

# Brodie Plat

## *Construction Drainage Report*

Prepared for

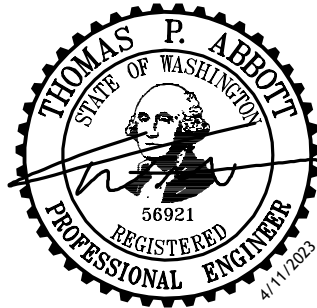
***City of Marysville***  
*80 Columbia Ave*  
*Marysville, WA 98270*

Prepared by

*Ryan Ferguson, EIT*

Reviewed by

*Tom Abbott, PE*



***April 2023***

***Job No: C22-177***

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**APPENDICES**

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## **SECTION 1: PROJECT OVERVIEW**

The proposed Brodie Plat project is comprised of parcel numbers 30052500302300, 30052500303800, and 30052500303900, and proposes the construction of 45 single family lots with associated utilities, ROW, and open spaces on a 10.02-acre site. There are frontage improvements proposed on the site along 60<sup>th</sup> St NE, and access to the site will be from 60<sup>th</sup> St NE. The site is located within the SW ¼ of the SW ¼ of Section 25, Township 30 N, Range 05 E, W.M. The project address is 8719 60<sup>th</sup> St NE Marysville, WA 98270. See the Vicinity Map in Appendix 1 for visual representation of the subject property.

### **Existing Site**

The parcel 30052500303800 is currently occupied by a cellular tower in the east and a cargo shipping storage container in the center of the parcel. The shipping container on site will be removed, and the cell tower will remain in Tract 996 with access from the public ROW. The site is bordered to the west by R18 (Multi-Family Medium) zoned land, to the north by Recreation zoned land, and to the south by R6.5 (Single Family High) zoned land. The project parcels are currently zoned Recreation and a rezone to R-18 zoning is proposed for the project site. Existing ground cover is a combination of trees, grass, and gravel.

The proposed development will exist within the bounds of the Onsite Basin and the frontage along 60<sup>th</sup> St NE. In the existing condition, the site discharges to the onsite wetland and conveyances north and west offsite. See Predeveloped and Developed Hydrology Maps in Appendix 4 for a visual representation of these basins. The project site includes a stream area and wetlands areas that are along the westerly portion of the site. Buffer averaging is proposed.

Site soils are classified as about 27% Norma loam and about 73% Tokul gravelly medial loam (where about 25% is at 0 to 8 percent slopes, about 39% is at 8 to 15 percent slopes, and about 9% is at 15 to 30 percent slopes). See the Soils Map in Appendix 3 for visual layout of soil type areas of the subject property. According to the Marysville topographic map, the existing site slopes are generally sloping from northeast to southwest. Due to till soils present onsite, the Geotechnical Engineer does not recommend infiltration for LID BMPs to be used onsite.

### **Proposed Development**

The proposed Brodie Plat project will develop associated utilities, driveways, ROW, landscaping, and open spaces. Stormwater will be mitigated via a detention and water quality treatment system and bypass basin. Onsite development will disturb 6.71 acres of area that will be collected to the detention vault for mitigation and stormwater quality treatment. Additional onsite and frontage improvements will impact 0.61 acres within the 87<sup>th</sup> Ave and 60<sup>th</sup> Ave dedicated ROW that cannot be collected to the detention vault but will be treated for stormwater quality treatment.

### **Proposed Drainage System**

This project is subject to the requirements of the 2014 Stormwater Management Manual for Western Washington (DOE Manual). In compliance with 2014 DOE Manual, all runoff from developed/disturbed surfaces must be collected, treated, and released to natural drainage courses unless it is dispersed or infiltrated.

Proposed pollution generating impervious surfaces (PGIS) will exceed the 5,000 SF threshold and thus basic water quality treatment will be provided via a water quality treatment structure that treats stormwater runoff from roadways and driveways.

The disturbed area of the development is contained within the Onsite Basin and the Bypass Basin. The Onsite Basin consists of developed roof, landscape, sidewalk, pavement and driveway. This project is required to meet flow control requirements which are achieved by a detention vault in the northwestern

northwestern portion of the site. Developed condition stormwater associated with the Onsite Basin will be collected within the detention vault and released directly into Grace Creek, which is located directly south of and parallel to Allen Creek, after treatment in the proposed Perfilter. Developed condition stormwater associated with the Bypass Basin will be treated by a Perfilter and dispersed. See Section 4.0 for additional discussion regarding proposed stormwater management and water quality treatment measures.

### **Erosion/Sedimentation Control**

Erosion control measures that will be utilized during construction will include a combination of silt fence, storm drain inlet protection, interceptor swales, and sediment pond. See Section 2.0 for discussion of how SWPPP Elements are addressed.

### **Minimum Requirements**

Per the 2014 DOE, Minimum Requirements 1-9 apply to the proposed development.

#### *Minimum Requirement #1: Preparation of Stormwater Site Plans*

A report along with the construction plans, to be submitted at a later date, satisfies the minimum requirement.

#### *Minimum Requirement #2: Construction Stormwater Pollution Prevention*

See Section 2 of this Report for the SWPPP BMP Elements, and the SWPPP (submitted as a separate document) for a complete discussion of erosion control BMP's and their use specific to the site.

#### *Minimum Requirement #3: Source of Pollution*

Permanent source control BMPs are not applicable for the subject site since the associated activities for the new residence do not fall within the types of facilities listed within Volume IV of the DOE Manual (Residential developments are not required to implement source control BMP's). BMPs for erosion and sedimentation control are specified in the Construction Plans and the SWPPP.

#### *Minimum Requirement #4: Preservation of Natural Drainage Systems and Outfalls*

Flow from the site will preserve its natural drainage pattern from the southeast to the northwest. Runoff flows towards Grace Creek and continues northwest before leaving the quarter mile buffer of analysis.

#### *Minimum Requirement #5: On-Site Stormwater Management*

The project will exceed the 10,000 SF PGHS threshold and is required to provide an Onsite Stormwater BMP. A detention vault will be installed in the northwestern end of the site and will discharge at a historic, mitigated rate that will be dispersed into native vegetation in Tract 999.

#### *Minimum Requirement #6: Runoff Treatment*

As the project will exceed the 5,000 SF threshold of PGHS, the project is required to provide "basic" water quality treatment per the 2014 DOE manual. A Perfilter water quality treatment unit will be installed downstream of the detention vault to meet this requirement and Modular Wetland unit will be installed along the 60<sup>th</sup> St NE frontage. Runoff from public ROW facilities will not be treated by the proposed on-site Perfilter, which will be privately owned and maintained.

#### *Minimum Requirement #7: Flow Control*

A detention vault is proposed at the northwestern end of the site to control flows and release at historic, mitigated rates. Please see Section 4.0 for additional flow control modeling and parameters for detention sizing.

#### *Minimum Requirement #8: Wetlands Protection*

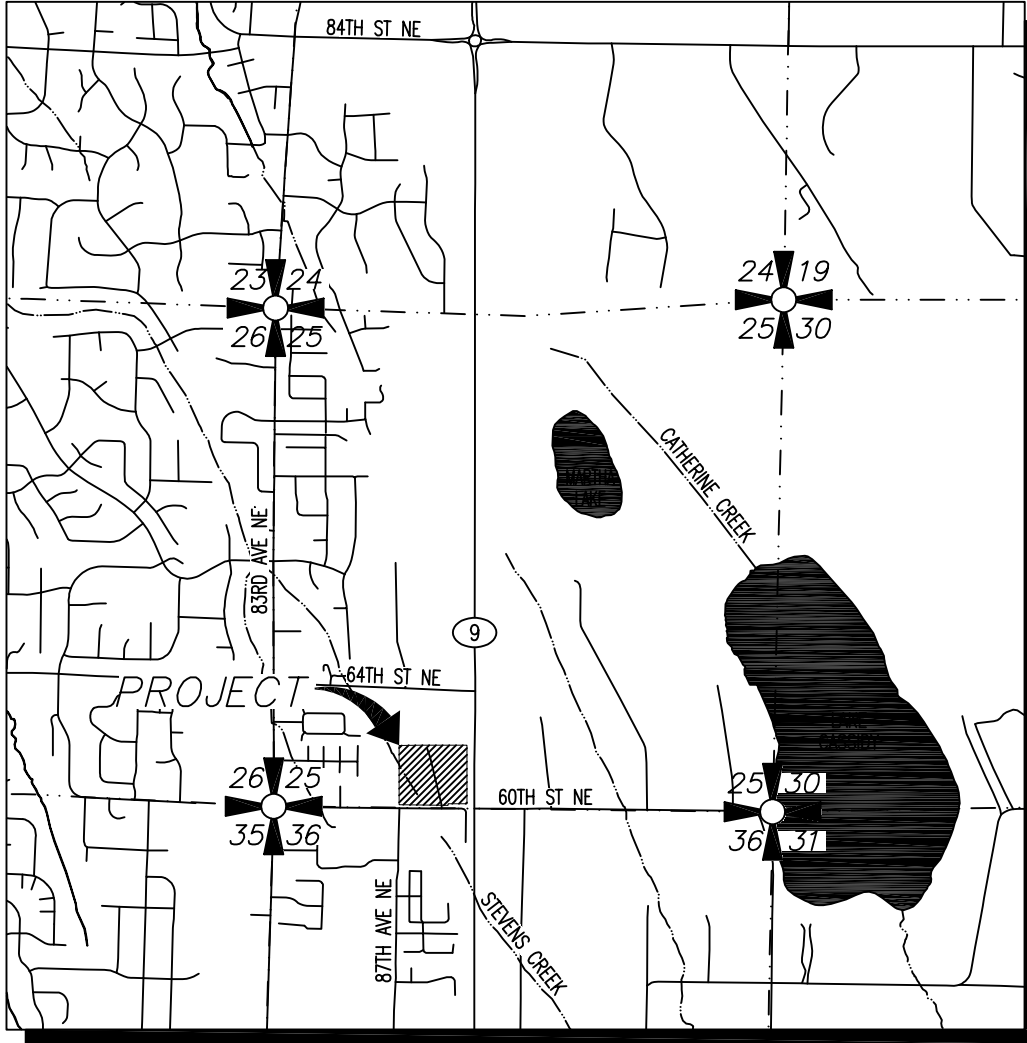
Wetlands exist onsite and have been given 100' buffers. Buffer averaging is proposed. The dispersion facility discharges from the Bypass Basin and the detention vault outfall are proposed within the outer 25% of the revised buffer line. Please see sheet RD-01 of the plan set for location information. Wetland areas will not be disturbed during site construction and will be protected with silt fencing and other BMPs throughout construction.

*Minimum Requirement #9: Operation and Maintenance*

See Operations and Maintenance in Section 6 of this report.

### **Appendix 1: Project Overview**

1. Figure 1.0 – Vicinity Map
2. Figure 2.0 – Existing Conditions Map
3. Proposed Development Map



VICINITY MAP

SCALE: 1"=2000'

Drawing: P:\Civ\2022\C22-177 Brodie Plat\Drawings\Exhibits\C22177-EX-VM.dwg Plotted: Oct 26, 2022 - 12:12pm

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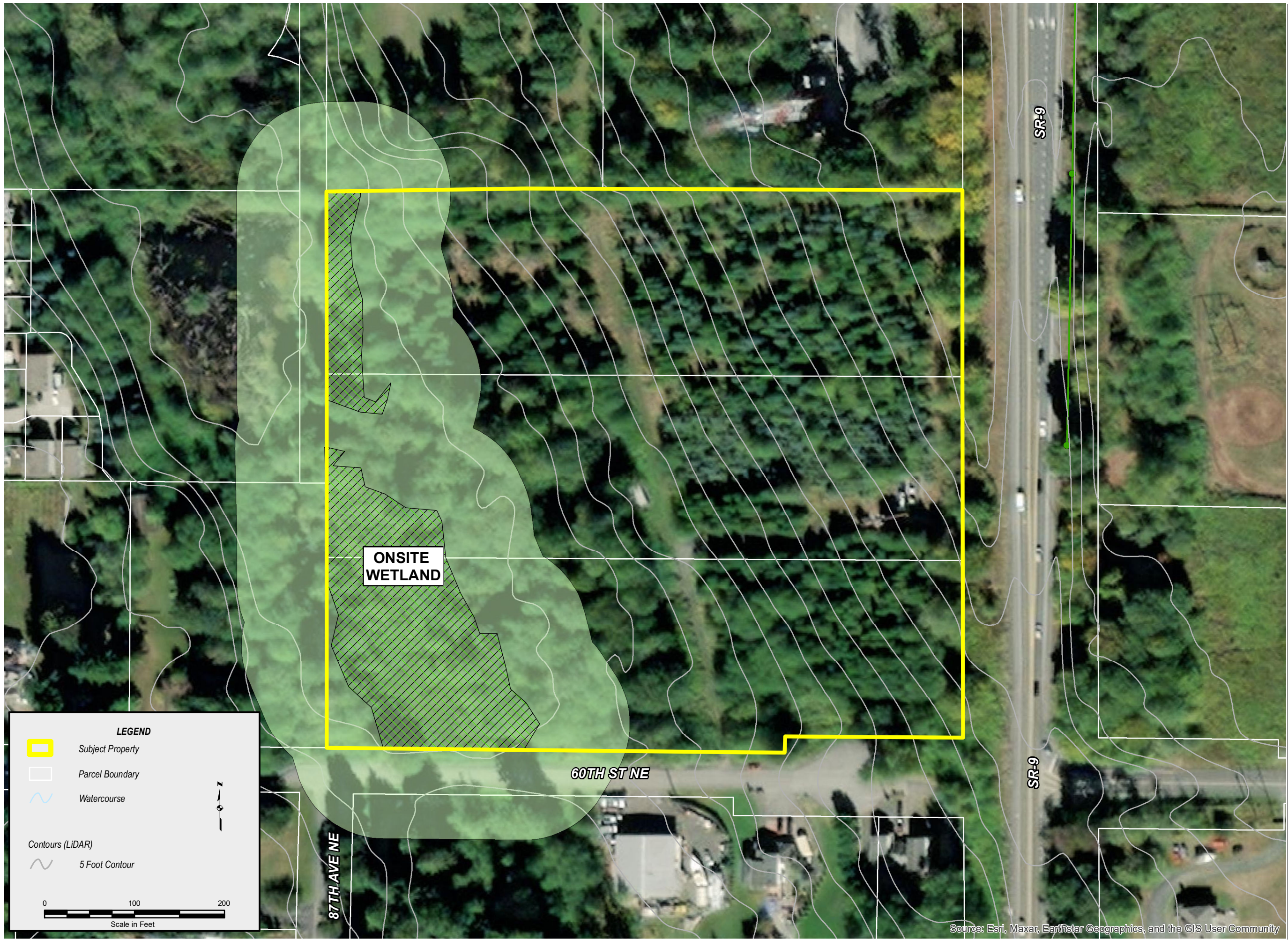
F 425.482.2893

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BRODIE PLAT

VICINITY MAP





**LEGEND**

- Subject Property
- Parcel Boundary
- ~ Watercourse

Contours (LiDAR)

- ~ 5 Foot Contour

0 100 200  
Scale in Feet

N  
↑

SOURCE INFORMATION	
SOURCE AGENCY	DESCRIPTION
SNOHOMISH COUNTY GIS	PARCEL BOUNDARY
SNOHOMISH COUNTY GIS	CONTOURS GENERATED FROM BARE EARTH LIDAR (KING COUNTY). THIS DATA HAS A STATED VERTICAL ACCURACY OF APPROXIMATELY 1 FOOT.

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**BRODIE PLAT**

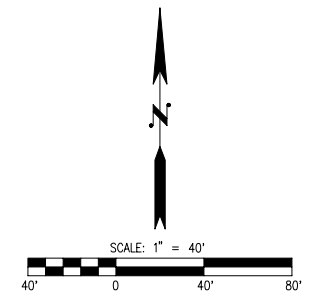
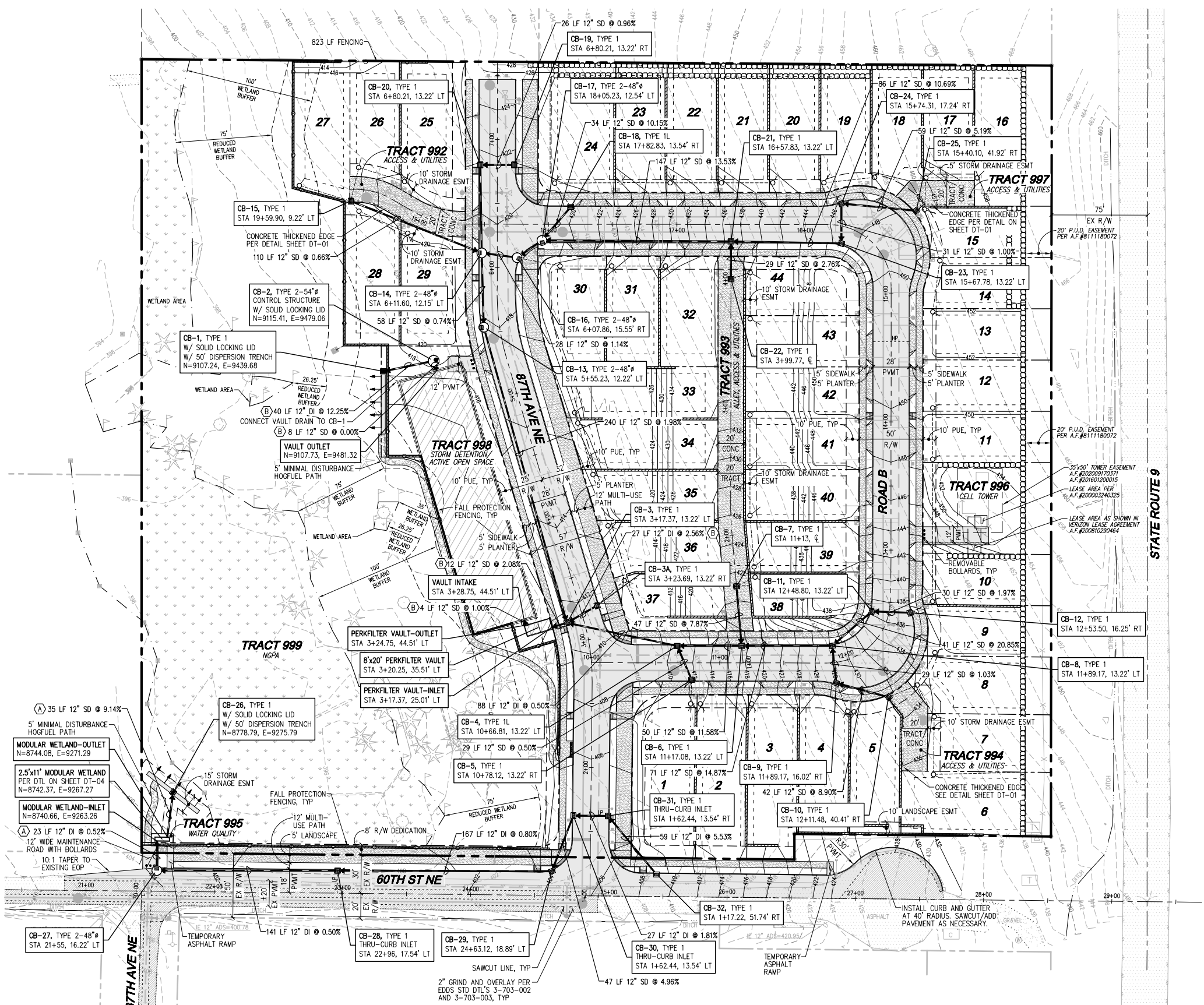
**EXISTING CONDITIONS MAP**

NAD 1983 HARN STATEPLANE WASHINGTON NORTH FIPS 4601 FEET
REVISION: JOB NUMBER: C22-177
DESIGNER: TABBOTT DRAWING BY: TABBOTT
DATE: 6/27/2022
SCALE: AS SHOWN
JURISDICTION: MARYSVILLE

**FIGURE:**  
**2.0**



PORTION OF SE1/4, SW1/4, SEC 25, TWN 30 N, RGE 5 E, W.M., SNOHOMISH COUNTY, WASHINGTON



**LEGEND**

- STORM PIPE
- DRAIN LINE
- 6" PVC FRENCH DRAIN
- SEWER PIPE
- WATER PIPE
- FALL PROTECTION FENCING
- SIGN ("NO PARKING" UNLESS OTHERWISE NOTED)
- STREET LIGHT
- FULL DEPTH ASPHALT
- CONCRETE
- 2" GRIND AND OVERLAY
- SEE STORM ALIGNMENT A ON SHEET RD-02
- SEE STORM ALIGNMENT B ON SHEET RD-05

**DRIVEWAY CUT TABLE**

LOT	STATION	WIDTH (FT)	SIDE	ROAD
1	10+63	18	RT	ROAD B
2	11+03	18	RT	ROAD B
3	11+43	18	RT	ROAD B
4	11+85	21	RT	ROAD B
TRACT 994, 5-8	12+17	44	RT	ROAD B
9	12+47	17	RT	ROAD B
10	12+83	18	RT	ROAD B
TRACT 996	13+12	12	RT	ROAD B
11	13+85	18	RT	ROAD B
12	14+31	18	RT	ROAD B
13	14+65	18	RT	ROAD B
14	15+10	19	RT	ROAD B
TRACT 997, 15-18	15+40	47	RT	ROAD B
19	15+70	17	RT	ROAD B
20	16+04	18	RT	ROAD B
21	16+45	18	RT	ROAD B
22	16+85	18	RT	ROAD B
23	17+25	18	RT	ROAD B
24	17+64	18	RT	ROAD B
TRACT 992, 25-29	18+34	20	LT	87TH AVE NE
30	17+72	18	LT	ROAD B
31	17+30	18	LT	ROAD B
TRACT 993, 32	16+67	53	LT	ROAD B
TRACT 993	11+16	34	LT	ROAD B
38	12+67	18	LT	ROAD B
39	13+07	18	LT	ROAD B
40	13+48	18	LT	ROAD B
41	13+88	18	LT	ROAD B
42	14+28	18	LT	87TH AVE NE
43	14+58	18	LT	ROAD B
44	14+98	18	LT	ROAD B
TRACT 998	5+31	12	LT	87TH AVE NE

- NOTES**
- SEE SHEET DT-01 FOR GENERAL NOTES.
  - SEE SHEET RD-06 FOR ROAD SECTIONS.
  - GRADING AND PLACEMENT OF WALLS MUST BE IN CONFORMANCE WITH 220.50.030 OF THE MMC.
  - ALL DISTURBED PERVIOUS AREAS TO BE UNDERLAIN WITH BMP 15.13 SOILS.
  - TRENCH RESTORATION SHALL BE PERFORMED IN ACCORDANCE WITH SECTION 3-703 OF THE EDDS.
  - ALL OVERHEAD UTILITIES ARE TO BE PLACED UNDERGROUND.
  - SEE SHEET RD-03 FOR YARD DRAIN TABLE.

**UTILITY NOTE**  
THE CONTRACTOR SHALL VERIFY THE LOCATION OF ALL EXISTING UTILITIES PRIOR TO ANY CONSTRUCTION. AGENCIES INVOLVED SHALL BE NOTIFIED WITHIN A REASONABLE TIME PRIOR TO THE START OF CONSTRUCTION.

**DISCLAIMER**  
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Call 2 Business Days Before You Dig  
811 or 1-800-424-5555  
Utilities Underground Location Center

CITY PROJECT NO: PA22-023, G22-0054  
CITY OF MARYSVILLE CONSTRUCTION DRAWING REVIEW ACKNOWLEDGEMENT  
THIS PLAN SHEET HAS BEEN REVIEWED AND EVALUATED FOR GENERAL COMPLIANCE WITH THE APPLICABLE CITY OF MARYSVILLE CODES AND ORDINANCES. CONFORMANCE OF THIS DESIGN WITH ALL APPLICABLE LAWS AND REGULATIONS IS THE FULL AND COMPLETE RESPONSIBILITY OF THE LICENSED DESIGN ENGINEER, WHOSE STAMP AND SIGNATURE APPEAR ON THIS SHEET. ACKNOWLEDGEMENT OF CONSTRUCTION DRAWING REVIEW DOES NOT IMPLY CITY APPROVAL FOR CONSTRUCTION ACTIVITIES THAT REQUIRE OTHER COUNTY, STATE OR FEDERAL PERMIT REVIEW AND APPROVAL. THE PROPERTY OWNER AND LICENSED DESIGN ENGINEER SHALL BE RESPONSIBLE FOR THE ACQUISITION AND COMPLIANCE OF ALL APPLICABLE PERMITS OR AUTHORIZATIONS WHICH MAY INCLUDE, BUT ARE NOT LIMITED TO, WSDRW HYDRAULIC PROJECT APPROVAL (HPS), WSDRW NOTICE OF INTENT (NOI), ANY CORPS OF ENGINEERS FILL PERMITS AND THE REQUIREMENTS OF THE ENDANGERED SPECIES ACT.  
THIS DAY OF \_\_\_\_\_  
BY: \_\_\_\_\_  
KEN MCINTYRE, PE, DEVELOPMENT SERVICES MANAGER  
APPROVAL FOR 18 MONTHS FROM DATE OF SIGNATURE.

**REVISIONS**

NO.	DATE	DESCRIPTION
1	1-27-23	REVISED PER 1ST CIVIL COMMENTS

**LAND PRO GROUP, INC.**  
**BRODIE PLAT**  
ROAD AND STORM DRAINAGE PLAN

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**THOMAS P. BRODIE**  
PROFESSIONAL ENGINEER

JOB NUMBER: C22-177  
DRAWING NAME: C22177C-RD-PL  
DESIGNER: TPA  
DRAFTING BY: DPN  
DATE: 11-15-22  
SCALE: 1"=40'  
JURISDICTION: MARYSVILLE

**RD-01**  
SHEET 15 OF 39

## **SECTION 2: TEMPORARY EROSION AND SEDIMENT CONTROL DESIGN**

### **SWPPP Design Elements**

A Stormwater Pollution Prevention Plan (SWPPP) will be provided prior to construction. The SWPPP report is modeled under the guidelines of Volume II, Section 3 of the 2014 Stormwater Management Manual for Western Washington. Construction SWPPP Elements #1 through #13 are addressed below.

#### *Element #1 – Mark Clearing Limits*

All clearing limits will be delineated with high visibility plastic fence and/or silt fence. See sheets ER-01 of the preliminary plans for locations and details.

#### *Element #2 – Establish Construction Access*

Stabilized construction accesses will be installed as shown on the preliminary plans. See sheets ER-01 and ER-02 of the construction plans for locations and details.

#### *Element #3 – Control Flow Rates*

Detention of construction period runoff will be provided by means of a sediment pond located at the northern portion of the site. See sheets ER-01 of the preliminary plans for location and details for flow and sediment control BMP's.

#### *Element #4 – Install Sediment Controls*

Silt fence, catch basin protection, and the temporary sediment pond will be utilized to contain sediments within the project's clearing limits. See sheets ER-01 and ER-02 of the preliminary plans for locations and details.

#### *Element #5 – Stabilize Soils*

Exposed soils will be stabilized as specified in the Grading and Erosion Control Notes with temporary and permanent seeding, mulching, and plastic covering. See sheet ER-02 of the preliminary plans for notes.

#### *Element #6 – Protect Slopes*

Slopes are minor on the subject site. Slopes shall be protected as specified under Element #5.

#### *Element #7 – Protect Drain Inlets*

Storm drain inlet protection will be utilized to contain sediments within the project's clearing limits. See sheets ER-01 and ER-02 of the preliminary plans for locations and details.

#### *Element #8 – Stabilize Channels and Outlets*

Temporary channels, shall be stabilized with check dams. See sheets ER-01 and ER-02 of the preliminary plans for locations and details.

#### *Element #9 – Control Pollutants*

Pollutants shall be controlled as specified in Volume IV of the 2014 DOE Manual—Source Control BMPs to address potential sources of pollution which may exacerbate possible soil/groundwater contamination identified onsite.

#### *Element #10 – Control De-Watering*

There will be no de-watering as a part of this project. See sheet ER-02 of the preliminary plans for notes.

#### *Element #11 – Maintain BMPs*

Maintenance of the BMPs is specified within the Construction Sequence and Grading and Erosion Control Notes. See sheets ER-01 and ER-02 of the preliminary plans for the Construction Sequence and notes.



Element #12: Manage the Project

The Grading and Erosion Control Notes specify seasonal work limitations. Maintenance of the BMPs is specified within the Construction Sequence and Grading and Erosion Control Notes. See sheets ER-01 and ER-02 of the preliminary plans for the Construction Sequence and notes.

Element #13: Protect on-site stormwater management BMPs

On-site stormwater management BMPs used for runoff from roofs and other hard surfaces are not feasible due to soil conditions and proposed project density.

## **SECTION 3: DOWNSTREAM ANALYSIS**

### **Task 1. Study Area Definition and Maps**

Snohomish County Bare Earth LiDAR, survey, and 2021 aerial photography were the best topographical references available for the area containing the site. The limits of the downstream analysis extend roughly 0.25 miles beyond the subject property's natural discharge location.

### **Task 2. Resource Review**

All of the resources below have been reviewed for existing and potential issues near the project site:

#### Adopted Basin Plans

No Adopted Basin Plans were located that include the project site.

#### Drainage Basin

This site is in the Allen Creek subbasin, within the Snohomish watershed. Discharge from the proposed development will discharge into Grace Creek, a tributary of Allen Creek, which eventually discharges into Ebey Slough.

#### Floodplain / Floodway (FEMA) maps

Per FEMA Floodplain map #53061C0736F the subject property is not within a floodplain.

#### Critical Areas Map

No critical areas have been identified on, or immediately adjacent to, the project site.

#### Drainage Complaints

No relevant issues were identified near the proposed site.

#### Road Drainage Problems

No issues were identified near the proposed site.

#### Soil Survey

Site soils are classified as Norma loam (0 to 3 percent slopes) which is classified as a Hydrologic Soil Group B/D type soil and Tokul gravelly medial loam (0 to 30 percent slopes) which is classified as a Hydrologic Soil Group B type soil.

#### Wetland Inventory Maps

Wetlands are identified to be on, or immediately adjacent to, the project site. Reference the critical areas report submitted with this report for additional information regarding the wetland areas onsite.

#### Migrating River Studies

Migrating River Studies are not considered applicable to the proposed development.

#### Section 303d List of Polluted Waters

Washington State Department of Ecology's Water Quality Assessment for Washington contains no listings for the Grace Creek upstream and downstream of the project.

#### Water Quality Problems

Grace Creek has no listings in the DOE Water Quality Assessment Review tools. No water quality problems were identified which would be exacerbated by the proposed development.

#### Stormwater Compliance Plans

Not applicable to the proposed project.

**Task 3. Field Inspection/Downstream Analysis**

On June 27<sup>th</sup>, 2022, a Downstream Analysis was performed at the site. The weather consisted of 84 °F and sunny skies. The following observations were verified during the visit.

The subject property areas consist primarily of lawn and forested area. There is a partially developed area in the existing condition with a gravel road leading to a cellular tower in the eastern portion of the site and a steel shipping container in the mid-western portion.

A flow path has been identified flowing from the southeast to the northwest within the threshold discharge area. Runoff generated onsite and within the 700 ft 60<sup>th</sup> St NE frontage collects within the wetland in the southwest portion of the site before continuing northwest into Grace Creek, a tributary of Allen Creek. The flowpath leaves the site and continues north west about 1200 ft before passing underneath 64th St NE through a culvert. The flow then continues north and west past the ¼-mile boundary of this analysis. See Figure 3.0, "Downstream Analysis Map" in Appendix 3 for a visual representation of current discharge.

A small amount of upstream flow occurs from the west along 60<sup>th</sup> St NE and upgradient vegetated area to the west (see image 2). This area drains to the wetland low point onsite and conveys north and west following the same flow path. None of this upstream area will be collected or captured by project improvements.

**Task 4. Drainage System Description and Problem Descriptions**

Based on the information available and all the resources available including visual inspection of the downstream flow path to the ¼-mile boundary, there is no evidence of existing or anticipated downstream drainage problems. All flows are adequately carried through natural channels to Ebey Slough.

**Task 5. Mitigation of Existing or Potential Drainage Problems**

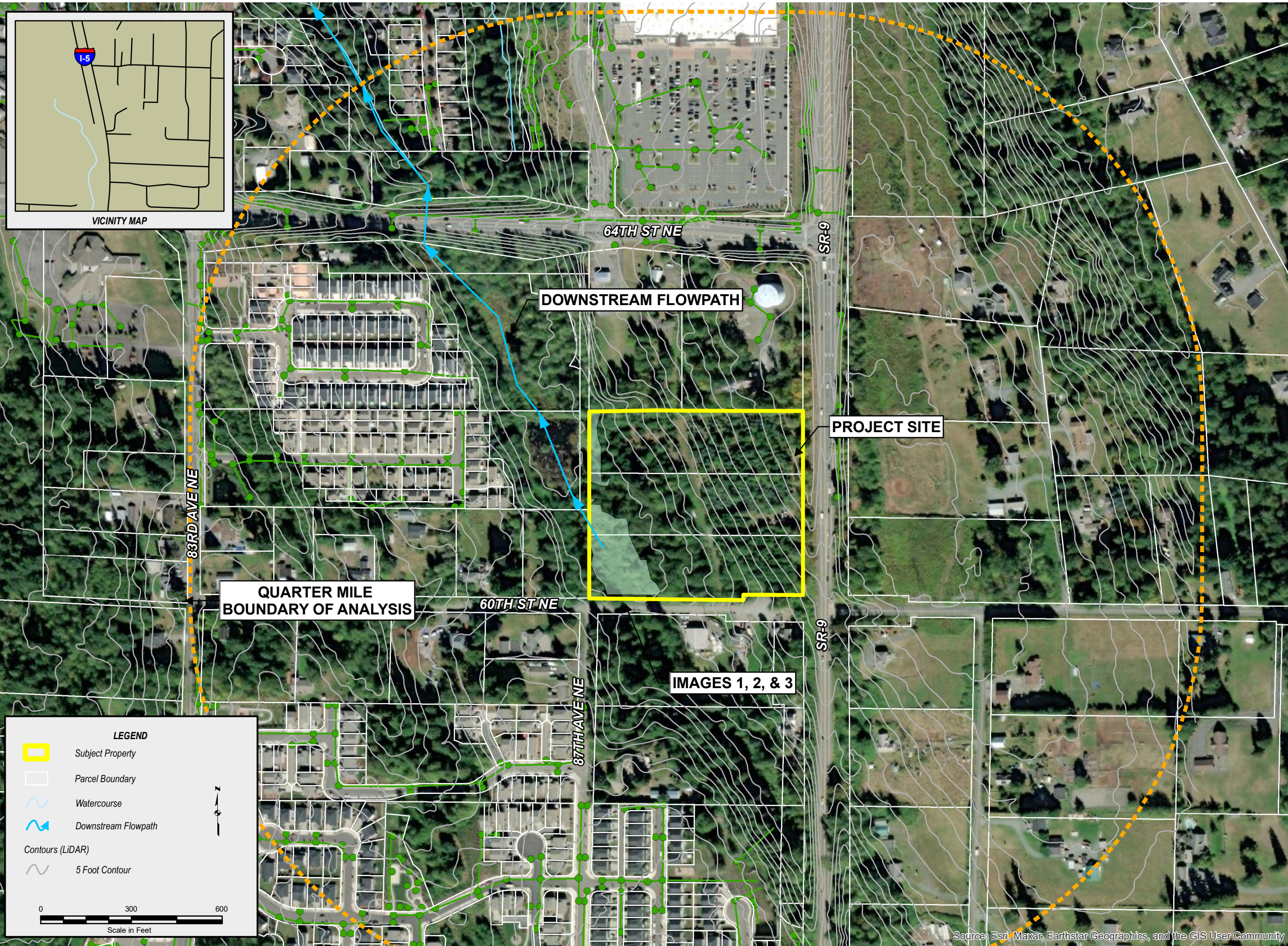
No evidence of existing or potential problems with downstream drainage conveyance infrastructure was found. Mitigation is not required.

### **Appendix 3: Resource Review**

1. Figure 3.0 - Downstream Analysis Map
2. Downstream Analysis Photographs
3. USDA Soils Map & Description
4. FEMA Floodplain Map – Panel #53061C0736F



Downstream 20221025.mxd | MOD: 10/26/2022 | Ferguson



**LEGEND**

- Subject Property
- Parcel Boundary
- Watercourse
- Downstream Flowpath
- Contours (LiDAR)
- 5 Foot Contour

0 300 600  
Scale in Feet

N

**LAND PRO GROUP**

**BRODIE PLAT**

**DOWNSTREAM ANALYSIS MAP**

NAD 1983 HARN  
STATEPLANE WASHINGTON  
NORTH FIPS 4601 FEET

REVISION:  
JOB NUMBER: C22-177

DESIGNER: TABBOTT  
DRAWING BY: RFERGUSON  
DATE: 10/26/2022  
SCALE: AS SHOWN  
JURISDICTION: MARYSVILLE

**FIGURE:**

**3.0**

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SOURCE AGENCY	DESCRIPTION
SNOHOMISH COUNTY GIS	PARCEL BOUNDARY
SNOHOMISH COUNTY GIS	CONTOURS GENERATED FROM BARE EARTH LIDAR (KING COUNTY). THIS DATA HAS A STATED VERTICAL ACCURACY OF APPROXIMATELY 1 FOOT.

Source: Esri, Maxar, Earthstar Geographics, and the GIS User Community



Downstream Analysis Photographs



**Image 1:** Low point along 60<sup>th</sup> St NE. Frontage runoff drains to this point and enters the onsite wetland before continuing north and west.



**Image 2:** Upstream area that flows along 60<sup>th</sup> St NE to the low point and into the onsite wetland area.



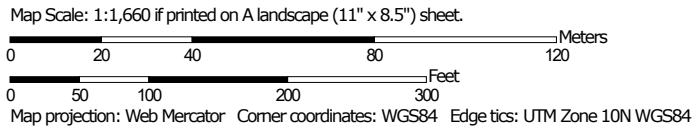
**Image 3:** Looking north from 60<sup>th</sup> St NE, flow travels north and west through the wetland from here before entering Grace Creek.



Soil Map—Snohomish County Area, Washington  
(Brodie Plat)



Soil Map may not be valid at this scale.



## MAP LEGEND

### Area of Interest (AOI)

 Area of Interest (AOI)

### Soils

 Soil Map Unit Polygons

 Soil Map Unit Lines

 Soil Map Unit Points

### Special Point Features



Blowout



Borrow Pit



Clay Spot



Closed Depression



Gravel Pit



Gravelly Spot



Landfill



Lava Flow



Marsh or swamp



Mine or Quarry



Miscellaneous Water



Perennial Water



Rock Outcrop



Saline Spot



Sandy Spot



Severely Eroded Spot



Sinkhole



Slide or Slip



Sodic Spot



Spoil Area



Stony Spot



Very Stony Spot



Wet Spot



Other



Special Line Features

### Water Features



Streams and Canals

### Transportation



Rails



Interstate Highways



US Routes



Major Roads



Local Roads

### Background



Aerial Photography

## MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:24,000.

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

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

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

Source of Map: Natural Resources Conservation Service

Web Soil Survey URL:

Coordinate System: Web Mercator (EPSG:3857)

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

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

Soil Survey Area: Snohomish County Area, Washington

Survey Area Data: Version 23, Aug 31, 2021

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

Date(s) aerial images were photographed: Aug 16, 2020—Aug 19, 2020

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

## Map Unit Legend

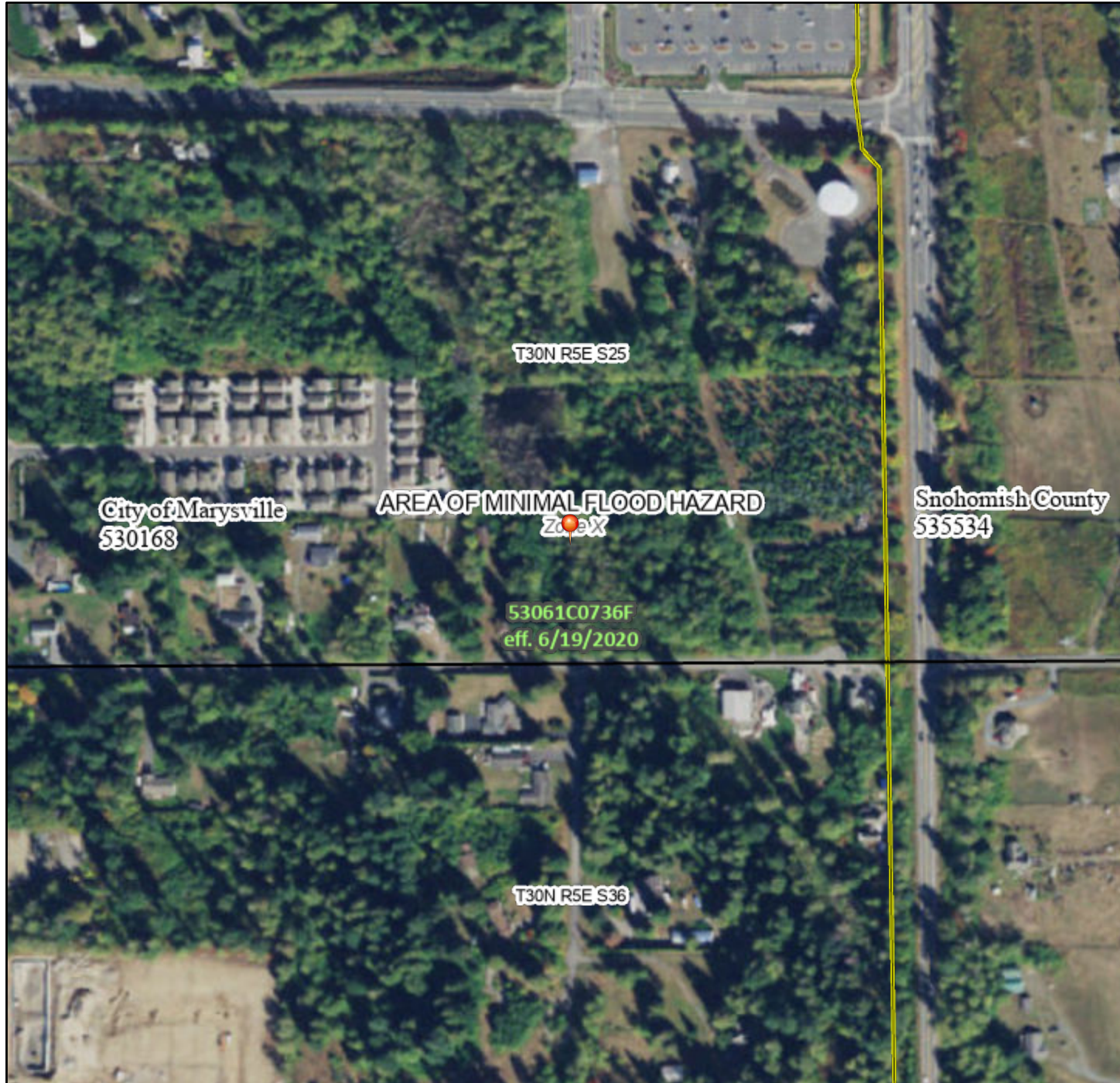
Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
39	Norma loam	2.6	25.5%
72	Tokul gravelly medial loam, 0 to 8 percent slopes	3.1	30.7%
73	Tokul gravelly medial loam, 8 to 15 percent slopes	3.5	34.6%
74	Tokul gravelly medial loam, 15 to 30 percent slopes	0.9	9.3%
<b>Totals for Area of Interest</b>		<b>10.1</b>	<b>100.0%</b>



# National Flood Hazard Layer FIRMette



122°7'9"W 48°3'15"N



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

122°6'32"W 48°2'51"N

## 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
		Levee, Dike, or Floodwall

OTHER FEATURES		20.2 Cross Sections with 1% Annual Chance Water Surface Elevation
		17.5 Coastal Transect
		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



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 1/25/2023 at 11:30 AM 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.

**SECTION 4: DETENTION AND WATER QUALITY TREATMENT DESIGN**

**4.1 Pre-Developed Hydrology/Land Cover**

The pre-developed and developed conditions were modeled in WWHM for the purpose of peak flow determination for direct discharge. Based on the site location, the WWHM used the Everett Gage and a Precipitation Scale factor of 1.2.

Onsite Basin:

The predeveloped condition applied to the Onsite and Bypass Basins, modeled as a combined single basin. It does not include the wetland buffer area onsite that will not be disturbed for development. For visual representation of the listed basins, see Figure 4.0, "Predeveloped Hydrology Map". The values as modeled in WWHM are as follows:

Table 1: Predeveloped Conditions: Onsite Basin

<b>Onsite Basin</b>	
<u>Ground Cover</u>	<u>Area (acre)</u>
Forest, mod	1.55
Forest, steep	5.77
<b>Total</b>	<b>7.32</b>

Upstream Basin:

The existing condition applied to the Upstream Basin. For visual representation of the listed basins, see Figure 4.0, "Predeveloped Hydrology Map". The values as modeled in WWHM are as follows:

Table 1: Predeveloped Conditions: Onsite Basin

<b>Upstream Basin</b>	
<u>Ground Cover</u>	<u>Area (acre)</u>
Forest, flat	0.09
Forest, mod	0.17
Forest, steep	0.14
<b>Total</b>	<b>0.40</b>

**4.2 Developed Site Hydrology**

In the developed condition, the project will develop 44 single-family lots and associated driveways and utilities. Frontage improvements, including pavement widening and construction of pedestrian facilities, will be constructed along 60<sup>th</sup> St NE.

In compliance with the 2014 DOE Manual, all runoff from onsite developed/disturbed surfaces will be collected, treated, and discharged directly to existing/historic flow paths.

Onsite Basin:

The developed Onsite Basin is 6.71 acres comprised of a 44 single family lots, open spaces, and ROW. A 70% impervious lot coverage assumption per lot was used. In the developed condition, the Onsite Basin has been modeled using WWHM with the following areas and ground cover designations:

Table 2: Developed Conditions: Onsite Basin

<b>Onsite Basin</b>	
<u>Ground Cover</u>	<u>Area (acre)</u>
Roof Tops, flat	2.56
Roads, flat	1.23
Roads, mod	0.38
Sidewalks, flat	0.40
Sidewalks, Mod	0.10
Pasture, flat	2.04
<b>Total</b>	<b>6.71</b>

***Bypass Basin:***

The developed Bypass Basin is 0.61 acres and is comprised of proposed frontage improvements along 60<sup>th</sup> St NE, including pavement widening, planters, and pedestrian accesses along with some onsite ROW area. The Bypass Basin cannot be collected due to topographical constraints. The Bypass Basin was modeled using WWHM with the following areas and ground cover designations:

*Table 3: Developed Conditions: Bypass Basin*

<b>Bypass Basin</b>	
<u>Ground Cover</u>	<u>Area (acre)</u>
Roads, flat	0.25
Roads, mod	0.05
Sidewalk, flat	0.16
Sidewalk, mod	0.02
Pasture, Flat	0.13
<b>Total</b>	<b>0.61</b>

**4.3 Detention Facility Design**

The proposed detention vault facility used for mitigating developed condition flows was designed in compliance with 2014 DOE requirements to model hydrologic conditions and detention in a continuous runoff model (WWHM2012) where the following evaluation parameters are employed:

*"Flow duration is computed by counting the number of flow values that exceed a specified flow level. The specified flow levels used by WWHM in the flow duration analysis are listed below.*

- 1. 50% of the 2-year predevelopment peak flow.*
- 2. 100% of the 2-year predevelopment peak flow.*
- 3. 100% of the 50-year predevelopment peak flow.*

*There are three criteria by which flow duration values are compared:*

- 1. If the postdevelopment flow duration values exceed any of the predevelopment flow levels between 50% and 100% of the 2-year predevelopment peak flow values (100 Percent Threshold) then the flow duration requirement has not been met.*
- 2. If the postdevelopment flow duration values exceed any of the predevelopment flow levels between 100% of the 2-year and 100% of the 50-year predevelopment peak flow values more than 10 percent of the time (110 Percent Threshold) then the flow duration requirement has not been met.*
- 3. If more than 50 percent of the flow duration levels exceed the 100 percent threshold then the flow duration requirement has not been met."*



Detention Vault Facility

The proposed detention facility detains, and releases collected storm water runoff from the Onsite Basin. The facility is located within Tract 998 in the northwestern corner of the site. Flows from the Onsite Basin are collected and conveyed to the detention vault via a proposed network of catch basins and storm water conveyance pipes. Detailed WWHM output is provided in Appendix 4. A summary of the detailed statistics and inputs used for modeling the system in WWHM2012 can be found below.

Table 4: Detention Vault Design Summary

Detention Vault	
Live Storage Bottom Area (modeled)	9,500 SF
Live Storage Bottom Area (provided)	9,590 SF
Number of Cells	3
Cell Dimensions	3 ea x 15.67' x 204'
Begin Live Storage Elevation	400.80
Riser Height	9.00'
Volume (modeled)	85,500 CF
Volume (provided)	86,310 CF
Top of Riser Elevation	409.80
Top Outside of Vault Elevation	411.30

See table below for the flow rates and water surface elevations by storm event for the detention vault.

Table 5: Flow Rates and Water Surface Elevations by Storm Event

Storm Event	Predeveloped Rate (cfs)	Mitigated Rates (cfs)	Water Surface Elevation (ft)
2-Year	0.3767	0.3813	205.56
10-Year	0.8137	0.6180	406.30
50-Year	1.3978	0.8838	407.32
100-Year	1.7164	1.0155	408.13

#### 4.4 Water Quality Treatment

##### Perkfilter

Water Quality Treatment for the Onsite Basin is accomplished through a Perkfilter structure located downstream of the detention vault. A summary of design criteria is provided below:

Table 6: Perkfilter Design Summary

<b>Ø Perkfilter Vault</b>	
Tributary Area	7.11 AC
Tributary PGIS Area	1.61 AC
Water Quality Flow Rate	0.8812 cfs
WQ Treatment Capacity	0.9100 cfs
Number of Cartridges	34
Cartridge Height	12"
Internal Drop	1.7'
Peak Flow Rate	6.7910 cfs
Peak Flow Storm Event	100-year

##### Modular Wetland

Water Quality Treatment for the Bypass Basin is accomplished through a Modular Wetland structure located in Tract 991. The Modular Wetland treats all stormwater that cannot be collected by the detention vault prior to discharge. A summary of design criteria is provided below:

Table 7: Modular Wetland Design Summary

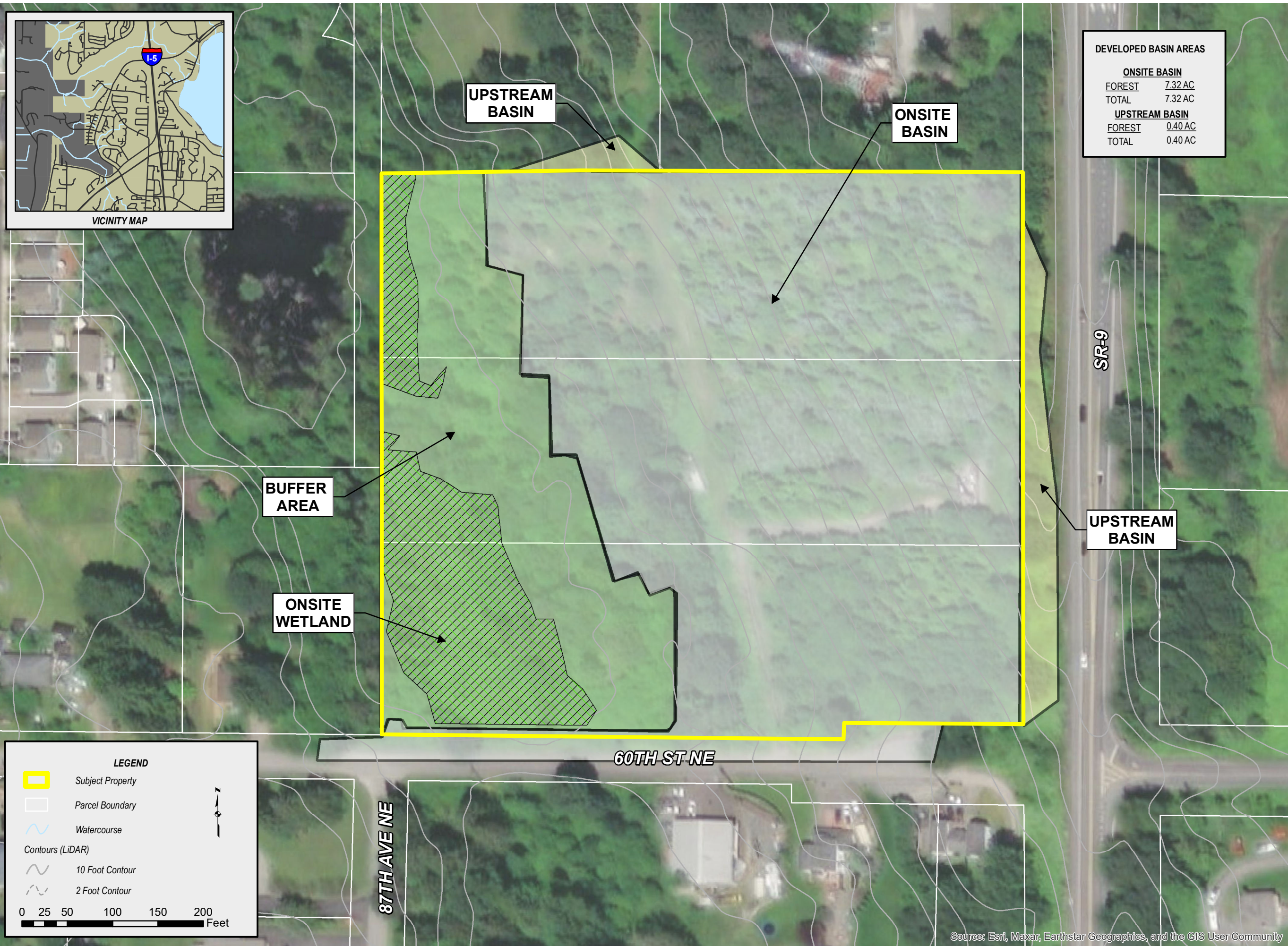
<b>Modular Wetland</b>	
Tributary Area	0.61 AC
Tributary PGIS Area	0.30 AC
Water Quality Flow Rate (91% of total volume)	0.092 cfs
WQ Treatment Capacity	0.103 cfs
Number of Cartridges	N/A
Cartridge Height	N/A
Internal Drop	0.5'
Peak Flow Rate	0.6862 cfs
Peak Flow Storm Event	100-year



**Appendix 4: Detention and Water Quality Design Analysis**

1. Figure 4.0: Predeveloped Hydrology Map
2. Figure 5.0: Developed Hydrology Map
3. Perkfilter Detail
4. Modular Wetland Detail
5. WWHM2012 Output – Detention Vault
6. WWHM2012 Output – Perkfilter - Onsite Basin
7. WWHM2012 Output – Modular Wetland - Frontage Bypass





**LEGEND**

- Subject Property
- Parcel Boundary
- ~ Watercourse
- Contours (LiDAR)
- ~ 10 Foot Contour
- ~ 2 Foot Contour

0 25 50 100 150 200 Feet

**DEVELOPED BASIN AREAS**

ONSITE BASIN	
FOREST	7.32 AC
TOTAL	7.32 AC
UPSTREAM BASIN	
FOREST	0.40 AC
TOTAL	0.40 AC

**LAND PRO GROUP, INC.**  
**BRODIE PLAT**  
**PREDEVELOPED HYDROLOGY MAP**

NAD 1983 HARN  
 STATEPLANE WASHINGTON  
 NORTH FIPS 4601 FEET

REVISION:  
 JOB NUMBER: C22-177  
 DRAWING NAME: C22-177-4.0  
 DESIGNER: RFERGUSON  
 DRAWING BY: RFERGUSON  
 DATE: 4/6/2023  
 SCALE: AS SHOWN  
 JURISDICTION: MARYSVILLE

**FIGURE:**  
**4.0**

**SOURCE INFORMATION**

SOURCE AGENCY	DESCRIPTION
KING COUNTY GIS	PARCEL BOUNDARY
KING COUNTY GIS	CONTOURS GENERATED FROM BARE EARTH LIDAR (KING COUNTY). THIS DATA HAS A STATED VERTICAL ACCURACY OF APPROXIMATELY 1 FOOT.

**LDC**

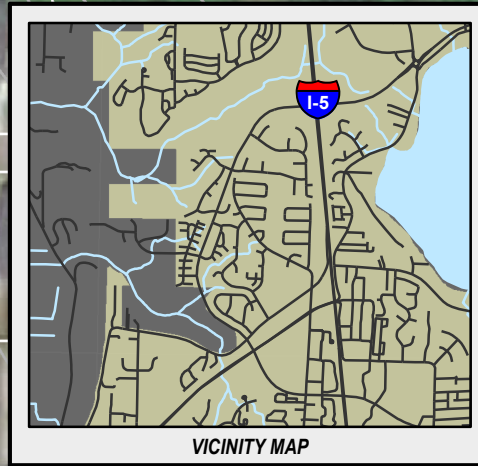
Woodinville  
 20210 142nd Avenue NE  
 Woodinville, WA 98072  
 T: 425.386.1869

Surveying  
 Engineering  
 Planning

Kent  
 1851 Central Pl S, #101  
 Kent, WA 98030  
 F: 425.482.2893  
 www.LDCcorp.com

Source: Esri, Maxar, Earthstar Geographics, and the GIS User Community





UPSTREAM BASIN

ONSITE BASIN

BUFFER AREA

ONSITE WETLAND

UPSTREAM BASIN

BYPASS BASIN

SR-9

60TH ST NE

87TH AVE NE

DEVELOPED BASIN AREAS	
<b>ONSITE BASIN</b>	
PASTURE	2.04 AC
ROOF	2.56 AC
SIDEWALK	0.50 AC
ROAD	1.61 AC
TOTAL	6.71 AC
<b>UPSTREAM BASIN</b>	
FOREST	0.40 AC
TOTAL	0.40 AC
<b>BYPASS BASIN</b>	
PASTURE	0.13 AC
SIDEWALK	0.18 AC
ROAD	0.30 AC
TOTAL	0.61 AC

SOURCE INFORMATION	
SOURCE AGENCY	PARCEL BOUNDARY
KING COUNTY GIS	CONTOURS GENERATED FROM BARE EARTH LIDAR (KING COUNTY). THIS DATA HAS A STATED VERTICAL ACCURACY OF APPROXIMATELY 1 FOOT.
KING COUNTY GIS	

**LDC** | Surveying  
Engineering  
Planning

Woodville  
20210 142nd Avenue NE  
Woodville, WA 98072  
F 425-806-1869

Kent  
1851 Central Pl S. #101  
Kent, WA 98030  
www.LDCcorp.com F 425-482-2885

LAND PRO GROUP, INC.  
**BRODIE PLAT**  
DEVELOPED HYDROLOGY MAP

NAD 1983 HARN STATEPLANE WASHINGTON
REVISION:
JOB NUMBER: C22-177
DRAWING NAME: C22-177-5.0
DESIGNER: RFERGUSON
DRAWING BY: RFERGUSON
DATE: 4/8/2023
SCALE: AS SHOWN
JURISDICTION: MARYSVILLE

FIGURE:  
**5.0**

**LEGEND**

- Subject Property
- Parcel Boundary
- Watercourse
- Contours (LiDAR)
  - 10 Foot Contour
  - 2 Foot Contour

0 25 50 100 150 200 Feet

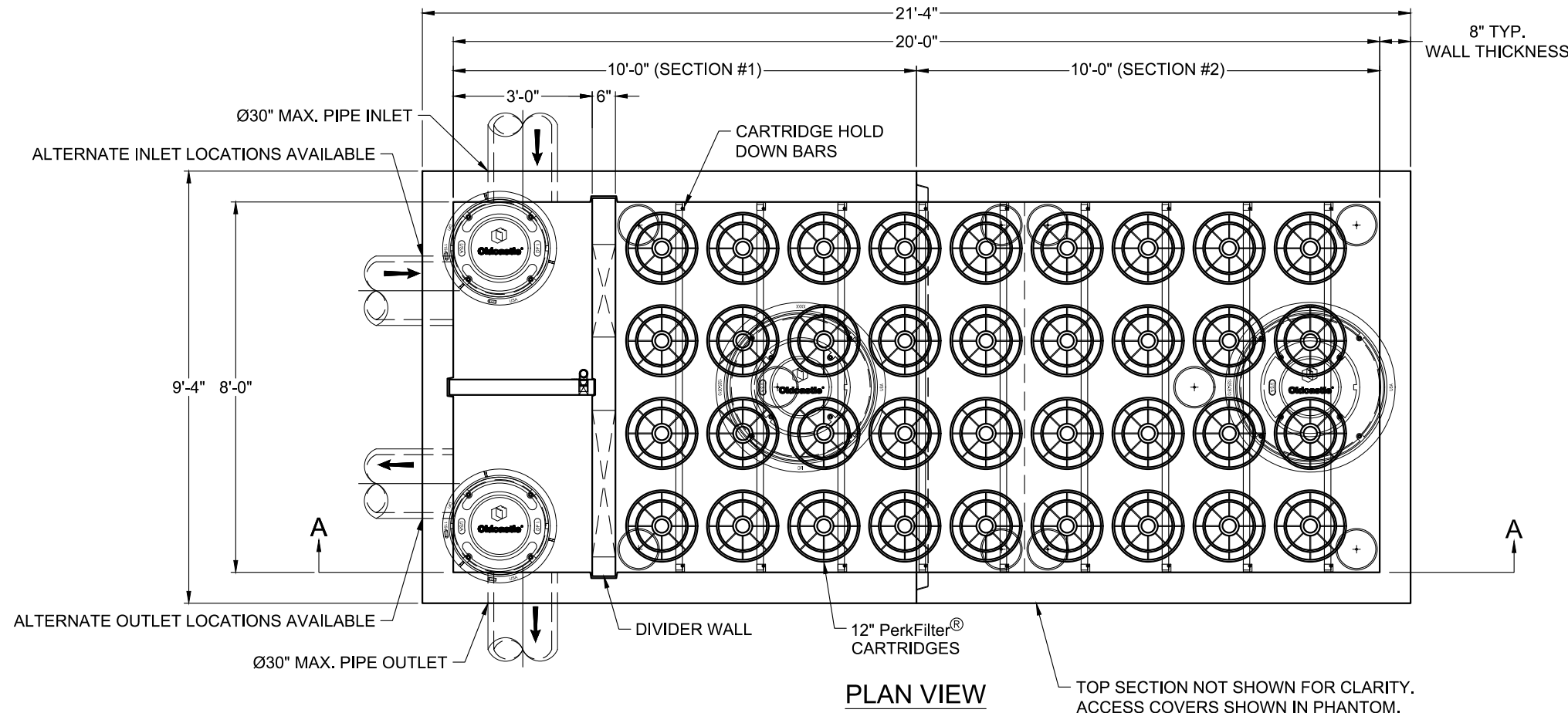
Source: Esri, Maxar, Earthstar Geographics, and the GIS User Community

5.0 Developed Hydrology 20230406.mxd | MOD: 4/6/2023 | rferguson

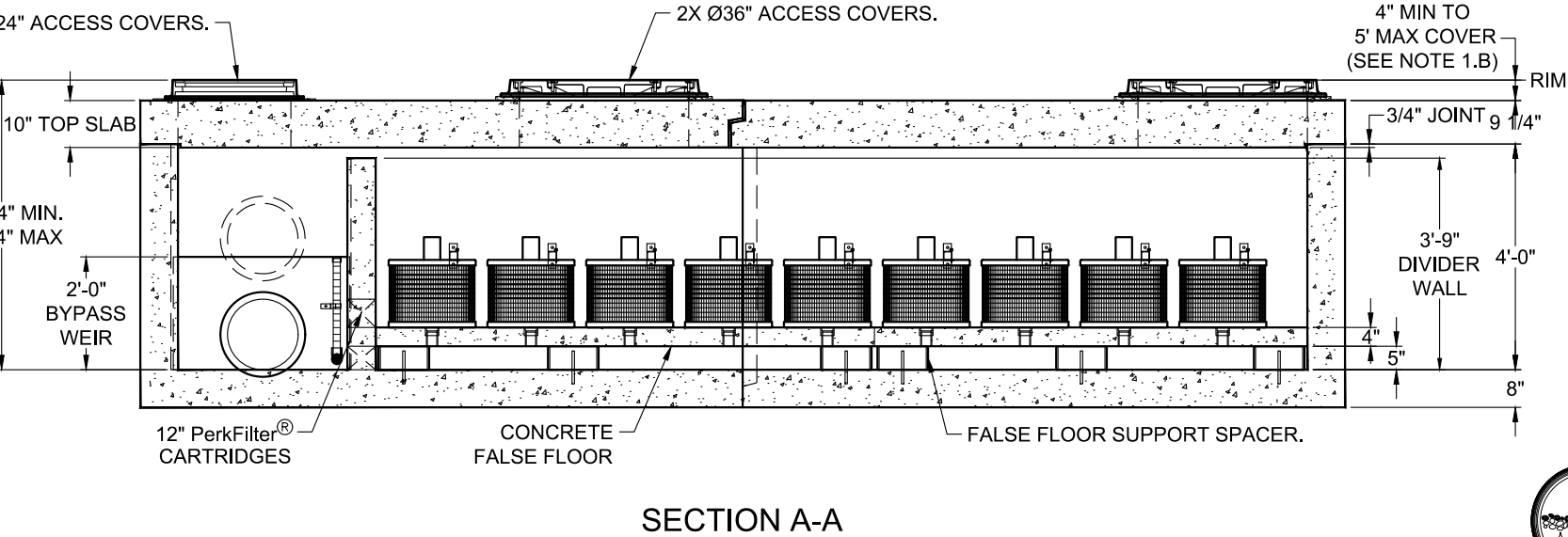
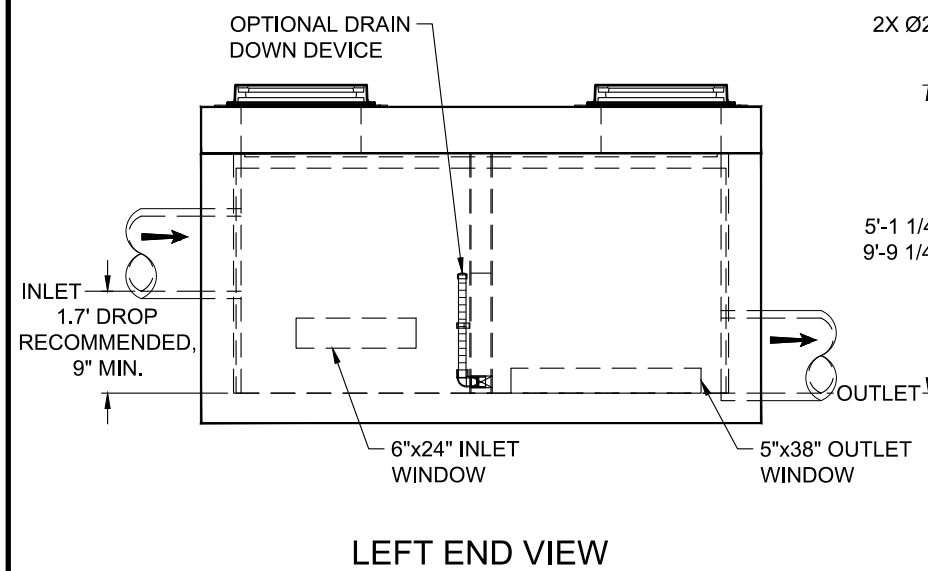


SITE SPECIFIC DATA				
Structure ID	PF VAULT			
Treatment Flow Rate (gpm/cfs)	0.8812			
Peak Flow Rate (cfs)	6.7910			
Cartridge Quantity	33			
Rim Elevation	412.50			
Pipe Data	Pipe Location	Pipe Size	Pipe Type	Invert Elevation
Inlet 1	E	12"	SD	407.31
Inlet 2	-	-	-	-
Outlet	N	12"	SD	405.61
Notes: -				

PERFORMANCE SPECIFICATIONS	
Peak Treatment Capacities: <sup>1</sup>	
Max. Cartridge Quantity	36
NJDEP 80% Removal, 75 micron	1.091 cfs
WA Ecology GULD - Basic & Phosphorus	0.545 cfs
Max. Bypass Capacity	25.1 cfs
1. Contact Oldcastle for alternative treatment and peak flow capacities.	



- NOTES:**
- DESIGN LOADINGS:
    - AASHTO HS-20-44 (WITH IMPACT)
    - DESIGN SOIL COVER: 5'-0" MAXIMUM
    - ASSUMED WATER TABLE: BELOW BASE OF PRECAST (ENGINEER-OF-RECORD TO CONFIRM SITE WATER TABLE ELEVATION)
    - LATERAL EARTH PRESSURE: 45 PCF (DRAINED)
    - LATERAL LIVE LOAD SURCHARGE: 80 PSF (APPLIED TO 8'-0" BELOW GRADE)
    - NO LATERAL SURCHARGE FROM ADJACENT BUILDINGS, WALLS, PIERS, OR FOUNDATIONS.
  - CONCRETE 28-DAY MINIMUM COMPRESSIVE STRENGTH: 5,000 PSI MINIMUM.
  - REINFORCING: REBAR, ASTM A615/A706, GRADE 60
  - CEMENT: ASTM C150
  - REQUIRED ALLOWABLE SOIL BEARING CAPACITY: 2,500 PSF
  - REFERENCE STANDARD:
    - ASTM C890
    - ASTM C913
    - ACI 318-14
  - THIS STRUCTURE IS DESIGNED TO THE PARAMETERS NOTED HEREIN. ENGINEER-OF-RECORD SHALL VERIFY THAT NOTED PARAMETERS MEET OR EXCEED PROJECT REQUIREMENTS. IF DESIGN PARAMETERS ARE INCORRECT, REVIEWING ENGINEER/AUTHORITY SHALL NOTIFY OLDCASTLE INFRASTRUCTURE UPON REVIEW OF THIS SUBMITTAL.
  - OVERSIZED HOLES TO ACCOMMODATE SPECIFIC PIPE TYPE MUST BE CONCENTRIC TO PIPE ID. AFTER PIPES ARE INSTALLED, ALL ANNULAR SPACES SHALL BE FILLED WITH A MINIMUM OF 3,000 PSI CONCRETE FOR FULL THICKNESS OF PRECAST WALLS. PIPES ARE TO BE FLUSH WITH THE INSIDE SURFACE OF THE CONCRETE STRUCTURE.
  - CONTRACTOR RESPONSIBLE TO VERIFY ALL SIZES, LOCATIONS, AND ELEVATIONS OF OPENINGS.
  - CONTRACTOR RESPONSIBLE TO ENSURE ADEQUATE BEARING SURFACE IS PROVIDED (I.E. COMPACTED AND LEVEL PER PROJECT SPECIFICATIONS).
  - 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.
  - FOR SITE SPECIFIC DRAWINGS WITH DETAILED STRUCTURE DIMENSIONS AND WEIGHTS, PLEASE CONTACT OLDCASTLE INFRASTRUCTURE.
  - MAXIMUM PICK WEIGHTS:
    - TOP: XX,XXX LBS
    - BASE: XX,XXX LBS\*
 (\* COMBINED WEIGHT OF BASE INCLUDES DIVIDER WALLS, FALSE FLOOR, AND PRODUCT INTERNALS.)
  - INTERNALS SHALL CONSIST OF CARTRIDGES, WEIR WALL, FALSE FLOOR, FALSE FLOOR SUPPORT SPACERS, AND DIVIDER WALL.



**Oldcastle Infrastructure**  
A CRH COMPANY

Ph: 800.579.8819 | www.oldcastleinfrastructure.com/stormwater

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PerkFilter® Vault (STANDARD)  
8'x20' With 12" Cartridges

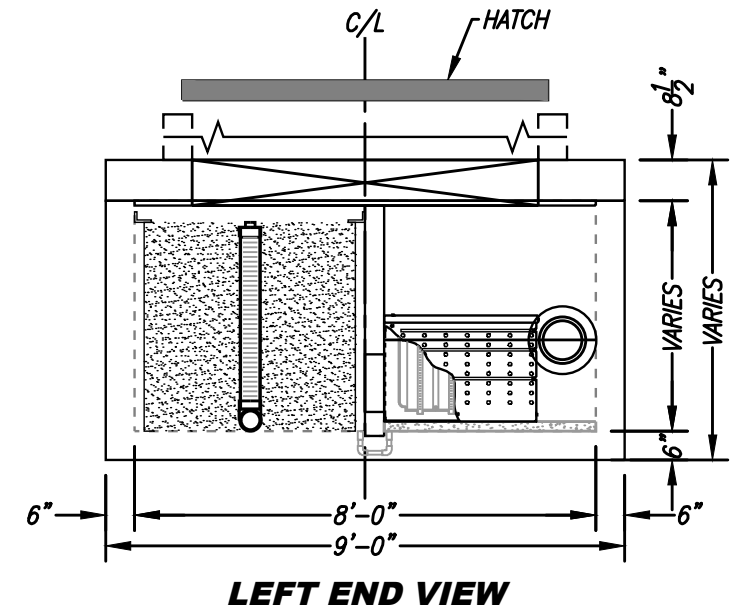
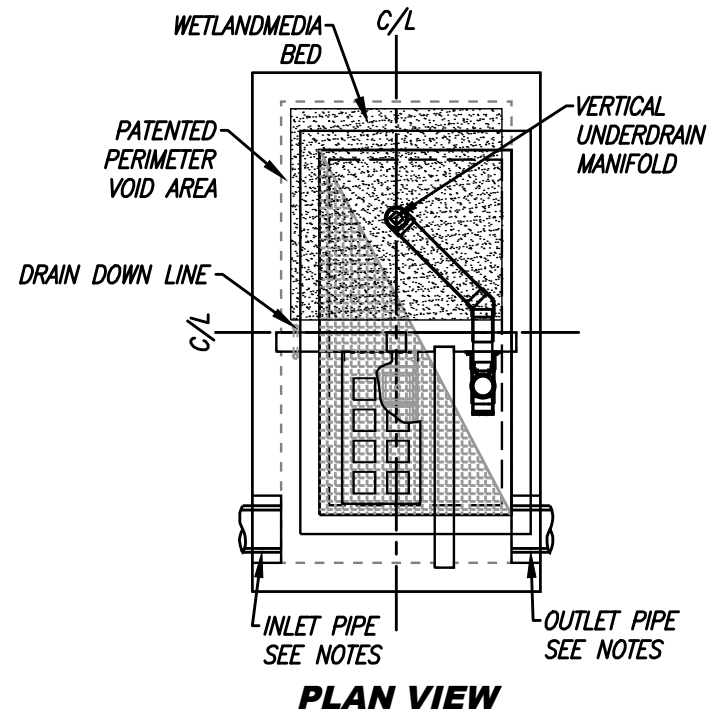
CUSTOMER  
LANDPRO GROUP, INC.

PROJECT NAME  
BRODIE PLAT

SHEET NAME	REVISION	SHEET
Specifier Drawing PFV-820-12	- REV DATE	1 OF 1



SITE SPECIFIC DATA			
PROJECT NUMBER			
PROJECT NAME			
PROJECT LOCATION			
STRUCTURE ID			
TREATMENT REQUIRED			
FLOW BASED (CFS)			
PEAK BYPASS REQUIRED (CFS) – IF APPLICABLE			
PIPE DATA	I.E.	MATERIAL	DIAMETER
INLET PIPE 1			
INLET PIPE 2			
OUTLET PIPE			
	PRETREATMENT	BIOFILTRATION	DISCHARGE
RIM ELEVATION			
SURFACE LOAD			
NOTES:			

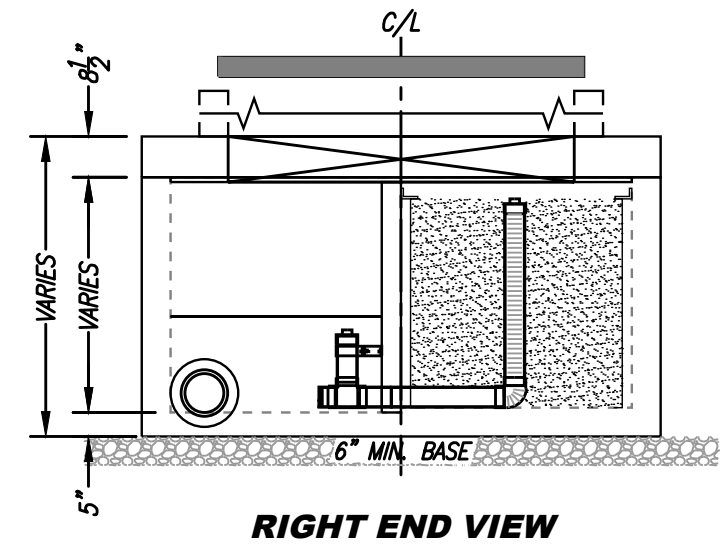
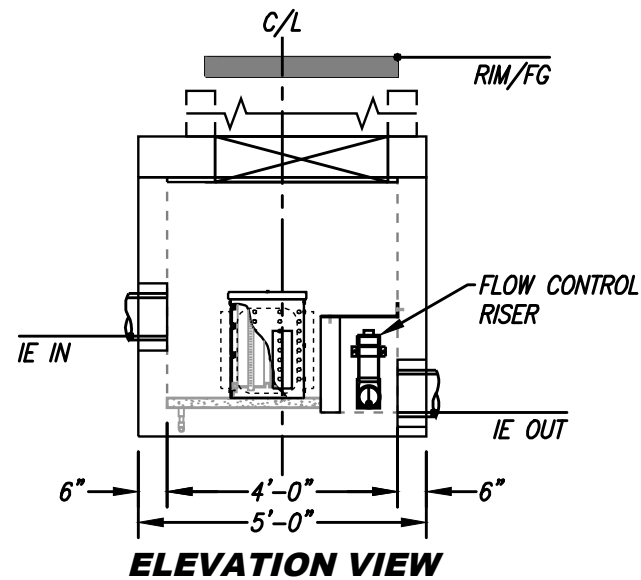


**INSTALLATION NOTES**

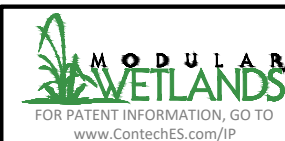
1. CONTRACTOR TO PROVIDE ALL LABOR, EQUIPMENT, MATERIALS AND INCIDENTALS REQUIRED TO OFFLOAD AND INSTALL THE SYSTEM AND APPURTENANCES IN ACCORDANCE WITH THIS DRAWING AND THE MANUFACTURERS' SPECIFICATIONS, UNLESS OTHERWISE STATED IN MANUFACTURER'S CONTRACT.
2. UNIT MUST BE INSTALLED ON LEVEL BASE. MANUFACTURER RECOMMENDS A MINIMUM 6" LEVEL ROCK BASE UNLESS SPECIFIED BY THE PROJECT ENGINEER. CONTRACTOR IS RESPONSIBLE FOR VERIFYING PROJECT ENGINEER'S RECOMMENDED BASE SPECIFICATIONS.
4. CONTRACTOR TO SUPPLY AND INSTALL ALL EXTERNAL CONNECTING PIPES. ALL PIPES MUST BE FLUSH WITH INSIDE SURFACE OF CONCRETE (PIPES CANNOT INTRUDE BEYOND FLUSH). INVERT OF OUTFLOW PIPE MUST BE FLUSH WITH DISCHARGE CHAMBER FLOOR. ALL PIPES SHALL BE SEALED WATERTIGHT PER MANUFACTURER'S STANDARD CONNECTION DETAIL.
5. CONTRACTOR RESPONSIBLE FOR INSTALLATION OF ALL PIPES, RISERS, MANHOLES, AND HATCHES. CONTRACTOR TO USE GROUT AND/OR BRICKS TO MATCH COVERS WITH FINISHED SURFACE UNLESS SPECIFIED OTHERWISE.
6. VEGETATION SUPPLIED AND INSTALLED BY OTHERS. ALL UNITS WITH VEGETATION MUST HAVE DRIP OR SPRAY IRRIGATION SUPPLIED AND INSTALLED BY OTHERS.
7. CONTRACTOR RESPONSIBLE FOR CONTACTING CONTECH FOR ACTIVATION OF UNIT. MANUFACTURER'S WARRANTY IS VOID WITHOUT PROPER ACTIVATION BY A CONTECH REPRESENTATIVE.

**GENERAL NOTES**

1. MANUFACTURER TO PROVIDE ALL MATERIALS UNLESS OTHERWISE NOTED.
2. ALL DIMENSIONS, ELEVATIONS, SPECIFICATIONS AND CAPACITIES ARE SUBJECT TO CHANGE. FOR PROJECT SPECIFIC DRAWINGS DETAILING EXACT DIMENSIONS, WEIGHTS AND ACCESSORIES PLEASE CONTACT CONTECH.



TREATMENT FLOW (CFS)	
OPERATING HEAD (FT)	
PRETREATMENT LOADING RATE (GPM/SF)	
WETLAND MEDIA LOADING RATE (GPM/SF)	



**MWS-L-4-8-V-UG**  
**STORMWATER BIOFILTRATION SYSTEM**  
**STANDARD DETAIL**

**WVHM2012  
PROJECT REPORT**

---

**Project Name:** 20230320 Brodie  
**Site Name:** Brodie  
**Site Address:**  
**City :**  
**Report Date:** 3/22/2023  
**Gage :** Everett  
**Data Start :** 1948/10/01  
**Data End :** 2009/09/30  
**Precip Scale:** 1.20  
**Version Date:** 2021/08/18  
**Version :** 4.2.18

---

**Low Flow Threshold for POC 1 :** 50 Percent of the 2 Year

---

**High Flow Threshold for POC 1:** 50 year

---

**PREDEVELOPED LAND USE**

**Name :** Project Site  
**Bypass:** No

**GroundWater:** No

<u>Pervious Land Use</u>	<u>acre</u>
C, Forest, Mod	1.55
C, Forest, Steep	5.77

**Pervious Total** 7.32

<u>Impervious Land Use</u>	<u>acre</u>
<b>Impervious Total</b>	0

**Basin Total** 7.32

---

<b>Element Flows To:</b>			
<b>Surface</b>	<b>Interflow</b>	<b>Groundwater</b>	

---

**Name :** Upstream  
**Bypass:** No

**GroundWater:** No

<u>Pervious Land Use</u>	<u>acre</u>
C, Forest, Flat	.09
C, Forest, Mod	.17
C, Forest, Steep	.14

Pervious Total 0.4

<u>Impervious Land Use</u>	<u>acre</u>
----------------------------	-------------

Impervious Total 0

Basin Total 0.4

---

Element Flows To:	Interflow	Groundwater
Surface		

---

**MITIGATED LAND USE**

Name : Onsite

Bypass: No

GroundWater: No

<u>Pervious Land Use</u>	<u>acre</u>
C, Pasture, Flat	2.04

Pervious Total 2.04

<u>Impervious Land Use</u>	<u>acre</u>
ROADS FLAT	1.23
ROADS MOD	0.38
ROOF TOPS FLAT	2.56
SIDEWALKS FLAT	0.4
SIDEWALKS MOD	0.1

Impervious Total 4.67

Basin Total 6.71

---

Element Flows To:	Interflow	Groundwater
Surface		
Vault 1	Vault 1	

---

Name : Bypass  
 Bypass: Yes

GroundWater: No

<u>Pervious Land Use</u>	<u>acre</u>
C, Pasture, Flat	.13
<b>Pervious Total</b>	<b>0.13</b>
<u>Impervious Land Use</u>	<u>acre</u>
ROADS FLAT	0.25
ROADS MOD	0.05
SIDEWALKS FLAT	0.16
SIDEWALKS MOD	0.02
<b>Impervious Total</b>	<b>0.48</b>
<b>Basin Total</b>	<b>0.61</b>

Element Flows To:

Surface	Interflow	Groundwater
---------	-----------	-------------

Name : Vault 1  
 Width : 100 ft.  
 Length : 95 ft.  
 Depth: 10 ft.

Discharge Structure  
 Riser Height: 9 ft.  
 Riser Diameter: 18 in.  
 Orifice 1 Diameter: 1.78125 in. Elevation: 0 ft.  
 Orifice 2 Diameter: 3.125 in. Elevation: 5.25 ft.

Element Flows To:

Outlet 1	Outlet 2
----------	----------

**Vault Hydraulic Table**

<u>Stage(feet)</u>	<u>Area(ac.)</u>	<u>Volume(ac-ft.)</u>	<u>Discharge(cfs)</u>	<u>Infilt(cfs)</u>
0.0000	0.218	0.000	0.000	0.000
0.1111	0.218	0.024	0.028	0.000
0.2222	0.218	0.048	0.040	0.000
0.3333	0.218	0.072	0.049	0.000
0.4444	0.218	0.096	0.057	0.000
0.5556	0.218	0.121	0.064	0.000
0.6667	0.218	0.145	0.070	0.000
0.7778	0.218	0.169	0.075	0.000



0.8889	0.218	0.193	0.081	0.000
1.0000	0.218	0.218	0.086	0.000
1.1111	0.218	0.242	0.090	0.000
1.2222	0.218	0.266	0.095	0.000
1.3333	0.218	0.290	0.099	0.000
1.4444	0.218	0.315	0.103	0.000
1.5556	0.218	0.339	0.107	0.000
1.6667	0.218	0.363	0.111	0.000
1.7778	0.218	0.387	0.114	0.000
1.8889	0.218	0.411	0.118	0.000
2.0000	0.218	0.436	0.121	0.000
2.1111	0.218	0.460	0.125	0.000
2.2222	0.218	0.484	0.128	0.000
2.3333	0.218	0.508	0.131	0.000
2.4444	0.218	0.533	0.134	0.000
2.5556	0.218	0.557	0.137	0.000
2.6667	0.218	0.581	0.140	0.000
2.7778	0.218	0.605	0.143	0.000
2.8889	0.218	0.630	0.146	0.000
3.0000	0.218	0.654	0.149	0.000
3.1111	0.218	0.678	0.151	0.000
3.2222	0.218	0.702	0.154	0.000
3.3333	0.218	0.727	0.157	0.000
3.4444	0.218	0.751	0.159	0.000
3.5556	0.218	0.775	0.162	0.000
3.6667	0.218	0.799	0.164	0.000
3.7778	0.218	0.823	0.167	0.000
3.8889	0.218	0.848	0.169	0.000
4.0000	0.218	0.872	0.172	0.000
4.1111	0.218	0.896	0.174	0.000
4.2222	0.218	0.920	0.176	0.000
4.3333	0.218	0.945	0.179	0.000
4.4444	0.218	0.969	0.181	0.000
4.5556	0.218	0.993	0.183	0.000
4.6667	0.218	1.017	0.186	0.000
4.7778	0.218	1.042	0.188	0.000
4.8889	0.218	1.066	0.190	0.000
5.0000	0.218	1.090	0.192	0.000
5.1111	0.218	1.114	0.194	0.000
5.2222	0.218	1.138	0.196	0.000
5.3333	0.218	1.163	0.275	0.000
5.4444	0.218	1.187	0.317	0.000
5.5556	0.218	1.211	0.349	0.000
5.6667	0.218	1.235	0.376	0.000
5.7778	0.218	1.260	0.399	0.000
5.8889	0.218	1.284	0.420	0.000
6.0000	0.218	1.308	0.440	0.000
6.1111	0.218	1.332	0.458	0.000
6.2222	0.218	1.357	0.476	0.000
6.3333	0.218	1.381	0.492	0.000
6.4444	0.218	1.405	0.508	0.000
6.5556	0.218	1.429	0.523	0.000
6.6667	0.218	1.453	0.537	0.000
6.7778	0.218	1.478	0.551	0.000
6.8889	0.218	1.502	0.565	0.000

7.0000	0.218	1.526	0.578	0.000
7.1111	0.218	1.550	0.591	0.000
7.2222	0.218	1.575	0.603	0.000
7.3333	0.218	1.599	0.615	0.000
7.4444	0.218	1.623	0.627	0.000
7.5556	0.218	1.647	0.639	0.000
7.6667	0.218	1.672	0.650	0.000
7.7778	0.218	1.696	0.661	0.000
7.8889	0.218	1.720	0.672	0.000
8.0000	0.218	1.744	0.683	0.000
8.1111	0.218	1.769	0.693	0.000
8.2222	0.218	1.793	0.703	0.000
8.3333	0.218	1.817	0.713	0.000
8.4444	0.218	1.841	0.723	0.000
8.5556	0.218	1.865	0.733	0.000
8.6667	0.218	1.890	0.743	0.000
8.7778	0.218	1.914	0.752	0.000
8.8889	0.218	1.938	0.762	0.000
9.0000	0.218	1.962	0.771	0.000
9.1111	0.218	1.987	1.368	0.000
9.2222	0.218	2.011	2.426	0.000
9.3333	0.218	2.035	3.681	0.000
9.4444	0.218	2.059	4.911	0.000
9.5556	0.218	2.084	5.913	0.000
9.6667	0.218	2.108	6.579	0.000
9.7778	0.218	2.132	7.083	0.000
9.8889	0.218	2.156	7.522	0.000
10.000	0.218	2.180	7.936	0.000
10.111	0.218	2.205	8.328	0.000
10.222	0.000	0.000	8.700	0.000

**Name** : Basin 3  
**Bypass**: Yes

**GroundWater**: No

<u>Pervious Land Use</u>	<u>acre</u>
C, Forest, Flat	.09
C, Forest, Mod	.17
C, Forest, Steep	.14

**Pervious Total** 0.4

<u>Impervious Land Use</u>	<u>acre</u>
<b>Impervious Total</b>	0

**Basin Total** 0.4

**Element Flows To:**  
 Surface Interflow Groundwater

**ANALYSIS RESULTS**

**Stream Protection Duration**

Predeveloped Landuse Totals for POC #1  
 Total Pervious Area:7.72  
 Total Impervious Area:0

Mitigated Landuse Totals for POC #1  
 Total Pervious Area:2.57  
 Total Impervious Area:5.15

**Flow Frequency Return Periods for Predeveloped. POC #1**

<u>Return Period</u>	<u>Flow(cfs)</u>
2 year	0.376691
5 year	0.613774
10 year	0.813706
25 year	1.12236
50 year	1.397754
100 year	1.716351

**Flow Frequency Return Periods for Mitigated. POC #1**

<u>Return Period</u>	<u>Flow(cfs)</u>
2 year	0.381338
5 year	0.515696
10 year	0.617964
25 year	0.763245
50 year	0.883799
100 year	1.015509

**Stream Protection Duration**

**Annual Peaks for Predeveloped and Mitigated. POC #1**

<u>Year</u>	<u>Predeveloped</u>	<u>Mitigated</u>
1949	0.409	0.380
1950	0.459	0.422
1951	0.331	0.377
1952	0.306	0.343
1953	0.268	0.400
1954	1.413	0.577
1955	0.468	0.389
1956	0.389	0.312
1957	0.524	0.424
1958	1.225	0.731
1959	0.340	0.335

1960	0.365	0.353
1961	1.497	0.923
1962	0.380	0.371
1963	0.625	0.464
1964	0.443	0.270
1965	0.275	0.275
1966	0.194	0.278
1967	0.383	0.610
1968	0.473	0.384
1969	1.236	0.713
1970	0.244	0.302
1971	0.440	0.370
1972	0.308	0.504
1973	0.266	0.388
1974	0.739	0.467
1975	0.323	0.387
1976	0.275	0.346
1977	0.239	0.307
1978	0.261	0.288
1979	0.759	0.503
1980	0.358	0.314
1981	0.257	0.293
1982	0.351	0.343
1983	0.641	0.361
1984	0.318	0.328
1985	0.435	0.438
1986	0.973	0.865
1987	0.427	0.553
1988	0.255	0.329
1989	0.320	0.338
1990	0.294	0.306
1991	0.314	0.301
1992	0.261	0.334
1993	0.259	0.286
1994	0.224	0.304
1995	0.318	0.305
1996	0.665	0.420
1997	1.191	1.024
1998	0.221	0.415
1999	0.259	0.265
2000	0.226	0.614
2001	0.095	0.282
2002	0.297	0.262
2003	0.234	0.294
2004	0.384	0.586
2005	0.284	0.295
2006	0.842	0.467
2007	0.670	0.443
2008	0.862	0.831
2009	0.262	0.322

**Stream Protection Duration**

**Ranked Annual Peaks for Predeveloped and Mitigated. POC #1**

**Rank            Predeveloped            Mitigated**



1	1.4966	1.0245
2	1.4128	0.9225
3	1.2357	0.8654
4	1.2254	0.8310
5	1.1908	0.7309
6	0.9727	0.7132
7	0.8625	0.6141
8	0.8417	0.6095
9	0.7592	0.5860
10	0.7385	0.5769
11	0.6698	0.5532
12	0.6655	0.5039
13	0.6412	0.5026
14	0.6245	0.4671
15	0.5235	0.4665
16	0.4732	0.4639
17	0.4681	0.4430
18	0.4585	0.4377
19	0.4426	0.4241
20	0.4403	0.4220
21	0.4354	0.4196
22	0.4275	0.4152
23	0.4085	0.4005
24	0.3887	0.3888
25	0.3839	0.3877
26	0.3826	0.3873
27	0.3797	0.3840
28	0.3654	0.3798
29	0.3579	0.3772
30	0.3509	0.3714
31	0.3403	0.3700
32	0.3310	0.3611
33	0.3235	0.3533
34	0.3198	0.3459
35	0.3183	0.3428
36	0.3180	0.3428
37	0.3139	0.3385
38	0.3084	0.3351
39	0.3064	0.3338
40	0.2971	0.3286
41	0.2940	0.3278
42	0.2842	0.3220
43	0.2754	0.3141
44	0.2752	0.3115
45	0.2678	0.3067
46	0.2660	0.3061
47	0.2622	0.3045
48	0.2613	0.3037
49	0.2605	0.3021
50	0.2590	0.3013
51	0.2586	0.2950
52	0.2569	0.2943
53	0.2546	0.2932
54	0.2445	0.2881
55	0.2388	0.2864

56	0.2344	0.2818
57	0.2256	0.2783
58	0.2244	0.2753
59	0.2205	0.2703
60	0.1938	0.2645
61	0.0955	0.2619

**Stream Protection Duration**

**POC #1**

**The Facility PASSED**

**The Facility PASSED.**

Flow(cfs)	Predev	Mit	Percentage	Pass/Fail
0.1883	11751	11659	99	Pass
0.2006	9593	7931	82	Pass
0.2128	7867	5452	69	Pass
0.2250	6391	3831	59	Pass
0.2372	5116	2748	53	Pass
0.2494	4171	2127	50	Pass
0.2616	3394	1710	50	Pass
0.2739	2821	1413	50	Pass
0.2861	2331	1241	53	Pass
0.2983	1962	1077	54	Pass
0.3105	1689	968	57	Pass
0.3227	1480	884	59	Pass
0.3349	1266	808	63	Pass
0.3472	1082	738	68	Pass
0.3594	954	684	71	Pass
0.3716	863	647	74	Pass
0.3838	780	615	78	Pass
0.3960	699	582	83	Pass
0.4082	646	551	85	Pass
0.4205	598	530	88	Pass
0.4327	555	513	92	Pass
0.4449	523	493	94	Pass
0.4571	496	467	94	Pass
0.4693	469	444	94	Pass
0.4815	450	419	93	Pass
0.4938	432	397	91	Pass
0.5060	404	377	93	Pass
0.5182	363	360	99	Pass
0.5304	346	346	100	Pass
0.5426	329	329	100	Pass
0.5548	317	314	99	Pass
0.5670	299	299	100	Pass
0.5793	288	288	100	Pass
0.5915	278	276	99	Pass
0.6037	266	266	100	Pass
0.6159	259	251	96	Pass
0.6281	248	236	95	Pass
0.6403	241	225	93	Pass
0.6526	229	213	93	Pass
0.6648	215	200	93	Pass

0.6770	204	187	91	Pass
0.6892	187	172	91	Pass
0.7014	174	163	93	Pass
0.7136	165	148	89	Pass
0.7259	158	133	84	Pass
0.7381	150	122	81	Pass
0.7503	135	105	77	Pass
0.7625	125	95	76	Pass
0.7747	113	81	71	Pass
0.7869	101	71	70	Pass
0.7992	85	57	67	Pass
0.8114	74	52	70	Pass
0.8236	65	41	63	Pass
0.8358	57	33	57	Pass
0.8480	43	29	67	Pass
0.8602	27	24	88	Pass
0.8725	24	18	75	Pass
0.8847	20	15	75	Pass
0.8969	18	12	66	Pass
0.9091	12	9	75	Pass
0.9213	10	7	70	Pass
0.9335	9	2	22	Pass
0.9458	9	2	22	Pass
0.9580	9	2	22	Pass
0.9702	8	2	25	Pass
0.9824	7	1	14	Pass
0.9946	7	1	14	Pass
1.0068	7	1	14	Pass
1.0191	7	1	14	Pass
1.0313	7	0	0	Pass
1.0435	7	0	0	Pass
1.0557	6	0	0	Pass
1.0679	6	0	0	Pass
1.0801	6	0	0	Pass
1.0923	5	0	0	Pass
1.1046	5	0	0	Pass
1.1168	5	0	0	Pass
1.1290	5	0	0	Pass
1.1412	5	0	0	Pass
1.1534	5	0	0	Pass
1.1656	5	0	0	Pass
1.1779	5	0	0	Pass
1.1901	5	0	0	Pass
1.2023	4	0	0	Pass
1.2145	4	0	0	Pass
1.2267	3	0	0	Pass
1.2389	2	0	0	Pass
1.2512	2	0	0	Pass
1.2634	2	0	0	Pass
1.2756	2	0	0	Pass
1.2878	2	0	0	Pass
1.3000	2	0	0	Pass
1.3122	2	0	0	Pass
1.3245	2	0	0	Pass
1.3367	2	0	0	Pass

1.3489	2	0	0	Pass
1.3611	2	0	0	Pass
1.3733	2	0	0	Pass
1.3855	2	0	0	Pass
1.3978	2	0	0	Pass

---

**Water Quality BMP Flow and Volume for POC #1**  
**On-line facility volume:** 0.5999 acre-feet  
**On-line facility target flow:** 0.8812 cfs.  
**Adjusted for 15 min:** 0.8812 cfs.  
**Off-line facility target flow:** 0.4988 cfs.  
**Adjusted for 15 min:** 0.4988 cfs.

---

**LID Report**

LID Technique	Used for	Total Volume	Volume	Infiltration	Cumulative
Percent	Water Quality	Percent	Through	Volume	Volume
Volume	Treatment?	Needs	Facility	(ac-ft.)	Infiltration
Infiltrated	Water Quality	Treatment	(ac-ft)	(ac-ft)	Credit
Vault	Treated	(ac-ft)	(ac-ft)	(ac-ft)	N
1 POC	N	964.61			N
0.00					
Total Volume Infiltrated		964.61	0.00	0.00	
0.00	0.00	0%	No Treat.	Credit	
Compliance with LID Standard 8					
Duration Analysis Result = Passed					

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**PerlnD and Implnd Changes**

No changes have been made.

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WWHM2012  
PROJECT REPORT

**Project Name:** 20230331 Perkfilter (Upstream of Vault)  
**Site Name:** Brodie  
**Site Address:**  
**City :**  
**Report Date:** 3/31/2023  
**Gage :** Everett  
**Data Start :** 1948/10/01  
**Data End :** 2009/09/30  
**Precip Scale:** 1.20  
**Version Date:** 2021/08/18  
**Version :** 4.2.18

Low Flow Threshold for POC 1 : 50 Percent of the 2 Year

High Flow Threshold for POC 1: 50 year

**PREDEVELOPED LAND USE**

**Name :** Project Site  
**Bypass:** No

**GroundWater:** No

<u>Pervious Land Use</u>	<u>acre</u>
C, Forest, Mod	6.71

Pervious Total 6.71

<u>Impervious Land Use</u>	<u>acre</u>
Impervious Total	0

Impervious Total 0

Basin Total 6.71

<b>Element Flows To:</b>		
Surface	Interflow	Groundwater

**Name :** Upstream  
**Bypass:** No

**GroundWater:** No

<u>Pervious Land Use</u>	<u>acre</u>
C, Forest, Flat	.09
C, Forest, Mod	.17
C, Forest, Steep	.14

Pervious Total 0.4

<u>Impervious Land Use</u>	<u>acre</u>
----------------------------	-------------

Impervious Total 0

Basin Total 0.4

---

Element Flows To:	Interflow	Groundwater
Surface		

---

**MITIGATED LAND USE**

Name : Onsite

Bypass: No

GroundWater: No

<u>Pervious Land Use</u>	<u>acre</u>
C, Pasture, Flat	2.04

Pervious Total 2.04

<u>Impervious Land Use</u>	<u>acre</u>
ROADS FLAT	1.23
ROADS MOD	0.38
ROOF TOPS FLAT	2.56
SIDEWALKS FLAT	0.4
SIDEWALKS MOD	0.1

Impervious Total 4.67

Basin Total 6.71

---

Element Flows To:	Interflow	Groundwater
Surface		

---

Name : Upstream  
 Bypass: No

GroundWater: No

<u>Pervious Land Use</u>	<u>acre</u>
C, Forest, Flat	.09
C, Forest, Mod	.17
C, Forest, Steep	.14

Pervious Total 0.4

<u>Impervious Land Use</u>	<u>acre</u>
Impervious Total	0

Impervious Total 0

Basin Total 0.4

Element Flows To:	Interflow	Groundwater
Surface		

### ANALYSIS RESULTS

#### Stream Protection Duration

Predeveloped Landuse Totals for POC #1  
 Total Pervious Area:7.11  
 Total Impervious Area:0

Mitigated Landuse Totals for POC #1  
 Total Pervious Area:2.44  
 Total Impervious Area:4.67

#### Flow Frequency Return Periods for Predeveloped. POC #1

<u>Return Period</u>	<u>Flow(cfs)</u>
2 year	0.264861
5 year	0.423436
10 year	0.549591
25 year	0.734533
50 year	0.891826
100 year	1.066688

#### Flow Frequency Return Periods for Mitigated. POC #1

<u>Return Period</u>	<u>Flow(cfs)</u>
2 year	2.603853
5 year	3.551677
10 year	4.249136
25 year	5.213246
50 year	5.993836
100 year	6.829802

The development has an increase in flow durations from 1/2 Predeveloped 2 year flow to the 2 year flow or more than a 10% increase from the 2 year to the 50 year flow.

The development has an increase in flow durations for more than 50% of the flows for the range of the duration analysis.

---

**Water Quality BMP Flow and Volume for POC #1**

On-line facility volume: 0.5999 acre-feet

**On-line facility target flow: 0.8812 cfs.**

Adjusted for 15 min: 0.8812 cfs.

Off-line facility target flow: 0.4988 cfs.

Adjusted for 15 min: 0.4988 cfs.

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PROJECT REPORT

**Project Name:** 20230331 Modular Wetland (Frontage Bypass)  
**Site Name:** Brodie  
**Site Address:**  
**City :**  
**Report Date:** 3/31/2023  
**Gage :** Everett  
**Data Start :** 1948/10/01  
**Data End :** 2009/09/30  
**Precip Scale:** 1.20  
**Version Date:** 2021/08/18  
**Version :** 4.2.18

Low Flow Threshold for POC 1 : 50 Percent of the 2 Year

High Flow Threshold for POC 1: 50 year

**PREDEVELOPED LAND USE**

**Name :** Bypass  
**Bypass:** No

**GroundWater:** No

<u>Pervious Land Use</u>	<u>acre</u>
C, Forest, Flat	.61
<b>Pervious Total</b>	<b>0.61</b>
<u>Impervious Land Use</u>	<u>acre</u>
<b>Impervious Total</b>	<b>0</b>
<b>Basin Total</b>	<b>0.61</b>

<b>Element Flows To:</b>		
Surface	Interflow	Groundwater

**MITIGATED LAND USE**

**Name :** Bypass  
**Bypass:** No

GroundWater: No

<u>Pervious Land Use</u>	<u>acre</u>
C, Pasture, Flat	.13

Pervious Total 0.13

<u>Impervious Land Use</u>	<u>acre</u>
ROADS FLAT	0.25
ROADS MOD	0.05
SIDEWALKS FLAT	0.16
SIDEWALKS MOD	0.02

Impervious Total 0.48

Basin Total 0.61

Element Flows To:	Interflow	Groundwater
Surface		

### ANALYSIS RESULTS

#### Stream Protection Duration

#### Predeveloped Landuse Totals for POC #1

Total Pervious Area:0.61

Total Impervious Area:0

#### Mitigated Landuse Totals for POC #1

Total Pervious Area:0.13

Total Impervious Area:0.48

#### Flow Frequency Return Periods for Predeveloped. POC #1

<u>Return Period</u>	<u>Flow(cfs)</u>
2 year	0.020496
5 year	0.031442
10 year	0.039883
25 year	0.051961
50 year	0.06202
100 year	0.07302

#### Flow Frequency Return Periods for Mitigated. POC #1

<u>Return Period</u>	<u>Flow(cfs)</u>
----------------------	------------------

2 year	0.265723
5 year	0.360626
10 year	0.430189
25 year	0.526048
50 year	0.603446
100 year	0.686153

---

The development has an increase in flow durations from 1/2 Predeveloped 2 year flow to the 2 year flow or more than a 10% increase from the 2 year to the 50 year flow.

The development has an increase in flow durations for more than 50% of the flows for the range of the duration analysis.

---

Water Quality BMP Flow and Volume for POC #1  
On-line facility volume: 0.0605 acre-feet  
On-line facility target flow: 0.092 cfs.  
Adjusted for 15 min: 0.092 cfs.  
Off-line facility target flow: 0.052 cfs.  
Adjusted for 15 min: 0.052 cfs.

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## **SECTION 5: CONVEYANCE DESIGN**

The stormwater conveyance system is comprised of a network of open/closed grate catch basins, buried pipe, a concrete detention vault and a Perfilter water quality vault, and the discharge to the existing wetland. Catch basins have been located such that each section of storm drainage pipe may adequately convey associated tributary area flows. All storm pipe located within the proposed private road was sized at the minimum diameter in accordance with the conveyance analysis.

Conveyance analysis for the drainage system was completed using AutoCAD Storm and Sanitary Analysis (SSA). The conveyance system was designed for the 100-year, 24-hour storm event, using the Santa Barbara Unit Hydrograph Method. The 100-year cumulative storm for Snohomish County, Washington, with a total rainfall amount of 3.20, using a SCS Type IA 24-hr storm distribution was applied to each subbasin. The Uniform Flow Method (Manning's Equation) was utilized to ensure that during the 100-year, 24-hour storm event, no catch basin structures would be overtopping. See Appendix 5 for full SSA output data as well as a visual representation of contributing conveyance basins.

The following catch basin summary table demonstrates that no catch basin structures overtop for the detention tributary drainage lines in the 100-year design storm event:

<b>Storm Drain Conveyance Analysis</b>				
<b>CB #</b>	<b>Rim</b>	<b>HGL</b>	<b>Distance to Overtopping (ft)</b>	<b>Pipe Dia (in)</b>
CB-10	431.89	428.49	3.40	<b>12</b>
CB-11	436.40	433.05	3.35	<b>12</b>
CB-12	436.99	433.64	3.35	<b>12</b>
CB-13	417.54	412.80	4.74	<b>12</b>
CB-14	419.20	413.23	5.97	<b>12</b>
CB-15	416.98	413.66	3.32	<b>12</b>
CB-16	418.76	413.46	5.30	<b>12</b>
CB-17	419.09	413.65	5.44	<b>12</b>
CB-18	419.99	416.87	3.12	<b>12</b>
CB-19	421.43	418.00	3.43	<b>12</b>
CB-20	421.43	418.25	3.18	<b>12</b>
CB-21	436.68	433.32	3.36	<b>12</b>
CB-22	439.98	434.03	5.95	<b>12</b>
CB-23	446.50	442.58	3.92	<b>12</b>
CB-24	446.18	442.89	3.29	<b>12</b>
CB-25	449.24	445.86	3.38	<b>12</b>
CB-27	403.86	397.70	6.16	<b>12</b>
CB-28	400.26	398.40	1.86	<b>12</b>
CB-29	403.93	399.64	4.29	<b>12</b>
CB-3	411.13	408.15	2.98	<b>12</b>
CB-30	404.62	401.90	2.72	<b>12</b>
CB-31	404.62	402.39	2.23	<b>12</b>
CB-32	406.93	403.86	3.07	<b>12</b>
CB-32A	408.73	405.59	3.14	<b>12</b>
CB-3A	411.46	408.43	3.03	<b>12</b>
CB-4	410.40	408.51	1.89	<b>12</b>
CB-5	411.63	408.32	3.31	<b>12</b>
CB-6	417.28	413.99	3.29	<b>12</b>
CB-7	420.99	417.55	3.44	<b>12</b>
CB-8	427.85	424.57	3.28	<b>12</b>
CB-9	427.87	424.87	3.00	<b>12</b>
MWIn	403.24	397.56	5.68	<b>12</b>
MWOut	403.24	396.89	6.35	<b>12</b>
PerkfilterIn	412.50	407.90	4.60	<b>12</b>
PerkfilterOut	412.50	406.23	6.27	<b>12</b>

### **Vault Discharge Line**

A conveyance capacity calculation was performed using Manning's Equation on the pipe slope (CB-2 to CB-1) within the detention discharge line to verify pipe capacity in the 100-year unmitigated storm event. A summary evaluation of pipe capacity, offered below, demonstrates compliance in an overtopping condition where the full 100-year peak flow is conveyed through the discharge line. The calculations associated with this evaluation can be found in Appendix 5.  
CB-2 to CB-1:

100-Year Peak Flow Rate:	6.79 cfs (WWHM2012 - 701 Series)
Pipe Diameter:	12"
Minimum Slope:	12.25%
Pipe Flow Depth:	100%
Pipe Flow Capacity:	12.50 cfs
Evaluation:	System Adequate

**Appendix 5: Conveyance Analysis**

1. AutoCAD Storm and Sanitary Analysis Output Data
2. Manning's Analysis: Vault Discharge



\*\*\*\*\*  
 Project Description  
 \*\*\*\*\*

File Name ..... Conveyance Model 20230403.SPF

\*\*\*\*\*  
 Analysis Options  
 \*\*\*\*\*

Flow Units ..... cfs  
 Subbasin Hydrograph Method. Santa Barbara UH  
 Time of Concentration..... SCS TR-55  
 Link Routing Method ..... Kinematic Wave  
 Storage Node Exfiltration.. None  
 Starting Date ..... MAR-30-2023 00:00:00  
 Ending Date ..... MAR-31-2023 00:00:00  
 Report Time Step ..... 00:00:10

\*\*\*\*\*  
 Element Count  
 \*\*\*\*\*

Number of rain gages ..... 1  
 Number of subbasins ..... 29  
 Number of nodes ..... 37  
 Number of links ..... 35

\*\*\*\*\*  
 Raingage Summary  
 \*\*\*\*\*

Gage ID	Data Source	Data Type	Recording Interval	min
Rain Gage-01	TS-01	CUMULATIVE	6.00	

\*\*\*\*\*  
 Subbasin Summary  
 \*\*\*\*\*

Subbasin ID	Total Area acres	Imperv. Area %	Raingage
Sub-06	0.09	100.00	Rain Gage-01
Sub-10	0.47	65.00	Rain Gage-01
Sub-11	0.50	91.00	Rain Gage-01
Sub-12	0.52	55.00	Rain Gage-01
Sub-13	0.04	75.00	Rain Gage-01
Sub-14	0.04	100.00	Rain Gage-01
Sub-15	0.59	65.00	Rain Gage-01
Sub-16	0.33	78.00	Rain Gage-01
Sub-17	0.08	88.00	Rain Gage-01
Sub-18	0.64	73.00	Rain Gage-01
Sub-19	0.06	67.00	Rain Gage-01
Sub-20	0.05	60.00	Rain Gage-01
Sub-21	0.05	80.00	Rain Gage-01
Sub-22	0.03	100.00	Rain Gage-01
Sub-23	0.23	82.00	Rain Gage-01
Sub-24	0.14	71.00	Rain Gage-01
Sub-25	0.73	75.00	Rain Gage-01
Sub-27	0.03	100.00	Rain Gage-01

Sub-28	0.25	52.00	Rain Gage-01
Sub-3	0.13	85.00	Rain Gage-01
Sub-30	0.12	58.00	Rain Gage-01
Sub-31	0.11	91.00	Rain Gage-01
Sub-32	0.37	62.00	Rain Gage-01
Sub-3A	0.72	79.00	Rain Gage-01
Sub-4	0.04	50.00	Rain Gage-01
Sub-5	0.43	62.00	Rain Gage-01
Sub-7	0.07	100.00	Rain Gage-01
Sub-8	0.03	67.00	Rain Gage-01
Sub-9	0.27	77.00	Rain Gage-01

\*\*\*\*\*  
Node Summary  
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Node ID	Element Type	Invert Elevation ft	Maximum Elev. ft	Ponded Area ft <sup>2</sup>	External Inflow
CB-10	JUNCTION	428.39	431.89	0.00	
CB-11	JUNCTION	432.90	436.40	0.00	
CB-12	JUNCTION	433.49	436.99	0.00	
CB-13	JUNCTION	412.32	417.54	0.00	
CB-14	JUNCTION	412.75	419.20	0.00	
CB-15	JUNCTION	413.48	416.98	0.00	
CB-16	JUNCTION	413.07	418.76	0.00	
CB-17	JUNCTION	413.29	419.09	0.00	
CB-18	JUNCTION	416.74	419.99	0.00	
CB-19	JUNCTION	417.92	421.43	0.00	
CB-20	JUNCTION	418.18	421.43	0.00	
CB-21	JUNCTION	433.18	436.68	0.00	
CB-22	JUNCTION	433.98	439.98	0.00	
CB-23	JUNCTION	442.37	446.50	0.00	
CB-24	JUNCTION	442.68	446.18	0.00	
CB-25	JUNCTION	445.74	449.24	0.00	
CB-27	JUNCTION	397.38	403.86	0.00	
CB-28	JUNCTION	398.09	400.26	0.00	
CB-29	JUNCTION	399.40	403.93	0.00	
CB-3	JUNCTION	407.56	411.13	0.00	
CB-30	JUNCTION	401.73	404.62	0.00	
CB-31	JUNCTION	402.22	404.62	0.00	
CB-32	JUNCTION	403.73	406.93	0.00	
CB-32A	JUNCTION	405.48	408.73	0.00	
CB-3A	JUNCTION	408.25	411.46	0.00	
CB-4	JUNCTION	407.75	410.40	0.00	
CB-5	JUNCTION	407.89	411.63	0.00	
CB-6	JUNCTION	413.79	417.28	0.00	
CB-7	JUNCTION	417.49	420.99	0.00	
CB-8	JUNCTION	424.35	427.85	0.00	
CB-9	JUNCTION	424.65	427.87	0.00	
MWIn	JUNCTION	397.24	403.24	0.00	
MWOut	JUNCTION	396.74	403.24	0.00	
PerkfilterIn	JUNCTION	407.31	412.50	0.00	
PerkfilterOut	JUNCTION	405.81	412.50	0.00	
CB-26	OUTFALL	393.54	394.54	0.00	
Vault	OUTFALL	405.57	406.57	0.00	

\*\*\*\*\*  
Link Summary  
\*\*\*\*\*

Link ID	From Node	To Node	Element Type	Length ft	Slope %	Manning's Roughness
Link-01	CB-24	CB-23	CONDUIT	31.0	1.0000	0.0150
Link-02	CB-12	CB-11	CONDUIT	30.0	1.9667	0.0150

Link-03	CB-6	CB-4	CONDUIT	51.0	11.3529	0.0150
Link-04	CB-4	CB-3	CONDUIT	87.0	0.5057	0.0150
Link-06	CB-31	CB-30	CONDUIT	27.0	1.8148	0.0150
Link-08	PerkfilterIn	PerkfilterOut	CONDUIT	9.0	16.6667	0.0150
Link-09	PerkfilterOut	Vault	CONDUIT	4.0	6.0000	0.0150
Link-10	MWIn	MWOut	CONDUIT	5.0	10.0000	0.0150
Link-11	MWOut	CB-26	CONDUIT	35.0	9.1429	0.0150
Link-12	CB-32A	CB-32	CONDUIT	23.0	7.6087	0.0150
Pipe - (149)	CB-32	CB-31	CONDUIT	44.0	3.4318	0.0150
Pipe - (164)	CB-3	PerkfilterIn	CONDUIT	13.0	1.9231	0.0150
Pipe - (167)	CB-16	CB-14	CONDUIT	28.0	1.1429	0.0150
Pipe - (172)	CB-13	CB-3	CONDUIT	239.0	1.9916	0.0150
Pipe - (27)	CB-29	CB-28	CONDUIT	167.0	0.7844	0.0150
Pipe - (28)	CB-30	CB-29	CONDUIT	46.0	5.0652	0.0150
Pipe - (30)	CB-27	MWIn	CONDUIT	27.0	0.5185	0.0150
Pipe - (32)	CB-3A	CB-3	CONDUIT	26.0	2.6538	0.0150
Pipe - (34)	CB-5	CB-4	CONDUIT	29.0	0.4828	0.0150
Pipe - (35)	CB-8	CB-6	CONDUIT	71.0	14.8732	0.0150
Pipe - (37)	CB-10	CB-9	CONDUIT	42.0	8.9048	0.0150
Pipe - (38)	CB-9	CB-8	CONDUIT	30.0	1.0000	0.0150
Pipe - (39)	CB-11	CB-8	CONDUIT	41.0	20.8537	0.0150
Pipe - (42)	CB-25	CB-24	CONDUIT	59.0	5.1864	0.0150
Pipe - (43)	CB-23	CB-21	CONDUIT	86.0	10.6860	0.0150
Pipe - (44)	CB-21	CB-17	CONDUIT	147.0	13.5306	0.0150
Pipe - (45)	CB-18	CB-17	CONDUIT	33.0	10.4545	0.0150
Pipe - (46)	CB-19	CB-18	CONDUIT	55.0	2.1455	0.0150
Pipe - (47)	CB-20	CB-19	CONDUIT	26.0	1.0000	0.0150
Pipe - (48)	CB-17	CB-16	CONDUIT	22.0	1.0000	0.0150
Pipe - (55)	CB-7	CB-6	CONDUIT	47.0	7.8723	0.0150
Pipe - (56)	CB-22	CB-21	CONDUIT	29.0	2.7586	0.0150
Pipe - (69)	CB-15	CB-14	CONDUIT	108.0	0.6759	0.0150
Pipe - (70)	CB-14	CB-13	CONDUIT	58.0	0.7414	0.0150
Pipe - (71)	CB-28	CB-27	CONDUIT	141.0	0.5035	0.0150

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Cross Section Summary  
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Link Design ID Flow Capacity	Shape	Depth/ Diameter ft	Width ft	No. of Barrels	Cross Sectional Area ft <sup>2</sup>	Full Flow Hydraulic Radius ft
Link-01 3.09	CIRCULAR	1.00	1.00	1	0.79	0.25
Link-02 4.33	CIRCULAR	1.00	1.00	1	0.79	0.25
Link-03 10.40	CIRCULAR	1.00	1.00	1	0.79	0.25
Link-04 2.20	CIRCULAR	1.00	1.00	1	0.79	0.25
Link-06 4.16	CIRCULAR	1.00	1.00	1	0.79	0.25
Link-08 12.61	CIRCULAR	1.00	1.00	1	0.79	0.25
Link-09 7.56	CIRCULAR	1.00	1.00	1	0.79	0.25
Link-10 9.76	CIRCULAR	1.00	1.00	1	0.79	0.25
Link-11 9.34	CIRCULAR	1.00	1.00	1	0.79	0.25

Link-12	CIRCULAR	1.00	1.00	1	0.79	0.25
8.52						
Pipe - (149)	CIRCULAR	1.00	1.00	1	0.79	0.25
5.72						
Pipe - (164)	CIRCULAR	1.00	1.00	1	0.79	0.25
4.28						
Pipe - (167)	CIRCULAR	1.00	1.00	1	0.79	0.25
3.30						
Pipe - (172)	CIRCULAR	1.00	1.00	1	0.79	0.25
4.36						
Pipe - (27)	CIRCULAR	1.00	1.00	1	0.79	0.25
2.73						
Pipe - (28)	CIRCULAR	1.00	1.00	1	0.79	0.25
6.95						
Pipe - (30)	CIRCULAR	1.00	1.00	1	0.79	0.25
2.22						
Pipe - (32)	CIRCULAR	1.00	1.00	1	0.79	0.25
5.03						
Pipe - (34)	CIRCULAR	1.00	1.00	1	0.79	0.25
2.15						
Pipe - (35)	CIRCULAR	1.00	1.00	1	0.79	0.25
11.91						
Pipe - (37)	CIRCULAR	1.00	1.00	1	0.79	0.25
9.21						
Pipe - (38)	CIRCULAR	1.00	1.00	1	0.79	0.25
3.09						
Pipe - (39)	CIRCULAR	1.00	1.00	1	0.79	0.25
14.10						
Pipe - (42)	CIRCULAR	1.00	1.00	1	0.79	0.25
7.03						
Pipe - (43)	CIRCULAR	1.00	1.00	1	0.79	0.25
10.09						
Pipe - (44)	CIRCULAR	1.00	1.00	1	0.79	0.25
11.36						
Pipe - (45)	CIRCULAR	1.00	1.00	1	0.79	0.25
9.98						
Pipe - (46)	CIRCULAR	1.00	1.00	1	0.79	0.25
4.52						
Pipe - (47)	CIRCULAR	1.00	1.00	1	0.79	0.25
3.09						
Pipe - (48)	CIRCULAR	1.00	1.00	1	0.79	0.25
3.09						
Pipe - (55)	CIRCULAR	1.00	1.00	1	0.79	0.25
8.66						
Pipe - (56)	CIRCULAR	1.00	1.00	1	0.79	0.25
5.13						
Pipe - (69)	CIRCULAR	1.00	1.00	1	0.79	0.25
2.54						
Pipe - (70)	CIRCULAR	1.00	1.00	1	0.79	0.25
2.66						
Pipe - (71)	CIRCULAR	1.00	1.00	1	0.79	0.25
2.19						

*****	Volume	Depth
Runoff Quantity Continuity	acre-ft	inches
*****	-----	-----
Total Precipitation .....	1.906	3.194
Surface Runoff .....	1.453	2.436
Continuity Error (%) .....	0.000	

*****	Volume	Volume
Flow Routing Continuity	acre-ft	Mgallons
*****	-----	-----
External Inflow .....	0.000	0.000
External Outflow .....	1.452	0.473



Initial Stored Volume .... 0.000 0.000  
 Final Stored Volume ..... 0.002 0.000  
 Continuity Error (%) ..... 0.000

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

-----  
 Subbasin Sub-06  
 -----

Soil/Surface Description	Area (acres)	Soil Group	CN
-----	-----	-----	-----
Composite Area & Weighted CN	0.09		98.00

-----  
 Subbasin Sub-10  
 -----

Soil/Surface Description	Area (acres)	Soil Group	CN
-----	-----	-----	-----
Composite Area & Weighted CN	0.47		90.30

-----  
 Subbasin Sub-11  
 -----

Soil/Surface Description	Area (acres)	Soil Group	CN
-----	-----	-----	-----
Composite Area & Weighted CN	0.50		96.02

-----  
 Subbasin Sub-12  
 -----

Soil/Surface Description	Area (acres)	Soil Group	CN
-----	-----	-----	-----
Composite Area & Weighted CN	0.52		88.10

-----  
 Subbasin Sub-13  
 -----

Soil/Surface Description	Area (acres)	Soil Group	CN
-----	-----	-----	-----
Composite Area & Weighted CN	0.04		92.50

-----  
 Subbasin Sub-14  
 -----

Soil/Surface Description	Area (acres)	Soil Group	CN
-----	-----	-----	-----
Composite Area & Weighted CN	0.04		98.00

-----  
 Subbasin Sub-15  
 -----

Soil/Surface Description	Area (acres)	Soil Group	CN
-----	-----	-----	-----
Composite Area & Weighted CN	0.59		90.30

-----  
 Subbasin Sub-16  
 -----

Soil/Surface Description	Area (acres)	Soil Group	CN
Composite Area & Weighted CN	0.33		93.16

Subbasin Sub-17

Soil/Surface Description	Area (acres)	Soil Group	CN
Composite Area & Weighted CN	0.08		95.36

Subbasin Sub-18

Soil/Surface Description	Area (acres)	Soil Group	CN
Composite Area & Weighted CN	0.64		92.06

Subbasin Sub-19

Soil/Surface Description	Area (acres)	Soil Group	CN
Composite Area & Weighted CN	0.06		90.74

Subbasin Sub-20

Soil/Surface Description	Area (acres)	Soil Group	CN
Composite Area & Weighted CN	0.05		89.20

Subbasin Sub-21

Soil/Surface Description	Area (acres)	Soil Group	CN
Composite Area & Weighted CN	0.05		93.60

Subbasin Sub-22

Soil/Surface Description	Area (acres)	Soil Group	CN
Composite Area & Weighted CN	0.03		98.00

Subbasin Sub-23

Soil/Surface Description	Area (acres)	Soil Group	CN
Composite Area & Weighted CN	0.23		94.04

Subbasin Sub-24

Soil/Surface Description	Area (acres)	Soil Group	CN

Composite Area & Weighted CN	0.14	91.62
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-----  
 Subbasin Sub-25  
 -----

Soil/Surface Description	Area (acres)	Soil Group	CN
Composite Area & Weighted CN	0.73		92.50

-----  
 Subbasin Sub-27  
 -----

Soil/Surface Description	Area (acres)	Soil Group	CN
Composite Area & Weighted CN	0.03		98.00

-----  
 Subbasin Sub-28  
 -----

Soil/Surface Description	Area (acres)	Soil Group	CN
Composite Area & Weighted CN	0.25		87.44

-----  
 Subbasin Sub-3  
 -----

Soil/Surface Description	Area (acres)	Soil Group	CN
Composite Area & Weighted CN	0.13		94.70

-----  
 Subbasin Sub-30  
 -----

Soil/Surface Description	Area (acres)	Soil Group	CN
Composite Area & Weighted CN	0.12		88.76

-----  
 Subbasin Sub-31  
 -----

Soil/Surface Description	Area (acres)	Soil Group	CN
Composite Area & Weighted CN	0.11		96.02

-----  
 Subbasin Sub-32  
 -----

Soil/Surface Description	Area (acres)	Soil Group	CN
Composite Area & Weighted CN	0.37		89.64

-----  
 Subbasin Sub-3A  
 -----

Soil/Surface Description	Area (acres)	Soil Group	CN
Composite Area & Weighted CN	0.72		93.38

-----  
 Subbasin Sub-4  
 -----

Soil/Surface Description	Area (acres)	Soil Group	CN
Composite Area & Weighted CN	0.04		87.00

-----  
 Subbasin Sub-5  
 -----

Soil/Surface Description	Area (acres)	Soil Group	CN
Composite Area & Weighted CN	0.43		89.64

-----  
 Subbasin Sub-7  
 -----

Soil/Surface Description	Area (acres)	Soil Group	CN
Composite Area & Weighted CN	0.07		98.00

-----  
 Subbasin Sub-8  
 -----

Soil/Surface Description	Area (acres)	Soil Group	CN
Composite Area & Weighted CN	0.03		90.74

-----  
 Subbasin Sub-9  
 -----

Soil/Surface Description	Area (acres)	Soil Group	CN
Composite Area & Weighted CN	0.27		92.94

\*\*\*\*\*  
 Runoff Coefficient Computations Report  
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 Subbasin Sub-06  
 -----

Soil/Surface Description	Area (acres)	Soil Group	Runoff Coeff.
-	0.09	-	0.72
Composite Area & Weighted Runoff Coeff.	0.09		0.72

-----  
 Subbasin Sub-10  
 -----

Soil/Surface Description	Area (acres)	Soil Group	Runoff Coeff.
-	0.47	-	0.72
Composite Area & Weighted Runoff Coeff.	0.47		0.72

-----  
 Subbasin Sub-11  
 -----

Soil/Surface Description	Area (acres)	Soil Group	Runoff Coeff.
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-	0.50	-	0.72
Composite Area & Weighted Runoff Coeff.	0.50		0.72

-----  
Subbasin Sub-12  
-----

Soil/Surface Description	Area (acres)	Soil Group	Runoff Coeff.
-	0.52	-	0.72
Composite Area & Weighted Runoff Coeff.	0.52		0.72

-----  
Subbasin Sub-13  
-----

Soil/Surface Description	Area (acres)	Soil Group	Runoff Coeff.
-	0.04	-	0.72
Composite Area & Weighted Runoff Coeff.	0.04		0.72

-----  
Subbasin Sub-14  
-----

Soil/Surface Description	Area (acres)	Soil Group	Runoff Coeff.
-	0.04	-	0.72
Composite Area & Weighted Runoff Coeff.	0.04		0.72

-----  
Subbasin Sub-15  
-----

Soil/Surface Description	Area (acres)	Soil Group	Runoff Coeff.
-	0.59	-	0.72
Composite Area & Weighted Runoff Coeff.	0.59		0.72

-----  
Subbasin Sub-16  
-----

Soil/Surface Description	Area (acres)	Soil Group	Runoff Coeff.
-	0.33	-	0.72
Composite Area & Weighted Runoff Coeff.	0.33		0.72

-----  
Subbasin Sub-17  
-----

Soil/Surface Description	Area (acres)	Soil Group	Runoff Coeff.
-	0.08	-	0.72
Composite Area & Weighted Runoff Coeff.	0.08		0.72

-----  
Subbasin Sub-18  
-----

Soil/Surface Description	Area (acres)	Soil Group	Runoff Coeff.
-	0.64	-	0.72
Composite Area & Weighted Runoff Coeff.	0.64		0.72

-----  
 Subbasin Sub-19  
 -----

Soil/Surface Description	Area (acres)	Soil Group	Runoff Coeff.
-	0.06	-	0.72
Composite Area & Weighted Runoff Coeff.	0.06		0.72

-----  
 Subbasin Sub-20  
 -----

Soil/Surface Description	Area (acres)	Soil Group	Runoff Coeff.
-	0.05	-	0.72
Composite Area & Weighted Runoff Coeff.	0.05		0.72

-----  
 Subbasin Sub-21  
 -----

Soil/Surface Description	Area (acres)	Soil Group	Runoff Coeff.
-	0.05	-	0.72
Composite Area & Weighted Runoff Coeff.	0.05		0.72

-----  
 Subbasin Sub-22  
 -----

Soil/Surface Description	Area (acres)	Soil Group	Runoff Coeff.
-	0.03	-	0.72
Composite Area & Weighted Runoff Coeff.	0.03		0.72

-----  
 Subbasin Sub-23  
 -----

Soil/Surface Description	Area (acres)	Soil Group	Runoff Coeff.
-	0.23	-	0.72
Composite Area & Weighted Runoff Coeff.	0.23		0.72

-----  
 Subbasin Sub-24  
 -----

Soil/Surface Description	Area (acres)	Soil Group	Runoff Coeff.
-	0.14	-	0.72
Composite Area & Weighted Runoff Coeff.	0.14		0.72

-----  
 Subbasin Sub-25  
 -----

Soil/Surface Description	Area (acres)	Soil Group	Runoff Coeff.
-	0.73	-	0.72
Composite Area & Weighted Runoff Coeff.	0.73		0.72

-----  
 Subbasin Sub-27  
 -----

Area	Soil	Runoff
------	------	--------

Soil/Surface Description	(acres)	Group	Coeff.
-	0.03	-	0.72
Composite Area & Weighted Runoff Coeff.	0.03		0.72

-----  
Subbasin Sub-28  
-----

Soil/Surface Description	Area (acres)	Soil Group	Runoff Coeff.
-	0.25	-	0.72
Composite Area & Weighted Runoff Coeff.	0.25		0.72

-----  
Subbasin Sub-3  
-----

Soil/Surface Description	Area (acres)	Soil Group	Runoff Coeff.
-	0.13	-	0.72
Composite Area & Weighted Runoff Coeff.	0.13		0.72

-----  
Subbasin Sub-30  
-----

Soil/Surface Description	Area (acres)	Soil Group	Runoff Coeff.
-	0.12	-	0.72
Composite Area & Weighted Runoff Coeff.	0.12		0.72

-----  
Subbasin Sub-31  
-----

Soil/Surface Description	Area (acres)	Soil Group	Runoff Coeff.
-	0.11	-	0.72
Composite Area & Weighted Runoff Coeff.	0.11		0.72

-----  
Subbasin Sub-32  
-----

Soil/Surface Description	Area (acres)	Soil Group	Runoff Coeff.
-	0.37	-	0.72
Composite Area & Weighted Runoff Coeff.	0.37		0.72

-----  
Subbasin Sub-3A  
-----

Soil/Surface Description	Area (acres)	Soil Group	Runoff Coeff.
-	0.72	-	0.72
Composite Area & Weighted Runoff Coeff.	0.72		0.72

-----  
Subbasin Sub-4  
-----

Soil/Surface Description	Area (acres)	Soil Group	Runoff Coeff.
-	0.04	-	0.72
Composite Area & Weighted Runoff Coeff.	0.04		0.72

-----  
 Subbasin Sub-5  
 -----

Soil/Surface Description	Area (acres)	Soil Group	Runoff Coeff.
-	0.43	-	0.72
Composite Area & Weighted Runoff Coeff.	0.43		0.72

-----  
 Subbasin Sub-7  
 -----

Soil/Surface Description	Area (acres)	Soil Group	Runoff Coeff.
-	0.07	-	0.72
Composite Area & Weighted Runoff Coeff.	0.07		0.72

-----  
 Subbasin Sub-8  
 -----

Soil/Surface Description	Area (acres)	Soil Group	Runoff Coeff.
-	0.03	-	0.72
Composite Area & Weighted Runoff Coeff.	0.03		0.72

-----  
 Subbasin Sub-9  
 -----

Soil/Surface Description	Area (acres)	Soil Group	Runoff Coeff.
-	0.27	-	0.72
Composite Area & Weighted Runoff Coeff.	0.27		0.72

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

Sheet Flow Equation  
 -----

$$T_c = (0.007 * ((n * L_f)^{0.8})) / ((P^{0.5}) * (S_f^{0.4}))$$

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<sup>0.5</sup>) (unpaved surface)
- V = 20.3282 \* (Sf<sup>0.5</sup>) (paved surface)
- V = 15.0 \* (Sf<sup>0.5</sup>) (grassed waterway surface)
- V = 10.0 \* (Sf<sup>0.5</sup>) (nearly bare & untilled surface)
- V = 9.0 \* (Sf<sup>0.5</sup>) (cultivated straight rows surface)
- V = 7.0 \* (Sf<sup>0.5</sup>) (short grass pasture surface)
- V = 5.0 \* (Sf<sup>0.5</sup>) (woodland surface)
- V = 2.5 \* (Sf<sup>0.5</sup>) (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 (ft<sup>2</sup>)  
Wp = Wetted Perimeter (ft)  
V = Velocity (ft/sec)  
Sf = Slope (ft/ft)  
n = Manning's Roughness

Subbasin Sub-06

User-Defined TOC override (minutes): 5.00

Subbasin Sub-10

Sheet Flow Computations

	Subarea A	Subarea B	Subarea
C			
0.00	Manning's Roughness:	0.40	0.00
0.00	Flow Length (ft):	85.00	0.00
0.00	Slope (%):	2.00	0.00
1.55	2 yr, 24 hr Rainfall (in):	1.55	1.55
0.00	Velocity (ft/sec):	0.05	0.00
0.00	Computed Flow Time (minutes):	27.09	0.00
=====			
	Total TOC (minutes):	27.09	
=====			

Subbasin Sub-11

Sheet Flow Computations

	Subarea A	Subarea B	Subarea
C			

0.00	Manning's Roughness:	0.40	0.00
0.00	Flow Length (ft):	85.00	0.00
0.00	Slope (%):	10.00	0.00
1.55	2 yr, 24 hr Rainfall (in):	1.55	1.55
0.00	Velocity (ft/sec):	0.10	0.00
0.00	Computed Flow Time (minutes):	14.23	0.00

=====  
Total TOC (minutes): 14.23  
=====

-----  
Subbasin Sub-12  
-----

Sheet Flow Computations  
-----

C		Subarea A	Subarea B	Subarea
0.00	Manning's Roughness:	0.40	0.00	
0.00	Flow Length (ft):	70.00	0.00	
0.00	Slope (%):	2.00	0.00	
1.55	2 yr, 24 hr Rainfall (in):	1.55	1.55	
0.00	Velocity (ft/sec):	0.05	0.00	
0.00	Computed Flow Time (minutes):	23.20	0.00	

=====  
Total TOC (minutes): 23.20  
=====

-----  
Subbasin Sub-13  
-----

User-Defined TOC override (minutes): 5.00

-----  
Subbasin Sub-14  
-----

User-Defined TOC override (minutes): 5.00

-----  
Subbasin Sub-15  
-----

Sheet Flow Computations  
-----

C		Subarea A	Subarea B	Subarea
	Manning's Roughness:	0.40	0.00	

0.00	Flow Length (ft):	90.00	0.00
0.00	Slope (%):	0.20	0.00
0.00	2 yr, 24 hr Rainfall (in):	1.55	1.55
1.55	Velocity (ft/sec):	0.02	0.00
0.00	Computed Flow Time (minutes):	71.24	0.00
0.00			

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	Total TOC (minutes):	71.24	
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-----  
Subbasin Sub-16  
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User-Defined TOC override (minutes): 5.00

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Subbasin Sub-17  
-----

User-Defined TOC override (minutes): 5.00

-----  
Subbasin Sub-18  
-----

Sheet Flow Computations

		Subarea A	Subarea B	Subarea
C	Manning's Roughness:	0.40	0.00	
0.00	Flow Length (ft):	90.00	0.00	
0.00	Slope (%):	2.00	0.00	
0.00	2 yr, 24 hr Rainfall (in):	1.55	1.55	
1.55	Velocity (ft/sec):	0.05	0.00	
0.00	Computed Flow Time (minutes):	28.36	0.00	
0.00				

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	Total TOC (minutes):	28.36	
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Subbasin Sub-19  
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User-Defined TOC override (minutes): 5.00

-----  
Subbasin Sub-20  
-----

User-Defined TOC override (minutes): 5.00

-----  
Subbasin Sub-21  
-----

User-Defined TOC override (minutes): 5.00

-----  
Subbasin Sub-22  
-----

User-Defined TOC override (minutes): 5.00

-----  
Subbasin Sub-23  
-----

Sheet Flow Computations  
-----

		Subarea A	Subarea B	Subarea
C				
0.00	Manning's Roughness:	0.40	0.00	
0.00	Flow Length (ft):	70.00	0.00	
0.00	Slope (%):	2.00	0.00	
1.55	2 yr, 24 hr Rainfall (in):	1.55	1.55	
0.00	Velocity (ft/sec):	0.05	0.00	
0.00	Computed Flow Time (minutes):	23.20	0.00	
0.00				
=====				
	Total TOC (minutes):	23.20		
=====				

-----  
Subbasin Sub-24  
-----

Sheet Flow Computations  
-----

		Subarea A	Subarea B	Subarea
C				
0.00	Manning's Roughness:	0.40	0.00	
0.00	Flow Length (ft):	90.00	0.00	
0.00	Slope (%):	2.00	0.00	
1.55	2 yr, 24 hr Rainfall (in):	1.55	1.55	
0.00	Velocity (ft/sec):	0.05	0.00	
0.00	Computed Flow Time (minutes):	28.36	0.00	
0.00				
=====				
	Total TOC (minutes):	28.36		
=====				



-----  
 Subbasin Sub-25  
 -----

Sheet Flow Computations  
 -----

		Subarea A	Subarea B	Subarea
C	Manning's Roughness:	0.40	0.00	
0.00	Flow Length (ft):	90.00	0.00	
0.00	Slope (%):	0.20	0.00	
0.00	2 yr, 24 hr Rainfall (in):	1.55	1.55	
1.55	Velocity (ft/sec):	0.02	0.00	
0.00	Computed Flow Time (minutes):	71.24	0.00	
0.00				
Total TOC (minutes):		71.24		

=====

-----  
 Subbasin Sub-27  
 -----

User-Defined TOC override (minutes): 5.00

-----  
 Subbasin Sub-28  
 -----

User-Defined TOC override (minutes): 5.00

-----  
 Subbasin Sub-3  
 -----

User-Defined TOC override (minutes): 5.00

-----  
 Subbasin Sub-30  
 -----

User-Defined TOC override (minutes): 5.00

-----  
 Subbasin Sub-31  
 -----

User-Defined TOC override (minutes): 5.00

-----  
 Subbasin Sub-32  
 -----

Sheet Flow Computations  
 -----

		Subarea A	Subarea B	Subarea
C	Manning's Roughness:	0.40	0.00	

0.00	Flow Length (ft):	30.00	0.00
0.00	Slope (%):	5.00	0.00
0.00	2 yr, 24 hr Rainfall (in):	1.55	1.55
1.55	Velocity (ft/sec):	0.06	0.00
0.00	Computed Flow Time (minutes):	8.16	0.00
0.00			

=====  
Total TOC (minutes): 8.16  
=====

-----  
Subbasin Sub-3A  
-----

Sheet Flow Computations  
-----

		Subarea A	Subarea B	Subarea
C	Manning's Roughness:	0.40	0.00	
0.00	Flow Length (ft):	110.00	0.00	
0.00	Slope (%):	5.00	0.00	
0.00	2 yr, 24 hr Rainfall (in):	1.55	1.55	
1.55	Velocity (ft/sec):	0.08	0.00	
0.00	Computed Flow Time (minutes):	23.08	0.00	
0.00				

=====  
Total TOC (minutes): 23.08  
=====

-----  
Subbasin Sub-4  
-----

User-Defined TOC override (minutes): 5.00

-----  
Subbasin Sub-5  
-----

Sheet Flow Computations  
-----

		Subarea A	Subarea B	Subarea
C	Manning's Roughness:	0.40	0.00	
0.00	Flow Length (ft):	115.00	0.00	
0.00	Slope (%):	2.00	0.00	
0.00	2 yr, 24 hr Rainfall (in):	1.55	1.55	
1.55				

0.00 Velocity (ft/sec): 0.06 0.00  
 0.00 Computed Flow Time (minutes): 34.50 0.00

=====  
 Total TOC (minutes): 34.50  
 =====

-----  
 Subbasin Sub-7  
 -----

User-Defined TOC override (minutes): 5.00

-----  
 Subbasin Sub-8  
 -----

User-Defined TOC override (minutes): 5.00

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 Subbasin Sub-9  
 -----

Sheet Flow Computations  
 -----

		Subarea A	Subarea B	Subarea
C	Manning's Roughness:	0.40	0.00	
0.00	Flow Length (ft):	105.00	0.00	
0.00	Slope (%):	2.00	0.00	
0.00	2 yr, 24 hr Rainfall (in):	1.55	1.55	
1.55	Velocity (ft/sec):	0.05	0.00	
0.00	Computed Flow Time (minutes):	32.08	0.00	
0.00				

=====  
 Total TOC (minutes): 32.08  
 =====

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

Subbasin ID	Total Precip in	Total Runoff in	Peak Runoff cfs	Weighted Curve Number	Time of Concentration days	hh:mm:ss
Sub-06	3.19	2.96	0.07	98.000	0	00:05:00
Sub-10	3.19	2.30	0.20	90.300	0	00:27:05
Sub-11	3.19	2.79	0.31	96.020	0	00:14:13
Sub-12	3.19	2.13	0.20	88.100	0	00:23:12
Sub-13	3.19	2.51	0.02	92.500	0	00:05:00
Sub-14	3.19	2.96	0.03	98.000	0	00:05:00
Sub-15	3.19	2.26	0.17	90.300	0	01:11:14
Sub-16	3.19	2.56	0.21	93.160	0	00:05:00

Sub-17	3.19	2.74	0.05	95.360	0	00:05:00
Sub-18	3.19	2.45	0.28	92.060	0	00:28:21
Sub-19	3.19	2.36	0.03	90.740	0	00:05:00
Sub-20	3.19	2.23	0.03	89.200	0	00:05:00
Sub-21	3.19	2.60	0.03	93.600	0	00:05:00
Sub-22	3.19	2.96	0.02	98.000	0	00:05:00
Sub-23	3.19	2.62	0.12	94.040	0	00:23:12
Sub-24	3.19	2.41	0.06	91.620	0	00:28:21
Sub-25	3.19	2.44	0.23	92.500	0	01:11:14
Sub-27	3.19	2.96	0.02	98.000	0	00:05:00
Sub-28	3.19	2.09	0.12	87.440	0	00:05:00
Sub-3	3.19	2.69	0.09	94.700	0	00:05:00
Sub-30	3.19	2.20	0.06	88.760	0	00:05:00
Sub-31	3.19	2.80	0.08	96.020	0	00:05:00
Sub-32	3.19	2.27	0.20	89.640	0	00:08:09
Sub-3A	3.19	2.56	0.36	93.380	0	00:23:04
Sub-4	3.19	2.05	0.02	87.000	0	00:05:00
Sub-5	3.19	2.24	0.16	89.640	0	00:34:30
Sub-7	3.19	2.96	0.05	98.000	0	00:05:00
Sub-8	3.19	2.36	0.02	90.740	0	00:05:00
Sub-9	3.19	2.52	0.12	92.940	0	00:32:04

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

Node ID	Average Depth	Maximum Depth	Maximum HGL	Time of Max Occurrence		Total Flooded Volume	Total Time Flooded	Retention Time
	Attained ft	Attained ft	Attained ft	days	hh:mm	acre-in	minutes	hh:mm:ss
CB-10	0.05	0.10	428.49	0	08:06	0	0	0:00:00
CB-11	0.07	0.15	433.05	0	08:06	0	0	0:00:00
CB-12	0.07	0.15	433.64	0	08:06	0	0	0:00:00
CB-13	0.22	0.48	412.80	0	08:00	0	0	0:00:00
CB-14	0.22	0.48	413.23	0	08:00	0	0	0:00:00
CB-15	0.10	0.18	413.66	0	08:18	0	0	0:00:00
CB-16	0.17	0.39	413.46	0	08:00	0	0	0:00:00
CB-17	0.17	0.36	413.65	0	08:00	0	0	0:00:00
CB-18	0.06	0.13	416.87	0	08:00	0	0	0:00:00
CB-19	0.03	0.08	418.00	0	07:54	0	0	0:00:00
CB-20	0.03	0.07	418.25	0	08:00	0	0	0:00:00
CB-21	0.07	0.14	433.32	0	08:06	0	0	0:00:00
CB-22	0.02	0.05	434.03	0	07:54	0	0	0:00:00
CB-23	0.11	0.21	442.58	0	08:12	0	0	0:00:00
CB-24	0.11	0.21	442.89	0	08:12	0	0	0:00:00
CB-25	0.07	0.12	445.86	0	08:12	0	0	0:00:00
CB-27	0.13	0.32	397.70	0	08:00	0	0	0:00:00
CB-28	0.12	0.31	398.40	0	07:59	0	0	0:00:00
CB-29	0.10	0.24	399.64	0	07:59	0	0	0:00:00
CB-3	0.25	0.59	408.15	0	08:01	0	0	0:00:00
CB-30	0.07	0.17	401.90	0	08:00	0	0	0:00:00
CB-31	0.07	0.17	402.39	0	08:00	0	0	0:00:00
CB-32	0.05	0.13	403.86	0	08:00	0	0	0:00:00
CB-32A	0.04	0.11	405.59	0	08:00	0	0	0:00:00
CB-3A	0.08	0.18	408.43	0	08:06	0	0	0:00:00
CB-4	0.46	0.76	408.51	0	08:00	0	0	0:00:00
CB-5	0.34	0.43	408.32	0	08:06	0	0	0:00:00
CB-6	0.09	0.20	413.99	0	08:00	0	0	0:00:00
CB-7	0.02	0.06	417.55	0	07:54	0	0	0:00:00
CB-8	0.10	0.22	424.57	0	08:06	0	0	0:00:00
CB-9	0.10	0.22	424.87	0	08:06	0	0	0:00:00
MWIn	0.12	0.32	397.56	0	08:00	0	0	0:00:00
MWOut	0.06	0.15	396.89	0	08:00	0	0	0:00:00

PerkfilterIn	0.25	0.59	407.90	0	08:01	0	0	0:00:00
PerkfilterOut	0.19	0.42	406.23	0	08:01	0	0	0:00:00
CB-26	0.06	0.15	393.69	0	08:00	0	0	0:00:00
Vault	0.19	0.42	405.99	0	08:01	0	0	0:00:00

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

Node ID	Element Type	Maximum Lateral Inflow cfs	Peak Inflow cfs	Time of Peak Inflow Occurrence days	Time of Peak Inflow Occurrence hh:mm	Maximum Flooding Overflow cfs	Time of Peak Flooding Occurrence days	Time of Peak Flooding Occurrence hh:mm
CB-10	JUNCTION	0.20	0.20	0	08:06	0.00		
CB-11	JUNCTION	0.31	0.51	0	08:00	0.00		
CB-12	JUNCTION	0.20	0.20	0	08:06	0.00		
CB-13	JUNCTION	0.02	1.25	0	08:00	0.00		
CB-14	JUNCTION	0.03	1.22	0	08:00	0.00		
CB-15	JUNCTION	0.17	0.17	0	08:18	0.00		
CB-16	JUNCTION	0.21	1.04	0	08:00	0.00		
CB-17	JUNCTION	0.05	0.83	0	08:00	0.00		
CB-18	JUNCTION	0.28	0.34	0	08:00	0.00		
CB-19	JUNCTION	0.03	0.06	0	07:54	0.00		
CB-20	JUNCTION	0.03	0.03	0	08:00	0.00		
CB-21	JUNCTION	0.03	0.45	0	08:06	0.00		
CB-22	JUNCTION	0.02	0.02	0	07:54	0.00		
CB-23	JUNCTION	0.12	0.40	0	08:06	0.00		
CB-24	JUNCTION	0.06	0.29	0	08:12	0.00		
CB-25	JUNCTION	0.23	0.23	0	08:12	0.00		
CB-27	JUNCTION	0.02	0.48	0	08:00	0.00		
CB-28	JUNCTION	0.12	0.46	0	07:59	0.00		
CB-29	JUNCTION	0.00	0.33	0	08:00	0.00		
CB-3	JUNCTION	0.09	2.81	0	08:01	0.00		
CB-30	JUNCTION	0.06	0.33	0	08:00	0.00		
CB-31	JUNCTION	0.08	0.27	0	08:00	0.00		
CB-32	JUNCTION	0.00	0.20	0	08:00	0.00		
CB-32A	JUNCTION	0.20	0.20	0	08:00	0.00		
CB-3A	JUNCTION	0.36	0.36	0	08:06	0.00		
CB-4	JUNCTION	0.02	1.13	0	08:00	0.00		
CB-5	JUNCTION	0.16	0.16	0	08:06	0.00		
CB-6	JUNCTION	0.07	0.95	0	08:00	0.00		
CB-7	JUNCTION	0.05	0.05	0	07:54	0.00		
CB-8	JUNCTION	0.02	0.84	0	08:00	0.00		
CB-9	JUNCTION	0.12	0.31	0	08:06	0.00		
MWIn	JUNCTION	0.00	0.48	0	08:00	0.00		
MWOut	JUNCTION	0.00	0.48	0	08:00	0.00		
PerkfilterIn	JUNCTION	0.00	2.81	0	08:01	0.00		
PerkfilterOut	JUNCTION	0.00	2.81	0	08:01	0.00		
CB-26	OUTFALL	0.00	0.48	0	08:00	0.00		
Vault	OUTFALL	0.00	2.81	0	08:01	0.00		

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

Outfall Node ID	Flow Frequency (%)	Average Flow cfs	Peak Inflow cfs
CB-26	95.88	0.09	0.48
Vault	96.52	0.67	2.81



System                    96.20            0.76            3.29

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

Link ID	Ratio of	Total Time	Element Reported Type Condition	Time of Peak Flow Occurrence	Maximum Velocity Attained	Length Factor	Peak Flow during Analysis	Design Flow Capacity	Ratio of Maximum /Design Flow
Flow Surcharged	Depth	minutes		days hh:mm	ft/sec		cfs	cfs	Flow
Link-01	0.21	0	Calculated CONDUIT	0 08:12	2.46	1.00	0.29	3.09	0.09
Link-02	0.15	0	Calculated CONDUIT	0 08:06	2.84	1.00	0.20	4.33	0.05
Link-03	0.20	0	Calculated CONDUIT	0 08:00	8.27	1.00	0.95	10.40	0.09
Link-04	0.51	0	Calculated CONDUIT	0 08:01	2.81	1.00	1.13	2.20	0.51
Link-06	0.17	0	Calculated CONDUIT	0 08:00	2.97	1.00	0.27	4.16	0.07
Link-08	0.32	0	Calculated CONDUIT	0 08:01	12.92	1.00	2.81	12.61	0.22
Link-09	0.42	0	Calculated CONDUIT	0 08:01	8.91	1.00	2.81	7.56	0.37
Link-10	0.15	0	Calculated CONDUIT	0 08:00	6.46	1.00	0.48	9.76	0.05
Link-11	0.15	0	Calculated CONDUIT	0 08:00	6.25	1.00	0.48	9.34	0.05
Link-12	0.11	0	Calculated CONDUIT	0 08:00	4.35	1.00	0.20	8.52	0.02
Pipe - (149)	0.13	0	Calculated CONDUIT	0 08:00	3.40	1.00	0.20	5.72	0.03
Pipe - (164)	0.59	0	Calculated CONDUIT	0 08:01	5.81	1.00	2.81	4.28	0.66
Pipe - (167)	0.39	0	Calculated CONDUIT	0 08:00	3.72	1.00	1.04	3.30	0.31
Pipe - (172)	0.37	0	Calculated CONDUIT	0 08:01	4.79	1.00	1.24	4.36	0.29
Pipe - (27)	0.24	0	Calculated CONDUIT	0 07:59	2.36	1.00	0.33	2.73	0.12
Pipe - (28)	0.15	0	Calculated CONDUIT	0 08:00	4.57	1.00	0.33	6.95	0.05
Pipe - (30)	0.32	0	Calculated CONDUIT	0 08:00	2.26	1.00	0.48	2.22	0.22
Pipe - (32)	0.18	0	Calculated CONDUIT	0 08:06	3.71	1.00	0.36	5.03	0.07
Pipe - (34)	0.18	0	Calculated CONDUIT	0 08:06	1.61	1.00	0.16	2.15	0.07
Pipe - (35)	0.18	0	Calculated CONDUIT	0 08:00	8.75	1.00	0.84	11.91	0.07
Pipe - (37)	0.10	0	Calculated CONDUIT	0 08:06	4.64	1.00	0.20	9.21	0.02
Pipe - (38)	0.22	0	Calculated CONDUIT	0 08:06	2.53	1.00	0.31	3.09	0.10
Pipe - (39)	0.13	0	Calculated CONDUIT	0 08:00	8.52	1.00	0.51	14.10	0.04

Pipe - (42)		CONDUIT	0	08:12	4.12	1.00	0.23	7.03	0.03
0.12	0	Calculated							
Pipe - (43)		CONDUIT	0	08:06	6.26	1.00	0.40	10.09	0.04
0.14	0	Calculated							
Pipe - (44)		CONDUIT	0	08:06	7.02	1.00	0.45	11.36	0.04
0.14	0	Calculated							
Pipe - (45)		CONDUIT	0	08:00	5.92	1.00	0.34	9.98	0.03
0.13	0	Calculated							
Pipe - (46)		CONDUIT	0	07:55	2.03	1.00	0.06	4.52	0.01
0.08	0	Calculated							
Pipe - (47)		CONDUIT	0	08:00	1.20	1.00	0.03	3.09	0.01
0.07	0	Calculated							
Pipe - (48)		CONDUIT	0	08:01	3.34	1.00	0.83	3.09	0.27
0.36	0	Calculated							
Pipe - (55)		CONDUIT	0	07:54	3.02	1.00	0.05	8.66	0.01
0.06	0	Calculated							
Pipe - (56)		CONDUIT	0	07:54	1.61	1.00	0.02	5.13	0.00
0.05	0	Calculated							
Pipe - (69)		CONDUIT	0	08:18	1.82	1.00	0.17	2.54	0.07
0.17	0	Calculated							
Pipe - (70)		CONDUIT	0	08:00	3.31	1.00	1.22	2.66	0.46
0.48	0	Calculated							
Pipe - (71)		CONDUIT	0	08:00	2.21	1.00	0.46	2.19	0.21
0.31	0	Calculated							

\*\*\*\*\*  
Highest Flow Instability Indexes  
\*\*\*\*\*  
All links are stable.

WARNING 108 : Surge elevation defined for Junction CB-3A is below junction maximum elevation. Assumed surge elevation equal to maximum elevation.

WARNING 107 : Initial water surface elevation defined for Junction PerkfilterOut is below junction invert elevation.

Assumed initial water surface elevation equal to invert elevation.

WARNING 117 : Conduit outlet invert elevation defined for Conduit Link-08 is below downstream node invert elevation.

Assumed conduit outlet invert elevation equal to downstream node invert

elevation.

WARNING 116 : Conduit inlet invert elevation defined for Conduit Link-09 is below upstream node invert elevation.

Assumed conduit inlet invert elevation equal to upstream node invert elevation.

WARNING 117 : Conduit outlet invert elevation defined for Conduit Pipe - (32) is below downstream node invert elevation.

Assumed conduit outlet invert elevation equal to downstream node invert

elevation.

WARNING 116 : Conduit inlet invert elevation defined for Conduit Pipe - (47) is below upstream node invert elevation.

Assumed conduit inlet invert elevation equal to upstream 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.

Analysis began on: Wed Apr 5 15:17:03 2023

Analysis ended on: Wed Apr 5 15:17:05 2023

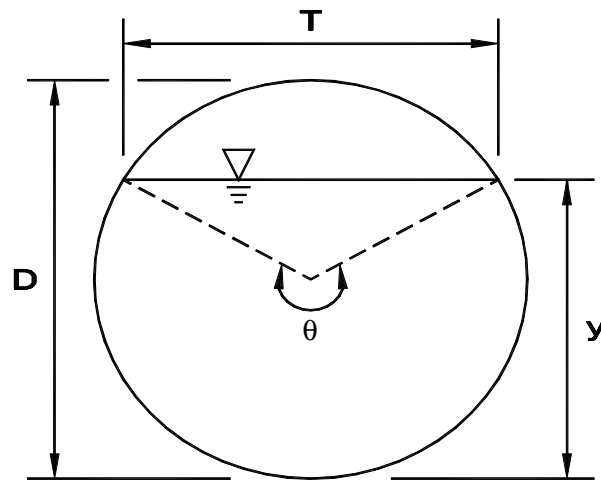
Total elapsed time: 00:00:02

<b>Open Channel Flow Calculator For Circular Pipes</b>	<b>Land Development Consultants, Inc.</b>	
	14201 NE 200th St. Ste. 100 Woodinville, WA 98072	Tel: (425) 806-1869 Fax: (425) 482-2893

Project Name: Brodie Plat  
 Description: Vault Outfall Conveyance

Project No.: C22-177  
 Date: 4/6/2023  
 Calc. By: RKF

Pipe Diameter (D) = 12 in  
 Pipe Slope (S) = 12.25 %  
 Flow Depth (y) = 1.00 ft  
**Flowrate (Q) = 10.84 cfs**  
 Mannings Coeff. (n) = 0.015  
 Theta Angle ( $\theta$ ) = 6.28 rad  
 Wetted Area (A) = 0.79 ft<sup>2</sup>  
 Wet. Perimeter (P) = 3.14 ft  
 Hydraulic Radius (R) = 0.25 ft  
 Top Width (T) = 0.00 ft  
 Flow Velocity = 13.80 fps



**Formulas:**

Theta Angle ( $\theta$ ): If  $y \geq r$ :  $\theta = 2\pi - 2a \cos\left(\frac{y-r}{r}\right)$  where: r = Pipe Radius

If  $y \leq r$ :  $\theta = 2a \cos\left(\frac{r-y}{r}\right)$  where: r = Pipe Radius

Wetted Area (A):  $A = \frac{1}{8}(\theta - \sin \theta)d^2$

Wetted Perimeter (P):  $P = \frac{1}{2}\theta d$

Hydraulic Radius (R):  $R = \frac{A}{P}$

Top Width (T):  $T = \sin\left(\frac{\theta}{2}\right)d$

## **SECTION 6: OPERATIONS AND MAINTENANCE MANUAL**

The proposed storm drainage system consists of buried pipes, catch basins, a detention vault, and a perfilter water quality treatment structure and a modular wetland water quality treatment structure. These facilities will require periodic maintenance and inspection. Inspection and maintenance procedures are contained on the following pages.

<b>NO. 5 – CATCH BASINS AND MANHOLES</b>			
<b>Maintenance Component</b>	<b>Defect or Problem</b>	<b>Condition When Maintenance is Needed</b>	<b>Results Expected When Maintenance is Performed</b>
Structure	Sediment	Sediment exceeds 60% of the depth from the bottom of the catch basin to the invert of the lowest pipe into or out of the catch basin or is within 6 inches of the invert of the lowest pipe into or out of the catch basin.	Sump of catch basin contains no sediment.
	Trash and debris	Trash or debris of more than ½ cubic foot which is located immediately in front of the catch basin opening or is blocking capacity of the catch basin by more than 10%.	No Trash or debris blocking or potentially blocking entrance to catch basin.
		Trash or debris in the catch basin that exceeds 1/3 the depth from the bottom of basin to invert the lowest pipe into or out of the basin.	No trash or debris in the catch basin.
		Dead animals or vegetation that could generate odors that could cause complaints or dangerous gases (e.g., methane).	No dead animals or vegetation present within catch basin.
		Deposits of garbage exceeding 1 cubic foot in volume.	No condition present which would attract or support the breeding of insects or rodents.
	Damage to frame and/or top slab	Corner of frame extends more than ¾ inch past curb face into the street (If applicable).	Frame is even with curb.
		Top slab has holes larger than 2 square inches or cracks wider than ¼ inch.	Top slab is free of holes and cracks.
		Frame not sitting flush on top slab, i.e., separation of more than ¾ inch of the frame from the top slab.	Frame is sitting flush on top slab.
	Cracks in walls or bottom	Cracks wider than ½ inch and longer than 3 feet, any evidence of soil particles entering catch basin through cracks, or maintenance person judges that catch basin is unsound.	Catch basin is sealed and is structurally sound.
		Cracks wider than ½ inch and longer than 1 foot at the joint of any inlet/outlet pipe or any evidence of soil particles entering catch basin through cracks.	No cracks more than 1/4 inch wide at the joint of inlet/outlet pipe.
	Settlement/ misalignment	Catch basin has settled more than 1 inch or has rotated more than 2 inches out of alignment.	Basin replaced or repaired to design standards.
	Damaged pipe joints	Cracks wider than ½-inch at the joint of the inlet/outlet pipes or any evidence of soil entering the catch basin at the joint of the inlet/outlet pipes.	No cracks more than ¼-inch wide at the joint of inlet/outlet pipes.
	Contaminants and pollution	Any evidence of contaminants or pollution such as oil, gasoline, concrete slurries or paint.	Materials removed and disposed of according to applicable regulations. Source control BMPs implemented if appropriate. No contaminants present other than a surface oil film.
	Inlet/Outlet Pipe	Sediment accumulation	Sediment filling 20% or more of the pipe.
Trash and debris		Trash and debris accumulated in inlet/outlet pipes (includes floatables and non-floatables).	No trash or debris in pipes.
Damaged		Cracks wider than ½-inch at the joint of the inlet/outlet pipes or any evidence of soil entering at the joints of the inlet/outlet pipes.	No cracks more than ¼-inch wide at the joint of the inlet/outlet pipe.



<b>NO. 5 – CATCH BASINS AND MANHOLES</b>			
<b>Maintenance Component</b>	<b>Defect or Problem</b>	<b>Condition When Maintenance is Needed</b>	<b>Results Expected When Maintenance is Performed</b>
Metal Grates (Catch Basins)	Unsafe grate opening	Grate with opening wider than $\frac{7}{8}$ inch.	Grate opening meets design standards.
	Trash and debris	Trash and debris that is blocking more than 20% of grate surface.	Grate free of trash and debris. footnote to guidelines for disposal
	Damaged or missing	Grate missing or broken member(s) of the grate. <b>Any open structure requires urgent maintenance.</b>	Grate is in place and meets design standards.
Manhole Cover/Lid	Cover/lid not in place	Cover/lid is missing or only partially in place. <b>Any open structure requires urgent maintenance.</b>	Cover/lid protects opening to structure.
	Locking mechanism Not Working	Mechanism cannot be opened by one maintenance person with proper tools. Bolts cannot be seated. Self-locking cover/lid does not work.	Mechanism opens with proper tools.
	Cover/lid difficult to Remove	One maintenance person cannot remove cover/lid after applying 80 lbs. of lift.	Cover/lid can be removed and reinstalled by one maintenance person.

<b>NO. 6 – CONVEYANCE PIPES AND DITCHES</b>			
<b>Maintenance Component</b>	<b>Defect or Problem</b>	<b>Conditions When Maintenance is Needed</b>	<b>Results Expected When Maintenance is Performed</b>
Pipes	Sediment & debris accumulation	Accumulated sediment or debris that exceeds 20% of the diameter of the pipe.	Water flows freely through pipes.
	Vegetation/roots	Vegetation/roots that reduce free movement of water through pipes.	Water flows freely through pipes.
	Contaminants and pollution	Any evidence of contaminants or pollution such as oil, gasoline, concrete slurries or paint.	Materials removed and disposed of according to applicable regulations. Source control BMPs implemented if appropriate. No contaminants present other than a surface oil film.
	Damage to protective coating or corrosion	Protective coating is damaged; rust or corrosion is weakening the structural integrity of any part of pipe.	Pipe repaired or replaced.
	Damaged	Any dent that decreases the cross section area of pipe by more than 20% or is determined to have weakened structural integrity of the pipe.	Pipe repaired or replaced.
Ditches	Trash and debris	Trash and debris exceeds 1 cubic foot per 1,000 square feet of ditch and slopes.	Trash and debris cleared from ditches.
	Sediment accumulation	Accumulated sediment that exceeds 20% of the design depth.	Ditch cleaned/flushed of all sediment and debris so that it matches design.
	Noxious weeds	Any noxious or nuisance vegetation which may constitute a hazard to County personnel or the public.	Noxious and nuisance vegetation removed according to applicable regulations. No danger of noxious vegetation where County personnel or the public might normally be.
	Contaminants and pollution	Any evidence of contaminants or pollution such as oil, gasoline, concrete slurries or paint.	Materials removed and disposed of according to applicable regulations. Source control BMPs implemented if appropriate. No contaminants present other than a surface oil film.
	Vegetation	Vegetation that reduces free movement of water through ditches.	Water flows freely through ditches.
	Erosion damage to slopes	Any erosion observed on a ditch slope.	Slopes are not eroding.
	Rock lining out of place or missing (If Applicable)	One layer or less of rock exists above native soil area 5 square feet or more, any exposed native soil.	Replace rocks to design standards.



# PERKFILTER™

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## Inspection and Maintenance Guide

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# PerkFilter™ Media Filtration System

## Description

The PerkFilter is a stormwater treatment device used to remove pollutants from urban runoff. Impervious surfaces and other urban and suburban landscapes generate a variety of contaminants that can enter stormwater and pollute downstream receiving waters. The PerkFilter is a media-filled cartridge filtration device designed to capture and retain sediment, gross solids, metals, nutrients, hydrocarbons, and trash and debris. As with any stormwater treatment system, the PerkFilter requires periodic maintenance to sustain optimum system performance.

## Function

The PerkFilter is a water quality treatment system consisting of three chambers: an inlet chamber, a filter cartridge treatment chamber, and an outlet chamber (Figure 1). Stormwater runoff enters the inlet chamber through an inlet pipe, curb opening, or grated inlet. Gross solids are settled out, and floating trash and debris are trapped in the inlet chamber. Pretreated flow is then directed to the treatment chamber through an opening in the baffle wall between the inlet chamber and treatment chamber. The treatment chamber contains media-filled filter cartridges (Figure 2) that use physical and chemical processes to remove pollutants. During a storm event, runoff pools in the treatment chamber before passing radially through the cylindrical cartridges from the outside surface, through the media for treatment, and into the center of the cartridge. At the center of the cartridge is a center tube assembly designed to distribute the hydraulic load evenly across the surface of the filter cartridge and control the treatment flow rate. The center tube assembly discharges treated flow through the false floor and into the outlet chamber. A draindown feature built into each cartridge allows the treatment chamber to dewater between storm events.

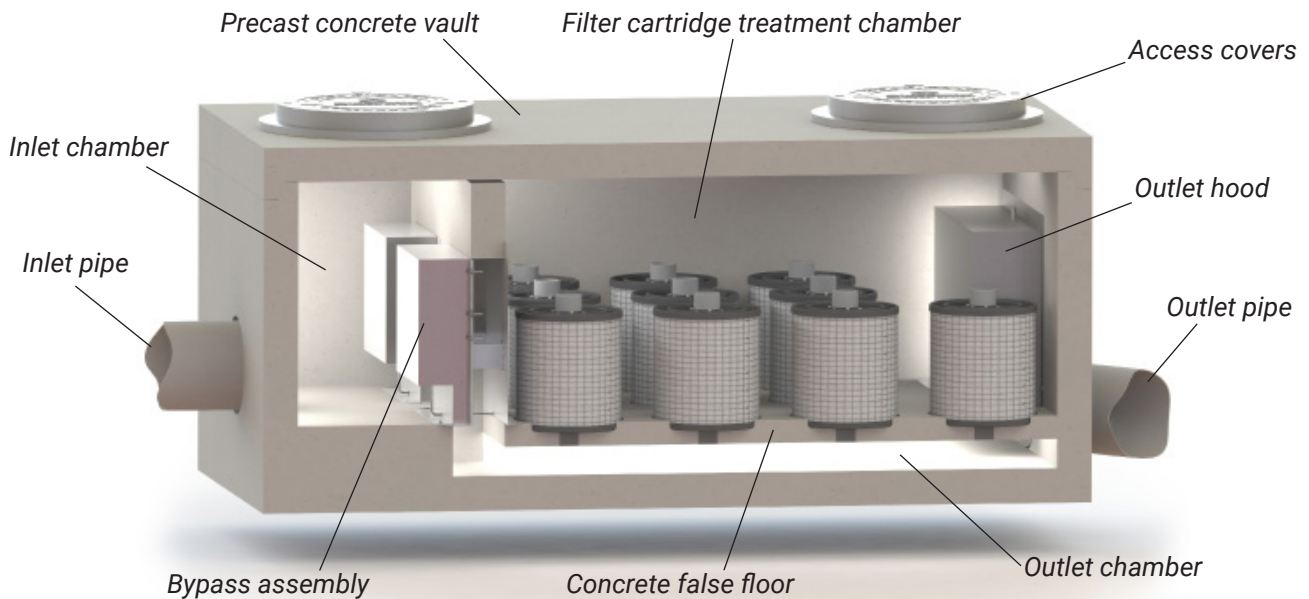
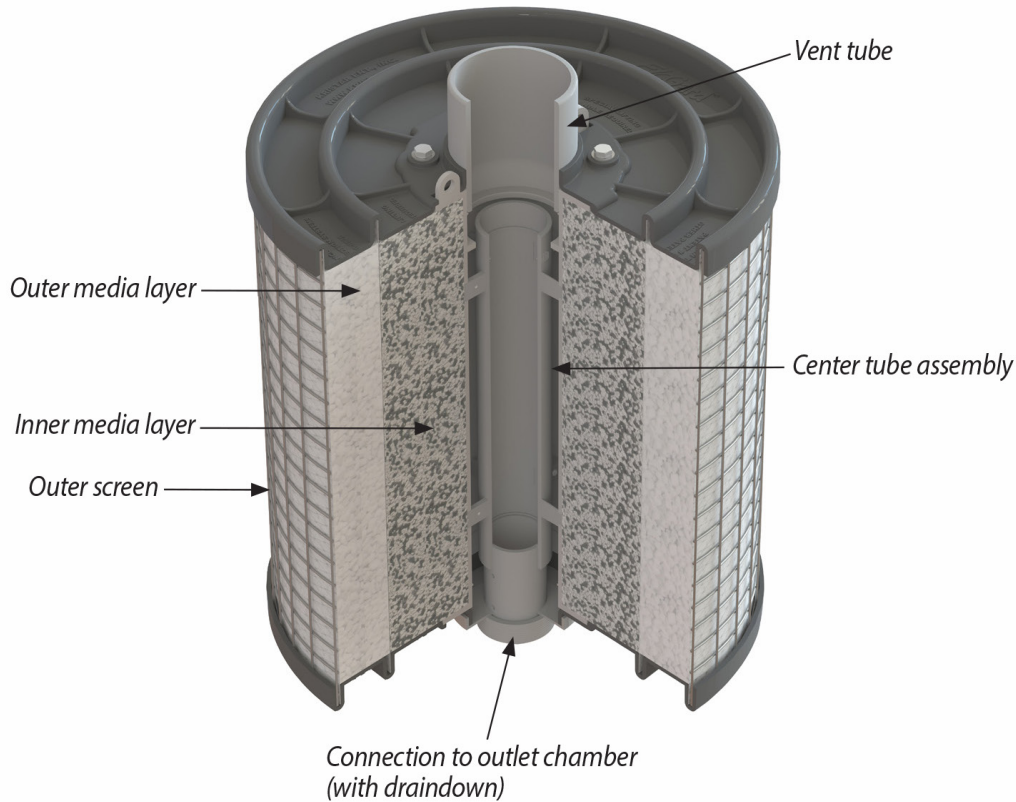


Figure 1. Schematic of the PerkFilter system.

All PerkFilter systems include a high-flow bypass assembly to divert flow exceeding the treatment capacity of the filter cartridges around the treatment chamber. The bypass assembly routes peak flow from the inlet chamber directly to the outlet chamber, bypassing the treatment chamber to prevent sediment and other captured pollutants from being scoured and re-entrained by high flow. Treated flow and bypass flow merge in the outlet chamber for discharge by a single outlet pipe.

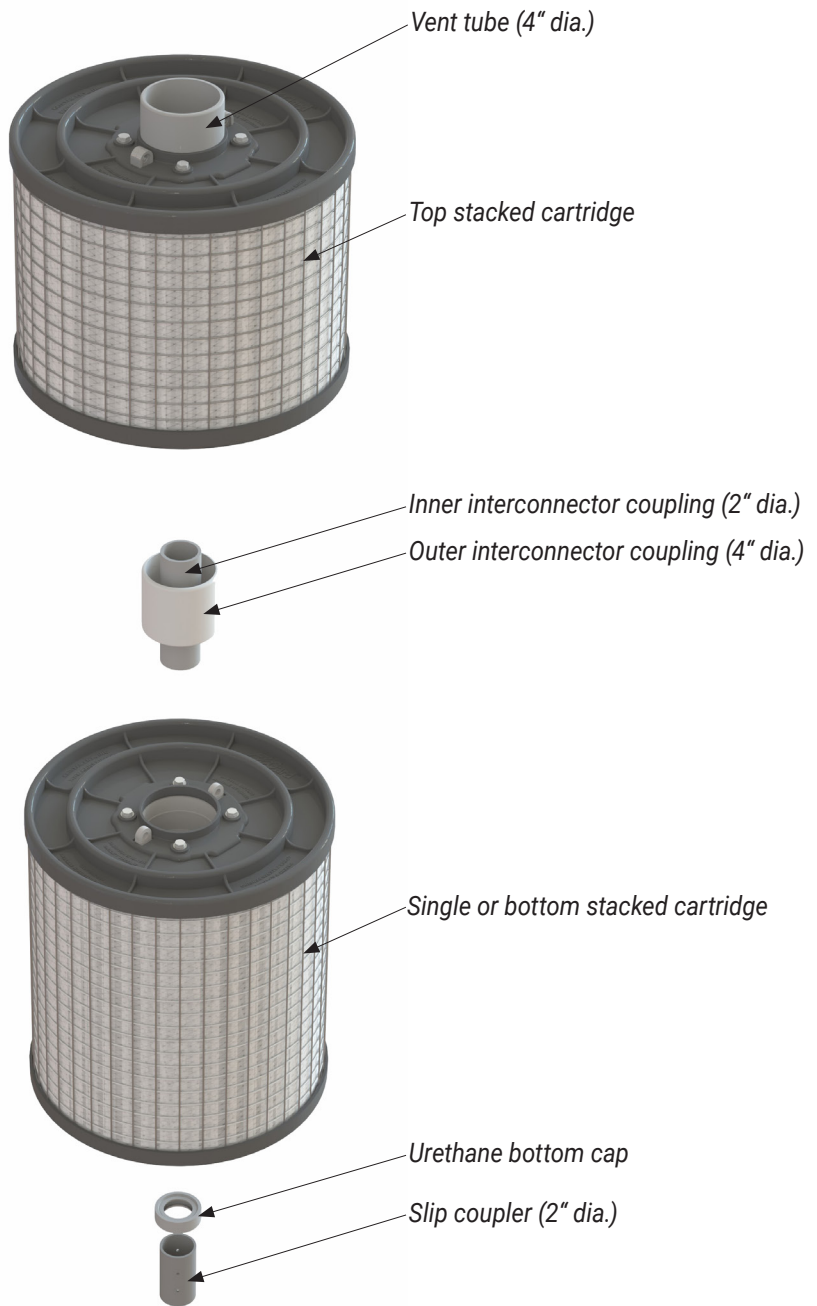


**Figure 2. Schematic of PerkFilter cartridge.**

## Configuration

The PerkFilter structure may consist of a vault, manhole, or catch basin configuration. Catch basin units may be fabricated from concrete or steel. Internal components including the PerkFilter cartridges are manufactured from durable plastic and stainless steel components and hardware. All cartridges are 18 inches in diameter and are available in two heights: 12-inch and 18-inch. Cartridges may be used alone or may be stacked (Figure 3) to provide 24-inch and 30-inch combinations. The capacity of each cartridge or cartridge combination is dictated by the allowable operating rate of the media and the outer surface area of the cartridge. Thus, taller cartridges have greater treatment capacity than shorter cartridges, but they also require more hydraulic drop across the system. Cartridges may be filled with various media depending on the target pollutants and desired treatment rate, among other factors.

Access to an installed PerkFilter system is typically provided by ductile iron castings or hatch covers. The location and number of access appurtenances is dependent on the size and configuration of the system.



**Figure 3. Schematic of stacked cartridges and connector components.**



## Maintenance Overview

State and local regulations require all stormwater management systems to be inspected on a periodic basis and maintained as necessary to ensure performance and protect downstream receiving waters. Maintenance prevents excessive pollutant buildup that can limit system performance by reducing the operating capacity and increasing the potential for scouring of pollutants during periods of high flow.

## Inspection and Maintenance Frequency

The PerkFilter should be inspected on a periodic basis, typically twice per year, and maintained as required. Initially, inspections of a new system should be conducted more frequently to help establish an appropriate site-specific inspection frequency. The maintenance frequency will be driven by the amount of runoff and pollutant loading encountered by a given system. In most cases, the optimum maintenance interval will be one to three years. Inspection and maintenance activities should be performed only during dry weather periods.

## Inspection Equipment

The following equipment is helpful when conducting PerkFilter inspections:

- Recording device (pen and paper form, voice recorder, iPad, etc.)
- Suitable clothing (appropriate footwear, gloves, hardhat, safety glasses, etc.)
- Traffic control equipment (cones, barricades, signage, flagging, etc.)
- Socket and wrench for bolt-down access covers
- Manhole hook or pry bar
- Flashlight
- Tape measure
- Measuring stick or sludge sampler
- Long-handled net (optional)

## Inspection Procedures

PerkFilter inspections are visual and may be conducted from the ground surface without entering the unit. To complete an inspection, safety measures including traffic control should be deployed before the access covers are removed. Once the covers have been removed, the following items should be checked and recorded (see form provided at the end of this document) to determine whether maintenance is required:

- Inspect the internal components and note whether there are any broken or missing parts. In the unlikely event that internal parts are broken or missing, contact Oldcastle Infrastructure at (800) 579-8819 to determine appropriate corrective action.
- Note whether the inlet pipe is blocked or obstructed. The outlet pipe is covered by a removable outlet hood and cannot be observed without entering the unit.
- Observe, quantify and record the accumulation of floating trash and debris in the inlet chamber. The significance of accumulated floating trash and debris is a matter of judgment. A long-handled net may be used to retrieve the bulk of trash and debris at the time of inspection if full maintenance due to accumulation of floating oils or settled sediment is not yet warranted.

- Observe, quantify and record the accumulation of oils in the inlet chamber. The significance of accumulated floating oils is a matter of judgment. However, if there is evidence of an oil or fuel spill, immediate maintenance by appropriate certified personnel is warranted.
- Observe, quantify and record the average accumulation of sediment in the inlet chamber and treatment chamber. A calibrated dipstick, tape measure, or sludge sampler may be used to determine the amount of accumulated sediment in each chamber. The depth of sediment may be determined by calculating the difference between the measurement from the rim of the PerkFilter to the top of the accumulated sediment, and the measurement from the rim of the PerkFilter to the bottom of the PerkFilter structure. Finding the top of the accumulated sediment below standing water takes some practice and a light touch, but increased resistance as the measuring device is lowered toward the bottom of the unit indicates the top of the accumulated sediment.
- Finally, observe, quantify and record the amount of standing water in the treatment chamber around the cartridges. If standing water is present, do not include the depth of sediment that may have settled out below the standing water in the measurement.

## **Maintenance Triggers**

Maintenance should be scheduled if any of the following conditions are identified during the inspection:

- Internal components are broken or missing.
- Inlet piping is obstructed.
- The accumulation of floating trash and debris that cannot be retrieved with a net and/or oil in the inlet chamber is significant.
- There is more than 6" of accumulated sediment in the inlet chamber.
- There is more than 4" of accumulated sediment in the treatment chamber.
- There is more than 4" of standing water in the treatment chamber more than 24 hours after end of rain event.
- A hazardous material release (e.g. automotive fluids) is observed or reported.
- The system has not been maintained for 3 years (wet climates) to 5 years (dry climates).

## **Maintenance Equipment**

The following equipment is helpful when conducting PerkFilter maintenance:

- Suitable clothing (appropriate footwear, gloves, hardhat, safety glasses, etc.)
- Traffic control equipment (cones, barricades, signage, flagging, etc.)
- Socket and wrench for bolt-down access covers
- Manhole hook or pry bar
- Confined space entry equipment, if needed
- Flashlight
- Tape measure
- 9/16" socket and wrench to remove hold-down struts and filter cartridge tops
- Replacement filter cartridges
- Vacuum truck with water supply and water jet

Contact Oldcastle Infrastructure at (800) 579-8819 for replacement filter cartridges. A lead time of four weeks is recommended.

## Maintenance Procedures

Maintenance should be conducted during dry weather when no flow is entering the system. Confined space entry is necessary to maintain vault and manhole PerkFilter configurations. Only personnel that are OSHA Confined Space Entry trained and certified may enter underground structures. Confined space entry is not required for catch basin PerkFilter configurations. Once safety measures such as traffic control are deployed, the access covers may be removed and the following activities may be conducted to complete maintenance:

- Remove floating trash, debris and oils from the water surface in the inlet chamber using the extension nozzle on the end of the boom hose of the vacuum truck. Continue using the vacuum truck to completely dewater the inlet chamber and evacuate all accumulated sediment from the inlet chamber. Some jetting may be required to fully remove sediment. The inlet chamber does not need to be refilled with water after maintenance is complete. The system will fill with water when the next storm event occurs.
- Remove the hold-down strut from each row of filter cartridges and then remove the top of each cartridge (the top is held on by four 9/16" bolts) and use the vacuum truck to evacuate the spent media. When empty, the spent cartridges may be easily lifted off their slip couplers and removed from the vault. The couplers may be left inserted into couplings cast into the false floor to prevent sediment and debris from being washed into the outlet chamber during washdown.
- Once all the spent cartridges have been removed from the structure, the vacuum truck may be used to evacuate all accumulated sediment from the treatment chamber. Some jetting may be required to fully remove sediment. Take care not to wash sediment and debris through the openings in the false floor and into the outlet chamber. All material removed from the PerkFilter during maintenance including the spent media must be disposed of in accordance with local, state, and/or federal regulations. In most cases, the material may be handled in the same manner as disposal of material removed from sumped catch basins or manholes.
- Place a fresh cartridge in each cartridge position using the existing slip couplers and urethane bottom caps. If the vault is equipped with stacked cartridges, the existing outer and inner interconnector couplers must be used between the stacked cartridges to provide hydraulic connection. Transfer the existing vent tubes from the spent cartridges to the fresh cartridges. Finally, refit the struts to hold the fresh cartridges in place.
- Securely replace access covers, as appropriate.
- Make arrangements to return the empty spent cartridges to Oldcastle Infrastructure.

# PerkFilter Inspection and Maintenance Log

Location \_\_\_\_\_

**Structure Configuration and Size:**

Inspection Date \_\_\_\_\_

- Vault \_\_\_\_\_ feet x \_\_\_\_\_ feet
- Manhole \_\_\_\_\_ feet diameter
- Catch Basin \_\_\_\_\_ feet x \_\_\_\_\_ feet

**Number and Height of Cartridge Stacks:**

**Media Type:**

Count \_\_\_\_\_ each  12"  18"  24"  30"

ZPC  Perlite  Other \_\_\_\_\_

***Condition of Internal Components***

Notes:

- Good       Damaged       Missing

***Inlet or Outlet Blockage or Obstruction***

Notes:

- Yes       No

***Floating Trash and Debris***

Notes:

- Significant       Not Significant

***Floating Oils***

Notes:

- Significant       Not Significant       Spill

***Sediment Depth in Inlet Chamber***

Notes:

Inches of Sediment: \_\_\_\_\_

***Sediment Depth in Treatment Chamber***

Notes:

Inches of Sediment: \_\_\_\_\_

***Standing Water in Treatment Chamber***

Notes:

Inches of Standing Water: \_\_\_\_\_

***Maintenance Required***

- Yes - Schedule Maintenance       No - Inspect Again in \_\_\_\_\_ Months

# PERKFILTER™

## OUR MARKETS



**BUILDING  
STRUCTURES**



**COMMUNICATIONS**



**WATER**



**ENERGY**



**TRANSPORTATION**

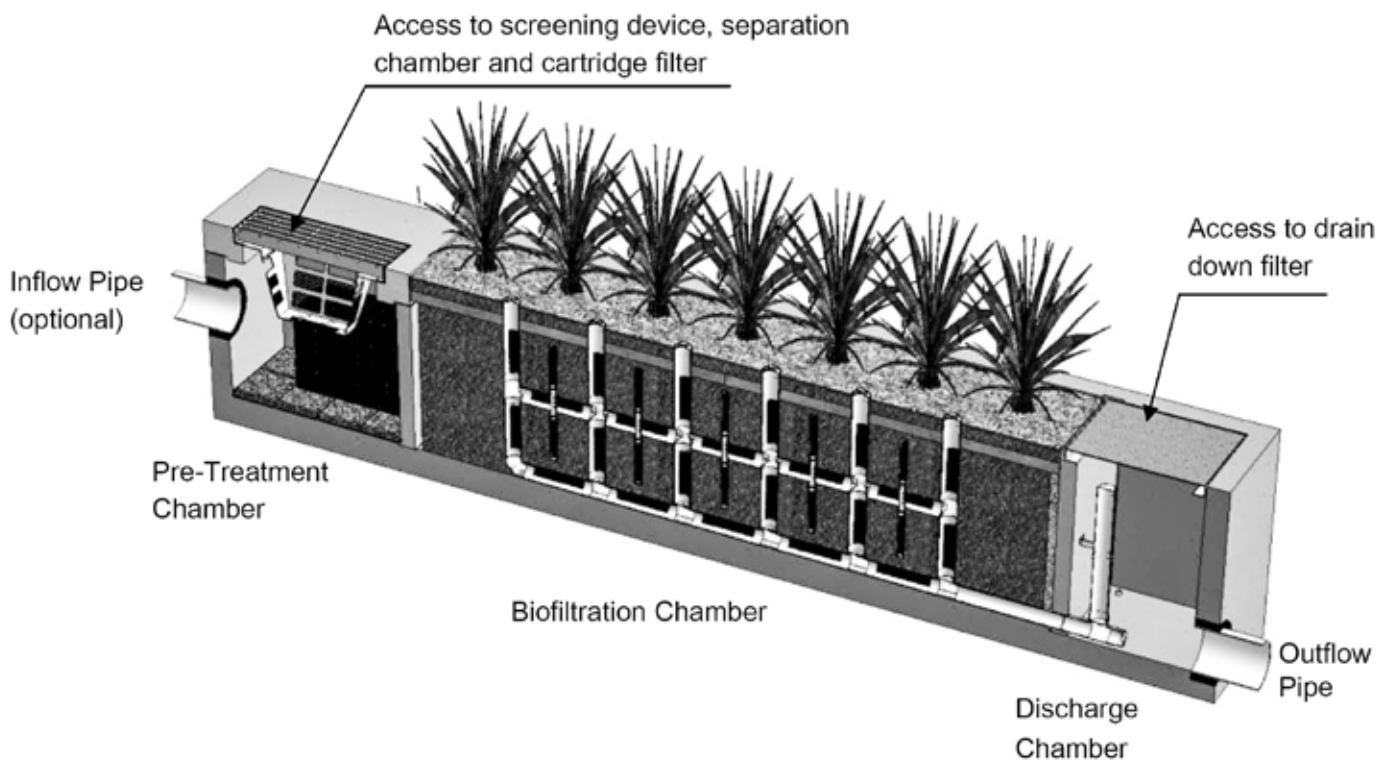
## Modular Wetlands<sup>®</sup> Linear Operation & Maintenance Manual





## Maintenance Summary

- Remove Trash from Screening Device – average maintenance interval is 6 to 12 months.
  - (5 minute average service time ).
- Remove Sediment from Separation Chamber – average maintenance interval is 12 to 24 months.
  - (10 minute average service time ).
- Replace Cartridge Filter Media – average maintenance interval 12 to 24 months.
  - (10-15 minute per cartridge average service time ).
- Replace Drain Down Filter Media – average maintenance interval is 12 to 24 months.
  - (5 minute average service time ).
- Trim Vegetation – average maintenance interval is 6 to 12 months.
  - (Service time varies).



*System Diagram*

# Maintenance Procedures

## ***Screening Device***

1. Remove grate or manhole cover to gain access to the screening device in the Pre- Treatment Chamber. Vault type units do not have screening device. Maintenance can be performed without entry.
2. Remove all pollutants collected by the screening device. Removal can be done manually or with the use of a vacuum truck.
3. Screening device can easily be removed from the Pre-Treatment Chamber to gain access to separation chamber and media filters below. Replace grate or manhole cover when completed.

## ***Separation Chamber***

1. Perform maintenance procedures of screening device listed above before maintaining the separation chamber.
2. With a pressure washer, spray down pollutants accumulated on walls and cartridge filters.
3. Vacuum out Separation Chamber and remove all accumulated pollutants. Replace screening device, grate or manhole cover when completed.

## ***Cartridge Filters***

1. Perform maintenance procedures on screening device and separation chamber before maintaining cartridge filters.
2. Enter separation chamber.
3. Unscrew the two bolts holding the lid on each cartridge filter and remove lid.
4. Remove each of 4 to 8 media cages holding the media in place.
5. Spray down the cartridge filter to remove any accumulated pollutants.
6. Vacuum out old media and accumulated pollutants.
7. Reinstall media cages and fill with new media from manufacturer or outside supplier. Manufacturer will provide specification of media and sources to purchase.
8. Replace the lid and tighten down bolts. Replace screening device, grate or manhole cover when completed.

## ***Drain Down Filter***

1. Remove hatch or manhole cover over discharge chamber and enter chamber. Entry into chambers may require confined space training based on state and local regulations.
2. Unlock and lift drain down filter housing and remove old media block. Replace with new media block. Lower drain down filter housing and lock into place.
3. Exit chamber and replace hatch or manhole cover.

## Maintenance Notes

1. Following maintenance and/or inspection, it is recommended the maintenance operator prepare a maintenance/inspection record. The record should include any maintenance activities performed, amount and description of debris collected, and condition of the system and its various filter mechanisms.
2. The owner should keep maintenance/inspection record(s) for a minimum of five years from the date of maintenance. These records should be made available to the governing municipality for inspection upon request at any time.
3. Transport all debris, trash, organics and sediments to approved facility for disposal in accordance with local and state requirements.
4. Entry into chambers may require confined space training based on state and local regulations.
5. No fertilizer shall be used in the Biofiltration Chamber.
6. Irrigation should be provided as recommended by manufacturer and/or landscape architect. Amount of irrigation required is dependent on plant species. Some plants may require irrigation.

## Maintenance Procedure Illustration

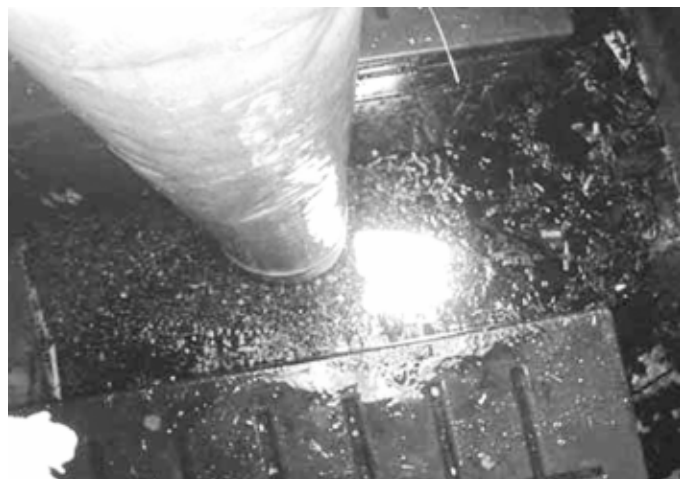
### **Screening Device**

*The screening device is located directly under the manhole or grate over the Pre-Treatment Chamber. It's mounted directly underneath for easy access and cleaning. Device can be cleaned by hand or with a vacuum truck.*



### **Separation Chamber**

*The separation chamber is located directly beneath the screening device. It can be quickly cleaned using a vacuum truck or by hand. A pressure washer is useful to assist in the cleaning process.*



### **Cartridge Filters**

The cartridge filters are located in the Pre-Treatment chamber connected to the wall adjacent to the biofiltration chamber. The cartridges have removable tops to access the individual media filters. Once the cartridge is open media can be easily removed and replaced by hand or a vacuum truck.



### **Drain Down Filter**

The drain down filter is located in the Discharge Chamber. The drain filter unlocks from the wall mount and hinges up. Remove filter block and replace with new block.



### **Trim Vegetation**

Vegetation should be maintained in the same manner as surrounding vegetation and trimmed as needed. No fertilizer shall be used on the plants. Irrigation per the recommendation of the manufacturer and or landscape architect. Different types of vegetation requires different amounts of irrigation.





## Inspection Report Modular Wetlands Linear

Project Name \_\_\_\_\_

For Office Use Only
(Reviewed By) _____
(Date) _____ Office personnel to complete section to the left.

Project Address \_\_\_\_\_ (city) (Zip Code)

Owner / Management Company \_\_\_\_\_

Contact \_\_\_\_\_ Phone ( ) - \_\_\_\_\_

Inspector Name \_\_\_\_\_ Date \_\_\_\_ / \_\_\_\_ / \_\_\_\_\_ Time \_\_\_\_\_ AM / PM

Type of Inspection    Routine    Follow Up    Complaint    Storm   Storm Event in Last 72-hours?    No    Yes

Weather Condition \_\_\_\_\_ Additional Notes \_\_\_\_\_

### Inspection Checklist

Modular Wetland System Type (Curb, Grate or UG Vault): \_\_\_\_\_ Size (22', 14' or etc.): \_\_\_\_\_

Structural Integrity:	Yes	No	Comments
Damage to pre-treatment access cover (manhole cover/grate) or cannot be opened using normal lifting pressure?			
Damage to discharge chamber access cover (manhole cover/grate) or cannot be opened using normal lifting pressure?			
Does the MWS unit show signs of structural deterioration (cracks in the wall, damage to frame)?			
Is the inlet/outlet pipe or drain down pipe damaged or otherwise not functioning properly?			
<b>Working Condition:</b>			
Is there evidence of illicit discharge or excessive oil, grease, or other automobile fluids entering and clogging the unit?			
Is there standing water in inappropriate areas after a dry period?			
Is the filter insert (if applicable) at capacity and/or is there an accumulation of debris/trash on the shelf system?			
Does the depth of sediment/trash/debris suggest a blockage of the inflow pipe, bypass or cartridge filter? If yes specify which one in the comments section. Note depth of accumulation in in pre-treatment chamber.			Depth:
Does the cartridge filter media need replacement in pre-treatment chamber and/or discharge chamber?			Chamber:
Any signs of improper functioning in the discharge chamber? Note issues in comments section.			
<b>Other Inspection Items:</b>			
Is there an accumulation of sediment/trash/debris in the wetland media (if applicable)?			
Is it evident that the plants are alive and healthy (if applicable)? Please note Plant Information below.			
Is there a septic or foul odor coming from inside the system?			

Waste:	Yes	No
Sediment / Silt / Clay		
Trash / Bags / Bottles		
Green Waste / Leaves / Foliage		

Recommended Maintenance	
No Cleaning Needed	
Schedule Maintenance as Planned	
Needs Immediate Maintenance	

Plant Information	
Damage to Plants	
Plant Replacement	
Plant Trimming	

Additional Notes: \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_



## Cleaning and Maintenance Report Modular Wetlands Linear

Project Name \_\_\_\_\_

For Office Use Only

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(Reviewed By) \_\_\_\_\_

---

(Date) \_\_\_\_\_  
Office personnel to complete section to the left.

Project Address \_\_\_\_\_ (city) (Zip Code)

Owner / Management Company \_\_\_\_\_

Contact \_\_\_\_\_

Phone (       ) - \_\_\_\_\_

Inspector Name \_\_\_\_\_

Date \_\_\_\_ / \_\_\_\_ / \_\_\_\_ Time \_\_\_\_\_ AM / PM

Type of Inspection     Routine     Follow Up     Complaint

Storm                      Storm Event in Last 72-hours?     No     Yes

Weather Condition \_\_\_\_\_

Additional Notes \_\_\_\_\_

Site Map #	GPS Coordinates of Insert	Manufacturer / Description / Sizing	Trash Accumulation	Foliage Accumulation	Sediment Accumulation	Total Debris Accumulation	Condition of Media 25/50/75/100 (will be changed @ 75%)	Operational Per Manufactures' Specifications (If not, why?)
	Lat: _____ Long: _____	MWS Catch Basins						
		MWS Sedimentation Basin						
		Media Filter Condition						
		Plant Condition						
		Drain Down Media Condition						
		Discharge Chamber Condition						
		Drain Down Pipe Condition						
		Inlet and Outlet Pipe Condition						

Comments:





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Modular Wetlands Maintenance Guide 08/22

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## **SECTION 7: SPECIAL REPORTS AND STUDIES**

The following studies were conducted in preparation of this Report:

- Wetland Report, Wetland Resources, June, 2022
- Geotechnical Investigation, Cobalt Geosciences, June 2022