PRELIMINARY TECHNICAL INFORMATION REPORT

Monte Verde

City of Camas, Washington

Prepared by:
PLS Engineering
Consulting Engineers and Planners
604 W Evergreen Blvd
Vancouver, WA 98660
(360) 944-6519
pm@plsengineering.com

Prepared for:
Ginn Group, LLC
502 NE 72nd Street
Vancouver, WA 98665

Prepared: July 2022

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CERTIFICATE OF ENGINEER

Monte Verde

Technical Information Report

The technical information and data contained in this report was prepared under the direction and supervision of the undersigned, whose seal, as a professional engineer licensed to practice as such, is affixed below.

This document was prepared by:

Scott W. Gilliland, PE

Section A – Project Overview

Section A.1 – Site Information

This project will comply with current City of Camas Standards for Stormwater and Erosion Control per CMC Title 14. The Final Grading / Erosion Control / Drainage Plans have been prepared by the project civil engineer, PLS Engineering, Inc. The site will be served by public sewer and water provided by the City of Camas. This project phase proposes construction of 35 single-family residential lots with associated structures, access, paved storage areas, sewer, water, and storm drain connections. Access to the site is from NE 28th Street.

The physical address of the site is currently 22205 NE 28th Street, but the postal office may change that prior to the completion of this project. The parcel serial number is 173184000. The property is located in the southeast and southwest quarter of Section 21, T2N, R3E of the Willamette Meridian. The property is bordered by NE 28th Street on the north side, 5 acre single family lots to the East and West, and Clark County Parks to the South. A narrow access easement to Clark County Parks immediately abuts the property to the East. The cumulative property area contains a total of 374,941.64 square feet (8.61 acres), with 89,290.53 square feet (2.06 acres) of right of way dedication, resulting in 285,290.53 square feet (6.55 acres) of developed area. This technical information report will address the stormwater runoff associated with the construction which will take place.

The topography of the site is moderately sloped from NE to SW, with elevations ranging from 289' to no greater than 232'. Slopes are generally between 3% and 10%, with some isolated steeper slopes at the South end of the site at around 20%. The site slopes down from relative high point in the NE corner towards the SW property corner. The site contains a 1,900 square-foot house, a 1,200 square-foot shop, and a 3,080 square-foot chicken coop. Each of these structures along with the existing impervious surfaces on-site are planned to be removed. There is an existing BPA easement along with some electrical power line towers that support the power lines that cross the site. This easement and associated structures will remain. The remainder of the site is filled with grass, weeds, and a variety of trees. There are potential wetlands mapped on Clark County Maps at the SW corner of the site. Otherwise, there are no known water courses, areas prone to flooding, floodplains, shoreline areas, water bodies, unstable slopes, landslide hazard areas, habitat, critical areas, or historic sites located on the site. Site drainage follows the slope of the land going from the NE corner to the SW corner. Some of the runoff will be infiltrated on site, and site discharge will not exceed historic rates.

After construction, the site will contain approximately 177,879 square feet of landscaped area. The remainder of the site is anticipated to be covered with impervious surfaces. This will include 95,200 square feet of roof area, 15,240 square feet of sidewalk, and 92,340 square feet of concrete and asphalt for driveways and drive aisles. Site stormwater will be routed to underground infiltration trenches and a detention pond that will release the runoff at rates less than existing in accordance with the SWMMWW. Frontage stormwater will be routed to a bioretention facility for treatment and infiltration. Site stormwater runoff treatment for the site's pollution generating impervious surfaces will be accomplished with media filter treatment cartridges located in stormwater structures throughout the site.

Section B – Minimum Requirements

Section B.2 – Determination of Applicable Minimum Requirements

After site development, disturbed impervious surfaces will cover approximately 202,776 square feet, or 53% of the disturbed project area; projects resulting in more than 5,000 square foot of hard surface area must meet all nine Minimum Requirements of the stormwater manual. The entirety of the developed site will all discharge to infiltration facilities, acting as one TDA, and will all be required to meet Minimum Requirements #6 and #7. The stormwater system is designed to comply with all City requirements for stormwater treatment and quantity control. The treatment regulations require treatment of 91% of the total runoff volume from pollution generating impervious surfaces while the quantity control regulations require that post-development discharges shall match pre-developed durations for the range of pre-developed discharge rates from 50% of the 2-year peak flow up to the full 50-year peak flow.

Existing hard surface	23,115 ft^2
New hard surface	181,639 ft^2
Replaced hard	20,804 ft^2
Native vegetation converted to lawn or landscaping	175,900 ft^2
Native vegetation converted to pasture	0 ft^2
Total land-disturbing activity	8.74 acre
Pollution-generating hard surface	90,982 ft^2
Pollution-generating pervious surface	0 ft^2
Total pollution-generating surfaces	92,338 ft^2
Total non-pollution-generating surfaces	289,673 ft^2

MR #1) Preparation of Stormwater Site Plans

All Stormwater System designs meet City of Camas Requirements for conveyance, quality control and quantity. See final construction documents for more details.

MR #2) Construction Stormwater Pollution Prevention

A Stormwater Pollution Prevention Plan is being included with this report and will be onsite for the duration of the project's construction.

MR #3) Source Control of Pollution

See Section D

MR #4) Preservation of Natural Drainage Systems and Outfalls

Site runoff flows to the SW corner of the site. The proposed development will capture the existing runoff and infiltrate some and releasing the rest at rates that are incompliance with the SWMMWW. This will maintain and preserve the natural drainage systems.

MR #5) Onsite Stormwater Management

See Section E

MR #6) Runoff Treatment
See Section F

MR #7) Flow Control
See Section G

MR #8) Wetland Protection
Clark County maps show the potential for a Wetland located in the SW corner of the site. See Appendix F for documentation showing that there are not any wetlands on the site.

MR #9) Operations and Maintenance
See Appendix D

Section C – Soils Evaluation

The soils are mapped by the NRCS as Lauren gravelly loam (LgB) in the North and SW corner of the sit, and Lauren loam (LeB) in the middle and South end of the site. The geotechnical soil investigation found surface soils generally consistent with that soil mapping. The geotechnical report has been included in Appendix C and a soil map is included in Appendix A.

True North Geotechnical, Inc. completed a geotechnical review of the site, dated July 2022. Infiltration testing was performed on the site in two locations. One location was in shallow silty soils and resulted in a coefficient of permeability of less than 0.3 in/hr. The other infiltration test was deeper and in an area with less silt and a higher content of gravel and sand. It resulted in a coefficient of permeability of 42.2 in/hr. Based on the boar logs for the site, it appears that the majority of the site contains dense gray-brown sandy gravel (4% fines) at deeper depths ranging from 5’ to 9’ and extending deeper. In most cases, this would indicate that the entire site can be infiltrated. Unfortunately, we have groundwater issues at the South end of the site, where the groundwater depth is higher than the sandy gravel soils. Consequently, based on the observed groundwater elevations, infiltration is not feasible on the South end of the site.

Section D – Source Control

The pollution risks involved with this project mainly include the sediment accumulation involved with construction. The Stormwater Pollution Prevention Plan is a document that notes our certain Best Management Practice's (BMP’s) that will help prevent sediment laden water from leaving the site during construction. The Erosion Control Plan located in the final construction drawings will provide protection measures involved with minimizing the chance that sediment from the site could enter downstream waterways. After construction is complete, this project does not necessitate any special source control measures due to abnormal risks associated with the project. As this is a single family home development, appropriate source control responsibilities will fall primarily on property owner(s). The SWPPP is provided in Appendix E.

Section E – On-site Stormwater Management BMPs

Minimum Requirement 5 requires the applicant to employ On-site Stormwater Management BMPs in accordance with the following project thresholds, standards, and lists to infiltrate, disperse, and retain stormwater runoff on-site to the maximum extent feasible without causing flooding or erosion impacts. Based on section I-2.5.1 of the Western Washington Stormwater Manual the development is within the UGA on a parcel that is less than 5 acres therefore Low Impact Development Performance Standards and BMP T5.13; or List #2 will apply (applicant option).

This site has a unique situation. As discussed in section C, the site accommodates infiltration if the infiltration trenches are deep enough. Unfortunately, the ground water is too shallow on the south end of the site. This means that for the Northern and Middle portions of the site infiltration is a viable solution, but on the south end of the site it is not.

To meet Minimum Requirement 5, the applicant proposes a hybrid solution. The North and Mid portions of the site will comply with the LID performance standards and BMP T5.13. The south end of the site will meet List #2 as outlined below. All requirements that will be applied to this project are noted below and shown in the final construction drawings. If certain BMP's are infeasible; infeasibility criteria per the 2019 Stormwater Management Manual for Western Washington are also noted.

List #2 (for the south end of the site only):
Lawn and Landscape areas:
BMP T5.13 Post-Construction Soil Quality and Depth:
This requirement will be met during final design and shown on final construction drawings.

Roofs:
BMPT5.30A or T5.30B Full Dispersion:
There is insufficient area and length to provide a 100' flow path to meet the requirements of full dispersion while still maintaining sufficient spacing to prevent overlap.

BMPT5.14A or BMPT5.14B Rain Gardens and Bioretention:
The soil permeability factor above groundwater is less than 0.3 inches per hour (measured by the Geotech at less than 0.06 inches per hours). Because the site soils don't accommodate infiltration, this is not a feasible BMP as part of Minimum requirement #5.

BMPT5.10C Downspout Dispersion Systems:
There is insufficient space to meet the required dispersion lengths and setbacks from the structures and the property lines.

BMP T5.10D Perforated Stub-out Connections
There is insufficient space to meet the required setback of 10' away from the structures and property lines, and infiltration rates are less than 0.3 inches per hour.

Other Hard Surfaces:
BMPT5.30A or T5.30B Full Dispersion:

There is insufficient area and length to provide a 100' flow path to meet the requirements of full dispersion while still maintaining sufficient spacing to prevent overlap.

BMPT5.15 Permeable Pavement:
Permeable pavement is insufficient due to soil infiltration above the groundwater table being less than 0.3 in/hr.

BMPT5.14A or BMPT5.14B Rain Gardens and Bioretention:
The soil permeability above the groundwater table is less than 0.3 inches per hour. This is not a feasible solution.

BMPT5.12 Sheet Flow Dispersion:
There is insufficient area and length to provide a 100' flow path to meet the requirements of full dispersion while still maintaining sufficient spacing to prevent overlap.

None of the List 2 requirements can be met by the southern portion of this project. Consequently, stormwater on the South end of the project will be treated and detained prior to discharge as described in Sections F and G of this report.

The following BMPs will be implemented to meet the minimum 5 requirements:

- **BMP T5.13: Post-Construction Soil Quality and Depth** for lawn and landscaped areas.
- **BMP T7.20: Infiltration Trenches** for runoff from the Northern portion of the site.

Section F – Runoff Treatment Analysis and Design

Treatment for the site will be accomplished via media filter cartridges that will be placed in catch basins and manholes throughout the site. The filter system will treat the pollution generating surface runoff that is conveyed to it. Runoff from the building roofs and other non-pollution generating areas will be piped to bypass the filter cartridges when possible. The cartridge units will be sized to treat all of the runoff that is routed to them.

For this preliminary phase it is assumed that all of the site will be treated. The Treatment Analysis WWHM model contained in Appendix B identifies an off-line WQ flow of 0.661CFS. Per Table 1 below, 18" ZPG cartridges are designed to treat 0.017 CFS each. So, the most 18" ZPG cartridges that would be used for this project will be 39 cartridges distributed throughout the site in catch basins and Manholes. The final design will evaluate sub-basin flows to each catch basin and identify where each of the cartridges are located.

Table 1-Contech Sizing Chart

	Perlite 2 GPM/ft²			ZPG 1 GPM/ft²			PhosphoSorb 1.67 GPM/ft²		
StormFilter	Flow (GPM)	Flow (CFS)	Color	Flow (GPM)	Flow (CFS)	Color	Flow (GPM)	Flow (CFS)	Color
LowDrop	10	0.022	Gray (GRY)	5.00	0.011	Blue (BLU)	8.35	0.019	Yellow (YLW)
18"	15	0.033	Black (BLK)	7.50	0.017	Blue (BLU)	12.53	0.028	Red (RED)
27"	22.5	0.05	Gold (GLD)	11.50	0.025	Pink (PNK)	18.79	0.042	White (WHT)

Section G - Flow Control Analysis and Design

The stormwater quantity control system for this site has been designed based on the current stormwater quantity control requirements of the City of Camas. The quantity control standards require that stormwater discharges shall match developed discharge durations to pre-developed durations for the range of pre-developed discharge rates from 50% of the 2-year peak flow up to the full 50-year peak flow.

The infiltration trenches mentioned in Section F were modelled in WWHM and successfully infiltrate most of the stormwater runoff from the site using an infiltration rate of 42.2 in/hr with a factor of safety of 2 resulting in a design infiltration rate of 21.1 in/hr. The infiltration trenches are designed to be located in the sandy gravel layers identified in the geotechnical report. Modeling basins were calculated as a developed site using Soil Group 4 as the underlying soils per the geotechnical recommendation contained in Appendix C. Calculations and values can be seen in Appendix B.

The infiltration trench design for Basin 1 is 100' long by 8' wide by 3' deep. The infiltration trench for Basin 2 is also 100' long by 8' wide by 3' deep. The Basin 1 infiltration trench is designed to overflow into the trench for Basin 2, which will over flow to a detention pond at the SW corner of the site. Basin 3 runoff areas can't be infiltrated and are directly discharged to the detention facility. The WWHM design model in Appendix B shows that the combined facilities exceed the SWMMWW requirements and can be reduced in size. This preliminary TIR is showing that stormwater for the site can meet the requirements of SWMMWW. The sizes of these facilities will be fine tuned in the final design.

Infiltration does not work if the groundwater is too shallow. Consequently, groundwater depth is a significant issue for this project. The geotechnical investigation discovered ground water in the 2 most southerly test pits. Given the gravel/sand soil conditions at deeper depths, and the fact that groundwater was not discovered in any other test pits, the water table is assumed to be flatter than the existing ground, and increase in depth as the site elevations rise to the North.

Section H – Wetland Protection

There are not any wetlands on the site. See appendix F.

Section I – Other Permits

The project will be required to obtain preliminary site plan approval, final site plan approval, construction drawing approval, an NPDES construction stormwater permit, and building permit approval prior to construction.

Section J – Conveyance Systems Analysis and Design

Conveyance will be provided with the Final TIR.

Section K – Special Reports and Studies

A Geotechnical Report for the site was prepared by True North, Inc. and is included in Appendix C. A Critical Areas report is included in Appendix F. No other special studies are anticipated to be needed.

Section L –Operations and Maintenance Manual

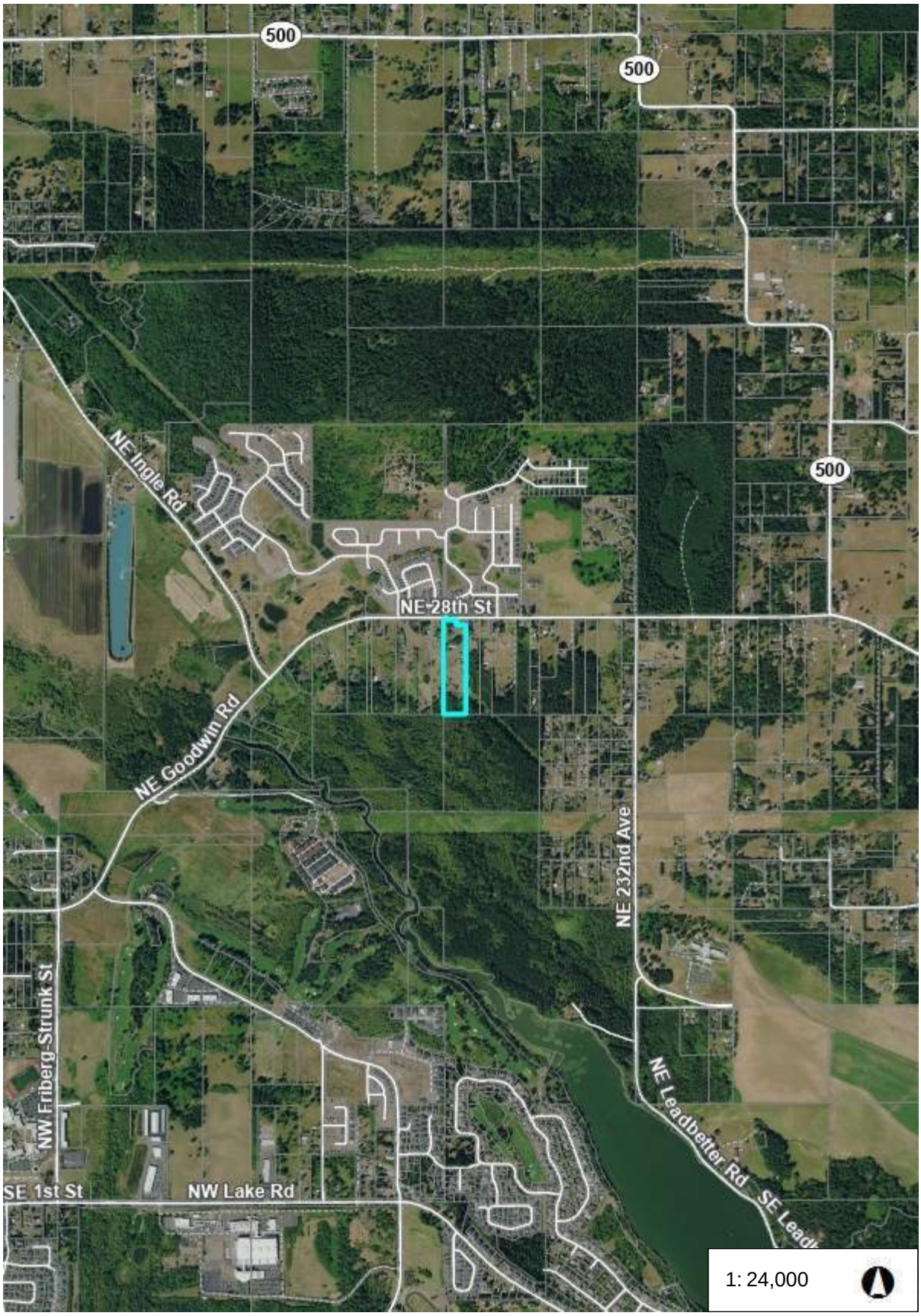
The stormwater facility located on-site will be maintained by the site owner. An Operations and Maintenance Manual is included as Appendix D of this report.

SEPARATOR SHEET

APPENDIX A

Maps

Vicinity Map



Legend

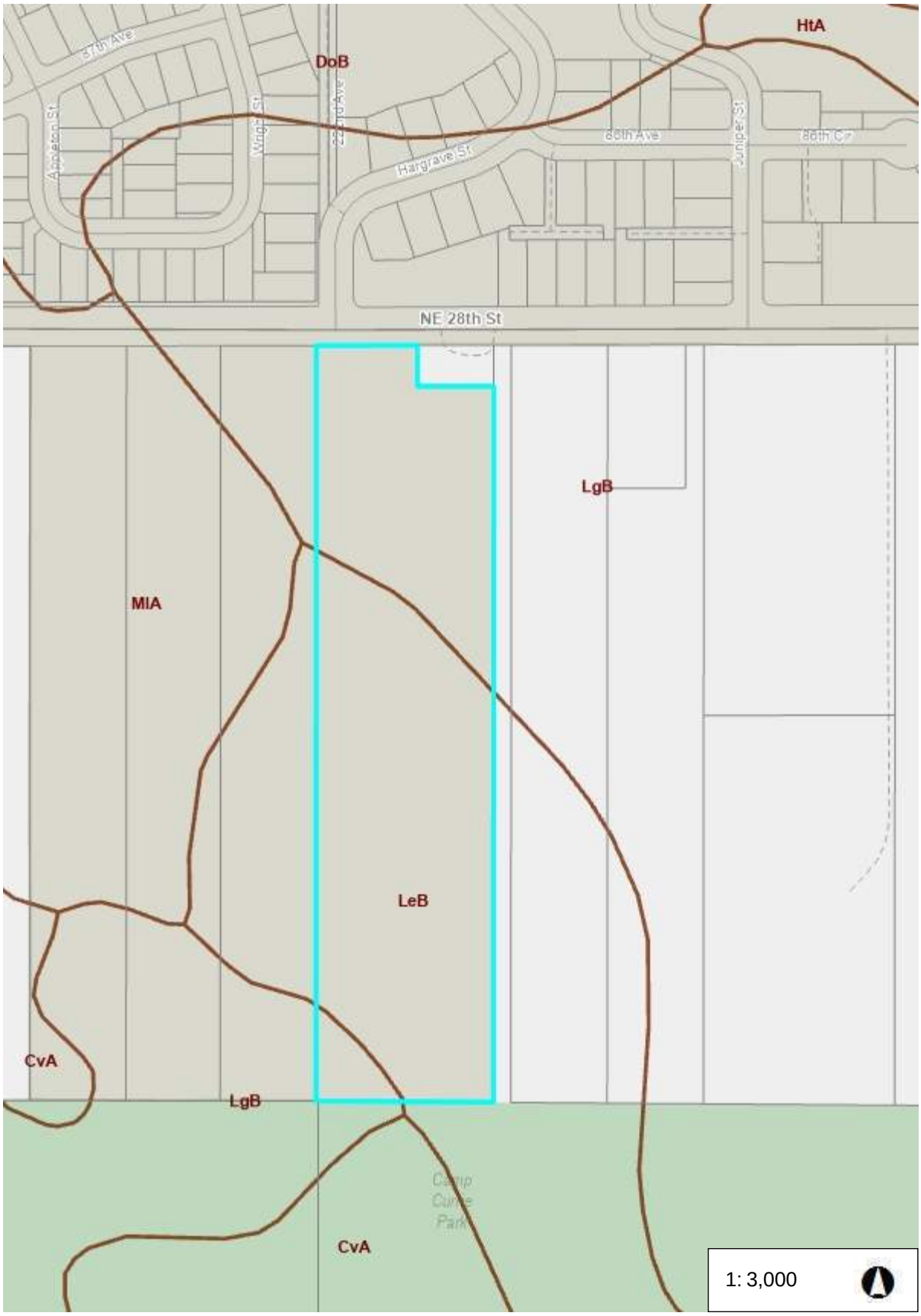
- Taxlots
- All Roads
  - Interstate or State Route
  - Arterial
  - Collector
  - Private or Other

Notes:

4,000.0 0 2,000.00 4,000.0 Feet

WGS_1984_Web_Mercator_Auxiliary_Sphere
Clark County, WA. GIS - http://gis.clark.wa.gov

Soils Map



Legend

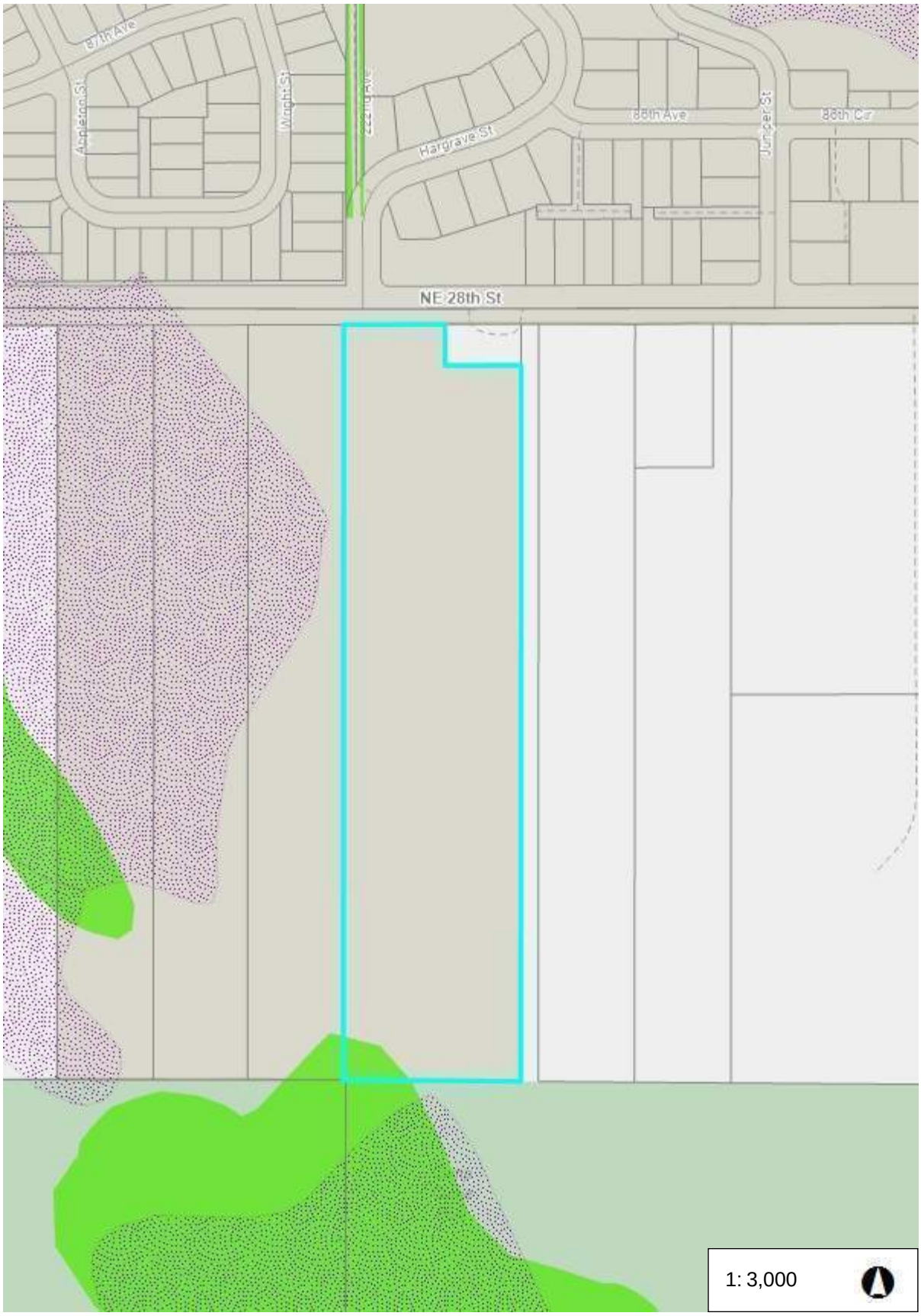
- Taxlots
- Soil Type
- Critical Aquifer Recharge Area

Notes:

500.0 0 250.00 500.0 Feet

WGS_1984_Web_Mercator_Auxiliary_Sphere
Clark County, WA. GIS - http://gis.clark.wa.gov

Critical Areas Map



Legend

- Taxlots
- Species
  - Species Area
  - Adjacent to Species Area
- Riparian Habitat
- Severe Erosion Hazard Areas
- Steep Slopes and Landslide H
  - Areas of Historic or Active Landslid
  - Areas of Potential Instability
  - Areas of Older Landslide Debris
  - Slopes > 15%
  - Slopes > 25%
- Hydric Soils
- Potential Wetlands Presence
- Flood Zone Designation
  - Floodway
  - Floodway Fringe
  - 500 Year Flood Area
  - Area Not Studied
- Stream
- Shoreline Designations
  - Aquatic
  - Natural
  - Urban Conservancy
  - Medium Intensity
  - High Intensity
  - Rural Conservancy Residential
  - Rural Conservancy Resource Land
- Critical Aquifer Recharge Area

Notes:

500.0 0 250.00 500.0 Feet

WGS_1984_Web_Mercator_Auxiliary_Sphere
Clark County, WA. GIS - http://gis.clark.wa.gov

Monte Verde

Located in the SE ¼ of Section 21, T2N, R3E and in
the SW ¼ of Section 21, T2N, R3E, W.M.
Camas, Washington

Sheet Index	
1.	Predevelopment Basin Map
2.	Postdevelopment Basin Map

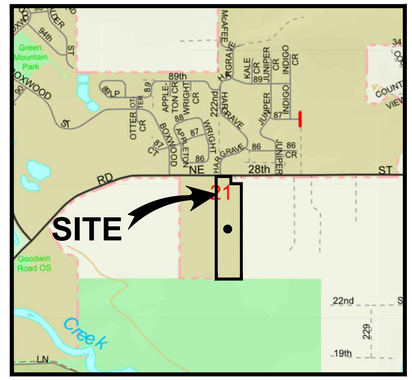
GENERAL NOTES

Applicant:
Pacific Lifestyle Homes
Ryan Stygar
11815 NE 99th Street
Vancouver, WA 98682
Office (360) 304-9901

OWNER:
Dwight Southern
22205 NE 28th Street
Camas, WA 98607

CIVIL ENGINEER:
PLS Engineering
Contact: Travis Johnson, PE
604 W Evergreen Blvd
Vancouver, WA 98660
PH: (360) 944-6519
pm@plsengineering.com

SITE ADDRESS:
Parcel # 173184-000
22205 NE 28th Street
Camas, WA 98607



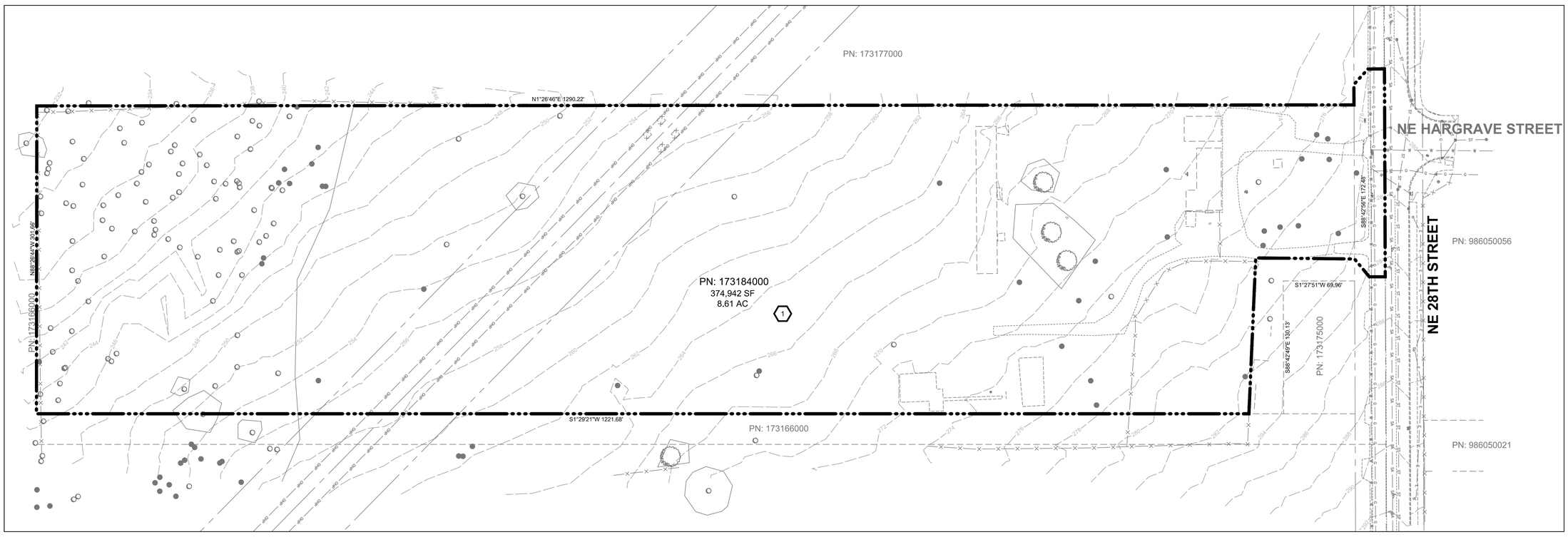
VICINITY MAP
NOT TO SCALE

① Point of Compliance 1: Pre-Development Basin Area
Basin 1 Areas:
Forested: 8.74 ac
Total: 8.74 ac

Total POC 1 Area: 8.74 ac

Drainage Basin Legend	
POC Line	
Basin Line	
Subcatchment Area ID	#

Scale 1" = 50'
50 25 0 50



ENGINEERING
PLS

Existing Conditions Plan For:
Monte Verde
A Subdivision Located In The City Of Camas, Washington
Engineering - Surveying - Planning | 604 W. Evergreen Blvd., Vancouver, WA 98660 | PH (360) 944-6519 | Fax (360) 944-6539

Revisions

1	2	3	4	5	6

Project No.	3382
SCALE:	H: 1" = 50' V: N/A
DESIGNED BY:	SWG
DRAFTED BY:	JSV
REVIEWED BY:	SWG

1
2

Monte Verde

Located in the SE ¼ of Section 21, T2N, R3E and in
the SW ¼ of Section 21, T2N, R3E, W.M.
Camas, Washington

Sheet Index	
1.	Predevelopment Basin Map
2.	Postdevelopment Basin Map

Point of Compliance 1: Post-Development Basin Area

1	Basin 1 Areas:	
	Road:	0.87 ac
	Sidewalk:	0.19 ac
	Roof:	1.03 ac
	Driveway:	0.29 ac
	Landscape:	1.42 ac
	Total:	3.80 ac
2	Basin 2 Areas:	
	Road:	0.36 ac
	Sidewalk:	0.09 ac
	Roof:	0.54 ac
	Driveway:	0.18 ac
	Landscape:	1.51 ac
	Total:	2.67 ac
3	Basin 3 Areas:	
	Road:	0.21 ac
	Sidewalk:	0.07 ac
	Roof:	0.64 ac
	Driveway:	0.18 ac
	Landscape:	1.17 ac
	Total:	2.27 ac
	Total POC 1 Area:	8.74 ac

Drainage Basin Legend	
POC Line	
Basin Line	
Subcatchment Area ID	#

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SITE ADDRESS:
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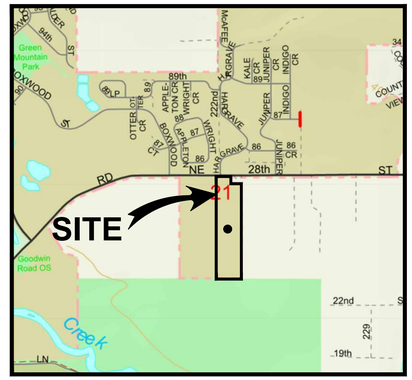
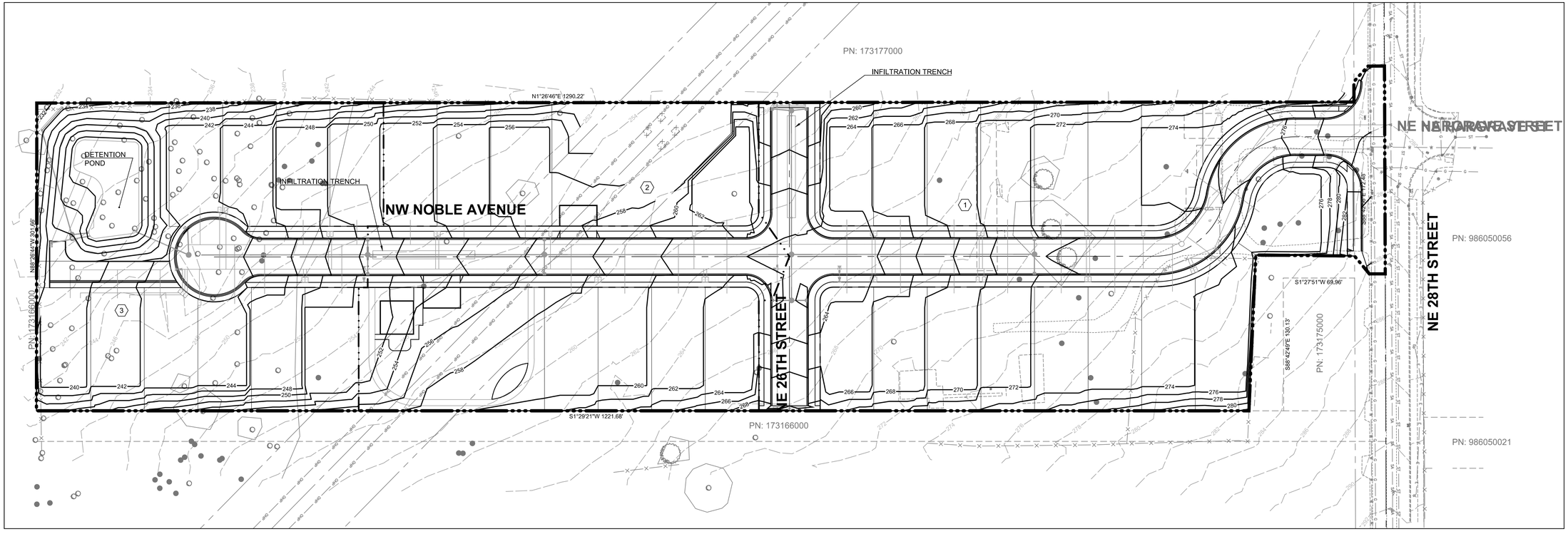


VICINITY MAP
NOT TO SCALE

Scale 1" = 50'
50 25 0 50



Post-Development Basin Map For:

Monte Verde

A Subdivision Located In The City Of Camas, Washington

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PLS ENGINEERING

Revisions

1	2	3	4	5	6

Project No.	3382
SCALE:	H: 1" = 50' V: N/A
DESIGNED BY:	SWG
DRAFTED BY:	JSV
REVIEWED BY:	SWG

2
2

SEPARATOR SHEET

APPENDIX B

Design Calculations and Modeling

Design Point of Compliance 1		
	sqft	acre
Total Basin	**380,654.32**	**8.7386**
Road	62,261.52	1.4293
Sidewalk	15,237.54	0.3498
Roof	96,224.00	2.2090
Driveway	28,720.00	0.6593
Landscape	178,211.26	4.0912
Impervious Area	202,443.06	4.6475
Pervious Area	178,211.26	4.0912
Pollution Generating Impervious Area	90,981.52	2.0886
Total Site	380,654.32	8.7386

Extg Point of Compliance 1		
	sqft	acre
Total Basin	**380,654.32**	**8.7386**
Modeled Existing Basin Area as Forested	**380,654.32**	**8.7386**

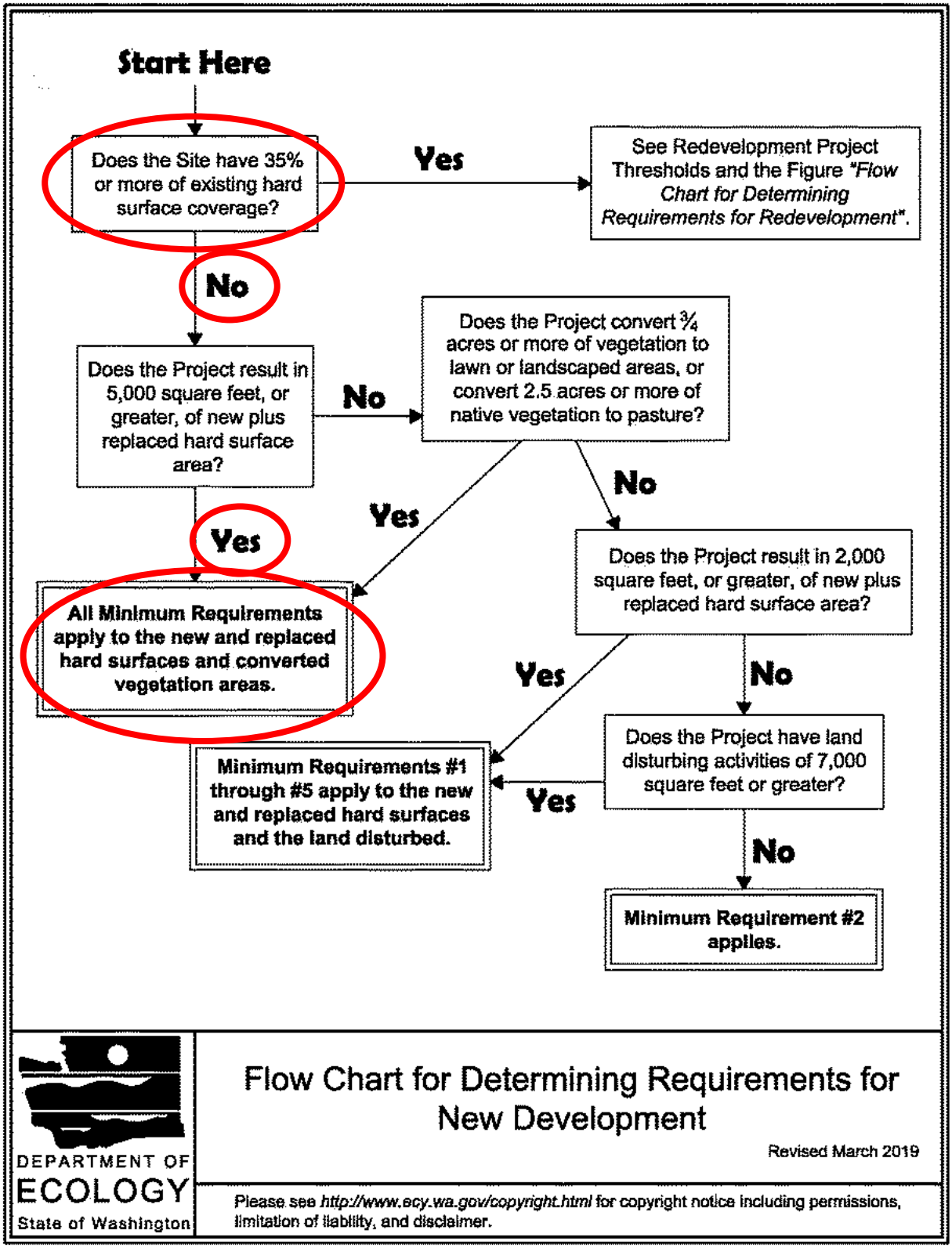
Basin Areas (sqft)						
Basin	**Road**	**SW**	**Roof**	**Driveway**	**Landscape**	**Total**
Basin 1 Site North	37,753.69	8,477.14	44,800.00	12,800.00	61,680.97	165,511.80
Basin 2 Site Mid	15,512.35	3,928.49	23,424.00	7,920.00	65,686.40	116,471.23
Basin 3 Site South	8,995.49	2,831.90	28,000.00	8,000.00	50,843.89	98,671.28
Total	62,261.52	15,237.54	96,224.00	28,720.00	178,211.26	380,654.32

Basin Areas (acre)						
	Road	**SW**	**Roof**	**Driveway**	**Landscape**	**Total**
Basin 1 Site North	0.8667	0.1946	1.0285	0.2938	1.4160	3.7996
Basin 2 Site Mid	0.3561	0.0902	0.5377	0.1818	1.5080	2.6738
Basin 3 Site South	0.2065	0.0650	0.6428	0.1837	1.1672	2.2652
	-	-	-	-	-	-
	-	-	-	-	-	-
	-	-	-	-	-	-
Total	1.4293	0.3498	2.2090	0.6593	4.0912	8.7386

WWHM Basin Treatment Flow Analysis (cfs)						
	WQ	**2-yr**	**10-yr**	**25-yr**	**50-yr**	**100-yr**
Total Site Treatment	0.6610	3.953092	6.020908	7.085902	7.892261	8.704543

SEPARATOR SHEET

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



Not Redevelopment. See New Development Flow Chart.

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

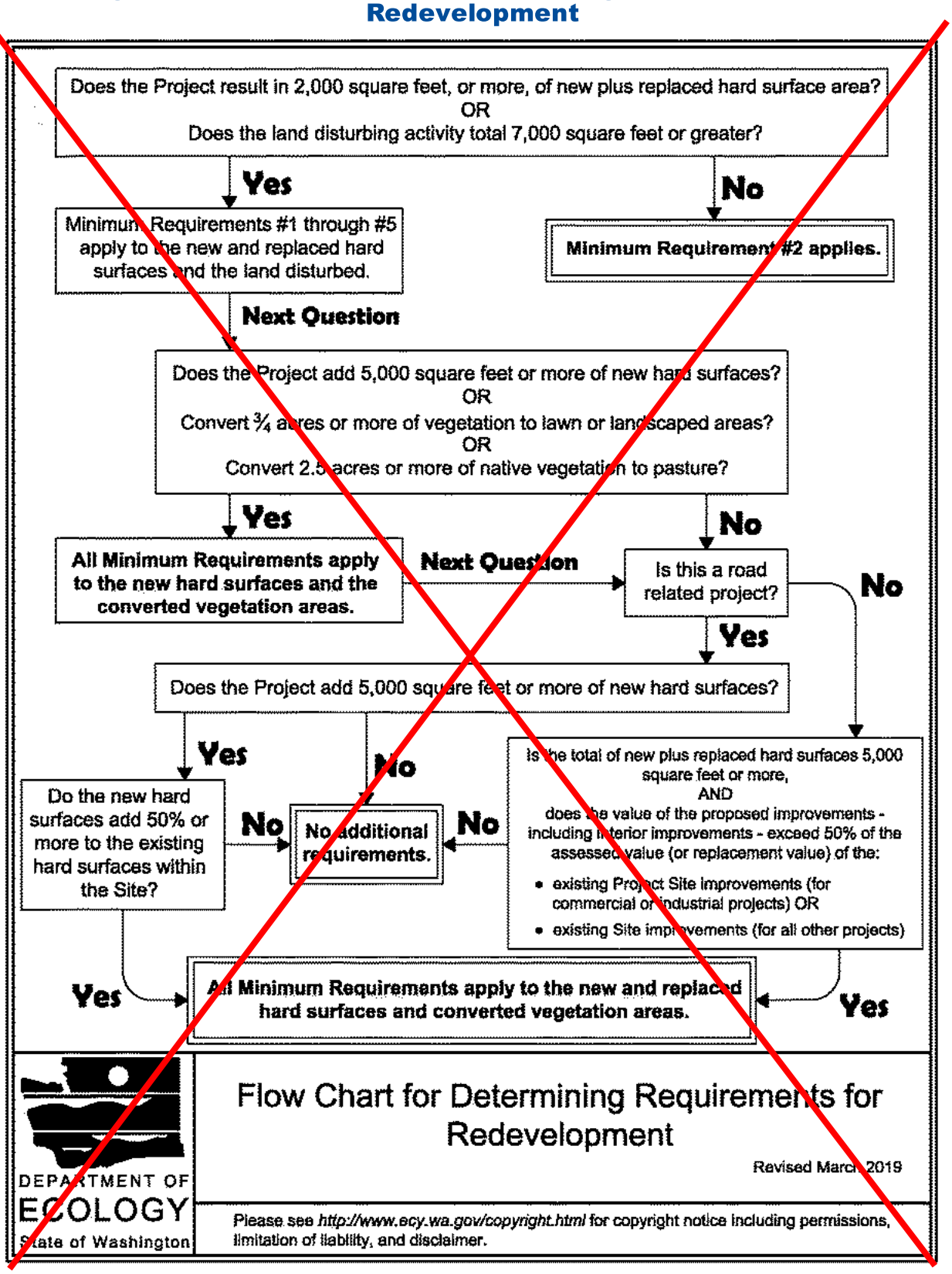
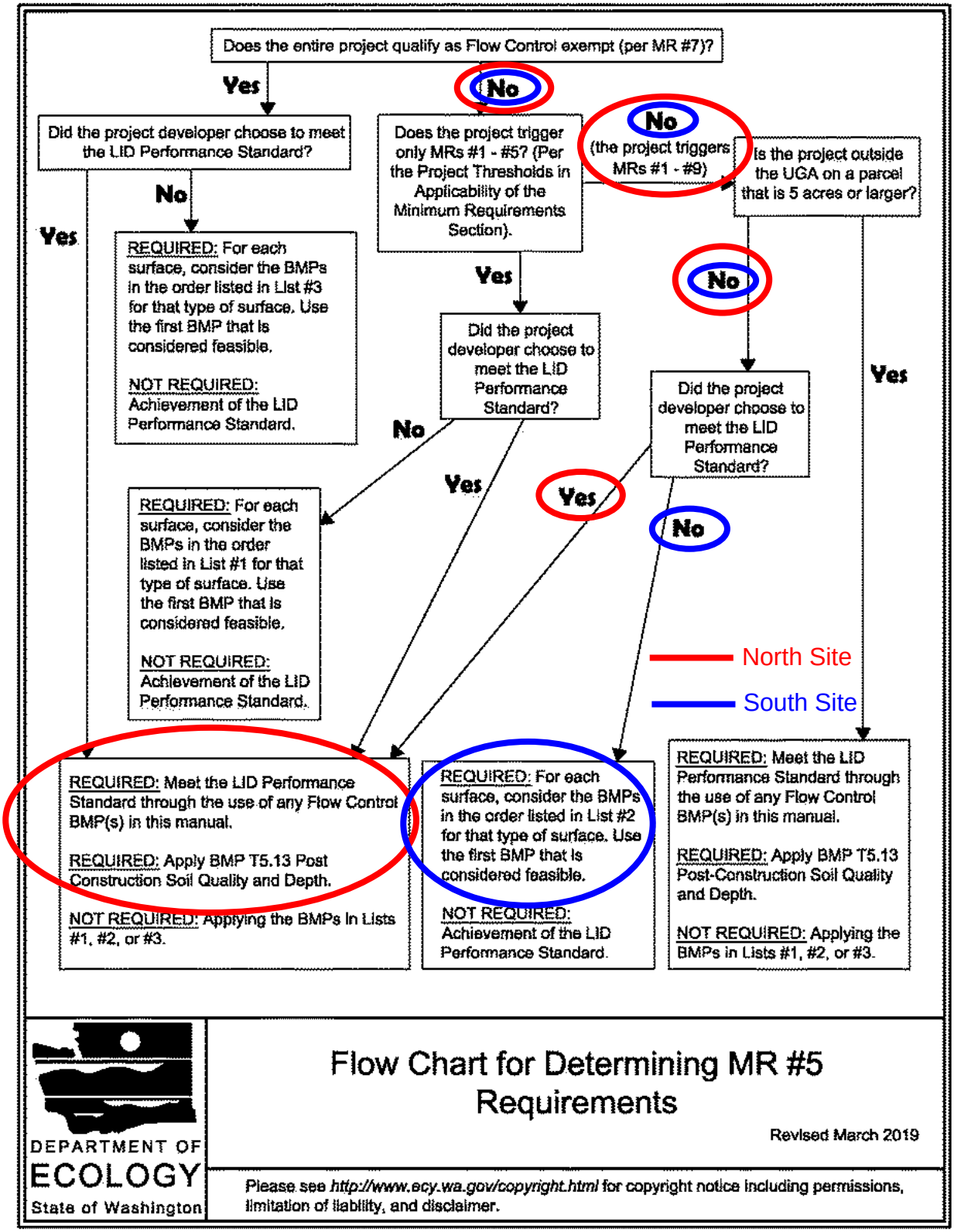


Figure I-3.3: Flow Chart for Determining MR #5 Requirements



NO WETLANDS ON SITE AND NOT DISCHARGING TO WETLANDS

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

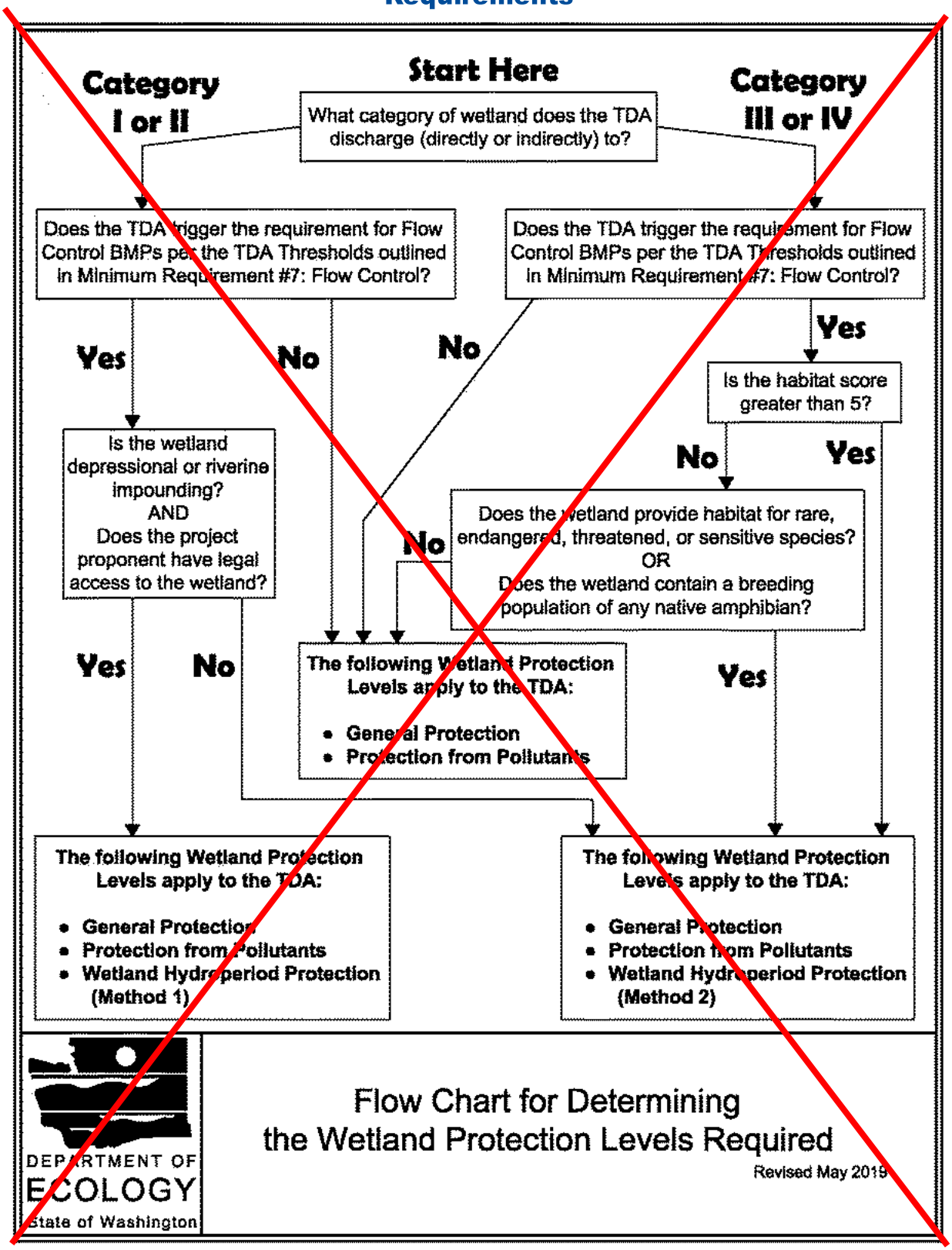
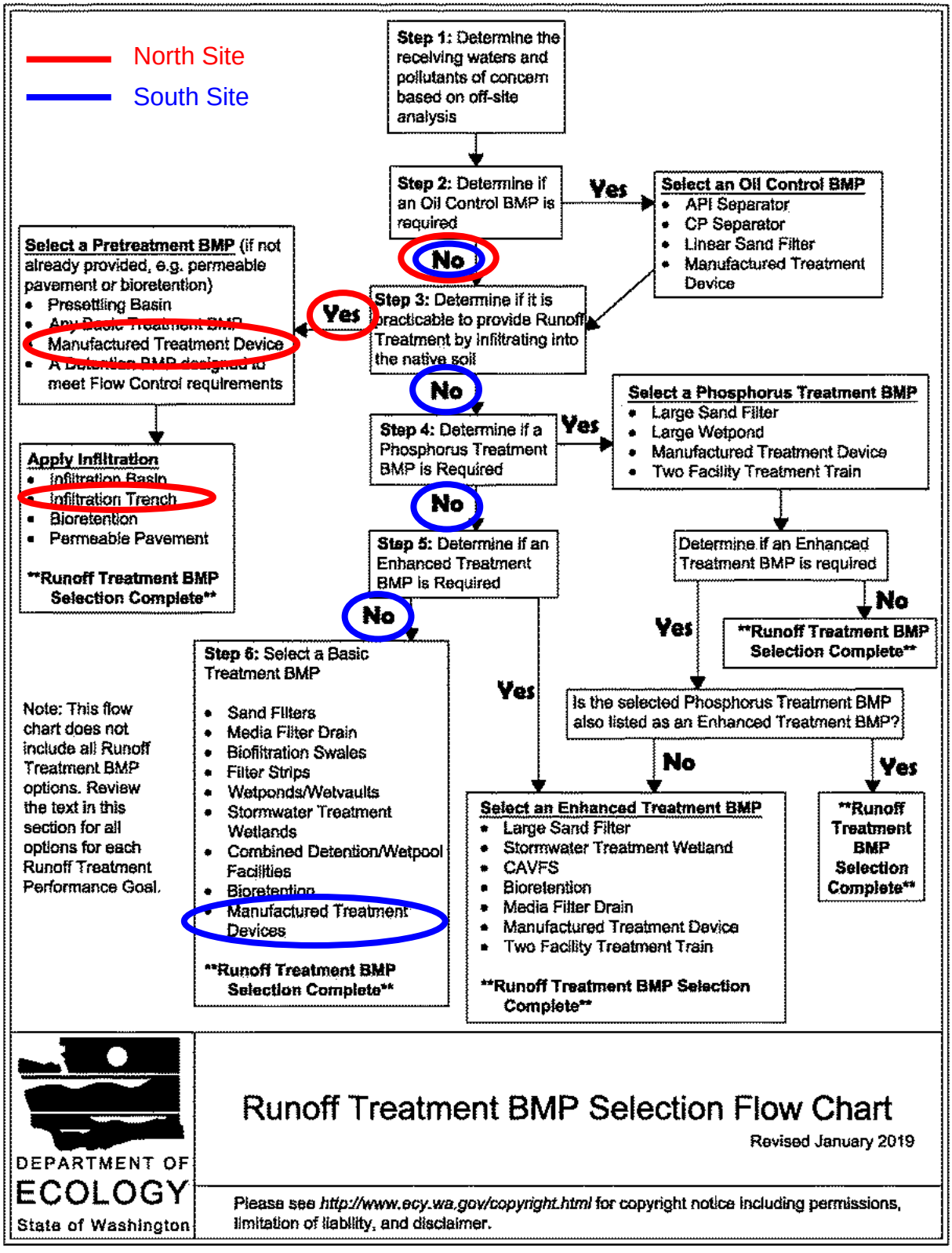


Figure III-1.1: Runoff Treatment BMP Selection Flow Chart



SEPARATOR SHEET

WWHM2012

PROJECT REPORT

This WWHM Model shows that the site meets the SWMMWW discharge requirements.

General Model Information

Project Name:	Prelim Storm Ananysis
Site Name:	Monte Verde
Site Address:	
City:	
Report Date:	7/28/2022
Gage:	Lacamas
Data Start:	1948/10/01
Data End:	2008/09/30
Timestep:	15 Minute
Precip Scale:	1.300
Version Date:	2018/10/10
Version:	4.2.16

POC Thresholds

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

Landuse Basin Data

Predeveloped Land Use

Extg

Bypass:	No
GroundWater:	No

Pervious Land Use	acre
SG4, Forest, Mod	8.7386
Pervious Total	8.7386

Impervious Land Use	acre
Impervious Total	0
Basin Total	8.7386

Element Flows To:

Surface	Interflow	Groundwater

Mitigated Land Use

Basin 1-North

Bypass:	No
GroundWater:	No

Pervious Land Use	acre
SG4, Lawn, Flat	0.708
SG4, Lawn, Mod	0.708
Pervious Total	1.416

Impervious Land Use	acre
ROADS FLAT	0.8667
ROOF TOPS FLAT	1.0285
DRIVEWAYS MOD	0.2938
SIDEWALKS FLAT	0.1946
Impervious Total	2.3836
Basin Total	3.7996

Element Flows To:

Surface	Interflow	Groundwater
Gravel Trench Bed 1	Gravel Trench Bed 1	

Basin 2-Mid

Bypass:	No
GroundWater:	No

Pervious Land Use	acre
SG4, Lawn, Flat	0.754
SG4, Lawn, Mod	0.754
Pervious Total	1.508

Impervious Land Use	acre
ROADS FLAT	0.3561
ROOF TOPS FLAT	0.5377
DRIVEWAYS MOD	0.1818
SIDEWALKS FLAT	0.0902
Impervious Total	1.1658
Basin Total	2.6738

Element Flows To:

Surface	Interflow	Groundwater
Gravel Trench Bed 2	Gravel Trench Bed 2	

Basin 3-South

Bypass:	No
GroundWater:	No

Pervious Land Use	acre
SG4, Lawn, Flat	0.5836
SG4, Lawn, Mod	0.5836
Pervious Total	1.1672

Impervious Land Use	acre
ROADS FLAT	0.2065
ROOF TOPS FLAT	0.6428
DRIVEWAYS MOD	0.1837
SIDEWALKS FLAT	0.065
Impervious Total	1.098
Basin Total	2.2652

Element Flows To:

Surface	Interflow	Groundwater
Trapezoidal Pond 1	Trapezoidal Pond 1	

Routing Elements

Predeveloped Routing

Mitigated Routing

Trapezoidal Pond 1

Bottom Length: 90.00 ft.
Bottom Width: 50.00 ft.
Depth: 4 ft.
Volume at riser head: 0.4079 acre-feet.
Side slope 1: 3 To 1
Side slope 2: 3 To 1
Side slope 3: 3 To 1
Side slope 4: 3 To 1
Discharge Structure
Riser Height: 3 ft.
Riser Diameter: 18 in.
Notch Type: Rectangular
Notch Width: 0.330 ft.
Notch Height: 0.500 ft.
Orifice 1 Diameter: 4 in. Elevation:0 ft.
Element Flows To:
Outlet 1 Outlet 2

Pond Hydraulic Table

Stage(feet)	Area(ac.)	Volume(ac-ft.)	Discharge(cfs)	Infilt(cfs)
0.0000	0.103	0.000	0.000	0.000
0.0444	0.104	0.004	0.091	0.000
0.0889	0.105	0.009	0.129	0.000
0.1333	0.105	0.013	0.158	0.000
0.1778	0.106	0.018	0.183	0.000
0.2222	0.107	0.023	0.204	0.000
0.2667	0.108	0.028	0.224	0.000
0.3111	0.109	0.033	0.242	0.000
0.3556	0.110	0.038	0.258	0.000
0.4000	0.111	0.042	0.274	0.000
0.4444	0.112	0.047	0.289	0.000
0.4889	0.112	0.052	0.303	0.000
0.5333	0.113	0.057	0.317	0.000
0.5778	0.114	0.063	0.330	0.000
0.6222	0.115	0.068	0.342	0.000
0.6667	0.116	0.073	0.354	0.000
0.7111	0.117	0.078	0.366	0.000
0.7556	0.118	0.083	0.377	0.000
0.8000	0.119	0.089	0.388	0.000
0.8444	0.120	0.094	0.399	0.000
0.8889	0.121	0.099	0.409	0.000
0.9333	0.122	0.105	0.419	0.000
0.9778	0.123	0.110	0.429	0.000
1.0222	0.123	0.116	0.439	0.000
1.0667	0.124	0.121	0.448	0.000
1.1111	0.125	0.127	0.457	0.000
1.1556	0.126	0.132	0.466	0.000
1.2000	0.127	0.138	0.475	0.000
1.2444	0.128	0.144	0.484	0.000
1.2889	0.129	0.149	0.492	0.000
1.3333	0.130	0.155	0.501	0.000
1.3778	0.131	0.161	0.509	0.000

1.4222	0.132	0.167	0.517	0.000
1.4667	0.133	0.173	0.525	0.000
1.5111	0.134	0.179	0.533	0.000
1.5556	0.135	0.185	0.541	0.000
1.6000	0.136	0.191	0.549	0.000
1.6444	0.137	0.197	0.556	0.000
1.6889	0.138	0.203	0.564	0.000
1.7333	0.139	0.209	0.571	0.000
1.7778	0.140	0.215	0.578	0.000
1.8222	0.141	0.221	0.586	0.000
1.8667	0.142	0.228	0.593	0.000
1.9111	0.143	0.234	0.600	0.000
1.9556	0.144	0.241	0.607	0.000
2.0000	0.145	0.247	0.614	0.000
2.0444	0.146	0.253	0.620	0.000
2.0889	0.147	0.260	0.627	0.000
2.1333	0.148	0.266	0.634	0.000
2.1778	0.149	0.273	0.640	0.000
2.2222	0.150	0.280	0.647	0.000
2.2667	0.151	0.286	0.653	0.000
2.3111	0.152	0.293	0.660	0.000
2.3556	0.153	0.300	0.666	0.000
2.4000	0.154	0.307	0.672	0.000
2.4444	0.155	0.314	0.678	0.000
2.4889	0.156	0.321	0.685	0.000
2.5333	0.157	0.328	0.697	0.000
2.5778	0.158	0.335	0.720	0.000
2.6222	0.159	0.342	0.750	0.000
2.6667	0.160	0.349	0.783	0.000
2.7111	0.161	0.356	0.821	0.000
2.7556	0.162	0.363	0.862	0.000
2.8000	0.163	0.370	0.907	0.000
2.8444	0.164	0.378	0.954	0.000
2.8889	0.165	0.385	1.004	0.000
2.9333	0.167	0.392	1.057	0.000
2.9778	0.168	0.400	1.112	0.000
3.0222	0.169	0.407	1.196	0.000
3.0667	0.170	0.415	1.422	0.000
3.1111	0.171	0.423	1.742	0.000
3.1556	0.172	0.430	2.129	0.000
3.2000	0.173	0.438	2.569	0.000
3.2444	0.174	0.446	3.047	0.000
3.2889	0.175	0.453	3.550	0.000
3.3333	0.176	0.461	4.063	0.000
3.3778	0.177	0.469	4.572	0.000
3.4222	0.179	0.477	5.063	0.000
3.4667	0.180	0.485	5.523	0.000
3.5111	0.181	0.493	5.939	0.000
3.5556	0.182	0.501	6.304	0.000
3.6000	0.183	0.509	6.613	0.000
3.6444	0.184	0.517	6.866	0.000
3.6889	0.185	0.526	7.071	0.000
3.7333	0.186	0.534	7.241	0.000
3.7778	0.188	0.542	7.482	0.000
3.8222	0.189	0.551	7.663	0.000
3.8667	0.190	0.559	7.839	0.000
3.9111	0.191	0.568	8.011	0.000
3.9556	0.192	0.576	8.179	0.000

4.0000	0.193	0.585	8.343	0.000
4.0444	0.194	0.593	8.504	0.000

Gravel Trench Bed 1

Bottom Length:	100.00 ft.
Bottom Width:	8.00 ft.
Trench bottom slope 1:	0 To 1
Trench Left side slope 0:	0 To 1
Trench right side slope 2:	0 To 1
Material thickness of first layer:	3
Pour Space of material for first layer:	0.33
Material thickness of second layer:	0
Pour Space of material for second layer:	0
Material thickness of third layer:	0
Pour Space of material for third layer:	0
Infiltration On	
Infiltration rate:	42.2
Infiltration safety factor:	0.5
Total Volume Infiltrated (ac-ft.):	559.48
Total Volume Through Riser (ac-ft.):	71.214
Total Volume Through Facility (ac-ft.):	630.694
Percent Infiltrated:	88.71
Total Precip Applied to Facility:	0
Total Evap From Facility:	0

Discharge Structure

Riser Height:	2.5 ft.	
Riser Diameter:	18 in.	
Orifice 1 Diameter:	2 in.	Elevation:0 ft.

Element Flows To:

Outlet 1 Outlet 2

Gravel Trench Bed 2

Gravel Trench Bed Hydraulic Table

Stage(feet)	Area(ac.)	Volume(ac-ft.)	Discharge(cfs)	Infilt(cfs)
0.0000	0.018	0.000	0.000	0.000
0.0333	0.018	0.000	0.019	0.390
0.0667	0.018	0.000	0.028	0.390
0.1000	0.018	0.000	0.034	0.390
0.1333	0.018	0.000	0.039	0.390
0.1667	0.018	0.001	0.044	0.390
0.2000	0.018	0.001	0.048	0.390
0.2333	0.018	0.001	0.052	0.390
0.2667	0.018	0.001	0.056	0.390
0.3000	0.018	0.001	0.059	0.390
0.3333	0.018	0.002	0.062	0.390
0.3667	0.018	0.002	0.065	0.390
0.4000	0.018	0.002	0.068	0.390
0.4333	0.018	0.002	0.071	0.390
0.4667	0.018	0.002	0.074	0.390
0.5000	0.018	0.003	0.076	0.390
0.5333	0.018	0.003	0.079	0.390
0.5667	0.018	0.003	0.081	0.390
0.6000	0.018	0.003	0.084	0.390
0.6333	0.018	0.003	0.086	0.390
0.6667	0.018	0.004	0.088	0.390
0.7000	0.018	0.004	0.090	0.390
0.7333	0.018	0.004	0.093	0.390
0.7667	0.018	0.004	0.095	0.390
0.8000	0.018	0.004	0.097	0.390

0.8333	0.018	0.005	0.099	0.390
0.8667	0.018	0.005	0.101	0.390
0.9000	0.018	0.005	0.103	0.390
0.9333	0.018	0.005	0.104	0.390
0.9667	0.018	0.005	0.106	0.390
1.0000	0.018	0.006	0.108	0.390
1.0333	0.018	0.006	0.110	0.390
1.0667	0.018	0.006	0.112	0.390
1.1000	0.018	0.006	0.113	0.390
1.1333	0.018	0.006	0.115	0.390
1.1667	0.018	0.007	0.117	0.390
1.2000	0.018	0.007	0.118	0.390
1.2333	0.018	0.007	0.120	0.390
1.2667	0.018	0.007	0.122	0.390
1.3000	0.018	0.007	0.123	0.390
1.3333	0.018	0.008	0.125	0.390
1.3667	0.018	0.008	0.126	0.390
1.4000	0.018	0.008	0.128	0.390
1.4333	0.018	0.008	0.130	0.390
1.4667	0.018	0.008	0.131	0.390
1.5000	0.018	0.009	0.132	0.390
1.5333	0.018	0.009	0.134	0.390
1.5667	0.018	0.009	0.135	0.390
1.6000	0.018	0.009	0.137	0.390
1.6333	0.018	0.009	0.138	0.390
1.6667	0.018	0.010	0.140	0.390
1.7000	0.018	0.010	0.141	0.390
1.7333	0.018	0.010	0.142	0.390
1.7667	0.018	0.010	0.144	0.390
1.8000	0.018	0.010	0.145	0.390
1.8333	0.018	0.011	0.147	0.390
1.8667	0.018	0.011	0.148	0.390
1.9000	0.018	0.011	0.149	0.390
1.9333	0.018	0.011	0.150	0.390
1.9667	0.018	0.011	0.152	0.390
2.0000	0.018	0.012	0.153	0.390
2.0333	0.018	0.012	0.154	0.390
2.0667	0.018	0.012	0.156	0.390
2.1000	0.018	0.012	0.157	0.390
2.1333	0.018	0.012	0.158	0.390
2.1667	0.018	0.013	0.159	0.390
2.2000	0.018	0.013	0.161	0.390
2.2333	0.018	0.013	0.162	0.390
2.2667	0.018	0.013	0.163	0.390
2.3000	0.018	0.013	0.164	0.390
2.3333	0.018	0.014	0.165	0.390
2.3667	0.018	0.014	0.167	0.390
2.4000	0.018	0.014	0.168	0.390
2.4333	0.018	0.014	0.169	0.390
2.4667	0.018	0.014	0.170	0.390
2.5000	0.018	0.015	0.171	0.390
2.5333	0.018	0.015	0.269	0.390
2.5667	0.018	0.015	0.447	0.390
2.6000	0.018	0.015	0.677	0.390
2.6333	0.018	0.016	0.947	0.390
2.6667	0.018	0.016	1.251	0.390
2.7000	0.018	0.016	1.582	0.390
2.7333	0.018	0.016	1.935	0.390

2.7667	0.018	0.016	2.304	0.390
2.8000	0.018	0.017	2.682	0.390
2.8333	0.018	0.017	3.065	0.390
2.8667	0.018	0.017	3.445	0.390
2.9000	0.018	0.017	3.817	0.390
2.9333	0.018	0.017	4.174	0.390
2.9667	0.018	0.018	4.513	0.390
3.0000	0.018	0.018	4.827	0.390

Gravel Trench Bed 2

Bottom Length:	100.00 ft.
Bottom Width:	8.00 ft.
Trench bottom slope 1:	0 To 1
Trench Left side slope 0:	0 To 1
Trench right side slope 2:	0 To 1
Material thickness of first layer:	3
Pour Space of material for first layer:	0.33
Material thickness of second layer:	0
Pour Space of material for second layer:	0
Material thickness of third layer:	0
Pour Space of material for third layer:	0
Infiltration On	
Infiltration rate:	42.2
Infiltration safety factor:	0.5
Total Volume Infiltrated (ac-ft.):	407.34
Total Volume Through Riser (ac-ft.):	63.856
Total Volume Through Facility (ac-ft.):	471.197
Percent Infiltrated:	86.45
Total Precip Applied to Facility:	0
Total Evap From Facility:	0

Discharge Structure

Riser Height:	2.5 ft.	
Riser Diameter:	18 in.	
Orifice 1 Diameter:	2 in.	Elevation:0 ft.

Element Flows To:

Outlet 1	Outlet 2
Trapezoidal Pond 1	

Gravel Trench Bed Hydraulic Table

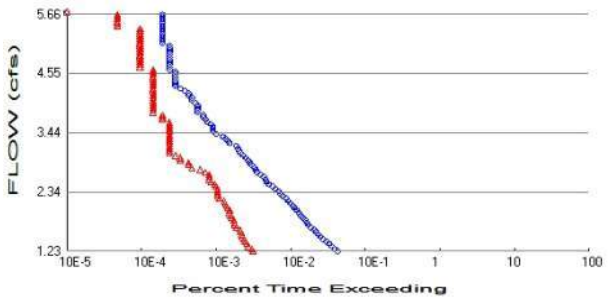
Stage(feet)	Area(ac.)	Volume(ac-ft.)	Discharge(cfs)	Infilt(cfs)
0.0000	0.018	0.000	0.000	0.000
0.0333	0.018	0.000	0.019	0.390
0.0667	0.018	0.000	0.028	0.390
0.1000	0.018	0.000	0.034	0.390
0.1333	0.018	0.000	0.039	0.390
0.1667	0.018	0.001	0.044	0.390
0.2000	0.018	0.001	0.048	0.390
0.2333	0.018	0.001	0.052	0.390
0.2667	0.018	0.001	0.056	0.390
0.3000	0.018	0.001	0.059	0.390
0.3333	0.018	0.002	0.062	0.390
0.3667	0.018	0.002	0.065	0.390
0.4000	0.018	0.002	0.068	0.390
0.4333	0.018	0.002	0.071	0.390
0.4667	0.018	0.002	0.074	0.390
0.5000	0.018	0.003	0.076	0.390
0.5333	0.018	0.003	0.079	0.390
0.5667	0.018	0.003	0.081	0.390
0.6000	0.018	0.003	0.084	0.390
0.6333	0.018	0.003	0.086	0.390
0.6667	0.018	0.004	0.088	0.390
0.7000	0.018	0.004	0.090	0.390
0.7333	0.018	0.004	0.093	0.390
0.7667	0.018	0.004	0.095	0.390
0.8000	0.018	0.004	0.097	0.390

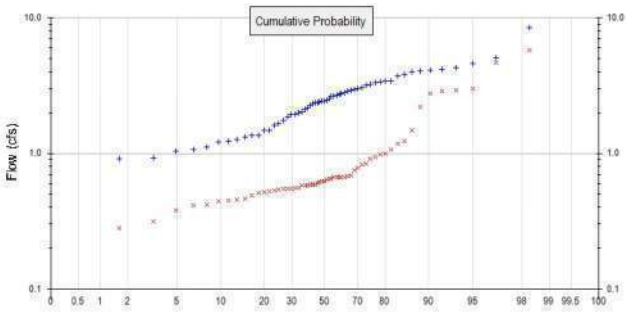
0.8333	0.018	0.005	0.099	0.390
0.8667	0.018	0.005	0.101	0.390
0.9000	0.018	0.005	0.103	0.390
0.9333	0.018	0.005	0.104	0.390
0.9667	0.018	0.005	0.106	0.390
1.0000	0.018	0.006	0.108	0.390
1.0333	0.018	0.006	0.110	0.390
1.0667	0.018	0.006	0.112	0.390
1.1000	0.018	0.006	0.113	0.390
1.1333	0.018	0.006	0.115	0.390
1.1667	0.018	0.007	0.117	0.390
1.2000	0.018	0.007	0.118	0.390
1.2333	0.018	0.007	0.120	0.390
1.2667	0.018	0.007	0.122	0.390
1.3000	0.018	0.007	0.123	0.390
1.3333	0.018	0.008	0.125	0.390
1.3667	0.018	0.008	0.126	0.390
1.4000	0.018	0.008	0.128	0.390
1.4333	0.018	0.008	0.130	0.390
1.4667	0.018	0.008	0.131	0.390
1.5000	0.018	0.009	0.132	0.390
1.5333	0.018	0.009	0.134	0.390
1.5667	0.018	0.009	0.135	0.390
1.6000	0.018	0.009	0.137	0.390
1.6333	0.018	0.009	0.138	0.390
1.6667	0.018	0.010	0.140	0.390
1.7000	0.018	0.010	0.141	0.390
1.7333	0.018	0.010	0.142	0.390
1.7667	0.018	0.010	0.144	0.390
1.8000	0.018	0.010	0.145	0.390
1.8333	0.018	0.011	0.147	0.390
1.8667	0.018	0.011	0.148	0.390
1.9000	0.018	0.011	0.149	0.390
1.9333	0.018	0.011	0.150	0.390
1.9667	0.018	0.011	0.152	0.390
2.0000	0.018	0.012	0.153	0.390
2.0333	0.018	0.012	0.154	0.390
2.0667	0.018	0.012	0.156	0.390
2.1000	0.018	0.012	0.157	0.390
2.1333	0.018	0.012	0.158	0.390
2.1667	0.018	0.013	0.159	0.390
2.2000	0.018	0.013	0.161	0.390
2.2333	0.018	0.013	0.162	0.390
2.2667	0.018	0.013	0.163	0.390
2.3000	0.018	0.013	0.164	0.390
2.3333	0.018	0.014	0.165	0.390
2.3667	0.018	0.014	0.167	0.390
2.4000	0.018	0.014	0.168	0.390
2.4333	0.018	0.014	0.169	0.390
2.4667	0.018	0.014	0.170	0.390
2.5000	0.018	0.015	0.171	0.390
2.5333	0.018	0.015	0.269	0.390
2.5667	0.018	0.015	0.447	0.390
2.6000	0.018	0.015	0.677	0.390
2.6333	0.018	0.016	0.947	0.390
2.6667	0.018	0.016	1.251	0.390
2.7000	0.018	0.016	1.582	0.390
2.7333	0.018	0.016	1.935	0.390

2.7667	0.018	0.016	2.304	0.390
2.8000	0.018	0.017	2.682	0.390
2.8333	0.018	0.017	3.065	0.390
2.8667	0.018	0.017	3.445	0.390
2.9000	0.018	0.017	3.817	0.390
2.9333	0.018	0.017	4.174	0.390
2.9667	0.018	0.018	4.513	0.390
3.0000	0.018	0.018	4.827	0.390

Analysis Results

POC 1





\+ Predeveloped x Mitigated

Predeveloped Landuse Totals for POC #1
Total Pervious Area: 8.7386
Total Impervious Area: 0

Mitigated Landuse Totals for POC #1
Total Pervious Area: 4.0912
Total Impervious Area: 4.6474

Flow Frequency Method: Log Pearson Type III 17B

Flow Frequency Return Periods for Predeveloped. POC #1

Return Period	**Flow(cfs)**
2 year	2.458123
5 year	3.785611
10 year	4.502037
25 year	5.228488
50 year	5.659129
100 year	6.012664

Flow Frequency Return Periods for Mitigated. POC #1

Return Period	**Flow(cfs)**
2 year	0.689244
5 year	1.232363
10 year	1.74583
25 year	2.62148
50 year	3.476668
100 year	4.542692

Annual Peaks

Annual Peaks for Predeveloped and Mitigated. POC #1

Year	**Predeveloped**	**Mitigated**
1949	1.848	0.581
1950	2.383	0.610
1951	3.230	0.519
1952	1.940	0.782
1953	2.642	0.531
1954	4.043	0.577
1955	2.031	0.463
1956	3.726	2.986
1957	3.294	0.644
1958	2.445	2.196

1959	1.479	0.379
1960	1.358	0.546
1961	3.399	0.670
1962	2.377	0.624
1963	2.660	0.591
1964	2.468	0.554
1965	2.116	0.649
1966	2.960	0.651
1967	2.675	0.552
1968	3.201	0.825
1969	3.064	2.758
1970	8.476	5.763
1971	1.353	0.449
1972	2.161	0.549
1973	2.248	0.674
1974	3.403	2.887
1975	1.935	0.545
1976	2.922	0.667
1977	0.087	0.250
1978	4.256	1.228
1979	2.776	1.474
1980	1.607	0.490
1981	3.811	1.069
1982	2.521	0.935
1983	4.610	0.835
1984	1.488	0.454
1985	1.072	0.580
1986	1.328	0.587
1987	2.344	0.589
1988	1.120	0.443
1989	1.211	0.527
1990	1.031	0.417
1991	2.722	0.604
1992	2.815	0.539
1993	3.342	1.176
1994	2.412	0.672
1995	1.992	0.908
1996	4.190	4.632
1997	5.107	2.923
1998	4.127	0.669
1999	2.878	0.689
2000	1.647	0.313
2001	0.909	0.282
2002	3.970	0.663
2003	3.023	0.744
2004	0.923	0.412
2005	1.229	0.513
2006	2.330	0.620
2007	1.269	0.997
2008	1.754	0.974

Ranked Annual Peaks

Ranked Annual Peaks for Predeveloped and Mitigated. POC #1

Rank	Predeveloped	Mitigated
1	8.4759	5.7629
2	5.1066	4.6324
3	4.6099	2.9856
4	4.2556	2.9225

5	4.1898	2.8871
6	4.1265	2.7581
7	4.0428	2.1961
8	3.9703	1.4744
9	3.8114	1.2284
10	3.7262	1.1756
11	3.4034	1.0693
12	3.3989	0.9972
13	3.3419	0.9743
14	3.2944	0.9346
15	3.2304	0.9082
16	3.2006	0.8347
17	3.0637	0.8246
18	3.0231	0.7824
19	2.9603	0.7436
20	2.9221	0.6894
21	2.8780	0.6743
22	2.8153	0.6718
23	2.7758	0.6697
24	2.7219	0.6691
25	2.6751	0.6672
26	2.6597	0.6635
27	2.6425	0.6506
28	2.5211	0.6488
29	2.4679	0.6438
30	2.4450	0.6241
31	2.4121	0.6200
32	2.3834	0.6105
33	2.3766	0.6044
34	2.3441	0.5913
35	2.3296	0.5889
36	2.2481	0.5867
37	2.1612	0.5808
38	2.1162	0.5801
39	2.0305	0.5766
40	1.9916	0.5542
41	1.9397	0.5517
42	1.9355	0.5492
43	1.8480	0.5463
44	1.7540	0.5447
45	1.6466	0.5391
46	1.6075	0.5306
47	1.4877	0.5272
48	1.4786	0.5193
49	1.3582	0.5129
50	1.3529	0.4902
51	1.3278	0.4626
52	1.2693	0.4545
53	1.2291	0.4494
54	1.2106	0.4435
55	1.1196	0.4167
56	1.0719	0.4122
57	1.0308	0.3790
58	0.9234	0.3133
59	0.9087	0.2817
60	0.0872	0.2499

Duration Flows

The Facility PASSED

Flow(cfs)	Predev	Mit	Percentage	Pass/Fail
1.2291	894	66	7	Pass
1.2738	823	63	7	Pass
1.3186	756	57	7	Pass
1.3633	687	54	7	Pass
1.4081	626	51	8	Pass
1.4528	576	50	8	Pass
1.4976	536	48	8	Pass
1.5423	492	46	9	Pass
1.5870	455	45	9	Pass
1.6318	431	44	10	Pass
1.6765	392	39	9	Pass
1.7213	364	38	10	Pass
1.7660	346	37	10	Pass
1.8108	324	36	11	Pass
1.8555	305	34	11	Pass
1.9003	287	33	11	Pass
1.9450	271	32	11	Pass
1.9898	253	32	12	Pass
2.0345	237	30	12	Pass
2.0793	226	29	12	Pass
2.1240	211	28	13	Pass
2.1688	193	27	13	Pass
2.2135	182	23	12	Pass
2.2583	165	22	13	Pass
2.3030	152	22	14	Pass
2.3478	145	22	15	Pass
2.3925	131	22	16	Pass
2.4373	120	21	17	Pass
2.4820	107	20	18	Pass
2.5268	100	18	18	Pass
2.5715	96	17	17	Pass
2.6163	91	17	18	Pass
2.6610	83	17	20	Pass
2.7058	75	15	20	Pass
2.7505	71	13	18	Pass
2.7952	69	10	14	Pass
2.8400	62	9	14	Pass
2.8847	59	9	15	Pass
2.9295	56	7	12	Pass
2.9742	52	7	13	Pass
3.0190	49	6	12	Pass
3.0637	44	5	11	Pass
3.1085	43	5	11	Pass
3.1532	41	5	12	Pass
3.1980	39	5	12	Pass
3.2427	32	5	15	Pass
3.2875	30	5	16	Pass
3.3322	28	5	17	Pass
3.3770	26	5	19	Pass
3.4217	21	5	23	Pass
3.4665	19	5	26	Pass
3.5112	19	5	26	Pass
3.5560	19	5	26	Pass

3.6007	18	5	27	Pass
3.6455	16	5	31	Pass
3.6902	15	4	26	Pass
3.7350	14	4	28	Pass
3.7797	14	4	28	Pass
3.8245	12	3	25	Pass
3.8692	12	3	25	Pass
3.9140	12	3	25	Pass
3.9587	12	3	25	Pass
4.0034	11	3	27	Pass
4.0482	10	3	30	Pass
4.0929	10	3	30	Pass
4.1377	9	3	33	Pass
4.1824	9	3	33	Pass
4.2272	8	3	37	Pass
4.2719	7	3	42	Pass
4.3167	6	3	50	Pass
4.3614	6	3	50	Pass
4.4062	6	3	50	Pass
4.4509	6	3	50	Pass
4.4957	6	3	50	Pass
4.5404	6	3	50	Pass
4.5852	6	3	50	Pass
4.6299	5	3	60	Pass
4.6747	5	2	40	Pass
4.7194	5	2	40	Pass
4.7642	5	2	40	Pass
4.8089	5	2	40	Pass
4.8537	5	2	40	Pass
4.8984	5	2	40	Pass
4.9432	5	2	40	Pass
4.9879	5	2	40	Pass
5.0327	5	2	40	Pass
5.0774	5	2	40	Pass
5.1222	4	2	50	Pass
5.1669	4	2	50	Pass
5.2116	4	2	50	Pass
5.2564	4	2	50	Pass
5.3011	4	2	50	Pass
5.3459	4	2	50	Pass
5.3906	4	2	50	Pass
5.4354	4	1	25	Pass
5.4801	4	1	25	Pass
5.5249	4	1	25	Pass
5.5696	4	1	25	Pass
5.6144	4	1	25	Pass
5.6591	4	1	25	Pass

Water Quality

Water Quality BMP Flow and Volume for POC #1

On-line facility volume:	0.9279 acre-feet
On-line facility target flow:	1.223 cfs.
Adjusted for 15 min:	1.223 cfs.
Off-line facility target flow:	0.661 cfs.
Adjusted for 15 min:	0.661 cfs.

LID Report

LID Technique	Used for Treatment ?	Total Volume Needs Treatment (ac-ft)	Volume Through Facility (ac-ft)	Infiltration Volume (ac-ft)	Cumulative Volume Infiltration Credit	Percent Volume Infiltrated	Water Quality	Percent Water Quality Treated	Comment
Trapezoidal Pond 1 POC	☐	394.02			☐	0.00			
Gravel Trench Bed 2	☐	428.79			☐	86.45			
Gravel Trench Bed 1	☐	573.93			☐	88.71			
Total Volume Infiltrated		1396.74	0.00	0.00		62.99	0.00	0%	No Treat. Credit
Compliance with LID Standard 8% of 2-yr to 50% of 2-yr									Duration Analysis Result = Passed

Model Default Modifications

Total of 0 changes have been made.

PERLND Changes

No PERLND changes have been made.

IMPLND Changes

No IMPLND changes have been made.

Appendix

Predeveloped Schematic

Mitigated Schematic

Predeveloped UCI File

```
RUN

GLOBAL
  WWHM4 model simulation
  START       1948 10 01        END    2008 09 30
  RUN INTERP OUTPUT LEVEL    3    0
  RESUME     0 RUN     1                   UNIT SYSTEM     1
END GLOBAL

FILES
<File>  <Un#>   <-----------File Name------------------------------>***
<-ID->                                                              ***
WDM         26   Prelim Storm Ananysis.wdm
MESSU       25   PrePrelim Storm Ananysis.MES
            27   PrePrelim Storm Ananysis.L61
            28   PrePrelim Storm Ananysis.L62
            30   POCPrelim Storm Ananysis1.dat
END FILES

OPN SEQUENCE
    INGRP              INDELT 00:15
      PERLND      29
      COPY       501
      DISPLY       1
    END INGRP
END OPN SEQUENCE
DISPLY
  DISPLY-INFO1
    # -  #<----------Title---------->***TRAN PIVL DIG1 FIL1  PYR DIG2 FIL2 YRND
    1        Extg                       MAX                   1    2   30    9
  END DISPLY-INFO1
END DISPLY
COPY
  TIMESERIES
    # -  #  NPT  NMN ***
    1         1    1
  501         1    1
  END TIMESERIES
END COPY
GENER
  OPCODE
    #    # OPCD ***
  END OPCODE
  PARM
    #    #         K ***
  END PARM
END GENER
PERLND
  GEN-INFO
    <PLS ><-------Name------->NBLKS   Unit-systems   Printer ***
    # -  #                         User  t-series Engl Metr ***
                                      in  out           ***
   29     SG4, Forest, Mod        1    1    1    1   27    0
  END GEN-INFO
  *** Section PWATER***

  ACTIVITY
    <PLS > ************ Active Sections ****************************
    # -  # ATMP SNOW PWAT  SED  PST  PWG PQAL MSTL PEST NITR PHOS TRAC ***
   29         0    0    1    0    0    0    0    0    0    0    0    0
  END ACTIVITY

  PRINT-INFO
    <PLS > ***************** Print-flags **************************** PIVL  PYR
    # -  # ATMP SNOW PWAT  SED  PST  PWG PQAL MSTL PEST NITR PHOS TRAC  *********
   29         0    0    4    0    0    0    0    0    0    0    0    0    1    9
  END PRINT-INFO
```

```
  PWAT-PARM1
    <PLS >  PWATER variable monthly parameter value flags  ***
    # -  # CSNO RTOP UZFG  VCS  VUZ  VNN VIFW VIRC  VLE INFC  HWT ***
   29         0    0    0    0    0    0    0    0    0    0
  END PWAT-PARM1

  PWAT-PARM2
    <PLS >      PWATER input info: Part 2         ***
    # -  # ***FOREST      LZSN    INFILT      LSUR     SLSUR     KVARY     AGWRC
   29             0         6      0.04       400       0.1         0      0.96
  END PWAT-PARM2

  PWAT-PARM3
    <PLS >      PWATER input info: Part 3         ***
    # -  # ***PETMAX    PETMIN    INFEXP    INFILD    DEEPFR    BASETP    AGWETP
   29             0         0         3         2         0         0         0
  END PWAT-PARM3
  PWAT-PARM4
    <PLS >     PWATER input info: Part 4                              ***
    # -  #     CEPSC      UZSN      NSUR     INTFW       IRC     LZETP ***
   29           0.2       0.4      0.35         2       0.4       0.7
  END PWAT-PARM4

  PWAT-STATE1
    <PLS > *** Initial conditions at start of simulation
               ran from 1990 to end of 1992 (pat 1-11-95) RUN 21 ***
    # -  # ***  CEPS      SURS       UZS      IFWS       LZS      AGWS      GWVS
   29             0         0         0         0       2.5         1         0
  END PWAT-STATE1

END PERLND

IMPLND
  GEN-INFO
    <PLS ><-------Name------->   Unit-systems   Printer ***
    # -  #                     User  t-series Engl Metr ***
                                     in  out           ***
  END GEN-INFO
  *** Section IWATER***

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

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

  IWAT-PARM1
    <PLS >  IWATER variable monthly parameter value flags  ***
    # -  # CSNO RTOP  VRS  VNN RTLI     ***
  END IWAT-PARM1

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

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

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

```
END IMPLND

SCHEMATIC
<-Source->                  <--Area-->     <-Target->   MBLK   ***
<Name>   #                  <-factor->     <Name>   #   Tbl#   ***
Extg***
PERLND  29                      8.7386     COPY   501     12
PERLND  29                      8.7386     COPY   501     13

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

NETWORK
<-Volume-> <-Grp> <-Member-><--Mult-->Tran <-Target vols> <-Grp> <-Member->  ***
<Name>   #        <Name> # #<-factor->strg <Name>   #   #        <Name> # #  ***
COPY   501 OUTPUT MEAN   1 1   48.4        DISPLY   1     INPUT  TIMSER 1



<-Volume-> <-Grp> <-Member-><--Mult-->Tran <-Target vols> <-Grp> <-Member->  ***
<Name>   #        <Name> # #<-factor->strg <Name>   #   #        <Name> # #  ***
END NETWORK

RCHRES
  GEN-INFO
    RCHRES       Name        Nexits   Unit Systems   Printer                ***
    # -  #<------------------><---> User T-series  Engl Metr LKFG           ***
                                       in  out                              ***
  END GEN-INFO
  *** Section RCHRES***

  ACTIVITY
    <PLS > ************ Active Sections ****************************
    # -  # HYFG ADFG CNFG HTFG SDFG GQFG OXFG NUFG PKFG PHFG ***
  END ACTIVITY

  PRINT-INFO
    <PLS > ***************** Print-flags ******************* PIVL  PYR
    # -  # HYDR ADCA CONS HEAT  SED  GQL OXRX NUTR PLNK PHCB PIVL  PYR  *********
  END PRINT-INFO

  HYDR-PARM1
    RCHRES  Flags for each HYDR Section                                  ***
    # -  #  VC A1 A2 A3  ODFVFG for each *** ODGTFG for each     FUNCT  for each
            FG FG FG FG  possible  exit  *** possible  exit      possible  exit
             *  *  *  *    *  *  *  *  *      *  *  *  *  *        ***
  END HYDR-PARM1

  HYDR-PARM2
    # -  #    FTABNO       LEN     DELTH     STCOR        KS      DB50       ***
  <------><--------><--------><--------><--------><--------><-------->       ***
  END HYDR-PARM2
  HYDR-INIT
    RCHRES  Initial conditions for each HYDR section                     ***
    # -  # ***   VOL     Initial  value  of COLIND     Initial  value  of OUTDGT
          *** ac-ft     for each possible exit        for each possible exit
  <------><-------->     <---><---><---><---><---> *** <---><---><---><---><--->
  END HYDR-INIT
END RCHRES

SPEC-ACTIONS
END SPEC-ACTIONS
FTABLES
END FTABLES

EXT SOURCES
<-Volume-> <Member> SsysSgap<--Mult-->Tran <-Target vols> <-Grp> <-Member->  ***
<Name>   # <Name> # tem strg<-factor->strg <Name>   #   #        <Name> # #  ***
WDM      2 PREC     ENGL    1.3            PERLND   1 999 EXTNL  PREC
WDM      2 PREC     ENGL    1.3            IMPLND   1 999 EXTNL  PREC
```

```
WDM      1 EVAP     ENGL    0.8             PERLND   1 999 EXTNL  PETINP
WDM      1 EVAP     ENGL    0.8             IMPLND   1 999 EXTNL  PETINP

END EXT SOURCES

EXT TARGETS
<-Volume-> <-Grp> <-Member-><--Mult-->Tran <-Volume-> <Member> Tsys Tgap Amd ***
<Name>   #        <Name> # #<-factor->strg <Name>   # <Name>    tem strg strg***
COPY   501 OUTPUT MEAN   1 1     48.4      WDM    501 FLOW     ENGL      REPL
END EXT TARGETS

MASS-LINK
<Volume>   <-Grp> <-Member-><--Mult-->     <Target>       <-Grp> <-Member->***
<Name>            <Name> # #<-factor->     <Name>                <Name> # #***
  MASS-LINK       12
PERLND     PWATER SURO       0.083333      COPY           INPUT  MEAN
  END MASS-LINK   12

  MASS-LINK       13
PERLND     PWATER IFWO       0.083333      COPY           INPUT  MEAN
  END MASS-LINK   13


END MASS-LINK

END RUN
```

Mitigated UCI File

```
RUN

GLOBAL
  WWHM4 model simulation
  START       1948 10 01        END    2008 09 30
  RUN INTERP OUTPUT LEVEL    3    0
  RESUME     0 RUN     1                    UNIT SYSTEM     1
END GLOBAL

FILES
<File>  <Un#>   <-----------File Name------------------------------>***
<-ID->                                                              ***
WDM         26   Prelim Storm Ananysis.wdm
MESSU       25   MitPrelim Storm Ananysis.MES
            27   MitPrelim Storm Ananysis.L61
            28   MitPrelim Storm Ananysis.L62
            30   POCPrelim Storm Ananysis1.dat
END FILES

OPN SEQUENCE
    INGRP               INDELT 00:15
      PERLND      34
      PERLND      35
      IMPLND       1
      IMPLND       4
      IMPLND       6
      IMPLND       8
      RCHRES       1
      RCHRES       2
      RCHRES       3
      COPY         1
      COPY       501
      DISPLY       1
    END INGRP
END OPN SEQUENCE
DISPLY
  DISPLY-INFO1
    # -  #<----------Title----------->***TRAN PIVL DIG1 FIL1  PYR DIG2 FIL2 YRND
    1        Trapezoidal Pond  1         MAX                    1    2   30    9
  END DISPLY-INFO1
END DISPLY
COPY
  TIMESERIES
    # -  #  NPT  NMN ***
    1         1    1
  501         1    1
  END TIMESERIES
END COPY
GENER
  OPCODE
    #    # OPCD ***
  END OPCODE
  PARM
    #    #         K ***
  END PARM
END GENER
PERLND
  GEN-INFO
    <PLS ><-------Name------->NBLKS   Unit-systems   Printer ***
    # -  #                          User  t-series Engl Metr ***
                                          in  out           ***
   34     SG4, Lawn, Flat         1    1    1    1   27    0
   35     SG4, Lawn, Mod          1    1    1    1   27    0
  END GEN-INFO
  *** Section PWATER***

  ACTIVITY
    <PLS > ************* Active Sections ****************************
```

```
    # -  # ATMP SNOW PWAT  SED  PST  PWG PQAL MSTL PEST NITR PHOS TRAC ***
   34         0    0    1    0    0    0    0    0    0    0    0    0
   35         0    0    1    0    0    0    0    0    0    0    0    0
  END ACTIVITY

  PRINT-INFO
    <PLS > ***************** Print-flags **************************** PIVL  PYR
    # -  # ATMP SNOW PWAT  SED  PST  PWG PQAL MSTL PEST NITR PHOS TRAC  *********
   34         0    0    4    0    0    0    0    0    0    0    0    0    1    9
   35         0    0    4    0    0    0    0    0    0    0    0    0    1    9
  END PRINT-INFO

  PWAT-PARM1
    <PLS >  PWATER variable monthly parameter value flags  ***
    # -  # CSNO RTOP UZFG  VCS  VUZ  VNN VIFW VIRC  VLE INFC  HWT ***
   34         0    0    0    0    0    0    0    0    0    0    0
   35         0    0    0    0    0    0    0    0    0    0    0
  END PWAT-PARM1

  PWAT-PARM2
    <PLS >      PWATER input info: Part 2         ***
    # -  # ***FOREST      LZSN    INFILT      LSUR     SLSUR     KVARY     AGWRC
   34              0         6      0.02       400      0.05         0      0.96
   35              0         6      0.02       400       0.1         0      0.96
  END PWAT-PARM2

  PWAT-PARM3
    <PLS >      PWATER input info: Part 3         ***
    # -  # ***PETMAX    PETMIN    INFEXP    INFILD    DEEPFR    BASETP    AGWETP
   34              0         0         3         2         0         0         0
   35              0         0         3         2         0         0         0
  END PWAT-PARM3
  PWAT-PARM4
    <PLS >     PWATER input info: Part 4                            ***
    # -  #     CEPSC      UZSN      NSUR     INTFW       IRC     LZETP ***
   34            0.1       0.2      0.25         2       0.4      0.25
   35            0.1       0.2      0.25         2       0.4      0.25
  END PWAT-PARM4

  PWAT-STATE1
    <PLS > *** Initial conditions at start of simulation
               ran from 1990 to end of 1992 (pat 1-11-95) RUN 21 ***
    # -  # ***  CEPS      SURS       UZS       IFWS       LZS       AGWS      GWVS
   34              0         0         0         0       2.5          1         0
   35              0         0         0         0       2.5          1         0
  END PWAT-STATE1

END PERLND

IMPLND
  GEN-INFO
    <PLS ><-------Name------->   Unit-systems   Printer ***
    # -  #                     User  t-series Engl Metr ***
                                     in  out           ***
    1      ROADS/FLAT              1    1    1   27    0
    4      ROOF TOPS/FLAT          1    1    1   27    0
    6      DRIVEWAYS/MOD           1    1    1   27    0
    8      SIDEWALKS/FLAT          1    1    1   27    0
  END GEN-INFO
  *** Section IWATER***

  ACTIVITY
    <PLS > ************ Active Sections ******************************
    # -  # ATMP SNOW IWAT  SLD  IWG IQAL   ***
    1         0    0    1    0    0    0
    4         0    0    1    0    0    0
    6         0    0    1    0    0    0
    8         0    0    1    0    0    0
  END ACTIVITY
```

```
  PRINT-INFO
    <ILS > ******** Print-flags ******** PIVL  PYR
    # -  # ATMP SNOW IWAT  SLD  IWG IQAL    *********
    1         0    0    4    0    0    0    1    9
    4         0    0    4    0    0    0    1    9
    6         0    0    4    0    0    0    1    9
    8         0    0    4    0    0    0    1    9
  END PRINT-INFO

  IWAT-PARM1
    <PLS >  IWATER variable monthly parameter value flags  ***
    # -  # CSNO RTOP  VRS  VNN RTLI     ***
    1         0    0    0    0    0
    4         0    0    0    0    0
    6         0    0    0    0    0
    8         0    0    0    0    0
  END IWAT-PARM1

  IWAT-PARM2
    <PLS >      IWATER input info: Part 2         ***
    # -  # ***  LSUR     SLSUR      NSUR     RETSC
    1            400      0.01       0.1       0.1
    4            400      0.01       0.1       0.1
    6            400      0.05       0.1      0.08
    8            400      0.01       0.1       0.1
  END IWAT-PARM2

  IWAT-PARM3
    <PLS >      IWATER input info: Part 3         ***
    # -  # ***PETMAX    PETMIN
    1              0         0
    4              0         0
    6              0         0
    8              0         0
  END IWAT-PARM3

  IWAT-STATE1
    <PLS > *** Initial conditions at start of simulation
    # -  # ***  RETS      SURS
    1              0         0
    4              0         0
    6              0         0
    8              0         0
  END IWAT-STATE1

END IMPLND

SCHEMATIC
<-Source->                 <--Area-->     <-Target->   MBLK   ***
<Name>   #                 <-factor->     <Name>   #   Tbl#   ***
Basin  1-North***
PERLND  34                      0.708     RCHRES   1      2
PERLND  34                      0.708     RCHRES   1      3
PERLND  35                      0.708     RCHRES   1      2
PERLND  35                      0.708     RCHRES   1      3
IMPLND   1                     0.8667     RCHRES   1      5
IMPLND   4                     1.0285     RCHRES   1      5
IMPLND   6                     0.2938     RCHRES   1      5
IMPLND   8                     0.1946     RCHRES   1      5
Basin  2-Mid***
PERLND  34                      0.754     RCHRES   2      2
PERLND  34                      0.754     RCHRES   2      3
PERLND  35                      0.754     RCHRES   2      2
PERLND  35                      0.754     RCHRES   2      3
IMPLND   1                     0.3561     RCHRES   2      5
IMPLND   4                     0.5377     RCHRES   2      5
IMPLND   6                     0.1818     RCHRES   2      5
IMPLND   8                     0.0902     RCHRES   2      5
Basin  3-South***
PERLND  34                      0.5836     RCHRES   3      2
```

```
PERLND  34                      0.5836     RCHRES   3      3
PERLND  35                      0.5836     RCHRES   3      2
PERLND  35                      0.5836     RCHRES   3      3
IMPLND   1                      0.2065     RCHRES   3      5
IMPLND   4                      0.6428     RCHRES   3      5
IMPLND   6                      0.1837     RCHRES   3      5
IMPLND   8                       0.065     RCHRES   3      5

******Routing******
PERLND  34                      0.5836     COPY     1     12
PERLND  35                      0.5836     COPY     1     12
IMPLND   1                      0.2065     COPY     1     15
IMPLND   4                      0.6428     COPY     1     15
IMPLND   6                      0.1837     COPY     1     15
IMPLND   8                       0.065     COPY     1     15
PERLND  34                      0.5836     COPY     1     13
PERLND  35                      0.5836     COPY     1     13
RCHRES   1                           1     RCHRES   2      7
RCHRES   2                           1     RCHRES   3      7
RCHRES   2                                 COPY     1     17
RCHRES   3                           1     COPY   501     16
END SCHEMATIC

NETWORK
<-Volume-> <-Grp> <-Member-><--Mult-->Tran <-Target vols> <-Grp> <-Member->  ***
<Name>   #        <Name> # #<-factor->strg <Name>   #   #        <Name> # #  ***
COPY   501 OUTPUT MEAN   1 1   48.4        DISPLY   1     INPUT  TIMSER 1



<-Volume-> <-Grp> <-Member-><--Mult-->Tran <-Target vols> <-Grp> <-Member->  ***
<Name>   #        <Name> # #<-factor->strg <Name>   #   #        <Name> # #  ***
END NETWORK

RCHRES
  GEN-INFO
    RCHRES       Name        Nexits   Unit Systems   Printer                ***
    # -  #<------------------><---> User T-series  Engl Metr LKFG           ***
                                       in  out                              ***
    1     Gravel Trench Be-009    2    1    1    1   28    0    1
    2     Gravel Trench Be-010    2    1    1    1   28    0    1
    3     Trapezoidal Pond-005    1    1    1    1   28    0    1
  END GEN-INFO
  *** Section RCHRES***

  ACTIVITY
    <PLS > ************ Active Sections ******************************
    # -  # HYFG ADFG CNFG HTFG SDFG GQFG OXFG NUFG PKFG PHFG ***
    1         1    0    0    0    0    0    0    0    0    0
    2         1    0    0    0    0    0    0    0    0    0
    3         1    0    0    0    0    0    0    0    0    0
  END ACTIVITY

  PRINT-INFO
    <PLS > ***************** Print-flags ****************** PIVL  PYR
    # -  # HYDR ADCA CONS HEAT  SED  GQL OXRX NUTR PLNK PHCB PIVL  PYR  *********
    1         4    0    0    0    0    0    0    0    0    0    1    9
    2         4    0    0    0    0    0    0    0    0    0    1    9
    3         4    0    0    0    0    0    0    0    0    0    1    9
  END PRINT-INFO

  HYDR-PARM1
    RCHRES  Flags for each HYDR Section                                  ***
    # -  #  VC A1 A2 A3  ODFVFG for each *** ODGTFG for each     FUNCT  for each
          FG FG FG FG  possible  exit  *** possible  exit      possible  exit
           *  *  *  *    *  *  *  *  *      *  *  *  *  *         ***
    1      0  1  0  0    4  5  0  0  0       0  0  0  0  0       2  2  2  2  2
    2      0  1  0  0    4  5  0  0  0       0  0  0  0  0       2  2  2  2  2
    3      0  1  0  0    4  0  0  0  0       0  0  0  0  0       2  2  2  2  2
  END HYDR-PARM1
```

```
  HYDR-PARM2
    # -  #    FTABNO       LEN      DELTH     STCOR        KS      DB50       ***
  <------><--------><--------><--------><--------><--------><--------><-------->       ***
    1              1      0.02       0.0       0.0       0.5       0.0
    2              2      0.02       0.0       0.0       0.5       0.0
    3              3      0.02       0.0       0.0       0.5       0.0
  END HYDR-PARM2
  HYDR-INIT
    RCHRES  Initial conditions for each HYDR section                          ***
    # -  # ***   VOL     Initial  value  of COLIND     Initial  value  of OUTDGT
           *** ac-ft     for each possible exit        for each possible exit
  <------><-------->     <---><---><---><---><---> *** <---><---><---><---><--->
    1            0         4.0  5.0  0.0  0.0  0.0       0.0  0.0  0.0  0.0  0.0
    2            0         4.0  5.0  0.0  0.0  0.0       0.0  0.0  0.0  0.0  0.0
    3            0         4.0  0.0  0.0  0.0  0.0       0.0  0.0  0.0  0.0  0.0
  END HYDR-INIT
END RCHRES

SPEC-ACTIONS
END SPEC-ACTIONS
FTABLES
  FTABLE      3
   91    4
     Depth      Area    Volume  Outflow1 Velocity  Travel Time***
      (ft)   (acres) (acre-ft)   (cfs)   (ft/sec)    (Minutes)***
  0.000000  0.103306  0.000000  0.000000
  0.044444  0.104164  0.004610  0.091535
  0.088889  0.105026  0.009259  0.129450
  0.133333  0.105892  0.013946  0.158543
  0.177778  0.106760  0.018672  0.183070
  0.222222  0.107632  0.023436  0.204679
  0.266667  0.108507  0.028239  0.224214
  0.311111  0.109385  0.033081  0.242179
  0.355556  0.110267  0.037962  0.258900
  0.400000  0.111152  0.042883  0.274605
  0.444444  0.112040  0.047843  0.289459
  0.488889  0.112931  0.052842  0.303587
  0.533333  0.113826  0.057881  0.317087
  0.577778  0.114723  0.062960  0.330034
  0.622222  0.115625  0.068079  0.342493
  0.666667  0.116529  0.073238  0.354514
  0.711111  0.117437  0.078437  0.366140
  0.755556  0.118348  0.083676  0.377409
  0.800000  0.119262  0.088957  0.388350
  0.844444  0.120179  0.094278  0.398992
  0.888889  0.121100  0.099639  0.409357
  0.933333  0.122024  0.105042  0.419466
  0.977778  0.122951  0.110486  0.429337
  1.022222  0.123882  0.115971  0.438987
  1.066667  0.124815  0.121498  0.448428
  1.111111  0.125752  0.127066  0.457675
  1.155556  0.126693  0.132676  0.466739
  1.200000  0.127636  0.138328  0.475630
  1.244444  0.128583  0.144021  0.484358
  1.288889  0.129533  0.149757  0.492931
  1.333333  0.130487  0.155536  0.501358
  1.377778  0.131443  0.161356  0.509646
  1.422222  0.132403  0.167219  0.517800
  1.466667  0.133366  0.173125  0.525829
  1.511111  0.134333  0.179074  0.533737
  1.555556  0.135303  0.185066  0.541529
  1.600000  0.136275  0.191101  0.549210
  1.644444  0.137252  0.197180  0.556786
  1.688889  0.138231  0.203301  0.564260
  1.733333  0.139214  0.209467  0.571636
  1.777778  0.140200  0.215676  0.578919
  1.822222  0.141189  0.221929  0.586110
  1.866667  0.142182  0.228226  0.593215
  1.911111  0.143178  0.234568  0.600235
```

```
1.955556  0.144177  0.240953  0.607175
2.000000  0.145179  0.247383  0.614036
2.044444  0.146185  0.253858  0.620821
2.088889  0.147194  0.260378  0.627533
2.133333  0.148206  0.266942  0.634173
2.177778  0.149221  0.273552  0.640745
2.222222  0.150240  0.280206  0.647251
2.266667  0.151262  0.286906  0.653691
2.311111  0.152287  0.293652  0.660069
2.355556  0.153315  0.300443  0.666385
2.400000  0.154347  0.307280  0.672643
2.444444  0.155382  0.314163  0.678842
2.488889  0.156420  0.321092  0.684986
2.533333  0.157462  0.328067  0.697762
2.577778  0.158507  0.335088  0.720947
2.622222  0.159555  0.342157  0.750049
2.666667  0.160606  0.349271  0.783798
2.711111  0.161661  0.356433  0.821504
2.755556  0.162718  0.363641  0.862714
2.800000  0.163780  0.370897  0.907105
2.844444  0.164844  0.378199  0.954426
2.888889  0.165912  0.385550  1.004479
2.933333  0.166983  0.392947  1.057101
2.977778  0.168057  0.400392  1.112155
3.022222  0.169134  0.407886  1.196074
3.066667  0.170215  0.415427  1.422563
3.111111  0.171299  0.423016  1.742162
3.155556  0.172386  0.430653  2.129808
3.200000  0.173477  0.438339  2.569685
3.244444  0.174570  0.446074  3.047905
3.288889  0.175667  0.453857  3.550658
3.333333  0.176768  0.461688  4.063756
3.377778  0.177871  0.469569  4.572787
3.422222  0.178978  0.477499  5.063593
3.466667  0.180088  0.485479  5.522962
3.511111  0.181202  0.493507  5.939493
3.555556  0.182318  0.501585  6.304588
3.600000  0.183438  0.509713  6.613556
3.644444  0.184561  0.517891  6.866825
3.688889  0.185688  0.526119  7.071238
3.733333  0.186817  0.534397  7.241442
3.777778  0.187950  0.542725  7.482285
3.822222  0.189086  0.551104  7.663321
3.866667  0.190226  0.559533  7.839630
3.911111  0.191369  0.568013  8.011571
3.955556  0.192515  0.576543  8.179456
4.000000  0.193664  0.585125  8.343565
END FTABLE  3
FTABLE      1
 92    5
   Depth      Area    Volume  Outflow1  Outflow2  Velocity  Travel Time***
    (ft)   (acres) (acre-ft)   (cfs)     (cfs)   (ft/sec)    (Minutes)***
0.000000  0.018365  0.000000  0.000000  0.000000
0.033333  0.018365  0.000202  0.019818  0.390741
0.066667  0.018365  0.000404  0.028027  0.390741
0.100000  0.018365  0.000606  0.034326  0.390741
0.133333  0.018365  0.000808  0.039636  0.390741
0.166667  0.018365  0.001010  0.044314  0.390741
0.200000  0.018365  0.001212  0.048544  0.390741
0.233333  0.018365  0.001414  0.052433  0.390741
0.266667  0.018365  0.001616  0.056054  0.390741
0.300000  0.018365  0.001818  0.059454  0.390741
0.333333  0.018365  0.002020  0.062670  0.390741
0.366667  0.018365  0.002222  0.065729  0.390741
0.400000  0.018365  0.002424  0.068651  0.390741
0.433333  0.018365  0.002626  0.071455  0.390741
0.466667  0.018365  0.002828  0.074152  0.390741
0.500000  0.018365  0.003030  0.076754  0.390741
0.533333  0.018365  0.003232  0.079272  0.390741
0.566667  0.018365  0.003434  0.081711  0.390741
```

0.600000	0.018365	0.003636	0.084080	0.390741
0.633333	0.018365	0.003838	0.086384	0.390741
0.666667	0.018365	0.004040	0.088628	0.390741
0.700000	0.018365	0.004242	0.090817	0.390741
0.733333	0.018365	0.004444	0.092954	0.390741
0.766667	0.018365	0.004646	0.095043	0.390741
0.800000	0.018365	0.004848	0.097088	0.390741
0.833333	0.018365	0.005051	0.099090	0.390741
0.866667	0.018365	0.005253	0.101052	0.390741
0.900000	0.018365	0.005455	0.102977	0.390741
0.933333	0.018365	0.005657	0.104867	0.390741
0.966667	0.018365	0.005859	0.106723	0.390741
1.000000	0.018365	0.006061	0.108547	0.390741
1.033333	0.018365	0.006263	0.110342	0.390741
1.066667	0.018365	0.006465	0.112107	0.390741
1.100000	0.018365	0.006667	0.113845	0.390741
1.133333	0.018365	0.006869	0.115557	0.390741
1.166667	0.018365	0.007071	0.117244	0.390741
1.200000	0.018365	0.007273	0.118908	0.390741
1.233333	0.018365	0.007475	0.120548	0.390741
1.266667	0.018365	0.007677	0.122166	0.390741
1.300000	0.018365	0.007879	0.123763	0.390741
1.333333	0.018365	0.008081	0.125340	0.390741
1.366667	0.018365	0.008283	0.126897	0.390741
1.400000	0.018365	0.008485	0.128435	0.390741
1.433333	0.018365	0.008687	0.129955	0.390741
1.466667	0.018365	0.008889	0.131457	0.390741
1.500000	0.018365	0.009091	0.132943	0.390741
1.533333	0.018365	0.009293	0.134412	0.390741
1.566667	0.018365	0.009495	0.135865	0.390741
1.600000	0.018365	0.009697	0.137303	0.390741
1.633333	0.018365	0.009899	0.138725	0.390741
1.666667	0.018365	0.010101	0.140134	0.390741
1.700000	0.018365	0.010303	0.141528	0.390741
1.733333	0.018365	0.010505	0.142909	0.390741
1.766667	0.018365	0.010707	0.144277	0.390741
1.800000	0.018365	0.010909	0.145631	0.390741
1.833333	0.018365	0.011111	0.146974	0.390741
1.866667	0.018365	0.011313	0.148304	0.390741
1.900000	0.018365	0.011515	0.149622	0.390741
1.933333	0.018365	0.011717	0.150929	0.390741
1.966667	0.018365	0.011919	0.152224	0.390741
2.000000	0.018365	0.012121	0.153509	0.390741
2.033333	0.018365	0.012323	0.154783	0.390741
2.066667	0.018365	0.012525	0.156046	0.390741
2.100000	0.018365	0.012727	0.157300	0.390741
2.133333	0.018365	0.012929	0.158543	0.390741
2.166667	0.018365	0.013131	0.159777	0.390741
2.200000	0.018365	0.013333	0.161002	0.390741
2.233333	0.018365	0.013535	0.162217	0.390741
2.266667	0.018365	0.013737	0.163423	0.390741
2.300000	0.018365	0.013939	0.164620	0.390741
2.333333	0.018365	0.014141	0.165809	0.390741
2.366667	0.018365	0.014343	0.166989	0.390741
2.400000	0.018365	0.014545	0.168161	0.390741
2.433333	0.018365	0.014747	0.169324	0.390741
2.466667	0.018365	0.014949	0.170480	0.390741
2.500000	0.018365	0.015152	0.171628	0.390741
2.533333	0.018365	0.015354	0.269621	0.390741
2.566667	0.018365	0.015556	0.447597	0.390741
2.600000	0.018365	0.015758	0.677205	0.390741
2.633333	0.018365	0.015960	0.947610	0.390741
2.666667	0.018365	0.016162	1.251526	0.390741
2.700000	0.018365	0.016364	1.582825	0.390741
2.733333	0.018365	0.016566	1.935709	0.390741
2.766667	0.018365	0.016768	2.304373	0.390741
2.800000	0.018365	0.016970	2.682896	0.390741
2.833333	0.018365	0.017172	3.065232	0.390741
2.866667	0.018365	0.017374	3.445289	0.390741
2.900000	0.018365	0.017576	3.817050	0.390741

```
2.933333  0.018365  0.017778  4.174735  0.390741
2.966667  0.018365  0.017980  4.512988  0.390741
3.000000  0.018365  0.018182  4.827101  0.390741
3.033333  0.018365  0.018794  5.113248  0.390741
END FTABLE  1
FTABLE      2
 92    5
   Depth      Area    Volume  Outflow1  Outflow2  Velocity  Travel Time***
    (ft)   (acres) (acre-ft)   (cfs)     (cfs)   (ft/sec)    (Minutes)***
0.000000  0.018365  0.000000  0.000000  0.000000
0.033333  0.018365  0.000202  0.019818  0.390741
0.066667  0.018365  0.000404  0.028027  0.390741
0.100000  0.018365  0.000606  0.034326  0.390741
0.133333  0.018365  0.000808  0.039636  0.390741
0.166667  0.018365  0.001010  0.044314  0.390741
0.200000  0.018365  0.001212  0.048544  0.390741
0.233333  0.018365  0.001414  0.052433  0.390741
0.266667  0.018365  0.001616  0.056054  0.390741
0.300000  0.018365  0.001818  0.059454  0.390741
0.333333  0.018365  0.002020  0.062670  0.390741
0.366667  0.018365  0.002222  0.065729  0.390741
0.400000  0.018365  0.002424  0.068651  0.390741
0.433333  0.018365  0.002626  0.071455  0.390741
0.466667  0.018365  0.002828  0.074152  0.390741
0.500000  0.018365  0.003030  0.076754  0.390741
0.533333  0.018365  0.003232  0.079272  0.390741
0.566667  0.018365  0.003434  0.081711  0.390741
0.600000  0.018365  0.003636  0.084080  0.390741
0.633333  0.018365  0.003838  0.086384  0.390741
0.666667  0.018365  0.004040  0.088628  0.390741
0.700000  0.018365  0.004242  0.090817  0.390741
0.733333  0.018365  0.004444  0.092954  0.390741
0.766667  0.018365  0.004646  0.095043  0.390741
0.800000  0.018365  0.004848  0.097088  0.390741
0.833333  0.018365  0.005051  0.099090  0.390741
0.866667  0.018365  0.005253  0.101052  0.390741
0.900000  0.018365  0.005455  0.102977  0.390741
0.933333  0.018365  0.005657  0.104867  0.390741
0.966667  0.018365  0.005859  0.106723  0.390741
1.000000  0.018365  0.006061  0.108547  0.390741
1.033333  0.018365  0.006263  0.110342  0.390741
1.066667  0.018365  0.006465  0.112107  0.390741
1.100000  0.018365  0.006667  0.113845  0.390741
1.133333  0.018365  0.006869  0.115557  0.390741
1.166667  0.018365  0.007071  0.117244  0.390741
1.200000  0.018365  0.007273  0.118908  0.390741
1.233333  0.018365  0.007475  0.120548  0.390741
1.266667  0.018365  0.007677  0.122166  0.390741
1.300000  0.018365  0.007879  0.123763  0.390741
1.333333  0.018365  0.008081  0.125340  0.390741
1.366667  0.018365  0.008283  0.126897  0.390741
1.400000  0.018365  0.008485  0.128435  0.390741
1.433333  0.018365  0.008687  0.129955  0.390741
1.466667  0.018365  0.008889  0.131457  0.390741
1.500000  0.018365  0.009091  0.132943  0.390741
1.533333  0.018365  0.009293  0.134412  0.390741
1.566667  0.018365  0.009495  0.135865  0.390741
1.600000  0.018365  0.009697  0.137303  0.390741
1.633333  0.018365  0.009899  0.138725  0.390741
1.666667  0.018365  0.010101  0.140134  0.390741
1.700000  0.018365  0.010303  0.141528  0.390741
1.733333  0.018365  0.010505  0.142909  0.390741
1.766667  0.018365  0.010707  0.144277  0.390741
1.800000  0.018365  0.010909  0.145631  0.390741
1.833333  0.018365  0.011111  0.146974  0.390741
1.866667  0.018365  0.011313  0.148304  0.390741
1.900000  0.018365  0.011515  0.149622  0.390741
1.933333  0.018365  0.011717  0.150929  0.390741
1.966667  0.018365  0.011919  0.152224  0.390741
2.000000  0.018365  0.012121  0.153509  0.390741
```

```
  2.033333  0.018365  0.012323  0.154783  0.390741
  2.066667  0.018365  0.012525  0.156046  0.390741
  2.100000  0.018365  0.012727  0.157300  0.390741
  2.133333  0.018365  0.012929  0.158543  0.390741
  2.166667  0.018365  0.013131  0.159777  0.390741
  2.200000  0.018365  0.013333  0.161002  0.390741
  2.233333  0.018365  0.013535  0.162217  0.390741
  2.266667  0.018365  0.013737  0.163423  0.390741
  2.300000  0.018365  0.013939  0.164620  0.390741
  2.333333  0.018365  0.014141  0.165809  0.390741
  2.366667  0.018365  0.014343  0.166989  0.390741
  2.400000  0.018365  0.014545  0.168161  0.390741
  2.433333  0.018365  0.014747  0.169324  0.390741
  2.466667  0.018365  0.014949  0.170480  0.390741
  2.500000  0.018365  0.015152  0.171628  0.390741
  2.533333  0.018365  0.015354  0.269621  0.390741
  2.566667  0.018365  0.015556  0.447597  0.390741
  2.600000  0.018365  0.015758  0.677205  0.390741
  2.633333  0.018365  0.015960  0.947610  0.390741
  2.666667  0.018365  0.016162  1.251526  0.390741
  2.700000  0.018365  0.016364  1.582825  0.390741
  2.733333  0.018365  0.016566  1.935709  0.390741
  2.766667  0.018365  0.016768  2.304373  0.390741
  2.800000  0.018365  0.016970  2.682896  0.390741
  2.833333  0.018365  0.017172  3.065232  0.390741
  2.866667  0.018365  0.017374  3.445289  0.390741
  2.900000  0.018365  0.017576  3.817050  0.390741
  2.933333  0.018365  0.017778  4.174735  0.390741
  2.966667  0.018365  0.017980  4.512988  0.390741
  3.000000  0.018365  0.018182  4.827101  0.390741
  3.033333  0.018365  0.018794  5.113248  0.390741
  END FTABLE  2
END FTABLES

EXT SOURCES
<-Volume-> <Member> SsysSgap<--Mult-->Tran <-Target vols> <-Grp> <-Member->  ***
<Name>   # <Name> # tem strg<-factor->strg <Name>   #   #        <Name> # #  ***
WDM      2 PREC     ENGL    1.3            PERLND   1 999 EXTNL  PREC
WDM      2 PREC     ENGL    1.3            IMPLND   1 999 EXTNL  PREC
WDM      1 EVAP     ENGL    0.8            PERLND   1 999 EXTNL  PETINP
WDM      1 EVAP     ENGL    0.8            IMPLND   1 999 EXTNL  PETINP
WDM      2 PREC     ENGL    1.3            RCHRES   3     EXTNL  PREC
WDM      1 EVAP     ENGL    0.8            RCHRES   3     EXTNL  POTEV

END EXT SOURCES

EXT TARGETS
<-Volume-> <-Grp> <-Member-><--Mult-->Tran <-Volume-> <Member> Tsys Tgap Amd ***
<Name>   #        <Name> # #<-factor->strg <Name>   # <Name>    tem strg strg***
RCHRES   3 HYDR   RO     1 1        1      WDM   1000 FLOW     ENGL      REPL
RCHRES   3 HYDR   STAGE  1 1        1      WDM   1001 STAG     ENGL      REPL
COPY     1 OUTPUT MEAN   1 1     48.4      WDM    701 FLOW     ENGL      REPL
COPY   501 OUTPUT MEAN   1 1     48.4      WDM    801 FLOW     ENGL      REPL
END EXT TARGETS

MASS-LINK
<Volume>   <-Grp> <-Member-><--Mult-->     <Target>       <-Grp> <-Member->***
<Name>             <Name> # #<-factor->     <Name>                <Name> # #***
  MASS-LINK        2
PERLND     PWATER SURO       0.083333      RCHRES         INFLOW IVOL
  END MASS-LINK    2

  MASS-LINK        3
PERLND     PWATER IFWO       0.083333      RCHRES         INFLOW IVOL
  END MASS-LINK    3

  MASS-LINK        5
IMPLND     IWATER SURO       0.083333      RCHRES         INFLOW IVOL
  END MASS-LINK    5
```

```
  MASS-LINK        7
RCHRES     OFLOW  OVOL   1                RCHRES          INFLOW IVOL
  END MASS-LINK    7

  MASS-LINK       12
PERLND     PWATER SURO       0.083333      COPY            INPUT  MEAN
  END MASS-LINK   12

  MASS-LINK       13
PERLND     PWATER IFWO       0.083333      COPY            INPUT  MEAN
  END MASS-LINK   13

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

  MASS-LINK       16
RCHRES     ROFLOW                          COPY            INPUT  MEAN
  END MASS-LINK   16

  MASS-LINK       17
RCHRES     OFLOW  OVOL   1                 COPY            INPUT  MEAN
  END MASS-LINK   17


END MASS-LINK

END RUN
```

Predeveloped HSPF Message File

Mitigated HSPF Message File

```
ERROR/WARNING ID:   341   6

DATE/TIME: 1953/12/ 9 13:45

RCHRES:     2

The volume of water in this reach/mixed reservoir is greater than the value
in the "volume" column of the last row of RCHTAB().  To continue the
simulation the table has been extrapolated, based on information contained
in the last two rows.  This will usually result in some loss of accuracy.
If depth is being calculated it will also cause an error condition.
Relevant data are:

NROWS         V1         V2        VOL
92  792.01     818.67     851.70
```

```
ERROR/WARNING ID:   341   5

DATE/TIME: 1953/12/ 9 13:45

RCHRES:     2

Calculation of relative depth, using Newton's method of successive
approximations, converged to an invalid value (not in range 0.0 to 1.0).
Probably ftable was extrapolated.  If extrapolation was small, no problem.
Remedy; extend ftable.  Relevant data are:

A          B          C      RDEP1      RDEP2  COUNT
0.0000E+00 1600.0     -3.583E+03    2.2392     2.2392       2
```

```
ERROR/WARNING ID:   341   6

DATE/TIME: 1968/ 8/19 16: 0

RCHRES:     2

The volume of water in this reach/mixed reservoir is greater than the value
in the "volume" column of the last row of RCHTAB().  To continue the
simulation the table has been extrapolated, based on information contained
in the last two rows.  This will usually result in some loss of accuracy.
If depth is being calculated it will also cause an error condition.
Relevant data are:

NROWS         V1         V2        VOL
92  792.01     818.67     872.25
```

```
ERROR/WARNING ID:   341   5

DATE/TIME: 1968/ 8/19 16: 0

RCHRES:     2

Calculation of relative depth, using Newton's method of successive
approximations, converged to an invalid value (not in range 0.0 to 1.0).
Probably ftable was extrapolated.  If extrapolation was small, no problem.
Remedy; extend ftable.  Relevant data are:

A          B          C      RDEP1      RDEP2  COUNT
0.0000E+00 1600.0     -4.816E+03    3.0098     3.0098       2
```

```
ERROR/WARNING ID:   341   6

DATE/TIME: 1969/ 9/17 21:30

RCHRES:     2
```

The volume of water in this reach/mixed reservoir is greater than the value
in the "volume" column of the last row of RCHTAB(). To continue the
simulation the table has been extrapolated, based on information contained
in the last two rows. This will usually result in some loss of accuracy.
If depth is being calculated it will also cause an error condition.
Relevant data are:

NROWS	V1	V2	VOL
92	792.01	818.67	958.98

ERROR/WARNING ID: 341 5

DATE/TIME: 1969/ 9/17 21:30

RCHRES: 2

Calculation of relative depth, using Newton's method of successive
approximations, converged to an invalid value (not in range 0.0 to 1.0).
Probably ftable was extrapolated. If extrapolation was small, no problem.
Remedy; extend ftable. Relevant data are:

A	B	C	RDEP1	RDEP2	COUNT
0.0000E+00	1600.0	-1.002E+04	6.2632	6.2632E+00	2

ERROR/WARNING ID: 341 6

DATE/TIME: 1970/ 1/22 16:15

RCHRES: 2

The volume of water in this reach/mixed reservoir is greater than the value
in the "volume" column of the last row of RCHTAB(). To continue the
simulation the table has been extrapolated, based on information contained
in the last two rows. This will usually result in some loss of accuracy.
If depth is being calculated it will also cause an error condition.
Relevant data are:

NROWS	V1	V2	VOL
92	7.9201E+02	818.67	1020.8

ERROR/WARNING ID: 341 5

DATE/TIME: 1970/ 1/22 16:15

RCHRES: 2

Calculation of relative depth, using Newton's method of successive
approximations, converged to an invalid value (not in range 0.0 to 1.0).
Probably ftable was extrapolated. If extrapolation was small, no problem.
Remedy; extend ftable. Relevant data are:

A	B	C	RDEP1	RDEP2	COUNT
0.0000E+00	1600.0	-1.373E+04	8.5835	8.5835E+00	2

ERROR/WARNING ID: 341 6

DATE/TIME: 1970/ 1/22 16:30

RCHRES: 2

The volume of water in this reach/mixed reservoir is greater than the value
in the "volume" column of the last row of RCHTAB(). To continue the
simulation the table has been extrapolated, based on information contained
in the last two rows. This will usually result in some loss of accuracy.
If depth is being calculated it will also cause an error condition.
Relevant data are:

NROWS	V1	V2	VOL
92	7.9201E+02	818.67	832.70

ERROR/WARNING ID: 341 5

DATE/TIME: 1970/ 1/22 16:30

RCHRES: 2

Calculation of relative depth, using Newton's method of successive approximations, converged to an invalid value (not in range 0.0 to 1.0). Probably ftable was extrapolated. If extrapolation was small, no problem. Remedy; extend ftable. Relevant data are:

A	B	C	RDEP1	RDEP2	COUNT
0.0000E+00	1600.0	-2.442E+03	1.5266	1.5266E+00	2

ERROR/WARNING ID: 341 6

DATE/TIME: 1970/ 1/22 16:45

RCHRES: 2

The volume of water in this reach/mixed reservoir is greater than the value in the "volume" column of the last row of RCHTAB(). To continue the simulation the table has been extrapolated, based on information contained in the last two rows. This will usually result in some loss of accuracy. If depth is being calculated it will also cause an error condition. Relevant data are:

NROWS	V1	V2	VOL
92	7.9201E+02	818.67	878.12

ERROR/WARNING ID: 341 5

DATE/TIME: 1970/ 1/22 16:45

RCHRES: 2

Calculation of relative depth, using Newton's method of successive approximations, converged to an invalid value (not in range 0.0 to 1.0). Probably ftable was extrapolated. If extrapolation was small, no problem. Remedy; extend ftable. Relevant data are:

A	B	C	RDEP1	RDEP2	COUNT
0.0000E+00	1600.0	-5.168E+03	3.2301	3.2301	2

ERROR/WARNING ID: 341 6

DATE/TIME: 1970/ 1/22 17: 0

RCHRES: 2

The volume of water in this reach/mixed reservoir is greater than the value in the "volume" column of the last row of RCHTAB(). To continue the simulation the table has been extrapolated, based on information contained in the last two rows. This will usually result in some loss of accuracy. If depth is being calculated it will also cause an error condition. Relevant data are:

NROWS	V1	V2	VOL
92	792.01	818.67	827.66

ERROR/WARNING ID: 341 5

DATE/TIME: 1970/ 1/22 17: 0

RCHRES: 2

Calculation of relative depth, using Newton's method of successive approximations, converged to an invalid value (not in range 0.0 to 1.0).

Probably ftable was extrapolated. If extrapolation was small, no problem.
Remedy; extend ftable. Relevant data are:

A	B	C	RDEP1	RDEP2	COUNT
0.0000E+00	1600.0	-2.140E+03	1.3372	1.3372E+00	2

ERROR/WARNING ID: 341   6

DATE/TIME: 1979/ 1/10 5: 0

RCHRES: 2

The volume of water in this reach/mixed reservoir is greater than the value
in the "volume" column of the last row of RCHTAB(). To continue the
simulation the table has been extrapolated, based on information contained
in the last two rows. This will usually result in some loss of accuracy.
If depth is being calculated it will also cause an error condition.
Relevant data are:

NROWS	V1	V2	VOL
92	7.9201E+02	818.67	838.57

ERROR/WARNING ID: 341   5

DATE/TIME: 1979/ 1/10 5: 0

RCHRES: 2

Calculation of relative depth, using Newton's method of successive
approximations, converged to an invalid value (not in range 0.0 to 1.0).
Probably ftable was extrapolated. If extrapolation was small, no problem.
Remedy; extend ftable. Relevant data are:

A	B	C	RDEP1	RDEP2	COUNT
0.0000E+00	1600.0	-2.795E+03	1.7468	1.7468E+00	2

ERROR/WARNING ID: 341   6

DATE/TIME: 1992/12/10 6: 0

RCHRES: 2

The volume of water in this reach/mixed reservoir is greater than the value
in the "volume" column of the last row of RCHTAB(). To continue the
simulation the table has been extrapolated, based on information contained
in the last two rows. This will usually result in some loss of accuracy.
If depth is being calculated it will also cause an error condition.
Relevant data are:

NROWS	V1	V2	VOL
92	7.9201E+02	818.67	832.67

ERROR/WARNING ID: 341   5

DATE/TIME: 1992/12/10 6: 0

RCHRES: 2

Calculation of relative depth, using Newton's method of successive
approximations, converged to an invalid value (not in range 0.0 to 1.0).
Probably ftable was extrapolated. If extrapolation was small, no problem.
Remedy; extend ftable. Relevant data are:

A	B	C	RDEP1	RDEP2	COUNT
0.0000E+00	1600.0	-2.440E+03	1.5252	1.5252E+00	2

ERROR/WARNING ID: 341   6

DATE/TIME: 1997/ 5/31 5: 0

RCHRES: 2

The volume of water in this reach/mixed reservoir is greater than the value
in the "volume" column of the last row of RCHTAB(). To continue the
simulation the table has been extrapolated, based on information contained
in the last two rows. This will usually result in some loss of accuracy.
If depth is being calculated it will also cause an error condition.
Relevant data are:

NROWS	V1	V2	VOL
92	7.9201E+02	818.67	881.95

ERROR/WARNING ID: 341 5

DATE/TIME: 1997/ 5/31 5: 0

RCHRES: 2

Calculation of relative depth, using Newton's method of successive
approximations, converged to an invalid value (not in range 0.0 to 1.0).
Probably ftable was extrapolated. If extrapolation was small, no problem.
Remedy; extend ftable. Relevant data are:

A	B	C	RDEP1	RDEP2	COUNT
0.0000E+00	1600.0	-5.398E+03	3.3739	3.3739E+00	2

ERROR/WARNING ID: 341 6

DATE/TIME: 1997/10/29 7:30

RCHRES: 2

The volume of water in this reach/mixed reservoir is greater than the value
in the "volume" column of the last row of RCHTAB(). To continue the
simulation the table has been extrapolated, based on information contained
in the last two rows. This will usually result in some loss of accuracy.
If depth is being calculated it will also cause an error condition.
Relevant data are:

NROWS	V1	V2	VOL
92	7.9201E+02	818.67	959.26

ERROR/WARNING ID: 341 5

DATE/TIME: 1997/10/29 7:30

RCHRES: 2

Calculation of relative depth, using Newton's method of successive
approximations, converged to an invalid value (not in range 0.0 to 1.0).
Probably ftable was extrapolated. If extrapolation was small, no problem.
Remedy; extend ftable. Relevant data are:

A	B	C	RDEP1	RDEP2	COUNT
0.0000E+00	1600.0	-1.004E+04	6.2737	6.2737E+00	2

ERROR/WARNING ID: 341 6

DATE/TIME: 2002/ 2/23 1:45

RCHRES: 2

The volume of water in this reach/mixed reservoir is greater than the value
in the "volume" column of the last row of RCHTAB(). To continue the
simulation the table has been extrapolated, based on information contained
in the last two rows. This will usually result in some loss of accuracy.
If depth is being calculated it will also cause an error condition.
Relevant data are:

```
NROWS         V1         V2        VOL
92 7.9201E+02  818.67     832.44
```

```
ERROR/WARNING ID:   341   5

DATE/TIME: 2002/ 2/23  1:45

RCHRES:     2

Calculation of relative depth, using Newton's method of successive
approximations, converged to an invalid value (not in range 0.0 to 1.0).
Probably ftable was extrapolated.  If extrapolation was small, no problem.
Remedy; extend ftable.  Relevant data are:

A          B          C      RDEP1      RDEP2  COUNT
0.0000E+00 1600.0     -2.426E+03    1.5166  1.5166E+00      2
```

```
ERROR/WARNING ID:   341   6

DATE/TIME: 2008/ 5/24 21:15

RCHRES:     2

The volume of water in this reach/mixed reservoir is greater than the value
in the "volume" column of the last row of RCHTAB().  To continue the
simulation the table has been extrapolated, based on information contained
in the last two rows.  This will usually result in some loss of accuracy.
If depth is being calculated it will also cause an error condition.
Relevant data are:

NROWS         V1         V2        VOL
92 7.9201E+02  818.67     884.15
```

```
ERROR/WARNING ID:   341   5

DATE/TIME: 2008/ 5/24 21:15

RCHRES:     2

Calculation of relative depth, using Newton's method of successive
approximations, converged to an invalid value (not in range 0.0 to 1.0).
Probably ftable was extrapolated.  If extrapolation was small, no problem.
Remedy; extend ftable.  Relevant data are:

A          B          C      RDEP1      RDEP2  COUNT
0.0000E+00 1600.0     -5.530E+03    3.4564  3.4564E+00      2
```

```
ERROR/WARNING ID:   341   6

DATE/TIME: 2008/ 5/24 22: 0

RCHRES:     2

The volume of water in this reach/mixed reservoir is greater than the value
in the "volume" column of the last row of RCHTAB().  To continue the
simulation the table has been extrapolated, based on information contained
in the last two rows.  This will usually result in some loss of accuracy.
If depth is being calculated it will also cause an error condition.
Relevant data are:

NROWS         V1         V2        VOL
92 7.9201E+02  818.67     992.51
```

```
ERROR/WARNING ID:   341   5

DATE/TIME: 2008/ 5/24 22: 0

RCHRES:     2
```

Calculation of relative depth, using Newton's method of successive approximations, converged to an invalid value (not in range 0.0 to 1.0). Probably ftable was extrapolated. If extrapolation was small, no problem. Remedy; extend ftable. Relevant data are:

A	B	C	RDEP1	RDEP2	COUNT
0.0000E+00	1600.0	-1.203E+04	7.5209	7.5209	2

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

www.clearcreeksolutions.com

SEPARATOR SHEET

WWHM2012

PROJECT REPORT

This WWHM Model identifies the WQ flow rate for sizing cartridges. The failed flow duration is unrelated and can be ignored.

General Model Information

Project Name:	TreatmentAnalysis
Site Name:	
Site Address:	
City:	
Report Date:	7/28/2022
Gage:	Lacamas
Data Start:	1948/10/01
Data End:	2008/09/30
Timestep:	15 Minute
Precip Scale:	1.300
Version Date:	2018/10/10
Version:	4.2.16

POC Thresholds

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

Landuse Basin Data

Predeveloped Land Use

Extg

Bypass:	No
GroundWater:	No
Pervious Land Use	acre
SG4, Forest, Mod	8.7386
Pervious Total	8.7386
Impervious Land Use	acre
Impervious Total	0
Basin Total	8.7386

Element Flows To:

Surface	Interflow	Groundwater

Mitigated Land Use

Treatment Area

Bypass:	No
GroundWater:	No

Pervious Land Use	acre
SG4, Lawn, Flat	2.0912
SG4, Lawn, Mod	2
Pervious Total	4.0912

Impervious Land Use	acre
ROADS FLAT	1.4293
ROOF TOPS FLAT	2.209
DRIVEWAYS MOD	0.6593
SIDEWALKS FLAT	0.3498
Impervious Total	4.6474
Basin Total	8.7386

Element Flows To:

Surface	Interflow	Groundwater

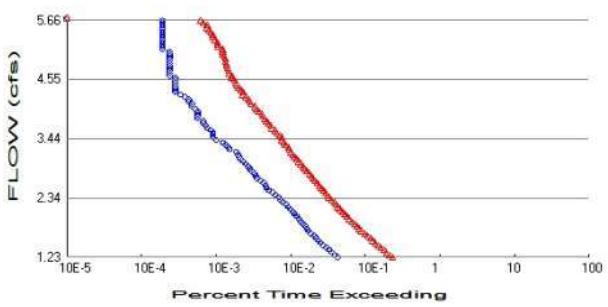
Routing Elements

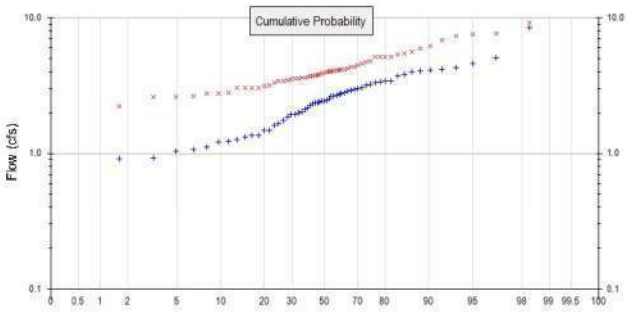
Predeveloped Routing

Mitigated Routing

Analysis Results

POC 1





\+ Predeveloped x Mitigated

Predeveloped Landuse Totals for POC #1
Total Pervious Area: 8.7386
Total Impervious Area: 0

Mitigated Landuse Totals for POC #1
Total Pervious Area: 4.0912
Total Impervious Area: 4.6474

Flow Frequency Method: Log Pearson Type III 17B

Flow Frequency Return Periods for Predeveloped. POC #1

Return Period	**Flow(cfs)**
2 year	2.458123
5 year	3.785611
10 year	4.502037
25 year	5.228488
50 year	5.659129
100 year	6.012664

Flow Frequency Return Periods for Mitigated. POC #1

Return Period	**Flow(cfs)**
2 year	3.953092
5 year	5.190564
10 year	6.020908
25 year	7.085902
50 year	7.892261
100 year	8.710693

Annual Peaks

Annual Peaks for Predeveloped and Mitigated. POC #1

Year	**Predeveloped**	**Mitigated**
1949	1.848	4.077
1950	2.383	3.606
1951	3.230	3.998
1952	1.940	4.067
1953	2.642	3.751
1954	4.043	5.402
1955	2.031	2.758
1956	3.726	4.356
1957	3.294	4.584
1958	2.445	5.146

1959	1.479	3.043
1960	1.358	3.031
1961	3.399	4.076
1962	2.377	3.582
1963	2.660	4.248
1964	2.468	3.057
1965	2.116	3.397
1966	2.960	3.954
1967	2.675	4.063
1968	3.201	7.549
1969	3.064	6.230
1970	8.476	9.174
1971	1.353	2.746
1972	2.161	3.838
1973	2.248	3.394
1974	3.403	3.992
1975	1.935	2.600
1976	2.922	3.488
1977	0.087	1.648
1978	4.256	5.123
1979	2.776	5.570
1980	1.607	3.033
1981	3.811	4.724
1982	2.521	4.445
1983	4.610	5.437
1984	1.488	2.640
1985	1.072	3.326
1986	1.328	4.787
1987	2.344	3.185
1988	1.120	3.696
1989	1.211	3.773
1990	1.031	3.545
1991	2.722	4.346
1992	2.815	4.182
1993	3.342	5.165
1994	2.412	3.154
1995	1.992	4.184
1996	4.190	5.912
1997	5.107	7.321
1998	4.127	7.656
1999	2.878	3.473
2000	1.647	2.601
2001	0.909	2.236
2002	3.970	5.127
2003	3.023	3.883
2004	0.923	2.806
2005	1.229	3.652
2006	2.330	3.696
2007	1.269	3.620
2008	1.754	6.873

Ranked Annual Peaks

Ranked Annual Peaks for Predeveloped and Mitigated. POC #1

Rank	Predeveloped	Mitigated
1	8.4759	9.1745
2	5.1066	7.6560
3	4.6099	7.5495
4	4.2556	7.3209

5	4.1898	6.8728
6	4.1265	6.2301
7	4.0428	5.9122
8	3.9703	5.5696
9	3.8114	5.4367
10	3.7262	5.4020
11	3.4034	5.1652
12	3.3989	5.1457
13	3.3419	5.1268
14	3.2944	5.1232
15	3.2304	4.7870
16	3.2006	4.7236
17	3.0637	4.5844
18	3.0231	4.4453
19	2.9603	4.3564
20	2.9221	4.3458
21	2.8780	4.2478
22	2.8153	4.1839
23	2.7758	4.1824
24	2.7219	4.0774
25	2.6751	4.0763
26	2.6597	4.0667
27	2.6425	4.0631
28	2.5211	3.9979
29	2.4679	3.9921
30	2.4450	3.9542
31	2.4121	3.8829
32	2.3834	3.8382
33	2.3766	3.7731
34	2.3441	3.7508
35	2.3296	3.6958
36	2.2481	3.6957
37	2.1612	3.6515
38	2.1162	3.6202
39	2.0305	3.6062
40	1.9916	3.5823
41	1.9397	3.5449
42	1.9355	3.4884
43	1.8480	3.4727
44	1.7540	3.3969
45	1.6466	3.3944
46	1.6075	3.3263
47	1.4877	3.1854
48	1.4786	3.1540
49	1.3582	3.0574
50	1.3529	3.0434
51	1.3278	3.0334
52	1.2693	3.0308
53	1.2291	2.8065
54	1.2106	2.7584
55	1.1196	2.7458
56	1.0719	2.6402
57	1.0308	2.6012
58	0.9234	2.6005
59	0.9087	2.2364
60	0.0872	1.6477

Duration Flows

Flow(cfs)	Predev	Mit	Percentage	Pass/Fail
1.2291	894	4877	545	Fail
1.2738	823	4454	541	Fail
1.3186	756	4073	538	Fail
1.3633	687	3743	544	Fail
1.4081	626	3421	546	Fail
1.4528	576	3154	547	Fail
1.4976	536	2884	538	Fail
1.5423	492	2647	538	Fail
1.5870	455	2430	534	Fail
1.6318	431	2249	521	Fail
1.6765	392	2062	526	Fail
1.7213	364	1874	514	Fail
1.7660	346	1738	502	Fail
1.8108	324	1622	500	Fail
1.8555	305	1500	491	Fail
1.9003	287	1393	485	Fail
1.9450	271	1283	473	Fail
1.9898	253	1191	470	Fail
2.0345	237	1112	469	Fail
2.0793	226	1041	460	Fail
2.1240	211	977	463	Fail
2.1688	193	912	472	Fail
2.2135	182	859	471	Fail
2.2583	165	805	487	Fail
2.3030	152	745	490	Fail
2.3478	145	688	474	Fail
2.3925	131	651	496	Fail
2.4373	120	617	514	Fail
2.4820	107	579	541	Fail
2.5268	100	540	540	Fail
2.5715	96	508	529	Fail
2.6163	91	478	525	Fail
2.6610	83	444	534	Fail
2.7058	75	421	561	Fail
2.7505	71	399	561	Fail
2.7952	69	375	543	Fail
2.8400	62	347	559	Fail
2.8847	59	321	544	Fail
2.9295	56	306	546	Fail
2.9742	52	291	559	Fail
3.0190	49	269	548	Fail
3.0637	44	254	577	Fail
3.1085	43	237	551	Fail
3.1532	41	223	543	Fail
3.1980	39	210	538	Fail
3.2427	32	202	631	Fail
3.2875	30	196	653	Fail
3.3322	28	179	639	Fail
3.3770	26	170	653	Fail
3.4217	21	162	771	Fail
3.4665	19	160	842	Fail
3.5112	19	151	794	Fail
3.5560	19	138	726	Fail
3.6007	18	129	716	Fail

3.6455	16	118	737	Fail
3.6902	15	113	753	Fail
3.7350	14	105	750	Fail
3.7797	14	99	707	Fail
3.8245	12	94	783	Fail
3.8692	12	89	741	Fail
3.9140	12	86	716	Fail
3.9587	12	78	650	Fail
4.0034	11	73	663	Fail
4.0482	10	70	700	Fail
4.0929	10	62	620	Fail
4.1377	9	60	666	Fail
4.1824	9	57	633	Fail
4.2272	8	53	662	Fail
4.2719	7	48	685	Fail
4.3167	6	48	800	Fail
4.3614	6	45	750	Fail
4.4062	6	42	700	Fail
4.4509	6	40	666	Fail
4.4957	6	39	650	Fail
4.5404	6	37	616	Fail
4.5852	6	34	566	Fail
4.6299	5	34	680	Fail
4.6747	5	32	640	Fail
4.7194	5	31	620	Fail
4.7642	5	30	600	Fail
4.8089	5	29	580	Fail
4.8537	5	29	580	Fail
4.8984	5	28	560	Fail
4.9432	5	28	560	Fail
4.9879	5	27	540	Fail
5.0327	5	26	520	Fail
5.0774	5	26	520	Fail
5.1222	4	26	650	Fail
5.1669	4	22	550	Fail
5.2116	4	22	550	Fail
5.2564	4	22	550	Fail
5.3011	4	20	500	Fail
5.3459	4	19	475	Fail
5.3906	4	19	475	Fail
5.4354	4	18	450	Fail
5.4801	4	17	425	Fail
5.5249	4	16	400	Fail
5.5696	4	16	400	Fail
5.6144	4	14	350	Fail
5.6591	4	13	325	Fail

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

Water Quality

Water Quality BMP Flow and Volume for POC #1

On-line facility volume:	0.9279 acre-feet
On-line facility target flow:	1.223 cfs.
Adjusted for 15 min:	1.223 cfs.
Off-line facility target flow:	0.661 cfs.
Adjusted for 15 min:	0.661 cfs.

LID Report

LID Technique	Used for Treatment ?	Total Volume Needs Treatment (ac-ft)	Volume Through Facility (ac-ft)	Infiltration Volume (ac-ft)	Cumulative Volume Infiltration Credit	Percent Volume Infiltrated	Water Quality	Percent Water Quality Treated	Comment
Total Volume Infiltrated		0.00	0.00	0.00		0.00	0.00	0%	No Treat. Credit
Compliance with LID Standard 8% of 2-yr to 50% of 2-yr									Duration Analysis Result = Failed

Model Default Modifications

Total of 0 changes have been made.

PERLND Changes

No PERLND changes have been made.

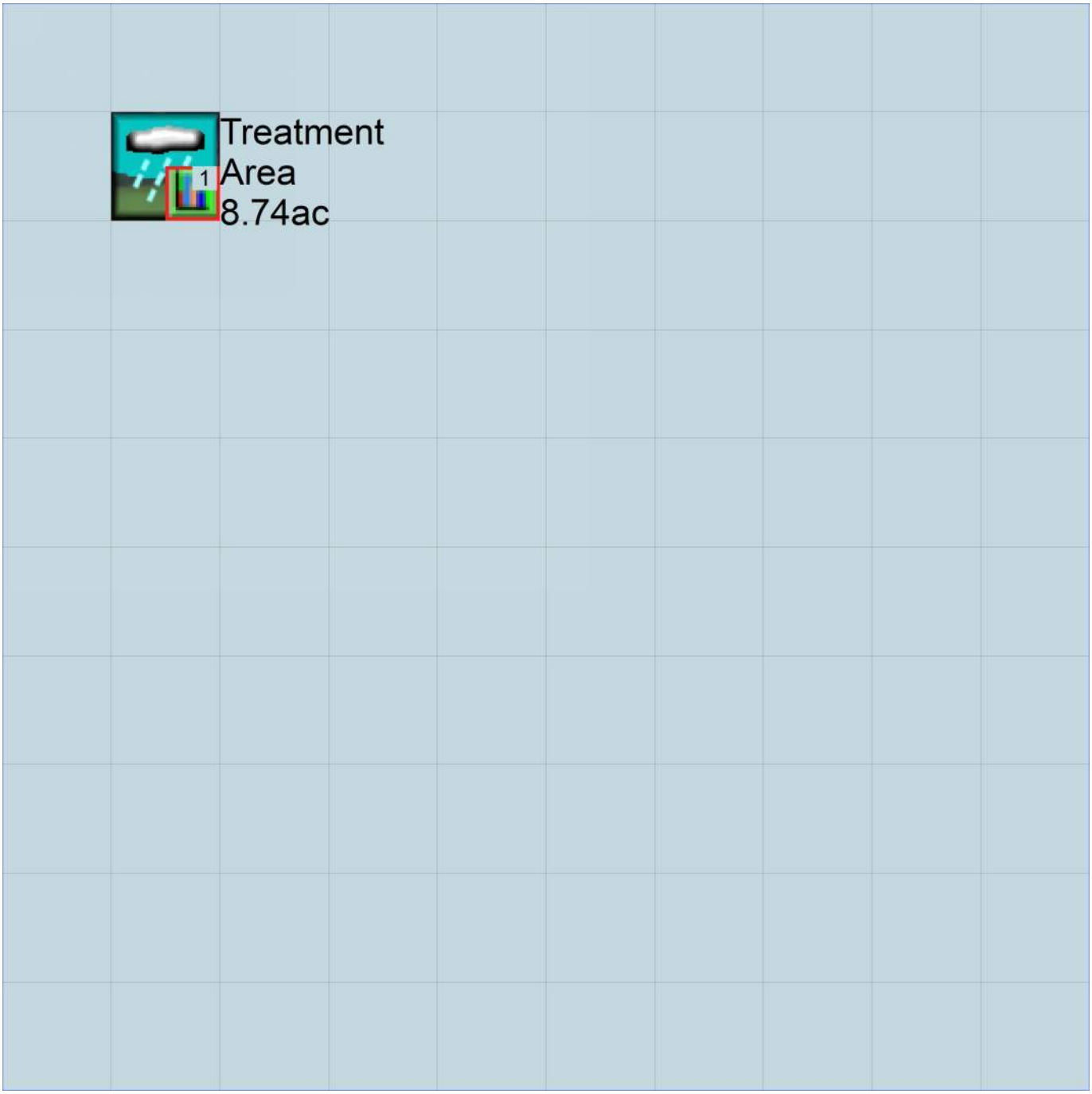
IMPLND Changes

No IMPLND changes have been made.

Appendix

Predeveloped Schematic

Mitigated Schematic



Predeveloped UCI File

```
RUN

GLOBAL
  WWHM4 model simulation
  START       1948 10 01        END    2008 09 30
  RUN INTERP OUTPUT LEVEL    3    0
  RESUME     0 RUN     1                    UNIT SYSTEM     1
END GLOBAL

FILES
<File>  <Un#>   <-----------File Name------------------------------>***
<-ID->                                                              ***
WDM         26   TreatmentAnalysis.wdm
MESSU       25   PreTreatmentAnalysis.MES
            27   PreTreatmentAnalysis.L61
            28   PreTreatmentAnalysis.L62
            30   POCTreatmentAnalysis1.dat
END FILES

OPN SEQUENCE
    INGRP               INDELT 00:15
      PERLND      29
      COPY       501
      DISPLY       1
    END INGRP
END OPN SEQUENCE
DISPLY
  DISPLY-INFO1
    # -  #<----------Title----------->***TRAN PIVL DIG1 FIL1  PYR DIG2 FIL2 YRND
    1        Extg                        MAX                    1    2   30    9
  END DISPLY-INFO1
END DISPLY
COPY
  TIMESERIES
    # -  #  NPT  NMN ***
    1         1    1
  501         1    1
  END TIMESERIES
END COPY
GENER
  OPCODE
    #    # OPCD ***
  END OPCODE
  PARM
    #    #         K ***
  END PARM
END GENER
PERLND
  GEN-INFO
    <PLS ><-------Name------->NBLKS   Unit-systems   Printer ***
    # -  #                         User  t-series Engl Metr ***
                                      in  out           ***
   29     SG4, Forest, Mod        1    1    1    1   27    0
  END GEN-INFO
  *** Section PWATER***

  ACTIVITY
    <PLS > ************ Active Sections ****************************
    # -  # ATMP SNOW PWAT  SED  PST  PWG PQAL MSTL PEST NITR PHOS TRAC ***
   29         0    0    1    0    0    0    0    0    0    0    0    0
  END ACTIVITY

  PRINT-INFO
    <PLS > ***************** Print-flags **************************** PIVL  PYR
    # -  # ATMP SNOW PWAT  SED  PST  PWG PQAL MSTL PEST NITR PHOS TRAC  *********
   29         0    0    4    0    0    0    0    0    0    0    0    0    1    9
  END PRINT-INFO
```

```
  PWAT-PARM1
    <PLS >  PWATER variable monthly parameter value flags  ***
    # -  # CSNO RTOP UZFG  VCS  VUZ  VNN VIFW VIRC  VLE INFC  HWT ***
   29         0    0    0    0    0    0    0    0    0    0    0
  END PWAT-PARM1

  PWAT-PARM2
    <PLS >      PWATER input info: Part 2         ***
    # -  # ***FOREST      LZSN    INFILT      LSUR     SLSUR     KVARY     AGWRC
   29              0         6      0.04       400       0.1         0      0.96
  END PWAT-PARM2

  PWAT-PARM3
    <PLS >      PWATER input info: Part 3         ***
    # -  # ***PETMAX    PETMIN    INFEXP    INFILD    DEEPFR    BASETP    AGWETP
   29              0         0         3         2         0         0         0
  END PWAT-PARM3
  PWAT-PARM4
    <PLS >     PWATER input info: Part 4                            ***
    # -  #     CEPSC      UZSN      NSUR     INTFW       IRC     LZETP ***
   29            0.2       0.4      0.35         2       0.4       0.7
  END PWAT-PARM4

  PWAT-STATE1
    <PLS > *** Initial conditions at start of simulation
               ran from 1990 to end of 1992 (pat 1-11-95) RUN 21 ***
    # -  # ***  CEPS      SURS       UZS      IFWS       LZS      AGWS      GWVS
   29              0         0         0         0       2.5         1         0
  END PWAT-STATE1

END PERLND

IMPLND
  GEN-INFO
    <PLS ><-------Name------->   Unit-systems   Printer ***
    # -  #                     User  t-series Engl Metr ***
                                     in  out           ***
  END GEN-INFO
  *** Section IWATER***

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

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

  IWAT-PARM1
    <PLS >  IWATER variable monthly parameter value flags  ***
    # -  # CSNO RTOP  VRS  VNN RTLI     ***
  END IWAT-PARM1

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

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

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

```
END IMPLND

SCHEMATIC
<-Source->                  <--Area-->     <-Target->   MBLK   ***
<Name>   #                  <-factor->     <Name>   #   Tbl#   ***
Extg***
PERLND  29                      8.7386     COPY   501     12
PERLND  29                      8.7386     COPY   501     13

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

NETWORK
<-Volume-> <-Grp> <-Member-><--Mult-->Tran <-Target vols> <-Grp> <-Member->  ***
<Name>   #        <Name> # #<-factor->strg <Name>   #   #        <Name> # #  ***
COPY   501 OUTPUT MEAN   1 1   48.4        DISPLY   1     INPUT  TIMSER 1



<-Volume-> <-Grp> <-Member-><--Mult-->Tran <-Target vols> <-Grp> <-Member->  ***
<Name>   #        <Name> # #<-factor->strg <Name>   #   #        <Name> # #  ***
END NETWORK

RCHRES
  GEN-INFO
    RCHRES       Name        Nexits   Unit Systems   Printer                ***
    # -  #<------------------><---> User T-series  Engl Metr LKFG           ***
                                       in  out                              ***
  END GEN-INFO
  *** Section RCHRES***

  ACTIVITY
    <PLS > ************ Active Sections ****************************
    # -  # HYFG ADFG CNFG HTFG SDFG GQFG OXFG NUFG PKFG PHFG ***
  END ACTIVITY

  PRINT-INFO
    <PLS > ***************** Print-flags ******************* PIVL  PYR
    # -  # HYDR ADCA CONS HEAT  SED  GQL OXRX NUTR PLNK PHCB PIVL  PYR  *********
  END PRINT-INFO

  HYDR-PARM1
    RCHRES  Flags for each HYDR Section                                  ***
    # -  #  VC A1 A2 A3  ODFVFG for each *** ODGTFG for each     FUNCT  for each
            FG FG FG FG  possible  exit  *** possible  exit      possible  exit
             *  *  *  *    *  *  *  *  *      *  *  *  *  *        ***
  END HYDR-PARM1

  HYDR-PARM2
    # -  #    FTABNO       LEN     DELTH     STCOR        KS      DB50       ***
  <------><--------><--------><--------><--------><--------><-------->       ***
  END HYDR-PARM2
  HYDR-INIT
    RCHRES  Initial conditions for each HYDR section                     ***
    # -  # ***   VOL     Initial  value  of COLIND     Initial  value  of OUTDGT
          *** ac-ft     for each possible exit        for each possible exit
  <------><-------->     <---><---><---><---><---> *** <---><---><---><---><--->
  END HYDR-INIT
END RCHRES

SPEC-ACTIONS
END SPEC-ACTIONS
FTABLES
END FTABLES

EXT SOURCES
<-Volume-> <Member> SsysSgap<--Mult-->Tran <-Target vols> <-Grp> <-Member->  ***
<Name>   # <Name> # tem strg<-factor->strg <Name>   #   #        <Name> # #  ***
WDM      2 PREC     ENGL    1.3            PERLND   1 999 EXTNL  PREC
WDM      2 PREC     ENGL    1.3            IMPLND   1 999 EXTNL  PREC
```

```
WDM      1 EVAP     ENGL    0.8             PERLND   1 999 EXTNL  PETINP
WDM      1 EVAP     ENGL    0.8             IMPLND   1 999 EXTNL  PETINP

END EXT SOURCES

EXT TARGETS
<-Volume-> <-Grp> <-Member-><--Mult-->Tran <-Volume-> <Member> Tsys Tgap Amd ***
<Name>   #        <Name> # #<-factor->strg <Name>   # <Name>    tem strg strg***
COPY   501 OUTPUT MEAN   1 1     48.4      WDM    501 FLOW     ENGL      REPL
END EXT TARGETS

MASS-LINK
<Volume>   <-Grp> <-Member-><--Mult-->     <Target>       <-Grp> <-Member->***
<Name>            <Name> # #<-factor->     <Name>                <Name> # #***
  MASS-LINK       12
PERLND     PWATER SURO       0.083333      COPY           INPUT  MEAN
  END MASS-LINK   12

  MASS-LINK       13
PERLND     PWATER IFWO       0.083333      COPY           INPUT  MEAN
  END MASS-LINK   13


END MASS-LINK

END RUN
```

Mitigated UCI File

```
RUN

GLOBAL
  WWHM4 model simulation
  START       1948 10 01        END    2008 09 30
  RUN INTERP OUTPUT LEVEL    3    0
  RESUME     0 RUN     1                    UNIT SYSTEM     1
END GLOBAL

FILES
<File>  <Un#>   <-----------File Name------------------------------>***
<-ID->                                                              ***
WDM         26   TreatmentAnalysis.wdm
MESSU       25   MitTreatmentAnalysis.MES
            27   MitTreatmentAnalysis.L61
            28   MitTreatmentAnalysis.L62
            30   POCTreatmentAnalysis1.dat
END FILES

OPN SEQUENCE
    INGRP               INDELT 00:15
      PERLND      34
      PERLND      35
      IMPLND       1
      IMPLND       4
      IMPLND       6
      IMPLND       8
      COPY       501
      DISPLY       1
    END INGRP
END OPN SEQUENCE
DISPLY
  DISPLY-INFO1
    # -  #<----------Title---------->***TRAN PIVL DIG1 FIL1  PYR DIG2 FIL2 YRND
    1        Treatment Area             MAX                    1    2   30    9
  END DISPLY-INFO1
END DISPLY
COPY
  TIMESERIES
    # -  #  NPT  NMN ***
    1         1    1
  501         1    1
  END TIMESERIES
END COPY
GENER
  OPCODE
    #    # OPCD ***
  END OPCODE
  PARM
    #    #         K ***
  END PARM
END GENER
PERLND
  GEN-INFO
    <PLS ><-------Name------->NBLKS   Unit-systems   Printer ***
    # -  #                          User  t-series Engl Metr ***
                                          in  out           ***
   34     SG4, Lawn, Flat         1    1    1    1   27    0
   35     SG4, Lawn, Mod          1    1    1    1   27    0
  END GEN-INFO
  *** Section PWATER***

  ACTIVITY
    <PLS > ************ Active Sections ******************************
    # -  # ATMP SNOW PWAT  SED  PST  PWG PQAL MSTL PEST NITR PHOS TRAC ***
   34         0    0    1    0    0    0    0    0    0    0    0    0
   35         0    0    1    0    0    0    0    0    0    0    0    0
  END ACTIVITY
```

```
  PRINT-INFO
    <PLS > ***************** Print-flags **************************** PIVL  PYR
    # -  # ATMP SNOW PWAT  SED  PST  PWG PQAL MSTL PEST NITR PHOS TRAC  *********
   34         0    0    4    0    0    0    0    0    0    0    0    0    1    9
   35         0    0    4    0    0    0    0    0    0    0    0    0    1    9
  END PRINT-INFO

  PWAT-PARM1
    <PLS >  PWATER variable monthly parameter value flags  ***
    # -  # CSNO RTOP UZFG  VCS  VUZ  VNN VIFW VIRC  VLE INFC  HWT ***
   34         0    0    0    0    0    0    0    0    0    0    0
   35         0    0    0    0    0    0    0    0    0    0    0
  END PWAT-PARM1

  PWAT-PARM2
    <PLS >      PWATER input info: Part 2         ***
    # -  # ***FOREST      LZSN    INFILT      LSUR     SLSUR     KVARY     AGWRC
   34              0         6      0.02       400      0.05         0      0.96
   35              0         6      0.02       400       0.1         0      0.96
  END PWAT-PARM2

  PWAT-PARM3
    <PLS >      PWATER input info: Part 3         ***
    # -  # ***PETMAX    PETMIN    INFEXP    INFILD    DEEPFR    BASETP    AGWETP
   34              0         0         3         2         0         0         0
   35              0         0         3         2         0         0         0
  END PWAT-PARM3
  PWAT-PARM4
    <PLS >     PWATER input info: Part 4                          ***
    # -  #     CEPSC      UZSN      NSUR     INTFW       IRC     LZETP ***
   34            0.1       0.2      0.25         2       0.4      0.25
   35            0.1       0.2      0.25         2       0.4      0.25
  END PWAT-PARM4

  PWAT-STATE1
    <PLS > *** Initial conditions at start of simulation
               ran from 1990 to end of 1992 (pat 1-11-95) RUN 21 ***
    # -  # ***  CEPS      SURS       UZS      IFWS       LZS      AGWS      GWVS
   34              0         0         0         0       2.5         1         0
   35              0         0         0         0       2.5         1         0
  END PWAT-STATE1

END PERLND

IMPLND
  GEN-INFO
    <PLS ><-------Name------->   Unit-systems   Printer ***
    # -  #                     User  t-series Engl Metr ***
                                     in  out           ***
    1      ROADS/FLAT             1    1    1   27    0
    4      ROOF TOPS/FLAT         1    1    1   27    0
    6      DRIVEWAYS/MOD          1    1    1   27    0
    8      SIDEWALKS/FLAT         1    1    1   27    0
  END GEN-INFO
  *** Section IWATER***

  ACTIVITY
    <PLS > ************* Active Sections ******************************
    # -  # ATMP SNOW IWAT  SLD  IWG IQAL   ***
    1         0    0    1    0    0    0
    4         0    0    1    0    0    0
    6         0    0    1    0    0    0
    8         0    0    1    0    0    0
  END ACTIVITY

  PRINT-INFO
    <ILS > ******** Print-flags ******** PIVL  PYR
    # -  # ATMP SNOW IWAT  SLD  IWG IQAL    *********
    1         0    0    4    0    0    0    1    9
```

```
    4         0    0    4    0    0    0    1    9
    6         0    0    4    0    0    0    1    9
    8         0    0    4    0    0    0    1    9
  END PRINT-INFO

  IWAT-PARM1
    <PLS >  IWATER variable monthly parameter value flags  ***
    # -  # CSNO RTOP  VRS  VNN RTLI     ***
    1         0    0    0    0    0
    4         0    0    0    0    0
    6         0    0    0    0    0
    8         0    0    0    0    0
  END IWAT-PARM1

  IWAT-PARM2
    <PLS >      IWATER input info: Part 2         ***
    # -  # ***  LSUR     SLSUR      NSUR     RETSC
    1            400      0.01       0.1       0.1
    4            400      0.01       0.1       0.1
    6            400      0.05       0.1      0.08
    8            400      0.01       0.1       0.1
  END IWAT-PARM2

  IWAT-PARM3
    <PLS >      IWATER input info: Part 3         ***
    # -  # ***PETMAX    PETMIN
    1              0         0
    4              0         0
    6              0         0
    8              0         0
  END IWAT-PARM3

  IWAT-STATE1
    <PLS > *** Initial conditions at start of simulation
    # -  # ***  RETS      SURS
    1              0         0
    4              0         0
    6              0         0
    8              0         0
  END IWAT-STATE1

END IMPLND

SCHEMATIC
<-Source->                 <--Area-->     <-Target->   MBLK   ***
<Name>   #                 <-factor->     <Name>   #   Tbl#   ***
Treatment Area***
PERLND  34                     2.0912     COPY   501     12
PERLND  34                     2.0912     COPY   501     13
PERLND  35                          2     COPY   501     12
PERLND  35                          2     COPY   501     13
IMPLND   1                     1.4293     COPY   501     15
IMPLND   4                      2.209     COPY   501     15
IMPLND   6                     0.6593     COPY   501     15
IMPLND   8                     0.3498     COPY   501     15

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

NETWORK
<-Volume-> <-Grp> <-Member-><--Mult-->Tran <-Target vols> <-Grp> <-Member->  ***
<Name>   #        <Name> # #<-factor->strg <Name>   #   #        <Name> # #  ***
COPY   501 OUTPUT MEAN   1 1   48.4        DISPLY   1     INPUT  TIMSER 1



<-Volume-> <-Grp> <-Member-><--Mult-->Tran <-Target vols> <-Grp> <-Member->  ***
<Name>   #        <Name> # #<-factor->strg <Name>   #   #        <Name> # #  ***
END NETWORK
```

```
RCHRES
  GEN-INFO
    RCHRES       Name        Nexits   Unit Systems   Printer                ***
    # -  #<------------------><---> User T-series  Engl Metr LKFG           ***
                                       in  out                              ***
  END GEN-INFO
  *** Section RCHRES***

  ACTIVITY
    <PLS > ************ Active Sections ****************************
    # -  # HYFG ADFG CNFG HTFG SDFG GQFG OXFG NUFG PKFG PHFG ***
  END ACTIVITY

  PRINT-INFO
    <PLS > ***************** Print-flags ****************** PIVL  PYR
    # -  # HYDR ADCA CONS HEAT  SED  GQL OXRX NUTR PLNK PHCB PIVL  PYR  *********
  END PRINT-INFO

  HYDR-PARM1
    RCHRES  Flags for each HYDR Section                                  ***
    # -  #  VC A1 A2 A3  ODFVFG for each *** ODGTFG for each     FUNCT  for each
            FG FG FG FG  possible  exit  *** possible  exit      possible  exit
             *  *  *  *    *  *  *  *  *       *  *  *  *  *         ***
  END HYDR-PARM1

  HYDR-PARM2
    # -  #    FTABNO       LEN     DELTH     STCOR        KS      DB50       ***
  <------><--------><--------><--------><--------><--------><-------->       ***
  END HYDR-PARM2
  HYDR-INIT
    RCHRES  Initial conditions for each HYDR section                     ***
    # -  # ***   VOL     Initial  value  of COLIND     Initial  value  of OUTDGT
          *** ac-ft     for each possible exit        for each possible exit
  <------><-------->     <---><---><---><---><---> *** <---><---><---><---><--->
  END HYDR-INIT
END RCHRES

SPEC-ACTIONS
END SPEC-ACTIONS
FTABLES
END FTABLES

EXT SOURCES
<-Volume-> <Member> SsysSgap<--Mult-->Tran <-Target vols> <-Grp> <-Member->  ***
<Name>   # <Name> # tem strg<-factor->strg <Name>   #   #        <Name> # #  ***
WDM      2 PREC     ENGL    1.3            PERLND   1 999 EXTNL  PREC
WDM      2 PREC     ENGL    1.3            IMPLND   1 999 EXTNL  PREC
WDM      1 EVAP     ENGL    0.8            PERLND   1 999 EXTNL  PETINP
WDM      1 EVAP     ENGL    0.8            IMPLND   1 999 EXTNL  PETINP

END EXT SOURCES

EXT TARGETS
<-Volume-> <-Grp> <-Member-><--Mult-->Tran <-Volume-> <Member> Tsys Tgap Amd ***
<Name>   #        <Name> # #<-factor->strg <Name>   # <Name>    tem strg strg***
COPY     1 OUTPUT MEAN   1 1     48.4      WDM    701 FLOW     ENGL      REPL
COPY   501 OUTPUT MEAN   1 1     48.4      WDM    801 FLOW     ENGL      REPL
END EXT TARGETS

MASS-LINK
<Volume>   <-Grp> <-Member-><--Mult-->     <Target>       <-Grp> <-Member->***
<Name>            <Name> # #<-factor->     <Name>                <Name> # #***
  MASS-LINK       12
PERLND     PWATER SURO       0.083333      COPY           INPUT  MEAN
  END MASS-LINK   12

  MASS-LINK       13
PERLND     PWATER IFWO       0.083333      COPY           INPUT  MEAN
  END MASS-LINK   13
```

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


END MASS-LINK

END RUN
```

Predeveloped HSPF Message File

Mitigated HSPF Message File

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

www.clearcreeksolutions.com

SEPARATOR SHEET

WASHINGTON STATE DEPARTMENT OF ECOLOGY

April 2017

GENERAL USE LEVEL DESIGNATION FOR BASIC (TSS) TREATMENT

For

CONTECH Engineered Solutions
Stormwater Management StormFilter®
With ZPG Media at 1 gpm/sq ft media surface area

Ecology's Decision:

Based on the CONTECH Engineered Solutions' (CONTECH) application submissions, Ecology hereby issues a General Use Level Designation (GULD) for the Stormwater Management StormFilter® (StormFilter):

1. **As a basic stormwater treatment practice for total suspended solids (TSS) removal,**
   - **Using ZPG™ media (zeolite/perlite/granular activated carbon), with the size distribution described below,**
   - **Sized at a hydraulic loading rate of 1 gpm/ft^2 of media surface area, per Table 1, and**
   - **Internal bypassing needs to be consistent with the design guidelines in CONTECH's current product design manual.**

Table 1. StormFilter Design Flow Rates per Cartridge

Effective Cartridge Height (inches)	12	18	27
Cartridge Flow Rate (gpm/cartridge)	5	7.5	11.3

2. **Ecology approves StormFilter systems containing ZPG™ media for treatment at the hydraulic loading rates shown in Table 1, and sized based on the water quality design flow rate for an off-line system when using an external bypass vault or a treatment vault with an internal bypass. Contech designs their StormFilter systems to maintain treatment of the water quality design flow while routing excess flows around the treatment chamber during periods of peak bypass. The water quality design flow rates are calculated using the following procedures:**
   - **Western Washington: For treatment installed upstream of detention or retention, the water quality design flow rate is the peak 15-minute flow rate as calculated using the latest version of the Western Washington Hydrology Model or other Ecology-approved continuous runoff model.**

- **Eastern Washington: For treatment installed upstream of detention or retention, the water quality design flow rate is the peak 15-minute flow rate as calculated using one of the three methods described in Chapter 2.2.5 of the Stormwater Management Manual for Eastern Washington (SWMMEW) or local manual.**
- **Entire State: For treatment installed downstream of detention, the water quality design flow rate is the full 2-year release rate of the detention facility.**

3. **This designation has no expiration date, but Ecology may amend or revoke it.**

<u>Ecology's Conditions of Use</u>:

The StormFilter with ZPG media shall comply with the following conditions:

1. **Design, install, operate, and maintain the StormFilter with ZPG media in accordance with applicable Contech Engineered Solutions manuals, documents, and the Ecology Decision.**

2. **Install StormFilter systems to bypass flows exceeding the water quality treatment rate. Additionally, high flows will not re-suspend captured sediments. Design StormFilter systems in accordance with the performance goals in Ecology's most recent Stormwater Manual and CONTECH's *Product Design Manual Version 4.1 (April 2006)*, or most current version, unless otherwise specified.**

3. **Owners must follow the design, pretreatment, land use application, and maintenance criteria in CONTECH's Design Manual.**

4. **Pretreatment of TSS and oil and grease may be necessary, and designers shall provide pre-treatment in accordance with the most current versions of the CONTECH's *Product Design Manual (April 2006)* or the applicable Ecology Stormwater Manual. Design pre-treatment using the performance criteria and pretreatment practices provided on Ecology's "Evaluation of Emerging Stormwater Treatment Technologies" website.**

5. **Maintenance: The required maintenance interval for stormwater treatment devices is often dependent upon the degree of pollutant loading from a particular drainage basin. Therefore, Ecology does not endorse or recommend a "one size fits all" maintenance cycle for a particular model/size of manufactured filter treatment device.**

    - **Typically, CONTECH designs StormFilter systems for a target filter media replacement interval of 12 months. Maintenance includes removing accumulated sediment from the vault, and replacing spent cartridges with recharged cartridges.**

- **Indications of the need for maintenance include effluent flow decreasing to below the design flow rate, as indicated by the scumline above the shoulder of the cartridge.**
- **Owners/operators must inspect StormFilter with ZPG media for a minimum of twelve months from the start of post-construction operation to determine site-specific maintenance schedules and requirements. You must conduct inspections monthly during the wet season, and every other month during the dry season. (According to the SWMMWW, the wet season in western Washington is October 1 to April 30. According to SWMMEW, the wet season in eastern Washington is October 1 to June 30). After the first year of operation, owners/operators must conduct inspections based on the findings during the first year of inspections.**
- **Conduct inspections by qualified personnel, follow manufacturer's guidelines, and use methods capable of determining either a decrease in treated effluent flowrate and/or a decrease in pollutant removal ability.**
- **When inspections are performed, the following findings typically serve as maintenance triggers:**
    - **Accumulated vault sediment depths exceed an average of 2 inches, or**
    - **Accumulated sediment depths on the tops of the cartridges exceed an average of 0.5 inches, or**
    - **Standing water remains in the vault between rain events, or**
    - **Bypass occurs during storms smaller than the design storm.**
- **Note: If excessive floatables (trash and debris) are present, perform a minor maintenance consisting of gross solids removal, not cartridge replacement.**

6. **CONTECH shall maintain readily available reports listed under "Application Documents" (above) as public, as well as the documentation submitted with its previous conditional use designation application. CONTECH shall provide links to this information from its corporate website, and make this information available upon request, at no cost and in a timely manner.**

7. **ZPG™ media used shall conform with the following specifications:**

- **Each cartridge contains a total of approximately 2.6 cubic feet of media. The ZPG™ cartridge consists of an outer layer of perlite that is approximately 1.3 cubic feet in volume and an inner layer, consisting of a mixture of 90% zeolite and 10% granular activated carbon, which is approximately 1.3 cubic feet in volume.**
- **Perlite Media: Perlite media shall be made of natural siliceous volcanic rock free of any debris or foreign matter. The expanded perlite shall**

have a bulk density ranging from 6.5 to 8.5 lbs per cubic foot and particle sizes ranging from 0.09" (#8 mesh) to 0.38" (3/8" mesh).

- **Zeolite Media: Zeolite media shall be made of naturally occurring clinoptilolite. The zeolite media shall have a bulk density ranging from 44 to 50 lbs per cubic foot and particle sizes ranging from 0.13" (#6 mesh) to 0.19" (#4 mesh). Additionally, the cation exchange capacity (CEC) of zeolite shall range from approximately 1.0 to 2.2 meq/g.**

- **Granular Activated Carbon: Granular activated carbon (GAC) shall be made of lignite coal that has been steam-activated. The GAC media shall have a bulk density ranging from 28 to 31 lbs per cubic foot and particle sizes ranging from a 0.09" (#8 mesh) to 0.19" (#4 mesh).**

Approved Alternate Configurations

Peak Diversion StormFilter

1. The Peak Diversion StormFilter allows for off-line bypass within the StormFilter structure. Design capture flows and peak flows enter the inlet bay which contains an internal weir. The internal weir allows design flows to enter the cartridge bay through a transfer hole located at the bottom of the inlet bay while the unit routs higher flows around the cartridge bay.
2. To select the size of the Peak Diversion StormFilter unit, the designer must determine the number of cartridges required and size of the standard StormFilter using the site-specific water quality design flow and the **StormFilter Design Flow Rates per Cartridge** as described above.
3. New owners may not install the Peak Diversion StormFilter at an elevation or in a location where backwatering may occur.

Applicant: Contech Engineered Solutions

Applicant's Address: 11835 NE Glenn Widing Dr.
Portland, OR 97220

Application Documents:

The applicant's master report, titled, "The Stormwater Management StormFilter Basic Treatment Application for General Use Level Designation in Washington", Stormwater Management, Inc., November 1, 2004, includes the following reports:

- (Public) *Evaluation of the Stormwater Management StormFilter Treatment System: Data Validation Report and Summary of the Technical Evaluation Engineering Report (TEER) by Stormwater Management Inc.,* October 29, 2004
  Ecology's technology assessment protocol requires the applicant to hire an independent consultant to complete the following work:

1. Complete the data validation report.
2. Prepare a TEER summary, including a testing summary and conclusions compared with the supplier's performance claims.
3. Provide a recommendation of the appropriate technology use level.
4. Work with Ecology to post recommend relevant information on Ecology's website.
5. Provide additional testing recommendations, if needed."
6. This report, authored by Dr. Gary Minton, Ph. D., P.E., Resource Planning Associates, satisfies the Ecology requirement.

- (Public) "Performance of the Stormwater Management StormFilter Relative to the Washington State Department of Ecology Performance Goals for Basic Treatment," is a summary of StormFilter performance that strictly adheres to the criteria listed in the Guidance for Evaluating Emerging Stormwater Treatment Technologies, Technology Assessment Protocol – Ecology (TAPE).
- "Heritage Marketplace Field Evaluation: Stormwater Management StormFilter with ZPG™ Media," is a report showing all of the information collected at Site A as stated in the SMI Quality Assurance Project Plan (QAPP). This document contains detailed information regarding each storm event collected at this site, and it provided a detailed overview of the data and project.
- "Lake Stevens Field Evaluation: Stormwater Management StormFilter with ZPG™ Media," is a report that corresponds to Site E as stated in the SMI QAPP. This document contains detailed information regarding each storm collected at this site, and includes a detailed overview of the data and project.
- (Public) "Evaluation of the Stormwater Management StormFilter for the removal of SIL-CO-SIL 106, a standardized silica product: ZPG™ at 7.5 GPM" is a report that describes laboratory testing at full design flow.
- "Factors Other Than Treatment Performance."
- "State of Washington Installations."
- "Peak Diversion StormFilter" is a technical document demonstrating the Peak Diversion StormFilter system complies with the Stormwater Management Manual for Western Washington Volume V Section 4.5.1.

Above-listed documents noted as "public" are available by contacting CONTECH.

Applicant's Use Level Request:

That Ecology grant a General Use Level Designation for Basic Treatment for the StormFilter using ZPG™ media (zeolite/perlite/granular activated carbon) at a hydraulic loading rate of 1 gpm/ft^2 of media surface area in accordance with Ecology's 2011 *Technical Guidance Manual for Evaluating Emerging Stormwater Treatment Technologies Technology Assessment Protocol – Ecology (TAPE).*

Applicant's Performance Claim:

The combined data from the two field sites reported in the TER (Heritage Marketplace and Lake Stevens) indicate that the performance of a StormFilter system configured for inline bypass with ZPG™ media and a hydraulic loading rate of 1 gpm/ft^2 of media surface area meets Ecology performance goals for Basic Treatment.

Ecology's Recommendations:

Based on the weight of the evidence and using its best professional judgment, Ecology finds that:

- StormFilter, using ZPG™ media and operating at a hydraulic loading rate of no more than 1 gpm/ft^2 of media surface area, is expected to provide effective stormwater treatment achieving Ecology's Basic Treatment (TSS removal) performance goals. Contech demonstrated this is through field and laboratory testing performed in accordance with the approved protocol. StormFilter is deemed satisfactory with respect to factors other than treatment performance (e.g., maintenance; see the protocol's Appendix B for complete list).

Findings of Fact:

- Influent TSS concentrations and particle size distributions were generally within the range of what Ecology considers "typical" for western Washington (silt-to-silt loam).
- Contech sampled thirty-two (32) storm events at two sites for storms from April 2003 to March 2004, of which Contech deemed twenty-two (22) as "qualified" and were therefore included in the data analysis set.
- Statistical analysis of these 22 storm events verifies the data set's adequacy.
- Analyzing all 22 qualifying events, the average influent and effluent concentrations and aggregate pollutant load reduction are 114 mg/L, 25 mg/L, and 82%, respectively.
- Analyzing all 22 qualifying events based on the *estimated average* flow rate during the event (versus the *measured peak* flow rate), and more heavily weighting those events near the design rate (versus events either far above or well below the design rate) does not significantly affect the reported results.
- For the 7 qualifying events with influent TSS concentrations greater than 100 mg/L, the average influent and effluent concentrations and aggregate pollutant load reduction are 241 mg/L, 34 mg/L, and 89%, respectively. If we exclude the 2 of 7 events that exceed the maximum 300 mg/L specified in Ecology's guidelines, the average influent and effluent concentrations and aggregate pollutant load reduction are 158 mg/L, 35 mg/L, and 78%, respectively.
- For the 15 qualifying events with influent TSS concentrations less than 100 mg/L, the average influent and effluent concentrations and aggregate pollutant load reduction are 55 mg/L, 20 mg/L, and 61%, respectively. If the 6 of 15 events that fall below the minimum 33 mg/L TSS specified in Ecology's guidelines are excluded, the average

influent and effluent concentrations and aggregate pollutant load reduction are 78 mg/L, 26 mg/L, and 67%, respectively.

- For the 8 qualifying events with peak discharge exceeding design flow (ranging from 120 to 257% of the design rate), results ranged from 52% to 96% TSS removal, with an average of 72%.
- Due to the characteristics of the hydrographs, the field results generally reflect flows below (ranging between 20 and 60 percent of) the tested facilities' design rate. During these sub-design flow rate periods, some of the cartridges operate at or near their *individual* full design flow rate (generally between 4 and 7.5 GPM for an 18" cartridge effective height) because their float valves have opened. Float valves remain closed on the remaining cartridges, which operate at their base "trickle" rate of 1 to 1.5 GPM.
- Laboratory testing using U.S. Silica's Sil-Co-Sil 106 fine silica product showed an average 87% TSS removal for testing at 7.5 GPM per cartridge (100% design flow rate).
- Other relevant testing at I-5 Lake Union, Greenville Yards (New Jersey), and Ski Run Marina (Lake Tahoe) facilities shows consistent TSS removals in the 75 to 85% range. *Note that the evaluators operated the I-5 Lake Union at 50%, 100%, and 125% of design flow*.
- SMI's application included a satisfactory "Factors other than treatment performance" discussion.

Note: Ecology's 80% TSS removal goal applies to 100 mg/l and greater influent TSS. Below 100 mg/L influent TSS, the goal is 20 mg/L effluent TSS.

Technology Description:

The Stormwater Management StormFilter® (StormFilter), a flow-through stormwater filtration system, improves the quality of stormwater runoff from the urban environment by removing pollutants. The StormFilter can treat runoff from a wide variety of sites including, but not limited to: retail and commercial development, residential streets, urban roadways, freeways, and industrial sites such as shipyards, foundries, etc.

Operation:

The StormFilter is typically comprised of a vault that houses rechargeable, media-filled, filter cartridges. Various media may be used, but this designation covers only the zeolite-perlite-granulated activated carbon (ZPG™) medium. Stormwater from storm drains percolates through these media-filled cartridges, which trap particulates and may remove pollutants such as dissolved metals, nutrients, and hydrocarbons. During the filtering process, the StormFilter system also removes surface scum and floating oil and grease. Once filtered through the media, the treated stormwater is directed to a collection pipe or discharged to an open channel drainage way.

This document includes a bypass schematic for flow rates exceeding the water quality design flow rate on page 8.

StormFilter Configurations:

Contech offers the StormFilter in multiple configurations: precast, high flow, catch basin, curb inlet, linear, volume, corrugated metal pipe, drywell, and CON/Span form. Most configurations use pre-manufactured units to ease the design and installation process. Systems may be either uncovered or covered underground units.

The typical precast StormFilter unit is composed of three sections: the energy dissipater, the filtration bay, and the outlet sump. As Stormwater enters the inlet of the StormFilter vault through the inlet pipe, piping directs stormwater through the energy dissipater into the filtration bay where treatment will take place. Once in the filtration bay, the stormwater ponds and percolates horizontally through the media contained in the StormFilter cartridges. After passing through the media, the treated water in each cartridge collects in the cartridge's center tube from where piping directs it into the outlet sump by a High Flow Conduit under-drain manifold. The treated water in the outlet sump discharges through the single outlet pipe to a collection pipe or to an open channel drainage way. In some applications where you anticipate heavy grit loads, pretreatment by settling may be necessary.

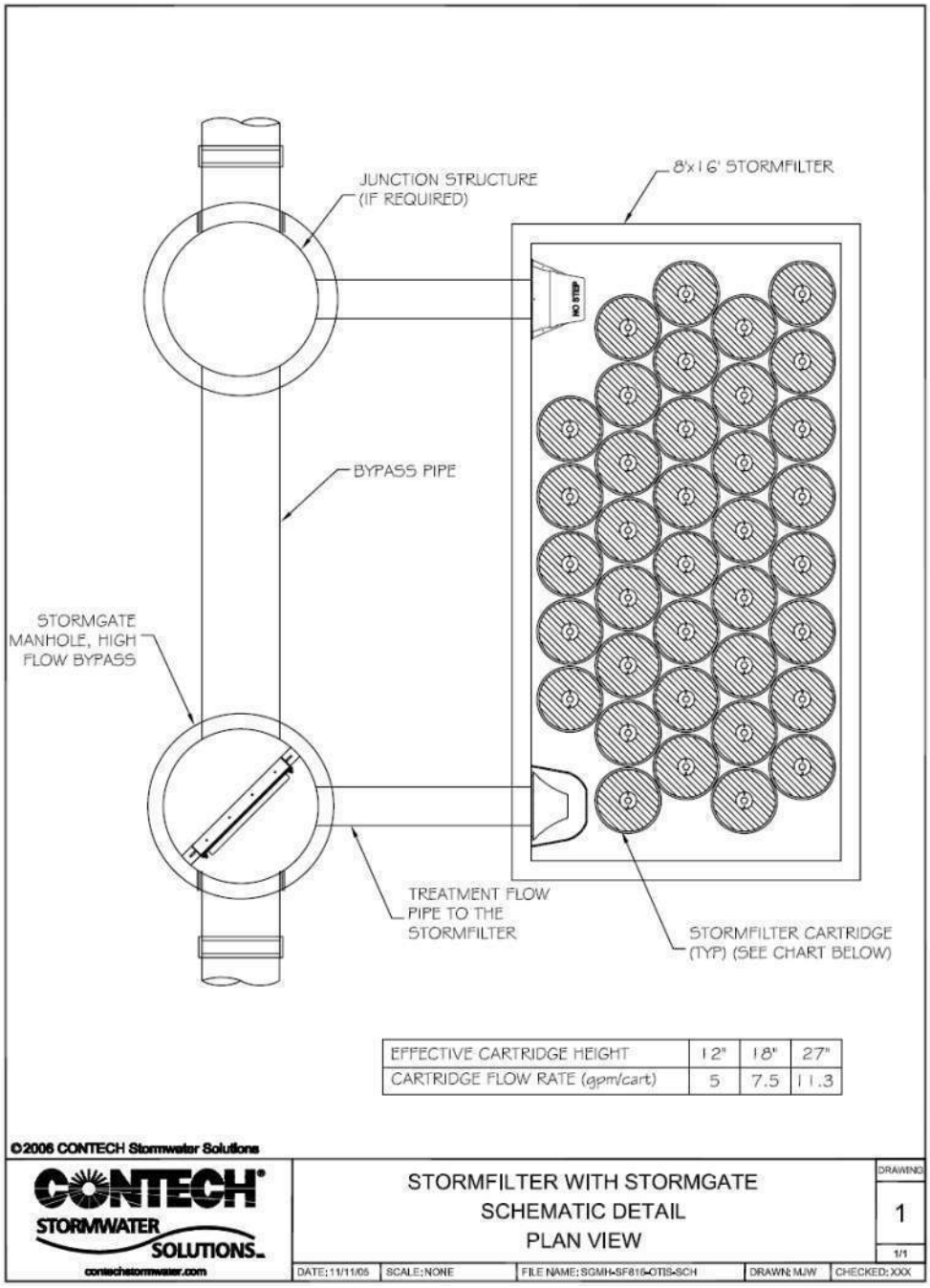


Figure 1. Stormwater Management StormFilter Configuration with Bypass

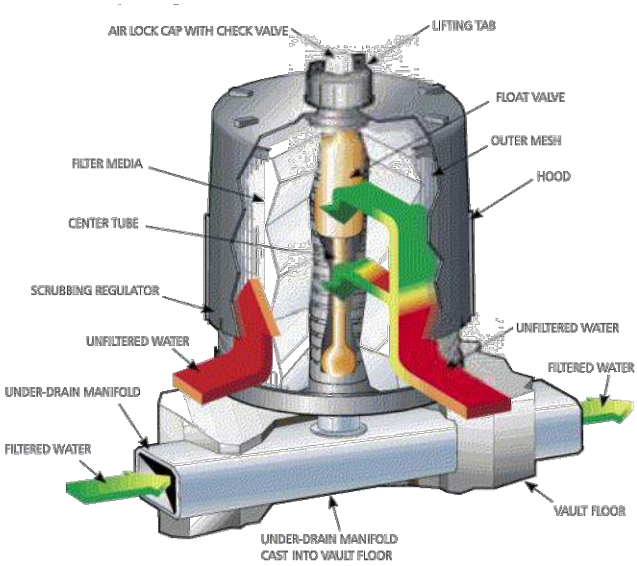


Figure 2. The StormFilter Cartridge

Cartridge Operation:

As the water level in the filtration bay begins to rise, stormwater enters the StormFilter cartridge. Stormwater in the cartridge percolates horizontally through the filter media and passes into the cartridge's center tube, where the float in the cartridge is in a closed (downward) position. As the water level in the filtration bay continues to rise, more water passes through the filter media and into the cartridge's center tube. Water displaces the air in the cartridge and it purges from beneath the filter hood through the one-way check valve located in the cap. Once water fills the center tube there is enough buoyant force on the float to open the float valve and allow the treated water to flow into the under-drain manifold. As the treated water drains, it tries to pull in air behind it. This causes the check valve to close, initiating a siphon that draws polluted water throughout the full surface area and volume of the filter. Thus, water filters through the entire filter cartridge throughout the duration of the storm, regardless of the water surface elevation in the filtration bay. This continues until the water surface elevation drops to the elevation of the scrubbing regulators. At this point, the siphon begins to break and air quickly flows beneath the hood through the scrubbing regulators, causing energetic bubbling between the inner surface of the hood and the outer surface of the filter. This bubbling agitates and cleans the surface of the filter, releasing accumulated sediments on the surface, flushing them from beneath the hood, and allowing them to settle to the vault floor.

Adjustable cartridge flow rate:

Inherent to the design of the StormFilter is the ability to control the individual cartridge flow rate with an orifice-control disc placed at the base of the cartridge. Depending on the treatment requirements and on the pollutant characteristics of the influent stream as

specified in the CONTECH *Product Design Manual*, operators may adjust the flow rate through the filter cartridges. By decreasing the flow rate through the filter cartridges, the influent contact time with the media is increased and the water velocity through the system is decreased, thus increasing both the level of treatment and the solids removal efficiencies of the filters, respectively (de Ridder, 2002).

Recommended research and development:

Ecology encourages CONTECH to pursue continuous improvements to the StormFilter. To that end, CONTECH recommends the following actions:

- Determine, through laboratory testing, the relationship between accumulated solids and flow rate through the cartridge containing the ZPG™ media. **Completed 11/05.**
- Determine the system's capabilities to meet Ecology's enhanced, phosphorus, and oil treatment goals.
- Develop easy-to-implement methods of determining that a StormFilter facility requires maintenance (cleaning and filter replacement).

Contact Information:

Applicant Contact: Jeremiah Lehman
Contech Engineered Solutions
11835 NE Glenn Widing Drive
Portland, OR, 97220
503-258-3136
jlehman@conteches.com

Applicant Web link http://www.conteches.com/

Ecology web link: http://www.ecy.wa.gov/programs/wq/stormwater/newtech/index.html

Ecology Contact: Douglas C. Howie, P.E.
Department of Ecology
Water Quality Program
(360) 407-6444
douglas.howie@ecy.wa.gov

Revision History

Date	**Revision**
Jan 2005	Original Use Level Designation
Dec 2007	Revision
May 2012	Maintenance requirements updated
November 2012	Design Storm and Maintenance requirements updated
January 2013	Updated format to match Ecology standard format
September 2014	Added Peak Diversion StormFilter Alternate Configuration
November 2016	Revised Contech contact information
April 2017	Revised sizing language to note sizing based on Off-line calculations

SEPARATOR SHEET

APPENDIX C

Geotechnical Report

Pacific Lifestyle Homes, Inc.
Geotechnical Engineering Evaluation

Monte Verde Subdivision
22205 NE 28th St, Camas WA 98607
Camas, Washington 98607

True North Project No. 22-0111-1
July 2022 (revised July 2022)

202 E Evergreen Blvd, Suite B, Vancouver, WA 98660 - 360-984-6584 - www.tnorthgeo.com

July 12, 2022 (revised July 31, 2022)

Pacific Lifestyle Homes, Inc
11815 NE 99th Street, Suite 1200
Vancouver, WA 98682

Attn: Mr. Nick Peets

Subject: Geotechnical Engineering Evaluation
Monte Verde Subdivision
22205 NE 28th St, Camas, WA 98607
Clark County Parcel No. 173184000
True North Project # 22-0111-1

Dear Mr. Peets:

At your request, True North Geotechnical Services (True North) is providing you with this report summarizing our geotechnical services for the proposed new Monte Verde Subdivision residential development to be located at the above-mentioned address in Camas, Washington (site). The purpose of our services was to provide a geotechnical evaluation of the site as it pertains to the proposed new development.

We have endeavored to prepare this report in accordance with generally accepted geotechnical engineering practices at the time we prepared it, for the exclusive use of Pacific Lifestyle Homes, Inc. (PLH), the owner, and their agents, for specific application to this project. Use or reliance upon this report by a third party is at their own risk. True North does not make any representation or warranty, express or implied, to such other parties as to the accuracy or completeness of this report or the suitability of its use by such other parties for any purpose whatever, known or unknown, to True North.

Based on the results of our study, development of the site with the proposed buildings and associated parking and utilities is feasible provided the recommendations in this report are included in the project design and implemented during construction. The chief geotechnical concerns of note associated with the project are ensuring foundations are bearing on dense, competent native soils and designing a stormwater system that meets the needs of the site while taking into account the depth of groundwater within the lower, southern portion of the site.

The attached report includes a summary of our project understanding, geologic site reconnaissance, subsurface explorations, and our conclusions regarding the expected effect that the proposed lot development will have on the site.

PURPOSE AND SCOPE OF WORK

The purpose of our services was to provide a geotechnical evaluation of the site as it pertains to the proposed new development. This report includes a summary of our project understanding, geologic site reconnaissance, subsurface exploration, our conclusions regarding the effects of the proposed lot development on the site, and recommendations for design and construction.
The following describes our specific scope of work that was completed:

- **Geologic Map and Literature Review**: We reviewed published geologic and geologic hazard mapping for the site.
- **Test Pit Excavations:** We completed eight (8) test pit excavations on the property. The test pit excavations extended to depths ranging from about 6 to 12 feet below the ground surface (bgs).
- **Laboratory Testing:** Samples collected from the borings were returned to our office for further examination including classification in general accordance with the Unified Soil Classification, Visual-Manual Procedure. Select samples were subjected to laboratory testing, including natural moisture content analysis, and fines content analysis.
- **Analysis:** Data collected during the literature research, subsurface explorations, and laboratory testing were used to develop site-specific geotechnical design parameters and construction recommendations.
- **Report Preparation:** This Geotechnical Engineering Evaluation summarizes the results of our explorations and analyses, including information relating to the following:
    - Exploration logs and site plan with exploration locations
    - Laboratory test results
    - Summary of interpreted surface and subsurface conditions
    - Shallow foundation design recommendations
        - Minimum embedment and allowable bearing pressure
        - Estimated settlement
        - Sliding coefficient and passive earth pressure
    - Subsurface drainage requirements
    - Earthwork recommendations
        - Temporary and permanent slope inclinations
        - Structural fill materials and preparation
        - Suitability of native and on-site soils for reuse as structural fill
        - Wet weather/conditions consideration
    - Foundation, slab and pavement subgrade preparation recommendations
    - Flexible and rigid pavement design recommendations
    - Utility trench excavation and backfill recommendations for associated utilities
    - Seismic design criteria and design considerations

PROJECT UNDERSTANDING

True North understands that you are planning to subdivide an existing City of Camas/Clark County Tax Parcel, No. 173184000, comprising approximately 8.84 acres.

True North's understanding of the proposed development is based on a review of a "Preliminary Plat" for the project, prepared by PLS Engineering, dated October 6, 2021. We understand that the proposed project consists of the subdivision of the existing lot into 34 new lots. The new lots will range in size from approximately to 5900 to 8300 square-feet, and will each accommodate one single-family home. An existing Bonneville Power Administration (BPA) transmission line easement bisects the site, where we understand no new lots will be developed, and instead a shared park area will be constructed. We understand that one new private roadway, NW Noble Ave, is planned to provide access to the lots from NE 28th Street, where some frontage improvements to NE 28th Street will be also be completed. In general, we understand that utilities are planned below the new roadways. The site with respect to existing nearby features is shown in the attached Vicinity Map, Figure 1. The location of our explorations with respect to existing site conditions and boundaries is shown on the attached Figure 2, Site and Exploration Plan.

We anticipate the future homes at all lots will have relatively short driveways to the new private roadway and will be supported by conventional concrete spread footings. We also understand that the stormwater management is planned for the lots at a planned storm facility tract located at the southwest corner of the site. Based on our understanding of proposed development, we anticipate cuts and fills of less than 4 feet across the site. The purpose of our explorations was to evaluate subsurface conditions and provide geotechnical recommendations for design and construction, including site preparation and support of the proposed new development.

SITE CONDITIONS

Geologic Setting

The site is located in the eastern margin of the Portland Basin, a structural basin with basalt bedrock overlain by sediment associated with repeated glacial outburst flooding of the Columbia River and its tributaries. The last of these outburst flooding events, known as the Missoula Floods, occurred about 10,000 years ago. The flood deposits include layers of clay, silt, sand, and gravel. Some layers may include boulders up to 8 feet in diameter.

In the immediate vicinity of the site, the near surface soils are mapped as Pliocene-age gravel facies (Qfg), consisting of unconsolidated bouldery pebble to cobble gravel, underlain at depth by Pleistocene- or Pliocene-age unconsolidated to semi-consolidated pebble to boulder conglomerate (QTc).

Surface Conditions

The site consists of the above-mentioned parcel, which comprises approximately 8.84 acres located on the south side of NE 28th Street. There is a 0.37 acre parcel currently developed with a

manufactured home at the northeastern extent of the site, which includes a driveway. The parcel to the west of the site is developed with a single family home, detached garage, and two outbuildings, including a driveway. The parcel to the east of the site is undeveloped and owned by Clark County Parks.

The ground surface at the site slopes gently towards the south at a gradient of approximately 0 to 10 percent. The site ranges in elevation from about 286 feet above mean sea level (AMSL) at the northern end of the property to about 238 feet AMSL at the southern extent. The majority of the site is open pasture and the southernmost quarter of the site is lightly wooded, consisting of undergrowth, shrubs, and tall deciduous and evergreen trees.

Subsurface Conditions

On May 6th, 2022, we visited the site to excavate eight test pits and to perform two infiltration tests (see attached Site Plan, Figure 2). The test pit explorations, designated TP-1 through TP-8, were excavated to maximum depths between about 6 and 12 feet bgs. The approximate test pit locations are shown on Figure 2. Descriptions of field and laboratory procedures and the interpreted exploration logs are included in Attachment A. The following is a generalized description of the subsurface units encountered in our explorations:

TOPSOIL: Dark brown silty topsoil with varying amounts of organics and tree roots was observed at the surface in all our test pits, extending to depths ranging from about 6 to 24 inches bgs.

Silty/Clayey SAND: Dark brown to light brown silty/clayey Sand (SM) with gravel was encountered just below the topsoil in all the test pits, extending to depths of about 4 to 9 feet below grade. Samples from TP-7 and TP-8 contained more clay and silt. Generally, the relative density of this layer was medium dense, with the density increasing with depth, and becoming consistently coarser with depth. The moisture content of eight samples tested from this layer ranged from about 27 to 36 percent. The fines content of one sample from this layer in TP-7 was measured to be about 14 percent.

Sandy GRAVEL: Gray-brown to brown Sandy Gravel (GP) with silt and cobbles was encountered below the sand layer in all test pits extending to the termination depth in all, at about 6 to 12 feet bgs. In general, the relative density of this layer was dense to very dense, and soil particles were observed to consistently increase in size with depth. The moisture content of samples tested from this layer ranged from about 18 to 58 percent. The fines content of one sample from this layer in TP-3 was about 4 percent.

Groundwater

Groundwater was encountered at three of the eight test pit explorations, TP-1, TP-2, and TP-4. At each of these locations, moderate seepage was observed at about 4 feet bgs and heavy seepage was encountered at approximately 5 to 7 feet bgs. These three test pits were all located within the lower, southern portion of the site. Groundwater was not encountered in the remaining five test pits, which were excavated to depths of up to 12 feet bgs. Generally, we expect the depth to groundwater to increase as one moves north and to higher elevations within the property. Based on a review of nearby well logs as well as Clark County data, the static groundwater level at the property is mapped at about 10 to 20 feet bgs, although zones of isolated restrictive layers may occur, resulting in seasonally higher perched water levels at times.

Infiltration Testing

Infiltration testing was completed in TP-3 and TP-7 at depths of about 5 and 2 feet bgs, respectively. The infiltration tests were conducted within 6-inch outside diameter PVC pipes embedded into the underlying soils using the single-ring falling head method, in general accordance with the 2015 Clark County Stormwater Manual. Water was placed into each pipe to achieve a minimum 6-inch-high column of water (head). After a period of saturation, the height of the water column in each pipe was measured initially and at regular timed intervals to determine the rate of water infiltration into the soil. Results of the field infiltration testing are presented in Table 1.

Table 1. Infiltration Testing Results

Location	Depth of Test (feet bgs)	Coefficient of Permeability, k (inches/hour)	Fines Content (percent)	Soil Classifiction[2]
TP-3	5	42.2	14.4	Brown Silty GRAVEL with Sand and Cobbles, moist
TP-7	2	0.26	32.3	Brown Silty SAND with Gravel, damp

[1] Average rate after saturation. [2] Based on visual-manual classification and limited lab testing

The recommended coefficients of permeability, k, presented in Table 1 have been determined using the guidelines presented in CCSM. It is recommended that the designer also include correction factors to account for the level of maintenance, type of system, vegetation, siltation, etc., as necessary.

Hydrologic Soil Properties

According to the USDA Web Soil Survey, the near-surface soils at the site are generally identified as Lauren Loam, which generally consists of soils classified as gravelly loamy coarse sand at the approximate test depths and are assigned the hydrologic soil group “B” based on drainage and other properties, indicating the soils have a moderately high to high capacity to transmit water.

For the purposes of the stormwater system design using the Western Washington Hydrologic Model (WWHM), it is our opinion, based on the results of our explorations, infiltration testing, and

laboratory testing, that the native near-surface soil conditions observed in our explorations can generally be classified as Soil Group 4 (SG4).

Geologic Hazards

The following provides a geologic hazard review for the subject site. The geologic hazard review as based on our site reconnaissance and explorations, as well as a review of publicly available published literature and maps.

Slope and Landslide Hazards:

For the most part the site is relatively level, with no slopes exceeding 15 percent within the site boundaries, or at adjacent lots. As a result, slope and landslide hazards are not a concern at the property.

Seismic Hazards:

The following seismic hazards have been considered as part of our geologic hazards review for the project site:

Ground Motion Amplification: Based on a review of Clark County Maps Online, the site is designated as seismic Site Class "C". Based on the presence of dense cobbly/gravelly soils at shallow depths in our explorations, it is our opinion that Site Class "C" is indeed appropriate for use at the site. The seismic design parameters, in accordance with the 2018 IBC (with Washington State amendments), are summarized in Table 2.

Table 2. 2018 IBC Seismic Design Parameters

Location	Short Period	1-Second
Maximum Credible Earthquake Spectral Acceleration	S_s = 0.793 g	S_1 = 0.350 g
Site Class	C	
Site Coefficient	F_a = 1.2	F_v = 1.5
Adjusted Spectral Acceleration	S_{MS} = 0.951 g	S_{M1} = 0.524 g
Design Spectral Response Acceleration Parameters	S_{DS} = 0.634 g	S_{D1} = 0.350 g

g – acceleration due to gravity

Liquefaction: While relatively shallow groundwater was encountered at the site, based on the relative density and grain size of the soils encountered in our explorations, we consider the potential for liquefaction settlement within the site boundaries to be low. Indeed, site is mapped as having a "very low" liquefaction susceptibility based on the Liquefaction Susceptibility Map of Clark County.

CONCLUSIONS AND RECOMMENDATIONS

Geotechnical Design and Construction Considerations

Based on the results of our site reconnaissance, subsurface explorations, and geologic map review, it is our opinion that the planned single-family residential development of the site within the proposed new lots and the associated utilities, access roads and driveways are feasible provided the recommendations in this report are included in the project design and implemented during construction. The chief geotechnical concerns of note associated with the project are ensuring foundations are bearing on competent dense native soils and designing a stormwater system that meets the needs of the site while taking into account the depth of groundwater within the lower portion of the site. Our opinion is based on field observations and subsurface explorations completed by True North and review of the following documents and information sources: County soils and groundwater mapping, a published geologic map, and our understanding of the proposed development plans.

Site Preparation

After any surface and near surface water sources have been controlled, the construction areas should be cleared and stripped of organic matter, and other deleterious materials. Silt fences, hay bales, buffer zones of natural growth, sedimentation ponds, and granular haul roads should be used as required to reduce sediment transport during construction to acceptable levels.

Where present, existing topsoil, buried structures, and other disturbed surface materials should be stripped and removed from proposed development locations and for a five-foot-margin around such areas. Based on our explorations, the depth of stripping may range from 6 to up to 24 inches, although greater stripping depths may be required if loose or soft materials are encountered, abandoned utilities or other embedded structures, or where mature trees and their associated roots are removed. Deleterious materials encountered during site preparation should be removed from the subgrade soils and hauled off site for disposal. Stripped material should be transported off site for disposal or stockpiled for use in landscaped areas. If stripping operations occur during wet weather, a generally greater stripping depth might be required in order to remove disturbed moisture sensitive soils; therefore, stripping is best performed during a period of dry weather.

Subgrade Verification

Following site preparation, including removal of all topsoil/till zone and compaction of the exposed subgrade and prior to placing aggregate base for the foundations, building pad, or pavement section, the exposed subgrade should be evaluated. The subgrades should be evaluated by qualified True North personnel using a steel foundation probe, proofroll, or other acceptable method. Unsuitable areas identified during the field evaluation should be re-compacted to or be excavated to firm ground and replaced with structural fill.

Wet/Freezing-Weather/Wet-Soil Conditions

Due to the presence of fine-grained silt and clay in the near-surface materials at the site, construction equipment may have difficulty operating on the near-surface soils when the moisture content of the surface soil is more than a few percentage points above the optimum moisture required for compaction. Soils that have been disturbed during site preparation activities, or unsuitable areas identified during proofrolling or probing, should be removed and replaced with compacted structural fill.

Site earthwork and subgrade preparation should not be completed during freezing conditions.

Protection of the subgrade is the responsibility of the contractor. Construction of granular haul roads may help reduce further damage to the pavement and disturbance of site soils. The thickness of the granular material for haul roads and staging areas will depend on the amount and type of construction traffic. The actual thickness of haul roads and staging areas should be based on the contractors' approach to site development, and the amount and type of construction traffic. The imported granular material should be placed in one lift over the prepared, undisturbed subgrade and compacted using a smooth-drum, non-vibratory roller. A geotextile fabric should be used to separate the subgrade from the imported granular material in areas of repeated construction traffic.

Excavations

Where required, temporary soil cuts associated with site excavations or regrading activities should be adequately sloped back to prevent sloughing and collapse, unless a shoring box or other suitable excavation side wall bracing is provided. It is the responsibility of the contractor to ensure that excavations are properly sloped or braced for worker safety protection, in accordance with OSHA safety guidelines.

Structural Fill

Structural fill includes any fill materials placed under footings, pavements, or driveways and backfill over the embedded mat foundation. Typical materials used for structural fill include: clean, well-graded sand and gravel; clean sand; crushed rock; controlled-density fill (CDF); lean-mix concrete; and various soil mixtures of silt, sand, and gravel. Use of the on-site soils as structural fill may be feasible, provided they are properly moisture conditioned prior to placement and compaction.

Imported granular structural fill should consist of angular pit or quarry run rock, crushed rock, or crushed gravel and sand that is fairly well graded between coarse and fine particle sizes. The fill should contain no organic matter or other deleterious materials, have a maximum particle size of one inch, and have less than 5 percent passing the U.S. No. 200 Sieve. In deep excavations, or where subgrade soils require stabilization, the particle size may be increased to four inches. The percentage of fines can be increased to 12 percent of the material passing the U.S. No. 200 Sieve

if placed during dry weather and provided the fill material is moisture-conditioned, as necessary, for proper compaction. The material should be placed in lifts with a maximum uncompacted thickness of 12 inches and be compacted to not less than 95 percent of the maximum dry density, as determined by ASTM D 1557. During the wet season or when wet subgrade conditions exist, the initial lift thickness may be increased to 24 inches and should be compacted by rolling with a smooth-drum, nonvibratory roller.

Foundations

Continuous-wall and isolated-spread footings should be at least 12 and 24 inches wide, respectively. For frost protection, the footings should be founded at least 12 inches below the lowest adjacent grades or deeper if required by local building code. The footings should be founded below an imaginary line project at a 1H:1V slope from the base of any adjacent, parallel utility trenches.

Footings should bear on the near-surface silt or gravelly clay or structural fill placed in accordance with our recommendations. Footings should be sized for an allowable bearing capacity of 1,500 psf. We estimate post construction settlements will be less than one inch for our recommended allowable bearing capacity. We estimate that the differential settlement will be approximately half of the total settlement. Our recommended bearing capacity is based on limiting settlements and includes a minimum factor of safety of 3 against ultimate bearing failure.

Lateral loads acting on the foundations can be resisted by passive earth pressures on the sides of the foundation and by friction along the soil-rock-concrete interface at the base of the foundation. We recommend using an allowable passive earth pressure of 250 pounds per cubic foot (pcf) for foundations confined by the near-surface silty sand or structural fill placed in accordance with our recommendations. We recommend an allowable coefficient of friction of 0.35 for foundations. In order to develop these capacities, concrete must be poured neat in excavations, the adjacent grade must be level, and the static ground water level must remain below the base of the footing throughout the year. The passive pressure within the upper foot of embedment should be neglected. These allowable lateral resistance values include a factor of safety of 1.5.

Slab-on-grade Floors

Satisfactory subgrade support for lightly-loaded building floor slabs can be obtained on the undisturbed native soil or on engineered structural fill. A subgrade modulus of 125 pounds per cubic inch may be used to design floor slabs.

A minimum 6-inch-thick layer of drain rock should be placed and compacted over the prepared subgrade to assist as a capillary break and blanket drain. The drain rock may include a capping layer of clean ¾ inch minus crushed rock that contains no more than 5% fines. The drain rock

and capping rock should be placed in one lift and compacted until well-keyed, about 90% of the maximum dry density as determined by ASTM D698.

A vapor retarder manufactured for use beneath floor slabs should be installed according to the manufacturer's recommendations. Careful attention should be made during construction to prevent perforating the retarder, and to seal edges and utility penetrations. We recommend following ACI 302.1, Chapter 3 with regard to installing a vapor retarder.

Pavement Design

The following pavement design recommendations are based on our experience with similar facilities and subgrade conditions.

For automobile parking areas, we recommend a pavement section consisting of 3 inches of asphaltic concrete (AC) over 8 inches of crushed rock base (CRB) or 5 inches of Portland Cement concrete (PCC) over 5 inches of crushed rock base (CRB). For truck traffic areas, the pavement section should consist of 4 inches of AC over 12 inches of CRB or 6 inches of PCC over 8 inches of CRB. These recommended pavement sections are based on the assumption that the subgrade consists of firm structural fill or compacted native subgrade and that the pavement will be constructed during the dry summer months. Proofrolling should be used to evaluate pavement subgrade. Any soft areas disclosed by proofrolling will likely need to be reworked. Some contingency should be provided for the repair of any soft areas. If pavement construction is scheduled for the wet season, it will be necessary to increase the above-recommended base course sections.

AC and CRB materials should conform to WSDOT specifications. All CRB should be compacted to at least 95 percent of the modified proctor ASTM D-1557 laboratory test standard.

Permanent, properly installed drainage is also an essential aspect of pavement design and construction. All paved areas should have positive drainage to prevent ponding of surface water and saturation of the base course. This is particularly important in cut sections or at low points within the paved areas, such as around stormwater catch basins.

Drainage

The Contractor should be made responsible for temporary drainage of surface water and groundwater as necessary during construction to prevent standing water and/or erosion at the site.

As a matter of good construction practice, we recommend that perimeter drains be installed for all buildings. Perimeter drains should consist of perforated drainpipe embedded in a zone of free draining fill that is wrapped in a non-woven geotextile filter. The pipe should be connected to a tightline drainpipe leading to storm drain facilities. Foundation and crawl space drainage should

be sloped to drain to a sump or low point drain outlet. Water should not be allowed to pond within crawl spaces. Roof drains should be connected to a tightline drainpipe leading to storm drain outlet facilities.

Water should not be allowed to "pond" or collect anywhere on the site. The ground surface around structures should be sloped to drain away from building foundations for a distance of at least 5 feet. Surface water should be directed away from all buildings into drainage swales or other approved drainage areas. "Trapped" planting areas should not be created next to any buildings without providing means for drainage.

Soil Erosion

Site-specific erosion control measures should be implemented to address the maintenance of slopes or exposed areas. This may include silt fence, bio-filter bags, straw wattles, or other suitable methods. During construction, all exposed areas should be well compacted and protected from erosion. Temporary slopes or expose areas may be covered with straw, crushed aggregate, or rip in localized areas to minimize erosion.

Finished slopes should be vegetated as soon as possible with erosion-resistant native grasses and plants. Once established, slope vegetation should be properly maintained. Concentrated water should be prevented from flowing over slope faces.

CONSTRUCTION OBSERVATIONS

Satisfactory earthwork performance depends on the quality of construction. Sufficient monitoring of the contractor's activities is a key part in ensuring that work is completed in accordance with the construction drawings and specifications. We recommend that True North observe that the subsurface conditions observed during our site investigation are consistent with those encountered during construction, and that foundation subgrades are suitable for placement of structural fill, rebar, or concrete for the new structures.

The City of Camas and/or Clark County may require a final letter of geotechnical compliance before they will finalize a permit. If such a letter is required, a representative from True North MUST observe foundation subgrades PRIOR to concrete being poured for the foundation. If True North does not perform this observation, we cannot provide a final letter of geotechnical compliance, and a permit will not be eligible for final sign-off. It is the owner's responsibility to ensure that True North be notified in a timely manner (i.e., at least 48 hours prior to the required site observation) of the need for our services on site during construction.

LIMITATIONS

We have prepared this report for use by the owner/developer and other members of the design and construction team for the proposed Monte Verde Subdivision. The opinions and recommendations contained within this report are not intended to be construed as a warranty of

subsurface conditions, but are forwarded to assist in the planning and design process. The conclusions and recommendations contained in this report are based on our understanding of the currently proposed project, as derived from written and verbal information supplied to us by you.

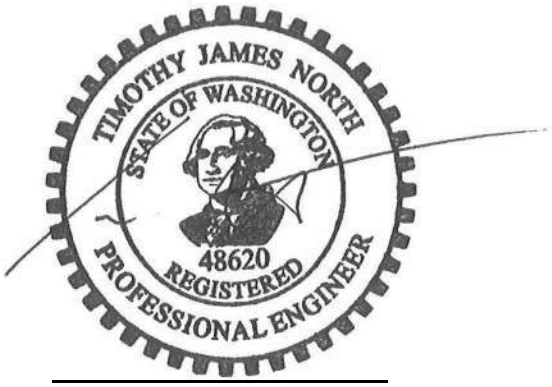
The conclusions and recommendations contained in this report are based on our understanding of the currently proposed project and potential future development, as derived from written and verbal information supplied to us by you. When the design has been finalized, we recommend that we review the design and specifications to see that our recommendations have been interpreted and implemented as intended. If design changes are made, we request that we be retained to review our conclusions and recommendations and to provide a written modification or verification.

Within the limitations of scope, schedule, and budget, our services have been executed in accordance with the generally accepted practices in this area at the time this report was prepared. No warranty or other conditions, express or implied, should be understood.

CLOSING

We appreciate the opportunity to be of service to you. If you have any questions, or if we can be of further assistance to you, please contact us at (360) 984-6584.

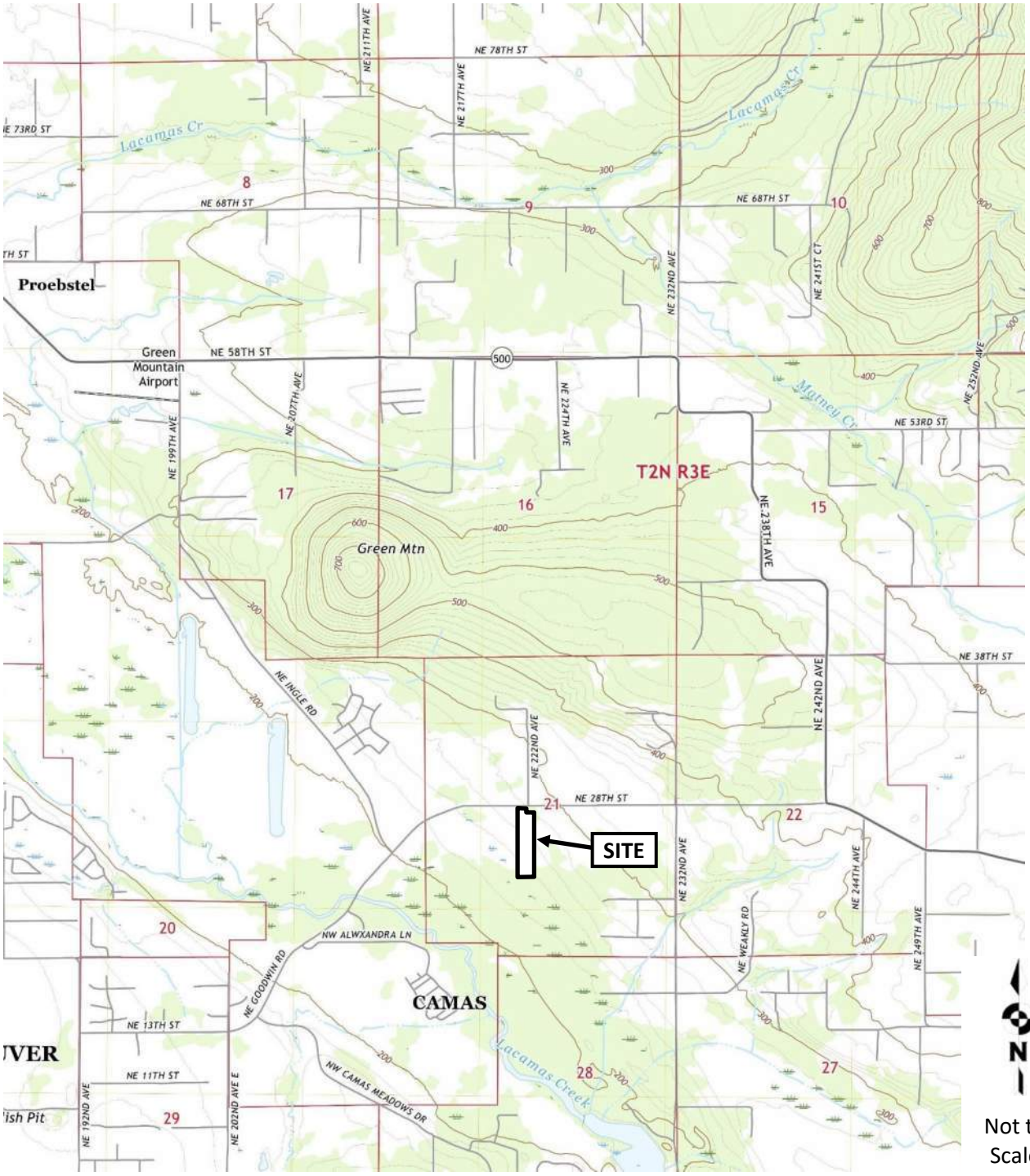
Respectfully Submitted,



Timothy J. North, P.E.
Geotechnical Engineer

Attachment: Figure 1 – Vicinity Map
Figure 2 – Site Plan
Figure 3 – Site Photographs
Appendix A – Field and Laboratory Procedures
Test Pit Logs TP-1 through TP-8

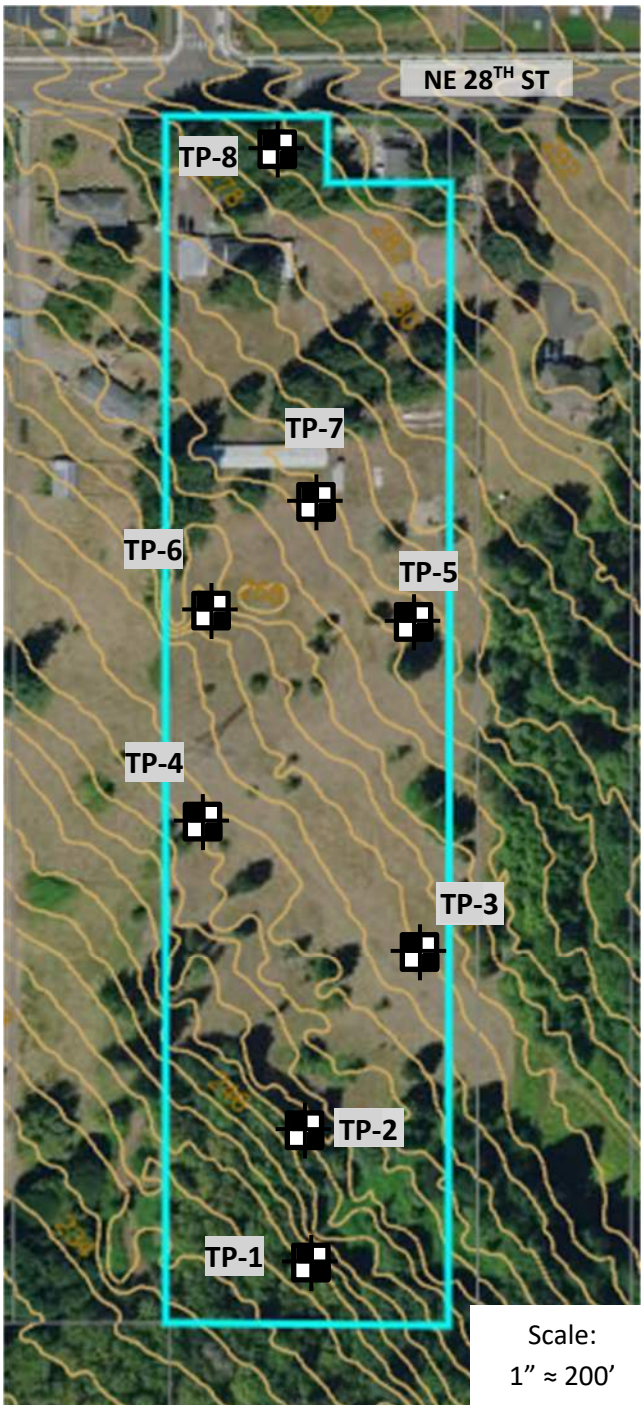
FIGURES



Not to Scale

Source: "Topographic Map of the Lacamas Creek Quadrangle, 7.5 minute series" 2020, United States Geological Survey (USGS).

TRUE NORTH GEOTECHNICAL	Pacific Lifestyle Homes Monte Verde Subdivision Camas, WA	Project # 22-0111-1
202 E Evergreen St, Suite B Vancouver, WA 98660 360-984-6584	July 2022	Figure 1 – Vicinity Map



Scale:
1” ≈ 200’

TP-1 Approximate Exploratory Test Pit Locations, May 6, 2022.

Source: Aerial & Topo – Clark County MapsOnline, accessed July 05, 2022.

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TRUE NORTH GEOTECHNICAL	Pacific Lifestyle Homes Monte Verde Subdivision Camas WA	Project # 22-0111-1
202 E. Evergreen Blvd Suite B Vancouver, WA 98660 360-984-6584	July 2022	Figure 2 –Site Plan

Photo 1. Seepage observed at TP-1.

Photo 2. Seepage ponding at TP-2 during backfill operations.

TRUE NORTH GEOTECHNICAL	Pacific Lifestyle Homes Monte Verde Subdivision Camas, WA	Project # 22-0111-1
202 E Evergreen Blvd, Suite B Vancouver, WA 98660 360-984-6584	July 2022	Figure 3A – Site Photographs (1 of 2)

Photo 3. Cobbles and gravel evident at TP-3.

Photo 4. Infiltration testing at TP-7.

TRUE NORTH GEOTECHNICAL	Pacific Lifestyle Homes Monte Verde Subdivision Camas, WA	Project # 22-0111-1
202 E Evergreen Blvd, Suite B Vancouver, WA 98660 360-984-6584	July 2022	Figure 3B – Site Photographs (2 of 2)

APPENDIX A

Field Exploration Procedures
Laboratory Testing Procedures
Exploration Test Pit Logs

FIELD EXPLORATION PROCEDURES

General

We explored subsurface conditions at the site by excavating eight test pits, designated TP-1 through TP-8, to depths ranging from about 6.0 to 12.0 feet bgs. The test pit explorations were excavated on May 6, 2022 with Deere 75G tracked excavator, owned and operated by Dan Tapani Excavating of Battle Ground, Washington. Upon completion, the test pits were backfilled with excavated soils tamped into place as best possible.

Soil Sampling

A True North representative observed subsurface explorations to record the soil, rock, and groundwater conditions encountered, and to obtain soil samples. Disturbed soil samples were obtained from the sidewalls of the excavation and the excavator bucket at selected depths throughout the explorations. Soil samples were sealed to retain moisture and returned to our laboratory for additional examination and testing.

Field Classification

The observed soils were classified initially on site in general accordance with ASTM D 2488 Description and Identification of Soils (Visual-Manual Procedure). Consistency, color, relative moisture, degree of plasticity, peculiar odors, and other distinguishing characteristics of the soil samples were noted. The terminology used is described in the key and glossary that follow.

Summary Exploration Logs

Results from the test pits are shown in the summary exploration logs. The left-hand portion of a log provides our interpretation of the soil encountered, sample depths, and groundwater information. The right-hand portion of a log shows the results of field and laboratory testing. Soil descriptions and interfaces between soil types shown in summary logs are interpretive, and actual transitions may be gradual.

LABORATORY TESTING PROCEDURES

Soil samples obtained during field explorations are examined in a laboratory, and representative samples may be selected for further testing. The testing program included visual-manual classification and natural moisture content testing.

Visual Manual Classification

Soil samples are classified in general accordance with guidelines presented in ASTM D2488, Standard Practice for Description and Identification of Soils (Visual-Manual Procedure). The physical characteristics of the samples are noted and the field classifications are modified, where necessary, in accordance with ASTM terminology, though certain terminology that incorporates current local engineering practice may be used. The term which best described the major portion of the sample is used to describe the soil type.

Natural Moisture Content

Natural moisture content is determined in general accordance with guidelines presented in ASTM D2216, Standard Test Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass. The natural moisture content is the ratio, expressed as a percentage, of the weight of water in a given amount of soil to the weight of solid particles.

Fines Content

Fines content testing is performed in general accordance with guidelines presented in ASTM D1140, *Standard Test Methods for Determining the Amount of Material Finer than 75-µm (No.200) Sieve in Soils by Washing*. The fines content is the fraction of soil that passes the U.S. Standard Number 200 Sieve. This sieve differentiates fines (silt and clay) from sand and gravel. Soil material that remains on the Number 200 sieve is sand and gravel. Material that passes the sieve is fines. The test is used to refine soil type.

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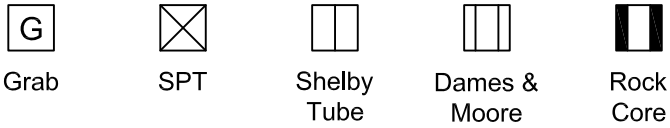
TABLE A1
Key to Test Pit and Boring Terminology and Symbols

MAJOR DIVISIONS			SYMBOLS GRAPH	SYMBOLS LETTER	TYPICAL DESCRIPTION
Coarse Grained Soils: More Than 50% Material Retained on No. 200 Sieve	Gravel and Gravelly Soils: More Than 50% Coarse Fraction Retained on No. 4 Sieve	Clean Gravels (Little or No Fines)		GW	Well-graded Gravels, Gravel-Sand Mixtures, Little or No Fines
				GP	Poorly-graded Gravels, Gravel-Sand Mixtures, Little or No Fines
		Gravels with Fines (Significant Percentage of FIne)		GM	Silty Gravels, Gravel-Sand-Silt Mixtures
				GC	Clayey Gravels, Gravel-Sand-Clay Mixtures
	Sand and Sandy Soils: More Than 50% Coarse Fraction Passing No. 4 Sieve	Clean Sands (Little or No Fines)		SW	Well-graded Sands, Gravelly Sands, Little or No Fines
				SP	Poorly-graded Sands, Gravelly Sands, Little or No Fines
		Sands with Fines (Significant Percentage of FIne)		SM	Silty Sands, Sand-Silt Mixtures
				SC	Clayey Sands, Sand-Clay Mixtures
Fine Grained Soils: More Than 50% Material Passing No. 200 Sieve	Silts and Clays	Liquid Limit Less than 50 percent		ML	Inorganic Silts and Very Fine Sands, Rock Flour, Silty-Clayey Fine Sands, Clayey Silts
				CL	Inorganic Clays of Low to Medium Plasticity, Gravelly Clays, Sandy Clays, Silty Clays
				OL	Organic Silts and Organic Silty Clays of Low Plasticity
	Silts and Clays	Liquid Limit Greater than 50 percent		MH	Inorganic Silts Micaceous or Diatomaceous Fine Sand or Silty Soils
				CH	Inorganic Clays of High Plasticity, Fat Clays
				OH	Organic Clays of Medium to High Plasticity, Organic Silts
				PT	Peat, Humus, Swamp Soils
Topsoil					Humus and Duff Layer
Fill					Highly Variable Constituents

Relative Density of Coarse-Grained Soils	
Relative Density	**N - Blows per Foot**
Very Loose	0 - 4
Loose	4 - 10
Medium Dense	10 - 30
Dense	30 - 50
Very Dense	50+

Consistency of Fine-Grained Soils	
Relative Density	**N - Blows per Foot**
Very Soft	0 - 2
Soft	2 - 4
Medium Stiff	4 -8
Stiff	8 - 15
Very Stiff	15 - 30
Hard	30 - 50
Very Hard	50+

Key to Sampler Type Symbols



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Project Name: PLH - Monte Verde Subdivision		TEST PIT LOG TP-1
Project Location: 22205 NE 28th St, Camas, WA 98607		Project No.: 22-0111-1
Operator: Dan Tapani Excavating	Equipment: Deere 75G with 2 ft bucket	Date Started: 05/6/22
Logged By: LS	Checked By: TJN	Date Completed: 05/6/22

Depth (feet)	Sample Type	Sample No.	Graphic Log	USCS Symbol	Soil Description	Water Content, %	Field Testing	Notes and Lab Data
0	G	S-1			Soft to medium stiff, dark brown silty TOPSOIL with roots and other organics; moist.	37		
1–7	G	S-2		SC	Medium dense, light brown Clayey SAND with gravel; moist.	33		
7	G	S-3		SM	Medium dense, gray-brown Silty SAND with clay; wet.	24		
10	G	S-4		GP	Dense to very dense, gray-brown Sandy GRAVEL with clay; wet.	39		
10.5					Excavation terminated at 10.5 feet bgs. Groundwater encountered at about 7 feet bgs during excavation. Backfilled with excavated soils.			

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Project Name: PLH - Monte Verde Subdivision		TEST PIT LOG TP-2
Project Location: 22205 NE 28th St, Camas, WA 98607		Project No.: 22-0111-1
Operator: Dan Tapani Excavating	Equipment: Deere 75G with 2 ft bucket	Date Started: 05/6/22
Logged By: LS	Checked By: TJN	Date Completed: 05/6/22

Depth (feet)	Sample Type	Sample No.	Graphic Log	USCS Symbol	Soil Description	Water Content, %	Field Testing	Notes and Lab Data
0					Soft to medium stiff, dark brown silty TOPSOIL with roots and other organics; moist.	32	PP = 0.5	
1	G	S-1						
2				SC	Medium dense, light brown Clayey SAND with gravel; moist.			
3								
4	G	S-2				36		
5								
6	G	S-3		GP	Dense, gray-brown Sandy GRAVEL with cobbles; wet.	37		
7					increasing sand with depth, increasing cobble size with depth			
8	G	S-4				28		
9					Excavation terminated at 8.5 feet bgs. Groundwater encountered at about 6 feet bgs during excavation. Backfilled with excavated soils.			
10								
11								
12								
13								
14								
15								

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Project Name: PLH - Monte Verde Subdivision		TEST PIT LOG TP-3
Project Location: 22205 NE 28th St, Camas, WA 98607		Project No.: 22-0111-1
Operator: Dan Tapani Excavating	Equipment: Deere 75G with 2 ft bucket	Date Started: 05/6/22
Logged By: LS	Checked By: TJN	Date Completed: 05/6/22

Depth (feet)	Sample Type	Sample No.	Graphic Log	USCS Symbol	Soil Description	Water Content, %	Field Testing	Notes and Lab Data
					Soft to medium stiff, dark brown silty TOPSOIL with organics; moist.			
1	G	S-1		SC	Medium dense, light brown Clayey SAND with gravel; moist.	22	PP = 0.5	
2								
3					increasing gravel and cobble content with depth			
4	G	S-2				27	PP = 0.5	
5	G	S-3		GP	Dense, gray-brown Sandy GRAVEL with cobbles; moist.			Fines content = 4%
6								
7	G	S-4				18		
8								
9					increasing cobble size with depth			
10								
11					Excavation terminated at 11 feet bgs. Groundwater not encountered. Backfilled with excavated soils.			
12								
13								
14								
15								

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Project Name: PLH - Monte Verde Subdivision		TEST PIT LOG TP-4
Project Location: 22205 NE 28th St, Camas, WA 98607		Project No.: 22-0111-1
Operator: Dan Tapani Excavating	Equipment: Deere 75G with 2 ft bucket	Date Started: 05/6/22
Logged By: LS	Checked By: TJN	Date Completed: 05/6/22

Depth (feet)	Sample Type	Sample No.	Graphic Log	USCS Symbol	Soil Description	Water Content, %	Field Testing	Notes and Lab Data
					Soft to medium stiff, dark brown silty TOPSOIL with organics; moist.			
1	G	S-1		SC	Medium dense, light brown Clayey SAND with gravel; moist.	25	PP = 0.5	
2							PP = 0.5	
3								
4	G	S-2				30	PP = 1.0	
5				GP	Dense, gray-brown Sandy GRAVEL with cobbles; moist.			
6	G	S-3				30		
					Excavation terminated at 6 feet bgs. Groundwater not encountered. Backfilled with excavated soils.			
7								
8								
9								
10								
11								
12								
13								
14								
15								

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Project Name: PLH - Monte Verde Subdivision		TEST PIT LOG TP-5
Project Location: 22205 NE 28th St, Camas, WA 98607		Project No.: 22-0111-1
Operator: Dan Tapani Excavating	Equipment: Deere 75G with 2 ft bucket	Date Started: 05/6/22
Logged By: LS	Checked By: TJN	Date Completed: 05/6/22

Depth (feet)	Sample Type	Sample No.	Graphic Log	USCS Symbol	Soil Description	Water Content, %	Field Testing	Notes and Lab Data
					Soft to medium stiff, dark brown silty TOPSOIL with organics; moist.			
1	G	S-1		SC	Medium dense, brown Clayey SAND; moist.	33	PP = 0.5	
2	G	S-2				27	PP = 0.5	
3								
4	G	S-3			Medium dense, brown Clayey SAND with gravel and cobbles; moist.	26	PP = 0.75	
5								
6				SC				
7								
8								
9	G	S-4		GP	Dense, yellow-gray GRAVEL with sand and clay; moist to wet.	58		
10								
11					Excavation terminated at 10.5 feet bgs. Groundwater not encountered. Backfilled with excavated soils.			
12								
13								
14								
15								

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Project Name: PLH - Monte Verde Subdivision		TEST PIT LOG TP-6
Project Location: 22205 NE 28th St, Camas, WA 98607		Project No.: 22-0111-1
Operator: Dan Tapani Excavating	Equipment: Deere 75G with 2 ft bucket	Date Started: 05/6/22
Logged By: LS	Checked By: TJN	Date Completed: 05/6/22

Depth (feet)	Sample Type	Sample No.	Graphic Log	USCS Symbol	Soil Description	Water Content, %	Field Testing	Notes and Lab Data
0					Soft to medium stiff, dark brown silty TOPSOIL with organics; moist.	29	PP = 0.5	
1	G	S-1						
2				ML/CL	Medium stiff, brown Clayey SILT with sand; moist.		PP = 1.0	
3	G	S-2				26	PP = 1.25	
4								
5								
6								
7				SP	Dense, gray-brown Gravelly SAND with cobbles; moist.			
8								
9					increasing cobble content and size with depth			
10								
11	G	S-3				30		
12					Excavation terminated at 12 feet bgs. Groundwater not encountered. Backfilled with excavated soils.			
13								
14								
15								

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Project Name: PLH - Monte Verde Subdivision		TEST PIT LOG TP-7
Project Location: 22205 NE 28th St, Camas, WA 98607		Project No.: 22-0111-1
Operator: Dan Tapani Excavating	Equipment: Deere 75G with 2 ft bucket	Date Started: 05/6/22
Logged By: LS	Checked By: TJN	Date Completed: 05/6/22

Depth (feet)	Sample Type	Sample No.	Graphic Log	USCS Symbol	Soil Description	Water Content, %	Field Testing	Notes and Lab Data
0					Soft to medium stiff, dark brown silty TOPSOIL with organics; moist.	23		
1	G	S-1						
2					Medium dense, brown Clayey SAND with gravel and cobbles; moist.		PP = 0.25	Infiltration Testing at 2.0 feet bgs
3	G	S-2				33	PP = 1.5	Fines content = 14%
4								
5					increasing gravel and cobble content with depth			
6				SM				
7								
8								
9								
10								
11	G	S-3		GP	Dense, yellow-gray Sandy GRAVEL with clay; moist to wet.	57		
12					Excavation terminated at 12 feet bgs. Groundwater not encountered. Backfilled with excavated soils.			
13								
14								
15								

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Project Name: PLH - Monte Verde Subdivision		TEST PIT LOG TP-8
Project Location: 22205 NE 28th St, Camas, WA 98607		Project No.: 22-0111-1
Operator: Dan Tapani Excavating	Equipment: Deere 75G with 2 ft bucket	Date Started: 05/6/22
Logged By: LS	Checked By: TJN	Date Completed: 05/6/22

Depth (feet)	Sample Type	Sample No.	Graphic Log	USCS Symbol	Soil Description	Water Content, %	Field Testing	Notes and Lab Data
0					Soft to medium stiff, dark brown silty TOPSOIL with organics; moist.	29	PP = 1.0	
1	G	S-1						
2							PP = 0.5	
3	G	S-2			Medium dense, orange-brown Silty SAND with gravel and cobbles; moist.	31	PP = 0.5	
4					increasing gravel and cobble content with depth			
5				SM				
6								
7								
8								
9	G	S-3				25		
					Excavation terminated at 9 feet bgs. Groundwater not encountered. Backfilled with excavated soils.			
10								
11								
12								
13								
14								
15								

SEPARATOR SHEET

APPENDIX D

Operations and Maintenance Manual

Catch Basin

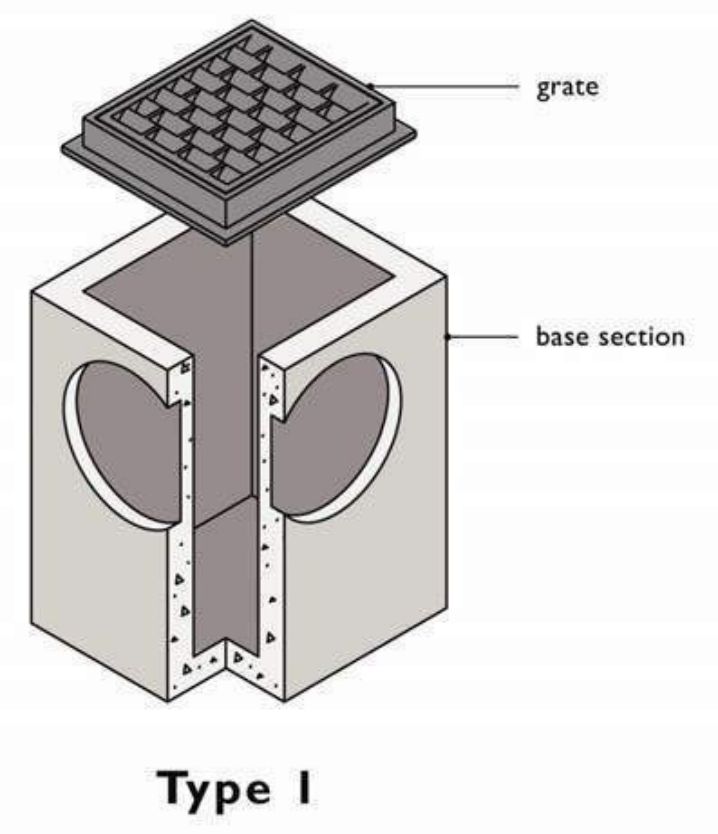
A catch basin is an underground concrete structure typically fitted with a slotted grate to collect stormwater runoff and route it through underground pipes. Catch basins can also be used as a junction in a pipe system and may have a solid lid. There are two types.

A Type 1 catch basin is a rectangular box with approximate dimensions of 3'x2'x5'. Type 1 catch basins are utilized when the connected conveyance pipes are less than 18 inches in diameter and the depth from the gate to the bottom of the pipe is less than 5 feet.

A Type 2 catch basin, also commonly referred to as a storm manhole, is listed separately under "Manhole" in this book.

Catch basins typically provide a storage volume (sump) below the outlet pipe to allow sediments and debris to settle out of the stormwater runoff. Some catch basins are also fitted with a spill control device (inverted elbow on outlet pipe) intended to contain large quantities of grease or debris.

Catch basins are frequently associated with all stormwater facilities.



Key Operations and Maintenance Considerations

- The most common tool for cleaning catch basins is an industrial vacuum truck with a tank and vacuum hose (e.g. Vactor® truck) to remove sediment and debris from the sump.
- A catch basin may be an enclosed space where harmful chemicals and vapors can accumulate. Therefore, if the inspection and maintenance requires entering a catch basin, it should be conducted by an individual trained and certified to work in hazardous confined spaces.

Catch Basin			
Drainage System Feature	Potential Defect	Conditions When Maintenance Is Needed	Minimum Performance Standard
			Note: table spans multiple pages.
General	Trash and Debris	Trash or debris which is located immediately in front of the catch basin opening or is blocking inletting capacity of the basin by more than 10%.	No trash or debris located immediately in front of catch basin or on grate opening.
		Trash or debris (in the basin) that exceeds 60 percent of the sump depth as measured from the bottom of basin to invert of the lowest pipe into or out of the basin, but in no case less than a minimum of six inches clearance from the debris surface to the invert of the lowest pipe.	No trash or debris in the catch basin.
		Trash or debris in any inlet or outlet pipe blocking more than 1/3 of its height.	Inlet and outlet pipes free of trash or debris.
		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 the catch basin.
	Sediment	Sediment (in the basin) that exceeds 60 percent of the sump depth as measured from the bottom of basin to invert of the lowest pipe into or out of the basin, but in no case less than a minimum of 6 inches clearance from the sediment surface to the invert of the lowest pipe.	No sediment in the catch basin.
	Structure Damage to Frame and/or Top Slab	Top slab has holes larger than 2 square inches or cracks wider than 1/4 inch. (Intent is to make sure no material is running into basin.)	Top slab is free of holes and cracks.
		Frame not sitting flush on top slab, i.e., separation of more than 3/4 inch of the frame from the top slab. Frame not securely attached.	Frame is sitting flush on the riser rings or top slab and firmly attached.
	Fractures or Cracks in	Maintenance person judges that structure is unsound.	Basin replaced or repaired to design standards.

	Basin Walls/ Bottom	Grout fillet has separated or cracked wider than 1/2 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.	Pipe is regrouted and secure at basin wall.
	Settlement/ Misalignment	If failure of basin has created a safety, function, or design problem.	Basin replaced or repaired to design standards.
	Vegetation Inhibiting System	Vegetation growing across and blocking more than 10% of the basin opening.	No vegetation blocking opening to basin.
		Vegetation growing in inlet/outlet pipe joints that is more than six inches tall and less than six inches apart.	No vegetation or root growth present.
	Contaminants and Pollution	Any evidence of oil, gasoline, contaminants or other pollutants. Sheen, obvious oil or other contaminants present. • Identify and remove source, AND • Report to Clark County Clean Water Program.	No contaminants or pollutants present.
Catch Basin Cover	Cover Not in Place	Cover is missing or only partially in place. Any open catch basin requires maintenance.	Catch basin cover is closed.
	Locking Mechanism Not Working	Mechanism cannot be opened by one maintenance person with proper tools. Bolts into frame have less than 1/2 inch of thread.	Mechanism opens with proper tools.
	Cover Difficult to Remove	One maintenance person cannot remove lid after applying normal lifting pressure (Intent is to keep cover from sealing off access to maintenance).	Cover can be removed by one maintenance person.
Metal Grates (If Applicable)	Grate Opening Unsafe	Grate with opening wider than 7/8 inch.	Grate opening meets design standards.
	Trash and Debris	Trash and debris that is blocking more than 20% of grate surface inletting capacity.	Grate free of trash and debris.
	Damaged or Missing	Grate missing or broken member(s) of the grate.	Grate is in place and meets design standards.
Oil/Debris Trap (If Applicable)	Dislodged	Oil or debris trap is misaligned with or dislodged from the outlet pipe.	Trap is connected to and aligned with outlet pipe.

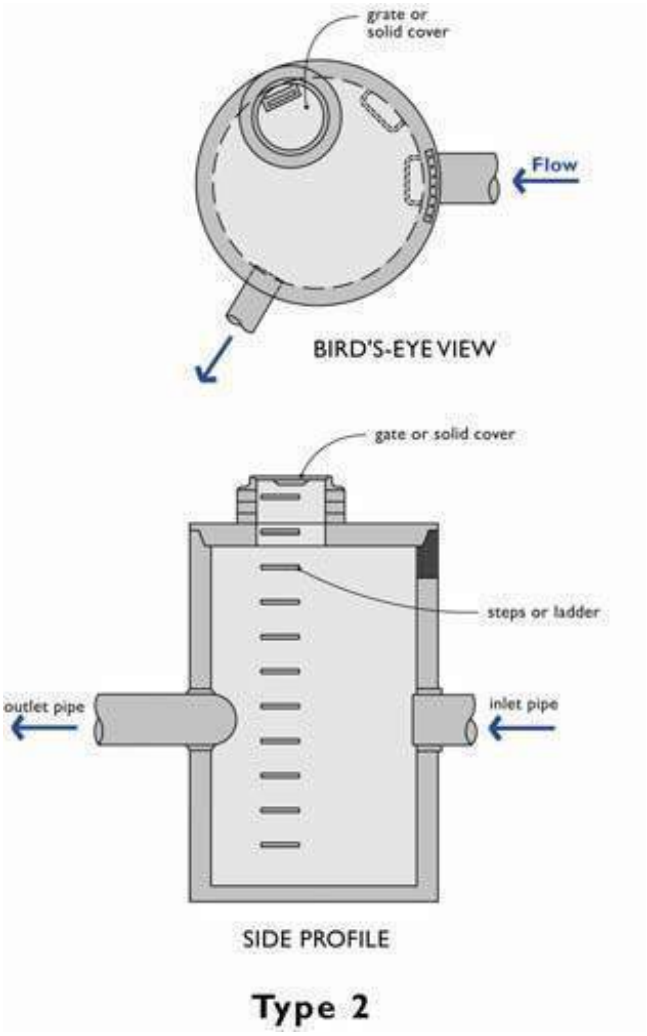
Manhole

A manhole is an underground concrete structure typically fitted with a slotted grate to collect stormwater runoff and route it through underground pipes. Manholes can also be used as a junction in a pipe system and may have a solid lid. A manhole is also known as a Type 2 catch basin.

Manholes are round concrete structures ranging in diameter from 4 feet to 8 feet. They are used when the connecting conveyance pipe is 18 inches or greater or the depth from grate to pipe bottom exceeds 5 feet. Manholes typically have steps mounted on the side of the structure to allow access.

Manholes typically provide a storage volume (sump) below the outlet pipe to allow sediments and debris to settle out of the stormwater runoff. Some manholes are also fitted with a spill control device (inverted elbow on outlet pipe) intended to contain large quantities of grease or oils.

Manholes are often associated with other stormwater facilities.



Key Operations and Maintenance Considerations

- The most common tool for cleaning manholes is a truck with a tank and vacuum hose (Vactor® truck) to remove sediment and debris from the sump.
- A manhole may be an enclosed space where harmful chemicals and vapors can accumulate. Therefore, if the inspection and maintenance requires entering a manhole, it should be conducted by an individual trained and certified to work in hazardous confined spaces.

Manhole			
Drainage System Feature	Potential Defect	Conditions When Maintenance Is Needed	Minimum Performance Standard
			Note: table spans multiple pages.
General	Trash and Debris	Trash or debris which is located immediately in front of the opening or is blocking inletting capacity of the basin by more than 10%.	No trash or debris located immediately in front of manhole or on grate opening.
		Trash or debris (in the basin) that exceeds 60 percent of the sump depth as measured from the bottom of basin to invert of the lowest pipe into or out of the basin, but in no case less than a minimum of six inches clearance from the debris surface to the invert of the lowest pipe.	No trash or debris in the basin.
		Trash or debris in any inlet or outlet pipe blocking more than 1/3 of its height.	Inlet and outlet pipes free of trash or debris.
		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 the catch basin.
	Sediment	Sediment (in the basin) that exceeds 60 percent of the sump depth as measured from the bottom of basin to invert of the lowest pipe into or out of the basin, but in no case less than a minimum of 6 inches clearance from the sediment surface to the invert of the lowest pipe.	No sediment in the basin.
	Structure Damage to Frame and/or Top Slab	Top slab has holes larger than 2 square inches or cracks wider than 1/4 inch. (Intent is to make sure no material is running into manhole.)	Top slab is free of holes and cracks.
		Frame not sitting flush on top slab, i.e., separation of more than 3/4 inch of the frame from the top slab. Frame not securely attached.	Frame is sitting flush on the riser rings or top slab and firmly attached.
	Fractures or Cracks in Basin Walls/ Bottom	Maintenance person judges that structure is unsound.	Basin replaced or repaired to design standards.
		Grout fillet has separated or cracked wider than 1/2 inch and longer than 1 foot at the joint of any inlet/outlet pipe or any evidence of soil particles entering manhole through cracks.	Pipe is regrouted and secure at basin wall.

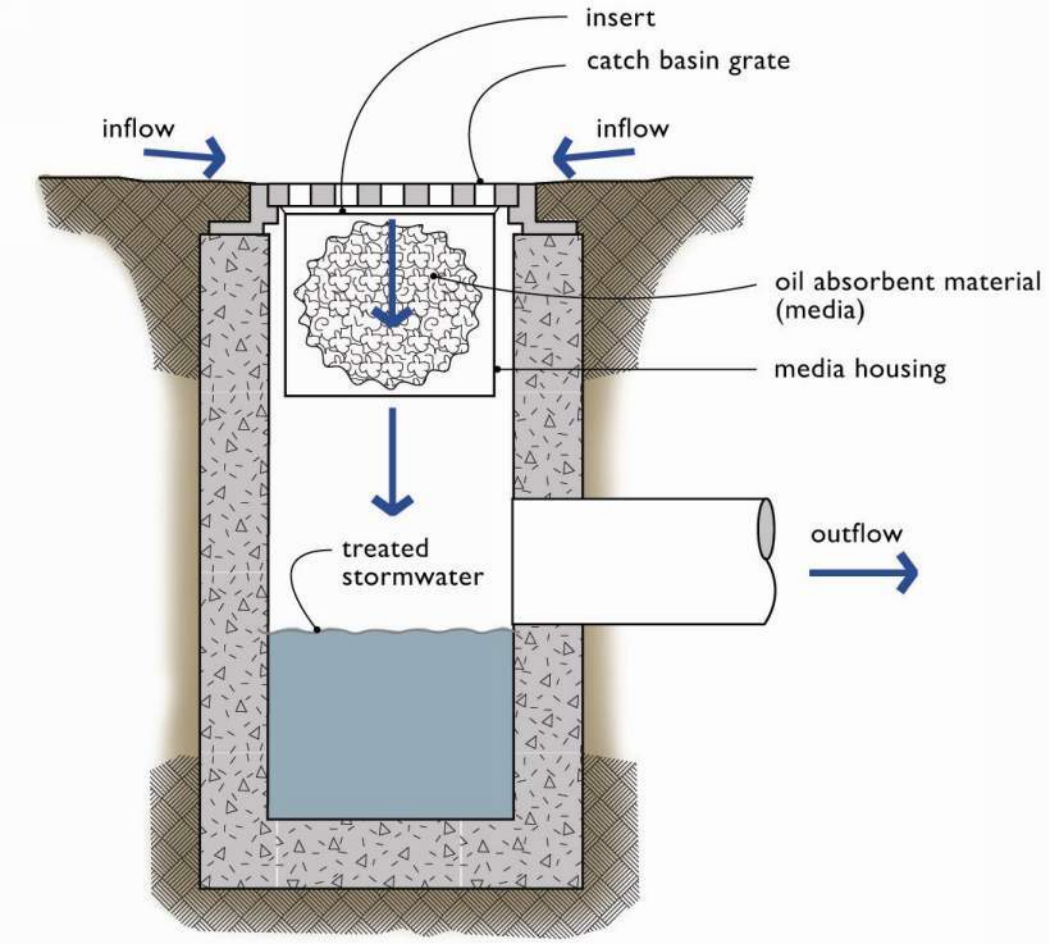
	Settlement/ Misalignment	If failure of manhole has created a safety, function, or design problem.	Manhole replaced or repaired to design standards.
	Vegetation Inhibiting System	Vegetation growing across and blocking more than 10% of the opening.	No vegetation blocking opening to manhole.
		Vegetation growing in inlet/outlet pipe joints that is more than six inches tall and less than six inches apart.	No vegetation or root growth present.
	Contaminants and Pollution	Any evidence of oil, gasoline, contaminants or other pollutants. Sheen, obvious oil or other contaminants present. • Identify and remove source, AND • Report to Clark County Clean Water Program.	No contaminants or pollutants present.
Manhole Cover	Cover Not in Place	Cover is missing or only partially in place. Any open manhole is a safety hazard and requires immediate maintenance.	Manhole cover is closed.
	Locking Mechanism Not Working	Mechanism cannot be opened by one maintenance person with proper tools. Bolts into frame have less than 1/2 inch of thread.	Mechanism opens with proper tools.
	Cover Difficult to Remove	One maintenance person cannot remove lid after applying normal lifting pressure (Intent is to keep cover from sealing off access to maintenance).	Cover can be removed by one maintenance person.
Ladder	Ladder Rungs Unsafe	Ladder is unsafe due to missing rungs, not securely attached to manhole wall, misalignment, rust, cracks, or sharp edges.	Ladder meets design standards and allows maintenance person safe access.
Metal Grates (If Applicable)	Grate Opening Unsafe	Grate with opening wider than 7/8 inch.	Grate opening meets design standards.
	Trash and Debris	Trash and debris that is blocking more than 20% of grate surface inletting capacity.	Grate free of trash and debris.
	Damaged or Missing	Grate missing or broken member(s) of the grate.	Grate is in place and meets design standards.

Catch Basin Insert

Catch basin inserts are used to trap sediment and oil entering catch basins. Most involve some type of filter media and oil-absorbent pads. Filters avoid flooding by overflowing when they become clogged or when there are high storm flows.

Catch basin inserts typically consist of the following components:

- A structure (screened box, brackets, etc.) which contains a pollutant removal medium
- A means of suspending the structure in a catch basin
- A filter medium such as sand, carbon, fabric, etc.
- A primary inlet and outlet for the stormwater
- A secondary outlet for bypassing flows that exceed design flow



Key Operations and Maintenance Considerations

- Catch basin inserts are proprietary; refer to the manufacturer's instructions for inspection and maintenance.
- Some catch basin inserts do not require specialized tools and can be removed and replaced by hand.
- See Catch Basins for additional considerations.

Catch Basin Insert			
Drainage System Feature	Potential Defect	Conditions When Maintenance Is Needed	Minimum Performance Standard
General	Sediment Accumulation	When sediment forms a cap over the insert media of the insert and/or unit.	No sediment cap on the insert media and its unit.
	Trash and Debris Accumulation	Trash and debris accumulates on insert unit creating a blockage/restriction.	Trash and debris removed from insert unit. Runoff freely flows into catch basin.
	Media Insert Not Removing Oil	Effluent water from media insert has a visible sheen.	Effluent water from media insert is free of oils and has no visible sheen.
	Media Insert Water Saturated	Catch basin insert is saturated with water and no longer has the capacity to absorb.	Media insert has been replaced.
	Media Insert Oil Saturated	Media oil saturated due to petroleum spill that drains into catch basin.	Media insert has been replaced.
	Media Insert Use Beyond Normal Product Life	Media has been used beyond the typical average life of media insert product.	Media removed and replaced at regular intervals (frequency depending on insert product).

Key Operations and Maintenance Considerations

- The most common tool for cleaning hydrodynamic separators is a truck with a tank and vacuum hose (Vactor® truck) to remove sediment and debris from the sediment chamber / sump.
- See manufacturer's publications for additional maintenance information.

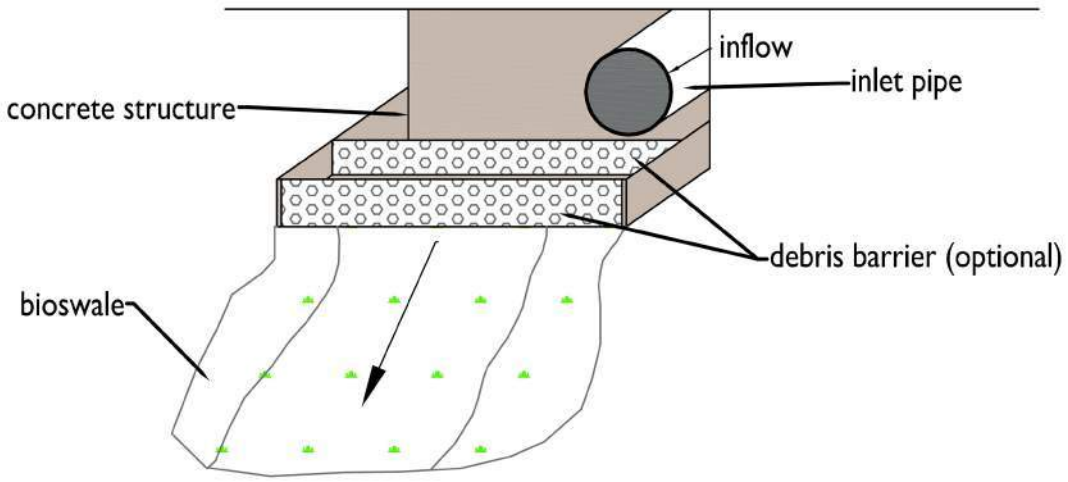
Hydrodynamic Separator System			
Drainage System Feature	Potential Defect	Conditions When Maintenance Is Needed	Minimum Performance Standard
General	Sediment Accumulation	Sediment depth is within 12 through 18" of dry weather water surface elevation.	Accumulated sediment has been removed.
	Trash and Debris Accumulation	Trash and debris accumulated in vault, or pipe inlet/outlet, floatables and non-floatables.	Trash and debris has been removed from vault, and inlet/outlet piping.
	Oil Accumulation	Oil accumulation that exceeds 1- inch at the water surface.	Oil has been extracted from vault. Coalescing plates have been cleaned. No visible oil depth on water.
	Damaged Pipes	Inlet or outlet piping damaged or broken and in need of repair.	Pipe has been repaired and / or replaced.
	Defects in Baffles	Baffles corroding, cracking, warping and/or showing signs of failure as determined by maintenance/inspection person.	Baffles repaired or replaced to design specifications.
	Vault Structure Damage - Includes Cracks in Walls, Bottom, Damage to Frame and/or Top Slab	Cracks wider than 1/2-inch or evidence of soil particles entering the structure through the cracks, or maintenance/inspection personnel determine that the vault is not structurally sound.	Vault replaced or repairs made so that vault meets design specifications and is structurally sound.
		Cracks wider than 1/2-inch at the joint of any inlet/ outlet pipe or evidence of soil particles entering through the cracks.	Vault repaired so that no cracks exist wider than 1/4-inch at the joint of the inlet/ outlet pipe.
	Sediment in Drain Pipes/Clean-Outs	When drain pipes, clean-outs, become full with sediment and/or debris.	Sediment and debris removed.
	Access Ladder Damaged	Ladder is corroded or deteriorated, not functioning properly, not securely attached to structure wall, missing rungs, cracks, and misaligned.	Ladder replaced or repaired, meets design specifications, and is safe to use as determined by inspection personnel.

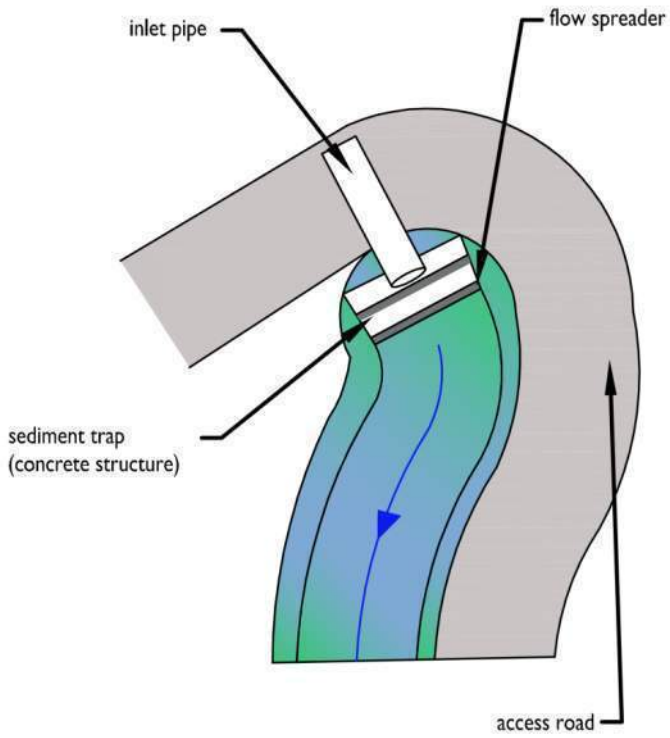
Sediment Trap

A sediment trap is a concrete structure typically fitted with a slotted grate or multiple slotted grates (debris barriers). The concrete structure provides a storage volume (sump) below the outlet pipe to allow sediments and debris to settle out of the stormwater runoff. Some sediment traps are fitted with a spill control device (elbow on outlet pipe) intended to help direct and dissipate flow. The slotted grate (debris barrier) prevents larger debris from exiting the level spreader.

Facility objects that are often associated with a sediment trap include:

- access road or easement
- fence, gate, and water quality sign
- typical bioswale
- wet bioswale





Sediment Trap with Accumulated Sediment

Key Operations and Maintenance Considerations

- The most common tool for cleaning sediment traps is a truck with a tank and vacuum hose (Vactor® truck) to remove sediment and debris from the sump area. Hand tools (e.g. rake, broom, square shovel) are also commonly used for cleaning.

Sediment Trap			
Drainage System Feature	Potential Defect	Conditions When Maintenance is Needed	Minimum Performance Standard
			Note: table spans multiple pages.
General	Trash and Debris	Trash or debris which is located immediately in front of the sediment trap opening or is blocking inletting capacity of the basin by more than 10%.	No trash or debris located immediately in front of sediment trap or on grate opening.
		Trash or debris (in the basin) that exceeds 60 percent of the sump depth as measured from the bottom of basin to invert of the lowest pipe into or out of the basin.	No trash or debris in the sediment trap.
		Trash or debris in any inlet or outlet pipe blocking more than 1/3 of its height.	Inlet and outlet pipes free of trash or debris.
		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 the sediment trap.
	Sediment	Sediment (in the basin) that exceeds 60 percent of the sump depth as measured from the bottom of basin to invert of the lowest pipe into or out of the basin .	No sediment in the sediment trap.
	Structure Damage to Frame and/or Top Slab	Slab has holes larger than 2 square inches or cracks wider than 1/4 inch. (Intent is to make sure no material is running into basin.)	Structure is free of holes and cracks.
	Fractures or Cracks in Basin Walls/ Bottom	Maintenance person judges that structure is unsound.	Sediment trap replaced or repaired to meet design specifications.
		Grout fillet has separated or cracked wider than 1/2 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.	Pipe is regrouted and secure at basin wall.
	Settlement/ Misalignment	If failure of basin has created a safety, function, or design problem.	Sediment trap replaced or repaired to design specifications.

Sediment Trap			
Drainage System Feature	Potential Defect	Conditions When Maintenance is Needed	Minimum Performance Standard
			Note: table spans multiple pages.
	Vegetation	Vegetation growing across and blocking more than 10% of the basin opening.	No vegetation blocking opening to sediment trap.
	Contaminants and Pollution	Any evidence of oil, gasoline, contaminants or other pollutants. (Coordinate removal/cleanup with local water quality response agency.)	No contaminants or pollutants present.
Debris Barrier (optional)	Trash and Debris	Trash and debris that is blocking more than 20% of grate surface inletting capacity.	Grate free of trash and debris.
	Damaged or Missing	Grate missing or broken member(s) of the grate.	Grate is in place and meets design standards.

Media Cartridge Filters

Media cartridge filters are passive, flow-through, stormwater treatment systems. They are comprised of one or more vaults that house rechargeable, media-filled filter cartridges. Stormwater passes through a filtering medium, which traps particulates and/or adsorb pollutants such as dissolved metals and hydrocarbons. Once filtered through the media, the treated stormwater is directed to a collection pipe or discharged into an open channel drainage way.

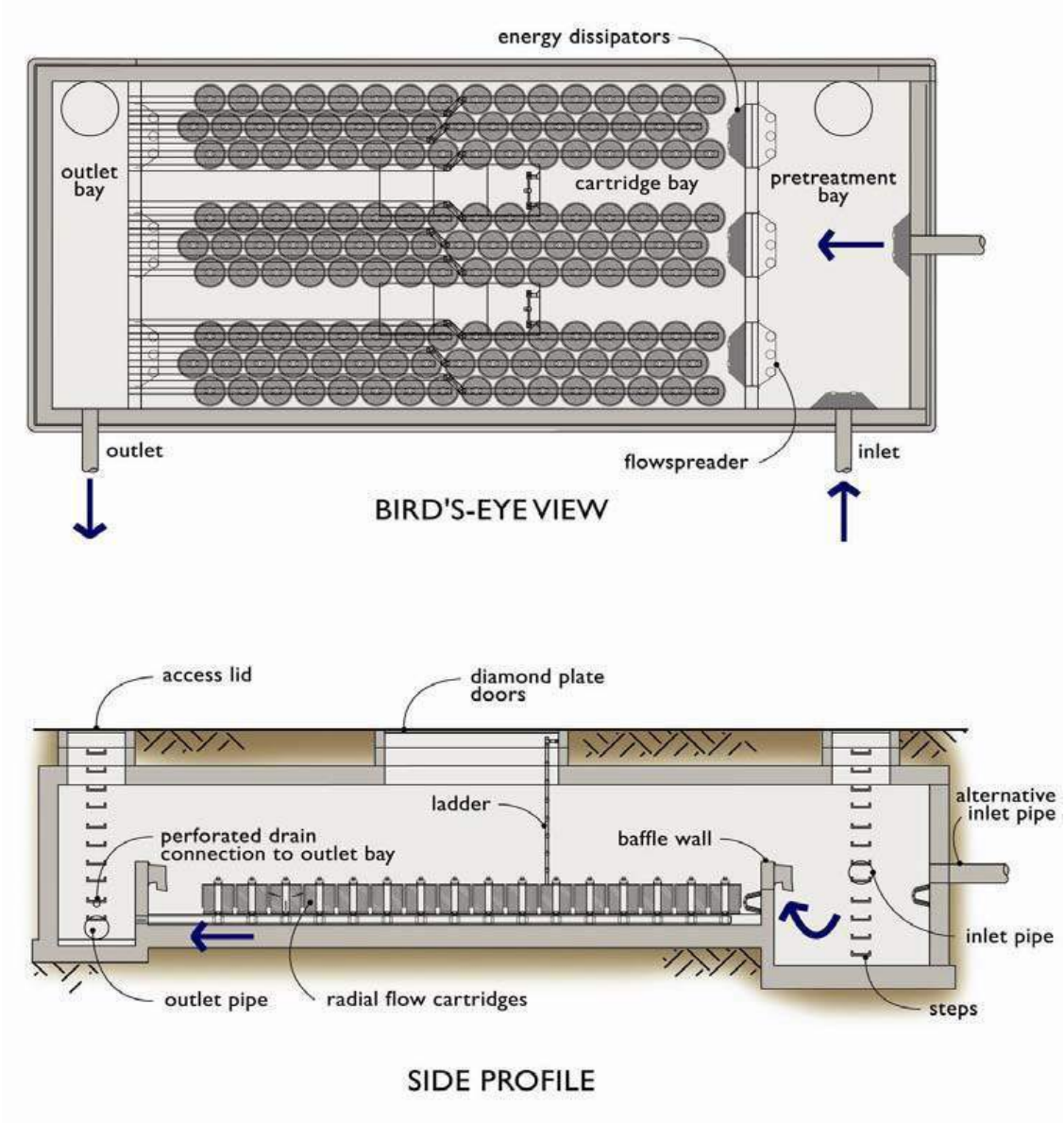
The filter media can be housed in cartridge filters enclosed in concrete vaults or catch basins. Structures will have vault doors or manhole lids (older designs) for maintenance access. Various types of filter media are available from system manufacturers.

StormFilter® units are an example of a proprietary manufactured media cartridge filter system that is common in Clark County. See manufacturer's publications for additional maintenance information.

Facility objects that are typically associated with a manufactured media filter system include:

- access road or easement
- control structure/flow restrictor
- conveyance stormwater pipe

Media Cartridge Filter Vault with Accumulated Sediment



Key Operations and Maintenance Considerations

- The most common tool for cleaning media cartridge filters is a truck with a tank and vacuum hose (e.g.Vactor® truck) to remove sediment and debris from the vault.
- Media cartridge filters are enclosed spaces where harmful chemicals and vapors can accumulate. Therefore, the inspection and maintenance of these facilities should be conducted by an individual trained and certified to work in hazardous confined spaces.
- Cartridges require replacement when the individual cartridges no longer meet the specifications for pollutant removal.

Media Cartridge Filters			
Drainage System Feature	Potential Defect	Conditions When Maintenance Is Needed	Minimum Performance Standard
			Note: table spans multiple pages.
Forebay	Sediment Accumulation	Sediment accumulation exceeds 6 inches or 1/3 of available sump.	Sediment accumulation less than 6 inches.
Media Filter Vault	Sediment Accumulation on Top Media Filters (Cartridges)	Sediment depth exceeds 0.25-inches (on top of filter cartridges).	No sediment deposits which would impede permeability of the compost media. No sediment deposits on top of cartridges. (Sediment on cartridges likely indicates that cartridges are plugged and require maintenance.)
	Sediment Accumulation in Vault	Sediment depth exceeds 4 inches in chamber. Look for other indicators of clogged cartridges or overflow.	No sediment deposits in vault bottom of first chamber. Cartridges have been checked and replaced or serviced as needed.
	Trash and Debris Accumulation	Trash and debris accumulated in vault.	No trash or debris in vault.
	Sediment in Drain Pipes/Clean-Outs	When drain pipes, clean-outs, become full with sediment and/or debris.	Sediment and debris has been removed.
	Damaged Pipes	Any part of the pipes that are crushed or damaged due to corrosion and/or settlement.	Pipe repaired and/or replaced to design specifications.
	Access Cover Damaged/Not Working	Cover cannot be opened; one person cannot open the cover using normal lifting pressure; corrosion/deformation of cover.	Cover repaired or replaced to design specifications.
	Vault Structure Includes Cracks in Wall, Bottom, Damage to Frame and/or Top Slab	Cracks wider than 1/2 inch or evidence of soil particles entering the structure through the cracks, or maintenance/inspection personnel determine that the vault is not structurally sound.	Vault replaced or repairs made so that vault meets design specifications and is structurally sound.
		Cracks wider than 1/2 inch at the joint of any inlet/outlet pipe or evidence of soil particles entering through the cracks.	Vault repaired so that no cracks exist wider than 1/4 inch at the joint of the inlet/outlet pipe.
	Baffles Damaged	Baffles corroding, cracking, warping, and/or showing signs of failure as determined by maintenance/inspection person.	Baffles repaired or replaced to design specifications.
	Access Ladder Damaged	Ladder is corroded or deteriorated, not functioning properly, not securely attached to structure wall, missing rungs, cracks, and misaligned.	Ladder replaced or repaired and meets design specifications, and is safe to use as determined by inspection personnel.
Below Ground Cartridge Type	Compost Media Clogging	Drawdown of water through the media takes longer than 1 hour, and/or overflow occurs frequently.	Media cartridges have been replaced and drawdown time and overflow frequency are per design standards.

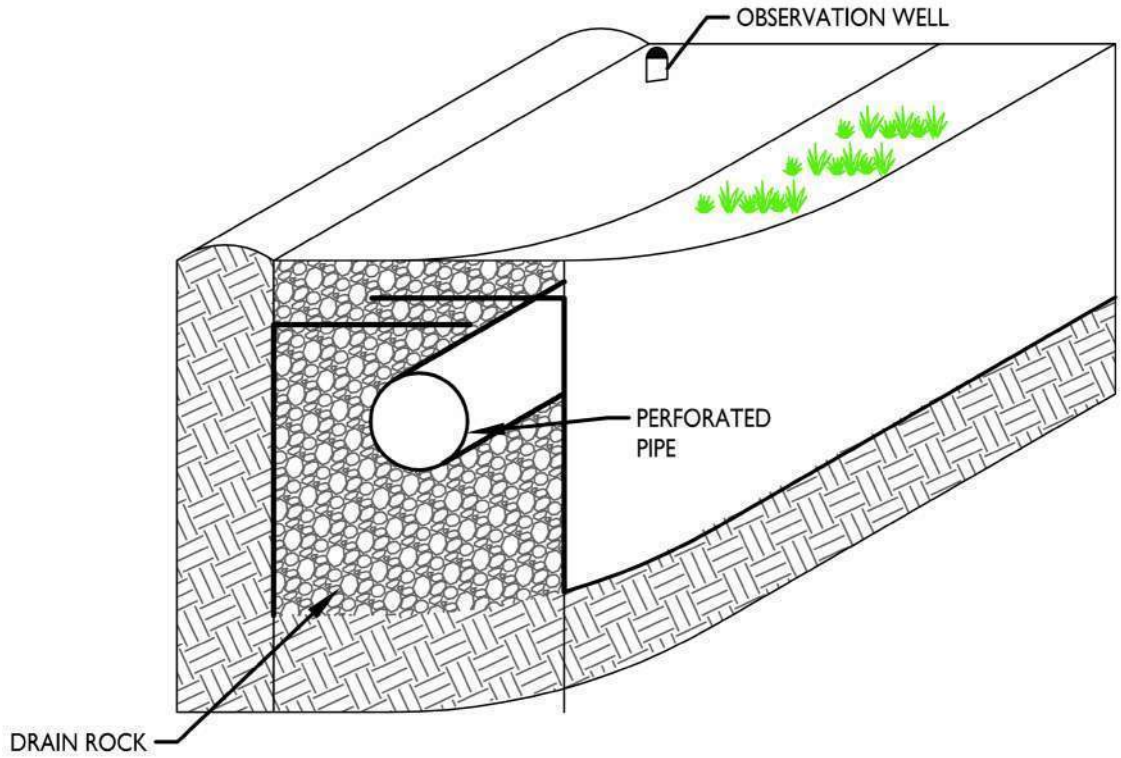
Media Cartridge Filters			
Drainage System Feature	Potential Defect	Conditions When Maintenance Is Needed	Minimum Performance Standard
			Note: table spans multiple pages.
	Short Circuiting	Flows do not properly enter filter cartridges.	Flows are properly entering filter cartridges. Cartridges have been replaced if necessary.
	Filter Cartridges Submerged	Filter vault does not drain within 24 hours following storm. Look for evidence of submergence due to backwater or excessive hydrocarbon loading.	Filter media have been checked and replaced if needed and vault drains down within 24 of a storm event. (If cartridges are plugged with oil, additional treatment or source control BMP may be needed.)

Infiltration Trench

A stormwater infiltration trench is a closed basin or an open-topped trench built by excavating below existing ground. Infiltration trenches temporarily store stormwater runoff during rain events. Infiltration trenches do not discharge to a downstream conveyance system or nearby surface water. Instead, infiltration trenches rely on the ability of the site's soils to infiltrate the stormwater into the ground.

Facility objects that are typically associated with an infiltration trench include:

- access road or easement
- fence, gate, and water quality sign
- bioswale
- sediment trap
- field inlet
- drywell



Key Operations and Maintenance Considerations

- Maintenance should be performed as indicated by routine inspections. The principal maintenance objective is to prevent clogging, which may lead to trench failure.
- Infiltration trenches and any pretreatment BMPs should be inspected after large storm events and any accumulated debris or material removed. A more thorough inspection of the trench should be conducted at least annually. Annual inspection should include monitoring the observation well (if one exists) to confirm that the trench is draining within the specified time.
- Monitor sediment buildup in the top foot of stone aggregate or the surface inlet on the same schedule as the observation well.
- Trenches with filter fabric should be inspected for sediment deposits by removing a small section of the top layer. If inspection indicates that the trench is partially or completely clogged, it should be restored to its design condition.
- The most common tools for cleaning infiltration trenches are hand tools to remove built-up sediments and the tops layers of clogged infiltration media from the trench.

Infiltration Trench			
Drainage System Feature	Potential Defect	Conditions When Maintenance Is Needed	Minimum Performance Standard
General	Contaminants and Pollution	Any evidence of oil, gasoline, contaminants or other pollutants. Sheen, obvious oil or other contaminants present. • Identify and remove source, AND • Report to Clark County Clean Water Program.	No contaminants or pollutants present.
	Sediment Depth (via Surface/ Observation Well Inspection)	Sediment depth greater than one foot above stone aggregate or the surface inlet.	No sediment in infiltration trench.
	Drainage Slow	Decreased capacity that indicates slow drainage. Does not meet facility design infiltration rate. The Water Quality Design Storm Volume does not infiltrate within 48 hours. Water remains in the trench for greater than 24 hours after the end of most moderate rainfall events.	Perforated drain pipe has been cleaned and drainage rates are per design specifications. (Do not allow removed sediment and water to discharge back into the storm sewer.)

On-site Stormwater Management

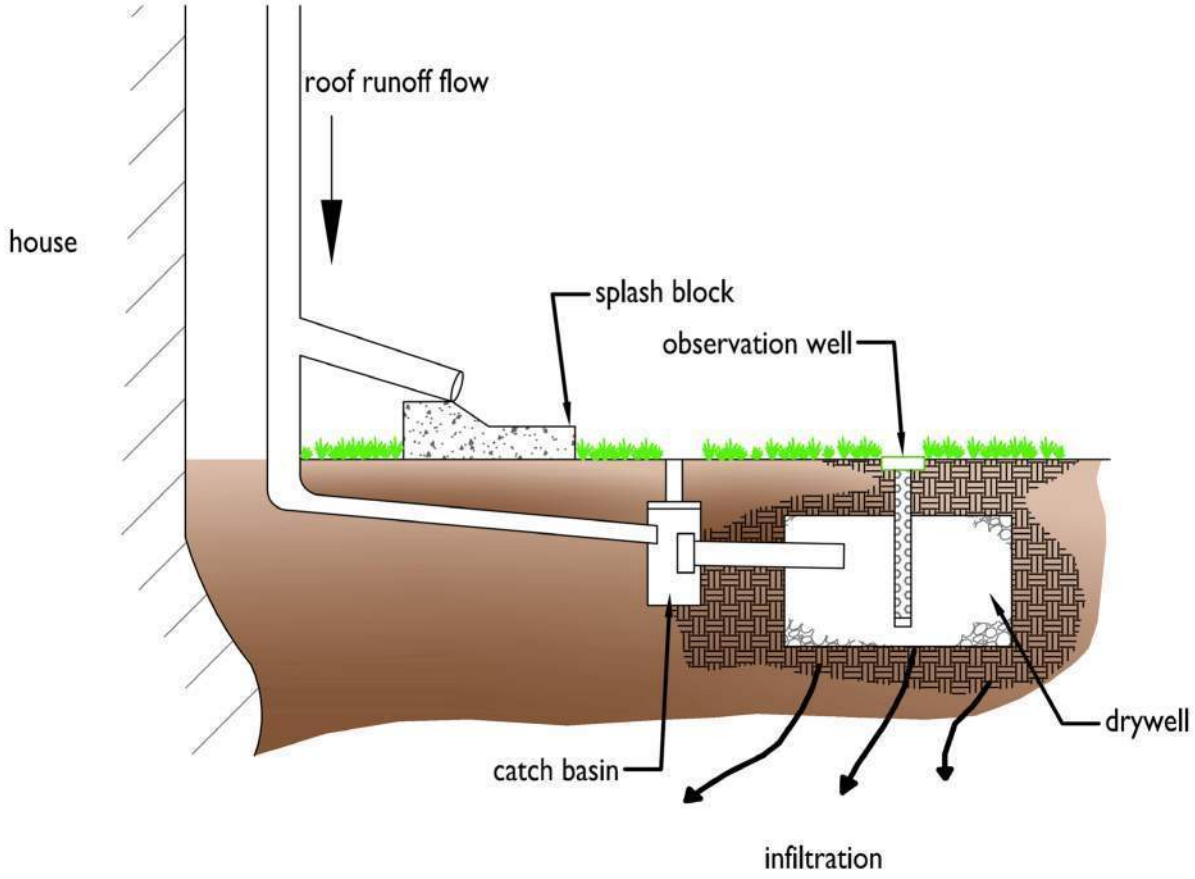
The BMPs in this section are generally located on residential sites and landscaped areas. This section does not include maintenance criteria for all types of on-site stormwater management BMPs because some are also considered treatment and flow control facilities, and therefore are described in the previous section, and others will be rare or absent in Clark County.

Downspout Infiltration

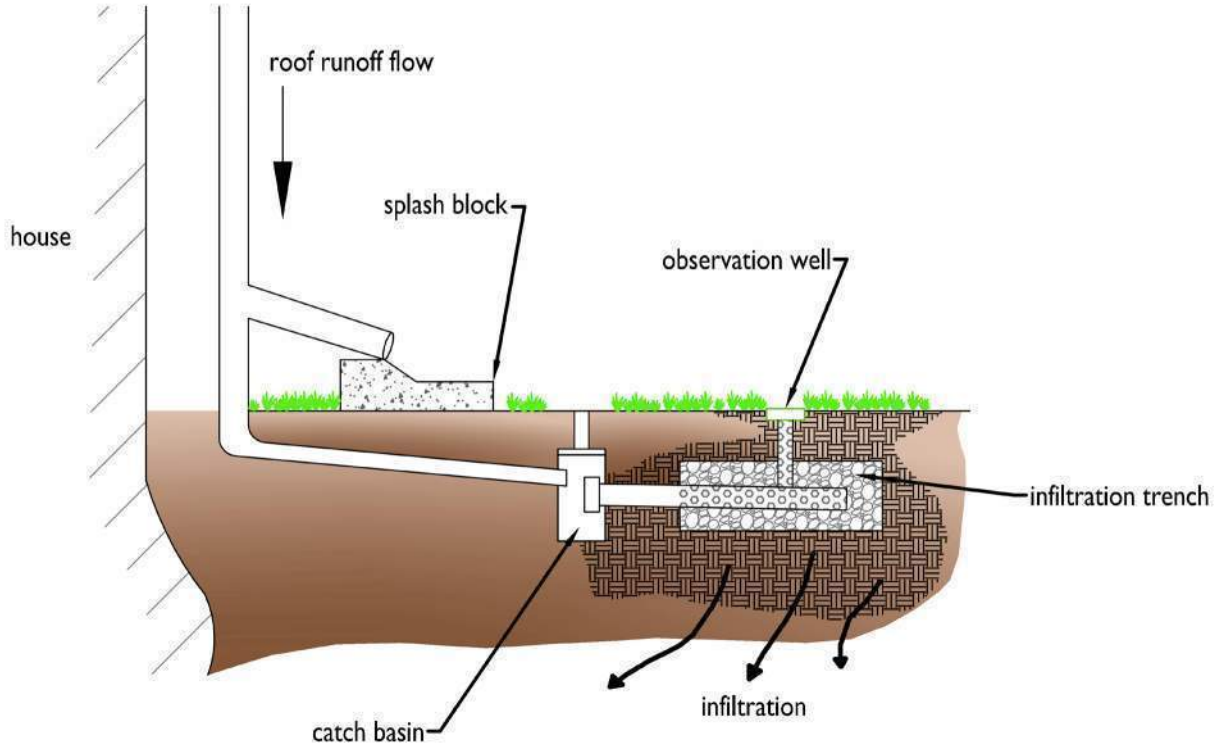
Roof downspout infiltration systems are simple pre-engineered designs for infiltrating roof runoff in residential yards.

Facility objects that are typically associated with downspout infiltration include:

- Downspout drywell
- Downspout infiltration trench



Downspout Drywell



Downspout Infiltration Trench

Key Operations and Maintenance Considerations

- Keep gutters free of debris and sediment or use a downspout insert to prevent debris or sediment from entering the downspout from the gutter while still allowing water to pass into the downspout.
- The most common tool for cleaning these systems is a hose to flush downspouts.

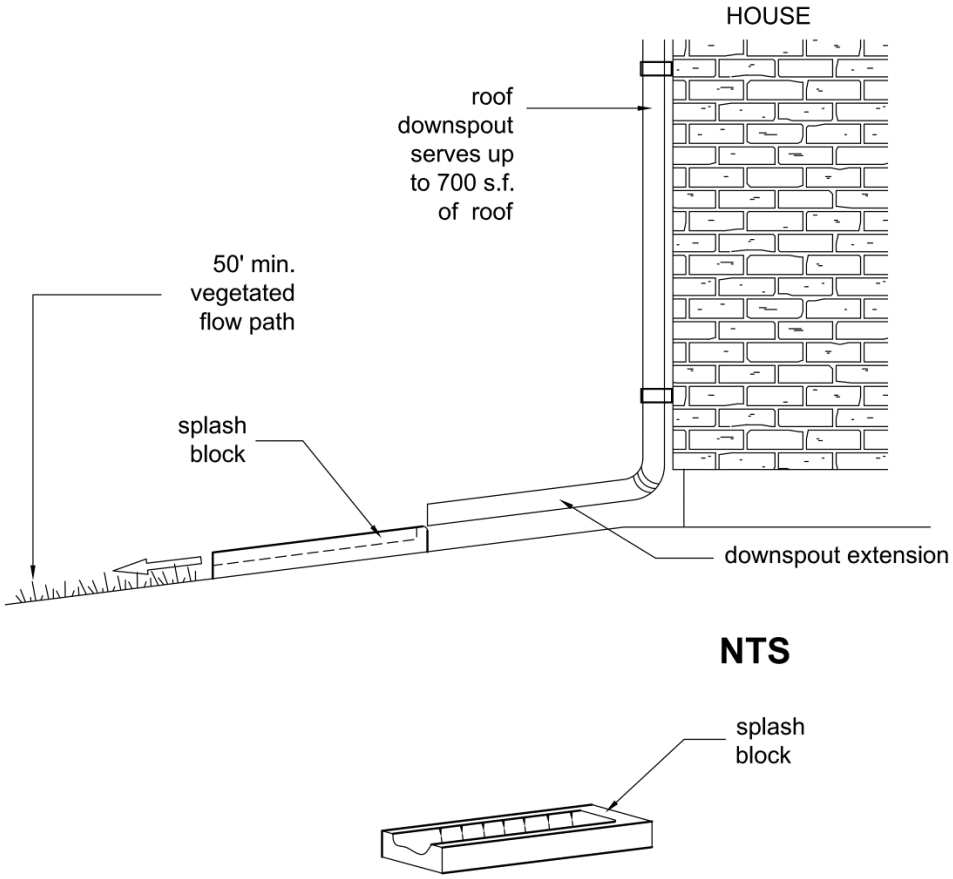
Downspout Infiltration			
Drainage System Feature	Potential Defect	Conditions When Maintenance Is Needed	Minimum Performance Standard
Infiltration Trench	Drainage Slow	Decreased capacity that indicates slow drainage.	Perforated drain pipe has been cleaned and drainage rates are per design specifications. (Do not allow removed sediment and water to discharge back into the storm sewer.)
	Damage to or Trash/Sediment Accumulation Around Pipes	Accumulation of trash, debris, or sediment in roof drains and gutters. Pipe from sump to trench has accumulated sediment or is plugged. Cracked, collapsed, broken, or misaligned drain pipes.	Trash, debris, and sediment is cleared from dispersion trench components (gutters, pipes, etc.). Pipes are free of damage or defects that hinder system from functioning according to design.
Downspout Drywell	Drainage Slow	Decreased capacity that indicates slow drainage. Does not meet facility design infiltration rate.	Drywell has been cleaned and drainage rates are per design specifications. (Do not allow removed sediment and water to discharge back into the storm sewer.)
	Standing Water	Standing water indicates the drywell is into the water table.	Rebuild drywell to prevent stormwater from going directly into groundwater.
	Sediment	Sediment in drywell exceeds 60 percent of the depth below the inlet pipe.	No sediment in drywell.

Downspout Dispersion

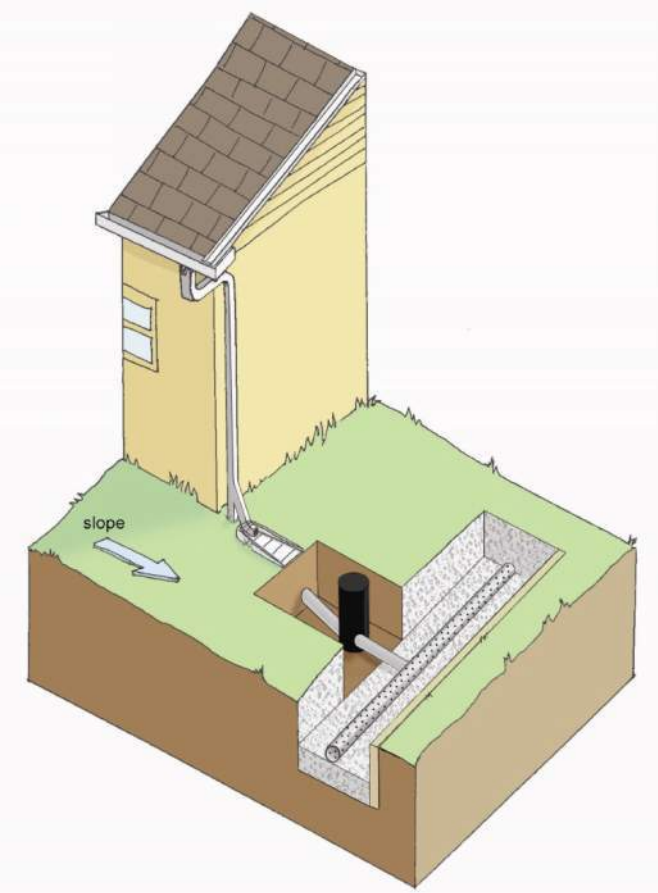
Downspout dispersion systems consist of splash blocks or gravel-filled trenches, which serve to spread roof runoff over vegetated pervious areas.

Facility objects that are typically associated with downspout dispersion include:

- Splash block
- Downspout extension
- Dispersion trench: Gravel-filled trenches used to spread stormwater runoff from a downspout drain over a vegetated pervious area. Downspout drains are routed to a trench via a perforated or slotted pipe. The trench typically includes a notched grade board or other device to distribute flow equally along the length of the trench.
- Dispersal area: Stormwater is dispersed to an area vegetated with well-established lawn or pasture, landscaping with well-established groundcover, or native vegetation with natural groundcover. The required vegetated flow path is 50 feet for splash blocks and concentrated dispersion, 25 feet when using a dispersion trench and varies for sheet flow dispersion.



Downspout Dispersion using Splash Blocks



Schematic Downspout Dispersion using Dispersion Trench

Key Operations and Maintenance Considerations

- For dispersion practices to be effective, the dispersion area must remain covered with dense, well-established vegetation. Site uses should protect vegetation and avoid compaction.
- A notched grade board at a dispersion trench must be maintained at a level grade to prevent concentrated flow. Downspout drains are directed to the trench via a storage sump that must be maintained to remove accumulated sediment.
- The groundcover for the extent of the flow in any dispersal area must be maintained to be dense enough to help disperse and infiltrate flows and to prevent erosion.
- The most common tools for cleaning these systems are hand tools to redistribute material disturbed by concentrated flows and a hose to flush downspouts.

Downspout Dispersion			
Drainage System Feature	Potential Defect	Conditions When Maintenance Is Needed	Minimum Performance Standard
			Note: table spans multiple pages.
General	Pests	Signs of pest infestations (IPM protocol threshold(s) are exceeded), including rodent holes or mounds that disturb dispersion flow paths.	Pests are not present or engaged in activities that present a significant public health risk or compromise to the intended design function of the facility. Pests that have exceeded acceptable thresholds have been addressed using appropriate IPM measures.
Splash Block	Water Directed Towards Building	Water is being directed towards building structure.	Water is directed away from foundations and other building structures.
	Erosion	Water disrupts soil media.	Water is dispersed into soil/mulch/plantings in a manner that does not create erosion or other issues due to concentrated flows.
Dispersion Trench	Concentrated Discharge	Visual evidence of water discharging at concentrated points along trench (normal condition is a “sheet flow” from edge of trench; intent is to prevent erosion damage).	Water is discharging as a sheet flow and any disruptive material (e.g. trash, debris, sediment accumulation) has been removed from trench surface.
	Surface of Trench	Accumulated trash, debris, or sediment on drain rock surface impedes sheet flow from facility. Vegetation/moss present on drain rock surface impedes sheet flow from facility.	Surface of drain rock is free of trash, debris, and sediment accumulation. Rock surface is open, free of vegetation buildup, and drains freely.
	Damage to or Trash/Sediment Accumulation Around Pipes	Accumulation of trash, debris, or sediment in roof drains, gutters, driveway drains, area drains, etc. Pipe from sump to trench or drywell has accumulated sediment or is plugged. Cracked, collapsed, broken, or misaligned drain pipes.	Trash, debris, and sediment is cleared from dispersion trench components (gutters, pipes, etc.). Pipes are free of damage or defects that hinder system from functioning according to design.
Storage Sump	Sediment in Sump	Sediment in the sump.	Sediment not present in sump. Sediment has also been removed from adjacent components (inlet/outlet pipes, etc.) to prevent immediate re-accumulation.
	Access Lid Not Working	Cannot be easily opened; buried; or cover missing.	Access lid present and functioning per design standards.
	Erosion	Erosion of the pond’s side slopes and/or scouring of the pond bottom, which exceeds 6-inches, or where continued erosion is prevalent.	Slopes stabilized using proper erosion control measures and repair methods.
Rock Pad	General	Only one layer of rock exists above native soil in area 6 square feet or larger, or any exposure of native soil. Soil erosion in or adjacent to rock pad.	Rock pad has been repaired or replaced to meet design standards.

Downspout Dispersion			
Drainage System Feature	Potential Defect	Conditions When Maintenance Is Needed	Minimum Performance Standard
			Note: table spans multiple pages.
Dispersal Area	Erosion or Sediment Accumulation	Erosion (gullies/ rills) greater than 2 inches deep in dispersal area. Accumulated sediment or debris to extent that blocks or channelizes flow path.	Cause of erosion has been eliminated and the damaged area has been repaired and stabilized.
	Standing Water After Storm Event	Standing surface water in dispersion area remains for more than 3 days after the end of a storm event.	Standing water drains within 72 hours of a storm event.
	Transition Zone Erosion and Sizing	Adjacent soil erosion; uneven surface creating concentrated flow discharge; or less than two feet of width.	Transition zone meets design criteria and does not exhibit erosion or other evidence of concentrated flows.
	Poor Vegetation Cover	Poor vegetation cover such that erosion is occurring.	Vegetation has been properly watered and established to meet facility design specifications.
	Excessive Vegetation Cover	Vegetation inhibits dispersed flow along flow path.	Vegetation has been weeded, trimmed, pruned, or thinned to meet facility design criteria.

SEPARATOR SHEET

SEPARATOR SHEET

APPENDIX E

Stormwater Pollution Prevention Plan

Stormwater Pollution Prevention Plan

For
NE 26th Street Townhomes

Prepared For
Ginn Group, LLC
502 NE 72nd Street
Vancouver, WA 98665

Owner	Developer	Operator/Contractor
Ginn Group LLC 502 NE 72nd Street Vancouver, WA 98665	Same as Owner	Unknown

Project Site Location
22205 NE 28th Street
Camas, WA 98607
Parcel #173184000

SWPPP Prepared By
PLS Engineering, Inc.
604 W Evergreen Blvd
Vancouver, WA 98660
(360) 944-6519

SWPPP Preparation Date
July 2022

Approximate Project Construction Dates
October 2022

Contents

Appendix A Site plans

- Vicinity map (with all discharge points)
- Site plan with TESC measures

Appendix B Construction BMPs

- Possibly reference in BMPs, but likely it will be a consolidated list so that the applicant can photocopy from the list from the SWMMWW.

Appendix C Alternative Construction BMP list

- List of BMPs not selected, but can be referenced if needed in each of the 12 elements

Appendix D General Permit

Appendix E Site Log and Inspection Forms

Appendix F Engineering Calculations

1.0 Introduction

This Stormwater Pollution Prevention Plan (SWPPP) has been prepared for the Monte Verde construction project in Camas, Washington. The site is located on Parcel 173184000. Current address for the site is 22205 NE 28th Street, Camas, WA 98607 and the existing site is approximately 8.61 acres. Current proposed development associated with this SWPPP includes the construction of 34 single family lots along with the associated infrastructure. The stormwater plan associated with this project provides for stormwater management of all runoff from the site using two private infiltration trenches, and one stormwater detention facility. Stormwater runoff from the pollution generating surfaces will be treated by a ConTech media cartridge before being infiltrated.

Construction activities will include excavation, grading, construction of paving and sidewalk to serve the site, construction of an infiltration trench to mitigate for impacts to stormwater runoff from the new paving, and installation of utilities to serve the site including sanitary sewer, storm sewer, potable water, electrical, phone, and cable TV. The purpose of this SWPPP is to describe the proposed construction activities and all temporary and permanent erosion and sediment control (TESC) measures, pollution prevention measures, inspection/monitoring activities, and recordkeeping that will be implemented during the proposed construction project. The objectives of the SWPPP are to:

1. Implement Best Management Practices (BMPs) to prevent erosion and sedimentation, and to identify, reduce, eliminate or prevent stormwater contamination and water pollution from construction activity.

2. Prevent violations of surface water quality, ground water quality, or sediment management standards.

3. Prevent, during the construction phase, adverse water quality impacts including impacts on beneficial uses of the receiving water by controlling peak flow rates and volumes of stormwater runoff at the Permittee's outfalls and downstream of the outfalls.

This SWPPP was prepared using the Ecology SWPPP Template downloaded from the Ecology website. This SWPPP was prepared based on the requirements set forth in the Construction Stormwater General Permit and the *Stormwater Management Manual for Western Washington* (SWMMWW). The report is divided into seven main sections with several appendices that include stormwater related reference materials. The topics presented in the each of the main sections are:

- Section 1 – INTRODUCTION. This section provides a summary description of the project, and the organization of the SWPPP document.

- Section 2 – SITE DESCRIPTION. This section provides a detailed description of the existing site conditions, proposed construction activities, and calculated stormwater flow rates for existing conditions and post–construction conditions.

- Section 3 – CONSTRUCTION BMPs. This section provides a detailed description of the BMPs to be implemented based on the 12 required elements of the SWPPP (SWMMEW 2004).

- Section 4 – CONSTRUCTION PHASING AND BMP IMPLEMENTATION. This section provides a description of the timing of the BMP implementation in relation to the project schedule.

- Section 5 – POLLUTION PREVENTION TEAM. This section identifies the appropriate contact names (emergency and non-emergency), monitoring personnel, and the onsite temporary erosion and sedimentation control inspector

- Section 6 – INSPECTION AND MONITORING. This section provides a description of the inspection and monitoring requirements such as the parameters of concern to be monitored, sample locations, sample frequencies, and sampling methods for all stormwater discharge locations from the site.

- Section 7 – RECORDKEEPING. This section describes the requirements for documentation of the BMP implementation, site inspections, monitoring results, and changes to the implementation of certain BMPs due to site factors experienced during construction.

Supporting documentation and standard forms are provided in the following Appendices:

Appendix A – Site plans
Appendix B – Construction BMPs
Appendix C – Alternative Construction BMP list
Appendix D – General Permit
Appendix E – Site Log and Inspection Forms
Appendix F – Engineering Calculations

2.0 Site Description

2.1 Existing Conditions

Current Addresses for the site is 22205 NE 28th Street, Camas, WA 98607. The site is approximately 8.61 acres. The property's topography is moderately sloped from a high point at the NE corner of the site to a low point at the SW corner of the site. The site has an existing house, shop, and Chickein coop which will be removed. The remaining area consists of grass, trees, and brush.

The soils are mapped by the NRCS as Lauren gravelly loam (LgB) in the North and SW corner of the sit, and Lauren loam (LeB) in the middle and South end of the site.

2.2 Proposed Construction Activities

The project proposes to develop the parcel into 34 single family lots and associated access. Construction activities will include excavation, grading, construction of paving and sidewalk to serve the site, construction of an infiltration trench to mitigate for impacts to stormwater runoff from the new paving, and installation of utilities to serve the site including sanitary sewer, storm sewer, potable water, electrical, phone, and cable TV.

Temporary erosion and sediment control facilities will be installed prior to site construction to handle construction-phase stormwater runoff. The schedule and phasing of BMPs during construction is provided in Section 4.0.

Stormwater runoff has been calculated using Western Washington Hydrology Model (WWHM). The infiltration trenches were designed to infiltrate the runoff generated by the site. ConTech™ catch basins will be used to treat runoff before conveying it to the infiltration trenches.

After the site has been graded and all new utilities are installed, the building construction will commence. Trees will also be planted in the landscape areas noted in the Landscape Plan. Temporary seeding will occur over the lots to establish vegetative cover until such time as individual buildings are developed and permanent landscaping occurs.

3.0 Construction Stormwater BMPs

3.1 The 13 BMP Elements

3.1.1 Element #1 – Mark Clearing Limits

To protect adjacent properties and to reduce the area of soil exposed to construction, the limits of construction will be clearly marked before land-disturbing activities begin. Trees that are to be preserved, as well as all sensitive areas and their buffers, shall be clearly delineated, both in the field and on the plans. In general, natural vegetation and native topsoil shall be retained in an undisturbed state to the maximum extent possible. The BMPs relevant to marking the clearing limits that will be applied for this project include:

- Preserving Native Vegetation (BMP C101)
- Silt Fence (BMP C233)

Alternate BMPs for marking clearing limits are included in Appendix C as a quick reference tool for the onsite inspector in the event the BMP(s) listed above are deemed ineffective or inappropriate during construction to satisfy the requirements set forth in the General NPDES Permit (Appendix D). To avoid potential erosion and sediment control issues that may cause a violation(s) of the NPDES Construction Stormwater permit (as provided in Appendix D), the Certified Erosion and Sediment Control Lead will promptly initiate the implementation of one or more of the alternative BMPs listed in Appendix C after the first sign that existing BMPs are ineffective or failing.

3.1.2 Element #2 – Establish Construction Access

Construction access or activities occurring on unpaved areas shall be minimized, yet where necessary, access points shall be stabilized to minimize the tracking of sediment onto public roads, and wheel washing, street sweeping, and street cleaning shall be employed to prevent sediment from entering state waters. All wash wastewater shall be controlled on site. The specific BMPs related to establishing construction access that will be used on this project include:

- Stabilized Construction Entrance (BMP C105)

Alternate construction access BMPs are included in Appendix C as a quick reference tool for the onsite inspector in the event the BMP(s) listed above are deemed ineffective or inappropriate during construction to satisfy the requirements set forth in the General NPDES Permit (Appendix D). To avoid potential erosion and sediment control issues that may cause a violation(s) of the NPDES Construction Stormwater permit (as provided in Appendix D), the Certified Erosion and Sediment Control Lead will promptly initiate the implementation of one or more of the alternative BMPs listed in Appendix C after the first sign that existing BMPs are ineffective or failing.

3.1.3 Element #3 – Control Flow Rates

In order to protect the properties and waterways downstream of the project site, stormwater discharges from the site will be controlled. The specific BMPs for flow control that shall be used on this project include:

- Downspout Full Infiltration - Infiltration Trenches (BMP T5.10B).
- Infiltration Trenches (BMP R5.11).

Alternate flow control BMPs are included in Appendix C as a quick reference tool for the onsite inspector in the event the BMP(s) listed above are deemed ineffective or inappropriate during construction to satisfy the requirements set forth in the General NPDES Permit (Appendix D). To avoid potential erosion and sediment control issues that may cause a violation(s) of the NPDES Construction Stormwater permit (as provided in Appendix D), the Certified Erosion and Sediment Control Lead will promptly initiate the implementation of one or more of the alternative BMPs listed in Appendix C after the first sign that existing BMPs are ineffective or failing.

The project site is located west of the Cascade Mountain Crest. As such, the project must comply with Minimum Requirement 7 (Ecology 2005).

In general, discharge rates of stormwater from the site will be controlled where increases in impervious area or soil compaction during construction could lead to downstream erosion, or where necessary to meet local agency stormwater discharge requirements (e.g. discharge to combined sewer systems).

3.1.4 Element #4 – Install Sediment Controls

All stormwater runoff from disturbed areas shall pass through an appropriate sediment removal BMP before leaving the construction site or prior to being discharged to an infiltration facility. The specific BMPs to be used for controlling sediment on this project include:

- Silt Fence (BMP C233)
- Storm Drain Inlet Protection (BMP C220)

Silt fencing and storm drain inlet protection will be adequate for sediment control during summer months. Alternate sediment control BMPs are included in Appendix C as a quick reference tool for the onsite inspector in the event the BMP(s) listed above are deemed ineffective or inappropriate during construction to satisfy the requirements set forth in the General NPDES Permit (Appendix D). To avoid potential erosion and sediment control issues that may cause a violation(s) of the NPDES Construction Stormwater permit (as provided in Appendix D), the Certified Erosion and Sediment Control Lead will promptly initiate the implementation of one or more of the alternative BMPs listed in Appendix C after the first sign that existing BMPs are ineffective or failing.

In addition, sediment will be removed from paved areas in and adjacent to construction work areas manually or using mechanical sweepers, as needed, to minimize tracking of sediments on vehicle tires away from the site and to minimize washoff of sediments from adjacent streets in runoff.

Whenever possible, sediment laden water shall be discharged into onsite, relatively level, vegetated areas (BMP C240 paragraph 5, page 4-102).

In some cases, sediment discharge in concentrated runoff can be controlled using permanent stormwater BMPs (e.g., infiltration swales, ponds, trenches). Sediment loads can limit the effectiveness of some permanent stormwater BMPs, such as those used for infiltration or biofiltration; however, those BMPs designed to remove solids by settling (wet ponds or detention ponds) can be used during the construction phase. When permanent stormwater BMPs will be used to control sediment discharge during construction, the structure will be protected from excessive sedimentation with adequate erosion and sediment control BMPs. Any accumulated sediment shall be removed after construction is complete and the permanent stormwater BMP will be restabilized with vegetation per applicable design requirements once the remainder of the site has been stabilized.

The following BMPs will be implemented as end-of-pipe sediment controls as required to meet permitted turbidity limits in the site discharge(s). Prior to the implementation of these technologies, sediment sources and erosion control and soil stabilization BMP efforts will be maximized to reduce the need for end-of-pipe sedimentation controls.

- Construction Stormwater Filtration (BMP C251)
- Construction Stormwater Chemical Treatment (BMP C 250) (implemented only with prior written approval from Ecology).

3.1.5 Element #5 – Stabilize Soils

Exposed and unworked soils shall be stabilized with the application of effective BMPs to prevent erosion throughout the life of the project. The specific BMPs for soil stabilization that shall be used on this project include:

- Temporary and Permanent Seeding (BMP C120)
- Mulching (BMP C121)
- Nets and Blankets (BMP C122)
- Plastic Covering (BMP C123)
- Topsoiling (BMP C125)
- Surface Roughening (BMP C130)
- Dust Control (BMP C140)
- Early application of gravel base on areas to be paved

Alternate soil stabilization BMPs are included in Appendix C as a quick reference tool for the onsite inspector in the event the BMP(s) listed above are deemed ineffective or inappropriate during construction to satisfy the requirements set forth in the General NPDES Permit (Appendix D). To avoid potential erosion and sediment control issues that may cause a violation(s) of the NPDES Construction Stormwater permit (as provided in Appendix D), the Certified Erosion and Sediment Control Lead will promptly initiate the implementation of one or more of the alternative BMPs listed in Appendix C after the first sign that existing BMPs are ineffective or failing.

The project site is located west of the Cascade Mountain Crest. As such, no soils shall remain exposed and unworked for more than 7 days during the dry season (May 1 to September 30) and 2 days during the wet season (October 1 to April 30). Regardless of the time of year, all soils shall be stabilized at the end of the shift before a holiday or weekend if needed based on weather forecasts.

In general, cut and fill slopes will be stabilized as soon as possible and soil stockpiles will be temporarily covered with plastic sheeting. All stockpiled soils shall be stabilized from erosion, protected with sediment trapping measures, and where possible, be located away from storm drain inlets, waterways, and drainage channels.

3.1.6 Element #6 – Protect Slopes

All cut and fill slopes will be designed, constructed, and protected in a manner that minimizes erosion. The following specific BMPs will be used to protect slopes for this project:

- Temporary and Permanent Seeding (BMP C120)

Alternate slope protection BMPs are included in Appendix C as a quick reference tool for the onsite inspector in the event the BMP(s) listed above are deemed ineffective or inappropriate during construction to satisfy the requirements set forth in the General NPDES Permit (Appendix D). To avoid potential erosion and sediment control issues that may cause a violation(s) of the NPDES Construction Stormwater permit (as provided in Appendix D), the Certified Erosion and Sediment Control Lead will promptly initiate the implementation of one or more of the alternative BMPs listed in Appendix C after the first sign that existing BMPs are ineffective or failing.

3.1.7 Element #7 – Protect Drain Inlets

All storm drain inlets and culverts made operable during construction or inlets near the site that could potentially receive surface runoff from the construction site shall be protected to prevent unfiltered or untreated water from entering the drainage conveyance system. However, the first priority is to keep all access roads clean of sediment and keep street wash water separate from entering storm drains until treatment can be provided. Storm Drain Inlet Protection (BMP C220) will be implemented for all drainage inlets and culverts that could potentially be impacted by sediment-laden runoff on and near the project site. The following inlet protection measures will be applied on this project:

Drop Inlet Protection

- Block and Gravel Drop Inlet Protection
- Gravel and Wire Drop Inlet Protection
- Catch Basin Filter

If the BMP options listed above are deemed ineffective or inappropriate during construction to satisfy the requirements set forth in the General NPDES Permit (Appendix D), or if no BMPs are listed above but deemed necessary during construction, the Certified Erosion and Sediment Control Lead shall implement one or more of the alternative BMP inlet protection options listed in Appendix C.

3.1.8 Element #8 – Stabilize Channels and Outlets

Where site runoff is to be conveyed in channels or discharged to a stream or some other natural drainage point, efforts will be taken to prevent downstream erosion. The specific BMPs for channel and outlet stabilization that shall be used on this project include:

- Outlet Protection (BMP C209)

Alternate channel and outlet stabilization BMPs are included in Appendix C as a quick reference tool for the onsite inspector in the event the BMP(s) listed above are deemed ineffective or inappropriate during construction to satisfy the requirements set forth in the General NPDES Permit (Appendix D). To avoid potential erosion and sediment control issues that may cause a violation(s) of the NPDES Construction Stormwater permit (as provided in Appendix D), the Certified Erosion and Sediment Control Lead will promptly initiate the implementation of one or more of the alternative BMPs listed in Appendix C after the first sign that existing BMPs are ineffective or failing.

The project site is located west of the Cascade Mountain Crest. As such, all temporary on-site conveyance channels shall be designed, constructed, and stabilized to prevent erosion from the expected peak 10-minute velocity of flow from a Type 1A, 10-year, 24-hour recurrence interval storm for the developed condition. Alternatively, the 10-year, 1-hour peak flow rate indicated by an approved continuous runoff simulation model, increased by a factor of 1.6, shall be used. Stabilization, including armoring material, adequate to prevent erosion of outlets, adjacent streambanks, slopes, and downstream reaches shall be provided at the outlets of all conveyance systems.

3.1.9 Element #9 – Control Pollutants

All pollutants, including waste materials and demolition debris, that occur onsite shall be handled and disposed of in a manner that does not cause contamination of stormwater. Good housekeeping and preventative measures will be taken to ensure that the site will be kept clean, well organized, and free of debris. If required, BMPs to be implemented to control specific sources of pollutants are discussed below.

Vehicles, construction equipment, and/or petroleum product storage/dispensing:

- All vehicles, equipment, and petroleum product storage/dispensing areas will be inspected regularly to detect any leaks or spills, and to identify maintenance needs to prevent leaks or spills.
- On-site fueling tanks and petroleum product storage containers shall include secondary containment.
- Spill prevention measures, such as drip pans, will be used when conducting maintenance and repair of vehicles or equipment.
- In order to perform emergency repairs on site, temporary plastic will be placed beneath and, if raining, over the vehicle.
- Contaminated surfaces shall be cleaned immediately following any discharge or spill incident.

Chemical storage:

- Any chemicals stored in the construction areas will conform to the appropriate source control BMPs listed in Volume IV of the Ecology stormwater manual. In Western WA, all chemicals shall have cover, containment, and protection provided on site, per BMPC153 for Material Delivery, Storage and Containment in SWMMWW 2005
- Application of agricultural chemicals, including fertilizers and pesticides, shall be conducted in a manner and at application rates that will not result in loss of chemical to stormwater runoff. Manufacturers' recommendations for application procedures and rates shall be followed.

Excavation and tunneling spoils dewatering waste:

- Dewatering BMPs and BMPs specific to the excavation and tunneling (including handling of contaminated soils) are discussed under Element 10.

Demolition:

- Dust released from demolished sidewalks, buildings, or structures will be controlled using Dust Control measures (BMP C140).
- Storm drain inlets vulnerable to stormwater discharge carrying dust, soil, or debris will be protected using Storm Drain Inlet Protection (BMP C220 as described above for Element 7).
- Process water and slurry resulting from sawcutting and surfacing operations will be prevented from entering the waters of the State by implementing Sawcutting and Surfacing Pollution Prevention measures (BMP C152).

Concrete and grout:

- Process water and slurry resulting from concrete work will be prevented from entering the waters of the State by implementing Concrete Handling measures (BMP C151).

Sanitary wastewater:

- Portable sanitation facilities will be firmly secured, regularly maintained, and emptied when necessary.
- Wheel wash or tire bath wastewater shall be discharged to a separate on-site treatment system or to the sanitary sewer as part of Wheel Wash implementation (BMP C106).

Solid Waste:

- Solid waste will be stored in secure, clearly marked containers.

Other:

- Other BMPs will be administered as necessary to address any additional pollutant sources on site.

The facility does not require a Spill Prevention, Control, and Countermeasure (SPCC) Plan under the Federal regulations of the Clean Water Act (CWA).

3.1.10 Element #10 – Control Dewatering

3.1.13 Element #13 – Protect Low Impact Development BMPs

- Protect all bioretention and rain garden BMP's from sedimentation through installation and maintenance of erosion control BMP's on portions of the site that drain into them. Restore the BMP's to their fully functioning condition if they accumulate sediment during construction. Restoring the BMP must include removal of sediment and any sediment-laden bioretention/ rain garden soils, and replacing the removed soils with soils meeting the design specification.
- Prevent compacting bioretention and rain garden BMP's by excluding construction equipment and foot traffic. Protect completed lawn and landscaped areas from compaction by construction equipment.
- Control erosion and avoid introducing sediment from surrounding land uses onto permeable pavements. Do not allow muddy construction equipment on the base material or pavement. Do not allow sediment-laden runoff into permeable pavements or base materials.
- Pavements fouled with sediments or no longer passing an initial infiltration test must be cleaned using procedures from Book 4 of the manufacturer's procedures.
- Keep all heavy equipment off existing soils under LID facilities that have been excavated to final grade to retain the infiltration rate of the soils

3.2 Site Specific BMPs

Site specific BMPs are shown on the TESC Plan Sheets and Details in Appendix A. These site-specific plan sheets will be updated annually.

3.3 Additional Advanced BMPs

- The following BMPs are advanced and are only recommended if construction activities are complex enough to warrant them; or if the site has the potential for significant impacts to water quality. The following BMPs are directed at "end-of-pipe" treatment for sedimentation issues related to turbid runoff from construction sites. Effective BMPs are most often the simple BMPs and focus on the minimization of erosion before sedimentation is an issue. The following BMPs will most likely be implemented only after other BMP options are exhausted, or if the construction activity is large and off-site sedimentation or turbid runoff occurs or is inevitable.
- For BMP 250, written pre-approval, through Ecology is required (see SWMMWW 2005):
- BMP C250: Construction Stormwater Chemical Treatment
- BMP C251: Construction Stormwater Filtration.

4.0 Construction Phasing and BMP Implementation

The BMP implementation schedule will be driven by the construction schedule. The following provides a sequential list of the proposed construction schedule milestones and the corresponding BMP implementation schedule. The list contains key milestones such as wet season construction.

The BMP implementation schedule listed below is keyed to proposed phases of the construction project and reflects differences in BMP installations and inspections that relate to wet season construction. The project site is located west of the Cascade Mountain Crest. As such, the dry season is considered to be from May 1 to September 30 and the wet season is considered to be from October 1 to April 30.

- Estimate of Construction start date: 10/01/22
- Estimate of Construction finish date: 9/06/25
- Mobilize equipment on site: 10/01/22
- Mobilize and store all ESC and soil stabilization products: 10/01/22
- Install ESC measures: 10/01/22
- Install stabilized construction entrance: 10/01/22
- Begin clearing and grubbing: 10/01/22
- Demolish existing structures: 10/01/22
- Begin site grading 10/01/22
- Site grading ends 10/30/22
- Excavate and install new utilities and services: 11/01/22
- Excavation for building foundations 10/06/22
- Begin building construction: 10/06/22
- Complete utility construction 10/06/22
- Begin implementing soil stabilization and sediment control BMPs throughout the site in preparation for wet season: 10/06/22
- Wet Season starts: 11/01/22
- Site inspections and monitoring conducted weekly and for applicable rain events as detailed in Section 6 of this SWPPP: 10/01/22
- Implement Element #12 BMPs and manage site to minimize soil disturbance during the wet season: 10/01/22
- Complete road paving 11/30/22
- Building construction complete: 9/06/24
- Dry Season starts: 5/01/23

5.0 Pollution Prevention Team

5.1 Roles and Responsibilities

The pollution prevention team consists of personnel responsible for implementation of the SWPPP, including the following:

- Certified Erosion and Sediment Control Lead (CESCL) – primary contractor contact, responsible for site inspections (BMPs, visual monitoring, sampling, etc.); to be called upon in case of failure of any ESC measures.
- Resident Engineer – For projects with engineered structures only (sediment ponds/traps, sand filters, etc.): site representative for the owner that is the project's supervising engineer responsible for inspections and issuing instructions and drawings to the contractor's site supervisor or representative
- Emergency Ecology Contact – individual to be contacted at Ecology in case of emergency.
- Emergency Owner Contact – individual that is the site owner or representative of the site owner to be contacted in the case of an emergency.
- Non-Emergency Ecology Contact – individual that is the site owner or representative of the site owner than can be contacted if required.
- Monitoring Personnel – personnel responsible for conducting water quality monitoring; for most sites this person is also the Certified Erosion and Sediment Control Lead.

5.2 Team Members

Names and contact information for those identified as members of the pollution prevention team are provided in the following table.

Title	Name(s)	Phone Number
Certified Erosion and Sediment Control Lead (CESCL)	Unknown	
Resident Engineer	Travis Johnson	(360)944-6519
Emergency Ecology Contact	Unknown	
Emergency Owner Contact	Unknown	
Non-Emergency Ecology Contact	Unknown	
Monitoring Personnel	Unknown	

6.0 Site Inspections and Monitoring

Monitoring includes visual inspection, monitoring for water quality parameters of concern, and documentation of the inspection and monitoring findings in a site log book. A site log book will be maintained for all on-site construction activities and will include:

- A record of the implementation of the SWPPP and other permit requirements;
- Site inspections; and,
- Stormwater quality monitoring.

For convenience, the inspection form and water quality monitoring forms included in this SWPPP include the required information for the site log book. This SWPPP may function as the site log book if desired, or the forms may be separated and included in a separate site log book. However, if separated, the site log book but must be maintained on-site or within reasonable access to the site and be made available upon request to Ecology or the local jurisdiction.

6.1 Site Inspection

All BMPs will be inspected, maintained, and repaired as needed to assure continued performance of their intended function. The inspector will be a Certified Erosion and Sediment Control Lead (CESCL) per BMP C160. The name and contact information for the CESCL is provided in Section 5 of this SWPPP.

Site inspection will occur in all areas disturbed by construction activities and at all stormwater discharge points. Stormwater will be examined for the presence of suspended sediment, turbidity, discoloration, and oily sheen. The site inspector will evaluate and document the effectiveness of the installed BMPs and determine if it is necessary to repair or replace any of the BMPs to improve the quality of stormwater discharges. All maintenance and repairs will be documented in the site log book or forms provided in this document. All new BMPs or design changes will be documented in the SWPPP as soon as possible.

6.1.1 Site Inspection Frequency

Site inspections will be conducted at least once a week and within 24 hours following any discharge from the site. For sites with temporary stabilization measures, the site inspection frequency can be reduced to once every month.

6.1.2 Site Inspection Documentation

The site inspector will record each site inspection using the site log inspection forms provided in Appendix E. The site inspection log forms may be separated from this SWPPP document, but will be maintained on-site or within reasonable access to the site and be made available upon request to Ecology or the local jurisdiction.

6.2 Stormwater Quality Monitoring

The construction site will comply with the requirements set forth in the 2015 Construction Stormwater General Permit (revised 2017) seen in Appendix D. A Certified Erosion and Sediment Control Lead shall be on-site or on-call at all times.

The following text describes the monitoring for the proposed development.

6.2.1 Turbidity Sampling

The receiving water body, Lacamas Creek Watershed, is impaired for turbidity. Mandatory BMPs (Best Management Practices) and erosion control practices put in place by the permit will appropriately minimize the turbidity of the stormwater discharge. Monitoring requirements for the proposed project will include weekly turbidity sampling to monitor site discharges for water quality compliance as required by the NPDES Construction Stormwater General Permit, provided that site discharges occur. It should be noted that the site is designed such that all site runoff will be infiltrated so it is likely that discharges will be rare or may not occur at all. Sampling will be conducted at all discharge points at least once per calendar week.

Turbidity sampling during construction will be completed weekly in order to confirm that erosion control measures are meeting the water quality standards for turbidity (Where an applicable TMDL has not specified a waste load allocation for construction stormwater discharge, but has not excluded these discharges, compliance with special Conditions S4 (monitoring) and S9 (SWPPPs) will constitute compliance with the approved TMDL (S8.E.1.c)). Special Conditions S4 establishes that the key benchmark values that require action are 25 NTU for turbidity (equivalent to 32 cm transparency) and 250 NTU for turbidity (equivalent to 6 cm transparency). If the 25 NTU benchmark for turbidity (equivalent to 32 cm transparency) is exceeded, the following steps will be conducted:

1. Ensure all BMPs specified in this SWPPP are installed and functioning as intended.
2. Assess whether additional BMPs should be implemented, and document revisions to the SWPPP as necessary.
3. Sample discharge location daily until the analysis results are less than 25 NTU (turbidity) or greater than 32 cm (transparency).

If the turbidity is greater than 25 NTU (or transparency is less than 32 cm) but less than 250 NTU (transparency greater than 6 cm) for more than 3 days, additional treatment BMPs will be implemented within 24 hours of the third consecutive sample that exceeded the benchmark value. Additional treatment BMPs to be considered will include, but are not limited to, off-site treatment, infiltration, filtration and chemical treatment.

If the 250 NTU benchmark for turbidity (or less than 6 cm transparency) is exceeded at any time, the following steps will be conducted:

1. Notify Ecology by phone within 24 hours of analysis (see Section 5.0 of this SWPPP for contact information).
2. Continue daily sampling until the turbidity is less than 25 NTU (or transparency is greater than 32 cm).

3. Initiate additional treatment BMPs such as off-site treatment, infiltration, filtration and chemical treatment within 24 hours of the first 250 NTU exceedance.
4. Implement additional treatment BMPs as soon as possible, but within 7 days of the first 250 NTU exceedance.
5. Describe inspection results and remedial actions taken in the site log book and in monthly discharge monitoring reports as described in Section 7.0 of this SWPPP.

In the event that Turbidity results are greater than 25 NTUs, or the site is determined to be out of compliance with surface water quality standards for turbidity, the following BMPs should be established, re-established or implemented as determined necessary by the Certified Erosion and Sediment Control lead (CESCL) in order to bring the site back into compliance:

BMP C105: Stabilized Construction Entrance / Exit (repair construction entrance as necessary)

BMP C106: Wheel Wash (repair wheel wash as necessary)

BMP C120: Temporary and permanent Seeding

BMP C124: Sodding

BMP C140: Dust Control

BMP C209: Outlet Protection

BMP C220: Storm Drain Inlet Protection (add more inlet protection, as necessary

BMP C233: Silt Fence (add more silt fencing as necessary)

7.0 Reporting and Recordkeeping

7.1 Recordkeeping

7.1.1 Site Log Book

A site log book will be maintained for all on-site construction activities and will include:

- A record of the implementation of the SWPPP and other permit requirements;
- Site inspections; and,
- Stormwater quality monitoring.

For convenience, the inspection form and water quality monitoring forms included in this SWPPP include the required information for the site log book.

7.1.2 Records Retention

Records of all monitoring information (site log book, inspection reports/checklists, etc.), this Stormwater Pollution Prevention Plan, and any other documentation of compliance with permit requirements will be retained during the life of the construction project and for a minimum of three years following the termination of permit coverage in accordance with permit condition S5.C.

7.1.3 Access to Plans and Records

The SWPPP, General Permit, Notice of Authorization letter, and Site Log Book will be retained on site or within reasonable access to the site and will be made immediately available upon request to Ecology or the local jurisdiction. A copy of this SWPPP will be provided to Ecology within 14 days of receipt of a written request for the SWPPP from Ecology. Any other information requested by Ecology will be submitted within a reasonable time. A copy of the SWPPP or access to the SWPPP will be provided to the public when requested in writing in accordance with permit condition S5.G.

7.1.4 Updating the SWPPP

In accordance with Conditions S3, S4.B, and S9.B.3 of the General Permit, this SWPPP will be modified if the SWPPP is ineffective in eliminating or significantly minimizing pollutants in stormwater discharges from the site or there has been a change in design, construction, operation, or maintenance at the site that has a significant effect on the discharge, or potential for discharge, of pollutants to the waters of the State. The SWPPP will be modified within seven days of determination based on inspection(s) that additional or modified BMPs are necessary to correct problems identified, and an updated timeline for BMP implementation will be prepared.

7.2 Reporting

7.2.1 Discharge Monitoring Reports

Discharge Monitoring Reports (DMRs) will be submitted to Ecology monthly. If there was no discharge during a given monitoring period, the Permittee shall submit the form as required, with the words "No discharge" entered in the place of monitoring results. The DMR due date is 15 days following the end of each month.

Water quality sampling results will be submitted to Ecology monthly on Discharge Monitoring Report (DMR) forms in accordance with permit condition S5.B. If there was no discharge during a given monitoring period, the form will be submitted with the words "no discharge" entered in place of the monitoring results. If a benchmark was exceeded, a brief summary of inspection results and remedial actions taken will be included. If sampling could not be performed during a monitoring period, a DMR will be submitted with an explanation of why sampling could not be performed.

7.2.2 Notification of Noncompliance

If any of the terms and conditions of the permit are not met, and it causes a threat to human health or the environment, the following steps will be taken in accordance with permit section S5.F:

1. Ecology will be immediately notified of the failure to comply.
2. Immediate action will be taken to control the noncompliance issue and to correct the problem. If applicable, sampling and analysis of any noncompliance will be repeated immediately and the results submitted to Ecology within five (5) days of becoming aware of the violation.
3. A detailed written report describing the noncompliance will be submitted to Ecology within five (5) days, unless requested earlier by Ecology.

Any time turbidity sampling indicates turbidity is 250 nephelometric turbidity units (NTU) or greater or water transparency is 6 centimeters or less, the Ecology regional office will be notified by phone within 24 hours of analysis as required by permit condition S5.A (see Section 5.0 of this SWPPP for contact information).

In accordance with permit condition S2.A, a complete application form will be submitted to Ecology and the appropriate local jurisdiction (if applicable) to be covered by the General Permit.

Appendix A – Site Plans

Appendix B – Construction BMPs

Stabilized Construction Entrance (BMP C105)

Silt Fence (BMP C233)

Storm Drain Inlet Protection (BMP C220)

Infiltration Trench (BMP T7.20)

Temporary and Permanent Seeding (BMP C120)

Mulching (BMP C121)

Nets and Blankets (BMP C122)

Plastic Covering (BMP C123)

Topsoiling (BMP C125)

Dust Control (BMP C140)

Early application of gravel base on areas to be paved

Outlet Protection (BMP C209)

Appendix C – Alternative BMPs

The following includes a list of possible alternative BMPs for each of the 12 elements not described in the main SWPPP text. This list can be referenced in the event a BMP for a specific element is not functioning as designed and an alternative BMP needs to be implemented.

Element #1 - Mark Clearing Limits
High Visibility Plastic or Metal Fence (BMP C103)
Stake and Wire Fence (BMP C104)
Element #2 - Establish Construction Access
Wheel Wash (BMP C106)
Water Bars (BMP C203)
Element #3 - Control Flow Rates
Wattles (BMP C235)

Element #4 - Install Sediment Controls
Straw Bale Barrier (BMP C230)
Gravel Filter Berm (BMP C232)
Straw Wattles (BMP C235)
Portable Water Storage Tanks (Baker Tanks)
Construction Stormwater Chemical Treatment (BMP C250)
Construction Stormwater Filtration (BMP C251)

Element #5 - Stabilize Soils
Polyacrylamide (BMP C126)

Element #6 - Protect Slopes
Straw Wattles (BMP C235)
Surface Roughening (BMP C240)

Element #8 - Stabilize Channels and Outlets
Level Spreader (BMP C206)
Check Dams (BMP C207)

Element #9 – Control Pollutants
Concrete Handling (BMP C151)
Construction Stormwater Chemical Treatment (BMP C250)
Construction Stormwater Filtration (BMP C251)

Element #10 - Control Dewatering
Vegetated Filtration (BMP C236)
Additional Advanced BMPs to Control Dewatering:

Appendix D – General Permit

Appendix E – Site Inspection Forms (and Site Log)

The results of each inspection shall be summarized in an inspection report or checklist that is entered into or attached to the site log book. It is suggested that the inspection report or checklist be included in this appendix to keep monitoring and inspection information in one document, but this is optional. However, it is mandatory that this SWPPP and the site inspection forms be kept onsite at all times during construction, and that inspections be performed and documented as outlined below.

At a minimum, each inspection report or checklist shall include:

a. Inspection date/times

b. Weather information: general conditions during inspection, approximate amount of precipitation since the last inspection, and approximate amount of precipitation within the last 24 hours.

c. A summary or list of all BMPs that have been implemented, including observations of all erosion/sediment control structures or practices.

d. The following shall be noted:

   i. locations of BMPs inspected,

   ii. locations of BMPs that need maintenance,

   iii. the reason maintenance is needed,

   iv. locations of BMPs that failed to operate as designed or intended, and

   v. locations where additional or different BMPs are needed, and the reason(s) why

e. A description of stormwater discharged from the site. The presence of suspended sediment, turbid water, discoloration, and/or oil sheen shall be noted, as applicable.

f. A description of any water quality monitoring performed during inspection, and the results of that monitoring.

g. General comments and notes, including a brief description of any BMP repairs, maintenance or installations made as a result of the inspection.

h. A statement that, in the judgment of the person conducting the site inspection, the site is either in compliance or out of compliance with the terms and conditions of the SWPPP and the NPDES permit. If the site inspection indicates that the site is out of compliance, the inspection report shall include a summary of the remedial actions required to bring the site back into compliance, as well as a schedule of implementation.

i. Name, title, and signature of person conducting the site inspection; and the following statement: "I certify under penalty of law that this report is true, accurate, and complete, to the best of my knowledge and belief".

When the site inspection indicates that the site is not in compliance with any terms and conditions of the NPDES permit, the Permittee shall take immediate action(s) to: stop, contain, and clean up the unauthorized discharges, or otherwise stop the noncompliance; correct the problem(s); implement appropriate Best Management Practices (BMPs), and/or conduct maintenance of existing BMPs; and achieve compliance with all applicable standards and permit conditions. In addition, if the noncompliance causes a threat to human health or the environment, the Permittee shall comply with the Noncompliance Notification requirements in Special Condition S5.F of the permit.

Site Inspection Form

General Information			
Project Name:			
Inspector Name:		**Title:**	
		CESCL # :	
Date:		**Time:**	
Inspection Type:	□ After a rain event □ Weekly □ Turbidity/transparency benchmark exceedance □ Other		
Weather			
Precipitation	Since last inspection	In last 24 hours	
Description of General Site Conditions:			

Inspection of BMPs							
Element 1: Mark Clearing Limits							
BMP:							
Location	Inspected			Functioning			Problem/Corrective Action
	Y	N		Y	N	NIP	
BMP:							
Location	Inspected			Functioning			Problem/Corrective Action
	Y	N		Y	N	NIP	
Element 2: Establish Construction Access							
BMP:							
Location	Inspected			Functioning			Problem/Corrective Action
	Y	N		Y	N	NIP	
BMP:							
Location	Inspected			Functioning			Problem/Corrective Action
	Y	N		Y	N	NIP	

Element 3: Control Flow Rates

BMP:

Location	Inspected		Functioning			Problem/Corrective Action
	Y	N	Y	N	NIP	

BMP:

Location	Inspected		Functioning			Problem/Corrective Action
	Y	N	Y	N	NIP	

Element 4: Install Sediment Controls

BMP:

Location	Inspected		Functioning			Problem/Corrective Action
	Y	N	Y	N	NIP	

BMP:

Location	Inspected		Functioning			Problem/Corrective Action
	Y	N	Y	N	NIP	

BMP:

Location	Inspected		Functioning			Problem/Corrective Action
	Y	N	Y	N	NIP	

BMP:

Location	Inspected		Functioning			Problem/Corrective Action
	Y	N	Y	N	NIP	

BMP:

Location	Inspected		Functioning			Problem/Corrective Action
	Y	N	Y	N	NIP	

Element 5: Stabilize Soils

BMP:

Location	Inspected		Functioning			Problem/Corrective Action
	Y	N	Y	N	NIP	

BMP:

Location	Inspected		Functioning			Problem/Corrective Action
	Y	N	Y	N	NIP	

BMP:

Location	Inspected		Functioning			Problem/Corrective Action
	Y	N	Y	N	NIP	

BMP:

Location	Inspected		Functioning			Problem/Corrective Action
	Y	N	Y	N	NIP	

Element 6: Protect Slopes

BMP:

Location	Inspected		Functioning			Problem/Corrective Action
	Y	N	Y	N	NIP	

BMP:

Location	Inspected		Functioning			Problem/Corrective Action
	Y	N	Y	N	NIP	

BMP:

Location	Inspected		Functioning			Problem/Corrective Action
	Y	N	Y	N	NIP	

Element 7: Protect Drain Inlets

BMP:

Location	Inspected		Functioning			Problem/Corrective Action
	Y	N	Y	N	NIP	

BMP:

Location	Inspected		Functioning			Problem/Corrective Action
	Y	N	Y	N	NIP	

BMP:

Location	Inspected		Functioning			Problem/Corrective Action
	Y	N	Y	N	NIP	

Element 8: Stabilize Channels and Outlets

BMP:

Location	Inspected		Functioning			Problem/Corrective Action
	Y	N	Y	N	NIP	

BMP:

Location	Inspected		Functioning			Problem/Corrective Action
	Y	N	Y	N	NIP	

BMP:

Location	Inspected		Functioning			Problem/Corrective Action
	Y	N	Y	N	NIP	

BMP:

Location	Inspected		Functioning			Problem/Corrective Action
	Y	N	Y	N	NIP	

Element 9: Control Pollutants							
BMP:							
Location	Inspected		Functioning			Problem/Corrective Action	
	Y	N	Y	N	NIP		
BMP:							
Location	Inspected		Functioning			Problem/Corrective Action	
	Y	N	Y	N	NIP		
Element 10: Control Dewatering							
BMP:							
Location	Inspected		Functioning			Problem/Corrective Action	
	Y	N	Y	N	NIP		
BMP:							
Location	Inspected		Functioning			Problem/Corrective Action	
	Y	N	Y	N	NIP		
BMP:							
Location	Inspected		Functioning			Problem/Corrective Action	
	Y	N	Y	N	NIP		

Stormwater Discharges From the Site		
	Observed?	Problem/Corrective Action

	Y	N
Location		
Turbidity		
Discoloration		
Sheen		
Location		
Turbidity		
Discoloration		
Sheen		

Water Quality Monitoring
Was any water quality monitoring conducted? □ Yes □ No
If water quality monitoring was conducted, record results here:
If water quality monitoring indicated turbidity 250 NTU or greater; or transparency 6 cm or less, was Ecology notified by phone within 24 hrs? □ Yes □ No
If Ecology was notified, indicate the date, time, contact name and phone number below:
Date:
Time:
Contact Name:
Phone #:
General Comments and Notes
Include BMP repairs, maintenance, or installations made as a result of the inspection.
Were Photos Taken? □ Yes □ No
If photos taken, describe photos below:

SEPARATOR SHEET

APPENDIX F

Environmental Documentation