BARGHAUSEN

KAREN E. HARRIS
STATE OF WASHINGTON
42779
REGISTERED PROFESSIONAL ENGINEER

Karen E. Harris

3/5/2024

Technical Information Report

Fortress - Puyallup

PREPARED BY

Barghausen Consulting Engineers
18215 72nd Ave. South
Kent, WA 98032

PREPARED FOR

CREF3 Puyallup, LLC

CLIENT ADDRESS

11611 San Vicente Blvd, 10th Floor
Los Angeles, CA 90049

SITE ADDRESS	JURISDICTION	DATE	PROJECT NO.
240 15th Street SE Puyallup, WA 98372	City of Puyallup	Rev. March 5, 2024 Rev. Dec. 08, 2023 July 27, 2023	22085

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Tab 1.0

1.0 PROJECT OVERVIEW

The proposed Fortress - Puyallup project is located on a 7.84-acre site located in the City of Puyallup, Washington. The project address is 240 15th Street SE, Puyallup, WA 98372 with the parcel numbers being 0420274126, 7845000161, and 7845000170. The site is located northwest of the intersection of 15th Street SE and East Pioneer Way. The current zoning of the project site is Limited Manufacturing (ML). Please see the enclosed Figure 1 - Vicinity Map for additional location information.

The existing site contains a cold storage warehouse that is in the process of demolition, a separate industrial building, and an office building. The majority of the site has been developed with buildings and pavement, though a small portion of the site is an undeveloped field. The property is not currently being used other than for demolition activity. There are three driveways serving the site off of 15th Street SE. The site is relatively flat and does not contain any steep slopes. The developed portion of the site drains to existing stormwater catch basins and piping, which discharge into the public stormwater systems in East Main Street and 15th Street SE, ultimately discharging to Deer Creek near the Puyallup River. See Figure 2 for a map of existing site conditions.

The site is not within a flood zone. See Figure 4 for a FEMA flood map. According to Puyallup GIS mapping, the project does not contain any wetlands or potential landslide hazards. The public stormwater system in 15th Street SE discharges to a wetland. See Figure 3 for a critical areas map.

The proposal for this development is to construct one warehouse building, new pavement, associate utilities, and landscaping. The developed runoff from the west portion of the site will be collected and conveyed to both water quality and detention vaults prior to discharge into the public stormwater system draining to East Main Street. The east part of the site will be collected and discharged through a water quality vault to the 15th Street SE system that drains to a wetland. This basin has been sized to match the existing conditions to match existing flows to the wetland. Stormwater treatment will be provided upstream of the detention vault by DOE-approved underground treatment vaults (Oldcastle Biopods).

This site has some incidental run-on from adjacent property that is accounted for by the proposed stormwater improvements.

Figure 1
Vicinity Map

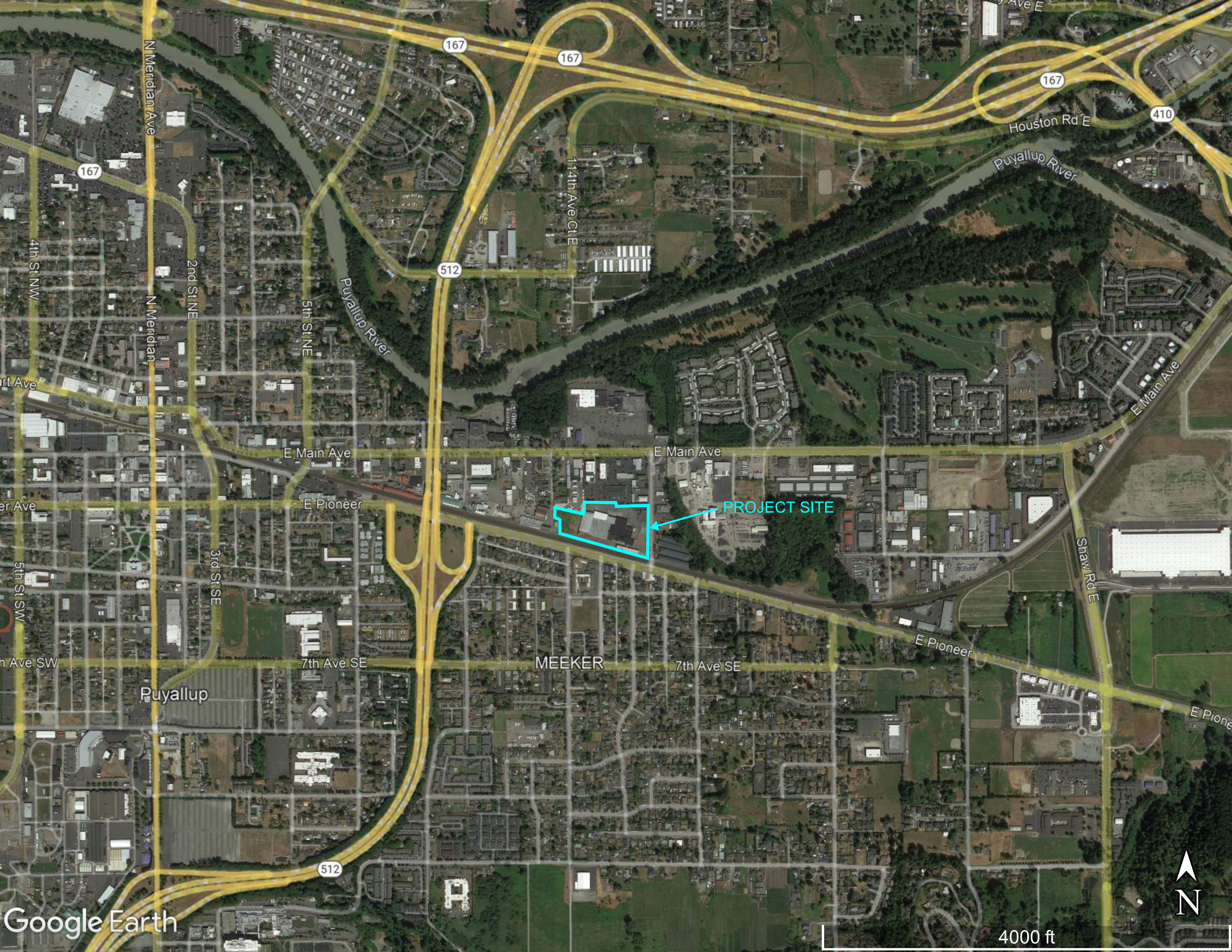
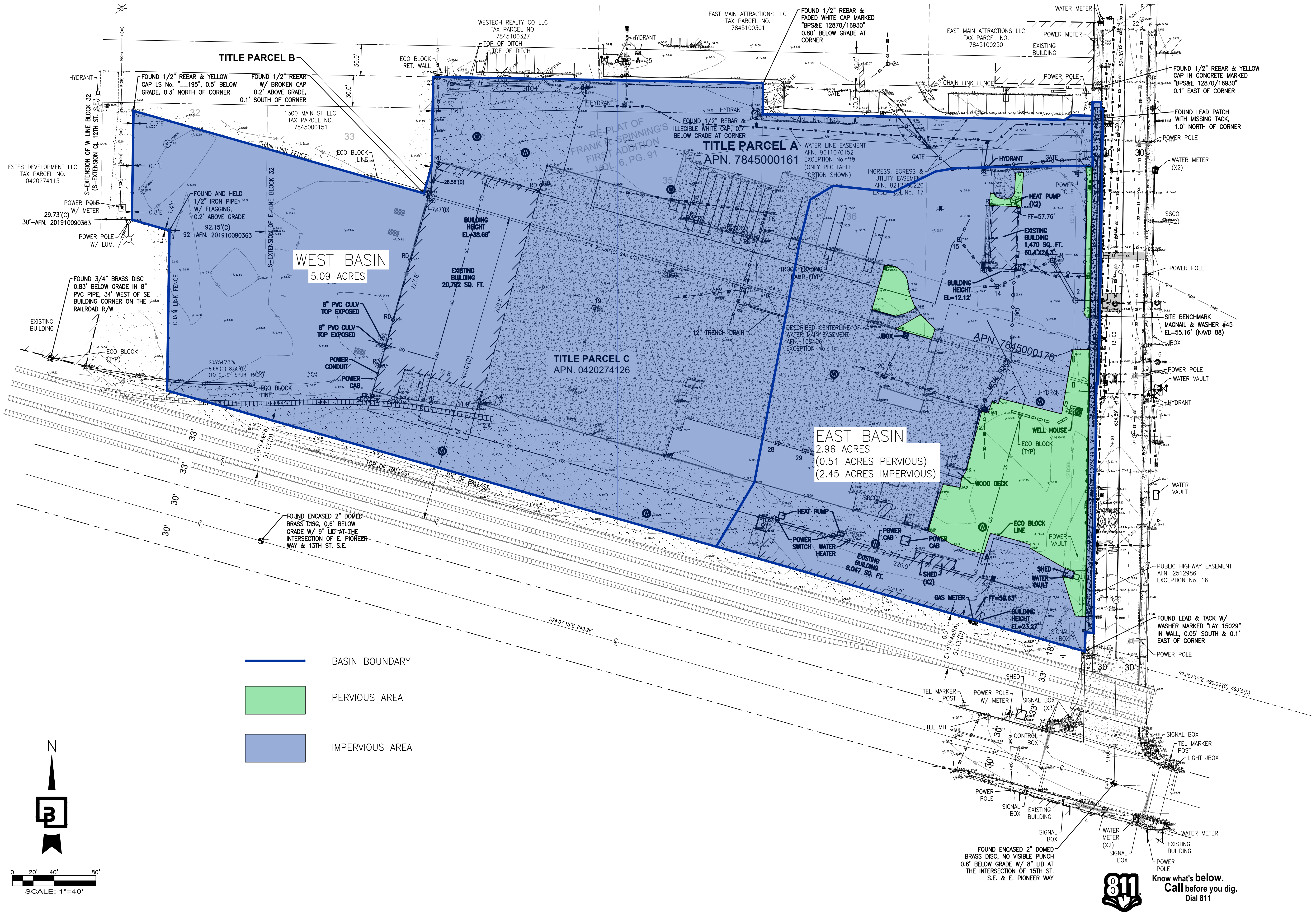

y Ave E
167
167
167
410
Houston Rd E
N Meridian Ave
167
Puyallup River
114th Ave Ct E
4th St NW
2nd St NE
N Meridian
5th St NE
512
Puyallup River
rt Ave
E Main Ave
E Main Ave
E Main Ave
er Ave
E Pioneer
PROJECT SITE
3rd St SE
5th St SW
Shaw Rd E
E Pioneer
h Ave SW
7th Ave SE
MEEKER
7th Ave SE
Puyallup
E Pione
512
Google Earth
N
4000 ft

Figure 2
Existing Conditions Map

EXISTING CONDITION BASIN MAP EXHIBIT



Title: EXISTING CONDITION BASIN MAP EXHIBIT

FORTRESS - PUYALLUP

For: FORTRESS INVESTMENT GROUP
11611 SAN VICENTE BLVD
10TH FLOOR
LOS ANGELES, CA 90049

No.	Date	By	Ckd.	Appr.	Revision

Scale: Horizontal 1"=40'
Vertical N/A

Designed VMS
Drawn VMS
Checked KEH
Approved KEH
Date 10/04/22

Barghausen Consulting Engineers, Inc.
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Job Number 22085

Sheet of

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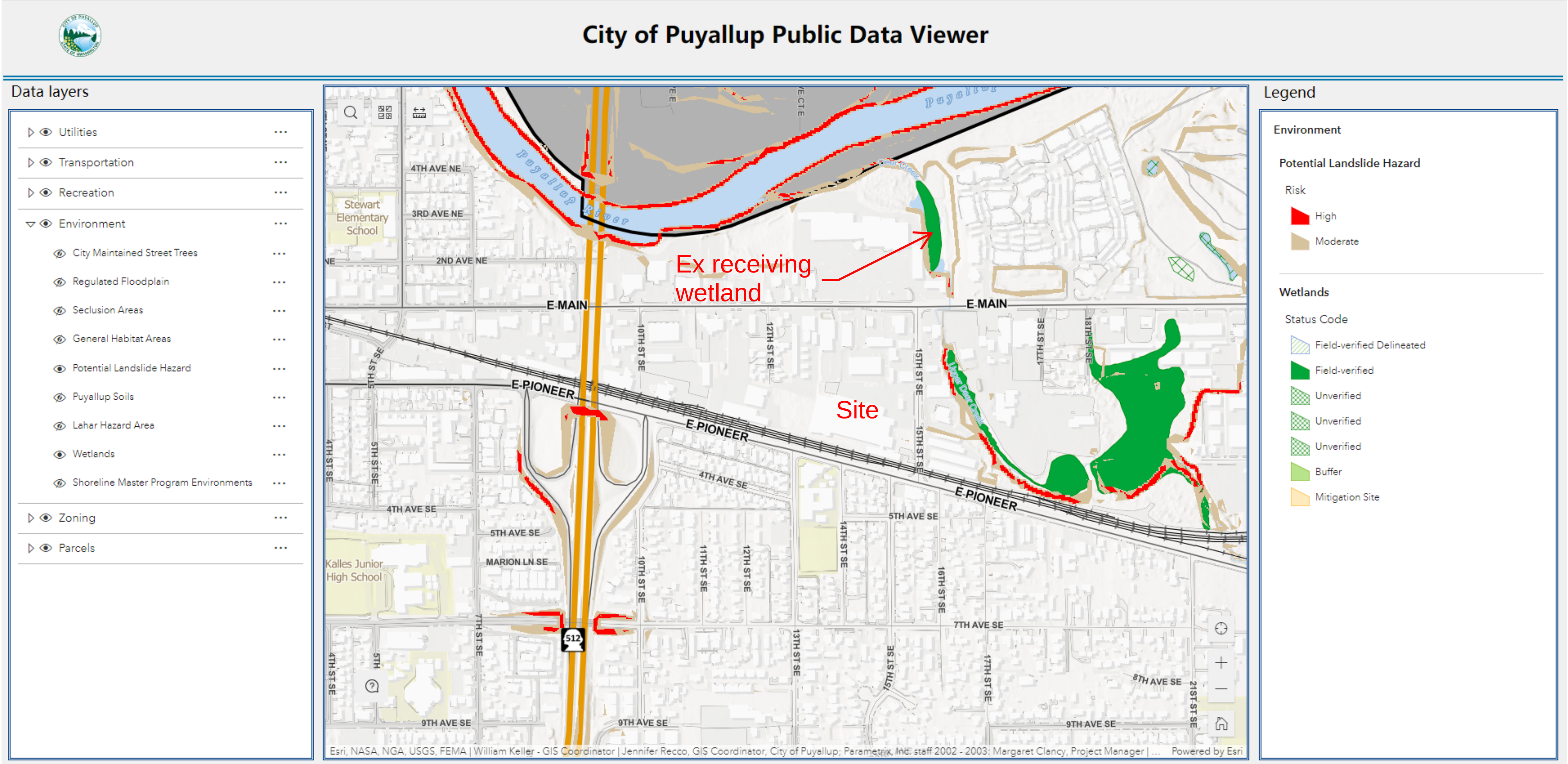
APPROXIMATE SITE BOUNDARY
EXISTING BUILDINGS UNDER DEMOLITION
15th St SE
15th St SE
E Pioneer
E Pioneer
E Pioneer
13th St SE
14th St SE
River
Google Earth
N
400 ft

Figure 3
Critical Areas Map



City of Puyallup Public Data Viewer

Data layers

- Utilities
- Transportation
- Recreation
- Environment
  - City Maintained Street Trees
  - Regulated Floodplain
  - Seclusion Areas
  - General Habitat Areas
  - Potential Landslide Hazard
  - Puyallup Soils
  - Lahar Hazard Area
  - Wetlands
  - Shoreline Master Program Environments
- Zoning
- Parcels

Legend

Environment

Potential Landslide Hazard

Risk

- 🟥 High
- ▨ Moderate

Wetlands

Status Code

- ▨ Field-verified Delineated
- 🟩 Field-verified
- ▨ Unverified
- ▨ Unverified
- ▨ Unverified
- 🟩 Buffer
- ▨ Mitigation Site

Esri, NASA, NGA, USGS, FEMA | William Keller - GIS Coordinator | Jennifer Recco, GIS Coordinator, City of Puyallup; Parametrix, Inc. staff 2002 - 2003: Margaret Clancy, Project Manager | ... Powered by Esri

Figure 4
FEMA Flood Map

National Flood Hazard Layer FIRMette

FEMA

122°16'52"W 47°11'35"N

122°16'14"W 47°11'11"N

0 250 500 1,000 1,500 2,000 Feet

1:6,000

Basemap: USGS National Map: Orthoimagery: Data refreshed October, 2020

Legend

SEE FIS REPORT FOR DETAILED LEGEND AND INDEX MAP FOR FIRM PANEL LAYOUT

SPECIAL FLOOD HAZARD AREAS	🟦	Without Base Flood Elevation (BFE) *Zone A, V, A99*
		With BFE or Depth *Zone AE, AO, AH, VE, AR*
	▨	Regulatory Floodway
OTHER AREAS OF FLOOD HAZARD	🟧	0.2% Annual Chance Flood Hazard, Areas of 1% annual chance flood with average depth less than one foot or with drainage areas of less than one square mile *Zone X*
	▨	Future Conditions 1% Annual Chance Flood Hazard *Zone X*
	▨	Area with Reduced Flood Risk due to Levee. See Notes. *Zone X*
	▨	Area with Flood Risk due to Levee *Zone D*
OTHER AREAS	NO SCREEN	Area of Minimal Flood Hazard *Zone X*
	▭	Effective LOMRs
	🟧	Area of Undetermined Flood Hazard *Zone D*
GENERAL STRUCTURES	— — —	Channel, Culvert, or Storm Sewer
	ıııııı	Levee, Dike, or Floodwall
OTHER FEATURES	Ⓑ 20.2 / 17.5	Cross Sections with 1% Annual Chance Water Surface Elevation
	8 — — —	Coastal Transect
	~~ 513 ~~~	Base Flood Elevation Line (BFE)
	═	Limit of Study
	═	Jurisdiction Boundary
	— — —	Coastal Transect Baseline
	— —	Profile Baseline
	—	Hydrographic Feature
MAP PANELS	☐	Digital Data Available
	☐	No Digital Data Available
	☒	Unmapped

N

The pin displayed on the map is an approximate point selected by the user and does not represent an authoritative property location.

This map complies with FEMA's standards for the use of digital flood maps if it is not void as described below. The basemap shown complies with FEMA's basemap accuracy standards

The flood hazard information is derived directly from the authoritative NFHL web services provided by FEMA. This map was exported on 9/29/2022 at 5:18 PM and does not reflect changes or amendments subsequent to this date and time. The NFHL and effective information may change or become superseded by new data over time.

This map image is void if the one or more of the following map elements do not appear: basemap imagery, flood zone labels, legend, scale bar, map creation date, community identifiers, FIRM panel number, and FIRM effective date. Map images for unmapped and unmodernized areas cannot be used for regulatory purposes.

Tab 2.0

2.0 MINIMUM REQUIREMENTS SUMMARY

Per Figure 1-3.1 of the 2019 Department of Ecology Stormwater Management Manual for Western Washington (the Manual), minimum requirements #1 through #9 apply to this project. Minimum requirements (MRs) as listed in the Manual are listed in this section.

MR1 - Preparation of Stormwater Site Plans.

This report and the prepared construction drawings satisfy this requirement.

MR2 - Construction Stormwater Pollution Prevention Plan (SWPPP)

A SWPPP has been prepared and submitted to the City under a separate cover.

MR3 - Source Control of Pollution

Source Control BMPs will be selected in accordance with Volume IV of the Manual once the property has been leased and actual commercial activities are able to be identified. Good housekeeping measures will be used to keep the site clean and to reduce the chance that stormwater will come into contact with pollutants. Some BMPs that are applicable to any use of the project site are:

- S410 BMPs for Correcting Illicit Discharges to Storm Drains
- S411 BMPs for Landscaping and Lawn/Vegetation Management
- S412 BMPs for Loading and Unloading Areas for Liquid or Solid Material
- S417 BMPs for Maintenance of Stormwater Drainage and Treatment Systems
- S421 BMPs for Parking and Storage of Vehicles and Equipment
- S424 BMPs for Roof/Building Drains at Manufacturing and Commercial Buildings
- S426 BMPs for Spills of Oil and Hazardous Substances
- S435 BMPs for Pesticides and an Integrated Pest Management Program
- S444 BMPs for the Storage of Dry Pesticides and Fertilizers
- S453 BMPs for Formation of a Pollution Prevention Team
- S454 BMPs for Preventive Maintenance/Good Housekeeping
- S455 BMPs for Spill Prevention and Cleanup
- S456 BMPs for Employee Training
- S457 BMPs for Inspections
- S458 BMPs for Record Keeping

MR4 - Preservation of Natural Drainage Systems and Outfalls

In the existing condition the site discharges into the public stormwater systems in East Main Street and 15th Street SE, ultimately discharging to Deer Creek and then to the Puyallup River. These discharge locations will be maintained.

MR5 - On-Site Stormwater Management

To satisfy this Minimum Requirement, the BMPs given by List #2 are evaluated for feasibility. In accordance with the geotechnical report prepared for this project, infiltration of stormwater on the project site is not feasible. Dispersion BMPs are also infeasible due to the absence of available dispersion areas on the project site. Therefore, the project proposes to manage stormwater by implementing BMP T5.13 to all landscape areas and by conveying onsite runoff from the western portion of the site to the proposed stormwater treatment and detention facilities.

MR6 - Runoff Treatment

The use of OldCastle Biopods is proposed. These are proprietary underground treatment vaults that have received a General Use Level Designation (GULD) approval from the DOE. Sizing is provided with this report. See Section 4.4 and Figure 9.

MR7 - Flow Control

The project will meet the duration matching requirement. Flow control will be provided by the proposed detention vault. See Section 4.3 of this report for more information.

MR8 - Wetlands Protection

Some runoff from the project site enters the public stormwater system in 15th Street SE, which ultimately discharges to Deer Creek at a location where it is mapped as wetlands per City GIS. In order to protect this wetland, the flow to this discharge location will be maintained. The eastern portion of the site will continue to discharge to the wetland. This area is largely impervious in the existing condition so flows will be matched by discharging the eastern portion of the site without detention. See Section 4.5 for additional narrative.

MR9 - Operation and Maintenance

An operations and maintenance manual has be completed and submitted as a separate document.

Figure 5
Minimum Requirements Flowchart

Figure I-3.1: Flow Chart for Determining Requirements for New Development

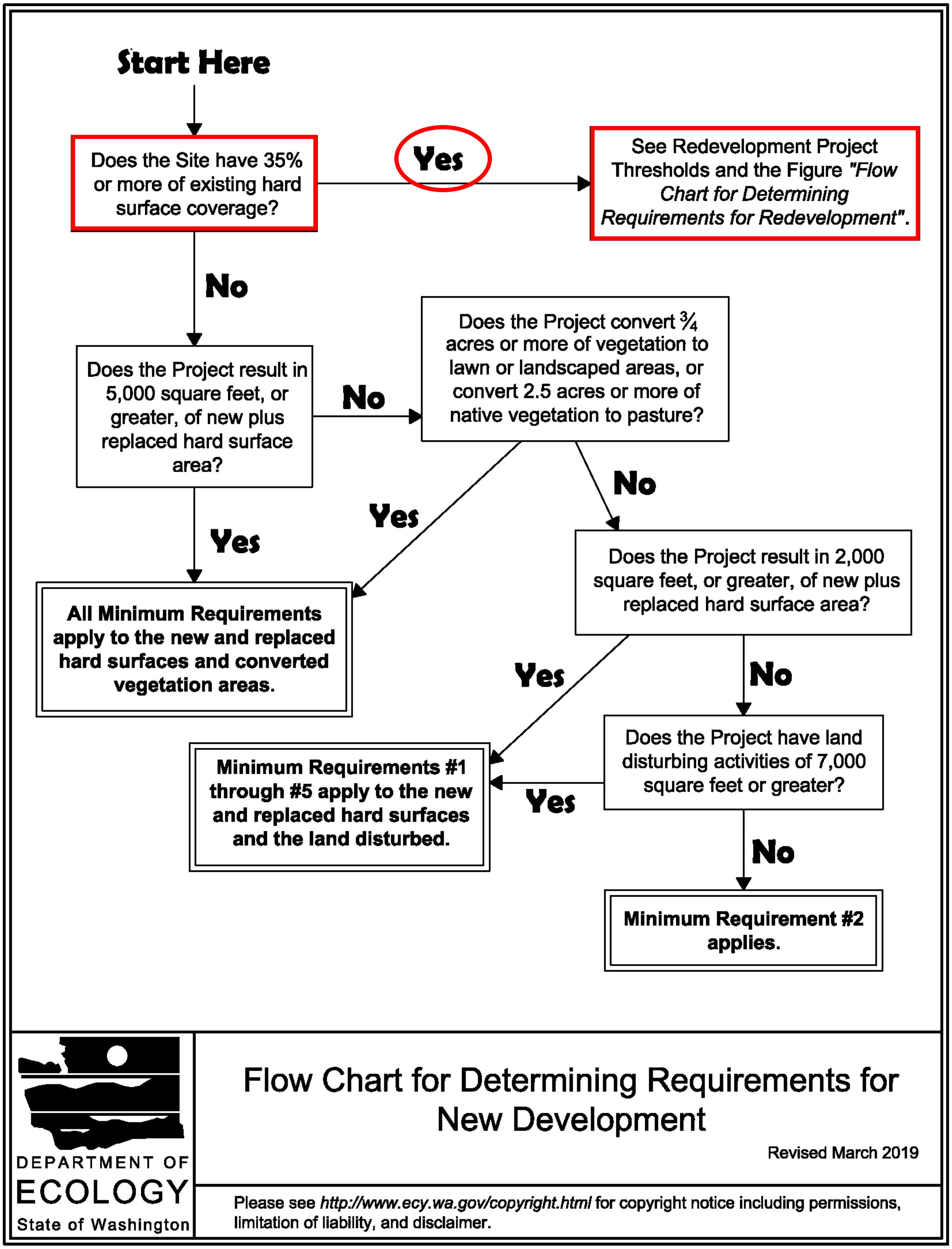


Figure I-3.2: Flow Chart for Determining Requirements for Redevelopment

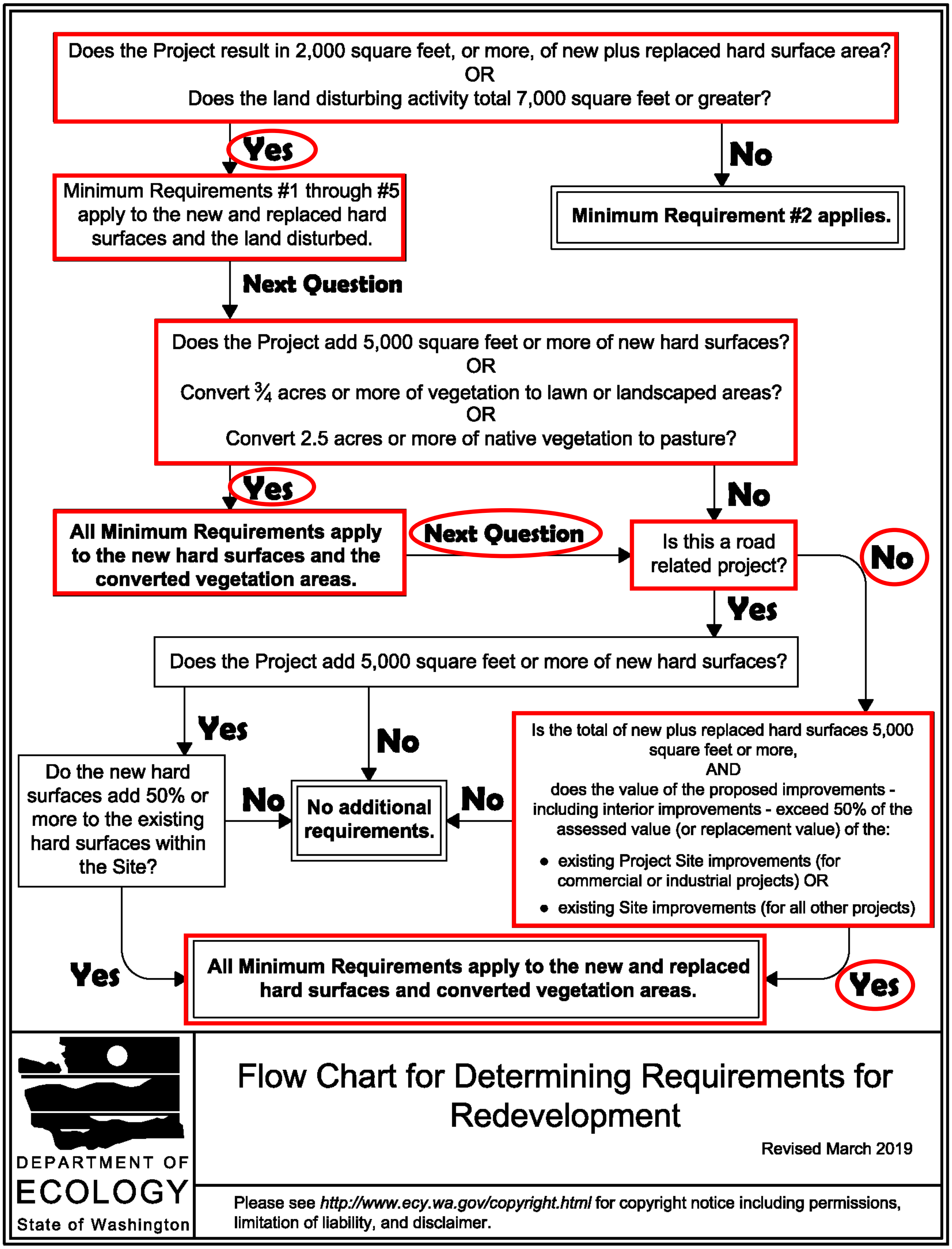


Figure III-1.1: Runoff Treatment BMP Selection Flow Chart

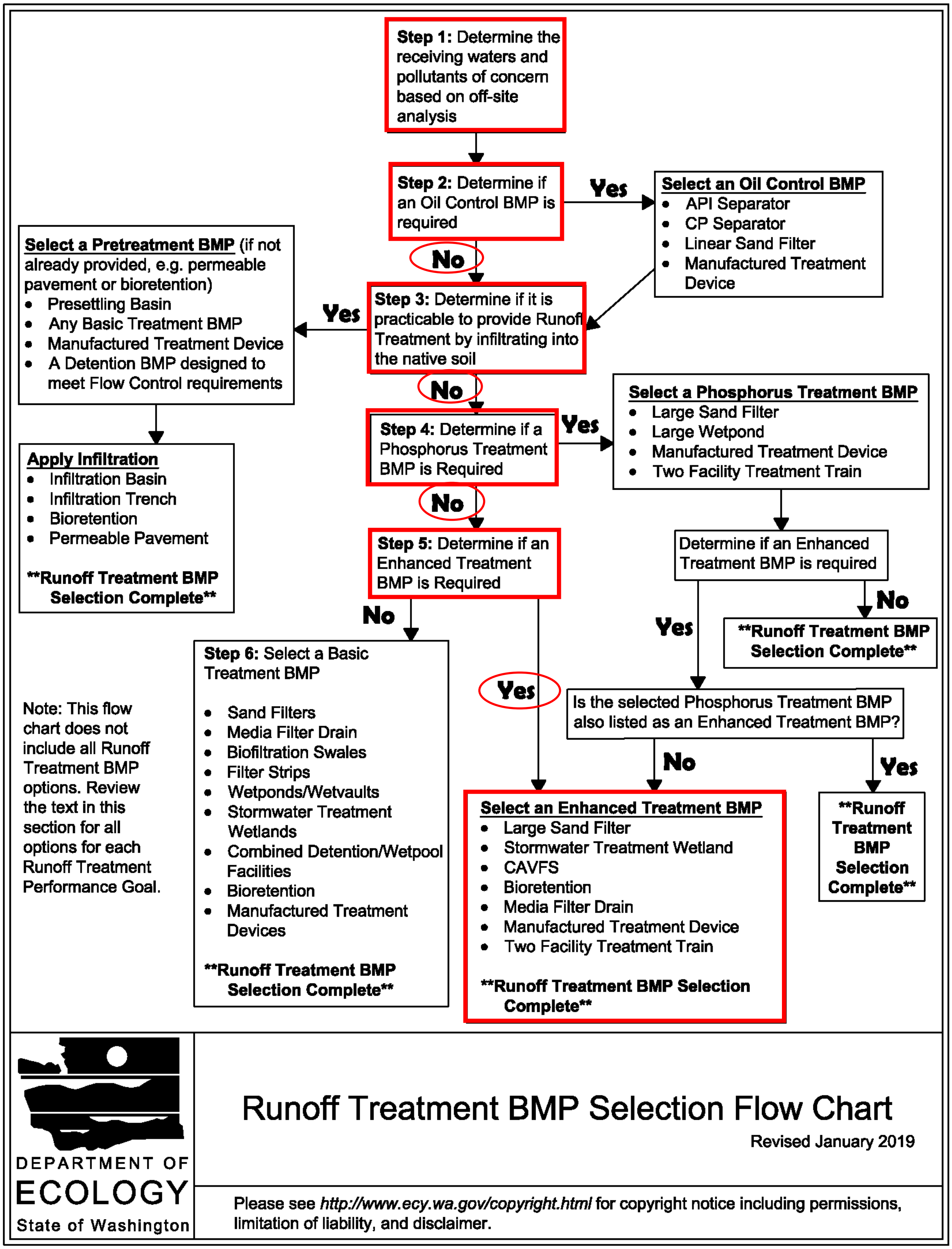
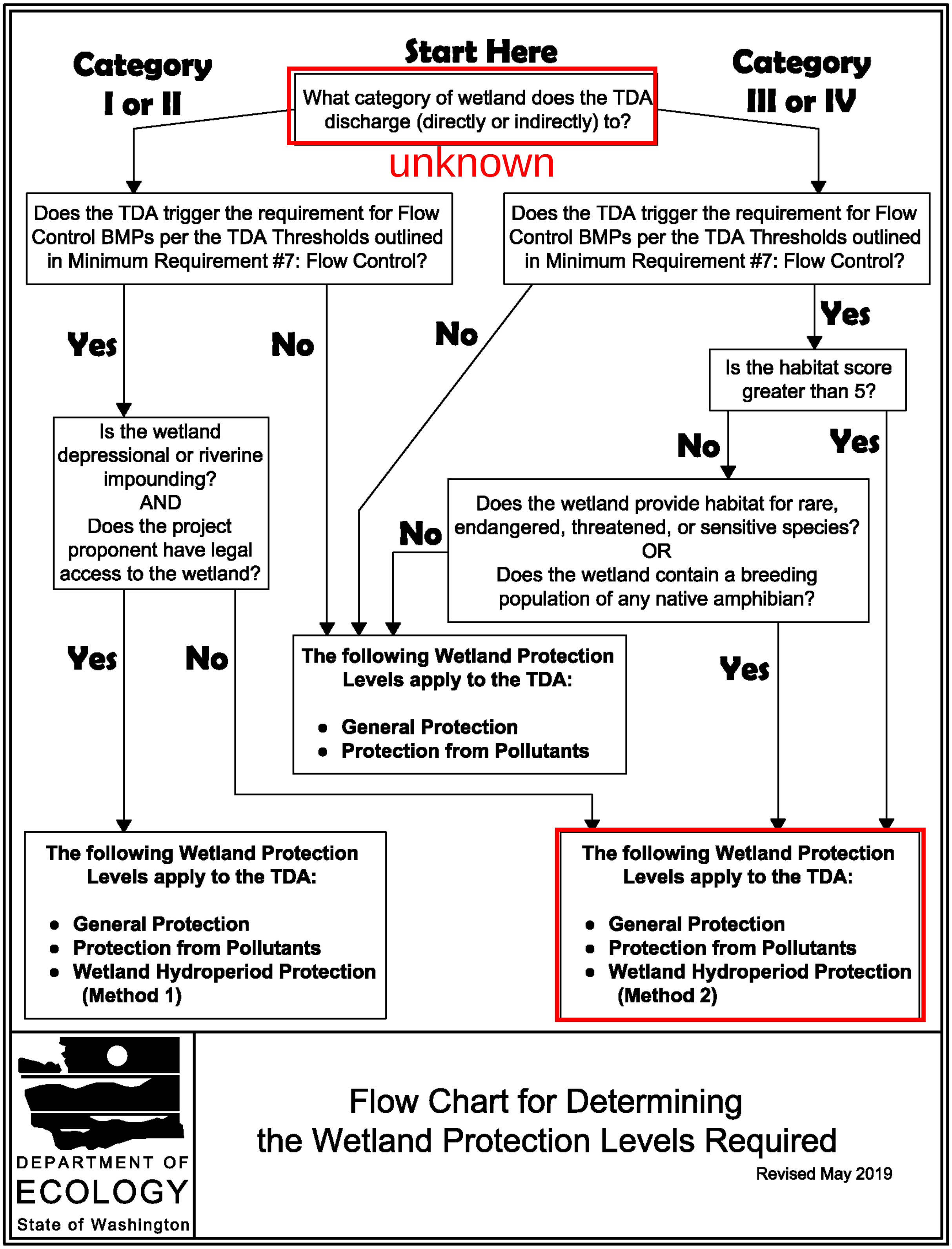


Figure I-3.5: Flow Chart for Determining Wetland Protection Level Requirements

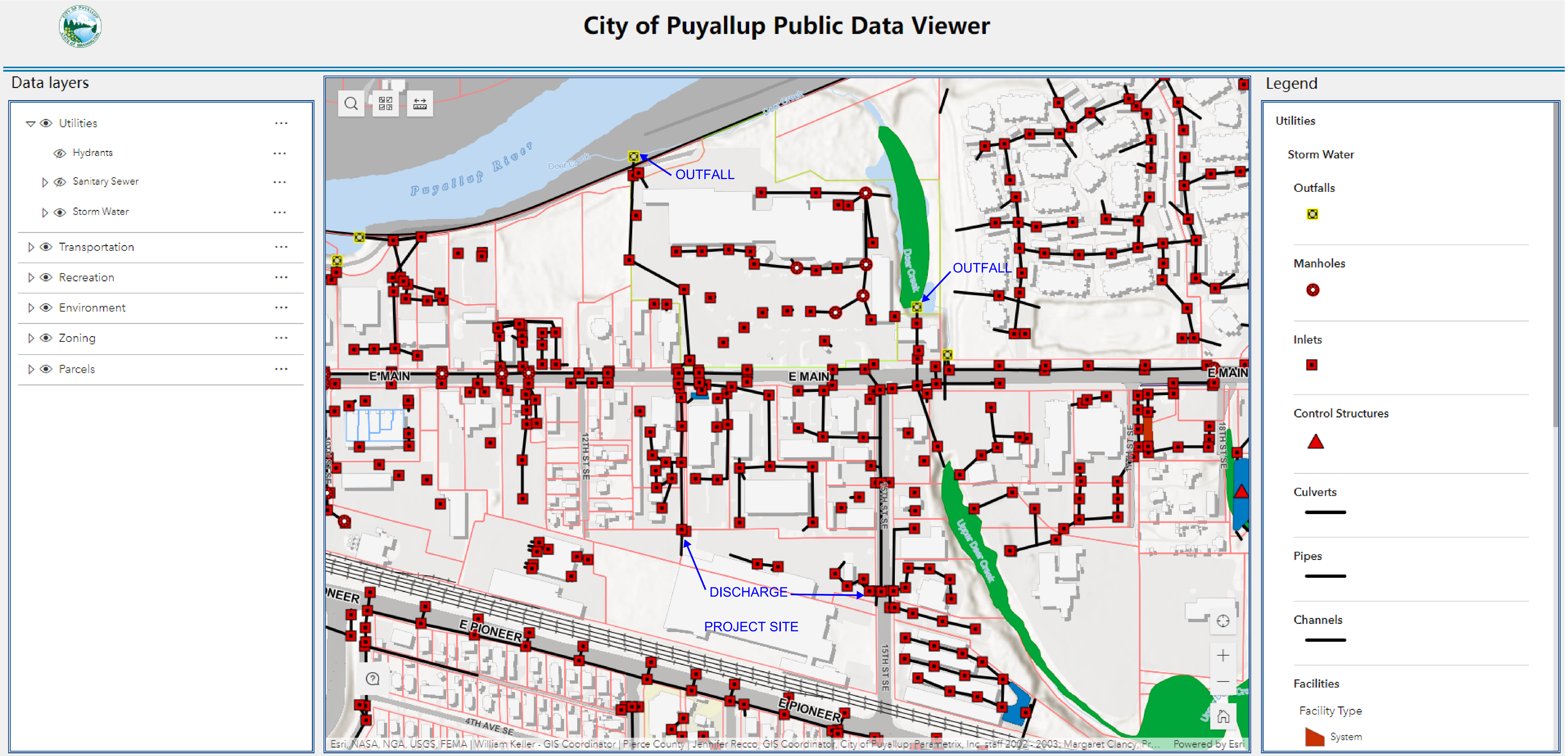


Tab 3.0

3.0 OFF-SITE ANALYSIS

The project site drains to existing stormwater catch basins and piping, which discharge into the public stormwater systems in East Main Street and 15th Street SE, ultimately discharging to Deer Creek near the Puyallup River. The outfall from the 15th Street SE system is location within an area classified as wetland per City of Puyallup GIS. See Figure 6. We are not aware of any known drainage issues with the existing downstream drainage systems.

Figure 6
Downstream Drainage Map



City of Puyallup Public Data Viewer

Data layers

- Utilities
  - Hydrants
  - Sanitary Sewer
  - Storm Water
- Transportation
- Recreation
- Environment
- Zoning
- Parcels

Esri, NASA, NGA, USGS, FEMA | William Keller - GIS Coordinator | Pierce County | Jennifer Recco, GIS Coordinator, City of Puyallup; Parametrix, Inc. staff 2002 - 2003; Margaret Clancy, Pr... Powered by Esri

Legend

Utilities

Storm Water

Outfalls

Manholes

Inlets

Control Structures

Culverts

Pipes

Channels

Facilities

Facility Type

System

Tab 4.0

4.0 FLOW CONTROL AND WATER QUALITY FACILITY ANALYSIS AND DESIGN

4.1 Existing Site Hydrology

For the purpose of flow control modeling, the predeveloped site condition for the west portion of the site (5.09 acres) is assumed to be forested. (For reference, amount of existing impervious area in the West Basin is 3.86 acres.) To meet the wetland protection guidelines, the eastern portion of the site (2.75 acres) is modeled as the current conditions which is mostly impervious. In accordance with soil characteristics described in the geotechnical report prepared for this project, existing site soils are modeled as Type C. The total area of the predeveloped basin is 7.84 acres. See Figure 7.

Basin ID	Existing Basin Area	
West Basin	5.09 ac	Forested
East Basin	2.75 acres	0.43 ac lawn 2.32 ac impervious

4.2 Developed Site Hydrology

The proposed development will convey runoff from the west portion of the site (5.31 acres) to the proposed detention vault using the proposed catch basins and gravity conveyance piping. The eastern portion of the site (2.52 acres) will discharge through a water quality unit prior to discharge. The pervious surface is modeled as pasture in accordance with BMP T5.13.

Basin ID	Basin Area	
West Basin	5.31 ac	4.59 ac impervious 0.72 ac pasture
East Basin	2.52 acres	2.10 ac impervious 0.42 ac pasture

4.3 Flow Control System

In accordance with the Manual the duration matching requirement that must be satisfied for flow control is: Stormwater discharges shall match developed discharge durations to pre-developed durations for the range of pre-developed discharge rates from 50% of the 2-year peak flow up to the full 50-year peak flow. The proposed detention vault has been modeled using WWHM, a DOE approved continuous rainfall runoff modeling program, to ensure that this requirement is met. See Figure 7 for modeling inputs and outputs. The discharge to the wetland requires flows to match existing/current conditions. Flow control is not necessary for the discharge to the wetland in order to match existing flows.

4.4 Water Quality System

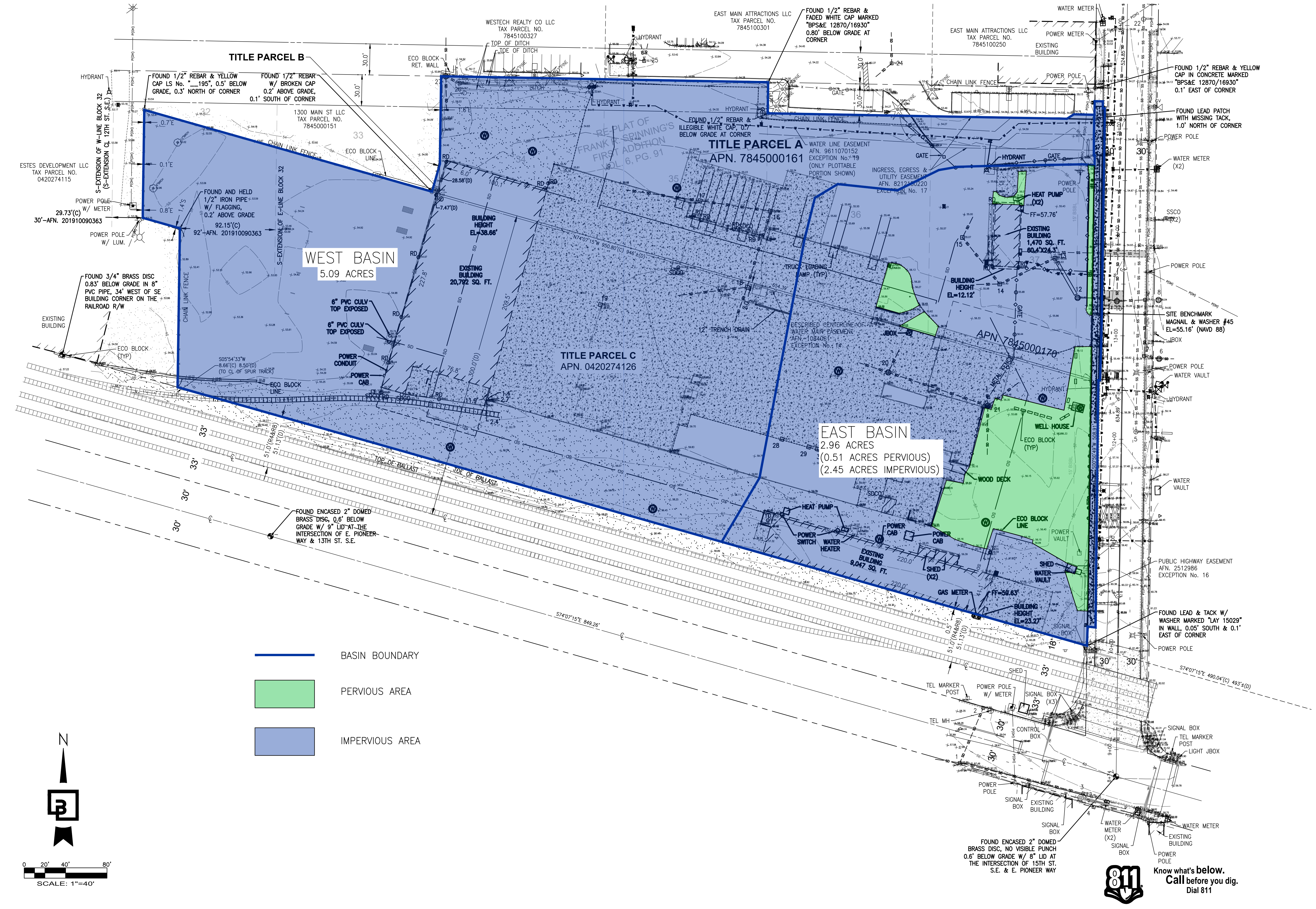
For commercial development, enhanced water quality treatment is required. OldCastle Bipods are proposed to provide the required treatment. These units have received a General Use Level Designation (GULD) approval from the DOE. Sizing is provided in Figure 9.

4.5 Wetland Protection

The discharge to Deer Creek for the eastern basin is shown as a wetland per the Puyallup critical areas map. It is assumed that the wetland requires General Protection, Protection from Pollutants and Wetland Hydroperiod Protection (Method 2). The discharge from the east basin will be discharged through a enhanced treatment water quality unit prior to discharge to protect the wetland from pollutants. The basin to the wetland was sized to match the existing conditions of the site, which is mostly impervious. Per I-3.4.8 MR8: Wetlands Protection from the DOE Stormwater Management Manual for Western Washington, when the flow control and wetlands protections requirements cannot bot be met, the wetlands protection is the overriding concern. In order to match current discharge conditions to the wetland, flow control matching forested conditions is not possible or flows to the wetland would be overly reduced. See East Basin - Wetland recharge in Figure 8 to see flow durations are being matched for the basin that flows to the wetland.

Figure 7
Flow Control Calculations

EXISTING CONDITION BASIN MAP EXHIBIT



▬	BASIN BOUNDARY
🟩	PERVIOUS AREA
🟦	IMPERVIOUS AREA

Know what's below. **Call** before you dig. Dial 811

No.	Date	By	Ckd.	Appr.	Revision

Title: **EXISTING CONDITION BASIN MAP EXHIBIT**

FORTRESS - PUYALLUP

For:
FORTRESS INVESTMENT GROUP
11611 SAN VICENTE BLVD
10TH FLOOR
LOS ANGELES, CA 90049

Scale: Horizontal 1"=40' Vertical N/A

Designed VMS
Drawn VMS
Checked KEH
Approved KEH
Date 10/04/22

Barghausen Consulting Engineers, Inc.
18215 72nd Avenue South
Kent, WA 98032
425.251.6222 **barghausen.com**

Job Number 22085

Sheet ___ of ___

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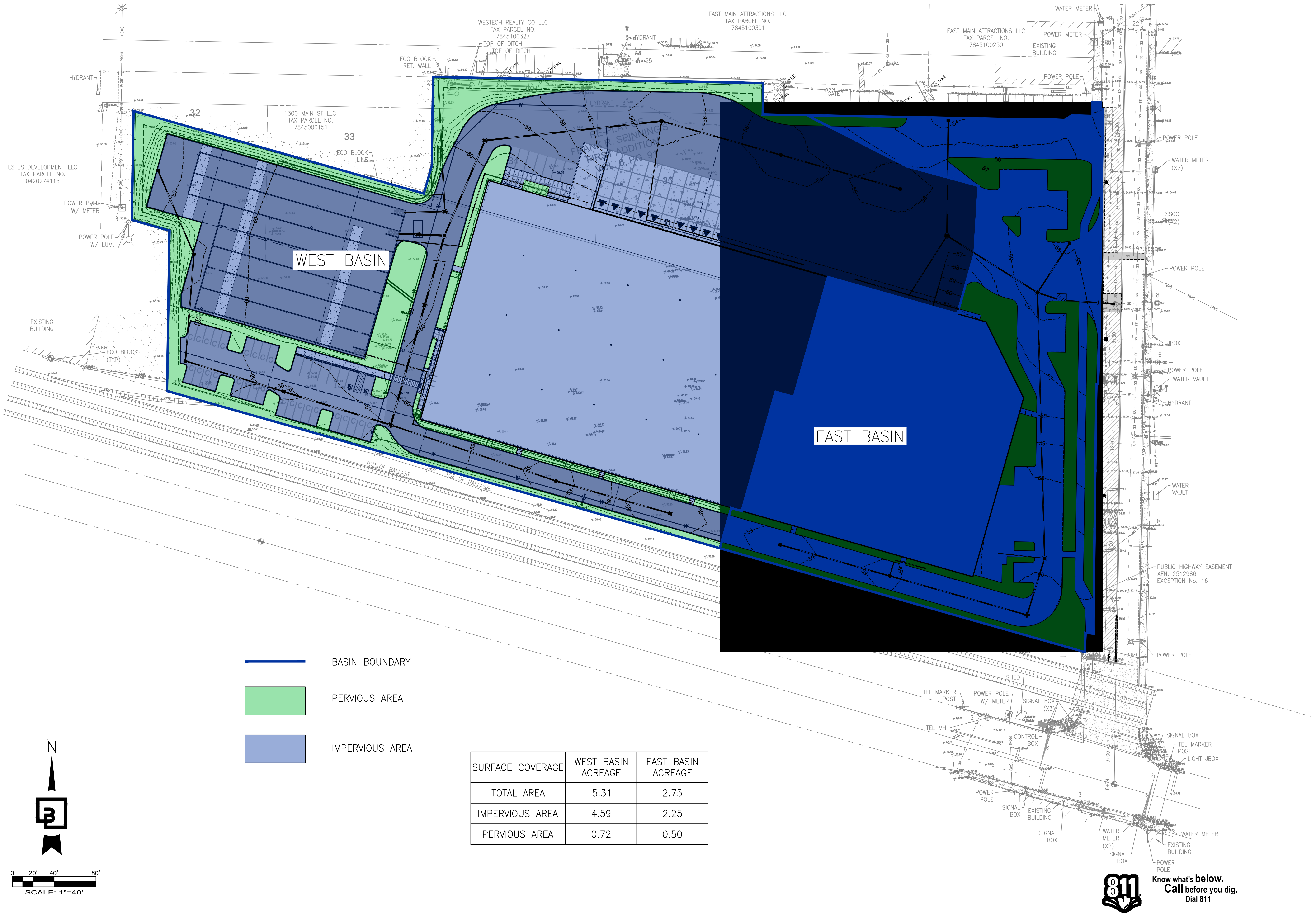
PROPOSED CONDITION BASIN MAP EXHIBIT



- BASIN BOUNDARY
- 🟩 PERVIOUS AREA
- 🟦 IMPERVIOUS AREA

SURFACE COVERAGE	WEST BASIN ACREAGE	EAST BASIN ACREAGE
TOTAL AREA	5.31	2.75
IMPERVIOUS AREA	4.59	2.25
PERVIOUS AREA	0.72	0.50

Know what's **below.**
Call before you dig.
Dial 811

Title:
PROPOSED CONDITION BASIN MAP EXHIBIT
FORTRESS - PUYALLUP

For:
CREF3 PUYALLUP OWNER LLC
11611 SAN VICENTE BLVD
10TH FLOOR
LOS ANGELES, CA 90049

No.	Date	By	Ckd.	Appr.	Revision

Scale: Horizontal 1"=40' Vertical N/A

Designed VMS
Drawn VMS
Checked KEH
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Date 10/04/22

Barghausen Consulting Engineers, Inc.
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barghausen.com

Job Number 22085
Sheet of

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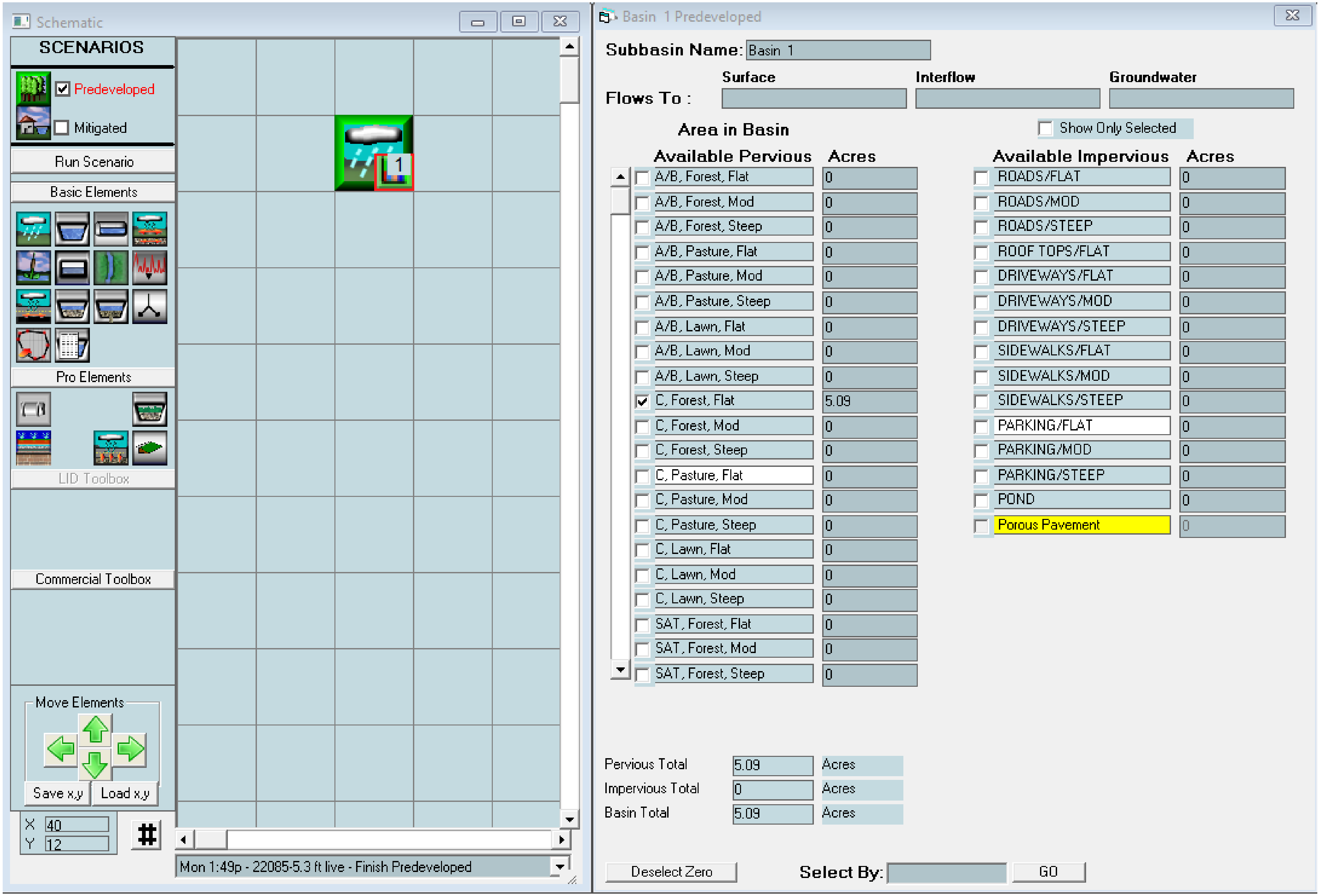
West Basin -Predeveloped Conditions



☑ Predeveloped

☐ Mitigated

X 40

Y 12

Mon 1:49p - 22085-5.3 ft live - Finish Predeveloped

Subbasin Name: Basin 1

Flows To : Surface: | Interflow: | Groundwater:

Area in Basin

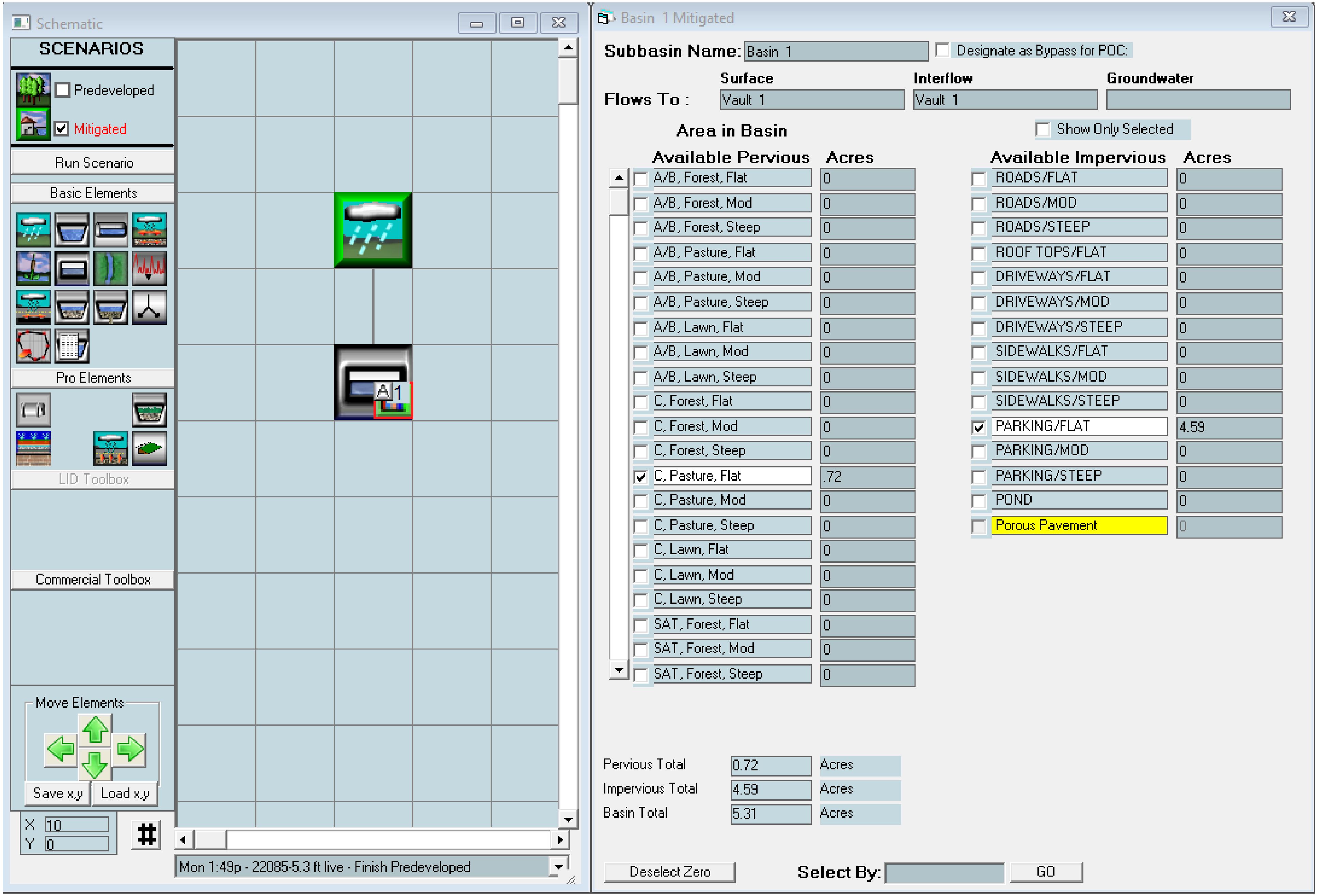
☐ Show Only Selected

Available Pervious	Acres	Available Impervious	Acres
☐ A/B, Forest, Flat	0	☐ ROADS/FLAT	0
☐ A/B, Forest, Mod	0	☐ ROADS/MOD	0
☐ A/B, Forest, Steep	0	☐ ROADS/STEEP	0
☐ A/B, Pasture, Flat	0	☐ ROOF TOPS/FLAT	0
☐ A/B, Pasture, Mod	0	☐ DRIVEWAYS/FLAT	0
☐ A/B, Pasture, Steep	0	☐ DRIVEWAYS/MOD	0
☐ A/B, Lawn, Flat	0	☐ DRIVEWAYS/STEEP	0
☐ A/B, Lawn, Mod	0	☐ SIDEWALKS/FLAT	0
☐ A/B, Lawn, Steep	0	☐ SIDEWALKS/MOD	0
☑ C, Forest, Flat	5.09	☐ SIDEWALKS/STEEP	0
☐ C, Forest, Mod	0	☐ PARKING/FLAT	0
☐ C, Forest, Steep	0	☐ PARKING/MOD	0
☐ C, Pasture, Flat	0	☐ PARKING/STEEP	0
☐ C, Pasture, Mod	0	☐ POND	0
☐ C, Pasture, Steep	0	☐ Porous Pavement	0
☐ C, Lawn, Flat	0		
☐ C, Lawn, Mod	0		
☐ C, Lawn, Steep	0		
☐ SAT, Forest, Flat	0		
☐ SAT, Forest, Mod	0		
☐ SAT, Forest, Steep	0		

Pervious Total	5.09	Acres
Impervious Total	0	Acres
Basin Total	5.09	Acres

Select By:

West Basin -Proposed Conditions



☐ Predeveloped
☑ Mitigated

X 10
Y 0

Mon 1:49p - 22085-5.3 ft live - Finish Predeveloped

Subbasin Name: Basin 1 ☐ Designate as Bypass for POC:

	Surface	Interflow	Groundwater
Flows To :	Vault 1	Vault 1	

Area in Basin ☐ Show Only Selected

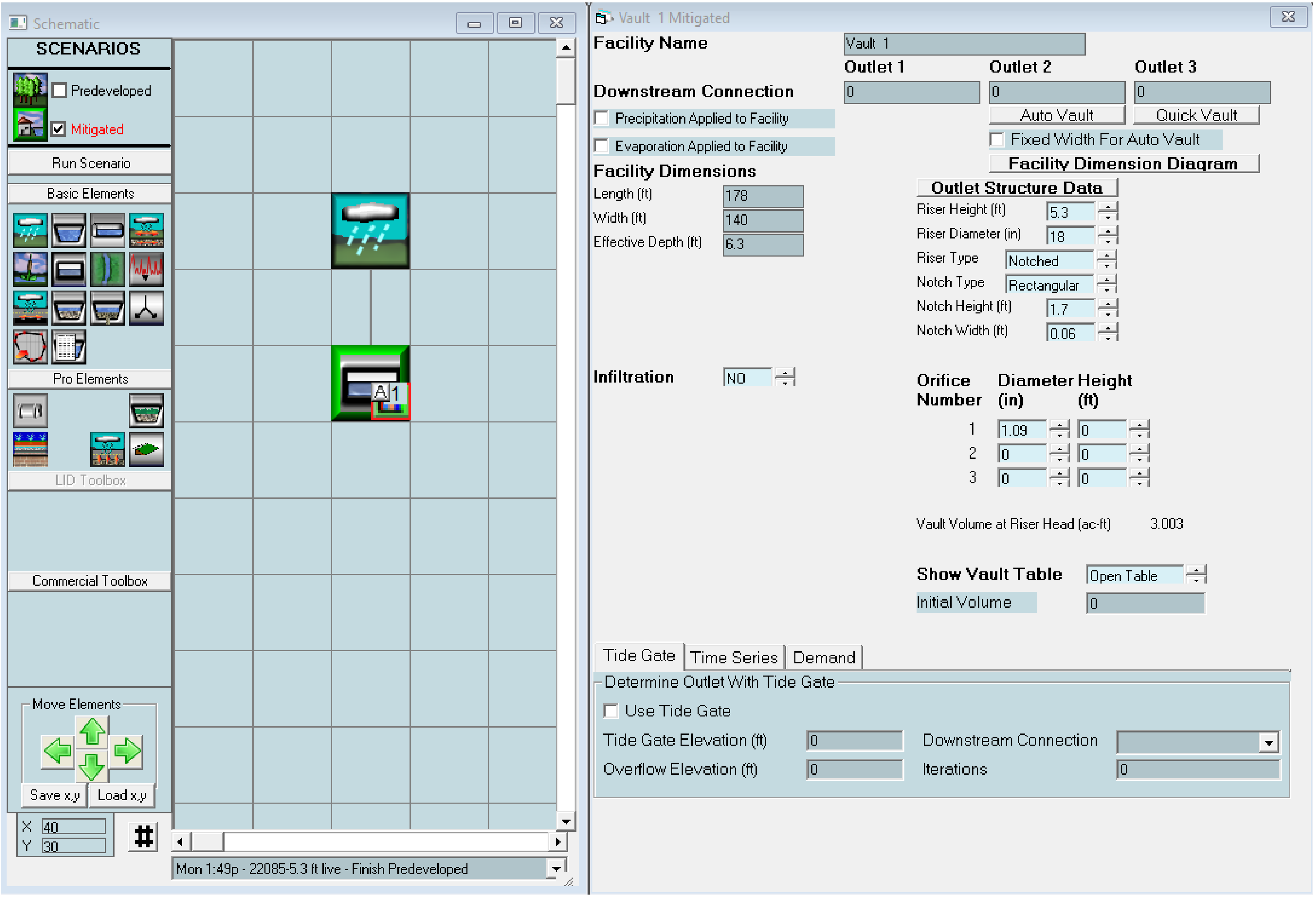
	Available Pervious	Acres
☐	A/B, Forest, Flat	0
☐	A/B, Forest, Mod	0
☐	A/B, Forest, Steep	0
☐	A/B, Pasture, Flat	0
☐	A/B, Pasture, Mod	0
☐	A/B, Pasture, Steep	0
☐	A/B, Lawn, Flat	0
☐	A/B, Lawn, Mod	0
☐	A/B, Lawn, Steep	0
☐	C, Forest, Flat	0
☐	C, Forest, Mod	0
☐	C, Forest, Steep	0
☑	C, Pasture, Flat	.72
☐	C, Pasture, Mod	0
☐	C, Pasture, Steep	0
☐	C, Lawn, Flat	0
☐	C, Lawn, Mod	0
☐	C, Lawn, Steep	0
☐	SAT, Forest, Flat	0
☐	SAT, Forest, Mod	0
☐	SAT, Forest, Steep	0

	Available Impervious	Acres
☐	ROADS/FLAT	0
☐	ROADS/MOD	0
☐	ROADS/STEEP	0
☐	ROOF TOPS/FLAT	0
☐	DRIVEWAYS/FLAT	0
☐	DRIVEWAYS/MOD	0
☐	DRIVEWAYS/STEEP	0
☐	SIDEWALKS/FLAT	0
☐	SIDEWALKS/MOD	0
☐	SIDEWALKS/STEEP	0
☑	PARKING/FLAT	4.59
☐	PARKING/MOD	0
☐	PARKING/STEEP	0
☐	POND	0
☐	Porous Pavement	0

Pervious Total	0.72	Acres
Impervious Total	4.59	Acres
Basin Total	5.31	Acres

Select By:

West Basin -Detention Vault



☐ Predeveloped
☑ Mitigated

X 40
Y 30

Mon 1:49p - 22085-5.3 ft live - Finish Predeveloped

Facility Name Vault 1

	Outlet 1	Outlet 2	Outlet 3
Downstream Connection	0	0	0

☐ Precipitation Applied to Facility
☐ Evaporation Applied to Facility
☐ Fixed Width For Auto Vault

Facility Dimensions

Length (ft) 178
Width (ft) 140
Effective Depth (ft) 6.3

Outlet Structure Data

Riser Height (ft) 5.3
Riser Diameter (in) 18
Riser Type Notched
Notch Type Rectangular
Notch Height (ft) 1.7
Notch Width (ft) 0.06

Infiltration NO

Orifice Number	Diameter (in)	Height (ft)
1	1.09	0
2	0	0
3	0	0

Vault Volume at Riser Head (ac-ft) 3.003

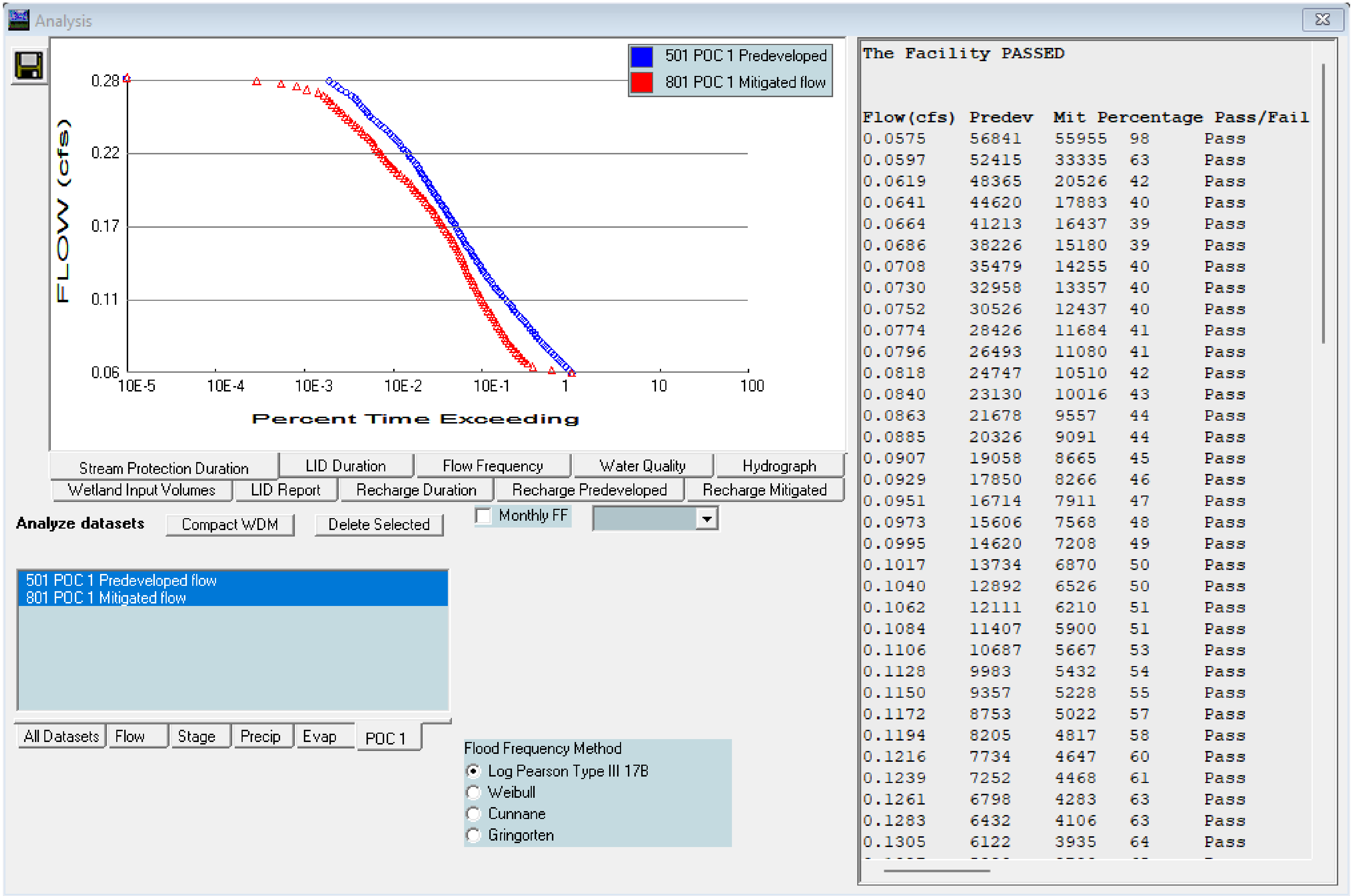
Show Vault Table Open Table
Initial Volume 0

Determine Outlet With Tide Gate

☐ Use Tide Gate

Tide Gate Elevation (ft) 0
Downstream Connection
Overflow Elevation (ft) 0
Iterations 0

West Basin -Flow Duration

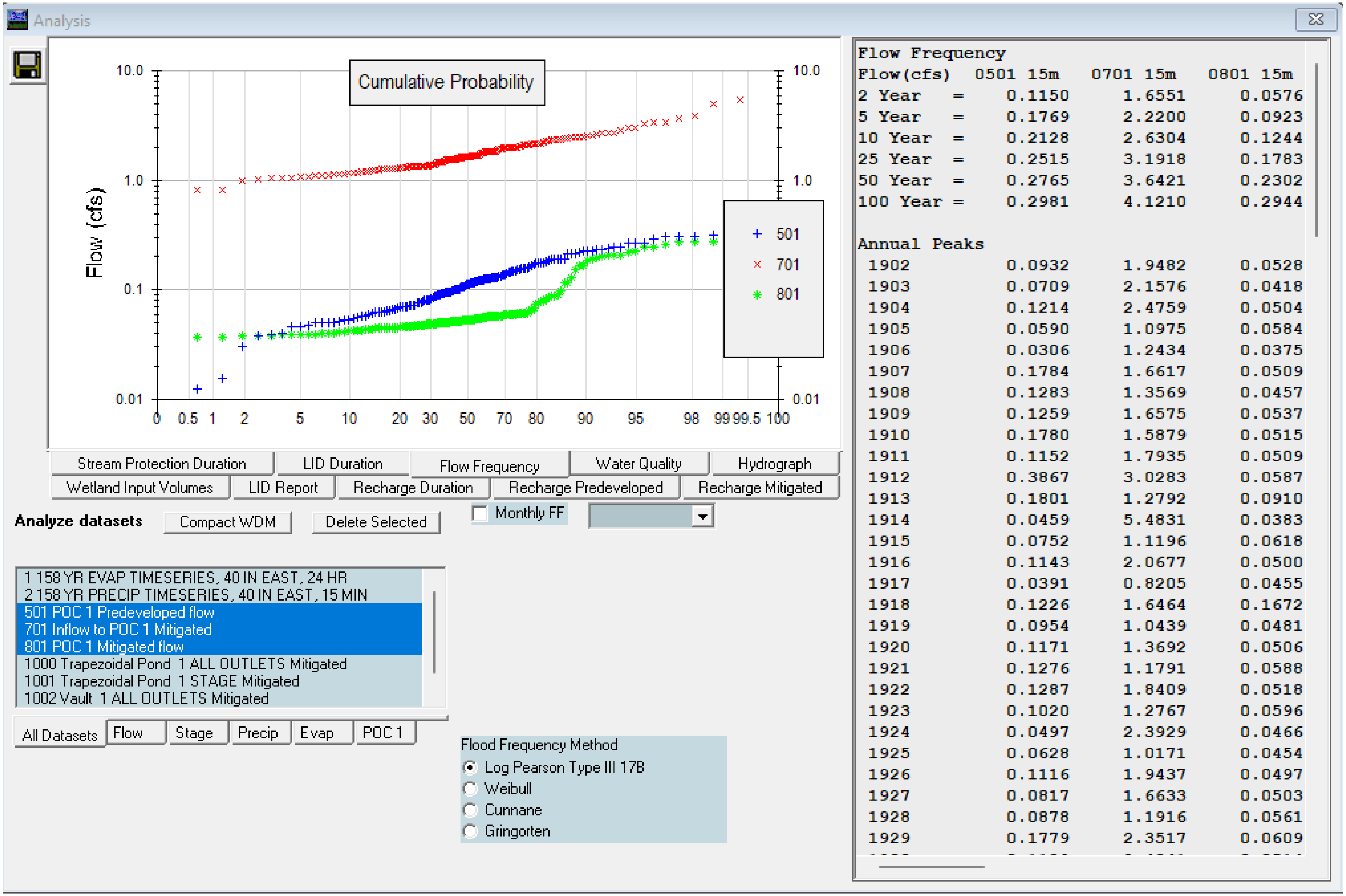


Flood Frequency Method
● Log Pearson Type III 17B
○ Weibull
○ Cunnane
○ Gringorten

```
The Facility PASSED


Flow(cfs)  Predev   Mit  Percentage Pass/Fail
0.0575     56841    55595   98        Pass
0.0597     52415    33335   63        Pass
0.0619     48365    20526   42        Pass
0.0641     44620    17883   40        Pass
0.0664     41213    16437   39        Pass
0.0686     38226    15180   39        Pass
0.0708     35479    14255   40        Pass
0.0730     32958    13357   40        Pass
0.0752     30526    12437   40        Pass
0.0774     28426    11684   41        Pass
0.0796     26493    11080   41        Pass
0.0818     24747    10510   42        Pass
0.0840     23130    10016   43        Pass
0.0863     21678    9557    44        Pass
0.0885     20326    9091    44        Pass
0.0907     19058    8665    45        Pass
0.0929     17850    8266    46        Pass
0.0951     16714    7911    47        Pass
0.0973     15606    7568    48        Pass
0.0995     14620    7208    49        Pass
0.1017     13734    6870    50        Pass
0.1040     12892    6526    50        Pass
0.1062     12111    6210    51        Pass
0.1084     11407    5900    51        Pass
0.1106     10687    5667    53        Pass
0.1128     9983     5432    54        Pass
0.1150     9357     5228    55        Pass
0.1172     8753     5022    57        Pass
0.1194     8205     4817    58        Pass
0.1216     7734     4647    60        Pass
0.1239     7252     4468    61        Pass
0.1261     6798     4283    63        Pass
0.1283     6432     4106    63        Pass
0.1305     6122     3935    64        Pass
```

West Basin -Flows



Analyze datasets

☐ Monthly FF

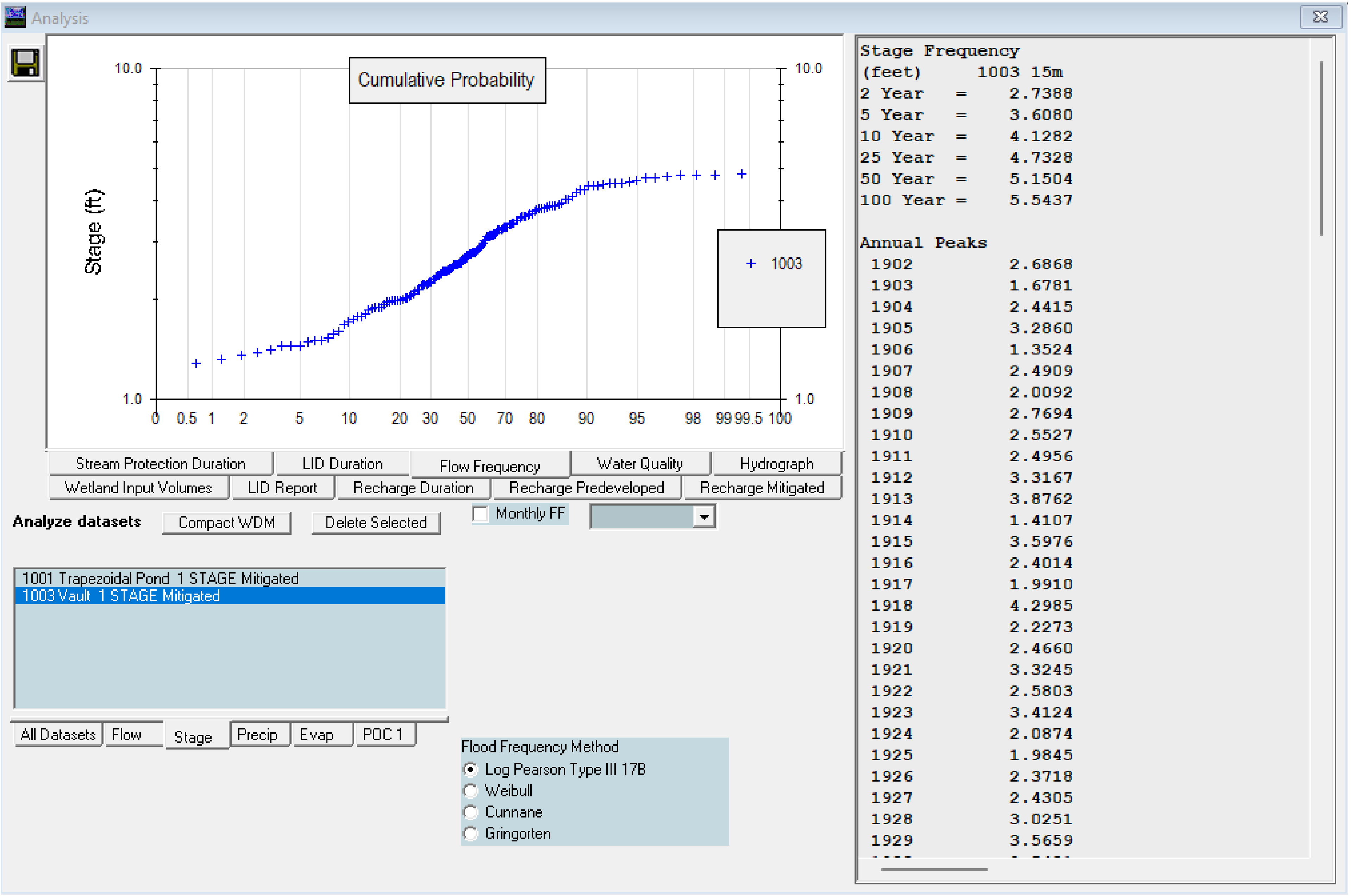
1 158 YR EVAP TIMESERIES, 40 IN EAST, 24 HR
2 158 YR PRECIP TIMESERIES, 40 IN EAST, 15 MIN
501 POC 1 Predeveloped flow
701 Inflow to POC 1 Mitigated
801 POC 1 Mitigated flow
1000 Trapezoidal Pond 1 ALL OUTLETS Mitigated
1001 Trapezoidal Pond 1 STAGE Mitigated
1002 Vault 1 ALL OUTLETS Mitigated

Flood Frequency Method
● Log Pearson Type III 17B
○ Weibull
○ Cunnane
○ Gringorten

```
Flow Frequency
Flow(cfs)  0501 15m   0701 15m   0801 15m
2 Year   =     0.1150     1.6551     0.0576
5 Year   =     0.1769     2.2200     0.0923
10 Year  =     0.2128     2.6304     0.1244
25 Year  =     0.2515     3.1918     0.1783
50 Year  =     0.2765     3.6421     0.2302
100 Year =     0.2981     4.1210     0.2944

Annual Peaks
 1902          0.0932     1.9482     0.0528
 1903          0.0709     2.1576     0.0418
 1904          0.1214     2.4759     0.0504
 1905          0.0590     1.0975     0.0584
 1906          0.0306     1.2434     0.0375
 1907          0.1784     1.6617     0.0509
 1908          0.1283     1.3569     0.0457
 1909          0.1259     1.6575     0.0537
 1910          0.1780     1.5879     0.0515
 1911          0.1152     1.7935     0.0509
 1912          0.3867     3.0283     0.0587
 1913          0.1801     1.2792     0.0910
 1914          0.0459     5.4831     0.0383
 1915          0.0752     1.1196     0.0618
 1916          0.1143     2.0677     0.0500
 1917          0.0391     0.8205     0.0455
 1918          0.1226     1.6464     0.1672
 1919          0.0954     1.0439     0.0481
 1920          0.1171     1.3692     0.0506
 1921          0.1276     1.1791     0.0588
 1922          0.1287     1.8409     0.0518
 1923          0.1020     1.2767     0.0596
 1924          0.0497     2.3929     0.0466
 1925          0.0628     1.0171     0.0454
 1926          0.1116     1.9437     0.0497
 1927          0.0817     1.6633     0.0503
 1928          0.0878     1.1916     0.0561
 1929          0.1779     2.3517     0.0609
```

West Basin -Detention Vault Stage



☐ Monthly FF

1001 Trapezoidal Pond 1 STAGE Mitigated
1003 Vault 1 STAGE Mitigated

Flood Frequency Method
● Log Pearson Type III 17B
○ Weibull
○ Cunnane
○ Gringorten

```
Stage Frequency
(feet)      1003 15m
2 Year   =    2.7388
5 Year   =    3.6080
10 Year  =    4.1282
25 Year  =    4.7328
50 Year  =    5.1504
100 Year =    5.5437

Annual Peaks
 1902          2.6868
 1903          1.6781
 1904          2.4415
 1905          3.2860
 1906          1.3524
 1907          2.4909
 1908          2.0092
 1909          2.7694
 1910          2.5527
 1911          2.4956
 1912          3.3167
 1913          3.8762
 1914          1.4107
 1915          3.5976
 1916          2.4014
 1917          1.9910
 1918          4.2985
 1919          2.2273
 1920          2.4660
 1921          3.3245
 1922          2.5803
 1923          3.4124
 1924          2.0874
 1925          1.9845
 1926          2.3718
 1927          2.4305
 1928          3.0251
 1929          3.5659
```

V-11 Miscellaneous LID BMPs

V-11.1 Introduction to Miscellaneous LID BMPs

BMPs in this chapter have been grouped because they have the following in common:

- They employ Low Impact Development (LID) Principles
- They cannot be used to meet I-3.4.6 MR6: Runoff Treatment
- They cannot, by themselves, be used to meet the Flow Control Performance Standard or the LID Performance Standard.
  - Some of the BMPs in this chapter do allow for some amount of Flow Control credit. See the guidance for each individual BMP for details.
- The design methods for each BMP in this chapter are unique. They do not have strong enough design similarities to other BMPs in this volume to place them in the other BMP categories identified in this volume.

BMP T5.13: Post-Construction Soil Quality and Depth

Purpose and Definition

Naturally occurring (undisturbed) soil and vegetation provide important stormwater functions including: water infiltration; nutrient, sediment, and pollutant adsorption; sediment and pollutant biofiltration; water interflow storage and transmission; and pollutant decomposition. These functions are largely lost when development strips away native soil and vegetation and replaces it with minimal topsoil and sod. Not only are these important stormwater functions lost, but such landscapes themselves become pollution generating pervious surfaces due to increased use of pesticides, fertilizers and other landscaping and household/industrial chemicals, the concentration of pet wastes, and pollutants that accompany roadside litter.

Establishing soil quality and depth regains greater stormwater functions in the post development landscape, provides increased treatment of pollutants and sediments that result from development and habitation, and minimizes the need for some landscaping chemicals, thus reducing pollution through prevention.

Applications and Limitations

Establishing a minimum soil quality and depth is not the same as preservation of naturally occurring soil and vegetation. However, establishing a minimum soil quality and depth will provide improved on-site management of stormwater flow and water quality.

Soil organic matter can be attained through numerous materials such as compost, composted woody material, biosolids, and forest product residuals. It is important that the materials used to

meet this BMP be appropriate and beneficial to the plant cover to be established. Likewise, it is important that imported topsoils improve soil conditions and do not have an excessive percent of clay fines.

This BMP can be considered infeasible on till soil slopes greater than 33 percent.

Design Guidelines

Soil Retention

Retain, in an undisturbed state, the duff layer and native topsoil to the maximum extent practicable. In any areas requiring grading, remove and stockpile the duff layer and topsoil on site in a designated, controlled area, not adjacent to public resources and critical areas, to be reapplied to other portions of the site where feasible.

Soil Quality

All areas subject to clearing and grading that have not been covered by impervious surface, incorporated into a drainage facility or engineered as structural fill or slope shall, at project completion, demonstrate the following:

1. A topsoil layer with a minimum organic matter content of 10% dry weight in planting beds, and 5% organic matter content in turf areas, and a pH from 6.0 to 8.0 or matching the pH of the undisturbed soil. The topsoil layer shall have a minimum depth of eight inches except where tree roots limit the depth of incorporation of amendments needed to meet the criteria. Subsoils below the topsoil layer should be scarified at least 4 inches with some incorporation of the upper material to avoid stratified layers, where feasible.
2. Mulch planting beds with 2 inches of organic material.
3. Use compost and other materials that meet the following organic content requirements:
    a. The organic content for “pre-approved” amendment rates can be met only using compost meeting the compost specification for BMP T7.30: Bioretention, with the exception that the compost may have up to 35% biosolids or manure.

       The compost must also have an organic matter content of 40% to 65%, and a carbon to nitrogen ratio below 25:1.

       The carbon to nitrogen ratio may be as high as 35:1 for plantings composed entirely of plants native to the Puget Sound Lowlands region.

    b. Calculated amendment rates may be met through use of composted material meeting (a.) above; or other organic materials amended to meet the carbon to nitrogen ratio requirements, and not exceeding the contaminant limits identified in Table 220-B, Testing Parameters, in WAC 173-350-220.

The resulting soil should be conducive to the type of vegetation to be established.

Implementation Options

The soil quality design guidelines listed above can be met by using one of the methods listed below:

1. Leave undisturbed native vegetation and soil, and protect from compaction during construction.
2. Amend existing site topsoil or subsoil either at default "pre-approved" rates, or at custom calculated rates based on tests of the soil and amendment.
3. Stockpile existing topsoil during grading, and replace it prior to planting. Stockpiled topsoil must also be amended if needed to meet the organic matter or depth requirements, either at a default "pre-approved" rate or at a custom calculated rate.
4. Import topsoil mix of sufficient organic content and depth to meet the requirements.

More than one method may be used on different portions of the same site. Soil that already meets the depth and organic matter quality standards, and is not compacted, does not need to be amended.

Planning/Permitting/Inspection/Verification Guidelines & Procedures

Local governments are encouraged to adopt guidelines and procedures similar to those recommended in *Building Soil: Guidelines and Resources for Implementing Soil Quality and Depth BMP T5.13 in WDOE Stormwater Management Manual for Western Washington* (Stenn et al., 2016).

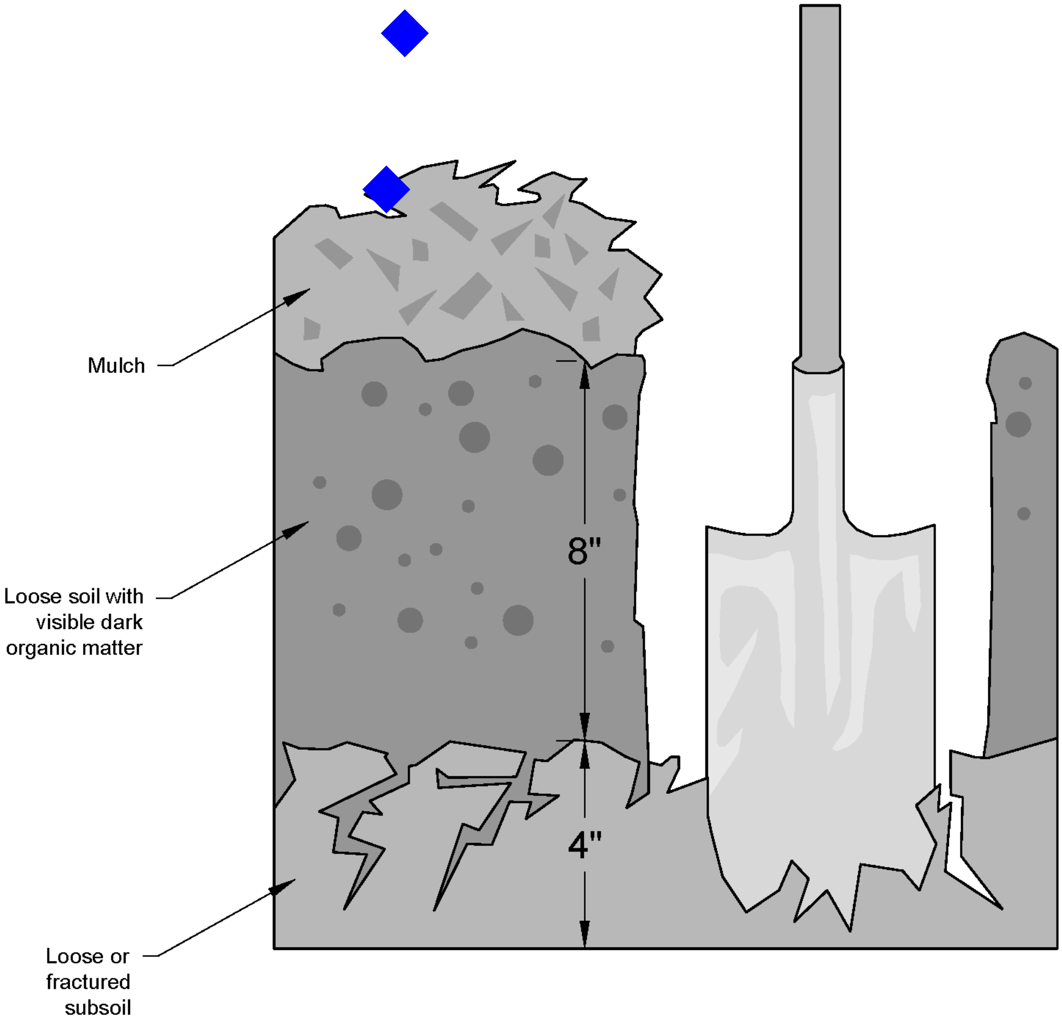
Maintenance

- Establish soil quality and depth toward the end of construction and once established, protect from compaction, such as from large machinery use, and from erosion.
- Plant vegetation and mulch the amended soil area after installation.
- Leave plant debris or its equivalent on the soil surface to replenish organic matter.
- Reduce and adjust, where possible, the use of irrigation, fertilizers, herbicides and pesticides, rather than continuing to implement formerly established practices.

Runoff Model Representation

All areas meeting the soil quality and depth design criteria may be entered into approved runoff models as "Pasture" rather than "Lawn/Landscaping".

Figure V-11.1: Planting Bed Cross-Section



Reprinted from *Guidelines and Resources For Implementing Soil Quality and Depth BMP T5.13 in WDOE Stormwater Management Manual for Western Washington*, 2010, Washington Organic Recycling Council

NOT TO SCALE

DEPARTMENT OF
ECOLOGY
State of Washington

Planting Bed Cross-Section

Revised June 2016

WWHM2012

PROJECT REPORT

Flow Control Calculation

General Model Information

Project Name: 22085-5.3 ft live

Site Name:

Site Address:

City:

Report Date: 11/6/2023

Gage: 40 IN EAST

Data Start: 10/01/1901

Data End: 09/30/2059

Timestep: 15 Minute

Precip Scale: 1.000

Version Date: 2019/09/13

Version: 4.2.17

POC Thresholds

Low Flow Threshold for POC1: 50 Percent of the 2 Year

High Flow Threshold for POC1: 50 Year

Landuse Basin Data

Predeveloped Land Use

Basin 1

Bypass:	No
GroundWater:	No
Pervious Land Use	acre
C, Forest, Flat	5.09
Pervious Total	5.09
Impervious Land Use	acre
Impervious Total	0
Basin Total	5.09

Element Flows To:

Surface	Interflow	Groundwater

Mitigated Land Use

Basin 1

Bypass:	No
GroundWater:	No
Pervious Land Use	acre
C, Pasture, Flat	0.72
Pervious Total	0.72
Impervious Land Use	acre
PARKING FLAT	4.59
Impervious Total	4.59
Basin Total	5.31

Element Flows To:

Surface	Interflow	Groundwater
Vault 1	Vault 1	

Routing Elements

Predeveloped Routing

Mitigated Routing

Vault 1

Width: 140 ft.
Length: 178 ft.
Depth: 6.3 ft.
Discharge Structure
Riser Height: 5.3 ft.
Riser Diameter: 18 in.
Notch Type: Rectangular
Notch Width: 0.060 ft.
Notch Height: 1.700 ft.
Orifice 1 Diameter: 1.09 in. Elevation:0 ft.
Element Flows To:
Outlet 1 Outlet 2

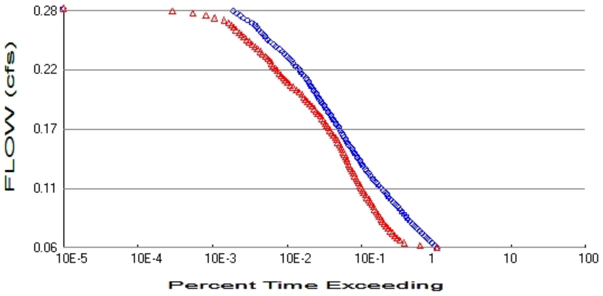
Vault Hydraulic Table

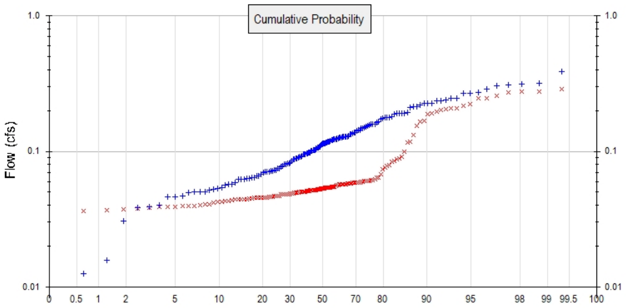
Stage(feet)	**Area(ac.)**	**Volume(ac-ft.)**	**Discharge(cfs)**	**Infilt(cfs)**
0.0000	0.572	0.000	0.000	0.000
0.0700	0.572	0.040	0.008	0.000
0.1400	0.572	0.080	0.012	0.000
0.2100	0.572	0.120	0.014	0.000
0.2800	0.572	0.160	0.017	0.000
0.3500	0.572	0.200	0.019	0.000
0.4200	0.572	0.240	0.020	0.000
0.4900	0.572	0.280	0.022	0.000
0.5600	0.572	0.320	0.024	0.000
0.6300	0.572	0.360	0.025	0.000
0.7000	0.572	0.400	0.027	0.000
0.7700	0.572	0.440	0.028	0.000
0.8400	0.572	0.480	0.029	0.000
0.9100	0.572	0.520	0.030	0.000
0.9800	0.572	0.560	0.031	0.000
1.0500	0.572	0.600	0.033	0.000
1.1200	0.572	0.640	0.034	0.000
1.1900	0.572	0.680	0.035	0.000
1.2600	0.572	0.720	0.036	0.000
1.3300	0.572	0.760	0.037	0.000
1.4000	0.572	0.800	0.038	0.000
1.4700	0.572	0.841	0.039	0.000
1.5400	0.572	0.881	0.040	0.000
1.6100	0.572	0.921	0.040	0.000
1.6800	0.572	0.961	0.041	0.000
1.7500	0.572	1.001	0.042	0.000
1.8200	0.572	1.041	0.043	0.000
1.8900	0.572	1.081	0.044	0.000
1.9600	0.572	1.121	0.045	0.000
2.0300	0.572	1.161	0.045	0.000
2.1000	0.572	1.201	0.046	0.000
2.1700	0.572	1.241	0.047	0.000
2.2400	0.572	1.281	0.048	0.000
2.3100	0.572	1.321	0.049	0.000
2.3800	0.572	1.361	0.049	0.000
2.4500	0.572	1.401	0.050	0.000
2.5200	0.572	1.441	0.051	0.000

2.5900	0.572	1.481	0.051	0.000
2.6600	0.572	1.521	0.052	0.000
2.7300	0.572	1.561	0.053	0.000
2.8000	0.572	1.601	0.053	0.000
2.8700	0.572	1.641	0.054	0.000
2.9400	0.572	1.681	0.055	0.000
3.0100	0.572	1.722	0.055	0.000
3.0800	0.572	1.762	0.056	0.000
3.1500	0.572	1.802	0.057	0.000
3.2200	0.572	1.842	0.057	0.000
3.2900	0.572	1.882	0.058	0.000
3.3600	0.572	1.922	0.059	0.000
3.4300	0.572	1.962	0.059	0.000
3.5000	0.572	2.002	0.060	0.000
3.5700	0.572	2.042	0.060	0.000
3.6400	0.572	2.082	0.063	0.000
3.7100	0.572	2.122	0.069	0.000
3.7800	0.572	2.162	0.077	0.000
3.8500	0.572	2.202	0.087	0.000
3.9200	0.572	2.242	0.097	0.000
3.9900	0.572	2.282	0.109	0.000
4.0600	0.572	2.322	0.121	0.000
4.1300	0.572	2.362	0.134	0.000
4.2000	0.572	2.402	0.147	0.000
4.2700	0.572	2.442	0.161	0.000
4.3400	0.572	2.482	0.175	0.000
4.4100	0.572	2.522	0.189	0.000
4.4800	0.572	2.562	0.204	0.000
4.5500	0.572	2.603	0.218	0.000
4.6200	0.572	2.643	0.234	0.000
4.6900	0.572	2.683	0.251	0.000
4.7600	0.572	2.723	0.270	0.000
4.8300	0.572	2.763	0.288	0.000
4.9000	0.572	2.803	0.308	0.000
4.9700	0.572	2.843	0.328	0.000
5.0400	0.572	2.883	0.437	0.000
5.1100	0.572	2.923	0.464	0.000
5.1800	0.572	2.963	0.492	0.000
5.2500	0.572	3.003	0.521	0.000
5.3200	0.572	3.043	0.587	0.000
5.3900	0.572	3.083	0.971	0.000
5.4600	0.572	3.123	1.554	0.000
5.5300	0.572	3.163	2.263	0.000
5.6000	0.572	3.203	3.045	0.000
5.6700	0.572	3.243	3.843	0.000
5.7400	0.572	3.283	4.603	0.000
5.8100	0.572	3.323	5.273	0.000
5.8800	0.572	3.363	5.817	0.000
5.9500	0.572	3.403	6.223	0.000
6.0200	0.572	3.443	6.513	0.000
6.0900	0.572	3.484	6.846	0.000
6.1600	0.572	3.524	7.119	0.000
6.2300	0.572	3.564	7.382	0.000
6.3000	0.572	3.604	7.635	0.000
6.3700	0.558	3.387	7.879	0.000

Analysis Results

POC 1





+ Predeveloped x Mitigated

Predeveloped Landuse Totals for POC #1

Total Pervious Area:	5.09
Total Impervious Area:	0

Mitigated Landuse Totals for POC #1

Total Pervious Area:	0.72
Total Impervious Area:	4.59

Flow Frequency Method: Log Pearson Type III 17B

Flow Frequency Return Periods for Predeveloped. POC #1

Return Period	Flow(cfs)
2 year	0.115006
5 year	0.176949
10 year	0.212753
25 year	0.251534
50 year	0.276481
100 year	0.298127

Flow Frequency Return Periods for Mitigated. POC #1

Return Period	Flow(cfs)
2 year	0.057605
5 year	0.092332
10 year	0.124438
25 year	0.178283
50 year	0.230221
100 year	0.29443

Annual Peaks

Annual Peaks for Predeveloped and Mitigated. POC #1

Year	Predeveloped	Mitigated
1902	0.093	0.053
1903	0.071	0.042
1904	0.121	0.050
1905	0.059	0.058
1906	0.031	0.037
1907	0.178	0.051
1908	0.128	0.046
1909	0.126	0.054
1910	0.178	0.052
1911	0.115	0.051

1912	0.387	0.059
1913	0.180	0.091
1914	0.046	0.038
1915	0.075	0.062
1916	0.114	0.050
1917	0.039	0.045
1918	0.123	0.167
1919	0.095	0.048
1920	0.117	0.051
1921	0.128	0.059
1922	0.129	0.052
1923	0.102	0.060
1924	0.050	0.047
1925	0.063	0.045
1926	0.112	0.050
1927	0.082	0.050
1928	0.088	0.056
1929	0.178	0.061
1930	0.114	0.051
1931	0.108	0.054
1932	0.083	0.058
1933	0.092	0.054
1934	0.234	0.273
1935	0.108	0.116
1936	0.097	0.057
1937	0.156	0.051
1938	0.096	0.052
1939	0.008	0.037
1940	0.105	0.059
1941	0.064	0.039
1942	0.158	0.209
1943	0.080	0.053
1944	0.165	0.064
1945	0.127	0.054
1946	0.075	0.044
1947	0.053	0.046
1948	0.245	0.053
1949	0.213	0.099
1950	0.062	0.047
1951	0.080	0.046
1952	0.317	0.088
1953	0.288	0.195
1954	0.102	0.056
1955	0.089	0.043
1956	0.047	0.043
1957	0.152	0.061
1958	0.306	0.289
1959	0.191	0.245
1960	0.056	0.040
1961	0.192	0.190
1962	0.104	0.057
1963	0.051	0.039
1964	0.053	0.045
1965	0.215	0.224
1966	0.063	0.048
1967	0.096	0.044
1968	0.101	0.057
1969	0.096	0.052

1970	0.148	0.053
1971	0.227	0.131
1972	0.149	0.056
1973	0.193	0.079
1974	0.106	0.051
1975	0.240	0.276
1976	0.129	0.054
1977	0.057	0.038
1978	0.211	0.208
1979	0.062	0.048
1980	0.123	0.052
1981	0.113	0.055
1982	0.054	0.040
1983	0.192	0.059
1984	0.087	0.048
1985	0.137	0.048
1986	0.115	0.057
1987	0.219	0.154
1988	0.137	0.085
1989	0.126	0.049
1990	0.144	0.052
1991	0.115	0.057
1992	0.150	0.166
1993	0.155	0.053
1994	0.227	0.055
1995	0.052	0.049
1996	0.248	0.217
1997	0.102	0.044
1998	0.123	0.050
1999	0.012	0.045
2000	0.091	0.058
2001	0.050	0.037
2002	0.164	0.052
2003	0.141	0.055
2004	0.125	0.054
2005	0.228	0.057
2006	0.073	0.049
2007	0.077	0.053
2008	0.122	0.052
2009	0.081	0.049
2010	0.071	0.060
2011	0.064	0.046
2012	0.096	0.050
2013	0.072	0.039
2014	0.050	0.040
2015	0.098	0.047
2016	0.040	0.046
2017	0.175	0.068
2018	0.312	0.275
2019	0.308	0.246
2020	0.097	0.045
2021	0.159	0.117
2022	0.066	0.045
2023	0.133	0.058
2024	0.267	0.051
2025	0.119	0.054
2026	0.190	0.064
2027	0.072	0.047

2028	0.062	0.039
2029	0.129	0.087
2030	0.236	0.061
2031	0.078	0.042
2032	0.046	0.040
2033	0.071	0.043
2034	0.069	0.046
2035	0.269	0.258
2036	0.143	0.058
2037	0.038	0.043
2038	0.118	0.061
2039	0.016	0.032
2040	0.067	0.048
2041	0.090	0.044
2042	0.271	0.189
2043	0.130	0.078
2044	0.173	0.076
2045	0.117	0.060
2046	0.136	0.206
2047	0.100	0.059
2048	0.133	0.050
2049	0.119	0.054
2050	0.085	0.050
2051	0.121	0.054
2052	0.072	0.053
2053	0.127	0.203
2054	0.158	0.074
2055	0.065	0.041
2056	0.057	0.044
2057	0.089	0.057
2058	0.106	0.060
2059	0.187	0.083

Ranked Annual Peaks

Ranked Annual Peaks for Predeveloped and Mitigated. POC #1

Rank	Predeveloped	Mitigated
1	0.3867	0.2890
2	0.3168	0.2763
3	0.3121	0.2753
4	0.3085	0.2729
5	0.3060	0.2582
6	0.2876	0.2463
7	0.2713	0.2453
8	0.2685	0.2237
9	0.2672	0.2173
10	0.2480	0.2087
11	0.2448	0.2078
12	0.2405	0.2062
13	0.2357	0.2029
14	0.2345	0.1955
15	0.2277	0.1899
16	0.2271	0.1885
17	0.2265	0.1672
18	0.2191	0.1656
19	0.2150	0.1541
20	0.2128	0.1314
21	0.2113	0.1174
22	0.1928	0.1156

23	0.1917	0.0988
24	0.1916	0.0910
25	0.1913	0.0883
26	0.1898	0.0873
27	0.1872	0.0848
28	0.1801	0.0832
29	0.1784	0.0787
30	0.1780	0.0775
31	0.1779	0.0759
32	0.1745	0.0739
33	0.1729	0.0680
34	0.1653	0.0643
35	0.1639	0.0638
36	0.1590	0.0618
37	0.1585	0.0611
38	0.1583	0.0609
39	0.1555	0.0608
40	0.1546	0.0607
41	0.1523	0.0602
42	0.1498	0.0600
43	0.1488	0.0596
44	0.1479	0.0595
45	0.1437	0.0592
46	0.1430	0.0591
47	0.1411	0.0588
48	0.1371	0.0587
49	0.1369	0.0587
50	0.1356	0.0584
51	0.1333	0.0581
52	0.1330	0.0581
53	0.1298	0.0580
54	0.1288	0.0577
55	0.1287	0.0575
56	0.1285	0.0572
57	0.1283	0.0571
58	0.1276	0.0570
59	0.1273	0.0570
60	0.1271	0.0569
61	0.1259	0.0568
62	0.1256	0.0561
63	0.1247	0.0561
64	0.1232	0.0561
65	0.1226	0.0554
66	0.1226	0.0551
67	0.1225	0.0547
68	0.1214	0.0545
69	0.1214	0.0544
70	0.1192	0.0542
71	0.1187	0.0540
72	0.1181	0.0538
73	0.1171	0.0538
74	0.1165	0.0537
75	0.1155	0.0536
76	0.1152	0.0536
77	0.1147	0.0535
78	0.1143	0.0534
79	0.1139	0.0533
80	0.1125	0.0533

81	0.1116	0.0528
82	0.1084	0.0528
83	0.1080	0.0528
84	0.1063	0.0523
85	0.1062	0.0521
86	0.1053	0.0518
87	0.1039	0.0518
88	0.1021	0.0517
89	0.1020	0.0517
90	0.1016	0.0516
91	0.1012	0.0515
92	0.1004	0.0515
93	0.0980	0.0514
94	0.0974	0.0511
95	0.0974	0.0509
96	0.0963	0.0509
97	0.0963	0.0506
98	0.0958	0.0505
99	0.0957	0.0504
100	0.0954	0.0504
101	0.0932	0.0504
102	0.0917	0.0503
103	0.0915	0.0500
104	0.0900	0.0499
105	0.0893	0.0497
106	0.0891	0.0496
107	0.0878	0.0494
108	0.0870	0.0489
109	0.0849	0.0488
110	0.0827	0.0486
111	0.0817	0.0484
112	0.0811	0.0482
113	0.0801	0.0481
114	0.0801	0.0481
115	0.0778	0.0480
116	0.0766	0.0479
117	0.0752	0.0472
118	0.0752	0.0471
119	0.0725	0.0470
120	0.0723	0.0466
121	0.0721	0.0462
122	0.0719	0.0462
123	0.0709	0.0459
124	0.0709	0.0458
125	0.0706	0.0457
126	0.0693	0.0455
127	0.0675	0.0455
128	0.0656	0.0454
129	0.0655	0.0454
130	0.0642	0.0453
131	0.0639	0.0452
132	0.0628	0.0448
133	0.0628	0.0445
134	0.0623	0.0444
135	0.0621	0.0444
136	0.0618	0.0442
137	0.0590	0.0441
138	0.0573	0.0434

139	0.0569	0.0430
140	0.0562	0.0430
141	0.0539	0.0427
142	0.0530	0.0423
143	0.0525	0.0418
144	0.0517	0.0409
145	0.0506	0.0404
146	0.0501	0.0399
147	0.0499	0.0396
148	0.0497	0.0396
149	0.0471	0.0394
150	0.0461	0.0389
151	0.0459	0.0388
152	0.0400	0.0387
153	0.0391	0.0383
154	0.0382	0.0378
155	0.0306	0.0375
156	0.0157	0.0369
157	0.0124	0.0365
158	0.0080	0.0320

Duration Flows

The Facility PASSED

Flow(cfs)	Predev	Mit	Percentage	Pass/Fail
0.0575	56841	55955	98	Pass
0.0597	52415	33335	63	Pass
0.0619	48365	20526	42	Pass
0.0641	44620	17883	40	Pass
0.0664	41213	16437	39	Pass
0.0686	38226	15180	39	Pass
0.0708	35479	14255	40	Pass
0.0730	32958	13357	40	Pass
0.0752	30526	12437	40	Pass
0.0774	28426	11684	41	Pass
0.0796	26493	11080	41	Pass
0.0818	24747	10510	42	Pass
0.0840	23130	10016	43	Pass
0.0863	21678	9557	44	Pass
0.0885	20326	9091	44	Pass
0.0907	19058	8665	45	Pass
0.0929	17850	8266	46	Pass
0.0951	16714	7911	47	Pass
0.0973	15606	7568	48	Pass
0.0995	14620	7208	49	Pass
0.1017	13734	6870	50	Pass
0.1040	12892	6526	50	Pass
0.1062	12111	6210	51	Pass
0.1084	11407	5900	51	Pass
0.1106	10687	5667	53	Pass
0.1128	9983	5432	54	Pass
0.1150	9357	5228	55	Pass
0.1172	8753	5022	57	Pass
0.1194	8205	4817	58	Pass
0.1216	7734	4647	60	Pass
0.1239	7252	4468	61	Pass
0.1261	6798	4283	63	Pass
0.1283	6432	4106	63	Pass
0.1305	6122	3935	64	Pass
0.1327	5828	3793	65	Pass
0.1349	5557	3674	66	Pass
0.1371	5271	3552	67	Pass
0.1393	5009	3450	68	Pass
0.1416	4790	3352	69	Pass
0.1438	4536	3248	71	Pass
0.1460	4345	3142	72	Pass
0.1482	4166	3027	72	Pass
0.1504	3936	2894	73	Pass
0.1526	3713	2788	75	Pass
0.1548	3537	2665	75	Pass
0.1570	3366	2554	75	Pass
0.1593	3231	2433	75	Pass
0.1615	3091	2296	74	Pass
0.1637	2968	2175	73	Pass
0.1659	2853	2067	72	Pass
0.1681	2741	1971	71	Pass
0.1703	2599	1879	72	Pass
0.1725	2477	1792	72	Pass

0.1747	2359	1708	72	Pass
0.1769	2267	1630	71	Pass
0.1792	2160	1538	71	Pass
0.1814	2059	1430	69	Pass
0.1836	1950	1345	68	Pass
0.1858	1840	1268	68	Pass
0.1880	1748	1180	67	Pass
0.1902	1659	1102	66	Pass
0.1924	1579	1030	65	Pass
0.1946	1510	969	64	Pass
0.1969	1445	918	63	Pass
0.1991	1368	869	63	Pass
0.2013	1298	802	61	Pass
0.2035	1243	731	58	Pass
0.2057	1182	664	56	Pass
0.2079	1129	606	53	Pass
0.2101	1079	560	51	Pass
0.2123	1026	522	50	Pass
0.2145	980	493	50	Pass
0.2168	925	459	49	Pass
0.2190	872	431	49	Pass
0.2212	819	407	49	Pass
0.2234	772	384	49	Pass
0.2256	717	355	49	Pass
0.2278	668	340	50	Pass
0.2300	629	325	51	Pass
0.2322	588	303	51	Pass
0.2345	549	283	51	Pass
0.2367	507	257	50	Pass
0.2389	475	241	50	Pass
0.2411	429	220	51	Pass
0.2433	392	204	52	Pass
0.2455	363	187	51	Pass
0.2477	329	171	51	Pass
0.2499	300	158	52	Pass
0.2522	281	145	51	Pass
0.2544	264	135	51	Pass
0.2566	248	125	50	Pass
0.2588	233	114	48	Pass
0.2610	219	106	48	Pass
0.2632	205	98	47	Pass
0.2654	186	91	48	Pass
0.2676	162	79	48	Pass
0.2698	143	59	41	Pass
0.2721	130	45	34	Pass
0.2743	117	30	25	Pass
0.2765	106	16	15	Pass

Water Quality

Water Quality BMP Flow and Volume for POC #1

On-line facility volume:	0 acre-feet
On-line facility target flow:	0 cfs.
Adjusted for 15 min:	0 cfs.
Off-line facility target flow:	0 cfs.
Adjusted for 15 min:	0 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
Total Volume Infiltrated		0.00	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 = Passed

Model Default Modifications

Total of 0 changes have been made.

PERLND Changes

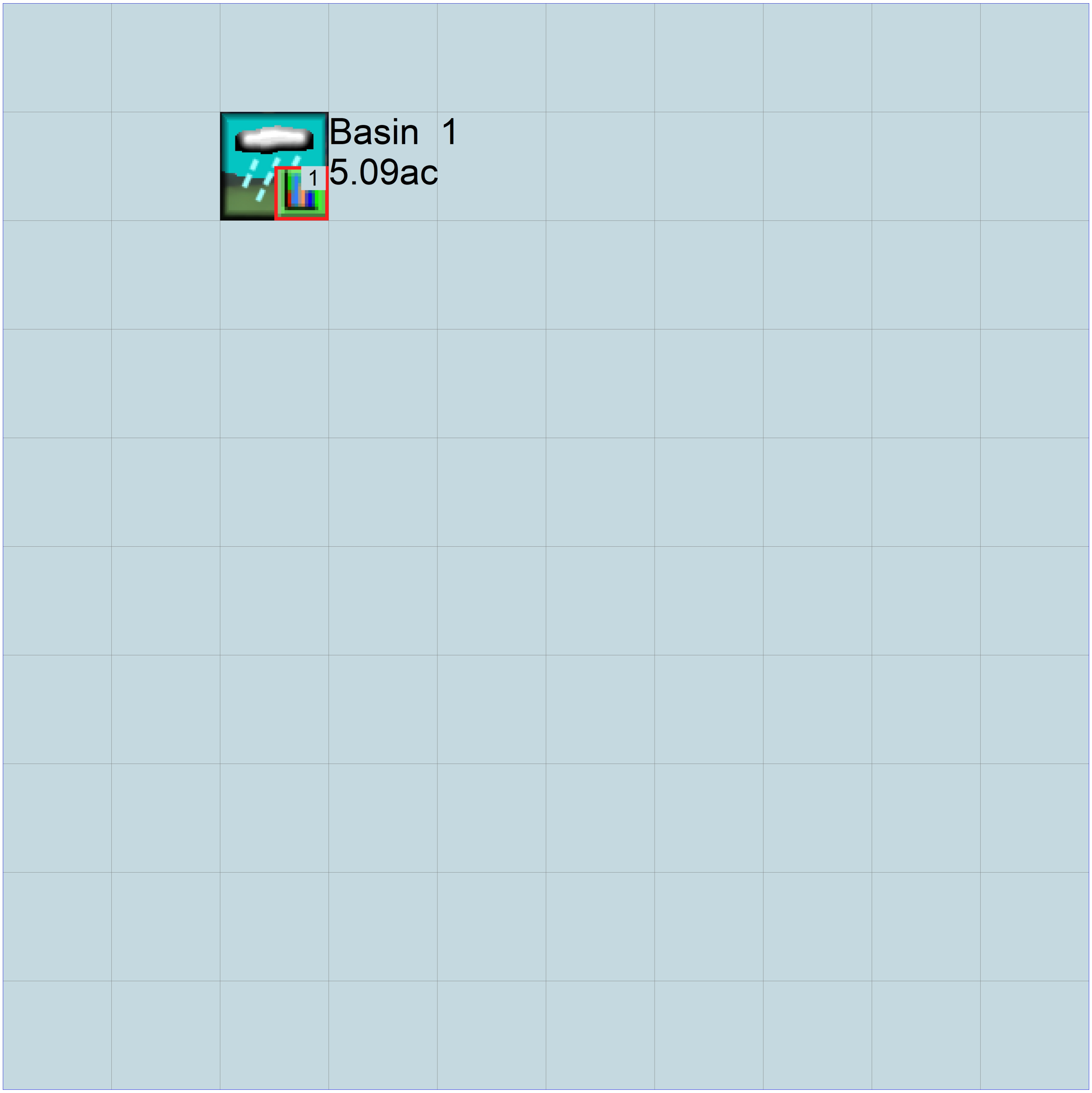
No PERLND changes have been made.

IMPLND Changes

No IMPLND changes have been made.

Appendix

Predeveloped Schematic



Mitigated Schematic

Predeveloped UCI File

```
RUN

GLOBAL
  WWHM4 model simulation
  START       1901 10 01        END    2059 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   22085-5.3 ft live.wdm
MESSU      25   Pre22085-5.3 ft live.MES
           27   Pre22085-5.3 ft live.L61
           28   Pre22085-5.3 ft live.L62
           30   POC22085-5.3 ft live1.dat
END FILES

OPN SEQUENCE
    INGRP              INDELT 00:15
      PERLND      10
      COPY       501
      DISPLY       1
    END INGRP
END OPN SEQUENCE
DISPLY
  DISPLY-INFO1
    # -  #<----------Title----------->***TRAN PIVL DIG1 FIL1  PYR DIG2 FIL2 YRND
    1        Basin  1                   MAX                     1    2   30    9
  END DISPLY-INFO1
END DISPLY
COPY
  TIMESERIES
    # -  #  NPT  NMN ***
    1         1    1
  501         1    1
  END TIMESERIES
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           ***
   10     C, Forest, 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 ***
   10         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  *********
   10         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 ***
   10         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
   10              0       4.5      0.08       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
   10              0         0         2         2         0         0         0
  END PWAT-PARM3
  PWAT-PARM4
    <PLS >     PWATER input info: Part 4                               ***
    # -  #     CEPSC      UZSN      NSUR     INTFW       IRC     LZETP ***
   10            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
   10              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  1***
PERLND  10                        5.09     COPY   501     12
PERLND  10                        5.09     COPY   501     13

******Routing******
END SCHEMATIC

NETWORK
<-Volume-> <-Grp> <-Member-><--Mult-->Tran <-Target vols> <-Grp> <-Member->  ***
<Name>   #        <Name> # #<-factor->strg <Name>   #   #        <Name> # #  ***
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    1              PERLND   1 999 EXTNL  PETINP
WDM      1 EVAP     ENGL    1              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   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

Predeveloped HSPF Message File

Mitigated HSPF Message File

Disclaimer

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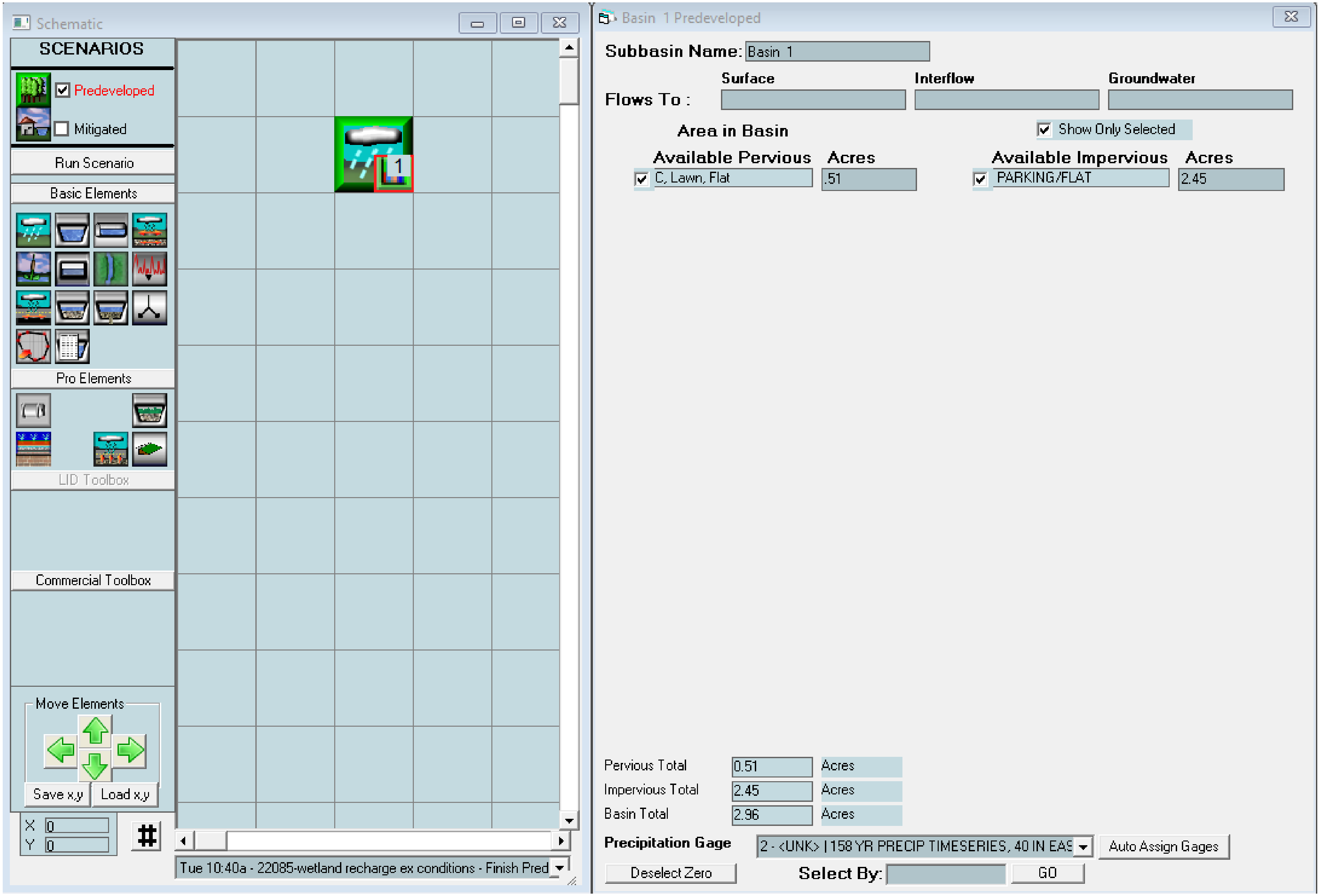
Figure 8
Wetland Protection WWHM Model

East Basin -Ex Conditions



☑ Predeveloped
☐ Mitigated

X 0
Y 0

Tue 10:40a - 22085-wetland recharge ex conditions - Finish Pred

Subbasin Name: Basin 1

Flows To : Surface / Interflow / Groundwater

Area in Basin

☑ Show Only Selected

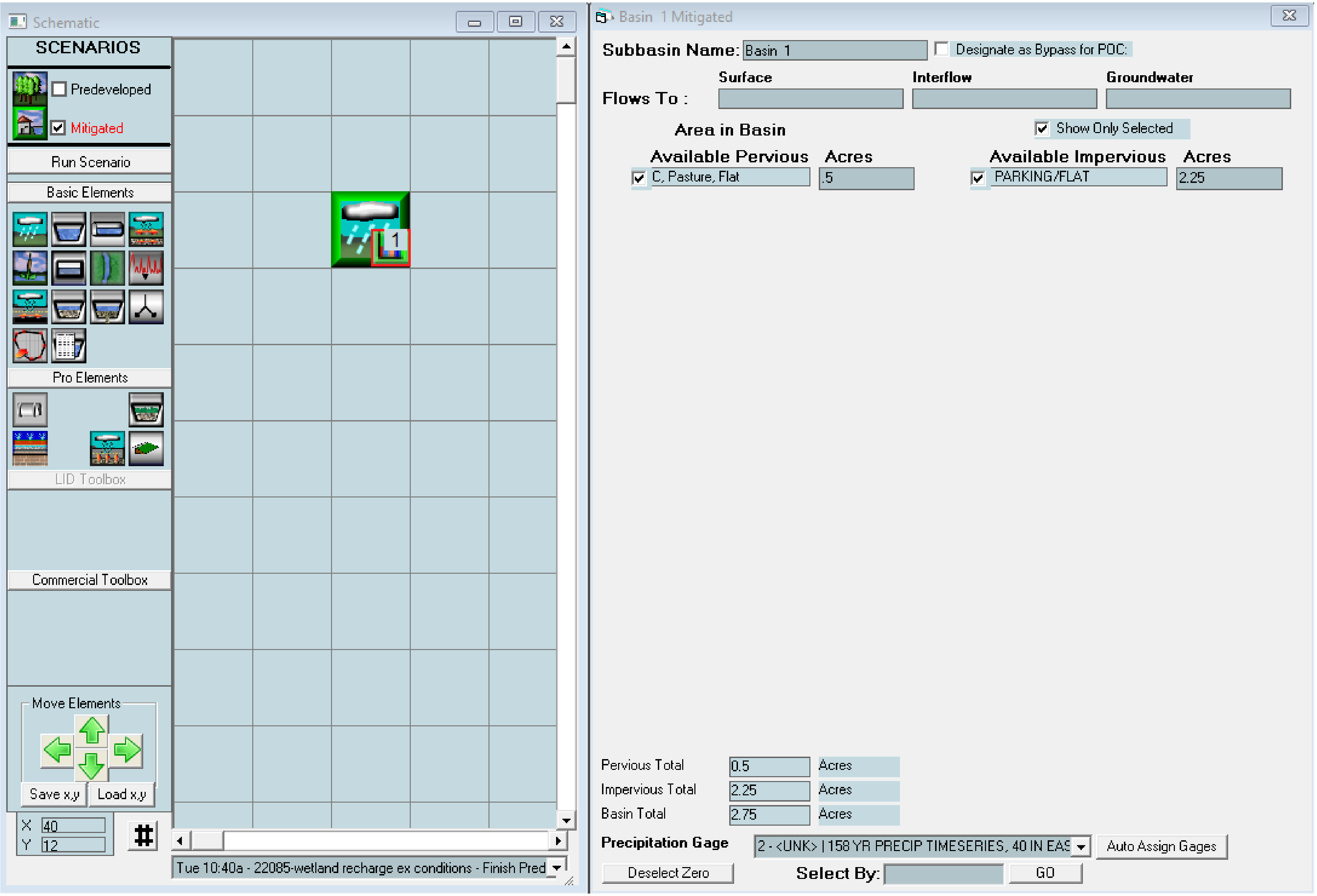
Available Pervious	**Acres**
☑ C, Lawn, Flat	.51

Available Impervious	**Acres**
☑ PARKING/FLAT	2.45

Pervious Total	0.51	Acres
Impervious Total	2.45	Acres
Basin Total	2.96	Acres

Precipitation Gage 2 - <UNK> | 158 YR PRECIP TIMESERIES, 40 IN EAS

East Basin -Proposed Conditions



☐ Predeveloped

☑ Mitigated

X 40

Y 12

Tue 10:40a - 22085-wetland recharge ex conditions - Finish Pred

Subbasin Name: Basin 1 ☐ Designate as Bypass for POC:

	Surface	Interflow	Groundwater
Flows To :			

Area in Basin ☑ Show Only Selected

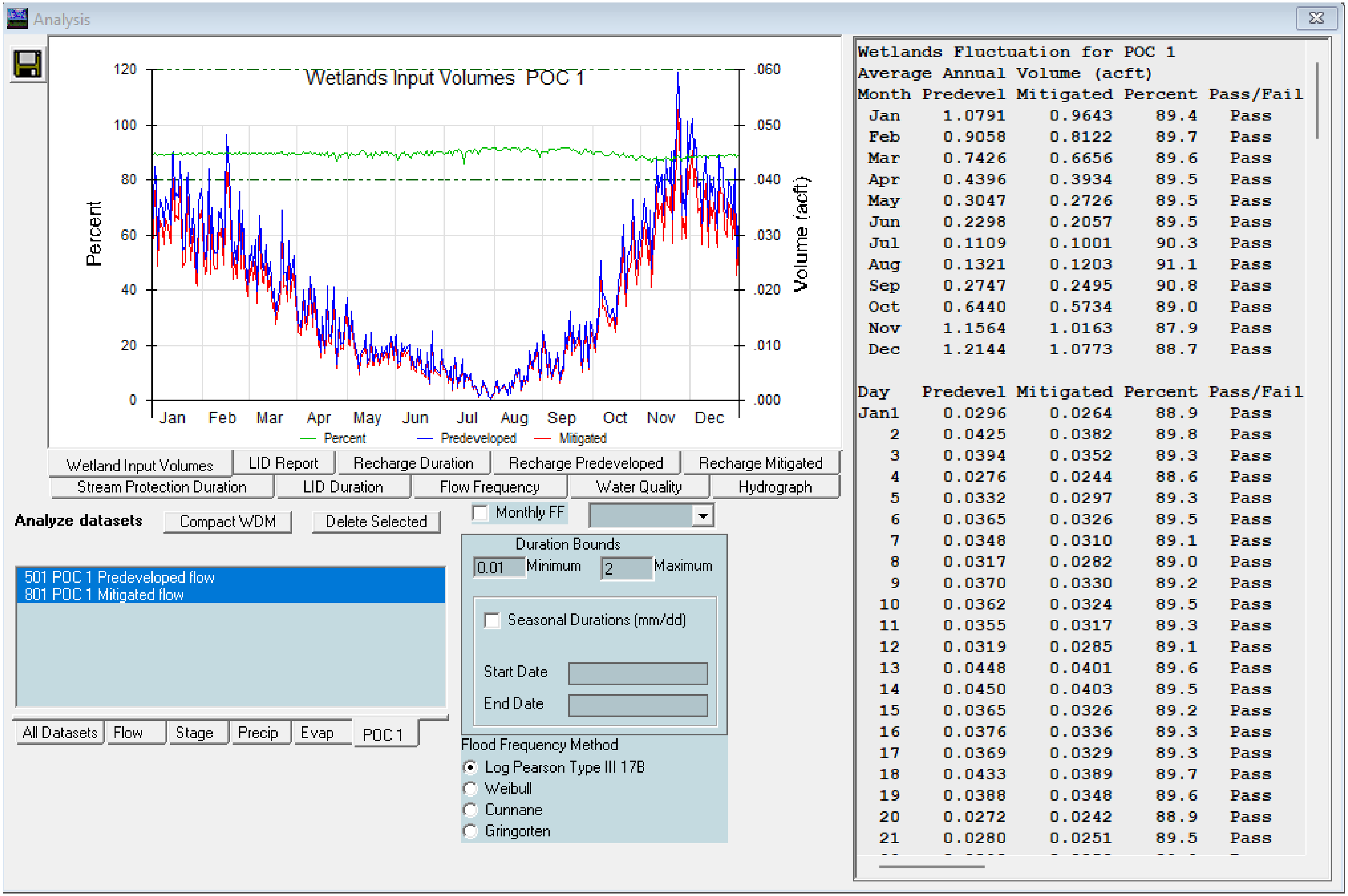
Available Pervious	Acres	Available Impervious	Acres
☑ C, Pasture, Flat	.5	☑ PARKING/FLAT	2.25

Pervious Total	0.5	Acres
Impervious Total	2.25	Acres
Basin Total	2.75	Acres

Precipitation Gage 2 - <UNK> | 158 YR PRECIP TIMESERIES, 40 IN EAS

Select By:

East Basin -Wetland recharge



☐ Monthly FF

501 POC 1 Predeveloped flow
801 POC 1 Mitigated flow

Duration Bounds
0.01 Minimum
2 Maximum

☐ Seasonal Durations (mm/dd)

Start Date

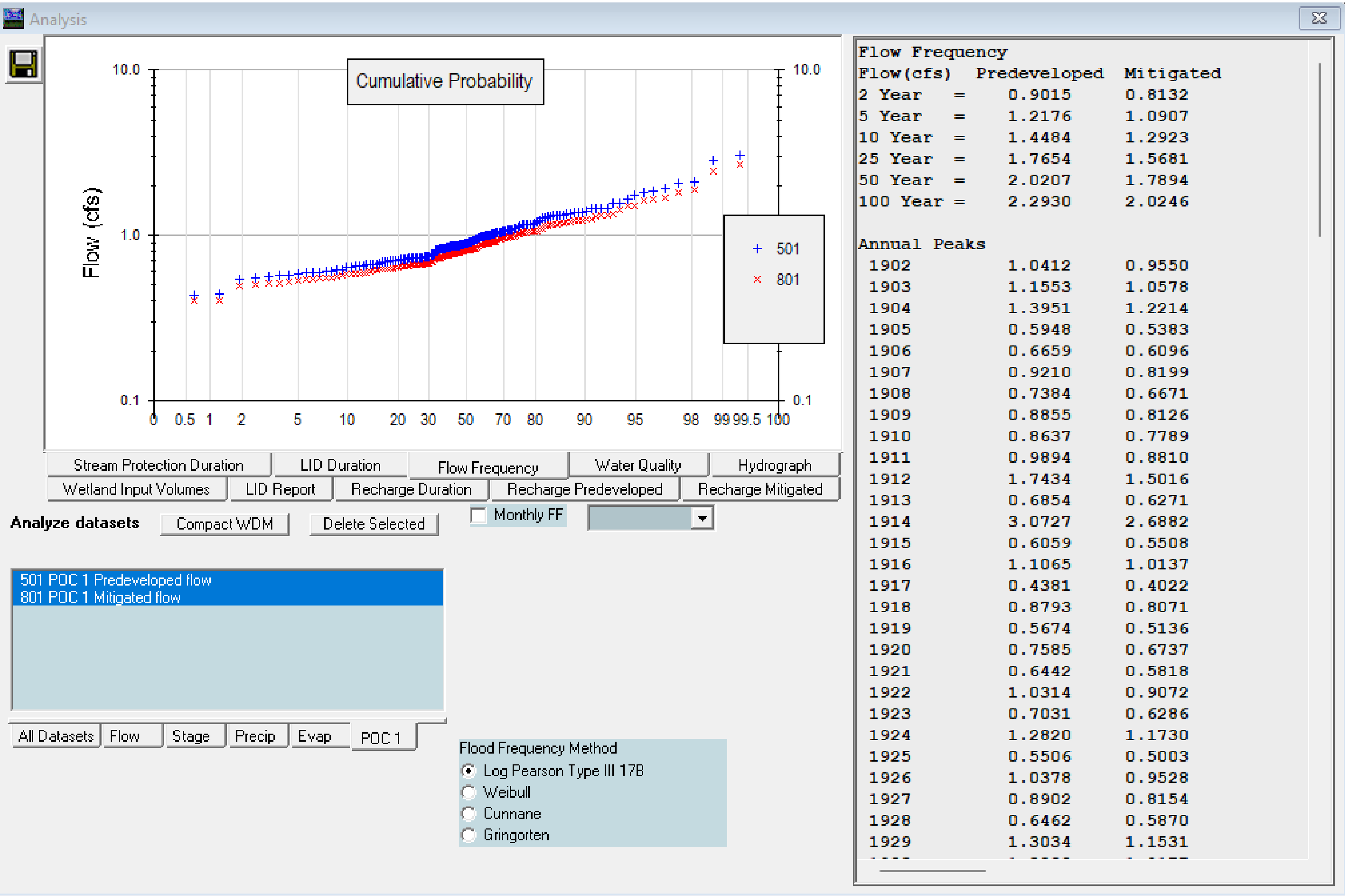
End Date

Flood Frequency Method
● Log Pearson Type III 17B
○ Weibull
○ Cunnane
○ Gringorten

```
Wetlands Fluctuation for POC 1
Average Annual Volume (acft)
Month Predevel Mitigated Percent Pass/Fail
 Jan     1.0791    0.9643    89.4    Pass
 Feb     0.9058    0.8122    89.7    Pass
 Mar     0.7426    0.6656    89.6    Pass
 Apr     0.4396    0.3934    89.5    Pass
 May     0.3047    0.2726    89.5    Pass
 Jun     0.2298    0.2057    89.5    Pass
 Jul     0.1109    0.1001    90.3    Pass
 Aug     0.1321    0.1203    91.1    Pass
 Sep     0.2747    0.2495    90.8    Pass
 Oct     0.6440    0.5734    89.0    Pass
 Nov     1.1564    1.0163    87.9    Pass
 Dec     1.2144    1.0773    88.7    Pass

Day   Predevel Mitigated Percent Pass/Fail
Jan1     0.0296    0.0264    88.9    Pass
   2     0.0425    0.0382    89.8    Pass
   3     0.0394    0.0352    89.3    Pass
   4     0.0276    0.0244    88.6    Pass
   5     0.0332    0.0297    89.3    Pass
   6     0.0365    0.0326    89.5    Pass
   7     0.0348    0.0310    89.1    Pass
   8     0.0317    0.0282    89.0    Pass
   9     0.0370    0.0330    89.2    Pass
  10     0.0362    0.0324    89.5    Pass
  11     0.0355    0.0317    89.3    Pass
  12     0.0319    0.0285    89.1    Pass
  13     0.0448    0.0401    89.6    Pass
  14     0.0450    0.0403    89.5    Pass
  15     0.0365    0.0326    89.2    Pass
  16     0.0376    0.0336    89.3    Pass
  17     0.0369    0.0329    89.3    Pass
  18     0.0433    0.0389    89.7    Pass
  19     0.0388    0.0348    89.6    Pass
  20     0.0272    0.0242    88.9    Pass
  21     0.0280    0.0251    89.5    Pass
```

East Basin -Flows



☐ Monthly FF

501 POC 1 Predeveloped flow
801 POC 1 Mitigated flow

Flood Frequency Method
● Log Pearson Type III 17B
○ Weibull
○ Cunnane
○ Gringorten

```
Flow Frequency
Flow(cfs)   Predeveloped   Mitigated
2 Year   =      0.9015      0.8132
5 Year   =      1.2176      1.0907
10 Year  =      1.4484      1.2923
25 Year  =      1.7654      1.5681
50 Year  =      2.0207      1.7894
100 Year =      2.2930      2.0246

Annual Peaks
 1902           1.0412      0.9550
 1903           1.1553      1.0578
 1904           1.3951      1.2214
 1905           0.5948      0.5383
 1906           0.6659      0.6096
 1907           0.9210      0.8199
 1908           0.7384      0.6671
 1909           0.8855      0.8126
 1910           0.8637      0.7789
 1911           0.9894      0.8810
 1912           1.7434      1.5016
 1913           0.6854      0.6271
 1914           3.0727      2.6882
 1915           0.6059      0.5508
 1916           1.1065      1.0137
 1917           0.4381      0.4022
 1918           0.8793      0.8071
 1919           0.5674      0.5136
 1920           0.7585      0.6737
 1921           0.6442      0.5818
 1922           1.0314      0.9072
 1923           0.7031      0.6286
 1924           1.2820      1.1730
 1925           0.5506      0.5003
 1926           1.0378      0.9528
 1927           0.8902      0.8154
 1928           0.6462      0.5870
 1929           1.3034      1.1531
```

V-11 Miscellaneous LID BMPs

V-11.1 Introduction to Miscellaneous LID BMPs

BMPs in this chapter have been grouped because they have the following in common:

- They employ Low Impact Development (LID) Principles
- They cannot be used to meet I-3.4.6 MR6: Runoff Treatment
- They cannot, by themselves, be used to meet the Flow Control Performance Standard or the LID Performance Standard.
    - Some of the BMPs in this chapter do allow for some amount of Flow Control credit. See the guidance for each individual BMP for details.
- The design methods for each BMP in this chapter are unique. They do not have strong enough design similarities to other BMPs in this volume to place them in the other BMP categories identified in this volume.

BMP T5.13: Post-Construction Soil Quality and Depth

Purpose and Definition

Naturally occurring (undisturbed) soil and vegetation provide important stormwater functions including: water infiltration; nutrient, sediment, and pollutant adsorption; sediment and pollutant biofiltration; water interflow storage and transmission; and pollutant decomposition. These functions are largely lost when development strips away native soil and vegetation and replaces it with minimal topsoil and sod. Not only are these important stormwater functions lost, but such landscapes themselves become pollution generating pervious surfaces due to increased use of pesticides, fertilizers and other landscaping and household/industrial chemicals, the concentration of pet wastes, and pollutants that accompany roadside litter.

Establishing soil quality and depth regains greater stormwater functions in the post development landscape, provides increased treatment of pollutants and sediments that result from development and habitation, and minimizes the need for some landscaping chemicals, thus reducing pollution through prevention.

Applications and Limitations

Establishing a minimum soil quality and depth is not the same as preservation of naturally occurring soil and vegetation. However, establishing a minimum soil quality and depth will provide improved on-site management of stormwater flow and water quality.

Soil organic matter can be attained through numerous materials such as compost, composted woody material, biosolids, and forest product residuals. It is important that the materials used to

meet this BMP be appropriate and beneficial to the plant cover to be established. Likewise, it is important that imported topsoils improve soil conditions and do not have an excessive percent of clay fines.

This BMP can be considered infeasible on till soil slopes greater than 33 percent.

Design Guidelines

Soil Retention

Retain, in an undisturbed state, the duff layer and native topsoil to the maximum extent practicable. In any areas requiring grading, remove and stockpile the duff layer and topsoil on site in a designated, controlled area, not adjacent to public resources and critical areas, to be reapplied to other portions of the site where feasible.

Soil Quality

All areas subject to clearing and grading that have not been covered by impervious surface, incorporated into a drainage facility or engineered as structural fill or slope shall, at project completion, demonstrate the following:

1. A topsoil layer with a minimum organic matter content of 10% dry weight in planting beds, and 5% organic matter content in turf areas, and a pH from 6.0 to 8.0 or matching the pH of the undisturbed soil. The topsoil layer shall have a minimum depth of eight inches except where tree roots limit the depth of incorporation of amendments needed to meet the criteria. Subsoils below the topsoil layer should be scarified at least 4 inches with some incorporation of the upper material to avoid stratified layers, where feasible.
2. Mulch planting beds with 2 inches of organic material.
3. Use compost and other materials that meet the following organic content requirements:
    a. The organic content for “pre-approved” amendment rates can be met only using compost meeting the compost specification for BMP T7.30: Bioretention, with the exception that the compost may have up to 35% biosolids or manure.

       The compost must also have an organic matter content of 40% to 65%, and a carbon to nitrogen ratio below 25:1.

       The carbon to nitrogen ratio may be as high as 35:1 for plantings composed entirely of plants native to the Puget Sound Lowlands region.

    b. Calculated amendment rates may be met through use of composted material meeting (a.) above; or other organic materials amended to meet the carbon to nitrogen ratio requirements, and not exceeding the contaminant limits identified in Table 220-B, Testing Parameters, in WAC 173-350-220.

The resulting soil should be conducive to the type of vegetation to be established.

Implementation Options

The soil quality design guidelines listed above can be met by using one of the methods listed below:

1. Leave undisturbed native vegetation and soil, and protect from compaction during construction.
2. Amend existing site topsoil or subsoil either at default “pre-approved” rates, or at custom calculated rates based on tests of the soil and amendment.
3. Stockpile existing topsoil during grading, and replace it prior to planting. Stockpiled topsoil must also be amended if needed to meet the organic matter or depth requirements, either at a default “pre-approved” rate or at a custom calculated rate.
4. Import topsoil mix of sufficient organic content and depth to meet the requirements.

More than one method may be used on different portions of the same site. Soil that already meets the depth and organic matter quality standards, and is not compacted, does not need to be amended.

Planning/Permitting/Inspection/Verification Guidelines & Procedures

Local governments are encouraged to adopt guidelines and procedures similar to those recommended in *Building Soil: Guidelines and Resources for Implementing Soil Quality and Depth BMP T5.13 in WDOE Stormwater Management Manual for Western Washington* (Stenn et al., 2016).

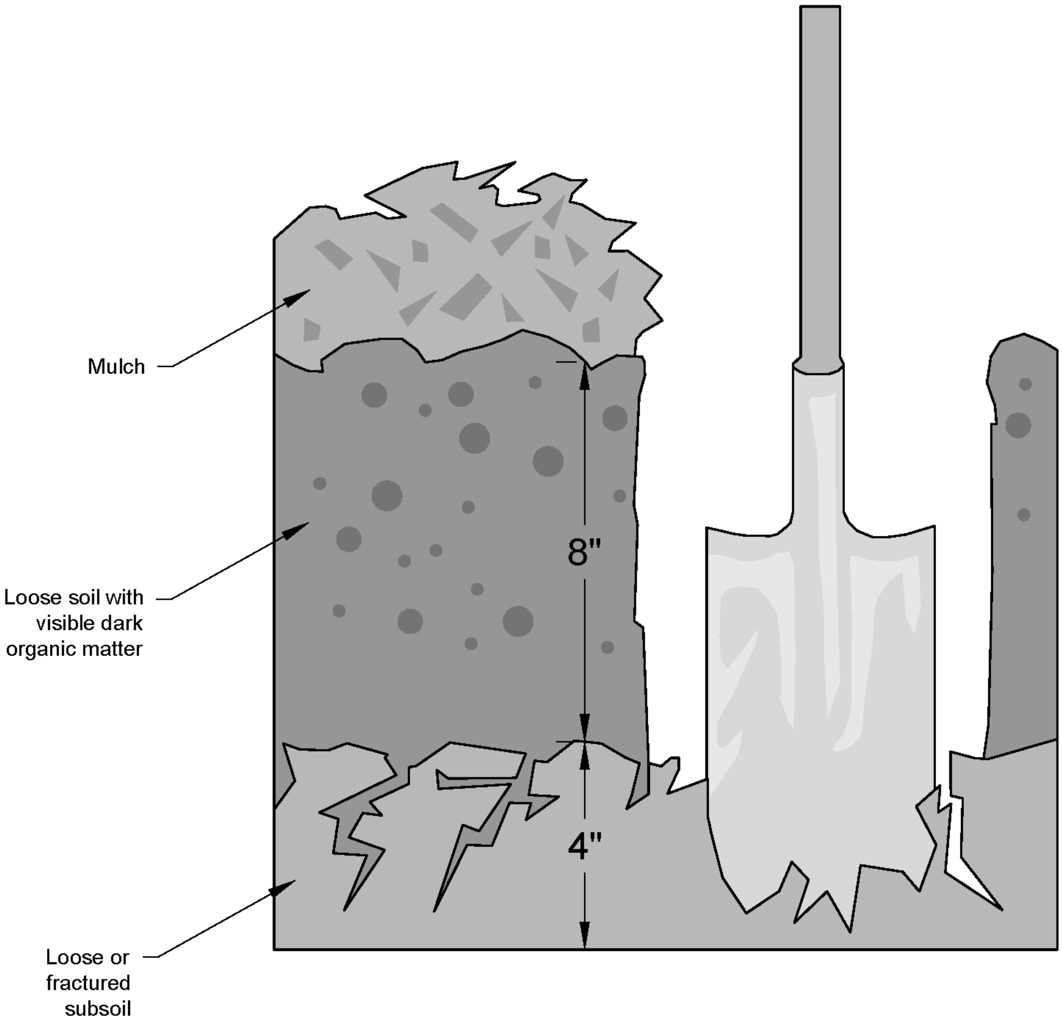
Maintenance

- Establish soil quality and depth toward the end of construction and once established, protect from compaction, such as from large machinery use, and from erosion.
- Plant vegetation and mulch the amended soil area after installation.
- Leave plant debris or its equivalent on the soil surface to replenish organic matter.
- Reduce and adjust, where possible, the use of irrigation, fertilizers, herbicides and pesticides, rather than continuing to implement formerly established practices.

Runoff Model Representation

All areas meeting the soil quality and depth design criteria may be entered into approved runoff models as “Pasture” rather than “Lawn/Landscaping”.

Figure V-11.1: Planting Bed Cross-Section



Reprinted from *Guidelines and Resources For Implementing Soil Quality and Depth BMP T5.13 in WDOE Stormwater Management Manual for Western Washington*, 2010, Washington Organic Recycling Council

NOT TO SCALE

DEPARTMENT OF
ECOLOGY
State of Washington

Planting Bed Cross-Section

Revised June 2016

WWHM2012

PROJECT REPORT

General Model Information

Project Name:	22085-wetland recharge ex conditions
Site Name:	
Site Address:	
City:	
Report Date:	11/7/2023
Gage:	40 IN EAST
Data Start:	10/01/1901
Data End:	09/30/2059
Timestep:	15 Minute
Precip Scale:	1.000
Version Date:	2019/09/13
Version:	4.2.17

POC Thresholds

Low Flow Threshold for POC1:	50 Percent of the 2 Year
High Flow Threshold for POC1:	50 Year

Landuse Basin Data

Predeveloped Land Use

Basin 1

Bypass:	No
GroundWater:	No
Pervious Land Use	acre
C, Lawn, Flat	0.51
Pervious Total	0.51
Impervious Land Use	acre
PARKING FLAT	2.45
Impervious Total	2.45
Basin Total	2.96

Element Flows To:

Surface	Interflow	Groundwater

Mitigated Land Use

Basin 1

Bypass:	No
GroundWater:	No

Pervious Land Use	acre
C, Pasture, Flat	0.5
Pervious Total	0.5

Impervious Land Use	acre
PARKING FLAT	2.25
Impervious Total	2.25
Basin Total	2.75

Element Flows To:

Surface	Interflow	Groundwater

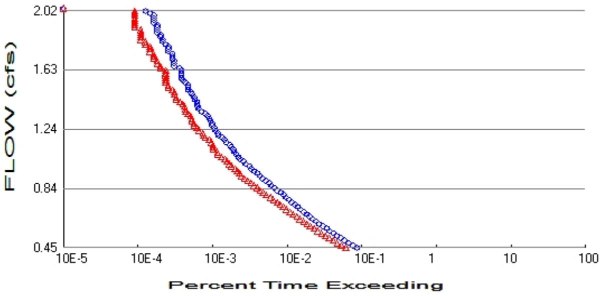
Routing Elements

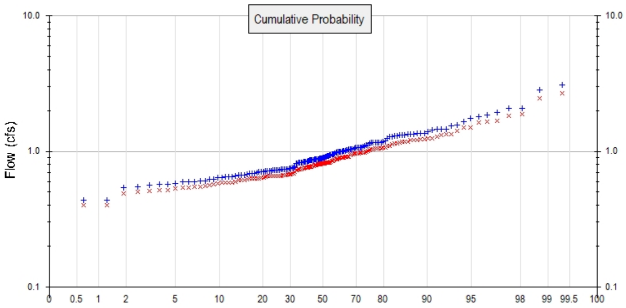
Predeveloped Routing

Mitigated Routing

Analysis Results

POC 1





+ Predeveloped x Mitigated

Predeveloped Landuse Totals for POC #1
Total Pervious Area: 0.51
Total Impervious Area: 2.45

Mitigated Landuse Totals for POC #1
Total Pervious Area: 0.5
Total Impervious Area: 2.25

Flow Frequency Method: Log Pearson Type III 17B

Flow Frequency Return Periods for Predeveloped. POC #1

Return Period	**Flow(cfs)**
2 year	0.901539
5 year	1.217573
10 year	1.448354
25 year	1.765409
50 year	2.02072
100 year	2.292968

Flow Frequency Return Periods for Mitigated. POC #1

Return Period	**Flow(cfs)**
2 year	0.813181
5 year	1.090728
10 year	1.292333
25 year	1.568127
50 year	1.789378
100 year	2.024605

Annual Peaks

Annual Peaks for Predeveloped and Mitigated. POC #1

Year	**Predeveloped**	**Mitigated**
1902	1.041	0.955
1903	1.155	1.058
1904	1.395	1.221
1905	0.595	0.538
1906	0.666	0.610
1907	0.921	0.820
1908	0.738	0.667
1909	0.885	0.813
1910	0.864	0.779
1911	0.989	0.881

1912	1.743	1.502
1913	0.685	0.627
1914	3.073	2.688
1915	0.606	0.551
1916	1.107	1.014
1917	0.438	0.402
1918	0.879	0.807
1919	0.567	0.514
1920	0.758	0.674
1921	0.644	0.582
1922	1.031	0.907
1923	0.703	0.629
1924	1.282	1.173
1925	0.551	0.500
1926	1.038	0.953
1927	0.890	0.815
1928	0.646	0.587
1929	1.303	1.153
1930	1.338	1.218
1931	0.653	0.590
1932	0.702	0.636
1933	0.690	0.628
1934	1.179	1.032
1935	0.600	0.551
1936	0.834	0.752
1937	1.066	0.979
1938	0.608	0.554
1939	0.740	0.677
1940	1.339	1.219
1941	1.455	1.333
1942	1.031	0.913
1943	0.995	0.896
1944	1.467	1.289
1945	1.072	0.969
1946	0.866	0.768
1947	0.647	0.588
1948	0.896	0.809
1949	1.362	1.246
1950	0.749	0.688
1951	1.158	1.064
1952	1.441	1.230
1953	1.316	1.135
1954	0.728	0.660
1955	0.670	0.614
1956	0.619	0.569
1957	0.721	0.655
1958	0.936	0.827
1959	0.940	0.828
1960	0.724	0.658
1961	2.067	1.829
1962	0.871	0.787
1963	0.636	0.584
1964	1.928	1.690
1965	0.904	0.790
1966	0.704	0.639
1967	1.028	0.905
1968	0.840	0.756
1969	0.758	0.684

1970	0.870	0.775
1971	0.861	0.760
1972	2.820	2.466
1973	1.552	1.422
1974	1.169	1.047
1975	1.282	1.098
1976	1.321	1.159
1977	0.541	0.491
1978	0.972	0.847
1979	1.015	0.899
1980	0.989	0.867
1981	0.906	0.820
1982	0.729	0.661
1983	1.011	0.902
1984	1.002	0.892
1985	1.169	1.022
1986	0.572	0.520
1987	0.996	0.914
1988	0.595	0.541
1989	0.579	0.532
1990	0.733	0.662
1991	1.110	0.982
1992	1.026	0.943
1993	1.138	1.044
1994	0.821	0.728
1995	0.619	0.562
1996	0.852	0.759
1997	0.746	0.675
1998	0.914	0.814
1999	1.000	0.915
2000	0.847	0.766
2001	0.678	0.623
2002	1.320	1.138
2003	0.719	0.652
2004	1.073	0.972
2005	2.089	1.893
2006	0.953	0.872
2007	1.094	0.979
2008	0.886	0.804
2009	0.666	0.612
2010	0.870	0.787
2011	0.889	0.816
2012	0.856	0.776
2013	0.826	0.730
2014	0.773	0.710
2015	1.363	1.177
2016	0.835	0.767
2017	1.305	1.181
2018	0.829	0.733
2019	1.239	1.093
2020	0.983	0.872
2021	0.815	0.735
2022	1.331	1.204
2023	1.648	1.509
2024	1.862	1.625
2025	0.863	0.792
2026	0.976	0.894
2027	1.064	0.973

2028	0.411	0.377
2029	0.701	0.631
2030	1.451	1.320
2031	0.436	0.399
2032	0.718	0.658
2033	0.907	0.833
2034	0.689	0.633
2035	0.930	0.828
2036	0.713	0.654
2037	0.955	0.877
2038	0.959	0.844
2039	1.813	1.663
2040	0.728	0.659
2041	0.925	0.831
2042	1.057	0.969
2043	1.160	1.063
2044	0.809	0.733
2045	0.661	0.597
2046	0.733	0.661
2047	0.879	0.807
2048	0.723	0.663
2049	1.072	0.983
2050	0.829	0.744
2051	1.196	1.052
2052	0.868	0.797
2053	0.734	0.672
2054	1.566	1.341
2055	0.840	0.761
2056	1.158	1.059
2057	0.562	0.511
2058	1.082	0.993
2059	1.365	1.253

Ranked Annual Peaks

Ranked Annual Peaks for Predeveloped and Mitigated. POC #1

Rank	Predeveloped	Mitigated
1	3.0727	2.6882
2	2.8196	2.4655
3	2.0894	1.8933
4	2.0673	1.8295
5	1.9285	1.6903
6	1.8620	1.6629
7	1.8133	1.6249
8	1.7434	1.5091
9	1.6483	1.5016
10	1.5657	1.4218
11	1.5518	1.3414
12	1.4666	1.3332
13	1.4546	1.3199
14	1.4512	1.2890
15	1.4409	1.2527
16	1.3951	1.2458
17	1.3648	1.2301
18	1.3625	1.2214
19	1.3621	1.2189
20	1.3390	1.2177
21	1.3383	1.2039
22	1.3312	1.1806

23	1.3208	1.1767
24	1.3198	1.1730
25	1.3158	1.1587
26	1.3045	1.1531
27	1.3034	1.1375
28	1.2820	1.1346
29	1.2818	1.0978
30	1.2395	1.0927
31	1.1960	1.0636
32	1.1792	1.0630
33	1.1694	1.0593
34	1.1690	1.0578
35	1.1599	1.0515
36	1.1584	1.0472
37	1.1577	1.0439
38	1.1553	1.0316
39	1.1378	1.0219
40	1.1104	1.0137
41	1.1065	0.9931
42	1.0937	0.9830
43	1.0816	0.9819
44	1.0733	0.9792
45	1.0719	0.9789
46	1.0719	0.9728
47	1.0662	0.9717
48	1.0639	0.9690
49	1.0568	0.9687
50	1.0412	0.9550
51	1.0378	0.9528
52	1.0314	0.9428
53	1.0311	0.9151
54	1.0282	0.9142
55	1.0265	0.9126
56	1.0146	0.9072
57	1.0108	0.9054
58	1.0018	0.9015
59	0.9997	0.8986
60	0.9960	0.8960
61	0.9949	0.8939
62	0.9894	0.8924
63	0.9894	0.8810
64	0.9831	0.8769
65	0.9760	0.8721
66	0.9723	0.8720
67	0.9590	0.8673
68	0.9551	0.8467
69	0.9526	0.8444
70	0.9399	0.8333
71	0.9359	0.8314
72	0.9297	0.8281
73	0.9249	0.8279
74	0.9210	0.8270
75	0.9136	0.8203
76	0.9074	0.8199
77	0.9062	0.8163
78	0.9036	0.8154
79	0.8961	0.8145
80	0.8902	0.8126

81	0.8889	0.8087
82	0.8860	0.8074
83	0.8855	0.8071
84	0.8793	0.8044
85	0.8792	0.7973
86	0.8711	0.7923
87	0.8704	0.7896
88	0.8703	0.7870
89	0.8681	0.7870
90	0.8663	0.7789
91	0.8637	0.7757
92	0.8627	0.7746
93	0.8613	0.7676
94	0.8557	0.7665
95	0.8525	0.7659
96	0.8470	0.7609
97	0.8403	0.7604
98	0.8397	0.7586
99	0.8348	0.7557
100	0.8343	0.7518
101	0.8293	0.7440
102	0.8292	0.7355
103	0.8260	0.7333
104	0.8212	0.7330
105	0.8148	0.7300
106	0.8095	0.7278
107	0.7727	0.7096
108	0.7585	0.6881
109	0.7575	0.6842
110	0.7493	0.6770
111	0.7462	0.6748
112	0.7405	0.6737
113	0.7384	0.6722
114	0.7339	0.6671
115	0.7335	0.6631
116	0.7325	0.6620
117	0.7287	0.6606
118	0.7282	0.6606
119	0.7281	0.6599
120	0.7236	0.6593
121	0.7227	0.6583
122	0.7212	0.6582
123	0.7191	0.6545
124	0.7179	0.6539
125	0.7131	0.6517
126	0.7042	0.6394
127	0.7031	0.6358
128	0.7018	0.6326
129	0.7009	0.6312
130	0.6904	0.6286
131	0.6889	0.6279
132	0.6854	0.6271
133	0.6779	0.6227
134	0.6698	0.6142
135	0.6663	0.6116
136	0.6659	0.6096
137	0.6607	0.5973
138	0.6529	0.5900

139	0.6468	0.5880
140	0.6462	0.5870
141	0.6442	0.5837
142	0.6359	0.5818
143	0.6192	0.5685
144	0.6186	0.5619
145	0.6082	0.5544
146	0.6059	0.5508
147	0.5995	0.5505
148	0.5950	0.5409
149	0.5948	0.5383
150	0.5793	0.5320
151	0.5717	0.5199
152	0.5674	0.5136
153	0.5615	0.5113
154	0.5506	0.5003
155	0.5411	0.4910
156	0.4381	0.4022
157	0.4364	0.3987
158	0.4112	0.3774

Duration Flows
The Facility PASSED

Flow(cfs)	Predev	Mit	Percentage	Pass/Fail
0.4508	4790	3369	70	Pass
0.4666	4216	2955	70	Pass
0.4825	3677	2587	70	Pass
0.4983	3239	2282	70	Pass
0.5142	2887	2012	69	Pass
0.5301	2558	1798	70	Pass
0.5459	2307	1591	68	Pass
0.5618	2062	1418	68	Pass
0.5776	1867	1270	68	Pass
0.5935	1675	1123	67	Pass
0.6094	1481	1017	68	Pass
0.6252	1352	915	67	Pass
0.6411	1219	815	66	Pass
0.6569	1106	747	67	Pass
0.6728	1012	657	64	Pass
0.6886	921	599	65	Pass
0.7045	833	538	64	Pass
0.7204	761	488	64	Pass
0.7362	694	444	63	Pass
0.7521	630	405	64	Pass
0.7679	589	360	61	Pass
0.7838	536	331	61	Pass
0.7996	491	286	58	Pass
0.8155	456	263	57	Pass
0.8314	406	238	58	Pass
0.8472	372	217	58	Pass
0.8631	340	199	58	Pass
0.8789	315	181	57	Pass
0.8948	283	164	57	Pass
0.9107	257	147	57	Pass
0.9265	239	133	55	Pass
0.9424	220	127	57	Pass
0.9582	199	119	59	Pass
0.9741	183	111	60	Pass
0.9899	174	98	56	Pass
1.0058	154	93	60	Pass
1.0217	144	86	59	Pass
1.0375	130	81	62	Pass
1.0534	123	72	58	Pass
1.0692	114	65	57	Pass
1.0851	108	64	59	Pass
1.1010	105	56	53	Pass
1.1168	99	56	56	Pass
1.1327	94	56	59	Pass
1.1485	84	53	63	Pass
1.1644	79	50	63	Pass
1.1802	74	44	59	Pass
1.1961	66	42	63	Pass
1.2120	64	41	64	Pass
1.2278	61	36	59	Pass
1.2437	58	34	58	Pass
1.2595	55	31	56	Pass
1.2754	55	31	56	Pass

1.2912	52	29	55	Pass
1.3071	50	29	58	Pass
1.3230	47	28	59	Pass
1.3388	44	26	59	Pass
1.3547	39	24	61	Pass
1.3705	36	24	66	Pass
1.3864	35	23	65	Pass
1.4023	34	22	64	Pass
1.4181	34	20	58	Pass
1.4340	32	18	56	Pass
1.4498	31	18	58	Pass
1.4657	29	17	58	Pass
1.4815	28	17	60	Pass
1.4974	26	16	61	Pass
1.5133	26	14	53	Pass
1.5291	26	14	53	Pass
1.5450	24	13	54	Pass
1.5608	22	13	59	Pass
1.5767	21	13	61	Pass
1.5926	21	13	61	Pass
1.6084	21	13	61	Pass
1.6243	21	13	61	Pass
1.6401	20	11	55	Pass
1.6560	17	11	64	Pass
1.6718	17	10	58	Pass
1.6877	17	10	58	Pass
1.7036	16	9	56	Pass
1.7194	16	9	56	Pass
1.7353	16	9	56	Pass
1.7511	14	8	57	Pass
1.7670	14	8	57	Pass
1.7828	14	8	57	Pass
1.7987	13	7	53	Pass
1.8146	12	7	58	Pass
1.8304	12	6	50	Pass
1.8463	11	6	54	Pass
1.8621	11	6	54	Pass
1.8780	10	6	60	Pass
1.8939	10	6	60	Pass
1.9097	10	5	50	Pass
1.9256	10	5	50	Pass
1.9414	9	5	55	Pass
1.9573	9	5	55	Pass
1.9731	9	5	55	Pass
1.9890	9	5	55	Pass
2.0049	8	5	62	Pass
2.0207	7	5	71	Pass

Water Quality

Water Quality BMP Flow and Volume for POC #1

On-line facility volume:	0 acre-feet
On-line facility target flow:	0 cfs.
Adjusted for 15 min:	0 cfs.
Off-line facility target flow:	0 cfs.
Adjusted for 15 min:	0 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
Total Volume Infiltrated		0.00	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 = Passed

Model Default Modifications

Total of 0 changes have been made.

PERLND Changes

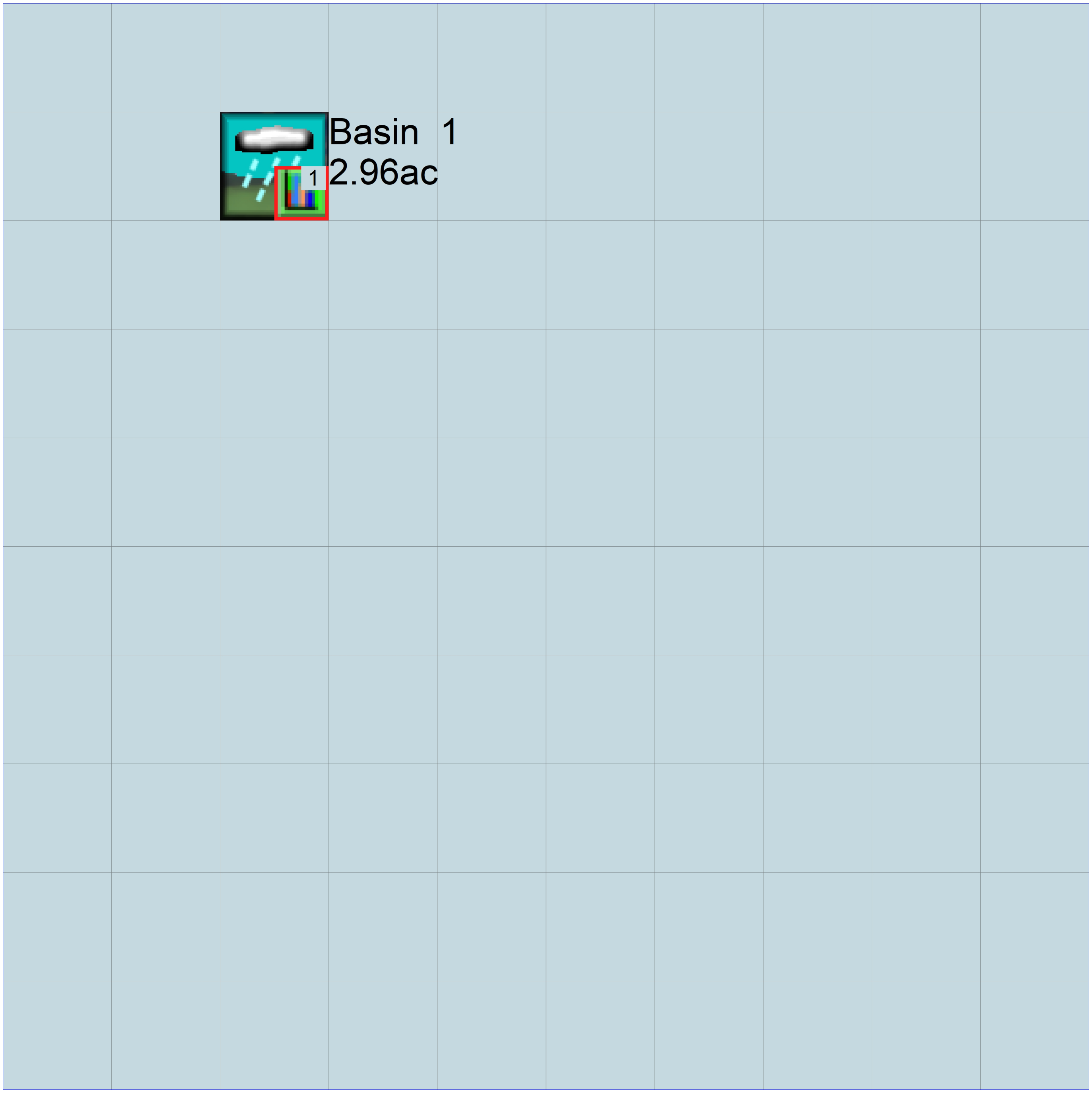
No PERLND changes have been made.

IMPLND Changes

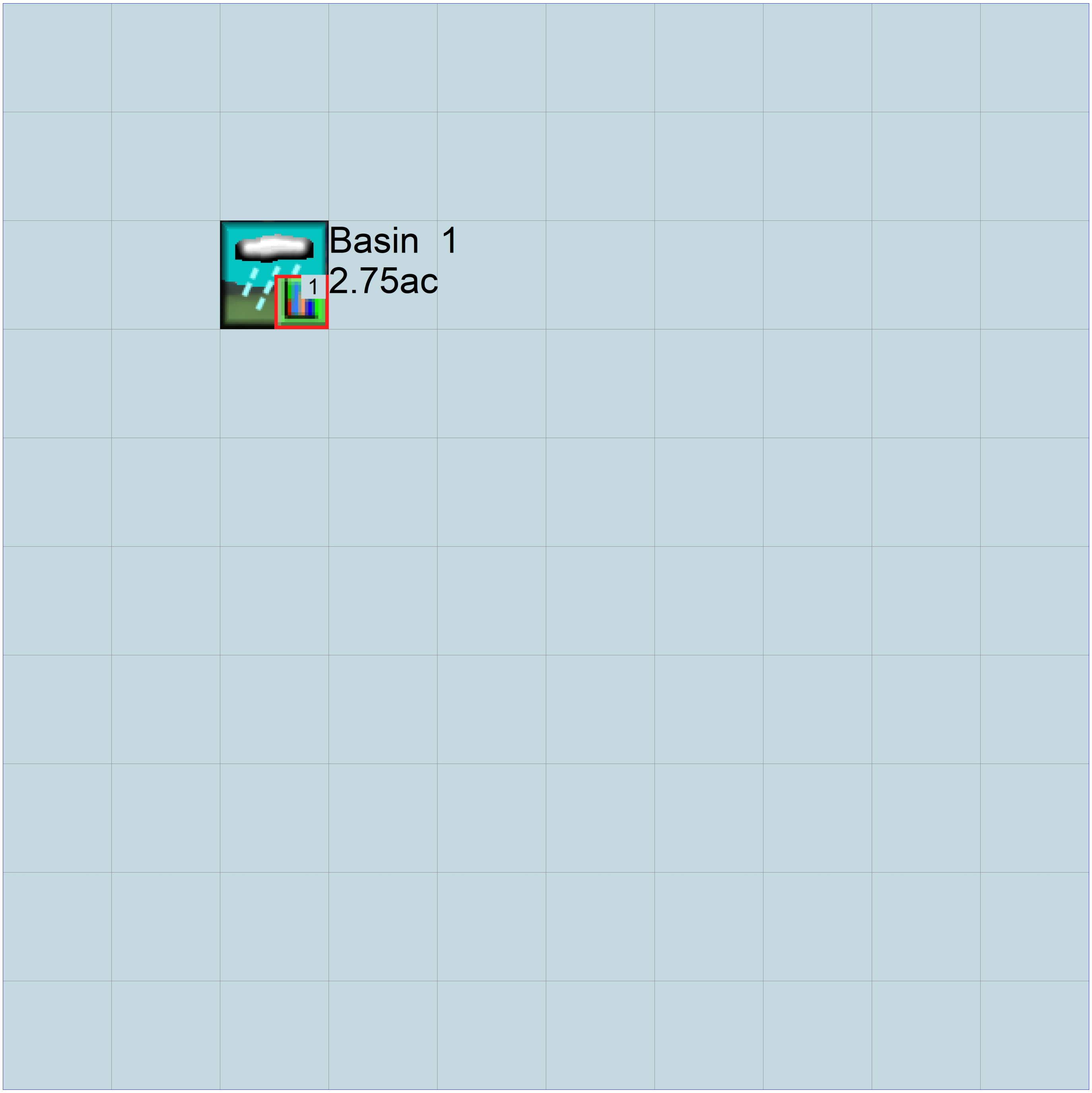
No IMPLND changes have been made.

Appendix

Predeveloped Schematic



Mitigated Schematic



Predeveloped UCI File

```
RUN

GLOBAL
  WWHM4 model simulation
  START       1901 10 01        END    2059 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   22085-wetland recharge ex conditions.wdm
MESSU      25   Pre22085-wetland recharge ex conditions.MES
           27   Pre22085-wetland recharge ex conditions.L61
           28   Pre22085-wetland recharge ex conditions.L62
           30   POC22085-wetland recharge ex conditions1.dat
END FILES

OPN SEQUENCE
    INGRP              INDELT 00:15
      PERLND      16
      IMPLND      11
      COPY       501
      DISPLY       1
    END INGRP
END OPN SEQUENCE
DISPLY
  DISPLY-INFO1
    # -  #<----------Title----------->***TRAN PIVL DIG1 FIL1  PYR DIG2 FIL2 YRND
    1        Basin  1                    MAX                     1    2   30    9
  END DISPLY-INFO1
END DISPLY
COPY
  TIMESERIES
    # -  #  NPT  NMN ***
    1         1    1
  501         1    1
  END TIMESERIES
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              ***
   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         ***
   11      PARKING/FLAT           1    1    1   27    0
  END GEN-INFO
  *** Section IWATER***

  ACTIVITY
    <PLS > ************* Active Sections *****************************
    # -  # ATMP SNOW IWAT  SLD  IWG IQAL   ***
   11         0    0    1    0    0    0
  END ACTIVITY

  PRINT-INFO
    <ILS > ******** Print-flags ******** PIVL  PYR
    # -  # ATMP SNOW IWAT  SLD  IWG IQAL    *********
   11         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     ***
   11         0    0    0    0    0
  END IWAT-PARM1

  IWAT-PARM2
    <PLS >      IWATER input info: Part 2         ***
    # -  # ***  LSUR     SLSUR      NSUR     RETSC
   11            400      0.01       0.1       0.1
  END IWAT-PARM2

  IWAT-PARM3
    <PLS >      IWATER input info: Part 3         ***
    # -  # ***PETMAX    PETMIN
   11              0         0
```

```
  END IWAT-PARM3

  IWAT-STATE1
    <PLS > *** Initial conditions at start of simulation
    # -  # ***  RETS      SURS
   11              0         0
  END IWAT-STATE1

END IMPLND

SCHEMATIC
<-Source->                  <--Area-->     <-Target->   MBLK   ***
<Name>   #                  <-factor->     <Name>   #   Tbl#   ***
Basin  1***
PERLND  16                        0.51     COPY   501     12
PERLND  16                        0.51     COPY   501     13
IMPLND  11                        2.45     COPY   501     15

******Routing******
END SCHEMATIC

NETWORK
<-Volume-> <-Grp> <-Member-><--Mult-->Tran <-Target vols> <-Grp> <-Member->  ***
<Name>   #        <Name> # #<-factor->strg <Name>   #   #        <Name> # #  ***
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    1              PERLND   1 999 EXTNL  PETINP
WDM      1 EVAP     ENGL    1              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   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

  MASS-LINK       15
IMPLND     IWATER SURO       0.083333      COPY          INPUT  MEAN
  END MASS-LINK   15


END MASS-LINK

END RUN
```

Mitigated UCI File

Predeveloped HSPF Message File

Mitigated HSPF Message File

Disclaimer

Legal Notice

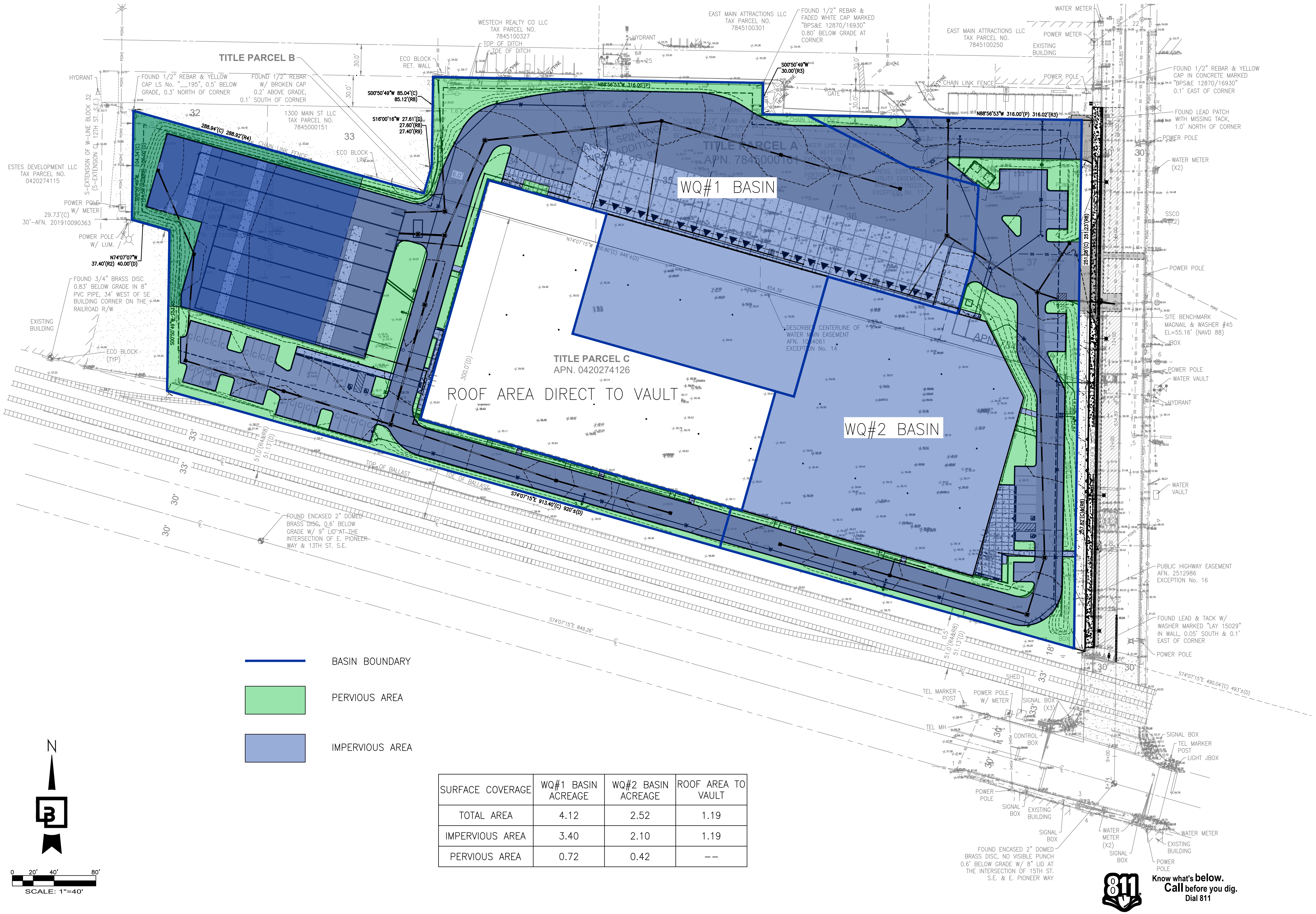
Clear Creek Solutions, Inc.
6200 Capitol Blvd. Ste F
Olympia, WA. 98501
Toll Free 1(866)943-0304
Local (360)943-0304

www.clearcreeksolutions.com

Figure 9

Water Quality Calculations

WATER QUALTY BASIN MAP EXHIBIT



—	BASIN BOUNDARY
🟩	PERVIOUS AREA
🟦	IMPERVIOUS AREA

SURFACE COVERAGE	WQ#1 BASIN ACREAGE	WQ#2 BASIN ACREAGE	ROOF AREA TO VAULT
TOTAL AREA	4.12	2.52	1.19
IMPERVIOUS AREA	3.40	2.10	1.19
PERVIOUS AREA	0.72	0.42	--

Know what's below.
Call before you dig.
Dial 811

No.	Date	By	Ckd.	Appr.	Revision

Title: WATER QUALITY BASIN MAP EXHIBIT
FORTRESS - PUYALLUP

For: CREF3 PUYALLUP OWNER LLC
11611 SAN VICENTE BLVD
10TH FLOOR
LOS ANGELES, CA 90049

Scale: Horizontal 1"=40'
Vertical N/A

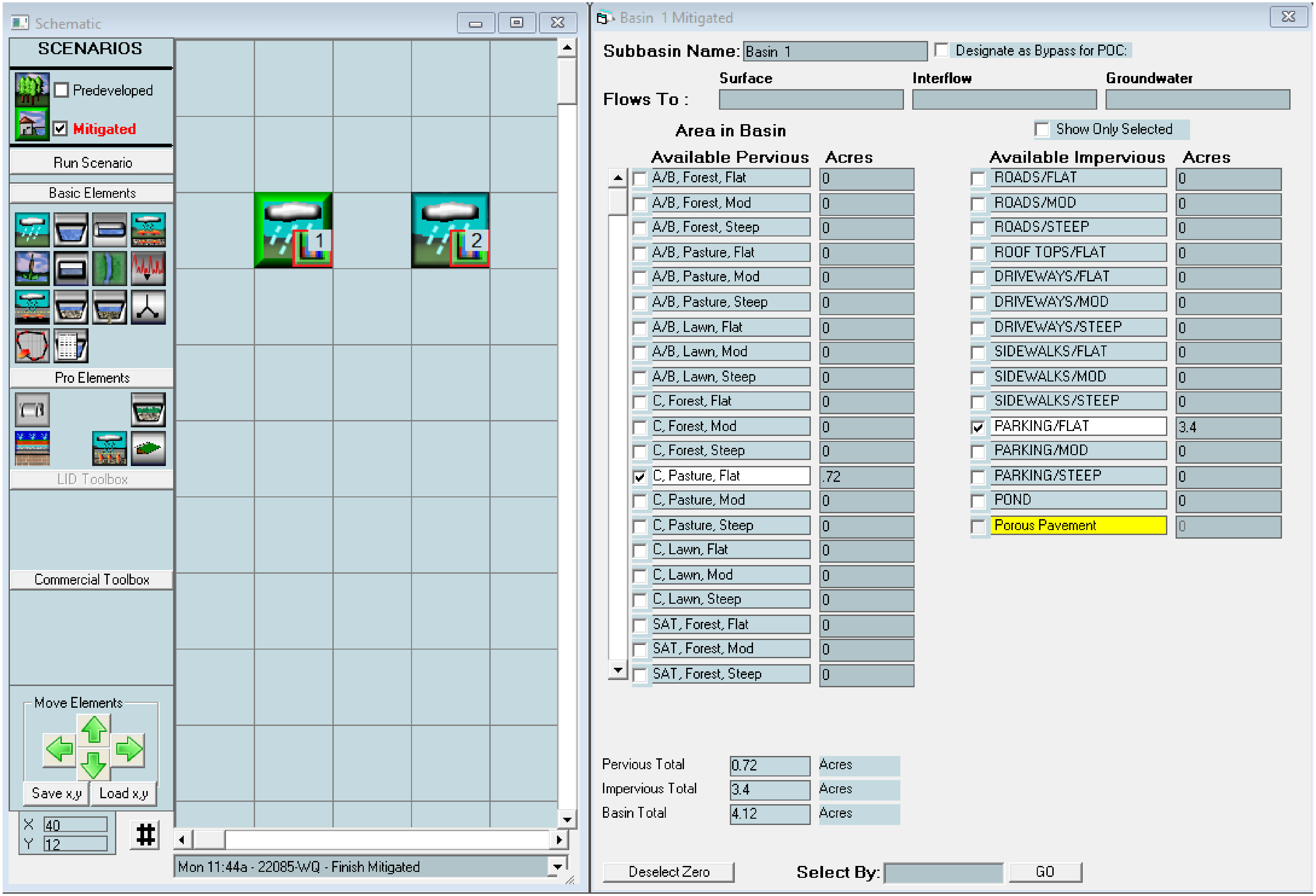
Designed VMS
Drawn VMS
Checked KEH
Approved KEH
Date 10/04/22

Barghausen Consulting Engineers, Inc.
18215 72nd Avenue South
Kent, WA 98032
425.251.6222
barghausen.com

Job Number 22085
Sheet 2 of 2

P:\22000s\22085\exhibit\WQ basin map.dwg 11/6/2023 4:29 PM VSCHLONGA

WQ #1 Basin



☐ Predeveloped
☑ Mitigated

X 40
Y 12

Mon 11:44a - 22085-WQ - Finish Mitigated

Subbasin Name: Basin 1 ☐ Designate as Bypass for POC:

Flows To : Surface, Interflow, Groundwater

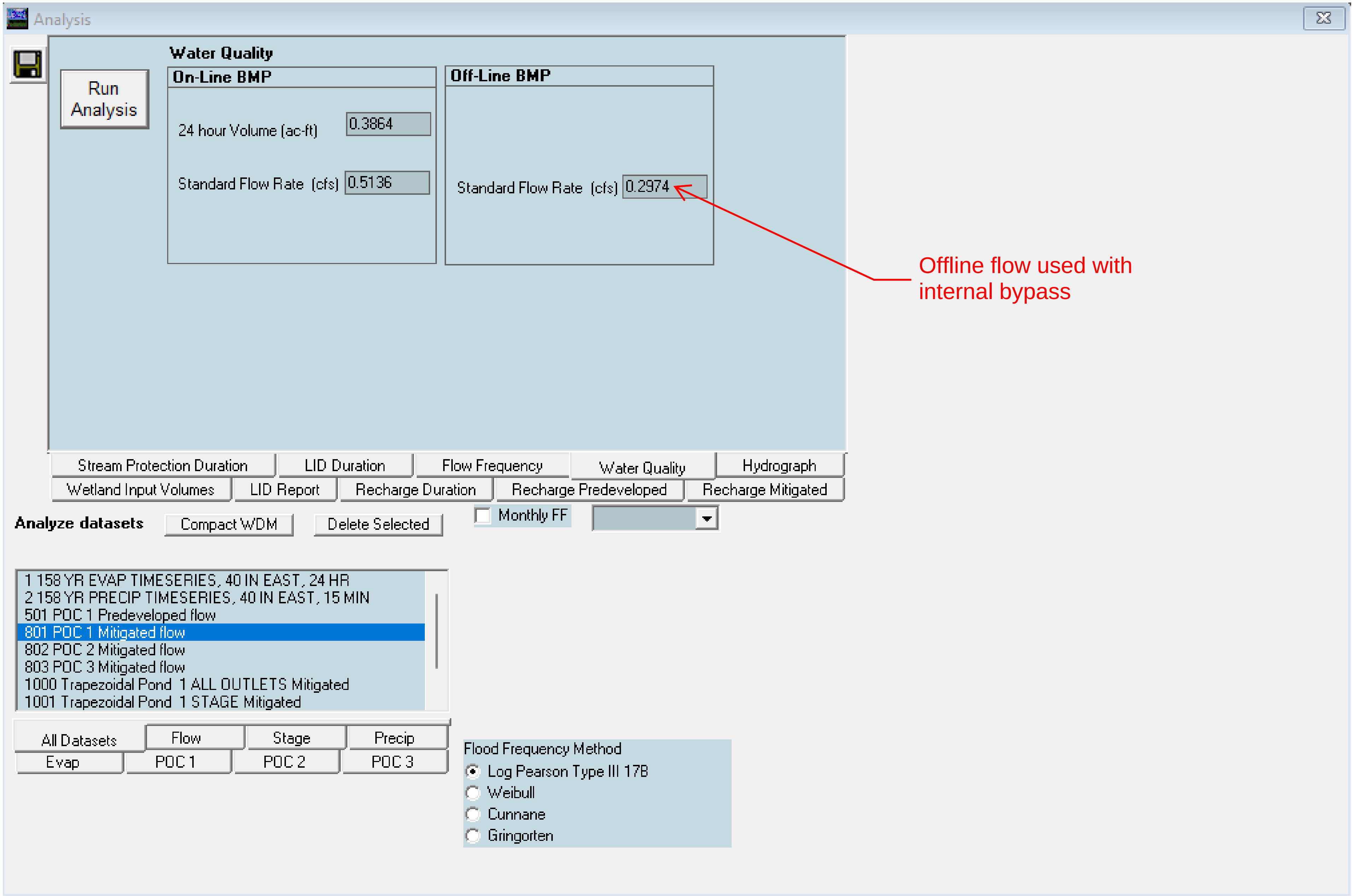
Area in Basin ☐ Show Only Selected

	Available Pervious	Acres		Available Impervious	Acres
☐	A/B, Forest, Flat	0	☐	ROADS/FLAT	0
☐	A/B, Forest, Mod	0	☐	ROADS/MOD	0
☐	A/B, Forest, Steep	0	☐	ROADS/STEEP	0
☐	A/B, Pasture, Flat	0	☐	ROOF TOPS/FLAT	0
☐	A/B, Pasture, Mod	0	☐	DRIVEWAYS/FLAT	0
☐	A/B, Pasture, Steep	0	☐	DRIVEWAYS/MOD	0
☐	A/B, Lawn, Flat	0	☐	DRIVEWAYS/STEEP	0
☐	A/B, Lawn, Mod	0	☐	SIDEWALKS/FLAT	0
☐	A/B, Lawn, Steep	0	☐	SIDEWALKS/MOD	0
☐	C, Forest, Flat	0	☐	SIDEWALKS/STEEP	0
☐	C, Forest, Mod	0	☑	PARKING/FLAT	3.4
☐	C, Forest, Steep	0	☐	PARKING/MOD	0
☑	C, Pasture, Flat	.72	☐	PARKING/STEEP	0
☐	C, Pasture, Mod	0	☐	POND	0
☐	C, Pasture, Steep	0	☐	Porous Pavement	0
☐	C, Lawn, Flat	0			
☐	C, Lawn, Mod	0			
☐	C, Lawn, Steep	0			
☐	SAT, Forest, Flat	0			
☐	SAT, Forest, Mod	0			
☐	SAT, Forest, Steep	0			

Pervious Total	0.72	Acres
Impervious Total	3.4	Acres
Basin Total	4.12	Acres

Select By:

WQ #1 WQ Flowrate



Water Quality

On-Line BMP

24 hour Volume (ac-ft) 0.3864

Standard Flow Rate (cfs) 0.5136

Off-Line BMP

Standard Flow Rate (cfs) 0.2974

Offline flow used with internal bypass

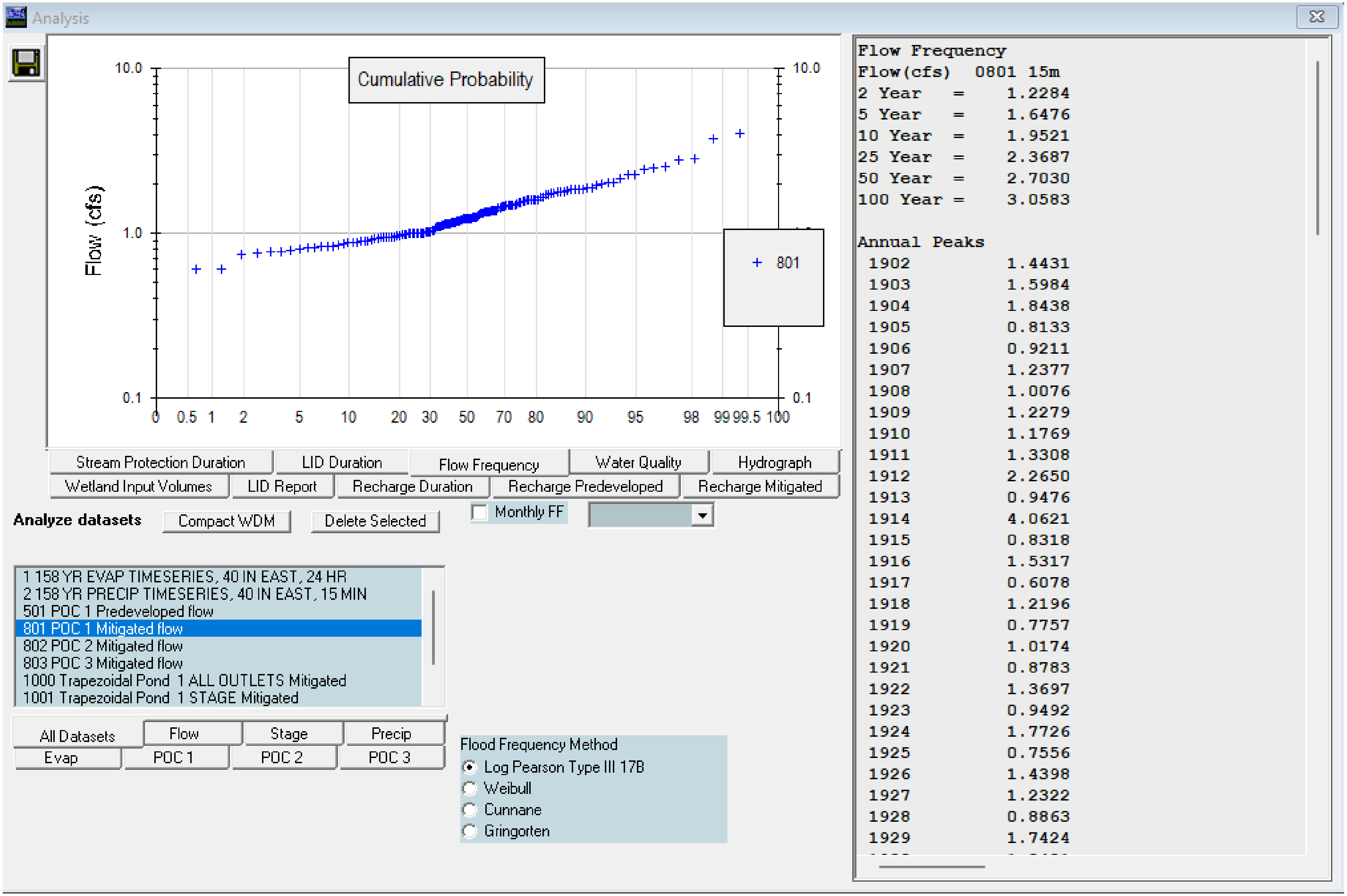
Analyze datasets

☐ Monthly FF

1 158 YR EVAP TIMESERIES, 40 IN EAST, 24 HR
2 158 YR PRECIP TIMESERIES, 40 IN EAST, 15 MIN
501 POC 1 Predeveloped flow
801 POC 1 Mitigated flow
802 POC 2 Mitigated flow
803 POC 3 Mitigated flow
1000 Trapezoidal Pond 1 ALL OUTLETS Mitigated
1001 Trapezoidal Pond 1 STAGE Mitigated

Flood Frequency Method
● Log Pearson Type III 17B
○ Weibull
○ Cunnane
○ Gringorten

WQ #1 Storm Events



☐ Monthly FF

1 158 YR EVAP TIMESERIES, 40 IN EAST, 24 HR
2 158 YR PRECIP TIMESERIES, 40 IN EAST, 15 MIN
501 POC 1 Predeveloped flow
801 POC 1 Mitigated flow
802 POC 2 Mitigated flow
803 POC 3 Mitigated flow
1000 Trapezoidal Pond 1 ALL OUTLETS Mitigated
1001 Trapezoidal Pond 1 STAGE Mitigated

Flood Frequency Method
● Log Pearson Type III 17B
○ Weibull
○ Cunnane
○ Gringorten

```
Flow Frequency
Flow(cfs)   0801 15m
2 Year    =     1.2284
5 Year    =     1.6476
10 Year   =     1.9521
25 Year   =     2.3687
50 Year   =     2.7030
100 Year  =     3.0583

Annual Peaks
 1902           1.4431
 1903           1.5984
 1904           1.8438
 1905           0.8133
 1906           0.9211
 1907           1.2377
 1908           1.0076
 1909           1.2279
 1910           1.1769
 1911           1.3308
 1912           2.2650
 1913           0.9476
 1914           4.0621
 1915           0.8318
 1916           1.5317
 1917           0.6078
 1918           1.2196
 1919           0.7757
 1920           1.0174
 1921           0.8783
 1922           1.3697
 1923           0.9492
 1924           1.7726
 1925           0.7556
 1926           1.4398
 1927           1.2322
 1928           0.8863
 1929           1.7424
```

SITE SPECIFIC DATA	
Structure ID	WQ#1
Treatment Flow Rate (cfs)	0.2974
Peak Flow Rate (cfs)	3.0583
Rim Elevation	60.39
Top of Vault Elevation	

Pipe Data	Pipe Location	Pipe Size	Pipe Type	Invert Elevation
Inlet	E	18"	CPEP	50.70
Outlet	W	18"	CPEP	50.20

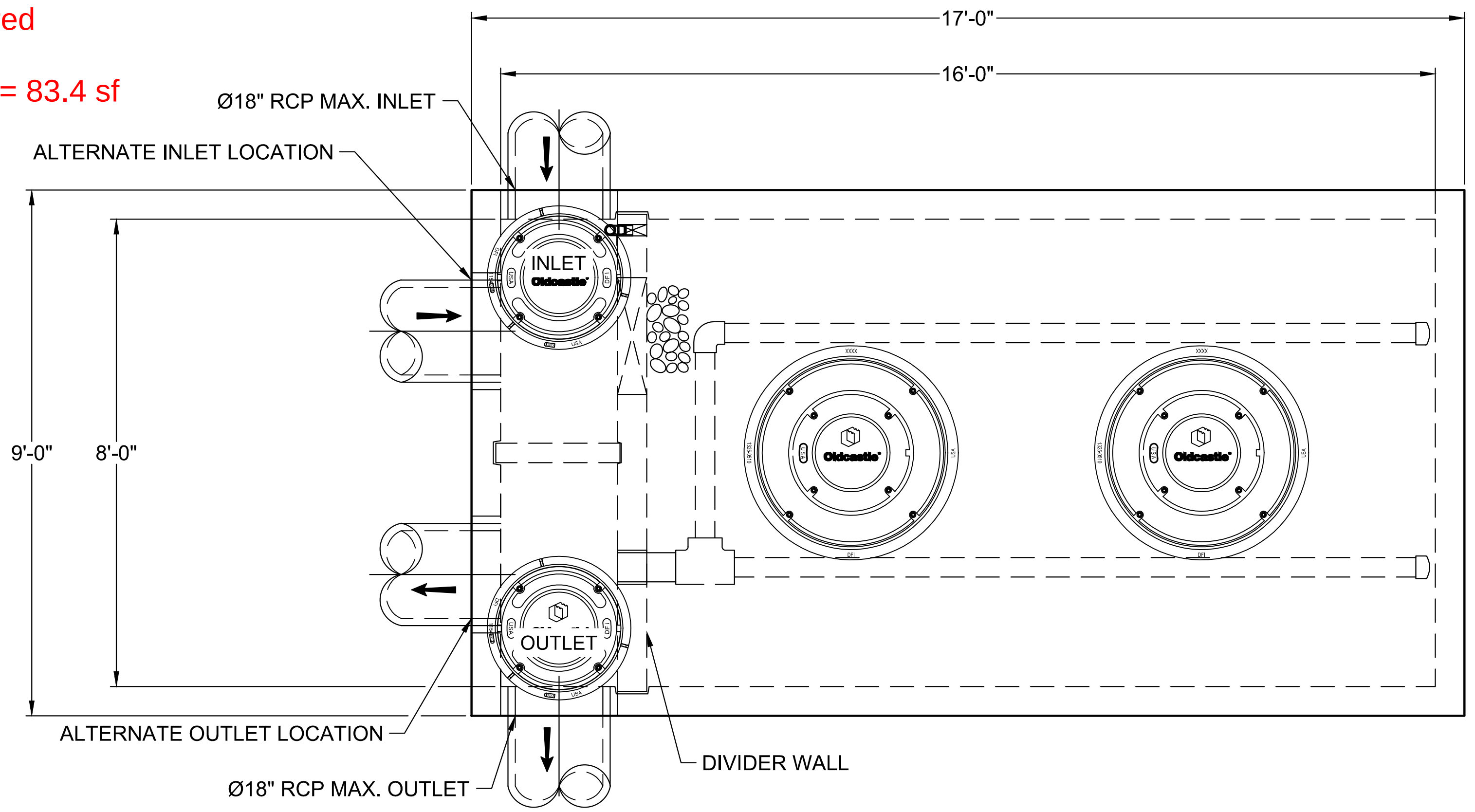
Notes:

PERFORMANCE SPECIFICATIONS	
Treatment Flow Capacities:*	
NJDEP 80% Removal, 75 micron	0.432 cfs
WA Ecology GULD - Basic, Enhanced & Phosphorus	0.384 cfs
Bypass Capacity	6.5 cfs

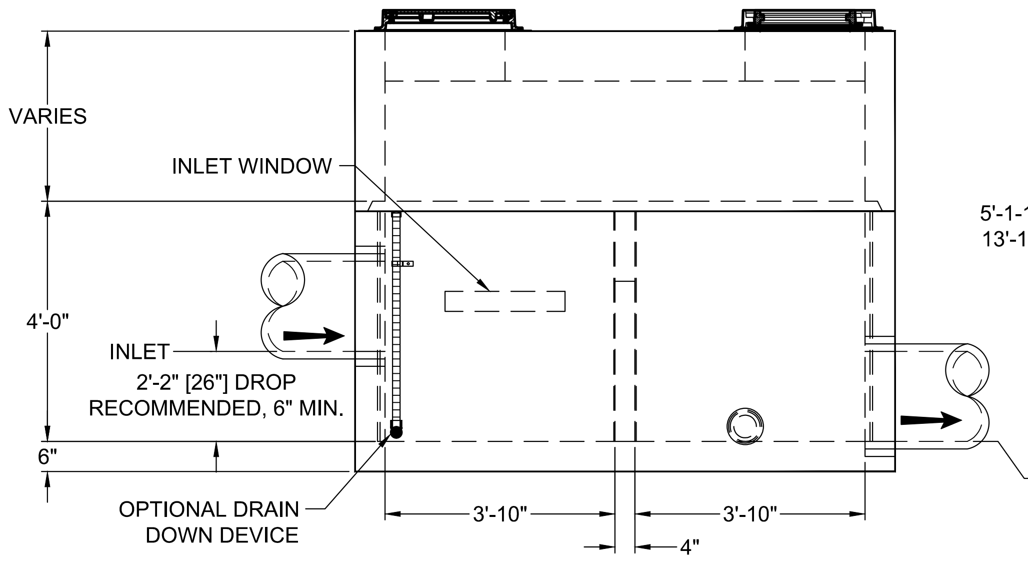
*Contact Oldcastle for alternative treatment flow capacities.

Minimum filter size required
0.2974 cfs = 133.48 gpm
133.48 gpm / 1.6 gpm/sf = 83.4 sf

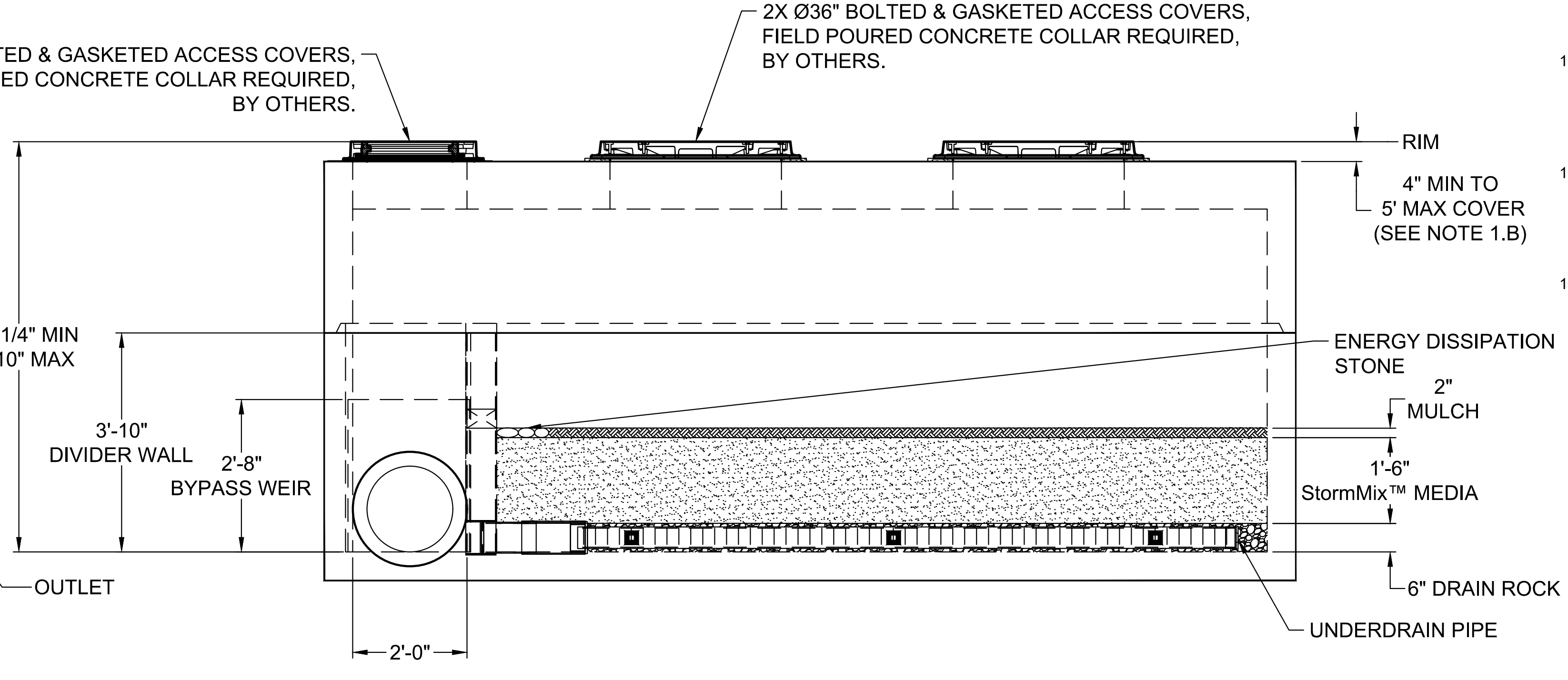
Filter size provided
8 ft x 13.5 ft = 108 sf



PLAN VIEW



LEFT END VIEW



ELEVATION VIEW

NOTES:

1. DESIGN LOADINGS:
   A. AASHTO HS-20-44 (WITH IMPACT)
   B. DESIGN SOIL COVER: 5'-0" MAXIMUM
   C. ASSUMED WATER TABLE: BELOW BASE OF PRECAST (ENGINEER-OF-RECORD TO CONFIRM SITE WATER TABLE ELEVATION)
   D. LATERAL EARTH PRESSURE: 45 PCF (DRAINED)
   E. LATERAL LIVE LOAD SURCHARGE: 80 PSF (APPLIED TO 8'-0" BELOW GRADE)
   F. NO LATERAL SURCHARGE FROM ADJACENT BUILDINGS, WALLS, PIERS, OR FOUNDATIONS.
2. CONCRETE 28-DAY MINIMUM COMPRESSIVE STRENGTH: 5,000 PSI MINIMUM.
3. REINFORCING: REBAR, ASTM A615/A706, GRADE 60
4. CEMENT: ASTM C150
5. REQUIRED ALLOWABLE SOIL BEARING CAPACITY: 2,500 PSF
6. REFERENCE STANDARD:
   A. ASTM C890
   B. ASTM C913
   C. ACI 318-14
7. THIS STRUCTURE IS DESIGNED TO THE PARAMETERS NOTED HEREIN. ENGINEER-OF-RECORD SHALL VERIFY FY THAT NOTED PARAMETERS MEET OR EXCEED PROJECT REQUIREMENTS. IF DESIGN PARAMETERS ARE INCORRECT, REVIEWING ENGINEER/AUTHORITY SHALL NOTIFY OLDCASTLE INFRASTRUCTURE UPON REVIEW.
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9. CONTRACTOR RESPONSIBLE TO VERIFY ALL SIZES, LOCATIONS, AND ELEVATIONS OF OPENINGS.
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11. SECTION HEIGHTS, SLAB/WALL THICKNESSES, AND KEYWAYS ARE SUBJECT TO CHANGE AS REQUIRED FOR SITE REQUIREMENTS AND/OR DUE TO PRODUCT AVAILABILITY AND PRODUCTION FACILITY CONSTRAINTS.
12. MAXIMUM PICK WEIGHTS*:
    A. TOP: XX,XXX LBS
    B. BASE: XX,XXX LBS*
    (* COMBINED WEIGHT OF BASE INCLUDES BYPASS WEIR, DIVIDER WALL, ROCK & MEDIA)
13. INTERNALS SHALL CONSIST OF UNDERDRAIN PIPE, ROCK, STORMMIX™ MEDIA, MULCH, DIVIDER WALL, BYPASS WEIR AND OPTIONAL DRAIN DOWN.

Oldcastle Infrastructure™
A CRH COMPANY

Ph: 800.579.8819 | www.oldcastleinfrastructure.com/stormwater

BioPod™ Biofilter System (STANDARD)
Underground Vault with Internal Bypass

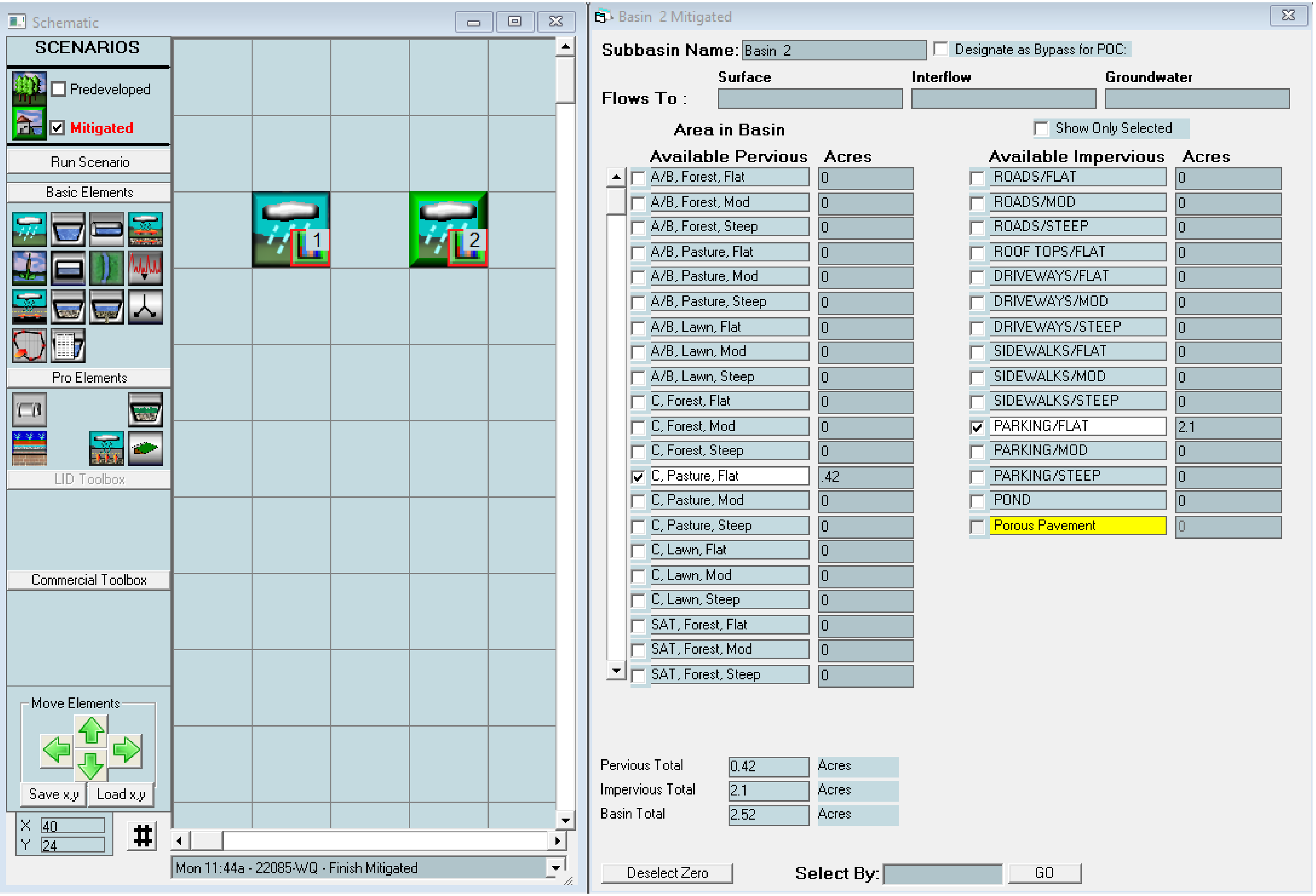
CUSTOMER
-

PROJECT NAME
-

SHEET NAME	REVISION	SHEET
Specifier Drawing BPU-816IB	- REV DATE -	1 OF 1

Bioretention/
Biofiltration

WQ #2 Basin



☐ Predeveloped
☑ Mitigated

X 40
Y 24

Mon 11:44a - 22085-WQ - Finish Mitigated

Subbasin Name: Basin 2 ☐ Designate as Bypass for POC:

	Surface	Interflow	Groundwater
Flows To :			

Area in Basin ☐ Show Only Selected

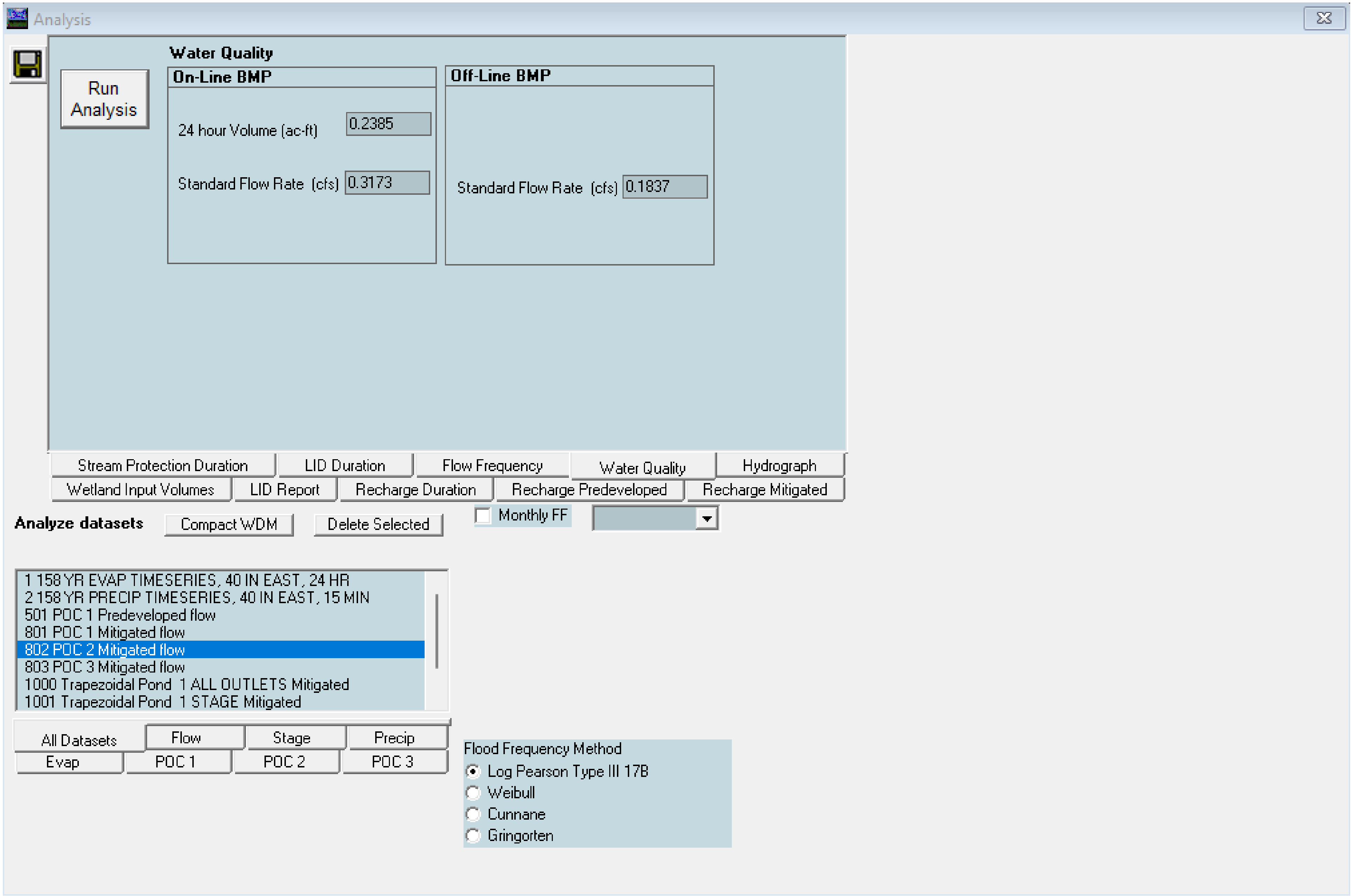
	Available Pervious	Acres
☐	A/B, Forest, Flat	0
☐	A/B, Forest, Mod	0
☐	A/B, Forest, Steep	0
☐	A/B, Pasture, Flat	0
☐	A/B, Pasture, Mod	0
☐	A/B, Pasture, Steep	0
☐	A/B, Lawn, Flat	0
☐	A/B, Lawn, Mod	0
☐	A/B, Lawn, Steep	0
☐	C, Forest, Flat	0
☐	C, Forest, Mod	0
☐	C, Forest, Steep	0
☑	C, Pasture, Flat	.42
☐	C, Pasture, Mod	0
☐	C, Pasture, Steep	0
☐	C, Lawn, Flat	0
☐	C, Lawn, Mod	0
☐	C, Lawn, Steep	0
☐	SAT, Forest, Flat	0
☐	SAT, Forest, Mod	0
☐	SAT, Forest, Steep	0

	Available Impervious	Acres
☐	ROADS/FLAT	0
☐	ROADS/MOD	0
☐	ROADS/STEEP	0
☐	ROOF TOPS/FLAT	0
☐	DRIVEWAYS/FLAT	0
☐	DRIVEWAYS/MOD	0
☐	DRIVEWAYS/STEEP	0
☐	SIDEWALKS/FLAT	0
☐	SIDEWALKS/MOD	0
☐	SIDEWALKS/STEEP	0
☑	PARKING/FLAT	2.1
☐	PARKING/MOD	0
☐	PARKING/STEEP	0
☐	POND	0
☐	Porous Pavement	0

Pervious Total	0.42	Acres
Impervious Total	2.1	Acres
Basin Total	2.52	Acres

Select By:

WQ #2 WQ Flowrate



Water Quality

On-Line BMP

24 hour Volume (ac-ft) 0.2385

Standard Flow Rate (cfs) 0.3173

Off-Line BMP

Standard Flow Rate (cfs) 0.1837

☐ Monthly FF

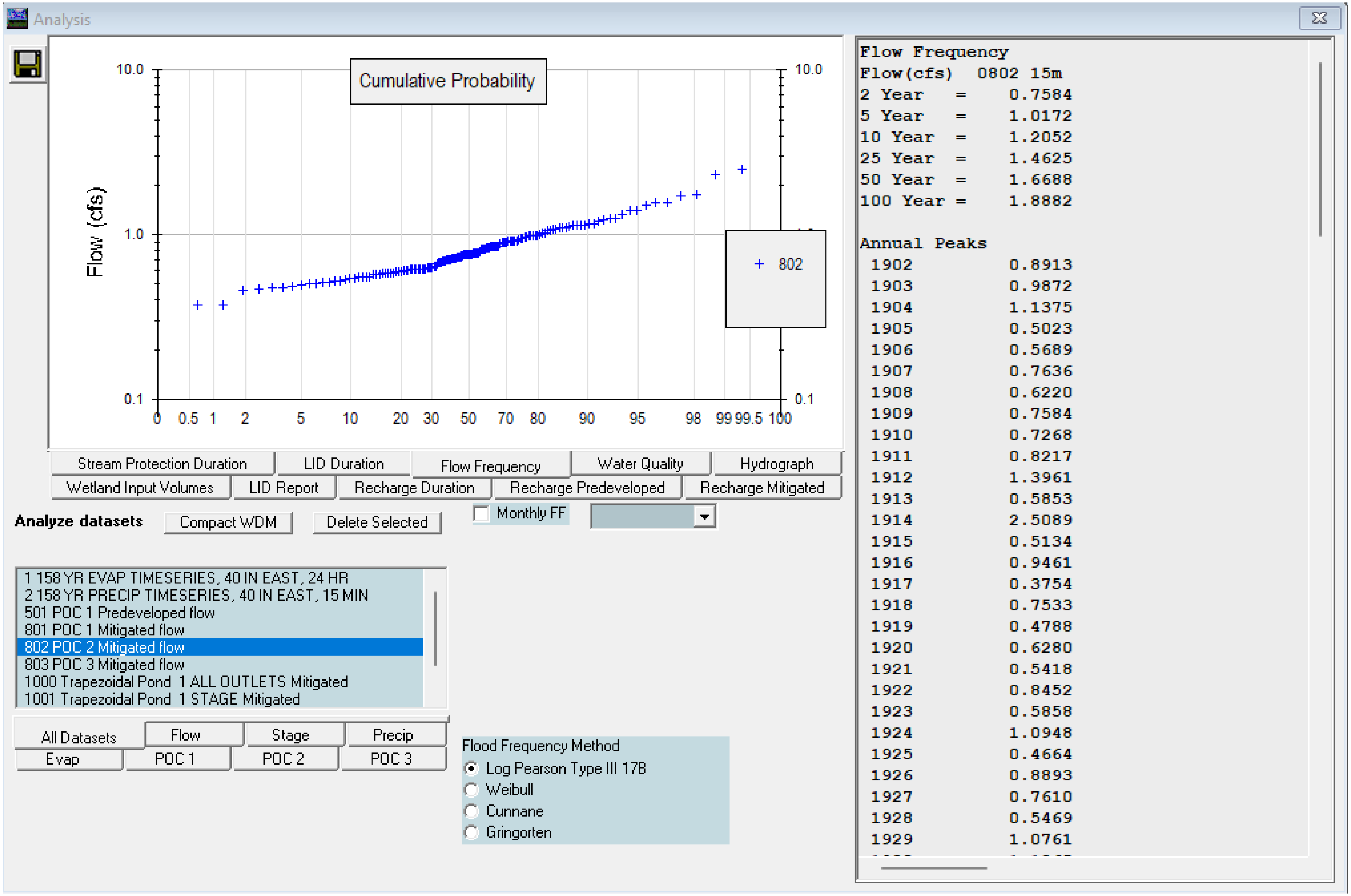
Analyze datasets

1 158 YR EVAP TIMESERIES, 40 IN EAST, 24 HR
2 158 YR PRECIP TIMESERIES, 40 IN EAST, 15 MIN
501 POC 1 Predeveloped flow
801 POC 1 Mitigated flow
802 POC 2 Mitigated flow
803 POC 3 Mitigated flow
1000 Trapezoidal Pond 1 ALL OUTLETS Mitigated
1001 Trapezoidal Pond 1 STAGE Mitigated

Flood Frequency Method

● Log Pearson Type III 17B
○ Weibull
○ Cunnane
○ Gringorten

WQ #2 Storm Events



Analyze datasets

☐ Monthly FF

1 158 YR EVAP TIMESERIES, 40 IN EAST, 24 HR
2 158 YR PRECIP TIMESERIES, 40 IN EAST, 15 MIN
501 POC 1 Predeveloped flow
801 POC 1 Mitigated flow
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803 POC 3 Mitigated flow
1000 Trapezoidal Pond 1 ALL OUTLETS Mitigated
1001 Trapezoidal Pond 1 STAGE Mitigated

Flood Frequency Method
● Log Pearson Type III 17B
○ Weibull
○ Cunnane
○ Gringorten

```
Flow Frequency
Flow(cfs)  0802 15m
2 Year   =     0.7584
5 Year   =     1.0172
10 Year  =     1.2052
25 Year  =     1.4625
50 Year  =     1.6688
100 Year =     1.8882

Annual Peaks
 1902          0.8913
 1903          0.9872
 1904          1.1375
 1905          0.5023
 1906          0.5689
 1907          0.7636
 1908          0.6220
 1909          0.7584
 1910          0.7268
 1911          0.8217
 1912          1.3961
 1913          0.5853
 1914          2.5089
 1915          0.5134
 1916          0.9461
 1917          0.3754
 1918          0.7533
 1919          0.4788
 1920          0.6280
 1921          0.5418
 1922          0.8452
 1923          0.5858
 1924          1.0948
 1925          0.4664
 1926          0.8893
 1927          0.7610
 1928          0.5469
 1929          1.0761
```

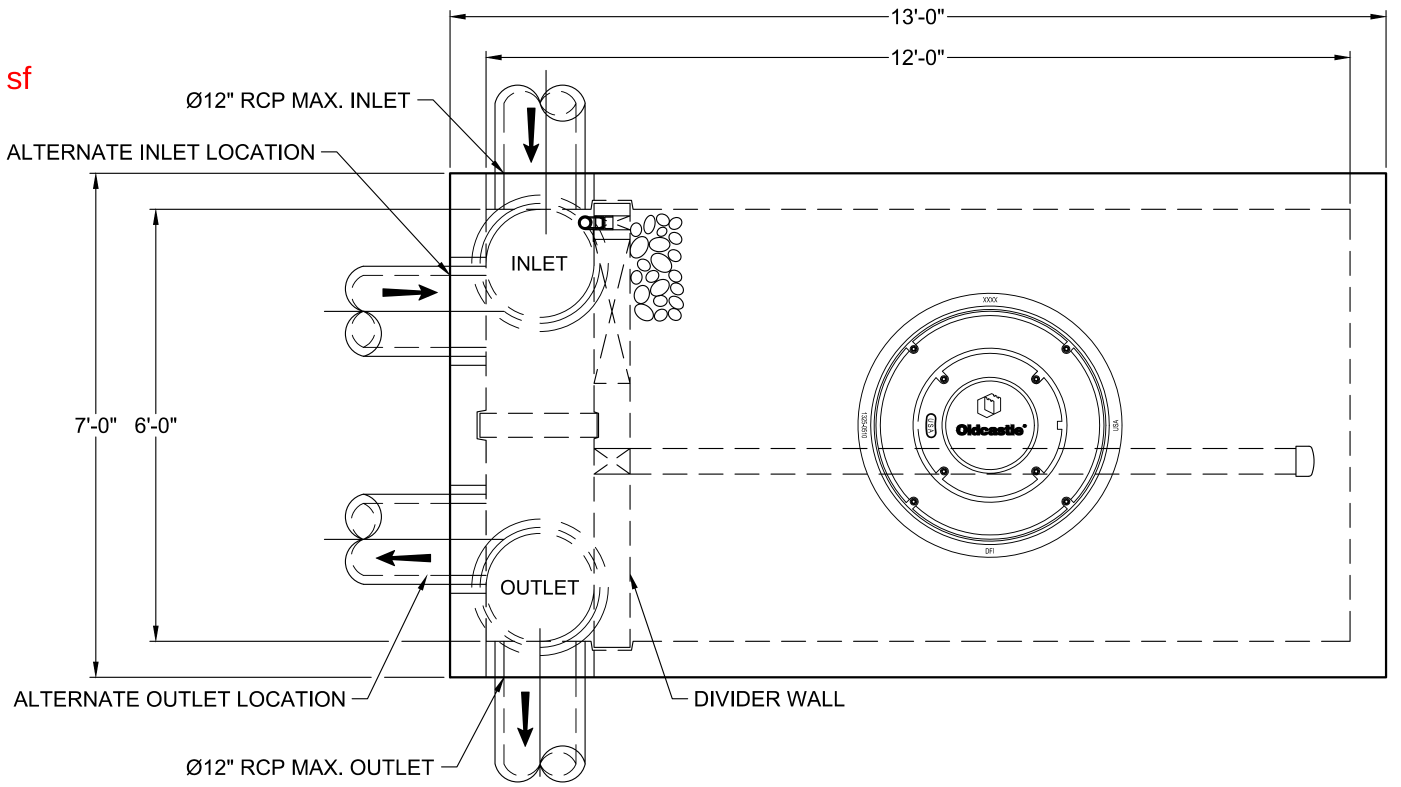
SITE SPECIFIC DATA				
Structure ID				WQ#2
Treatment Flow Rate (cfs)				0.1837
Peak Flow Rate (cfs)				1.8882
Rim Elevation				55.43
Top of Vault Elevation				
Pipe Data	**Pipe Location**	**Pipe Size**	**Pipe Type**	**Invert Elevation**
Inlet	W	12"	CPEP	49.42
Outlet	E	12"	CPEP	48.92
Notes:				

PERFORMANCE SPECIFICATIONS	
Treatment Flow Capacities:*	
NJDEP 80% Removal, 75 micron	0.240 cfs
WA Ecology GULD - Basic, Enhanced & Phosphorus	0.213 cfs
Bypass Capacity	5.0 cfs

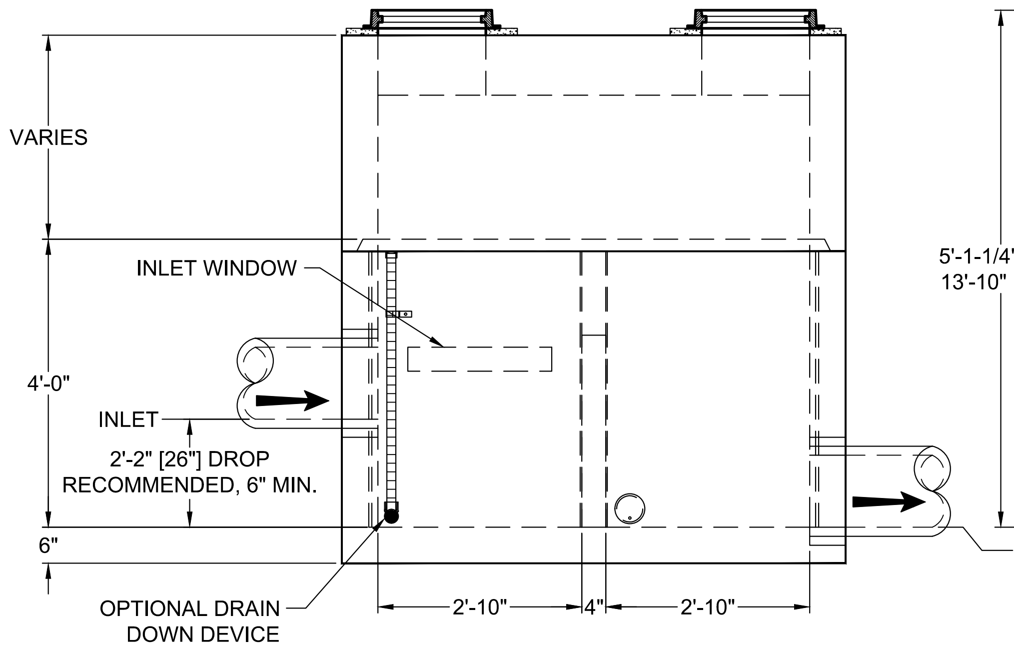
*Contact Oldcastle for alternative treatment flow capacities.

Minimum filter size required
0.1837 cfs = 82.45 gpm
82.45 gpm / 1.6 gpm/sf = 51.5 sf

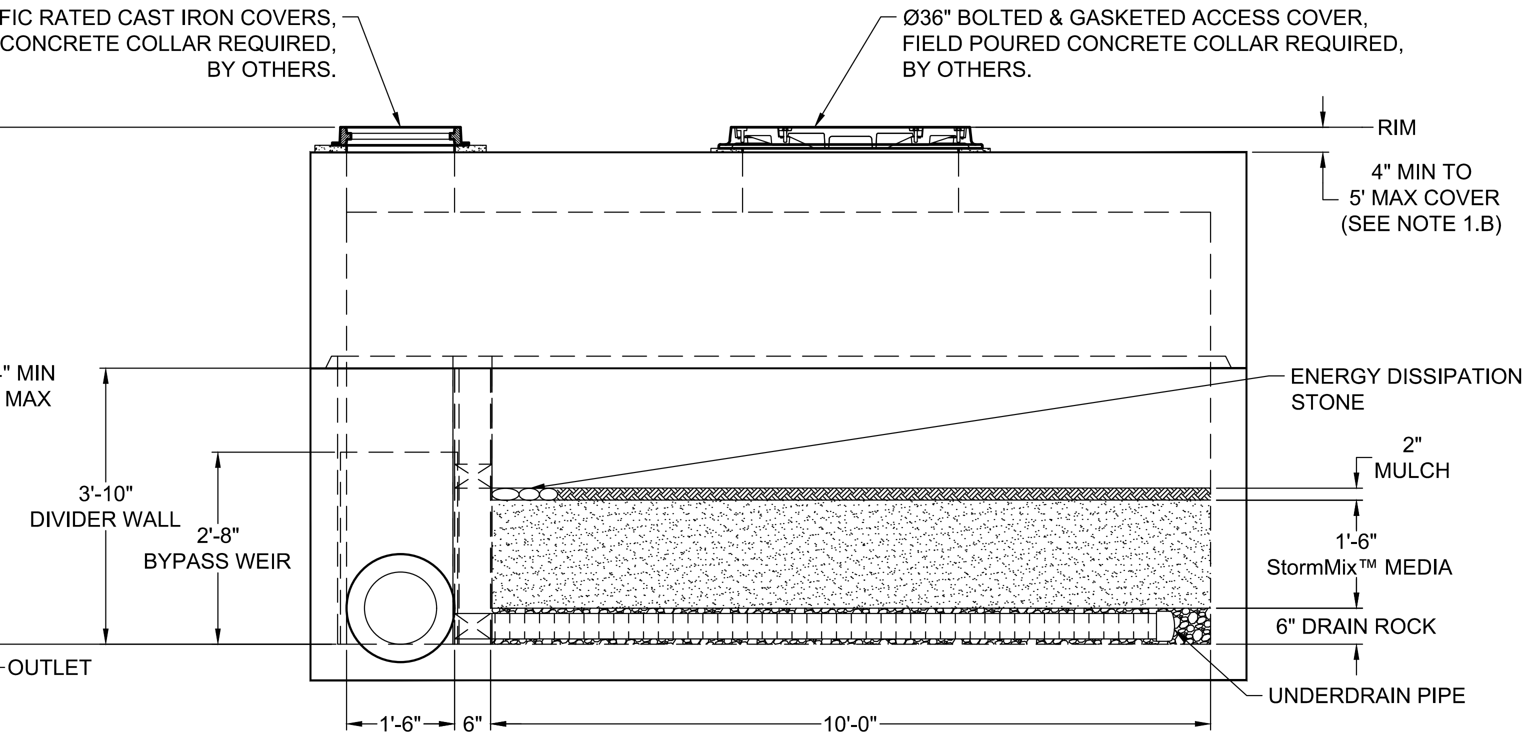
Filter size provided
6 ft x 10 ft = 60 sf



PLAN VIEW



LEFT END VIEW



ELEVATION VIEW

NOTES:

1. DESIGN LOADINGS:
   A. AASHTO HS-20-44 (WITH IMPACT)
   B. DESIGN SOIL COVER: 5'-0" MAXIMUM
   C. ASSUMED WATER TABLE: BELOW BASE OF PRECAST (ENGINEER-OF-RECORD TO CONFIRM SITE WATER TABLE ELEVATION)
   D. LATERAL EARTH PRESSURE: 45 PCF (DRAINED)
   E. LATERAL LIVE LOAD SURCHARGE: 80 PSF (APPLIED TO 8'-0" BELOW GRADE)
   F. NO LATERAL SURCHARGE FROM ADJACENT BUILDINGS, WALLS, PIERS, OR FOUNDATIONS.
2. CONCRETE 28-DAY MINIMUM COMPRESSIVE STRENGTH: 5,000 PSI MINIMUM.
3. REINFORCING: REBAR, ASTM A615/A706, GRADE 60
4. CEMENT: ASTM C150
5. REQUIRED ALLOWABLE SOIL BEARING CAPACITY: 2,500 PSF
6. REFERENCE STANDARD:
   A. ASTM C890
   B. ASTM C913
   C. ACI 318-14
7. THIS STRUCTURE IS DESIGNED TO THE PARAMETERS NOTED HEREIN. ENGINEER-OF-RECORD SHALL VERIFY FY THAT NOTED PARAMETERS MEET OR EXCEED PROJECT REQUIREMENTS. IF DESIGN PARAMETERS ARE INCORRECT, REVIEWING ENGINEER/AUTHORITY SHALL NOTIFY OLDCASTLE INFRASTRUCTURE UPON REVIEW.
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12. MAXIMUM PICK WEIGHTS":
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13. INTERNALS SHALL CONSIST OF UNDERDRAIN PIPE, ROCK, STORMMIX™ MEDIA, MULCH, DIVIDER WALL, BYPASS WEIR AND OPTIONAL DRAIN DOWN.

Bioretention/
Biofiltration

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BioPod™ Biofilter System (STANDARD)
Underground Vault with Internal Bypass

CUSTOMER
-

PROJECT NAME
-

SHEET NAME	REVISION	SHEET
Specifier Drawing BPU-612IB	- REV DATE -	1 OF 1

V-11 Miscellaneous LID BMPs

V-11.1 Introduction to Miscellaneous LID BMPs

BMPs in this chapter have been grouped because they have the following in common:

- They employ Low Impact Development (LID) Principles
- They cannot be used to meet I-3.4.6 MR6: Runoff Treatment
- They cannot, by themselves, be used to meet the Flow Control Performance Standard or the LID Performance Standard.
    - Some of the BMPs in this chapter do allow for some amount of Flow Control credit. See the guidance for each individual BMP for details.
- The design methods for each BMP in this chapter are unique. They do not have strong enough design similarities to other BMPs in this volume to place them in the other BMP categories identified in this volume.

BMP T5.13: Post-Construction Soil Quality and Depth

Purpose and Definition

Naturally occurring (undisturbed) soil and vegetation provide important stormwater functions including: water infiltration; nutrient, sediment, and pollutant adsorption; sediment and pollutant biofiltration; water interflow storage and transmission; and pollutant decomposition. These functions are largely lost when development strips away native soil and vegetation and replaces it with minimal topsoil and sod. Not only are these important stormwater functions lost, but such landscapes themselves become pollution generating pervious surfaces due to increased use of pesticides, fertilizers and other landscaping and household/industrial chemicals, the concentration of pet wastes, and pollutants that accompany roadside litter.

Establishing soil quality and depth regains greater stormwater functions in the post development landscape, provides increased treatment of pollutants and sediments that result from development and habitation, and minimizes the need for some landscaping chemicals, thus reducing pollution through prevention.

Applications and Limitations

Establishing a minimum soil quality and depth is not the same as preservation of naturally occurring soil and vegetation. However, establishing a minimum soil quality and depth will provide improved on-site management of stormwater flow and water quality.

Soil organic matter can be attained through numerous materials such as compost, composted woody material, biosolids, and forest product residuals. It is important that the materials used to

meet this BMP be appropriate and beneficial to the plant cover to be established. Likewise, it is important that imported topsoils improve soil conditions and do not have an excessive percent of clay fines.

This BMP can be considered infeasible on till soil slopes greater than 33 percent.

Design Guidelines

Soil Retention

Retain, in an undisturbed state, the duff layer and native topsoil to the maximum extent practicable. In any areas requiring grading, remove and stockpile the duff layer and topsoil on site in a designated, controlled area, not adjacent to public resources and critical areas, to be reapplied to other portions of the site where feasible.

Soil Quality

All areas subject to clearing and grading that have not been covered by impervious surface, incorporated into a drainage facility or engineered as structural fill or slope shall, at project completion, demonstrate the following:

1. A topsoil layer with a minimum organic matter content of 10% dry weight in planting beds, and 5% organic matter content in turf areas, and a pH from 6.0 to 8.0 or matching the pH of the undisturbed soil. The topsoil layer shall have a minimum depth of eight inches except where tree roots limit the depth of incorporation of amendments needed to meet the criteria. Subsoils below the topsoil layer should be scarified at least 4 inches with some incorporation of the upper material to avoid stratified layers, where feasible.
2. Mulch planting beds with 2 inches of organic material.
3. Use compost and other materials that meet the following organic content requirements:
    a. The organic content for “pre-approved” amendment rates can be met only using compost meeting the compost specification for BMP T7.30: Bioretention, with the exception that the compost may have up to 35% biosolids or manure.

       The compost must also have an organic matter content of 40% to 65%, and a carbon to nitrogen ratio below 25:1.

       The carbon to nitrogen ratio may be as high as 35:1 for plantings composed entirely of plants native to the Puget Sound Lowlands region.

    b. Calculated amendment rates may be met through use of composted material meeting (a.) above; or other organic materials amended to meet the carbon to nitrogen ratio requirements, and not exceeding the contaminant limits identified in Table 220-B, Testing Parameters, in WAC 173-350-220.

The resulting soil should be conducive to the type of vegetation to be established.

Implementation Options

The soil quality design guidelines listed above can be met by using one of the methods listed below:

1. Leave undisturbed native vegetation and soil, and protect from compaction during construction.
2. Amend existing site topsoil or subsoil either at default “pre-approved” rates, or at custom calculated rates based on tests of the soil and amendment.
3. Stockpile existing topsoil during grading, and replace it prior to planting. Stockpiled topsoil must also be amended if needed to meet the organic matter or depth requirements, either at a default “pre-approved” rate or at a custom calculated rate.
4. Import topsoil mix of sufficient organic content and depth to meet the requirements.

More than one method may be used on different portions of the same site. Soil that already meets the depth and organic matter quality standards, and is not compacted, does not need to be amended.

Planning/Permitting/Inspection/Verification Guidelines & Procedures

Local governments are encouraged to adopt guidelines and procedures similar to those recommended in *Building Soil: Guidelines and Resources for Implementing Soil Quality and Depth BMP T5.13 in WDOE Stormwater Management Manual for Western Washington* (Stenn et al., 2016).

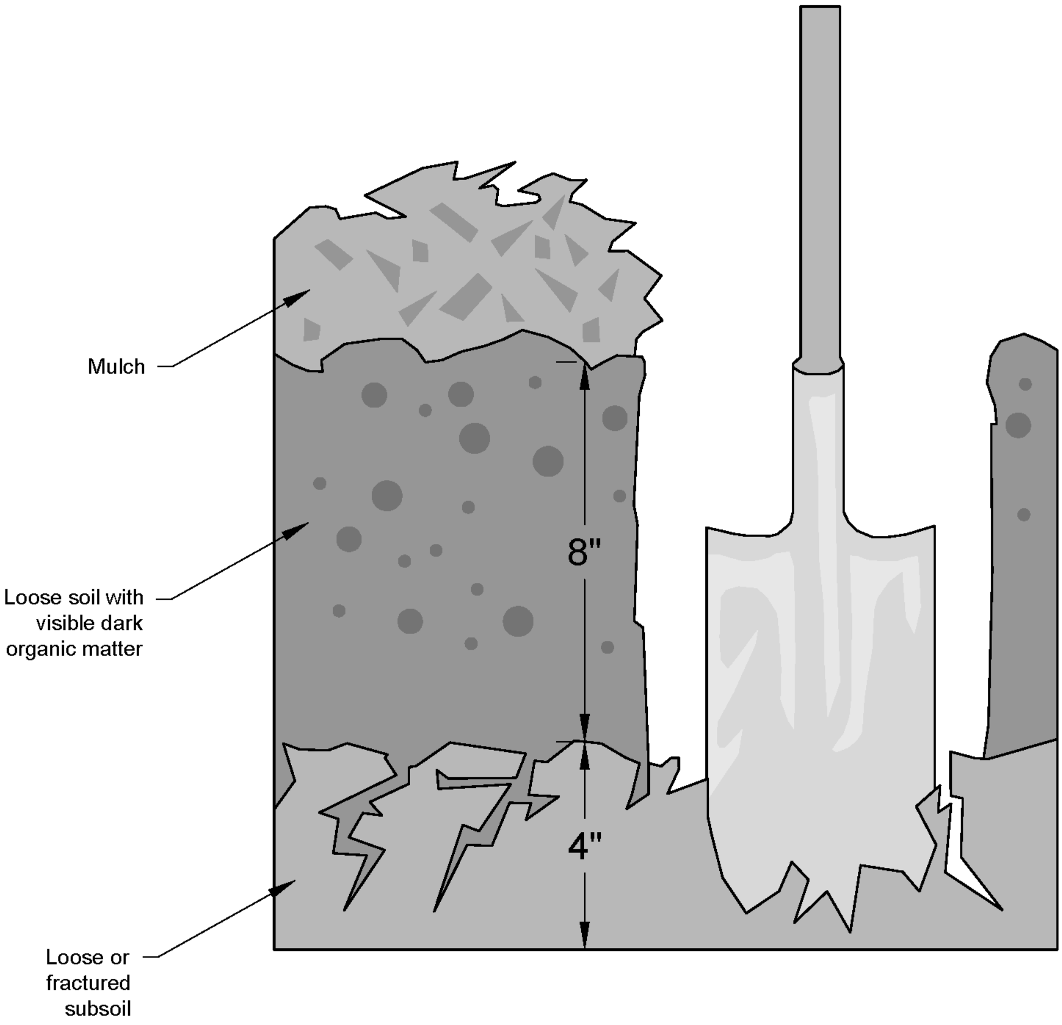
Maintenance

- Establish soil quality and depth toward the end of construction and once established, protect from compaction, such as from large machinery use, and from erosion.
- Plant vegetation and mulch the amended soil area after installation.
- Leave plant debris or its equivalent on the soil surface to replenish organic matter.
- Reduce and adjust, where possible, the use of irrigation, fertilizers, herbicides and pesticides, rather than continuing to implement formerly established practices.

Runoff Model Representation

All areas meeting the soil quality and depth design criteria may be entered into approved runoff models as “Pasture” rather than “Lawn/Landscaping”.

Figure V-11.1: Planting Bed Cross-Section



Reprinted from *Guidelines and Resources For Implementing Soil Quality and Depth BMP T5.13 in WDOE Stormwater Management Manual for Western Washington*, 2010, Washington Organic Recycling Council

NOT TO SCALE

DEPARTMENT OF ECOLOGY
State of Washington

Planting Bed Cross-Section

Revised June 2016

WASHINGTON STATE
DEPARTMENT OF
ECOLOGY

March 2022

GENERAL USE LEVEL DESIGNATION FOR BASIC (TSS), DISSOLVED METALS (ENHANCED), AND PHOSPHORUS TREATMENT

For

Oldcastle Infrastructure, Inc.'s
The BioPod™ Biofilter
(Formerly the TreePod Biofilter)

Ecology's Decision

Based on Oldcastle Infrastructure, Inc. application submissions for The BioPod™ Biofilter (BioPod), Ecology hereby issues the following use level designation:

1) General Use Level Designation (GULD) for Basic, Enhanced, and Phosphorus Treatment:
    - Sized at a hydraulic loading rate of 1.6 gallons per minute (gpm) per square foot (sq ft) of media surface area.
    - Constructed with a minimum media thickness of 18-inches (1.5-feet)
2) Ecology approves the BioPod at the hydraulic loading rate listed above, to achieve the maximum water quality design flow rate. The water quality design flow rates are calculated using the following procedures:
    - Western Washington: For treatment installed upstream of detention or retention, the water quality design flow rate is the peak 15-minute flow rate as calculated using the latest version of the Western Washington Hydrology Model or other Ecology- approved continuous runoff model.
    - Eastern Washington: For treatment installed upstream of detention or retention, the water quality design flow rate is the peak 15-minute flow rate as calculated using one of the three methods described in Chapter 2.7.6 of the Stormwater Management Manual for Eastern Washington (SWMMEW) or local manual.
    - Entire State: For treatment installed downstream of detention, the water quality design flow rate is the full 2-year release rate of the detention facility.
3) For systems that have a drain down outlet, designers must increase the water quality design flow rate calculated in Item 2, above, to account for the water that will enter the initial bay but won't be treated by the engineered soil. Multiply the flow rate determined above by 1.05

to determine the required flowrate for the BioPod unit.

4) The GULD has no expiration date, but may be amended or revoked by Ecology.

Ecology's Conditions of Use

The BioPod shall comply with these conditions:

1) Applicants shall design, assemble, install, operate, and maintain the BioPod installations in accordance with Oldcastle Infrastructure Inc.'s applicable manuals and the Ecology Decision.
2) The minimum size filter surface-area for use in Washington is determined by using the design water quality flow rate (as determined in Ecology Decision, Item 3, above) and the hydraulic loading rate (as identified in Ecology Decision, Item 1, above). Calculate the required area by dividing the water quality design flow rate (cu-ft/sec) by the hydraulic loading rate (converted to ft/sec) to obtain the required surface area (sq ft) of the BioPod unit.
3) BioPod media shall conform to the specifications submitted to and approved by Ecology.
4) The applicant tested the BioPod without plants. This GULD applies to the BioPod Stormwater Treatment System whether plants are included in the final product or not.
5) Maintenance: The required inspection/maintenance interval for stormwater treatment devices is often dependent on the efficiency of the device and the degree of pollutant loading from a particular drainage basin. Therefore, Ecology does not endorse or recommend a "one size fits all" maintenance cycle for a particular model/size of manufactured filter treatment device.
    - The BioPod is designed for a target maintenance interval of 1 year. Maintenance includes replacing the mulch, assessing plant health, removal of trash, and raking the top few inches of engineered media.
    - The BioPod system initially tested at the Lake Union Ship Canal Test Facility in Seattle, WA required maintenance after 1.5 months, or 6.3% of a water year. Monitoring personnel observed similar maintenance issues with other systems evaluated at the Test Facility. Runoff from the Test Facility may be unusual and maintenance requirements of systems installed at the Test Facility may not be indicative of typical maintenance requirements. Because of this, the initial version of the GULD required Oldcastle to subsequently "conduct hydraulic testing to obtain information about maintenance requirements on a site with runoff that is more typical of the Pacific Northwest". Quarterly testing from a 15-month maintenance frequency assessment conducted on a BioPod system installed along a roadway in Des Moines, WA indicated the system was able to treat a full water year before requiring maintenance.
    - Test results provided to Ecology from a BioPod System evaluated in a lab following New Jersey Department of Environmental Protection Laboratory Protocol for Filtration MTDs have indicated the BioPod System is capable of longer maintenance intervals.
    - Owners/operators must inspect BioPod systems for a minimum of twelve months from the start of post-construction operation to determine site-specific inspection/maintenance schedules and requirements. Owners/operators must conduct inspections monthly during the wet season, and every other month during the dry season. (According to the SWMMWW, the wet season in western Washington is October 1 to April 30. According

to the SWMMEW, the wet season in eastern Washington is October 1 to June 30.) After the first year of operation, owners/operators must conduct inspections based on the findings during the first year of inspections.

- Conduct inspections by qualified personnel, follow manufacturer's guidelines, and use methods capable of determining either a decrease in treated effluent flow rate and/or a decrease in pollutant removal ability.

6) Install the BioPod in such a manner that you bypass flows exceeding the maximum operating rate and you will not resuspend captured sediment.
7) Discharges from the BioPod shall not cause or contribute to water quality standard violations in receiving waters.

Approved Alternate Configurations

BioPod Internal Bypass

1) The BioPod Internal Bypass configuration may be combined with a Curb Inlet, Grated Inlet, and Piped-In Inlet. Water quality flows and peak flows are directed from the curb, overhead grate, or piped inlet to a contoured inlet rack. The inlet rack disperses water quality flows over the top surface of the biofiltration chamber. Excess flows are diverted over a curved bypass weir to the outlet area without passing through the treatment area. Both water quality flows and bypass flows are combined in the outlet area prior to being discharged out of the system.
2) To select a BioPod Internal Bypass unit, the designer must determine the size of the standard unit using the sizing guidance described above. Systems that have an internal bypass may use the off-line water quality design flow rate.
3) The internal bypass configuration has a maximum flow rate of 900 gallons per minute. Sites where the anticipated flow rate at the treatment device is larger than 900 gpm must use an external bypass, or size the treatment device for the on-line water quality design flow rate.

Applicant: Oldcastle Infrastructure, Inc.

Applicant's Address:
7100 Longe St, Suite 100
Stockton, CA 95206

Application Documents:

BioPod™ Stormwater Filter Maintenance Frequency Assessment, Prepared for Oldcastle Infrastructure, Inc., Prepared by Herrera Environmental Consultants, Inc. February 2022

Technical Evaluation Report TreePod™ BioFilter System Performance Certification Project, Prepared for Oldcastle, Inc., Prepared by Herrera Environmental Consultants, Inc. February 2018

Technical Memorandum: Response to Board of External Reviewers' Comments on the Technical Evaluation Report for the TreePod™ Biofilter System Performance Certification Project, Oldcastle, Inc. and Herrera Environmental Consultants, Inc., February 2018

Technical Memorandum: Response to Board of External Reviewers' Comments on the Technical Evaluation Report for the TreePod™ Biofilter System Performance Certification Project, Oldcastle, Inc. and Herrera Environmental Consultants, Inc., January 2018

Application for Pilot Use Level Designation, TreePod™ Biofilter – Stormwater Treatment System, Oldcastle Stormwater Solutions, May 2016

Emerging Stormwater Treatment Technologies Application for Certification: The TreePod™ Biofilter, Oldcastle Stormwater Solutions, April 2016

Applicant's Use Level Request:

- General Use Level Designation as a Basic, Enhanced, and Phosphorus Treatment device in accordance with Ecology's *Stormwater Management Manual for Western Washington*

Applicant's Performance Claims:

Based on results from laboratory and field-testing, the applicant claims the BioPod™ Biofilter operating at a hydraulic loading rate of 153 inches per hour is able to remove:

- 80% of Total Suspended Solids (TSS) for influent concentrations greater than 100 mg/L and achieve a 20 mg/L effluent for influent concentrations less than 100 mg/L.
- 60% dissolved zinc for influent concentrations 0.02 to 0.3 mg/L.
- 30% dissolved copper for influent concentrations 0.005 to 0.02 mg/L.
- 50% or greater total phosphorus for influent concentrations 0.1 to 0.5 mg/L.

Ecology's Recommendations:

Ecology finds that:

- Oldcastle Infrastructure, Inc. has shown Ecology, through laboratory and field testing, that the BioPod™ Biofilter is capable of attaining Ecology's Basic, Total Phosphorus, and Enhanced treatment goals.

Findings of Fact:

Field Testing

- Herrera Environmental Consultants, Inc. conducted monitoring of the BioPod™ Biofilter at the Lake Union Ship Canal Test Facility in Seattle Washington between November 2016 and April 2018. Herrera collected flow-weight composite samples during 14 separate storm events and peak flow grab samples during 3 separate storm events. The system was sized at an infiltration rate of 153 inches per hour or a hydraulic loading rate of 1.6 gpm/ft^2.

  - The D_{50} of the influent PSD ranged from 3 to 292 microns, with an average D_{50} of 28 microns.
  - Influent TSS concentrations ranged from 17 mg/L to 666 mg/L, with a mean concentration of 98 mg/L. For all samples (influent concentrations above and below 100 mg/L) the bootstrap estimate of the lower 95 percent confidence limit (LCL 95) of the mean TSS reduction was 84% and the bootstrap estimate of the upper 95 percent confidence limit (UCL95) of the mean TSS effluent concentration was 8.2 mg/L.
  - Dissolved copper influent concentrations from the 17 events ranged from 9.0 µg/L to 21.1 µg/L. The 21.1 µg/L data point was reduced to 20.0 µg/L, the upper limit to the TAPE allowed influent concentration range, prior to calculating the pollutant removal. A bootstrap estimate of the LCL95 of the mean dissolved copper reduction was 35%.
  - Dissolved zinc influent concentrations from the 17 events ranged from 26.1 µg/L to 43.3 µg/L. A bootstrap estimate of the LCL95 of the mean dissolved zinc reduction was 71%.
  - Total phosphorus influent concentrations from the 17 events ranged from 0.064 mg/L to 1.56 mg/L. All influent data greater than 0.5 mg/L were reduced to 0.5 mg/L, the upper limit to the TAPE allowed influent concentration range, prior to calculating the pollutant removal. A bootstrap estimate of the LCL95 of the mean total phosphorus reduction was 64%.
  - The system experienced rapid sediment loading and needed to be maintained after 1.5 months. Monitoring personnel observed similar sediment loading issues with other systems evaluated at the Test Facility. The runoff from the Test Facility may not be indicative of maintenance requirements for all sites.
- Herrera Environmental Consultants, Inc. conducted a maintenance frequency assessment of the BioPod™ installed along a roadway in Des Moines, WA between September 2020 and January 2022.
  - Herrera collected influent grab samples during 10 storm events and paired effluent samples during 5 storm events. Influent concentrations ranged from 1 mg/L to 164 mg/L, with a median concentration of 23 mg/L. Effluent concentrations ranged from 1 mg/L to 19 mg/L, with a median of 5 mg/L.
  - Herrera collected influent PSD samples during 3 storm events. The D_{50} for the samples were 42, 1306, and 57 microns. The 1306 micron value was collected during an event with an influent TSS concentration of 1 mg/L. It is assumed this sample was atypical and that it contained a few grains of very coarse sand and almost no other particles.
  - Herrera used a water truck to conduct flow testing 7 times to assess how long the system could filter at the design flow rate without bypass. Results show the system was able to treat up to a full water year before the system needed maintenance.

Laboratory Testing

- Good Harbour Laboratories (GHL) conducted laboratory testing at their site in Mississauga, Ontario in October 2017 following the New Jersey Department of Environmental Protection Laboratory Protocol for Filtration MTDs. The testing evaluated a 4-foot by 6-foot standard biofiltration chamber and inlet contour rack with bypass weir. The test sediment used during the testing was custom blended by GHL using various commercially available silica sands, which had an average d_{50} of 69 µm. Based on the lab test results:

  - GHL evaluated removal efficiency over 15 events at a Maximum Treatment Flow Rate (MTFR) of 37.6 gpm, which corresponds to a MTFR to effective filtration treatment area ratio of 1.80 gpm/ft^2. The system, operating at 100% of the MTFR with an average influent concentration of 201.3 mg/L, had an average removal efficiency of 99 percent.
  - GHL evaluated sediment mass loading capacity over an additional 16 events using an influent SSC concentration of 400 mg/L. The first 11 runs were evaluated at 100% of the MTFR. The BioPod began to bypass, so the remaining 5 runs were evaluated at 90% of the MTFR. The total mass of the sediment captured was 245.0 lbs and the cumulative mass removal efficiency was 96.3%.
- Herrera Environmental Consultants Inc. conducted laboratory testing in September 2014 at the Seattle University Engineering Laboratory. The testing evaluated the flushing characteristics, hydraulic conductivity, and pollutant removal ability of twelve different media blends. Based on this testing, Oldcastle Infrastructure, Inc. selected one media blend, Mix 8, for inclusion in their TAPE evaluation of the BioPod™ Biofilter.
  - Herrera evaluated Mix 8 in an 8-inch diameter by 36-inch tall polyvinyl chloride (PVC) column. The column contained 18-inches of Mix 8 on top of 6-inches of pea gravel. The BioPod will normally include a 3-inch mulch layer on top of the media layer; however, this was not included in the laboratory testing.
  - Mix 8 has a hydraulic conductivity of 218 inches per hour; however, evaluation of the pollutant removal ability of the media was based on an infiltration rate of 115 inches per hour. The media was tested at 75%, 100%, and 125% of the infiltration rate. Based on the lab test results:
    - The system was evaluated using natural stormwater. The dissolved copper and dissolved zinc concentrations in the natural stormwater were lower than the TAPE influent standards; therefore, the stormwater was spiked with 66.4 mL of 100 mg/L Cu solution and 113.6 mL of 1,000 mg/L Zn solution.
    - The BioPod removed an average of 81% of TSS, with a mean influent concentration of 48.4 mg/L and a mean effluent concentration of 9.8 mg/L.
    - The BioPod removed an average of 94% of dissolved copper, with a mean influent concentration of 10.6 µg/L and a mean effluent concentration of 0.6 µg/L.
    - The BioPod removed an average of 97% of dissolved zinc, with a mean influent concentration of 117 µg/L and a mean effluent concentration of 4 µg/L.
    - The BioPod removed an average of 97% of total phosphorus, with a mean influent concentration of 2.52 mg/L and a mean effluent concentration of 0.066 mg/L. When total phosphorus influent concentrations were capped at the TAPE upper limit of 0.5 mg/L, calculations showed an average removal of 87%.

Other BioPod Related Issues to be Addressed by the Company:

1. None identified at this time.

Technology Description: Download at https://oldcastleprecast.com/stormwater/bioretention-biofiltration-applications/bioretention-biofiltration-solutions/

Contact Information:

Applicant:
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Applicant website: https://oldcastleprecast.com/stormwater/

Ecology web link: https://ecology.wa.gov/Regulations-Permits/Guidance-technical-assistance/Stormwater-permittee-guidance-resources/Emerging-stormwater-treatment-technologies

Ecology:
Douglas C. Howie, P.E.
Department of Ecology
Water Quality Program
(360) 870-0983
douglas.howie@ecy.wa.gov

Revision History

Date	**Revision**
March 2018	GULD granted for Basic Treatment
March 2018	Provisional GULD granted for Enhanced and Phosphorus Treatment
June 2016	PULD Granted
April 2018	GULD for Basic and Provisional GULD for Enhanced and Phosphorus granted, changed name to BioPod from TreePod
July 2018	GULD for Enhanced and Phosphorus granted
September 2018	Changed Address for Oldcastle
December 2018	Added minimum media thickness requirement
May 2019	Changed language on who must Install and maintain the device from Oldcastle to Applicants
August 2019	Added text on sizing using infiltration rate and water quality design flow rate
October 2019	Added text describing ability to use off-line design water quality flow rate for sizing due to internal bypass
December 2021	Extended approval to installations without plants, added sizing adjustment when using facilities with a drawdown outlet
March 2022	Added results from the maintenance frequency assessment to the Ecology's Conditions of Use and the Findings of Fact sections

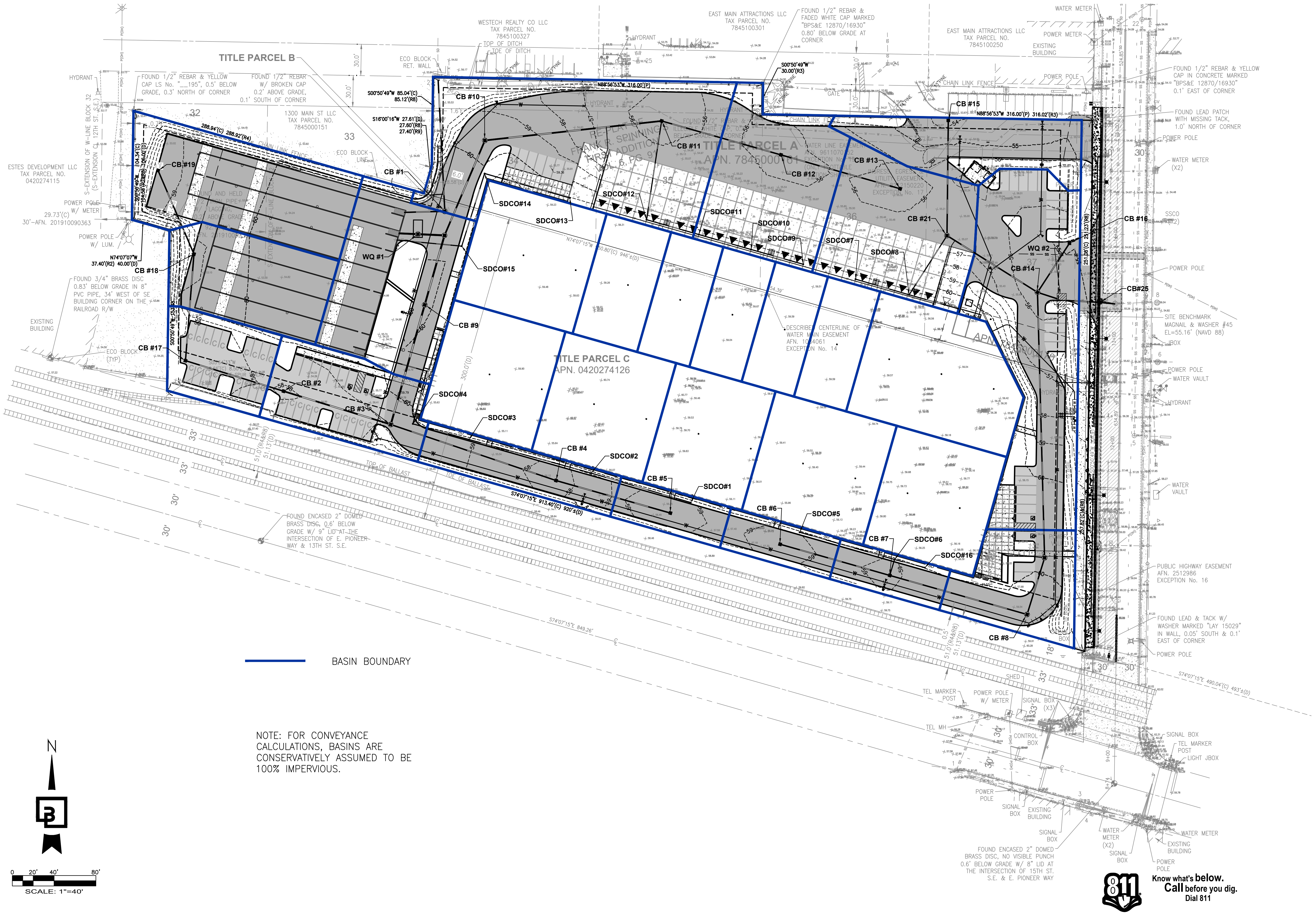
Tab 5.0

5.0 CONVEYANCE SYSTEM ANALYSIS AND DESIGN

The conveyance system for this project consists of a series of catch basins and storm drainage conveyance pipes. Pipe sizing calculations are included in Figure 10. The 25-year and 100-year storm events are analyzed.

Figure 10
Conveyance Calculations

CONVEYANCE BASIN MAP EXHIBIT



BASIN BOUNDARY

NOTE: FOR CONVEYANCE
CALCULATIONS, BASINS ARE
CONSERVATIVELY ASSUMED TO BE
100% IMPERVIOUS.

Know what's **below.**
Call before you dig.
Dial 811

No.	Date	By	Ckd.	Appr.	Revision

Title:
CONVEYANCE BASIN MAP
EXHIBIT

FORTRESS - PUYALLUP

For:
CREF3 PUYALLUP OWNER LLC
11611 SAN VICENTE BLVD
10TH FLOOR
LOS ANGELES, CA 90049

Designed VMS
Drawn VMS
Checked KEH
Approved KEH
Date 10/04/22

Scale:
Horizontal 1"=40'
Vertical N/A

Barghausen
Consulting Engineers, Inc.
18215 72nd Avenue South
Kent, WA 98032
425.251.6222 **barghausen.com**

Job Number
22085

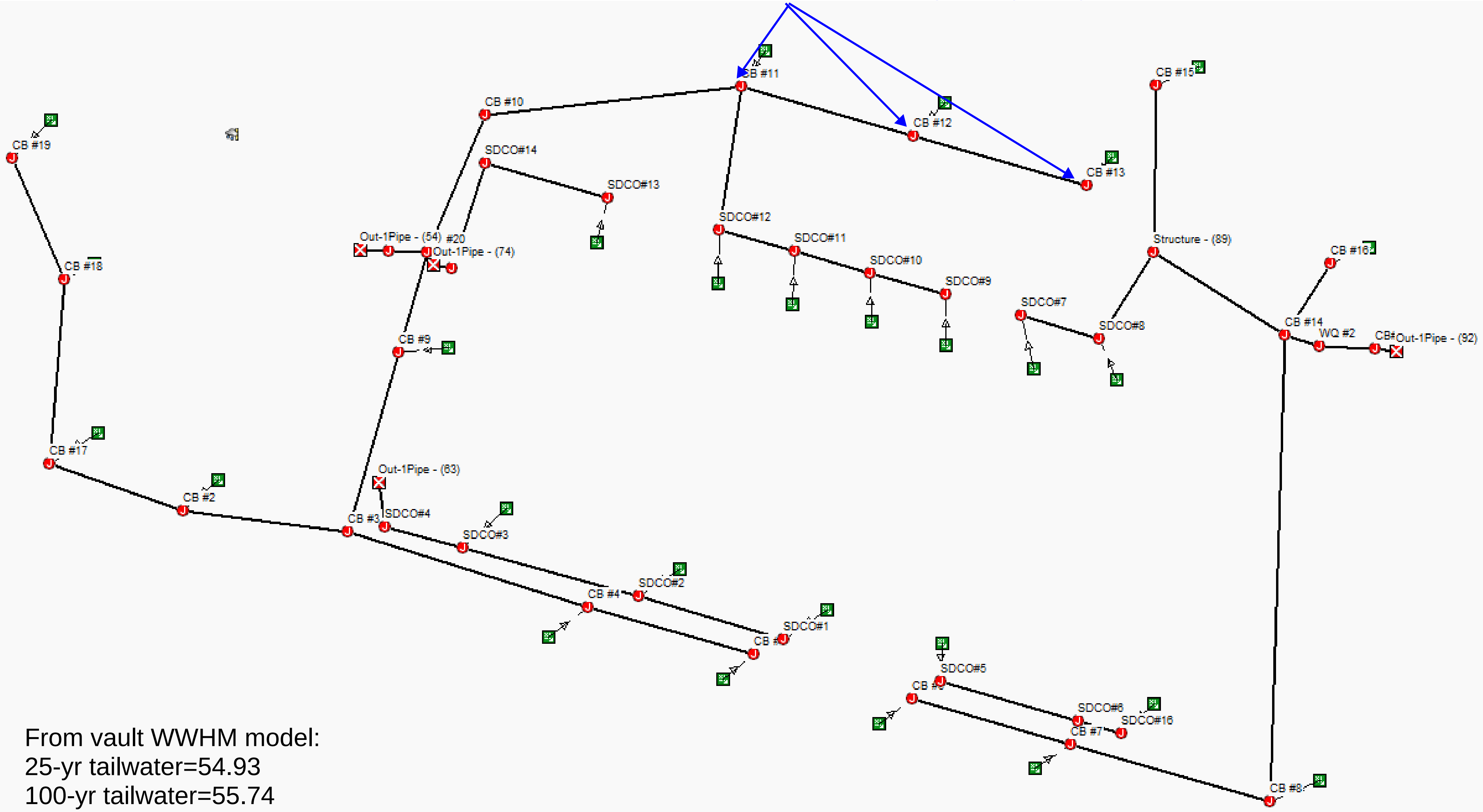
Sheet

of

P:\22000s\22085\exhibit\conveyance map.dwg 11/6/2023 4:09 PM VSCHLONGA

Conveyance Model Diagram

0.5' of flooding during 100-year event as a result of backwater effects



From vault WWHM model:
25-yr tailwater=54.93
100-yr tailwater=55.74

25-yr storm event

```
Autodesk® Storm and Sanitary Analysis 2016 - Version 12.0.42 (Build 0)
-----------------------------------------------------------------------------------------

*******************
Project Description
*******************
File Name ................ 22085-conveyance25.SPF


****************
Analysis Options
****************
Flow Units ............... cfs
Subbasin Hydrograph Method. Santa Barbara UH
Time of Concentration...... SCS TR-55
Link Routing Method ....... Hydrodynamic
Storage Node Exfiltration.. None
Starting Date ............. NOV-06-2023 00:00:00
Ending Date ............... NOV-07-2023 00:00:00
Report Time Step .......... 00:00:10


*************
Element Count
*************
Number of rain gages ...... 1
Number of subbasins ....... 27
Number of nodes ........... 43
Number of links ........... 39


****************
Raingage Summary
****************
Gage                Data                Data       Recording
ID                  Source              Type        Interval
                                                             min
------------------------------------------------------------
Rain Gage-01        25-yr               CUMULATIVE      6.00


****************
Subbasin Summary
****************
Subbasin                 Total   Imperv.    Raingage
                          Area      Area
ID                       acres         %
----------------------------------------------------
Sub-CB #11                0.80    100.00    Rain Gage-01
Sub-CB #12                0.39    100.00    Rain Gage-01
Sub-CB #13                0.41    100.00    Rain Gage-01
Sub-CB #15                0.26    100.00    Rain Gage-01
Sub-CB #16                0.65    100.00    Rain Gage-01
Sub-CB #17                0.19    100.00    Rain Gage-01
Sub-CB #18                0.30    100.00    Rain Gage-01
Sub-CB #19                0.44    100.00    Rain Gage-01
Sub-CB #2                 0.28    100.00    Rain Gage-01
Sub-CB #4                 0.18    100.00    Rain Gage-01
Sub-CB #5                 0.10    100.00    Rain Gage-01
Sub-CB #6                 0.10    100.00    Rain Gage-01
Sub-CB #7                 0.10    100.00    Rain Gage-01
Sub-CB #8                 0.24    100.00    Rain Gage-01
Sub-CB #9                 0.44    100.00    Rain Gage-01
Sub-SDCO#1                0.27    100.00    Rain Gage-01
Sub-SDCO#10               0.14    100.00    Rain Gage-01
Sub-SDCO#11               0.14    100.00    Rain Gage-01
```

```
Sub-SDCO#12               0.18    100.00    Rain Gage-01
Sub-SDCO#13               0.32    100.00    Rain Gage-01
Sub-SDCO#16               0.30    100.00    Rain Gage-01
Sub-SDCO#2                0.30    100.00    Rain Gage-01
Sub-SDCO#3                0.30    100.00    Rain Gage-01
Sub-SDCO#5                0.33    100.00    Rain Gage-01
Sub-SDCO#7                0.14    100.00    Rain Gage-01
Sub-SDCO#8                0.40    100.00    Rain Gage-01
Sub-SDCO#9                0.14    100.00    Rain Gage-01


************
Node Summary
************
Node                Element             Invert   Maximum    Ponded    External
ID                  Type             Elevation     Elev.      Area      Inflow
                                            ft        ft       ft²
------------------------------------------------------------------------------
CB #10              JUNCTION             51.32     59.79      0.00
CB #11              JUNCTION             52.17     55.50   3344.00
CB #12              JUNCTION             52.76     55.50   3960.00
CB #13              JUNCTION             53.35     55.50   3580.00
CB #14              JUNCTION             49.54     55.50      0.00
CB #15              JUNCTION             50.60     53.60      0.00
CB #16              JUNCTION             51.63     54.64      0.00
CB #17              JUNCTION             53.95     56.86      0.00
CB #18              JUNCTION             54.56     58.62      0.00
CB #19              JUNCTION             55.00     58.22      0.00
CB #2               JUNCTION             53.48     57.22      0.00
CB #20              JUNCTION             50.83     60.35      0.00
CB #3               JUNCTION             51.80     59.17      0.00
CB #4               JUNCTION             53.93     57.50      0.00
CB #5               JUNCTION             54.50     58.50      0.00
CB #6               JUNCTION             54.50     58.50      0.00
CB #7               JUNCTION             53.95     58.73      0.00
CB #8               JUNCTION             53.27     59.00      0.00
CB #9               JUNCTION             51.18     59.40      0.00
CB#25               JUNCTION             48.74     54.64      0.00
SDCO#1              JUNCTION             57.00     59.34      0.00
SDCO#10             JUNCTION             55.14     57.05      0.00
SDCO#11             JUNCTION             54.62     57.05      0.00
SDCO#12             JUNCTION             54.10     57.05      0.00
SDCO#13             JUNCTION             58.50     60.85      0.00
SDCO#14             JUNCTION             57.65     60.39      0.00
SDCO#15             JUNCTION             56.90     60.75      0.00
SDCO#16             JUNCTION             57.10     60.10      0.00
SDCO#2              JUNCTION             56.01     59.40      0.00
SDCO#3              JUNCTION             54.80     59.49      0.00
SDCO#4              JUNCTION             54.27     59.61      0.00
SDCO#5              JUNCTION             58.80     59.69      0.00
SDCO#6              JUNCTION             57.60     59.58      0.00
SDCO#7              JUNCTION             55.78     57.05      0.00
SDCO#8              JUNCTION             55.26     57.06      0.00
SDCO#9              JUNCTION             55.66     57.05      0.00
Structure - (89)    JUNCTION             50.05     56.48      0.00
WQ #1               JUNCTION             50.20     60.39      0.00
WQ #2               JUNCTION             48.92     55.43      0.00
Out-1Pipe - (54)    OUTFALL              50.20     51.70      0.00
Out-1Pipe - (63)    OUTFALL              50.20     53.17      0.00
Out-1Pipe - (74)    OUTFALL              50.20     56.67      0.00
Out-1Pipe - (92)    OUTFALL              49.00     50.00      0.00


************
Link Summary
************
Link            From Node       To Node         Element         Length     Slope   Manning's
```

```
  ID                                              Type                ft         %   Roughness
  -------------------------------------------------------------------------------------------
  Pipe - (42)     CB #13          CB #12          CONDUIT          118.7    0.4970      0.0140
  Pipe - (43)     CB #12          CB #11          CONDUIT          118.7    0.4970      0.0140
  Pipe - (44)     CB #11          CB #10          CONDUIT          170.2    0.4994      0.0120
  Pipe - (45)     CB #10          CB #20          CONDUIT           98.8    0.4957      0.0120
  Pipe - (46)     CB #3           CB #9           CONDUIT          123.5    0.5000      0.0140
  Pipe - (47)     CB #7           CB #8           CONDUIT          136.7    0.4976      0.0120
  Pipe - (48)     CB #6           CB #7           CONDUIT          109.2    0.5000      0.0120
  Pipe - (49)     SDCO#1          SDCO#2          CONDUIT           99.5    0.9954      0.0140
  Pipe - (50)     CB #5           CB #4           CONDUIT          113.8    0.5000      0.0140
  Pipe - (51)     CB #4           CB #3           CONDUIT          166.9    1.2762      0.0140
  Pipe - (52)     CB #2           CB #3           CONDUIT          109.1    1.5393      0.0140
  Pipe - (53) (1) CB #9           CB #20          CONDUIT           69.2    0.5000      0.0120
  Pipe - (54)     WQ #1           Out-1Pipe - (54)CONDUIT           18.4    2.7160      0.0120
  Pipe - (58)     CB #15          Structure - (89)CONDUIT          110.4    0.4980      0.0120
  Pipe - (58) (1) Structure - (89)CB #14          CONDUIT          102.3    0.4986      0.0120
  Pipe - (59)     CB #14          WQ #2           CONDUIT           24.3    0.5000      0.0120
  Pipe - (59) (1) WQ #2           CB#25           CONDUIT           36.3    0.4959      0.0120
  Pipe - (59) (2) CB #16          CB #14          CONDUIT           56.1    0.4989      0.0120
  Pipe - (60)     CB #8           CB #14          CONDUIT          308.8    0.5000      0.0120
  Pipe - (61)     SDCO#2          SDCO#3          CONDUIT          121.2    0.9983      0.0140
  Pipe - (62)     SDCO#3          SDCO#4          CONDUIT           52.8    1.0000      0.0140
  Pipe - (63)     SDCO#4          Out-1Pipe - (63)CONDUIT           84.0    2.1083      0.0140
  Pipe - (64)     SDCO#5          SDCO#6          CONDUIT           94.5    1.2700      0.0140
  Pipe - (65)     SDCO#6          CB #7           CONDUIT           15.9   20.8706      0.0140
  Pipe - (66)     SDCO#7          SDCO#8          CONDUIT           53.5    0.9723      0.0140
  Pipe - (67)     SDCO#8          Structure - (89)CONDUIT           67.3    7.2452      0.0140
  Pipe - (68)     SDCO#9          SDCO#10         CONDUIT           51.9    1.0013      0.0140
  Pipe - (69)     SDCO#10         SDCO#11         CONDUIT           52.0    0.9992      0.0140
  Pipe - (70)     SDCO#11         SDCO#12         CONDUIT           52.0    1.0000      0.0140
  Pipe - (71)     SDCO#12         CB #11          CONDUIT           95.7    2.0167      0.0140
  Pipe - (72)     SDCO#13         SDCO#14         CONDUIT           84.9    1.0000      0.0140
  Pipe - (73)     SDCO#14         SDCO#15         CONDUIT           73.0    1.0277      0.0140
  Pipe - (74)     SDCO#15         Out-1Pipe - (74)CONDUIT           62.6    1.4380      0.0140
  Pipe - (75)     CB #17          CB #2           CONDUIT           94.1    0.4992      0.0140
  Pipe - (76)     CB #18          CB #17          CONDUIT          122.1    0.4994      0.0140
  Pipe - (77)     CB #19          CB #18          CONDUIT           87.2    0.5000      0.0140
  Pipe - (90)     CB #20          WQ #1           CONDUIT           25.4    0.5003      0.0140
  Pipe - (91)     SDCO#6          SDCO#16         CONDUIT           30.0    1.6665      0.0140
  Pipe - (92)     Out-1Pipe - (92)CB#25           CONDUIT           14.4    1.8083      0.0130


  *********************
  Cross Section Summary
  *********************
  Link             Shape              Depth/         Width         No. of         Cross     Full Flow
Design
  ID                                Diameter                      Barrels    Sectional     Hydraulic
Flow
                                                                                  Area        Radius
Capacity
                                          ft            ft                         ft²            ft
cfs

-----------------------------------------------------------------------------------------------
---------
  Pipe - (42)       CIRCULAR            1.00          1.00              1          0.79          0.25
2.33
  Pipe - (43)       CIRCULAR            1.00          1.00              1          0.79          0.25
2.33
  Pipe - (44)       CIRCULAR            1.25          1.25              1          1.23          0.31
4.95
  Pipe - (45)       CIRCULAR            1.25          1.25              1          1.23          0.31
4.93
  Pipe - (46)       CIRCULAR            1.50          1.50              1          1.77          0.38
6.90
```

```
  Pipe - (47)      CIRCULAR          1.00        1.00          1         0.79        0.25
2.72
  Pipe - (48)      CIRCULAR          1.00        1.00          1         0.79        0.25
2.73
  Pipe - (49)      CIRCULAR          0.67        0.67          1         0.35        0.17
1.12
  Pipe - (50)      CIRCULAR          1.00        1.00          1         0.79        0.25
2.34
  Pipe - (51)      CIRCULAR          1.00        1.00          1         0.79        0.25
3.74
  Pipe - (52)      CIRCULAR          1.25        1.25          1         1.23        0.31
7.44
  Pipe - (53) (1)  CIRCULAR          1.50        1.50          1         1.77        0.38
8.05
  Pipe - (54)      CIRCULAR          1.50        1.50          1         1.77        0.38
18.75
  Pipe - (58)      CIRCULAR          1.00        1.00          1         0.79        0.25
2.72
  Pipe - (58) (1)  CIRCULAR          1.00        1.00          1         0.79        0.25
2.73
  Pipe - (59)      CIRCULAR          1.00        1.00          1         0.79        0.25
2.73
  Pipe - (59) (1)  CIRCULAR          1.00        1.00          1         0.79        0.25
2.72
  Pipe - (59) (2)  CIRCULAR          1.00        1.00          1         0.79        0.25
2.73
  Pipe - (60)      CIRCULAR          1.00        1.00          1         0.79        0.25
2.73
  Pipe - (61)      CIRCULAR          0.67        0.67          1         0.35        0.17
1.12
  Pipe - (62)      CIRCULAR          0.67        0.67          1         0.35        0.17
1.12
  Pipe - (63)      CIRCULAR          0.67        0.67          1         0.35        0.17
1.63
  Pipe - (64)      CIRCULAR          0.67        0.67          1         0.35        0.17
1.26
  Pipe - (65)      CIRCULAR          0.67        0.67          1         0.35        0.17
5.13
  Pipe - (66)      CIRCULAR          0.67        0.67          1         0.35        0.17
1.11
  Pipe - (67)      CIRCULAR          0.67        0.67          1         0.35        0.17
3.02
  Pipe - (68)      CIRCULAR          0.67        0.67          1         0.35        0.17
1.12
  Pipe - (69)      CIRCULAR          0.67        0.67          1         0.35        0.17
1.12
  Pipe - (70)      CIRCULAR          0.67        0.67          1         0.35        0.17
1.12
  Pipe - (71)      CIRCULAR          0.67        0.67          1         0.35        0.17
1.59
  Pipe - (72)      CIRCULAR          0.67        0.67          1         0.35        0.17
1.12
  Pipe - (73)      CIRCULAR          0.67        0.67          1         0.35        0.17
1.14
  Pipe - (74)      CIRCULAR          0.67        0.67          1         0.35        0.17
1.35
  Pipe - (75)      CIRCULAR          1.00        1.00          1         0.79        0.25
2.34
  Pipe - (76)      CIRCULAR          1.00        1.00          1         0.79        0.25
2.34
  Pipe - (77)      CIRCULAR          1.00        1.00          1         0.79        0.25
2.34
  Pipe - (90)      CIRCULAR          1.50        1.50          1         1.77        0.38
6.90
  Pipe - (91)      CIRCULAR          0.67        0.67          1         0.35        0.17
1.45
  Pipe - (92)      CIRCULAR          1.00        1.00          1         0.79        0.25
```

```
4.79


  *************************        Volume         Depth
  Runoff Quantity Continuity      acre-ft        inches
  *************************     ---------       -------
  Total Precipitation ......        2.248         3.444
  Surface Runoff ...........        2.094         3.208
  Continuity Error (%) .....        0.000


  *************************        Volume        Volume
  Flow Routing Continuity         acre-ft      Mgallons
  *************************     ---------     ---------
  External Inflow ..........        0.003         0.001
  External Outflow .........        2.093         0.682
  Initial Stored Volume ....        0.035         0.011
  Final Stored Volume ......        0.037         0.012
  Continuity Error (%) .....        0.000


  ******************************************
  Composite Curve Number Computations Report
  ******************************************

  ----------------------
  Subbasin Sub-CB #11
  ----------------------
                                                          Area          Soil
  Soil/Surface Description                              (acres)         Group            CN
  ---------------------------------------------------------------------------------------
  Composite Area & Weighted CN                             0.80                       98.00

  ----------------------
  Subbasin Sub-CB #12
  ----------------------
                                                          Area          Soil
  Soil/Surface Description                              (acres)         Group            CN
  ---------------------------------------------------------------------------------------
  Composite Area & Weighted CN                             0.39                       98.00

  ----------------------
  Subbasin Sub-CB #13
  ----------------------
                                                          Area          Soil
  Soil/Surface Description                              (acres)         Group            CN
  ---------------------------------------------------------------------------------------
  Composite Area & Weighted CN                             0.41                       98.00

  ----------------------
  Subbasin Sub-CB #15
  ----------------------
                                                          Area          Soil
  Soil/Surface Description                              (acres)         Group            CN
  ---------------------------------------------------------------------------------------
  Composite Area & Weighted CN                             0.26                       98.00

  ----------------------
  Subbasin Sub-CB #16
  ----------------------
                                                          Area          Soil
  Soil/Surface Description                              (acres)         Group            CN
  ---------------------------------------------------------------------------------------
  Composite Area & Weighted CN                             0.65                       98.00

  ----------------------
  Subbasin Sub-CB #17
```

```
----------------------
                                                         Area           Soil
Soil/Surface Description                               (acres)         Group          CN
----------------------------------------------------------------------------------------
Composite Area & Weighted CN                              0.19                     98.00

----------------------
Subbasin Sub-CB #18
----------------------
                                                         Area           Soil
Soil/Surface Description                               (acres)         Group          CN
----------------------------------------------------------------------------------------
Composite Area & Weighted CN                              0.30                     98.00

----------------------
Subbasin Sub-CB #19
----------------------
                                                         Area           Soil
Soil/Surface Description                               (acres)         Group          CN
----------------------------------------------------------------------------------------
Composite Area & Weighted CN                              0.44                     98.00

---------------------
Subbasin Sub-CB #2
---------------------
                                                         Area           Soil
Soil/Surface Description                               (acres)         Group          CN
----------------------------------------------------------------------------------------
Composite Area & Weighted CN                              0.28                     98.00

---------------------
Subbasin Sub-CB #4
---------------------
                                                         Area           Soil
Soil/Surface Description                               (acres)         Group          CN
----------------------------------------------------------------------------------------
Composite Area & Weighted CN                              0.18                     98.00

---------------------
Subbasin Sub-CB #5
---------------------
                                                         Area           Soil
Soil/Surface Description                               (acres)         Group          CN
----------------------------------------------------------------------------------------
Composite Area & Weighted CN                              0.10                     98.00

---------------------
Subbasin Sub-CB #6
---------------------
                                                         Area           Soil
Soil/Surface Description                               (acres)         Group          CN
----------------------------------------------------------------------------------------
Composite Area & Weighted CN                              0.10                     98.00

---------------------
Subbasin Sub-CB #7
---------------------
                                                         Area           Soil
Soil/Surface Description                               (acres)         Group          CN
----------------------------------------------------------------------------------------
Composite Area & Weighted CN                              0.10                     98.00

---------------------
Subbasin Sub-CB #8
---------------------
                                                         Area           Soil
Soil/Surface Description                               (acres)         Group          CN
```

```
----------------------------------------------------------------------------------------
Composite Area & Weighted CN                              0.24                     98.00

---------------------
Subbasin Sub-CB #9
---------------------
                                                         Area           Soil
Soil/Surface Description                               (acres)         Group          CN
----------------------------------------------------------------------------------------
Composite Area & Weighted CN                              0.44                     98.00

----------------------
Subbasin Sub-SDCO#1
----------------------
                                                         Area           Soil
Soil/Surface Description                               (acres)         Group          CN
----------------------------------------------------------------------------------------
Composite Area & Weighted CN                              0.27                     98.00

-----------------------
Subbasin Sub-SDCO#10
-----------------------
                                                         Area           Soil
Soil/Surface Description                               (acres)         Group          CN
----------------------------------------------------------------------------------------
Composite Area & Weighted CN                              0.14                     98.00

-----------------------
Subbasin Sub-SDCO#11
-----------------------
                                                         Area           Soil
Soil/Surface Description                               (acres)         Group          CN
----------------------------------------------------------------------------------------
Composite Area & Weighted CN                              0.14                     98.00

-----------------------
Subbasin Sub-SDCO#12
-----------------------
                                                         Area           Soil
Soil/Surface Description                               (acres)         Group          CN
----------------------------------------------------------------------------------------
Composite Area & Weighted CN                              0.18                     98.00

-----------------------
Subbasin Sub-SDCO#13
-----------------------
                                                         Area           Soil
Soil/Surface Description                               (acres)         Group          CN
----------------------------------------------------------------------------------------
Composite Area & Weighted CN                              0.32                     98.00

-----------------------
Subbasin Sub-SDCO#16
-----------------------
                                                         Area           Soil
Soil/Surface Description                               (acres)         Group          CN
----------------------------------------------------------------------------------------
Composite Area & Weighted CN                              0.30                     98.00

----------------------
Subbasin Sub-SDCO#2
----------------------
                                                         Area           Soil
Soil/Surface Description                               (acres)         Group          CN
----------------------------------------------------------------------------------------
Composite Area & Weighted CN                              0.30                     98.00
```

```
----------------------
Subbasin Sub-SDCO#3
----------------------
                                                         Area           Soil
Soil/Surface Description                               (acres)         Group          CN
----------------------------------------------------------------------------------------
Composite Area & Weighted CN                              0.30                     98.00

----------------------
Subbasin Sub-SDCO#5
----------------------
                                                         Area           Soil
Soil/Surface Description                               (acres)         Group          CN
----------------------------------------------------------------------------------------
Composite Area & Weighted CN                              0.33                     98.00

----------------------
Subbasin Sub-SDCO#7
----------------------
                                                         Area           Soil
Soil/Surface Description                               (acres)         Group          CN
----------------------------------------------------------------------------------------
Composite Area & Weighted CN                              0.14                     98.00

----------------------
Subbasin Sub-SDCO#8
----------------------
                                                         Area           Soil
Soil/Surface Description                               (acres)         Group          CN
----------------------------------------------------------------------------------------
Composite Area & Weighted CN                              0.40                     98.00

----------------------
Subbasin Sub-SDCO#9
----------------------
                                                         Area           Soil
Soil/Surface Description                               (acres)         Group          CN
----------------------------------------------------------------------------------------
Composite Area & Weighted CN                              0.14                     98.00

**************************************
Runoff Coefficient Computations Report
**************************************

----------------------
Subbasin Sub-CB #11
----------------------
                                                          Area          Soil       Runoff
Soil/Surface Description                                (acres)        Group       Coeff.
-----------------------------------------------------------------------------------------
-                                                          0.80            -         0.50
Composite Area & Weighted Runoff Coeff.                    0.80                      0.50

----------------------
Subbasin Sub-CB #12
----------------------
                                                          Area          Soil       Runoff
Soil/Surface Description                                (acres)        Group       Coeff.
-----------------------------------------------------------------------------------------
-                                                          0.39            -         0.50
Composite Area & Weighted Runoff Coeff.                    0.39                      0.50

----------------------
Subbasin Sub-CB #13
----------------------
                                                          Area          Soil       Runoff
Soil/Surface Description                                (acres)        Group       Coeff.
```

```
-----------------------------------------------------------------------------------------
-                                                          0.41            -         0.50
Composite Area & Weighted Runoff Coeff.                    0.41                      0.50

----------------------
Subbasin Sub-CB #15
----------------------
                                                          Area          Soil       Runoff
Soil/Surface Description                                (acres)        Group       Coeff.
-----------------------------------------------------------------------------------------
-                                                          0.26            -         0.50
Composite Area & Weighted Runoff Coeff.                    0.26                      0.50

----------------------
Subbasin Sub-CB #16
----------------------
                                                          Area          Soil       Runoff
Soil/Surface Description                                (acres)        Group       Coeff.
-----------------------------------------------------------------------------------------
-                                                          0.65            -         0.50
Composite Area & Weighted Runoff Coeff.                    0.65                      0.50

----------------------
Subbasin Sub-CB #17
----------------------
                                                          Area          Soil       Runoff
Soil/Surface Description                                (acres)        Group       Coeff.
-----------------------------------------------------------------------------------------
-                                                          0.19            -         0.50
Composite Area & Weighted Runoff Coeff.                    0.19                      0.50

----------------------
Subbasin Sub-CB #18
----------------------
                                                          Area          Soil       Runoff
Soil/Surface Description                                (acres)        Group       Coeff.
-----------------------------------------------------------------------------------------
-                                                          0.30            -         0.50
Composite Area & Weighted Runoff Coeff.                    0.30                      0.50

----------------------
Subbasin Sub-CB #19
----------------------
                                                          Area          Soil       Runoff
Soil/Surface Description                                (acres)        Group       Coeff.
-----------------------------------------------------------------------------------------
-                                                          0.44            -         0.50
Composite Area & Weighted Runoff Coeff.                    0.44                      0.50

---------------------
Subbasin Sub-CB #2
---------------------
                                                          Area          Soil       Runoff
Soil/Surface Description                                (acres)        Group       Coeff.
-----------------------------------------------------------------------------------------
-                                                          0.28            -         0.50
Composite Area & Weighted Runoff Coeff.                    0.28                      0.50

---------------------
Subbasin Sub-CB #4
---------------------
                                                          Area          Soil       Runoff
Soil/Surface Description                                (acres)        Group       Coeff.
-----------------------------------------------------------------------------------------
-                                                          0.18            -         0.50
Composite Area & Weighted Runoff Coeff.                    0.18                      0.50
```

```
---------------------
Subbasin Sub-CB #5
---------------------
                                                          Area          Soil       Runoff
Soil/Surface Description                                (acres)        Group       Coeff.
-----------------------------------------------------------------------------------------
-                                                          0.10            -         0.50
Composite Area & Weighted Runoff Coeff.                    0.10                      0.50

---------------------
Subbasin Sub-CB #6
---------------------
                                                          Area          Soil       Runoff
Soil/Surface Description                                (acres)        Group       Coeff.
-----------------------------------------------------------------------------------------
-                                                          0.10            -         0.50
Composite Area & Weighted Runoff Coeff.                    0.10                      0.50

---------------------
Subbasin Sub-CB #7
---------------------
                                                          Area          Soil       Runoff
Soil/Surface Description                                (acres)        Group       Coeff.
-----------------------------------------------------------------------------------------
-                                                          0.10            -         0.50
Composite Area & Weighted Runoff Coeff.                    0.10                      0.50

---------------------
Subbasin Sub-CB #8
---------------------
                                                          Area          Soil       Runoff
Soil/Surface Description                                (acres)        Group       Coeff.
-----------------------------------------------------------------------------------------
-                                                          0.24            -         0.50
Composite Area & Weighted Runoff Coeff.                    0.24                      0.50

---------------------
Subbasin Sub-CB #9
---------------------
                                                          Area          Soil       Runoff
Soil/Surface Description                                (acres)        Group       Coeff.
-----------------------------------------------------------------------------------------
-                                                          0.44            -         0.50
Composite Area & Weighted Runoff Coeff.                    0.44                      0.50

----------------------
Subbasin Sub-SDCO#1
----------------------
                                                          Area          Soil       Runoff
Soil/Surface Description                                (acres)        Group       Coeff.
-----------------------------------------------------------------------------------------
-                                                          0.27            -         0.50
Composite Area & Weighted Runoff Coeff.                    0.27                      0.50

-----------------------
Subbasin Sub-SDCO#10
-----------------------
                                                          Area          Soil       Runoff
Soil/Surface Description                                (acres)        Group       Coeff.
-----------------------------------------------------------------------------------------
-                                                          0.14            -         0.50
Composite Area & Weighted Runoff Coeff.                    0.14                      0.50

-----------------------
Subbasin Sub-SDCO#11
-----------------------
                                                          Area          Soil       Runoff
```

```
Soil/Surface Description                                (acres)        Group       Coeff.
-----------------------------------------------------------------------------------------
-                                                          0.14           -          0.50
Composite Area & Weighted Runoff Coeff.                    0.14                      0.50

-----------------------
Subbasin Sub-SDCO#12
-----------------------
                                                          Area          Soil       Runoff
Soil/Surface Description                                (acres)        Group       Coeff.
-----------------------------------------------------------------------------------------
-                                                          0.18           -          0.50
Composite Area & Weighted Runoff Coeff.                    0.18                      0.50

-----------------------
Subbasin Sub-SDCO#13
-----------------------
                                                          Area          Soil       Runoff
Soil/Surface Description                                (acres)        Group       Coeff.
-----------------------------------------------------------------------------------------
-                                                          0.32           -          0.50
Composite Area & Weighted Runoff Coeff.                    0.32                      0.50

-----------------------
Subbasin Sub-SDCO#16
-----------------------
                                                          Area          Soil       Runoff
Soil/Surface Description                                (acres)        Group       Coeff.
-----------------------------------------------------------------------------------------
-                                                          0.30           -          0.50
Composite Area & Weighted Runoff Coeff.                    0.30                      0.50

----------------------
Subbasin Sub-SDCO#2
----------------------
                                                          Area          Soil       Runoff
Soil/Surface Description                                (acres)        Group       Coeff.
-----------------------------------------------------------------------------------------
-                                                          0.30           -          0.50
Composite Area & Weighted Runoff Coeff.                    0.30                      0.50

----------------------
Subbasin Sub-SDCO#3
----------------------
                                                          Area          Soil       Runoff
Soil/Surface Description                                (acres)        Group       Coeff.
-----------------------------------------------------------------------------------------
-                                                          0.30           -          0.50
Composite Area & Weighted Runoff Coeff.                    0.30                      0.50

----------------------
Subbasin Sub-SDCO#5
----------------------
                                                          Area          Soil       Runoff
Soil/Surface Description                                (acres)        Group       Coeff.
-----------------------------------------------------------------------------------------
-                                                          0.33           -          0.50
Composite Area & Weighted Runoff Coeff.                    0.33                      0.50

----------------------
Subbasin Sub-SDCO#7
----------------------
                                                          Area          Soil       Runoff
Soil/Surface Description                                (acres)        Group       Coeff.
-----------------------------------------------------------------------------------------
-                                                          0.14           -          0.50
Composite Area & Weighted Runoff Coeff.                    0.14                      0.50
```

```
----------------------
Subbasin Sub-SDCO#8
----------------------
                                                          Area          Soil       Runoff
Soil/Surface Description                                (acres)        Group       Coeff.
-----------------------------------------------------------------------------------------
-                                                          0.40            -         0.50
Composite Area & Weighted Runoff Coeff.                    0.40                      0.50

----------------------
Subbasin Sub-SDCO#9
----------------------
                                                          Area          Soil       Runoff
Soil/Surface Description                                (acres)        Group       Coeff.
-----------------------------------------------------------------------------------------
-                                                          0.14            -         0.50
Composite Area & Weighted Runoff Coeff.                    0.14                      0.50


***************************************************
SCS TR-55 Time of Concentration Computations Report
***************************************************

Sheet Flow Equation
-------------------

        Tc = (0.007 * ((n * Lf)^0.8)) / ((P^0.5) * (Sf^0.4))

        Where:

        Tc = Time of Concentration (hrs)
        n  = Manning's Roughness
        Lf = Flow Length (ft)
        P  = 2 yr, 24 hr Rainfall (inches)
        Sf = Slope (ft/ft)

Shallow Concentrated Flow Equation
----------------------------------

        V  = 16.1345 * (Sf^0.5) (unpaved surface)
        V  = 20.3282 * (Sf^0.5) (paved surface)
        V  = 15.0 * (Sf^0.5) (grassed waterway surface)
        V  = 10.0 * (Sf^0.5) (nearly bare & untilled surface)
        V  = 9.0 * (Sf^0.5) (cultivated straight rows surface)
        V  = 7.0 * (Sf^0.5) (short grass pasture surface)
        V  = 5.0 * (Sf^0.5) (woodland surface)
        V  = 2.5 * (Sf^0.5) (forest w/heavy litter surface)
        Tc = (Lf / V) / (3600 sec/hr)

        Where:

        Tc = Time of Concentration (hrs)
        Lf = Flow Length (ft)
        V  = Velocity (ft/sec)
        Sf = Slope (ft/ft)

Channel Flow Equation
---------------------

        V  = (1.49 * (R^(2/3)) * (Sf^0.5)) / n
        R  = Aq / Wp
        Tc = (Lf / V) / (3600 sec/hr)

        Where:

        Tc = Time of Concentration (hrs)
```

```
          Lf = Flow Length (ft)
          R  = Hydraulic Radius (ft)
          Aq = Flow Area (ft²)
          Wp = Wetted Perimeter (ft)
          V  = Velocity (ft/sec)
          Sf = Slope (ft/ft)
          n  = Manning's Roughness

  ----------------------
  Subbasin Sub-CB #11
  ----------------------

================================================================================================
          Total TOC (minutes):                        0.00

================================================================================================


  ----------------------
  Subbasin Sub-CB #12
  ----------------------

================================================================================================
          Total TOC (minutes):                        0.00

================================================================================================


  ----------------------
  Subbasin Sub-CB #13
  ----------------------

================================================================================================
          Total TOC (minutes):                        0.00

================================================================================================


  ----------------------
  Subbasin Sub-CB #15
  ----------------------

================================================================================================
          Total TOC (minutes):                        0.00

================================================================================================


  ----------------------
  Subbasin Sub-CB #16
  ----------------------

================================================================================================
          Total TOC (minutes):                        0.00

================================================================================================


  ----------------------
  Subbasin Sub-CB #17
  ----------------------

================================================================================================
          Total TOC (minutes):                        0.00

================================================================================================
```

```
  ----------------------
  Subbasin Sub-CB #18
  ----------------------

================================================================================================
          Total TOC (minutes):                        0.00

================================================================================================


  ----------------------
  Subbasin Sub-CB #19
  ----------------------

================================================================================================
          Total TOC (minutes):                        0.00

================================================================================================


  ---------------------
  Subbasin Sub-CB #2
  ---------------------

================================================================================================
          Total TOC (minutes):                        0.00

================================================================================================


  ---------------------
  Subbasin Sub-CB #4
  ---------------------

================================================================================================
          Total TOC (minutes):                        0.00

================================================================================================


  ---------------------
  Subbasin Sub-CB #5
  ---------------------

================================================================================================
          Total TOC (minutes):                        0.00

================================================================================================


  ---------------------
  Subbasin Sub-CB #6
  ---------------------

================================================================================================
          Total TOC (minutes):                        0.00

================================================================================================


  ---------------------
  Subbasin Sub-CB #7
  ---------------------

================================================================================================
          Total TOC (minutes):                        0.00
```

```
================================================================================================

  ---------------------
  Subbasin Sub-CB #8
  ---------------------

================================================================================================
          Total TOC (minutes):                        0.00

================================================================================================

  ---------------------
  Subbasin Sub-CB #9
  ---------------------

================================================================================================
          Total TOC (minutes):                        0.00

================================================================================================

  ----------------------
  Subbasin Sub-SDCO#1
  ----------------------

================================================================================================
          Total TOC (minutes):                        0.00

================================================================================================

  -----------------------
  Subbasin Sub-SDCO#10
  -----------------------

================================================================================================
          Total TOC (minutes):                        0.00

================================================================================================

  -----------------------
  Subbasin Sub-SDCO#11
  -----------------------

================================================================================================
          Total TOC (minutes):                        0.00

================================================================================================

  -----------------------
  Subbasin Sub-SDCO#12
  -----------------------

================================================================================================
          Total TOC (minutes):                        0.00

================================================================================================

  -----------------------
  Subbasin Sub-SDCO#13
  -----------------------
```

```
================================================================================================
          Total TOC (minutes):                        0.00

================================================================================================


  -----------------------
  Subbasin Sub-SDCO#16
  -----------------------

================================================================================================
          Total TOC (minutes):                        0.00

================================================================================================


  ----------------------
  Subbasin Sub-SDCO#2
  ----------------------

================================================================================================
          Total TOC (minutes):                        0.00

================================================================================================


  ----------------------
  Subbasin Sub-SDCO#3
  ----------------------

================================================================================================
          Total TOC (minutes):                        0.00

================================================================================================


  ----------------------
  Subbasin Sub-SDCO#5
  ----------------------

================================================================================================
          Total TOC (minutes):                        0.00

================================================================================================


  ----------------------
  Subbasin Sub-SDCO#7
  ----------------------

================================================================================================
          Total TOC (minutes):                        0.00

================================================================================================


  ----------------------
  Subbasin Sub-SDCO#8
  ----------------------

================================================================================================
          Total TOC (minutes):                        0.00

================================================================================================
```

```
  ------------------------
  Subbasin Sub-SDCO#9
  ------------------------

============================================================================================================
           Total TOC (minutes):                              0.00

============================================================================================================


  ***********************
  Subbasin Runoff Summary
  ***********************

  -----------------------------------------------------------------------------------
  Subbasin                 Total      Total       Peak   Weighted             Time of
  ID                      Precip     Runoff     Runoff      Curve       Concentration
                              in         in        cfs     Number      days  hh:mm:ss
  -----------------------------------------------------------------------------------
  Sub-CB #11                3.44       3.21       0.64     98.000         0  00:05:00
  Sub-CB #12                3.44       3.21       0.32     98.000         0  00:05:00
  Sub-CB #13                3.44       3.21       0.33     98.000         0  00:05:00
  Sub-CB #15                3.44       3.21       0.21     98.000         0  00:05:00
  Sub-CB #16                3.44       3.21       0.52     98.000         0  00:05:00
  Sub-CB #17                3.44       3.21       0.15     98.000         0  00:05:00
  Sub-CB #18                3.44       3.21       0.24     98.000         0  00:05:00
  Sub-CB #19                3.44       3.21       0.36     98.000         0  00:05:00
  Sub-CB #2                 3.44       3.21       0.22     98.000         0  00:05:00
  Sub-CB #4                 3.44       3.21       0.14     98.000         0  00:05:00
  Sub-CB #5                 3.44       3.21       0.08     98.000         0  00:05:00
  Sub-CB #6                 3.44       3.21       0.08     98.000         0  00:05:00
  Sub-CB #7                 3.44       3.21       0.08     98.000         0  00:05:00
  Sub-CB #8                 3.44       3.21       0.20     98.000         0  00:05:00
  Sub-CB #9                 3.44       3.21       0.35     98.000         0  00:05:00
  Sub-SDCO#1                3.44       3.21       0.22     98.000         0  00:05:00
  Sub-SDCO#10               3.44       3.21       0.11     98.000         0  00:05:00
  Sub-SDCO#11               3.44       3.21       0.11     98.000         0  00:05:00
  Sub-SDCO#12               3.44       3.21       0.14     98.000         0  00:05:00
  Sub-SDCO#13               3.44       3.21       0.26     98.000         0  00:05:00
  Sub-SDCO#16               3.44       3.21       0.24     98.000         0  00:05:00
  Sub-SDCO#2                3.44       3.21       0.24     98.000         0  00:05:00
  Sub-SDCO#3                3.44       3.21       0.24     98.000         0  00:05:00
  Sub-SDCO#5                3.44       3.21       0.26     98.000         0  00:05:00
  Sub-SDCO#7                3.44       3.21       0.11     98.000         0  00:05:00
  Sub-SDCO#8                3.44       3.21       0.32     98.000         0  00:05:00
  Sub-SDCO#9                3.44       3.21       0.11     98.000         0  00:05:00
  -----------------------------------------------------------------------------------


  ******************
  Node Depth Summary
  ******************

  -------------------------------------------------------------------------------------------------
  Node              Average    Maximum    Maximum    Time of Max      Total      Total    Retention
  ID                  Depth      Depth        HGL     Occurrence    Flooded       Time         Time
                   Attained   Attained   Attained                    Volume    Flooded
                         ft         ft         ft    days  hh:mm    acre-in    minutes     hh:mm:ss
  -------------------------------------------------------------------------------------------------
  CB #10               3.64       3.86      55.18       0  07:55          0          0      0:00:00
  CB #11               2.80       3.15      55.32       0  07:54          0          0      0:00:00
  CB #12               2.21       2.62      55.38       0  07:54          0          0      0:00:00
  CB #13               1.63       2.04      55.39       0  07:54          0          0      0:00:00
  CB #14               0.52       0.98      50.52       0  07:57          0          0      0:00:00
  CB #15               0.08       0.19      50.79       0  07:54          0          0      0:00:00
  CB #16               0.14       0.33      51.96       0  07:54          0          0      0:00:00
  CB #17               1.01       1.28      55.23       0  07:55          0          0      0:00:00
```

```
CB #18             0.41      0.72     55.28      0  07:55         0         0     0:00:00
CB #19             0.12      0.31     55.31      0  07:55         0         0     0:00:00
CB #2              1.47      1.69     55.17      0  07:55         0         0     0:00:00
CB #20             4.12      4.25     55.08      0  07:55         0         0     0:00:00
CB #3              3.15      3.34     55.13      0  07:55         0         0     0:00:00
CB #4              1.02      1.21     55.14      0  07:55         0         0     0:00:00
CB #5              0.45      0.64     55.14      0  07:55         0         0     0:00:00
CB #6              0.05      0.12     54.62      0  07:54         0         0     0:00:00
CB #7              0.15      0.34     54.29      0  07:55         0         0     0:00:00
CB #8              0.17      0.40     53.67      0  07:56         0         0     0:00:00
CB #9              3.77      3.93     55.11      0  07:55         0         0     0:00:00
CB#25              1.27      4.12     52.86      0  00:00         0         0     0:00:00
SDCO#1             0.09      0.20     57.20      0  07:54         0         0     0:00:00
SDCO#10            0.10      0.48     55.62      0  07:55         0         0     0:00:00
SDCO#11            0.38      0.97     55.59      0  07:55         0         0     0:00:00
SDCO#12            0.89      1.43     55.53      0  07:55         0         0     0:00:00
SDCO#13            0.10      0.23     58.73      0  07:54         0         0     0:00:00
SDCO#14            0.10      0.23     57.88      0  07:54         0         0     0:00:00
SDCO#15            0.09      0.21     57.11      0  07:55         0         0     0:00:00
SDCO#16            0.57      0.77     57.87      0  07:54         0         0     0:00:00
SDCO#2             0.13      0.30     56.31      0  07:55         0         0     0:00:00
SDCO#3             0.20      0.79     55.59      0  07:54         0         0     0:00:00
SDCO#4             0.70      1.05     55.32      0  07:54         0         0     0:00:00
SDCO#5             0.10      0.22     59.02      0  07:54         0         0     0:00:00
SDCO#6             0.07      0.16     57.76      0  07:54         0         0     0:00:00
SDCO#7             0.06      0.14     55.92      0  07:54         0         0     0:00:00
SDCO#8             0.08      0.18     55.44      0  07:54         0         0     0:00:00
SDCO#9             0.06      0.14     55.80      0  07:54         0         0     0:00:00
Structure - (89)   0.15      0.50     50.55      0  07:57         0         0     0:00:00
WQ #1              4.74      4.80     55.00      0  07:55         0         0     0:00:00
WQ #2              1.11      1.43     50.35      0  07:57         0         0     0:00:00
Out-1Pipe - (54)   4.73      4.73     54.93      0  00:00         0         0     0:00:00
Out-1Pipe - (63)   4.73      4.73     54.93      0  00:00         0         0     0:00:00
Out-1Pipe - (74)   4.73      4.73     54.93      0  00:00         0         0     0:00:00
Out-1Pipe - (92)   1.00      1.00     50.00      0  00:00         0         0     0:00:00


*****************
Node Flow Summary
*****************

------------------------------------------------------------------------------------
Node                Element     Maximum     Peak      Time of   Maximum Time of Peak
ID                     Type     Lateral   Inflow  Peak Inflow  Flooding     Flooding
                                 Inflow            Occurrence  Overflow   Occurrence
                                    cfs      cfs  days  hh:mm       cfs  days  hh:mm
------------------------------------------------------------------------------------
CB #10               JUNCTION      0.00      1.77     0  07:54       0.00
CB #11               JUNCTION      0.64      1.77     0  07:54       0.00
CB #12               JUNCTION      0.32      0.64     0  07:54       0.00
CB #13               JUNCTION      0.33      0.33     0  07:54       0.00
CB #14               JUNCTION      0.00      2.02     0  07:57       0.00
CB #15               JUNCTION      0.21      0.21     0  07:54       0.00
CB #16               JUNCTION      0.52      0.52     0  07:54       0.00
CB #17               JUNCTION      0.15      0.75     0  07:56       0.00
CB #18               JUNCTION      0.24      0.59     0  07:55       0.00
CB #19               JUNCTION      0.36      0.36     0  07:54       0.00
CB #2                JUNCTION      0.22      0.97     0  07:56       0.00
CB #20               JUNCTION      0.00      3.31     0  07:55       0.00
CB #3                JUNCTION      0.00      1.19     0  07:56       0.00
CB #4                JUNCTION      0.14      0.22     0  07:55       0.00
CB #5                JUNCTION      0.08      0.08     0  07:54       0.00
CB #6                JUNCTION      0.08      0.08     0  07:54       0.00
CB #7                JUNCTION      0.08      0.67     0  07:54       0.00
CB #8                JUNCTION      0.20      0.86     0  07:55       0.00
CB #9                JUNCTION      0.35      1.54     0  07:55       0.00
CB#25                JUNCTION      0.00      3.69     0  00:00       0.00
```

```
  SDCO#1              JUNCTION      0.22      0.22     0  07:54      0.00
  SDCO#10             JUNCTION      0.11      0.23     0  07:54      0.00
  SDCO#11             JUNCTION      0.11      0.35     0  08:01      0.00
  SDCO#12             JUNCTION      0.14      0.48     0  07:56      0.00
  SDCO#13             JUNCTION      0.26      0.26     0  07:54      0.00
  SDCO#14             JUNCTION      0.00      0.26     0  07:54      0.00
  SDCO#15             JUNCTION      0.00      0.26     0  07:55      0.00
  SDCO#16             JUNCTION      0.24      0.24     0  07:54      0.00
  SDCO#2              JUNCTION      0.24      0.46     0  07:54      0.00
  SDCO#3              JUNCTION      0.24      0.70     0  07:54      0.00
  SDCO#4              JUNCTION      0.00      0.70     0  07:54      0.00
  SDCO#5              JUNCTION      0.26      0.26     0  07:54      0.00
  SDCO#6              JUNCTION      0.00      0.50     0  07:54      0.00
  SDCO#7              JUNCTION      0.11      0.11     0  07:54      0.00
  SDCO#8              JUNCTION      0.32      0.44     0  07:54      0.00
  SDCO#9              JUNCTION      0.11      0.11     0  07:54      0.00
  Structure - (89)    JUNCTION      0.00      0.65     0  07:54      0.00
  WQ #1               JUNCTION      0.00      3.31     0  07:55      0.00
  WQ #2               JUNCTION      0.00      2.42     0  00:00      0.00
  Out-1Pipe - (54)    OUTFALL       0.00      3.31     0  07:55      0.00
  Out-1Pipe - (63)    OUTFALL       0.00      0.70     0  07:54      0.00
  Out-1Pipe - (74)    OUTFALL       0.00      0.26     0  07:55      0.00
  Out-1Pipe - (92)    OUTFALL       0.00      3.69     0  00:00      0.00


  ***********************
  Outfall Loading Summary
  ***********************

  -----------------------------------------------
  Outfall Node ID          Flow   Average      Peak
                      Frequency      Flow    Inflow
                            (%)       cfs       cfs
  -----------------------------------------------
  Out-1Pipe - (54)        99.76      0.75      3.31
  Out-1Pipe - (63)        98.54      0.16      0.70
  Out-1Pipe - (74)        98.24      0.06      0.26
  Out-1Pipe - (92)        99.61      0.46      3.69
  -----------------------------------------------
  System                  99.04      1.44      6.28


  *****************
  Link Flow Summary
  *****************


-------------------------------------------------------------------------------------------------
-------------------------------
  Link ID                Element       Time of   Maximum  Length   Peak Flow      Design  Ratio of
Ratio of       Total  Reported
                            Type     Peak Flow  Velocity  Factor      during        Flow   Maximum
Maximum        Time  Condition
                                    Occurrence  Attained            Analysis    Capacity   /Design
Flow  Surcharged
                                    days hh:mm    ft/sec                 cfs         cfs      Flow
Depth     minutes

-------------------------------------------------------------------------------------------------
-------------------------------
  Pipe - (42)            CONDUIT      0  07:54      0.42    1.00        0.33        2.33      0.14
1.00        1440  SURCHARGED
  Pipe - (43)            CONDUIT      0  07:54      0.82    1.00        0.64        2.33      0.28
1.00        1440  SURCHARGED
  Pipe - (44)            CONDUIT      0  07:54      1.44    1.00        1.77        4.95      0.36
1.00        1440  SURCHARGED
  Pipe - (45)            CONDUIT      0  07:54      1.44    1.00        1.77        4.93      0.36
```

```
1.00        1440  SURCHARGED
  Pipe - (46)          CONDUIT      0  07:56      0.67    1.00        1.19        6.90       0.17
1.00        1440  SURCHARGED
  Pipe - (47)          CONDUIT      0  07:55      2.52    1.00        0.67        2.72       0.24
0.37           0  Calculated
  Pipe - (48)          CONDUIT      0  07:54      0.59    1.00        0.08        2.73       0.03
0.23           0  Calculated
  Pipe - (49)          CONDUIT      0  07:54      1.84    1.00        0.22        1.12       0.19
0.37           0  Calculated
  Pipe - (50)          CONDUIT      0  08:01      0.13    1.00        0.09        2.34       0.04
0.82           0  Calculated
  Pipe - (51)          CONDUIT      0  08:01      0.28    1.00        0.22        3.74       0.06
1.00        1410  SURCHARGED
  Pipe - (52)          CONDUIT      0  07:56      0.79    1.00        0.97        7.44       0.13
1.00        1440  SURCHARGED
  Pipe - (53) (1)      CONDUIT      0  07:55      0.87    1.00        1.54        8.05       0.19
1.00        1440  SURCHARGED
  Pipe - (54)          CONDUIT      0  07:55      1.87    1.00        3.31       18.75       0.18
1.00        1440  SURCHARGED
  Pipe - (58)          CONDUIT      0  07:54      1.22    1.00        0.21        2.72       0.08
0.35           0  Calculated
  Pipe - (58) (1)      CONDUIT      0  07:58      1.17    1.00        0.64        2.73       0.24
0.74           0  Calculated
  Pipe - (59)          CONDUIT      0  07:57      2.61    1.00        2.02        2.73       0.74
0.96           0  Calculated
  Pipe - (59) (1)      CONDUIT      0  00:00      3.83    1.00        2.42        2.72       0.89
1.00        1439  SURCHARGED
  Pipe - (59) (2)      CONDUIT      0  07:54      2.51    1.00        0.52        2.73       0.19
0.31           0  Calculated
  Pipe - (60)          CONDUIT      0  07:57      3.02    1.00        0.86        2.73       0.31
0.39           0  Calculated
  Pipe - (61)          CONDUIT      0  07:55      1.99    1.00        0.46        1.12       0.41
0.72           0  Calculated
  Pipe - (62)          CONDUIT      0  07:54      2.01    1.00        0.70        1.12       0.62
1.00          17  SURCHARGED
  Pipe - (63)          CONDUIT      0  07:54      2.01    1.00        0.70        1.63       0.43
1.00         762  SURCHARGED
  Pipe - (64)          CONDUIT      0  07:54      3.22    1.00        0.26        1.26       0.21
0.29           0  Calculated
  Pipe - (65)          CONDUIT      0  07:54      8.60    1.00        0.50        5.13       0.10
0.22           0  Calculated
  Pipe - (66)          CONDUIT      0  07:54      1.76    1.00        0.11        1.11       0.10
0.24           0  Calculated
  Pipe - (67)          CONDUIT      0  07:54      6.00    1.00        0.44        3.02       0.14
0.26           0  Calculated
  Pipe - (68)          CONDUIT      0  07:54      1.46    1.00        0.11        1.12       0.10
0.47           0  Calculated
  Pipe - (69)          CONDUIT      0  08:01      0.81    1.00        0.24        1.12       0.21
0.86           0  Calculated
  Pipe - (70)          CONDUIT      0  08:01      0.99    1.00        0.35        1.12       0.31
1.00          30  SURCHARGED
  Pipe - (71)          CONDUIT      0  07:56      1.39    1.00        0.48        1.59       0.30
1.00        1440  SURCHARGED
  Pipe - (72)          CONDUIT      0  07:54      2.50    1.00        0.26        1.12       0.23
0.34           0  Calculated
  Pipe - (73)          CONDUIT      0  07:55      2.63    1.00        0.26        1.14       0.23
0.33           0  Calculated
  Pipe - (74)          CONDUIT      0  07:55      2.89    1.00        0.26        1.35       0.19
0.30           0  Calculated
  Pipe - (75)          CONDUIT      0  07:56      0.95    1.00        0.75        2.34       0.32
1.00         159  SURCHARGED
  Pipe - (76)          CONDUIT      0  08:01      0.83    1.00        0.59        2.34       0.25
0.86           0  Calculated
  Pipe - (77)          CONDUIT      0  07:56      0.95    1.00        0.35        2.34       0.15
0.51           0  Calculated
  Pipe - (90)          CONDUIT      0  07:55      1.87    1.00        3.31        6.90       0.48
1.00        1440  SURCHARGED
```

```
  Pipe - (91)          CONDUIT      0  07:54      1.06    1.00        0.24        1.45      0.17
0.62          0  Calculated
  Pipe - (92)          CONDUIT      0  00:00      5.68    1.00        3.69        4.79      0.77
1.00       1440  SURCHARGED


  ********************************
  Highest Flow Instability Indexes
  ********************************
  Link Pipe - (59) (1) (3)
  Link Pipe - (59) (3)
  Link Pipe - (92) (2)

  WARNING 117 : Conduit outlet invert elevation defined for Conduit Pipe - (42) is below
downstream node invert elevation.
                Assumed conduit outlet invert elevation equal to downstream node invert
elevation.
  WARNING 117 : Conduit outlet invert elevation defined for Conduit Pipe - (43) is below
downstream node invert elevation.
                Assumed conduit outlet invert elevation equal to downstream node invert
elevation.
  WARNING 117 : Conduit outlet invert elevation defined for Conduit Pipe - (44) is below
downstream node invert elevation.
                Assumed conduit outlet invert elevation equal to downstream node invert
elevation.
  WARNING 117 : Conduit outlet invert elevation defined for Conduit Pipe - (47) is below
downstream node invert elevation.
                Assumed conduit outlet invert elevation equal to downstream node invert
elevation.
  WARNING 117 : Conduit outlet invert elevation defined for Conduit Pipe - (49) is below
downstream node invert elevation.
                Assumed conduit outlet invert elevation equal to downstream node invert
elevation.
  WARNING 117 : Conduit outlet invert elevation defined for Conduit Pipe - (58) is below
downstream node invert elevation.
                Assumed conduit outlet invert elevation equal to downstream node invert
elevation.
  WARNING 117 : Conduit outlet invert elevation defined for Conduit Pipe - (58) (1) is below
downstream node invert elevation.
                Assumed conduit outlet invert elevation equal to downstream node invert
elevation.
  WARNING 117 : Conduit outlet invert elevation defined for Conduit Pipe - (59) (1) is below
downstream node invert elevation.
                Assumed conduit outlet invert elevation equal to downstream node invert
elevation.
  WARNING 117 : Conduit outlet invert elevation defined for Conduit Pipe - (61) is below
downstream node invert elevation.
                Assumed conduit outlet invert elevation equal to downstream node invert
elevation.
  WARNING 117 : Conduit outlet invert elevation defined for Conduit Pipe - (64) is below
downstream node invert elevation.
                Assumed conduit outlet invert elevation equal to downstream node invert
elevation.
  WARNING 117 : Conduit outlet invert elevation defined for Conduit Pipe - (68) is below
downstream node invert elevation.
                Assumed conduit outlet invert elevation equal to downstream node invert
elevation.
  WARNING 117 : Conduit outlet invert elevation defined for Conduit Pipe - (69) is below
downstream node invert elevation.
                Assumed conduit outlet invert elevation equal to downstream node invert
elevation.
  WARNING 117 : Conduit outlet invert elevation defined for Conduit Pipe - (75) is below
downstream node invert elevation.
                Assumed conduit outlet invert elevation equal to downstream node invert
elevation.
  WARNING 117 : Conduit outlet invert elevation defined for Conduit Pipe - (76) is below
downstream node invert elevation.
```

```
                Assumed conduit outlet invert elevation equal to downstream node invert
elevation.
  WARNING 117 : Conduit outlet invert elevation defined for Conduit Pipe - (92) is below
downstream node invert elevation.
                Assumed conduit outlet invert elevation equal to downstream node invert
elevation.

  Analysis began on:  Tue Nov 07 08:20:21 2023
  Analysis ended on:  Tue Nov 07 08:20:23 2023
  Total elapsed time: 00:00:02
```

100-yr storm event

```
Autodesk® Storm and Sanitary Analysis 2016 - Version 12.0.42 (Build 0)
--------------------------------------------------------------------------------------

*******************
Project Description
*******************
File Name ................. 22085-conveyance.SPF


****************
Analysis Options
****************
Flow Units ................ cfs
Subbasin Hydrograph Method. Santa Barbara UH
Time of Concentration...... SCS TR-55
Link Routing Method ....... Hydrodynamic
Storage Node Exfiltration.. None
Starting Date ............. NOV-06-2023 00:00:00
Ending Date ............... NOV-07-2023 00:00:00
Report Time Step .......... 00:00:10


*************
Element Count
*************
Number of rain gages ...... 1
Number of subbasins ....... 27
Number of nodes ........... 43
Number of links ........... 39


****************
Raingage Summary
****************
Gage                Data                Data       Recording
ID                  Source              Type        Interval
                                                              min
------------------------------------------------------------
Rain Gage-01        100-yr              CUMULATIVE      6.00


****************
Subbasin Summary
****************
Subbasin                 Total   Imperv.    Raingage
                          Area      Area
ID                       acres         %
----------------------------------------------------
Sub-CB #11                0.80    100.00    Rain Gage-01
Sub-CB #12                0.39    100.00    Rain Gage-01
Sub-CB #13                0.41    100.00    Rain Gage-01
Sub-CB #15                0.26    100.00    Rain Gage-01
Sub-CB #16                0.65    100.00    Rain Gage-01
Sub-CB #17                0.19    100.00    Rain Gage-01
Sub-CB #18                0.30    100.00    Rain Gage-01
Sub-CB #19                0.44    100.00    Rain Gage-01
Sub-CB #2                 0.28    100.00    Rain Gage-01
Sub-CB #4                 0.18    100.00    Rain Gage-01
Sub-CB #5                 0.10    100.00    Rain Gage-01
Sub-CB #6                 0.10    100.00    Rain Gage-01
Sub-CB #7                 0.10    100.00    Rain Gage-01
Sub-CB #8                 0.24    100.00    Rain Gage-01
Sub-CB #9                 0.44    100.00    Rain Gage-01
Sub-SDCO#1                0.27    100.00    Rain Gage-01
Sub-SDCO#10               0.14    100.00    Rain Gage-01
Sub-SDCO#11               0.14    100.00    Rain Gage-01
```

```
Sub-SDCO#12               0.18    100.00    Rain Gage-01
Sub-SDCO#13               0.32    100.00    Rain Gage-01
Sub-SDCO#16               0.30    100.00    Rain Gage-01
Sub-SDCO#2                0.30    100.00    Rain Gage-01
Sub-SDCO#3                0.30    100.00    Rain Gage-01
Sub-SDCO#5                0.33    100.00    Rain Gage-01
Sub-SDCO#7                0.14    100.00    Rain Gage-01
Sub-SDCO#8                0.40    100.00    Rain Gage-01
Sub-SDCO#9                0.14    100.00    Rain Gage-01


************
Node Summary
************
Node                Element             Invert   Maximum    Ponded    External
ID                  Type             Elevation     Elev.      Area      Inflow
                                            ft        ft       ft²
------------------------------------------------------------------------------
CB #10              JUNCTION             51.32     59.79      0.00
CB #11              JUNCTION             52.17     55.50   3344.00
CB #12              JUNCTION             52.76     55.50   3960.00
CB #13              JUNCTION             53.35     55.50   3580.00
CB #14              JUNCTION             49.54     55.50      0.00
CB #15              JUNCTION             50.60     53.60      0.00
CB #16              JUNCTION             51.63     54.64      0.00
CB #17              JUNCTION             53.95     56.86      0.00
CB #18              JUNCTION             54.56     58.62      0.00
CB #19              JUNCTION             55.00     58.22      0.00
CB #2               JUNCTION             53.48     57.22      0.00
CB #20              JUNCTION             50.83     60.35      0.00
CB #3               JUNCTION             51.80     59.17      0.00
CB #4               JUNCTION             53.93     57.50      0.00
CB #5               JUNCTION             54.50     58.50      0.00
CB #6               JUNCTION             54.50     58.50      0.00
CB #7               JUNCTION             53.95     58.73      0.00
CB #8               JUNCTION             53.27     59.00      0.00
CB #9               JUNCTION             51.18     59.40      0.00
CB#25               JUNCTION             48.74     54.64      0.00
SDCO#1              JUNCTION             57.00     59.34      0.00
SDCO#10             JUNCTION             55.14     57.05      0.00
SDCO#11             JUNCTION             54.62     57.05      0.00
SDCO#12             JUNCTION             54.10     57.05      0.00
SDCO#13             JUNCTION             58.50     60.85      0.00
SDCO#14             JUNCTION             57.65     60.39      0.00
SDCO#15             JUNCTION             56.90     60.75      0.00
SDCO#16             JUNCTION             57.10     60.10      0.00
SDCO#2              JUNCTION             56.01     59.40      0.00
SDCO#3              JUNCTION             54.80     59.49      0.00
SDCO#4              JUNCTION             54.27     59.61      0.00
SDCO#5              JUNCTION             58.80     59.69      0.00
SDCO#6              JUNCTION             57.60     59.58      0.00
SDCO#7              JUNCTION             55.78     57.05      0.00
SDCO#8              JUNCTION             55.26     57.06      0.00
SDCO#9              JUNCTION             55.66     57.05      0.00
Structure - (89)    JUNCTION             50.05     56.48      0.00
WQ #1               JUNCTION             50.20     60.39      0.00
WQ #2               JUNCTION             48.92     55.43      0.00
Out-1Pipe - (54)    OUTFALL              50.20     51.70      0.00
Out-1Pipe - (63)    OUTFALL              50.20     53.17      0.00
Out-1Pipe - (74)    OUTFALL              50.20     56.67      0.00
Out-1Pipe - (92)    OUTFALL              49.00     50.00      0.00


************
Link Summary
************
Link            From Node       To Node         Element         Length     Slope   Manning's
```

```
  ID                                              Type                ft         %   Roughness
  --------------------------------------------------------------------------------------------
  Pipe - (42)     CB #13          CB #12          CONDUIT          118.7    0.4970      0.0140
  Pipe - (43)     CB #12          CB #11          CONDUIT          118.7    0.4970      0.0140
  Pipe - (44)     CB #11          CB #10          CONDUIT          170.2    0.4994      0.0120
  Pipe - (45)     CB #10          CB #20          CONDUIT           98.8    0.4957      0.0120
  Pipe - (46)     CB #3           CB #9           CONDUIT          123.5    0.5000      0.0140
  Pipe - (47)     CB #7           CB #8           CONDUIT          136.7    0.4976      0.0120
  Pipe - (48)     CB #6           CB #7           CONDUIT          109.2    0.5000      0.0120
  Pipe - (49)     SDCO#1          SDCO#2          CONDUIT           99.5    0.9954      0.0140
  Pipe - (50)     CB #5           CB #4           CONDUIT          113.8    0.5000      0.0140
  Pipe - (51)     CB #4           CB #3           CONDUIT          166.9    1.2762      0.0140
  Pipe - (52)     CB #2           CB #3           CONDUIT          109.1    1.5393      0.0140
  Pipe - (53) (1) CB #9           CB #20          CONDUIT           69.2    0.5000      0.0120
  Pipe - (54)     WQ #1           Out-1Pipe - (54)CONDUIT           18.4    2.7160      0.0120
  Pipe - (58)     CB #15          Structure - (89)CONDUIT          110.4    0.4980      0.0120
  Pipe - (58) (1) Structure - (89)CB #14          CONDUIT          102.3    0.4986      0.0120
  Pipe - (59)     CB #14          WQ #2           CONDUIT           24.3    0.5000      0.0120
  Pipe - (59) (1) WQ #2           CB#25           CONDUIT           36.3    0.4959      0.0120
  Pipe - (59) (2) CB #16          CB #14          CONDUIT           56.1    0.4989      0.0120
  Pipe - (60)     CB #8           CB #14          CONDUIT          308.8    0.5000      0.0120
  Pipe - (61)     SDCO#2          SDCO#3          CONDUIT          121.2    0.9983      0.0140
  Pipe - (62)     SDCO#3          SDCO#4          CONDUIT           52.8    1.0000      0.0140
  Pipe - (63)     SDCO#4          Out-1Pipe - (63)CONDUIT           84.0    2.1083      0.0140
  Pipe - (64)     SDCO#5          SDCO#6          CONDUIT           94.5    1.2700      0.0140
  Pipe - (65)     SDCO#6          CB #7           CONDUIT           15.9   20.8706      0.0140
  Pipe - (66)     SDCO#7          SDCO#8          CONDUIT           53.5    0.9723      0.0140
  Pipe - (67)     SDCO#8          Structure - (89)CONDUIT           67.3    7.2452      0.0140
  Pipe - (68)     SDCO#9          SDCO#10         CONDUIT           51.9    1.0013      0.0140
  Pipe - (69)     SDCO#10         SDCO#11         CONDUIT           52.0    0.9992      0.0140
  Pipe - (70)     SDCO#11         SDCO#12         CONDUIT           52.0    1.0000      0.0140
  Pipe - (71)     SDCO#12         CB #11          CONDUIT           95.7    2.0167      0.0140
  Pipe - (72)     SDCO#13         SDCO#14         CONDUIT           84.9    1.0000      0.0140
  Pipe - (73)     SDCO#14         SDCO#15         CONDUIT           73.0    1.0277      0.0140
  Pipe - (74)     SDCO#15         Out-1Pipe - (74)CONDUIT           62.6    1.4380      0.0140
  Pipe - (75)     CB #17          CB #2           CONDUIT           94.1    0.4992      0.0140
  Pipe - (76)     CB #18          CB #17          CONDUIT          122.1    0.4994      0.0140
  Pipe - (77)     CB #19          CB #18          CONDUIT           87.2    0.5000      0.0140
  Pipe - (90)     CB #20          WQ #1           CONDUIT           25.4    0.5003      0.0140
  Pipe - (91)     SDCO#6          SDCO#16         CONDUIT           30.0    1.6665      0.0140
  Pipe - (92)     Out-1Pipe - (92)CB#25           CONDUIT           14.4    1.8083      0.0130


  *********************
  Cross Section Summary
  *********************
  Link             Shape            Depth/        Width        No. of        Cross    Full Flow
Design
  ID                              Diameter                    Barrels    Sectional    Hydraulic
Flow
                                                                              Area       Radius
Capacity
                                        ft           ft                        ft²           ft
cfs

-------------------------------------------------------------------------------------------------
---------
  Pipe - (42)      CIRCULAR           1.00         1.00             1         0.79         0.25
2.33
  Pipe - (43)      CIRCULAR           1.00         1.00             1         0.79         0.25
2.33
  Pipe - (44)      CIRCULAR           1.25         1.25             1         1.23         0.31
4.95
  Pipe - (45)      CIRCULAR           1.25         1.25             1         1.23         0.31
4.93
  Pipe - (46)      CIRCULAR           1.50         1.50             1         1.77         0.38
6.90
```

```
  Pipe - (47)      CIRCULAR           1.00        1.00          1        0.79        0.25
2.72
  Pipe - (48)      CIRCULAR           1.00        1.00          1        0.79        0.25
2.73
  Pipe - (49)      CIRCULAR           0.67        0.67          1        0.35        0.17
1.12
  Pipe - (50)      CIRCULAR           1.00        1.00          1        0.79        0.25
2.34
  Pipe - (51)      CIRCULAR           1.00        1.00          1        0.79        0.25
3.74
  Pipe - (52)      CIRCULAR           1.25        1.25          1        1.23        0.31
7.44
  Pipe - (53) (1)  CIRCULAR           1.50        1.50          1        1.77        0.38
8.05
  Pipe - (54)      CIRCULAR           1.50        1.50          1        1.77        0.38
18.75
  Pipe - (58)      CIRCULAR           1.00        1.00          1        0.79        0.25
2.72
  Pipe - (58) (1)  CIRCULAR           1.00        1.00          1        0.79        0.25
2.73
  Pipe - (59)      CIRCULAR           1.00        1.00          1        0.79        0.25
2.73
  Pipe - (59) (1)  CIRCULAR           1.00        1.00          1        0.79        0.25
2.72
  Pipe - (59) (2)  CIRCULAR           1.00        1.00          1        0.79        0.25
2.73
  Pipe - (60)      CIRCULAR           1.00        1.00          1        0.79        0.25
2.73
  Pipe - (61)      CIRCULAR           0.67        0.67          1        0.35        0.17
1.12
  Pipe - (62)      CIRCULAR           0.67        0.67          1        0.35        0.17
1.12
  Pipe - (63)      CIRCULAR           0.67        0.67          1        0.35        0.17
1.63
  Pipe - (64)      CIRCULAR           0.67        0.67          1        0.35        0.17
1.26
  Pipe - (65)      CIRCULAR           0.67        0.67          1        0.35        0.17
5.13
  Pipe - (66)      CIRCULAR           0.67        0.67          1        0.35        0.17
1.11
  Pipe - (67)      CIRCULAR           0.67        0.67          1        0.35        0.17
3.02
  Pipe - (68)      CIRCULAR           0.67        0.67          1        0.35        0.17
1.12
  Pipe - (69)      CIRCULAR           0.67        0.67          1        0.35        0.17
1.12
  Pipe - (70)      CIRCULAR           0.67        0.67          1        0.35        0.17
1.12
  Pipe - (71)      CIRCULAR           0.67        0.67          1        0.35        0.17
1.59
  Pipe - (72)      CIRCULAR           0.67        0.67          1        0.35        0.17
1.12
  Pipe - (73)      CIRCULAR           0.67        0.67          1        0.35        0.17
1.14
  Pipe - (74)      CIRCULAR           0.67        0.67          1        0.35        0.17
1.35
  Pipe - (75)      CIRCULAR           1.00        1.00          1        0.79        0.25
2.34
  Pipe - (76)      CIRCULAR           1.00        1.00          1        0.79        0.25
2.34
  Pipe - (77)      CIRCULAR           1.00        1.00          1        0.79        0.25
2.34
  Pipe - (90)      CIRCULAR           1.50        1.50          1        1.77        0.38
6.90
  Pipe - (91)      CIRCULAR           0.67        0.67          1        0.35        0.17
1.45
  Pipe - (92)      CIRCULAR           1.00        1.00          1        0.79        0.25
```

```
4.79


  *************************        Volume         Depth
  Runoff Quantity Continuity      acre-ft        inches
  *************************      ---------       -------
  Total Precipitation ......         2.639         4.043
  Surface Runoff ..........          2.484         3.804
  Continuity Error (%) .....         0.000


  *************************        Volume        Volume
  Flow Routing Continuity         acre-ft      Mgallons
  *************************      ---------     ---------
  External Inflow .........          0.075         0.025
  External Outflow .........         2.480         0.808
  Initial Stored Volume ....         0.029         0.009
  Final Stored Volume ......         0.103         0.034
  Continuity Error (%) .....         0.002


  ******************************************
  Composite Curve Number Computations Report
  ******************************************

  ----------------------
  Subbasin Sub-CB #11
  ----------------------
                                                              Area          Soil
  Soil/Surface Description                                  (acres)         Group          CN
  ---------------------------------------------------------------------------------------------
  Composite Area & Weighted CN                                 0.80                     98.00

  ----------------------
  Subbasin Sub-CB #12
  ----------------------
                                                              Area          Soil
  Soil/Surface Description                                  (acres)         Group          CN
  ---------------------------------------------------------------------------------------------
  Composite Area & Weighted CN                                 0.39                     98.00

  ----------------------
  Subbasin Sub-CB #13
  ----------------------
                                                              Area          Soil
  Soil/Surface Description                                  (acres)         Group          CN
  ---------------------------------------------------------------------------------------------
  Composite Area & Weighted CN                                 0.41                     98.00

  ----------------------
  Subbasin Sub-CB #15
  ----------------------
                                                              Area          Soil
  Soil/Surface Description                                  (acres)         Group          CN
  ---------------------------------------------------------------------------------------------
  Composite Area & Weighted CN                                 0.26                     98.00

  ----------------------
  Subbasin Sub-CB #16
  ----------------------
                                                              Area          Soil
  Soil/Surface Description                                  (acres)         Group          CN
  ---------------------------------------------------------------------------------------------
  Composite Area & Weighted CN                                 0.65                     98.00

  ----------------------
  Subbasin Sub-CB #17
```

```
----------------------
                                                         Area           Soil
Soil/Surface Description                               (acres)         Group          CN
----------------------------------------------------------------------------------------
Composite Area & Weighted CN                              0.19                     98.00

----------------------
Subbasin Sub-CB #18
----------------------
                                                         Area           Soil
Soil/Surface Description                               (acres)         Group          CN
----------------------------------------------------------------------------------------
Composite Area & Weighted CN                              0.30                     98.00

----------------------
Subbasin Sub-CB #19
----------------------
                                                         Area           Soil
Soil/Surface Description                               (acres)         Group          CN
----------------------------------------------------------------------------------------
Composite Area & Weighted CN                              0.44                     98.00

---------------------
Subbasin Sub-CB #2
---------------------
                                                         Area           Soil
Soil/Surface Description                               (acres)         Group          CN
----------------------------------------------------------------------------------------
Composite Area & Weighted CN                              0.28                     98.00

---------------------
Subbasin Sub-CB #4
---------------------
                                                         Area           Soil
Soil/Surface Description                               (acres)         Group          CN
----------------------------------------------------------------------------------------
Composite Area & Weighted CN                              0.18                     98.00

---------------------
Subbasin Sub-CB #5
---------------------
                                                         Area           Soil
Soil/Surface Description                               (acres)         Group          CN
----------------------------------------------------------------------------------------
Composite Area & Weighted CN                              0.10                     98.00

---------------------
Subbasin Sub-CB #6
---------------------
                                                         Area           Soil
Soil/Surface Description                               (acres)         Group          CN
----------------------------------------------------------------------------------------
Composite Area & Weighted CN                              0.10                     98.00

---------------------
Subbasin Sub-CB #7
---------------------
                                                         Area           Soil
Soil/Surface Description                               (acres)         Group          CN
----------------------------------------------------------------------------------------
Composite Area & Weighted CN                              0.10                     98.00

---------------------
Subbasin Sub-CB #8
---------------------
                                                         Area           Soil
Soil/Surface Description                               (acres)         Group          CN
```

```
----------------------------------------------------------------------------------------
Composite Area & Weighted CN                                  0.24                     98.00

---------------------
Subbasin Sub-CB #9
---------------------
                                                         Area           Soil
Soil/Surface Description                               (acres)         Group          CN
----------------------------------------------------------------------------------------
Composite Area & Weighted CN                                  0.44                     98.00

----------------------
Subbasin Sub-SDCO#1
----------------------
                                                         Area           Soil
Soil/Surface Description                               (acres)         Group          CN
----------------------------------------------------------------------------------------
Composite Area & Weighted CN                                  0.27                     98.00

-----------------------
Subbasin Sub-SDCO#10
-----------------------
                                                         Area           Soil
Soil/Surface Description                               (acres)         Group          CN
----------------------------------------------------------------------------------------
Composite Area & Weighted CN                                  0.14                     98.00

-----------------------
Subbasin Sub-SDCO#11
-----------------------
                                                         Area           Soil
Soil/Surface Description                               (acres)         Group          CN
----------------------------------------------------------------------------------------
Composite Area & Weighted CN                                  0.14                     98.00

-----------------------
Subbasin Sub-SDCO#12
-----------------------
                                                         Area           Soil
Soil/Surface Description                               (acres)         Group          CN
----------------------------------------------------------------------------------------
Composite Area & Weighted CN                                  0.18                     98.00

-----------------------
Subbasin Sub-SDCO#13
-----------------------
                                                         Area           Soil
Soil/Surface Description                               (acres)         Group          CN
----------------------------------------------------------------------------------------
Composite Area & Weighted CN                                  0.32                     98.00

-----------------------
Subbasin Sub-SDCO#16
-----------------------
                                                         Area           Soil
Soil/Surface Description                               (acres)         Group          CN
----------------------------------------------------------------------------------------
Composite Area & Weighted CN                                  0.30                     98.00

----------------------
Subbasin Sub-SDCO#2
----------------------
                                                         Area           Soil
Soil/Surface Description                               (acres)         Group          CN
----------------------------------------------------------------------------------------
Composite Area & Weighted CN                                  0.30                     98.00
```

```
----------------------
Subbasin Sub-SDCO#3
----------------------
                                                         Area           Soil
Soil/Surface Description                               (acres)         Group          CN
----------------------------------------------------------------------------------------
Composite Area & Weighted CN                              0.30                     98.00

----------------------
Subbasin Sub-SDCO#5
----------------------
                                                         Area           Soil
Soil/Surface Description                               (acres)         Group          CN
----------------------------------------------------------------------------------------
Composite Area & Weighted CN                              0.33                     98.00

----------------------
Subbasin Sub-SDCO#7
----------------------
                                                         Area           Soil
Soil/Surface Description                               (acres)         Group          CN
----------------------------------------------------------------------------------------
Composite Area & Weighted CN                              0.14                     98.00

----------------------
Subbasin Sub-SDCO#8
----------------------
                                                         Area           Soil
Soil/Surface Description                               (acres)         Group          CN
----------------------------------------------------------------------------------------
Composite Area & Weighted CN                              0.40                     98.00

----------------------
Subbasin Sub-SDCO#9
----------------------
                                                         Area           Soil
Soil/Surface Description                               (acres)         Group          CN
----------------------------------------------------------------------------------------
Composite Area & Weighted CN                              0.14                     98.00

**************************************
Runoff Coefficient Computations Report
**************************************

----------------------
Subbasin Sub-CB #11
----------------------
                                                          Area          Soil       Runoff
Soil/Surface Description                                (acres)        Group       Coeff.
-----------------------------------------------------------------------------------------
-                                                          0.80            -         0.50
Composite Area & Weighted Runoff Coeff.                    0.80                      0.50

----------------------
Subbasin Sub-CB #12
----------------------
                                                          Area          Soil       Runoff
Soil/Surface Description                                (acres)        Group       Coeff.
-----------------------------------------------------------------------------------------
-                                                          0.39            -         0.50
Composite Area & Weighted Runoff Coeff.                    0.39                      0.50

----------------------
Subbasin Sub-CB #13
----------------------
                                                          Area          Soil       Runoff
Soil/Surface Description                                (acres)        Group       Coeff.
```

```
-----------------------------------------------------------------------------------------
-                                                          0.41            -         0.50
Composite Area & Weighted Runoff Coeff.                    0.41                      0.50

----------------------
Subbasin Sub-CB #15
----------------------
                                                          Area          Soil       Runoff
Soil/Surface Description                                (acres)        Group       Coeff.
-----------------------------------------------------------------------------------------
-                                                          0.26            -         0.50
Composite Area & Weighted Runoff Coeff.                    0.26                      0.50

----------------------
Subbasin Sub-CB #16
----------------------
                                                          Area          Soil       Runoff
Soil/Surface Description                                (acres)        Group       Coeff.
-----------------------------------------------------------------------------------------
-                                                          0.65            -         0.50
Composite Area & Weighted Runoff Coeff.                    0.65                      0.50

----------------------
Subbasin Sub-CB #17
----------------------
                                                          Area          Soil       Runoff
Soil/Surface Description                                (acres)        Group       Coeff.
-----------------------------------------------------------------------------------------
-                                                          0.19            -         0.50
Composite Area & Weighted Runoff Coeff.                    0.19                      0.50

----------------------
Subbasin Sub-CB #18
----------------------
                                                          Area          Soil       Runoff
Soil/Surface Description                                (acres)        Group       Coeff.
-----------------------------------------------------------------------------------------
-                                                          0.30            -         0.50
Composite Area & Weighted Runoff Coeff.                    0.30                      0.50

----------------------
Subbasin Sub-CB #19
----------------------
                                                          Area          Soil       Runoff
Soil/Surface Description                                (acres)        Group       Coeff.
-----------------------------------------------------------------------------------------
-                                                          0.44            -         0.50
Composite Area & Weighted Runoff Coeff.                    0.44                      0.50

---------------------
Subbasin Sub-CB #2
---------------------
                                                          Area          Soil       Runoff
Soil/Surface Description                                (acres)        Group       Coeff.
-----------------------------------------------------------------------------------------
-                                                          0.28            -         0.50
Composite Area & Weighted Runoff Coeff.                    0.28                      0.50

---------------------
Subbasin Sub-CB #4
---------------------
                                                          Area          Soil       Runoff
Soil/Surface Description                                (acres)        Group       Coeff.
-----------------------------------------------------------------------------------------
-                                                          0.18            -         0.50
Composite Area & Weighted Runoff Coeff.                    0.18                      0.50
```

```
---------------------
Subbasin Sub-CB #5
---------------------
                                                          Area          Soil       Runoff
Soil/Surface Description                                (acres)        Group       Coeff.
-----------------------------------------------------------------------------------------
-                                                          0.10            -         0.50
Composite Area & Weighted Runoff Coeff.                    0.10                      0.50

---------------------
Subbasin Sub-CB #6
---------------------
                                                          Area          Soil       Runoff
Soil/Surface Description                                (acres)        Group       Coeff.
-----------------------------------------------------------------------------------------
-                                                          0.10            -         0.50
Composite Area & Weighted Runoff Coeff.                    0.10                      0.50

---------------------
Subbasin Sub-CB #7
---------------------
                                                          Area          Soil       Runoff
Soil/Surface Description                                (acres)        Group       Coeff.
-----------------------------------------------------------------------------------------
-                                                          0.10            -         0.50
Composite Area & Weighted Runoff Coeff.                    0.10                      0.50

---------------------
Subbasin Sub-CB #8
---------------------
                                                          Area          Soil       Runoff
Soil/Surface Description                                (acres)        Group       Coeff.
-----------------------------------------------------------------------------------------
-                                                          0.24            -         0.50
Composite Area & Weighted Runoff Coeff.                    0.24                      0.50

---------------------
Subbasin Sub-CB #9
---------------------
                                                          Area          Soil       Runoff
Soil/Surface Description                                (acres)        Group       Coeff.
-----------------------------------------------------------------------------------------
-                                                          0.44            -         0.50
Composite Area & Weighted Runoff Coeff.                    0.44                      0.50

----------------------
Subbasin Sub-SDCO#1
----------------------
                                                          Area          Soil       Runoff
Soil/Surface Description                                (acres)        Group       Coeff.
-----------------------------------------------------------------------------------------
-                                                          0.27            -         0.50
Composite Area & Weighted Runoff Coeff.                    0.27                      0.50

-----------------------
Subbasin Sub-SDCO#10
-----------------------
                                                          Area          Soil       Runoff
Soil/Surface Description                                (acres)        Group       Coeff.
-----------------------------------------------------------------------------------------
-                                                          0.14            -         0.50
Composite Area & Weighted Runoff Coeff.                    0.14                      0.50

-----------------------
Subbasin Sub-SDCO#11
-----------------------
                                                          Area          Soil       Runoff
```

```
Soil/Surface Description                                (acres)        Group       Coeff.
-----------------------------------------------------------------------------------------
-                                                          0.14            -         0.50
Composite Area & Weighted Runoff Coeff.                    0.14                      0.50

-----------------------
Subbasin Sub-SDCO#12
-----------------------
                                                          Area          Soil       Runoff
Soil/Surface Description                                (acres)        Group       Coeff.
-----------------------------------------------------------------------------------------
-                                                          0.18            -         0.50
Composite Area & Weighted Runoff Coeff.                    0.18                      0.50

-----------------------
Subbasin Sub-SDCO#13
-----------------------
                                                          Area          Soil       Runoff
Soil/Surface Description                                (acres)        Group       Coeff.
-----------------------------------------------------------------------------------------
-                                                          0.32            -         0.50
Composite Area & Weighted Runoff Coeff.                    0.32                      0.50

-----------------------
Subbasin Sub-SDCO#16
-----------------------
                                                          Area          Soil       Runoff
Soil/Surface Description                                (acres)        Group       Coeff.
-----------------------------------------------------------------------------------------
-                                                          0.30            -         0.50
Composite Area & Weighted Runoff Coeff.                    0.30                      0.50

----------------------
Subbasin Sub-SDCO#2
----------------------
                                                          Area          Soil       Runoff
Soil/Surface Description                                (acres)        Group       Coeff.
-----------------------------------------------------------------------------------------
-                                                          0.30            -         0.50
Composite Area & Weighted Runoff Coeff.                    0.30                      0.50

----------------------
Subbasin Sub-SDCO#3
----------------------
                                                          Area          Soil       Runoff
Soil/Surface Description                                (acres)        Group       Coeff.
-----------------------------------------------------------------------------------------
-                                                          0.30            -         0.50
Composite Area & Weighted Runoff Coeff.                    0.30                      0.50

----------------------
Subbasin Sub-SDCO#5
----------------------
                                                          Area          Soil       Runoff
Soil/Surface Description                                (acres)        Group       Coeff.
-----------------------------------------------------------------------------------------
-                                                          0.33            -         0.50
Composite Area & Weighted Runoff Coeff.                    0.33                      0.50

----------------------
Subbasin Sub-SDCO#7
----------------------
                                                          Area          Soil       Runoff
Soil/Surface Description                                (acres)        Group       Coeff.
-----------------------------------------------------------------------------------------
-                                                          0.14            -         0.50
Composite Area & Weighted Runoff Coeff.                    0.14                      0.50
```

```
----------------------
Subbasin Sub-SDCO#8
----------------------
                                                          Area          Soil       Runoff
Soil/Surface Description                                (acres)        Group       Coeff.
-----------------------------------------------------------------------------------------
-                                                          0.40            -         0.50
Composite Area & Weighted Runoff Coeff.                    0.40                      0.50

----------------------
Subbasin Sub-SDCO#9
----------------------
                                                          Area          Soil       Runoff
Soil/Surface Description                                (acres)        Group       Coeff.
-----------------------------------------------------------------------------------------
-                                                          0.14            -         0.50
Composite Area & Weighted Runoff Coeff.                    0.14                      0.50


***************************************************
SCS TR-55 Time of Concentration Computations Report
***************************************************

Sheet Flow Equation
-------------------

        Tc = (0.007 * ((n * Lf)^0.8)) / ((P^0.5) * (Sf^0.4))

        Where:

        Tc = Time of Concentration (hrs)
        n  = Manning's Roughness
        Lf = Flow Length (ft)
        P  = 2 yr, 24 hr Rainfall (inches)
        Sf = Slope (ft/ft)

Shallow Concentrated Flow Equation
----------------------------------

        V  = 16.1345 * (Sf^0.5) (unpaved surface)
        V  = 20.3282 * (Sf^0.5) (paved surface)
        V  = 15.0 * (Sf^0.5) (grassed waterway surface)
        V  = 10.0 * (Sf^0.5) (nearly bare & untilled surface)
        V  = 9.0 * (Sf^0.5) (cultivated straight rows surface)
        V  = 7.0 * (Sf^0.5) (short grass pasture surface)
        V  = 5.0 * (Sf^0.5) (woodland surface)
        V  = 2.5 * (Sf^0.5) (forest w/heavy litter surface)
        Tc = (Lf / V) / (3600 sec/hr)

        Where:

        Tc = Time of Concentration (hrs)
        Lf = Flow Length (ft)
        V  = Velocity (ft/sec)
        Sf = Slope (ft/ft)

Channel Flow Equation
---------------------

        V  = (1.49 * (R^(2/3)) * (Sf^0.5)) / n
        R  = Aq / Wp
        Tc = (Lf / V) / (3600 sec/hr)

        Where:

        Tc = Time of Concentration (hrs)
```

```
          Lf = Flow Length (ft)
          R  = Hydraulic Radius (ft)
          Aq = Flow Area (ft²)
          Wp = Wetted Perimeter (ft)
          V  = Velocity (ft/sec)
          Sf = Slope (ft/ft)
          n  = Manning's Roughness

  ----------------------
  Subbasin Sub-CB #11
  ----------------------

================================================================================================
          Total TOC (minutes):                        0.00

================================================================================================


  ----------------------
  Subbasin Sub-CB #12
  ----------------------

================================================================================================
          Total TOC (minutes):                        0.00

================================================================================================


  ----------------------
  Subbasin Sub-CB #13
  ----------------------

================================================================================================
          Total TOC (minutes):                        0.00

================================================================================================


  ----------------------
  Subbasin Sub-CB #15
  ----------------------

================================================================================================
          Total TOC (minutes):                        0.00

================================================================================================


  ----------------------
  Subbasin Sub-CB #16
  ----------------------

================================================================================================
          Total TOC (minutes):                        0.00

================================================================================================


  ----------------------
  Subbasin Sub-CB #17
  ----------------------

================================================================================================
          Total TOC (minutes):                        0.00

================================================================================================
```

```
  ----------------------
  Subbasin Sub-CB #18
  ----------------------

================================================================================================
          Total TOC (minutes):                        0.00

================================================================================================


  ----------------------
  Subbasin Sub-CB #19
  ----------------------

================================================================================================
          Total TOC (minutes):                        0.00

================================================================================================


  ---------------------
  Subbasin Sub-CB #2
  ---------------------

================================================================================================
          Total TOC (minutes):                        0.00

================================================================================================


  ---------------------
  Subbasin Sub-CB #4
  ---------------------

================================================================================================
          Total TOC (minutes):                        0.00

================================================================================================


  ---------------------
  Subbasin Sub-CB #5
  ---------------------

================================================================================================
          Total TOC (minutes):                        0.00

================================================================================================


  ---------------------
  Subbasin Sub-CB #6
  ---------------------

================================================================================================
          Total TOC (minutes):                        0.00

================================================================================================


  ---------------------
  Subbasin Sub-CB #7
  ---------------------

================================================================================================
          Total TOC (minutes):                        0.00
```

```
================================================================================================


  ---------------------
  Subbasin Sub-CB #8
  ---------------------

================================================================================================
          Total TOC (minutes):                        0.00

================================================================================================


  ----------------------
  Subbasin Sub-CB #9
  ----------------------

================================================================================================
          Total TOC (minutes):                        0.00

================================================================================================


  ----------------------
  Subbasin Sub-SDCO#1
  ----------------------

================================================================================================
          Total TOC (minutes):                        0.00

================================================================================================


  -----------------------
  Subbasin Sub-SDCO#10
  -----------------------

================================================================================================
          Total TOC (minutes):                        0.00

================================================================================================


  -----------------------
  Subbasin Sub-SDCO#11
  -----------------------

================================================================================================
          Total TOC (minutes):                        0.00

================================================================================================


  -----------------------
  Subbasin Sub-SDCO#12
  -----------------------

================================================================================================
          Total TOC (minutes):                        0.00

================================================================================================


  -----------------------
  Subbasin Sub-SDCO#13
  -----------------------
```

```
===============================================================================================
          Total TOC (minutes):                         0.00

===============================================================================================


  ----------------------
  Subbasin Sub-SDCO#16
  ----------------------

===============================================================================================
          Total TOC (minutes):                         0.00

===============================================================================================


  ----------------------
  Subbasin Sub-SDCO#2
  ----------------------

===============================================================================================
          Total TOC (minutes):                         0.00

===============================================================================================


  ----------------------
  Subbasin Sub-SDCO#3
  ----------------------

===============================================================================================
          Total TOC (minutes):                         0.00

===============================================================================================


  ----------------------
  Subbasin Sub-SDCO#5
  ----------------------

===============================================================================================
          Total TOC (minutes):                         0.00

===============================================================================================


  ----------------------
  Subbasin Sub-SDCO#7
  ----------------------

===============================================================================================
          Total TOC (minutes):                         0.00

===============================================================================================


  ----------------------
  Subbasin Sub-SDCO#8
  ----------------------

===============================================================================================
          Total TOC (minutes):                         0.00

===============================================================================================
```

```
  ----------------------
  Subbasin Sub-SDCO#9
  ----------------------

==============================================================================================
        Total TOC (minutes):                      0.00

==============================================================================================


  ***********************
  Subbasin Runoff Summary
  ***********************

  ------------------------------------------------------------------------
  Subbasin            Total     Total      Peak  Weighted          Time of
  ID                 Precip    Runoff    Runoff     Curve    Concentration
                         in        in       cfs    Number    days hh:mm:ss
  ------------------------------------------------------------------------
  Sub-CB #11           4.04      3.80      0.76    98.000       0 00:05:00
  Sub-CB #12           4.04      3.80      0.37    98.000       0 00:05:00
  Sub-CB #13           4.04      3.80      0.39    98.000       0 00:05:00
  Sub-CB #15           4.04      3.80      0.25    98.000       0 00:05:00
  Sub-CB #16           4.04      3.80      0.62    98.000       0 00:05:00
  Sub-CB #17           4.04      3.80      0.18    98.000       0 00:05:00
  Sub-CB #18           4.04      3.80      0.28    98.000       0 00:05:00
  Sub-CB #19           4.04      3.80      0.42    98.000       0 00:05:00
  Sub-CB #2            4.04      3.80      0.26    98.000       0 00:05:00
  Sub-CB #4            4.04      3.80      0.17    98.000       0 00:05:00
  Sub-CB #5            4.04      3.80      0.10    98.000       0 00:05:00
  Sub-CB #6            4.04      3.80      0.10    98.000       0 00:05:00
  Sub-CB #7            4.04      3.80      0.10    98.000       0 00:05:00
  Sub-CB #8            4.04      3.80      0.23    98.000       0 00:05:00
  Sub-CB #9            4.04      3.80      0.42    98.000       0 00:05:00
  Sub-SDCO#1           4.04      3.80      0.26    98.000       0 00:05:00
  Sub-SDCO#10          4.04      3.80      0.14    98.000       0 00:05:00
  Sub-SDCO#11          4.04      3.80      0.14    98.000       0 00:05:00
  Sub-SDCO#12          4.04      3.80      0.17    98.000       0 00:05:00
  Sub-SDCO#13          4.04      3.80      0.31    98.000       0 00:05:00
  Sub-SDCO#16          4.04      3.80      0.28    98.000       0 00:05:00
  Sub-SDCO#2           4.04      3.80      0.29    98.000       0 00:05:00
  Sub-SDCO#3           4.04      3.80      0.29    98.000       0 00:05:00
  Sub-SDCO#5           4.04      3.80      0.31    98.000       0 00:05:00
  Sub-SDCO#7           4.04      3.80      0.14    98.000       0 00:05:00
  Sub-SDCO#8           4.04      3.80      0.38    98.000       0 00:05:00
  Sub-SDCO#9           4.04      3.80      0.14    98.000       0 00:05:00
  ------------------------------------------------------------------------


  ******************
  Node Depth Summary
  ******************

  ------------------------------------------------------------------------------------------
  Node             Average   Maximum   Maximum   Time of Max     Total     Total  Retention
  ID                 Depth     Depth       HGL    Occurrence   Flooded      Time       Time
                  Attained  Attained  Attained                  Volume   Flooded
                        ft        ft        ft   days  hh:mm   acre-in   minutes   hh:mm:ss
  ------------------------------------------------------------------------------------------
  CB #10              4.44      4.58     55.90      0  08:04         0         0    0:00:00
  CB #11              3.60      3.80     55.97      0  08:08      0.45      1439    0:00:00
  CB #12              3.02      3.23     55.99      0  08:14      0.54      1438    0:00:00
  CB #13              2.43      2.64     55.99      0  08:15      0.50      1438    0:00:00
  CB #14              0.54      1.18     50.72      0  07:58         0         0    0:00:00
  CB #15              0.09      0.20     50.80      0  07:54         0         0    0:00:00
  CB #16              0.15      0.36     51.99      0  07:54         0         0    0:00:00
  CB #17              1.83      2.11     56.06      0  08:00         0         0    0:00:00
```

```
CB #18             1.22      1.57     56.13      0  07:54         0         0     0:00:00
CB #19             0.79      1.14     56.14      0  07:54         0         0     0:00:00
CB #2              2.29      2.50     55.98      0  08:00         0         0     0:00:00
CB #20             4.93      5.03     55.86      0  08:00         0         0     0:00:00
CB #3              3.97      4.13     55.92      0  08:00         0         0     0:00:00
CB #4              1.83      2.01     55.94      0  08:00         0         0     0:00:00
CB #5              1.26      1.57     56.07      0  00:01         0         0     0:00:00
CB #6              0.06      0.13     54.63      0  07:54         0         0     0:00:00
CB #7              0.16      0.38     54.33      0  07:55         0         0     0:00:00
CB #8              0.19      0.44     53.71      0  07:56         0         0     0:00:00
CB #9              4.58      4.71     55.89      0  08:00         0         0     0:00:00
CB#25              1.28      3.00     51.74      0  00:00         0         0     0:00:00
SDCO#1             0.10      0.22     57.22      0  07:54         0         0     0:00:00
SDCO#10            0.68      1.22     56.36      0  08:00         0         0     0:00:00
SDCO#11            1.19      1.70     56.32      0  08:00         0         0     0:00:00
SDCO#12            1.70      2.22     56.32      0  00:01         0         0     0:00:00
SDCO#13            0.11      0.25     58.75      0  07:54         0         0     0:00:00
SDCO#14            0.11      0.25     57.90      0  07:54         0         0     0:00:00
SDCO#15            0.10      0.23     57.13      0  07:55         0         0     0:00:00
SDCO#16            0.59      0.81     57.91      0  07:54         0         0     0:00:00
SDCO#2             0.17      1.27     57.28      0  07:47         0         0     0:00:00
SDCO#3             1.03      2.01     56.81      0  00:02         0         0     0:00:00
SDCO#4             1.52      3.12     57.39      0  00:00         0         0     0:00:00
SDCO#5             0.11      0.24     59.04      0  07:54         0         0     0:00:00
SDCO#6             0.07      0.17     57.77      0  07:54         0         0     0:00:00
SDCO#7             0.07      0.16     55.94      0  07:54         0         0     0:00:00
SDCO#8             0.08      0.19     55.45      0  07:54         0         0     0:00:00
SDCO#9             0.16      0.71     56.37      0  08:00         0         0     0:00:00
Structure - (89)   0.18      0.72     50.77      0  07:58         0         0     0:00:00
WQ #1              5.55      5.59     55.79      0  08:00         0         0     0:00:00
WQ #2              1.13      1.57     50.49      0  07:58         0         0     0:00:00
Out-1Pipe - (54)  5.54       5.54     55.74      0  00:00         0         0     0:00:00
Out-1Pipe - (63)  5.54       5.54     55.74      0  00:00         0         0     0:00:00
Out-1Pipe - (74)  5.54       5.54     55.74      0  00:00         0         0     0:00:00
Out-1Pipe - (92)  1.00       1.00     50.00      0  00:00         0         0     0:00:00


*****************
Node Flow Summary
*****************

------------------------------------------------------------------------------------
Node                Element     Maximum     Peak      Time of   Maximum Time of Peak
ID                     Type     Lateral   Inflow  Peak Inflow  Flooding     Flooding
                                 Inflow            Occurrence  Overflow   Occurrence
                                    cfs      cfs  days  hh:mm       cfs days   hh:mm
------------------------------------------------------------------------------------
CB #10               JUNCTION      0.00     5.65     0  00:00      0.00
CB #11               JUNCTION      0.76     5.64     0  00:00      3.41     0  00:01
CB #12               JUNCTION      0.37     3.57     0  00:01      1.22     0  00:01
CB #13               JUNCTION      0.39     2.13     0  00:01      1.83     0  00:02
CB #14               JUNCTION      0.00     2.38     0  07:57      0.00
CB #15               JUNCTION      0.25     0.25     0  07:54      0.00
CB #16               JUNCTION      0.62     0.62     0  07:54      0.00
CB #17               JUNCTION      0.18     0.88     0  07:54      0.00
CB #18               JUNCTION      0.28     0.70     0  07:54      0.00
CB #19               JUNCTION      0.42     0.42     0  07:54      0.00
CB #2                JUNCTION      0.26     1.15     0  07:54      0.00
CB #20               JUNCTION      0.00     5.64     0  00:00      0.00
CB #3                JUNCTION      0.00     1.41     0  07:54      0.00
CB #4                JUNCTION      0.17     0.26     0  07:54      0.00
CB #5                JUNCTION      0.10     0.17     0  00:01      0.00
CB #6                JUNCTION      0.10     0.10     0  07:54      0.00
CB #7                JUNCTION      0.10     0.79     0  07:54      0.00
CB #8                JUNCTION      0.23     1.02     0  07:55      0.00
CB #9                JUNCTION      0.42     1.83     0  07:54      0.00
CB#25                JUNCTION      0.00     3.61     0  00:00      0.00
```

```
  SDCO#1               JUNCTION       0.26      0.26     0  07:54       0.00
  SDCO#10              JUNCTION       0.14      0.27     0  07:54       0.00
  SDCO#11              JUNCTION       0.14      0.55     0  00:02       0.00
  SDCO#12              JUNCTION       0.17      0.97     0  00:01       0.00
  SDCO#13              JUNCTION       0.31      0.31     0  07:54       0.00
  SDCO#14              JUNCTION       0.00      0.31     0  07:54       0.00
  SDCO#15              JUNCTION       0.00      0.31     0  07:55       0.00
  SDCO#16              JUNCTION       0.28      0.28     0  07:54       0.00
  SDCO#2               JUNCTION       0.29      0.54     0  07:54       0.00
  SDCO#3               JUNCTION       0.29      0.83     0  07:54       0.00
  SDCO#4               JUNCTION       0.00      1.14     0  00:00       0.00
  SDCO#5               JUNCTION       0.31      0.31     0  07:54       0.00
  SDCO#6               JUNCTION       0.00      0.60     0  07:54       0.00
  SDCO#7               JUNCTION       0.14      0.14     0  07:54       0.00
  SDCO#8               JUNCTION       0.38      0.52     0  07:54       0.00
  SDCO#9               JUNCTION       0.14      0.14     0  07:54       0.00
  Structure - (89)     JUNCTION       0.00      0.76     0  07:54       0.00
  WQ #1                JUNCTION       0.00      5.03     0  00:00       0.00
  WQ #2                JUNCTION       0.00      2.38     0  07:58       0.00
  Out-1Pipe - (54)     OUTFALL        0.00      5.03     0  00:00       0.00
  Out-1Pipe - (63)     OUTFALL        0.00      1.14     0  00:00       0.00
  Out-1Pipe - (74)     OUTFALL        0.00      0.31     0  07:55       0.00
  Out-1Pipe - (92)     OUTFALL        0.00      3.61     0  00:00       0.00


  ***********************
  Outfall Loading Summary
  ***********************

  -----------------------------------------------
  Outfall Node ID         Flow   Average      Peak
                     Frequency      Flow    Inflow
                           (%)       cfs       cfs
  -----------------------------------------------
  Out-1Pipe - (54)      100.00      0.87      5.03
  Out-1Pipe - (63)       99.27      0.19      1.14
  Out-1Pipe - (74)       98.51      0.07      0.31
  Out-1Pipe - (92)       99.72      0.56      3.61
  -----------------------------------------------
  System                 99.38      1.70      7.43


  *****************
  Link Flow Summary
  *****************


--------------------------------------------------------------------------------------------------
-------------------------------
  Link ID               Element        Time of   Maximum  Length   Peak Flow      Design  Ratio of
Ratio of       Total  Reported
                           Type      Peak Flow  Velocity  Factor      during        Flow   Maximum
Maximum        Time  Condition
                                    Occurrence  Attained            Analysis    Capacity   /Design
Flow  Surcharged
                                    days hh:mm    ft/sec                 cfs         cfs      Flow
Depth     minutes

--------------------------------------------------------------------------------------------------
-------------------------------
  Pipe - (42)           CONDUIT      0  00:01      3.77    1.00        2.13        2.33      0.91
1.00        1438  SURCHARGED
  Pipe - (43)           CONDUIT      0  00:01      5.08    1.00        3.57        2.33      1.53
1.00        1438  SURCHARGED
  Pipe - (44)           CONDUIT      0  00:00      4.89    1.00        5.64        4.95      1.14
1.00        1439  SURCHARGED
  Pipe - (45)           CONDUIT      0  00:00      4.61    1.00        5.65        4.93      1.15
```

```
1.00        1440  SURCHARGED
  Pipe - (46)          CONDUIT      0  07:54      0.80    1.00        1.41        6.90      0.20
1.00        1440  SURCHARGED
  Pipe - (47)          CONDUIT      0  07:55      2.62    1.00        0.79        2.72      0.29
0.41           0  Calculated
  Pipe - (48)          CONDUIT      0  07:54      0.62    1.00        0.10        2.73      0.03
0.25           0  Calculated
  Pipe - (49)          CONDUIT      0  07:54      1.72    1.00        0.26        1.12      0.23
0.66           0  Calculated
  Pipe - (50)          CONDUIT      0  00:01      0.22    1.00        0.17        2.34      0.07
1.00        1439  SURCHARGED
  Pipe - (51)          CONDUIT      0  07:54      0.33    1.00        0.26        3.74      0.07
1.00        1440  SURCHARGED
  Pipe - (52)          CONDUIT      0  07:54      0.93    1.00        1.15        7.44      0.15
1.00        1440  SURCHARGED
  Pipe - (53) (1)      CONDUIT      0  07:54      1.03    1.00        1.83        8.05      0.23
1.00        1440  SURCHARGED
  Pipe - (54)          CONDUIT      0  00:00      2.85    1.00        5.03       18.75      0.27
1.00        1440  SURCHARGED
  Pipe - (58)          CONDUIT      0  07:54      1.22    1.00        0.25        2.72      0.09
0.46           0  Calculated
  Pipe - (58) (1)      CONDUIT      0  08:01      1.17    1.00        0.76        2.73      0.28
0.86           0  Calculated
  Pipe - (59)          CONDUIT      0  07:58      3.03    1.00        2.38        2.73      0.87
1.00          16  SURCHARGED
  Pipe - (59) (1)      CONDUIT      0  07:58      4.09    1.00        2.38        2.72      0.88
1.00        1439  SURCHARGED
  Pipe - (59) (2)      CONDUIT      0  07:54      2.62    1.00        0.62        2.73      0.23
0.34           0  Calculated
  Pipe - (60)          CONDUIT      0  07:57      3.15    1.00        1.01        2.73      0.37
0.43           0  Calculated
  Pipe - (61)          CONDUIT      0  07:54      1.55    1.00        0.54        1.12      0.48
1.00          19  SURCHARGED
  Pipe - (62)          CONDUIT      0  07:54      2.37    1.00        0.83        1.12      0.74
1.00        1438  SURCHARGED
  Pipe - (63)          CONDUIT      0  00:00      3.45    1.00        1.14        1.63      0.70
1.00        1439  SURCHARGED
  Pipe - (64)          CONDUIT      0  07:54      3.35    1.00        0.31        1.26      0.25
0.31           0  Calculated
  Pipe - (65)          CONDUIT      0  07:54      8.93    1.00        0.60        5.13      0.12
0.25           0  Calculated
  Pipe - (66)          CONDUIT      0  07:54      1.88    1.00        0.14        1.11      0.12
0.26           0  Calculated
  Pipe - (67)          CONDUIT      0  07:54      6.11    1.00        0.52        3.02      0.17
0.43           0  Calculated
  Pipe - (68)          CONDUIT      0  07:54      0.39    1.00        0.13        1.12      0.12
1.00          10  SURCHARGED
  Pipe - (69)          CONDUIT      0  07:54      1.28    1.00        0.27        1.12      0.24
1.00         178  SURCHARGED
  Pipe - (70)          CONDUIT      0  00:02      2.15    1.00        0.55        1.12      0.49
1.00        1437  SURCHARGED
  Pipe - (71)          CONDUIT      0  00:01      3.09    1.00        0.97        1.59      0.61
1.00        1438  SURCHARGED
  Pipe - (72)          CONDUIT      0  07:54      2.60    1.00        0.31        1.12      0.27
0.37           0  Calculated
  Pipe - (73)          CONDUIT      0  07:55      2.74    1.00        0.31        1.14      0.27
0.36           0  Calculated
  Pipe - (74)          CONDUIT      0  07:55      3.02    1.00        0.31        1.35      0.23
0.33           0  Calculated
  Pipe - (75)          CONDUIT      0  07:54      1.12    1.00        0.88        2.34      0.38
1.00        1440  SURCHARGED
  Pipe - (76)          CONDUIT      0  07:54      0.89    1.00        0.70        2.34      0.30
1.00        1438  SURCHARGED
  Pipe - (77)          CONDUIT      0  07:54      0.57    1.00        0.42        2.34      0.18
1.00          28  SURCHARGED
  Pipe - (90)          CONDUIT      0  00:00      2.87    1.00        5.06        6.90      0.73
1.00        1440  SURCHARGED
```

```
  Pipe - (91)          CONDUIT      0  07:54      1.22    1.00        0.28        1.45      0.20
0.63          0  Calculated
  Pipe - (92)          CONDUIT      0  00:00      5.44    1.00        3.61        4.79      0.75
1.00       1440  SURCHARGED


  ********************************
  Highest Flow Instability Indexes
  ********************************
  Link Pipe - (59) (1) (2)
  Link Pipe - (59) (2)
  Link Pipe - (92) (1)

  WARNING 117 : Conduit outlet invert elevation defined for Conduit Pipe - (42) is below
downstream node invert elevation.
                Assumed conduit outlet invert elevation equal to downstream node invert
elevation.
  WARNING 117 : Conduit outlet invert elevation defined for Conduit Pipe - (43) is below
downstream node invert elevation.
                Assumed conduit outlet invert elevation equal to downstream node invert
elevation.
  WARNING 117 : Conduit outlet invert elevation defined for Conduit Pipe - (44) is below
downstream node invert elevation.
                Assumed conduit outlet invert elevation equal to downstream node invert
elevation.
  WARNING 117 : Conduit outlet invert elevation defined for Conduit Pipe - (47) is below
downstream node invert elevation.
                Assumed conduit outlet invert elevation equal to downstream node invert
elevation.
  WARNING 117 : Conduit outlet invert elevation defined for Conduit Pipe - (49) is below
downstream node invert elevation.
                Assumed conduit outlet invert elevation equal to downstream node invert
elevation.
  WARNING 117 : Conduit outlet invert elevation defined for Conduit Pipe - (58) is below
downstream node invert elevation.
                Assumed conduit outlet invert elevation equal to downstream node invert
elevation.
  WARNING 117 : Conduit outlet invert elevation defined for Conduit Pipe - (58) (1) is below
downstream node invert elevation.
                Assumed conduit outlet invert elevation equal to downstream node invert
elevation.
  WARNING 117 : Conduit outlet invert elevation defined for Conduit Pipe - (59) (1) is below
downstream node invert elevation.
                Assumed conduit outlet invert elevation equal to downstream node invert
elevation.
  WARNING 117 : Conduit outlet invert elevation defined for Conduit Pipe - (61) is below
downstream node invert elevation.
                Assumed conduit outlet invert elevation equal to downstream node invert
elevation.
  WARNING 117 : Conduit outlet invert elevation defined for Conduit Pipe - (64) is below
downstream node invert elevation.
                Assumed conduit outlet invert elevation equal to downstream node invert
elevation.
  WARNING 117 : Conduit outlet invert elevation defined for Conduit Pipe - (68) is below
downstream node invert elevation.
                Assumed conduit outlet invert elevation equal to downstream node invert
elevation.
  WARNING 117 : Conduit outlet invert elevation defined for Conduit Pipe - (69) is below
downstream node invert elevation.
                Assumed conduit outlet invert elevation equal to downstream node invert
elevation.
  WARNING 117 : Conduit outlet invert elevation defined for Conduit Pipe - (75) is below
downstream node invert elevation.
                Assumed conduit outlet invert elevation equal to downstream node invert
elevation.
  WARNING 117 : Conduit outlet invert elevation defined for Conduit Pipe - (76) is below
downstream node invert elevation.
```

```
                Assumed conduit outlet invert elevation equal to downstream node invert
elevation.
  WARNING 117 : Conduit outlet invert elevation defined for Conduit Pipe - (92) is below
downstream node invert elevation.
                Assumed conduit outlet invert elevation equal to downstream node invert
elevation.

  Analysis began on:  Mon Nov 06 14:27:04 2023
  Analysis ended on:  Mon Nov 06 14:27:07 2023
  Total elapsed time: 00:00:03
```

Tab 6.0

6.0 SPECIAL REPORTS AND STUDIES

The following special reports and studies are included in this section:

- *Geotechnical Report*

Figure 11
Geotechnical Report

GEOTECHNICAL REPORT

240 – 15th Street SE Industrial
240 – 15th Street Southeast
Puyallup, Washington

Project No. T-8661

Terra Associates, Inc.

Prepared for:

Cref3 Puyallup Owner, LLC
Los Angeles, California

January 12, 2022
Revised June 23, 2023

TERRA ASSOCIATES, Inc.
Consultants in Geotechnical Engineering, Geology
and
Environmental Earth Sciences

January 12, 2022
Revised June 23, 2023
Project No. T-8661

Mr. Michael Cohn
Cref3 Puyallup Owner, LLC
11611 San Vicente Boulevard, 10th Floor
Los Angeles, California 90049

Subject: Geotechnical Report
240 – 15th Street SE Industrial
240 – 15th Street Southeast
Puyallup, Washington

Dear Mr. Cohn:

As requested, we have conducted a geotechnical engineering study for the subject project. The attached report presents our findings and recommendations for the geotechnical aspects of project design and construction.

The native soils observed in the test borings are alluvial deposits generally consisting of loose to medium dense, wet, fine sand, silty fine sand, and silt with varying proportions of fine sand. The CPT data shows similar interbedded alluvial soils extending to a depth of about 80 feet. Groundwater levels at the site range between depths of about two and one-half feet and five feet. In our opinion, the soil and groundwater conditions observed at the site would not preclude the proposed development provided the recommendations contained herein are incorporated into design and construction.

We trust the information presented in this report is sufficient for your current needs. If you have any questions or require additional information, please call.

Sincerely yours,
TERRA ASSOCIATES, INC.

John C Sadler

John C. Sadler, L.E.G., L.H.G.
Senior Engineering Geologist

Carolyn S Decker

6-23-2023

Carolyn S. Decker, P.E.
President

47016

12220 113th Avenue NE, Ste. 130, Kirkland, Washington 98034
Phone (425) 821-7777

TABLE OF CONTENTS

Geotechnical Report
240 – 15th Street SE Industrial
240 – 15th Street Southeast
Puyallup, Washington

1.0 PROJECT DESCRIPTION

The proposed project is an industrial development consisting of a warehouse-style building and associated paved access, parking, and utility improvements. A conceptual site plan by Mackenzie, dated September 27, 2021, shows a 131,250 square-foot building in the central portion of the site. Truck and trailer parking is shown on the northern and western sides of the building, respectively. Passenger vehicle parking is shown on the eastern side of the building. Building plans are currently not available; however, we expect the building will be constructed using precast concrete tilt-up perimeter wall panels with interior columns spaced at 30 to 50 feet. Building floors will be constructed at grade with dock high access on the northern side of the building. Structural loading is expected to be light to moderate, with isolated columns carrying loads of 50 to 100 kips, and bearing walls carrying 4 to 8 kips per foot.

The recommendations in this report are based on our understanding of the design features outlined above. We should review design drawings as they become available to verify that our recommendations have been properly interpreted and to supplement them, if required.

2.0 SCOPE OF WORK

Our scope of work for this project included subsurface exploration, laboratory testing, office review, engineering analysis, and preparation of this report. Our subsurface exploration included ten test borings drilled to maximum depths of 6.5 feet and 31.5 feet with a limited access, track-mounted drill rig using hollow-stem auger drilling methods, one approximately 60-foot deep cone penetration test (CPTs), and one approximately 84-foot deep CPT.

Using the results of our subsurface explorations and laboratory testing, analyses were undertaken to develop geotechnical recommendations for project design and construction. Specifically, this report addresses the following:

- Soil and groundwater conditions.
- Geologic hazards per the City of Puyallup Municipal Code.
- Seismic Site Class.
- Site preparation and grading including recommendations for building preload or surcharge to mitigate floor and foundation settlement.

- Excavations.
- Foundations.
- Slab-on-grade floors.
- Lateral earth pressures for wall design.
- Subsurface drainage.
- Infiltration feasibility.
- Utilities.
- Pavement.

3.0 SITE CONDITIONS

3.1 Surface

The site is an approximately 8.74-acre assemblage of three parcels located northwest of and adjacent to the intersection of 15th Street Southeast and East Pioneer Avenue in Puyallup, Washington. The site location is shown on Figure 1.

Existing site improvements include a small office building in the northeastern portion of the site, a vacant industrial building in the southeast corner of the site, and the remains of a large cold-storage warehouse in the central portion of the site that was recently destroyed by fire. Areas around the buildings are typically surfaced with asphalt or concrete pavement or crushed gravel. An open area of the site located west of the cold storage building is an undeveloped grass field. Site topography is relatively flat.

3.2 Soils

The native soils observed in the test borings are alluvial deposits generally consisting of loose to medium dense, wet, fine sand, silty fine sand, and silt with varying proportions of fine sand and traces of fine organic particles. Fine-grained sand deposits encountered between depths of 20 and 21.5 feet in Borings B-1, B-2, B-6, and B-10 contained numerous fine pumice grains.

The upper approximately 3 to 4 feet of soil encountered in Borings B-7 through B-10 consists of loose to medium dense, silty fine sand that is interpreted to be fill. The fill materials observed in Borings B-7 and B-10 contain numerous wood shavings or fragments.

The CPT data shows interbedded alluvial soils extending the full 60-foot depth of CPT-2 and to a depth of about 80 feet in CPT-1. Soil behavior types determined from the CPT data generally consist of about 30 feet of sand to silty sand and silty sand to sandy silt with scattered clayey silt to silty clay interbeds underlain primarily by interbedded sandy silt to silty clay. A soil behavior type consistent with gravelly sand to sand was encountered below a depth of about 80 feet in CPT-1. In general, where cohesive silt and clay soils are indicated, correlated N_{60} values, indicate consistencies in the medium stiff to stiff range above a depth of about 72 feet and stiff to very stiff below that depth. Where cohesionless sand, silty sand, and silt soils are indicated, correlated N_{60} values indicate relative densities typically in the loose to medium dense range. The soil conditions determined from the CPTs are generally consistent with those observed in the test borings.

The *Geologic map of the Tacoma 1:100,000-scale quadrangle, Washington,* by J.E. Schuster (2015), shows surficial geology at the site mapped as Holocene alluvium (Qa). The soils observed in our subsurface explorations are consistent with this geologic map unit.

Detailed descriptions of the conditions observed in our subsurface explorations are given on the Boring Logs in Appendix A. The CPT data plots are also attached in Appendix A. The approximate test boring and CPT locations are shown on Figure 2.

3.3 Groundwater

Groundwater was encountered in all of the test borings with groundwater levels typically encountered below a depth of about 5 feet. Pore pressure dissipation testing performed in CPT-2 determined a hydrostatic level approximately 5 feet below ground surface as well. Borings B-3 through B-5 and Boring B-7 all encountered wet soils below depths of about 2.5 to 3 feet.

The depths to groundwater at the site will fluctuate on a seasonal basis with maximum levels occurring during the wet winter and spring months. Considering that our field work occurred during late November, we expect that the observed groundwater levels are approaching seasonal high levels.

3.4 Seismic Site Class

Soil conditions at the site, as discussed in the following section, will be subject to the soil liquefaction phenomenon. Because of this condition, per the current International Building Code (IBC), subsurface conditions would be assigned site class “F” which would require performing a site-specific seismic analysis to determine seismic forces for structural design. However, the IBC allows for using code derived seismic values for the soil conditions indicated if the building’s fundamental period is equal to or less than 0.5 seconds. We expect that the proposed industrial building will fall into this category. In this case, based on soil conditions encountered and our knowledge of the area geology, site class “D” can be used to determine seismic design forces.

3.5 Geologic Hazards

Chapter 21.06.1210(1) of the Puyallup Municipal Code (PMC) defines geologic hazard areas as "…areas susceptible to erosion, landsliding, earthquake, volcanic activity or other potentially hazardous geological processes." Site conditions do not meet the PMC criteria defining landslide hazard areas or erosion hazard areas. In our opinion, site conditions are susceptible to potential seismic and volcanic hazards as discussed below.

3.5.1 Seismic Hazards

Chapter 21.06.1210(3)(c) of the PMC defines seismic hazard areas as "…areas subject to severe risk of damage as a result of earthquake-induced ground shaking, slope failure, settlement or subsidence, soil liquefaction, or tsunamis. Settlement and soil liquefaction conditions occur in areas underlain by cohesionless, loose, or soft-saturated soils of low density, typically in association with a shallow ground water table."

The site conditions are not susceptible to seismically-induced slope failure and the site is not located within an area that is susceptible to tsunamis inundation. In our opinion, potential hazards associated with ground shaking would be adequately mitigated by designing with seismic forces determined by local building codes or site specific seismic analysis, if needed.

Liquefaction is a phenomenon where there is a reduction or complete loss of soil strength due to an increase in water pressure induced by vibrations. Liquefaction mainly affects geologically recent deposits of fine-grained sands underlying the groundwater table. Soils of this nature derive their strength from intergranular friction. The generated water pressure or pore pressure essentially separates the soil grains and eliminates this intergranular friction; thus, eliminating the soil's strength.

We completed a liquefaction analysis using the computer program LiquefyPro published by CivilTech Corporation. The analysis was completed using a site modified peak ground acceleration (PGA_M) of 0.60g representing the peak horizontal acceleration for the maximum considered earthquake (MCE) having a 2 percent probability of exceedance in 50 years. The value was obtained for Latitude 47.18978287°N and Longitude -122.27573704°W using the Structural Engineers Association of California (SEAOC) U.S. Seismic Design Maps website (https://seismicmaps.org/) accessed on December 27, 2021. The results of the liquefaction analysis are attached in Appendix B.

The results of our analysis indicate the site is a seismic hazard area with respect to soil liquefaction. Soil liquefaction could occur during the design earthquake event resulting in total settlements ranging between about four and one-half and seven inches with about one-half of this settlement likely being differential in nature. In our opinion, this amount of settlement has the potential to structurally impair the building. The structural engineer should review the estimated settlement to determine if additional mitigation measures are necessary. Additionally, cosmetic damage to the structure in the form of misaligned doors and windows, cracking, and floor settlement could occur. Some utility connections may also be impacted. If the owner is not willing to accept the risk of building damage requiring repair should liquefaction-induced settlements occur, foundations should be supported on ground improved using stone columns designed to mitigate soil liquefaction settlements below the building foundations.

3.5.2 Volcanic Hazards

Chapter 21.06.1210(3)(d) of the PMC defines volcanic hazard areas as "…areas subject to pyroclastic flows, lava flows, debris avalanche, inundation by debris flows, lahars, mudflows, or related flooding resulting from volcanic activity. Volcanic hazard areas shall be classified as Case I or Case II lahars per the definitions in PMC 21.06.210." The site is located in a potential Case II lahar inundation zone. Therefore, per the PMC, the site is considered a volcanic hazard area.

4.0 DISCUSSION AND RECOMMENDATIONS

4.1 General

In our opinion, there are no geotechnical considerations that would preclude development of the site as planned. The fine-grained native soils observed at the site will consolidate under static dead loads imposed by the structure and by product loading on structure floor slabs. To mitigate the potential for post-construction settlement due to this consolidation, we recommend preloading the building location. Preloading will involve placing the structural fill required to achieve the finish floor elevation and allowing settlements to occur under this load before building construction is initiated. We expect that these settlements would occur in about two to four weeks following full application of the building fill.

The preloading program will adequately mitigate post-construction settlement under static loading but will not eliminate the risk of damage resulting from seismically-induced soil liquefaction. If the owner is not willing to accept the risk of building damage requiring repair should liquefaction-induced settlements occur, foundations should be supported on ground improved using stone columns designed to mitigate soil liquefaction settlements below the building foundations. The use of stone columns to improve the foundation subgrade would preclude the need for preloading.

After completing the preload, building construction can begin. The buildings can be supported on conventional spread footings bearing on a minimum of two feet of compacted structural fill. Overexcavation of native soils and replacement with structural fill will likely be required where deeper footing depths are required, such as below the perimeter foundations adjacent to the loading dock areas or where perimeter footings are deepened for seismic resistance. In our opinion, mitigation of the weak subgrade soils in paved areas will require cement amending or excavation and replacement with imported gravel base material.

The native soils encountered at the site contain a sufficient percentage of fines that will make it difficult to compact as structural fill when too wet. The ability to use soils from site excavations as structural fill will depend on the soil moisture content and the prevailing weather conditions at the time of construction. The contractor should be prepared to dry the native soils by aeration during the normally dry summer season to facilitate compaction as structural fill. Alternatively, stabilizing the moisture in the native soil with cement or lime can be considered. If grading activities will take place during the winter season, the contractor should be prepared to import clean granular material for use as structural fill and backfill.

The following sections provide detailed recommendations regarding the above issues and other geotechnical design considerations. These recommendations should be incorporated into the final design drawings and construction specifications.

4.2 Site Preparation and Grading

In general, it will not be necessary to strip the organic surface layer where structural fill thicknesses above existing grade are a minimum of 3 feet and 2 feet in building and pavement areas, respectively. However, existing surface vegetation, such as that in the western portion of the site, should be mowed close to the ground with the cut debris removed from the site. Clearing of trees should include removal of the entire tree root ball. Where structural fill thicknesses are less than the recommended minimums, both the organic surface soil and vegetation should be stripped from below building and pavement areas. In this case surface stripping depths of four to six inches should be expected. Topsoil will not be suitable for use as structural fill, but can be used in landscaped areas.

We recommend removing existing building foundations and slabs and abandoning underground septic systems and other buried utilities from the planned development area. Abandoned utility pipes that fall outside of new building areas can be left in place provided they are sealed to prevent intrusion of groundwater seepage and soil.

Prior to placing fill or constructing footings, all exposed bearing surfaces should be observed by a representative of Terra Associates, Inc. to verify that soil conditions are as expected and suitable for support of new fill or building elements. Our representative may request proofrolling the exposed subgrade for pavement and floor slab support with a loaded ten yard dump truck. If unstable soils are observed and cannot be stabilized in place by compaction, the affected soils should be excavated and removed to firm bearing and grade restored with new structural fill.

All building footings should obtain support on a minimum of two feet of granular structural fill. The fill should extend laterally from the edge of footing a minimum distance of one-foot. Based on planned grades, for normal perimeter footings bearing at the frost depth and interior footings immediately below the slab-on-grade floor, we expect that this requirement will be met over most of the building area with the fill depth required to achieve the design floor elevations. Deeper footings such as the perimeter footings adjacent the loading docks and for shear walls may require some overexcavation and grade restoration with structural fill.

Our study indicates that the native soils contain a sufficient percentage of fines (silt and clay size particles) that will make them difficult to compact as structural fill if they are too wet or too dry. Accordingly, the ability to use these native soils from site excavations as structural fill will depend upon their moisture content and the prevailing weather conditions when site grading activities take place. Native soils that are too wet to properly compact could be dried by aeration during dry weather conditions or mixed with an additive such as cement or lime to stabilize the soil and facilitate compaction. If an additive is used, additional Best Management Practices (BMPs) for its use will need to be incorporated into the Temporary Erosion and Sedimentation Control plan (TESC) for the project. If grading activities are planned during the wet winter months, and the onsite soils become too wet to achieve adequate compaction, the owner or contractor should be prepared to treat soils with lime, cement, or import wet weather structural fill.

For this purpose, we recommend importing a granular soil that meets the following grading requirements:

U.S. Sieve Size	Percent Passing
6 inches	100
No. 4	75 maximum
No. 200	5 maximum*

*Based on the 3/4-inch fraction

Prior to use, Terra Associates, Inc. should examine and test all materials to be imported to the site for use as structural fill. If building subgrades were constructed using native soils and will be exposed during wet weather, it would be advisable to place 12 inches of this granular structural fill on the building pad to prevent deterioration of the floor subgrade.

Structural fill should be placed in uniform loose layers not exceeding 12 inches and compacted to a minimum of 95 percent of the soil's maximum dry density, as determined by American Society for Testing and Materials (ASTM) Test Designation D-698 (Standard Proctor). The moisture content of the soil at the time of compaction should be within two percent of its optimum, as determined by this same ASTM standard. In nonstructural areas the degree of compaction can be reduced to 90 percent.

4.3 Preload

We recommend preloading the building areas to limit building and floor slab settlements to tolerable levels. For this procedure, we recommend placing structural fill in the building areas to the design floor elevation, and delaying building construction until settlement under this fill load has occurred. The preload fill should extend a minimum of five feet beyond the building perimeter. A minimum of three feet of fill should be placed. If this fill depth exceeds that required to achieve design floor grade, the surplus depth would be treated as a surcharge and removed following completion of settlement as indicated by survey readings at settlement markers as discussed below.

Total settlement under the building fill is estimated in the range of one to three inches. These settlements are expected to occur in about three to four weeks following full application of the building fill.

To verify the amount of settlement and the time rate of movement, the preload program should be monitored by installing settlement markers. The settlement markers should be installed on the existing grade prior to placing any building or preload fills. Once installed, elevations of both the fill height and marker should be taken daily until the full height of the preload is in place. Once fully preloaded, readings should continue weekly until the anticipated settlements have occurred. A typical settlement marker detail is provided as Figure 3.

It is critical that the grading contractor recognize the importance of the settlement marker installations. All efforts must be made to protect the markers from damage during fill placement. It is difficult, if not impossible, to evaluate the progress of the preload program if the markers are damaged or destroyed by construction equipment. As a result, it may be necessary to install new markers and extend the surcharging time period in order to ensure that settlements have ceased and building construction can begin.

Following the successful completion of the preload program, with foundations designed as recommended in Section 4.5 of this report, you should expect maximum total and differential post-construction static settlements of 0.5 inches for perimeter foundations and 1 inch for interior columns.

4.4 Excavations

All excavations at the site associated with confined spaces, such as lower building level retaining walls, must be completed in accordance with local, state, or federal requirements. Based on current Washington Industrial Safety and Health Act (WISHA) regulations, the site soils would be classified as a Type C soil.

For properly dewatered excavations in Type C soils that are greater than 4 feet and less than 20 feet in depth, the side slopes should be laid back at an inclination of 1.5:1 (Horizontal:Vertical) or flatter. If there is insufficient room to complete the excavations in this manner, or if excavations greater than 20 feet in depth are planned, using temporary shoring to support the excavations may need to be considered.

Based on our study, groundwater seepage should be anticipated within excavations extending below depths of about two and one-half to five feet. Excavations extending below these depths will likely encounter groundwater seepage with volumes and flow rates sufficient to require some level of dewatering. Shallow excavations that do not extend more than two feet below the groundwater table can likely be dewatered by conventional sump-pumping procedures along with a system of collection trenches. Deeper excavations will likely require dewatering by well points or isolated deep-pump wells. The utility subcontractor should be prepared to implement excavation dewatering by well point or deep-pump wells, as needed. This will be an especially critical consideration for any deep excavations such as stormwater detention vaults, lift stations, and sanitary sewer tie-ins.

This information is provided solely for the benefit of the owner and other design consultants and should not be construed to imply that Terra Associates, Inc. assumes responsibility for job site safety. It is understood that job site safety is the sole responsibility of the project contractor.

4.5 Foundations

In our opinion, following the completion of a successful preload program, the building may be supported on conventional spread footing foundations bearing on a minimum of 2 feet of structural fill placed and compacted as recommended in Section 4.2 of this report. Foundations exposed to the weather should bear at a minimum depth of one and one-half feet below adjacent grades for frost protection.

We recommend designing foundations for a net allowable bearing capacity of 2,500 pounds per square foot (psf). For short-term loads, such as wind and seismic, a one-third increase in this allowable capacity can be used. With the expected building loads and this bearing stress applied, in general, total and differential settlements should not exceed 0.5 inches for perimeter foundations and 1 inch for interior column supports.

For designing foundations to resist lateral loads, a base friction coefficient of 0.35 can be used. Passive earth pressures acting on the sides of the footings can also be considered. We recommend calculating this lateral resistance using an equivalent fluid weight of 300 pounds per cubic foot (pcf). We do not recommend including the upper 12 inches of soil in this computation because it can be affected by weather or disturbed by future grading activity. This value assumes the foundation will be constructed neat against competent native soil or backfilled with structural fill, as described in Section 4.2 of this report. The values recommended include a safety factor of 1.5.

4.6 Lateral Earth Pressures for Retaining Walls

The magnitude of earth pressure development on below-grade walls, such as basement or retaining walls, will partly depend upon the quality of the wall backfill. We recommend placing and compacting wall backfill as structural fill as described in Section 4.2 of this report. To guard against hydrostatic pressure development, drainage must be installed behind the wall. A typical wall drainage detail is shown on Figure 4.

With wall backfill placed and compacted as recommended and drainage properly installed, unrestrained walls can be designed for an active earth pressure equivalent to a fluid weighing 35 pcf. For restrained walls, an additional uniform lateral pressure of 100 psf should be included. For evaluating the walls under seismic loading, a uniform earth pressure equivalent to 8H psf, where H is the height of the retained earth in feet, can be used. These values assume a horizontal backfill condition and that no other surcharge loading, such as traffic, sloping embankments, or adjacent buildings, will act on the wall. If such conditions exist, then the imposed loading must be included in the wall design.

Friction at the base of the wall foundation and passive earth pressure will provide resistance to these lateral loads. Values for these parameters are provided in Section 4.5.

4.7 Slab-on-Grade Floors

Slab-on-grade floors may be supported on subgrades prepared as recommended in Section 4.2 of this report. Immediately below the floor slabs, we recommend placing a 4-inch thick capillary break layer of clean, free-draining, coarse sand or fine gravel that has less than 5 percent passing the No. 200 sieve. This material will reduce the potential for upward capillary movement of water through the underlying soil and subsequent wetting of the floor slabs.

The capillary break layer will not prevent moisture intrusion through the slab caused by water vapor transmission. Where moisture by vapor transmission is undesirable, such as covered floor areas, a common practice is to place a durable plastic membrane on the capillary break layer and then cover the membrane with a layer of clean sand or fine gravel to protect it from damage during construction, and aid in uniform curing of the concrete slab.

It should be noted that if the sand or gravel layer overlying the membrane is saturated prior to pouring the slab, it will be ineffective in assisting in uniform curing of the slab and can actually serve as a water supply for moisture transmission through the slab and affecting floor coverings. Therefore, in our opinion, covering the membrane with a layer of sand or gravel should be avoided if floor slab construction occurs during the wet winter months and the layer cannot be effectively drained. We recommend floor designers and contractors refer to the American Concrete Institute (ACI) Manual of Concrete Practice for further information regarding vapor barrier installation below slab-on-grade floors.

For design of the floor slabs on grade, a subgrade modulus (k_s) of 100 pounds per cubic inch (pci) can be used.

4.8 Drainage

Surface

Final exterior grades should promote free and positive drainage away from the building at all times. Water must not be allowed to pond or collect adjacent to foundations or within the immediate building area. We recommend providing positive gradient away from the building perimeter.

Subsurface

We expect that building floor elevations will be above existing surface grades and that permanent hard surfaces will extend to the building over most of its perimeter. With these conditions, it is our opinion that building foundation drains would not be required. However, footing drains associated with retaining wall drainage, such as loading dock walls should be installed. Foundation drains should also be installed where landscaping is adjacent to the building.

4.9 Infiltration Feasibility

Based on the shallow seasonal water table and the fine-grained nature of the soils observed across the site, it is our opinion that infiltration is not a feasible option for stormwater management.

4.10 Utilities

Utility pipes should be bedded and backfilled in accordance with American Public Works Associates (APWA) or local jurisdictional specifications. At a minimum, trench backfill should be placed and compacted as structural fill as described in Section 4.2 of this report. At the time of our study, soil moisture contents were generally above optimum; therefore, drying back or other means to condition the material will probably be necessary to facilitate proper compaction. If utility construction takes place during the winter, it may be necessary to import suitable wet weather fill for utility trench backfilling.

For any structure installed below a depth of approximately two and one-half feet, buoyancy effects must be considered. Buoyancy or uplift will be resisted by the weight of the structure and the weight of the soil overlying its foundation or cover. For backfill placed as structural fill, a soil unit weight of 110 pcf can be used.

Buoyancy, or an unbalanced hydrostatic head, will also impact the trench bottom stability. Where an unbalanced hydrostatic head exists in the trench excavation, the trench bottom can heave and, subsequently, become unstable causing installed utility pipes to settle when overburdened stresses from utility trench backfill are replaced.

Two methods for stabilizing the trench bottoms can be considered. The first involves using well point dewatering systems to lower the groundwater table adjacent to utility excavation and prevent development of an unbalanced hydrostatic head. Single-stage well point dewatering systems are typically effective for utility excavations occurring to depths of 15 to 20 feet.

The second method that can be used to mitigate heave or unstable soil conditions at the trench bottom involves overexcavation of the affected soils and replacement with additional free-draining bedding material. As a general rule, the depth of overexcavation below the pipe invert and replacement with free-draining bedding material would be equivalent to one foot for every two feet of unbalanced hydrostatic head.

4.11 Pavements

Pavements should be constructed on subgrades prepared as recommended in Section 4.2 of this report. Regardless of the degree of relative compaction achieved, the subgrade must be firm and relatively unyielding before paving. Proofrolling the subgrade with heavy construction equipment should be completed to verify this condition.

The pavement design section is dependent upon the supporting capability of the subgrade soils and the traffic conditions to which it will be subjected. We expect traffic at the facility will consist of cars and light trucks, along with heavy traffic in the form of tractor-trailer-rigs. For design considerations, we have assumed traffic in parking and in car/light truck access pavement areas can be represented by an 18-kip Equivalent Single Axle Loading (ESAL) of 50,000 over a 20-year design life. For heavy traffic pavement areas, we have assumed an ESAL of 300,000 would be representative of the expected loading. These ESALs represent loading approximately equivalent to 3 and 18, loaded (80,000-pound GVW) tractor-trailer rigs traversing the pavement daily in each area, respectively.

With a stable subgrade prepared as recommended, for the design ESAL values, we recommend the following pavement sections:

Light Traffic/Car Access:

- 2 inches of hot mix asphalt (HMA) over 6 inches of crushed rock surfacing (CRS).
- 4 inches full depth HMA.

Heavy Traffic/Truck Access:

- 3 inches of HMA over 8 inches of CRS.
- 6 inches full depth HMA.

For exterior Portland cement concrete (PCC) pavement, we recommend the following:

- 6 inches of PCC over 2 inches of CRS.
    - 28-day compressive strength – 4,000 psi.
    - Control joints spaced at a maximum of 15 feet.

Soil cement stabilization or constructing a soil cement base for support of the pavement section can also be considered as an alternate to the above conventional pavement sections. Assuming a properly constructed soil cement base having a minimum thickness of 12 inches and a minimum 7-day compressive strength of 100 pounds per square inch (psi), the following pavement sections are recommended:

Light Traffic/Car Access:

- 2 inches of HMA over 12 inches of soil cement base (SCB).

Heavy Traffic/Truck Access:

- 3 inches of HMA over 12 inches of SCB.
- 6 inches of PCC over 12 inches of SCB.

The design of the soil cement base should be completed using samples of the subgrade exposed at the time of construction.

The paving materials used should conform to the Washington State Department of Transportation (WSDOT) specifications for ½-inch class HMA and CRS.

Long-term pavement performance will depend upon surface drainage. A poorly-drained pavement section will be subject to premature failure as a result of surface water infiltrating into the subgrade soils and reducing their supporting capability. For optimum pavement performance, we recommend surface drainage gradients of at least two percent. Some degree of longitudinal and transverse cracking of the pavement surface should be expected over time. Regular maintenance should be planned to seal cracks when they occur.

5.0 ADDITIONAL SERVICES

Terra Associates, Inc. should review the final design and specifications in order to verify that earthwork recommendations have been properly interpreted and incorporated into project design and construction. We should also provide geotechnical services during construction in order to observe compliance with the design concepts, specifications, and recommendations. This will allow for design changes if subsurface conditions differ from those anticipated prior to the start of construction.

6.0 LIMITATIONS

We prepared this report in accordance with generally accepted geotechnical engineering practices. This report is the property of Terra Associates, Inc. and is intended for specific application to the 240 – 15th Street SE Industrial project in Puyallup, Washington. This report is for the exclusive use of Fortress, LLC, and its authorized representatives.

The analyses and recommendations presented in this report are based upon data obtained from the subsurface explorations completed onsite. Variations in soil conditions can occur, the nature and extent of which may not become evident until construction. If variations appear evident, Terra Associates, Inc. should be requested to reevaluate the recommendations in this report prior to proceeding with construction.

REFERENCE: WSDOT GEOPORTAL

NOT TO SCALE

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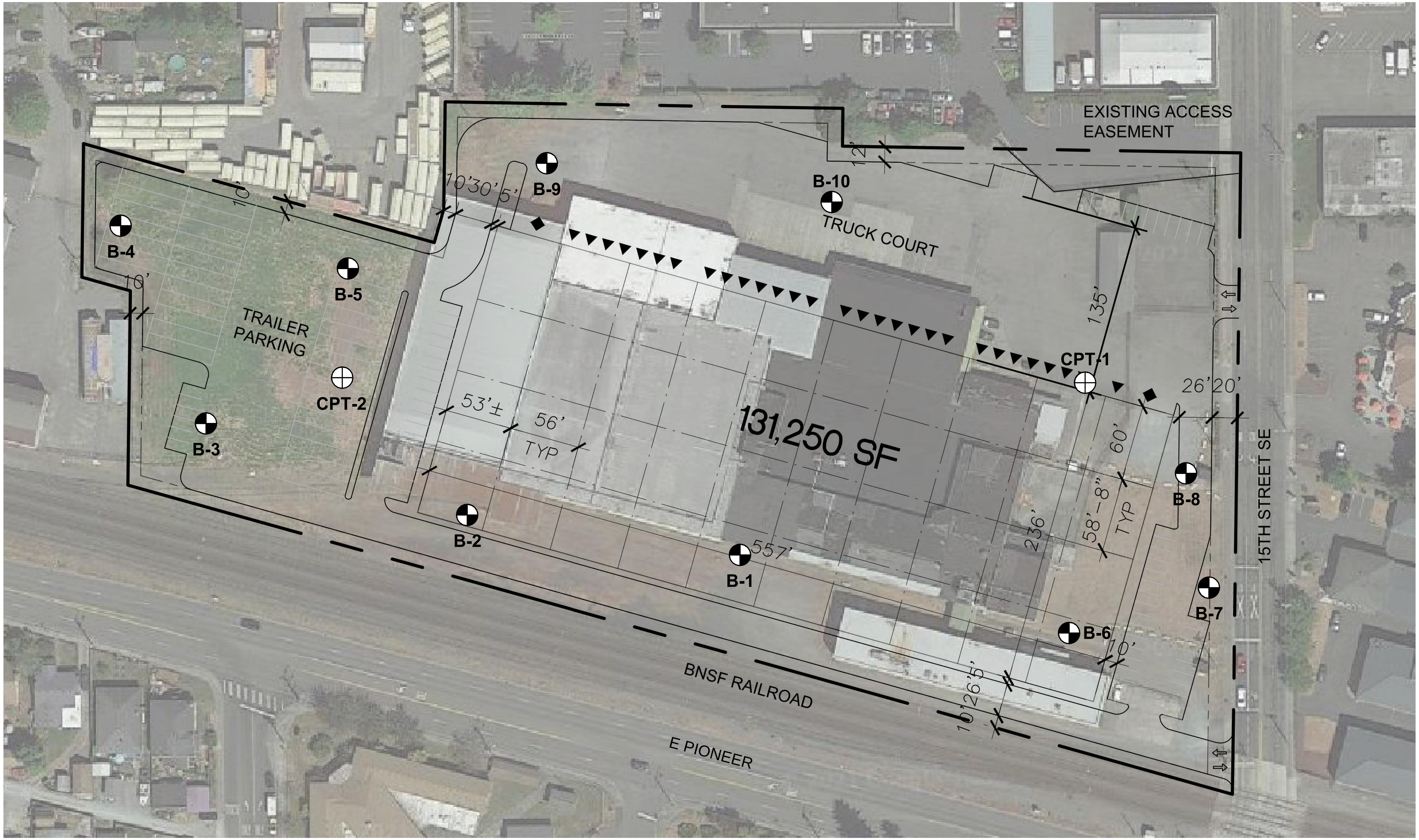
VICINITY MAP
240 - 15TH STREET SE INDUSTRIAL
PUYALLUP, WASHINGTON

Proj. No.T-8661	Date JUNE 2023	Figure 1



NOTE:

THIS SITE PLAN IS SCHEMATIC. ALL LOCATIONS AND DIMENSIONS ARE APPROXIMATE. IT IS INTENDED FOR REFERENCE ONLY AND SHOULD NOT BE USED FOR DESIGN OR CONSTRUCTION PURPOSES.

REFERENCE:

MACKENZIE

LEGEND:

◐ APPROXIMATE BORING LOCATION

⊕ APPROXIMATE CPT LOCATION

N

0 80 160

APPROXIMATE SCALE IN FEET

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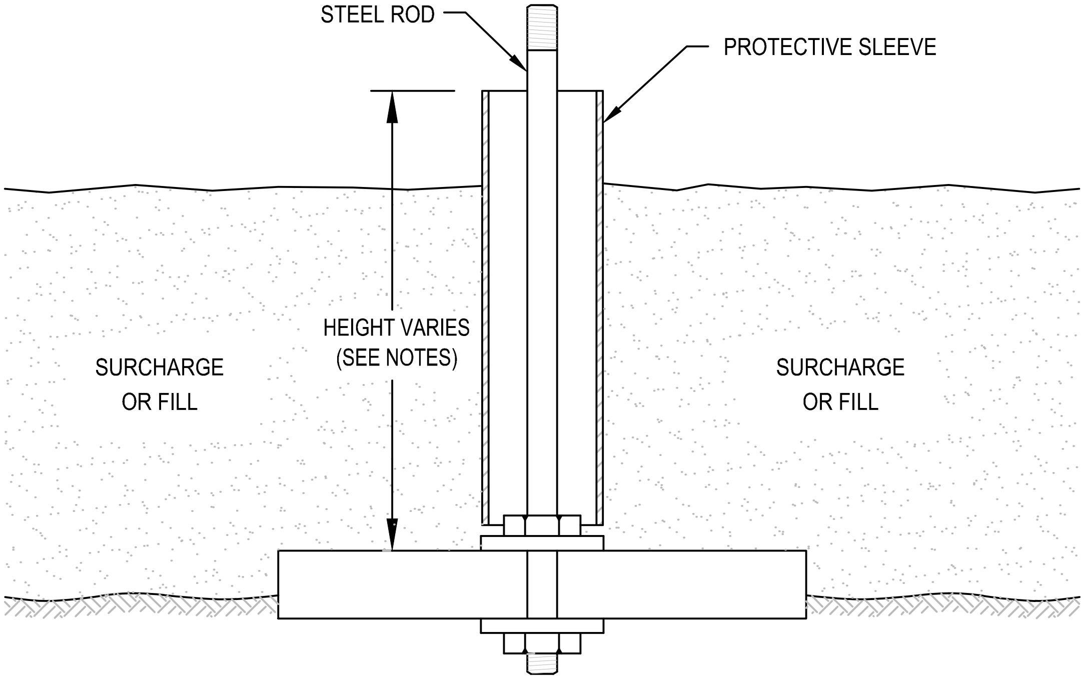
EXPLORATION LOCATION PLAN
240 - 15TH STREET SE INDUSTRIAL
PUYALLUP, WASHINGTON

Proj. No.T-8661	Date JUNE 2023	Figure 2



NOT TO SCALE

NOTES:

1. BASE CONSISTS OF 3/4" THICK, 2'x2' PLYWOOD WITH CENTER DRILLED 5/8" DIAMETER HOLE.
2. BEDDING MATERIAL, IF REQUIRED, SHOULD CONSIST OF CLEAN COARSE SAND.
3. MARKER ROD IS 1/2" DIAMETER STEEL ROD THREADED AT BOTH ENDS.
4. MARKER ROD IS ATTACHED TO BASE BY NUT AND WASHER ON EACH SIDE OF BASE.
5. PROTECTIVE SLEEVE SURROUNDING MARKER ROD SHOULD CONSIST OF 2" DIAMETER PLASTIC TUBING. SLEEVE IS NOT ATTACHED TO ROD OR BASE.
6. ADDITIONAL SECTIONS OF STEEL ROD CAN BE CONNECTED WITH THREADED COUPLINGS.
7. ADDITIONAL SECTIONS OF PLASTIC PROTECTIVE SLEEVE CAN BE CONNECTED WITH PRESS-FIT PLASTIC COUPLINGS.
8. STEEL MARKER ROD SHOULD EXTEND AT LEAST 6" ABOVE TOP OF PLASTIC PROTECTIVE SLEEVE.
9. PLASTIC PROTECTIVE SLEEVE SHOULD EXTEND AT LEAST 1" ABOVE TOP OF FILL SURFACE.

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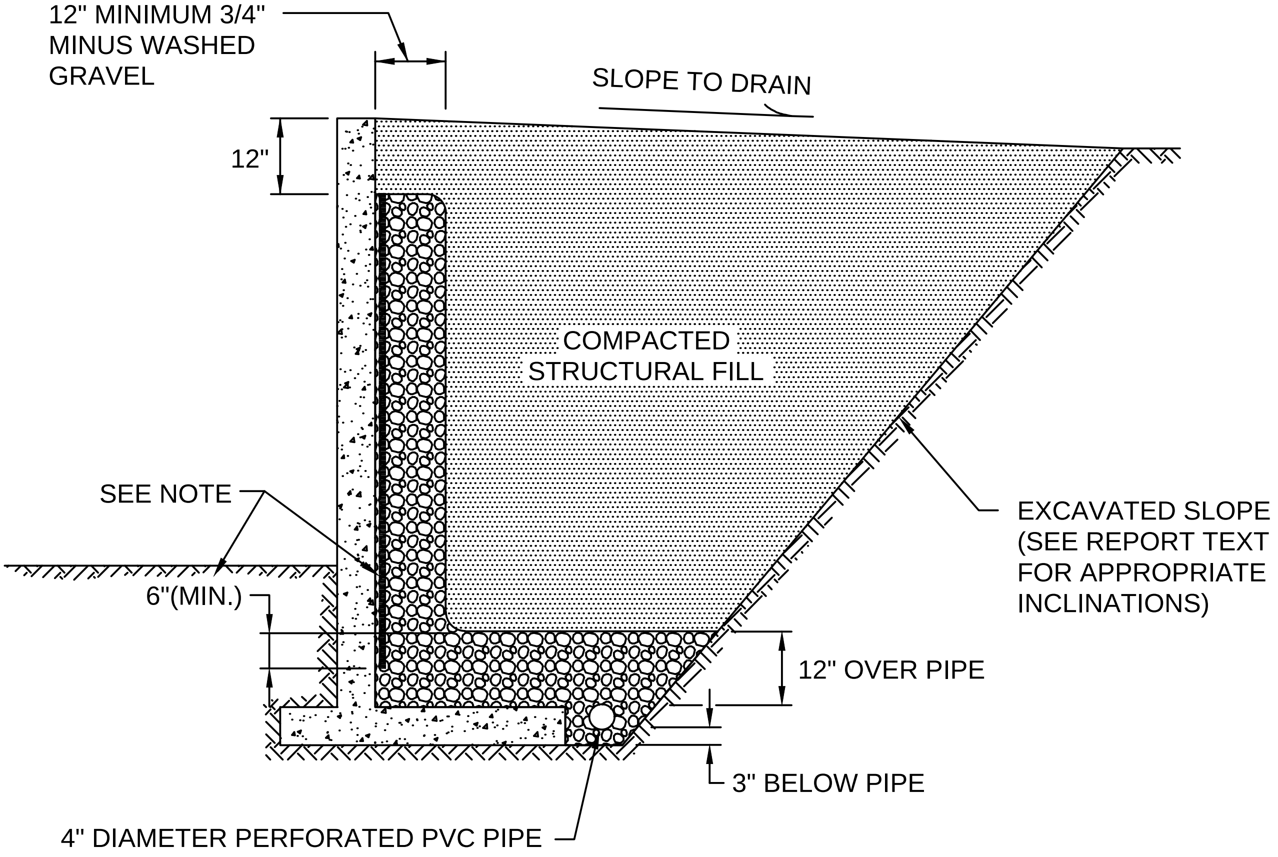
TYPICAL SETTLEMENT MARKER DETAIL
240 - 15TH STREET SE INDUSTRIAL
PUYALLUP, WASHINGTON

Proj. No.T-8661

Date JUNE 2023

Figure 3



NOT TO SCALE

NOTE:

MIRADRAIN G100N PREFABRICATED DRAINAGE PANELS OR SIMILAR PRODUCT CAN BE SUBSTITUTED FOR THE 12-INCH WIDE GRAVEL DRAIN BEHIND WALL. DRAINAGE PANELS SHOULD EXTEND A MINIMUM OF SIX INCHES INTO 12-INCH THICK DRAINAGE GRAVEL LAYER OVER PERFORATED DRAIN PIPE.

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TYPICAL WALL DRAINAGE DETAIL
240 - 15TH STREET SE INDUSTRIAL
PUYALLUP, WASHINGTON

Proj. No.T-8661	Date JUNE 2023	Figure 4

APPENDIX A

FIELD EXPLORATION AND LABORATORY TESTING

240 – 15th Street SE Industrial
Puyallup, Washington

We explored subsurface conditions at the site by drilling six 31.5-foot deep test borings and four 6.5-foot deep test borings with a track-mounted drill rig using hollow-stem auger drilling methods, and by conducting two cone penetration tests (CPTs) to maximum depths of about 60 feet and about 84 feet. The test boring and CPT locations were approximately determined in the field by pacing and sighting from existing site features. The test boring and CPT locations are shown on Figure 2. The Boring Logs are presented as Figures A-2 through A-11.

An engineering geologist from our office conducted the field exploration. Our representative classified the soil conditions encountered, maintained a log of each boring, obtained representative soil samples, and recorded groundwater levels observed during drilling. Soil samples were obtained during drilling in general accordance with ASTM Test Designation D-1586. Using this procedure, a 2-inch (outside diameter) split barrel sampler is driven into the ground 18 inches using a 140-pound hammer free falling a height of 30 inches the number of blows required to drive the sampler 12 inches after an initial 6-inch set is referred to as the Standard Penetration Resistance value or N value. This is an index related to the consistency of cohesive soils and relative density of cohesionless materials. N values obtained for each sampling interval are recorded on the Boring Logs. All soil samples were visually classified in accordance with the Unified Soil Classification System (USCS) described on Figure A-1.

Representative soil samples obtained from the test borings were placed in sealed plastic bags and taken to our laboratory for further examination and testing. The moisture content of each sample was measured and is reported on the Boring Logs. Grain size analyses were performed on eight soil samples. The results are shown on Figures A-12 through A-14.

In Situ Engineering, under subcontract to Terra Associates, Inc., performed the CPTs at locations selected by Terra Associates, Inc. The CPT consists of pushing an instrumented, approximately one and one-half inch diameter cone into the ground at a constant rate. During advancement, continuous measurements are made of the resistance to penetration of the cone and the friction of the outer surface of a sleeve. The cone is also equipped with a porous filter and a pressure transducer for measuring the generated groundwater or pore water pressure. Measurements of tip and sleeve frictional resistance, pore pressure, and interpreted soil conditions are summarized in graphical form on the attached CPT Logs.

MAJOR DIVISIONS				LETTER SYMBOL	TYPICAL DESCRIPTION
COARSE GRAINED SOILS	More than 50% material larger than No. 200 sieve size	**GRAVELS** More than 50% of coarse fraction is larger than No. 4 sieve	Clean Gravels (less than 5% fines)	GW	Well-graded gravels, gravel-sand mixtures, little or no fines.
				GP	Poorly-graded gravels, gravel-sand mixtures, little or no fines.
			Gravels with fines	GM	Silty gravels, gravel-sand-silt mixtures, non-plastic fines.
				GC	Clayey gravels, gravel-sand-clay mixtures, plastic fines.
		SANDS More than 50% of coarse fraction is smaller than No. 4 sieve	Clean Sands (less than 5% fines)	SW	Well-graded sands, sands with gravel, little or no fines.
				SP	Poorly-graded sands, sands with gravel, little or no fines.
			Sands with fines	SM	Silty sands, sand-silt mixtures, non-plastic fines.
				SC	Clayey sands, sand-clay mixtures, plastic fines.
FINE GRAINED SOILS	More than 50% material smaller than No. 200 sieve size	**SILTS AND CLAYS** Liquid Limit is less than 50%		ML	Inorganic silts, rock flour, clayey silts with slight plasticity.
				CL	Inorganic clays of low to medium plasticity. (Lean clay)
				OL	Organic silts and organic clays of low plasticity.
		SILTS AND CLAYS Liquid Limit is greater than 50%		MH	Inorganic silts, elastic.
				CH	Inorganic clays of high plasticity. (Fat clay)
				OH	Organic clays of high plasticity.
HIGHLY ORGANIC SOILS				PT	Peat.

DEFINITION OF TERMS AND SYMBOLS

COHESIONLESS

Density	Standard Penetration Resistance in Blows/Foot
Very Loose	0-4
Loose	4-10
Medium Dense	10-30
Dense	30-50
Very Dense	>50

COHESIVE

Consistancy	Standard Penetration Resistance in Blows/Foot
Very Soft	0-2
Soft	2-4
Medium Stiff	4-8
Stiff	8-16
Very Stiff	16-32
Hard	>32

⌶	2" OUTSIDE DIAMETER SPILT SPOON SAMPLER
‖	2.4" INSIDE DIAMETER RING SAMPLER OR SHELBY TUBE SAMPLER
▼	WATER LEVEL (Date)
Tr	TORVANE READINGS, tsf
Pp	PENETROMETER READING, tsf
DD	DRY DENSITY, pounds per cubic foot
LL	LIQUID LIMIT, percent
PI	PLASTIC INDEX
N	STANDARD PENETRATION, blows per foot

Terra Associates, Inc.
Consultants in Geotechnical Engineering
Geology and
Environmental Earth Sciences

UNIFIED SOIL CLASSIFICATION SYSTEM
240 - 15TH STREET SE INDUSTRIAL
PUYALLUP, WASHINGTON

Proj. No.T-8661	Date JUNE 2023	Figure A-1

LOG OF BORING NO. 1

Figure No. A-2

Project: 240 - 15th Street SE Industrial **Project No:** T-8661 **Date Drilled:** November 30, 2021

Client: Fortress, LLC **Driller:** Boretec1 **Logged By:** JCS

Location: Puyallup, Washington **Depth to Groundwater:** 5 ft **Approx. Elev:** NA

Depth (ft)	Sample Interval	Soil Description	Consistency/ Relative Density	SPT (N) Blows/foot 10 30 50	Moisture Content (%)
0					
	I	Dark brown to gray-brown SAND, fine grained, moist. (SP)	Medium Dense	12	23.9
▼ 5	I	- Becomes fine to medium grained and wet below 5 feet.		10	24.3
	I	- Trace of brown silt seams and gray silt pockets below 8.5 feet.		12	23.7
10	I			12	23.9
	I	Dark gray-brown silty SAND, fine grained, wet, trace of dark brown fine organic particles and wood fragments. (SM)		22	35.4
15	I	Dark gray-brown sandy SILT, fine sand, wet. (ML)		12	30.1
		Dark gray-brown SAND, fine grained, wet, scattered layers containing numerous fine pumice fragments, trace of silt seams. (SP)			
20	I			12	24.7
		Dark gray-brown silty SAND to sandy SILT, fine sand, wet. (SM/ML)			
25	I	Dark gray-brown SAND, fine to medium grained, wet. (SP)		14	26.5
30	I	Dark gray-brown SAND with silt to silty SAND, fine sand, wet, scattered brown silt seams, trace of wood fragments and gray-brown silt pockets. (SP-SM/SM)	Loose	6	64.8
		Boring terminated at 31.5 feet. Groundwater encountered below 5 feet.			
35					

NOTE: This borehole log has been prepared for geotechnical purposes. This information pertains only to this boring location and should not be interpeted as being indicative of other areas of the site

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LOG OF BORING NO. 2

Figure No. A-3

Project: 240 - 15th Street SE Industrial **Project No:** T-8661 **Date Drilled:** November 30, 2021

Client: Fortress, LLC **Driller:** Boretec1 **Logged By:** JCS

Location: Puyallup, Washington **Depth to Groundwater:** 5 ft **Approx. Elev:** NA

Depth (ft)	Sample Interval	Soil Description	Consistency/ Relative Density	SPT (N) Blows/foot 10 30 50	Moisture Content (%)
0					
	I	Dark brown to dark gray-brown SAND, fine grained, moist, scattered silty fine sand seams and layers. (SP)	Loose	9	27.2
▼ 5	I	- Becomes wet below 5 feet.	Medium Dense	10	26.4
	I	- Numerous silty fine sand seams and trace of dark brown organic partings and seams below 8 feet.		12	31.6
10	I			13	25.7
	I			27	
					29.1
15	I	Dark gray-brown silty SAND, fine grained, wet. (SM)		15	33.9
		Interbedded dark gray-brown silty fine SAND to fine sandy SILT and fine to medium grained SAND, wet, trace of fine dark brown organic fragments. (SM/ML and SP)			
20	I	Dark gray-brown SAND, fine grained, wet, numerous fine pumice fragments. (SP)		12	27.4
		Dark gray SILT, wet, trace of fine black organic fragments. (ML)			
25	I			13	39.4 25.7
		Dark gray-brown silty SAND, fine grained, wet. (SM)			
		Dark gray-brown SAND, fine grained, wet. (SP)	Loose		
30	I			6	31.0
		Dark gray-brown SILT, wet. (ML)			
		Boring terminated at 31.5 feet. Groundwater encountered below 5 feet.			
35					
40					

NOTE: This borehole log has been prepared for geotechnical purposes. This information pertains only to this boring location and should not be interpeted as being indicative of other areas of the site

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LOG OF BORING NO. 3

Figure No. A-4

Project: 240 - 15th Street SE Industrial **Project No:** T-8661 **Date Drilled:** November 30, 2021

Client: Fortress, LLC **Driller:** Boretec1 **Logged By:** JCS

Location: Puyallup, Washington **Depth to Groundwater:** 3 ft **Approx. Elev:** NA

Depth (ft)	Sample Interval	Soil Description	Consistency/ Relative Density	SPT (N) Blows/foot 10 30 50	Moisture Content (%)
0					
▼		Dark gray-brown SAND with silt, fine grained, moist (wet below 3 feet), trace of gray silty fine sand layers, mottled above 3 feet. (SP-SM)	Medium Dense	11	25.2
5		- Scattered iron-oxide stained pockets below 5 feet.	Loose	9	28.8
		Dark gray SILT, wet. (ML)			
		Boring terminated at 6.5 feet. Groundwater encountered below about 3 feet.			
10					

NOTE: This borehole log has been prepared for geotechnical purposes. This information pertains only to this boring location and should not be interpeted as being indicative of other areas of the site

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LOG OF BORING NO. 4

Figure No. A-5

Project: 240 - 15th Street SE Industrial **Project No:** T-8661 **Date Drilled:** November 30, 2021

Client: Fortress, LLC **Driller:** Boretec1 **Logged By:** JCS

Location: Puyallup, Washington **Depth to Groundwater:** 2.5 ft **Approx. Elev:** NA

Depth (ft)	Sample Interval	Soil Description	Consistency/ Relative Density	SPT (N) Blows/foot 10 30 50	Moisture Content (%)
0					
▼		Dark gray-brown SAND, fine to medium grained, wet. (SP)	Loose	● 8	25.5
5				● 5	
		Dark gray-brown SILT to sandy SILT, fine sand, wet, coarse wood fragment at 6.5 feet. (ML)			44.0
		Boring terminated at 6.5 feet. Groundwater encountered below about 2.5 feet.			
10					

NOTE: This borehole log has been prepared for geotechnical purposes. This information pertains only to this boring location and should not be interpeted as being indicative of other areas of the site

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LOG OF BORING NO. 5

Figure No. A-6

Project: 240 - 15th Street SE Industrial **Project No:** T-8661 **Date Drilled:** November 30, 2021

Client: Fortress, LLC **Driller:** Boretec1 **Logged By:** JCS

Location: Puyallup, Washington **Depth to Groundwater:** 2.5 ft **Approx. Elev:** NA

Depth (ft)	Sample Interval	Soil Description	Consistency/ Relative Density	SPT (N) Blows/foot 10 30 50	Moisture Content (%)
0					
▼	I	No recovery at 2.5 feet. Sampler wet.	Medium Dense	● 21	
5	I	Dark gray-brown SAND, fine to medium grained, wet. (SP)		● 13	22.2
		Boring terminated at 6.5 feet. Groundwater encountered below about 2.5 feet.			
10					

NOTE: This borehole log has been prepared for geotechnical purposes. This information pertains only to this boring location and should not be interpeted as being indicative of other areas of the site

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LOG OF BORING NO. 6

Figure No. A-7

Project: 240 - 15th Street SE Industrial **Project No:** T-8661 **Date Drilled:** November 30, 2021

Client: Fortress, LLC **Driller:** Boretec1 **Logged By:** JCS

Location: Puyallup, Washington **Depth to Groundwater:** 5 ft **Approx. Elev:** NA

Depth (ft)	Sample Interval	Soil Description	Consistency/ Relative Density	SPT (N) Blows/foot 10 30 50	Moisture Content (%)
0	I	Dark brown SAND, fine grained, moist. (SP)	Medium Dense	12	23.8
▼ 5 10	I I I I	Dark gray-brown SAND to SAND with silt, fine to medium grained, wet. (SP/SP-SM)		10 10 10 29	24.1 23.2 21.6
15	I	Dark gray-brown silty SAND, fine grained, wet. (SM)		10	26.1 23.4
		Interbedded dark gray-brown fine to medium SAND and silty fine SAND, wet. (SP and SM)			25.6
		Dark gray SILT, wet, wood fragments in tip of sampler. (ML)			
20	I	Dark gray SAND to SAND with silt, fine grained, wet, numerous fine pumice fragments. (SP/SP-SM)		22	27.6
25	I	Interbedded dark gray-brown fine SAND and gray SILT, wet, trace of wood fragments. (SP and ML)	Loose	7	31.6
30	I	Dark gray SAND, fine grained, wet. (SP)	Medium Dense	25	25.4
35 40		Boring terminated at 31.5 feet. Groundwater encountered below 5 feet.			

NOTE: This borehole log has been prepared for geotechnical purposes. This information pertains only to this boring location and should not be interpeted as being indicative of other areas of the site

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LOG OF BORING NO. 7

Figure No. A-8

Project: 240 - 15th Street SE Industrial **Project No:** T-8661 **Date Drilled:** November 30, 2021

Client: Fortress, LLC **Driller:** Boretec1 **Logged By:** JCS

Location: Puyallup, Washington **Depth to Groundwater:** 2.5 ft **Approx. Elev:** NA

Depth (ft)	Sample Interval	Soil Description	Consistency/ Relative Density	SPT (N) Blows/foot 10 30 50	Moisture Content (%)
0					
▼		Fill: Dark brown silty SAND, fine grained, wet, numerous wood fragments. (SM)		9	
		Brown to gray-brown sandy SILT to silty SAND, fine grained, wet, mottled. (ML/SM)	Loose		30.8
5		Dark gray-brown SAND, fine grained, wet, scattered silty fine sand seams, trace of wood fragments. (SP)		8	25.2
		Boring terminated at 6.5 feet. Groundwater encountered below about 2.5 feet.			
10					

NOTE: This borehole log has been prepared for geotechnical purposes. This information pertains only to this boring location and should not be interpeted as being indicative of other areas of the site

Terra Associates, Inc.
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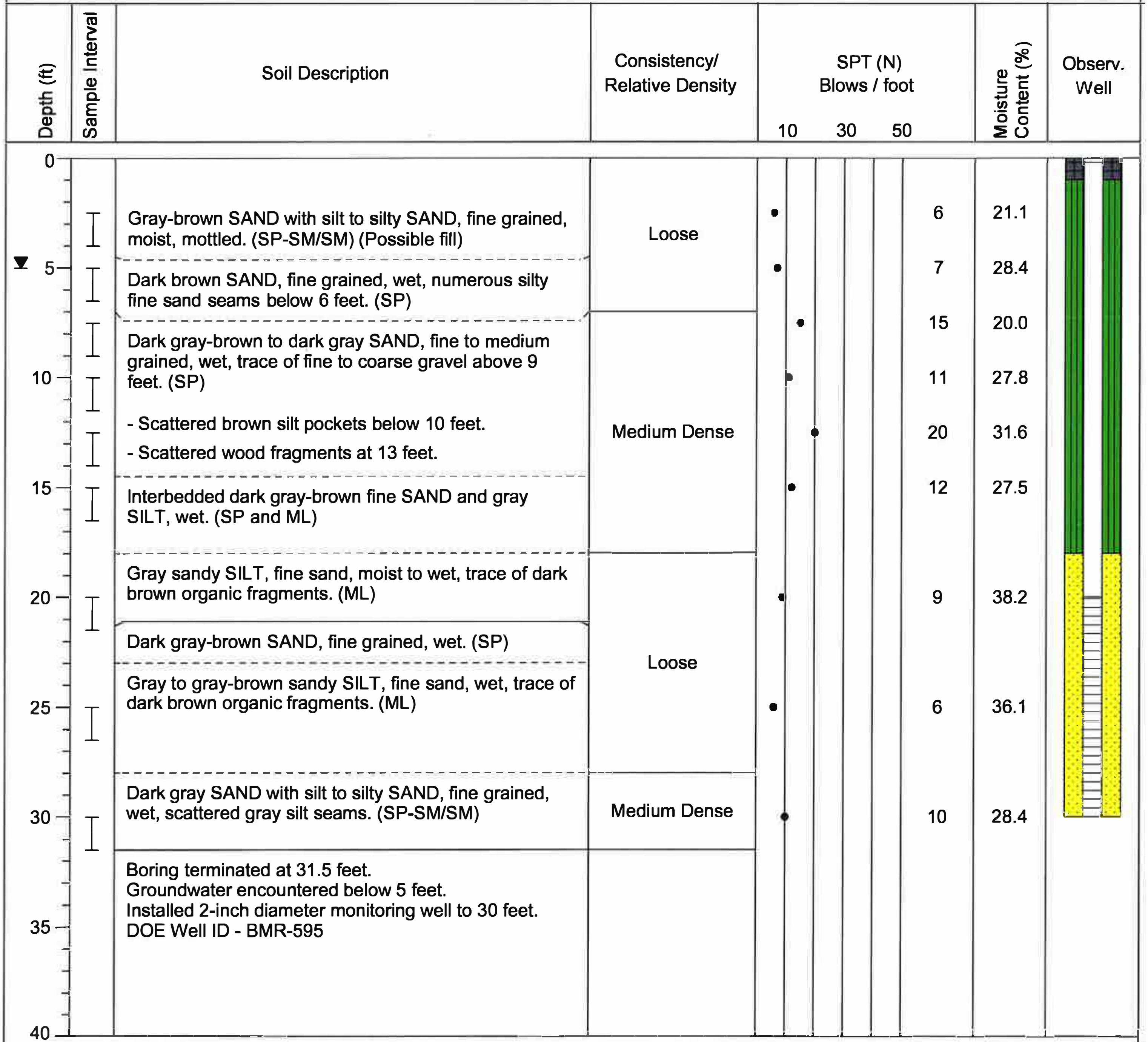
LOG OF BORING NO. 8

Figure No. A-9

Project: 240 - 15th Street SE Industrial **Project No:** T-8661 **Date Drilled:** November 30, 2021

Client: Fortress, LLC **Driller:** Boretec1 **Logged By:** JCS

Location: Puyallup, Washington **Depth to Groundwater:** 5 ft **Approx. Elev:** NA



Soil Description	Consistency/ Relative Density	SPT (N) Blows / foot	Moisture Content (%)
Gray-brown SAND with silt to silty SAND, fine grained, moist, mottled. (SP-SM/SM) (Possible fill)	Loose	6	21.1
Dark brown SAND, fine grained, wet, numerous silty fine sand seams below 6 feet. (SP)		7	28.4
Dark gray-brown to dark gray SAND, fine to medium grained, wet, trace of fine to coarse gravel above 9 feet. (SP) - Scattered brown silt pockets below 10 feet. - Scattered wood fragments at 13 feet.	Medium Dense	15 11 20	20.0 27.8 31.6
Interbedded dark gray-brown fine SAND and gray SILT, wet. (SP and ML)		12	27.5
Gray sandy SILT, fine sand, moist to wet, trace of dark brown organic fragments. (ML)	Loose	9	38.2
Dark gray-brown SAND, fine grained, wet. (SP)			
Gray to gray-brown sandy SILT, fine sand, wet, trace of dark brown organic fragments. (ML)		6	36.1
Dark gray SAND with silt to silty SAND, fine grained, wet, scattered gray silt seams. (SP-SM/SM)	Medium Dense	10	28.4
Boring terminated at 31.5 feet. Groundwater encountered below 5 feet. Installed 2-inch diameter monitoring well to 30 feet. DOE Well ID - BMR-595			

NOTE: This borehole log has been prepared for geotechnical purposes. This information pertains only to this boring location and should not be interpeted as being indicative of other areas of the site

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LOG OF BORING NO. 9

Figure No. A-10

Project: 240 - 15th Street SE Industrial **Project No:** T-8661 **Date Drilled:** December 1, 2021

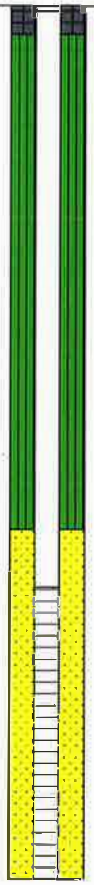
Client: Fortress, LLC **Driller:** Boretec1 **Logged By:** JCS

Location: Puyallup, Washington **Depth to Groundwater:** 5 ft **Approx. Elev:** NA

Depth (ft)	Sample Interval	Soil Description	Consistency/ Relative Density	SPT (N) Blows / foot	Moisture Content (%)
0					
	I	Brown silty SAND, fine grained, moist, scattered fine to coarse angular gravel. (SM) (Possible fill/disturbed)	Medium Dense	14	13.7
▼ 5	I	Brown to dark gray-brown SAND, fine grained, moist (wet below 5.5 feet), scattered brown silt to silty fine sand seams and layers above 9 feet. (SP)		12	24.2
	I			13	22.5
10	I	- Trace of organic partings and fine pumice graines between 10 and 11.5 feet.		10	29.4
	I	- Scattered brown silt seams below 12.5 feet.		28	28.4
15	I	Interbedded dark gray-brown SAND and gray silty SAND to sandy SILT, fine sand, wet. (SP and SM/ML)	Loose	8	30.8
		Dark gray to green-gray SILT, wet, scattered dark gray-brown fine sand seams and layers. (ML)			
20	I			9	33.9
25	I		Medium Dense	13	35.9 30.7
		Dark gray-brown SAND, fine grained, wet. (SP)			
30	I	- Scattered clayey silt layers between 30 and 30.5 feet.	Loose	5	30.4
		Boring terminated at 31.5 feet. Groundwater encountered below 5 feet. Installed 2-inch diameter monitoring well to 30 feet. DOE Well ID - BMR-596			
35					
40					

SPT (N) Blows / foot: 10 30 50

Observ. Well



NOTE: This borehole log has been prepared for geotechnical purposes. This information pertains only to this boring location and should not be interpeted as being indicative of other areas of the site

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LOG OF BORING NO. 10

Figure No. A-11

Project: 240 - 15th Street SE Industrial **Project No:** T-8661 **Date Drilled:** December 1, 2021

Client: Fortress, LLC **Driller:** Boretec1 **Logged By:** JCS

Location: Puyallup, Washington **Depth to Groundwater:** 5 ft **Approx. Elev:** NA

Depth (ft)	Sample Interval	Soil Description	Consistency/ Relative Density	SPT (N) Blows/foot	Moisture Content (%)
0	I	Fill: Dark brown to tan silty SAND with gravel, fine sand, fine to coarse gravel, moist to wet, numerous wood shavings. (SM)	Medium Dense	11	16.0
▼ 5	I	Gray-brown SAND, fine grained, moist, mottled. (SP)	Loose	8	25.7
	I	Dark gray-brown SAND, fine grained, wet, mottled. (SP)	Medium Dense	12	26.1
10	I	- 1-inch silt layer at 10.5 feet. - Trace of wood fragments below 10.5 feet		20	26.9
	I			11	27.6
15	I	Dark gray sandy SILT to silty SAND, fine sand, wet, trace of wood fragments. (ML/SM)		17	28.7
20	I	Gray-brown SAND, fine to medium grained, wet, scattered fine pumice grains. (SP)		12	21.6
25	I	Interbedded gray SILT to sandy SILT and dark gray-brown SAND, fine sand, wet, trace of wood fragments. (ML and SP)		10	26.2
30	I			10	28.1
35		Boring terminated at 31.5 feet. Groundwater encountered below 5 feet.			
40					

SPT scale: 10 30 50

NOTE: This borehole log has been prepared for geotechnical purposes. This information pertains only to this boring location and should not be interpeted as being indicative of other areas of the site

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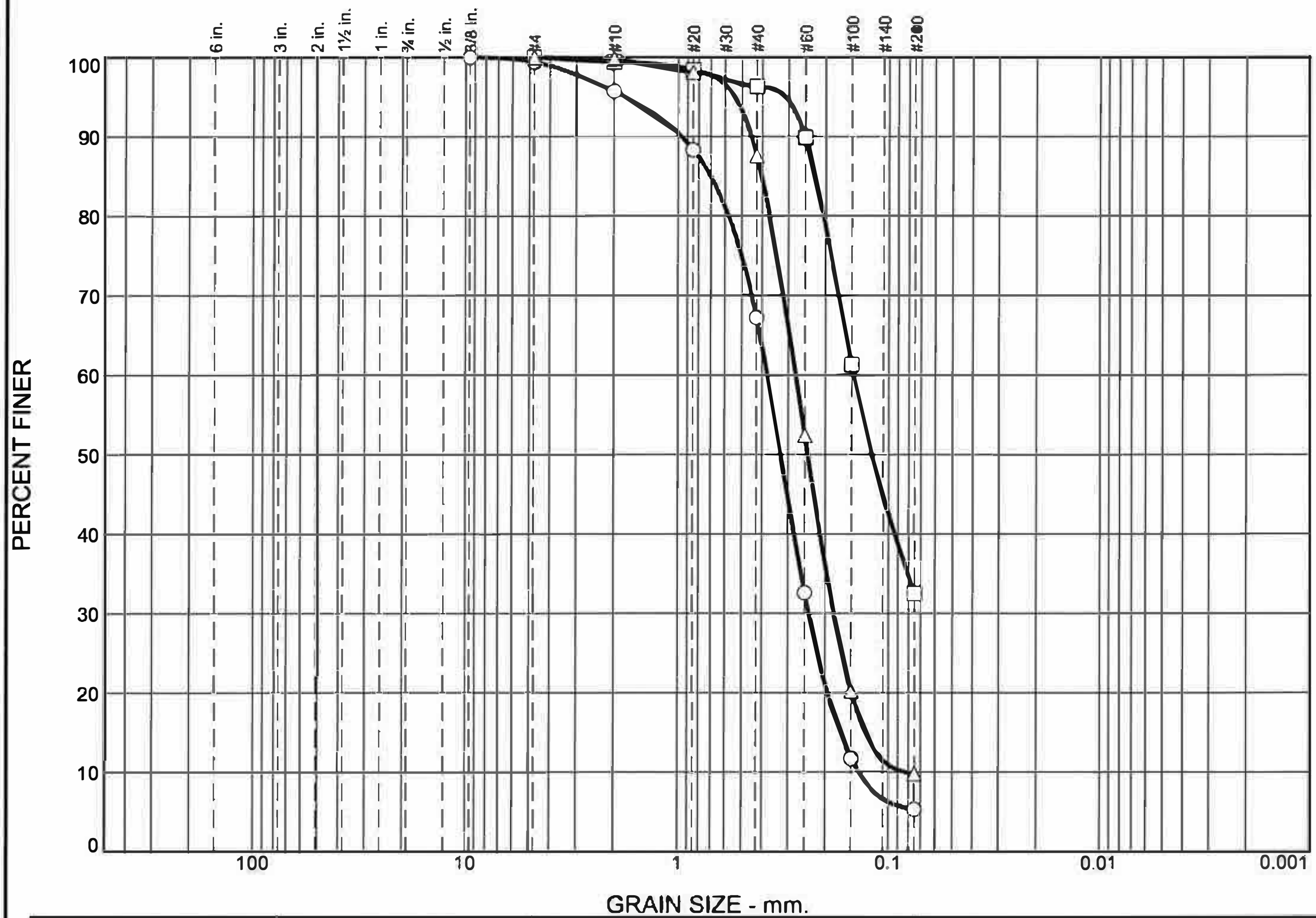
Particle Size Distribution Report



	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0.0	0.0	0.6	3.7	28.5	61.9	5.3	
□	0.0	0.0	0.0	0.6	3.1	63.8	32.5	
△	0.0	0.0	0.0	0.2	12.2	77.8	9.8	

☒	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○			0.7016	0.3770	0.3250	0.2390	0.1692	0.1384	1.09	2.72
□			0.2237	0.1466	0.1198					
△			0.4026	0.2764	0.2421	0.1812	0.1285	0.0836	1.42	3.31

Material Description	USCS	AASHTO
○ SAND with silt	SP-SM	
□ silty SAND	SM	
△ SAND with silt	SP-SM	

Project No. T-8661 **Client:** Fortress,LLC

Project: 240 - 15 Street SE Industrial

○ **Location:** B-1 **Depth:** 5'

□ **Location:** B-1 **Depth:** 12.5'

△ **Location:** B-3 **Depth:** 2.5'

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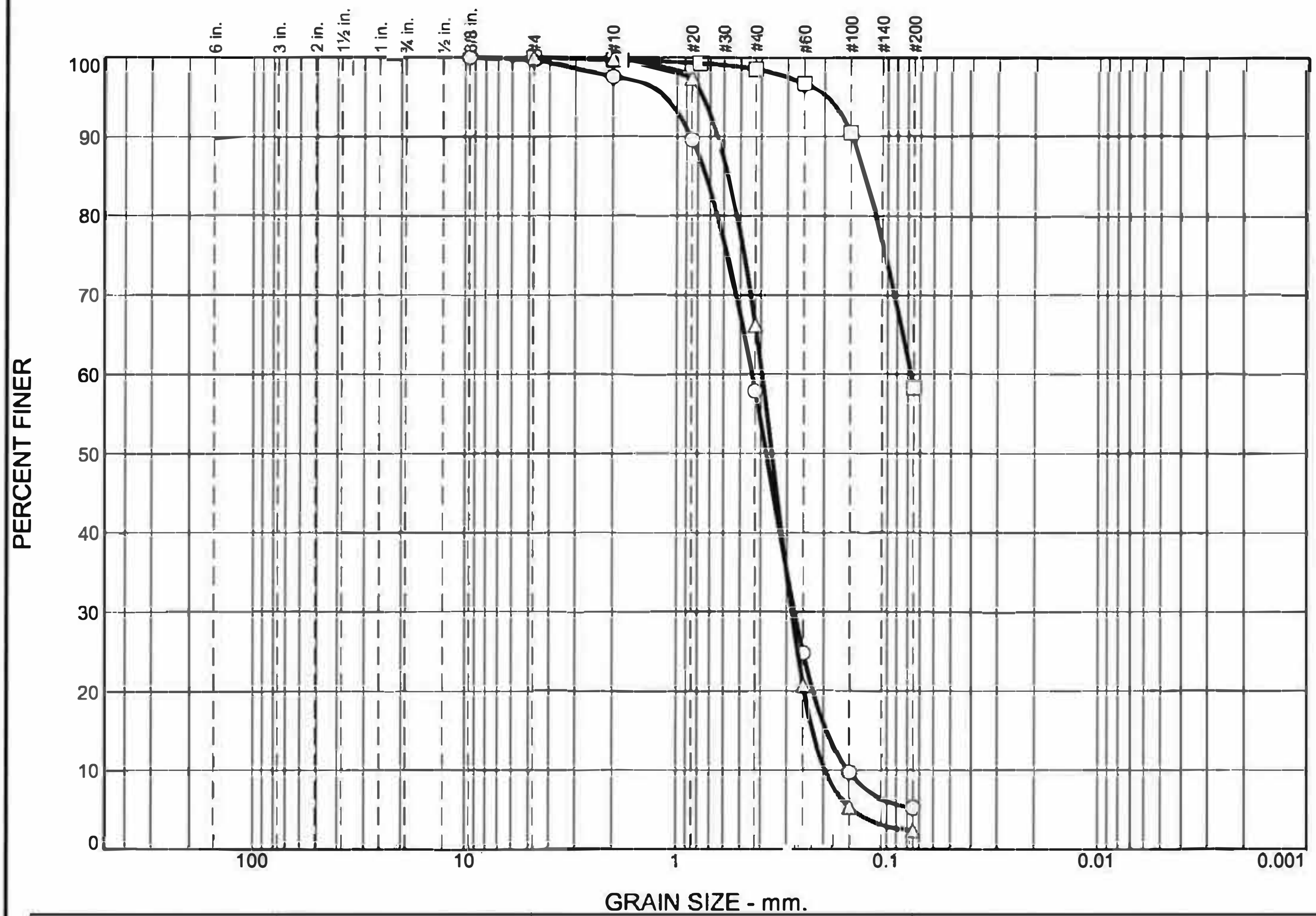
Kirkland, WA

Remarks:

Figure A-12

Tested By: FQ

Particle Size Distribution Report



	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0.0	0.0	0.3	2.1	39.7	52.6	5.3	
□	0.0	0.0	0.0	0.3	1.2	40.2	58.3	
△	0.0	0.0	0.0	0.2	33.6	63.8	2.4	

╳	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○			0.7323	0.4396	0.3765	0.2755	0.1932	0.1530	1.13	2.87
□			0.1275	0.0773						
△			0.5722	0.3949	0.3538	0.2835	0.2252	0.1964	1.04	2.01

Material Description	USCS	AASHTO
○ SAND with silt	SP-SM	
□ sandy SILT	ML	
△ SAND	SP	

Project No. T-8661 **Client:** Fortress,LLC

Project: 240 - 15 Street SE Industrial

○ **Location:** B-6 **Depth:** 7.5'
□ **Location:** B-7 **Depth:** 3'
△ **Location:** B-8 **Depth:** 10'

Remarks:

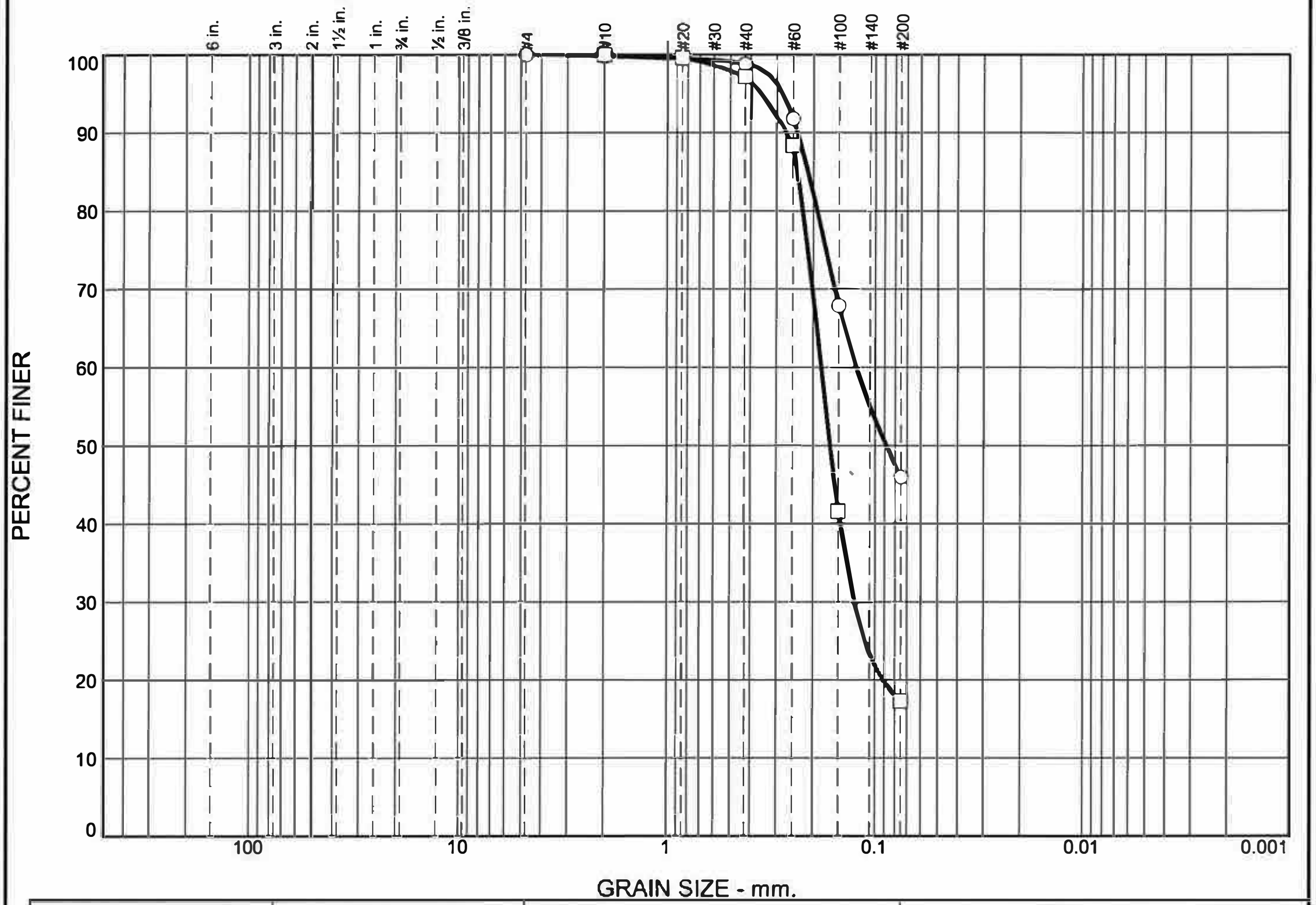
Terra Associates, Inc.

Kirkland, WA

Figure A-13

Tested By: FQ

Particle Size Distribution Report



	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0.0	0.0	0.0	0.2	1.0	52.8	46.0	
□	0.0	0.0	0.0	0.0	2.8	79.9	17.3	

☒	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○			0.2117	0.1233	0.0881					
□			0.2379	0.1822	0.1648	0.1254				

Material Description	USCS	AASHTO
○ silty SAND	SM	
□ silty SAND	SM	

Project No. T-8661 **Client:** Fortress,LLC
Project: 240 - 15 Street SE Industrial

○ **Location:** B-8 **Depth:** 30'
□ **Location:** B-9 **Depth:** 10'

Remarks:

Terra Associates, Inc.

Kirkland, WA

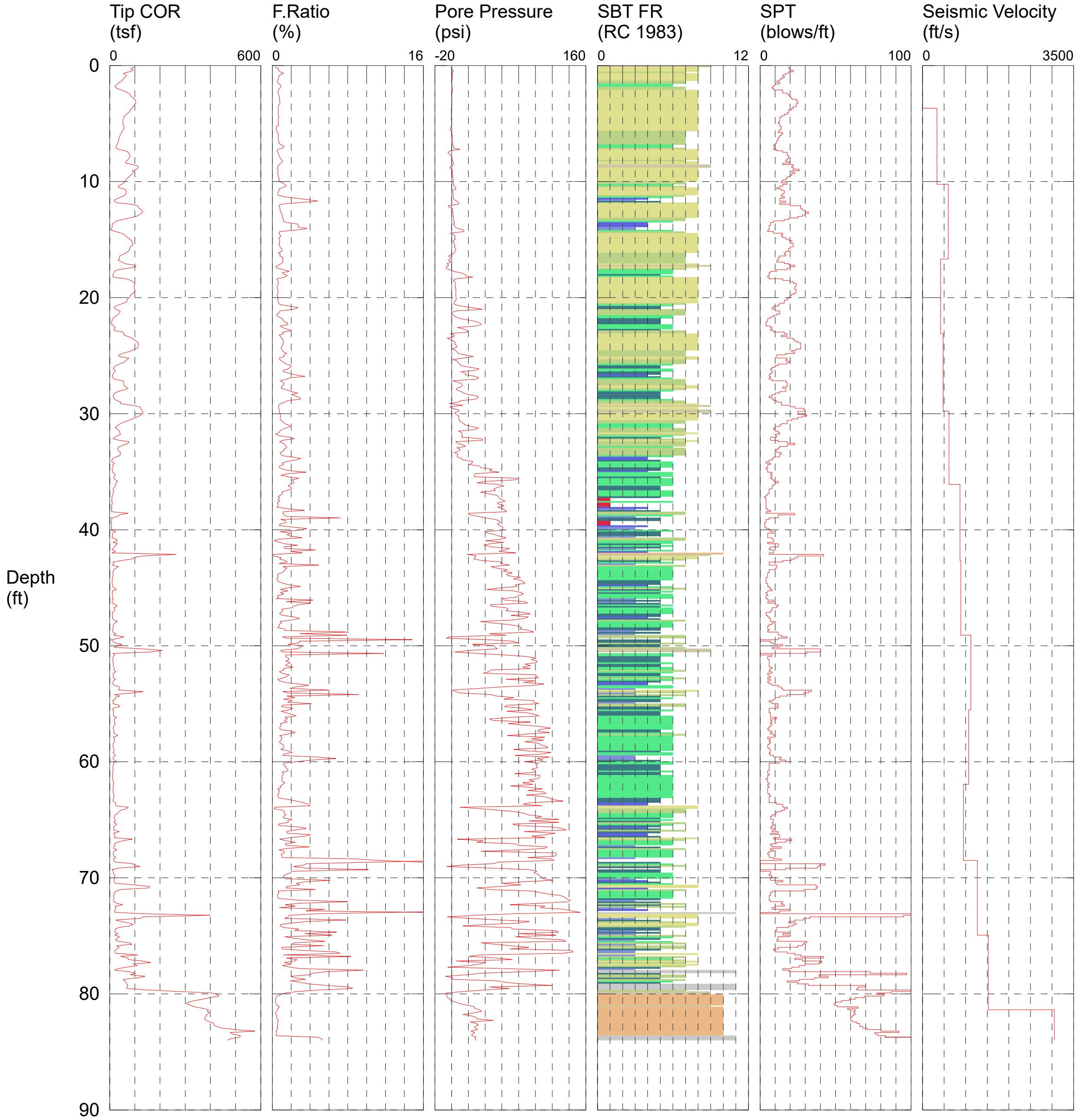
Figure A-14

Tested By: FQ

CPT- 01

CPT CONTRUCTOR: In Situ Engineering
CUSTOMER: Terra Asso
LOCATION: Puyallup
JOB NUMBER: T-8661
COMMENT: 240 - 15th St SE
COMMENT:

OPERATOR: Okbay
CONE ID: DDG1369
TEST DATE: 12/8/2021 9:38:13 AM
PREDRILL: 0 ft
BACK FILL: 20% Grout + Bentonite Chips
SURFACE PATCH: None



TOTAL DEPTH: 83.990 ft

🟥 1 sensitive fine grained
🟥 2 organic material
🟦 3 clay
🟦 4 silty clay to clay
🟦 5 clayey silt to silty clay
🟩 6 sandy silt to clayey silt
🟩 7 silty sand to sandy silt
🟨 8 sand to silty sand
🟫 9 sand
🟧 10 gravelly sand to sand
⬜ 11 very stiff fine grained (*)
⬛ 12 sand to clayey sand (*)

*SBT/SPT CORRELATION: UBC-1983

HOLE NUMBER: CPT- 01

OPERATOR: Okbay

CUSTOMER: Terra Asso

LOCATION: Puyallup

JOB NUMBER: T-8661

CPT CONTRUCTOR: In Situ Engineering

CONE ID: DDG1369

TEST DATE: 12/8/2021 9:38:13 AM

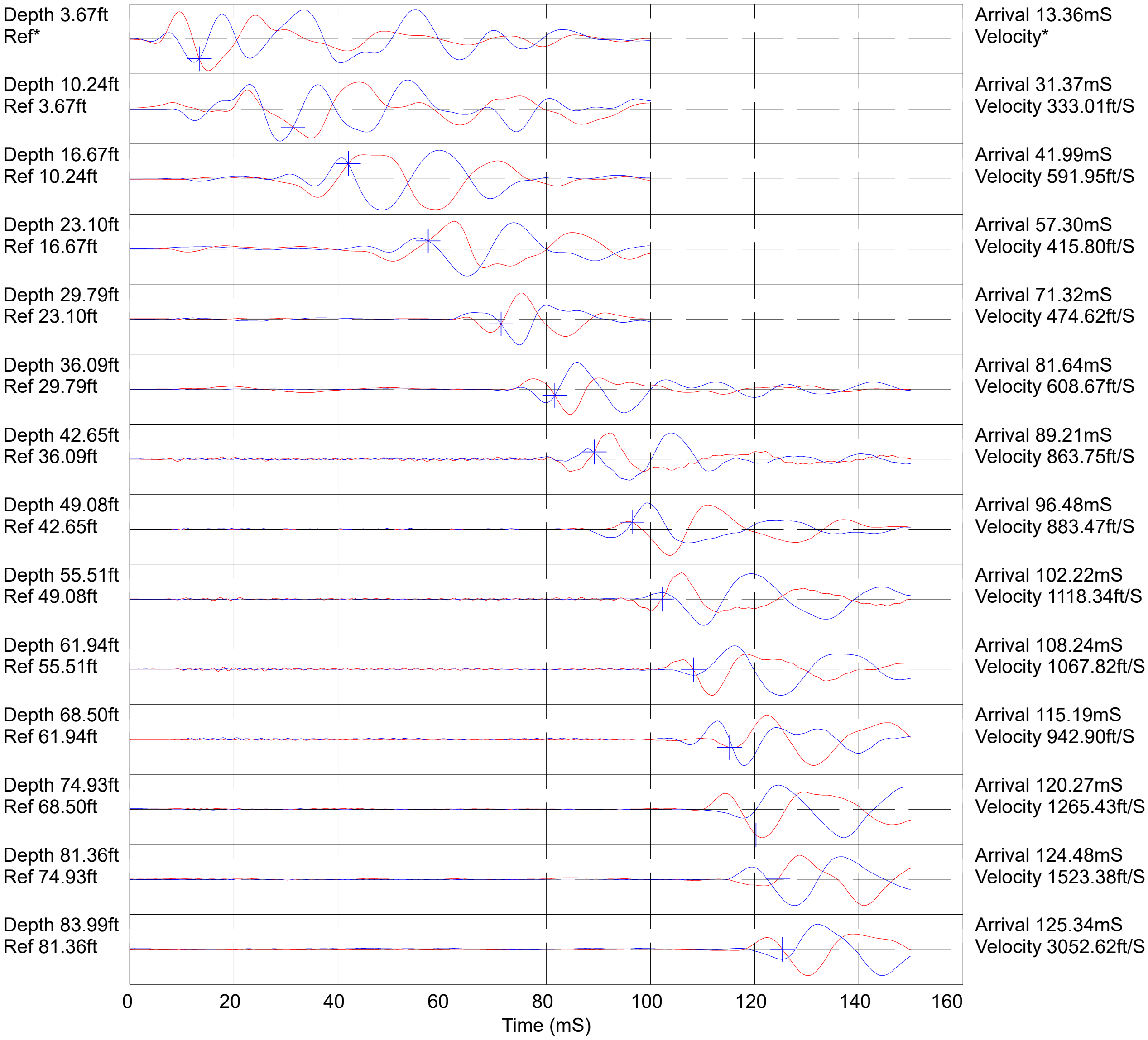
COMMENT: 240 - 15th St SE

PREDRILL0 ft

BACK FILL: 20% Grout + Bentonite Chips

SURFACE PATCH: none

HOLE NUMBER: CPT- 01



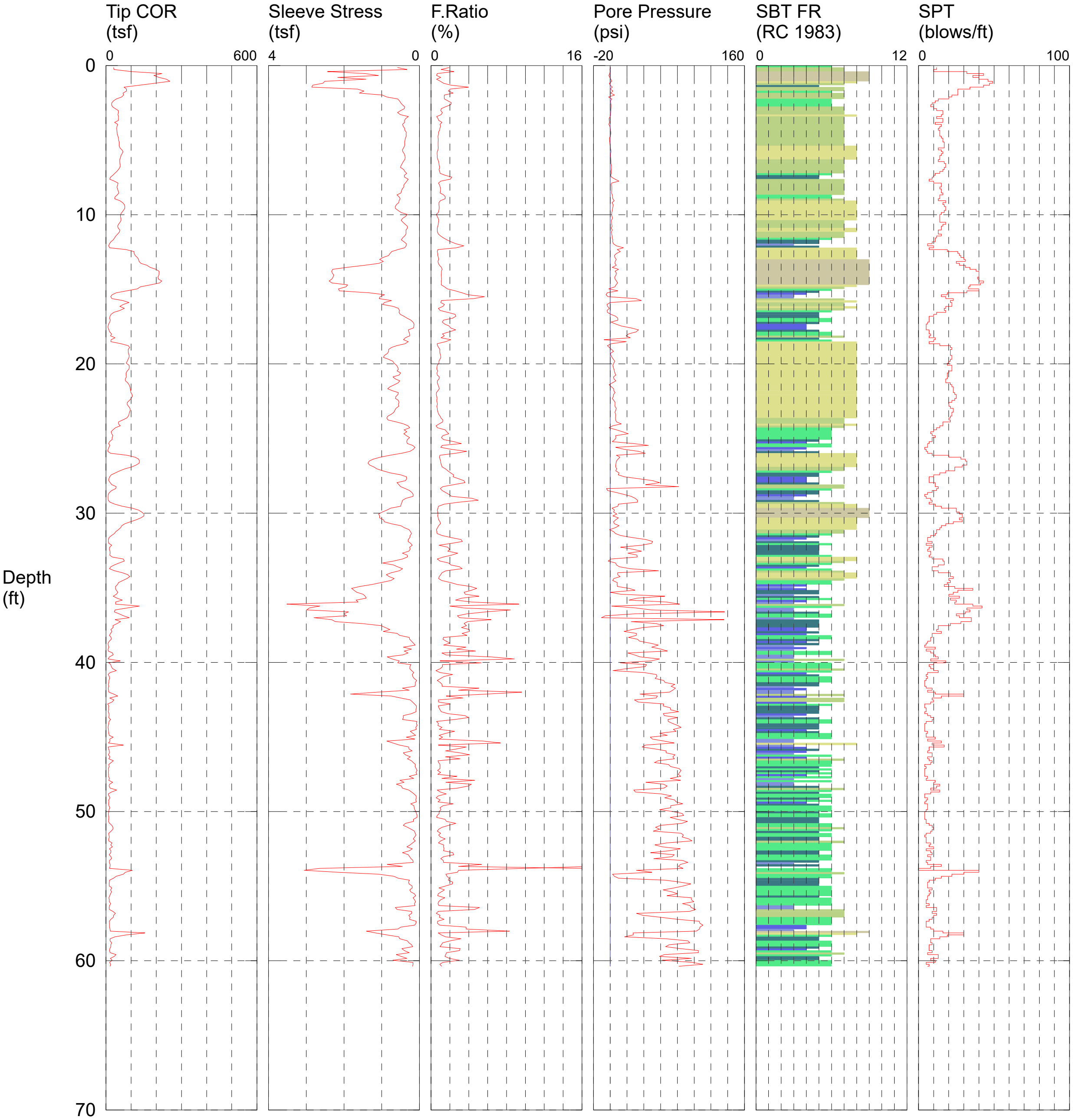
Hammer to Rod String Distance (ft): 2.79
* = Not Determined

COMMENT: 240 - 15th St SE

CPT- 02

CPT CONTRUCTOR: In Situ Engineering
CUSTOMER: Terra Asso
LOCATION: Puyallup
JOB NUMBER: T-8661
COMMENT: 240 - 15th St SE
COMMENT:

OPERATOR: Okbay
CONE ID: DDG1369
TEST DATE: 12/8/2021 12:37:48 PM
PREDRILL: 0 ft
BACK FILL: 20% Grout + Bentonite Chips
SURFACE PATCH: None



TOTAL DEPTH: 60.367 ft

■ 1 sensitive fine grained
■ 2 organic material
■ 3 clay

■ 4 silty clay to clay
■ 5 clayey silt to silty clay
■ 6 sandy silt to clayey silt

■ 7 silty sand to sandy silt
■ 8 sand to silty sand
■ 9 sand

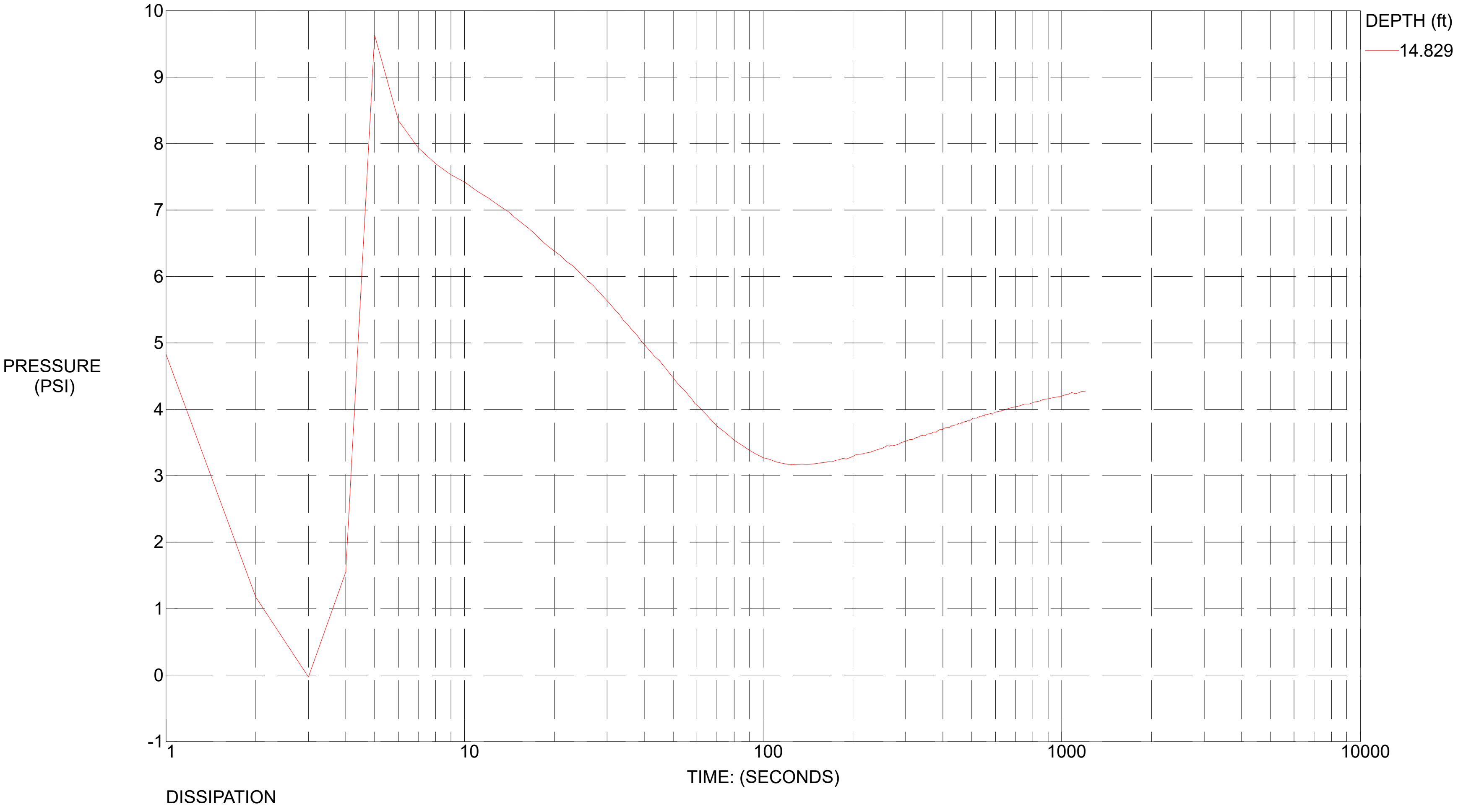
■ 10 gravelly sand to sand
■ 11 very stiff fine grained (*)
■ 12 sand to clayey sand (*)

*SBT/SPT CORRELATION: UBC-1983

CPT- 02

CPT CONTRUCTOR: In Situ Engineering
CUSTOMER: Terra Asso
LOCATION: Puyallup
JOB NUMBER: T-8661

OPERATOR: Okbay
CONE ID: DDG1369
TEST DATE: 12/8/2021 12:37:48 PM
PREDRILL: 0 ft
BACK FILL: 20% Grout + Bentonite Chips
SURFACE PATCH: Cold Patch



APPENDIX B

LIQUEFACTION ANALYSES

LIQUEFACTION ANALYSIS

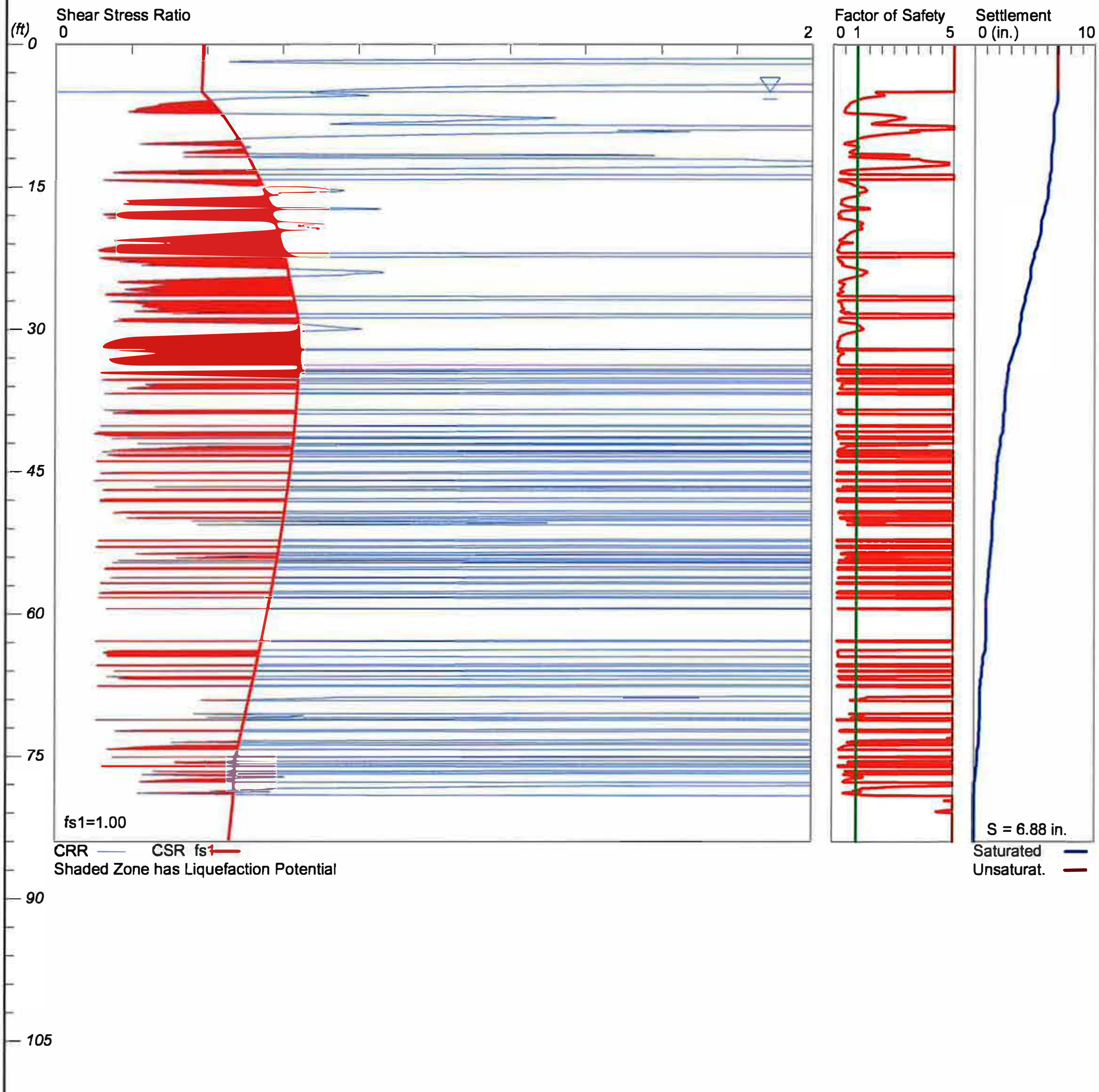
240 - 15th St SE Industrial

Hole No.=CPT-1 Water Depth=5.0 ft

Ground Improvement of Fill=3 ft

Magnitude=7

Acceleration=0.6g



LIQUEFACTION ANALYSIS

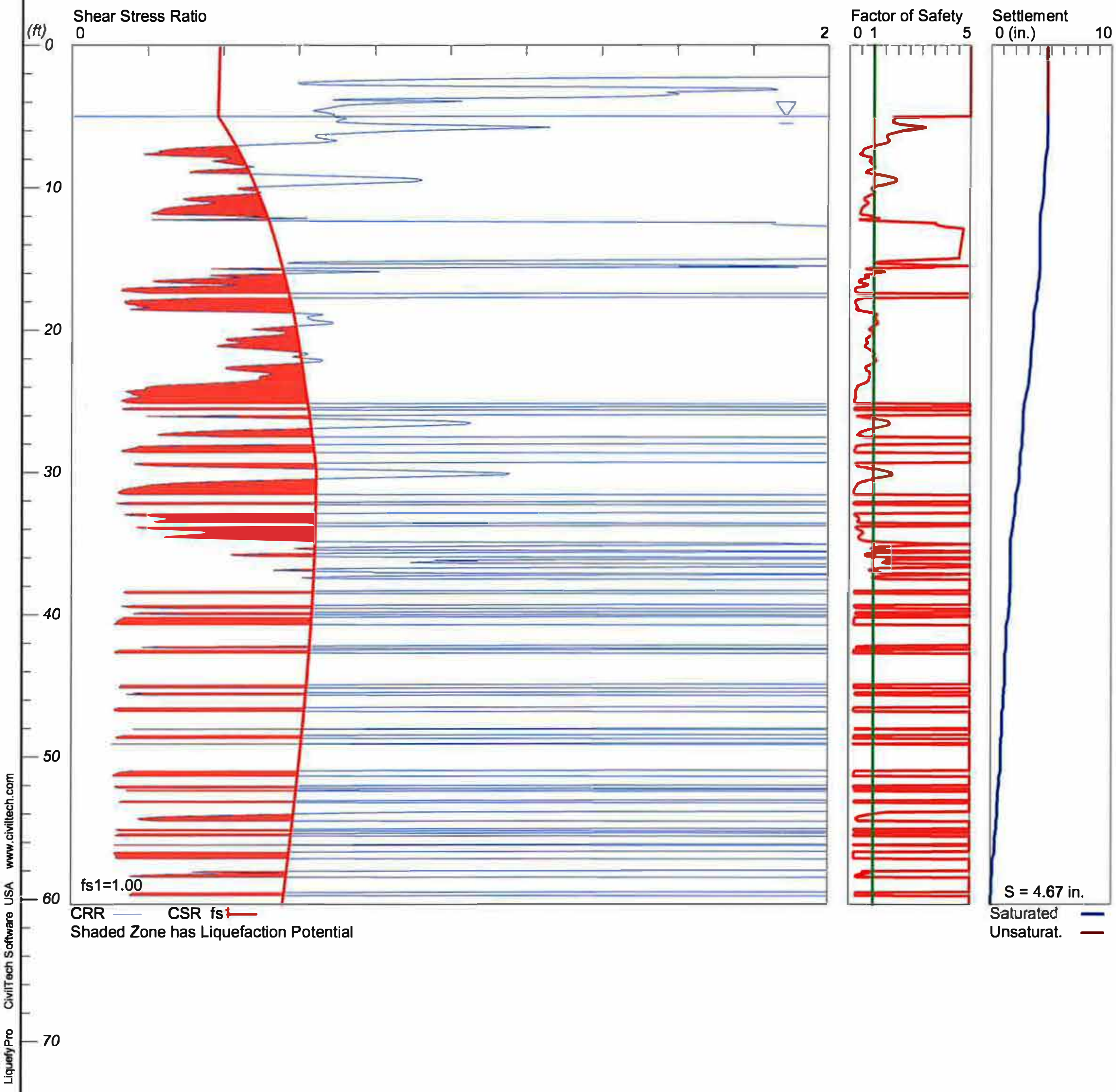
240 - 15th St SE Industrial

Hole No.=CPT-2 Water Depth=5.0 ft

Ground Improvement of Fill=3 ft

Magnitude=7

Acceleration=0.6g



Tab 7.0

7.0 OTHER PERMITS

Other permits that may be required for this project include:

- SEPA Environmental Checklist
- Civil Construction Permit
- Building Permits
- Construction Stormwater General Permit
- Fire Permit

Tab 8.0

8.0 ESC ANALYSIS AND DESIGN

An erosion and sediment control plan will be prepared as part of the civil construction plan set. These plans will follow the measures outlined in the Erosion and Sediment Control Standards. The measures outlined in the Manual are discussed below.

Clearing Limits: Prior to any site clearing or grading, the construction limits will be clearly marked with a combination of silt fencing and/or brightly colored survey tape.

Cover Measures: Temporary and permanent cover measures shall be provided when necessary to protect disturbed areas. Temporary cover shall be installed if an area is to remain unworked for more than seven days during the dry season (May 1 to September 30) or for more than two days during the wet season (October 1 to April 30), unless otherwise noted by the City. Any area to remain unworked for more than 30 days shall be seeded or sodded, unless the City determines that winter weather makes vegetation establishment unfeasible. During the wet season, slopes and stockpiles 3H:1V or steeper with more than 10 feet of vertical relief shall be covered if they are to remain unworked for more than 12 hours. The CESCL lead shall be responsible for determining what specific measures to implement to suit changing site conditions.

Perimeter Protection: Silt fence shall be installed along the property lines prior to any upstream grading to prevent and filter sediment sheet flow from adjacent areas.

Traffic Area Stabilization: A construction entrance will be installed to minimize erosion tracking of sediment offsite. Should there be parking areas used by construction traffic onsite they shall also require stabilization.

Sediment Retention: Surface water collected from disturbed areas of the site shall be routed through a sediment pond or trap prior to release from the site.

Surface Water Controls: Surface water controls shall be installed in the form of temporary "v" ditches with rock check dams to intercept and convey surface water from disturbed areas to the sediment trap.

Dust Control: Preventative measures to minimize the wind transport of soil shall be taken as necessary depending on site conditions. The most common method shall be to spray exposed soils until wet, but not so wet as to cause the soils to generate runoff from the spraying.

Tab 9.0

9.0 BOND QUANTITIES, FACILITY SUMMARIES, AND DECLARATION OF COVENANT

All required bonding and financial guarantees will be provided as required by the City of Puyallup.

Tab 10.0

10.0 OPERATIONS AND MAINTENANCE MANUAL

The proposed on-site facilities will be owned and maintained by the owner. An Operations and Maintenance Manual has been completed and submitted as a separate document with the permit construction plans.