @ 7.89 hrs, Volume= 0.157 af, Depth= 1.01"
Routed to Pond 2P : S-1 West WQ Bioretention Area

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type IA 24-hr 6 Month Rainfall=1.22"

	Area (ac)	CN	Description
*	1.878	98	Roads
	1.878	98	100.00% Impervious Area

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

Subcatchment 1S: S-1 West Basin



Summary for Pond 2P: S-1 West WQ Bioretention Area

Inflow Area = 1.878 ac,100.00% Impervious, Inflow Depth = 1.01" for 6 Month event
Inflow = 0.49 cfs @ 7.89 hrs, Volume= 0.157 af
Outflow = 0.12 cfs @ 9.89 hrs, Volume= 0.157 af, Atten= 76%, Lag= 119.7 min
Discarded = 0.12 cfs @ 9.89 hrs, Volume= 0.157 af
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Peak Elev= 100.96' @ 9.89 hrs Surf.Area= 0.038 ac Storage= 0.031 af

Plug-Flow detention time= 105.9 min calculated for 0.157 af (100% of inflow)
Center-of-Mass det. time= 105.9 min (808.0 - 702.1)

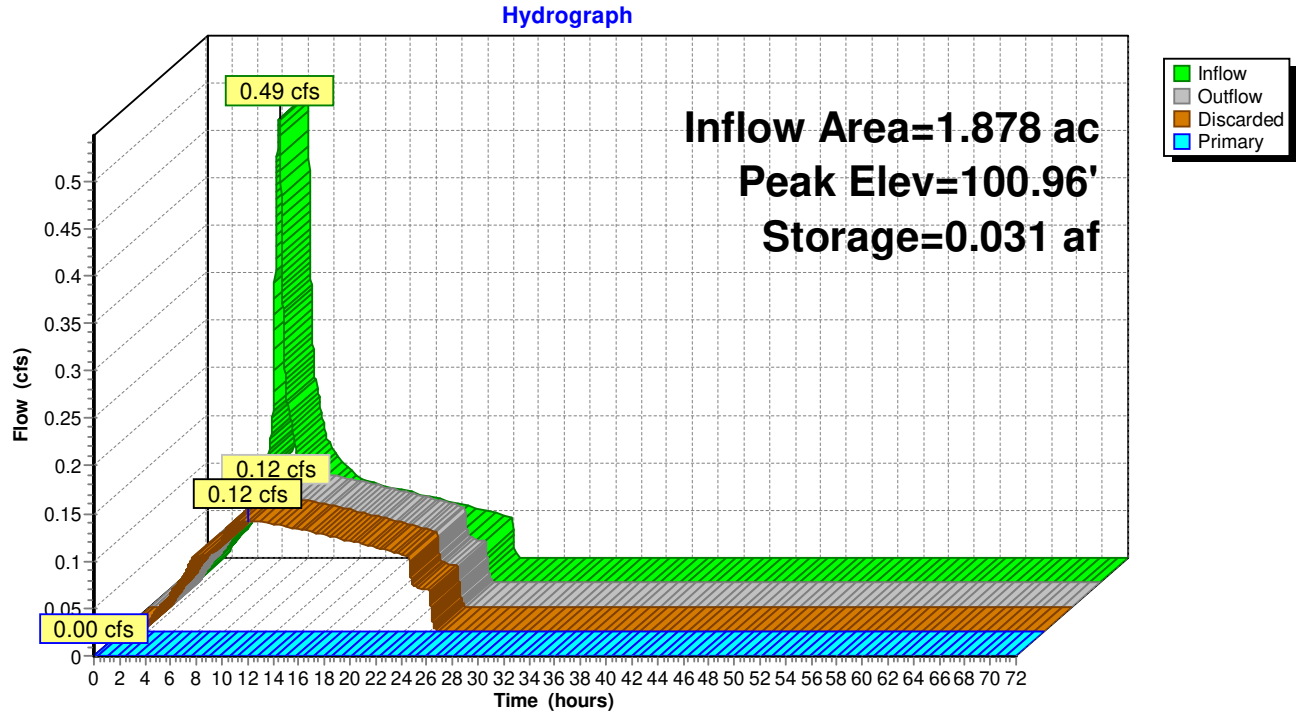
Volume	Invert	Avail.Storage	Storage Description
#1	100.00'	0.079 af	**15.00'W x 75.00'L x 2.00'H Prismatoid Z=3.0**

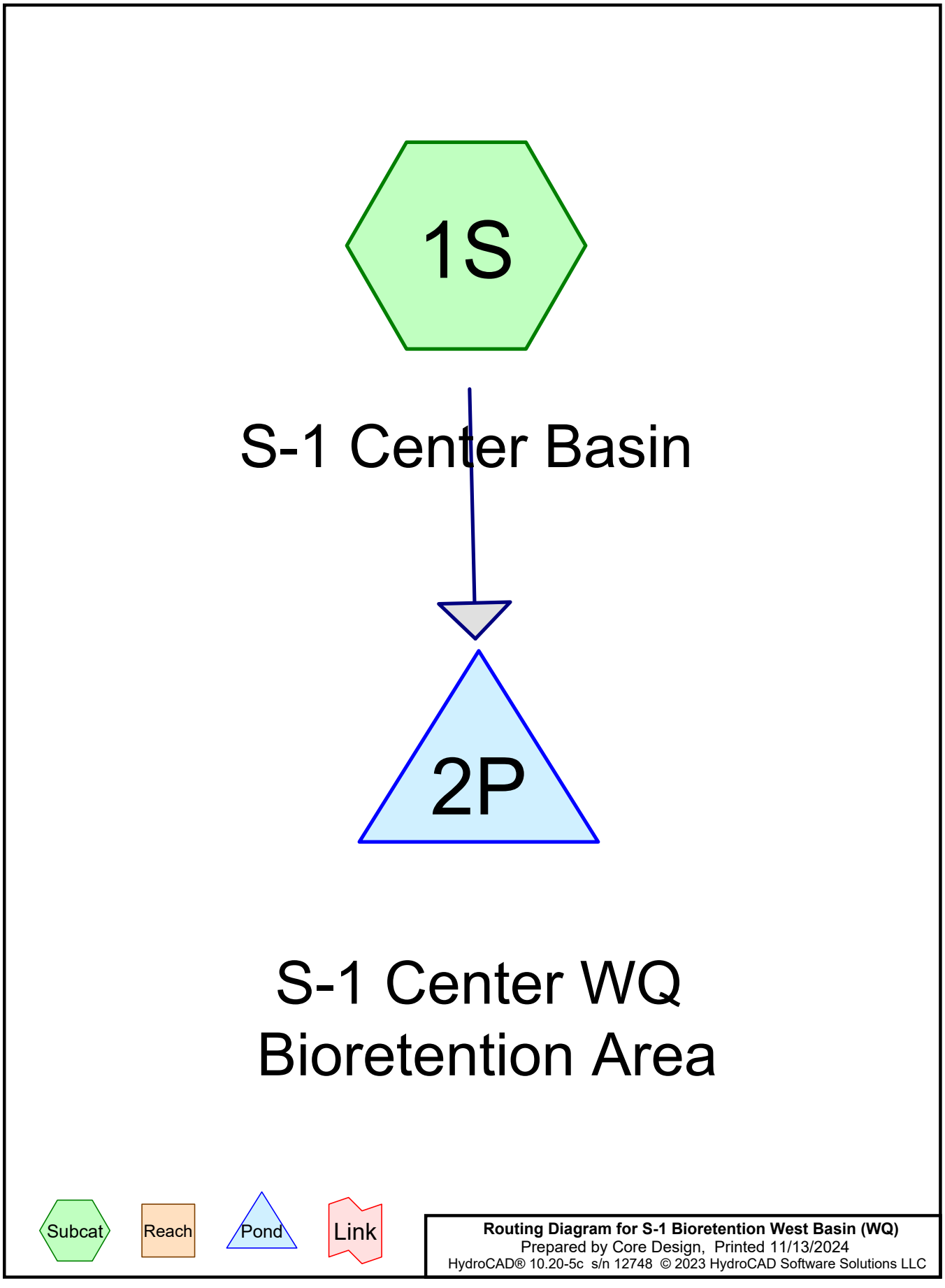
Device	Routing	Invert	Outlet Devices
#1	Primary	101.00'	**24.0" Vert. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#2	Discarded	100.00'	**3.000 in/hr Exfiltration over Surface area**

Discarded OutFlow Max=0.12 cfs @ 9.89 hrs HW=100.96' (Free Discharge)
└**2=Exfiltration** (Exfiltration Controls 0.12 cfs)

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=100.00' (Free Discharge)
└**1=Orifice/Grate** (Controls 0.00 cfs)

Pond 2P: S-1 West WQ Bioretention Area





Routing Diagram for S-1 Bioretention West Basin (WQ)
Prepared by Core Design, Printed 11/13/2024
HydroCAD® 10.20-5c s/n 12748 © 2023 HydroCAD Software Solutions LLC

Area Listing (all nodes)

Area (acres)	CN	Description (subcatchment-numbers)
5.810	98	Roads (1S)
5.810	**98**	**TOTAL AREA**

Soil Listing (all nodes)

Area (acres)	Soil Group	Subcatchment Numbers
0.000	HSG A	
0.000	HSG B	
0.000	HSG C	
0.000	HSG D	
5.810	Other	1S
5.810		**TOTAL AREA**

Ground Covers (all nodes)

HSG-A (acres)	HSG-B (acres)	HSG-C (acres)	HSG-D (acres)	Other (acres)	Total (acres)	Ground Cover	Subcatchment Numbers
0.000	0.000	0.000	0.000	5.810	5.810	Roads	1S
0.000	**0.000**	**0.000**	**0.000**	**5.810**	**5.810**	**TOTAL AREA**	

Time span=0.00-72.00 hrs, dt=0.05 hrs, 1441 points
Runoff by SBUH method, Split Pervious/Imperv.
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment1S: S-1 Center Basin Runoff Area=5.810 ac 100.00% Impervious Runoff Depth=1.39"
Tc=5.0 min CN=0/98 Runoff=2.08 cfs 0.672 af

Pond 2P: S-1 Center WQ Bioretention Area Peak Elev=101.00' Storage=0.135 af Inflow=2.08 cfs 0.672 af
Discarded=0.44 cfs 0.672 af Primary=0.00 cfs 0.000 af Outflow=0.44 cfs 0.672 af

Total Runoff Area = 5.810 ac Runoff Volume = 0.672 af Average Runoff Depth = 1.39"
0.00% Pervious = 0.000 ac 100.00% Impervious = 5.810 ac

Summary for Subcatchment 1S: S-1 Center Basin

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

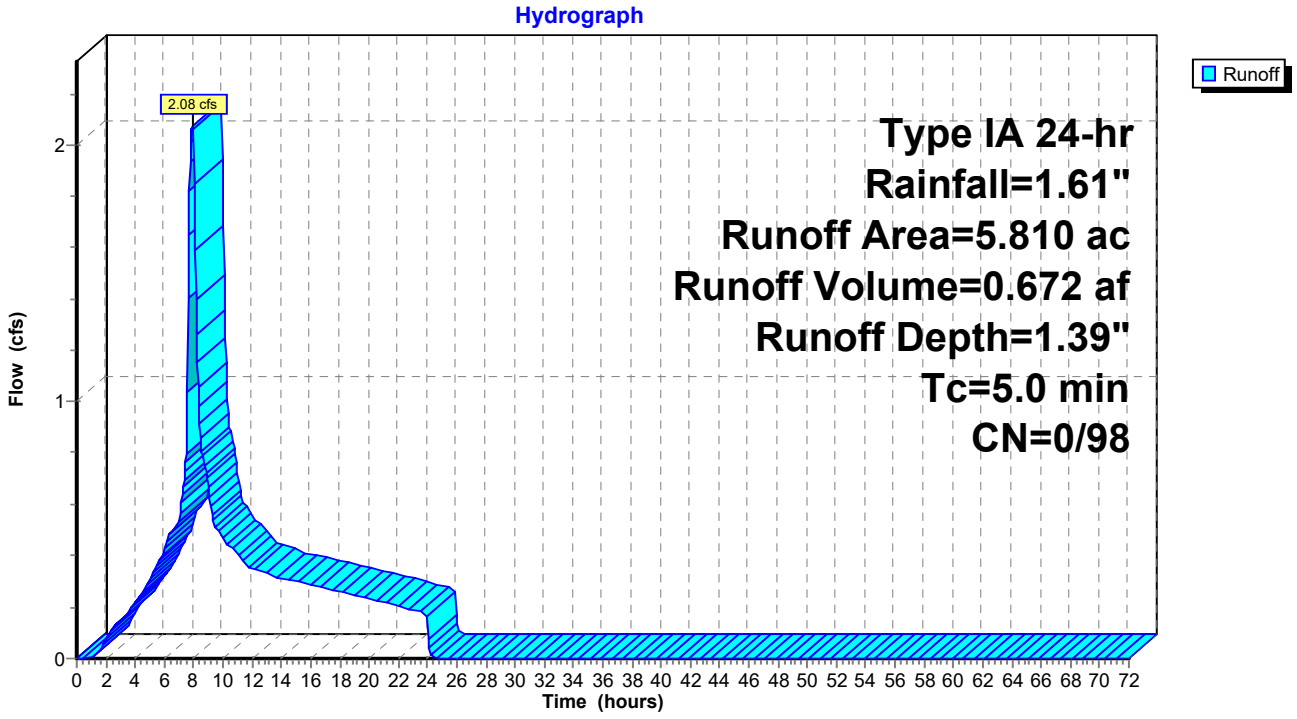
Runoff = 2.08 cfs @ 7.91 hrs, Volume= 0.672 af, Depth= 1.39"
Routed to Pond 2P : S-1 Center WQ Bioretention Area

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type IA 24-hr Rainfall=1.61"

	Area (ac)	CN	Description
*	5.810	98	Roads
	5.810	98	100.00% Impervious Area

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

Subcatchment 1S: S-1 Center Basin



Hydrograph for Subcatchment 1S: S-1 Center Basin

Time (hours)	Precip. (inches)	Perv.Excess (inches)	Imp.Excess (inches)	Runoff (cfs)
0.00	0.00	**0.00**	0.00	0.00
2.50	0.11	0.00	0.02	0.12
5.00	0.25	0.00	0.11	0.31
7.50	0.50	0.00	0.32	**0.80**
10.00	0.93	0.00	0.72	**0.48**
12.50	1.10	0.00	0.89	0.35
15.00	1.24	0.00	1.02	0.30
17.50	1.36	0.00	1.14	0.27
20.00	1.47	0.00	1.25	0.23
22.50	**1.56**	0.00	**1.34**	0.20
25.00	**1.61**	0.00	**1.39**	0.00
27.50	1.61	0.00	1.39	0.00
30.00	1.61	0.00	1.39	0.00
32.50	1.61	0.00	1.39	0.00
35.00	1.61	0.00	1.39	0.00
37.50	1.61	0.00	1.39	0.00
40.00	1.61	0.00	1.39	0.00
42.50	1.61	0.00	1.39	0.00
45.00	1.61	0.00	1.39	0.00
47.50	1.61	0.00	1.39	0.00
50.00	1.61	0.00	1.39	0.00
52.50	1.61	0.00	1.39	0.00
55.00	1.61	0.00	1.39	0.00
57.50	1.61	0.00	1.39	0.00
60.00	1.61	0.00	1.39	0.00
62.50	1.61	0.00	1.39	0.00
65.00	1.61	0.00	1.39	0.00
67.50	1.61	0.00	1.39	0.00
70.00	1.61	0.00	1.39	0.00

Summary for Pond 2P: S-1 Center WQ Bioretention Area

Inflow Area = 5.810 ac,100.00% Impervious, Inflow Depth = 1.39"
Inflow = 2.08 cfs @ 7.91 hrs, Volume= 0.672 af
Outflow = 0.44 cfs @ 10.28 hrs, Volume= 0.672 af, Atten= 79%, Lag= 142.5 min
Discarded = 0.44 cfs @ 10.28 hrs, Volume= 0.672 af
Primary = 0.00 cfs @ 10.28 hrs, Volume= 0.000 af

Routing by Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Peak Elev= 101.00' @ 10.28 hrs Surf.Area= 0.146 ac Storage= 0.135 af

Plug-Flow detention time= 119.4 min calculated for 0.672 af (100% of inflow)
Center-of-Mass det. time= 119.3 min (809.6 - 690.3)

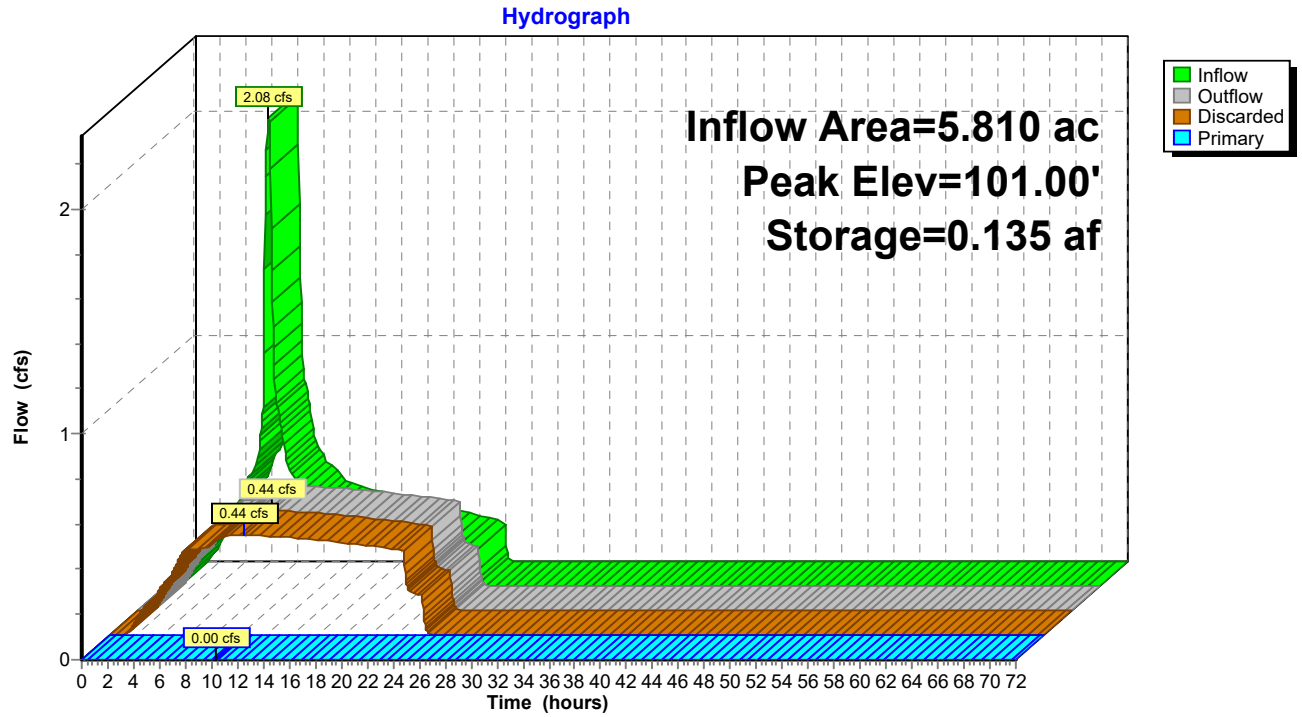
Volume	Invert	Avail.Storage	Storage Description
#1	100.00'	0.476 af	**102.00'W x 53.00'L x 3.00'H Prismatoid Z=3.0**

Device	Routing	Invert	Outlet Devices
#1	Primary	101.00'	**24.0" Vert. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#2	Discarded	100.00'	**3.000 in/hr Exfiltration over Surface area**

Discarded OutFlow Max=0.44 cfs @ 10.28 hrs HW=101.00' (Free Discharge)
└**2=Exfiltration** (Exfiltration Controls 0.44 cfs)

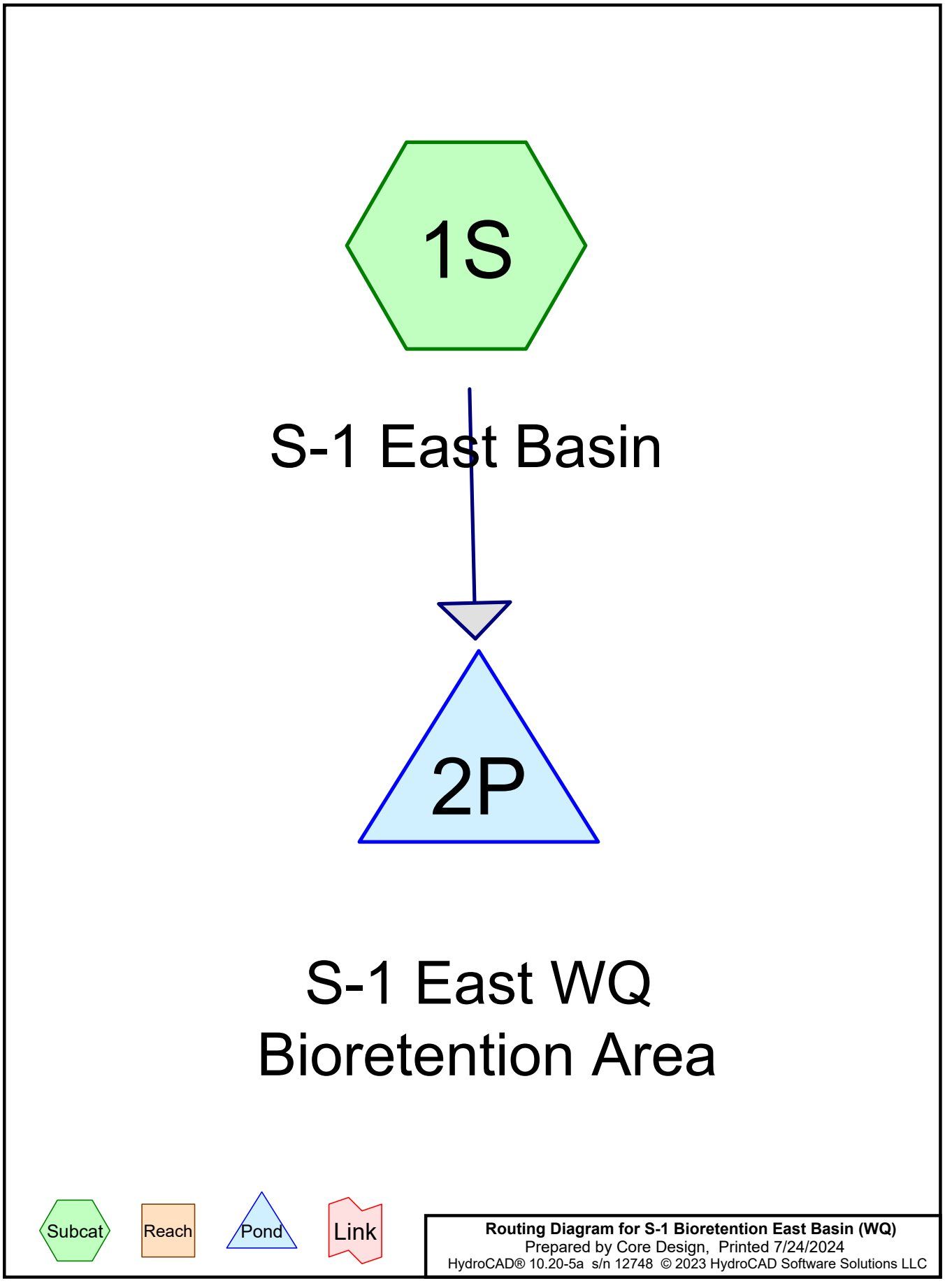
Primary OutFlow Max=0.00 cfs @ 10.28 hrs HW=101.00' (Free Discharge)
└**1=Orifice/Grate** (Orifice Controls 0.00 cfs @ 0.08 fps)

Pond 2P: S-1 Center WQ Bioretention Area



Hydrograph for Pond 2P: S-1 Center WQ Bioretention Area

Time (hours)	Inflow (cfs)	Storage (acre-feet)	Elevation (feet)	Outflow (cfs)	Discarded (cfs)	Primary (cfs)
0.00	0.00	0.000	100.00	0.00	0.00	0.00
2.50	0.12	0.001	100.01	0.11	0.11	0.00
5.00	0.31	0.003	100.02	0.29	0.29	0.00
7.50	**0.80**	0.024	100.19	0.39	0.39	0.00
10.00	**0.48**	**0.135**	**101.00**	**0.44**	**0.44**	**0.00**
12.50	0.35	**0.125**	**100.93**	**0.44**	**0.44**	**0.00**
15.00	0.30	0.102	100.77	0.43	0.43	0.00
17.50	0.27	0.074	100.57	0.41	0.41	0.00
20.00	0.23	0.042	100.33	0.40	0.40	0.00
22.50	0.20	0.006	100.05	0.38	0.38	0.00
25.00	0.00	0.000	100.00	0.00	0.00	0.00
27.50	0.00	0.000	100.00	0.00	0.00	0.00
30.00	0.00	0.000	100.00	0.00	0.00	0.00
32.50	0.00	0.000	100.00	0.00	0.00	0.00
35.00	0.00	0.000	100.00	0.00	0.00	0.00
37.50	0.00	0.000	100.00	0.00	0.00	0.00
40.00	0.00	0.000	100.00	0.00	0.00	0.00
42.50	0.00	0.000	100.00	0.00	0.00	0.00
45.00	0.00	0.000	100.00	0.00	0.00	0.00
47.50	0.00	0.000	100.00	0.00	0.00	0.00
50.00	0.00	0.000	100.00	0.00	0.00	0.00
52.50	0.00	0.000	100.00	0.00	0.00	0.00
55.00	0.00	0.000	100.00	0.00	0.00	0.00
57.50	0.00	0.000	100.00	0.00	0.00	0.00
60.00	0.00	0.000	100.00	0.00	0.00	0.00
62.50	0.00	0.000	100.00	0.00	0.00	0.00
65.00	0.00	0.000	100.00	0.00	0.00	0.00
67.50	0.00	0.000	100.00	0.00	0.00	0.00
70.00	0.00	0.000	100.00	0.00	0.00	0.00


1S
S-1 East Basin
2P
S-1 East WQ
Bioretention Area
Subcat
Reach
Pond
Link
Routing Diagram for S-1 Bioretention East Basin (WQ)
Prepared by Core Design, Printed 7/24/2024
HydroCAD® 10.20-5a s/n 12748 © 2023 HydroCAD Software Solutions LLC

Area Listing (all nodes)

Area (acres)	CN	Description (subcatchment-numbers)
3.000	98	Roads (1S)
3.000	**98**	**TOTAL AREA**

Soil Listing (all nodes)

Area (acres)	Soil Group	Subcatchment Numbers
0.000	HSG A	
0.000	HSG B	
0.000	HSG C	
0.000	HSG D	
3.000	Other	1S
3.000		**TOTAL AREA**

Ground Covers (all nodes)

HSG-A (acres)	HSG-B (acres)	HSG-C (acres)	HSG-D (acres)	Other (acres)	Total (acres)	Ground Cover	Subcatchment Numbers
0.000	0.000	0.000	0.000	3.000	3.000	Roads	1S
0.000	**0.000**	**0.000**	**0.000**	**3.000**	**3.000**	**TOTAL AREA**	

Time span=0.00-72.00 hrs, dt=0.05 hrs, 1441 points
Runoff by SBUH method, Split Pervious/Imperv.
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment1S: S-1 East Basin Runoff Area=3.000 ac 100.00% Impervious Runoff Depth=1.39"
Tc=5.0 min CN=0/98 Runoff=1.07 cfs 0.347 af

Pond 2P: S-1 East WQ Bioretention Area Peak Elev=100.94' Storage=0.068 af Inflow=1.07 cfs 0.347 af
Discarded=0.22 cfs 0.347 af Primary=0.00 cfs 0.000 af Outflow=0.22 cfs 0.347 af

Total Runoff Area = 3.000 ac Runoff Volume = 0.347 af Average Runoff Depth = 1.39"
0.00% Pervious = 0.000 ac 100.00% Impervious = 3.000 ac

Summary for Subcatchment 1S: S-1 East Basin

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

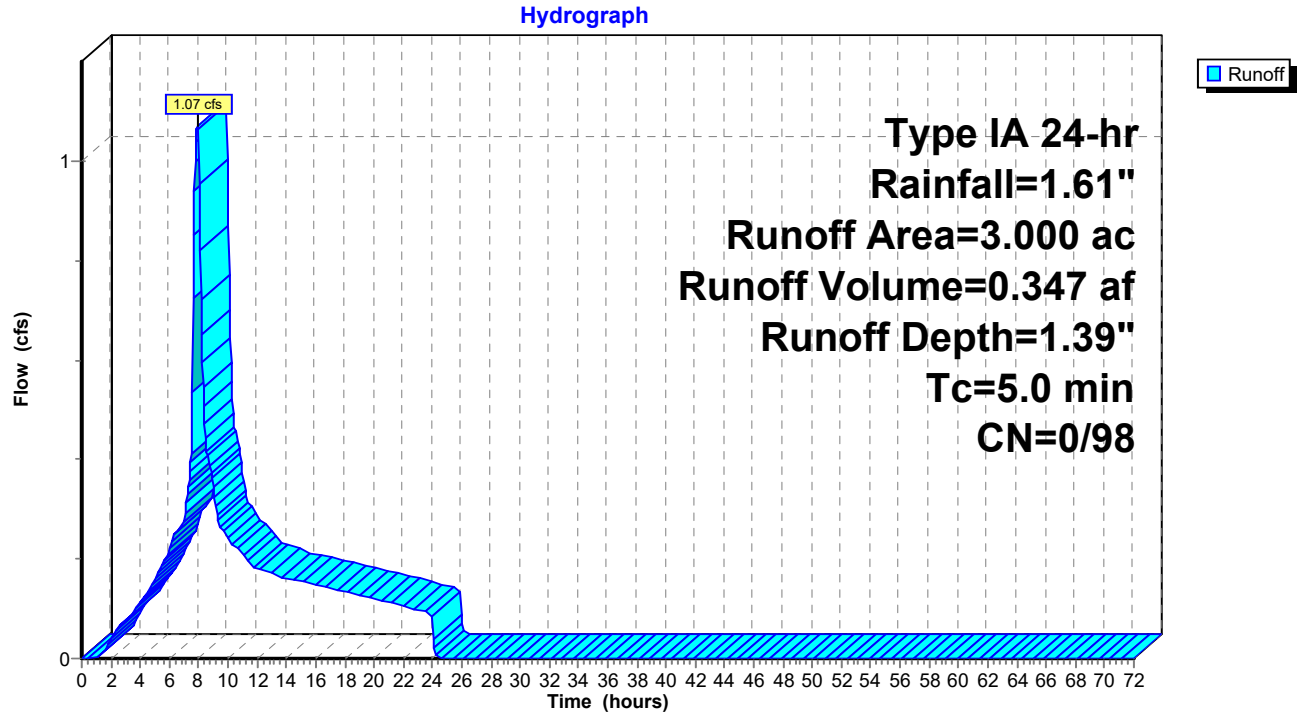
Runoff = 1.07 cfs @ 7.91 hrs, Volume= 0.347 af, Depth= 1.39"
Routed to Pond 2P : S-1 East WQ Bioretention Area

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type IA 24-hr Rainfall=1.61"

	Area (ac)	CN	Description
*	3.000	98	Roads
	3.000	98	100.00% Impervious Area

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

Subcatchment 1S: S-1 East Basin



Hydrograph for Subcatchment 1S: S-1 East Basin

Time (hours)	Precip. (inches)	Perv.Excess (inches)	Imp.Excess (inches)	Runoff (cfs)
0.00	0.00	**0.00**	0.00	0.00
2.50	0.11	0.00	0.02	0.06
5.00	0.25	0.00	0.11	0.16
7.50	0.50	0.00	0.32	**0.41**
10.00	0.93	0.00	0.72	**0.25**
12.50	1.10	0.00	0.89	0.18
15.00	1.24	0.00	1.02	0.16
17.50	1.36	0.00	1.14	0.14
20.00	1.47	0.00	1.25	0.12
22.50	**1.56**	0.00	**1.34**	0.10
25.00	**1.61**	0.00	**1.39**	0.00
27.50	1.61	0.00	1.39	0.00
30.00	1.61	0.00	1.39	0.00
32.50	1.61	0.00	1.39	0.00
35.00	1.61	0.00	1.39	0.00
37.50	1.61	0.00	1.39	0.00
40.00	1.61	0.00	1.39	0.00
42.50	1.61	0.00	1.39	0.00
45.00	1.61	0.00	1.39	0.00
47.50	1.61	0.00	1.39	0.00
50.00	1.61	0.00	1.39	0.00
52.50	1.61	0.00	1.39	0.00
55.00	1.61	0.00	1.39	0.00
57.50	1.61	0.00	1.39	0.00
60.00	1.61	0.00	1.39	0.00
62.50	1.61	0.00	1.39	0.00
65.00	1.61	0.00	1.39	0.00
67.50	1.61	0.00	1.39	0.00
70.00	1.61	0.00	1.39	0.00

Summary for Pond 2P: S-1 East WQ Bioretention Area

Inflow Area = 3.000 ac,100.00% Impervious, Inflow Depth = 1.39"
Inflow = 1.07 cfs @ 7.91 hrs, Volume= 0.347 af
Outflow = 0.22 cfs @ 6.15 hrs, Volume= 0.347 af, Atten= 80%, Lag= 0.0 min
Discarded = 0.22 cfs @ 6.15 hrs, Volume= 0.347 af
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Peak Elev= 100.94' @ 10.80 hrs Surf.Area= 0.072 ac Storage= 0.068 af

Plug-Flow detention time= 115.7 min calculated for 0.347 af (100% of inflow)
Center-of-Mass det. time= 115.7 min (806.0 - 690.3)

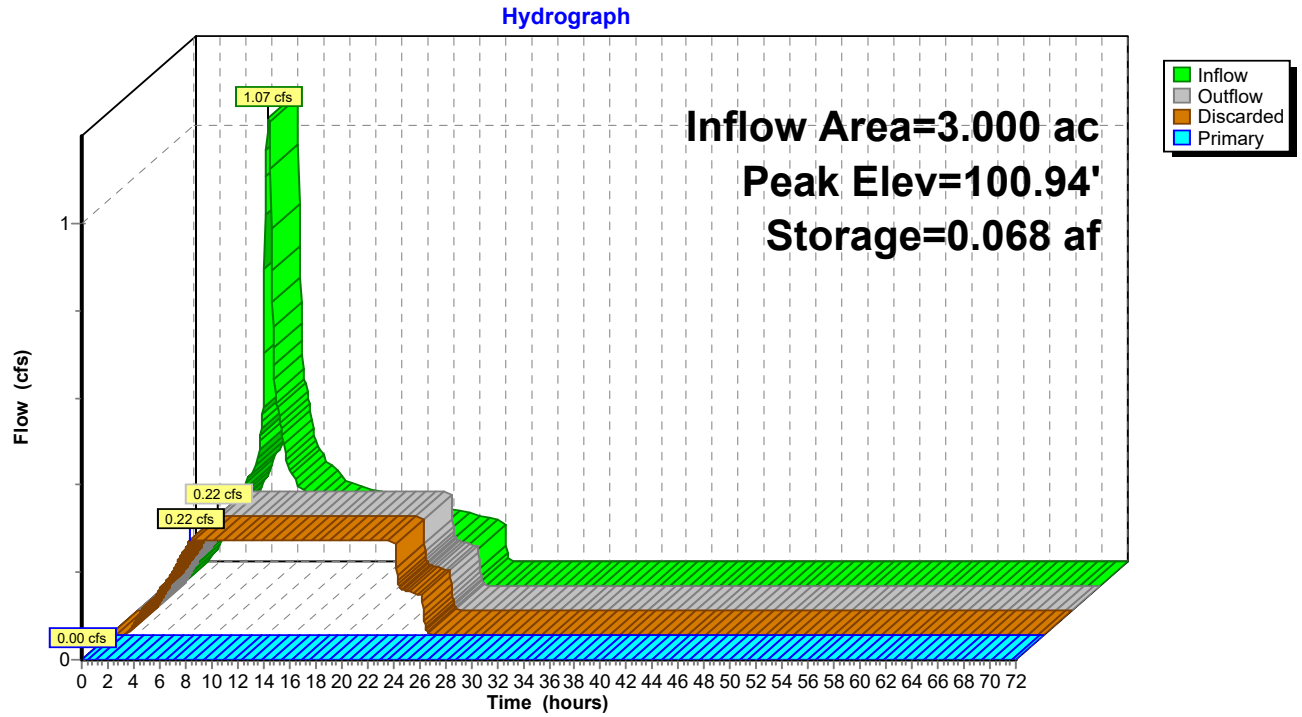
Volume	Invert	Avail.Storage	Storage Description
#1	100.00'	0.217 af	**45.00'W x 70.00'L x 3.00'H Prismatoid**

Device	Routing	Invert	Outlet Devices
#1	Primary	101.00'	**24.0" Vert. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#2	Discarded	100.00'	**3.000 in/hr Exfiltration over Surface area**

Discarded OutFlow Max=0.22 cfs @ 6.15 hrs HW=100.03' (Free Discharge)
↳**2=Exfiltration** (Exfiltration Controls 0.22 cfs)

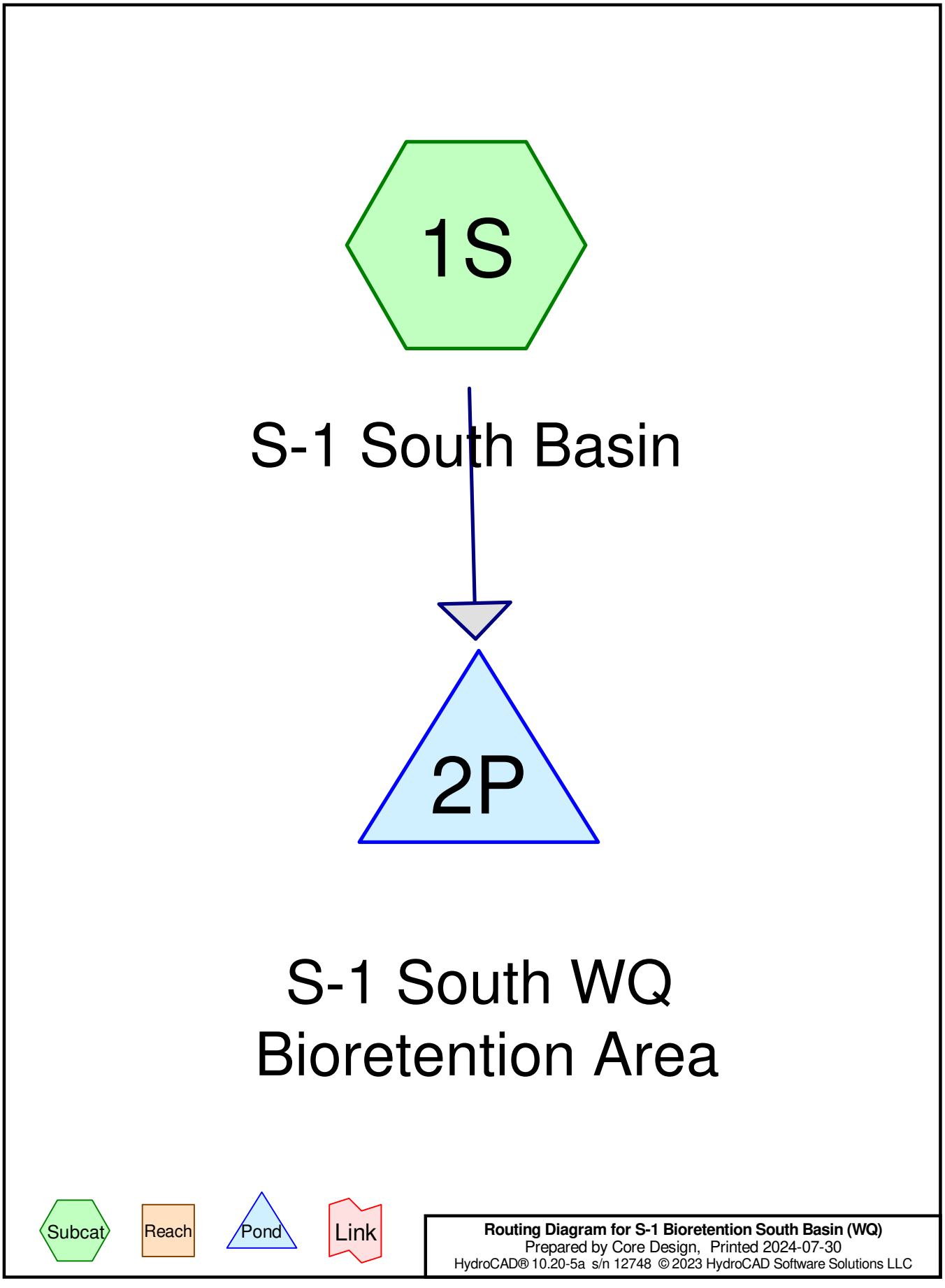
Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=100.00' (Free Discharge)
↳**1=Orifice/Grate** (Controls 0.00 cfs)

Pond 2P: S-1 East WQ Bioretention Area



Hydrograph for Pond 2P: S-1 East WQ Bioretention Area

Time (hours)	Inflow (cfs)	Storage (acre-feet)	Elevation (feet)	Outflow (cfs)	Discarded (cfs)	Primary (cfs)
0.00	0.00	0.000	100.00	0.00	0.00	**0.00**
2.50	0.06	0.001	100.01	0.06	0.06	0.00
5.00	0.16	0.002	100.02	**0.15**	**0.15**	0.00
7.50	**0.41**	0.010	100.13	**0.22**	**0.22**	0.00
10.00	**0.25**	**0.067**	**100.93**	0.22	0.22	0.00
12.50	0.18	**0.064**	**100.89**	0.22	0.22	0.00
15.00	0.16	0.053	100.73	0.22	0.22	0.00
17.50	0.14	0.038	100.53	0.22	0.22	0.00
20.00	0.12	0.020	100.27	0.22	0.22	0.00
22.50	0.10	0.001	100.01	0.10	0.10	0.00
25.00	0.00	0.000	100.00	0.00	0.00	0.00
27.50	0.00	0.000	100.00	0.00	0.00	0.00
30.00	0.00	0.000	100.00	0.00	0.00	0.00
32.50	0.00	0.000	100.00	0.00	0.00	0.00
35.00	0.00	0.000	100.00	0.00	0.00	0.00
37.50	0.00	0.000	100.00	0.00	0.00	0.00
40.00	0.00	0.000	100.00	0.00	0.00	0.00
42.50	0.00	0.000	100.00	0.00	0.00	0.00
45.00	0.00	0.000	100.00	0.00	0.00	0.00
47.50	0.00	0.000	100.00	0.00	0.00	0.00
50.00	0.00	0.000	100.00	0.00	0.00	0.00
52.50	0.00	0.000	100.00	0.00	0.00	0.00
55.00	0.00	0.000	100.00	0.00	0.00	0.00
57.50	0.00	0.000	100.00	0.00	0.00	0.00
60.00	0.00	0.000	100.00	0.00	0.00	0.00
62.50	0.00	0.000	100.00	0.00	0.00	0.00
65.00	0.00	0.000	100.00	0.00	0.00	0.00
67.50	0.00	0.000	100.00	0.00	0.00	0.00
70.00	0.00	0.000	100.00	0.00	0.00	0.00



Routing Diagram for S-1 Bioretention South Basin (WQ)
Prepared by Core Design, Printed 2024-07-30
HydroCAD® 10.20-5a s/n 12748 © 2023 HydroCAD Software Solutions LLC

Area Listing (all nodes)

Area (acres)	CN	Description (subcatchment-numbers)
1.050	98	Roads (1S)
1.050	**98**	**TOTAL AREA**

Soil Listing (all nodes)

Area (acres)	Soil Group	Subcatchment Numbers
0.000	HSG A	
0.000	HSG B	
0.000	HSG C	
0.000	HSG D	
1.050	Other	1S
1.050		**TOTAL AREA**

Ground Covers (all nodes)

HSG-A (acres)	HSG-B (acres)	HSG-C (acres)	HSG-D (acres)	Other (acres)	Total (acres)	Ground Cover	Subcatchment Numbers
0.000	0.000	0.000	0.000	1.050	1.050	Roads	1S
0.000	**0.000**	**0.000**	**0.000**	**1.050**	**1.050**	**TOTAL AREA**	

Time span=0.00-72.00 hrs, dt=0.05 hrs, 1441 points
Runoff by SBUH method, Split Pervious/Imperv.
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 1S: S-1 South Basin Runoff Area=1.050 ac 100.00% Impervious Runoff Depth=1.39"
Tc=5.0 min CN=0/98 Runoff=0.38 cfs 0.122 af

Pond 2P: S-1 South WQ Bioretention Area Peak Elev=100.98' Storage=0.024 af Inflow=0.38 cfs 0.122 af
Discarded=0.07 cfs 0.122 af Primary=0.00 cfs 0.000 af Outflow=0.07 cfs 0.122 af

Total Runoff Area = 1.050 ac Runoff Volume = 0.122 af Average Runoff Depth = 1.39"
0.00% Pervious = 0.000 ac 100.00% Impervious = 1.050 ac

Summary for Subcatchment 1S: S-1 South Basin

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

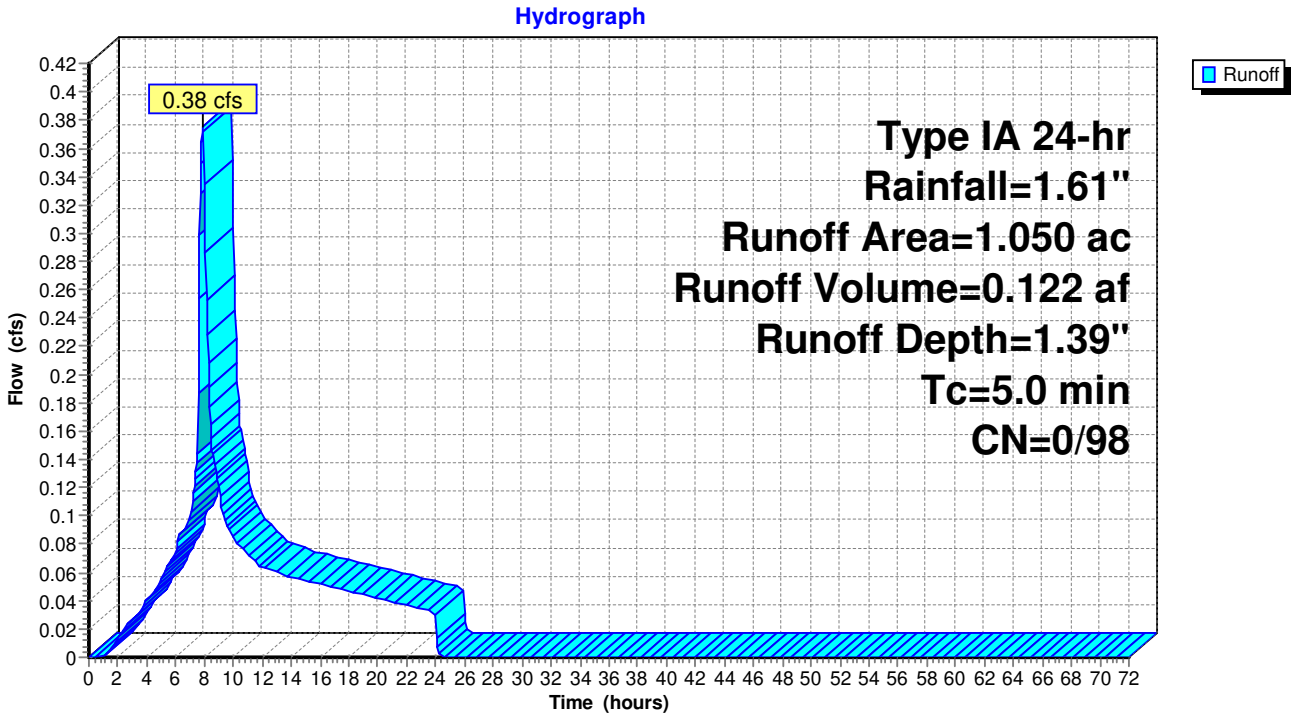
Runoff = 0.38 cfs @ 7.91 hrs, Volume= 0.122 af, Depth= 1.39"
Routed to Pond 2P : S-1 South WQ Bioretention Area

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type IA 24-hr Rainfall=1.61"

	Area (ac)	CN	Description
*	1.050	98	Roads
	1.050	98	100.00% Impervious Area

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

Subcatchment 1S: S-1 South Basin



Summary for Pond 2P: S-1 South WQ Bioretention Area

Inflow Area = 1.050 ac,100.00% Impervious, Inflow Depth = 1.39"
Inflow = 0.38 cfs @ 7.91 hrs, Volume= 0.122 af
Outflow = 0.07 cfs @ 6.10 hrs, Volume= 0.122 af, Atten= 80%, Lag= 0.0 min
Discarded = 0.07 cfs @ 6.10 hrs, Volume= 0.122 af
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Peak Elev= 100.98' @ 10.93 hrs Surf.Area= 0.025 ac Storage= 0.024 af

Plug-Flow detention time= 124.3 min calculated for 0.121 af (100% of inflow)
Center-of-Mass det. time= 124.2 min (814.5 - 690.3)

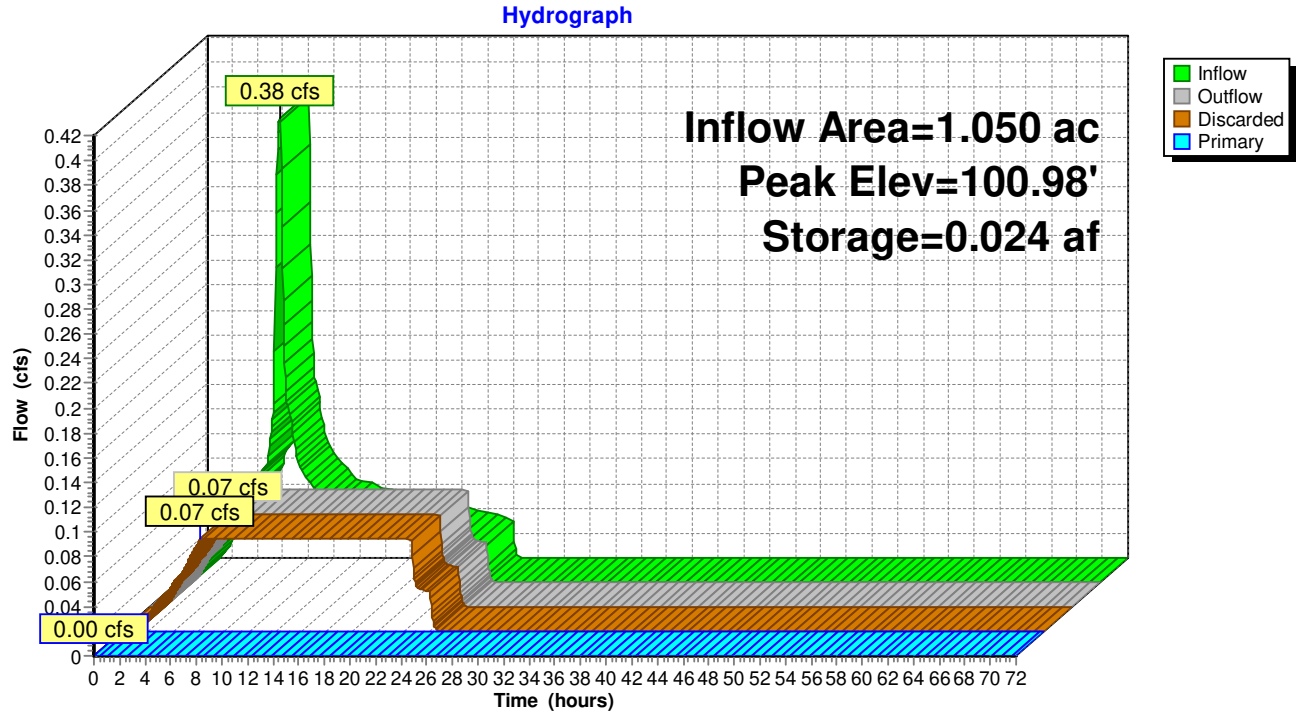
Volume	Invert	Avail.Storage	Storage Description
#1	100.00'	0.074 af	**12.00'W x 90.00'L x 3.00'H Prismatoid**

Device	Routing	Invert	Outlet Devices
#1	Primary	101.00'	**24.0" Vert. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#2	Discarded	100.00'	**3.000 in/hr Exfiltration over Surface area**

Discarded OutFlow Max=0.07 cfs @ 6.10 hrs HW=100.03' (Free Discharge)
↑—**2=Exfiltration** (Exfiltration Controls 0.07 cfs)

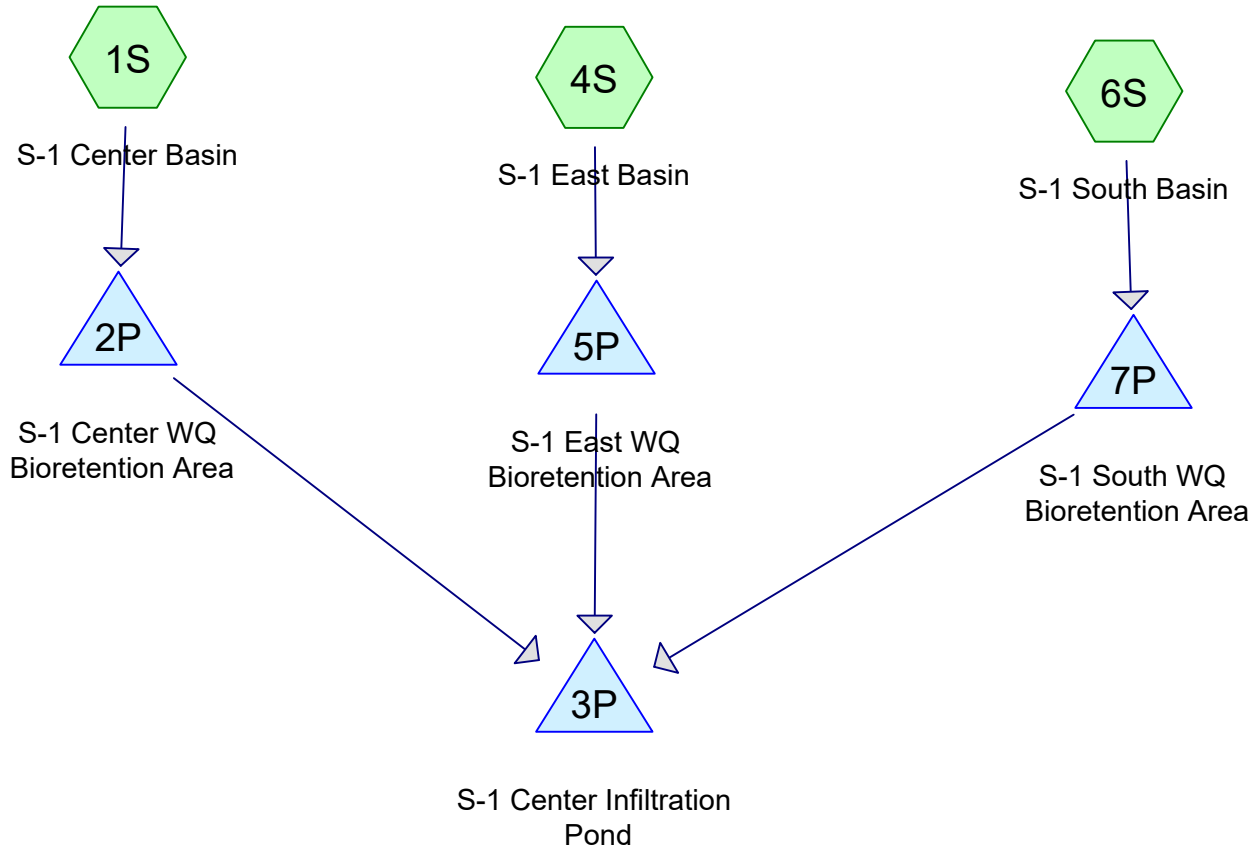
Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=100.00' (Free Discharge)
↑—**1=Orifice/Grate** (Controls 0.00 cfs)

Pond 2P: S-1 South WQ Bioretention Area



Appendix B

Overall HydroCAD Report



Subcat Reach Pond Link

Routing Diagram for S-1 Bioretention & Infiltration Ponds Connected
Prepared by Core Design, Printed 11/13/2024
HydroCAD® 10.20-5c s/n 12748 © 2023 HydroCAD Software Solutions LLC

Area Listing (all nodes)

Area (acres)	CN	Description (subcatchment-numbers)
9.860	98	Roads (1S, 4S, 6S)
9.860	**98**	**TOTAL AREA**

Soil Listing (all nodes)

Area (acres)	Soil Group	Subcatchment Numbers
0.000	HSG A	
0.000	HSG B	
0.000	HSG C	
0.000	HSG D	
9.860	Other	1S, 4S, 6S
9.860		**TOTAL AREA**

Ground Covers (all nodes)

HSG-A (acres)	HSG-B (acres)	HSG-C (acres)	HSG-D (acres)	Other (acres)	Total (acres)	Ground Cover	Subcatchment Numbers
0.000	0.000	0.000	0.000	9.860	9.860	Roads	1S, 4S, 6S
0.000	**0.000**	**0.000**	**0.000**	**9.860**	**9.860**	**TOTAL AREA**	

Time span=0.00-72.00 hrs, dt=0.05 hrs, 1441 points
Runoff by SBUH method, Split Pervious/Imperv.
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment1S: S-1 Center Basin Runoff Area=5.810 ac 100.00% Impervious Runoff Depth=5.65"
Tc=5.0 min CN=0/98 Runoff=8.11 cfs 2.737 af

Subcatchment4S: S-1 East Basin Runoff Area=3.000 ac 100.00% Impervious Runoff Depth=5.65"
Tc=5.0 min CN=0/98 Runoff=4.19 cfs 1.413 af

Subcatchment6S: S-1 South Basin Runoff Area=1.050 ac 100.00% Impervious Runoff Depth=5.65"
Tc=5.0 min CN=0/98 Runoff=1.47 cfs 0.495 af

Pond 2P: S-1 Center WQ Bioretention Area Peak Elev=101.51' Storage=0.212 af Inflow=8.11 cfs 2.737 af
Discarded=0.48 cfs 0.995 af Primary=7.45 cfs 1.742 af Outflow=7.92 cfs 2.737 af

Pond 3P: S-1 Center Infiltration Pond Peak Elev=5.87' Storage=1.432 af Inflow=12.74 cfs 2.987 af
Discarded=1.34 cfs 2.987 af Primary=0.00 cfs 0.000 af Outflow=1.34 cfs 2.987 af

Pond 5P: S-1 East WQ Bioretention Area Peak Elev=101.33' Storage=0.096 af Inflow=4.19 cfs 1.413 af
Discarded=0.22 cfs 0.494 af Primary=3.94 cfs 0.919 af Outflow=4.16 cfs 1.413 af

Pond 7P: S-1 South WQ Bioretention Area Peak Elev=101.17' Storage=0.029 af Inflow=1.47 cfs 0.495 af
Discarded=0.07 cfs 0.169 af Primary=1.39 cfs 0.326 af Outflow=1.46 cfs 0.495 af

Total Runoff Area = 9.860 ac Runoff Volume = 4.644 af Average Runoff Depth = 5.65"
0.00% Pervious = 0.000 ac 100.00% Impervious = 9.860 ac

Summary for Subcatchment 1S: S-1 Center Basin

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

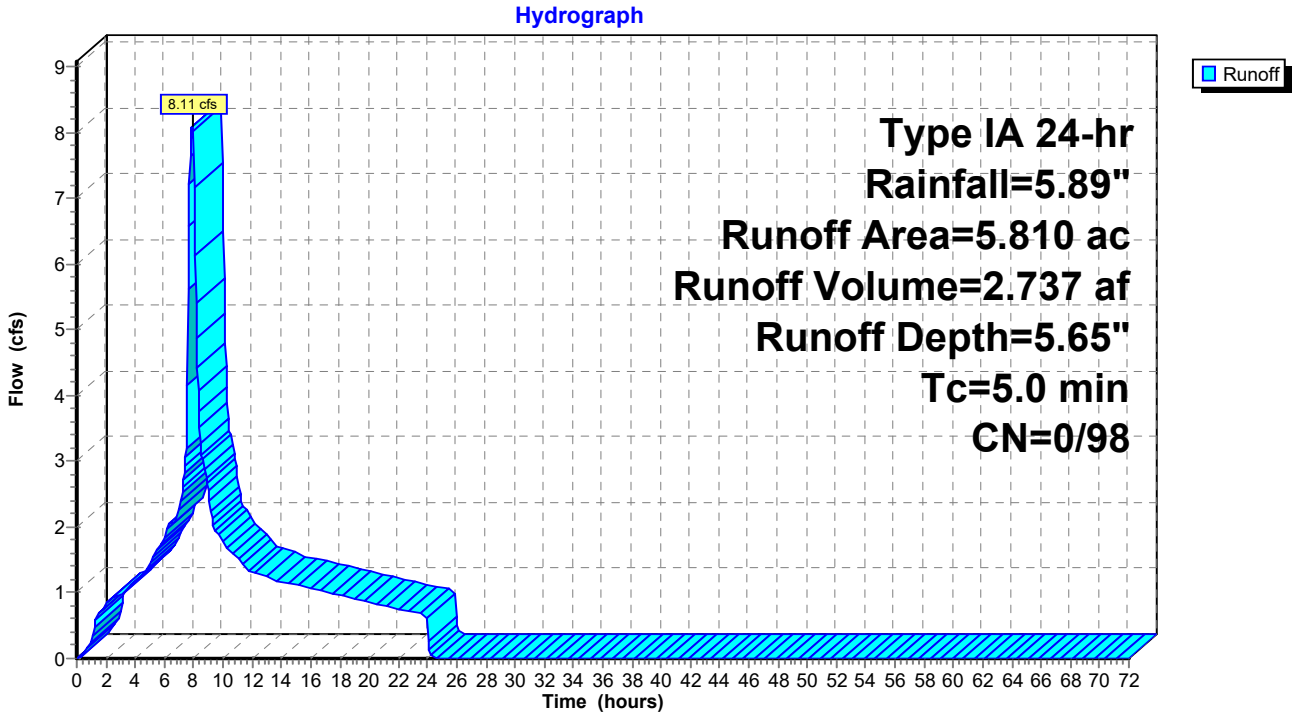
Runoff = 8.11 cfs @ 7.89 hrs, Volume= 2.737 af, Depth= 5.65"
Routed to Pond 2P : S-1 Center WQ Bioretention Area

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type IA 24-hr Rainfall=5.89"

	Area (ac)	CN	Description
*	5.810	98	Roads
	5.810	98	100.00% Impervious Area

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

Subcatchment 1S: S-1 Center Basin



Hydrograph for Subcatchment 1S: S-1 Center Basin

Time (hours)	Precip. (inches)	Perv.Excess (inches)	Imp.Excess (inches)	Runoff (cfs)
0.00	0.00	**0.00**	0.00	0.00
2.50	0.39	0.00	0.22	0.95
5.00	0.92	0.00	0.71	1.44
7.50	1.83	0.00	1.60	**3.19**
10.00	3.40	0.00	3.17	**1.80**
12.50	4.02	0.00	3.79	1.33
15.00	4.53	0.00	4.29	1.12
17.50	4.98	0.00	4.74	0.99
20.00	5.38	0.00	5.14	0.86
22.50	**5.71**	0.00	**5.48**	0.73
25.00	**5.89**	0.00	**5.65**	0.00
27.50	5.89	0.00	5.65	0.00
30.00	5.89	0.00	5.65	0.00
32.50	5.89	0.00	5.65	0.00
35.00	5.89	0.00	5.65	0.00
37.50	5.89	0.00	5.65	0.00
40.00	5.89	0.00	5.65	0.00
42.50	5.89	0.00	5.65	0.00
45.00	5.89	0.00	5.65	0.00
47.50	5.89	0.00	5.65	0.00
50.00	5.89	0.00	5.65	0.00
52.50	5.89	0.00	5.65	0.00
55.00	5.89	0.00	5.65	0.00
57.50	5.89	0.00	5.65	0.00
60.00	5.89	0.00	5.65	0.00
62.50	5.89	0.00	5.65	0.00
65.00	5.89	0.00	5.65	0.00
67.50	5.89	0.00	5.65	0.00
70.00	5.89	0.00	5.65	0.00

Summary for Subcatchment 4S: S-1 East Basin

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

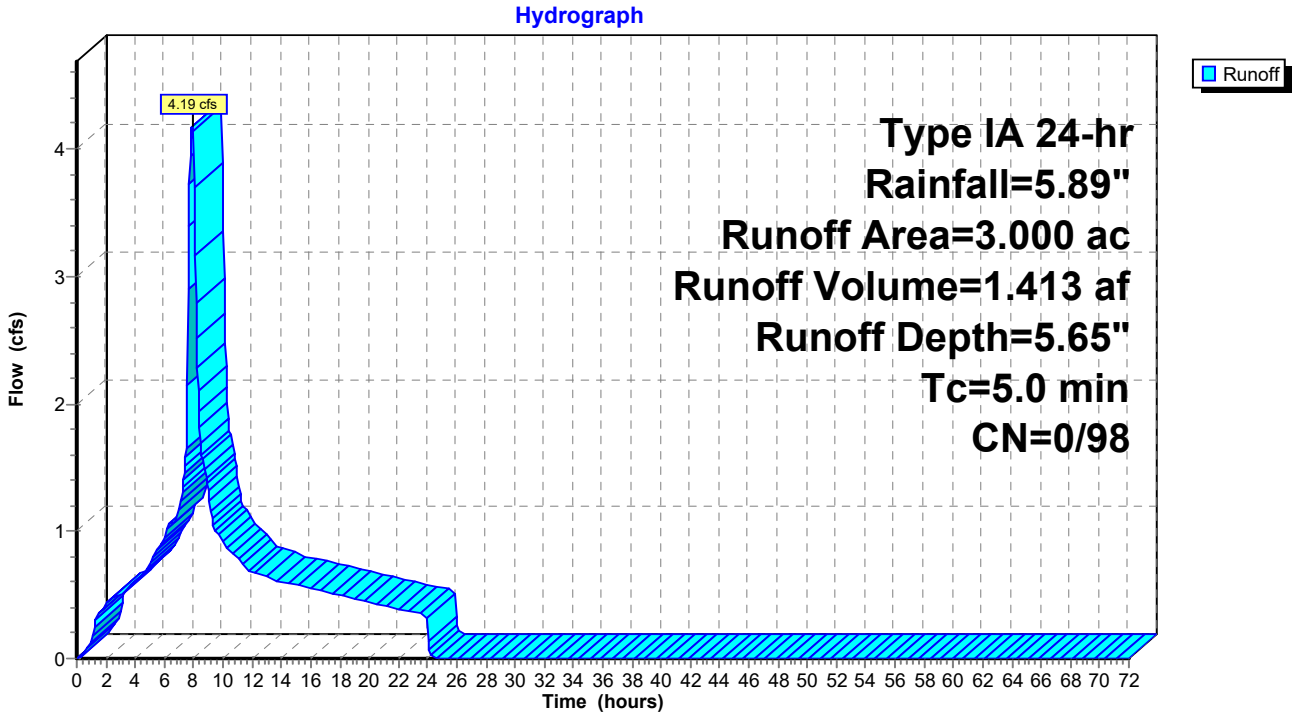
Runoff = 4.19 cfs @ 7.89 hrs, Volume= 1.413 af, Depth= 5.65"
Routed to Pond 5P : S-1 East WQ Bioretention Area

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type IA 24-hr Rainfall=5.89"

	Area (ac)	CN	Description
*	3.000	98	Roads
	3.000	98	100.00% Impervious Area

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

Subcatchment 4S: S-1 East Basin



Hydrograph for Subcatchment 4S: S-1 East Basin

Time (hours)	Precip. (inches)	Perv.Excess (inches)	Imp.Excess (inches)	Runoff (cfs)
0.00	0.00	**0.00**	0.00	0.00
2.50	0.39	0.00	0.22	0.49
5.00	0.92	0.00	0.71	0.75
7.50	1.83	0.00	1.60	**1.65**
10.00	3.40	0.00	3.17	**0.93**
12.50	4.02	0.00	3.79	0.69
15.00	4.53	0.00	4.29	0.58
17.50	4.98	0.00	4.74	0.51
20.00	5.38	0.00	5.14	0.45
22.50	**5.71**	0.00	**5.48**	0.38
25.00	**5.89**	0.00	**5.65**	0.00
27.50	5.89	0.00	5.65	0.00
30.00	5.89	0.00	5.65	0.00
32.50	5.89	0.00	5.65	0.00
35.00	5.89	0.00	5.65	0.00
37.50	5.89	0.00	5.65	0.00
40.00	5.89	0.00	5.65	0.00
42.50	5.89	0.00	5.65	0.00
45.00	5.89	0.00	5.65	0.00
47.50	5.89	0.00	5.65	0.00
50.00	5.89	0.00	5.65	0.00
52.50	5.89	0.00	5.65	0.00
55.00	5.89	0.00	5.65	0.00
57.50	5.89	0.00	5.65	0.00
60.00	5.89	0.00	5.65	0.00
62.50	5.89	0.00	5.65	0.00
65.00	5.89	0.00	5.65	0.00
67.50	5.89	0.00	5.65	0.00
70.00	5.89	0.00	5.65	0.00

Summary for Subcatchment 6S: S-1 South Basin

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

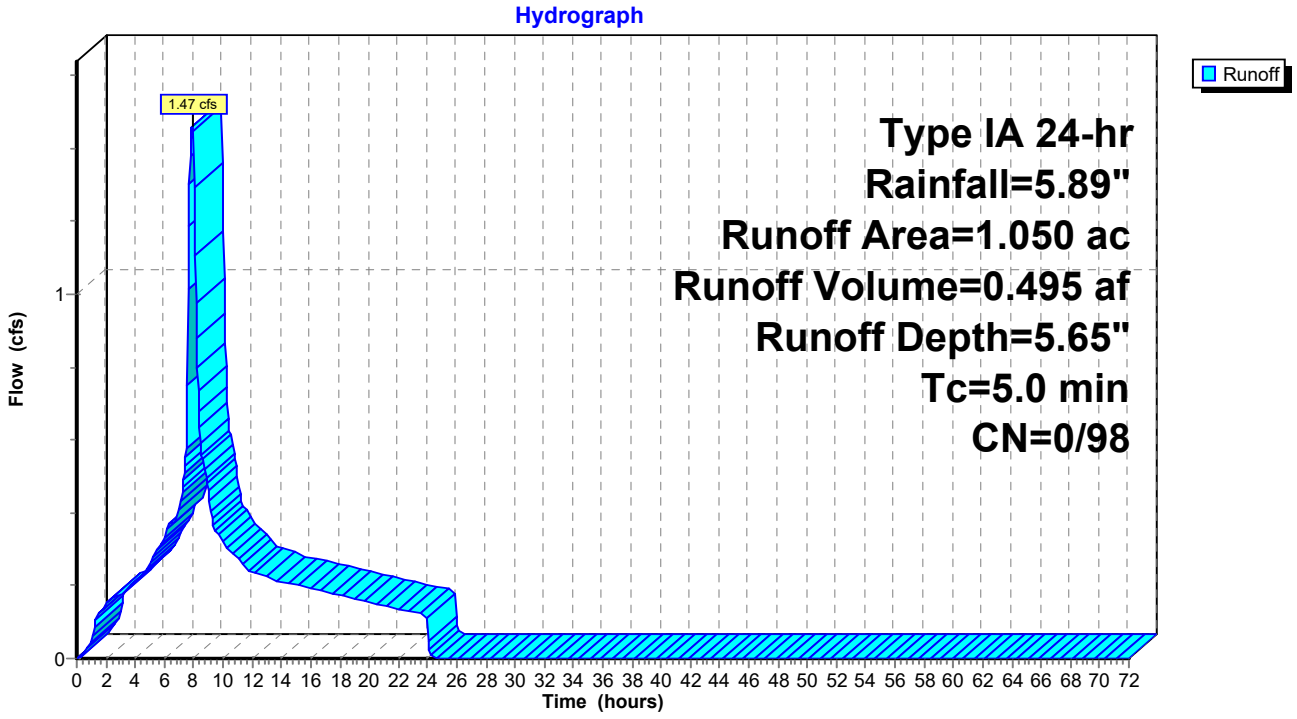
Runoff = 1.47 cfs @ 7.89 hrs, Volume= 0.495 af, Depth= 5.65"
Routed to Pond 7P : S-1 South WQ Bioretention Area

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type IA 24-hr Rainfall=5.89"

	Area (ac)	CN	Description
*	1.050	98	Roads
	1.050	98	100.00% Impervious Area

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

Subcatchment 6S: S-1 South Basin



Hydrograph for Subcatchment 6S: S-1 South Basin

Time (hours)	Precip. (inches)	Perv.Excess (inches)	Imp.Excess (inches)	Runoff (cfs)
0.00	0.00	**0.00**	0.00	0.00
2.50	0.39	0.00	0.22	0.17
5.00	0.92	0.00	0.71	0.26
7.50	1.83	0.00	1.60	**0.58**
10.00	3.40	0.00	3.17	**0.33**
12.50	4.02	0.00	3.79	0.24
15.00	4.53	0.00	4.29	0.20
17.50	4.98	0.00	4.74	0.18
20.00	5.38	0.00	5.14	0.16
22.50	**5.71**	0.00	**5.48**	0.13
25.00	**5.89**	0.00	**5.65**	0.00
27.50	5.89	0.00	5.65	0.00
30.00	5.89	0.00	5.65	0.00
32.50	5.89	0.00	5.65	0.00
35.00	5.89	0.00	5.65	0.00
37.50	5.89	0.00	5.65	0.00
40.00	5.89	0.00	5.65	0.00
42.50	5.89	0.00	5.65	0.00
45.00	5.89	0.00	5.65	0.00
47.50	5.89	0.00	5.65	0.00
50.00	5.89	0.00	5.65	0.00
52.50	5.89	0.00	5.65	0.00
55.00	5.89	0.00	5.65	0.00
57.50	5.89	0.00	5.65	0.00
60.00	5.89	0.00	5.65	0.00
62.50	5.89	0.00	5.65	0.00
65.00	5.89	0.00	5.65	0.00
67.50	5.89	0.00	5.65	0.00
70.00	5.89	0.00	5.65	0.00

Summary for Pond 2P: S-1 Center WQ Bioretention Area

Inflow Area = 5.810 ac,100.00% Impervious, Inflow Depth = 5.65"
Inflow = 8.11 cfs @ 7.89 hrs, Volume= 2.737 af
Outflow = 7.92 cfs @ 7.98 hrs, Volume= 2.737 af, Atten= 2%, Lag= 5.4 min
Discarded = 0.48 cfs @ 7.98 hrs, Volume= 0.995 af
Primary = 7.45 cfs @ 7.98 hrs, Volume= 1.742 af
Routed to Pond 3P : S-1 Center Infiltration Pond

Routing by Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Peak Elev= 101.51' @ 7.98 hrs Surf.Area= 0.158 ac Storage= 0.212 af

Plug-Flow detention time= 77.3 min calculated for 2.735 af (100% of inflow)
Center-of-Mass det. time= 77.4 min (730.2 - 652.8)

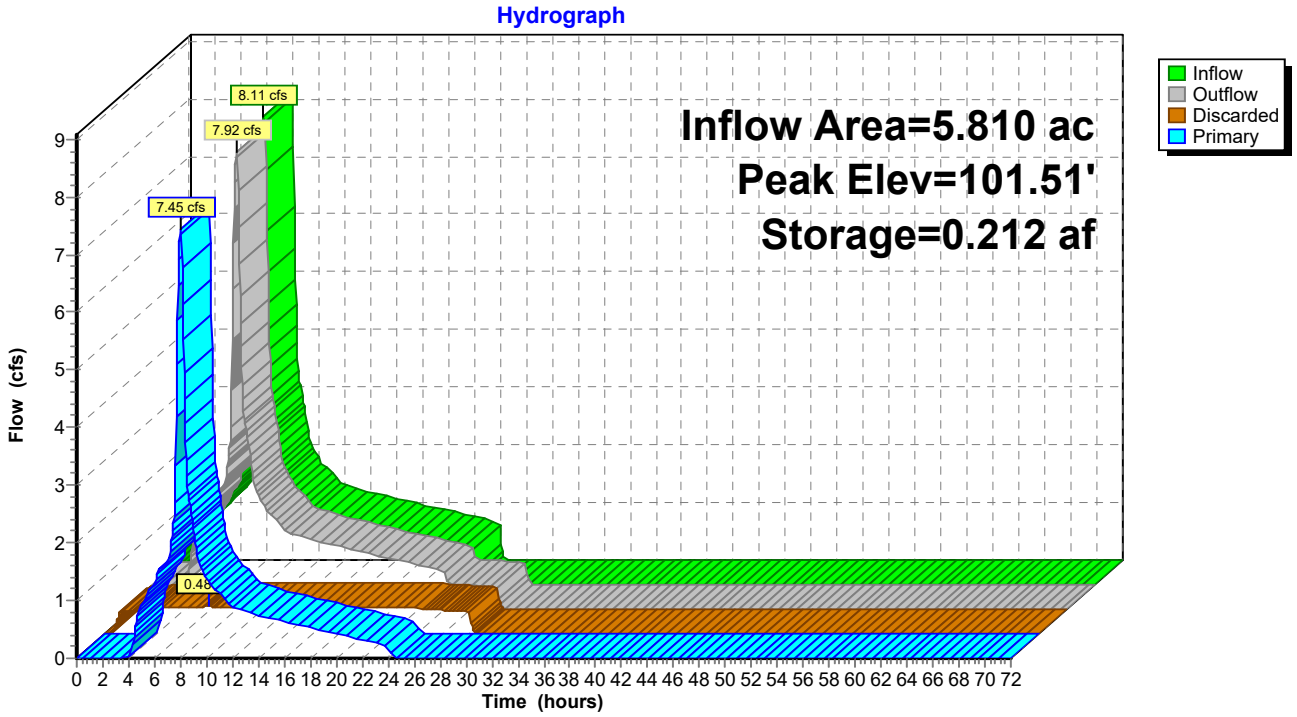
Volume	Invert	Avail.Storage	Storage Description
#1	100.00'	0.476 af	**102.00'W x 53.00'L x 3.00'H Prismatoid Z=3.0**

Device	Routing	Invert	Outlet Devices
#1	Primary	101.00'	**24.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#2	Discarded	100.00'	**3.000 in/hr Exfiltration over Surface area**

Discarded OutFlow Max=0.48 cfs @ 7.98 hrs HW=101.51' (Free Discharge)
↑**2=Exfiltration** (Exfiltration Controls 0.48 cfs)

Primary OutFlow Max=7.42 cfs @ 7.98 hrs HW=101.51' (Free Discharge)
↑**1=Orifice/Grate** (Weir Controls 7.42 cfs @ 2.33 fps)

Pond 2P: S-1 Center WQ Bioretention Area



Hydrograph for Pond 2P: S-1 Center WQ Bioretention Area

Time (hours)	Inflow (cfs)	Storage (acre-feet)	Elevation (feet)	Outflow (cfs)	Discarded (cfs)	Primary (cfs)
0.00	0.00	0.000	100.00	0.00	0.00	0.00
2.50	0.95	0.046	100.36	0.40	0.40	0.00
5.00	1.44	0.154	101.13	1.37	0.45	0.92
7.50	**3.19**	**0.171**	**101.24**	**2.91**	**0.46**	**2.45**
10.00	**1.80**	**0.160**	**101.17**	**1.85**	**0.45**	**1.40**
12.50	1.33	0.153	101.12	1.31	0.45	0.86
15.00	1.12	0.150	101.10	1.13	0.45	0.68
17.50	0.99	0.148	101.09	1.00	0.45	0.55
20.00	0.86	0.146	101.08	0.87	0.45	0.43
22.50	0.73	0.144	101.06	0.74	0.45	0.30
25.00	0.00	0.109	100.82	0.43	0.43	0.00
27.50	0.00	0.025	100.19	0.39	0.39	0.00
30.00	0.00	0.000	100.00	0.00	0.00	0.00
32.50	0.00	0.000	100.00	0.00	0.00	0.00
35.00	0.00	0.000	100.00	0.00	0.00	0.00
37.50	0.00	0.000	100.00	0.00	0.00	0.00
40.00	0.00	0.000	100.00	0.00	0.00	0.00
42.50	0.00	0.000	100.00	0.00	0.00	0.00
45.00	0.00	0.000	100.00	0.00	0.00	0.00
47.50	0.00	0.000	100.00	0.00	0.00	0.00
50.00	0.00	0.000	100.00	0.00	0.00	0.00
52.50	0.00	0.000	100.00	0.00	0.00	0.00
55.00	0.00	0.000	100.00	0.00	0.00	0.00
57.50	0.00	0.000	100.00	0.00	0.00	0.00
60.00	0.00	0.000	100.00	0.00	0.00	0.00
62.50	0.00	0.000	100.00	0.00	0.00	0.00
65.00	0.00	0.000	100.00	0.00	0.00	0.00
67.50	0.00	0.000	100.00	0.00	0.00	0.00
70.00	0.00	0.000	100.00	0.00	0.00	0.00

Summary for Pond 3P: S-1 Center Infiltration Pond

Inflow Area = 9.860 ac,100.00% Impervious, Inflow Depth = 3.63"
Inflow = 12.74 cfs @ 7.97 hrs, Volume= 2.987 af
Outflow = 1.34 cfs @ 13.53 hrs, Volume= 2.987 af, Atten= 89%, Lag= 333.1 min
Discarded = 1.34 cfs @ 13.53 hrs, Volume= 2.987 af
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Peak Elev= 5.87' @ 13.53 hrs Surf.Area= 0.332 ac Storage= 1.432 af

Plug-Flow detention time= 569.4 min calculated for 2.987 af (100% of inflow)
Center-of-Mass det. time= 569.3 min (1,219.1 - 649.8)

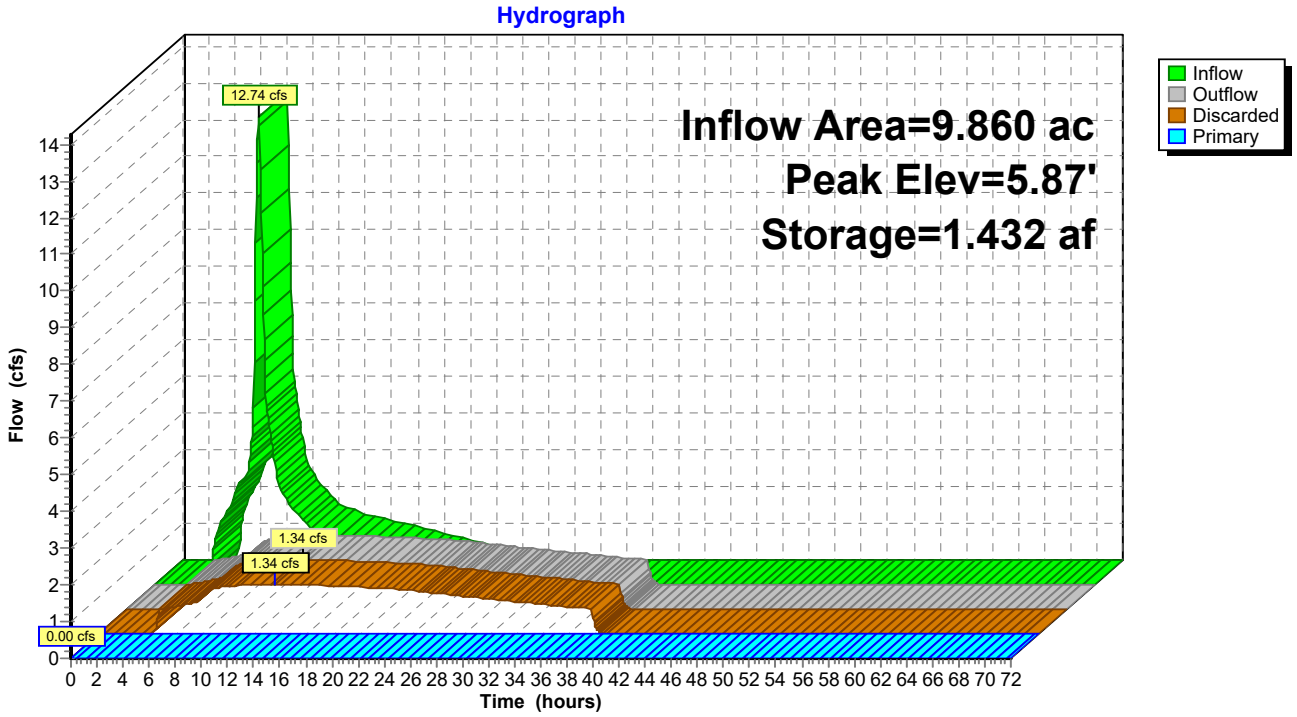
Volume	Invert	Avail.Storage	Storage Description
#1	0.00'	1.829 af	**85.00'W x 85.00'L x 7.00'H Prismatoid Z=3.0**

Device	Routing	Invert	Outlet Devices
#1	Primary	6.00'	**24.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#2	Discarded	0.00'	**4.000 in/hr Exfiltration over Surface area**

Discarded OutFlow Max=1.34 cfs @ 13.53 hrs HW=5.87' (Free Discharge)
↑—**2=Exfiltration** (Exfiltration Controls 1.34 cfs)

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

Pond 3P: S-1 Center Infiltration Pond



Hydrograph for Pond 3P: S-1 Center Infiltration Pond

Time (hours)	Inflow (cfs)	Storage (acre-feet)	Elevation (feet)	Outflow (cfs)	Discarded (cfs)	Primary (cfs)
0.00	0.00	0.000	0.00	0.00	0.00	**0.00**
2.50	0.00	0.000	0.00	0.00	0.00	0.00
5.00	1.61	0.036	0.21	0.69	0.69	0.00
7.50	**4.27**	0.402	2.10	0.88	0.88	0.00
10.00	**2.38**	1.327	5.55	1.30	1.30	0.00
12.50	1.48	**1.427**	**5.85**	**1.34**	**1.34**	0.00
15.00	1.18	**1.421**	**5.83**	**1.33**	**1.33**	0.00
17.50	0.96	1.368	5.67	1.31	1.31	0.00
20.00	0.74	1.275	5.38	1.27	1.27	0.00
22.50	0.52	1.147	4.97	1.22	1.22	0.00
25.00	0.00	0.963	4.34	1.14	1.14	0.00
27.50	0.00	0.737	3.51	1.04	1.04	0.00
30.00	0.00	0.532	2.67	0.95	0.95	0.00
32.50	0.00	0.346	1.84	0.85	0.85	0.00
35.00	0.00	0.179	1.01	0.77	0.77	0.00
37.50	0.00	0.029	0.17	0.69	0.69	0.00
40.00	0.00	0.000	0.00	0.00	0.00	0.00
42.50	0.00	0.000	0.00	0.00	0.00	0.00
45.00	0.00	0.000	0.00	0.00	0.00	0.00
47.50	0.00	0.000	0.00	0.00	0.00	0.00
50.00	0.00	0.000	0.00	0.00	0.00	0.00
52.50	0.00	0.000	0.00	0.00	0.00	0.00
55.00	0.00	0.000	0.00	0.00	0.00	0.00
57.50	0.00	0.000	0.00	0.00	0.00	0.00
60.00	0.00	0.000	0.00	0.00	0.00	0.00
62.50	0.00	0.000	0.00	0.00	0.00	0.00
65.00	0.00	0.000	0.00	0.00	0.00	0.00
67.50	0.00	0.000	0.00	0.00	0.00	0.00
70.00	0.00	0.000	0.00	0.00	0.00	0.00

Summary for Pond 5P: S-1 East WQ Bioretention Area

Inflow Area = 3.000 ac,100.00% Impervious, Inflow Depth = 5.65"
Inflow = 4.19 cfs @ 7.89 hrs, Volume= 1.413 af
Outflow = 4.16 cfs @ 7.95 hrs, Volume= 1.413 af, Atten= 1%, Lag= 3.2 min
Discarded = 0.22 cfs @ 1.25 hrs, Volume= 0.494 af
Primary = 3.94 cfs @ 7.95 hrs, Volume= 0.919 af
Routed to Pond 3P : S-1 Center Infiltration Pond

Routing by Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Peak Elev= 101.33' @ 7.95 hrs Surf.Area= 0.072 ac Storage= 0.096 af

Plug-Flow detention time= 76.2 min calculated for 1.412 af (100% of inflow)
Center-of-Mass det. time= 76.3 min (729.2 - 652.8)

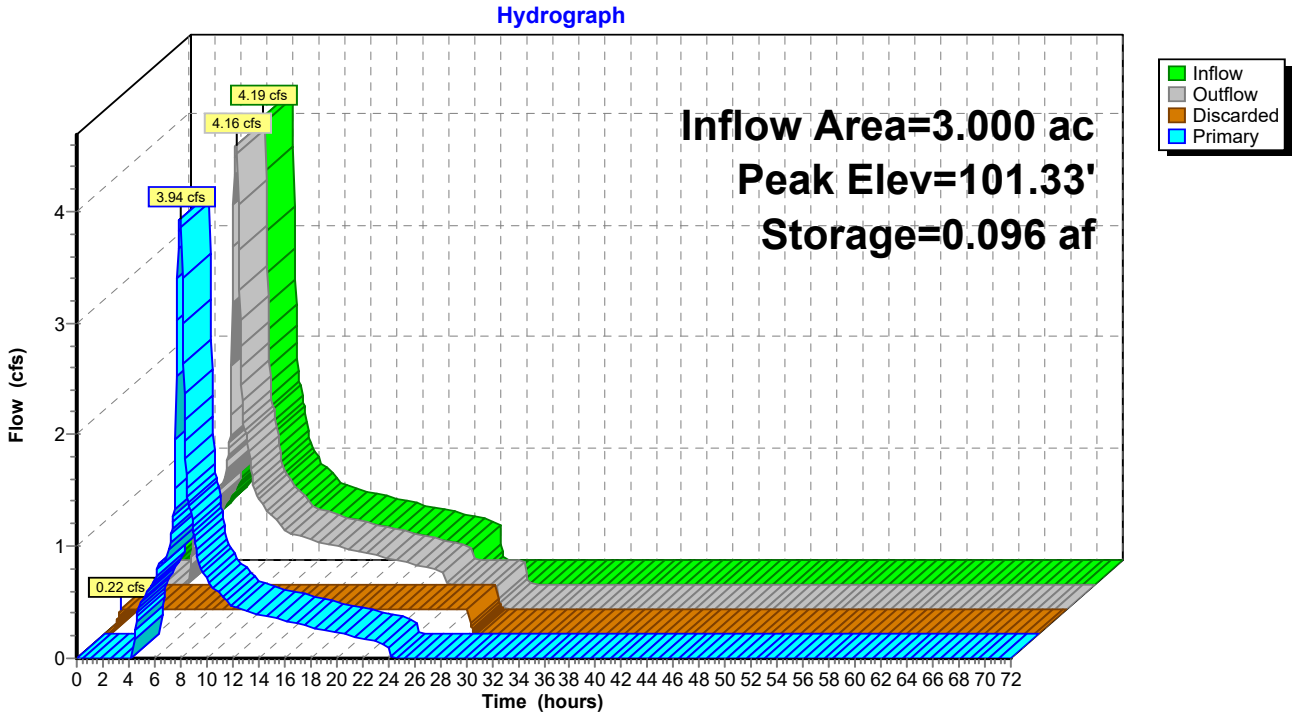
Volume	Invert	Avail.Storage	Storage Description
#1	100.00'	0.217 af	**70.00'W x 45.00'L x 3.00'H Prismatoid**

Device	Routing	Invert	Outlet Devices
#1	Primary	101.00'	**24.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#2	Discarded	100.00'	**3.000 in/hr Exfiltration over Surface area**

Discarded OutFlow Max=0.22 cfs @ 1.25 hrs HW=100.03' (Free Discharge)
↑└**2=Exfiltration** (Exfiltration Controls 0.22 cfs)

Primary OutFlow Max=3.94 cfs @ 7.95 hrs HW=101.33' (Free Discharge)
↑└**1=Orifice/Grate** (Weir Controls 3.94 cfs @ 1.88 fps)

Pond 5P: S-1 East WQ Bioretention Area



Hydrograph for Pond 5P: S-1 East WQ Bioretention Area

Time (hours)	Inflow (cfs)	Storage (acre-feet)	Elevation (feet)	Outflow (cfs)	Discarded (cfs)	Primary (cfs)
0.00	0.00	0.000	100.00	0.00	**0.00**	0.00
2.50	0.49	0.022	100.30	0.22	**0.22**	0.00
5.00	0.75	0.078	101.08	0.73	0.22	0.51
7.50	**1.65**	**0.084**	**101.16**	**1.56**	0.22	**1.34**
10.00	**0.93**	**0.080**	**101.11**	**0.95**	0.22	**0.73**
12.50	0.69	0.078	101.08	0.68	0.22	0.46
15.00	0.58	0.077	101.07	0.58	0.22	0.36
17.50	0.51	0.077	101.06	0.52	0.22	0.30
20.00	0.45	0.076	101.05	0.45	0.22	0.23
22.50	0.38	0.075	101.04	0.38	0.22	0.16
25.00	0.00	0.058	100.81	0.22	0.22	0.00
27.50	0.00	0.013	100.18	0.22	0.22	0.00
30.00	0.00	0.000	100.00	0.00	0.00	0.00
32.50	0.00	0.000	100.00	0.00	0.00	0.00
35.00	0.00	0.000	100.00	0.00	0.00	0.00
37.50	0.00	0.000	100.00	0.00	0.00	0.00
40.00	0.00	0.000	100.00	0.00	0.00	0.00
42.50	0.00	0.000	100.00	0.00	0.00	0.00
45.00	0.00	0.000	100.00	0.00	0.00	0.00
47.50	0.00	0.000	100.00	0.00	0.00	0.00
50.00	0.00	0.000	100.00	0.00	0.00	0.00
52.50	0.00	0.000	100.00	0.00	0.00	0.00
55.00	0.00	0.000	100.00	0.00	0.00	0.00
57.50	0.00	0.000	100.00	0.00	0.00	0.00
60.00	0.00	0.000	100.00	0.00	0.00	0.00
62.50	0.00	0.000	100.00	0.00	0.00	0.00
65.00	0.00	0.000	100.00	0.00	0.00	0.00
67.50	0.00	0.000	100.00	0.00	0.00	0.00
70.00	0.00	0.000	100.00	0.00	0.00	0.00

Summary for Pond 7P: S-1 South WQ Bioretention Area

Inflow Area = 1.050 ac,100.00% Impervious, Inflow Depth = 5.65"
Inflow = 1.47 cfs @ 7.89 hrs, Volume= 0.495 af
Outflow = 1.46 cfs @ 7.92 hrs, Volume= 0.495 af, Atten= 0%, Lag= 1.5 min
Discarded = 0.07 cfs @ 1.25 hrs, Volume= 0.169 af
Primary = 1.39 cfs @ 7.92 hrs, Volume= 0.326 af
Routed to Pond 3P : S-1 Center Infiltration Pond

Routing by Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Peak Elev= 101.17' @ 7.92 hrs Surf.Area= 0.025 ac Storage= 0.029 af

Plug-Flow detention time= 72.2 min calculated for 0.494 af (100% of inflow)
Center-of-Mass det. time= 72.3 min (725.1 - 652.8)

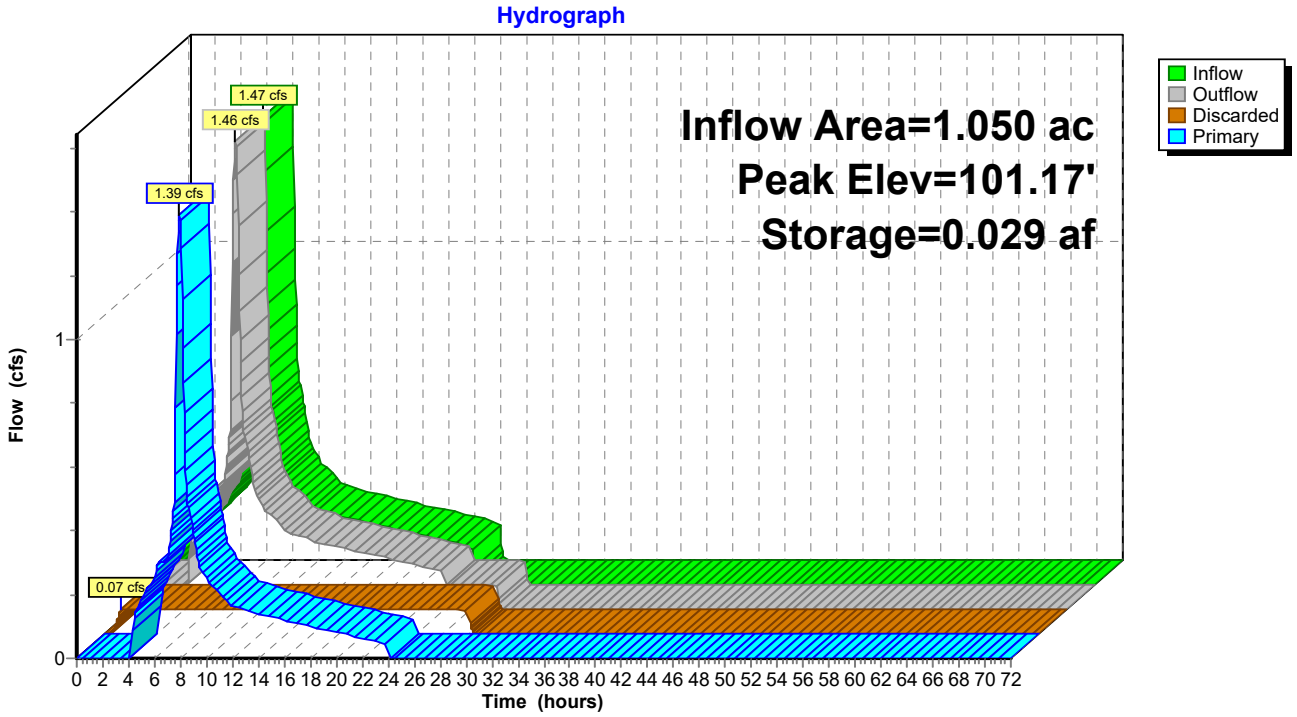
Volume	Invert	Avail.Storage	Storage Description
#1	100.00'	0.074 af	**90.00'W x 12.00'L x 3.00'H Prismatoid**

Device	Routing	Invert	Outlet Devices
#1	Primary	101.00'	**24.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#2	Discarded	100.00'	**3.000 in/hr Exfiltration over Surface area**

Discarded OutFlow Max=0.07 cfs @ 1.25 hrs HW=100.03' (Free Discharge)
↑└**2=Exfiltration** (Exfiltration Controls 0.07 cfs)

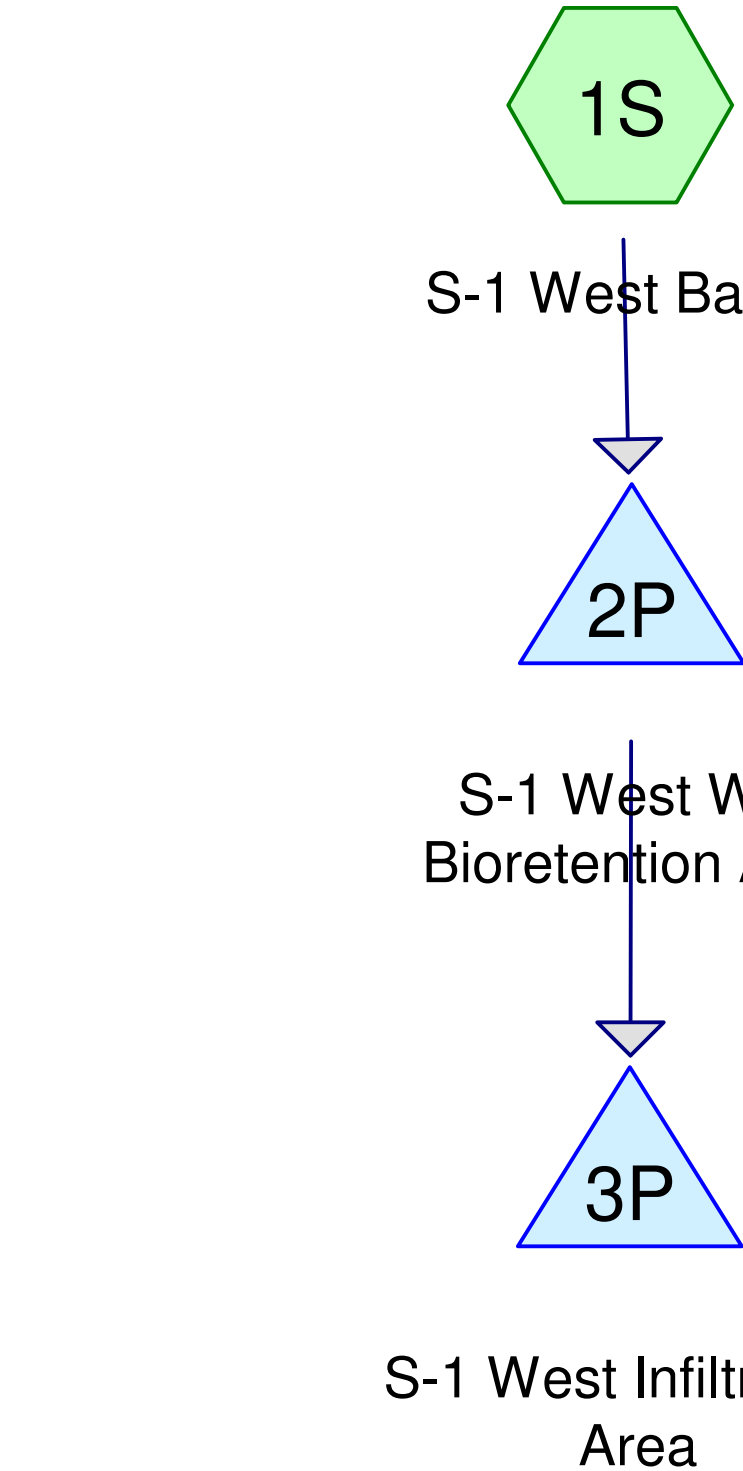
Primary OutFlow Max=1.38 cfs @ 7.92 hrs HW=101.17' (Free Discharge)
↑└**1=Orifice/Grate** (Weir Controls 1.38 cfs @ 1.33 fps)

Pond 7P: S-1 South WQ Bioretention Area



Hydrograph for Pond 7P: S-1 South WQ Bioretention Area

Time (hours)	Inflow (cfs)	Storage (acre-feet)	Elevation (feet)	Outflow (cfs)	Discarded (cfs)	Primary (cfs)
0.00	0.00	0.000	100.00	0.00	**0.00**	0.00
2.50	0.17	0.008	100.31	0.07	**0.07**	0.00
5.00	0.26	0.026	101.04	0.26	0.07	0.18
7.50	**0.58**	**0.027**	**101.08**	**0.56**	0.07	**0.49**
10.00	**0.33**	**0.026**	**101.05**	**0.33**	0.07	**0.25**
12.50	0.24	0.026	101.04	0.24	0.07	0.16
15.00	0.20	0.026	101.03	0.20	0.07	0.13
17.50	0.18	0.025	101.03	0.18	0.07	0.11
20.00	0.16	0.025	101.02	0.16	0.07	0.08
22.50	0.13	0.025	101.02	0.13	0.07	0.06
25.00	0.00	0.020	100.79	0.07	0.07	0.00
27.50	0.00	0.004	100.17	0.07	0.07	0.00
30.00	0.00	0.000	100.00	0.00	0.00	0.00
32.50	0.00	0.000	100.00	0.00	0.00	0.00
35.00	0.00	0.000	100.00	0.00	0.00	0.00
37.50	0.00	0.000	100.00	0.00	0.00	0.00
40.00	0.00	0.000	100.00	0.00	0.00	0.00
42.50	0.00	0.000	100.00	0.00	0.00	0.00
45.00	0.00	0.000	100.00	0.00	0.00	0.00
47.50	0.00	0.000	100.00	0.00	0.00	0.00
50.00	0.00	0.000	100.00	0.00	0.00	0.00
52.50	0.00	0.000	100.00	0.00	0.00	0.00
55.00	0.00	0.000	100.00	0.00	0.00	0.00
57.50	0.00	0.000	100.00	0.00	0.00	0.00
60.00	0.00	0.000	100.00	0.00	0.00	0.00
62.50	0.00	0.000	100.00	0.00	0.00	0.00
65.00	0.00	0.000	100.00	0.00	0.00	0.00
67.50	0.00	0.000	100.00	0.00	0.00	0.00
70.00	0.00	0.000	100.00	0.00	0.00	0.00



Subcat Reach Pond Link

Routing Diagram for S-1 Infiltration Area West Basin (WQ)
Prepared by Core Design, Printed 2024-11-12
HydroCAD® 10.20-5c s/n 12748 © 2023 HydroCAD Software Solutions LLC

Rainfall Events Listing (selected events)

Event#	Event Name	Storm Type	Curve	Mode	Duration (hours)	B/B	Depth (inches)	AMC
1	25 Year + Snowmelt	Type IA 24-hr		Default	24.00	1	4.87	2

Area Listing (all nodes)

Area (acres)	CN	Description (subcatchment-numbers)
1.878	98	Roads (1S)
1.878	**98**	**TOTAL AREA**

Soil Listing (all nodes)

Area (acres)	Soil Group	Subcatchment Numbers
0.000	HSG A	
0.000	HSG B	
0.000	HSG C	
0.000	HSG D	
1.878	Other	1S
1.878		**TOTAL AREA**

Ground Covers (all nodes)

HSG-A (acres)	HSG-B (acres)	HSG-C (acres)	HSG-D (acres)	Other (acres)	Total (acres)	Ground Cover	Subcatchment Numbers
0.000	0.000	0.000	0.000	1.878	1.878	Roads	1S
0.000	**0.000**	**0.000**	**0.000**	**1.878**	**1.878**	**TOTAL AREA**	

Time span=0.00-72.00 hrs, dt=0.01 hrs, 7201 points
Runoff by SBUH method, Split Pervious/Imperv.
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 1S: S-1 West Basin Runoff Area=1.878 ac 100.00% Impervious Runoff Depth=4.63"
Tc=5.0 min CN=0/98 Runoff=2.16 cfs 0.725 af

Pond 2P: S-1 West WQ Bioretention Area Peak Elev=2,103.58' Storage=0.057 af Inflow=2.16 cfs 0.725 af
Discarded=0.14 cfs 0.270 af Primary=1.96 cfs 0.455 af Outflow=2.10 cfs 0.725 af

Pond 3P: S-1 West Infiltration Area Peak Elev=2,097.78' Storage=0.195 af Inflow=1.96 cfs 0.455 af
Discarded=0.20 cfs 0.455 af Primary=0.00 cfs 0.000 af Outflow=0.20 cfs 0.455 af

Total Runoff Area = 1.878 ac Runoff Volume = 0.725 af Average Runoff Depth = 4.63"
0.00% Pervious = 0.000 ac 100.00% Impervious = 1.878 ac

Summary for Subcatchment 1S: S-1 West Basin

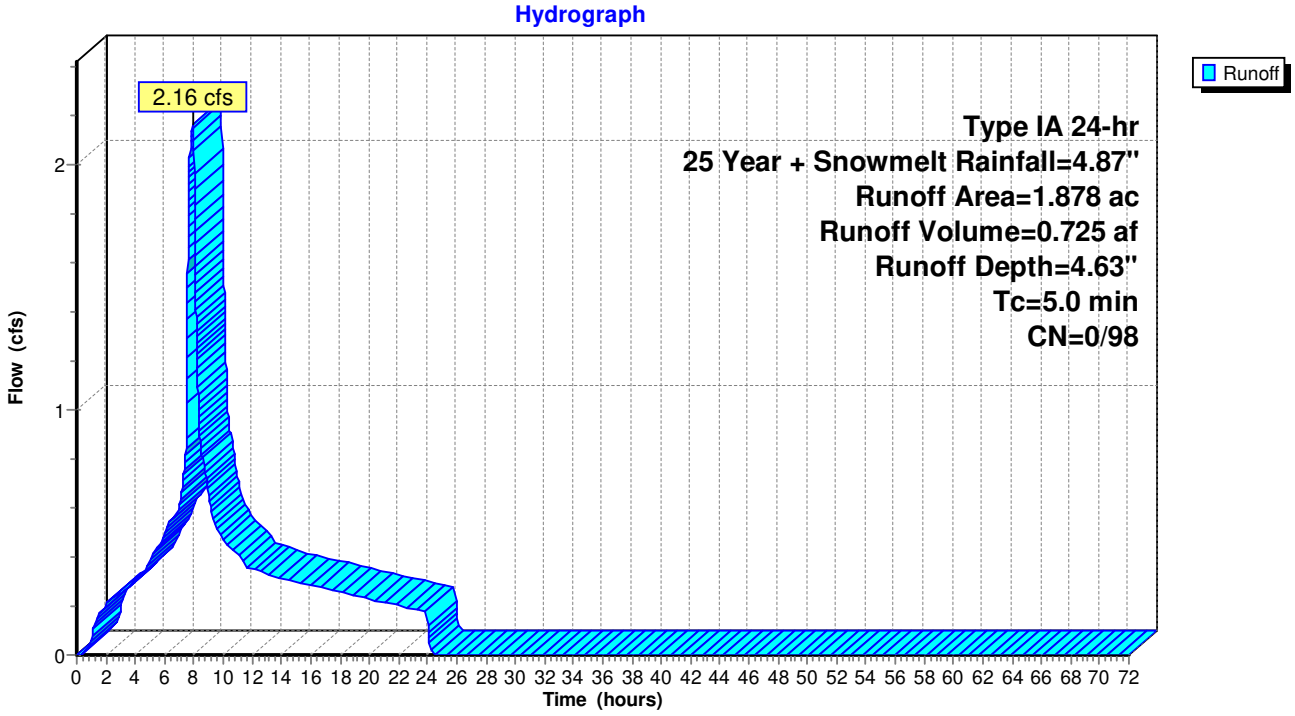
Runoff = 2.16 cfs @ 7.88 hrs, Volume= 0.725 af, Depth= 4.63"
Routed to Pond 2P : S-1 West WQ Bioretention Area

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type IA 24-hr 25 Year + Snowmelt Rainfall=4.87"

	Area (ac)	CN	Description
*	1.878	98	Roads
	1.878	98	100.00% Impervious Area

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

Subcatchment 1S: S-1 West Basin



Summary for Pond 2P: S-1 West WQ Bioretention Area

Inflow Area = 1.878 ac,100.00% Impervious, Inflow Depth = 4.63" for 25 Year + Snowmelt event
Inflow = 2.16 cfs @ 7.88 hrs, Volume= 0.725 af
Outflow = 2.10 cfs @ 7.98 hrs, Volume= 0.725 af, Atten= 3%, Lag= 6.2 min
Discarded = 0.14 cfs @ 7.98 hrs, Volume= 0.270 af
Primary = 1.96 cfs @ 7.98 hrs, Volume= 0.455 af
Routed to Pond 3P : S-1 West Infiltration Area

Routing by Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Peak Elev= 2,103.58' @ 7.98 hrs Surf.Area= 0.047 ac Storage= 0.057 af

Plug-Flow detention time= 75.9 min calculated for 0.725 af (100% of inflow)
Center-of-Mass det. time= 75.9 min (731.2 - 655.2)

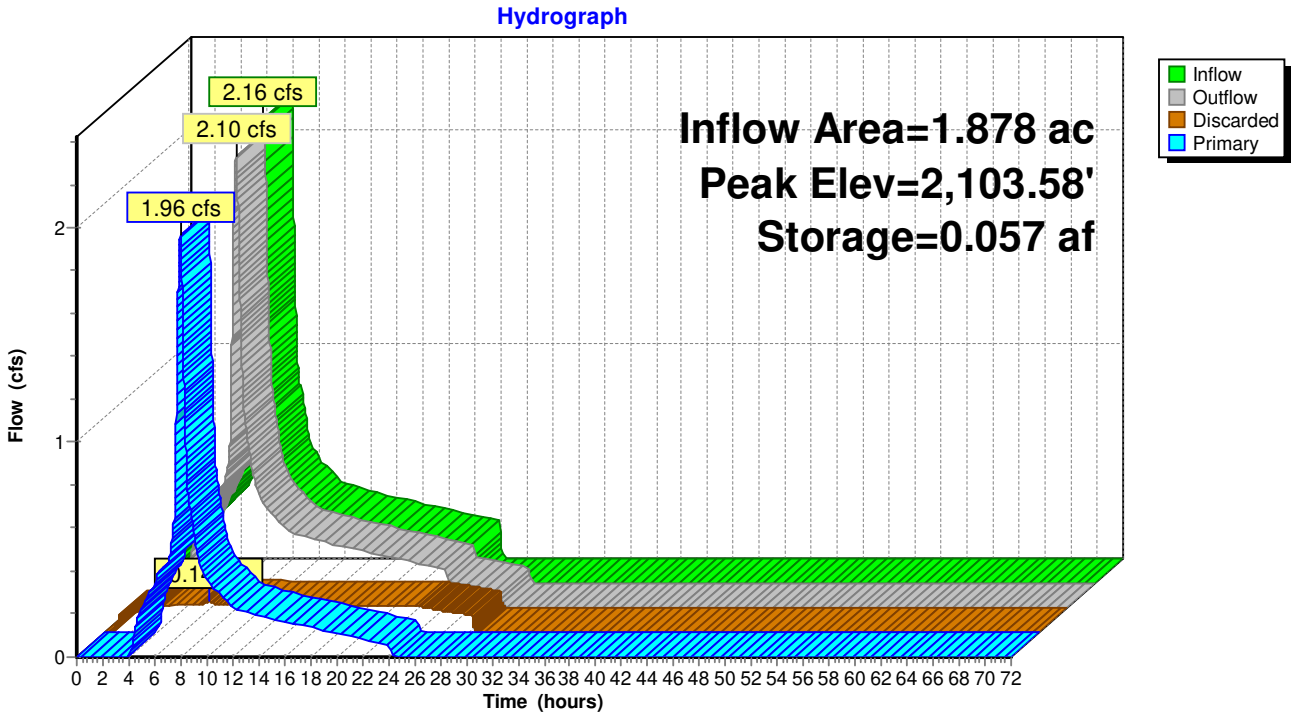
Volume	Invert	Avail.Storage	Storage Description
#1	2,102.00'	0.079 af	**15.00'W x 75.00'L x 2.00'H Prismatoid Z=3.0**

Device	Routing	Invert	Outlet Devices
#1	Primary	2,103.00'	**24.0" Vert. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#2	Discarded	2,102.00'	**3.000 in/hr Exfiltration over Surface area**

Discarded OutFlow Max=0.14 cfs @ 7.98 hrs HW=2,103.58' (Free Discharge)
↑—**2=Exfiltration** (Exfiltration Controls 0.14 cfs)

Primary OutFlow Max=1.96 cfs @ 7.98 hrs HW=2,103.58' (Free Discharge)
↑—**1=Orifice/Grate** (Orifice Controls 1.96 cfs @ 2.59 fps)

Pond 2P: S-1 West WQ Bioretention Area



Summary for Pond 3P: S-1 West Infiltration Area

Inflow Area = 1.878 ac,100.00% Impervious, Inflow Depth = 2.91" for 25 Year + Snowmelt event
Inflow = 1.96 cfs @ 7.98 hrs, Volume= 0.455 af
Outflow = 0.20 cfs @ 5.02 hrs, Volume= 0.455 af, Atten= 90%, Lag= 0.0 min
Discarded = 0.20 cfs @ 5.02 hrs, Volume= 0.455 af
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Peak Elev= 2,097.78' @ 13.58 hrs Surf.Area= 0.037 ac Storage= 0.195 af

Plug-Flow detention time= 446.5 min calculated for 0.455 af (100% of inflow)
Center-of-Mass det. time= 446.5 min (1,095.0 - 648.6)

Volume	Invert	Avail.Storage	Storage Description
#1	2,092.50'	0.259 af	**23.00'W x 70.00'L x 7.00'H Prismatoid**

Device	Routing	Invert	Outlet Devices
#1	Primary	2,098.50'	**24.0" Vert. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#2	Discarded	2,092.50'	**5.400 in/hr Exfiltration over Surface area**

Discarded OutFlow Max=0.20 cfs @ 5.02 hrs HW=2,092.58' (Free Discharge)
2=Exfiltration (Exfiltration Controls 0.20 cfs)

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=2,092.50' (Free Discharge)
1=Orifice/Grate (Controls 0.00 cfs)

Pond 3P: S-1 West Infiltration Area