Received 11-13-2023

BARGHAUSEN

STORMWATER SITE PLAN

DuPont - West
DuPont, Washington

Prepared for:
Avenue 55, LLC
601 Union Street, Suite 2930
Seattle, WA 98101

DANIEL K. BALMELLI
STATE OF WASHINGTON
25672
REGISTERED
PROFESSIONAL ENGINEER
Daniel K. Balmelli
11/06/2023

November 6, 2023
Our Job No. 18666

BARGHAUSEN CONSULTING ENGINEERS, INC.
18215 72ND AVENUE SOUTH KENT, WA 98032 P) 425-251-6222 F) 425-251-8782
BRANCH OFFICES: TUMWATER, WA KLAMATH FALLS, OR LONG BEACH, CA ROSEVILLE, CA SAN DIEGO, CA
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EXECUTIVE SUMMARY

EXECUTIVE SUMMARY

This 19.65 acre site is located within a portion of the Northwest quarter of Section 26, Township 19 North, Range 1 East, Willamette Meridian, Pierce County, Washington. Of these 19.65 acres, 15.25 acres will be cleared, graded, and developed into a commercial building site and new public roadway. There are no known wetlands on the project site.

All Minimum Requirements apply to this project site and the following pages of this report describe how those Minimum Requirements will be met with this development. Flow control will be provided by an infiltration pond which has been sized to serve the proposed development of Lot 1 under this permit as well as any potential future development of Lot 3. In addition, a separate infiltration gallery has been provided to serve the new public road on Lot 2. Water quality will be provided by three Modular Wetland Systems which have General Use Level Designation for Enhanced, Phosphorus, and Basic Water Quality treatment per the Department of Ecology.

According to the topographic survey, there are no upstream basins that contribute runoff to this site.

A new infiltration pond will be constructed to provide stormwater flow control for the proposed development. This pond has been sized to serve the proposed development of Lot 1 under this permit as well as any potential future development of Lot 3. In addition, a separate infiltration gallery has been provided to serve the new public road on Lot 2. Per Pierce County requirements, the pond and gallery been sized to infiltrate all stormwater runoff from the site up to the 100-year storm event. The conveyance system for this project has been sized using Santa Barbara Urban Hydrograph (SBUH) methodology to convey the 25-year storm event in all conveyance elements without surcharging any manholes or catch basins. Please see the following pages of this report for stormwater facility details and sizing calculations.

1.0 ANALYSIS OF THE MINIMUM REQUIREMENTS

1.0 ANALYSIS OF THE MINIMUM REQUIREMENTS

Per Figure 1.1, the Flow Chart for Determining the Minimum Requirements for New Developments, all Minimum Requirements 1 through 9 apply to this project. The following is a list of each of the Minimum Requirements and how this Stormwater Site Plan and site development project meet those requirements.

Minimum Requirement No. 1: Preparation of Stormwater Site Plan.

Response: This document meets the requirements for preparation of a Stormwater Site Plan.

Minimum Requirement No. 2: Stormwater Pollution Prevention Plan.

Response: Please see Section 6.0 of this report for the Stormwater Pollution Prevention Plan prepared for this project.

Minimum Requirement No. 3: Source Control of Pollution.

Response: All known, available, and reasonable Source Control BMPs will be applied to this project. At a minimum the owner will be educated about the proper use of pesticides and fertilizers, the parking lot will be swept on a regular basis, and the trash enclosure will be covered.

Minimum Requirement No. 4: Preservation of Natural Drainage Systems and Outfalls.

Response: Under existing conditions, all stormwater onsite infiltrates into the ground. Because the development proposes to infiltrate all stormwater runoff onsite, the existing drainage system will be preserved.

Minimum Requirement No. 5: On-Site Stormwater Management.

Response: Per the attached geotechnical report in section 7.0, soils on site will provide a minimum infiltration rate of 15 inches per hour. For this reason, an infiltration pond and gallery are proposed to provide onsite stormwater management.

Minimum Requirement No. 6: Runoff Treatment.

Response: Three Modular Wetland Systems are proposed to provide water quality treatment for all runoff from this project. This system has General Use Level Designation (GULD) from the Department of Ecology for enhanced water quality treatment.

Minimum Requirement No. 7: Flow Control.

Response: Flow control will be provided for this site by an onsite stormwater infiltration pond. In addition, a separate infiltration gallery is proposed to serve the improvements to Sequalitchew Drive. Per Pierce County Requirements, these facilities have been designed to infiltrate 100% of runoff from the project site up to and including the 100-year storm event.

Minimum Requirement No. 8: Wetlands Protection.

Response: There are no known wetlands on or adjacent to this site.

Minimum Requirement No. 9: Operation and Maintenance.

Response: An Operations and Maintenance Manual is included in this report and meets the requirements of the Pierce County stormwater manual.

FIGURE 1.1 - MINIMUM REQUIREMENTS SUMMARY

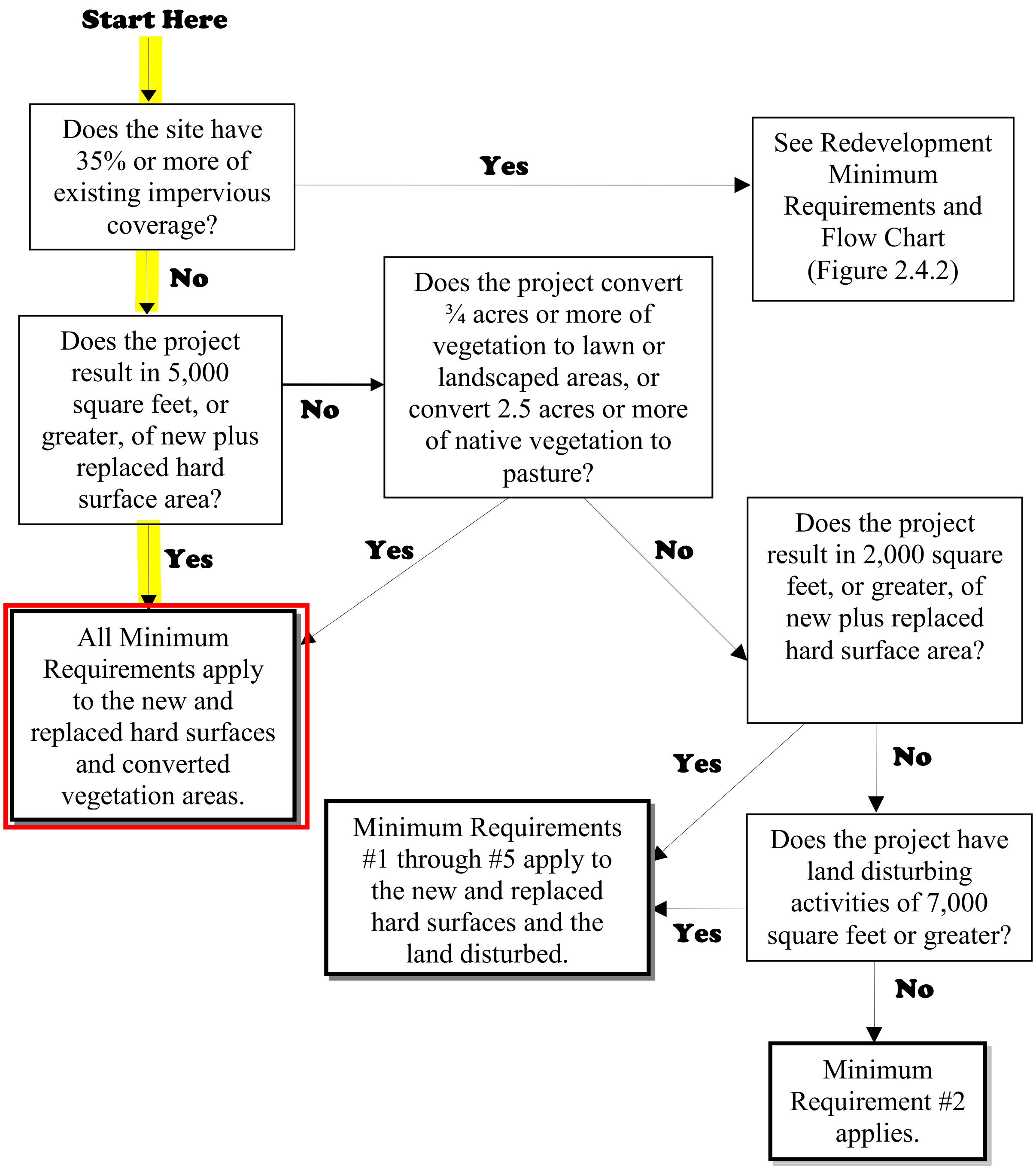


Figure 2.4.1 – Flow Chart for Determining Requirements for New Development

2.0 PROJECT OVERVIEW

2.0 PROJECT OVERVIEW

The site is located within a portion of the Northwest quarter of section 26, Township 19 North, Range 1 East, Willamette Meridian, Pierce County, Washington. The address of this site is 1700 Center Drive DuPont, WA 98327

The proposal of this project is to construct one new warehouse building approximately 256,800 SF in size along with a loading dock, paved drive aisles, and new utilities. Half street construction is also proposed to connect into the existing portion of Sequalitchew Drive to the southeast of the site. The remaining eastern side of Sequalitchew Drive will be constructed when Lot 3 is developed. Improvements under this permit include 13.10 acres of impervious surfaces while the remaining site area will consist of pervious surfaces in the form of landscaping, pond area, and undisturbed land, which total 6.55 acres.

For stormwater flow control, a new infiltration pond is proposed. This pond has been sized to serve the proposed development of Lot 1 under this permit as well as any potential future development of Lot 3. In addition, a separate infiltration gallery has been provided to serve the new public road on Lot 2. These facilities have been sized to handle the 100-year storm event for site. Stormwater quality treatment will be provided by three Modular Wetland Units which have General Use Level Designation (GULD) from the Department of Ecology for enhanced water quality treatment. Please see the following pages of this report for sizing of these facilities.

3.0 EXISTING CONDITIONS SUMMARY

3.0 EXISTING CONDITIONS SUMMARY

Under existing conditions, the eastern and western portions of the site are thickly forested. The center of the site is an open area of gravel with downward slopes of approximately 3:1. To the west of the gravel area, the site is relatively flat, other than a few areas of moderate slopes. On the east of the gravel area, the site is moderately steep, where it generally slopes downward to the southwest at a minimum of 7% and at most 30% on the far east side of the site. Overall, the site slopes downward to the southwest.

Per the geotechnical report, groundwater levels in the area are at an elevation of roughly 140' and none is expected to be encountered during construction. A minimum infiltration rate of 15 inches per hour can be used to size the proposed infiltration pond.

4.0 OFF-SITE ANALYSIS REPORT

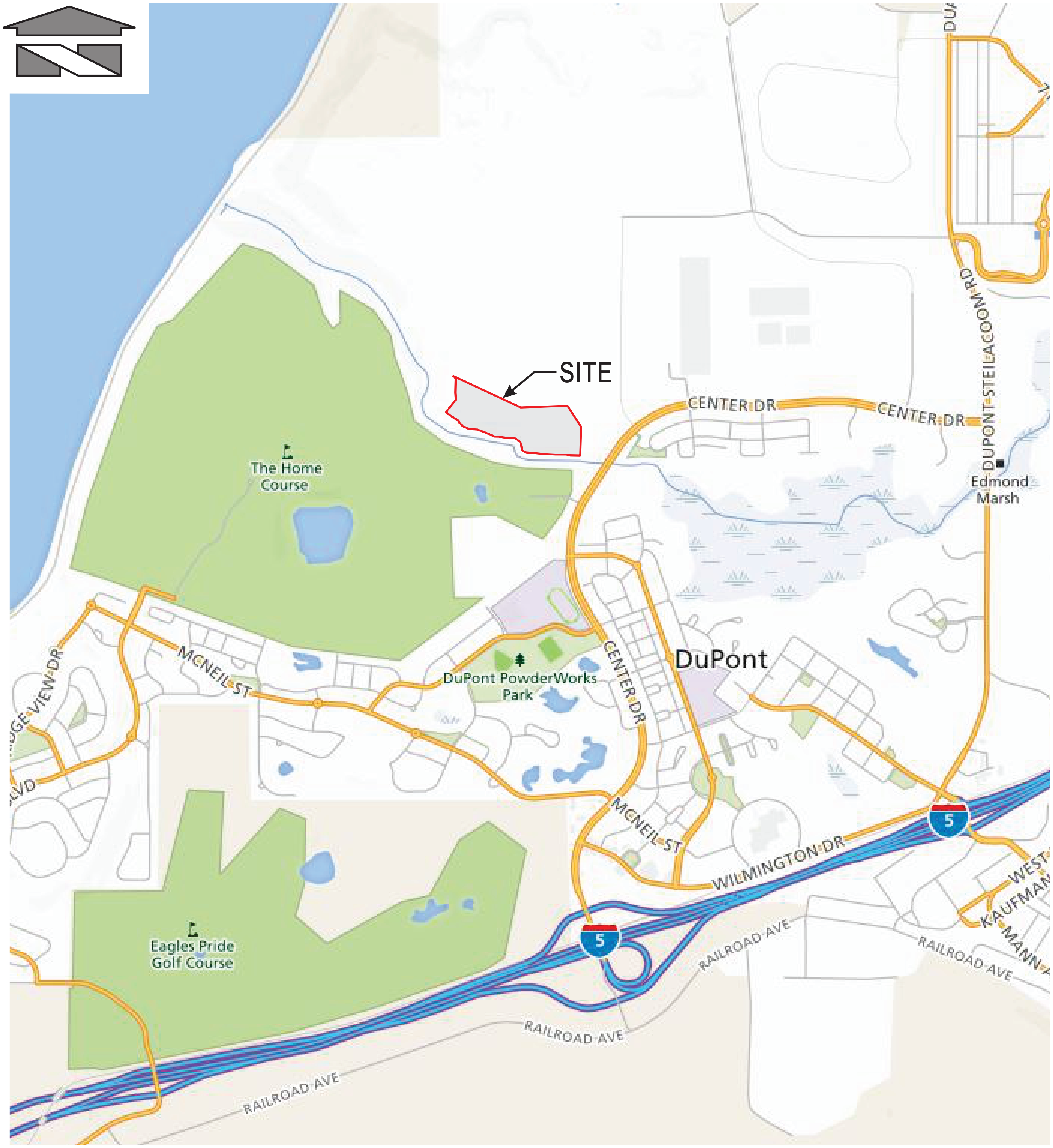
4.0 OFF-SITE ANALYSIS REPORT

An Off-Site Analysis Report will be included with the final Stormwater Site Plan.

Upstream Basin Analysis

There do not appear to be any upstream basins that contribute runoff to this project.

VICINITY MAP



REFERENCE: Rand McNally (2017)

Scale: *Horizontal:* ***N.T.S.*** *Vertical:* ***N/A***	*For:* Dupont Industrial Warehouse Dupont, Washington	Job Number 18666
BARGHAUSEN CONSULTING ENGINEERS, INC. 18215 72ND AVENUE SOUTH KENT, WA 98032 (425) 251-6222 (425) 251-8782 CIVIL ENGINEERING, LAND PLANNING, SURVEYING, ENVIRONMENTAL SERVICES	*Title:* VICINITY MAP	DATE: 12/19/17

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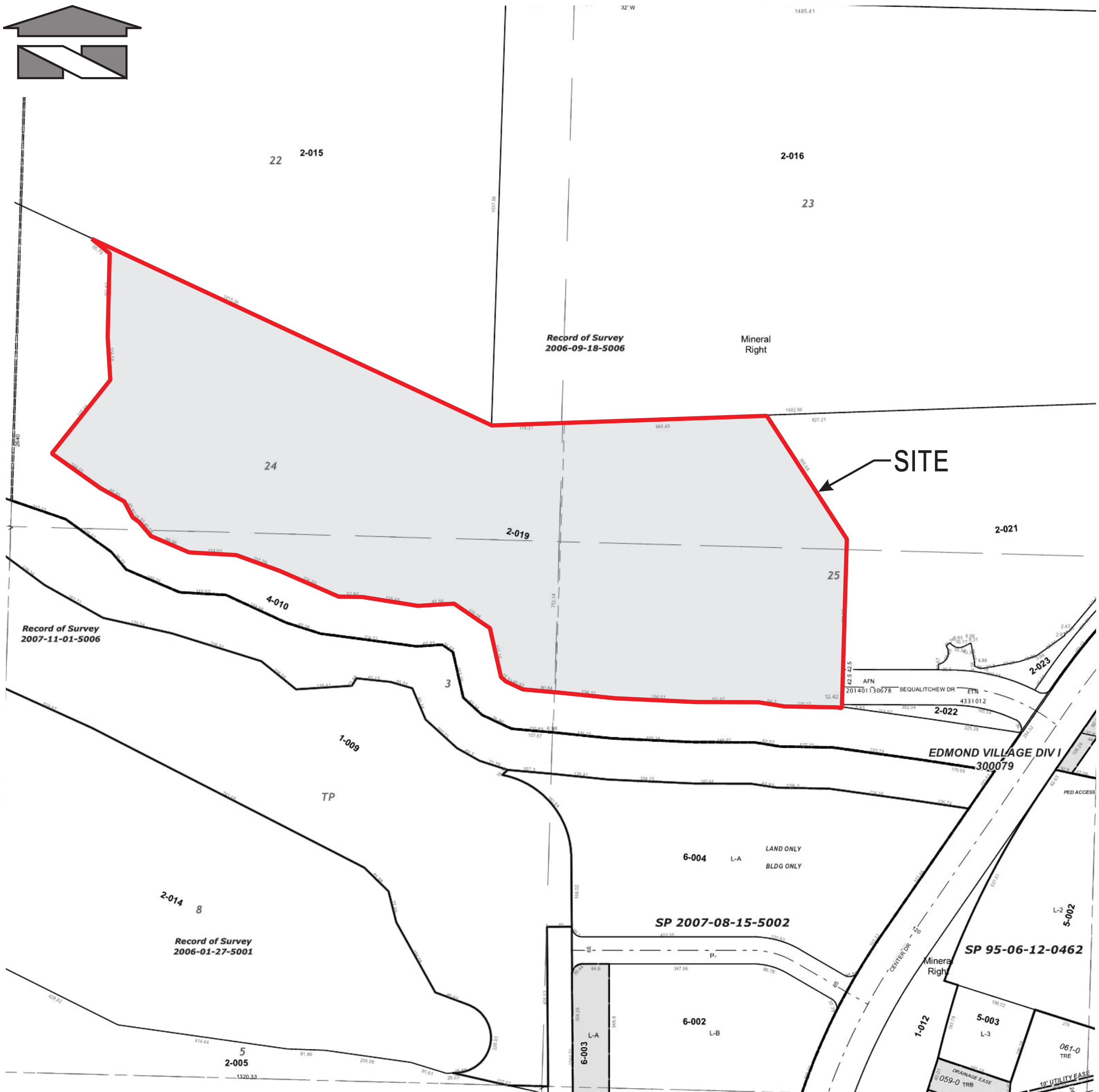
ASSESSOR'S MAP



REFERENCE: Pierce County Department of Assessments (Dec. 2015)

Scale: Horizontal: N.T.S. Vertical: N/A	For: Dupont Industrial Warehouse Dupont, Washington	Job Number 18666
BARGHAUSEN CONSULTING ENGINEERS, INC. 18215 72ND AVENUE SOUTH KENT, WA 98032 (425) 251-6222 (425) 251-8782 CIVIL ENGINEERING, LAND PLANNING, SURVEYING, ENVIRONMENTAL SERVICES	Title: ASSESSOR MAP	DATE: 12/19/17

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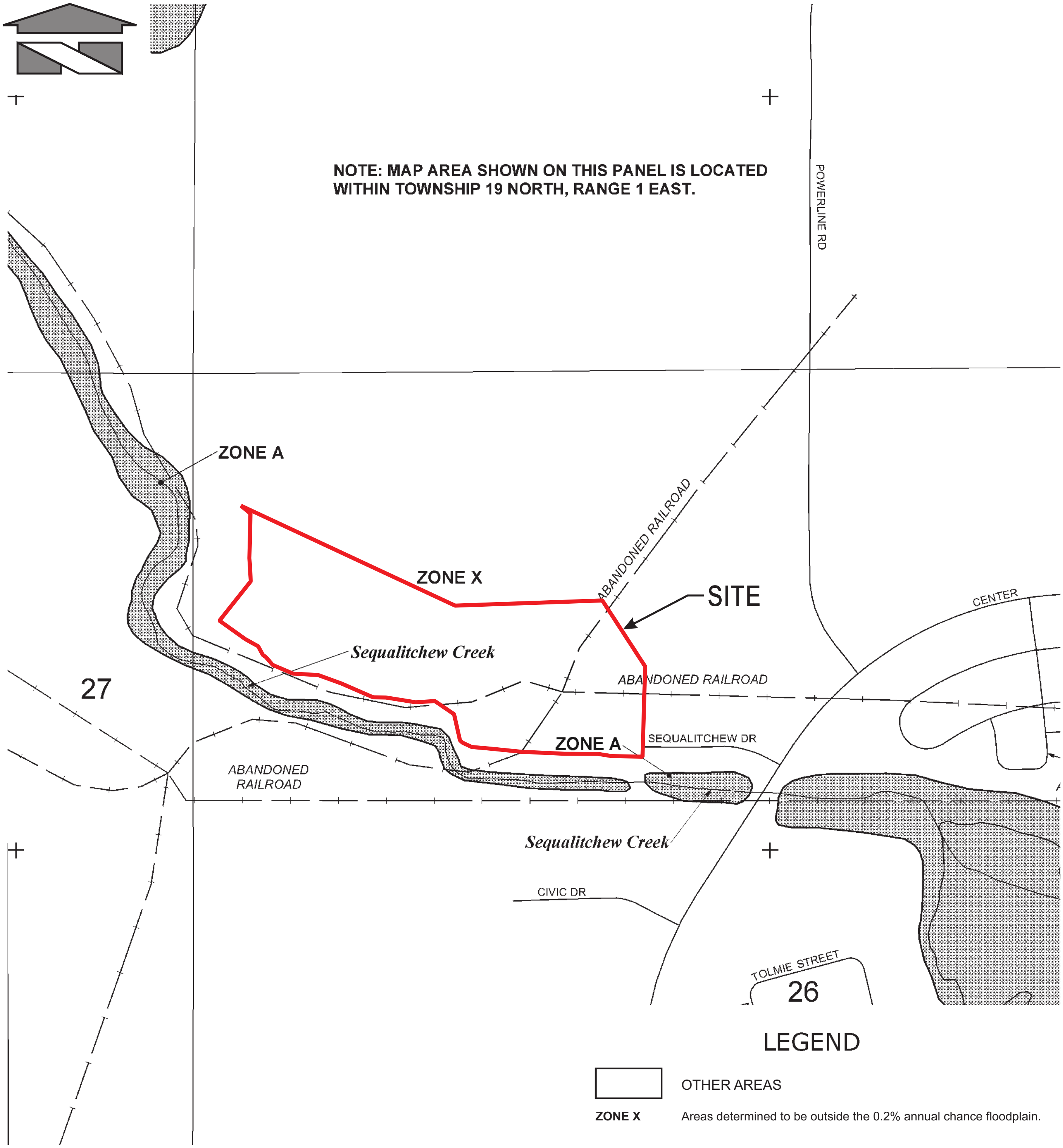
FEMA MAP



REFERENCE: Federal Emergency Management Agency (Portion of Map 53053C0507E, March 2017)

Scale: Horizontal: **N.T.S.** Vertical: **N/A**	For: Dupont Industrial Warehouse Dupont, Washington	Job Number 18666
BARGHAUSEN CONSULTING ENGINEERS, INC. 18215 72ND AVENUE SOUTH KENT, WA 98032 (425) 251-6222 (425) 251-8782 CIVIL ENGINEERING, LAND PLANNING, SURVEYING, ENVIRONMENTAL SERVICES	Title: FEMA MAP	DATE: 12/19/17

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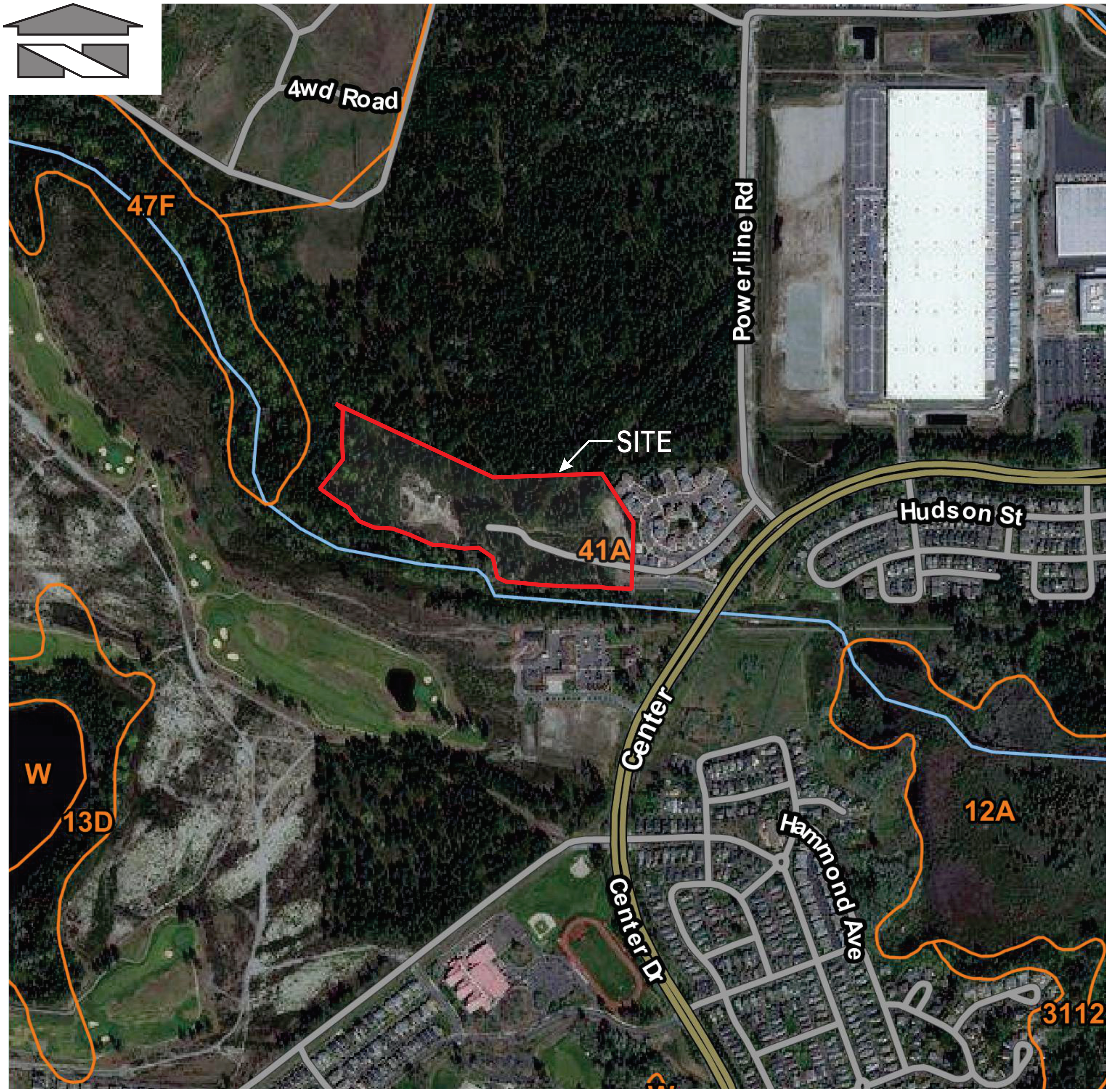
SOILS MAP



REFERENCE: USDA, Natural Resources Conservation Service

LEGEND:

41A = Spanaway gravelly sandy loam

Scale: Horizontal: N.T.S. Vertical: N/A	For: Dupont Industrial Warehouse Dupont, Washington	Job Number 18666
BARGHAUSEN CONSULTING ENGINEERS, INC. 18215 72ND AVENUE SOUTH KENT, WA 98032 (425) 251-6222 (425) 251-8782 CIVIL ENGINEERING, LAND PLANNING, SURVEYING, ENVIRONMENTAL SERVICES	Title: SOIL SURVEY MAP	DATE: 12/19/17

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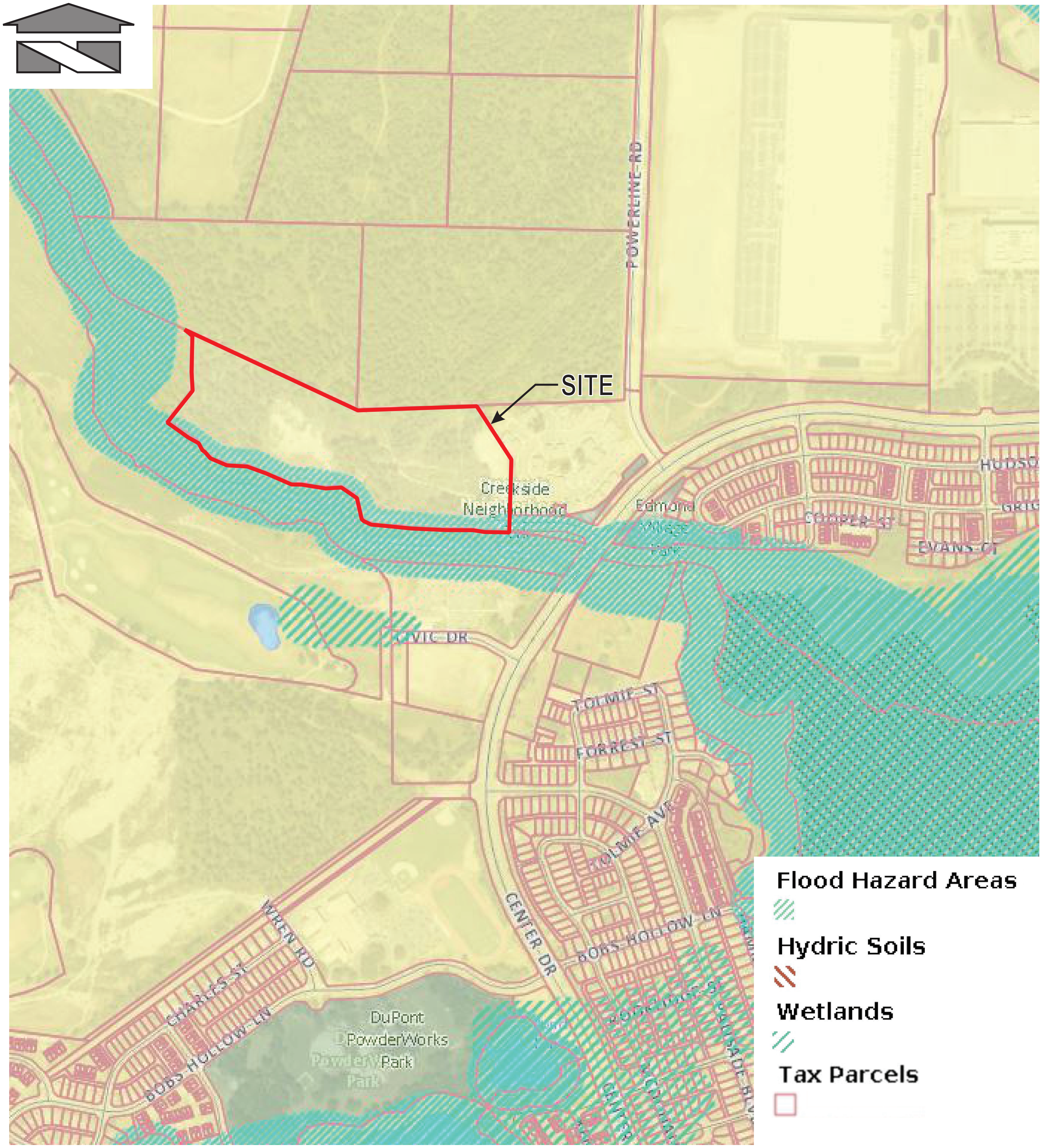
SENSITIVE AREAS MAP



REFERENCE: Pierce County PublicGIS

Scale:

Horizontal: ***N.T.S.*** Vertical: ***N/A***

For:

Dupont Industrial Warehouse
Dupont, Washington

Job Number

18666

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CIVIL ENGINEERING, LAND PLANNING,
SURVEYING, ENVIRONMENTAL SERVICES

Title:

SENSITIVE AREAS
MAP

DATE: 12/19/17

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5.0 PERMANENT STORMWATER CONTROL PLAN

5.0 PERMANENT STORMWATER CONTROL PLAN

Part A Existing Site Hydrology

The existing project site consists of approximately 19.65 acres of forested land. There is an existing gravel area near the center of the site, which depresses at a slopes ranging from 30% to 45%. There are existing 1:1 slopes to the south of the property. The majority of the site is moderately steep, with slopes ranging from 2% to 20%. The east side of the site has slopes ranging from 13% to 70%. The site generally slopes southwest. This site lies within Spanaway gravelly sandy loam, according to the USDA Web Soil survey.

Under existing conditions, all stormwater onsite infiltrates into the ground. Full infiltration is also the proposed means of stormwater flow control for the project, preserving the natural site discharge.

Part B Developed Site Hydrology

The developed site will include approximately 13.10 acres of impervious surfaces and 6.55 acres of pervious landscaped and undeveloped areas. Of the impervious areas, the proposed building roof area will be approximately 5.90 acres while the remaining 7.20 acres will consist of asphalt and concrete paving. An infiltration pond and two modular wetland units are proposed to serve the development of Lot 1 under this permit. These facilities have been sized to handle any additional runoff that would potentially be generated from the future development of Lot 3. In addition, a separate infiltration gallery and Modular Wetland Unit are proposed to serve runoff from the public roadway on Lot 2. Because roof area is a non-pollution generating surface, roof runoff will be discharged directly into the infiltration pond, bypassing the water quality system.

As required by the Pierce County Stormwater Management and Site Development Manual, the infiltration pond and gallery were sized using WWHM 2012 to handle runoff from the 100-year storm event. However, in the unlikely occurrence of a storm beyond the 100-year storm event, additional storage is provided onsite. Once 0.60’ of freeboard is reached in the pond above the maximum water surface, water will also begin to pond in the truck court area, providing emergency storage for events beyond the 100-year storm.

Part C Performance Standards and Goals

The flow control standard for this project is 100% infiltration of all stormwater runoff up to and including the 100-year storm event. The water quality devices have been sized to treat 91% of total stormwater volume across all modeled storm events. The Santa Barbara Urban Hydrograph (SBUH) methodology will be used in the final report to size all conveyance elements for the 25-year storm event.

Part D Low Impact Development Features

Flow control for this project will be provided by a new infiltration pond and gallery which will infiltrate 100% of stormwater runoff from the project onsite, eliminating any discharge from the property.

Part E Flow Control System

Flow control for the project will be provided by a new infiltration pond and gallery which have been sized using WWHM 2012 to process 100% of stormwater runoff from the development of Lots 1 and 2 proposed under this permit as well as any runoff from the potential future development of Lot 3.

Part F Water Quality System

Water quality for this project will be provided by three Modular Wetland Systems which have General use Level Designation (GULD) for enhanced water quality treatment from the Department of Ecology. These units have been sized using WWHM 2012 to treat 91% of the total runoff volume across all storm events per the Pierce County Stormwater Management and Site Development Manual.

Part G Conveyance System Analysis and Design

The conveyance system for this project has been sized to convey the 25-year storm event per the requirements of the Pierce County stormwater manual using a 5-minute time of concentration and a Manning's 'n' value of 0.013 for all pipes. Conveyance calculations will be provided in the final storm report.

FLOW CONTROL AND WATER QUALITY SIZING CRITERIA

FLOW CONTROL AND WATER QUALITY SIZING CRITERIA

Lot 1

Roof Tops	=	5.90 Acres
Pavement	=	5.75 Acres
Pond	=	0.50 Acres
Landscape	=	5.57 Acres
Total	=	17.72 Acres

Lot 2 (Sequalitchew Drive)

Pavement	=	1.45 Acres
Landscape	=	0.48 Acres
Total	=	1.93 Acres

Lot 3 (Future development under separate permit)

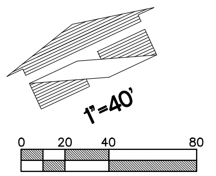
Roof Tops	=	1.30 Acres
Pavement	=	2.26 Acres
Landscape	=	2.08 Acres
Total	=	5.64 Acres

BASIN MAP

Pipe Conveyance Calculations will be included in the final Stormwater Site Plan.

GRADING PLAN

PRELIMINARY GRADING AND STORM DRAINAGE PLAN-WEST
FOR
DUPONT - WEST
A PORTION OF THE NW 1/4 OF SECTION 26, TOWNSHIP 19N, RANGE 01E, W.M.
CITY OF DUPONT, PIERCE COUNTY, WASHINGTON



APPROVED FOR CONSTRUCTION

BY: ____________ DATE: ____________
CITY OF DUPONT

THESE DRAWINGS ARE APPROVED FOR CONSTRUCTION FOR A PERIOD OF 12 MONTHS FROM THE DATE SHOWN HEREON. THE CITY RESERVES THE RIGHT TO MAKE REVISIONS, ADDITIONS, DELETIONS, OR MODIFICATIONS SHOULD CONSTRUCTION BE DELAYED BEYOND THIS TIME LIMITATION. THE CITY, BY APPROVING THESE DRAWINGS, ASSUMES NO LIABILITY IN REGARDS TO THEIR ACCURACY OR OMISSIONS.

NOTE:
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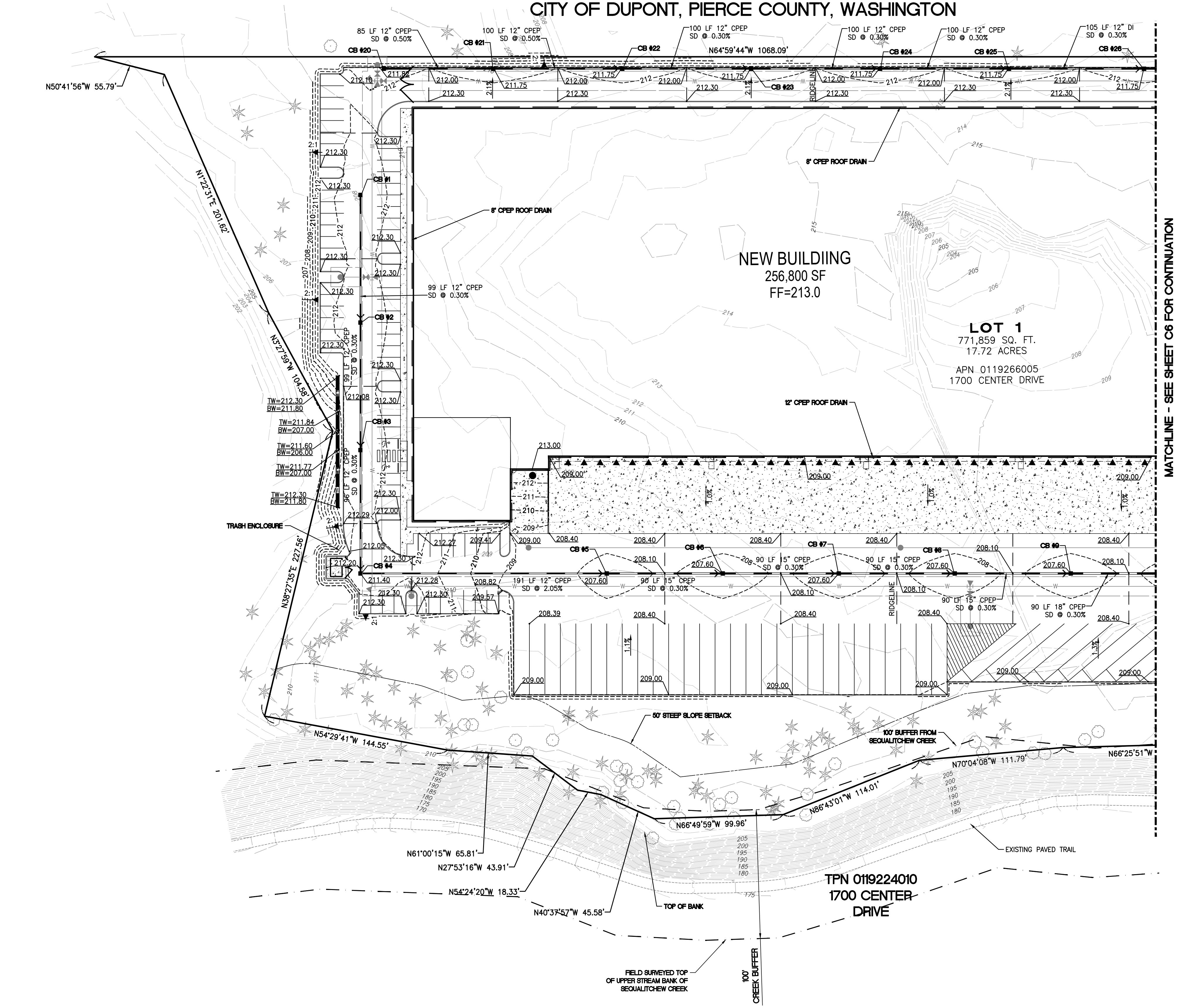

No.	Date	By	Ckd.	Appr.	Revision
2	11/06/23	JT	DKB	DKB	REVISED PER CITY COMMENTS

Title: PRELIMINARY GRADING AND STORM DRAINAGE PLAN-WEST FOR DUPONT - WEST

For: AVENUE 55, LLC
601 UNION STREET, SUITE 2930
SEATTLE, WA 98101
(206) 707-9696

DANIEL K. BALMELLI, STATE OF WASHINGTON, 25672, REGISTERED PROFESSIONAL ENGINEER, 11/06/2023

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

Designed JAT
Drawn JAT
Checked DKB
Approved DKB
Date 11/06/23

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CIVIL ENGINEERING, LAND PLANNING, SURVEYING, ENVIRONMENTAL SERVICES

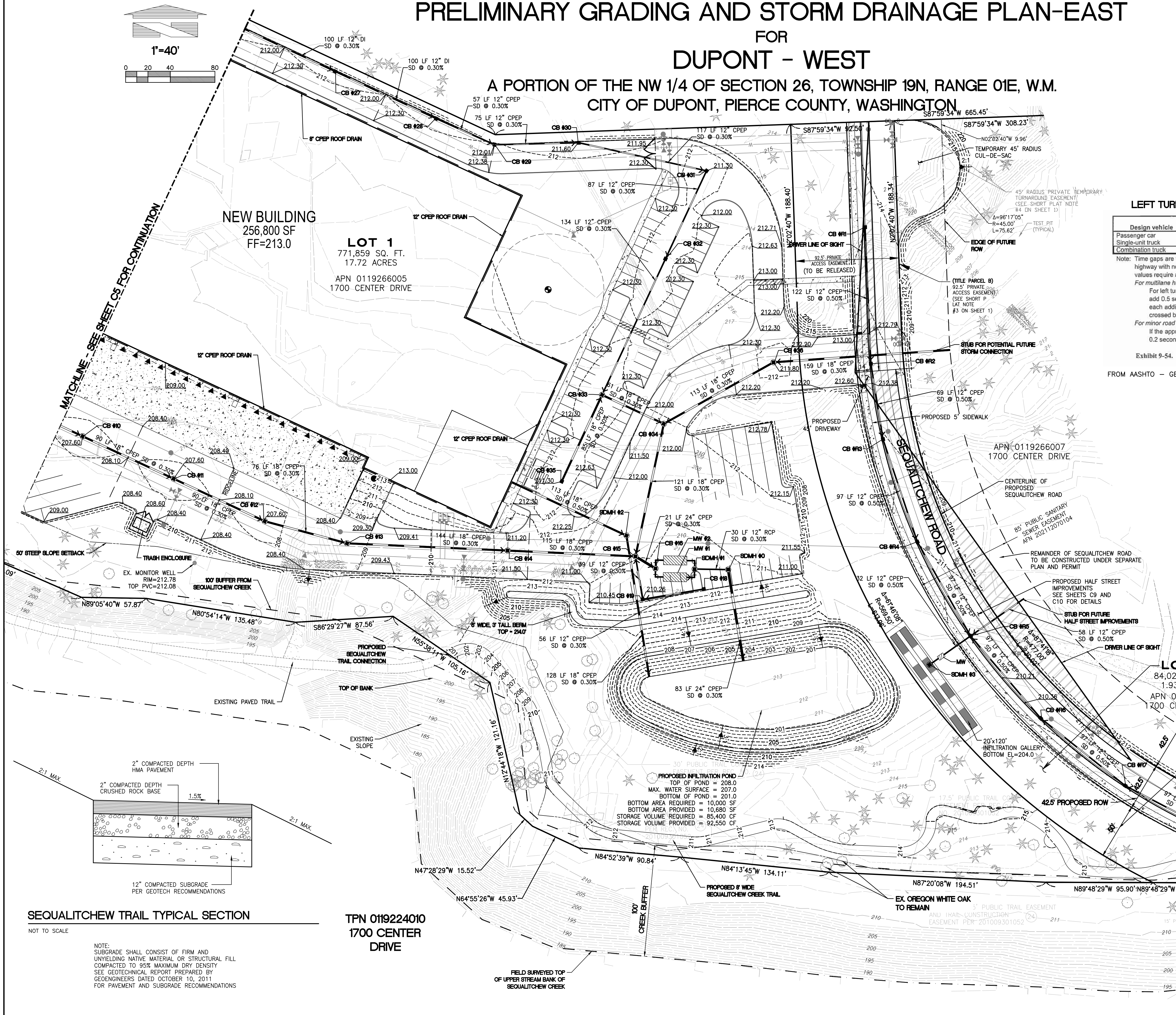
Job Number 18666

Sheet C5 of 13

PRELIMINARY GRADING AND STORM DRAINAGE PLAN-EAST
FOR
DUPONT - WEST
A PORTION OF THE NW 1/4 OF SECTION 26, TOWNSHIP 19N, RANGE 01E, W.M.
CITY OF DUPONT, PIERCE COUNTY, WASHINGTON

1"=40'

0 20 40 80



TPN 0119224010
1700 CENTER
DRIVE

NOTE:
ALL TREES SHOWN ON THIS SHEET ARE TO REMAIN DURING DEMOLITION

LEFT TURN SIGHT DISTANCE

Design vehicle	Time gap (t_g) (seconds) at design speed of major road
Passenger car	7.5
Single-unit truck	9.5
Combination truck	11.5

Note: Time gaps are for a stopped vehicle to turn left onto a two-lane highway with no median and grades 3 percent or less. The table values require adjustment as follows:
For multilane highways:
For left turns onto two-way highways with more than two lanes, add 0.5 seconds for passenger cars or 0.7 seconds for trucks for each additional lane, from the left, in excess of one, to be crossed by the turning vehicle.
For minor road approach grades:
If the approach grade is an upgrade that exceeds 3 percent; add 0.2 seconds for each percent grade for left turns

Exhibit 9-54. Time Gap for Case B1—Left Turn from Stop

FROM AASHTO – GEOMETRIC DESIGN OF HIGHWAYS AND STREETS

ISD = SPEED x TG
ISD = 73.3 ft/s x 11.5 s
ISD = 843 ft

RIGHT TURN SIGHT DISTANCE

Design vehicle	Time gap (t_g) (seconds) at design speed of major road
Passenger car	6.5
Single-unit truck	8.5
Combination truck	10.5

Note: Time gaps are for a stopped vehicle to turn right onto or cross a two-lane highway with no median and grades 3 percent or less. The table values require adjustment as follows:
For multilane highways:
For crossing a major road with more than two lanes, add 0.5 seconds for passenger cars and 0.7 seconds for trucks for each additional lane to be crossed and for narrow medians that cannot store the design vehicle.
For minor road approach grades:
If the approach grade is an upgrade that exceeds 3 percent, add 0.1 seconds for each percent grade.

Exhibit 9-57. Time Gap for Case B2—Right Turn from Stop and Case B3—Crossing Maneuver

FROM AASHTO – GEOMETRIC DESIGN OF HIGHWAYS AND STREETS

ISD = SPEED x TG
ISD = 73.3 ft/s x 10.5 s
ISD = 770 ft

2:1 MAX.
2" COMPACTED DEPTH HMA PAVEMENT
2" COMPACTED DEPTH CRUSHED ROCK BASE
1.5%
2:1 MAX.
12" COMPACTED SUBGRADE PER GEOTECH RECOMMENDATIONS

SEQUALITCHEW TRAIL TYPICAL SECTION

NOT TO SCALE

NOTE:
SUBGRADE SHALL CONSIST OF FIRM AND UNYIELDING NATIVE MATERIAL OR STRUCTURAL FILL COMPACTED TO 95% MAXIMUM DRY DENSITY SEE GEOTECHNICAL REPORT PREPARED BY GEOENGINEERS DATED OCTOBER 10, 2011 FOR PAVEMENT AND SUBGRADE RECOMMENDATIONS

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CITY OF DUPONT

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No.	Date	By	Ckd.	Appr.	Revision
2	11/06/23		DKB		REVISED PER CITY COMMENTS

Title: PRELIMINARY GRADING AND STORM DRAINAGE PLAN-EAST FOR DUPONT - WEST

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Designed JAT
Drawn JAT
Checked DKB
Approved DKB
Date 11/06/23

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CIVIL ENGINEERING, LAND PLANNING, SURVEYING, ENVIRONMENTAL SERVICES

Job Number 18666
Sheet C6 of 13

FLOW CONTROL CALCULATIONS

WWHM2012

PROJECT REPORT

18666 - DuPont West
Pond Flow Control Calculations

General Model Information

Project Name:	18666 FC Pond3
Site Name:	
Site Address:	
City:	
Report Date:	11/6/2023
Gage:	40 IN WEST
Data Start:	10/01/1901
Data End:	09/30/2059
Timestep:	15 Minute
Precip Scale:	1.000
Version Date:	2019/09/13
Version:	4.2.17

POC Thresholds

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

Mitigated Land Use

Basin 1

Bypass:	No
GroundWater:	No
Pervious Land Use	acre
A B, Lawn, Flat	7.65
Pervious Total	7.65
Impervious Land Use	acre
ROOF TOPS FLAT	7.2
PARKING FLAT	8.01
POND	0.5
Impervious Total	15.71
Basin Total	23.36

Element Flows To:

Surface	Interflow	Groundwater
Trapezoidal Pond 1	Trapezoidal Pond 1	

Mitigated Routing

Trapezoidal Pond 1

Bottom Length:	100.00 ft.	
Bottom Width:	100.00 ft.	
Depth:	7 ft.	
Volume at riser head:	1.9612 acre-feet.	
Infiltration On		
Infiltration rate:	15	
Infiltration safety factor:	1	
Total Volume Infiltrated (ac-ft.):		6749.59
Total Volume Through Riser (ac-ft.):		0
Total Volume Through Facility (ac-ft.):		6749.59
Percent Infiltrated:		100
Total Precip Applied to Facility:		0
Total Evap From Facility:		0
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:	6 ft.	
Riser Diameter:	18 in.	
Element Flows To:		
Outlet 1	Outlet 2	

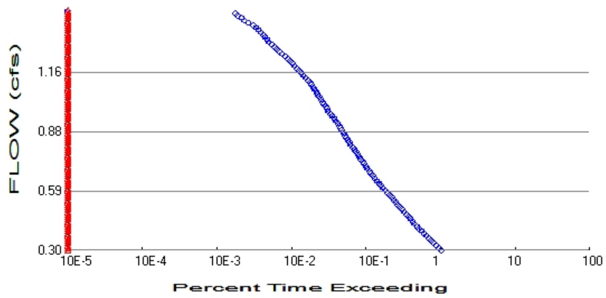
Pond Hydraulic Table

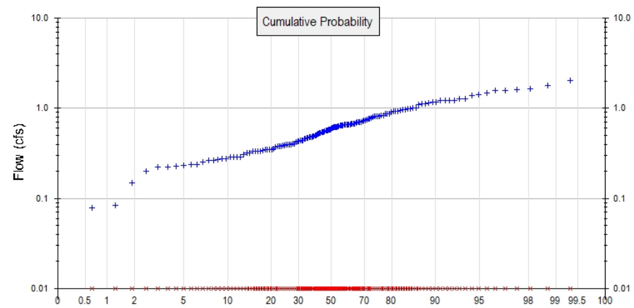
Stage(feet)	**Area(ac.)**	**Volume(ac-ft.)**	**Discharge(cfs)**	**Infilt(cfs)**
0.0000	0.229	0.000	0.000	0.000
0.0778	0.231	0.017	0.000	3.472
0.1556	0.233	0.036	0.000	3.472
0.2333	0.236	0.054	0.000	3.472
0.3111	0.238	0.072	0.000	3.472
0.3889	0.240	0.091	0.000	3.472
0.4667	0.242	0.110	0.000	3.472
0.5444	0.244	0.129	0.000	3.472
0.6222	0.247	0.148	0.000	3.472
0.7000	0.249	0.167	0.000	3.472
0.7778	0.251	0.187	0.000	3.472
0.8556	0.253	0.206	0.000	3.472
0.9333	0.256	0.226	0.000	3.472
1.0111	0.258	0.246	0.000	3.472
1.0889	0.260	0.266	0.000	3.472
1.1667	0.262	0.287	0.000	3.472
1.2444	0.265	0.307	0.000	3.472
1.3222	0.267	0.328	0.000	3.472
1.4000	0.269	0.349	0.000	3.472
1.4778	0.272	0.370	0.000	3.472
1.5556	0.274	0.391	0.000	3.472
1.6333	0.276	0.412	0.000	3.472
1.7111	0.279	0.434	0.000	3.472
1.7889	0.281	0.456	0.000	3.472
1.8667	0.283	0.478	0.000	3.472
1.9444	0.286	0.500	0.000	3.472
2.0222	0.288	0.522	0.000	3.472

2.1000	0.291	0.545	0.000	3.472
2.1778	0.293	0.568	0.000	3.472
2.2556	0.295	0.591	0.000	3.472
2.3333	0.298	0.614	0.000	3.472
2.4111	0.300	0.637	0.000	3.472
2.4889	0.303	0.660	0.000	3.472
2.5667	0.305	0.684	0.000	3.472
2.6444	0.308	0.708	0.000	3.472
2.7222	0.310	0.732	0.000	3.472
2.8000	0.313	0.756	0.000	3.472
2.8778	0.315	0.781	0.000	3.472
2.9556	0.318	0.805	0.000	3.472
3.0333	0.320	0.830	0.000	3.472
3.1111	0.323	0.855	0.000	3.472
3.1889	0.325	0.881	0.000	3.472
3.2667	0.328	0.906	0.000	3.472
3.3444	0.330	0.932	0.000	3.472
3.4222	0.333	0.958	0.000	3.472
3.5000	0.336	0.984	0.000	3.472
3.5778	0.338	1.010	0.000	3.472
3.6556	0.341	1.036	0.000	3.472
3.7333	0.343	1.063	0.000	3.472
3.8111	0.346	1.090	0.000	3.472
3.8889	0.349	1.117	0.000	3.472
3.9667	0.351	1.144	0.000	3.472
4.0444	0.354	1.172	0.000	3.472
4.1222	0.357	1.199	0.000	3.472
4.2000	0.359	1.227	0.000	3.472
4.2778	0.362	1.255	0.000	3.472
4.3556	0.365	1.284	0.000	3.472
4.4333	0.367	1.312	0.000	3.472
4.5111	0.370	1.341	0.000	3.472
4.5889	0.373	1.370	0.000	3.472
4.6667	0.376	1.399	0.000	3.472
4.7444	0.378	1.428	0.000	3.472
4.8222	0.381	1.458	0.000	3.472
4.9000	0.384	1.488	0.000	3.472
4.9778	0.387	1.518	0.000	3.472
5.0556	0.390	1.548	0.000	3.472
5.1333	0.392	1.578	0.000	3.472
5.2111	0.395	1.609	0.000	3.472
5.2889	0.398	1.640	0.000	3.472
5.3667	0.401	1.671	0.000	3.472
5.4444	0.404	1.702	0.000	3.472
5.5222	0.406	1.734	0.000	3.472
5.6000	0.409	1.765	0.000	3.472
5.6778	0.412	1.797	0.000	3.472
5.7556	0.415	1.830	0.000	3.472
5.8333	0.418	1.862	0.000	3.472
5.9111	0.421	1.895	0.000	3.472
5.9889	0.424	1.928	0.000	3.472
6.0667	0.427	1.961	0.273	3.472
6.1444	0.430	1.994	0.869	3.472
6.2222	0.433	2.028	1.636	3.472
6.3000	0.435	2.061	2.501	3.472
6.3778	0.438	2.095	3.386	3.472
6.4556	0.441	2.130	4.216	3.472
6.5333	0.444	2.164	4.924	3.472

6.6111	0.447	2.199	5.468	3.472
6.6889	0.450	2.234	5.848	3.472
6.7667	0.453	2.269	6.205	3.472
6.8444	0.456	2.304	6.512	3.472
6.9222	0.459	2.340	6.805	3.472
7.0000	0.462	2.376	7.086	3.472
7.0778	0.465	2.412	7.357	3.472

Analysis Results
POC 1





+ Predeveloped x Mitigated

Predeveloped Landuse Totals for POC #1
Total Pervious Area: 25.29
Total Impervious Area: 0

Mitigated Landuse Totals for POC #1
Total Pervious Area: 7.65
Total Impervious Area: 15.71

Flow Frequency Method: Log Pearson Type III 17B

Flow Frequency Return Periods for Predeveloped. POC #1

Return Period	**Flow(cfs)**
2 year	0.603392
5 year	0.928695
10 year	1.116774
25 year	1.320514
50 year	1.451587
100 year	1.565325

Flow Frequency Return Periods for Mitigated. POC #1

Return Period	**Flow(cfs)**
2 year	0
5 year	0
10 year	0
25 year	0
50 year	0
100 year	0

Annual Peaks

Annual Peaks for Predeveloped and Mitigated. POC #1

Year	**Predeveloped**	**Mitigated**
1902	0.425	0.000
1903	0.398	0.000
1904	0.648	0.000
1905	0.322	0.000
1906	0.148	0.000
1907	0.925	0.000
1908	0.677	0.000
1909	0.660	0.000
1910	0.916	0.000
1911	0.622	0.000

1912	2.022	0.000
1913	0.940	0.000
1914	0.238	0.000
1915	0.408	0.000
1916	0.618	0.000
1917	0.230	0.000
1918	0.651	0.000
1919	0.508	0.000
1920	0.617	0.000
1921	0.662	0.000
1922	0.665	0.000
1923	0.551	0.000
1924	0.266	0.000
1925	0.337	0.000
1926	0.581	0.000
1927	0.383	0.000
1928	0.461	0.000
1929	0.922	0.000
1930	0.595	0.000
1931	0.565	0.000
1932	0.432	0.000
1933	0.471	0.000
1934	1.211	0.000
1935	0.571	0.000
1936	0.528	0.000
1937	0.817	0.000
1938	0.524	0.000
1939	0.042	0.000
1940	0.547	0.000
1941	0.305	0.000
1942	0.835	0.000
1943	0.435	0.000
1944	0.872	0.000
1945	0.699	0.000
1946	0.402	0.000
1947	0.278	0.000
1948	1.277	0.000
1949	1.130	0.000
1950	0.333	0.000
1951	0.370	0.000
1952	1.642	0.000
1953	1.494	0.000
1954	0.548	0.000
1955	0.445	0.000
1956	0.221	0.000
1957	0.815	0.000
1958	1.592	0.000
1959	0.978	0.000
1960	0.286	0.000
1961	0.988	0.000
1962	0.567	0.000
1963	0.289	0.000
1964	0.285	0.000
1965	1.131	0.000
1966	0.333	0.000
1967	0.493	0.000
1968	0.503	0.000
1969	0.505	0.000

1970	0.792	0.000
1971	1.172	0.000
1972	0.772	0.000
1973	1.017	0.000
1974	0.557	0.000
1975	1.229	0.000
1976	0.675	0.000
1977	0.268	0.000
1978	1.100	0.000
1979	0.319	0.000
1980	0.643	0.000
1981	0.626	0.000
1982	0.266	0.000
1983	0.997	0.000
1984	0.475	0.000
1985	0.726	0.000
1986	0.616	0.000
1987	1.155	0.000
1988	0.731	0.000
1989	0.663	0.000
1990	0.771	0.000
1991	0.605	0.000
1992	0.783	0.000
1993	0.810	0.000
1994	1.179	0.000
1995	0.253	0.000
1996	1.289	0.000
1997	0.481	0.000
1998	0.654	0.000
1999	0.079	0.000
2000	0.480	0.000
2001	0.227	0.000
2002	0.870	0.000
2003	0.757	0.000
2004	0.662	0.000
2005	1.235	0.000
2006	0.382	0.000
2007	0.339	0.000
2008	0.645	0.000
2009	0.444	0.000
2010	0.391	0.000
2011	0.290	0.000
2012	0.519	0.000
2013	0.345	0.000
2014	0.279	0.000
2015	0.529	0.000
2016	0.221	0.000
2017	0.867	0.000
2018	1.627	0.000
2019	1.585	0.000
2020	0.489	0.000
2021	0.817	0.000
2022	0.349	0.000
2023	0.703	0.000
2024	1.810	0.000
2025	0.636	0.000
2026	1.000	0.000
2027	0.399	0.000

2028	0.348	0.000
2029	0.666	0.000
2030	1.223	0.000
2031	0.397	0.000
2032	0.238	0.000
2033	0.379	0.000
2034	0.353	0.000
2035	1.411	0.000
2036	0.729	0.000
2037	0.200	0.000
2038	0.578	0.000
2039	0.083	0.000
2040	0.384	0.000
2041	0.444	0.000
2042	1.378	0.000
2043	0.691	0.000
2044	0.925	0.000
2045	0.605	0.000
2046	0.704	0.000
2047	0.540	0.000
2048	0.706	0.000
2049	0.624	0.000
2050	0.458	0.000
2051	0.671	0.000
2052	0.395	0.000
2053	0.673	0.000
2054	0.837	0.000
2055	0.348	0.000
2056	0.337	0.000
2057	0.467	0.000
2058	0.578	0.000
2059	0.969	0.000

Ranked Annual Peaks

Ranked Annual Peaks for Predeveloped and Mitigated. POC #1

Rank	**Predeveloped**	**Mitigated**
1	2.0225	0.0000
2	1.8101	0.0000
3	1.6419	0.0000
4	1.6272	0.0000
5	1.5923	0.0000
6	1.5850	0.0000
7	1.4944	0.0000
8	1.4107	0.0000
9	1.3781	0.0000
10	1.2890	0.0000
11	1.2770	0.0000
12	1.2348	0.0000
13	1.2287	0.0000
14	1.2234	0.0000
15	1.2113	0.0000
16	1.1790	0.0000
17	1.1724	0.0000
18	1.1549	0.0000
19	1.1306	0.0000
20	1.1297	0.0000
21	1.1001	0.0000
22	1.0165	0.0000

23	1.0003	0.0000
24	0.9967	0.0000
25	0.9880	0.0000
26	0.9777	0.0000
27	0.9689	0.0000
28	0.9399	0.0000
29	0.9249	0.0000
30	0.9247	0.0000
31	0.9222	0.0000
32	0.9160	0.0000
33	0.8716	0.0000
34	0.8701	0.0000
35	0.8675	0.0000
36	0.8374	0.0000
37	0.8355	0.0000
38	0.8171	0.0000
39	0.8171	0.0000
40	0.8147	0.0000
41	0.8103	0.0000
42	0.7916	0.0000
43	0.7827	0.0000
44	0.7721	0.0000
45	0.7715	0.0000
46	0.7568	0.0000
47	0.7314	0.0000
48	0.7289	0.0000
49	0.7258	0.0000
50	0.7063	0.0000
51	0.7036	0.0000
52	0.7027	0.0000
53	0.6988	0.0000
54	0.6911	0.0000
55	0.6772	0.0000
56	0.6747	0.0000
57	0.6733	0.0000
58	0.6705	0.0000
59	0.6655	0.0000
60	0.6647	0.0000
61	0.6627	0.0000
62	0.6620	0.0000
63	0.6619	0.0000
64	0.6595	0.0000
65	0.6543	0.0000
66	0.6514	0.0000
67	0.6475	0.0000
68	0.6453	0.0000
69	0.6428	0.0000
70	0.6363	0.0000
71	0.6255	0.0000
72	0.6236	0.0000
73	0.6223	0.0000
74	0.6177	0.0000
75	0.6168	0.0000
76	0.6163	0.0000
77	0.6051	0.0000
78	0.6051	0.0000
79	0.5949	0.0000
80	0.5811	0.0000

81	0.5782	0.0000
82	0.5776	0.0000
83	0.5715	0.0000
84	0.5672	0.0000
85	0.5645	0.0000
86	0.5572	0.0000
87	0.5506	0.0000
88	0.5477	0.0000
89	0.5469	0.0000
90	0.5402	0.0000
91	0.5292	0.0000
92	0.5282	0.0000
93	0.5239	0.0000
94	0.5186	0.0000
95	0.5082	0.0000
96	0.5047	0.0000
97	0.5029	0.0000
98	0.4928	0.0000
99	0.4888	0.0000
100	0.4805	0.0000
101	0.4799	0.0000
102	0.4745	0.0000
103	0.4715	0.0000
104	0.4673	0.0000
105	0.4606	0.0000
106	0.4581	0.0000
107	0.4446	0.0000
108	0.4445	0.0000
109	0.4436	0.0000
110	0.4345	0.0000
111	0.4321	0.0000
112	0.4250	0.0000
113	0.4083	0.0000
114	0.4023	0.0000
115	0.3986	0.0000
116	0.3976	0.0000
117	0.3968	0.0000
118	0.3953	0.0000
119	0.3914	0.0000
120	0.3842	0.0000
121	0.3828	0.0000
122	0.3817	0.0000
123	0.3786	0.0000
124	0.3703	0.0000
125	0.3531	0.0000
126	0.3493	0.0000
127	0.3482	0.0000
128	0.3477	0.0000
129	0.3451	0.0000
130	0.3385	0.0000
131	0.3374	0.0000
132	0.3365	0.0000
133	0.3334	0.0000
134	0.3329	0.0000
135	0.3225	0.0000
136	0.3187	0.0000
137	0.3054	0.0000
138	0.2897	0.0000

139	0.2890	0.0000
140	0.2864	0.0000
141	0.2851	0.0000
142	0.2785	0.0000
143	0.2784	0.0000
144	0.2685	0.0000
145	0.2656	0.0000
146	0.2656	0.0000
147	0.2527	0.0000
148	0.2385	0.0000
149	0.2381	0.0000
150	0.2302	0.0000
151	0.2274	0.0000
152	0.2214	0.0000
153	0.2211	0.0000
154	0.2003	0.0000
155	0.1485	0.0000
156	0.0829	0.0000
157	0.0793	0.0000
158	0.0420	0.0000

Mitigated Schematic

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WWHM2012

PROJECT REPORT

18666 - DuPont West
Road Gallery Flow Control Calculations

General Model Information

Project Name:	18666 FC Road
Site Name:	
Site Address:	
City:	
Report Date:	11/6/2023
Gage:	40 IN WEST
Data Start:	10/01/1901
Data End:	09/30/2059
Timestep:	15 Minute
Precip Scale:	1.000
Version Date:	2019/09/13
Version:	4.2.17

POC Thresholds

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

Mitigated Land Use

Basin 1

Bypass:	No
GroundWater:	No
Pervious Land Use	acre
A B, Lawn, Flat	0.48
Pervious Total	0.48
Impervious Land Use	acre
PARKING FLAT	1.45
Impervious Total	1.45
Basin Total	1.93

Element Flows To:

Surface	Interflow	Groundwater
Gravel Trench Bed 1	Gravel Trench Bed 1	

Mitigated Routing

Gravel Trench Bed 1

Bottom Length:	120.00 ft.
Bottom Width:	20.00 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:	1
Pour Space of material for first layer:	0.3
Material thickness of second layer:	2.5
Pour Space of material for second layer:	0.7
Material thickness of third layer:	1
Pour Space of material for third layer:	0.3
Infiltration On	
Infiltration rate:	6
Infiltration safety factor:	1
Total Volume Infiltrated (ac-ft.):	622.167
Total Volume Through Riser (ac-ft.):	0
Total Volume Through Facility (ac-ft.):	622.167
Percent Infiltrated:	100
Total Precip Applied to Facility:	0
Total Evap From Facility:	0

Discharge Structure
Riser Height: 4.5 ft.
Riser Diameter: 18 in.
Element Flows To:
Outlet 1 Outlet 2

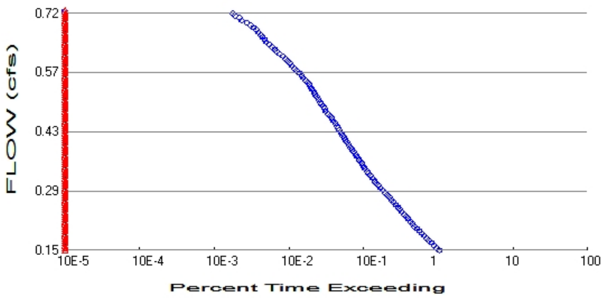
Gravel Trench Bed Hydraulic Table

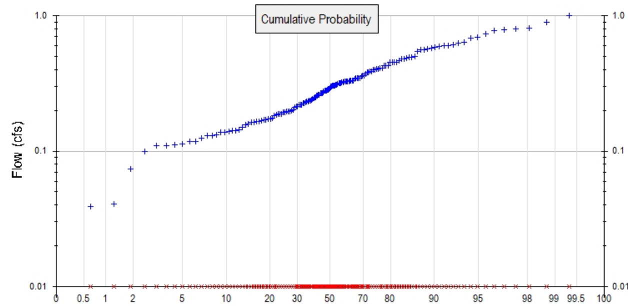
Stage(feet)	Area(ac.)	Volume(ac-ft.)	Discharge(cfs)	Infilt(cfs)
0.0000	0.055	0.000	0.000	0.000
0.0611	0.055	0.001	0.000	0.333
0.1222	0.055	0.002	0.000	0.333
0.1833	0.055	0.003	0.000	0.333
0.2444	0.055	0.004	0.000	0.333
0.3056	0.055	0.005	0.000	0.333
0.3667	0.055	0.006	0.000	0.333
0.4278	0.055	0.007	0.000	0.333
0.4889	0.055	0.008	0.000	0.333
0.5500	0.055	0.009	0.000	0.333
0.6111	0.055	0.010	0.000	0.333
0.6722	0.055	0.011	0.000	0.333
0.7333	0.055	0.012	0.000	0.333
0.7944	0.055	0.013	0.000	0.333
0.8556	0.055	0.014	0.000	0.333
0.9167	0.055	0.015	0.000	0.333
0.9778	0.055	0.016	0.000	0.333
1.0389	0.055	0.018	0.000	0.333
1.1000	0.055	0.020	0.000	0.333
1.1611	0.055	0.023	0.000	0.333
1.2222	0.055	0.025	0.000	0.333
1.2833	0.055	0.027	0.000	0.333
1.3444	0.055	0.030	0.000	0.333
1.4056	0.055	0.032	0.000	0.333

1.4667	0.055	0.035	0.000	0.333
1.5278	0.055	0.037	0.000	0.333
1.5889	0.055	0.039	0.000	0.333
1.6500	0.055	0.042	0.000	0.333
1.7111	0.055	0.044	0.000	0.333
1.7722	0.055	0.046	0.000	0.333
1.8333	0.055	0.049	0.000	0.333
1.8944	0.055	0.051	0.000	0.333
1.9556	0.055	0.053	0.000	0.333
2.0167	0.055	0.056	0.000	0.333
2.0778	0.055	0.058	0.000	0.333
2.1389	0.055	0.060	0.000	0.333
2.2000	0.055	0.063	0.000	0.333
2.2611	0.055	0.065	0.000	0.333
2.3222	0.055	0.068	0.000	0.333
2.3833	0.055	0.070	0.000	0.333
2.4444	0.055	0.072	0.000	0.333
2.5056	0.055	0.075	0.000	0.333
2.5667	0.055	0.077	0.000	0.333
2.6278	0.055	0.079	0.000	0.333
2.6889	0.055	0.082	0.000	0.333
2.7500	0.055	0.084	0.000	0.333
2.8111	0.055	0.086	0.000	0.333
2.8722	0.055	0.089	0.000	0.333
2.9333	0.055	0.091	0.000	0.333
2.9944	0.055	0.093	0.000	0.333
3.0556	0.055	0.096	0.000	0.333
3.1167	0.055	0.098	0.000	0.333
3.1778	0.055	0.101	0.000	0.333
3.2389	0.055	0.103	0.000	0.333
3.3000	0.055	0.105	0.000	0.333
3.3611	0.055	0.108	0.000	0.333
3.4222	0.055	0.110	0.000	0.333
3.4833	0.055	0.112	0.000	0.333
3.5444	0.055	0.113	0.000	0.333
3.6056	0.055	0.114	0.000	0.333
3.6667	0.055	0.115	0.000	0.333
3.7278	0.055	0.116	0.000	0.333
3.7889	0.055	0.117	0.000	0.333
3.8500	0.055	0.118	0.000	0.333
3.9111	0.055	0.119	0.000	0.333
3.9722	0.055	0.120	0.000	0.333
4.0333	0.055	0.121	0.000	0.333
4.0944	0.055	0.122	0.000	0.333
4.1556	0.055	0.123	0.000	0.333
4.2167	0.055	0.124	0.000	0.333
4.2778	0.055	0.125	0.000	0.333
4.3389	0.055	0.126	0.000	0.333
4.4000	0.055	0.127	0.000	0.333
4.4611	0.055	0.129	0.000	0.333
4.5222	0.055	0.132	0.052	0.333
4.5833	0.055	0.135	0.382	0.333
4.6444	0.055	0.139	0.869	0.333
4.7056	0.055	0.142	1.461	0.333
4.7667	0.055	0.145	2.123	0.333
4.8278	0.055	0.149	2.819	0.333
4.8889	0.055	0.152	3.509	0.333
4.9500	0.055	0.155	4.160	0.333

5.0111	0.055	0.159	4.737	0.333
5.0722	0.055	0.162	5.218	0.333
5.1333	0.055	0.166	5.592	0.333
5.1944	0.055	0.169	5.870	0.333
5.2556	0.055	0.172	6.159	0.333
5.3167	0.055	0.176	6.404	0.333
5.3778	0.055	0.179	6.639	0.333
5.4389	0.055	0.182	6.866	0.333
5.5000	0.055	0.186	7.086	0.333

Analysis Results
POC 1





+ Predeveloped   x Mitigated

Predeveloped Landuse Totals for POC #1
Total Pervious Area: 12.47
Total Impervious Area: 0

Mitigated Landuse Totals for POC #1
Total Pervious Area: 0.48
Total Impervious Area: 1.45

Flow Frequency Method: Log Pearson Type III 17B

Flow Frequency Return Periods for Predeveloped. POC #1

Return Period	**Flow(cfs)**
2 year	0.29752
5 year	0.457921
10 year	0.550659
25 year	0.651119
50 year	0.715749
100 year	0.771831

Flow Frequency Return Periods for Mitigated. POC #1

Return Period	**Flow(cfs)**
2 year	0
5 year	0
10 year	0
25 year	0
50 year	0
100 year	0

Annual Peaks

Annual Peaks for Predeveloped and Mitigated. POC #1

Year	**Predeveloped**	**Mitigated**
1902	0.210	0.000
1903	0.196	0.000
1904	0.319	0.000
1905	0.159	0.000
1906	0.073	0.000
1907	0.456	0.000
1908	0.334	0.000
1909	0.325	0.000
1910	0.452	0.000
1911	0.307	0.000

1912	0.997	0.000
1913	0.463	0.000
1914	0.117	0.000
1915	0.201	0.000
1916	0.305	0.000
1917	0.113	0.000
1918	0.321	0.000
1919	0.251	0.000
1920	0.304	0.000
1921	0.326	0.000
1922	0.328	0.000
1923	0.271	0.000
1924	0.131	0.000
1925	0.166	0.000
1926	0.287	0.000
1927	0.189	0.000
1928	0.227	0.000
1929	0.455	0.000
1930	0.293	0.000
1931	0.278	0.000
1932	0.213	0.000
1933	0.232	0.000
1934	0.597	0.000
1935	0.282	0.000
1936	0.260	0.000
1937	0.403	0.000
1938	0.258	0.000
1939	0.021	0.000
1940	0.270	0.000
1941	0.151	0.000
1942	0.412	0.000
1943	0.214	0.000
1944	0.430	0.000
1945	0.345	0.000
1946	0.198	0.000
1947	0.137	0.000
1948	0.630	0.000
1949	0.557	0.000
1950	0.164	0.000
1951	0.183	0.000
1952	0.810	0.000
1953	0.737	0.000
1954	0.270	0.000
1955	0.219	0.000
1956	0.109	0.000
1957	0.402	0.000
1958	0.785	0.000
1959	0.482	0.000
1960	0.141	0.000
1961	0.487	0.000
1962	0.280	0.000
1963	0.142	0.000
1964	0.141	0.000
1965	0.557	0.000
1966	0.164	0.000
1967	0.243	0.000
1968	0.248	0.000
1969	0.249	0.000

1970	0.390	0.000
1971	0.578	0.000
1972	0.381	0.000
1973	0.501	0.000
1974	0.275	0.000
1975	0.606	0.000
1976	0.333	0.000
1977	0.132	0.000
1978	0.542	0.000
1979	0.157	0.000
1980	0.317	0.000
1981	0.308	0.000
1982	0.131	0.000
1983	0.491	0.000
1984	0.234	0.000
1985	0.358	0.000
1986	0.304	0.000
1987	0.569	0.000
1988	0.361	0.000
1989	0.327	0.000
1990	0.380	0.000
1991	0.298	0.000
1992	0.386	0.000
1993	0.400	0.000
1994	0.581	0.000
1995	0.125	0.000
1996	0.636	0.000
1997	0.237	0.000
1998	0.323	0.000
1999	0.039	0.000
2000	0.237	0.000
2001	0.112	0.000
2002	0.429	0.000
2003	0.373	0.000
2004	0.326	0.000
2005	0.609	0.000
2006	0.188	0.000
2007	0.167	0.000
2008	0.318	0.000
2009	0.219	0.000
2010	0.193	0.000
2011	0.143	0.000
2012	0.256	0.000
2013	0.170	0.000
2014	0.137	0.000
2015	0.261	0.000
2016	0.109	0.000
2017	0.428	0.000
2018	0.802	0.000
2019	0.782	0.000
2020	0.241	0.000
2021	0.403	0.000
2022	0.172	0.000
2023	0.346	0.000
2024	0.893	0.000
2025	0.314	0.000
2026	0.493	0.000
2027	0.197	0.000

2028	0.172	0.000
2029	0.328	0.000
2030	0.603	0.000
2031	0.196	0.000
2032	0.118	0.000
2033	0.187	0.000
2034	0.174	0.000
2035	0.696	0.000
2036	0.359	0.000
2037	0.099	0.000
2038	0.285	0.000
2039	0.041	0.000
2040	0.189	0.000
2041	0.219	0.000
2042	0.680	0.000
2043	0.341	0.000
2044	0.456	0.000
2045	0.298	0.000
2046	0.347	0.000
2047	0.266	0.000
2048	0.348	0.000
2049	0.307	0.000
2050	0.226	0.000
2051	0.331	0.000
2052	0.195	0.000
2053	0.332	0.000
2054	0.413	0.000
2055	0.171	0.000
2056	0.166	0.000
2057	0.230	0.000
2058	0.285	0.000
2059	0.478	0.000

Ranked Annual Peaks

Ranked Annual Peaks for Predeveloped and Mitigated. POC #1

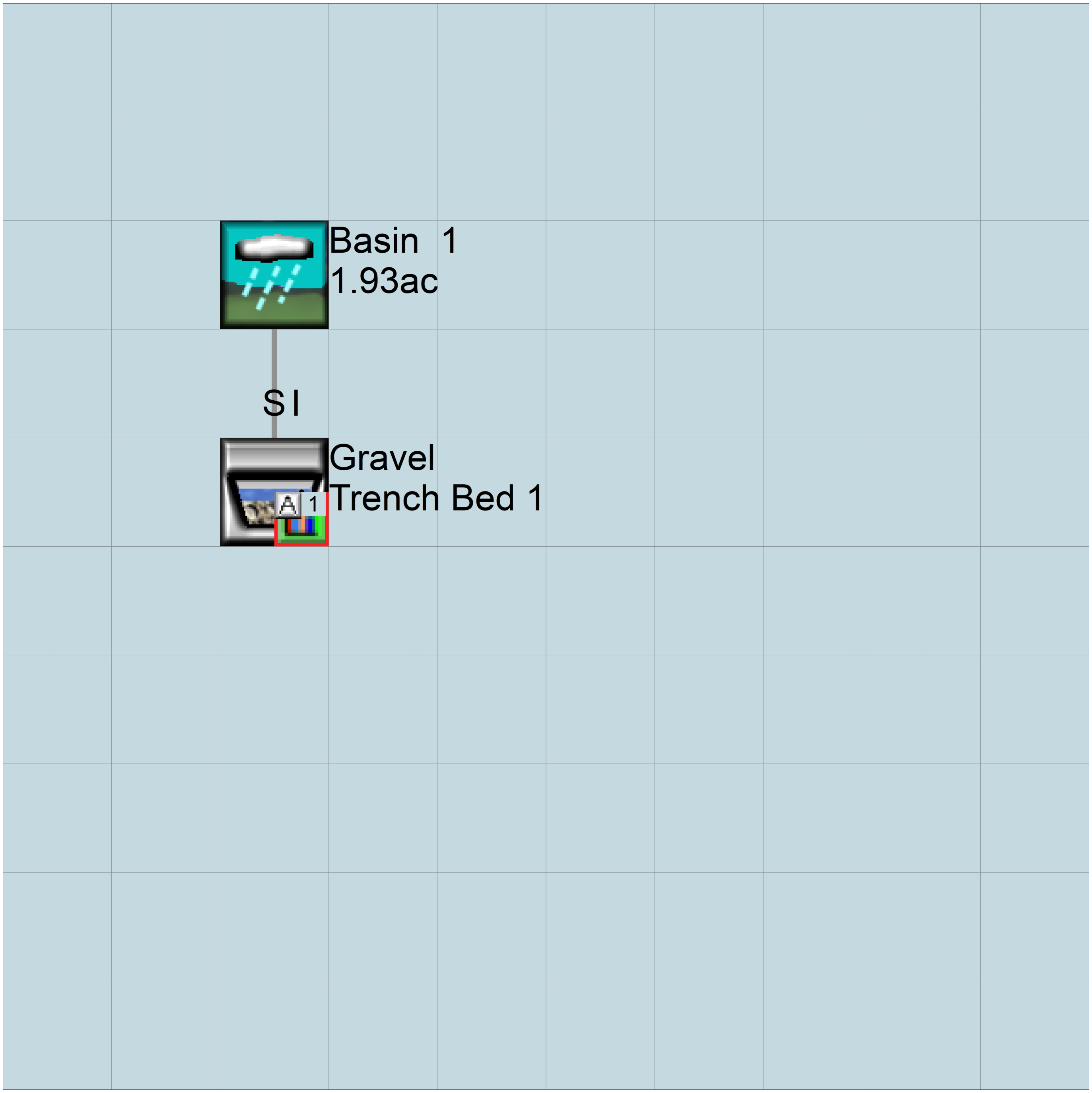
Rank	Predeveloped	Mitigated
1	0.9972	0.0000
2	0.8925	0.0000
3	0.8096	0.0000
4	0.8023	0.0000
5	0.7851	0.0000
6	0.7815	0.0000
7	0.7369	0.0000
8	0.6956	0.0000
9	0.6795	0.0000
10	0.6356	0.0000
11	0.6296	0.0000
12	0.6088	0.0000
13	0.6059	0.0000
14	0.6032	0.0000
15	0.5973	0.0000
16	0.5813	0.0000
17	0.5781	0.0000
18	0.5695	0.0000
19	0.5575	0.0000
20	0.5570	0.0000
21	0.5425	0.0000
22	0.5012	0.0000

23	0.4932	0.0000
24	0.4914	0.0000
25	0.4872	0.0000
26	0.4821	0.0000
27	0.4777	0.0000
28	0.4635	0.0000
29	0.4560	0.0000
30	0.4559	0.0000
31	0.4547	0.0000
32	0.4517	0.0000
33	0.4298	0.0000
34	0.4290	0.0000
35	0.4277	0.0000
36	0.4129	0.0000
37	0.4120	0.0000
38	0.4029	0.0000
39	0.4029	0.0000
40	0.4017	0.0000
41	0.3996	0.0000
42	0.3903	0.0000
43	0.3859	0.0000
44	0.3807	0.0000
45	0.3804	0.0000
46	0.3732	0.0000
47	0.3607	0.0000
48	0.3594	0.0000
49	0.3579	0.0000
50	0.3483	0.0000
51	0.3469	0.0000
52	0.3465	0.0000
53	0.3445	0.0000
54	0.3408	0.0000
55	0.3339	0.0000
56	0.3327	0.0000
57	0.3320	0.0000
58	0.3306	0.0000
59	0.3282	0.0000
60	0.3277	0.0000
61	0.3267	0.0000
62	0.3264	0.0000
63	0.3264	0.0000
64	0.3252	0.0000
65	0.3226	0.0000
66	0.3212	0.0000
67	0.3193	0.0000
68	0.3182	0.0000
69	0.3170	0.0000
70	0.3137	0.0000
71	0.3084	0.0000
72	0.3075	0.0000
73	0.3068	0.0000
74	0.3046	0.0000
75	0.3042	0.0000
76	0.3039	0.0000
77	0.2984	0.0000
78	0.2984	0.0000
79	0.2933	0.0000
80	0.2865	0.0000

81	0.2851	0.0000
82	0.2848	0.0000
83	0.2818	0.0000
84	0.2797	0.0000
85	0.2784	0.0000
86	0.2748	0.0000
87	0.2715	0.0000
88	0.2701	0.0000
89	0.2697	0.0000
90	0.2664	0.0000
91	0.2609	0.0000
92	0.2605	0.0000
93	0.2583	0.0000
94	0.2557	0.0000
95	0.2506	0.0000
96	0.2489	0.0000
97	0.2479	0.0000
98	0.2430	0.0000
99	0.2410	0.0000
100	0.2369	0.0000
101	0.2366	0.0000
102	0.2340	0.0000
103	0.2325	0.0000
104	0.2304	0.0000
105	0.2271	0.0000
106	0.2259	0.0000
107	0.2192	0.0000
108	0.2192	0.0000
109	0.2187	0.0000
110	0.2143	0.0000
111	0.2131	0.0000
112	0.2095	0.0000
113	0.2013	0.0000
114	0.1984	0.0000
115	0.1965	0.0000
116	0.1960	0.0000
117	0.1957	0.0000
118	0.1949	0.0000
119	0.1930	0.0000
120	0.1894	0.0000
121	0.1888	0.0000
122	0.1882	0.0000
123	0.1867	0.0000
124	0.1826	0.0000
125	0.1741	0.0000
126	0.1722	0.0000
127	0.1717	0.0000
128	0.1715	0.0000
129	0.1702	0.0000
130	0.1669	0.0000
131	0.1664	0.0000
132	0.1659	0.0000
133	0.1644	0.0000
134	0.1641	0.0000
135	0.1590	0.0000
136	0.1571	0.0000
137	0.1506	0.0000
138	0.1429	0.0000

139	0.1425	0.0000
140	0.1412	0.0000
141	0.1406	0.0000
142	0.1373	0.0000
143	0.1373	0.0000
144	0.1324	0.0000
145	0.1310	0.0000
146	0.1309	0.0000
147	0.1246	0.0000
148	0.1176	0.0000
149	0.1174	0.0000
150	0.1135	0.0000
151	0.1121	0.0000
152	0.1092	0.0000
153	0.1090	0.0000
154	0.0987	0.0000
155	0.0732	0.0000
156	0.0409	0.0000
157	0.0391	0.0000
158	0.0207	0.0000

Mitigated Schematic



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WATER QUALITY CALCULATIONS

WWHM2012

PROJECT REPORT

18666 - DuPont West
Pond Water Quality Calculations

General Model Information

Project Name:	18666 FC Pond3
Site Name:	
Site Address:	
City:	
Report Date:	11/6/2023
Gage:	40 IN WEST
Data Start:	10/01/1901
Data End:	09/30/2059
Timestep:	15 Minute
Precip Scale:	1.000
Version Date:	2019/09/13
Version:	4.2.17

POC Thresholds

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

Mitigated Land Use

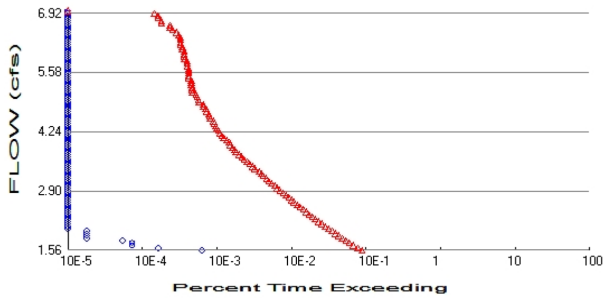
Basin 1

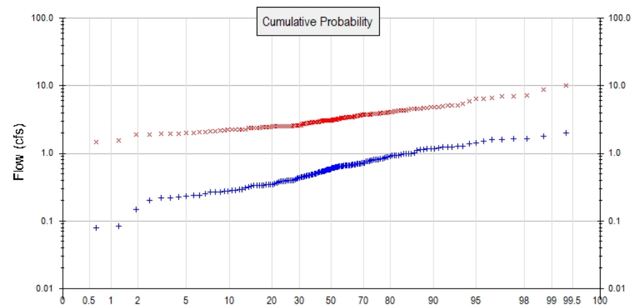
Bypass:	No
GroundWater:	No
Pervious Land Use	acre
A B, Lawn, Flat	7.65
Pervious Total	7.65
Impervious Land Use	acre
PARKING FLAT	8.01
POND	0.5
Impervious Total	8.51
Basin Total	16.16

Element Flows To:

Surface	Interflow	Groundwater

Analysis Results
POC 1





+ Predeveloped x Mitigated

Predeveloped Landuse Totals for POC #1
Total Pervious Area: 25.29
Total Impervious Area: 0

Mitigated Landuse Totals for POC #1
Total Pervious Area: 7.65
Total Impervious Area: 8.51

Flow Frequency Method: Log Pearson Type III 17B

Flow Frequency Return Periods for Predeveloped. POC #1

Return Period	**Flow(cfs)**
2 year	0.603392
5 year	0.928695
10 year	1.116774
25 year	1.320514
50 year	1.451587
100 year	1.565325

Flow Frequency Return Periods for Mitigated. POC #1

Return Period	**Flow(cfs)**
2 year	3.12261
5 year	4.198647
10 year	4.981738
25 year	6.054631
50 year	6.916497
100 year	7.833775

Annual Peaks

Annual Peaks for Predeveloped and Mitigated. POC #1

Year	**Predeveloped**	**Mitigated**
1902	0.425	3.672
1903	0.398	4.045
1904	0.648	4.597
1905	0.322	2.073
1906	0.148	2.262
1907	0.925	3.082
1908	0.677	2.539
1909	0.660	3.133
1910	0.916	2.986
1911	0.622	3.359

1912	2.022	7.053
1913	0.940	2.437
1914	0.238	10.208
1915	0.408	2.103
1916	0.618	3.888
1917	0.230	1.456
1918	0.651	3.135
1919	0.508	1.962
1920	0.617	2.568
1921	0.662	2.183
1922	0.665	3.488
1923	0.551	2.418
1924	0.266	4.354
1925	0.337	1.903
1926	0.581	3.586
1927	0.383	3.052
1928	0.461	2.217
1929	0.922	4.419
1930	0.595	4.580
1931	0.565	2.280
1932	0.432	2.440
1933	0.471	2.400
1934	1.211	3.880
1935	0.571	2.018
1936	0.528	2.906
1937	0.817	3.891
1938	0.524	2.118
1939	0.042	2.543
1940	0.547	4.677
1941	0.305	5.086
1942	0.835	3.452
1943	0.435	3.410
1944	0.872	4.912
1945	0.699	3.715
1946	0.402	2.884
1947	0.278	2.268
1948	1.277	3.117
1949	1.130	4.774
1950	0.333	2.748
1951	0.370	4.164
1952	1.642	5.070
1953	1.494	4.314
1954	0.548	2.526
1955	0.445	2.402
1956	0.221	2.348
1957	0.815	2.514
1958	1.592	3.404
1959	0.978	3.376
1960	0.286	2.558
1961	0.988	7.000
1962	0.567	3.047
1963	0.289	2.224
1964	0.285	6.503
1965	1.131	3.089
1966	0.333	2.457
1967	0.493	3.434
1968	0.503	2.893
1969	0.505	2.606

1970	0.792	2.943
1971	1.172	2.890
1972	0.772	8.854
1973	1.017	5.454
1974	0.557	3.977
1975	1.229	4.160
1976	0.675	4.373
1977	0.268	1.919
1978	1.100	3.525
1979	0.319	3.464
1980	0.643	3.333
1981	0.626	3.218
1982	0.266	2.549
1983	0.997	3.419
1984	0.475	3.390
1985	0.726	3.882
1986	0.616	1.975
1987	1.155	3.214
1988	0.731	2.070
1989	0.663	1.930
1990	0.771	2.525
1991	0.605	3.767
1992	0.783	3.593
1993	0.810	4.010
1994	1.179	2.785
1995	0.253	2.156
1996	1.289	2.913
1997	0.481	2.594
1998	0.654	3.082
1999	0.079	3.556
2000	0.480	2.909
2001	0.227	2.361
2002	0.870	4.318
2003	0.757	2.609
2004	0.662	3.710
2005	1.235	7.289
2006	0.382	3.364
2007	0.339	3.754
2008	0.645	3.114
2009	0.444	2.372
2010	0.391	3.014
2011	0.290	3.109
2012	0.519	2.960
2013	0.345	2.766
2014	0.279	2.764
2015	0.529	4.533
2016	0.221	2.830
2017	0.867	4.514
2018	1.627	3.093
2019	1.585	4.054
2020	0.489	3.291
2021	0.817	2.776
2022	0.349	4.680
2023	0.703	5.853
2024	1.810	6.669
2025	0.636	3.070
2026	1.000	3.709
2027	0.399	3.713

2028	0.348	1.469
2029	0.666	2.417
2030	1.223	4.880
2031	0.397	1.546
2032	0.238	2.537
2033	0.379	3.205
2034	0.353	2.511
2035	1.411	3.097
2036	0.729	2.525
2037	0.200	3.386
2038	0.578	3.192
2039	0.083	6.510
2040	0.384	2.528
2041	0.444	3.195
2042	1.378	3.670
2043	0.691	4.067
2044	0.925	2.841
2045	0.605	2.238
2046	0.704	2.515
2047	0.540	3.082
2048	0.706	2.553
2049	0.624	3.779
2050	0.458	2.844
2051	0.671	3.961
2052	0.395	3.084
2053	0.673	2.575
2054	0.837	5.127
2055	0.348	2.906
2056	0.337	4.021
2057	0.467	1.998
2058	0.578	3.830
2059	0.969	4.863

Ranked Annual Peaks

Ranked Annual Peaks for Predeveloped and Mitigated. POC #1

Rank	**Predeveloped**	**Mitigated**
1	2.0225	10.2079
2	1.8101	8.8544
3	1.6419	7.2889
4	1.6272	7.0526
5	1.5923	7.0000
6	1.5850	6.6694
7	1.4944	6.5102
8	1.4107	6.5030
9	1.3781	5.8529
10	1.2890	5.4538
11	1.2770	5.1267
12	1.2348	5.0861
13	1.2287	5.0701
14	1.2234	4.9121
15	1.2113	4.8798
16	1.1790	4.8626
17	1.1724	4.7744
18	1.1549	4.6796
19	1.1306	4.6772
20	1.1297	4.5973
21	1.1001	4.5803
22	1.0165	4.5331

23	1.0003	4.5135
24	0.9967	4.4195
25	0.9880	4.3728
26	0.9777	4.3540
27	0.9689	4.3182
28	0.9399	4.3142
29	0.9249	4.1645
30	0.9247	4.1598
31	0.9222	4.0671
32	0.9160	4.0539
33	0.8716	4.0451
34	0.8701	4.0210
35	0.8675	4.0101
36	0.8374	3.9772
37	0.8355	3.9614
38	0.8171	3.8914
39	0.8171	3.8882
40	0.8147	3.8819
41	0.8103	3.8796
42	0.7916	3.8299
43	0.7827	3.7795
44	0.7721	3.7670
45	0.7715	3.7543
46	0.7568	3.7150
47	0.7314	3.7130
48	0.7289	3.7101
49	0.7258	3.7094
50	0.7063	3.6716
51	0.7036	3.6700
52	0.7027	3.5928
53	0.6988	3.5861
54	0.6911	3.5561
55	0.6772	3.5248
56	0.6747	3.4883
57	0.6733	3.4638
58	0.6705	3.4521
59	0.6655	3.4342
60	0.6647	3.4195
61	0.6627	3.4100
62	0.6620	3.4043
63	0.6619	3.3905
64	0.6595	3.3863
65	0.6543	3.3763
66	0.6514	3.3643
67	0.6475	3.3585
68	0.6453	3.3327
69	0.6428	3.2907
70	0.6363	3.2176
71	0.6255	3.2142
72	0.6236	3.2047
73	0.6223	3.1951
74	0.6177	3.1920
75	0.6168	3.1347
76	0.6163	3.1330
77	0.6051	3.1172
78	0.6051	3.1144
79	0.5949	3.1092
80	0.5811	3.0968

81	0.5782	3.0928
82	0.5776	3.0889
83	0.5715	3.0844
84	0.5672	3.0821
85	0.5645	3.0820
86	0.5572	3.0817
87	0.5506	3.0704
88	0.5477	3.0519
89	0.5469	3.0474
90	0.5402	3.0138
91	0.5292	2.9863
92	0.5282	2.9599
93	0.5239	2.9426
94	0.5186	2.9126
95	0.5082	2.9093
96	0.5047	2.9061
97	0.5029	2.9061
98	0.4928	2.8926
99	0.4888	2.8904
100	0.4805	2.8836
101	0.4799	2.8441
102	0.4745	2.8409
103	0.4715	2.8297
104	0.4673	2.7845
105	0.4606	2.7763
106	0.4581	2.7658
107	0.4446	2.7638
108	0.4445	2.7480
109	0.4436	2.6087
110	0.4345	2.6058
111	0.4321	2.5945
112	0.4250	2.5752
113	0.4083	2.5683
114	0.4023	2.5583
115	0.3986	2.5531
116	0.3976	2.5487
117	0.3968	2.5428
118	0.3953	2.5395
119	0.3914	2.5373
120	0.3842	2.5283
121	0.3828	2.5256
122	0.3817	2.5249
123	0.3786	2.5245
124	0.3703	2.5148
125	0.3531	2.5138
126	0.3493	2.5110
127	0.3482	2.4566
128	0.3477	2.4396
129	0.3451	2.4366
130	0.3385	2.4179
131	0.3374	2.4169
132	0.3365	2.4021
133	0.3334	2.3998
134	0.3329	2.3721
135	0.3225	2.3607
136	0.3187	2.3481
137	0.3054	2.2798
138	0.2897	2.2675

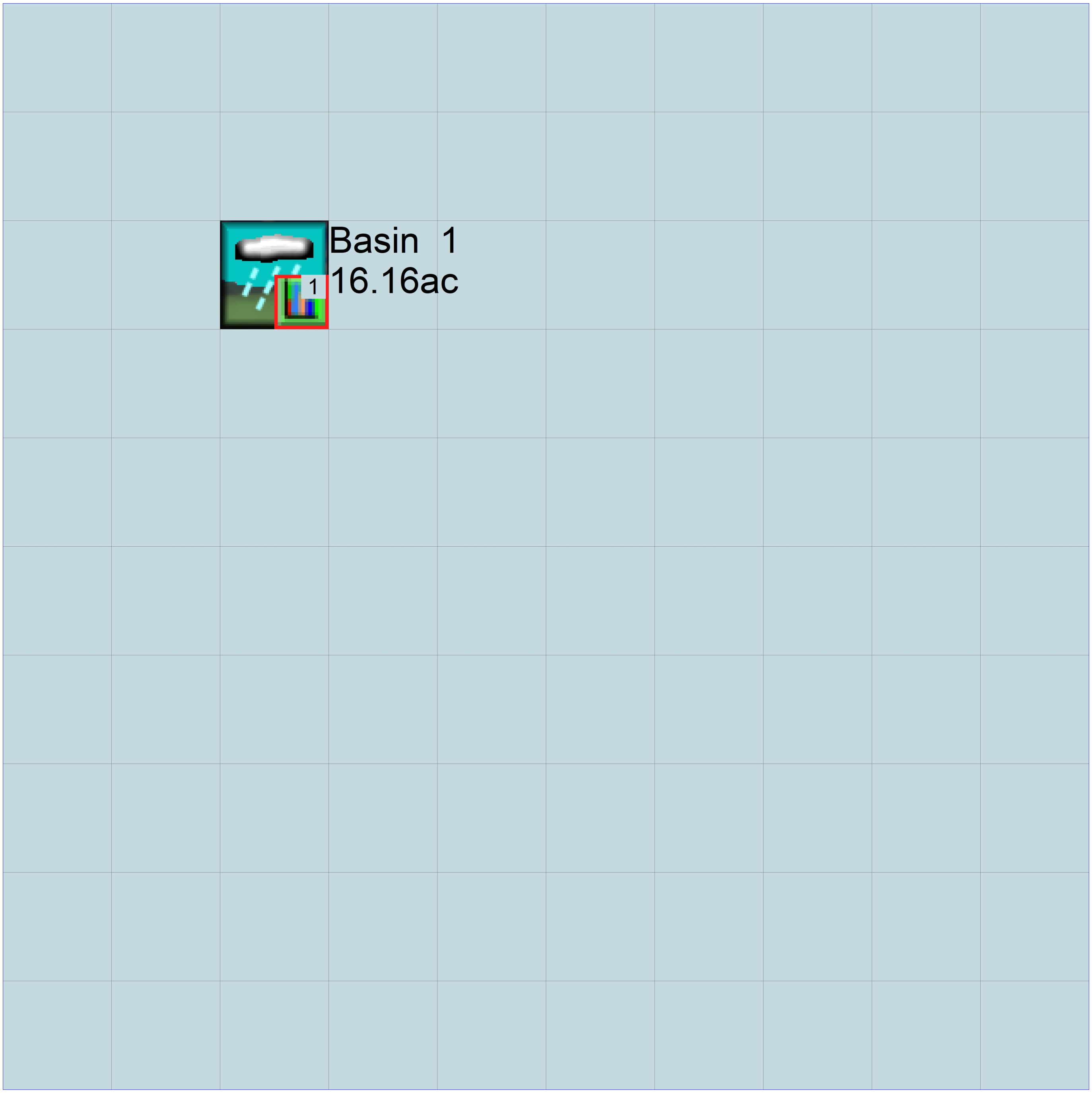
139	0.2890	2.2622
140	0.2864	2.2377
141	0.2851	2.2244
142	0.2785	2.2173
143	0.2784	2.1834
144	0.2685	2.1558
145	0.2656	2.1183
146	0.2656	2.1029
147	0.2527	2.0729
148	0.2385	2.0704
149	0.2381	2.0179
150	0.2302	1.9979
151	0.2274	1.9749
152	0.2214	1.9624
153	0.2211	1.9299
154	0.2003	1.9187
155	0.1485	1.9034
156	0.0829	1.5460
157	0.0793	1.4688
158	0.0420	1.4557

Water Quality

Water Quality BMP Flow and Volume for POC #1

On-line facility volume:	0.9784 acre-feet
On-line facility target flow:	1.3232 cfs.
Adjusted for 15 min:	1.3232 cfs.
Off-line facility target flow:	0.7668 cfs.
Adjusted for 15 min:	0.7668 cfs.

Mitigated Schematic



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Local (360)943-0304

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WWHM2012

PROJECT REPORT

18666 - DuPont West
Road Gallery Water Quality Calculations

General Model Information

Project Name:	18666 FC Road
Site Name:	
Site Address:	
City:	
Report Date:	11/6/2023
Gage:	40 IN WEST
Data Start:	10/01/1901
Data End:	09/30/2059
Timestep:	15 Minute
Precip Scale:	1.000
Version Date:	2019/09/13
Version:	4.2.17

POC Thresholds

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

Mitigated Land Use

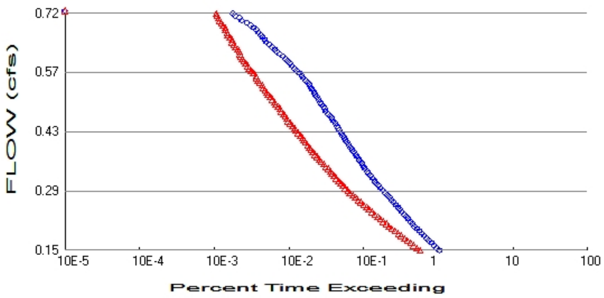
Basin 1

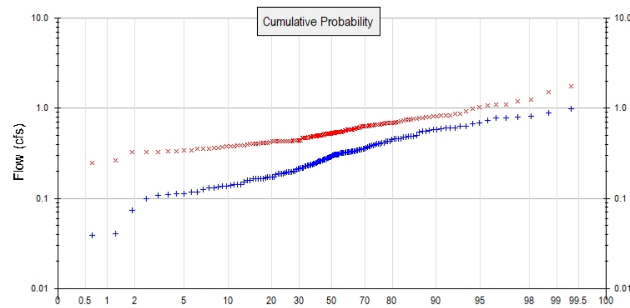
Bypass:	No
GroundWater:	No
Pervious Land Use	acre
A B, Lawn, Flat	0.48
Pervious Total	0.48
Impervious Land Use	acre
PARKING FLAT	1.45
Impervious Total	1.45
Basin Total	1.93

Element Flows To:

Surface	Interflow	Groundwater

Analysis Results
POC 1





+ Predeveloped x Mitigated

Predeveloped Landuse Totals for POC #1
Total Pervious Area: 12.47
Total Impervious Area: 0

Mitigated Landuse Totals for POC #1
Total Pervious Area: 0.48
Total Impervious Area: 1.45

Flow Frequency Method: Log Pearson Type III 17B

Flow Frequency Return Periods for Predeveloped. POC #1

Return Period	**Flow(cfs)**
2 year	0.29752
5 year	0.457921
10 year	0.550659
25 year	0.651119
50 year	0.715749
100 year	0.771831

Flow Frequency Return Periods for Mitigated. POC #1

Return Period	**Flow(cfs)**
2 year	0.529777
5 year	0.710348
10 year	0.841475
25 year	1.020818
50 year	1.164666
100 year	1.317576

Annual Peaks

Annual Peaks for Predeveloped and Mitigated. POC #1

Year	**Predeveloped**	**Mitigated**
1902	0.210	0.626
1903	0.196	0.689
1904	0.319	0.782
1905	0.159	0.353
1906	0.073	0.385
1907	0.456	0.525
1908	0.334	0.433
1909	0.325	0.533
1910	0.452	0.509
1911	0.307	0.572

1912	0.997	1.027
1913	0.463	0.415
1914	0.117	1.739
1915	0.201	0.358
1916	0.305	0.662
1917	0.113	0.248
1918	0.321	0.533
1919	0.251	0.334
1920	0.304	0.438
1921	0.326	0.372
1922	0.328	0.586
1923	0.271	0.404
1924	0.131	0.742
1925	0.166	0.324
1926	0.287	0.611
1927	0.189	0.520
1928	0.227	0.378
1929	0.455	0.753
1930	0.293	0.780
1931	0.278	0.387
1932	0.213	0.416
1933	0.232	0.409
1934	0.597	0.661
1935	0.282	0.343
1936	0.260	0.495
1937	0.403	0.663
1938	0.258	0.361
1939	0.021	0.433
1940	0.270	0.797
1941	0.151	0.867
1942	0.412	0.588
1943	0.214	0.581
1944	0.430	0.837
1945	0.345	0.633
1946	0.198	0.491
1947	0.137	0.386
1948	0.630	0.531
1949	0.557	0.813
1950	0.164	0.468
1951	0.183	0.710
1952	0.810	0.809
1953	0.737	0.726
1954	0.270	0.430
1955	0.219	0.409
1956	0.109	0.400
1957	0.402	0.428
1958	0.785	0.549
1959	0.482	0.545
1960	0.141	0.436
1961	0.487	1.193
1962	0.280	0.519
1963	0.142	0.379
1964	0.141	1.107
1965	0.557	0.505
1966	0.164	0.419
1967	0.243	0.585
1968	0.248	0.493
1969	0.249	0.444

1970	0.390	0.500
1971	0.578	0.490
1972	0.381	1.508
1973	0.501	0.929
1974	0.275	0.678
1975	0.606	0.701
1976	0.333	0.745
1977	0.132	0.327
1978	0.542	0.562
1979	0.157	0.590
1980	0.317	0.568
1981	0.308	0.548
1982	0.131	0.434
1983	0.491	0.583
1984	0.234	0.578
1985	0.358	0.661
1986	0.304	0.336
1987	0.569	0.548
1988	0.361	0.353
1989	0.327	0.329
1990	0.380	0.430
1991	0.298	0.642
1992	0.386	0.612
1993	0.400	0.683
1994	0.581	0.474
1995	0.125	0.367
1996	0.636	0.493
1997	0.237	0.442
1998	0.323	0.525
1999	0.039	0.606
2000	0.237	0.496
2001	0.112	0.402
2002	0.429	0.730
2003	0.373	0.444
2004	0.326	0.632
2005	0.609	1.241
2006	0.188	0.573
2007	0.167	0.640
2008	0.318	0.530
2009	0.219	0.404
2010	0.193	0.514
2011	0.143	0.529
2012	0.256	0.504
2013	0.170	0.471
2014	0.137	0.471
2015	0.261	0.772
2016	0.109	0.482
2017	0.428	0.769
2018	0.802	0.486
2019	0.782	0.688
2020	0.241	0.560
2021	0.403	0.473
2022	0.172	0.797
2023	0.346	0.997
2024	0.893	1.084
2025	0.314	0.523
2026	0.493	0.632
2027	0.197	0.633

2028	0.172	0.250
2029	0.328	0.409
2030	0.603	0.831
2031	0.196	0.263
2032	0.118	0.432
2033	0.187	0.546
2034	0.174	0.427
2035	0.696	0.527
2036	0.359	0.430
2037	0.099	0.577
2038	0.285	0.544
2039	0.041	1.109
2040	0.189	0.431
2041	0.219	0.544
2042	0.680	0.625
2043	0.341	0.693
2044	0.456	0.478
2045	0.298	0.381
2046	0.347	0.428
2047	0.266	0.525
2048	0.348	0.435
2049	0.307	0.644
2050	0.226	0.485
2051	0.331	0.675
2052	0.195	0.525
2053	0.332	0.439
2054	0.413	0.873
2055	0.171	0.495
2056	0.166	0.685
2057	0.230	0.340
2058	0.285	0.653
2059	0.478	0.828

Ranked Annual Peaks

Ranked Annual Peaks for Predeveloped and Mitigated. POC #1

Rank	Predeveloped	Mitigated
1	0.9972	1.7392
2	0.8925	1.5083
3	0.8096	1.2412
4	0.8023	1.1926
5	0.7851	1.1093
6	0.7815	1.1075
7	0.7369	1.0842
8	0.6956	1.0268
9	0.6795	0.9972
10	0.6356	0.9292
11	0.6296	0.8734
12	0.6088	0.8666
13	0.6059	0.8369
14	0.6032	0.8313
15	0.5973	0.8285
16	0.5813	0.8135
17	0.5781	0.8088
18	0.5695	0.7973
19	0.5575	0.7969
20	0.5570	0.7823
21	0.5425	0.7804
22	0.5012	0.7723

23	0.4932	0.7690
24	0.4914	0.7530
25	0.4872	0.7446
26	0.4821	0.7419
27	0.4777	0.7302
28	0.4635	0.7258
29	0.4560	0.7095
30	0.4559	0.7009
31	0.4547	0.6929
32	0.4517	0.6892
33	0.4298	0.6883
34	0.4290	0.6851
35	0.4277	0.6833
36	0.4129	0.6776
37	0.4120	0.6749
38	0.4029	0.6630
39	0.4029	0.6625
40	0.4017	0.6614
41	0.3996	0.6609
42	0.3903	0.6525
43	0.3859	0.6440
44	0.3807	0.6418
45	0.3804	0.6397
46	0.3732	0.6330
47	0.3607	0.6326
48	0.3594	0.6321
49	0.3579	0.6318
50	0.3483	0.6256
51	0.3469	0.6253
52	0.3465	0.6122
53	0.3445	0.6110
54	0.3408	0.6059
55	0.3339	0.5902
56	0.3327	0.5882
57	0.3320	0.5861
58	0.3306	0.5851
59	0.3282	0.5826
60	0.3277	0.5810
61	0.3267	0.5777
62	0.3264	0.5770
63	0.3264	0.5732
64	0.3252	0.5722
65	0.3226	0.5678
66	0.3212	0.5624
67	0.3193	0.5599
68	0.3182	0.5488
69	0.3170	0.5482
70	0.3137	0.5476
71	0.3084	0.5457
72	0.3075	0.5449
73	0.3068	0.5444
74	0.3046	0.5436
75	0.3042	0.5335
76	0.3039	0.5334
77	0.2984	0.5311
78	0.2984	0.5302
79	0.2933	0.5293
80	0.2865	0.5268

81	0.2851	0.5251
82	0.2848	0.5251
83	0.2818	0.5250
84	0.2797	0.5247
85	0.2784	0.5227
86	0.2748	0.5200
87	0.2715	0.5192
88	0.2701	0.5135
89	0.2697	0.5088
90	0.2664	0.5052
91	0.2609	0.5043
92	0.2605	0.5001
93	0.2583	0.4957
94	0.2557	0.4952
95	0.2506	0.4951
96	0.2489	0.4928
97	0.2479	0.4926
98	0.2430	0.4913
99	0.2410	0.4895
100	0.2369	0.4864
101	0.2366	0.4846
102	0.2340	0.4821
103	0.2325	0.4775
104	0.2304	0.4741
105	0.2271	0.4730
106	0.2259	0.4712
107	0.2192	0.4709
108	0.2192	0.4682
109	0.2187	0.4445
110	0.2143	0.4440
111	0.2131	0.4421
112	0.2095	0.4388
113	0.2013	0.4376
114	0.1984	0.4359
115	0.1965	0.4347
116	0.1960	0.4343
117	0.1957	0.4327
118	0.1949	0.4327
119	0.1930	0.4323
120	0.1894	0.4308
121	0.1888	0.4303
122	0.1882	0.4302
123	0.1867	0.4297
124	0.1826	0.4285
125	0.1741	0.4277
126	0.1722	0.4275
127	0.1717	0.4186
128	0.1715	0.4157
129	0.1702	0.4150
130	0.1669	0.4089
131	0.1664	0.4088
132	0.1659	0.4087
133	0.1644	0.4038
134	0.1641	0.4038
135	0.1590	0.4022
136	0.1571	0.3996
137	0.1506	0.3865
138	0.1429	0.3858

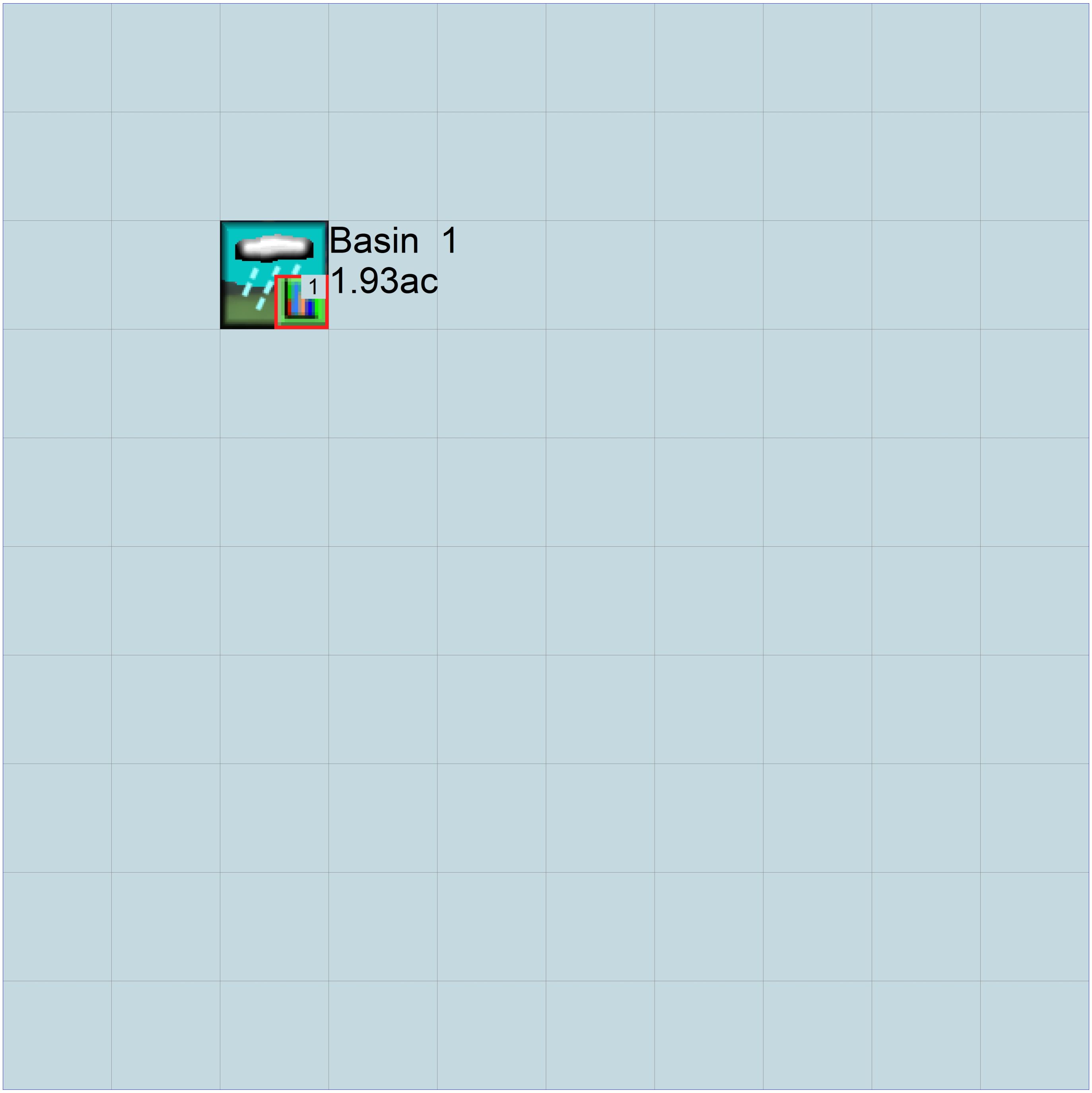
139	0.1425	0.3854
140	0.1412	0.3809
141	0.1406	0.3788
142	0.1373	0.3777
143	0.1373	0.3716
144	0.1324	0.3673
145	0.1310	0.3609
146	0.1309	0.3583
147	0.1246	0.3528
148	0.1176	0.3527
149	0.1174	0.3432
150	0.1135	0.3402
151	0.1121	0.3364
152	0.1092	0.3344
153	0.1090	0.3288
154	0.0987	0.3267
155	0.0732	0.3243
156	0.0409	0.2628
157	0.0391	0.2500
158	0.0207	0.2479

Water Quality

Water Quality BMP Flow and Volume for POC #1

On-line facility volume:	0.1665 acre-feet
On-line facility target flow:	0.2251 cfs.
Adjusted for 15 min:	0.2251 cfs.
Off-line facility target flow:	0.1303 cfs.
Adjusted for 15 min:	0.1303 cfs.

Mitigated Schematic



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PIPE CONVEYANCE BASIN MAP

Pipe Conveyance Calculations will be included in the final Stormwater Site Plan.

PIPE CONVEYANCE CALCULATIONS

Pipe Conveyance Calculations will be included in the final Stormwater Site Plan.

6.0 STORMWATER POLLUTION PREVENTION PLAN

Construction Stormwater General Permit

Stormwater Pollution Prevention Plan (SWPPP)

for

Proposed DuPont West

Prepared for:

The Washington State Department of Ecology

Southwest Regional Office

Permittee / Owner	Developer	Operator / Contractor
Avenue 55, LLC 601 Union Street, Suite 2930 Seattle, WA 98101	Avenue 55, LLC 601 Union Street, Suite 2930 Seattle, WA 98101	TBD

Certified Erosion and Sediment Control Lead (CESCL)

Name	Organization	Contact Phone Number
TBD by contractor	TBD	TBD

SWPPP Prepared By

Name	Organization	Contact Phone Number
Josh Towne	Barghausen Consulting Engineers, Inc.	(425) 251-6222

SWPPP Preparation Date

11/06/2023

Project Construction Dates

Activity / Phase	Start Date	End Date
Phase 1	May 2024	September 2025

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Appendix/Glossary

List of Acronyms and Abbreviations

Acronym / Abbreviation	Explanation
303(d)	Section of the Clean Water Act pertaining to Impaired Waterbodies
BFO	Bellingham Field Office of the Department of Ecology
BMP(s)	Best Management Practice(s)
CESCL	Certified Erosion and Sediment Control Lead
CO_2	Carbon Dioxide
CRO	Central Regional Office of the Department of Ecology
CSWGP	Construction Stormwater General Permit
CWA	Clean Water Act
DMR	Discharge Monitoring Report
DO	Dissolved Oxygen
Ecology	Washington State Department of Ecology
EPA	United States Environmental Protection Agency
ERO	Eastern Regional Office of the Department of Ecology
ERTS	Environmental Report Tracking System
ESC	Erosion and Sediment Control
GULD	General Use Level Designation
NPDES	National Pollutant Discharge Elimination System
NTU	Nephelometric Turbidity Units
NWRO	Northwest Regional Office of the Department of Ecology
pH	Power of Hydrogen
RCW	Revised Code of Washington
SPCC	Spill Prevention, Control, and Countermeasure
su	Standard Units
SWMMEW	Stormwater Management Manual for Eastern Washington
SWMMWW	Stormwater Management Manual for Western Washington
SWPPP	Stormwater Pollution Prevention Plan
TESC	Temporary Erosion and Sediment Control
SWRO	Southwest Regional Office of the Department of Ecology
TMDL	Total Maximum Daily Load
VFO	Vancouver Field Office of the Department of Ecology
WAC	Washington Administrative Code
WSDOT	Washington Department of Transportation
WWHM	Western Washington Hydrology Model

1 Project Information

Project/Site Name: DuPont West
Street/Location: 1700 Center Drive
City: DuPont State: WA Zip code: 98327
Subdivision: N/A
Receiving waterbody: N/A

1.1 Existing Conditions

Total acreage (including support activities such as off-site equipment staging yards, material storage areas, borrow areas).

Total acreage: 19.65
Disturbed acreage: 15.25
Existing structures: 0
Landscape topography: The existing site is approximately 19.65 acres of forested land. There is an existing gravel area near the center of the site, which depresses at a slopes ranging from 30% to 45%. There are existing1:1 slopes to the south of the property. The majority of the site is moderately steep, with slopes ranging from 2% to 20%. The east side of the site has slopes ranging from 13% to 70%. The site generally slopes southwest. This site lies within Spanaway gravelly sandy loam, according to the USDA Web Soil survey.
Drainage patterns: The site currently infiltrates, as it is undeveloped land.
Existing Vegetation: The site is grassy with numerous trees.
Critical Areas (wetlands, streams, high erosion risk, steep or difficult to stabilize slopes): There are no known sensitive areas on this site, according to Pierce County PublicGIS.

List of known impairments for 303(d) listed or Total Maximum Daily Load (TMDL) for the receiving waterbody: This does not apply to this project

Table 1 includes a list of suspected and/or known contaminants associated with the construction activity.

Table 1 – Summary of Site Pollutant Constituents

Constituent (Pollutant)	Location	Depth	Concentration
Hydraulic Fluid	Spill from equipment maintenance	Surface	

1.2 Proposed Construction Activities

Description of site development (example: subdivision):

The proposed conditions for this site will include one warehouse building with impervious paving, utilities, and an infiltration pond and gallery.

Description of construction activities (example: site preparation, demolition, excavation):

This project is proposing to construct one warehouse building of approximately 256,800 square feet. Half street improvements are also proposed to connect into the existing portion of Sequalitchew Drive to the southeast of the site. This project also proposes sidewalks, asphalt and concrete pavement, utilities, landscaping, and a retaining wall. These improvements will include a total of 13.10 acres of impervious surfaces. The remaining site area will consist of pervious surfaces in the form of landscaping and undisturbed land, which total 6.55 acres.

Description of site drainage including flow from and onto adjacent properties. Must be consistent with Site Map in Appendix A:

The existing sites surrounding this project are undeveloped, so they are expected to infiltrate all stormwater. The surrounding properties also generally slope away from this site, so there are no upstream basins that contribute runoff to this site.

Description of final stabilization (example: extent of revegetation, paving, landscaping):

At the completion of construction the proposed site will be approximately 67% impervious surfaces and 33% pervious areas. The building will be approximately 30% of the site area while roughly 37% of the site will be paved.

Contaminated Site Information:

Proposed activities regarding contaminated soils or groundwater (example: on-site treatment system, authorized sanitary sewer discharge):

No contaminated groundwater is anticipated to be encountered during construction. If contaminated groundwater is encountered, the groundwater will be pumped to a Baker Tank where it will be treated and discharged to sanitary sewer.

2 Construction Stormwater Best Management Practices (BMPs)

The SWPPP is a living document reflecting current conditions and changes throughout the life of the project. These changes may be informal (i.e., hand-written notes and deletions). Update the SWPPP when the CESCL has noted a deficiency in BMPs or deviation from original design.

2.1 The 13 Elements

2.1.1 Element 1: Preserve Vegetation / 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. Areas 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. A silt fence will be installed around the perimeter of the project site to mark the limits of construction as well as protect surrounding properties from any possible sediment laden runoff. As this site has contaminated soils present, the existing topsoils will be left in place with imported clean fill placed on top.

List and describe BMPs:

- High Visibility Plastic or Metal Fence (BMP C103)

Installation Schedules: TBD

Inspection and Maintenance plan:

Silt Fence Maintenance

- Repair any damage immediately.
- Intercept and convey all evident concentrated flows uphill of the silt fence to a sediment pond.
- Check the uphill side of the fence for signs of the fence clogging and acting as a barrier to flow and then causing channelization of flows parallel to the fence. If this occurs, replace the fence or remove the trapped sediment.
- Remove sediment deposits when the deposit reaches approximately one-third the height of the silt fence, or install a second silt fence.
- Replace filter fabric that has deteriorated due to ultraviolet breakdown.

Responsible Staff: Contractor/CESL

2.1.2 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, street sweeping, and street cleaning shall be employed to prevent sediment from entering state waters. A temporary construction entrance will be installed at the southeast corner of the site from Sequalitchew Drive. Wheel washing will occur onsite if necessary in order to prevent sediment from leaving the site. Street sweeping and street cleaning may be necessary if the stabilized construction access is not effective. Roads shall be swept daily if any sediment collects on them. All wheel wash wastewater shall be controlled on-site and will not be discharged into waters of the State.

List and describe BMPs:

- Stabilized Construction Entrance/ Exit (BMP C105)

Installation Schedules: TBD

Inspection and Maintenance plan:

Stabilized Construction Entrance Maintenance

- Quarry spalls shall be added if the pad is no longer in accordance with the specifications.
- If the entrance is not preventing sediment from being tracked onto pavement, then alternative measures to keep the streets free of sediment shall be used. This may include replacement/cleaning of the existing quarry spalls, street sweeping, an increase in the dimensions of the entrance, or the installation of a wheel wash.
- Any sediment that is tracked onto pavement shall be removed by shoveling or street sweeping. The sediment collected by sweeping shall be removed or stabilized on site. The pavement shall not be cleaned by washing down the street, except when high efficiency sweeping is ineffective and there is a threat to public safety. If it is necessary to wash the streets, the construction of a small sump to contain the wash water shall be considered. The sediment would then be washed into the sump where it can be controlled.
- Perform street sweeping by hand or with a high efficiency sweeper. Do not use a non-high efficiency mechanical sweeper because this creates dust and throws soils into storm systems or conveyance ditches.
- Any quarry spalls that are loosened from the pad, which end up on the roadway shall be removed immediately.
- If vehicles are entering or exiting the site at points other than the construction entrance(s), fencing (see BMP C103) shall be installed to control traffic.
- Upon project completion and site stabilization, all construction accesses intended as permanent access for maintenance shall be permanently stabilized.

Responsible Staff: Contractor/CESL

2.1.3 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 by construction of a sediment pond as one of the first items of construction as well as a silt fence around the property boundary. Stormwater during construction will be captured through v-ditches with rock check dams in order to control the flow of stormwater runoff before reaching the sediment pond. The sediment pond has been sized with adequate surface area for sediment settlement per the DOE requirements from BMP C240 and C241.

Detention facilities must be functioning property before construction of site improvements.

Will you construct stormwater retention and/or detention facilities?
☒ Yes ☐ No

Will you use permanent infiltration ponds or other low impact development (example: rain gardens, bio-retention, porous pavement) to control flow during construction?
☐ Yes ☒ No

List and describe BMPs:

- Sediment Pond (BMP C241)
- Check Dams (BMP C207)

Installation Schedules: TBD

Inspection and Maintenance plan:

Sediment Pond/Trap Maintenance

- Sediment shall be removed from the pond when it reaches 1-foot in depth.
- Any damage to the pond embankments or slopes shall be repaired.

Check Dam Maintenance

- Check dams shall be monitored for performance and sediment accumulation during and after each runoff producing rainfall.
- Sediment shall be removed when it reaches one half the sump depth.
- Anticipate submergence and deposition above the check dam and erosion from high flows around the edges of the dam.
- If significant erosion occurs between dams, install a protective riprap liner in that portion of the channel

Responsible Staff: Contractor/CESL

2.1.4 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 the downstream drainage course. Constructing the sediment control pond is one of the first steps of grading and must be done before other land disturbing activities take place. Rock check dams and v-ditches will be used to convey stormwater runoff into the sediment pond to settle out sediment as well. There are no juvenile Salmonids attempting to enter off-channel areas or drainages within the vicinity. The surface area requirements for the TESC pond are met with the designed TESC plan and it is not expected that further treatment or other sediment controlling measures are necessary.

However, if the proposed sediment controls are ineffective as determined by the CESCL, they will promptly initiate the implementation of one or more of the alternative BMPs listed in Appendix B.

List and describe BMPs:

- Silt Fence (BMP C233)
- Temporary Sediment Pond (BMP C241)
- Check Dams (BMP C207)

Installation Schedules: TBD

Inspection and Maintenance plan:

Silt Fence Maintenance

- Repair any damage immediately.
- Intercept and convey all evident concentrated flows uphill of the silt fence to a sediment pond.
- Check the uphill side of the fence for signs of the fence clogging and acting as a barrier to flow and then causing channelization of flows parallel to the fence. If this occurs, replace the fence or remove the trapped sediment.
- Remove sediment deposits when the deposit reaches approximately one-third the height of the silt fence, or install a second silt fence.
- Replace filter fabric that has deteriorated due to ultraviolet breakdown.

Sediment Pond/Trap Maintenance

- Sediment shall be removed from the pond when it reaches 1-foot in depth.
- Any damage to the pond embankments or slopes shall be repaired.

Check Dam Maintenance

- Check dams shall be monitored for performance and sediment accumulation during and after each runoff producing rainfall.
- Sediment shall be removed when it reaches one half the sump depth.

- Anticipate submergence and deposition above the check dam and erosion from high flows around the edges of the dam.
- If significant erosion occurs between dams, install a protective riprap liner in that portion of the channel.

Responsible Staff: Contractor/CESL

2.1.5 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. Temporary seeding shall occur on all areas to remain unworked pursuant to below. 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. To the northwest of the site, there is an area that will be used for stockpiling any contaminated soils uncovered during the project. These stockpiles will be covered with plastic sheeting while being stored and waiting for testing to determine any present contaminants before disposal or reuse depending on the testing outcome. To minimize the amount of soil exposed through the life of the project, grading will be completed within a reasonable time frame after the preloading of the building footprints is completed. To minimize soil compaction, a construction entrance will be used as well as keeping heavy equipment and machinery off unpaved areas as much as possible.

West of the Cascade Mountains Crest

Season	Dates	Number of Days Soils Can be Left Exposed
During the Dry Season	May 1 – September 30	7 days
During the Wet Season	October 1 – April 30	2 days

Soils must be stabilized at the end of the shift before a holiday or weekend if needed based on the weather forecast.

Anticipated project dates: Start date: October 2017 End date: October 2018

Will you construct during the wet season?
☒ Yes ☐ No

List and describe BMPs:

- Temporary and Permanent Seeding (BMP C120)
- Mulching (BMP C121)
- Dust Control (BMP C140)

Installation Schedules: TBD

Inspection and Maintenance plan: Temporary and Permanent Seeding Maintenance

- Reseed any seeded areas that fail to establish at least 80 percent cover (100 percent cover for areas that receive sheet or concentrated flows). If reseeding is ineffective, use an alternate method such as sodding, mulching, or nets/blankets. If winter weather prevents adequate grass growth, this time limit may be relaxed at the discretion of the local authority when sensitive areas would otherwise be protected.
- Reseed and protect by mulch any areas that experience erosion after achieving adequate cover. Reseed and protect by mulch any eroded area.
- Supply seeded areas with adequate moisture, but do not water to the extent that it causes runoff.

Mulching Maintenance

- The thickness of the cover must be maintained.
- Any areas that experience erosion shall be remulched and/or protected with a net or blanket. If the erosion problem is drainage related, then the problem shall be fixed and the eroded area remulched.

Dust Control Maintenance

- Respray area as necessary to keep dust to a minimum.

Responsible Staff: Contractor/CESL

2.1.6 Element 6: Protect Slopes

All cut and fill slopes will be designed, constructed, and protected in a manner that minimizes erosion. It is required that any temporary pipe slope drains must handle the peak 10-minute flow rate from a Type 1A, 10-year, 24-hour frequency storm for the developed condition. Alternatively, the 10-year, 1-hour flow rate predicted by an approved continuous runoff model, increased by a factor of 1.6, may be used. The hydrologic analysis must use the existing land cover condition for predicting flow rates from tributary areas outside the project limits. For tributary areas on the project site, the analysis must use the temporary or permanent project land cover condition, whichever will produce the highest flow rates. For modeling the condition with the Western Washington Hydrology Model (WWHM) to predict flows, bare soil areas have been modeled as "landscaped area". Scouring will be reduced by using v-ditches with rock check dams to convey stormwater to the sediment pond and trap on site. However, if the proposed BMPs to protect slopes are ineffective as determined by the CESCL, they will promptly initiate the implementation of one or more of the alternative BMPs listed in Appendix B.

Will steep slopes be present at the site during construction?
☒ Yes ☐ No

List and describe BMPs:

- Temporary and Permanent Seeding (BMP C120)

Installation Schedules: TBD

Inspection and Maintenance plan:

Temporary and Permanent Seeding Maintenance

- Reseed any seeded areas that fail to establish at least 80 percent cover (100 percent cover for areas that receive sheet or concentrated flows). If reseeding is ineffective, use an alternate method such as sodding, mulching, or nets/blankets. If winter weather prevents adequate grass growth, this time limit may be relaxed at the discretion of the local authority when sensitive areas would otherwise be protected.
- Reseed and protect by mulch any areas that experience erosion after achieving adequate cover. Reseed and protect by mulch any eroded area.
- Supply seeded areas with adequate moisture, but do not water to the extent that it causes runoff.

Check Dam Maintenance

- Check dams shall be monitored for performance and sediment accumulation during and after each runoff producing rainfall.
- Sediment shall be removed when it reaches one half the sump depth.
- Anticipate submergence and deposition above the check dam and erosion from high flows around the edges of the dam.

- If significant erosion occurs between dams, install a protective riprap liner in that portion of the channel.

Responsible Staff: Contractor/CESL

2.1.7 Element 7: Protect Drain Inlets

All storm drain inlets and culverts made operable during construction 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 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 temporary sediment pond and trap on site will function to settle out sediment particles before discharge to the existing storm system in order to prevent sediment from entering the system. If this is deemed ineffective by the CESCL, additional BMPs may be necessary, as listed in Appendix B. Inlet protection is the last component of a treatment train and protection of drain inlets include additional sediment and erosion control measures. Inlet protection devices will be cleaned (or removed and replaced), when sediment has filled the device by one third (1/3) or as specified by the manufacturer.

List and describe BMPs:

- Storm Drain Inlet Protection (BMP C220)

Installation Schedules: TBD

Inspection and Maintenance plan:

Storm Drain Inlet Protection Maintenance

- Inspect catch basin filters frequently, especially after storm events. Clean and replace clogged inserts. For systems with clogged stone filters: pull away the stones from the inlet and clean or replace. An alternative approach would be to use the clogged stone as fill and put fresh stone around the inlet.
- Do not wash sediment into storm drains while cleaning. Spread all excavated material evenly over the surrounding land area or stockpile and stabilize as appropriate.
- Inlets to be inspected weekly and a minimum of daily during storm events

Responsible Staff: Contractor/CESL

2.1.8 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. For construction stormwater conveyance, v-ditches with rock check dams will be installed to stabilize channels. 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. 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 frequency storm for the developed condition. Alternatively, the 10-year, 1-hour flow rate predicted by an approved continuous runoff model, increased by a factor of 1.6, may be used. The hydrologic analysis must use the existing land cover condition for predicting flow rates from tributary areas outside the project limits. For tributary areas on the project site, the analysis must use the temporary or permanent project land cover condition, whichever will produce the highest flow rates. If using the WWHM to predict flows, bare soil areas should be modeled as "landscaped area".

Provide stabilization, including armoring material, adequate to prevent erosion of outlets, adjacent stream banks, slopes, and downstream reaches, will be installed at the outlets of all conveyance systems.

List and describe BMPs:

- Check Dams (BMP C207)

Installation Schedules: TBD

Inspection and Maintenance plan:

Check Dam Maintenance

- Check dams shall be monitored for performance and sediment accumulation during and after each runoff producing rainfall. Sediment shall be removed when it reaches one half the sump depth.
- Anticipate submergence and deposition above the check dam and erosion from high flows around the edges of the dam.
- If significant erosion occurs between dams, install a protective riprap liner in that portion of the channel.

Responsible Staff: Contractor/CESL

2.1.9 Element 9: Control Pollutants

The following pollutants are anticipated to be present on-site:

Table 2 – Pollutants

Pollutant (List pollutants and source, if applicable)
Hydraulic fluid- May be present on sie with construct ion equipment.
Diesel – May be present on site with construction equipment.
Motor Oil – May be presne on site with construction equipment.

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.

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).

List and describe BMPs:

- Concrete Handling (BMP C151)

Installation Schedules: TBD

Inspection and Maintenance plan:

Concrete Handling Maintenance

- Check containers for holes in the liner daily during concrete pours and repair the same day.

Responsible Staff: Contractor/CESL

Will maintenance, fueling, and/or repair of heavy equipment and vehicles occur on-site?
☒ Yes ☐ No

In order to prevent spills and minimize risk, the following list should be applied

- Temporary storage area should be located away from vehicular traffic, near the construction entrance(s), and away from waterways or storm drains.
- Material Safety Data Sheets (MSDS) should be supplied for all materials stored. Chemicals should be kept in their original labeled containers.
- Hazardous material storage on-site should be minimized.
- Hazardous materials should be handled as infrequently as possible.
- During the wet weather season (Oct 1 – April 30), consider storing materials in a covered area.
- Materials should be stored in secondary containments, such as earthen dike, horse trough, or even a children's wading pool for non-reactive materials such as detergents, oil, grease, and paints. Small amounts of material may be secondarily contained in "bus boy" trays or concrete mixing trays.
- Do not store chemicals, drums, or bagged materials directly on the ground. Place these items on a pallet and, when possible, and within secondary containment.
- If drums must be kept uncovered, store them at a slight angle to reduce ponding of rainwater on the lids to reduce corrosion. Domed plastic covers are inexpensive and snap to the top of drums, preventing water from collecting.

Liquids, petroleum products, and substances listed in 40 CFR Parts 110, 117, or 302 shall be stored in approved containers and drums and shall not be overfilled. Containers and drums shall be stored in temporary secondary containment facilities.

List and describe BMPs:

- Material Delivery, Storage and Containment (BMP C153)

Installation Schedules: TBD

Inspection and Maintenance plan: The spill kit should include, at a minimum:

- 1-Water Resistant Nylon Bag
- 3-Oil Absorbent Socks 3”x 4’
- 2-Oil Absorbent Socks 3”x 10’
- 12-Oil Absorbent Pads 17”x19”
- 1-Pair Splash Resistant Goggles
- 3-Pair Nitrile Gloves
- 10-Disposable Bags with Ties
- Instructions

Responsible Staff: Contractor/CESL

Will wheel wash or tire bath system BMPs be used during construction?
☐ Yes ☒ No

If yes, provide disposal methods for wastewater generated by BMPs.

If discharging to the sanitary sewer, include the approval letter from your local sewer district under Correspondence in Appendix C.

List and describe BMPs: N/A

Installation Schedules: N/A

Inspection and Maintenance plan: N/A

Responsible Staff: N/A

Will pH-modifying sources be present on-site?
☐ Yes ☒ No

Table 3 – pH-Modifying Sources

☒	None
☐	Bulk cement
☐	Cement kiln dust
☐	Fly ash
☐	Other cementitious materials
☐	New concrete washing or curing waters
☐	Waste streams generated from concrete grinding and sawing
☐	Exposed aggregate processes
☐	Dewatering concrete vaults

☐	Concrete pumping and mixer washout waters
☐	Recycled concrete
☐	Recycled concrete stockpiles
☐	Other (i.e., calcium lignosulfate) [please describe:]

Describe BMPs you will use to prevent pH-modifying sources from contaminating stormwater.

List and describe BMPs: N/A

Installation Schedules: N/A

Inspection and Maintenance plan: N/A

Responsible Staff: N/A

Concrete trucks must not be washed out onto the ground, or into storm drains, open ditches, streets, or streams. Excess concrete must not be dumped on-site, except in designated concrete washout areas with appropriate BMPs installed.

Will uncontaminated water from water-only based shaft drilling for construction of building, road, and bridge foundations be infiltrated provided the wastewater is managed in a way that prohibits discharge to surface waters?
☐ Yes ☒ No

List and describe BMPs: N/A

Installation Schedules: N/A

Inspection and Maintenance plan: N/A

Responsible Staff: N/A

2.1.10 Element 10: Control Dewatering

Because soils onsite are highly infiltrative and no groundwater was encountered during geotechnical investigations, no construction dewatering is anticipated for this project.

If BMP C250: Construction Stormwater Chemical Treatment and BMP C251: Construction Stormwater Filtration are required for treatment, approval from Ecology is required prior.

Table 4 – Dewatering BMPs

☒	Infiltration
☐	Transport off-site in a vehicle (vacuum truck for legal disposal)
☐	Ecology-approved on-site chemical treatment or other suitable treatment technologies
☐	Sanitary or combined sewer discharge with local sewer district approval (last resort)
☐	Use of sedimentation bag with discharge to ditch or swale (small volumes of localized dewatering)

List and describe BMPs:

- Construciton Stormwater Chemical Treatement (BMP C250)
- Construction Stormwater Filtration (BMP C251)

Installation Schedules: TBD

Inspection and Maintenance plan:

Construction Stormwater Chemical Treatment Maintenance

Monitoring: At a minimum, the following monitoring shall be conducted. Test results shall be recorded on a daily log kept on site. Additional testing may be required by the NPDES permit based on site conditions.

Operational Monitoring:

- Total volume treated and discharged.
- Flow must be continuously monitored and recorded at not greater than 15-minute intervals.
- Type and amount of chemical used for pH adjustment.
- Amount of polymer used for treatment.
- Settling time.

Compliance Monitoring:

- Influent and effluent pH, flocculent chemical concentration, and turbidity must be continuously monitored and recorded at not greater than 15-minute intervals. pH and turbidity of the receiving water.
-

Biomonitoring:

Treated stormwater must be non-toxic to aquatic organisms. Treated stormwater must be tested for aquatic toxicity or residual chemicals. Frequency of biomonitoring will be determined by Ecology.

Residual chemical tests must be approved by Ecology prior to their use.

If testing treated stormwater for aquatic toxicity, you must test for acute (lethal) toxicity. Bioassays shall be conducted by a laboratory accredited by Ecology, unless otherwise approved by Ecology. Acute toxicity tests shall be conducted per the CTAPE protocol.

Discharge Compliance: Prior to discharge, treated stormwater must be sampled and tested for compliance with pH, flocculent chemical concentration, and turbidity limits. These limits may be established by the Construction Stormwater General Permit or a site-specific discharge permit. Sampling and testing for other pollutants may also be necessary at some sites. pH must be within the range of 6.5 to 8.5 standard units and not cause a change in the pH of the receiving water of more than 0.2 standard units. Treated stormwater samples and measurements shall be taken from the discharge pipe or another location representative of the nature of the treated stormwater discharge. Samples used for determining compliance with the water quality standards in the receiving water shall not be taken from the treatment pond prior to decanting. Compliance with the water quality standards is determined in the receiving water.

Operator Training: Each contractor who intends to use chemical treatment shall be trained by an experienced contractor . Each site using chemical treatment must have an operator trained and certified by an organization approved by Ecology.

Standard BMPs: Surface stabilization BMPs should be implemented on site to prevent significant erosion. All sites shall use a truck wheel wash to prevent tracking of sediment off site.

Sediment Removal and Disposal:

- Sediment shall be removed from the storage or treatment cells as necessary. Typically, sediment removal is required at least once during a wet season and at the decommissioning of the cells. Sediment remaining in the cells between batches may enhance the settling process and reduce the required chemical dosage.
- Sediment that is known to be non-toxic may be incorporated into the site away from drainages.

Construction Stormwater Filtration Maintenance

Rapid sand filters typically have automatic backwash systems that are triggered by a pre-set pressure drop across the filter. If the backwash water volume is not large or substantially more turbid than the untreated stormwater stored in the holding pond or tank, backwash return to the untreated stormwater pond or tank may be appropriate. However, other means of treatment and disposal may be necessary.

- Screen, bag, and fiber filters must be cleaned and/or replaced when they become clogged.
- Sediment shall be removed from the storage and/or treatment ponds as necessary. Typically, sediment removal is required once or twice during a wet season and at the decommissioning of the ponds.

Responsible Staff: Contractor/CESL

2.1.11 Element 11: Maintain BMPs

All temporary and permanent Erosion and Sediment Control (ESC) BMPs shall be maintained and repaired as needed to ensure continued performance of their intended function.

Maintenance and repair shall be conducted in accordance with each particular BMP specification (see *Volume II of the SWMMWW or Chapter 7 of the SWMMEW*).

Visual monitoring of all BMPs installed at the site will be conducted at least once every calendar week and within 24 hours of any stormwater or non-stormwater discharge from the site. If the site becomes inactive and is temporarily stabilized, the inspection frequency may be reduced to once every calendar month.

All temporary ESC BMPs shall be removed within 30 days after final site stabilization is achieved or after the temporary BMPs are no longer needed.

Trapped sediment shall be stabilized on-site or removed. Disturbed soil resulting from removal of either BMPs or vegetation shall be permanently stabilized.

Additionally, protection must be provided for all BMPs installed for the permanent control of stormwater from sediment and compaction. BMPs that are to remain in place following completion of construction shall be examined and restored to full operating condition. If sediment enters these BMPs during construction, the sediment shall be removed and the facility shall be returned to conditions specified in the construction documents.

2.1.12 Element 12: Manage the Project

The project will be managed based on the following principles:

- Projects will be phased to the maximum extent practicable and seasonal work limitations will be taken into account.
- Inspection and monitoring:
  - Inspection, maintenance and repair of all BMPs will occur as needed to ensure performance of their intended function.
  - Site inspections and monitoring will be conducted in accordance with Special Condition S4 of the CSWGP. Sampling locations are indicated on the Site Map. Sampling station(s) are located in accordance with applicable requirements of the CSWGP.
- Maintain an updated SWPPP.
  - The SWPPP will be updated, maintained, and implemented in accordance with Special Conditions S3, S4, and S9 of the CSWGP.

As site work progresses the SWPPP will be modified routinely to reflect changing site conditions. The SWPPP will be reviewed monthly to ensure the content is current.

Table 5 – Management

☒	Design the project to fit the existing topography, soils, and drainage patterns
☒	Emphasize erosion control rather than sediment control
☒	Minimize the extent and duration of the area exposed
☒	Keep runoff velocities low
☒	Retain sediment on-site
☒	Thoroughly monitor site and maintain all ESC measures
☒	Schedule major earthwork during the dry season
☐	Other (please describe)

Table 6 – BMP Implementation Schedule

Phase of Construction Project	Stormwater BMPs	Date	Wet/Dry Season
TBD			

2.1.13 Element 13: Protect Low Impact Development (LID) BMPs

Low Impact Developed (LID) BMPs are practices that emphasize pre-disturbance hydrologic processes of infiltration, filtration, storage, evaporation and transpiration integrated into project design. The idea behind these is to emphasize conservation, use of on-site natural features, and site planning to minimize impervious surfaces, native vegetation loss, and stormwater runoff. At this time, there are no LID BMPs in place, however the following shall apply in the event of additional LID BMPs added to the project:

- Permittees must protect all Bioretention and Rain Garden facilities from sedimentation through installation and maintenance of erosion and sediment control BMPs on portions of the site that drain into the Bioretention and/or Rain Garden facilities. Restore the facilities to their fully functioning condition if they accumulate sediment during construction. Restoring the facility must include removal of sediment and any sediment-laden Bioretention/Rain Garden soils, and replacing the removed soils with soils meeting the design specification.
- Permittees must maintain the infiltration capabilities of Bioretention and Rain Garden facilities by protecting against compaction by construction equipment and foot traffic. Protect completed lawn and landscaped areas from compaction due to construction equipment.
- Permittees must 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 onto permeable pavements.
- Permittees must clean permeable pavements fouled with sediments or no longer passing an initial infiltration test using local stormwater manual methodology or the manufacturer's procedures.
- Permittees must 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 Pollution Prevention Team

Table 7 – Team Information

Title	Name(s)	Phone Number
Certified Erosion and Sediment Control Lead (CESCL)	TBD	
Resident Engineer	Dan Balmelli	(425) 251-6222
Emergency Ecology Contact	TBD	TBD
Emergency Permittee/ Owner Contact	TBD	TBD
Non-Emergency Owner Contact	TBD	TBD
Monitoring Personnel	TBD	TBD
Ecology Regional Office	Northwest Regional Office	425-649-7000

4 Monitoring and Sampling Requirements

Monitoring includes visual inspection, sampling for water quality parameters of concern, and documentation of the inspection and sampling 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
- Stormwater sampling data

File a blank form under Appendix D.

The site log book must be maintained on-site within reasonable access to the site and be made available upon request to Ecology or the local jurisdiction.

Numeric effluent limits may be required for certain discharges to 303(d) listed waterbodies. See CSWGP Special Condition S8 and Section 5 of this template.

4.1 Site Inspection

Site inspections will be conducted at least once every calendar week and within 24 hours following any discharge from the site. For sites that are temporarily stabilized and inactive, the required frequency is reduced to once per calendar month.

The discharge point(s) are indicated on the Site Map (see Appendix A) and in accordance with the applicable requirements of the CSWGP.

4.2 Stormwater Quality Sampling

4.2.1 Turbidity Sampling

Requirements include calibrated turbidity meter or transparency tube to sample site discharges for compliance with the CSWGP. Sampling will be conducted at all discharge points at least once per calendar week.

Method for sampling turbidity:

Table 8 – Turbidity Sampling Method

☒	Turbidity Meter/Turbidimeter (required for disturbances 5 acres or greater in size)
☐	Transparency Tube (option for disturbances less than 1 acre and up to 5 acres in size)

The benchmark for turbidity value is 25 nephelometric turbidity units (NTU) and a transparency less than 33 centimeters.

If the discharge's turbidity is 26 to 249 NTU **or** the transparency is less than 33 cm but equal to or greater than 6 cm, the following steps will be conducted:

1. Review the SWPPP for compliance with Special Condition S9. Make appropriate revisions within 7 days of the date the discharge exceeded the benchmark.

2. Immediately begin the process to fully implement and maintain appropriate source control and/or treatment BMPs as soon as possible. Address the problems within 10 days of the date the discharge exceeded the benchmark. If installation of necessary treatment BMPs is not feasible within 10 days, Ecology may approve additional time when the Permittee requests an extension within the initial 10-day response period.
3. Document BMP implementation and maintenance in the site log book.

If the turbidity exceeds 250 NTU **or** the transparency is 6 cm or less at any time, the following steps will be conducted:

1. Telephone or submit an electronic report to the applicable Ecology Region's Environmental Report Tracking System (ERTS) within 24 hours.
    - **Central Region** (Benton, Chelan, Douglas, Kittitas, Klickitat, Okanogan, Yakima): (509) 575-2490 or http://www.ecy.wa.gov/programs/spills/forms/nerts_online/CRO_nerts_online.html
    - **Eastern Region** (Adams, Asotin, Columbia, Ferry, Franklin, Garfield, Grant, Lincoln, Pend Oreille, Spokane, Stevens, Walla Walla, Whitman): (509) 329-3400 or http://www.ecy.wa.gov/programs/spills/forms/nerts_online/ERO_nerts_online.html
    - **Northwest Region** (King, Kitsap, Island, San Juan, Skagit, Snohomish, Whatcom): (425) 649-7000 or http://www.ecy.wa.gov/programs/spills/forms/nerts_online/NWRO_nerts_online.html
    - **Southwest Region** (Clallam, Clark, Cowlitz, Grays Harbor, Jefferson, Lewis, Mason, Pacific, Pierce, Skamania, Thurston, Wahkiakum,): (360) 407-6300 or http://www.ecy.wa.gov/programs/spills/forms/nerts_online/SWRO_nerts_online.html
2. Immediately begin the process to fully implement and maintain appropriate source control and/or treatment BMPs as soon as possible. Address the problems within 10 days of the date the discharge exceeded the benchmark. If installation of necessary treatment BMPs is not feasible within 10 days, Ecology may approve additional time when the Permittee requests an extension within the initial 10-day response period
3. Document BMP implementation and maintenance in the site log book.
4. Continue to sample discharges daily until one of the following is true:
    - Turbidity is 25 NTU (or lower).
    - Transparency is 33 cm (or greater).
    - Compliance with the water quality limit for turbidity is achieved.
        - 1 - 5 NTU over background turbidity, if background is less than 50 NTU
        - 1% - 10% over background turbidity, if background is 50 NTU or greater
    - The discharge stops or is eliminated.

4.2.2 pH Sampling

pH monitoring is required for “Significant concrete work” (i.e., greater than 1000 cubic yards poured concrete over the life of the project). The use of recycled concrete or engineered soils (soil amendments including but not limited to Portland cement-treated base [CTB], cement kiln dust [CKD] or fly ash) also requires pH monitoring.

For significant concrete work, pH sampling will start the first day concrete is poured and continue until it is cured, typically three (3) weeks after the last pour.

For engineered soils and recycled concrete, pH sampling begins when engineered soils or recycled concrete are first exposed to precipitation and continues until the area is fully stabilized.

If the measured pH is 8.5 or greater, the following measures will be taken:

1. Prevent high pH water from entering storm sewer systems or surface water.
2. Adjust or neutralize the high pH water to the range of 6.5 to 8.5 su using appropriate technology such as carbon dioxide (CO_2) sparging (liquid or dry ice).
3. Written approval will be obtained from Ecology prior to the use of chemical treatment other than CO_2 sparging or dry ice.

Method for sampling pH:

Table 9 – pH Sampling Method

☒	pH meter
☐	pH test kit
☐	Wide range pH indicator paper

5 Discharges to 303(d) or Total Maximum Daily Load (TMDL) Waterbodies

5.1 303(d) Listed Waterbodies

Is the receiving water 303(d) (Category 5) listed for turbidity, fine sediment, phosphorus, or pH?

☐ Yes ☒ No

List the impairment(s):

N/A

5.2 TMDL Waterbodies

Waste Load Allocation for CWSGP discharges:

N/A

List and describe BMPs:

N/A

Discharges to TMDL receiving waterbodies will meet in-stream water quality criteria at the point of discharge.

The Construction Stormwater General Permit Proposed New Discharge to an Impaired Water Body form is included in Appendix F.

6 Reporting and Record Keeping

6.1 Record Keeping

6.1.1 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
- Sample logs

6.1.2 Records Retention

Records will be retained during the life of the project and for a minimum of three (3) years following the termination of permit coverage in accordance with Special Condition S5.C of the CSWGP.

Permit documentation to be retained on-site:

- CSWGP
- Permit Coverage Letter
- SWPPP
- Site Log Book

Permit documentation will be provided within 14 days of receipt of a written request from Ecology. A copy of the SWPPP or access to the SWPPP will be provided to the public when requested in writing in accordance with Special Condition S5.G.2.b of the CSWGP.

6.1.3 Updating the SWPPP

The SWPPP will be modified if:

- Found ineffective in eliminating or significantly minimizing pollutants in stormwater discharges from the site.
- There is a change in design, construction, operation, or maintenance at the construction site that has, or could have, a significant effect on the discharge of pollutants to waters of the State.

The SWPPP will be modified within seven (7) days if inspection(s) or investigation(s) determine additional or modified BMPs are necessary for compliance. An updated timeline for BMP implementation will be prepared.

6.2 Reporting

6.2.1 Discharge Monitoring Reports

Cumulative soil disturbance is less than one (1) acre; therefore, Discharge Monitoring Reports (DMRs) will not be submitted to Ecology because water quality sampling is not being conducted at the site.

6.2.2 Notification of Noncompliance

If any of the terms and conditions of the permit is not met, and the resulting noncompliance may cause a threat to human health or the environment, the following actions will be taken:

1. Ecology will be notified within 24-hours of the failure to comply by calling the applicable Regional office ERTS phone number (Regional office numbers listed below).
2. Immediate action will be taken to prevent the discharge/pollution or otherwise stop or correct the noncompliance. 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.

Anytime turbidity sampling indicates turbidity is 250 NTUs or greater, or water transparency is 6 cm or less, the Ecology Regional office will be notified by phone within 24 hours of analysis as required by Special Condition S5.A of the CSWGP.

- **Central Region** at (509) 575-2490 for Benton, Chelan, Douglas, Kittitas, Klickitat, Okanogan, or Yakima County
- **Eastern Region** at (509) 329-3400 for Adams, Asotin, Columbia, Ferry, Franklin, Garfield, Grant, Lincoln, Pend Oreille, Spokane, Stevens, Walla Walla, or Whitman County
- **Northwest Region** at (425) 649-7000 for Island, King, Kitsap, San Juan, Skagit, Snohomish, or Whatcom County
- **Southwest Region** at (360) 407-6300 for Clallam, Clark, Cowlitz, Grays Harbor, Jefferson, Lewis, Mason, Pacific, Pierce, Skamania, Thurston, or Wahkiakum

Include the following information:

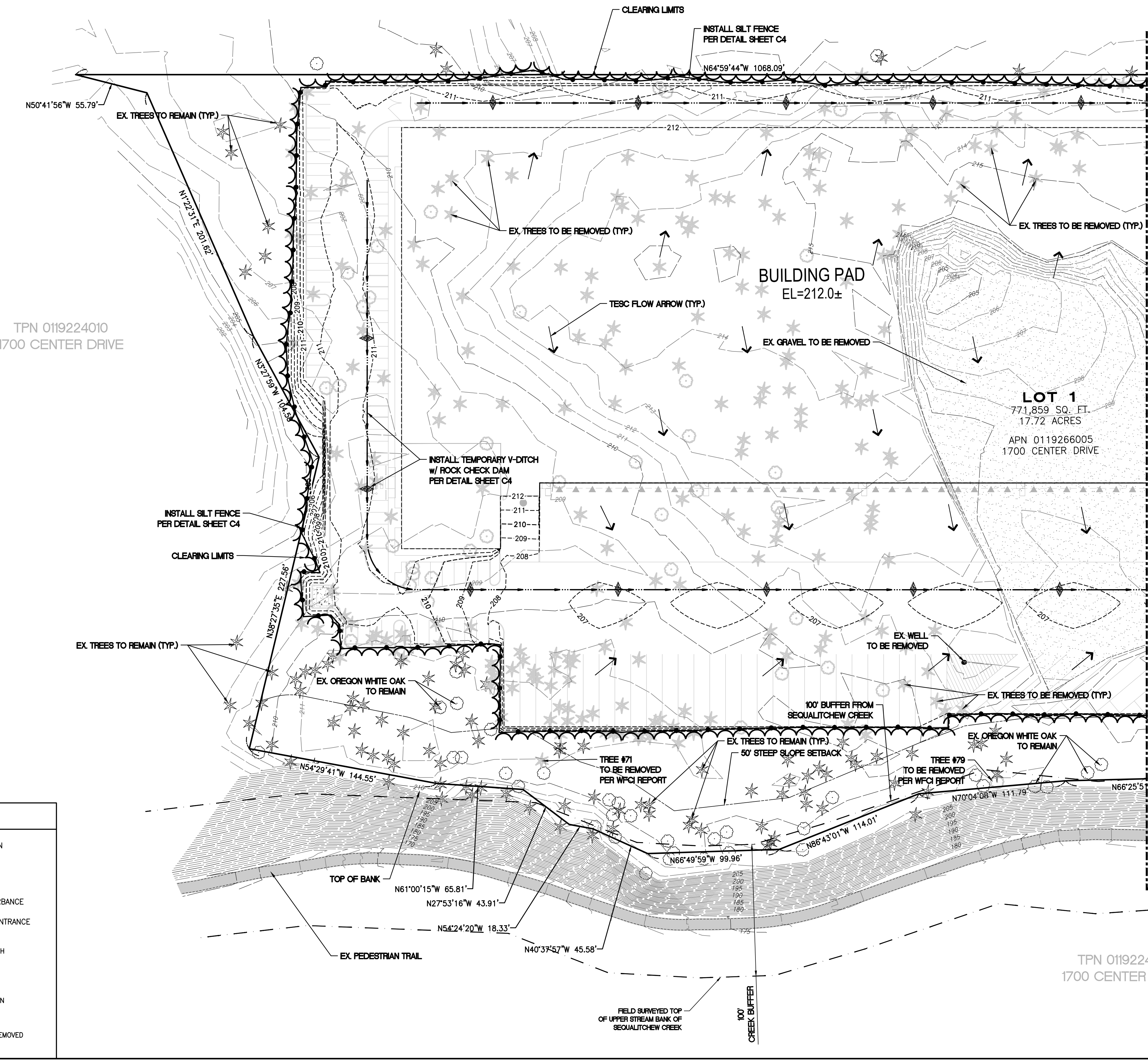
1. Your name and / Phone number
2. Permit number
3. City / County of project
4. Sample results
5. Date / Time of call
6. Date / Time of sample
7. Project name

In accordance with Special Condition S4.D.5.b of the CSWGP, the Ecology Regional office will be notified if chemical treatment other than CO_2 sparging is planned for adjustment of high pH water.

A. Site Map

PRELIMINARY TESC AND DEMOLITION PLAN-WEST
FOR
DUPONT - WEST
A PORTION OF THE NW 1/4 OF SECTION 26, TOWNSHIP 19N, RANGE 01E, W.M.
CITY OF DUPONT, PIERCE COUNTY, WASHINGTON

1"=40'
0 20 40 80



TESC LEGEND:

	INLET PROTECTION
	SILT FENCE
	LIMITS OF DISTURBANCE
	CONSTRUCTION ENTRANCE
	TEMPORARY V-DITCH
	ROCK CHECK DAM
	EX. TREE TO REMAIN
	EX. TREE TO BE REMOVED

APPROVED FOR CONSTRUCTION

BY: ____________ DATE: ____________
CITY OF DUPONT

THESE DRAWINGS ARE APPROVED FOR CONSTRUCTION FOR A PERIOD OF 12 MONTHS FROM THE DATE SHOWN HEREON. THE CITY RESERVES THE RIGHT TO MAKE REVISIONS, ADDITIONS, DELETIONS, OR MODIFICATIONS SHOULD CONSTRUCTION BE DELAYED BEYOND THIS TIME LIMITATION. THE CITY, BY APPROVING THESE DRAWINGS, ASSUMES NO LIABILITY IN REGARDS TO THEIR ACCURACY OR OMISSIONS.

No.	Date	By	Ckd.	Appr.	Revision
2	11/06/23	JT	DKB	DKB	REVISED PER CITY COMMENTS

Title: PRELIMINARY TESC AND DEMOLITION PLAN-WEST FOR DUPONT - WEST

For: AVENUE 55, LLC
601 UNION STREET, SUITE 2930
SEATTLE, WA 98101
(206) 707-9696

DANIEL K. BALMELLI
STATE OF WASHINGTON
25672
REGISTERED PROFESSIONAL ENGINEER
11/06/2023

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

Designed JAT
Drawn JAT
Checked DKB
Approved DKB
Date 11/06/23

BARGHAUSEN CONSULTING ENGINEERS, INC.

18215 72ND AVENUE SOUTH
KENT, WA 98032
(425)251-6222
(425)251-8782 FAX

CIVIL ENGINEERING, LAND PLANNING, SURVEYING, ENVIRONMENTAL SERVICES

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Job Number 18666

Sheet C2 of 13

PRELIMINARY TESC AND DEMOLITION PLAN-EAST
FOR
DUPONT - WEST
A PORTION OF THE NW 1/4 OF SECTION 26, TOWNSHIP 19N, RANGE 01E, W.M.
CITY OF DUPONT, PIERCE COUNTY, WASHINGTON

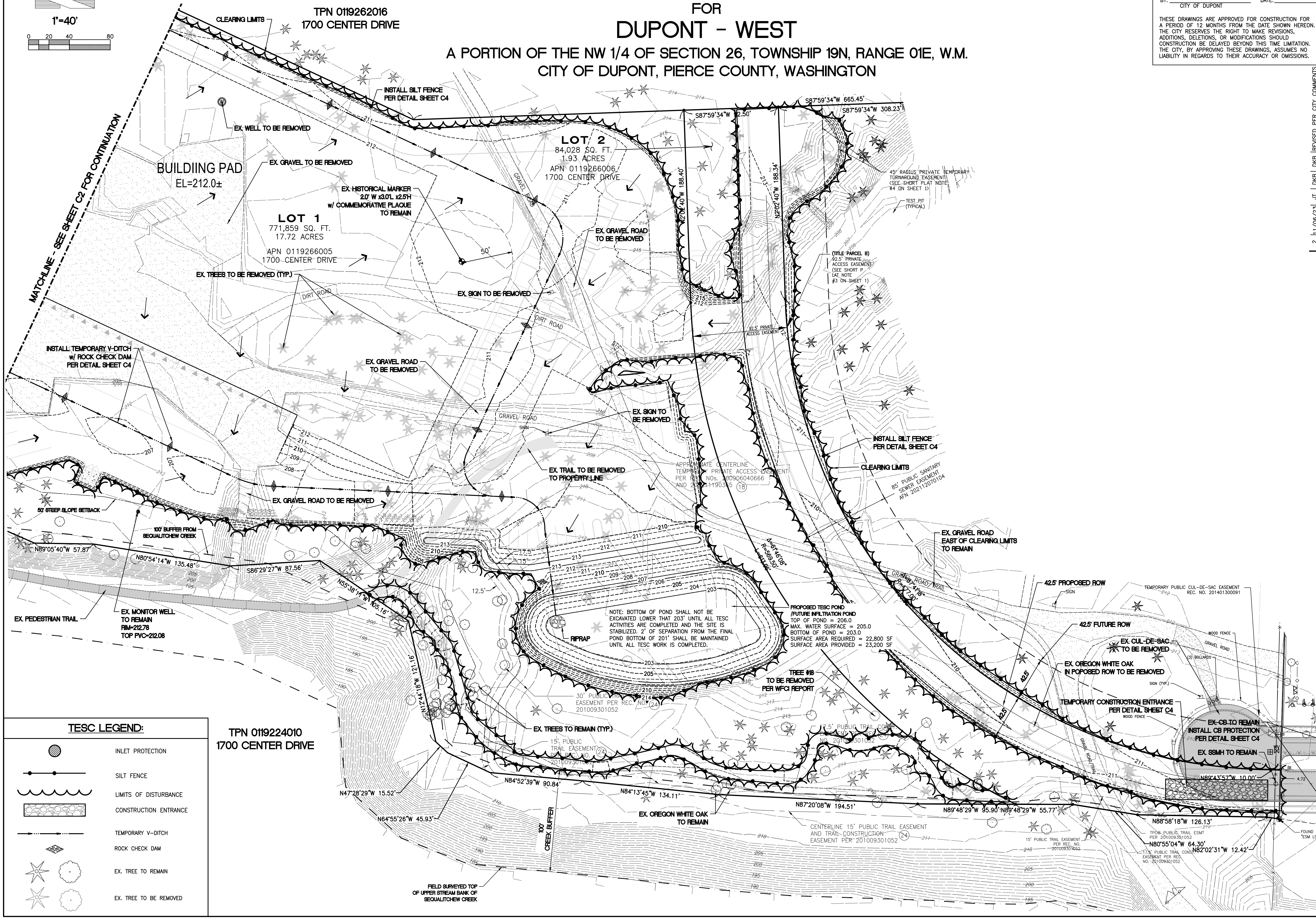
APPROVED FOR CONSTRUCTION

BY: ______________ DATE: ______________
CITY OF DUPONT

THESE DRAWINGS ARE APPROVED FOR CONSTRUCTION FOR A PERIOD OF 12 MONTHS FROM THE DATE SHOWN HEREON. THE CITY RESERVES THE RIGHT TO MAKE REVISIONS, ADDITIONS, DELETIONS, OR MODIFICATIONS SHOULD CONSTRUCTION BE DELAYED BEYOND THIS TIME LIMITATION. THE CITY, BY APPROVING THESE DRAWINGS, ASSUMES NO LIABILITY IN REGARDS TO THEIR ACCURACY OR OMISSIONS.

1"=40'

0 20 40 80



TESC LEGEND:

	INLET PROTECTION
	SILT FENCE
	LIMITS OF DISTURBANCE
	CONSTRUCTION ENTRANCE
	TEMPORARY V-DITCH
	ROCK CHECK DAM
	EX. TREE TO REMAIN
	EX. TREE TO BE REMOVED

No.	Date	By	Ckd.	Appr.	Revision
2	11/06/23	JT	DKB	DKB	REVISED PER CITY COMMENTS

Title: PRELIMINARY TESC AND DEMOLITION PLAN-EAST FOR DUPONT - WEST

For: AVENUE 55, LLC
601 UNION STREET, SUITE 2930
SEATTLE, WA 98101
(206) 707-9696

DANIEL K. BALMELLI, STATE OF WASHINGTON, 25672, REGISTERED PROFESSIONAL ENGINEER, 11/06/2023

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

Designed JAT
Drawn JAT
Checked DKB
Approved DKB
Date 11/06/23

18215 72ND AVENUE SOUTH
KENT, WA 98032
(425)251-6222
(425)251-8782 FAX
CIVIL ENGINEERING, LAND PLANNING, SURVEYING, ENVIRONMENTAL SERVICES
BARGHAUSEN CONSULTING ENGINEERS, INC.

Job Number 18666

Sheet C3 of 13

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B. BMP Detail

Please see following pages for appropriate BMP details.

Below is a list of Alternative BMPs the be used if the BMPs listed in the body of this document are deemed ineffective by the CESCL.

Element #1 - Mark Clearing Limits
BMP C101: Preserving Natural Vegetation
BMP C102: Buffer Zones
BMP C103: High Visibility Fence

Element #2 - Establish Construction Access
BMP C107: Construction Road/Parking Area Stabilization

Element #3 - Control Flow Rates
BMP C203: Water Bars
BMP C209: Outlet Protection
BMP C235: Wattles

Element #4 - Install Sediment Controls
BMP C231: Brush Barrier
BMP C232: Gravel Filter Berm
BMP C234: Vegetated Strip
BMP C235: Wattles
BMP C250: Construction Stormwater Chemical Treatment
BMP C251: Construction Stormwater Filtration
Other Proprietary Sediment Control Technologies

Element #5 - Stabilize Soils
BMP C122: Nets and Blankets
BMP C124: Sodding
BMP C125 Compost
BMP C126: Topsoiling
BMP C127: Polyacrylamide for Soil Erosion Protection
BMP C130: Surface Roughening
BMP C131: Gradient Terraces

Element #6 - Protect Slopes
BMP C121: Mulching
BMP C122: Nets and Blankets
BMP C131: Gradient Terraces
BMP C200: Interceptor Dike and Swale
BMP C201: Grass-Lined Channels
BMP C203: Water Bars
BMP C204: Pipe Slope Drains
BMP C205: Subsurface Drains
BMP C206: Level Spreader
BMP C208: Triangular Silt Dike (Geotextile-Encased Check Dam)

Element #7 - Protect Drain Inlets
BMP C220: Storm Drain Inlet Protection

Element #8 - Stabilize Channels and Outlets
BMP C122: Nets and Blankets
BMP C202: Channel Lining
BMP C209: Outlet Protection

Element #9 - Control Pollutants
BMP C152: Sawcutting and Surface Pollution Prevention
BMP C153: Material Delivery, Storage, Containment
BMP C154: Concrete Washout Area
BMP C250: Construction Stormwater Chemical Treatment
BMP C251: Construction Stormwater Filtration
BMP C252: High pH Neutralization Using Co_2
BMP C253: pH Control for High pH Water
Source Control BMPs As Appropriate

Element #10 - Control Dewatering
BMP C203: Water Bars
BMP C226: Vegetative Filtration

Element #11 - Maintain BMPs
BMP C150: Materials on Hand
BMP C160 Erosion and Sedimentation Control Lead

Element #12 - Manage the Project
BMP C150: Materials on Hand
BMP C160: Erosion and Sediment Control Lead
BMP C162: Scheduling

Element #13: Protect Low Impact Development
BMP C102: Buffer Zone
BMP C103: High Visibility Fence
BMP C200: Interceptor Dike and Swale
BMP C201: Grass-Lined Channels
BMP C207: Check Dams
BMP C208: Triangular Silt Dike (TSD) (Geotextile-Encased Check Dam)
BMP C231: Brush Barrier
BMP C233: Silt Fence
BMP C234: Vegetated Strip

BMP C103: High Visibility Fence

Purpose

Fencing is intended to:

1. Restrict clearing to approved limits.
2. Prevent disturbance of sensitive areas, their buffers, and other areas required to be left undisturbed.
3. Limit construction traffic to designated construction entrances, exits, or internal roads.
4. Protect areas where marking with survey tape may not provide adequate protection.

Conditions of Use

To establish clearing limits plastic, fabric, or metal fence may be used:

- At the boundary of sensitive areas, their buffers, and other areas required to be left uncleared.
- As necessary to control vehicle access to and on the site.

Design and Installation Specifications

High visibility plastic fence shall be composed of a high-density polyethylene material and shall be at least four feet in height. Posts for the fencing shall be steel or wood and placed every 6 feet on center (maximum) or as needed to ensure rigidity. The fencing shall be fastened to the post every six inches with a polyethylene tie. On long continuous lengths of fencing, a tension wire or rope shall be used as a top stringer to prevent sagging between posts. The fence color shall be high visibility orange. The fence tensile strength shall be 360 lbs./ft. using the ASTM D4595 testing method.

If appropriate install fabric silt fence in accordance with BMP C233 to act as high visibility fence. Silt fence shall be at least 3 feet high and must be highly visible to meet the requirements of this BMP.

Metal fences shall be designed and installed according to the manufacturer's specifications.

Metal fences shall be at least 3 feet high and must be highly visible.

Fences shall not be wired or stapled to trees.

Maintenance Standards

If the fence has been damaged or visibility reduced, it shall be repaired or replaced immediately and visibility restored.

BMP C105: Stabilized Construction Entrance / Exit

Purpose

Stabilized Construction entrances are established to reduce the amount of sediment transported onto paved roads by vehicles or equipment. This is done by constructing a stabilized pad of quarry spalls at entrances and exits for construction sites.

Conditions of Use

Construction entrances shall be stabilized wherever traffic will be entering or leaving a construction site if paved roads or other paved areas are within 1,000 feet of the site.

For residential construction provide stabilized construction entrances for each residence, rather than only at the main subdivision entrance. Stabilized surfaces shall be of sufficient length/width to provide vehicle access/parking, based on lot size/configuration.

On large commercial, highway, and road projects, the designer should include enough extra materials in the contract to allow for additional stabilized entrances not shown in the initial Construction SWPPP. It is difficult to determine exactly where access to these projects will take place; additional materials will enable the contractor to install them where needed.

Design and Installation Specifications

See Figure 4.1.1 for details. Note: the 100’ minimum length of the entrance shall be reduced to the maximum practicable size when the size or configuration of the site does not allow the full length (100’).

Construct stabilized construction entrances with a 12-inch thick pad of 4-inch to 8-inch quarry spalls, a 4-inch course of asphalt treated base (ATB), or use existing pavement. Do not use crushed concrete, cement, or calcium chloride for construction entrance stabilization because these products raise pH levels in stormwater and concrete discharge to surface waters of the State is prohibited.

A separation geotextile shall be placed under the spalls to prevent fine sediment from pumping up into the rock pad. The geotextile shall meet the following standards:

Grab Tensile Strength (ASTM D4751)	200 psi min.
Grab Tensile Elongation (ASTM D4632)	30% max.
Mullen Burst Strength (ASTM D3786-80a)	400 psi min.
AOS (ASTM D4751)	20-45 (U.S. standard sieve size)

- Consider early installation of the first lift of asphalt in areas that will paved; this can be used as a stabilized entrance. Also consider the installation of excess concrete as a stabilized entrance. During large concrete pours, excess concrete is often available for this purpose.

- Fencing (see BMP C103) shall be installed as necessary to restrict traffic to the construction entrance.
- Whenever possible, the entrance shall be constructed on a firm, compacted subgrade. This can substantially increase the effectiveness of the pad and reduce the need for maintenance.
- Construction entrances should avoid crossing existing sidewalks and back of walk drains if at all possible. If a construction entrance must cross a sidewalk or back of walk drain, the full length of the sidewalk and back of walk drain must be covered and protected from sediment leaving the site.

Maintenance Standards

Quarry spalls shall be added if the pad is no longer in accordance with the specifications.

- If the entrance is not preventing sediment from being tracked onto pavement, then alternative measures to keep the streets free of sediment shall be used. This may include replacement/cleaning of the existing quarry spalls, street sweeping, an increase in the dimensions of the entrance, or the installation of a wheel wash.
- Any sediment that is tracked onto pavement shall be removed by shoveling or street sweeping. The sediment collected by sweeping shall be removed or stabilized on site. The pavement shall not be cleaned by washing down the street, except when high efficiency sweeping is ineffective and there is a threat to public safety. If it is necessary to wash the streets, the construction of a small sump to contain the wash water shall be considered. The sediment would then be washed into the sump where it can be controlled.
- Perform street sweeping by hand or with a high efficiency sweeper. Do not use a non-high efficiency mechanical sweeper because this creates dust and throws soils into storm systems or conveyance ditches.
- Any quarry spalls that are loosened from the pad, which end up on the roadway shall be removed immediately.
- If vehicles are entering or exiting the site at points other than the construction entrance(s), fencing (see BMP C103) shall be installed to control traffic.
- Upon project completion and site stabilization, all construction accesses intended as permanent access for maintenance shall be permanently stabilized.

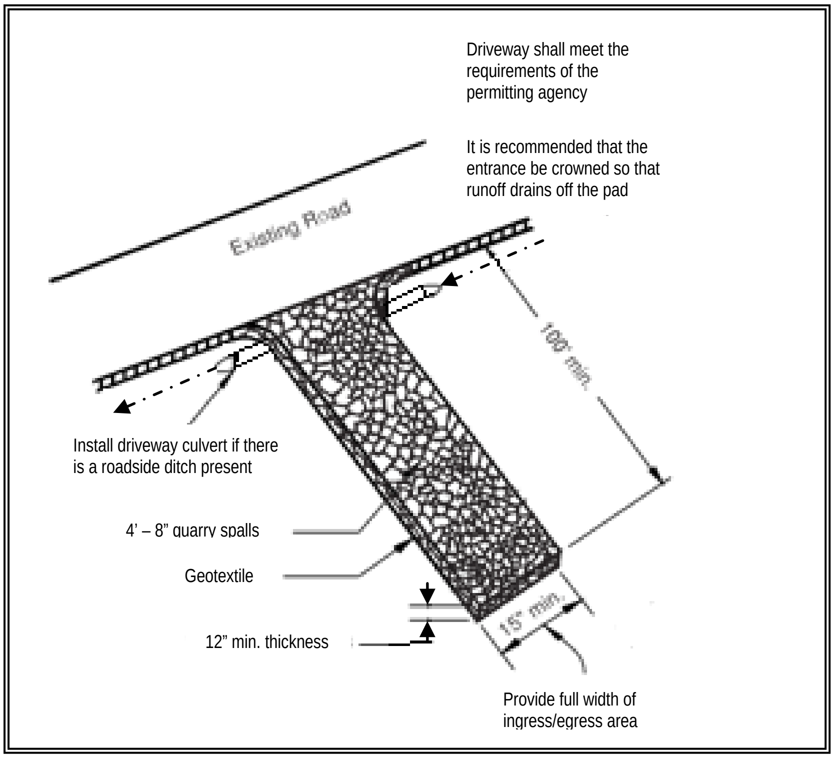


Figure 4.1.1 – Stabilized Construction Entrance

Approved as Equivalent

Ecology has approved products as able to meet the requirements of BMP C105. The products did not pass through the Technology Assessment Protocol – Ecology (TAPE) process. Local jurisdictions may choose not to accept this product approved as equivalent, or may require additional testing prior to consideration for local use. The products are available for review on Ecology's website at http://www.ecy.wa.gov/programs/wq/stormwater/newtech/equivalent.html

BMP C106: Wheel Wash

Purpose

Wheel washes reduce the amount of sediment transported onto paved roads by motor vehicles.

Conditions of Use

When a stabilized construction entrance (see BMP C105) is not preventing sediment from being tracked onto pavement.

- Wheel washing is generally an effective BMP when installed with careful attention to topography. For example, a wheel wash can be detrimental if installed at the top of a slope abutting a right-of-way where the water from the dripping truck can run unimpeded into the street.
- Pressure washing combined with an adequately sized and surfaced pad with direct drainage to a large 10-foot x 10-foot sump can be very effective.
- Discharge wheel wash or tire bath wastewater to a separate on-site treatment system that prevents discharge to surface water, such as closed-loop recirculation or upland land application, or to the sanitary sewer with local sewer district approval.
- Wheel wash or tire bath wastewater should not include wastewater from concrete washout areas.

Design and Installation Specifications

Suggested details are shown in Figure 4.1.2. The Local Permitting Authority may allow other designs. A minimum of 6 inches of asphalt treated base (ATB) over crushed base material or 8 inches over a good subgrade is recommended to pave the wheel wash.

Use a low clearance truck to test the wheel wash before paving. Either a belly dump or lowboy will work well to test clearance.

Keep the water level from 12 to 14 inches deep to avoid damage to truck hubs and filling the truck tongues with water.

Midpoint spray nozzles are only needed in extremely muddy conditions.

Wheel wash systems should be designed with a small grade change, 6- to 1-inches for a 10-foot-wide pond, to allow sediment to flow to the low side of pond to help prevent re-suspension of sediment. A drainpipe with a 2- to 3-foot riser should be installed on the low side of the pond to allow for easy cleaning and refilling. Polymers may be used to promote coagulation and flocculation in a closed-loop system. Polyacrylamide (PAM) added to the wheel wash water at a rate of 0.25 - 0.5 pounds per 1,000 gallons of water increases effectiveness and reduces cleanup time. If PAM is already being used for dust or erosion control and is being applied by a water truck, the same truck can be used to change the wash water.

Maintenance Standards

The wheel wash should start out the day with fresh water.

The wash water should be changed a minimum of once per day. On large earthwork jobs where more than 10-20 trucks per hour are expected, the wash water will need to be changed more often.

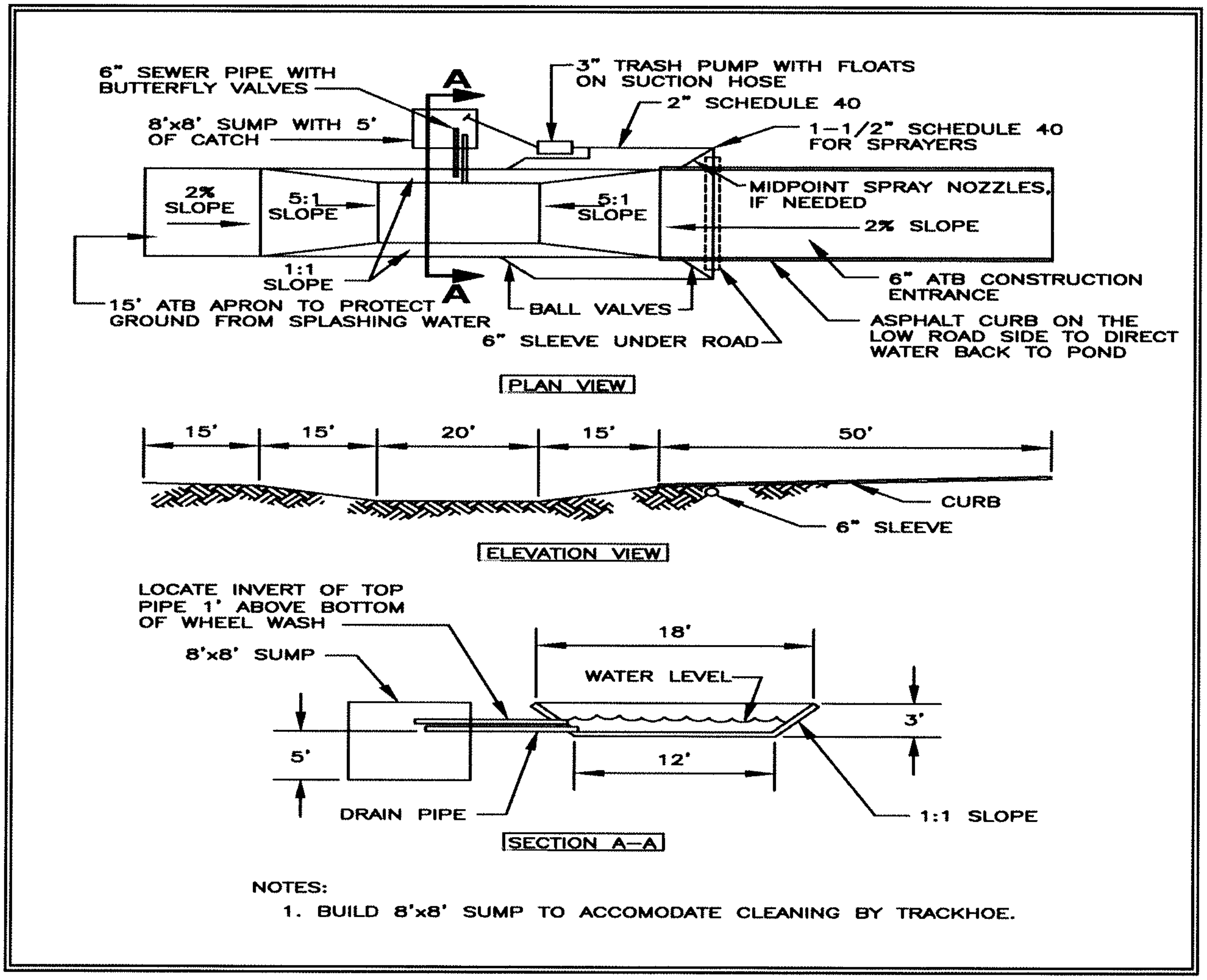


Figure 4.1.2 – Wheel Wash

Notes:

1. Asphalt construction entrance 6 in. asphalt treated base (ATB).
2. 3-inch trash pump with floats on the suction hose.
3. Midpoint spray nozzles, if needed.
4. 6-inch sewer pipe with butterfly valves. Bottom one is a drain. Locate top pipe's invert 1 foot above bottom of wheel wash.
5. 8 foot x 8 foot sump with 5 feet of catch. Build so the sump can be cleaned with a trackhoe.
6. Asphalt curb on the low road side to direct water back to pond.
7. 6-inch sleeve under road.
8. Ball valves.
9. 15 foot. ATB apron to protect ground from splashing water.

BMP C107: Construction Road/Parking Area Stabilization

Purpose

Stabilizing subdivision roads, parking areas, and other on-site vehicle transportation routes immediately after grading reduces erosion caused by construction traffic or runoff.

Conditions of Use

Roads or parking areas shall be stabilized wherever they are constructed, whether permanent or temporary, for use by construction traffic.

- High Visibility Fencing (see BMP C103) shall be installed, if necessary, to limit the access of vehicles to only those roads and parking areas that are stabilized.

Design and Installation Specifications

- On areas that will receive asphalt as part of the project, install the first lift as soon as possible.
- A 6-inch depth of 2- to 4-inch crushed rock, gravel base, or crushed surfacing base course shall be applied immediately after grading or utility installation. A 4-inch course of asphalt treated base (ATB) may also be used, or the road/parking area may be paved. It may also be possible to use cement or calcium chloride for soil stabilization. If cement or cement kiln dust is used for roadbase stabilization, pH monitoring and BMPs (BMPs C252 and C253) are necessary to evaluate and minimize the effects on stormwater. If the area will not be used for permanent roads, parking areas, or structures, a 6-inch depth of hog fuel may also be used, but this is likely to require more maintenance. Whenever possible, construction roads and parking areas shall be placed on a firm, compacted subgrade.
- Temporary road gradients shall not exceed 15 percent. Roadways shall be carefully graded to drain. Drainage ditches shall be provided on each side of the roadway in the case of a crowned section, or on one side in the case of a super-elevated section. Drainage ditches shall be directed to a sediment control BMP.
- Rather than relying on ditches, it may also be possible to grade the road so that runoff sheet-flows into a heavily vegetated area with a well-developed topsoil. Landscaped areas are not adequate. If this area has at least 50 feet of vegetation that water can flow through, then it is generally preferable to use the vegetation to treat runoff, rather than a sediment pond or trap. The 50 feet shall not include wetlands or their buffers. If runoff is allowed to sheetflow through adjacent vegetated areas, it is vital to design the roadways and parking areas so that no concentrated runoff is created.
- Storm drain inlets shall be protected to prevent sediment-laden water entering the storm drain system (see BMP C220).

Maintenance Standards

Inspect stabilized areas regularly, especially after large storm events.

Crushed rock, gravel base, etc. shall be added as required to maintain a

BMP C120: Temporary and Permanent Seeding

Purpose

Seeding reduces erosion by stabilizing exposed soils. A well-established vegetative cover is one of the most effective methods of reducing erosion.

Conditions of Use

Use seeding throughout the project on disturbed areas that have reached final grade or that will remain unworked for more than 30 days.

The optimum seeding windows for western Washington are April 1 through June 30 and September 1 through October 1.

Between July 1 and August 30 seeding requires irrigation until 75 percent grass cover is established.

Between October 1 and March 30 seeding requires a cover of mulch with straw or an erosion control blanket until 75 percent grass cover is established.

Review all disturbed areas in late August to early September and complete all seeding by the end of September. Otherwise, vegetation will not establish itself enough to provide more than average protection.

- Mulch is required at all times for seeding because it protects seeds from heat, moisture loss, and transport due to runoff. Mulch can be applied on top of the seed or simultaneously by hydroseeding. See BMP C121: Mulching for specifications.
- Seed and mulch, all disturbed areas not otherwise vegetated at final site stabilization. Final stabilization means the completion of all soil disturbing activities at the site and the establishment of a permanent vegetative cover, or equivalent permanent stabilization measures (such as pavement, riprap, gabions or geotextiles) which will prevent erosion.

Design and Installation Specifications

Seed retention/detention ponds as required.

Install channels intended for vegetation before starting major earthwork and hydroseed with a Bonded Fiber Matrix. For vegetated channels that will have high flows, install erosion control blankets over hydroseed. Before allowing water to flow in vegetated channels, establish 75 percent vegetation cover. If vegetated channels cannot be established by seed before water flow; install sod in the channel bottom—over hydromulch and erosion control blankets.

- Confirm the installation of all required surface water control measures to prevent seed from washing away.
- Hydroseed applications shall include a minimum of 1,500 pounds per acre of mulch with 3 percent tackifier. See BMP C121: Mulching for specifications.
- Areas that will have seeding only and not landscaping may need compost or meal-based mulch included in the hydroseed in order to establish vegetation. Re-install native topsoil on the disturbed soil surface before application.
- When installing seed via hydroseeding operations, only about 1/3 of the seed actually ends up in contact with the soil surface. This reduces the ability to establish a good stand of grass quickly. To overcome this, consider increasing seed quantities by up to 50 percent.
- Enhance vegetation establishment by dividing the hydromulch operation into two phases:

  1. Phase 1- Install all seed and fertilizer with 25-30 percent mulch and tackifier onto soil in the first lift.
  2. Phase 2- Install the rest of the mulch and tackifier over the first lift.

  Or, enhance vegetation by:

  1. Installing the mulch, seed, fertilizer, and tackifier in one lift.
  2. Spread or blow straw over the top of the hydromulch at a rate of 800-1000 pounds per acre.
  3. Hold straw in place with a standard tackifier.

  Both of these approaches will increase cost moderately but will greatly improve and enhance vegetative establishment. The increased cost may be offset by the reduced need for:

  - Irrigation.
  - Reapplication of mulch.
  - Repair of failed slope surfaces.

  This technique works with standard hydromulch (1,500 pounds per acre minimum) and BFM/MBFMs (3,000 pounds per acre minimum).
- Seed may be installed by hand if:
  - Temporary and covered by straw, mulch, or topsoil.
  - Permanent in small areas (usually less than 1 acre) and covered with mulch, topsoil, or erosion blankets.
- The seed mixes listed in the tables below include recommended mixes for both temporary and permanent seeding.

- Apply these mixes, with the exception of the wetland mix, at a rate of 120 pounds per acre. This rate can be reduced if soil amendments or slow-release fertilizers are used.
- Consult the local suppliers or the local conservation district for their recommendations because the appropriate mix depends on a variety of factors, including location, exposure, soil type, slope, and expected foot traffic. Alternative seed mixes approved by the local authority may be used.
- Other mixes may be appropriate, depending on the soil type and hydrology of the area.

- Table 4.1.2 lists the standard mix for areas requiring a temporary vegetative cover.

Table 4.1.2
Temporary Erosion Control Seed Mix

	% Weight	% Purity	% Germination
Chewings or annual blue grass *Festuca rubra var. commutata* or *Poa anna*	40	98	90
Perennial rye - *Lolium perenne*	50	98	90
Redtop or colonial bentgrass *Agrostis alba* or *Agrostis tenuis*	5	92	85
White dutch clover *Trifolium repens*	5	98	90

- Table 4.1.3 lists a recommended mix for landscaping seed.

Table 4.1.3
Landscaping Seed Mix

	% Weight	% Purity	% Germination
Perennial rye blend *Lolium perenne*	70	98	90
Chewings and red fescue blend *Festuca rubra var. commutata* or *Festuca rubra*	30	98	90

- Table 4.1.4 lists a turf seed mix for dry situations where there is no need for watering. This mix requires very little maintenance.

Table 4.1.4
Low-Growing Turf Seed Mix

	% Weight	% Purity	% Germination
Dwarf tall fescue (several varieties) *Festuca arundinacea var.*	45	98	90
Dwarf perennial rye (Barclay) *Lolium perenne var. barclay*	30	98	90
Red fescue *Festuca rubra*	20	98	90
Colonial bentgrass *Agrostis tenuis*	5	98	90

- Table 4.1.5 lists a mix for bioswales and other intermittently wet areas.

Table 4.1.5
Bioswale Seed Mix*

	% Weight	% Purity	% Germination
Tall or meadow fescue *Festuca arundinacea* or *Festuca elatior*	75-80	98	90
Seaside/Creeping bentgrass *Agrostis palustris*	10-15	92	85
Redtop bentgrass *Agrostis alba* or *Agrostis gigantea*	5-10	90	80

* *Modified Briargreen, Inc. Hydroseeding Guide Wetlands Seed Mix*

- Table 4.1.6 lists a low-growing, relatively non-invasive seed mix appropriate for very wet areas that are not regulated wetlands. Apply this mixture at a rate of 60 pounds per acre. Consult Hydraulic Permit Authority (HPA) for seed mixes if applicable.

Table 4.1.6
Wet Area Seed Mix*

	% Weight	% Purity	% Germination
Tall or meadow fescue *Festuca arundinacea* or *Festuca elatior*	60-70	98	90
Seaside/Creeping bentgrass *Agrostis palustris*	10-15	98	85
Meadow foxtail *Alepocurus pratensis*	10-15	90	80
Alsike clover *Trifolium hybridum*	1-6	98	90
Redtop bentgrass *Agrostis alba*	1-6	92	85

** Modified Briargreen, Inc. Hydroseeding Guide Wetlands Seed Mix*

- Table 4.1.7 lists a recommended meadow seed mix for infrequently maintained areas or non-maintained areas where colonization by native plants is desirable. Likely applications include rural road and utility right-of-way. Seeding should take place in September or very early October in order to obtain adequate establishment prior to the winter months. Consider the appropriateness of clover, a fairly invasive species, in the mix. Amending the soil can reduce the need for clover.

Table 4.1.7
Meadow Seed Mix

	% Weight	% Purity	% Germination
Redtop or Oregon bentgrass *Agrostis alba* or *Agrostis oregonensis*	20	92	85
Red fescue *Festuca rubra*	70	98	90
White dutch clover *Trifolium repens*	10	98	90

- **Roughening and Rototilling:**
  - The seedbed should be firm and rough. Roughen all soil no matter what the slope. Track walk slopes before seeding if engineering purposes require compaction. Backblading or smoothing of slopes greater than 4H:1V is not allowed if they are to be seeded.
  - Restoration-based landscape practices require deeper incorporation than that provided by a simple single-pass rototilling treatment. Wherever practical, initially rip the subgrade to improve long-term permeability, infiltration, and water inflow qualities. At a minimum, permanent areas shall use soil amendments to achieve organic matter and permeability performance defined in engineered soil/landscape systems. For systems that are deeper than 8 inches complete the rototilling process in multiple lifts, or prepare the engineered soil system per specifications and place to achieve the specified depth.
- **Fertilizers:**
  - Conducting soil tests to determine the exact type and quantity of fertilizer is recommended. This will prevent the over-application of fertilizer.
  - Organic matter is the most appropriate form of fertilizer because it provides nutrients (including nitrogen, phosphorus, and potassium) in the least water-soluble form.
  - In general, use 10-4-6 N-P-K (nitrogen-phosphorus-potassium) fertilizer at a rate of 90 pounds per acre. Always use slow-release fertilizers because they are more efficient and have fewer environmental impacts. Do not add fertilizer to the hydromulch machine, or agitate, more than 20 minutes before use. Too much agitation destroys the slow-release coating.
  - There are numerous products available that take the place of chemical fertilizers. These include several with seaweed extracts that are beneficial to soil microbes and organisms. If 100 percent cottonseed meal is used as the mulch in hydroseed, chemical fertilizer may not be necessary. Cottonseed meal provides a good source of long-term, slow-release, available nitrogen.
- **Bonded Fiber Matrix and Mechanically Bonded Fiber Matrix:**
  - On steep slopes use Bonded Fiber Matrix (BFM) or Mechanically Bonded Fiber Matrix (MBFM) products. Apply BFM/MBFM products at a minimum rate of 3,000 pounds per acre of mulch with approximately 10 percent tackifier. Achieve a minimum of 95 percent soil coverage during application. Numerous products are available commercially. Installed products per manufacturer’s instructions. Most products require 24-36 hours to cure before rainfall and cannot be installed on wet or saturated soils.

Generally, products come in 40-50 pound bags and include all necessary ingredients except for seed and fertilizer.

- BFMs and MBFMs provide good alternatives to blankets in most areas requiring vegetation establishment. Advantages over blankets include:
  - BFM and MBFMs do not require surface preparation.
  - Helicopters can assist in installing BFM and MBFMs in remote areas.
  - On slopes steeper than 2.5H:1V, blanket installers may require ropes and harnesses for safety.
  - Installing BFM and MBFMs can save at least $1,000 per acre compared to blankets.

Maintenance Standards

Reseed any seeded areas that fail to establish at least 80 percent cover (100 percent cover for areas that receive sheet or concentrated flows). If reseeding is ineffective, use an alternate method such as sodding, mulching, or nets/blankets. If winter weather prevents adequate grass growth, this time limit may be relaxed at the discretion of the local authority when sensitive areas would otherwise be protected.

- Reseed and protect by mulch any areas that experience erosion after achieving adequate cover. Reseed and protect by mulch any eroded area.
- Supply seeded areas with adequate moisture, but do not water to the extent that it causes runoff.

Approved as Equivalent

Ecology has approved products as able to meet the requirements of BMP C120. The products did not pass through the Technology Assessment Protocol – Ecology (TAPE) process. Local jurisdictions may choose not to accept this product approved as equivalent, or may require additional testing prior to consideration for local use. The products are available for review on Ecology's website at http://www.ecy.wa.gov/programs/wq/stormwater/newtech/equivalent.html

BMP C121: Mulching

Purpose

Mulching soils provides immediate temporary protection from erosion. Mulch also enhances plant establishment by conserving moisture, holding fertilizer, seed, and topsoil in place, and moderating soil temperatures. There is an enormous variety of mulches that can be used. This section discusses only the most common types of mulch.

Conditions of Use

As a temporary cover measure, mulch should be used:

- For less than 30 days on disturbed areas that require cover.
- At all times for seeded areas, especially during the wet season and during the hot summer months.
- During the wet season on slopes steeper than 3H:1V with more than 10 feet of vertical relief.

Mulch may be applied at any time of the year and must be refreshed periodically.

- For seeded areas mulch may be made up of 100 percent: cottonseed meal; fibers made of wood, recycled cellulose, hemp, kenaf; compost; or blends of these. Tackifier shall be plant-based, such as guar or alpha plantago, or chemical-based such as polyacrylamide or polymers. Any mulch or tackifier product used shall be installed per manufacturer's instructions. Generally, mulches come in 40-50 pound bags. Seed and fertilizer are added at time of application.

Design and Installation Specifications

For mulch materials, application rates, and specifications, see Table 4.1.8. Always use a 2-inch minimum mulch thickness; increase the thickness until the ground is 95% covered (i.e. not visible under the mulch layer). Note: Thickness may be increased for disturbed areas in or near sensitive areas or other areas highly susceptible to erosion.

Mulch used within the ordinary high-water mark of surface waters should be selected to minimize potential flotation of organic matter. Composted organic materials have higher specific gravities (densities) than straw, wood, or chipped material. Consult Hydraulic Permit Authority (HPA) for mulch mixes if applicable.

Maintenance Standards

- The thickness of the cover must be maintained.
- Any areas that experience erosion shall be remulched and/or protected with a net or blanket. If the erosion problem is drainage related, then the problem shall be fixed and the eroded area remulched.

BMP C123: Plastic Covering

Purpose

Plastic covering provides immediate, short-term erosion protection to slopes and disturbed areas.

Conditions of Use

Plastic covering may be used on disturbed areas that require cover measures for less than 30 days, except as stated below.

- Plastic is particularly useful for protecting cut and fill slopes and stockpiles. Note: The relatively rapid breakdown of most polyethylene sheeting makes it unsuitable for long-term (greater than six months) applications.
- Due to rapid runoff caused by plastic covering, do not use this method upslope of areas that might be adversely impacted by concentrated runoff. Such areas include steep and/or unstable slopes.
- Plastic sheeting may result in increased runoff volumes and velocities, requiring additional on-site measures to counteract the increases. Creating a trough with wattles or other material can convey clean water away from these areas.
- To prevent undercutting, trench and backfill rolled plastic covering products.
- While plastic is inexpensive to purchase, the added cost of installation, maintenance, removal, and disposal make this an expensive material, up to $1.50-2.00 per square yard.
- Whenever plastic is used to protect slopes install water collection measures at the base of the slope. These measures include plastic-covered berms, channels, and pipes used to covey clean rainwater away from bare soil and disturbed areas. Do not mix clean runoff from a plastic covered slope with dirty runoff from a project.
- Other uses for plastic include:
  1. Temporary ditch liner.
  2. Pond liner in temporary sediment pond.
  3. Liner for bermed temporary fuel storage area if plastic is not reactive to the type of fuel being stored.
  4. Emergency slope protection during heavy rains.
  5. Temporary drainpipe (“elephant trunk”) used to direct water.

Design and Installation Specifications

- Plastic slope cover must be installed as follows:
  1. Run plastic up and down slope, not across slope.
  2. Plastic may be installed perpendicular to a slope if the slope length is less than 10 feet.
  3. Minimum of 8-inch overlap at seams.

4. On long or wide slopes, or slopes subject to wind, tape all seams.
5. Place plastic into a small (12-inch wide by 6-inch deep) slot trench at the top of the slope and backfill with soil to keep water from flowing underneath.
6. Place sand filled burlap or geotextile bags every 3 to 6 feet along seams and tie them together with twine to hold them in place.
7. Inspect plastic for rips, tears, and open seams regularly and repair immediately. This prevents high velocity runoff from contacting bare soil which causes extreme erosion.
8. Sandbags may be lowered into place tied to ropes. However, all sandbags must be staked in place.

- Plastic sheeting shall have a minimum thickness of 0.06 millimeters.
- If erosion at the toe of a slope is likely, a gravel berm, riprap, or other suitable protection shall be installed at the toe of the slope in order to reduce the velocity of runoff.

Maintenance Standards

- Torn sheets must be replaced and open seams repaired.
- Completely remove and replace the plastic if it begins to deteriorate due to ultraviolet radiation.
- Completely remove plastic when no longer needed.
- Dispose of old tires used to weight down plastic sheeting appropriately.

Approved as Equivalent

Ecology has approved products as able to meet the requirements of BMP C123. The products did not pass through the Technology Assessment Protocol – Ecology (TAPE) process. Local jurisdictions may choose not to accept this product approved as equivalent, or may require additional testing prior to consideration for local use. The products are available for review on Ecology’s website at http://www.ecy.wa.gov/programs/wq/stormwater/newtech/equivalent.html

BMP C124: Sodding

Purpose

The purpose of sodding is to establish permanent turf for immediate erosion protection and to stabilize drainage ways where concentrated overland flow will occur.

Conditions of Use

Sodding may be used in the following areas:

- Disturbed areas that require short-term or long-term cover.
- Disturbed areas that require immediate vegetative cover.
- All waterways that require vegetative lining. Waterways may also be seeded rather than sodded, and protected with a net or blanket.

Design and Installation Specifications

Sod shall be free of weeds, of uniform thickness (approximately 1-inch thick), and shall have a dense root mat for mechanical strength.

The following steps are recommended for sod installation:

- Shape and smooth the surface to final grade in accordance with the approved grading plan. The swale needs to be overexcavated 4 to 6 inches below design elevation to allow room for placing soil amendment and sod.
- Amend 4 inches (minimum) of compost into the top 8 inches of the soil if the organic content of the soil is less than ten percent or the permeability is less than 0.6 inches per hour. See http://www.ecy.wa.gov/programs/swfa/organics/soil.html for further information.
- Fertilize according to the supplier's recommendations.
- Work lime and fertilizer 1 to 2 inches into the soil, and smooth the surface.
- Lay strips of sod beginning at the lowest area to be sodded and perpendicular to the direction of water flow. Wedge strips securely into place. Square the ends of each strip to provide for a close, tight fit. Stagger joints at least 12 inches. Staple on slopes steeper than 3H:1V. Staple the upstream edge of each sod strip.
- Roll the sodded area and irrigate.
- When sodding is carried out in alternating strips or other patterns, seed the areas between the sod immediately after sodding.

Maintenance Standards

If the grass is unhealthy, the cause shall be determined and appropriate action taken to reestablish a healthy groundcover. If it is impossible to establish a healthy groundcover due to frequent saturation, instability, or some other cause, the sod shall be removed, the area seeded with an appropriate mix, and protected with a net or blanket.

BMP C125: Topsoiling / Composting

Purpose

Topsoiling and composting provide a suitable growth medium for final site stabilization with vegetation. While not a permanent cover practice in itself, topsoiling and composting are an integral component of providing permanent cover in those areas where there is an unsuitable soil surface for plant growth. Use this BMP in conjunction with other BMPs such as seeding, mulching, or sodding.

Native soils and disturbed soils that have been organically amended not only retain much more stormwater, but they also serve as effective biofilters for urban pollutants and, by supporting more vigorous plant growth, reduce the water, fertilizer and pesticides needed to support installed landscapes. Topsoil does not include any subsoils but only the material from the top several inches including organic debris.

Conditions of Use

- Permanent landscaped areas shall contain healthy topsoil that reduces the need for fertilizers, improves overall topsoil quality, provides for better vegetal health and vitality, improves hydrologic characteristics, and reduces the need for irrigation.
- Leave native soils and the duff layer undisturbed to the maximum extent practicable. Stripping of existing, properly functioning soil system and vegetation for the purpose of topsoiling during construction is not acceptable. Preserve existing soil systems in undisturbed and uncompacted conditions if functioning properly.
- Areas that already have good topsoil, such as undisturbed areas, do not require soil amendments.
- Restore, to the maximum extent practical, native soils disturbed during clearing and grading to a condition equal to or better than the original site condition’s moisture-holding capacity. Use on-site native topsoil, incorporate amendments into on-site soil, or import blended topsoil to meet this requirement.
- Topsoiling is a required procedure when establishing vegetation on shallow soils, and soils of critically low pH (high acid) levels.
- Beware of where the topsoil comes from, and what vegetation was on site before disturbance, invasive plant seeds may be included and could cause problems for establishing native plants, landscaped areas, or grasses.
- Topsoil from the site will contain mycorrhizal bacteria that are necessary for healthy root growth and nutrient transfer. These native mycorrhiza are acclimated to the site and will provide optimum conditions for establishing grasses. Use commercially available mycorrhiza products when using off-site topsoil.

Design and Installation Specifications

Meet the following requirements for areas requiring disruption and topsoiling:

- Maximize the depth of the topsoil wherever possible to provide the maximum possible infiltration capacity and beneficial growth medium. Topsoil shall have:
  - A minimum depth of 8-inches. Scarify subsoils below the topsoil layer at least 4-inches with some incorporation of the upper material to avoid stratified layers, where feasible. Ripping or re-structuring the subgrade may also provide additional benefits regarding the overall infiltration and interflow dynamics of the soil system.

  - A minimum organic content of 10% dry weight, and 5% organic matter content in turf areas. Incorporate organic amendments to a minimum 8-inch depth except where tree roots or other natural features limit the depth of incorporation.
  - A pH between 6.0 and 8.0 or matching the pH of the undisturbed soil.
  - If blended topsoil is imported, then fines should be limited to 25 percent passing through a 200 sieve.
- Accomplish the required organic content and pH by either returning native topsoil to the site and/or incorporating organic amendments.
  - To meet the organic content use compost that meets the definition of "composted materials" in [WAC 173-350-220](http://apps.leg.wa.gov/WAC/default.aspx?cite=173-350-220). This code is available online at: http://apps.leg.wa.gov/WAC/default.aspx?cite=173-350-220.

    The compost must also have an organic matter content of 35% to 65%, and a carbon to nitrogen ratio below 25H:1V.

    The carbon to nitrogen ratio may be as high as 35H:1V for plantings composed entirely of plants native to the Puget Sound Lowlands region.
  - For till soils use a mixture of approximately two parts soil to one part compost. This equates to 4 inches of compost mixed to a depth of 12 inches in till soils. Increasing the concentration of compost beyond this level can have negative effects on vegetal health, while decreasing the concentrations can reduce the benefits of amended soils.
  - Gravel or cobble outwash soils, may require different approaches. Organics and fines easily migrate through the loose structure of these soils. Therefore, the importation of at least 6 inches of quality topsoil, underlain by some type of filter fabric to prevent the migration of fines, may be more appropriate for these soils.
- The final composition and construction of the soil system will result in a natural selection or favoring of certain plant species over time. For example, incorporation of topsoil may favor grasses, while layering with mildly acidic, high-carbon amendments may favor more woody vegetation.
- Allow sufficient time in scheduling for topsoil spreading prior to seeding, sodding, or planting.
- Take care when applying top soil to subsoils with contrasting textures. Sandy topsoil over clayey subsoil is a particularly poor combination, as water creeps along the junction between the soil layers and causes the topsoil to slough. If topsoil and subsoil are not properly bonded, water will not infiltrate the soil profile evenly and it will be difficult to

establish vegetation. The best method to prevent a lack of bonding is to actually work the topsoil into the layer below for a depth of at least 6 inches.

- Field exploration of the site shall be made to determine if there is surface soil of sufficient quantity and quality to justify stripping. Topsoil shall be friable and loamy (loam, sandy loam, silt loam, sandy clay loam, and clay loam). Avoid areas of natural ground water recharge.
- Stripping shall be confined to the immediate construction area. A 4-inch to 6-inch stripping depth is common, but depth may vary depending on the particular soil. All surface runoff control structures shall be in place prior to stripping.
- Do not place topsoil while in a frozen or muddy condition, when the subgrade is excessively wet, or when conditions exist that may otherwise be detrimental to proper grading or proposed sodding or seeding.
- In any areas requiring grading remove and stockpile the duff layer and topsoil on site in a designated, controlled area, not adjacent to public resources and critical areas. Stockpiled topsoil is to be reapplied to other portions of the site where feasible.
- Locate the topsoil stockpile so that it meets specifications and does not interfere with work on the site. It may be possible to locate more than one pile in proximity to areas where topsoil will be used.

Stockpiling of topsoil shall occur in the following manner:

  - Side slopes of the stockpile shall not exceed 2H:1V.
  - Between October 1 and April 30:
    - An interceptor dike with gravel outlet and silt fence shall surround all topsoil.
    - Within 2 days complete erosion control seeding, or covering stockpiles with clear plastic, or other mulching materials.
  - Between May 1 and September 30:
    - An interceptor dike with gravel outlet and silt fence shall surround all topsoil if the stockpile will remain in place for a longer period of time than active construction grading.
    - Within 7 days complete erosion control seeding, or covering stockpiles with clear plastic, or other mulching materials.

- When native topsoil is to be stockpiled and reused the following should apply to ensure that the mycorrhizal bacterial, earthworms, and other beneficial organisms will not be destroyed:
  1. Re-install topsoil within 4 to 6 weeks.

2. Do not allow the saturation of topsoil with water.
3. Do not use plastic covering.

Maintenance Standards

- Inspect stockpiles regularly, especially after large storm events. Stabilize any areas that have eroded.
- Establish soil quality and depth toward the end of construction and once established, protect from compaction, such as from large machinery use, and from erosion.
- Plant and mulch soil after installation.
- Leave plant debris or its equivalent on the soil surface to replenish organic matter.
- Reduce and adjust, where possible, the use of irrigation, fertilizers, herbicides and pesticides, rather than continuing to implement formerly established practices.

BMP C126: Polyacrylamide (PAM) for Soil Erosion Protection

Purpose

Polyacrylamide (PAM) is used on construction sites to prevent soil erosion.

Applying PAM to bare soil in advance of a rain event significantly reduces erosion and controls sediment in two ways. First, PAM increases the soil's available pore volume, thus increasing infiltration through flocculation and reducing the quantity of stormwater runoff. Second, it increases flocculation of suspended particles and aids in their deposition, thus reducing stormwater runoff turbidity and improving water quality.

Conditions of Use

PAM shall not be directly applied to water or allowed to enter a water body.

In areas that drain to a sediment pond, PAM can be applied to bare soil under the following conditions:

- During rough grading operations.
- In Staging areas.
- Balanced cut and fill earthwork.
- Haul roads prior to placement of crushed rock surfacing.
- Compacted soil roadbase.
- Stockpiles.
- After final grade and before paving or final seeding and planting.
- Pit sites.

- Sites having a winter shut down. In the case of winter shut down, or where soil will remain unworked for several months, PAM should be used together with mulch.

Design and Installation Specifications

PAM may be applied with water in dissolved form. The preferred application method is the dissolved form.

PAM is to be applied at a maximum rate of 2/3 pound PAM per 1,000 gallons water (80 mg/L) per 1 acre of bare soil. Table 4.1.9 can be used to determine the PAM and water application rate for a disturbed soil area. Higher concentrations of PAM **do not** provide any additional effectiveness.

Table 4.1.9
PAM and Water Application Rates

Disturbed Area (ac)	PAM (lbs)	Water (gal)
0.50	0.33	500
1.00	0.66	1,000
1.50	1.00	1,500
2.00	1.32	2,000
2.50	1.65	2,500
3.00	2.00	3,000
3.50	2.33	3,500
4.00	2.65	4,000
4.50	3.00	4,500
5.00	3.33	5,000

The Preferred Method:

- Pre-measure the area where PAM is to be applied and calculate the amount of product and water necessary to provide coverage at the specified application rate (2/3 pound PAM/1000 gallons/acre).
- PAM has infinite solubility in water, but dissolves very slowly. Dissolve pre-measured dry granular PAM with a known quantity of clean water in a bucket several hours or overnight. Mechanical mixing will help dissolve the PAM. Always add PAM to water - not water to PAM.
- Pre-fill the water truck about 1/8 full with water. The water does not have to be potable, but it must have relatively low turbidity – in the range of 20 NTU or less.
- Add PAM /Water mixture to the truck
- Completely fill the water truck to specified volume.
- Spray PAM/Water mixture onto dry soil until the soil surface is uniformly and completely wetted.

An Alternate Method:

PAM may also be applied as a powder at the rate of 5 lbs. per acre. This must be applied on a day that is dry. For areas less than 5-10 acres, a hand-held “organ grinder” fertilizer spreader set to the smallest setting will work. Tractor-mounted spreaders will work for larger areas.

The following shall be used for application of powdered PAM:

- Powered PAM shall be used in conjunction with other BMPs and not in place of other BMPs.
- Do not use PAM on a slope that flows directly into a stream or wetland. The stormwater runoff shall pass through a sediment control BMP prior to discharging to surface waters.
- Do not add PAM to water discharging from site.
- When the total drainage area is greater than or equal to 5 acres, PAM treated areas shall drain to a sediment pond.
- Areas less than 5 acres shall drain to sediment control BMPs, such as a minimum of 3 check dams per acre. The total number of check dams used shall be maximized to achieve the greatest amount of settlement of sediment prior to discharging from the site. Each check dam shall be spaced evenly in the drainage channel through which stormwater flows are discharged off-site.
- On all sites, the use of silt fence shall be maximized to limit the discharges of sediment from the site.
- All areas not being actively worked shall be covered and protected from rainfall. PAM shall not be the only cover BMP used.
- PAM can be applied to wet soil, but dry soil is preferred due to less sediment loss.
- PAM will work when applied to saturated soil but is not as effective as applications to dry or damp soil.
- Keep the granular PAM supply out of the sun. Granular PAM loses its effectiveness in three months after exposure to sunlight and air.
- Proper application and re-application plans are necessary to ensure total effectiveness of PAM usage.
- PAM, combined with water, is very slippery and can be a safety hazard. Care must be taken to prevent spills of PAM powder onto paved surfaces. During an application of PAM, prevent over-spray from reaching pavement as pavement will become slippery. If PAM powder gets on skin or clothing, wipe it off with a rough towel rather than washing with water-this only makes cleanup messier and take longer.
- Some PAMs are more toxic and carcinogenic than others. Only the most environmentally safe PAM products should be used.

The specific PAM copolymer formulation must be anionic. **Cationic PAM shall not be used in any application because of known aquatic toxicity problems.** Only the highest drinking water grade PAM, certified for compliance with ANSI/NSF Standard 60 for drinking water treatment, will be used for soil applications. Recent media attention and high interest in PAM has resulted in some entrepreneurial exploitation of the term "polymer." All PAM are polymers, but not all polymers are PAM, and not all PAM products comply with ANSI/NSF Standard 60. PAM use shall be reviewed and approved by the local permitting authority.

  - PAM designated for these uses should be "water soluble" or "linear" or "non-crosslinked". Cross-linked or water absorbent PAM, polymerized in highly acidic (pH<2) conditions, are used to maintain soil moisture content.
  - The PAM anionic charge density may vary from 2-30 percent; a value of 18 percent is typical. Studies conducted by the United States Department of Agriculture (USDA)/ARS demonstrated that soil stabilization was optimized by using very high molecular weight (12-15 mg/mole), highly anionic (>20% hydrolysis) PAM.

- PAM tackifiers are available and being used in place of guar and alpha plantago. Typically, PAM tackifiers should be used at a rate of no more than 0.5-1 lb. per 1000 gallons of water in a hydromulch machine. Some tackifier product instructions say to use at a rate of 3 –5 lbs. per acre, which can be too much. In addition, pump problems can occur at higher rates due to increased viscosity.

Maintenance Standards

- PAM may be reapplied on actively worked areas after a 48-hour period.
- Reapplication is not required unless PAM treated soil is disturbed or unless turbidity levels show the need for an additional application. If PAM treated soil is left undisturbed a reapplication may be necessary after two months. More PAM applications may be required for steep slopes, silty and clayey soils (USDA Classification Type "C" and "D" soils), long grades, and high precipitation areas. When PAM is applied first to bare soil and then covered with straw, a reapplication may not be necessary for several months.
- Loss of sediment and PAM may be a basis for penalties per RCW 90.48.080.

BMP C130: Surface Roughening

Purpose

Surface roughening aids in the establishment of vegetative cover, reduces runoff velocity, increases infiltration, and provides for sediment trapping through the provision of a rough soil surface. Horizontal depressions are created by operating a tiller or other suitable equipment on the contour or by leaving slopes in a roughened condition by not fine grading them.

Use this BMP in conjunction with other BMPs such as seeding, mulching, or sodding.

Conditions for Use

- All slopes steeper than 3H:1V and greater than 5 vertical feet require surface roughening to a depth of 2 to 4 inches prior to seeding..
- Areas that will not be stabilized immediately may be roughened to reduce runoff velocity until seeding takes place.
- Slopes with a stable rock face do not require roughening.
- Slopes where mowing is planned should not be excessively roughened.

Design and Installation Specifications

There are different methods for achieving a roughened soil surface on a slope, and the selection of an appropriate method depends upon the type of slope. Roughening methods include stair-step grading, grooving, contour furrows, and tracking. See Figure 4.1.5 for tracking and contour furrows. Factors to be considered in choosing a method are slope steepness, mowing requirements, and whether the slope is formed by cutting or filling.

- Disturbed areas that will not require mowing may be stair-step graded, grooved, or left rough after filling.
- Stair-step grading is particularly appropriate in soils containing large amounts of soft rock. Each "step" catches material that sloughs from above, and provides a level site where vegetation can become established. Stairs should be wide enough to work with standard earth moving equipment. Stair steps must be on contour or gullies will form on the slope.
- Areas that will be mowed (these areas should have slopes less steep than 3H:1V) may have small furrows left by disking, harrowing, raking, or seed-planting machinery operated on the contour.
- Graded areas with slopes steeper than 3H:1V but less than 2H:1V should be roughened before seeding. This can be accomplished in a variety of ways, including "track walking," or driving a crawler tractor up and down the slope, leaving a pattern of cleat imprints parallel to slope contours.
- Tracking is done by operating equipment up and down the slope to leave horizontal depressions in the soil.

Maintenance Standards

- Areas that are graded in this manner should be seeded as quickly as possible.
- Regular inspections should be made of the area. If rills appear, they should be re-graded and re-seeded immediately.

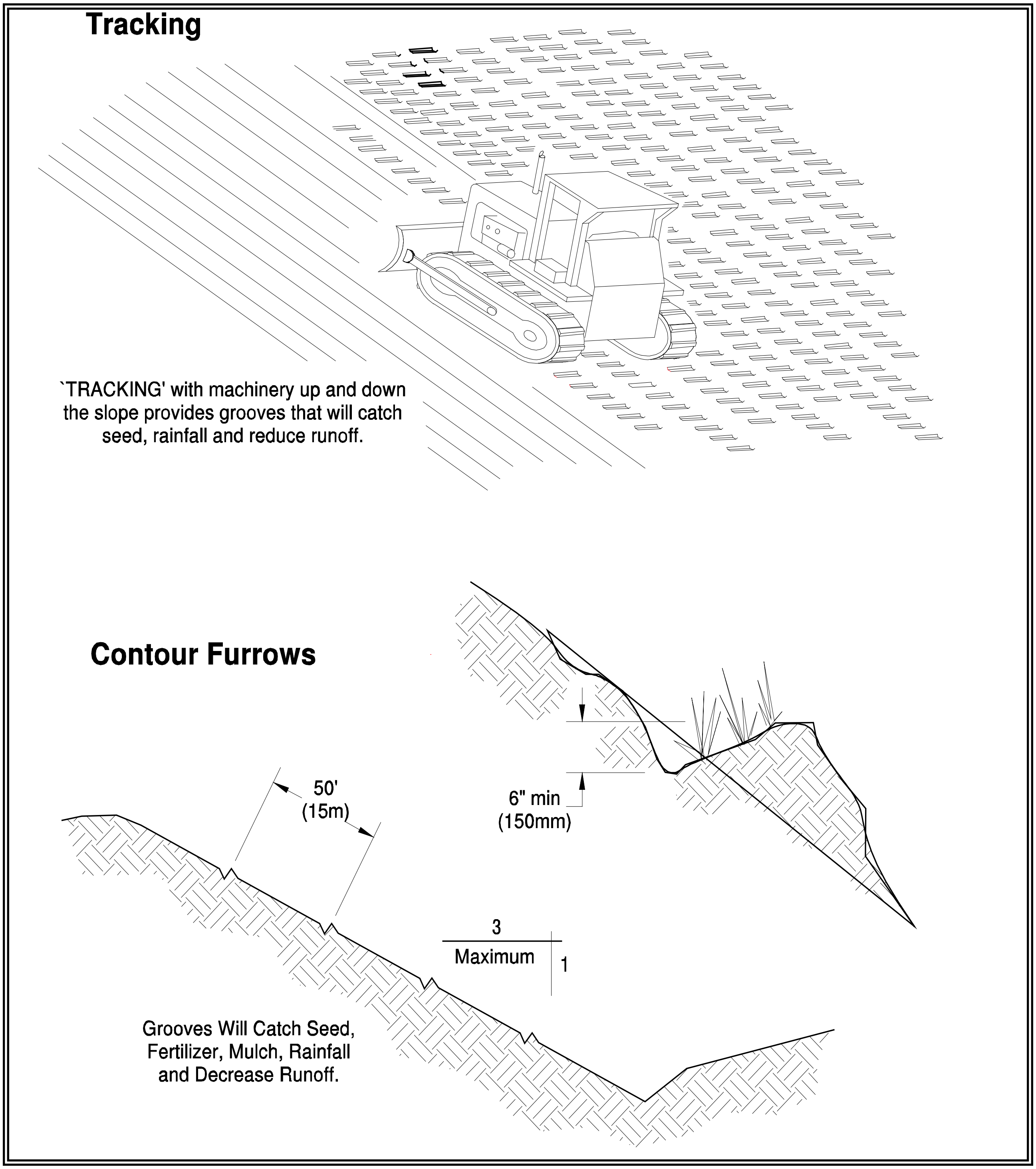


Figure 4.1.5 – Surface Roughening by Tracking and Contour Furrows

BMP C124: Sodding

Purpose

The purpose of sodding is to establish permanent turf for immediate erosion protection and to stabilize drainage ways where concentrated overland flow will occur.

Conditions of Use

Sodding may be used in the following areas:

- Disturbed areas that require short-term or long-term cover.
- Disturbed areas that require immediate vegetative cover.
- All waterways that require vegetative lining. Waterways may also be seeded rather than sodded, and protected with a net or blanket.

Design and Installation Specifications

Sod shall be free of weeds, of uniform thickness (approximately 1-inch thick), and shall have a dense root mat for mechanical strength.

The following steps are recommended for sod installation:

- Shape and smooth the surface to final grade in accordance with the approved grading plan. The swale needs to be overexcavated 4 to 6 inches below design elevation to allow room for placing soil amendment and sod.
- Amend 4 inches (minimum) of compost into the top 8 inches of the soil if the organic content of the soil is less than ten percent or the permeability is less than 0.6 inches per hour. See http://www.ecy.wa.gov/programs/swfa/organics/soil.html for further information.
- Fertilize according to the supplier's recommendations.
- Work lime and fertilizer 1 to 2 inches into the soil, and smooth the surface.
- Lay strips of sod beginning at the lowest area to be sodded and perpendicular to the direction of water flow. Wedge strips securely into place. Square the ends of each strip to provide for a close, tight fit. Stagger joints at least 12 inches. Staple on slopes steeper than 3H:1V. Staple the upstream edge of each sod strip.
- Roll the sodded area and irrigate.
- When sodding is carried out in alternating strips or other patterns, seed the areas between the sod immediately after sodding.

Maintenance Standards

If the grass is unhealthy, the cause shall be determined and appropriate action taken to reestablish a healthy groundcover. If it is impossible to establish a healthy groundcover due to frequent saturation, instability, or some other cause, the sod shall be removed, the area seeded with an appropriate mix, and protected with a net or blanket.

BMP C125: Topsoiling / Composting

Purpose

Topsoiling and composting provide a suitable growth medium for final site stabilization with vegetation. While not a permanent cover practice in itself, topsoiling and composting are an integral component of providing permanent cover in those areas where there is an unsuitable soil surface for plant growth. Use this BMP in conjunction with other BMPs such as seeding, mulching, or sodding.

Native soils and disturbed soils that have been organically amended not only retain much more stormwater, but they also serve as effective biofilters for urban pollutants and, by supporting more vigorous plant growth, reduce the water, fertilizer and pesticides needed to support installed landscapes. Topsoil does not include any subsoils but only the material from the top several inches including organic debris.

Conditions of Use

- Permanent landscaped areas shall contain healthy topsoil that reduces the need for fertilizers, improves overall topsoil quality, provides for better vegetal health and vitality, improves hydrologic characteristics, and reduces the need for irrigation.
- Leave native soils and the duff layer undisturbed to the maximum extent practicable. Stripping of existing, properly functioning soil system and vegetation for the purpose of topsoiling during construction is not acceptable. Preserve existing soil systems in undisturbed and uncompacted conditions if functioning properly.
- Areas that already have good topsoil, such as undisturbed areas, do not require soil amendments.
- Restore, to the maximum extent practical, native soils disturbed during clearing and grading to a condition equal to or better than the original site condition's moisture-holding capacity. Use on-site native topsoil, incorporate amendments into on-site soil, or import blended topsoil to meet this requirement.
- Topsoiling is a required procedure when establishing vegetation on shallow soils, and soils of critically low pH (high acid) levels.
- Beware of where the topsoil comes from, and what vegetation was on site before disturbance, invasive plant seeds may be included and could cause problems for establishing native plants, landscaped areas, or grasses.
- Topsoil from the site will contain mycorrhizal bacteria that are necessary for healthy root growth and nutrient transfer. These native mycorrhiza are acclimated to the site and will provide optimum conditions for establishing grasses. Use commercially available mycorrhiza products when using off-site topsoil.

Design and Installation Specifications

Meet the following requirements for areas requiring disruption and topsoiling:

- Maximize the depth of the topsoil wherever possible to provide the maximum possible infiltration capacity and beneficial growth medium. Topsoil shall have:
    - A minimum depth of 8-inches. Scarify subsoils below the topsoil layer at least 4-inches with some incorporation of the upper material to avoid stratified layers, where feasible. Ripping or re-structuring the subgrade may also provide additional benefits regarding the overall infiltration and interflow dynamics of the soil system.

- A minimum organic content of 10% dry weight, and 5% organic matter content in turf areas. Incorporate organic amendments to a minimum 8-inch depth except where tree roots or other natural features limit the depth of incorporation.
- A pH between 6.0 and 8.0 or matching the pH of the undisturbed soil.
- If blended topsoil is imported, then fines should be limited to 25 percent passing through a 200 sieve.

- Accomplish the required organic content and pH by either returning native topsoil to the site and/or incorporating organic amendments.
  - To meet the organic content use compost that meets the definition of "composted materials" in WAC 173-350-220. This code is available online at: http://apps.leg.wa.gov/WAC/default.aspx?cite=173-350-220.

    The compost must also have an organic matter content of 35% to 65%, and a carbon to nitrogen ratio below 25H:1V.

    The carbon to nitrogen ratio may be as high as 35H:1V for plantings composed entirely of plants native to the Puget Sound Lowlands region.
  - For till soils use a mixture of approximately two parts soil to one part compost. This equates to 4 inches of compost mixed to a depth of 12 inches in till soils. Increasing the concentration of compost beyond this level can have negative effects on vegetal health, while decreasing the concentrations can reduce the benefits of amended soils.
  - Gravel or cobble outwash soils, may require different approaches. Organics and fines easily migrate through the loose structure of these soils. Therefore, the importation of at least 6 inches of quality topsoil, underlain by some type of filter fabric to prevent the migration of fines, may be more appropriate for these soils.
- The final composition and construction of the soil system will result in a natural selection or favoring of certain plant species over time. For example, incorporation of topsoil may favor grasses, while layering with mildly acidic, high-carbon amendments may favor more woody vegetation.
- Allow sufficient time in scheduling for topsoil spreading prior to seeding, sodding, or planting.
- Take care when applying top soil to subsoils with contrasting textures. Sandy topsoil over clayey subsoil is a particularly poor combination, as water creeps along the junction between the soil layers and causes the topsoil to slough. If topsoil and subsoil are not properly bonded, water will not infiltrate the soil profile evenly and it will be difficult to

establish vegetation. The best method to prevent a lack of bonding is to actually work the topsoil into the layer below for a depth of at least 6 inches.

- Field exploration of the site shall be made to determine if there is surface soil of sufficient quantity and quality to justify stripping. Topsoil shall be friable and loamy (loam, sandy loam, silt loam, sandy clay loam, and clay loam). Avoid areas of natural ground water recharge.
- Stripping shall be confined to the immediate construction area. A 4-inch to 6-inch stripping depth is common, but depth may vary depending on the particular soil. All surface runoff control structures shall be in place prior to stripping.
- Do not place topsoil while in a frozen or muddy condition, when the subgrade is excessively wet, or when conditions exist that may otherwise be detrimental to proper grading or proposed sodding or seeding.
- In any areas requiring grading remove and stockpile the duff layer and topsoil on site in a designated, controlled area, not adjacent to public resources and critical areas. Stockpiled topsoil is to be reapplied to other portions of the site where feasible.
- Locate the topsoil stockpile so that it meets specifications and does not interfere with work on the site. It may be possible to locate more than one pile in proximity to areas where topsoil will be used.

Stockpiling of topsoil shall occur in the following manner:

- Side slopes of the stockpile shall not exceed 2H:1V.
- Between October 1 and April 30:
  - An interceptor dike with gravel outlet and silt fence shall surround all topsoil.
  - Within 2 days complete erosion control seeding, or covering stockpiles with clear plastic, or other mulching materials.
- Between May 1 and September 30:
  - An interceptor dike with gravel outlet and silt fence shall surround all topsoil if the stockpile will remain in place for a longer period of time than active construction grading.
  - Within 7 days complete erosion control seeding, or covering stockpiles with clear plastic, or other mulching materials.

- When native topsoil is to be stockpiled and reused the following should apply to ensure that the mycorrhizal bacterial, earthworms, and other beneficial organisms will not be destroyed:

  1. Re-install topsoil within 4 to 6 weeks.

2. Do not allow the saturation of topsoil with water.
3. Do not use plastic covering.

Maintenance Standards

- Inspect stockpiles regularly, especially after large storm events. Stabilize any areas that have eroded.
- Establish soil quality and depth toward the end of construction and once established, protect from compaction, such as from large machinery use, and from erosion.
- Plant and mulch soil after installation.
- Leave plant debris or its equivalent on the soil surface to replenish organic matter.
- Reduce and adjust, where possible, the use of irrigation, fertilizers, herbicides and pesticides, rather than continuing to implement formerly established practices.

stable driving surface and to stabilize any areas that have eroded.

Following construction, these areas shall be restored to pre-construction condition or better to prevent future erosion.

Perform street cleaning at the end of each day or more often if necessary.

BMP C150: Materials on Hand

Purpose Keep quantities of erosion prevention and sediment control materials on the project site at all times to be used for regular maintenance and emergency situations such as unexpected heavy summer rains. Having these materials on-site reduces the time needed to implement BMPs when inspections indicate that existing BMPs are not meeting the Construction SWPPP requirements. In addition, contractors can save money by buying some materials in bulk and storing them at their office or yard.

Conditions of Use

- Construction projects of any size or type can benefit from having materials on hand. A small commercial development project could have a roll of plastic and some gravel available for immediate protection of bare soil and temporary berm construction. A large earthwork project, such as highway construction, might have several tons of straw, several rolls of plastic, flexible pipe, sandbags, geotextile fabric and steel "T" posts.
- Materials are stockpiled and readily available before any site clearing, grubbing, or earthwork begins. A large contractor or developer could keep a stockpile of materials that are available for use on several projects.
- If storage space at the project site is at a premium, the contractor could maintain the materials at their office or yard. The office or yard must be less than an hour from the project site.

Design and Installation Specifications

Depending on project type, size, complexity, and length, materials and quantities will vary. A good minimum list of items that will cover numerous situations includes:

Material
Clear Plastic, 6 mil
Drainpipe, 6 or 8 inch diameter
Sandbags, filled
Straw Bales for mulching,
Quarry Spalls
Washed Gravel
Geotextile Fabric
Catch Basin Inserts
Steel “T” Posts
Silt fence material
Straw Wattles

Maintenance Standards

- All materials with the exception of the quarry spalls, steel “T” posts, and gravel should be kept covered and out of both sun and rain.
- Re-stock materials used as needed.

BMP C151: Concrete Handling

Purpose Concrete work can generate process water and slurry that contain fine particles and high pH, both of which can violate water quality standards in the receiving water. Concrete spillage or concrete discharge to surface waters of the State is prohibited. Use this BMP to minimize and eliminate concrete, concrete process water, and concrete slurry from entering waters of the state.

Conditions of Use Any time concrete is used, utilize these management practices. Concrete construction projects include, but are not limited to, the following:

- Curbs
- Sidewalks
- Roads
- Bridges
- Foundations
- Floors
- Runways

Design and Installation

- Wash out concrete truck chutes, pumps, and internals into formed areas only. Assure that washout of concrete trucks is performed off-

Specifications

site or in designated concrete washout areas. Do not wash out concrete trucks onto the ground, or into storm drains, open ditches, streets, or streams. Refer to BMP C154 for information on concrete washout areas.

- Return unused concrete remaining in the truck and pump to the originating batch plant for recycling. Do not dump excess concrete on site, except in designated concrete washout areas.
- Wash off hand tools including, but not limited to, screeds, shovels, rakes, floats, and trowels into formed areas only.
- Wash equipment difficult to move, such as concrete pavers in areas that do not directly drain to natural or constructed stormwater conveyances.
- Do not allow washdown from areas, such as concrete aggregate driveways, to drain directly to natural or constructed stormwater conveyances.
- Contain washwater and leftover product in a lined container when no formed areas are available,. Dispose of contained concrete in a manner that does not violate ground water or surface water quality standards.
- Always use forms or solid barriers for concrete pours, such as pilings, within 15-feet of surface waters.
- Refer to BMPs C252 and C253 for pH adjustment requirements.
- Refer to the Construction Stormwater General Permit for pH monitoring requirements if the project involves one of the following activities:
    - Significant concrete work (greater than 1,000 cubic yards poured concrete or recycled concrete used over the life of a project).
    - The use of engineered soils amended with (but not limited to) Portland cement-treated base, cement kiln dust or fly ash.
    - Discharging stormwater to segments of water bodies on the 303(d) list (Category 5) for high pH.

Maintenance Standards

Check containers for holes in the liner daily during concrete pours and repair the same day.

BMP C152: Sawcutting and Surfacing Pollution Prevention

Purpose

Sawcutting and surfacing operations generate slurry and process water that contains fine particles and high pH (concrete cutting), both of which can violate the water quality standards in the receiving water. Concrete spillage or concrete discharge to surface waters of the State is prohibited. Use this BMP to minimize and eliminate process water and slurry created through sawcutting or surfacing from entering waters of the State.

Conditions of Use

Utilize these management practices anytime sawcutting or surfacing operations take place. Sawcutting and surfacing operations include, but are not limited to, the following:

- Sawing
- Coring
- Grinding
- Roughening
- Hydro-demolition
- Bridge and road surfacing

Design and Installation Specifications

- Vacuum slurry and cuttings during cutting and surfacing operations.
- Slurry and cuttings shall not remain on permanent concrete or asphalt pavement overnight.
- Slurry and cuttings shall not drain to any natural or constructed drainage conveyance including stormwater systems. This may require temporarily blocking catch basins.
- Dispose of collected slurry and cuttings in a manner that does not violate ground water or surface water quality standards.
- Do not allow process water generated during hydro-demolition, surface roughening or similar operations to drain to any natural or constructed drainage conveyance including stormwater systems. Dispose process water in a manner that does not violate ground water or surface water quality standards.
- Handle and dispose cleaning waste material and demolition debris in a manner that does not cause contamination of water. Dispose of sweeping material from a pick-up sweeper at an appropriate disposal site.

Maintenance Standards

Continually monitor operations to determine whether slurry, cuttings, or process water could enter waters of the state. If inspections show that a violation of water quality standards could occur, stop operations and immediately implement preventive measures such as berms, barriers, secondary containment, and vacuum trucks.

BMP C153: Material Delivery, Storage and Containment

Purpose

Prevent, reduce, or eliminate the discharge of pollutants to the stormwater system or watercourses from material delivery and storage. Minimize the storage of hazardous materials on-site, store materials in a designated area, and install secondary containment.

Conditions of Use

These procedures are suitable for use at all construction sites with delivery and storage of the following materials:

- Petroleum products such as fuel, oil and grease
- Soil stabilizers and binders (e.g. Polyacrylamide)
- Fertilizers, pesticides and herbicides
- Detergents
- Asphalt and concrete compounds
- Hazardous chemicals such as acids, lime, adhesives, paints, solvents and curing compounds
- Any other material that may be detrimental if released to the environment

Design and Installation Specifications

The following steps should be taken to minimize risk:

- Temporary storage area should be located away from vehicular traffic, near the construction entrance(s), and away from waterways or storm drains.
- Material Safety Data Sheets (MSDS) should be supplied for all materials stored. Chemicals should be kept in their original labeled containers.
- Hazardous material storage on-site should be minimized.
- Hazardous materials should be handled as infrequently as possible.
- During the wet weather season (Oct 1 – April 30), consider storing materials in a covered area.
- Materials should be stored in secondary containments, such as earthen dike, horse trough, or even a children’s wading pool for non-reactive materials such as detergents, oil, grease, and paints. Small amounts of material may be secondarily contained in “bus boy” trays or concrete mixing trays.
- Do not store chemicals, drums, or bagged materials directly on the ground. Place these items on a pallet and, when possible, and within secondary containment.
- If drums must be kept uncovered, store them at a slight angle to reduce ponding of rainwater on the lids to reduce corrosion. Domed plastic covers are inexpensive and snap to the top of drums, preventing water from collecting.

Material Storage Areas and Secondary Containment Practices:

- Liquids, petroleum products, and substances listed in 40 CFR Parts 110, 117, or 302 shall be stored in approved containers and drums and shall not be overfilled. Containers and drums shall be stored in temporary secondary containment facilities.
- Temporary secondary containment facilities shall provide for a spill containment volume able to contain 10% of the total enclosed container volume of all containers, or 110% of the capacity of the largest container within its boundary, whichever is greater.
- Secondary containment facilities shall be impervious to the materials stored therein for a minimum contact time of 72 hours.
- Secondary containment facilities shall be maintained free of accumulated rainwater and spills. In the event of spills or leaks, accumulated rainwater and spills shall be collected and placed into drums. These liquids shall be handled as hazardous waste unless testing determines them to be non-hazardous.
- Sufficient separation should be provided between stored containers to allow for spill cleanup and emergency response access.
- During the wet weather season (Oct 1 – April 30), each secondary containment facility shall be covered during non-working days, prior to and during rain events.
- Keep material storage areas clean, organized and equipped with an ample supply of appropriate spill clean-up material (spill kit).
- The spill kit should include, at a minimum:
    - 1-Water Resistant Nylon Bag
    - 3-Oil Absorbent Socks 3”x 4’
    - 2-Oil Absorbent Socks 3”x 10’
    - 12-Oil Absorbent Pads 17”x19”
    - 1-Pair Splash Resistant Goggles
    - 3-Pair Nitrile Gloves
    - 10-Disposable Bags with Ties
    - Instructions

BMP C154: Concrete Washout Area

Purpose

Prevent or reduce the discharge of pollutants to stormwater from concrete waste by conducting washout off-site, or performing on-site washout in a designated area to prevent pollutants from entering surface waters or ground water.

Conditions of Use

Concrete washout area best management practices are implemented on construction projects where:

- Concrete is used as a construction material
- It is not possible to dispose of all concrete wastewater and washout off-site (ready mix plant, etc.).
- Concrete trucks, pumpers, or other concrete coated equipment are washed on-site.
- Note: If less than 10 concrete trucks or pumpers need to be washed out on-site, the washwater may be disposed of in a formed area awaiting concrete or an upland disposal site where it will not contaminate surface or ground water. The upland disposal site shall be at least 50 feet from sensitive areas such as storm drains, open ditches, or water bodies, including wetlands.

Design and Installation Specifications

Implementation

The following steps will help reduce stormwater pollution from concrete wastes:

- Perform washout of concrete trucks off-site or in designated concrete washout areas only.
- Do not wash out concrete trucks onto the ground, or into storm drains, open ditches, streets, or streams.
- Do not allow excess concrete to be dumped on-site, except in designated concrete washout areas.
- Concrete washout areas may be prefabricated concrete washout containers, or self-installed structures (above-grade or below-grade).
- Prefabricated containers are most resistant to damage and protect against spills and leaks. Companies may offer delivery service and provide regular maintenance and disposal of solid and liquid waste.
- If self-installed concrete washout areas are used, below-grade structures are preferred over above-grade structures because they are less prone to spills and leaks.
- Self-installed above-grade structures should only be used if excavation is not practical.

Education

- Discuss the concrete management techniques described in this BMP with the ready-mix concrete supplier before any deliveries are made.
- Educate employees and subcontractors on the concrete waste management techniques described in this BMP.
- Arrange for contractor's superintendent or Certified Erosion and Sediment Control Lead (CESCL) to oversee and enforce concrete waste management procedures.
- A sign should be installed adjacent to each temporary concrete washout facility to inform concrete equipment operators to utilize the proper facilities.

Contracts

Incorporate requirements for concrete waste management into concrete supplier and subcontractor agreements.

Location and Placement

- Locate washout area at least 50 feet from sensitive areas such as storm drains, open ditches, or water bodies, including wetlands.
- Allow convenient access for concrete trucks, preferably near the area where the concrete is being poured.
- If trucks need to leave a paved area to access washout, prevent track-out with a pad of rock or quarry spalls (see BMP C105). These areas should be far enough away from other construction traffic to reduce the likelihood of accidental damage and spills.
- The number of facilities you install should depend on the expected demand for storage capacity.
- On large sites with extensive concrete work, washouts should be placed in multiple locations for ease of use by concrete truck drivers.

On-site Temporary Concrete Washout Facility, Transit Truck Washout Procedures:

- Temporary concrete washout facilities shall be located a minimum of 50 ft from sensitive areas including storm drain inlets, open drainage facilities, and watercourses. See Figures 4.1.7 and 4.1.8.
- Concrete washout facilities shall be constructed and maintained in sufficient quantity and size to contain all liquid and concrete waste generated by washout operations.
- Approximately 7 gallons of wash water are used to wash one truck chute.
- Approximately 50 gallons are used to wash out the hopper of a concrete pump truck.

- Washout of concrete trucks shall be performed in designated areas only.
- Concrete washout from concrete pumper bins can be washed into concrete pumper trucks and discharged into designated washout area or properly disposed of off-site.
- Once concrete wastes are washed into the designated area and allowed to harden, the concrete should be broken up, removed, and disposed of per applicable solid waste regulations. Dispose of hardened concrete on a regular basis.
- <u>Temporary Above-Grade Concrete Washout Facility</u>
    - Temporary concrete washout facility (type above grade) should be constructed as shown on the details below, with a recommended minimum length and minimum width of 10 ft, but with sufficient quantity and volume to contain all liquid and concrete waste generated by washout operations.
    - Plastic lining material should be a minimum of 10 mil polyethylene sheeting and should be free of holes, tears, or other defects that compromise the impermeability of the material.
- <u>Temporary Below-Grade Concrete Washout Facility</u>
    - Temporary concrete washout facilities (type below grade) should be constructed as shown on the details below, with a recommended minimum length and minimum width of 10 ft. The quantity and volume should be sufficient to contain all liquid and concrete waste generated by washout operations.
    - Lath and flagging should be commercial type.
    - Plastic lining material shall be a minimum of 10 mil polyethylene sheeting and should be free of holes, tears, or other defects that compromise the impermeability of the material.
    - Liner seams shall be installed in accordance with manufacturers' recommendations.
    - Soil base shall be prepared free of rocks or other debris that may cause tears or holes in the plastic lining material.

Maintenance Standards

Inspection and Maintenance

- <u>Inspect and verify that concrete washout BMPs are in place prior to the commencement of concrete work.</u>
- <u>During periods of concrete work, inspect daily to verify continued performance</u>.
    - Check overall condition and performance.
    - Check remaining capacity (% full).

- If using self-installed washout facilities, verify plastic liners are intact and sidewalls are not damaged.
- If using prefabricated containers, check for leaks.

- Washout facilities shall be maintained to provide adequate holding capacity with a minimum freeboard of 12 inches.
- Washout facilities must be cleaned, or new facilities must be constructed and ready for use once the washout is 75% full.
- If the washout is nearing capacity, vacuum and dispose of the waste material in an approved manner.
  - Do not discharge liquid or slurry to waterways, storm drains or directly onto ground.
  - Do not use sanitary sewer without local approval.
  - Place a secure, non-collapsing, non-water collecting cover over the concrete washout facility prior to predicted wet weather to prevent accumulation and overflow of precipitation.
  - Remove and dispose of hardened concrete and return the structure to a functional condition. Concrete may be reused on-site or hauled away for disposal or recycling.
- When you remove materials from the self-installed concrete washout, build a new structure; or, if the previous structure is still intact, inspect for signs of weakening or damage, and make any necessary repairs. Re-line the structure with new plastic after each cleaning.

Removal of Temporary Concrete Washout Facilities

- When temporary concrete washout facilities are no longer required for the work, the hardened concrete, slurries and liquids shall be removed and properly disposed of.
- Materials used to construct temporary concrete washout facilities shall be removed from the site of the work and disposed of or recycled.
- Holes, depressions or other ground disturbance caused by the removal of the temporary concrete washout facilities shall be backfilled, repaired, and stabilized to prevent erosion.

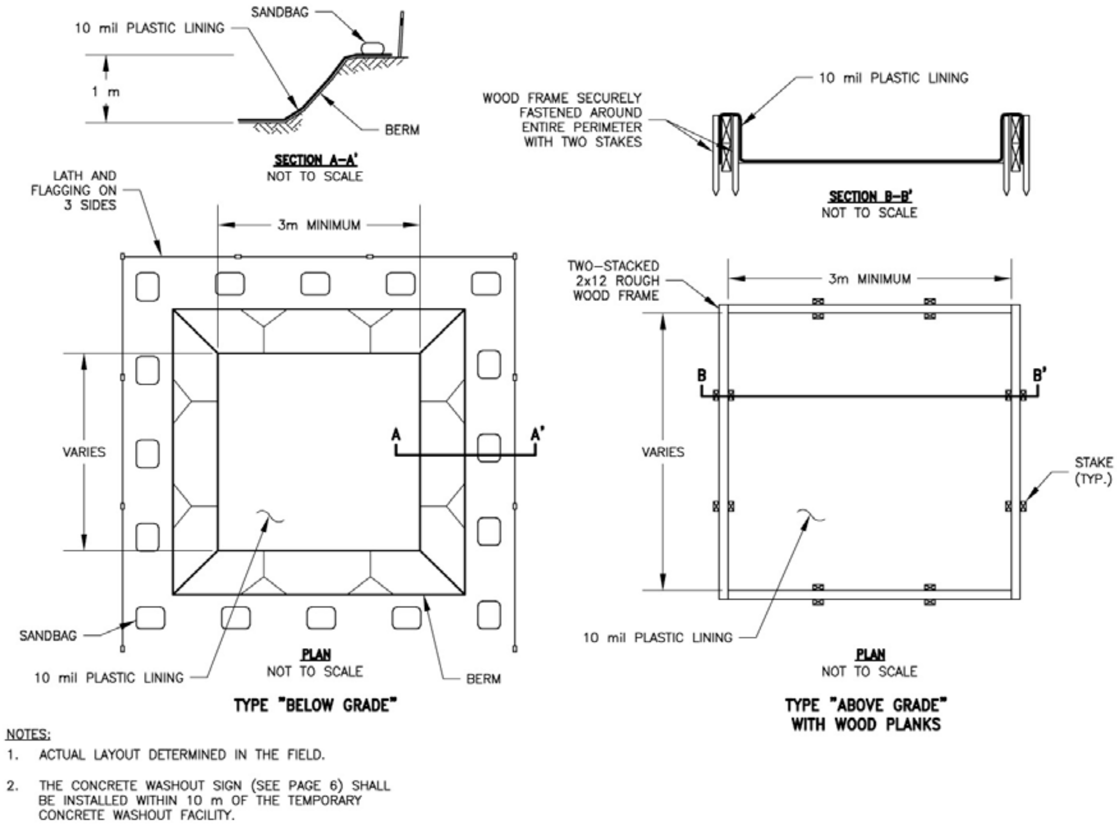


Figure 4.1.7a – Concrete Washout Area

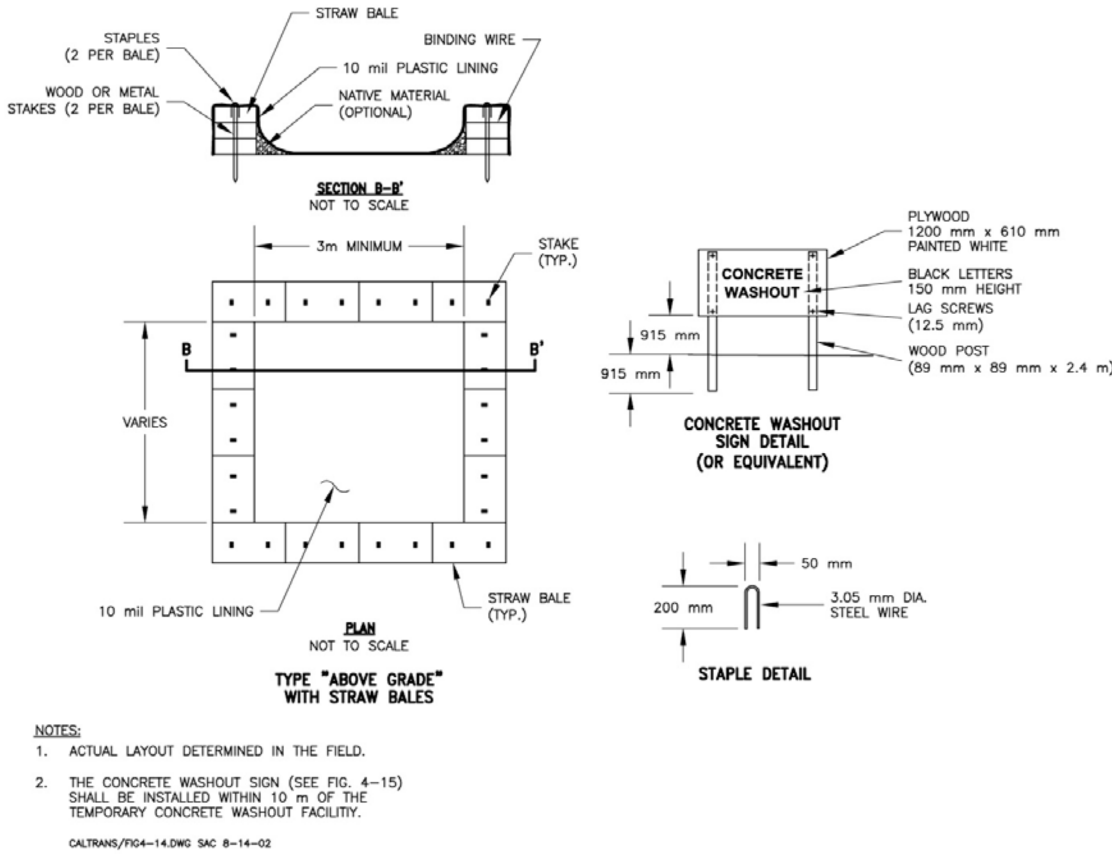


Figure 4.1.7b – Concrete Washout Area

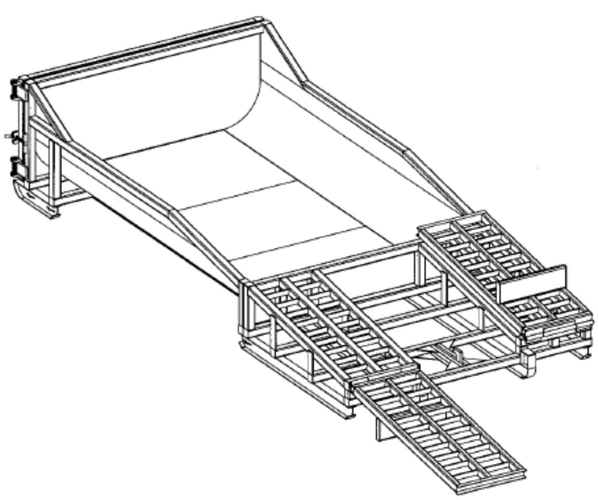


Figure 4.1.8 – Prefabricated Concrete Washout Container w/Ramp

BMP C200: Interceptor Dike and Swale

Purpose

Provide a ridge of compacted soil, or a ridge with an upslope swale, at the top or base of a disturbed slope or along the perimeter of a disturbed construction area to convey stormwater. Use the dike and/or swale to intercept the runoff from unprotected areas and direct it to areas where erosion can be controlled. This can prevent storm runoff from entering the work area or sediment-laden runoff from leaving the construction site.

Conditions of Use

Where the runoff from an exposed site or disturbed slope must be conveyed to an erosion control facility which can safely convey the stormwater.

- Locate upslope of a construction site to prevent runoff from entering disturbed area.
- When placed horizontally across a disturbed slope, it reduces the amount and velocity of runoff flowing down the slope.
- Locate downslope to collect runoff from a disturbed area and direct water to a sediment basin.

Design and Installation Specifications

- Dike and/or swale and channel must be stabilized with temporary or permanent vegetation or other channel protection during construction.
- Channel requires a positive grade for drainage; steeper grades require channel protection and check dams.
- Review construction for areas where overtopping may occur.
- Can be used at top of new fill before vegetation is established.
- May be used as a permanent diversion channel to carry the runoff.
- Sub-basin tributary area should be one acre or less.
- Design capacity for the peak flow from a 10-year, 24-hour storm, assuming a Type 1A rainfall distribution, for temporary facilities. Alternatively, use 1.6 times the 10-year, 1-hour flow indicated by an approved continuous runoff model. For facilities that will also serve on a permanent basis, consult the local government's drainage requirements.

Interceptor dikes shall meet the following criteria:

Top Width	2 feet minimum.
Height	1.5 feet minimum on berm.
Side Slope	2H:1V or flatter.
Grade	Depends on topography, however, dike system minimum is 0.5%, and maximum is 1%.
Compaction	Minimum of 90 percent ASTM D698 standard proctor.

Horizontal Spacing of Interceptor Dikes:

Average Slope	Slope Percent	Flowpath Length
20H:1V or less	3-5%	300 feet
(10 to 20)H:1V	5-10%	200 feet
(4 to 10)H:1V	10-25%	100 feet
(2 to 4)H:1V	25-50%	50 feet

Stabilization depends on velocity and reach

Slopes <5%	Seed and mulch applied within 5 days of dike construction (see BMP C121, Mulching).
Slopes 5 - 40%	Dependent on runoff velocities and dike materials. Stabilization should be done immediately using either sod or riprap or other measures to avoid erosion.

- The upslope side of the dike shall provide positive drainage to the dike outlet. No erosion shall occur at the outlet. Provide energy dissipation measures as necessary. Sediment-laden runoff must be released through a sediment trapping facility.
- Minimize construction traffic over temporary dikes. Use temporary cross culverts for channel crossing.

Interceptor swales shall meet the following criteria:

Bottom Width	2 feet minimum; the cross-section bottom shall be level.
Depth	1-foot minimum.
Side Slope	2H:1V or flatter.
Grade	Maximum 5 percent, with positive drainage to a suitable outlet (such as a sediment pond).
Stabilization	Seed as per BMP C120, *Temporary and Permanent Seeding*, or *BMP C202*, *Channel Lining*, 12 inches thick riprap pressed into the bank and extending at least 8 inches vertical from the bottom.

- Inspect diversion dikes and interceptor swales once a week and after every rainfall. Immediately remove sediment from the flow area.
- Damage caused by construction traffic or other activity must be repaired before the end of each working day.

Check outlets and make timely repairs as needed to avoid gully formation. When the area below the temporary diversion dike is permanently stabilized, remove the dike and fill and stabilize the channel to blend with the natural surface.

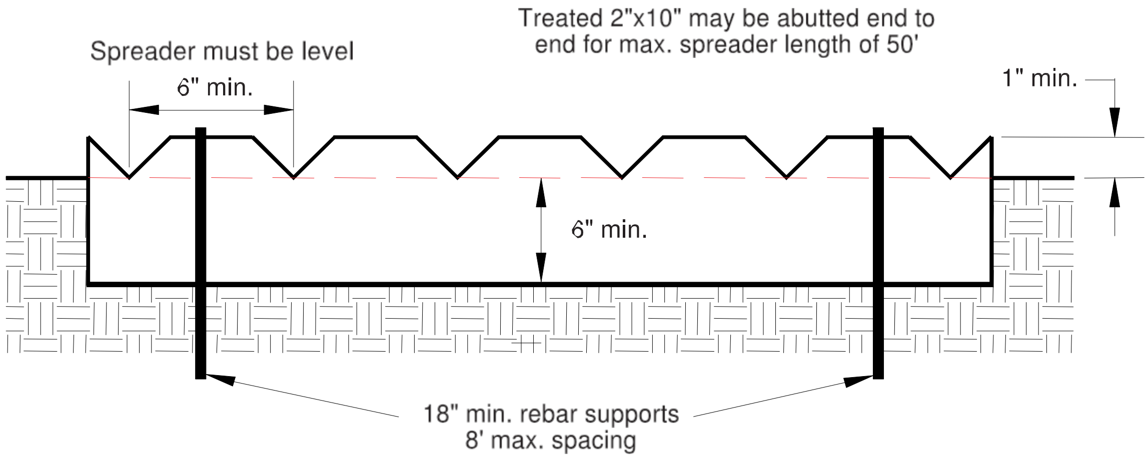


Figure 4.2.6 – Detail of Level Spreader

BMP C207: Check Dams

Purpose Construction of small dams across a swale or ditch reduces the velocity of concentrated flow and dissipates energy at the check dam.

Conditions of Use Where temporary channels or permanent channels are not yet vegetated, channel lining is infeasible, and/or velocity checks are required.

- Check dams may not be placed in streams unless approved by the State Department of Fish and Wildlife. Check dams may not be placed in wetlands without approval from a permitting agency.
- Do not place check dams below the expected backwater from any salmonid bearing water between October 1 and May 31 to ensure that there is no loss of high flow refuge habitat for overwintering juvenile salmonids and emergent salmonid fry.
- Construct rock check dams from appropriately sized rock. The rock used must be large enough to stay in place given the expected design flow through the channel. The rock must be placed by hand or by mechanical means (no dumping of rock to form dam) to achieve complete coverage of the ditch or swale and to ensure that the center of the dam is lower than the edges.
- Check dams may also be constructed of either rock or pea-gravel filled bags. Numerous new products are also available for this purpose. They tend to be re-usable, quick and easy to install, effective, and cost efficient.
- Place check dams perpendicular to the flow of water.
- The dam should form a triangle when viewed from the side. This prevents undercutting as water flows over the face of the dam rather than falling directly onto the ditch bottom.

- Before installing check dams impound and bypass upstream water flow away from the work area. Options for bypassing include pumps, siphons, or temporary channels.
- Check dams in association with sumps work more effectively at slowing flow and retaining sediment than just a check dam alone. A deep sump should be provided immediately upstream of the check dam.
- In some cases, if carefully located and designed, check dams can remain as permanent installations with very minor regrading. They may be left as either spillways, in which case accumulated sediment would be graded and seeded, or as check dams to prevent further sediment from leaving the site.
- The maximum spacing between the dams shall be such that the toe of the upstream dam is at the same elevation as the top of the downstream dam.
- Keep the maximum height at 2 feet at the center of the dam.
- Keep the center of the check dam at least 12 inches lower than the outer edges at natural ground elevation.
- Keep the side slopes of the check dam at 2H:1V or flatter.
- Key the stone into the ditch banks and extend it beyond the abutments a minimum of 18 inches to avoid washouts from overflow around the dam.
- Use filter fabric foundation under a rock or sand bag check dam. If a blanket ditch liner is used, filter fabric is not necessary. A piece of organic or synthetic blanket cut to fit will also work for this purpose.
- In the case of grass-lined ditches and swales, all check dams and accumulated sediment shall be removed when the grass has matured sufficiently to protect the ditch or swale - unless the slope of the swale is greater than 4 percent. The area beneath the check dams shall be seeded and mulched immediately after dam removal.
- Ensure that channel appurtenances, such as culvert entrances below check dams, are not subject to damage or blockage from displaced stones. Figure 4.2.7 depicts a typical rock check dam.

Maintenance Standards

Check dams shall be monitored for performance and sediment accumulation during and after each runoff producing rainfall. Sediment shall be removed when it reaches one half the sump depth.

- Anticipate submergence and deposition above the check dam and erosion from high flows around the edges of the dam.
- If significant erosion occurs between dams, install a protective riprap liner in that portion of the channel.

Approved as Equivalent

Ecology has approved products as able to meet the requirements of BMP C207. The products did not pass through the Technology Assessment Protocol – Ecology (TAPE) process. Local jurisdictions may choose not to accept this product approved as equivalent, or may require additional testing prior to consideration for local use. The products are available for review on Ecology's website at http://www.ecy.wa.gov/programs/wq/stormwater/newtech/equivalent.html

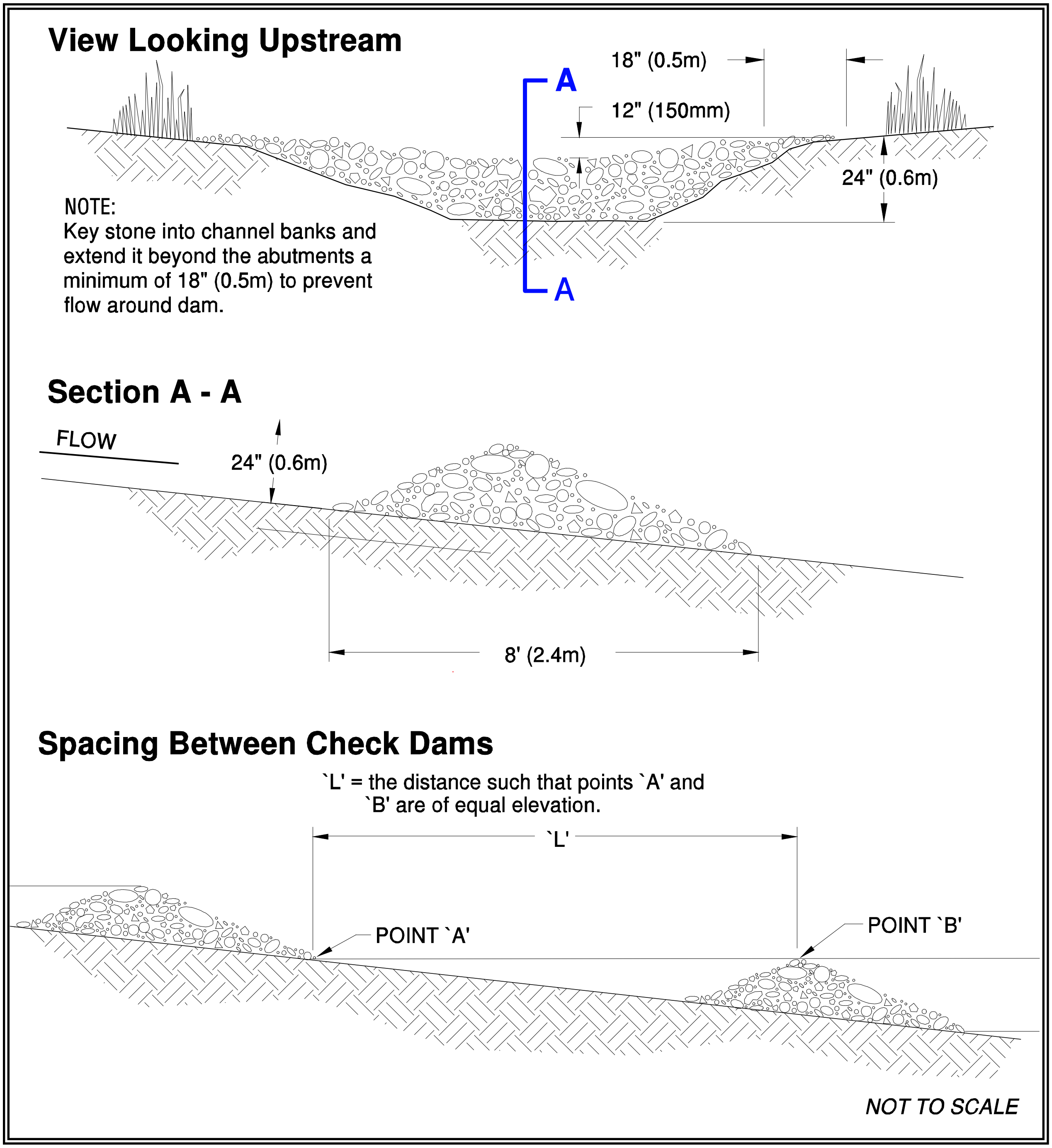


Figure 4.2.7 – Rock Check Dam

BMP C220: Storm Drain Inlet Protection

Purpose Storm drain inlet protection prevents coarse sediment from entering drainage systems prior to permanent stabilization of the disturbed area.

Conditions of Use Use storm drain inlet protection at inlets that are operational before permanent stabilization of the disturbed drainage area. Provide protection for all storm drain inlets downslope and within 500 feet of a disturbed or construction area, unless conveying runoff entering catch basins to a sediment pond or trap.

Also consider inlet protection for lawn and yard drains on new home construction. These small and numerous drains coupled with lack of gutters in new home construction can add significant amounts of sediment into the roof drain system. If possible delay installing lawn and yard drains until just before landscaping or cap these drains to prevent sediment from entering the system until completion of landscaping. Provide 18-inches of sod around each finished lawn and yard drain.

Table 4.2.2 lists several options for inlet protection. All of the methods for storm drain inlet protection tend to plug and require a high frequency of maintenance. Limit drainage areas to one acre or less. Possibly provide emergency overflows with additional end-of-pipe treatment where stormwater ponding would cause a hazard.

Table 4.2.2
Storm Drain Inlet Protection

Type of Inlet Protection	Emergency Overflow	Applicable for Paved/ Earthen Surfaces	Conditions of Use
Drop Inlet Protection			
Excavated drop inlet protection	Yes, temporary flooding will occur	Earthen	Applicable for heavy flows. Easy to maintain. Large area Requirement: 30’ X 30’/acre
Block and gravel drop inlet protection	Yes	Paved or Earthen	Applicable for heavy concentrated flows. Will not pond.
Gravel and wire drop inlet protection	No		Applicable for heavy concentrated flows. Will pond. Can withstand traffic.
Catch basin filters	Yes	Paved or Earthen	Frequent maintenance required.
Curb Inlet Protection			
Curb inlet protection with a wooden weir	Small capacity overflow	Paved	Used for sturdy, more compact installation.
Block and gravel curb inlet protection	Yes	Paved	Sturdy, but limited filtration.
Culvert Inlet Protection			
Culvert inlet sediment trap			18 month expected life.

Design and Installation Specifications

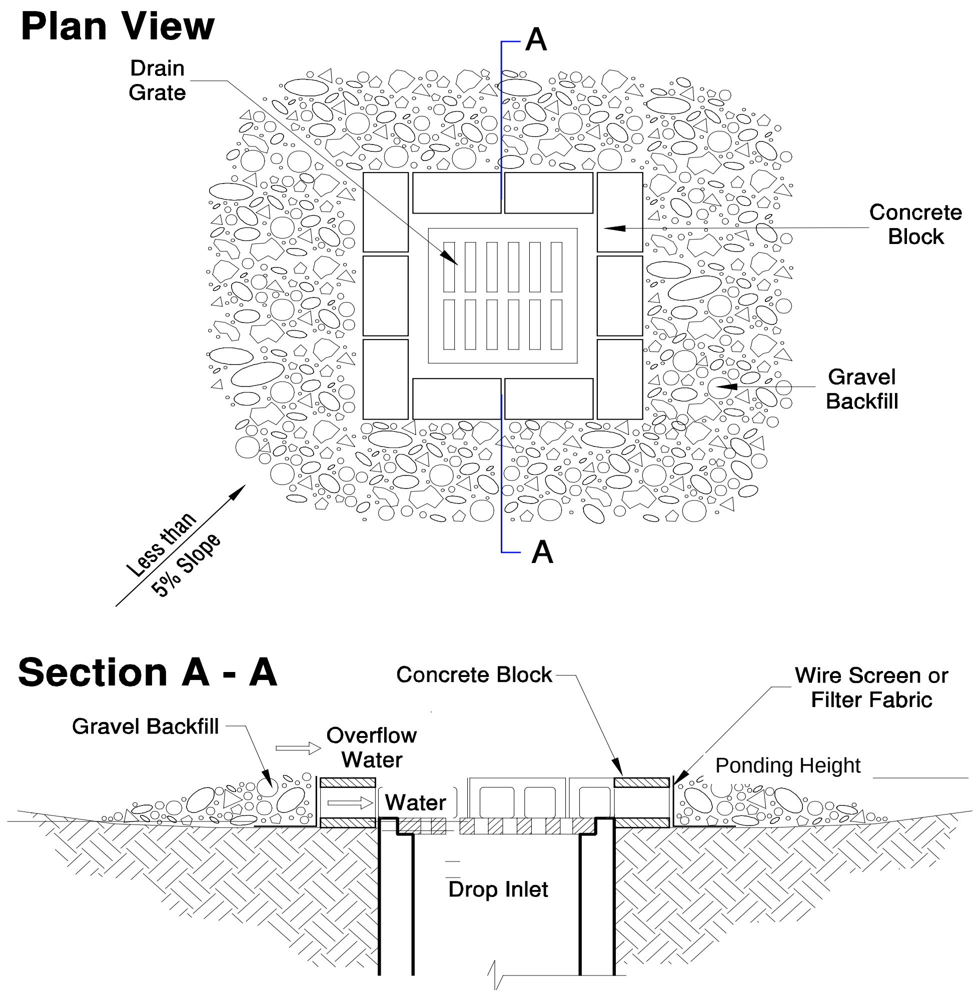
Excavated Drop Inlet Protection - An excavated impoundment around the storm drain. Sediment settles out of the stormwater prior to entering the storm drain.

- Provide a depth of 1-2 ft as measured from the crest of the inlet structure.
- Slope sides of excavation no steeper than 2H:1V.
- Minimum volume of excavation 35 cubic yards.
- Shape basin to fit site with longest dimension oriented toward the longest inflow area.
- Install provisions for draining to prevent standing water problems.
- Clear the area of all debris.
- Grade the approach to the inlet uniformly.
- Drill weep holes into the side of the inlet.
- Protect weep holes with screen wire and washed aggregate.
- Seal weep holes when removing structure and stabilizing area.

- Build a temporary dike, if necessary, to the down slope side of the structure to prevent bypass flow.

Block and Gravel Filter - A barrier formed around the storm drain inlet with standard concrete blocks and gravel. See Figure 4.2.8.

- Provide a height of 1 to 2 feet above inlet.
- Recess the first row 2-inches into the ground for stability.
- Support subsequent courses by placing a 2x4 through the block opening.
- Do not use mortar.
- Lay some blocks in the bottom row on their side for dewatering the pool.
- Place hardware cloth or comparable wire mesh with ½-inch openings over all block openings.
- Place gravel just below the top of blocks on slopes of 2H:1V or flatter.
- An alternative design is a gravel donut.
- Provide an inlet slope of 3H:1V.
- Provide an outlet slope of 2H:1V.
- Provide a1-foot wide level stone area between the structure and the inlet.
- Use inlet slope stones 3 inches in diameter or larger.
- Use gravel ½- to ¾-inch at a minimum thickness of 1-foot for the outlet slope.



Notes:
1. Drop inlet sediment barriers are to be used for small, nearly level drainage areas. (less than 5%)
2. Excavate a basin of sufficient size adjacent to the drop inlet.
3. The top of the structure (ponding height) must be well below the ground elevation downslope to prevent runoff from bypassing the inlet. A temporary dike may be necessary on the downslope side of the structure.

Figure 4.2.8 – Block and Gravel Filter

Gravel and Wire Mesh Filter - A gravel barrier placed over the top of the inlet. This structure does not provide an overflow.

- Use a hardware cloth or comparable wire mesh with ½-inch openings.
- Use coarse aggregate.
- Provide a height 1-foot or more, 18-inches wider than inlet on all sides.
- Place wire mesh over the drop inlet so that the wire extends a minimum of 1-foot beyond each side of the inlet structure.
- Overlap the strips if more than one strip of mesh is necessary.

- Place coarse aggregate over the wire mesh.
- Provide at least a 12-inch depth of gravel over the entire inlet opening and extend at least 18-inches on all sides.

Catchbasin Filters – Use inserts designed by manufacturers for construction sites. The limited sediment storage capacity increases the amount of inspection and maintenance required, which may be daily for heavy sediment loads. To reduce maintenance requirements combine a catchbasin filter with another type of inlet protection. This type of inlet protection provides flow bypass without overflow and therefore may be a better method for inlets located along active rights-of-way.

- Provides 5 cubic feet of storage.
- Requires dewatering provisions.
- Provides a high-flow bypass that will not clog under normal use at a construction site.
- Insert the catchbasin filter in the catchbasin just below the grating.

Curb Inlet Protection with Wooden Weir – Barrier formed around a curb inlet with a wooden frame and gravel.

- Use wire mesh with ½-inch openings.
- Use extra strength filter cloth.
- Construct a frame.
- Attach the wire and filter fabric to the frame.
- Pile coarse washed aggregate against wire/fabric.
- Place weight on frame anchors.

Block and Gravel Curb Inlet Protection – Barrier formed around a curb inlet with concrete blocks and gravel. See Figure 4.2.9.

- Use wire mesh with ½-inch openings.
- Place two concrete blocks on their sides abutting the curb at either side of the inlet opening. These are spacer blocks.
- Place a 2x4 stud through the outer holes of each spacer block to align the front blocks.
- Place blocks on their sides across the front of the inlet and abutting the spacer blocks.
- Place wire mesh over the outside vertical face.
- Pile coarse aggregate against the wire to the top of the barrier.

Curb and Gutter Sediment Barrier – Sandbag or rock berm (riprap and aggregate) 3 feet high and 3 feet wide in a horseshoe shape. See Figure 4.2.10.

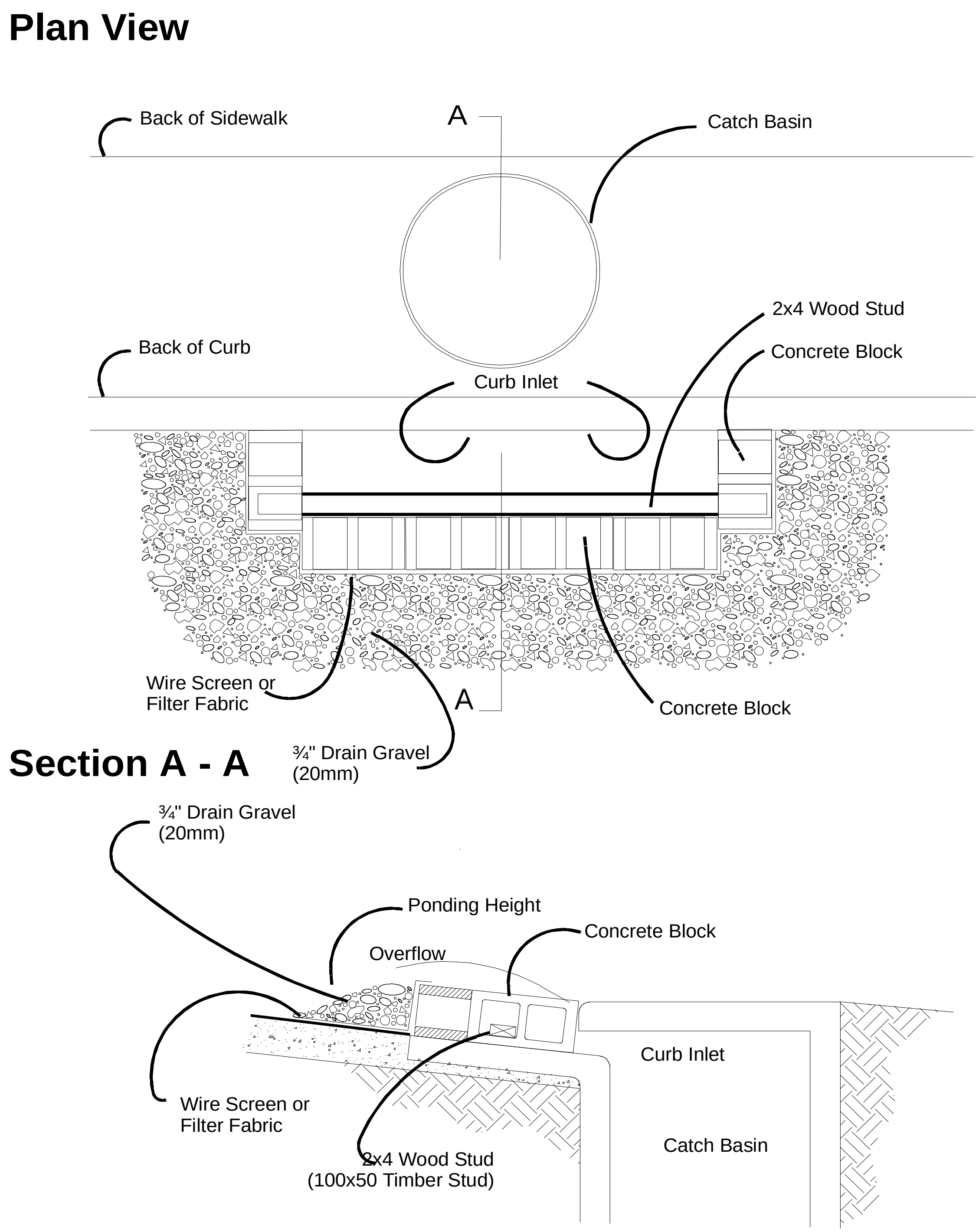
- Construct a horseshoe shaped berm, faced with coarse aggregate if using riprap, 3 feet high and 3 feet wide, at least 2 feet from the inlet.
- Construct a horseshoe shaped sedimentation trap on the outside of the berm sized to sediment trap standards for protecting a culvert inlet.

Maintenance Standards

- Inspect catch basin filters frequently, especially after storm events. Clean and replace clogged inserts. For systems with clogged stone filters: pull away the stones from the inlet and clean or replace. An alternative approach would be to use the clogged stone as fill and put fresh stone around the inlet.
- Do not wash sediment into storm drains while cleaning. Spread all excavated material evenly over the surrounding land area or stockpile and stabilize as appropriate.

Approved as Equivalent

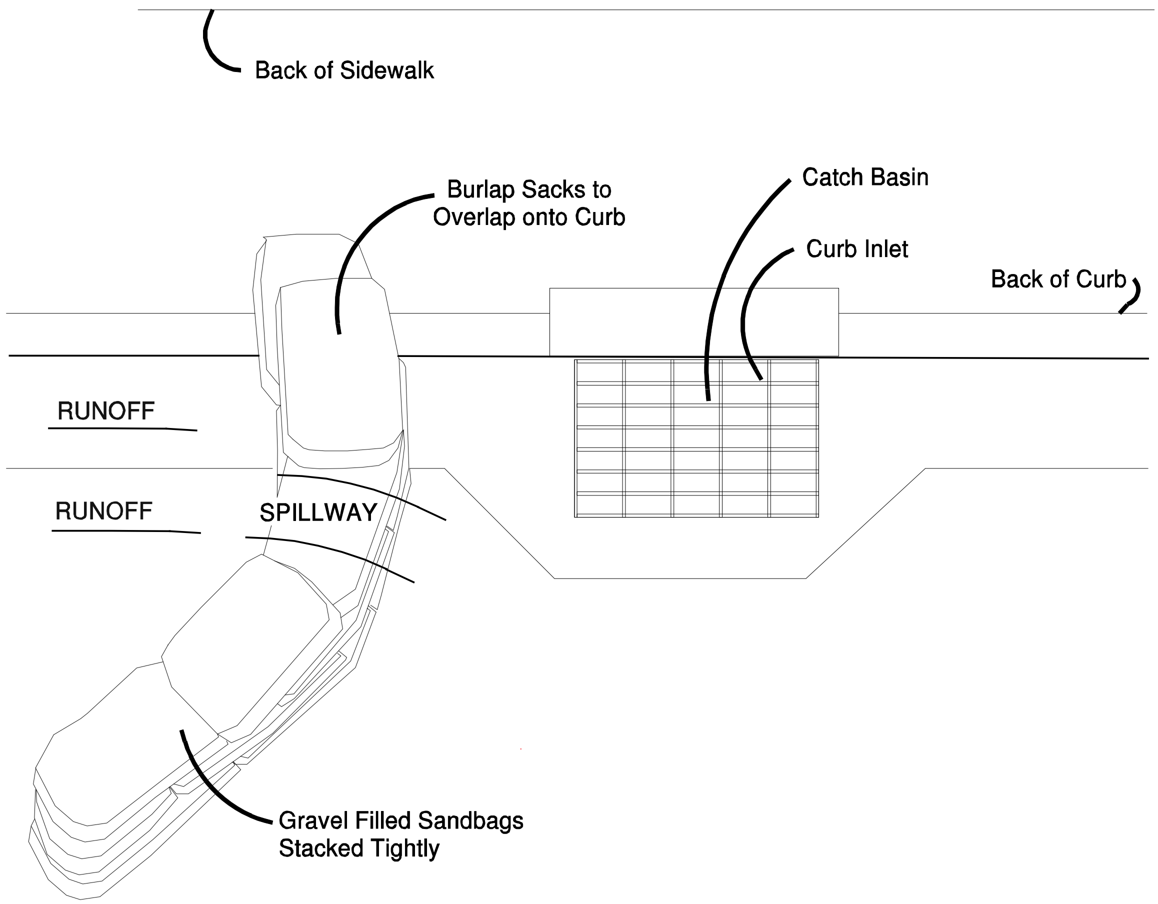
Ecology has approved products as able to meet the requirements of BMP C220. The products did not pass through the Technology Assessment Protocol – Ecology (TAPE) process. Local jurisdictions may choose not to accept this product approved as equivalent, or may require additional testing prior to consideration for local use. The products are available for review on Ecology's website at http://www.ecy.wa.gov/programs/wq/stormwater/newtech/equivalent.html



NOTES:
1. Use block and gravel type sediment barrier when curb inlet is located in gently sloping street segment, where water can pond and allow sediment to separate from runoff.
2. Barrier shall allow for overflow from severe storm event.
3. Inspect barriers and remove sediment after each storm event. Sediment and gravel must be removed from the traveled way immediately.

Figure 4.2.9 – Block and Gravel Curb Inlet Protection

Plan View



NOTES:
1. Place curb type sediment barriers on gently sloping street segments, where water can pond and allow sediment to separate from runoff.
2. Sandbags of either burlap or woven `geotextile' fabric, are filled with gravel, layered and packed tightly.
3. Leave a one sandbag gap in the top row to provide a spillway for overflow.
4. Inspect barriers and remove sediment after each storm event. Sediment and gravel must be removed from the traveled way immediately.

Figure 4.2.10 – Curb and Gutter Barrier

BMP C233: Silt Fence

Purpose

Use of a silt fence reduces the transport of coarse sediment from a construction site by providing a temporary physical barrier to sediment and reducing the runoff velocities of overland flow. See Figure 4.2.12 for details on silt fence construction.

Conditions of Use

Silt fence may be used downslope of all disturbed areas.

- Silt fence shall prevent soil carried by runoff water from going beneath, through, or over the top of the silt fence, but shall allow the water to pass through the fence.
- Silt fence is not intended to treat concentrated flows, nor is it intended to treat substantial amounts of overland flow. Convey any concentrated flows through the drainage system to a sediment pond.
- Do not construct silt fences in streams or use in V-shaped ditches. Silt fences do not provide an adequate method of silt control for anything deeper than sheet or overland flow.

BMP C241: Temporary Sediment Pond

Purpose

Sediment ponds remove sediment from runoff originating from disturbed areas of the site. Sediment ponds are typically designed to remove sediment no smaller than medium silt (0.02 mm). Consequently, they usually reduce turbidity only slightly.

Conditions of Use

Prior to leaving a construction site, stormwater runoff must pass through a sediment pond or other appropriate sediment removal best management practice.

A sediment pond shall be used where the contributing drainage area is 3 acres or more. Ponds must be used in conjunction with erosion control practices to reduce the amount of sediment flowing into the basin.

Design and Installation Specifications

- Sediment basins must be installed only on sites where failure of the structure would not result in loss of life, damage to homes or buildings, or interruption of use or service of public roads or utilities. Also, sediment traps and ponds are attractive to children and can be very dangerous. Compliance with local ordinances regarding health and safety must be addressed. If fencing of the pond is required, the type of fence and its location shall be shown on the ESC plan.
- Structures having a maximum storage capacity at the top of the dam of 10 acre-ft (435,600 ft^3) or more are subject to the Washington Dam Safety Regulations (Chapter 173-175 WAC).
- See Figures 4.2.18, 4.2.19, and 4.2.20 for details.
- If permanent runoff control facilities are part of the project, they should be used for sediment retention. The surface area requirements of the sediment basin must be met. This may require temporarily enlarging the permanent basin to comply with the surface area requirements. The permanent control structure must be temporarily replaced with a control structure that only allows water to leave the pond from the surface or by pumping. The permanent control structure must be installed after the site is fully stabilized. .
- Use of infiltration facilities for sedimentation basins during construction tends to clog the soils and reduce their capacity to infiltrate. If infiltration facilities are to be used, the sides and bottom of the facility must only be rough excavated to a minimum of 2 feet above final grade. Final grading of the infiltration facility shall occur only when all contributing drainage areas are fully stabilized. The infiltration pretreatment facility should be fully constructed and used with the sedimentation basin to help prevent clogging.
- Determining Pond Geometry

  Obtain the discharge from the hydrologic calculations of the peak flow for the 2-year runoff event (Q_2). The 10-year peak flow shall be used if the project size, expected timing and duration of construction, or downstream conditions warrant a higher level of protection. If no hydrologic analysis is required, the Rational Method may be used.

Determine the required surface area at the top of the riser pipe with the equation:

$SA = 2 \times Q_2/0.00096$ or
2080 square feet per cfs of inflow

See BMP C240 for more information on the derivation of the surface area calculation.

The basic geometry of the pond can now be determined using the following design criteria:

- Required surface area SA (from Step 2 above) at top of riser.
- Minimum 3.5-foot depth from top of riser to bottom of pond.
- Maximum 3H:1V interior side slopes and maximum 2H:1V exterior slopes. The interior slopes can be increased to a maximum of 2H:1V if fencing is provided at or above the maximum water surface.
- One foot of freeboard between the top of the riser and the crest of the emergency spillway.
- Flat bottom.
- Minimum 1-foot deep spillway.
- Length-to-width ratio between 3:1 and 6:1.
- Sizing of Discharge Mechanisms.

The outlet for the basin consists of a combination of principal and emergency spillways. These outlets must pass the peak runoff expected from the contributing drainage area for a 100-year storm. If, due to site conditions and basin geometry, a separate emergency spillway is not feasible, the principal spillway must pass the entire peak runoff expected from the 100-year storm. However, an attempt to provide a separate emergency spillway should always be made. The runoff calculations should be based on the site conditions during construction. The flow through the dewatering orifice cannot be utilized when calculating the 100-year storm elevation because of its potential to become clogged; therefore, available spillway storage must begin at the principal spillway riser crest.

The principal spillway designed by the procedures contained in this standard will result in some reduction in the peak rate of runoff. However, the riser outlet design will not adequately control the basin discharge to the predevelopment discharge limitations as stated in Minimum Requirement #7: Flow Control. However, if the basin for a permanent stormwater detention pond is used for a temporary sedimentation basin, the control structure for the permanent pond can be used to maintain predevelopment discharge limitations. The size of the basin, the expected life of the construction project, the anticipated downstream effects and the anticipated weather conditions during construction, should be considered to determine the need of additional discharge control. See Figure 4.2.21 for riser inflow curves.

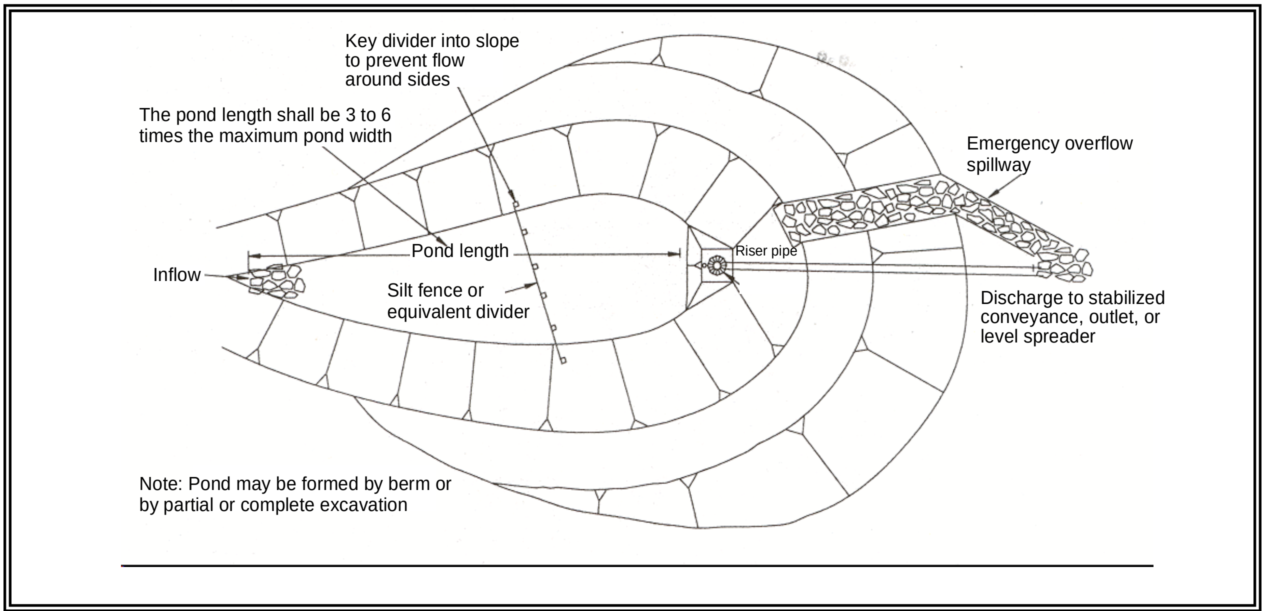


Figure 4.2.18 – Sediment Pond Plan View

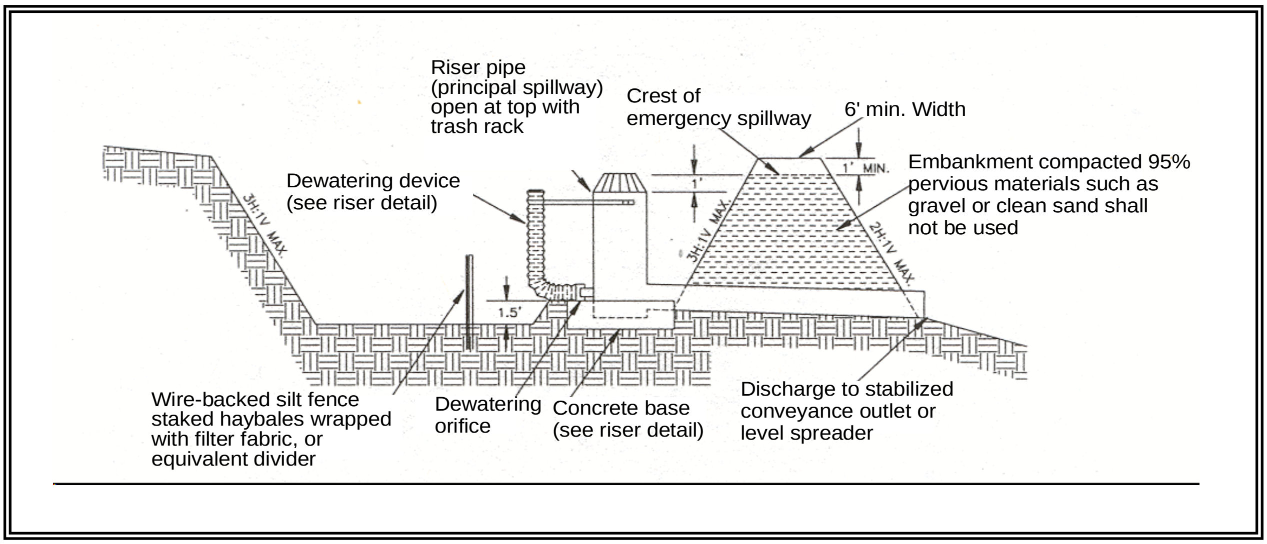


Figure 4.2.19 – Sediment Pond Cross Section

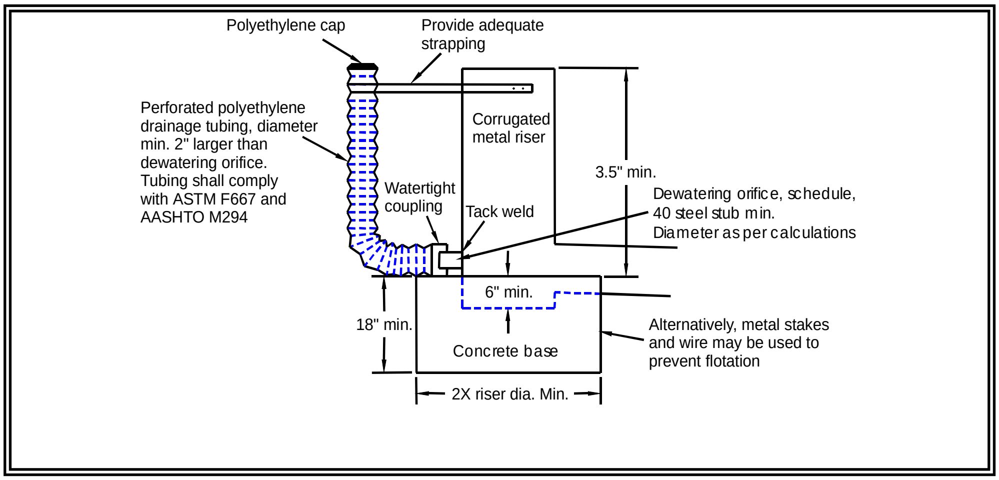


Figure 4.2.20 – Sediment Pond Riser Detail

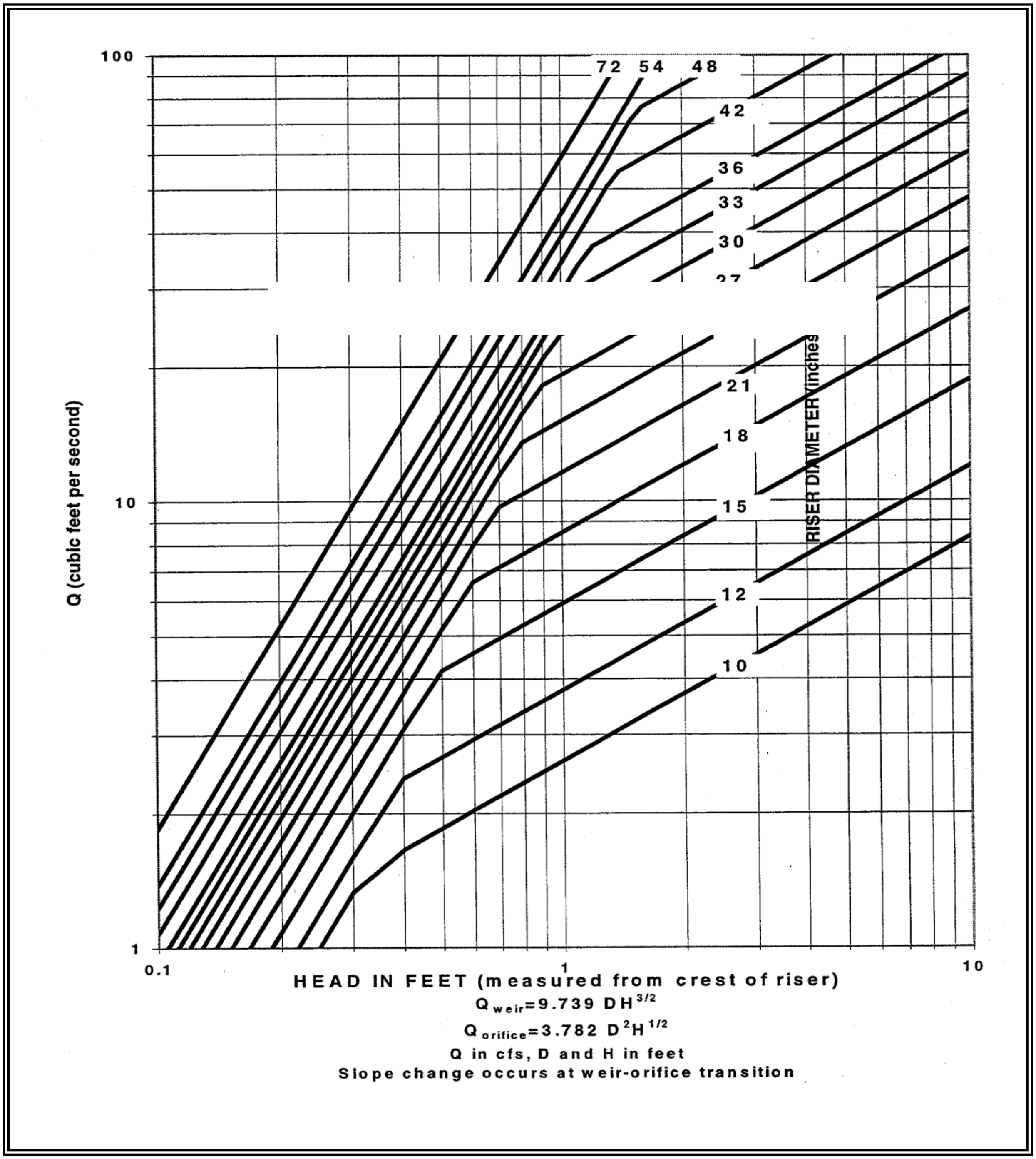


Figure 4.2.21 – Riser Inflow Curves

Principal Spillway: Determine the required diameter for the principal spillway (riser pipe). The diameter shall be the minimum necessary to pass the site's 15-minute, 10-year flowrate. If using the Western Washington Hydrology Model (WWHM), Version 2 or 3, design flow is the 10-year (1 hour) flow for the developed (unmitigated) site, multiplied by a factor of 1.6. Use Figure 4.2.21 to determine this diameter (h = 1-foot). *Note: A permanent control structure may be used instead of a temporary riser.*

Emergency Overflow Spillway: Determine the required size and design of the emergency overflow spillway for the developed 100-year peak flow using the method contained in Volume III.

Dewatering Orifice: Determine the size of the dewatering orifice(s) (minimum 1-inch diameter) using a modified version of the discharge equation for a vertical orifice and a basic equation for the area of a circular orifice. Determine the required area of the orifice with the following equation:

$$A_o = \frac{A_s (2h)^{0.5}}{0.6 \text{x} 3600 T g^{0.5}}$$

where A_o = orifice area (square feet)

A_S = pond surface area (square feet)

h = head of water above orifice (height of riser in feet)

T = dewatering time (24 hours)

g = acceleration of gravity (32.2 feet/second^2)

Convert the required surface area to the required diameter D of the orifice:

$$D = 24\text{x}\sqrt{\frac{A_o}{\pi}} = 13.54\text{x}\sqrt{A_o}$$

The vertical, perforated tubing connected to the dewatering orifice must be at least 2 inches larger in diameter than the orifice to improve flow characteristics. The size and number of perforations in the tubing should be large enough so that the tubing does not restrict flow. The orifice should control the flow rate.

- Additional Design Specifications

  The pond shall be divided into two roughly equal volume cells by a permeable divider that will reduce turbulence while allowing movement of water between cells. The divider shall be at least one-half the height of the riser and a minimum of one foot below the top of the riser. Wire-backed, 2- to 3-foot high, extra strength filter fabric supported by treated 4"x4"s can be used as a divider. Alternatively, staked straw bales wrapped with filter fabric (geotextile) may be used. If the pond is more than 6 feet deep, a different mechanism must be proposed. A riprap embankment is one acceptable method of separation for deeper ponds. Other designs that satisfy the intent of this provision are allowed as long as the divider is permeable, structurally sound, and designed to prevent erosion under or around the barrier.

To aid in determining sediment depth, one-foot intervals shall be prominently marked on the riser.

If an embankment of more than 6 feet is proposed, the pond must comply with the criteria contained in Volume III regarding dam safety for detention BMPs.

- The most common structural failure of sedimentation basins is caused by piping. Piping refers to two phenomena: (1) water seeping through fine-grained soil, eroding the soil grain by grain and forming pipes or tunnels; and, (2) water under pressure flowing upward through a granular soil with a head of sufficient magnitude to cause soil grains to lose contact and capability for support.

  The most critical construction sequences to prevent piping will be:

  1. Tight connections between riser and barrel and other pipe connections.
  2. Adequate anchoring of riser.
  3. Proper soil compaction of the embankment and riser footing.
  4. Proper construction of anti-seep devices.

Maintenance Standards

- Sediment shall be removed from the pond when it reaches 1–foot in depth.
- Any damage to the pond embankments or slopes shall be repaired.

BMP C252: High pH Neutralization Using CO_2

Purpose

When pH levels in stormwater rise above 8.5 it is necessary to lower the pH levels to the acceptable range of 6.5 to 8.5, this process is called pH neutralization. pH neutralization involves the use of solid or compressed carbon dioxide gas in water requiring neutralization. Neutralized stormwater may be discharged to surface waters under the General Construction NPDES permit.

Neutralized process water such as concrete truck wash-out, hydro-demolition, or saw-cutting slurry must be managed to prevent discharge to surface waters. Any stormwater contaminated during concrete work is considered process wastewater and must not be discharged to surface waters.

Reason for pH Neutralization:

A pH level range of 6.5 to 8.5 is typical for most natural watercourses, and this neutral pH is required for the survival of aquatic organisms. Should the pH rise or drop out of this range, fish and other aquatic organisms may become stressed and may die.

Calcium hardness can contribute to high pH values and cause toxicity that is associated with high pH conditions. A high level of calcium hardness in waters of the state is not allowed.

The water quality standard for pH in Washington State is in the range of 6.5 to 8.5. Ground water standard for calcium and other dissolved solids in Washington State is less than 500 mg/l.

Conditions of Use

Causes of High pH:

High pH at construction sites is most commonly caused by the contact of stormwater with poured or recycled concrete, cement, mortars, and other Portland cement or lime containing construction materials. (See BMP C151: Concrete Handling for more information on concrete handling procedures). The principal caustic agent in cement is calcium hydroxide (free lime).

Advantages of CO_2 Sparging:

- Rapidly neutralizes high pH water.
- Cost effective and safer to handle than acid compounds.
- CO_2 is self-buffering. It is difficult to overdose and create harmfully low pH levels.
- Material is readily available.

The Chemical Process:

When carbon dioxide (CO_2) is added to water (H_2O), carbonic acid (H_2CO_3) is formed which can further dissociate into a proton (H^+) and a bicarbonate anion (HCO_3^-) as shown below:

$CO_2 + H_2O \leftrightarrow H_2CO_3 \leftrightarrow H^+ + HCO_3^-$

The free proton is a weak acid that can lower the pH. Water temperature has an effect on the reaction as well. The colder the water temperature is the slower the reaction occurs and the warmer the water temperature is the quicker the reaction occurs. Most construction applications in Washington State have water temperatures in the 50°F or higher range so the reaction is almost simultaneous.

Design and Installation Specifications

Treatment Process:

High pH water may be treated using continuous treatment, continuous discharge systems. These manufactured systems continuously monitor influent and effluent pH to ensure that pH values are within an acceptable range before being discharged. All systems must have fail safe automatic shut off switches in the event that pH is not within the acceptable discharge range. Only trained operators may operate manufactured systems. System manufacturers often provide trained operators or training on their devices.

The following procedure may be used when not using a continuous discharge system:

1. Prior to treatment, the appropriate jurisdiction should be notified in accordance with the regulations set by the jurisdiction.
2. Every effort should be made to isolate the potential high pH water in order to treat it separately from other stormwater on-site.
3. Water should be stored in an acceptable storage facility, detention pond, or containment cell prior to treatment.
4. Transfer water to be treated to the treatment structure. Ensure that treatment structure size is sufficient to hold the amount of water that is to be treated. Do not fill tank completely, allow at least 2 feet of freeboard.
5. The operator samples the water for pH and notes the clarity of the water. As a rule of thumb, less CO_2 is necessary for clearer water. This information should be recorded.
6. In the pH adjustment structure, add CO_2 until the pH falls in the range of 6.9-7.1. Remember that pH water quality standards apply so adjusting pH to within 0.2 pH units of receiving water (background pH) is recommended. It is unlikely that pH can be adjusted to within 0.2 pH units using dry ice. Compressed carbon dioxide gas should be introduced to the water using a carbon dioxide diffuser located near

the bottom of the tank, this will allow carbon dioxide to bubble up through the water and diffuse more evenly.

7. Slowly discharge the water making sure water does not get stirred up in the process. Release about 80% of the water from the structure leaving any sludge behind.
8. Discharge treated water through a pond or drainage system.
9. Excess sludge needs to be disposed of properly as concrete waste. If several batches of water are undergoing pH treatment, sludge can be left in treatment structure for the next batch treatment. Dispose of sludge when it fills 50% of tank volume.

Sites that must implement flow control for the developed site must also control stormwater release rates during construction. All treated stormwater must go through a flow control facility before being released to surface waters which require flow control.

Maintenance Standards

Safety and Materials Handling:

- All equipment should be handled in accordance with OSHA rules and regulations.
- Follow manufacturer guidelines for materials handling.

Operator Records:

Each operator should provide:

- A diagram of the monitoring and treatment equipment.
- A description of the pumping rates and capacity the treatment equipment is capable of treating.

Each operator should keep a written record of the following:

- Client name and phone number.
- Date of treatment.
- Weather conditions.
- Project name and location.
- Volume of water treated.
- pH of untreated water.
- Amount of CO_2 needed to adjust water to a pH range of 6.9-7.1.
- pH of treated water.
- Discharge point location and description.

A copy of this record should be given to the client/contractor who should retain the record for three years.

BMP C253: pH Control for High pH Water

Purpose

When pH levels in stormwater rise above 8.5 it is necessary to lower the pH levels to the acceptable range of 6.5 to 8.5, this process is called pH neutralization. Stormwater with pH levels exceeding water quality standards may be treated by infiltration, dispersion in vegetation or compost, pumping to a sanitary sewer, disposal at a permitted concrete batch plant with pH neutralization capabilities, or carbon dioxide sparging. BMP C252 gives guidelines for carbon dioxide sparging.

Reason for pH Neutralization:

A pH level range of 6.5 to 8.5 is typical for most natural watercourses, and this pH range is required for the survival of aquatic organisms. Should the pH rise or drop out of this range, fish and other aquatic organisms may become stressed and may die.

Conditions of Use

Causes of High pH:

High pH levels at construction sites are most commonly caused by the contact of stormwater with poured or recycled concrete, cement, mortars, and other Portland cement or lime containing construction materials. (See BMP C151: Concrete Handling for more information on concrete handling procedures). The principal caustic agent in cement is calcium hydroxide (free lime).

Design and Installation Specifications

Disposal Methods:

Infiltration

- Infiltration is only allowed if soil type allows all water to infiltrate (no surface runoff) without causing or contributing to a violation of surface or ground water quality standards.
- Infiltration techniques should be consistent with Volume V, Chapter 7

Dispersion

Use BMP T5.30 Full Dispersion

Sanitary Sewer Disposal

- Local sewer authority approval is required prior to disposal via the sanitary sewer.

Concrete Batch Plant Disposal

- Only permitted facilities may accept high pH water.
- Facility should be contacted before treatment to ensure they can accept the high pH water.

Stormwater Discharge

Any pH treatment options that generate treated water that must be discharged off site are subject to flow control requirements. Sites that must implement flow control for the developed site must also control stormwater release rates during construction. All treated stormwater must go through a flow control facility before being released to surface waters which require flow control.

C. Correspondence

Any pertinent correspondence regarding this project will be included in this section.

D. Site Inspection Form

Please see the following pages for the site intspection form.

Construction Stormwater Site Inspection Form

Project Name ________________ Permit # ____________ Inspection Date ___________ Time _______

Name of Certified Erosion Sediment Control Lead (CESCL) or qualified inspector if *less than one acre*
Print Name: ____

Approximate rainfall amount since the last inspection (in inches): ______________________

Approximate rainfall amount in the last 24 hours (in inches): ______________________

Current Weather Clear ☐ Cloudy ☐ Mist ☐ Rain ☐ Wind ☐ Fog ☐

A. Type of inspection: Weekly ☐ Post Storm Event ☐ Other ☐

B. Phase of Active Construction (*check all that apply*):

Pre Construction/installation of erosion/sediment controls	☐	Clearing/Demo/Grading	☐	Infrastructure/storm/roads	☐
Concrete pours	☐	Vertical Construction/buildings	☐	Utilities	☐
Offsite improvements	☐	Site temporary stabilized	☐	Final stabilization	☐

C. Questions:

1. Were all areas of construction and discharge points inspected? Yes ___ No ___
2. Did you observe the presence of suspended sediment, turbidity, discoloration, or oil sheen Yes ___ No ___
3. Was a water quality sample taken during inspection? (*refer to permit conditions S4 & S5*) Yes ___ No ___
4. Was there a turbid discharge 250 NTU or greater, or Transparency 6 cm or less?* Yes ___ No ___
5. If yes to #4 was it reported to Ecology? Yes ___ No ___
6. Is pH sampling required? pH range required is 6.5 to 8.5. Yes ___ No ___

If answering yes to a discharge, describe the event. Include when, where, and why it happened; what action was taken, and when.

____

____

____

____

*If answering yes to # 4 record NTU/Transparency with continual sampling daily until turbidity is 25 NTU or less/ transparency is 33 cm or greater.

Sampling Results: Date: ______________________

Parameter	Method (circle one)	Result			Other/Note
		NTU	cm	pH	
Turbidity	tube, meter, laboratory				
pH	Paper, kit, meter				

D. Check the observed status of all items. Provide "Action Required "details and dates.

Element #	Inspection	BMPs Inspected			BMP needs maintenance	BMP failed	Action required (describe in section F)
		yes	no	n/a			
1 Clearing Limits	Before beginning land disturbing activities are all clearing limits, natural resource areas (streams, wetlands, buffers, trees) protected with barriers or similar BMPs? (high visibility recommended)						
2 Construction Access	Construction access is stabilized with quarry spalls or equivalent BMP to prevent sediment from being tracked onto roads?						
	Sediment tracked onto the road way was cleaned thoroughly at the end of the day or more frequent as necessary.						
3 Control Flow Rates	Are flow control measures installed to control stormwater volumes and velocity during construction and do they protect downstream properties and waterways from erosion?						
	If permanent infiltration ponds are used for flow control during construction, are they protected from siltation?						
4 Sediment Controls	All perimeter sediment controls (e.g. silt fence, wattles, compost socks, berms, etc.) installed, and maintained in accordance with the Stormwater Pollution Prevention Plan (SWPPP).						
	Sediment control BMPs (sediment ponds, traps, filters etc.) have been constructed and functional as the first step of grading.						
	Stormwater runoff from disturbed areas is directed to sediment removal BMP.						
5 Stabilize Soils	Have exposed un-worked soils been stabilized with effective BMP to prevent erosion and sediment deposition?						

Construction Stormwater Site Inspection Form

Element #	Inspection	BMPs Inspected			BMP needs maintenance	BMP failed	Action required (describe in section F)
		yes	no	n/a			
5 Stabilize Soils Cont.	Are stockpiles stabilized from erosion, protected with sediment trapping measures and located away from drain inlet, waterways, and drainage channels?						
	Have soils been stabilized at the end of the shift, before a holiday or weekend if needed based on the weather forecast?						
6 Protect Slopes	Has stormwater and ground water been diverted away from slopes and disturbed areas with interceptor dikes, pipes and or swales?						
	Is off-site storm water managed separately from stormwater generated on the site?						
	Is excavated material placed on uphill side of trenches consistent with safety and space considerations?						
	Have check dams been placed at regular intervals within constructed channels that are cut down a slope?						
7 Drain Inlets	Storm drain inlets made operable during construction are protected.						
	Are existing storm drains within the influence of the project protected?						
8 Stabilize Channel and Outlets	Have all on-site conveyance channels been designed, constructed and stabilized to prevent erosion from expected peak flows?						
	Is stabilization, including armoring material, adequate to prevent erosion of outlets, adjacent stream banks, slopes and downstream conveyance systems?						
9 Control Pollutants	Are waste materials and demolition debris handled and disposed of to prevent contamination of stormwater?						
	Has cover been provided for all chemicals, liquid products, petroleum products, and other material?						
	Has secondary containment been provided capable of containing 110% of the volume?						
	Were contaminated surfaces cleaned immediately after a spill incident?						
	Were BMPs used to prevent contamination of stormwater by a pH modifying sources?						

Construction Stormwater Site Inspection Form

Element #	Inspection	BMPs Inspected			BMP needs maintenance	BMP failed	Action required (describe in section F)
		yes	no	n/a			
9 Cont.	Wheel wash wastewater is handled and disposed of properly.						
10 Control Dewatering	Concrete washout in designated areas. No washout or excess concrete on the ground.						
	Dewatering has been done to an approved source and in compliance with the SWPPP.						
	Were there any clean non turbid dewatering discharges?						
11 Maintain BMP	Are all temporary and permanent erosion and sediment control BMPs maintained to perform as intended?						
12 Manage the Project	Has the project been phased to the maximum degree practicable?						
	Has regular inspection, monitoring and maintenance been performed as required by the permit?						
	Has the SWPPP been updated, implemented and records maintained?						
13 Protect LID	Is all Bioretention and Rain Garden Facilities protected from sedimentation with appropriate BMPs?						
	Is the Bioretention and Rain Garden protected against over compaction of construction equipment and foot traffic to retain its infiltration capabilities?						
	Permeable pavements are clean and free of sediment and sediment laden-water runoff. Muddy construction equipment has not been on the base material or pavement.						
	Have soiled permeable pavements been cleaned of sediments and pass infiltration test as required by stormwater manual methodology?						
	Heavy equipment has been kept off existing soils under LID facilities to retain infiltration rate.						

E. Check all areas that have been inspected. ✔

All in place BMPs ☐ All disturbed soils ☐ All concrete wash out area ☐ All material storage areas ☐
All discharge locations ☐ All equipment storage areas ☐ All construction entrances/exits ☐

F. Elements checked "Action Required" (section D) describe corrective action to be taken. List the element number; be specific on location and work needed. Document, initial, and date when the corrective action has been completed and inspected.

Element #	Description and Location	Action Required	Completion Date	Initials

Attach additional page if needed

<u>Sign the following certification:</u>

"I certify that this report is true, accurate, and complete, to the best of my knowledge and belief"

Inspected by: (print) ______________________ (Signature) ____________________________ Date: ________________

Title/Qualification of Inspector: ____

E. Construction Stormwater General Permit (CSWGP)

The CSWGP will be included in the final SWPPP.

F. 303(d) List Waterbodies / TMDL Waterbodies Information

There are no 303(d) List Waterbodies in this project, so this section is not required.

G. Contaminated Site Information

There is no contaminated site at this time.

H. Engineering Calculations

Please see the following for calculations.

WWHM2012

PROJECT REPORT

18666 - DuPont 243
TESC Calculations

General Model Information

Project Name:	18666 ESC
Site Name:	
Site Address:	
City:	
Report Date:	3/10/2023
Gage:	38 IN CENTRAL
Data Start:	10/01/1901
Data End:	09/30/2059
Timestep:	15 Minute
Precip Scale:	1.000
Version Date:	2019/09/13
Version:	4.2.17

POC Thresholds

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

Mitigated Land Use

Basin 1

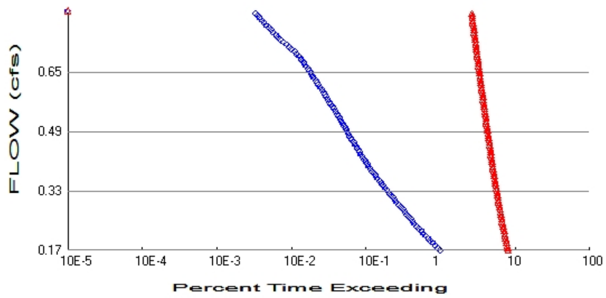
Bypass:	No
GroundWater:	No
Pervious Land Use	acre
Pervious Total	0
Impervious Land Use	acre
PARKING FLAT	19.65
Impervious Total	19.65
Basin Total	19.65

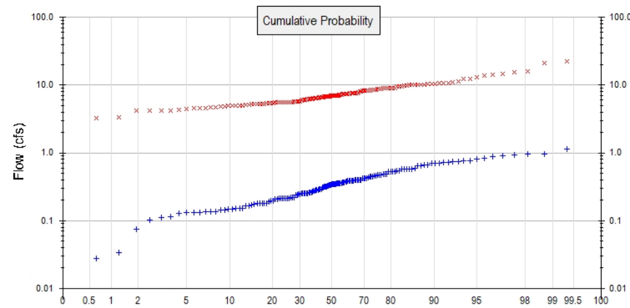
Element Flows To:

Surface	Interflow	Groundwater

Analysis Results

POC 1





\+ Predeveloped x Mitigated

Predeveloped Landuse Totals for POC #1
Total Pervious Area: 16.37
Total Impervious Area: 0

Mitigated Landuse Totals for POC #1
Total Pervious Area: 0
Total Impervious Area: 19.65

Flow Frequency Method: Log Pearson Type III 17B

Flow Frequency Return Periods for Predeveloped. POC #1

Return Period	**Flow(cfs)**
2 year	0.344962
5 year	0.536659
10 year	0.64082
25 year	0.746836
50 year	0.80985
100 year	0.861666

Flow Frequency Return Periods for Mitigated. POC #1

Return Period	**Flow(cfs)**
2 year	6.886359
5 year	9.243738
10 year	10.957095
25 year	13.302061
50 year	15.184052
100 year	17.185574

Annual Peaks

Annual Peaks for Predeveloped and Mitigated. POC #1

Year	**Predeveloped**	**Mitigated**
1902	0.253	8.143
1903	0.210	9.026
1904	0.344	10.217
1905	0.166	4.580
1906	0.074	5.122
1907	0.529	6.852
1908	0.392	5.634
1909	0.388	6.951
1910	0.535	6.642
1911	0.348	7.454

1912	1.148	12.353
1913	0.550	5.383
1914	0.134	22.596
1915	0.222	4.634
1916	0.344	8.669
1917	0.115	3.274
1918	0.369	6.942
1919	0.272	4.247
1920	0.351	5.651
1921	0.392	4.847
1922	0.394	7.603
1923	0.316	5.298
1924	0.145	10.026
1925	0.179	4.185
1926	0.334	8.168
1927	0.217	6.654
1928	0.267	4.935
1929	0.548	9.849
1930	0.352	10.310
1931	0.326	4.968
1932	0.255	5.363
1933	0.246	5.318
1934	0.722	8.639
1935	0.335	4.579
1936	0.291	6.409
1937	0.465	9.532
1938	0.284	4.659
1939	0.018	5.859
1940	0.314	10.339
1941	0.150	10.215
1942	0.473	7.684
1943	0.244	7.609
1944	0.446	10.939
1945	0.394	8.290
1946	0.213	6.433
1947	0.135	5.017
1948	0.742	6.902
1949	0.636	10.660
1950	0.180	6.031
1951	0.222	9.124
1952	0.968	10.227
1953	0.873	9.465
1954	0.315	5.605
1955	0.257	5.211
1956	0.126	5.140
1957	0.447	5.556
1958	0.934	6.893
1959	0.577	6.906
1960	0.154	5.483
1961	0.580	15.646
1962	0.312	6.727
1963	0.149	4.997
1964	0.164	14.487
1965	0.650	6.499
1966	0.182	5.437
1967	0.279	7.619
1968	0.285	6.422
1969	0.284	5.791

1970	0.445	6.583
1971	0.701	6.378
1972	0.454	21.093
1973	0.579	12.252
1974	0.313	8.867
1975	0.735	9.150
1976	0.389	9.759
1977	0.131	4.191
1978	0.655	7.067
1979	0.180	7.429
1980	0.371	7.326
1981	0.355	6.894
1982	0.145	5.617
1983	0.581	7.617
1984	0.237	7.573
1985	0.385	8.615
1986	0.345	4.375
1987	0.659	7.683
1988	0.418	4.582
1989	0.375	4.192
1990	0.425	5.537
1991	0.333	8.275
1992	0.476	7.868
1993	0.461	8.991
1994	0.692	6.150
1995	0.133	4.780
1996	0.758	6.407
1997	0.291	5.744
1998	0.346	6.825
1999	0.028	7.417
2000	0.263	6.520
2001	0.135	5.229
2002	0.481	9.493
2003	0.419	5.540
2004	0.385	8.311
2005	0.709	15.879
2006	0.214	7.450
2007	0.215	8.335
2008	0.366	6.868
2009	0.251	5.241
2010	0.214	6.728
2011	0.173	7.079
2012	0.251	6.570
2013	0.196	6.197
2014	0.146	5.994
2015	0.279	10.075
2016	0.111	6.295
2017	0.532	10.103
2018	0.967	6.052
2019	0.902	8.958
2020	0.294	7.333
2021	0.479	6.183
2022	0.198	10.513
2023	0.403	12.989
2024	0.757	13.888
2025	0.355	6.761
2026	0.580	7.425
2027	0.209	8.283

2028	0.181	3.242
2029	0.393	5.322
2030	0.729	10.669
2031	0.241	3.352
2032	0.131	5.679
2033	0.211	7.134
2034	0.208	5.585
2035	0.823	6.873
2036	0.427	5.576
2037	0.102	7.501
2038	0.341	7.118
2039	0.034	14.305
2040	0.189	5.599
2041	0.255	7.104
2042	0.801	8.197
2043	0.387	9.065
2044	0.522	6.228
2045	0.355	5.040
2046	0.416	5.590
2047	0.306	6.900
2048	0.396	5.689
2049	0.354	8.441
2050	0.254	6.287
2051	0.369	8.860
2052	0.212	6.768
2053	0.380	5.751
2054	0.483	11.415
2055	0.150	6.990
2056	0.168	9.018
2057	0.261	4.434
2058	0.330	8.489
2059	0.584	10.585

Ranked Annual Peaks

Ranked Annual Peaks for Predeveloped and Mitigated. POC #1

Rank	Predeveloped	Mitigated
1	1.1483	22.5964
2	0.9676	21.0934
3	0.9666	15.8792
4	0.9338	15.6458
5	0.9016	14.4866
6	0.8729	14.3048
7	0.8229	13.8879
8	0.8006	12.9886
9	0.7581	12.3531
10	0.7570	12.2518
11	0.7421	11.4151
12	0.7352	10.9387
13	0.7295	10.6685
14	0.7223	10.6600
15	0.7092	10.5854
16	0.7005	10.5126
17	0.6918	10.3387
18	0.6585	10.3100
19	0.6546	10.2265
20	0.6496	10.2165
21	0.6358	10.2154
22	0.5836	10.1029

23	0.5805	10.0745
24	0.5804	10.0257
25	0.5803	9.8493
26	0.5789	9.7594
27	0.5773	9.5322
28	0.5502	9.4932
29	0.5479	9.4649
30	0.5346	9.1501
31	0.5316	9.1244
32	0.5294	9.0649
33	0.5216	9.0259
34	0.4831	9.0178
35	0.4809	8.9909
36	0.4787	8.9579
37	0.4758	8.8667
38	0.4734	8.8599
39	0.4653	8.6694
40	0.4612	8.6394
41	0.4542	8.6149
42	0.4470	8.4888
43	0.4461	8.4408
44	0.4449	8.3347
45	0.4273	8.3110
46	0.4249	8.2901
47	0.4187	8.2831
48	0.4175	8.2747
49	0.4161	8.1969
50	0.4026	8.1677
51	0.3964	8.1427
52	0.3943	7.8681
53	0.3935	7.6836
54	0.3933	7.6828
55	0.3924	7.6190
56	0.3921	7.6173
57	0.3893	7.6085
58	0.3878	7.6035
59	0.3866	7.5729
60	0.3852	7.5012
61	0.3849	7.4541
62	0.3801	7.4497
63	0.3754	7.4295
64	0.3707	7.4250
65	0.3694	7.4171
66	0.3686	7.3328
67	0.3664	7.3256
68	0.3554	7.1336
69	0.3552	7.1179
70	0.3549	7.1043
71	0.3544	7.0789
72	0.3521	7.0670
73	0.3508	6.9896
74	0.3481	6.9511
75	0.3460	6.9418
76	0.3452	6.9065
77	0.3444	6.9021
78	0.3442	6.8998
79	0.3408	6.8939
80	0.3353	6.8934

81	0.3341	6.8731
82	0.3327	6.8680
83	0.3305	6.8517
84	0.3257	6.8249
85	0.3163	6.7684
86	0.3150	6.7612
87	0.3142	6.7280
88	0.3134	6.7272
89	0.3117	6.6541
90	0.3063	6.6425
91	0.2941	6.5829
92	0.2915	6.5705
93	0.2908	6.5200
94	0.2847	6.4988
95	0.2841	6.4334
96	0.2836	6.4218
97	0.2795	6.4095
98	0.2790	6.4065
99	0.2725	6.3782
100	0.2674	6.2948
101	0.2632	6.2874
102	0.2610	6.2278
103	0.2574	6.1970
104	0.2554	6.1833
105	0.2550	6.1495
106	0.2544	6.0525
107	0.2530	6.0311
108	0.2514	5.9938
109	0.2508	5.8594
110	0.2460	5.7907
111	0.2435	5.7513
112	0.2410	5.7439
113	0.2365	5.6888
114	0.2217	5.6787
115	0.2217	5.6508
116	0.2167	5.6336
117	0.2151	5.6174
118	0.2145	5.6051
119	0.2140	5.5988
120	0.2132	5.5900
121	0.2125	5.5850
122	0.2110	5.5758
123	0.2104	5.5559
124	0.2085	5.5404
125	0.2076	5.5370
126	0.1982	5.4834
127	0.1958	5.4371
128	0.1894	5.3826
129	0.1821	5.3634
130	0.1807	5.3220
131	0.1802	5.3180
132	0.1795	5.2976
133	0.1794	5.2407
134	0.1729	5.2294
135	0.1679	5.2114
136	0.1656	5.1397
137	0.1643	5.1220
138	0.1536	5.0405

139	0.1497	5.0167
140	0.1497	4.9968
141	0.1494	4.9679
142	0.1459	4.9349
143	0.1450	4.8465
144	0.1445	4.7804
145	0.1347	4.6595
146	0.1347	4.6341
147	0.1344	4.5818
148	0.1327	4.5803
149	0.1312	4.5793
150	0.1311	4.4336
151	0.1262	4.3751
152	0.1149	4.2468
153	0.1112	4.1922
154	0.1021	4.1905
155	0.0741	4.1848
156	0.0342	3.3516
157	0.0279	3.2742
158	0.0177	3.2422

Disclaimer

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TESC Calculations

Project: **DuPont Industrial**

BCE #: 18666

REQUIRED SURFACE AREA

SA = (2,080)(Q_{10})	=	**22797**	SF

PRINCIPAL SPILLWAY SIZING

D = $[(Q_{10}) / (3.782)(H)^{0.5}]^{0.5}$	=	1.702	FT
	=	**20.43**	IN
**H MIN (DEFAULT 1)*	*=*	*1*	*FT*

∴ USE RISER DIAMETER 12 INCHES

EMERGENCY OVERFLOW SPILLWAY

L = $[Q_{100} / (3.21)(H)^{1.5}] - 2.4H$	=	13.95	FT
**H MIN (DEFAULT .5)*	*=*	*0.5*	*FT*

∴ USE SPILLWAY LENGTH 5 FEET

DEWATERING ORIFICE

$A_0 = (S.A.)(2H)^{0.5}/(0.6)(3,600)(T)(g)^{0.5}$	=	0.205	SF
DIAM. = $13.54\ (A_0)^{0.5}$	=	**6.13**	IN
**H MIN (DEFAULT 3.5')*	*=*	*3.5*	*FT*

∴ USE ORIFICE DIAMETER 1"

Flow	cfs
Q2*	**6.89**
Q10	**10.96**
Q100	**17.19**

KEY

INPUT
OUTPUT
CHECK

*IF CONSTRUCTION TAKES PLACE OUTSIDE THE WET SEASON IN SUMMER MONTHS, Q2 IS ALLOWED TO SIZE POND S.A.

7.0 SPECIAL REPORTS AND STUDIES

7.0 SPECIAL REPORTS AND STUDIES

- Geotechnical Report by GeoEngineers dated October 10, 2011
- Geotechnical Report Addendum by GeoEngineers dated May 11, 2018
- Geotechnical Report Addendum 2 by GeoEngineers dated August 1, 2023
- Geotechnical Report Addendum 3 by GeoEngineers dated October 20, 2023

Geotechnical Engineering Services

DuPont Apartment Complex/Lot X
DuPont, Washington

for

Creekside DuPont Partners, LLC

May 10, 2011

GeoEngineers

Earth Science + Technology

Geotechnical Engineering Services

DuPont Apartment Complex/Lot X
DuPont, Washington

for
Creekside DuPont Partners, LLC

May 10, 2011

GeoEngineers

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30 YEARS 2010

Geotechnical Engineering Services

DuPont Apartment Complex/Lot X
DuPont, Washington

File No. 16785-002-00

May 10, 2011

Prepared for:

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05-10-11

DJT:GHS:tt

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GEOENGINEERS

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INTRODUCTION AND PROJECT UNDERSTANDING

GeoEngineers is pleased to present this proposal to provide geotechnical engineering services to support development and construction of the apartment complex to be constructed at 14464 Center Drive in DuPont, Washington, otherwise referred to as Lot X. A Vicinity Map is included as Figure 1. Our understanding of the project is based on our discussion with you and the project civil engineer (Barghausen Consulting Engineers), project architect (BCRA), and our review of preliminary site plans and a topographic survey.

The final site layout and number of apartment units has not been determined. At this time, proposed plans might include construction of approximately 180 apartment units in 14 to 15 buildings. Balanced cuts and fills are anticipated. We understand the buildings will be constructed near existing grade and deep excavations are not anticipated. Additional improvements will include construction of parking areas and installation of underground utilities. Stormwater will be conveyed to on-site infiltration galleries or ponds. Stormwater facilities will be designed in accordance with the 2005 Washington State Department of Ecology (Ecology) Stormwater Management Manual.

SCOPE OF SERVICES

The purpose of our services is to conduct subsurface investigations to use as a basis for developing geotechnical recommendations for the proposed site improvements. Our specific scope of services includes:

1. Reviewing readily available published geologic data, select in-house files, and existing subsurface information on soil and groundwater conditions in the site vicinity.
2. Coordinating clearance and location of existing utilities in the project area. We contacted the Washington Utilities Coordinating Council "One Call" service prior to beginning explorations.
3. Exploring subsurface conditions at the project site by observing nine test pits. The explorations extended to depths between 10 and 12 feet below surrounding grade.
4. Performing laboratory tests on selected soil samples obtained from the explorations to assist in evaluating the physical and engineering properties of the site soils. Laboratory testing consisted of eight moisture content and grain size analyses.
5. Providing a general discussion of site soil and groundwater conditions based on our review, explorations and testing.
6. Evaluating the results of the sieve analyses with the infiltration criteria presented in the 2005 Ecology Stormwater Management Manual. We include preliminary infiltration rates for the samples tested.
7. Providing recommendations for site preparation and earthwork. We discuss clearing and stripping, temporary and permanent slopes, suitability of on-site soils for use as structural fill, including constraints for wet weather construction, specifications for imported soil for use as structural fill, and fill placement and compaction requirements.

8. Providing general recommendations for site drainage and control of groundwater.
9. Classifying the Seismic Site Class and soil profile in accordance with Table 1613.5.2 of the International Building Code (IBC) and providing our opinion of soil liquefaction susceptibility based on the results of our review and explorations.
10. Providing recommendations for design of shallow foundations and conventional below grade and retaining wall structures. We provide allowable soil bearing pressures, settlement (total and differential) estimates, lateral earth pressures (active and passive) and coefficient of friction for evaluating sliding resistance. We discuss suitable foundation material and bearing surface preparation, including removal of uncontrolled fill, soft, organic or otherwise unsuitable material, and backfill compaction.
11. Providing recommendations for support of on-grade floor slabs including capillary break, vapor retarder, underslab drainage, and modulus of subgrade reaction, as appropriate.
12. Providing recommendations for asphalt concrete pavement (ACP) design, including base and subbase requirements for proposed parking areas. We provide typical minimum ACP section recommendations based on our experience. We can provide other recommendations based on actual traffic data, if requested.

SITE CONDITIONS

Published Literature

Based on review of geologic maps in our files, Vashon recessional outwash sand and gravel is the dominant, near-surface, geologic material mapped in the immediate project area. This material is commonly known as Steilacoom gravel. Vashon recessional outwash was deposited by melt water streams in front of the most recent glacier during its retreat from the Puget Sound region approximately 10,000 to 15,000 years ago. These deposits generally consist of permeable sand, or sand and gravel. Cobbles and boulders can also be encountered in this deposit, depending on the depositional history. Glacial till and/or advance outwash is commonly encountered at depth below the recessional outwash.

The United States Department of Agriculture (USDA) Soil Conservation Service (SCS) Soil Survey of Pierce County Area, Washington, maps the project area as Spanaway gravelly sandy loam (41A). This soil unit is described as being formed in glacial outwash. It is further described as somewhat excessively drained with moderately rapid permeability, slow surface runoff and little erosion hazard.

Surface Conditions

The project area is located west of the intersection of Center Drive and Power Line Road in DuPont, Washington. Power Line Road and Center Drive make up the eastern boundary of the site. Sequalitchew Creek flows along the southern boundary of the site. A chain link fence is located along the northern and western edges of the site.

The project area is irregular in shape and is flat or slightly sloping down to the southwest. A gravel road extends generally east-west in the southern part of the site. Overhead power lines extend north-south within the property near the eastern border of the site. Sewer, power and water manholes and junction boxes were observed within the property near the intersection of Center Drive and Power Line Road. Vegetation in the approximate southeast half of the property is low growing and sparse to moderately thick and is mostly grasses and scotch broom. The approximate northwest half of the property is densely forested with large evergreen fir trees and some oak trees. We did not observe standing water or indications of wet surface conditions during our time on site.

Subsurface Explorations

Our understanding of subsurface conditions at the project site is based on conditions disclosed in nine test pits excavated at the approximate locations shown in Figure 2. Details of the exploratory program, laboratory testing program and test pit logs completed for this study are presented in Appendix A.

Subsurface Conditions

We observed approximately 3 inches of forest duff or sod at the surface in all of the explorations with the exception of test pit TP-3. From the surface to a depth of 1 foot in test pit TP-3 we observed fill consisting of gravel with silt and sand. Underlying the duff or fill, we observed a weathered zone of soil, consisting of silty sand with gravel and traces of organic material in a medium dense condition. Underlying the weathered zone we typically observed glacial outwash consisting of gravel with sand and trace silt and variable cobbles. Exceptions to this include test pit TP-1 where gravel with silt and sand was observed below a depth of 7½ feet and in test pit TP-9 where sand with gravel and trace silt was observed from below a depth of 7 feet. The outwash was observed to be in a dense condition. Caving was typically noted below a depths of about 4 feet.

No groundwater seepage was observed during exploration. Groundwater conditions should be expected to vary as a result of season, precipitation and other factors. Based on our observations and previous explorations completed in the project vicinity, static groundwater elevation is expected to be well below the depths of the test pit explorations completed for this project.

CONCLUSIONS AND RECOMMENDATIONS

General

Based on the results of our study, it is our opinion that the site is generally suitable for the proposed development with regard to geotechnical considerations. A summary of the primary geotechnical considerations for the proposed development is provided below, and is followed by our detailed recommendations

- Organic-rich surficial material should be stripped from all areas to be improved.
- Granular soils were generally encountered; however, we did observe that some of the near-surface site soil has a higher fines (silt and clay-sized particles passing the U.S. Standard No. 200 sieve) content. Soil with a higher fines content is more sensitive to small changes in moisture content and may be difficult, if not impossible, to work and compact during wet weather conditions. This material can also be susceptible to disturbance from construction traffic when wet, or if earthwork is performed during wet weather.

- The proposed structures may be satisfactorily supported on continuous and isolated shallow foundations supported on the medium dense or dense native soils or on structural fill that extends to native soil.
- Floor slabs may be supported on compacted fill or native soils.
- The glacial outwash deposits can contain cobbles and boulders. The contractor should be prepared for this possibility.
- On-site stormwater infiltration appears feasible based on the subsurface conditions observed. We provide preliminary infiltration rate recommendations below.

Stormwater Infiltration

General

Soil consisting of gravel with sand or gravel with silt and sand was typically encountered below a depth of 1 to 2 feet in the explorations completed in the project area. In general, it is our opinion that the natural soils encountered in our explorations should have adequate permeability to infiltrate stormwater from the site. We did not encounter groundwater seepage, staining or other indications of seasonal shallow groundwater in the explorations.

Soil Infiltration Rates

Stormwater infiltration rates for the site soils were established based on the 2005 Ecology Stormwater Management Manual for Western Washington Volume III in conjunction with the sieve analysis results presented in Appendix A, Figures A-11 and A-12.

TABLE 1. SOIL INFILTRATION RATES[1]

Test Pit No.	Soil Sample No.	Soil Sample Depth (feet)	Percent Fines[2]	D10 Size (mm)[3]	USCS[4] Soil Classification	Long-term Design Infiltration Rate[6] (Inches per Hour)
1	5	7.5	7.5	0.14	GP-GM	2.0
2	3	5.5	2.6	0.49	GP	9
3	4	5.5	3.8	0.44	GP	9
5	2	3.5	3.0	0.82	GW	9
7	3	5.5	2.5	0.51	GP	9
8	3	7.5	4.7	0.25	GW	3.5
9	3	5.5	1.7	0.48	GP	9
9	4	7.5	2.2	0.25	SP	3.5

Notes:

[1] For selected soil samples.

[2] Fines = Silt and clay-sized particles passing U.S. No. 200 (0.75 mm) sieve.

[3] Based on ASTM C 136 Soil Gradation Test.

[4] Unified Soil Classification System (USCS).

[5] Based on grain-size analysis and the procedures outlined in the 2005 Ecology Stormwater Management Manual for Western Washington Volume III Table 3.8.

These rates are an estimate of subsurface infiltration properties. We expect that the relatively clean gravel soils encountered in the test pits should have adequate permeability and storage capacity to infiltrate stormwater. We did not complete explorations at specific pond locations because this information was not available at the time of our explorations. We recommend that the project plans include provisions for GeoEngineers to observe subsurface explorations during construction to check that the preliminary infiltration rate(s) used for design are appropriate for the conditions encountered. Site- and location-specific testing may also be required by local jurisdictions. It should be noted that infiltration through fill is not permissible according to the 2005 Ecology Stormwater Management Manual for Western Washington Volume III.

Stormwater should be treated in accordance with current regulations prior to infiltration. To help reduce clogging of infiltration facilities, we recommend they be protected during construction with siltation control facilities such as temporary settling basins, silt fences and hay bales. Suspended solids can clog the soil and reduce the infiltration rate. Periodic sweeping of paved areas, during and following construction, will help extend the life of the infiltration facilities. Equipment should not be permitted in the infiltration areas after they are excavated to grade because of the potential for compaction of the subgrade that could reduce the infiltration rate of the soil.

Site Development and Earthwork

General

We anticipate that site development and earthwork will include clearing and stripping of surface vegetation, constructing foundations and then placing and compacting fill and backfill materials. We expect that the majority of site grading can be accomplished with conventional earthmoving equipment. The following sections provide recommendations for stripping, excavation, erosion control, subgrade development, fill materials, fill placement and compaction.

Clearing and Stripping

Based on our observations at the site, we estimate that the depth of stripping could be on the order of 3 to 6 inches. Greater stripping depths may be required to remove localized zones of loose or organic-rich soil. In addition, the primary root systems of shrubs should be completely removed. Stripped material should be transported off site for disposal or processed and used as fill in landscaping areas.

Although we did not encounter boulders during our subsurface investigation, it is our experience they can be present in the glacial deposits in the area. Accordingly, the contractor should be prepared to remove boulders, if encountered during grading or utility excavations. Boulders may be removed from the site or buried in landscape areas. Voids caused by boulder removal should be backfilled with structural fill.

Temporary Excavations, Support and Dewatering

Excavations deeper than 4 feet should be shored or laid back at a stable slope if workers are required to enter. Shoring and temporary slope inclinations must conform to the provisions of Title 296 Washington Administrative Code (WAC), Part N, “Excavation, Trenching and Shoring.” Regardless of the soil type encountered in the excavation, shoring, trench boxes or sloped sidewalls will be required under Washington Industrial Safety and Health Act (WISHA). The contract documents should specify that the contractor is responsible for selecting excavation and dewatering methods, monitoring the excavations for safety and providing shoring, as required, to protect personnel and structures. We provide additional recommendations in regard to temporary and permanent shoring below.

In general, temporary cut slopes should be inclined no steeper than about 1-1/2H to 1V (horizontal to vertical). This guideline assumes that all surface loads are kept at a minimum distance of at least one-half the depth of the cut away from the top of the slope and that seepage is not present on the slope face. Flatter cut slopes will be necessary where seepage occurs or if surcharge loads are anticipated. We observed caving in our explorations; therefore, some sloughing and raveling of cut slopes should be expected. Temporary covering with heavy plastic sheeting should be used to protect these slopes during periods of wet weather.

Based on our explorations, we do not expect groundwater to be a major factor during shallow excavations and earthwork. However, some perched groundwater could occur in the near-surface soil depending on the time of year of construction. We anticipate that groundwater handling needs will typically be lower during the late summer and early fall months. We anticipate that shallow perched groundwater can typically be handled adequately with sumps, pumps, and/or diversion ditches, as necessary. Ultimately, we recommend that the contractor performing the work be made responsible for controlling and collecting groundwater encountered.

Permanent Cut and Fill Slopes

Based on site grades and the proposed construction, we anticipate that only minor cutting and filling will be required for this project. However, if permanent slopes are necessary, we recommend they be constructed at a maximum inclination of 2H to 1V. Where 2H to 1V permanent slopes are not feasible, protective facings and/or retaining structures should be considered.

To achieve uniform compaction, we recommend that fill slopes be overbuilt slightly and subsequently cut back to expose well-compacted fill. Fill placement on slopes steeper than 5H to 1V should be benched into the slope face and include keyways. The configuration of the bench and keyway depends on the equipment being used. Bench excavations should be level and extend into the slope face. We recommend that a vertical cut of about 3 feet be maintained for benched excavations. Keyways should be about 1-1/2 times the width of the equipment used for grading or compaction.

Exposed areas should be re-vegetated as soon as practical to reduce the surface erosion and sloughing. Temporary protection should be used until permanent protection is established.

Surface Drainage

Surface water from roofs, driveways and landscape areas should be collected and controlled. Curbs or other appropriate measures such as sloping pavements, sidewalks and landscape areas should be used to direct surface flow away from the buildings, erosion sensitive areas and from behind retaining structures. Roof and catchment drains should not be connected to wall or foundation drains.

Erosion and Sedimentation Control

Potential sources or causes of erosion and sedimentation can be influenced by construction methods, slope length and gradient, amount of soil exposed and/or disturbed, soil type, construction sequencing and weather. Implementing an erosion and sedimentation control plan will reduce the project impact on erosion-prone areas. The plan should be designed in accordance with applicable city, county and/or state standards. The plan should incorporate basic planning principles, including:

- Scheduling grading and construction to reduce soil exposure.
- Re-vegetating or mulching denuded areas.
- Directing runoff away from denuded areas.
- Reducing the length and steepness of slopes with exposed soils.
- Decreasing runoff velocities.
- Preparing drainage ways and outlets to handle concentrated or increased runoff.
- Confining sediment to the project site.
- Inspecting and maintaining control measures frequently.

Some sloughing and raveling of exposed or disturbed soil on slopes should be expected. We recommend that disturbed soil be restored promptly so that surface runoff does not become channeled.

Temporary erosion protection should be used and maintained in areas with exposed or disturbed soils to help reduce erosion and reduce transport of sediment to adjacent areas and receiving waters. Permanent erosion protection should be provided by paving, structure construction or landscape planting.

Until the permanent erosion protection is established and the site is stabilized, site monitoring may be required by qualified personnel to evaluate the effectiveness of the erosion control measures and to repair and/or modify them as appropriate. Provision for modifications to the erosion control system based on monitoring observations should be included in the erosion and sedimentation control plan.

Subgrade Preparation and Evaluation

Subgrade areas should be thoroughly compacted with heavy, smooth-drum vibratory equipment to a uniformly dense and unyielding condition prior to placement of structural fill or structural elements. We recommend that prepared subgrades be observed by a member of our firm, who will evaluate the suitability of the subgrade and identify any areas of yielding which are indicative of soft or loose soil. The exposed subgrade soil should be proof-rolled with heavy rubber-tired equipment or probed with a 1/2-inch-diameter steel rod, as appropriate depending on prevailing conditions. If soft or otherwise unsuitable areas revealed during probing or proof-rolling cannot be compacted to a stable and uniformly firm condition, we recommend that: 1) the subgrade soils be scarified (e.g., with a ripper or a farmer's disc), aerated and recompacted; or 2) the unsuitable soils be removed and replaced with structural fill, as needed.

Subgrade Protection and Wet Weather Considerations

The wet weather season generally begins in October and continues through May in western Washington; however, periods of wet weather can occur during any month of the year. In our opinion, site grading and fill placement could be considered during wet weather, but it should be noted that some of the soils encountered in our explorations contain a significant amount of fines and will be susceptible to disturbance during extended periods of wet weather. Soil with high fines content is very sensitive to small changes in moisture and is susceptible to disturbance from construction traffic when wet or if earthwork is performed during wet weather. If wet weather earthwork is unavoidable, we recommend that the following steps be taken.

- The ground surface in and around the work area should be sloped so that surface water is directed away from the work area. The ground surface should be graded so that areas of ponded water do not develop. Measures should be taken by the contractor to prevent surface water from collecting in excavations and trenches. Measures should be implemented to remove surface water from the work area.
- Earthwork activities should not take place during periods of heavy precipitation.
- Slopes with exposed soils should be covered with plastic sheeting.
- The contractor should take necessary measures to prevent on-site soils and other soils to be used as fill from becoming wet or unstable. These measures may include the use of plastic sheeting, sumps with pumps and grading. The site soils should not be left uncompacted and exposed to moisture. Sealing the surficial soils by rolling with a smooth-drum roller prior to periods of precipitation will help reduce the extent to which these soils become wet or unstable.
- Construction traffic should be restricted to specific areas of the site, preferably areas that are surfaced with working pad materials not susceptible to wet weather disturbance.
- Construction activities should be scheduled so that the length of time that soils are left exposed to moisture is reduced to the extent practical.
- Protective surfacing such as placing asphalt-treated base (ATB) or haul roads made of quarry spalls or a layer of free-draining material such as well graded pit-run sand and gravel may be necessary to protect completed areas. Typically, minimum gravel thicknesses on the order of 24 inches are necessary to provide adequate subgrade protection.
- During periods of wet weather, concrete should be placed as soon as practical after preparation of the footing excavations. Foundation bearing surfaces should not be exposed to standing water. Should water infiltrate and pool in the excavation, it should be removed before placing structural fill or reinforcing steel. Subgrade protection for foundations consisting of a lean concrete mat should be considered if footing excavations are exposed to extended wet weather conditions.

Fill Materials

General

Material used for structural fill should be free of debris, organic contaminants and rock fragments larger than 6 inches. The workability of material for use as structural fill will depend on the gradation and moisture content of the soil. As the amount of fines increases, soil becomes increasingly more sensitive to small changes in moisture content. We recommend that select granular fill or crushed rock be used for structural fill during the rainy season. If prolonged dry weather prevails during the earthwork phase of construction, materials with a somewhat higher fines content may be acceptable. The following paragraphs summarize the material requirements for fill and backfill.

Select Granular Fill

We recommend select granular fill for construction during wet weather conditions, consist of well-graded sand and gravel or crushed rock with a maximum particle size of 6 inches and less than 5 percent fines by weight based on the minus 3/4-inch fraction. Organic matter, debris or other deleterious material should not be present. In our opinion, material conforming to Washington State Department of Transportation (WSDOT) Specification 9-03.9 (Aggregates for Ballast and Crushed Surfacing), 9-03.10 (Aggregate for Gravel Base), or 9-03.14 (Borrow) is suitable for use as import fill material during wet weather with the exception that the fines content should be less than 5 percent based on the minus 3/4-inch fraction. In addition, some larger particle sizes are acceptable, as described above.

On-Site Soil

During dry weather and periods of light rain fall any non-organic on-site soil may be considered for use as fill provided it meets the criteria described above and can be compacted as recommended. When the fines content in the soil exceeds about 5 percent, the soil becomes more sensitive to moisture. Portions of the on-site soil contain enough fines to be moisture sensitive and may not be suitable for use as fill during extended periods of wet weather and/or if exposed to wet conditions. Even when properly compacted, this material can be easily disturbed and will soften when exposed to moisture. Based on our subsurface explorations, on-site material will typically not be suitable for use as drainage material, for use behind retaining walls or as a capillary break material.

Fill Placement and Compaction

General

To obtain proper compaction, fill soil should be compacted near optimum moisture content and in uniform horizontal lifts. Lift thickness and compaction procedures will depend on the moisture content and gradation characteristics of the soil and the type of equipment used. The maximum allowable moisture content varies with the soil gradation and should be evaluated during construction. Silty soil and other fine granular soil may be difficult or impossible to compact during persistent wet conditions. Generally, 12-inch loose lifts are appropriate for steel-drum vibratory roller compaction equipment. Compaction should be achieved by mechanical means. During fill and backfill placement, sufficient testing of in-place density should be conducted to check that adequate compaction is being achieved.

Area Fills and Bases

Fill placed to raise site grades and materials under pavements should be placed on subgrades prepared as previously recommended. In general, area fills and bases should be compacted to at least 95 percent of the maximum dry density (MDD) determined by ASTM International (ASTM) Test Method D 1557 (modified Proctor).

Trench Backfill

For utility excavations, we recommend that the initial lift of fill over the pipe be thick enough to reduce the potential for damage during compaction but generally should not be greater than about 18 inches. In addition, rock fragments greater than about 1 inch in maximum dimension should be excluded from this lift.

In paved and structural areas, trench backfill should be uniformly compacted in horizontal lifts to at least 95 percent of the MDD in the upper 2 feet below subgrade. Fill placed below a depth of 2 feet from subgrade in paved areas must be compacted to at least 90 percent of the MDD. In nonstructural areas, trench backfill should be compacted to a firm condition that will support construction equipment, as necessary.

Seismic Design Considerations

General

The site is located within the Puget Sound region, which is seismically active. Seismicity in this region is attributed primarily to the interaction between the Pacific, Juan de Fuca, and North American plates. The Juan de Fuca plate is subducting beneath the North American plate. It is thought that the resulting deformation and breakup of the Juan de Fuca plate might account for the deep focus earthquakes in the region. Hundreds of earthquakes have been recorded in the Puget Sound area. In recent history, four of these earthquakes were large events: 1) in 1946, a Richter magnitude 7.2 earthquake occurred in the Vancouver Island, British Columbia area; 2) in 1949, a Richter magnitude 7.1 earthquake occurred in the Olympia area; 3) in 1965, a Richter magnitude 6.5 earthquake occurred between Seattle and Tacoma; and 4) on February 28, 2001, a magnitude 6.8 earthquake occurred at Nisqually near Olympia.

Research is currently underway regarding historical large magnitude subduction-related earthquake activity along the Washington and Oregon coasts. Geologists are reporting evidence that suggests several large magnitude earthquakes (Richter magnitude 8 to 9) have occurred in the last 1,500 years, the most recent of which occurred about 300 years ago. No earthquakes of this magnitude have been documented during the recorded history of the Pacific Northwest. Local design practice in Puget Sound assumes that the magnitude felt from such an earthquake is about the same as from the existing design earthquake because of the distance.

Seismic Design Criteria

Seismic design may be performed using the equivalent static force procedure outlined in the 2009 IBC using the design parameters provided below.

TABLE 2. SEISMIC DESIGN PARAMETERS

2009 IBC
Spectral Response Accel. at Short Periods (SS) = 1.18
Spectral Response Accel. at 1 Second Periods (S1) = 0.42
Site Class = C
Site Coefficient (FA) = 1.0
Site Coefficient (FV) = 1.38

Liquefaction Potential

Liquefaction refers to a condition where vibration or shaking of the ground, usually from earthquake forces, results in development of excess pore pressures in loose, saturated soils and subsequent loss of strength in the deposit of soil so affected. In general, soils that are susceptible to liquefaction include loose to medium dense "clean" to silty sands that are below the water table. In our opinion, the potential for liquefaction at this site is low.

Shallow Foundations

Foundation Support

Proposed structures can be satisfactorily founded on continuous wall or isolated column footings supported on undisturbed native soils, or on structural fill placed over native soils. If the bearing surface is loose or disturbed it must be compacted to a dense, unyielding condition and the loose soil removed and replaced with compacted structural fill. The exterior footings should be established at least 18 inches below the lowest adjacent grade. The recommended minimum footing depth is greater than the anticipated frost depth. Interior footings can be founded a minimum of 12 inches below the top of the floor slab. Isolated column and continuous wall footings should have minimum widths of 24 and 18 inches, respectively.

Bearing Capacity

We recommend that footings founded as recommended be proportioned using an allowable soil bearing pressure of 3,500 pounds per square foot (psf). The allowable soil bearing pressure may be increased to 4,500 psf for footings greater than 4 feet in width. The bearing pressures apply to the total of dead and long-term live loads and may be increased by one third when considering total loads, including earthquake or wind loads. These are net bearing pressures. The weight of the footing and overlying backfill can be ignored in calculating footing sizes.

Footing Bearing Surface Preparation

Footing excavations should be performed using a smooth-edged bucket to limit bearing surface disturbance. The foundation bearing surface should be recompacted as necessary to a dense, non-yielding condition. Loose or disturbed materials present at the base of footing excavations should be removed or compacted. Foundation bearing surfaces should not be exposed to standing water. Should water infiltrate and pool in the excavation, it should be removed before placing structural fill or reinforcing steel.

We recommend that a member from our firm observe foundation excavations before placing reinforcing steel in order to confirm that adequate bearing surfaces have been prepared or provide recommendations for removal of unsuitable soil. Unsuitable bearing materials should be recompacted or removed and replaced with compacted structural fill as recommended by the geotechnical engineer.

Foundation Settlement

We estimate that settlement of footings designed and constructed as recommended will be less than 1 inch, for an assumed loading condition of up to 300 kips per column. Differential settlements between comparably loaded isolated column footings or along 50 feet of continuous footing should be less than 1/2 inch. Settlement is expected to occur rapidly as loads are applied. Settlements could be larger than estimated if footings are placed on loose or disturbed soil.

Lateral Resistance

The ability of the soil to resist lateral loads is a function of frictional resistance, which can develop on the base of footings and slabs and the passive resistance, which can develop on the face of below-grade elements of the structure as these elements tend to move into the soil. For footings and floor slabs founded in accordance with the recommendations presented above, the allowable frictional resistance may be computed using a coefficient of friction of 0.40 applied to vertical dead-load forces. The allowable passive resistance on the face of footings, grade beams or other embedded foundation elements may be computed using an equivalent fluid density of 300 pounds per cubic foot (pcf) for undisturbed on-site soils or structural fill extending out from the face of the foundation element a distance at least equal to two and one-half times the depth of the element.

The passive earth pressure and friction components may be combined provided that the passive component does not exceed two-thirds of the total. The passive earth pressure value is based on the assumptions that the adjacent grade is level and that groundwater remains below the base of the footing throughout the year. The top foot of soil should be neglected when calculating passive lateral earth pressures unless the foundation area is covered with pavement or slab-on-grade. The lateral resistance values include a safety factor of approximately 1.5.

Conventional Subgrade and Retaining Walls

Drainage

Positive drainage is imperative behind any retaining structure. This can be accomplished by providing a zone of free-draining material behind the wall with perforated pipes to collect seepage water. The drainage material should consist of coarse sand and gravel containing less than 5 percent fines based on the fraction of material passing the 3/4-inch sieve. The wall drainage zone should extend horizontally at least 18 inches from the back of the wall.

Perforated smooth-walled rigid PVC pipe having a minimum diameter of 4 inches should be placed at the bottom of the drainage zone along the entire length of the wall, with the pipe invert at or below the elevation of the base of the wall footing. The drainpipes should discharge to a tightline leading to an appropriate collection and disposal system. An adequate number of cleanouts should be incorporated into the design of the drains in order to provide access for regular maintenance. In general, roof downspouts, perimeter drains or other types of drainage systems should not be connected to retaining wall drain systems.

Design Parameters

The pressures presented assume that backfill placed within 2 feet of the wall is compacted by hand-operated equipment to a density of 90 percent of the MDD and that wall drainage measures are included as previously recommended. For walls constructed as described above, we recommend using an active lateral earth pressure corresponding to an equivalent fluid density of 35 pcf for the level backfill condition. For walls with backfill sloping upward behind the wall at 2H to 1V, an equivalent fluid density of 55 pcf should be used. This assumes that the tops of the walls are not structurally restrained and are free to rotate. For the at-rest condition (walls restrained from movement at the top) an equivalent fluid density of 55 pcf should be used for design. For seismic conditions, we recommend a uniform lateral pressure of 6H (where H is the height of the wall) psf be added to these lateral pressures. Note that if the retaining system is designed as a braced system but is expected to yield a small amount during a seismic event, an active earth pressure condition may be assumed and combined with the uniform seismic surcharge pressure.

The recommended pressures do not include the effects of surcharges from surface loads. If vehicles will be operated within one-half the height of the wall, a traffic surcharge should be added to the wall pressure. The traffic surcharge can be approximated by the equivalent weight of an additional 2 feet of backfill behind the wall. Additional surcharge loading conditions should also be considered on a case-by-case basis.

Retaining walls founded on native soil or structural fill extending to these materials may be designed using the allowable soil bearing values and lateral resistance values presented above in the "Shallow Foundations" section of this report. We estimate settlement of retaining structures will be similar to the values previously presented for building foundations.

Building Pads and Floor Slabs

A modulus of subgrade reaction of 300 pounds per cubic inch (pci) can be used for designing the building floor slab provided that the subgrade consists of dense native soil or structural fill and has been prepared in accordance with the "Site Development and Earthwork" section of this report. Settlement for floor slabs designed and constructed as recommended are estimated to be less than 3/4 inch for a floor load of 500 psf. We estimate that differential settlement of floor slabs will be 1/2 inch or less over a span of 50 feet providing that the fill below the slab is compacted as specified. The subgrade soils are non-expansive, so heave is not anticipated beneath the floor slab.

We recommend that on-grade slabs be underlain by a minimum 6-inch-thick capillary break layer to reduce the potential for moisture migration into the slab. The capillary break material should consist of a well-graded sand and gravel or crushed rock with a maximum particle size of 3/4 inch and less than 5 percent fines. The material should be placed as recommended in the "Fill Placement and Compaction" section of this report. If dry slabs are required (e.g., where adhesives are used to anchor carpet or tile to the slab), a waterproof liner may be placed as a vapor barrier below the slab.

Pavement Recommendations

Asphaltic Concrete Pavement

Pavement subgrades and fill should be prepared and placed as previously described. The crushed rock base course should be moisture conditioned near the optimum moisture content and compacted to at least 95 percent of the MDD determined in accordance with ASTM D 1557 test procedures. An appropriate number of in-place density tests should be conducted on the compacted base course to check that adequate compaction has been obtained. Crushed rock base course should conform to applicable sections of 4-04 and 9-03.9(3) of the WSDOT Standards.

For this project, we based the recommended pavement sections described below on an assumed in-situ California Bearing Ratio (CBR) between 15 and 20. The heavy-duty pavement section thickness is based on a traffic loading of about 1,000,000, 18-kip equivalent single-axle loads (ESALs); we used a design life of 10 years. The standard-duty section is appropriate for areas that will not be exposed to heavy truck loads. Hot mix asphalt (HMA) should conform to applicable sections of 5-04, 9-02 and 9-03 of the WSDOT Standards. The recommended pavement sections assume that final improvements surrounding the pavement will be designed and constructed such that stormwater or excess irrigation water from landscape areas does not infiltrate below the pavement section into the crushed base.

STANDARD-DUTY ASPHALTIC CONCRETE PAVEMENT

- 2 inches of hot mix asphalt.
- 3 inches of crushed surfacing base course and/or top course compacted as recommended.
- 12 inches compacted depth of native subgrades and/or existing fill compacted to 95 percent MDD (ASTM D 1557) and in a firm and unyielding condition.

HEAVY-DUTY ASPHALTIC CONCRETE PAVEMENT

- 3 inches of hot mix asphalt.
- 4 inches of crushed surfacing base course and/or top course compacted as recommended.
- 12 inches compacted depth of native subgrades and/or existing fill at 95 percent MDD (ASTM D 1557) and in a firm and unyielding condition.

LIMITATIONS

We have prepared this report for the exclusive use by Creekside DuPont Partners, LLC and their authorized agents for the DuPont Apartment Complex/Lot X to be located west of the intersection of Center Drive and Power Line Road in DuPont, Washington. Within the limitations of scope, schedule and budget, our services have been executed in accordance with generally accepted practices in the field of geotechnical engineering in this area at the time this report was prepared. No warranty or other conditions, express or implied, should be understood.

Please refer to Appendix B titled "Report Limitations and Guidelines for Use" for additional information pertaining to use of this report.

Office: Tacoma Path: W:\Tacoma\Projects\16\1678500200\GIS\1678500200_F1.mxd Map Revised: 05/11/2011 EL:SCY

T19N, R 1W, Section 26
USGS 7.5' Topographic Map Series, Nisqually (1981) Quad.

N W E S

2,000 0 2,000
Feet

Notes:
1. The locations of all features shown are approximate.
2. This drawing is for information purposes. It is intended to assist in showing features discussed in an attached document. GeoEngineers, Inc. cannot guarantee the accuracy and content of electronic files. The master file is stored by GeoEngineers, Inc. and will serve as the official record of this communication.
3. It is unlawful to copy or reproduce all or any part thereof, whether for personal use or resale, without permission.

Data Sources: ESRI Data & Maps, Street Maps 2005

Transverse Mercator, Zone 10 N North, North American Datum 1983
North arrow oriented to grid north

Vicinity Map

DuPont Apartment Complex / Lot X
DuPont, Washington

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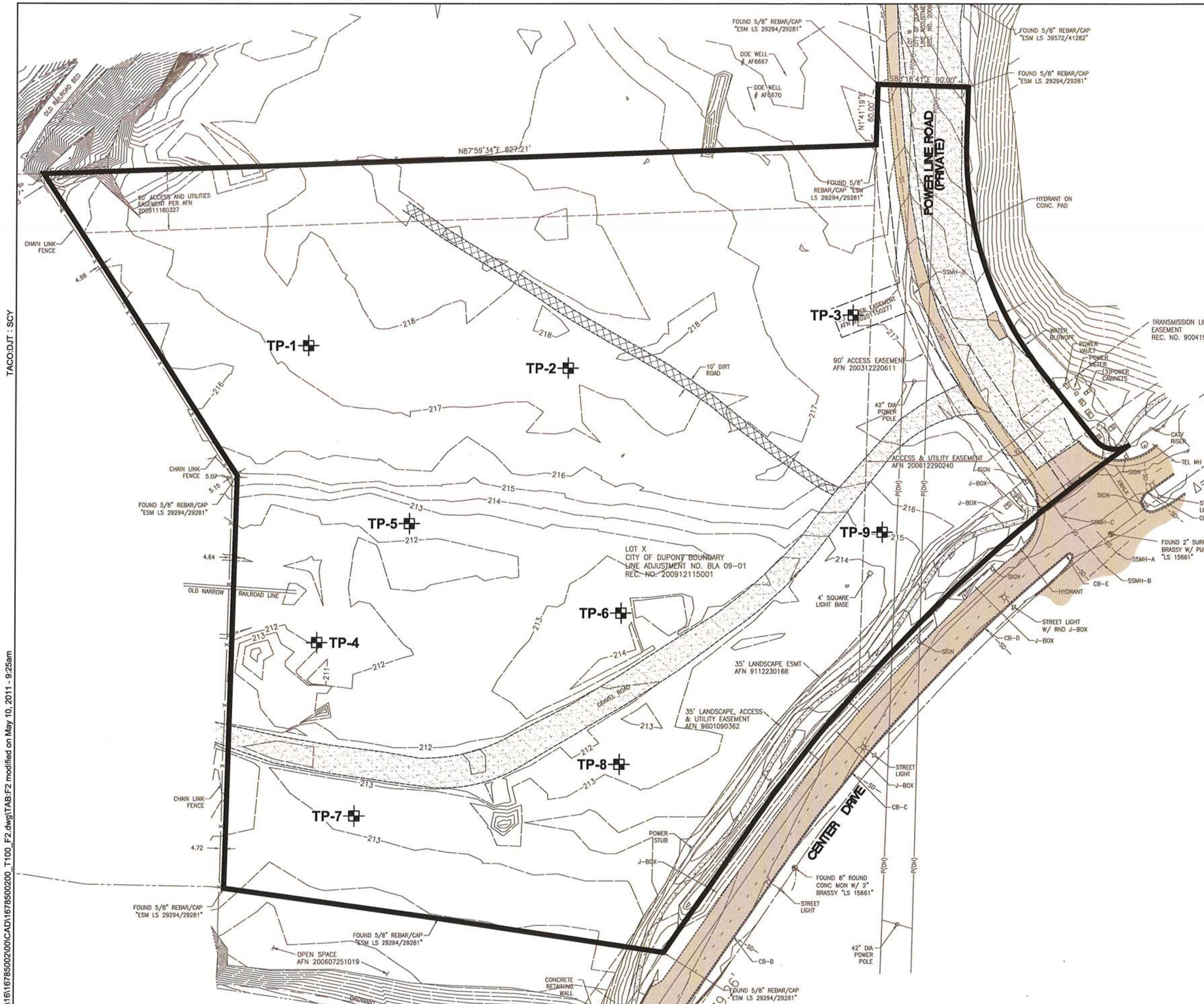
Figure 1



Legend

TP-1 ⊕ Test Pit number and location

▭ Project boundary

Notes:
1. The locations of all features shown are approximate.
2. This drawing is for information purposes. It is intended to assist in showing features discussed in an attached document. GeoEngineers, Inc. cannot guarantee the accuracy and content of electronic files. The master file is stored by GeoEngineers, Inc. and will serve as the official record of this communication.

Reference: Drawing provided by Barghausen Consulting Engineers, Inc.

100 0 100
Feet

Site Plan

DuPont Apartment Complex / Lot X
DuPont, Washington

GEOENGINEERS

Figure 2

APPENDIX A
Field Explorations and Laboratory Testing

APPENDIX A
FIELD EXPLORATIONS AND LABORATORY TESTING

Subsurface Explorations

Soil and groundwater conditions at the proposed development site were explored by excavating nine test pits on August 26, 2010. Subsurface exploratory services were subcontracted to GeoEngineers, Inc. The test pit explorations extended to depths between 10 and 12 feet below surrounding site grades.

The locations of the test pits were determined by electronic global positioning system (GPS) where available and by pacing and visual triangulation from existing site features such as roadways and property corners.. The elevations presented on the test pit logs are based on a site plan obtained from Barghausen Consulting Engineers. The locations and elevations of the explorations should be considered approximate. Locations of the explorations are provided on the Site Plan, Figure 2.

Our field representative obtained samples, classified the soils, maintained a detailed log of each exploration and observed groundwater conditions where applicable. The samples were retained in sealed plastic bags to prevent moisture loss. The soils were classified visually in general accordance with the system described in Figure A-1, which includes a key to the exploration logs. Summary logs of the explorations are included as Figures A-2 through A-10. The densities noted on the test pit exploration logs are based on the difficulty of excavation, observations of caving and our experience and judgment.

Laboratory Testing

Soil samples obtained from the test pits were transported to our laboratory and examined to confirm or modify field classifications, as well as to evaluate engineering properties of the soil. Representative samples were selected for laboratory testing. Laboratory testing included moisture content determination conducted in general accordance with ASTM International (ASTM) D 2216 and grain-size analyses conducted in general accordance with ASTM C 136. The sample test depths and moisture content test results are shown on the exploration logs. Sieve analysis results are presented in Figures A-11 and A-12.

SOIL CLASSIFICATION CHART

MAJOR DIVISIONS			SYMBOLS GRAPH	SYMBOLS LETTER	TYPICAL DESCRIPTIONS
COARSE GRAINED SOILS MORE THAN 50% RETAINED ON NO. 200 SIEVE	GRAVEL AND GRAVELLY SOILS MORE THAN 50% OF COARSE FRACTION RETAINED ON NO. 4 SIEVE	CLEAN GRAVELS (LITTLE OR NO FINES)		GW	WELL-GRADED GRAVELS, GRAVEL - SAND MIXTURES
				GP	POORLY-GRADED GRAVELS, GRAVEL - SAND MIXTURES
		GRAVELS WITH FINES (APPRECIABLE AMOUNT OF FINES)		GM	SILTY GRAVELS, GRAVEL - SAND - SILT MIXTURES
				GC	CLAYEY GRAVELS, GRAVEL - SAND - CLAY MIXTURES
	SAND AND SANDY SOILS MORE THAN 50% OF COARSE FRACTION PASSING NO. 4 SIEVE	CLEAN SANDS (LITTLE OR NO FINES)		SW	WELL-GRADED SANDS, GRAVELLY SANDS
				SP	POORLY-GRADED SANDS, GRAVELLY SAND
		SANDS WITH FINES (APPRECIABLE AMOUNT OF FINES)		SM	SILTY SANDS, SAND - SILT MIXTURES
				SC	CLAYEY SANDS, SAND - CLAY MIXTURES
FINE GRAINED SOILS MORE THAN 50% PASSING NO. 200 SIEVE	SILTS AND CLAYS	LIQUID LIMIT LESS THAN 50		ML	INORGANIC SILTS, ROCK FLOUR, CLAYEY SILTS WITH SLIGHT PLASTICITY
				CL	INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, GRAVELLY CLAYS, SANDY CLAYS, SILTY CLAYS, LEAN CLAYS
				OL	ORGANIC SILTS AND ORGANIC SILTY CLAYS OF LOW PLASTICITY
	SILTS AND CLAYS	LIQUID LIMIT GREATER THAN 50		MH	INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS SILTY SOILS
				CH	INORGANIC CLAYS OF HIGH PLASTICITY
				OH	ORGANIC CLAYS AND SILTS OF MEDIUM TO HIGH PLASTICITY
HIGHLY ORGANIC SOILS				PT	PEAT, HUMUS, SWAMP SOILS WITH HIGH ORGANIC CONTENTS

NOTE: Multiple symbols are used to indicate borderline or dual soil classifications

ADDITIONAL MATERIAL SYMBOLS

SYMBOLS GRAPH	SYMBOLS LETTER	TYPICAL DESCRIPTIONS
	CC	Cement Concrete
	AC	Asphalt Concrete
	CR	Crushed Rock/ Quarry Spalls
	TS	Topsoil/ Forest Duff/Sod

Measured groundwater level in exploration, well, or piezometer

Groundwater observed at time of exploration

Perched water observed at time of exploration

Measured free product in well or piezometer

Graphic Log Contact

Distinct contact between soil strata or geologic units

Approximate location of soil strata change within a geologic soil unit

Material Description Contact

Distinct contact between soil strata or geologic units

Approximate location of soil strata change within a geologic soil unit

Sampler Symbol Descriptions

2.4-inch I.D. split barrel

Standard Penetration Test (SPT)

Shelby tube

Piston

Direct-Push

Bulk or grab

Blowcount is recorded for driven samplers as the number of blows required to advance sampler 12 inches (or distance noted). See exploration log for hammer weight and drop.

A "P" indicates sampler pushed using the weight of the drill rig.

Laboratory / Field Tests

%F	Percent fines
AL	Atterberg limits
CA	Chemical analysis
CP	Laboratory compaction test
CS	Consolidation test
DS	Direct shear
HA	Hydrometer analysis
MC	Moisture content
MD	Moisture content and dry density
OC	Organic content
PM	Permeability or hydraulic conductivity
PP	Pocket penetrometer
SA	Sieve analysis
TX	Triaxial compression
UC	Unconfined compression
VS	Vane shear

Sheen Classification

NS	No Visible Sheen
SS	Slight Sheen
MS	Moderate Sheen
HS	Heavy Sheen
NT	Not Tested

NOTE: The reader must refer to the discussion in the report text and the logs of explorations for a proper understanding of subsurface conditions. Descriptions on the logs apply only at the specific exploration locations and at the time the explorations were made; they are not warranted to be representative of subsurface conditions at other locations or times.

KEY TO EXPLORATION LOGS

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FIGURE A-1

Date Excavated: 8/26/2010
Equipment: Case 580 Super M
Logged By: EAW
Total Depth (ft) 12.0

Elevation (feet)	Depth (feet)	Testing Sample	Sample Name / Testing	Graphic Log	Group Classification	Encountered Water	MATERIAL DESCRIPTION	Moisture Content, %	REMARKS
217	0–0.25				DUFF		3 inches duff		
	0.25–1	X	1		SM		Dark brown silty fine to coarse sand with gravel, trace organics (medium dense, moist)		
216–210	1–7.5	X	2		GP		Brown fine to coarse gravel with sand, trace silt, occasional cobbles (dense, moist)		
		X	3						
		X	4						
210–205	7.5–12	X	5 SA		GP-GM		Brown fine to coarse gravel with silt and sand, occasional cobbles (dense, moist)	4	
		X	6						
		X	7						

Test pit completed at 12 feet on 8/26/10
No groundwater seepage observed
Moderate caving observed at approximately 4+ feet

Notes: See Figure A-1 for explanation of symbols.
The depths on the test pit logs are based on an average of measurements across the test pit and should be considered accurate to 0.5 foot.

Tacoma: Date:5/10/11 Path:P:\16\16785002\GINT\1678500200.GPJ DBTemplate/LibTemplate:GEOENGINEERS8.GDT/GEI8_TESTPIT_1P_GEOTEC

Log of Test Pit TP-1

GeoEngineers

Project: DuPont Apartment Complex/Lot X
Project Location: DuPont, Washington
Project Number: 16785-002-00

Date Excavated: 8/26/2010 | Logged By: EAW
Equipment: Case 580 Super M | Total Depth (ft) 12.0

Elevation (feet)	Depth (feet)	SAMPLE: Testing Sample	SAMPLE: Sample Name / Testing	Graphic Log	Group Classification	Encountered Water	MATERIAL DESCRIPTION	Moisture Content, %	REMARKS
217	0				DUFF		3 inches duff		
		X	1		SM		Dark brown silty fine to coarse sand with gravel, occasional cobbles (medium dense, moist)		
216	1				GP		Brown fine to coarse gravel with sand, trace silt, occasional cobbles (dense, moist)		
		X	2						
215	2								
214	3								
213	4								
212	5	X	3 SA					3	
211	6								
210	7								
209	8								
208	9	X	4						
207	10								
206	11	X	5						
	12								

Test pit completed at 12 feet on 8/26/10
No groundwater seepage observed
Moderate caving observed at 8+ feet

Notes: See Figure A-1 for explanation of symbols.
The depths on the test pit logs are based on an average of measurements across the test pit and should be considered accurate to 0.5 foot.

Tacoma: Date:5/10/11 Path:P:\16\16785002\GINT\1678500200.GPJ DBTemplate/LibTemplate:GEOENGINEERS8.GDT/GEI8_TESTPIT_1P_GEOTEC

Log of Test Pit TP-2

GEOENGINEERS

Project: DuPont Apartment Complex/Lot X
Project Location: DuPont, Washington
Project Number: 16785-002-00

Figure A-3
Sheet 1 of 1

Date Excavated: 8/26/2010

Equipment: Case 580 Super M

Logged By: EAW

Total Depth (ft) 12.0

Elevation (feet)	Depth (feet)	Testing Sample	Sample Name / Testing	Graphic Log	Group Classification	Encountered Water	MATERIAL DESCRIPTION	Moisture Content, %	REMARKS
216	0–1	X	1		GP-GM		Gray fine to coarse gravel with silt and sand, occasional cobbles (medium dense, moist) (fill)		
215	1–2	X	2		SM		Dark brown silty fine to coarse sand with gravel, occasional cobbles, trace organics (medium dense, moist)		
214	2–3				GP		Brown fine to coarse gravel with sand, trace silt, occasional cobbles (dense, moist)		
213	4	X	3						
212	5								
211	6	X	4 SA					3	
210	7								
209	8	X	5						
208	9								
207	10								
206	11								
205	12	X	6						

Test pit completed at 12 feet on 8/26/10
No groundwater seepage observed
Moderate caving observed at 4+ feet

Notes: See Figure A-1 for explanation of symbols.
The depths on the test pit logs are based on an average of measurements across the test pit and should be considered accurate to 0.5 foot.

Tacoma: Date:5/10/11 Path:P:\16\1678500200\GINT\1678500200.GPJ DBTemplate/LibTemplate:GEOENGINEERS8.GDT/GEI8_TESTPIT_1P_GEOTEC

Log of Test Pit TP-3

GEOENGINEERS

Project: DuPont Apartment Complex/Lot X
Project Location: DuPont, Washington
Project Number: 16785-002-00

Date Excavated: 8/26/2010 Logged By: EAW
Equipment: Case 580 Super M Total Depth (ft) 10.0

Elevation (feet)	Depth (feet)	SAMPLE: Testing Sample	SAMPLE: Sample Name Testing	Graphic Log	Group Classification	Encountered Water	MATERIAL DESCRIPTION	Moisture Content, %	REMARKS
	0				DUFF		3 inches duff		
211	1	X	1		SM		Dark brown silty fine to coarse sand with gravel (medium dense, moist)		
210	2				GP		Brown fine to coarse gravel with sand, trace silt, occasional cobbles (dense, moist)		
209	3								
208	4	X	2						
207	5								
206	6	X	3						
205	7								
204	8								
203	9								
202	10	X	4						

Test pit completed at 10 feet on 8/26/10
No groundwater seepage observed
Minor caving observed at 6+ feet

Notes: See Figure A-1 for explanation of symbols.
The depths on the test pit logs are based on an average of measurements across the test pit and should be considered accurate to 0.5 foot.

Tacoma: Date:5/10/11 Path:P:\16\16785002\GINT\1678500200.GPJ DBTemplate/LibTemplate:GEOENGINEERS8.GDT/GE8_TESTPIT_1P_GEOTEC

Log of Test Pit TP-4

GEOENGINEERS

Project: DuPont Apartment Complex/Lot X
Project Location: DuPont, Washington
Project Number: 16785-002-00

Figure A-5
Sheet 1 of 1

Date Excavated: 8/26/2010

Equipment: Case 580 Super M

Logged By: EAW

Total Depth (ft) 10.0

Elevation (feet)	Depth (feet)	Testing Sample	Sample Name / Testing	Graphic Log	Group Classification	Encountered Water	MATERIAL DESCRIPTION	Moisture Content, %	REMARKS
212	0				DUFF		3 inches duff		
					SM		Dark brown silty fine to coarse sand with gravel, trace organics (medium dense, moist)		
211	1				GW		Brown fine to coarse gravel with sand, trace silt (dense, moist)		
210	2	X	1						
209	3	X	2 SA					2	
208	4								
207	5	X	3						
206	6								
205	7								
204	8								
203	9	X	4						
	10								

Test pit completed at 10 feet on 8/26/10
No groundwater seepage observed
Minor caving observed at approximately 4+ feet

Notes: See Figure A-1 for explanation of symbols.
The depths on the test pit logs are based on an average of measurements across the test pit and should be considered accurate to 0.5 foot.

Tacoma: Date:5/10/11 Path:P:\16\1678500200\GINT\1678500200.GPJ DBTemplate/LibTemplate:GEOENGINEERS8.GDT/GEI8_TESTPIT_1P_GEOTEC

Log of Test Pit TP-5

GEOENGINEERS

Project: DuPont Apartment Complex/Lot X

Project Location: DuPont, Washington

Project Number: 16785-002-00

Figure A-6

Sheet 1 of 1

Date Excavated: 8/26/2010

Equipment: Case 580 Super M

Logged By: EAW

Total Depth (ft) 10.0

Elevation (feet)	Depth (feet)	Testing Sample	Sample Name Testing	Graphic Log	Group Classification	Encountered Water	MATERIAL DESCRIPTION	Moisture Content, %	REMARKS
	0				SOD		3 inches sod		
213					SM		Dark brown silty fine to coarse sand with gravel, trace organics (medium dense, moist) (topsoil)		
212	1				GP		Brown fine to coarse gravel with sand, trace silt (dense, moist)		
211	2	X	1						
210	3								
209	4								
208	5	X	2						
207	6								
206	7	X	3						
205	8								
204	9	X	4						
	10								

Test pit completed at 10 feet on 8/26/10
No groundwater seepage observed
Minor caving observed at approximately 4+ feet

Notes: See Figure A-1 for explanation of symbols.
The depths on the test pit logs are based on an average of measurements across the test pit and should be considered accurate to 0.5 foot.

Tacoma: Date:5/10/11 Path:P:\16\1678502\GINT\1678500200.GPJ DBTemplate/LibTemplate:GEOENGINEERS8.GDT/GEI8_TESTPIT_1P_GEOTEC

Log of Test Pit TP-6

GEOENGINEERS

Project: DuPont Apartment Complex/Lot X
Project Location: DuPont, Washington
Project Number: 16785-002-00

Date Excavated: 8/26/2010

Equipment: Case 580 Super M

Logged By: EAW

Total Depth (ft) 12.0

Elevation (feet)	Depth (feet)	SAMPLE: Testing Sample	SAMPLE: Sample Name / Testing	Graphic Log	Group Classification	Encountered Water	MATERIAL DESCRIPTION	Moisture Content, %	REMARKS
					DUFF		3 inches duff		
212	1	X	1		SM		Dark brown silty fine to coarse sand with gravel (medium dense, moist)		
211	2				GP		Brown fine to coarse gravel with sand, trace silt (dense, moist)		
210	3	X	2						
209	4								
208	5								
207	6	X	3 SA					3	
206	7								
205	8	X	4						
204	9								
203	10	X	5						
202	11								
201	12	X	6						

Test pit completed at 12 feet on 8/26/10
No groundwater seepage observed
Moderate caving observed at approximately 4+ feet

Notes: See Figure A-1 for explanation of symbols.
The depths on the test pit logs are based on an average of measurements across the test pit and should be considered accurate to 0.5 foot.

Log of Test Pit TP-7

GeoEngineers

Project: DuPont Apartment Complex/Lot X
Project Location: DuPont, Washington
Project Number: 16785-002-00

Date Excavated: 8/26/2010
Equipment: Case 580 Super M

Logged By: EAW
Total Depth (ft) 12.0

Elevation (feet)	Depth (feet)	SAMPLE: Testing Sample	SAMPLE: Sample Name / Testing	Graphic Log	Group Classification	Encountered Water	MATERIAL DESCRIPTION	Moisture Content, %	REMARKS
212	0				DUFF		3 inches duff		
					SM		Dark brown silty fine to coarse sand with gravel, trace organics (medium dense, moist) (topsoil)		
211	1				GP		Brown fine to coarse gravel with sand, trace silt (dense, moist)		
210	2		1						
209	3								
208	4								
207	5		2						
206	6				GW		Brown fine to coarse gravel with sand, trace silt (dense, moist)		
205	7		3 SA					4	
204	8								
203	9		4						
202	10								
201	11		5						
	12								

Test pit completed at 12 feet on 8/26/10
No groundwater seepage observed
Moderate caving observed at approximately 4+ feet

Notes: See Figure A-1 for explanation of symbols.
The depths on the test pit logs are based on an average of measurements across the test pit and should be considered accurate to 0.5 foot.

Tacoma: Date:5/10/11 Path:P:\16\1678500\2\GINT\1678500200.GPJ DBTemplate/LibTemplate:GEOENGINEERS8.GDT/GEI8_TESTPIT_1P_GEOTEC

Log of Test Pit TP-8

GEOENGINEERS

Project: DuPont Apartment Complex/Lot X
Project Location: DuPont, Washington
Project Number: 16785-002-00

Figure A-9
Sheet 1 of 1

Date Excavated: 8/26/2010
Equipment: Case 580 Super M
Logged By: EAW
Total Depth (ft) 12.0

Elevation (feet)	Depth (feet)	Testing Sample	Sample Name / Testing	Graphic Log	Group Classification	Encountered Water	MATERIAL DESCRIPTION	Moisture Content, %	REMARKS
	0				DUFF		3 inches duff		
214	1	X	1		SM		Dark brown silty fine to coarse sand with gravel (medium dense, moist) (topsoil)		
213	2	X	2		GP		Brown fine to coarse gravel with sand, trace silt (dense, moist)		
212	3								
211	4								
210	5								
209	6	X	3 SA					3	
208	7				SP		Brown fine to coarse sand with gravel, trace silt (dense, moist)		
207	8	X	4 SA					5	
206	9								
205	10	X	5						
204	11						Grades to without gravel		
203	12	X	6						

Test pit completed at 12 feet on 8/26/10
No groundwater seepage observed
Moderate caving observed at approximately 4+ feet

Notes: See Figure A-1 for explanation of symbols.
The depths on the test pit logs are based on an average of measurements across the test pit and should be considered accurate to 0.5 foot.

Log of Test Pit TP-9

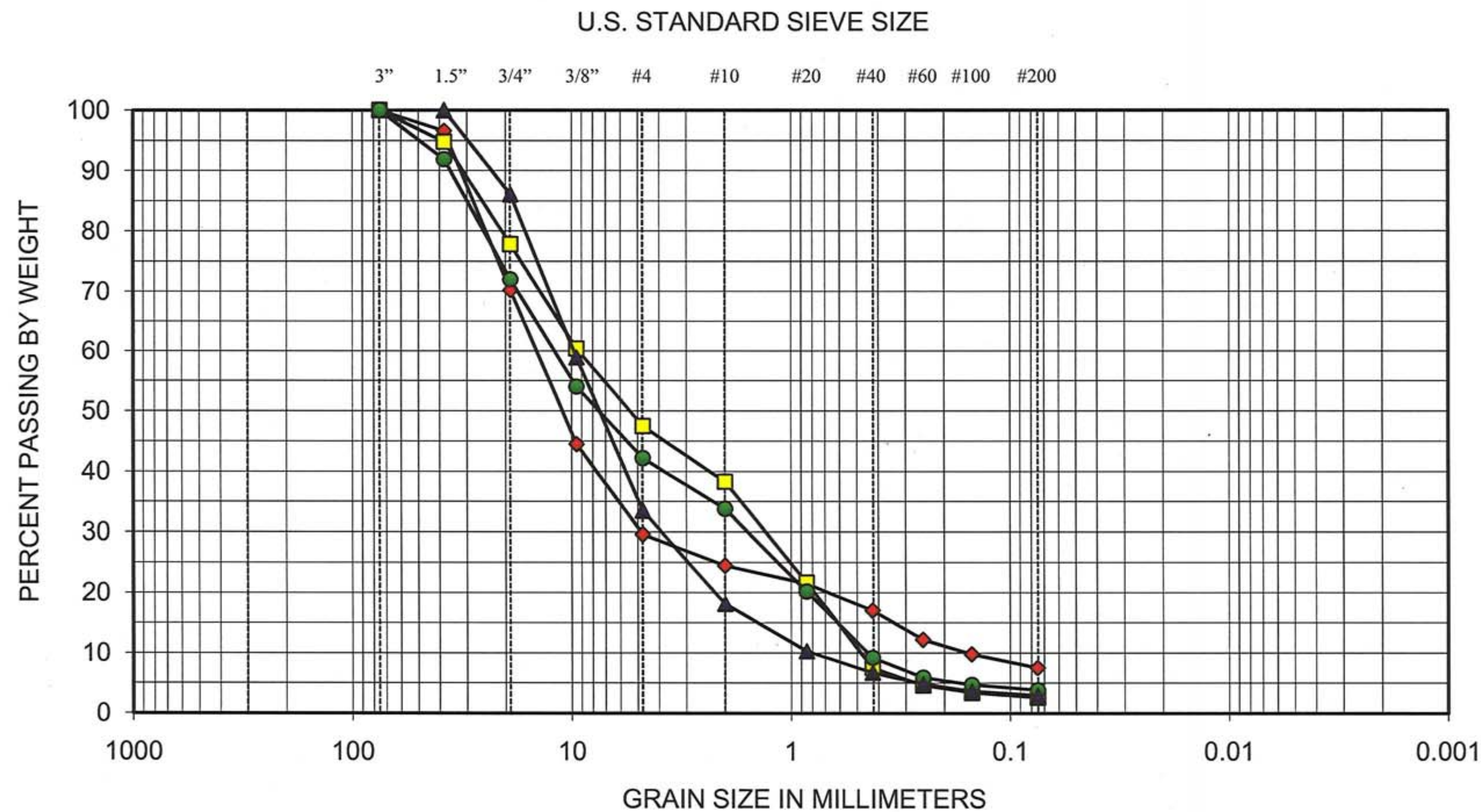
GEOENGINEERS

Project: DuPont Apartment Complex/Lot X
Project Location: DuPont, Washington
Project Number: 16785-002-00

Figure A-10
Sheet 1 of 1

Tacoma: Date:5/10/11 Path:P:\16\16785002\GINT\1678500200.GPJ DBTemplate/LibTemplate:GEOENGINEERS8.GDT/GEI8_TESTPIT_1P_GEOTEC

16785-002-00 MJH:AMD:tt 051011



BOULDERS	COBBLES	GRAVEL		SAND			SILT OR CLAY
		COARSE	FINE	COARSE	MEDIUM	FINE	

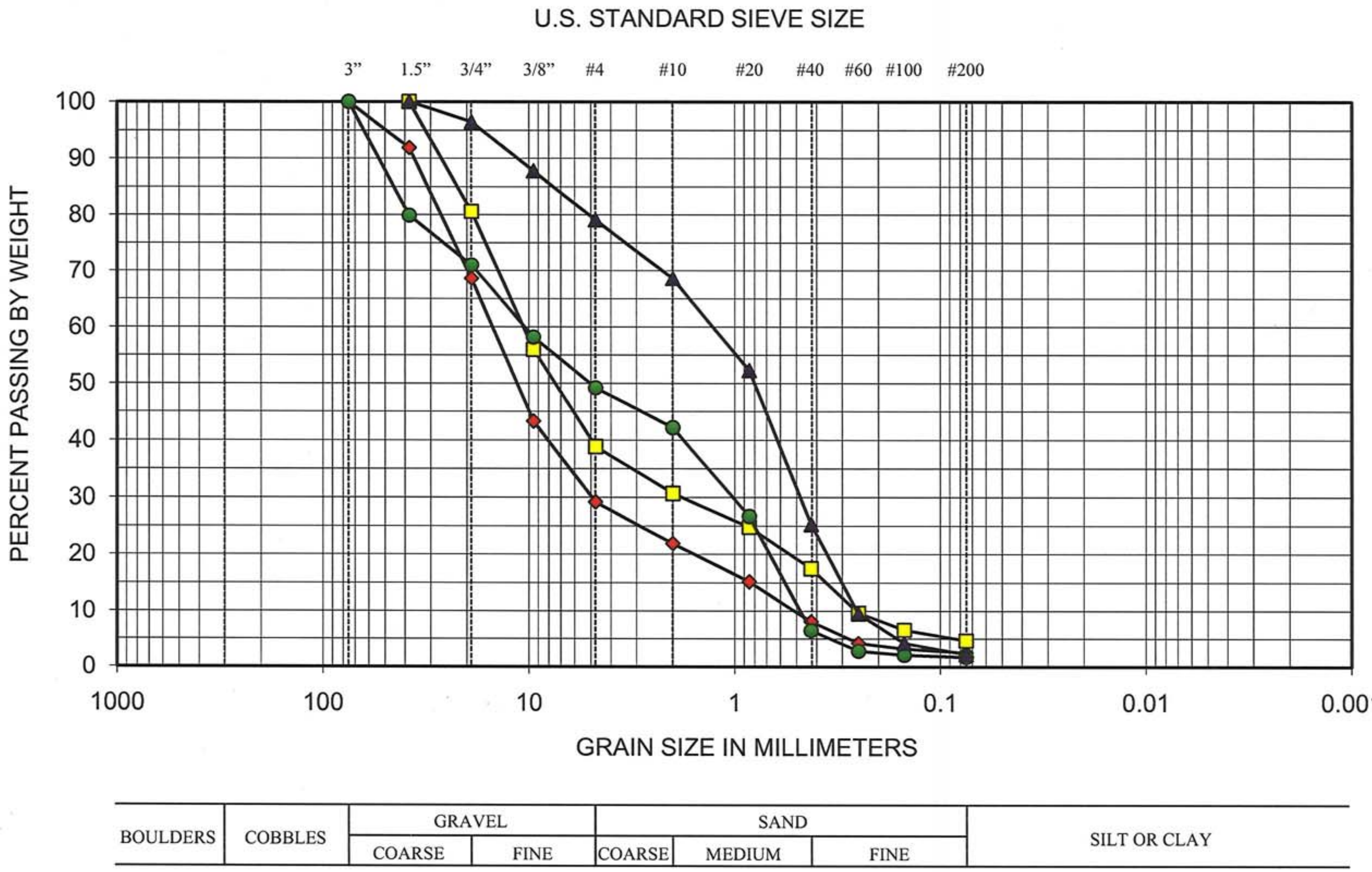
SYMBOL	EXPLORATION NUMBER	DEPTH (ft)	SOIL CLASSIFICATION
◆ (red diamond)	TP-1	7.5	Gravel with silt and sand (GP-GM)
■ (yellow square)	TP-2	5.5	Gravel with sand (GP)
● (green circle)	TP-3	5.5	Gravel with sand (GP)
▲ (triangle)	TP-5	3.5	Gravel with sand (GW)

GEOENGINEERS

SIEVE ANALYSIS RESULTS

FIGURE A-11

16785-002-00 MJH:AMD:tt 051011



SYMBOL	EXPLORATION NUMBER	DEPTH (ft)	SOIL CLASSIFICATION
◆	TP-7	5.5	Gravel with sand (GP)
□	TP-8	7.5	Gravel with sand (GW)
●	TP-9	5.5	Gravel with sand (GP)
▲	TP-9	7.5	Sand with gravel (SP)

GEOENGINEERS

SIEVE ANALYSIS RESULTS

FIGURE A-12

APPENDIX B
Report Limitations and Guidelines for Use

APPENDIX B
REPORT LIMITATIONS AND GUIDELINES FOR USE[1]

This appendix provides information to help you manage your risks with respect to the use of this report.

Geotechnical Services are Performed for Specific Purposes, Persons and Projects

This report has been prepared for the exclusive use of Creekside DuPont Partners, LLC and their authorized agents. This report is not intended for use by others, and the information contained herein is not applicable to other sites.

GeoEngineers structures our services to meet the specific needs of our clients. For example, a geotechnical or geologic study conducted for a civil engineer or architect may not fulfill the needs of a construction contractor or even another civil engineer or architect that are involved in the same project. Because each geotechnical or geologic study is unique, each geotechnical engineering or geologic report is unique, prepared solely for the specific client and project site. Our report is prepared for the exclusive use of our Client. No other party may rely on the product of our services unless we agree in advance to such reliance in writing. This is to provide our firm with reasonable protection against open-ended liability claims by third parties with whom there would otherwise be no contractual limits to their actions. Within the limitations of scope, schedule and budget, our services have been executed in accordance with our Agreement with the Client and generally accepted geotechnical practices in this area at the time this report was prepared. This report should not be applied for any purpose or project except the one originally contemplated.

A Geotechnical Engineering or Geologic Report is Based on a Unique Set of Project-Specific Factors

This report has been prepared for the DuPont Apartment Complex/Lot X. GeoEngineers considered a number of unique, project-specific factors when establishing the scope of services for this project and report. Unless GeoEngineers specifically indicates otherwise, do not rely on this report if it was:

- not prepared for you,
- not prepared for your project,
- not prepared for the specific site explored, or
- completed before important project changes were made.

For example, changes that can affect the applicability of this report include those that affect:

- the function of the proposed structure;
- elevation, configuration, location, orientation or weight of the proposed structure;

---

[1] Developed based on material provided by ASFE, Professional Firms Practicing in the Geosciences; www.asfe.org.

- composition of the design team; or
- project ownership.

If important changes are made after the date of this report, GeoEngineers should be given the opportunity to review our interpretations and recommendations and provide written modifications or confirmation, as appropriate.

Subsurface Conditions Can Change

This geotechnical or geologic report is based on conditions that existed at the time the study was performed. The findings and conclusions of this report may be affected by the passage of time, by manmade events such as construction on or adjacent to the site, or by natural events such as floods, earthquakes, slope instability or groundwater fluctuations. Always contact GeoEngineers before applying a report to determine if it remains applicable.

Topsoil

For the purposes of this report, we consider topsoil to consist of generally fine-grained soil with an appreciable amount of organic matter based on visual examination, and to be unsuitable for direct support of the proposed improvements. However, the organic content and other mineralogical and gradational characteristics used to evaluate the suitability of soil for use in landscaping and agricultural purposes was not determined, nor considered in our analyses. Therefore, the information and recommendations in this report, and our logs and descriptions should not be used as a basis for estimating the volume of topsoil available for such purposes.

Most Geotechnical and Geologic Findings Are Professional Opinions

Our interpretations of subsurface conditions are based on field observations from widely spaced sampling locations at the site. Site exploration identifies subsurface conditions only at those points where subsurface tests are conducted or samples are taken. GeoEngineers reviewed field and laboratory data and then applied our professional judgment to render an opinion about subsurface conditions throughout the site. Actual subsurface conditions may differ, sometimes significantly, from those indicated in this report. Our report, conclusions and interpretations should not be construed as a warranty of the subsurface conditions.

Geotechnical Engineering Report Recommendations Are Not Final

Do not over-rely on the preliminary construction recommendations included in this report. These recommendations are not final, because they were developed principally from GeoEngineers' professional judgment and opinion. GeoEngineers' recommendations can be finalized only by observing actual subsurface conditions revealed during construction. GeoEngineers cannot assume responsibility or liability for this report's recommendations if we do not perform construction observation.

Sufficient monitoring, testing and consultation by GeoEngineers should be provided during construction to confirm that the conditions encountered are consistent with those indicated by the explorations, to provide recommendations for design changes should the conditions revealed during the work differ from those anticipated, and to evaluate whether or not earthwork activities are completed in accordance with our recommendations. Retaining GeoEngineers for construction observation for this project is the most effective method of managing the risks associated with unanticipated conditions.

A Geotechnical Engineering or Geologic Report Could be Subject to Misinterpretation

Misinterpretation of this report by other design team members can result in costly problems. You could lower that risk by having GeoEngineers confer with appropriate members of the design team after submitting the report. Also retain GeoEngineers to review pertinent elements of the design team's plans and specifications. Contractors can also misinterpret a geotechnical engineering or geologic report. Reduce that risk by having GeoEngineers participate in pre-bid and preconstruction conferences, and by providing construction observation.

Do Not Redraw the Exploration Logs

Geotechnical engineers and geologists prepare final boring and testing logs based upon their interpretation of field logs and laboratory data. To prevent errors or omissions, the logs included in a geotechnical engineering or geologic report should never be redrawn for inclusion in architectural or other design drawings. Only photographic or electronic reproduction is acceptable, but recognize that separating logs from the report can elevate risk.

Give Contractors a Complete Report and Guidance

Some owners and design professionals believe they can make contractors liable for unanticipated subsurface conditions by limiting what they provide for bid preparation. To help prevent costly problems, give contractors the complete geotechnical engineering or geologic report, but preface it with a clearly written letter of transmittal. In that letter, advise contractors that the report was not prepared for purposes of bid development and that the report's accuracy is limited; encourage them to confer with GeoEngineers and/or to conduct additional study to obtain the specific types of information they need or prefer. A pre-bid conference can also be valuable. Be sure contractors have sufficient time to perform additional study. Only then might an owner be in a position to give contractors the best information available, while requiring them to at least share the financial responsibilities stemming from unanticipated conditions. Further, a contingency for unanticipated conditions should be included in your project budget and schedule.

Contractors are Responsible for Site Safety on their Own Construction Projects

Our geotechnical recommendations are not intended to direct the contractor's procedures, methods, schedule or management of the work site. The contractor is solely responsible for job site safety and for managing construction operations to minimize risks to on-site personnel and to adjacent properties.

Read These Provisions Closely

Some clients, design professionals and contractors may not recognize that the geoscience practices (geotechnical engineering or geology) are far less exact than other engineering and natural science disciplines. This lack of understanding can create unrealistic expectations that could lead to disappointments, claims and disputes. GeoEngineers includes these explanatory “limitations” provisions in our reports to help reduce such risks. Please confer with GeoEngineers if you are unclear how these "Report Limitations and Guidelines for Use" apply to your project or site.

Geotechnical, Geologic and Environmental Reports Should not be Interchanged

The equipment, techniques and personnel used to perform an environmental study differ significantly from those used to perform a geotechnical or geologic study and vice versa. For that reason, a geotechnical engineering or geologic report does not usually relate any environmental findings, conclusions or recommendations; e.g., about the likelihood of encountering underground storage tanks or regulated contaminants. Similarly, environmental reports are not used to address geotechnical or geologic concerns regarding a specific project.

Biological Pollutants

GeoEngineers' Scope of Work specifically excludes the investigation, detection, prevention, or assessment of the presence of Biological Pollutants in or around any structure. Accordingly, this report includes no interpretations, recommendations, findings, or conclusions for the purpose of detecting, preventing, assessing, or abating Biological Pollutants. The term "Biological Pollutants" includes, but is not limited to, molds, fungi, spores, bacteria, and viruses, and/or any of their byproducts.

GeoEngineers
1101 South Fawcett Avenue, Suite 200
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253.383.4940

May 11, 2018

DuPont Industrial Partners, LLC
C/O Barghausen Consulting Engineers, Inc.
18215 72nd Avenue South
Kent, Washington 98032

Attention: Dan Balmelli, PE

Subject: Report Addendum
Geotechnical Engineering Services
DuPont Industrial Warehouse
DuPont, Washington
File No. 16785-003-01

INTRODUCTION AND PROJECT UNDERSTANDING

This report addendum presents supplemental geotechnical recommendations and considerations for the DuPont Industrial Warehouse (previously titled as Lot "Y" Industrial Park). As part of this addendum, we are addressing comments in the City of DuPont Type III Site Plan Review and SEPA Environmental Review (PLNG 2018-008, -009) letter dated February 23, 2018. We have prepaired a geotechnical study dated October 10, 2011 for this project (October report). We understand that plans are underway to design and construct two (approximately 130,000 square feet each) industrial buildings (Building A and Building B) in the west portion of the site. Finished floor will be near Elevation 214 to 215 feet (NGVD29). Additional improvements will include site grading, installation of utilities, asphalt paving and construction of retaining structures. We include a revised and updated Site Plan with the proposed buildings and construction, attached as Figure 1.

We have reviewed preliminary civil engineering plan sheets C1 through C13 (civil plans). We understand that a retaining wall will be constructed south of Building B. The retaining wall will be located in a current ravine/depression area that will retain fill as part of site grading. The retaining wall is also just north of the border of a 50-foot setback boundary or buffer from the steep slopes located north of the property. The wall foundations of the retaining wall may encroach into the buffer. From the grading plan, it appears that the retaining wall will retain approximately 7 feet of fill at it's deepest point and taper off in the east and west direction.

CONCLUSIONS AND RECOMMENDATIONS

Encroachment Into Buffer Setback Area

Based on our review of proposed plans and subsurface explorations completed as part of our October study, we provide the following:

- It is our opinion that the proposed final site development condition, as reviewed, will not create a hazard to the subject property, surrounding properties, erosion, or sedimentation to off-site properties or bodies of water. The property will be paved and stormwater will be managed and directed into stormwater infiltration galleries. The proposed construction appears to eliminate the potential for erosion and channeling of water onto the slope area.
- Proper erosion and sedimentation will be required during construction. A temporary erosion and sedimentation control (TESC) plan has been developed for the subject site (sheets C2, C3, and C4 of the civil plans). This plan includes TESC measures that surround the proposed retaining structure. Temporary slope inclinations, protection of temporary slopes and erosion control recommendations are provided in our report and should be followed during construction.
- Additional construction recommendations presented in DMC 25.105.04(2)(c) should be implemented during physical grading and site development. These include minimizing erosion and landslide potential and minimizing disruption of the existing topography and natural vegetation. Care should be taken to cut slopes at inclinations recommended in our report and disturb only areas required to complete the work. Contractors completing earthwork should be made aware of the requirements presented in the DMC 25.105.02(2)(c).
- Final erosion control measures, once construction is complete, should include provisions as described in our October report.
- Because the retaining wall will be constructed between a sloping ravine, foundation elements for the retaining wall should be embeded deep enough such that a 2H to 1V (horizontal:vertical) slope from the lowest outermost foundation element is maintained from the toe of surrounding slopes. This may require additional excavation for the foundation and subsequent burying of portions of the retaining wall. Subgrade and bearing surface preparation recommendations presented in our October report should be followed.

UPDATED SEISMIC DESIGN CONSIDERATIONS

During preparation of our report, the 2009 International Building Code (IBC) was cited for seismic design criteria. Based on the 2015 IBC, we still conclude that the site may be characterized as Class C. Seismic design parameters in accordance with the 2015 IBC are provided in Table 1 below.

TABLE 1. 2015 IBC SEISMIC DESIGN VALUES

Site Coefficient	Site Factor	MCE[1] Spectral Response	Design Spectral Response
S_s = 1.304 g	F_a = 1.000	S_{MS} = 1.304 g	S_{DS} = 0.869 g
S_1 = 0.520 g	F_v = 1.300	S_{M1} = 0.676 g	S_{D1} = 0.451 g

Note:

[1] MCE = Maximum Considered Earthquake

Based on our understanding of site conditions, we recommend using a peak ground acceleration (PGA) equal to 0.5g as determined in accordance with Section 11.8.3 of American Society of Civil Engineers (ASCE) Standard 7-10. This is the same value as sited in the 2009 IBC.

USE OF PREVIOUS REPORT

Except as modified herin, we conclude that the recommendations and design considerations presented in our Ocbober 10, 2011 are still appropriate for this site and may be used for this project.

LIMITATIONS

We have prepared this report addendum for DuPont Industrial Partners LLC and Barghausen Engineers Inc. for the DuPont Industrial Warehouse project. The client may distribute copies of this report addendum to owner and owner's authorized agents and regulatory agencies as may be required for the project.

Within the limitations of scope, schedule and budget, our services have been executed in accordance with generally accepted practices for geotechnical engineering services in this area at the time this report addendum was prepared. The conclusions, recommendations, and opinions presented in this report addendum are based on our professional knowledge, judgment and experience. No warranty, express or implied, applies to the services or this report addendum.

The limitations presented in our October 11, 2011 report apply to this addendum. Please refer to Appendix B titled "Report Limitations and Guidelines for Use" of our October 11, 2011 Geotechnical Engineering Services Report for additional information pertaining to use of this report addendum.

Respectfully Submitted,
GeoEngineers, Inc.

Dennis (DJ) Thompson, PE
Associate

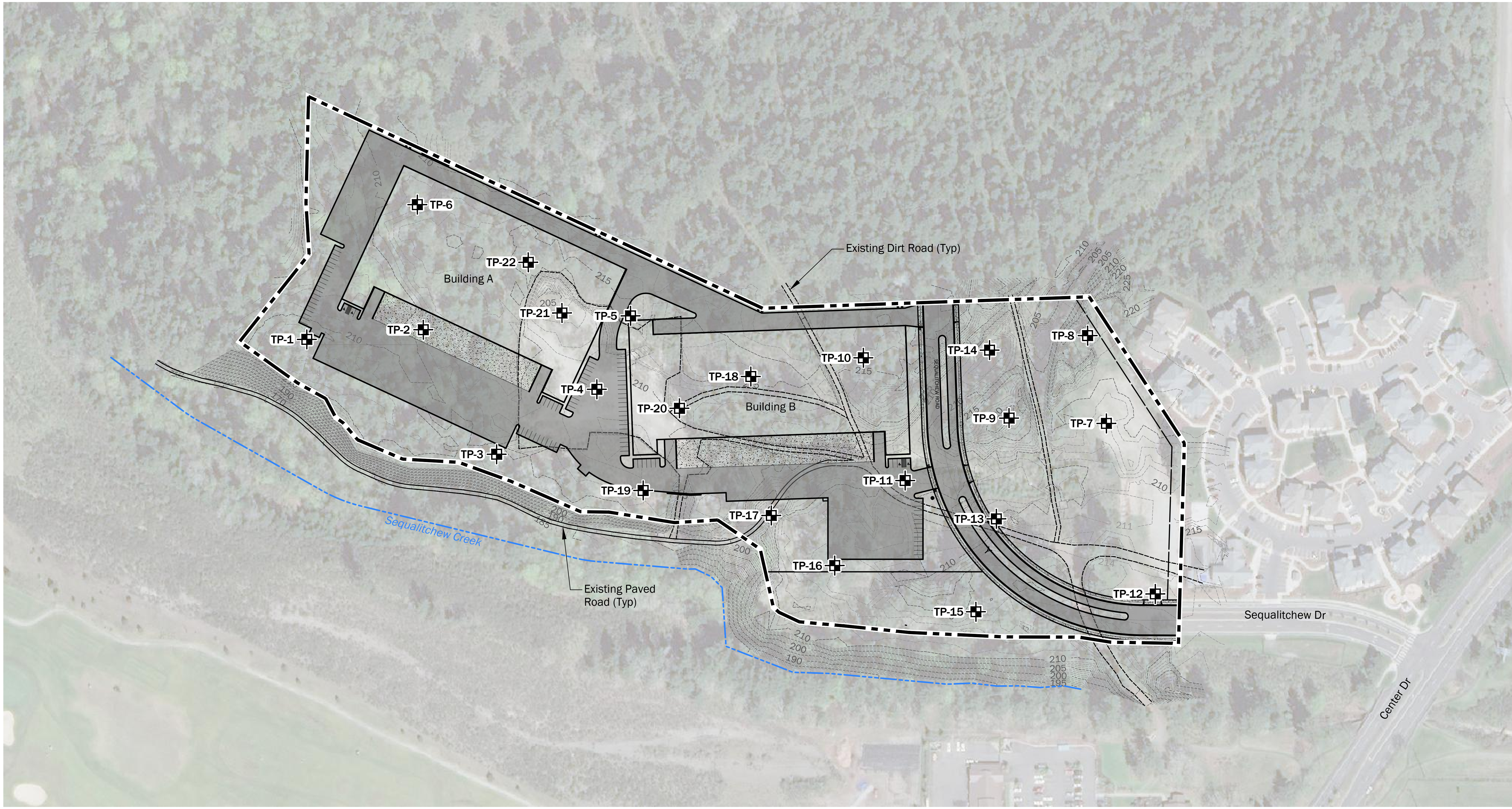
DENNIS JOHN THOMPSON
STATE OF WASHINGTON
38397
REGISTERED
PROFESSIONAL ENGINEER

May 11, 2018

DJT:tt

Attachment:
Figure 1 – Vicinity Map

Disclaimer: Any electronic form, facsimile or hard copy of the original document (email, text, table, and/or figure), if provided, and any attachments are only a copy of the original document. The original document is stored by GeoEngineers, Inc. and will serve as the official document of record.



Notes:

1. The locations of all features shown are approximate.
2. This drawing is for information purposes. It is intended to assist in showing features discussed in an attached document. GeoEngineers, Inc. cannot guarantee the accuracy and content of electronic files. The master file is stored by GeoEngineers, Inc. and will serve as the official record of this communication.

Data Source:
Aerial from Microsoft Bing. Survey background from Barghausen Consulting Engineers, Inc dated 8/8/2011. Proposed Plan from Barghausen Consulting Engineers, Inc dated 9/17/17.

Projection: Washington State Plane, South Zone, NAD83, US Foot

Legend

Site Boundary

TP-X Test Pit

N W E S

200 0 200
Feet

Site Plan

Lot Y Industrial Park
DuPont, Washington

GEOENGINEERS

Figure 1

P:\16\16785003\CAD\00\GeoTech Report\1678500300_F02_Site Plan.dwg TAB:F02 Date Exported: 05/04/18 - 12:49 by cstickel

GeoEngineers
1101 South Fawcett Avenue, Suite 200
Tacoma, Washington 98402
253.383.4940

August 1, 2023

Avenue 55, LLC
601 Union Street, Suite 2930
Seattle, Washington 98101

Attention: Ben Varin

Subject: Revised Report Addendum 2
Geotechnical Engineering Services
DuPont 243
DuPont, Washington
File No. 26421-001-00

INTRODUCTION AND PROJECT UNDERSTANDING

This revised report addendum presents supplemental geotechnical recommendations and considerations for the proposed DuPont 243 project and is intended to replace our Report Addendum dated November 8, 2022 (2022 Addendum[1]). The purpose of this revision is to reflect the updated site plan layout described below and review final geotechnical design considerations presented in that study. The site is located at 1700 Center Drive in DuPont, Washington. An overview of the property and surrounding area is shown on the Figure 1, Vicinity Map.

Our experience at the site includes involvement with the previous owner, Dupont Station Partners, LLC. for the proposed DuPont Industrial Warehouse (also referred to as Lot "Y" Industrial Park). We understand you have been given permission by Dupont Station Partners, LLC and have the full use of studies held by GeoEngineers, Inc. (GeoEngineers) and as related to the site address. Our previous geotechnical deliverables for the site consist of:

- "Geotechnical Engineering Services, Lot 'Y' Industrial Park, DuPont, Washington" dated October 10, 2011 (2011 Report). As part of our services, we advanced 22 test pit explorations in the project area to develop an understanding of subsurface conditions. The 2011 Report presents

[1] "Report Addendum, Geotechnical Engineering Services, DuPont Industrial Park, DuPont, Washington", prepared for Avenue 55, LLC, dated November 8, 2022.

a summary of our findings, conclusions and recommendations regarding geotechnical engineering aspects of the proposed industrial park development.

- "Report Addendum, Geotechnical Engineering Services, DuPont Industrial Warehouse, DuPont, Washington" dated May 11, 2018 (2018 Addendum), which includes our review of a proposed development site plan and updated recommended seismic design parameters.

Our understanding of the current project is based on discussions and correspondence with Avenue 55, LLC, Barghausen Consulting Engineers, Inc. (project civil engineer) and Innova Architects (project architect). We were provided an updated site plan sheet A0.1 "SEPA Permit Date July 17, 2023". The overall project will include construction of an approximate 243,000 square foot, dock-high slab, warehouse building, referred to as Building A. Surrounding improvements will include paved parking and driveway areas, hardscaping, new utility installation, landscaping and stormwater management facilities, including an approximate 27,000 square foot infiltration pond (inferred from above plans). Additional elements may or may not include relatively short retaining walls (less than 8 feet tall) along the south property area, which will be considered as landscaping elements, to separate the project site from the Lower Sequalitchew Creek and associated buffers.

This report addendum is intended to provide recommendations to accommodate the proposed current design but also, some slight variations to the site planning and design (e.g., addition or elimination of retaining walls, small outbuilding structures, changes to roadway alignments, etc.). As such, we support the use of this geotechnical report for slight variations in site design. We would still recommend our review and comment on the variations, once established.

PURPOSE AND SCOPE OF SERVICES

The purpose of our services is to review site conditions and our previously provided geotechnical recommendations for the site. Based on the currently proposed improvements, we provide our opinion on the suitability of our previous recommendations and provide updated/revised recommendations (if necessary). Our services have been provided in accordance with our signed agreement with Avenue 55, LLC (signed October 17, 2022). Details regarding our specific scope of services for the project can be reviewed in our agreement or provided upon request.

SUBSURFACE CONDITIONS

Subsurface Explorations

We previously explored subsurface conditions at the site by excavating 22 test pits to depths between about 8 and 11 feet below ground surface (bgs), corresponding to Elevation 209 to 183.5 feet. Approximate locations of each test pit relative to currently proposed improvements are shown on the Figure 2, Site Plan. A detailed summary of the test pit explorations, including completed laboratory testing and test pit logs, is presented in our 2011 Geotechnical Report. A brief overview is provided below.

Soil Conditions

We interpret native soils encountered in the test pits to be recessional glacial outwash deposits, consisting of medium dense to very dense sand and gravel with varying amounts of silt and cobble. The upper few feet were occasionally weathered and loose to medium dense. Fill consisting of medium dense sand with gravel and trace silt was observed in one test pit (TP-9) extending to the full depths explored (8 feet bgs).

Based on our understanding of geologic conditions and experience in the area, we anticipate recessional outwash soils are underlain by dense to very dense glacially consolidated soils at depth (glacial till and/or advance outwash).

Groundwater Conditions

Groundwater seepage was observed in one test pit (TP-14) at about 8 feet bgs, corresponding to Elevation 196 feet. Seepage and/or wet soils were not observed in remaining test pit excavations (as deep as about Elevation 183.5 feet).

We reviewed published groundwater maps and well information available online from the United States Geological Survey (USGS) National Water Information System (NWIS). Our review indicates groundwater elevations in the vicinity decrease from east to west, between about Elevation 200 feet (east of site, near Interstate 5) to Elevation 10 feet (west of site, near Puget Sound). The nearest readily available and most recently discovered information reviewed consisted of five groundwater wells within an approximate 1-mile radius of the project site; measured groundwater depths at these locations were below Elevation 140 feet.

In addition to the regional groundwater, areas of shallow perched groundwater could also be present throughout the site. It is common for perched groundwater to be present near contacts where soil that is more permeable overlies soil that is less permeable (i.e., sand over silt). The quantity and location of perched groundwater, if encountered, at this site is expected to be dependent on infiltration of surface water. Site grading can affect infiltration and therefore, the quantity and location of perched groundwater. Slow to moderate groundwater seepage should be expected if perched groundwater conditions are encountered. Slow seepage is defined as less than 1 gallon per minute (gpm) while moderate seepage is between 1 and 3 gpm.

GEOTECHNICAL DESIGN RECOMMENDATIONS

General

Except as modified in this addendum, the conclusions and recommendations presented in our 2011 Report and 2018 Addendum are appropriate for project design and construction. This includes but is not limited to site development and earthwork, fill placement and compaction, shallow foundation support and bearing surface preparation, retaining walls and stormwater designs. Updated and/or revised geotechnical design recommendations to these reports are provided in the sections below. The recommendations provided in this addendum supersede the recommendations presented in all our past studies, where applicable.

Seismic Design

Seismic Design Approach

Proposed structures will be designed in accordance with seismic design requirements presented in the 2018 or 2021 International Building Code (IBC). The 2018 and 2021 IBC both state that structures shall be designed and constructed to resist the effects of earthquake ground motions in accordance with the

American Society of Civil Engineers (ASCE) "Minimum Design Loads and Associated Criteria for Buildings and Other Structures, ASCE/SE 7-2016" (ASCE 7-16).

Seismic Design Parameters

We used map-based values available online as recommended by the USGS to determine the seismic design spectrum in accordance with ASCE 7-16.

Soils encountered in the test pits (as deep as about 11 feet bgs) consisted of medium dense to very dense sand and gravel recessional outwash deposits. We anticipate these soils are underlain by dense to very dense glacially consolidated soils at depth. We anticipate soils below the explorations and extending to depths of 100 feet bgs consist of dense to very dense glacially consolidated deposits. Based on subsurface conditions encountered, our review and our experience in similar soil conditions, we recommend using a design response spectrum for Site Class C. In our opinion, the parameters provided in Table 1 below are suitable for seismic design and analysis.

TABLE 1. RECOMMENDED SEISMIC DESIGN CRITERIA (2018 OR 2021 IBC PER ASCE 7-16)

ASCE 7-16 Seismic Design Parameters	
Site Class	C
Mapped Spectral Response Acceleration at Short Periods (S_S)	1.371 g
Mapped Spectral Response Acceleration at 1-Second Periods (S_1)	0.487 g
Site Amplification Factor at 0.2 Seconds (F_a)	1.2
Site Amplification Factor at 1.0 Seconds (F_v)	1.5
Design Spectral Response Acceleration at Short Periods (S_{DS})	1.097 g
Design Spectral Response Acceleration at 1-Second Periods (S_{D1})	0.487 g
Site Modified Peak Ground Acceleration (PGA_M)	0.632 g

Liquefaction Potential

DESCRIPTION

Liquefaction refers to the condition by which vibration or shaking of the ground, usually from earthquake forces, disturbs the soil structure (i.e., the arrangement of individual soil particles) within saturated and unconsolidated soils. This rearrangement of particles results in the development of excess pore pressures in saturated soils with subsequent loss of strength. Liquefaction susceptibility is difficult to predict and not all soils are susceptible to liquefaction. In general, soils that are susceptible to liquefaction include very loose to medium dense, "clean" to silty sands below the water table.

Ground settlement, lateral spreading and/or sand boils may result from soil liquefaction. Structures, such as buildings, supported on liquefied soils may suffer loss of bearing capacity, foundation settlement and/or lateral movement that can be damaging to the buildings.

SEISMIC HAZARD MAP REVIEW

We re-reviewed the "Liquefaction Susceptibility Map of Pierce County, Washington" (Palmer et al. 2004[2]) and the Washington State Department of Natural Resources (DNR) Interactive Natural Hazards Map. According to the maps, the site has "very low to low" potential for liquefaction.

ESTIMATED LIQUEFACTION POTENTIAL

Based on the soil and groundwater conditions observed in our explorations, our interpretation of the regional geology and review of hazard maps in the area, it is still our opinion the potential for liquefaction at the site is low.

Lateral Spreading Potential

Lateral spreading related to seismic activity typically involves lateral displacement of large, surficial blocks of non-liquefied soil when an underlying soil layer loses strength during seismic shaking. Lateral spreading usually develops in areas where sloping ground or large grade changes (including retaining walls) are present. Based on our understanding of the subsurface conditions, liquefaction risk, current site topography and proposed site grading, it is our opinion the risk of lateral spreading at the site is low.

Surface Rupture Potential

We reviewed published geologic seismic feature maps of the project vicinity, including maps available online from the DNR, USGS and the Washington Department of Geology and Earth Sciences map "Faults and Earthquakes in Washington State" (Czajkowski and Bowman 2014[3]). The nearest mapped faults to the project site are the Tacoma fault zone (approximately 10 miles northeast of the site) and the Olympia structure (approximately 10 miles southwest). Locations of these fault zones have been inferred from geophysical studies and there are no known surface expressions of the fault. Based on our understanding of local geology, bedrock in the project area is covered by several hundred feet of glacial soils. Based on this information and the fault distance from the project site, it is our opinion the risk for seismic surface rupture at the site is low.

Conventional Retaining Walls and Below-grade Structures

We recommend the following updates to the lateral earth pressures be used for design of conventional retaining walls and below-grade structures in Table 2 below. The parameters below include additional conditions not presented in our 2011 Report that we typically provide in today's studies, for use as needed. Our design pressures assume two conditions: level backfill and 2H:1V (horizontal: vertical) sloping backfill. If drained design parameters are used, drainage systems must be included in the design in accordance with the recommendations presented in our 2011 Report. Our 2011 Report also provides descriptions for the active and at-rest conditions, including surcharge loading, and should be used as part of retaining wall design.

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[2] Palmer, Stephen P., Magsino, Sammantha L., Bilderback, Eric L., Poelstra, James L., Folger, Derek S., and Niggemann, Rebecca A. 2004. Liquefaction Susceptibility Map of Pierce County, Washington. Washington state Department of Natural Resources. Dated September 1, 2004.

[3] Czajkowski, Jessica L. and Bowman, Jeffrey D. 2014. Faults and Earthquakes in Washington State. Washington State Department of Natural Resources. Open File Report 2014-05, 1 sheet, scale 1:750,000.

TABLE 2. LATERAL SOIL PRESSURE PARAMETERS FOR RETAINING WALLS AND BELOW-GRADE STRUCTURES

Soil Parameter	EFD[1] (Level Backfill Condition) (pounds per cubic foot [pcf])	EFD[1] (2H:1V Backfill Condition) (pcf)
Active Earth Pressure	35 pcf drained; 80 pcf undrained[2]	55 pcf drained; 90 pcf undrained[2]
At-rest Earth Pressure	55 pcf drained; 90 pcf undrained[2]	80 pcf drained; 100 pcf undrained[2]
Seismic Loading[3]	14*H pounds per square foot (psf)	22*H psf

Notes:

[1] Equivalent fluid density in pcf.

[2] This value includes hydrostatic pressures.

[3] If the retaining wall is to be designed for seismic forces, we recommend that the seismic loading be approximated using a uniform lateral pressure based on backfill condition, where H is the height (in feet) of the structure. This seismic lateral pressure is in addition to the static soil load and any anticipated hydrostatic pressures. This assumes that the wall is free to yield somewhat during a seismic event.

Infiltration Feasibility Assessment

Infiltration Approach

Stormwater management facilities at the site could include bioretention and on-site infiltration areas. We understand stormwater facilities will be designed in accordance with the City of DuPont 2022 Municipal Code. Per Section 22.01.090 of the DuPont Code, the Washington State Department of Ecology (Ecology) *Stormwater Management Manual for Western Washington* (SWMMWW), shall be used for stormwater drainage design.

According to the 2019 SWMMWW, infiltration rate of on-site soils can be determined by either in-situ testing (e.g., pilot infiltration tests [PIT]) or correlation to grain-size distribution from soil samples. Grain-size analysis is only appropriate for soils unconsolidated by glacial advance. We interpret soils encountered in test pits at the site to consist of recessional outwash deposits, which are unconsolidated by glacial advance. Therefore, it is our opinion that the grain-size analysis method is appropriate for the site.

Where necessary, we also refer to the *2021 Pierce County Stormwater and Site Development Manual* (SMSDM).

Soil Grain-Size Analysis

Using the recommended procedures in the 2019 SWMMWW, we estimated initial saturated hydraulic conductivity ($K_{sat,initial}$) of selected soil samples based on grain-size analysis results using the Massmann method. Calculated $K_{sat,initial}$ was then reduced through correction factors to produce a preliminary long-term design infiltration rate ($K_{sat,design}$). Correction factors in the SWMMWW are based on site variability and number of tests conducted (C_{Fv}), uncertainty of the test method (C_{Ft}), and the potential for long-term clogging due to siltation and bio-buildup (C_{Fm}). Recommended correction factors are outlined in Section V-5.4 of the SWMMWW.

Table 3 below summarizes the partial and total correction factor(s) we considered in our analysis.

TABLE 3. GRAIN-SIZE ANALYSIS CORRECTION FACTOR SUMMARY

Issue	Correction Factor Value
Site Variability and Number of Locations Tested (CF_v)	0.80
Test Method (CF_t)	0.40
Siltation and Bio-Buildup (CF_m)	0.90
Total Correction Factor = CF_v x CF_r x CF_m	**CF_T = 0.29**

Table 4 below summarizes selected samples for grain-size analysis, calculated initial (short-term) infiltration rates and calculated design (long-term, with correction factors applied) infiltration rates. We considered a maximum initial infiltration rate of 100 inches per hour (in/hr) (corresponding to a maximum design rate of 29 in/hr) in our analysis. This is consistent with guidance presented in the Pierce County SMSDM, which allows a maximum design infiltration rate of 30 in/hr.

TABLE 4. ESTIMATED INFILTRATION RATE SUMMARY

Exploration	Depth (feet)	Elevation (feet)	Geologic Unit	USCS Soil Type	Percent Fines	$K_{sat,initial}$ (in/hr)[1]	$K_{sat,design}$ (in/hr)[2]
TP-2	6	203	Recessional Outwash	GP	1.7	100	29
TP-4	4	206	Recessional Outwash	SP	1.0	100	29
TP-7	4	207	Recessional Outwash	GP	1.1	100	29
TP-11	4	190	Recessional Outwash	GP	1.5	100	29
TP-12	6	196	Recessional Outwash	GP	1.0	100	29
TP-14	6	198	Recessional Outwash	GW	2.0	100	29
TP-15	4	199	Recessional Outwash	GP	1.2	54.7	15.7
TP-16	6	209	Recessional Outwash	GW	0.6	100	29
TP-20	6	192	Recessional Outwash	GP	4.2	94.1	27.1
TP-22	4	206	Recessional Outwash	GP	1.1	100	29

Notes:

[1] We considered a maximum initial (measured) infiltration rate of 100 in/hr.

[2] Per Pierce County, maximum allowable design infiltration rate is 30 in/hr.

USCS = Unified Soil Classification System

Recommended Design Infiltration Rate

Calculated design infiltration rates for the selected samples vary between about 15 and 29 in/hr, when also considering Pierce County SMSDM design criteria, and the limit of 30 in/hr. The upper few feet of soil encountered in the test pits were occasionally weathered and somewhat siltier. We anticipate slower infiltration rates within these upper siltier soils. Somewhat “cleaner” soils (fewer fines) were typically observed at depth, on average of about 3 feet bgs. We anticipate, and the data supports, faster infiltration rates in these soils at depth, compared to the upper weathered soils.

Due to the presence of surface weathered recessional outwash deposits, we recommend a design infiltration rate of 15 in/hr be used as an average value across the site for this project. This value may be considered somewhat conservative. It is likely higher rates can be considered for deeper facilities. This rate would have to be considered on a case-by-case basis.

Stormwater Facility Code Assessment and Additional Design Considerations

Per Section V-5.6.SSC-5 of the SWMMWW, the base of the infiltration facility shall be no less than 5 feet above seasonal high water, bedrock or other low permeability layer. A reduced 3-foot minimum separation can be considered if groundwater mounding analysis and other design factors indicate the prevention of overtopping and that the other site suitability criteria specified in Section V-5.6 are met. Per Section V-5.2.7 of the SWMMWW, the minimum required vertical separation increases to 15 feet if the infiltration facility has a contributing drainage area exceeding 1-acre, otherwise an analytical groundwater model would be required to determine the final design infiltration rate.

- We anticipate static groundwater elevations to be below the depths of the completed test pits, and as deep as 20 feet below surrounding grade, based on recent review of published information and our work in the nearby area.
- Soils encountered in the explorations at depth were observed to consist of recessional outwash deposits and are relatively uniform across exploration locations. No clear demarcation was observed between high or low permeable layers, and in general, low permeability soils were not observed.
- It is our opinion a detailed groundwater analysis will not be required for relatively shallow infiltration facilities anticipated for this project. We suggest we be consulted for further review if infiltration facilities will be more than about 15 feet deep (below existing site grade).
- Additional field infiltration testing, such as PITs, could be considered as a part of this project design and review, especially if site-specific and/or faster rates were desired. At this time, it is our opinion that a PIT study would not provide much more benefit to this project. Additionally, maintaining enough water in the hole for this test may also prove difficult. If PIT studies are desired/required, we recommend the process also be observed with Regulatory Stormwater Agencies in the field so they can directly observe the infiltration process.
- Other considerations such as separation limits from structures, pond locations, security, set-backs, treatments or other requirements presented in the SWMMWW should also be reviewed and considered as a part of the final stormwater facility design.
- To help reduce clogging of infiltration facilities, we recommend they be protected during construction with siltation elimination/siltation control facilities, such as sweeping, temporary settling basins, silt fences and hay bales.
- Compaction of infiltration pond subgrade should be avoided, and equipment should not be permitted in the infiltration areas after they are excavated to design grade.
- We recommend we review project plans and specifications regarding infiltration and be retained during construction to observe soil conditions at the base of the infiltration facilities and verify exposed soil conditions are as anticipated for the proposed design.

Additional Geotechnical Services

Recommendations provided in this report are based on the assumptions and design information stated herein. We welcome the opportunity to review and discuss construction plans and specifications for this project as they are being developed. In addition, GeoEngineers should be retained to review the project plans and specifications when complete to confirm that our design recommendations have been implemented as intended.

Satisfactory foundation and earthwork performance depend to a large degree on quality of construction. Sufficient monitoring of the contractor's activities is a key part of determining that the work is completed in accordance with the construction drawings and specifications. Subsurface conditions observed during construction should be compared with those encountered during the subsurface explorations. Recognition of changed conditions often requires experience; therefore, qualified personnel should visit the site with sufficient frequency to detect whether subsurface conditions change significantly from those anticipated.

We recommend that GeoEngineers be retained to observe construction at the site to confirm that subsurface conditions are consistent with the site explorations and to confirm that the intent of project plans and specifications relating to earthwork, pavement and foundation construction are being met.

LIMITATIONS

We have prepared this letter for the exclusive use by Avenue 55, LLC and their authorized agents for the proposed DuPont 243 project in DuPont, Washington. Avenue 55, LLC may distribute copies of this report to the owner and owner's authorized agents and regulatory agencies as may be required for the project.

Within the limitations of scope, schedule and budget, our services have been executed in accordance with generally accepted practices in the field of geotechnical engineering in this area at the time this letter was prepared. The conclusions, recommendations and opinions presented in this report are based on our professional knowledge, judgment and experience. No warranty or other conditions, express or implied, should be understood. Please refer to Appendix A, Report Limitations and Guidelines for Use for additional information pertaining to the use of this report.

Sincerely,
GeoEngineers, Inc.

DENNIS JOHN THOMPSON
STATE OF WASHINGTON
38397
REGISTERED
PROFESSIONAL ENGINEER
8/1/2023

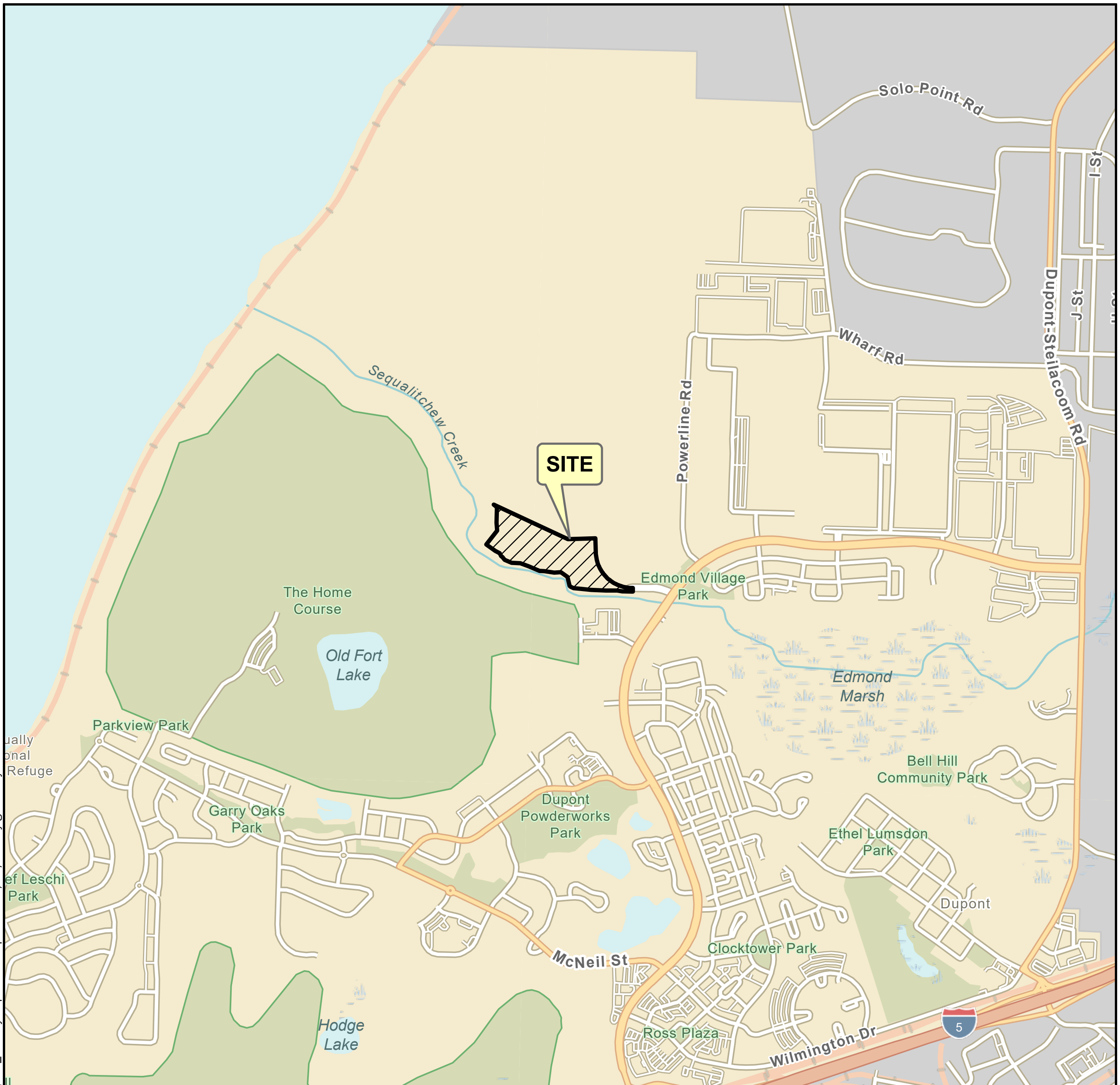
Christopher R. Newton, PE
Geotechnical Engineer

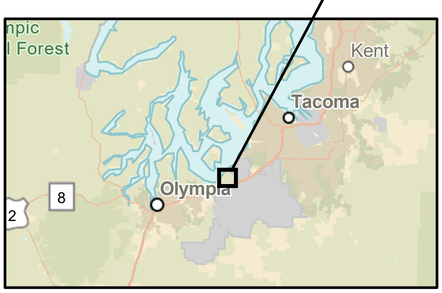
Dennis (DJ) Thompson, PE
Associate

CRN:DJT:tlm:mce

Attachments
Figure 1. Vicinity Map
Figure 2. Site Plan
Appendix A. Report Limitations and Guidelines for Use

One electronic copy submitted





N

0 2,000

Feet

Vicinity Map

DuPont 243
DuPont, Washington

GeoEngineers

Figure 1

Source(s):
- ESRI

Coordinate System: NAD 1983 StatePlane Washington South FIPS 4602 Feet

Disclaimer: This figure was created for a specific purpose and project. Any use of this figure for any other project or purpose shall be at the user's sole risk and without liability to GeoEngineers. The locations of features shown may be approximate. GeoEngineers makes no warranty or representation as to the accuracy, completeness, or suitability of the figure, or data contained therein. The file containing this figure is a copy of a master document, the original of which is retained by GeoEngineers and is the official document of record.

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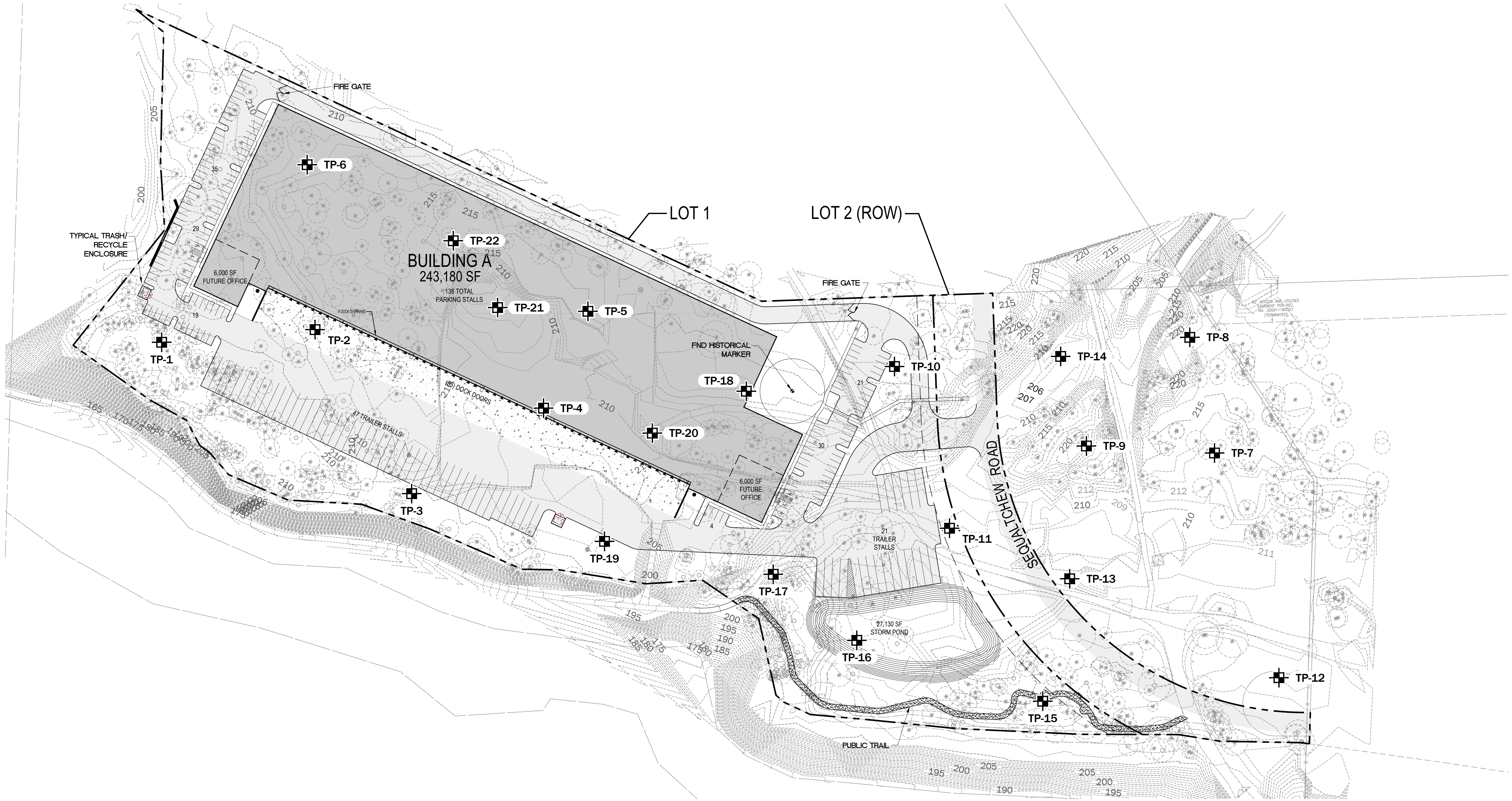

Legend

TP-1 Test Pit by GeoEngineers, Inc., 2011

N W E S

150 0 150
Feet

Notes:
1. The locations of all features shown are approximate.
2. This drawing is for information purposes. It is intended to assist in showing features discussed in an attached document. GeoEngineers, Inc. cannot guarantee the accuracy and content of electronic files. The master file is stored by GeoEngineers, Inc. and will serve as the official record of this communication.

Data Source: Existing Grade Surface from Barghausen Consulting Engineers, Inc dated 6/5/2018.
Designs from Innova Architechts dated 7/17/2023.

Projection: NAD83 Washington State Planes, South Zone, US Foot

Site Plan

DuPont 243
DuPont, Washington

GEOENGINEERS

Figure 2

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APPENDIX A
Report Limitations and Guidelines for Use

APPENDIX A
REPORT LIMITATIONS AND GUIDELINES FOR USE[4]

This appendix provides information to help you manage your risks with respect to the use of this report.

Read These Provisions Closely

It is important to recognize that the geoscience practices (geotechnical engineering, geology and environmental science) rely on professional judgment and opinion to a greater extent than other engineering and natural science disciplines, where more precise and/or readily observable data may exist. To help clients better understand how this difference pertains to our services, GeoEngineers includes the following explanatory "limitations" provisions in its reports. Please confer with GeoEngineers if you need to know more how these "Report Limitations and Guidelines for Use" apply to your project or site.

Geotechnical Services are Performed for Specific Purposes, Persons and Projects

This report has been prepared for Avenue 55, LLC for the Project(s) specifically identified in the report. The information contained herein is not applicable to other sites or projects.

GeoEngineers structures its services to meet the specific needs of its clients. No party other than the party to whom this report is addressed may rely on the product of our services unless we agree to such reliance in advance and in writing. Within the limitations of the agreed scope of services for the Project, and its schedule and budget, our services have been executed in accordance with our agreement with Avenue 55, LLC authorized October 17, 2022 and generally accepted geotechnical practices in this area at the time this report was prepared. We do not authorize, and will not be responsible for, the use of this report for any purposes or projects other than those identified in the report.

A Geotechnical Engineering or Geologic Report is based on a Unique Set of Project-Specific Factors

This report has been prepared for the proposed DuPont 243 project located in DuPont, Washington. GeoEngineers considered a number of unique, project-specific factors when establishing the scope of services for this project and report. Unless GeoEngineers specifically indicates otherwise, it is important not to rely on this report if it was:

- Not prepared for you,
- Not prepared for your project,
- Not prepared for the specific site explored, or
- Completed before important project changes were made.

[4] Developed based on material provided by ASFE, Professional Firms Practicing in the Geosciences; www.asfe.org.

For example, changes that can affect the applicability of this report include those that affect:

- The function of the proposed structure;
- Elevation, configuration, location, orientation or weight of the proposed structure;
- Composition of the design team; or
- Project ownership.

If changes occur after the date of this report, GeoEngineers cannot be responsible for any consequences of such changes in relation to this report unless we have been given the opportunity to review our interpretations and recommendations. Based on that review, we can provide written modifications or confirmation, as appropriate.

Environmental Concerns are Not Covered

Unless environmental services were specifically included in our scope of services, this report does not provide any environmental findings, conclusions, or recommendations, including but not limited to, the likelihood of encountering underground storage tanks or regulated contaminants.

Information Provided by Others

GeoEngineers has relied upon certain data or information provided or compiled by others in the performance of our services. Although we use sources that we reasonably believe to be trustworthy, GeoEngineers cannot warrant or guarantee the accuracy or completeness of information provided or compiled by others.

Subsurface Conditions Can Change

This geotechnical or geologic report is based on conditions that existed at the time the study was performed. The findings and conclusions of this report may be affected by the passage of time, by man-made events such as construction on or adjacent to the site, new information or technology that becomes available subsequent to the report date, or by natural events such as floods, earthquakes, slope instability or groundwater fluctuations. If more than a few months have passed since issuance of our report or work product, or if any of the described events may have occurred, please contact GeoEngineers before applying this report for its intended purpose so that we may evaluate whether changed conditions affect the continued reliability or applicability of our conclusions and recommendations.

Geotechnical and Geologic Findings are Professional Opinions

Our interpretations of subsurface conditions are based on field observations from widely spaced sampling locations at the site. Site exploration identifies the specific subsurface conditions only at those points where subsurface tests are conducted or samples are taken. GeoEngineers reviewed field and laboratory data and then applied its professional judgment to render an informed opinion about subsurface conditions at other locations. Actual subsurface conditions may differ, sometimes significantly, from the opinions presented in this report. Our report, conclusions and interpretations are not a warranty of the actual subsurface conditions.

Geotechnical Engineering Report Recommendations are Not Final

We have developed the following recommendations based on data gathered from subsurface investigation(s). These investigations sample just a small percentage of a site to create a snapshot of the subsurface conditions elsewhere on the site. Such sampling on its own cannot provide a complete and accurate view of subsurface conditions for the entire site. Therefore, the recommendations included in this report are preliminary and should not be considered final. GeoEngineers' recommendations can be finalized only by observing actual subsurface conditions revealed during construction. GeoEngineers cannot assume responsibility or liability for the recommendations in this report if we do not perform construction observation.

We recommend that you allow sufficient monitoring, testing and consultation during construction by GeoEngineers to confirm that the conditions encountered are consistent with those indicated by the explorations, to provide recommendations for design changes if the conditions revealed during the work differ from those anticipated, and to evaluate whether earthwork activities are completed in accordance with our recommendations. Retaining GeoEngineers for construction observation for this project is the most effective means of managing the risks associated with unanticipated conditions. If another party performs field observation and confirms our expectations, the other party must take full responsibility for both the observations and recommendations. Please note, however, that another party would lack our project-specific knowledge and resources.

A Geotechnical Engineering or Geologic Report Could Be Subject to Misinterpretation

Misinterpretation of this report by members of the design team or by contractors can result in costly problems. GeoEngineers can help reduce the risks of misinterpretation by conferring with appropriate members of the design team after submitting the report, reviewing pertinent elements of the design team's plans and specifications, participating in pre-bid and preconstruction conferences, and providing construction observation.

Do Not Redraw the Exploration Logs

Geotechnical engineers and geologists prepare final boring and testing logs based upon their interpretation of field logs and laboratory data. The logs included in a geotechnical engineering or geologic report should never be redrawn for inclusion in architectural or other design drawings. Photographic or electronic reproduction is acceptable but separating logs from the report can create a risk of misinterpretation.

Give Contractors a Complete Report and Guidance

To help reduce the risk of problems associated with unanticipated subsurface conditions, GeoEngineers recommends giving contractors the complete geotechnical engineering or geologic report, including these "Report Limitations and Guidelines for Use." When providing the report, you should preface it with a clearly written letter of transmittal that:

- Advises contractors that the report was not prepared for purposes of bid development and that its accuracy is limited; and
- Encourages contractors to confer with GeoEngineers and/or to conduct additional study to obtain the specific types of information they need or prefer.

Contractors are Responsible for Site Safety on Their Own Construction Projects

Our geotechnical recommendations are not intended to direct the contractor's procedures, methods, schedule or management of the work site. The contractor is solely responsible for job site safety and for managing construction operations to minimize risks to on-site personnel and adjacent properties.

Biological Pollutants

GeoEngineers' Scope of Work specifically excludes the investigation, detection, prevention or assessment of the presence of Biological Pollutants. Accordingly, this report does not include any interpretations, recommendations, findings or conclusions regarding the detecting, assessing, preventing or abating of Biological Pollutants, and no conclusions or inferences should be drawn regarding Biological Pollutants as they may relate to this project. The term "Biological Pollutants" includes, but is not limited to, molds, fungi, spores, bacteria and viruses, and/or any of their byproducts.

A Client that desires these specialized services is advised to obtain them from a consultant who offers services in this specialized field.

GeoEngineers
1101 Fawcett Ave, Suite 200
Tacoma, Washington 98402
253.383.4940

October 20, 2023

Avenue 55, LLC
601 Union Street, Suite 2930
Seattle, Washington 98101

Attention: Ben Varin

Subject: Report Addendum 3
Geotechnical Engineering Services
DuPont-West
DuPont, Washington
File No. 26421-001-00

INTRODUCTION AND PROJECT UNDERSTANDING

This report addendum (Addendum 3) presents geotechnical recommendations and considerations for the proposed DuPont-West project and is intended to provide supplemental geotechnical design recommendations to our previous studies at the site. The purpose of this addendum is to reflect the updated site plan layout described below and provide discussion on critical areas, specifically geologically hazardous areas consisting of landslide and erosion hazards near the site. The site is located at 1700 Center Drive in DuPont, Washington. An overview of the property and its surrounding area is shown on the Figure 1, Vicinity Map.

Our experience at the site includes involvement with the previous owner, Dupont Station Partners, LLC for the proposed DuPont Industrial Warehouse (also referred to as Lot "Y" Industrial Park). We understand Avenue 55, LLC has been given permission by Dupont Station Partners, LLC to have the full use of studies held by GeoEngineers, Inc. (GeoEngineers) and as related to the site address. Our previous geotechnical deliverables for the site include:

- "Geotechnical Engineering Services, Lot 'Y' Industrial Park, DuPont, Washington" dated October 10, 2011 (2011 Report). As part of our services, we advanced 22 test pit explorations in the project area to develop an understanding of subsurface conditions. The 2011 Report presents a summary of our findings, conclusions, and recommendations regarding geotechnical engineering aspects of the proposed industrial park development.
- "Report Addendum, Geotechnical Engineering Services, DuPont Industrial Warehouse, DuPont, Washington" dated May 11, 2018 (2018 Addendum), which includes our review of a proposed development site plan and updated recommended seismic design parameters.

- Report Addendum, Geotechnical Engineering Services, DuPont Industrial Park, DuPont, Washington", dated November 8, 2022 (November 2022 Addendum).
- "Revised Report Addendum 2, Geotechnical Engineering Services, DuPont 243, DuPont, Washington" dated August 1, 2023 (August 2023 Addendum), which includes our review of an updated development site plan and confirmation of previously provided geotechnical design recommendations.

We have also reviewed the following document by GeoEngineers, prepared for others, nearby:

- GeoEngineers, Inc. 2011. Stream Habitat Assessment Summary, Creekside Village Development, DuPont, Washington. Prepared for Creekside DuPont Partners, LLC, on October 12, 2011. (GeoEngineers File No. 16785-002-01).

Our understanding of the current project is based on discussions and correspondence with Avenue 55, LLC and review of an updated site plan sheet A0.1 "SEPA Site Plan" dated July 11, 2023 (Site Plan). The project will include construction of a 256,800-square-foot, dock-high slab, warehouse building, referred to as Building A. Surrounding improvements will include paved parking and driveway areas, hardscaping, new utility installation, landscaping, and stormwater management facilities, including a 21,930-square-foot stormwater pond (inferred from above Site Plan). A relatively short retaining wall (up to 6 feet tall) is proposed along the west parking lot and adjacent to the west property boundary. The site development features are shown on the attached Figure 2, Site Plan.

The south property boundary runs near parallel and above a southward facing slope that leads down to Sequalitchew Creek Trail and Sequalitchew Creek. The slope is typically in excess of 25 feet tall, with height increasing up to or even greater than 50 feet toward the west. The slope is inclined downward from the site between about 1H:1V (horizontal:vertical) and 3½H:1V. Some local areas are on the order of ¾H:1V. The Sequalitchew Creek Trail bisects the approximate center of the slope and runs approximately parallel with the top of the slope. The eastern half of the trail varies in elevation and essentially rises near the elevation of the top of the slope.

PURPOSE AND SCOPE OF SERVICES

The purpose of our services is to complete a limited slope reconnaissance and to provide discussion on critical areas (geologically hazardous areas) at the site. The terms of our services have been provided in accordance with our signed agreement with Avenue 55, LLC (signed October 17, 2022). We have been requested to address the City of DuPont Comments provided in their review letter dated September 22, 2023, as follows: "Provide a letter from the geotechnical engineer that address the City's Geologic Hazard assessment requirements, makes a recommendation for a protective buffer, and depict the protective buffer on the plans."

LITERATURE REVIEW AND ASSESSMENT

Geology Review

We include our geology literature review from our past studies (2011 Report) which states:

"Based on review of the Geologic Map of the Nisqually 7.5 Minute Quadrangle, Thurston and Pierce Counties, Washington (Walsh et al., 2003). Vashon recessional outwash sand and gravel is the dominant, near-surface, geologic material mapped in the immediate project area. This material is commonly known as Steilacoom gravel. Vashon recessional outwash was deposited by melt water streams in front of the most recent glacier during its retreat from the Puget Sound region approximately 10,000 to 15,000 years ago. These deposits generally consist of permeable sand, or sand and gravel. Cobbles and boulders can also be encountered in this deposit, depending on the depositional history. Glacial till and/or advance outwash is commonly encountered at depth below the recessional outwash."

We also provide the following contained in our 2011 report: "The United States Department of Agriculture (USDA) Soil Conservation Service (SCS) Soil Survey of Pierce County Area, Washington, maps the project area as Spanaway gravelly sandy loam (41A). This soil unit is described as being formed in glacial outwash. It is further described as somewhat excessively drained with moderately rapid permeability, slow surface runoff and little erosion hazard."

Based on our current review and studies, it is our opinion that the soil descriptions in the published literature documents are still appropriate for this project.

Washington State DNR Geologic Information Portal

We reviewed the Washington State Department of Natural Resources (Washington State DNR) Geologic Information Portal (accessed October 16, 2023), which provides maps of landslides and areas susceptible to landslides. Based on our review, the southward facing slope near the southern property boundary is mapped as having a susceptibility to shallow landsliding. No active landslides appear to be mapped in the project vicinity.

DuPont Municipal Code

General

We reviewed the City of DuPont "DuPont Municipal Code" (DMC). Specifically, we reviewed Chapter 25.105 "Critical Areas" of the DMC which provides criteria for Geologically Hazardous Areas consisting of Landslide and Erosion Hazards. Seismic design and opinions have been provided in our past studies. In summary, we concluded that seismic hazards (liquefaction, lateral spreading, surface fault ruptures) do not appear to be present at this site and in our opinion, are at a low risk of occurring.

Landslide Hazard Areas

Based on our review of the Site Plan and understanding of the site, the southward facing slope meets the following criteria provided in the DMC for landslide hazard areas based on the following:

- Slope is mapped by the Washington State DNR as having a susceptibility to shallow landsliding.
- A majority of the slope grade is 40 percent or steeper and has vertical relief of 10 feet or more.

Erosion Hazard Areas

Per the DMC, the southward facing slope would be designated as an erosion hazard area, primarily because it is associated with the Sequalitchew Creek "channel migration zone". The DMC states that "Channel migration zones, also known as riverine erosion areas, are defined as the areas along a river or stream within which the channel(s) can be reasonably predicted to migrate over time. This is a result of natural and normally occurring geomorphic, hydrological, and related processes when considered with the characteristics of the river or stream and its surroundings, and in consideration of river and stream management plans. Channel migration hazard areas shall include potential channel migration, channel avulsion, bank erosion, and stability of slopes along the river or stream".

Slope Reconnaissance

We completed a limited slope reconnaissance on October 12, 2023, of the southward facing slope between the upland part of the site and Sequilitchew Creek. Our slope reconnaissance was focused primarily on the central to western half of the site, where the slope is generally steepest and closest to proposed parking and building improvements. Our observations were made from hiking the top of the slope and at the approximate midline-base of the slope along the Sequalitchew Creek Trail.

The slope is generally forested with deciduous and coniferous trees, and densely vegetated with underbrush (i.e., small shrubs and trees, sword ferns, etc.). "Horse tails", plant vegetation typically formed in the presence of constant wet surface water, were also observed in isolated, clustered sections (approximately 50 feet or less in length) along the northern edge of the Sequalitchew Creek trail below the project area. The ground appeared wet where horse tails were present, and intermittently outside of areas containing horse tails. We did not observe the presence of groundwater seepage flow in this area during our reconnaissance.

We probed the slope surfaces around the trail area, primarily to north of the trail, with a ½-inch diameter steel probe rod and through forest duff and/or vegetative matter, where accessible and as needed. Typical probe depths were generally less than 6 inches, with isolated locations between 12 and 18 inches, before firmer underlying soil conditions were encountered. Similarly, near the top of the slope, probe depths were generally between about 12 and 18 inches before reaching firm soil conditions.

Natural soil along the slope surfaces was observed to be intermittently exposed and generally consisted of sand and gravel with varying silt content. Probe depths were generally less than 2 inches in these exposed soils and were noted to be in a dense condition. We interpret the soil conditions, where exposed, along the slope surfaces to generally be consistent with the glacial recessional outwash deposits recorded in our 2011 Report and the overall geologic conditions reported in the project vicinity. Some of the exposures could be indicative of a glacial till or glacial drift material, and generally comprised very dense, glacially consolidated silty sand with gravel. It is common for glacial till and drift materials to underly recessional outwash deposits in the project area.

Where accessible, we did not observe tension cracks or signs of movement near the top of the slope. Periodic and isolated "pistol butting" of tree trunks, at their base, were observed along the slope faces, but were typically surrounded by well-established mature trees growing vertically. Pistol butting of trees can indicate past or current slope movements; however, based on the soil conditions observed and the vertical growth patterns for surrounding trees, the pistol butting observed is, in our opinion, likely attributed to the tree germinating on a slope, potential damage incurred early in the tree's life, and/or due to slow colluvial creep of the duff and upper weathered soil zone. In some isolated areas of exposed soil, we observed minor surface raveling, shallow surficial slumps, and sloughing.

We consider the surface raveling, shallow surficial slumps, and sloughing observed to be associated with minor erosion and surficial failures common to natural slopes in the project vicinity and region. We did not observe any indications of significant seepage or global slope instability. Since our field efforts were completed in 2011, and in some instances prior to 2011 (studies completed for nearby projects), we have not observed any indications of landsliding or received reports of soil movements within the slope below the project area.

CONCLUSIONS AND RECOMMENDATIONS

General

Except as modified in this addendum, the conclusions and recommendations presented in our 2011 Report and subsequent addenda are appropriate for geotechnical project design and construction. In this addendum, we provide additional geotechnical considerations for the project, specifically relating to geologically hazardous areas south of the proposed development.

Based on definitions presented in the DMC, it is our opinion that the southward facing slope can be designated as both a landslide hazard and erosion hazard area due to characteristics of a steep slope, shallow landslide potential, and its association with the channel migration zone of Sequalitchew Creek. Per the DMC, setbacks for each hazard should be based on the findings of a qualified professional. We provide additional discussion on each hazard, including an overview of current setbacks in the sections below.

Landslide Hazard

Soil conditions at the site, including the steep slope areas, comprise dense glacial deposits. Typically, deep-seated failures on these types of glacial slopes inclined at about ¾H:1V, or shallower, are rare. Based on our studies, explorations, and site experience, it is our opinion that there is a low risk of large-scale global instability occurring on the southward facing slope below the proposed development. It is also our opinion that landslide hazards designated at this site should not be considered a limiting factor for the proposed development, provided that proper design, setbacks, and engineering controls are implemented.

The southward facing steep slope will be at risk for relatively shallow sloughing, slow “creep” movement and/or local surficial failures. We observed evidence of these features, as described above. These are natural processes that occur with or without development. Mitigation measures are often limited to appropriate setbacks and monitoring and maintenance. The amount and magnitude of sloughing is typically due to natural processes that can include weathering, seepage, saturation during heavy rain events, decay of roots, downed trees, and activity of burrowing animals. The addition of human design elements, such as fill scattering, mis-directed stormwater sheet flow, and irrigation, can also increase this risk.

Site plans reviewed indicate the closest improvement to the top of the steep slope will be the paved parking and driveway areas, which are 50 feet away. Proposed Building A is shown to be setback more than 100 feet from the top of the slope. The stormwater pond proposed is at least 100 feet away from the top of the slope. It should be noted that this pond location is consistent with the 100-foot setback guidance as described in Volume V, Section 1.2 of the 2019 Washington State Department of Ecology’s Stormwater Management Manual for Western Washington.

Based on our studies, we recommend a non-improvement area/buffer/setback of 50 feet be established and maintained from the top of the slope to address landslide hazard considerations described. Review of the project Site Plan indicates that this recommended setback has been established as a part of the project design, and as such we take no issue with this. Other requirements presented in the DMC related to development near landslide hazard areas, such as construction methods, erosion control, site disturbance, etc., should also be considered, and incorporated, where necessary.

Erosion Hazard

Based on our studies, it is our opinion that there is the potential for shallow erosion and surficial failures/sloughing within the south slope face, particularly in areas where vegetation is sparse or non-existent. We observed these features during our site visit and should be expected to continue. These are natural processes that occur with or without development. Areas with thicker weathered and organic or forest duff materials that have undergone several weather cycles are also subject to shallow erosion and surficial failures, especially if it becomes oversaturated. Areas of the slope that are more exposed and contain less vegetation are more likely subject to erosion, compared to areas that contain denser vegetation.

Based on our studies, it is our opinion that erosion hazards, as defined in the DMC, as well as the other potential erosion hazards described above, should not be considered a limiting factor for the proposed development. It is our opinion that the 50-foot setback buffer established for the project is adequate to protect structures and improvements from the erosion hazards expected at this site. We further conclude that the risk of toe erosion caused by significant stream meandering of Sequilitchew Creek along base of slope is low. This creek appears to be relatively dry for most of the time of the year, contains a relatively large channel, has a linear alignment through the project area, and overall, not expected to develop stream velocities that would compromise the toe of the slope.

Temporary and permanent site development should include provisions to protect steep slopes from erosion. Engineering controls to mitigate erosion by limiting soil disturbance in steep slope areas, controlling surface water management, and re-establishment of ground cover and vegetation should be included in design and planning. Stormwater facilities and other site drainage should be designed such that they do not discharge directly over or within the buffers and the steep slope areas. Other provisions in the DMC for development in erosion hazard areas should also be considered during design and planning. In addition, discussions on erosion control have been provided in the “Erosion and Sedimentation Control” section of our 2011 Report and should be considered as a part project development and design.

LIMITATIONS

We have prepared this report for Avenue 55, LLC, for the DuPont-West project located at 1700 Center Drive in DuPont, Washington and is intended to provide supplemental geotechnical design recommendations to our previous studies at this site for this project. Avenue 55, LLC may distribute copies of this report to authorized agents and regulatory agencies as may be required for the project.

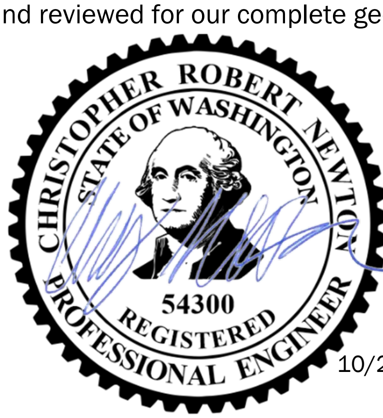
Our services were provided to assist in the design of foundations for a planned structure to be located on or near sloping property. Our recommendations are intended to improve the overall stability of the site and to reduce the potential for future property damage related to earth movements, drainage, or erosion. Qualified engineering and construction practices can help mitigate the risks inherent in construction on slopes, although those risks cannot be eliminated completely. Favorable performance of structures in the near term is useful information for anticipating future performance, but it cannot predict or imply a certainty of long-term performance, especially under conditions of adverse weather or seismic activity.

Within the limitations of scope, schedule and budget, our services have been executed in accordance with generally accepted practices in the field of geotechnical engineering in this area at the time this report was prepared. The conclusions, recommendations, and opinions presented in this report are based on our professional knowledge, judgment, and experience. No warranty or other conditions, express or implied, should be understood.

Any electronic form, facsimile or hard copy of the original document (email, text, table and/or figure), if provided, and any attachments should be considered a copy of the original document. The original document is stored by GeoEngineers, Inc. and will serve as the official document of record.

Please refer to Appendix A titled "Report Limitations and Guidelines for Use" provided in our "Revised Report Addendum 2, Geotechnical Engineering Services, DuPont 243, DuPont, Washington" dated August 1, 2023 (August 2023 Addendum) for additional limitations and information pertaining to use of this report. The recommendations, limitations, and information presented in the August 2023 Addendum also apply to this letter. Except as modified herein, our August 2023 letter is still applicable and should be considered a part of this study and reviewed for our complete geotechnical recommendations.

Sincerely,
GeoEngineers, Inc.



10/20/23

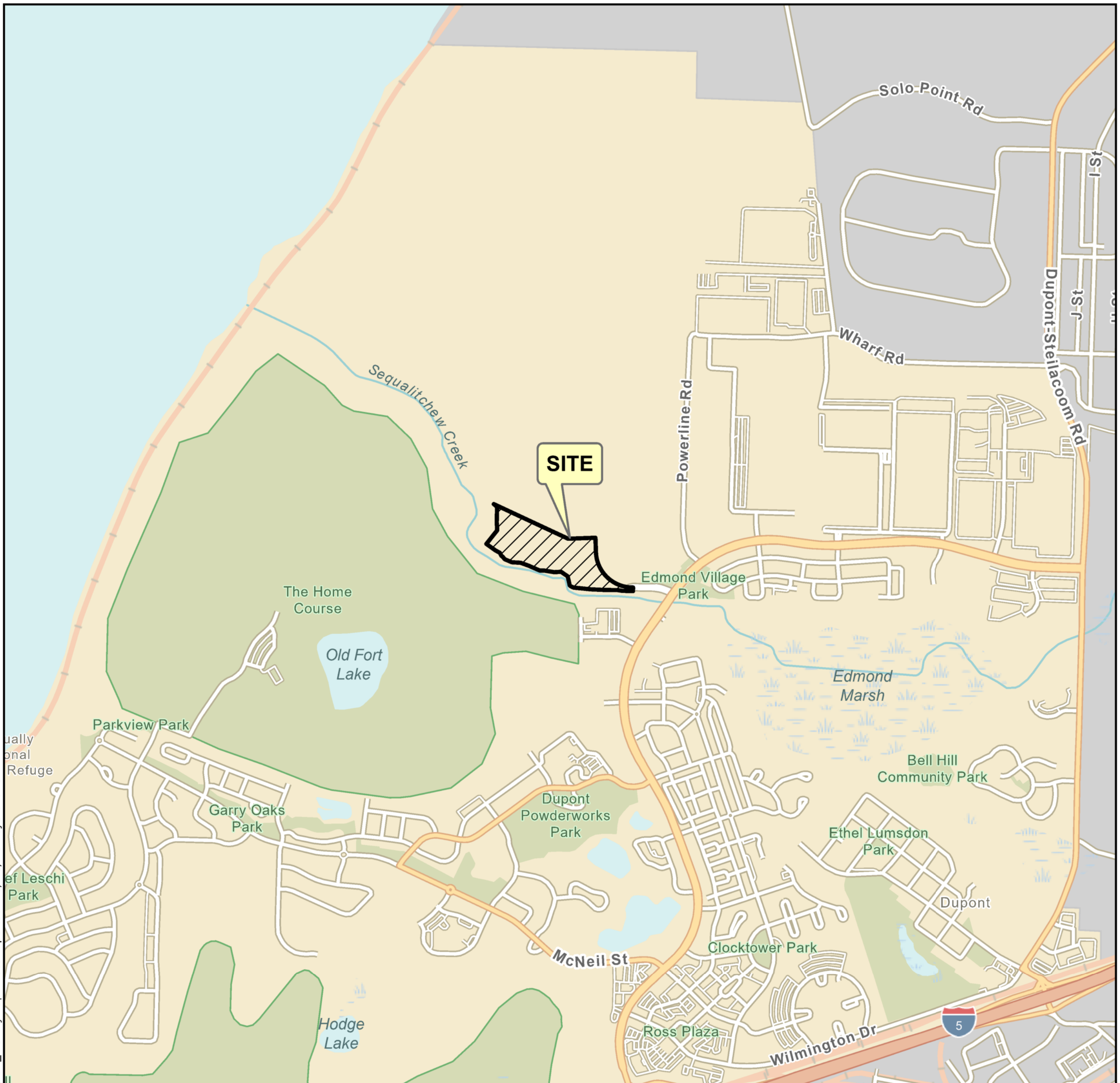
Christopher R. Newton, PE
Geotechnical Engineer

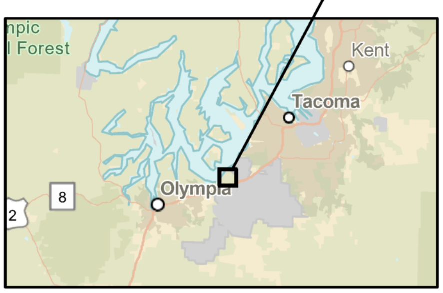
10/20/23

Dennis (DJ) Thompson, PE
Associate

CRN:DJT:atk

Attachments
Figure 1. Vicinity Map
Figure 2. Site Plan





N

0 2,000

Feet

Source(s):
- ESRI

Coordinate System: NAD 1983 StatePlane Washington South FIPS 4602 Feet

Disclaimer: This figure was created for a specific purpose and project. Any use of this figure for any other project or purpose shall be at the user's sole risk and without liability to GeoEngineers. The locations of features shown may be approximate. GeoEngineers makes no warranty or representation as to the accuracy, completeness, or suitability of the figure, or data contained therein. The file containing this figure is a copy of a master document, the original of which is retained by GeoEngineers and is the official document of record.

Vicinity Map

DuPont - West
DuPont, Washington

GeoEngineers

Figure 1

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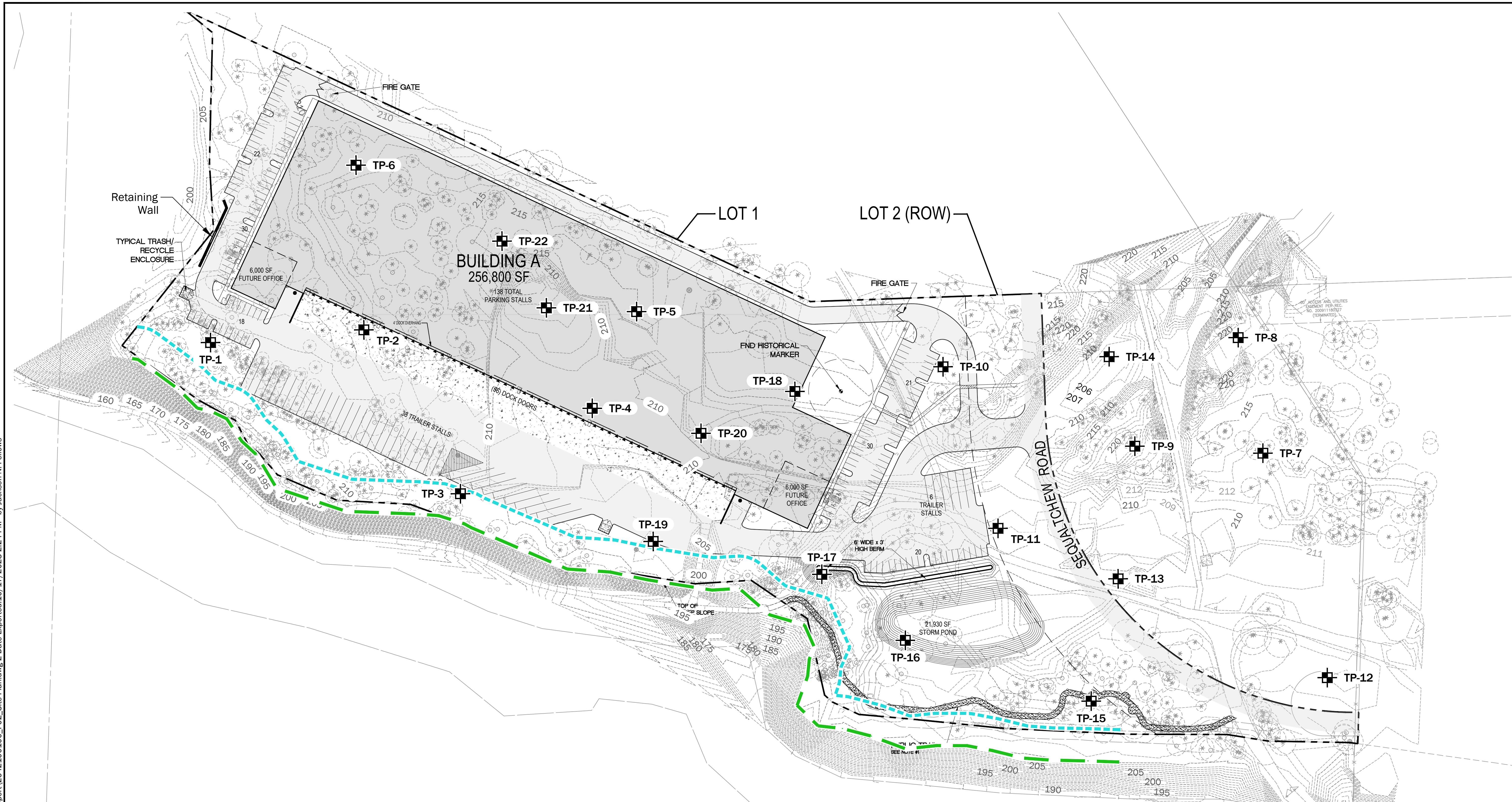

Legend

Top of slope (green dashed line)

50' Setback from Top of Slope (cyan dotted line)

TP-1 Test Pit by GeoEngineers, Inc., 2011

Source(s):
- Survey from Barghausen Consulting Engineers Inc., dated 6/5/2018
- Proposed site features from Innova Architects, dated 7/17/2022

Projection: WA State Plane, North Zone, NAD83, US Foot

Disclaimer: This figure was created for a specific purpose and project. Any use of this figure for any other project or purpose shall be at the user's sole risk and without liability to GeoEngineers. The locations of features shown may be approximate. GeoEngineers makes no warranty or representation as to the accuracy, completeness, or suitability of the figure, or data contained therein. The file containing this figure is a copy of a master document, the original of which is retained by GeoEngineers and is the official document of record.

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Feet

Site Plan

DuPont - West
DuPont, Washington

GeoEngineers

Figure 2

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8.0 OTHER PERMITS

8.0 OTHER PERMITS

Other permits for this project site include:

- NPDES General Permit from the Department of Ecology for construction on sites with areas of disturbance over an acre of land which this site qualifies for
- Site Development Permit
- Clear and Grade Permit
- Building Permit
- Right-of-Way Use Permit
- Forest Practices Permit
- Water Line Extension Permit
- Sanitary Sewer Extension Permit

9.0 OPERATIONS AND MAINTENANCE MANUAL

No. 2 – Infiltration

Maintenance Component	Defect	Conditions When Maintenance Is Needed	Results Expected When Maintenance Is Performed
General	Trash & Debris	See "Detention Ponds" (No. 1).	See "Detention Ponds" (No. 1).
	Poisonous/Noxious Vegetation	See "Detention Ponds" (No. 1).	See "Detention Ponds" (No. 1).
	Contaminants and Pollution	See "Detention Ponds" (No. 1).	See "Detention Ponds" (No. 1).
	Rodent Holes	See "Detention Ponds" (No. 1).	See "Detention Ponds" (No. 1)
Storage Area	Sediment	Water ponding in infiltration pond after rainfall ceases and appropriate time allowed for infiltration. Treatment basins should infiltrate Water Quality Design Storm Volume within 48 hours, and empty within 24 hours after cessation of most rain events. (A percolation test pit or test of facility indicates facility is only working at 90% of its designed capabilities. Test every 2 to 5 years. If two inches or more sediment is present, remove).	Sediment is removed and/or facility is cleaned so that infiltration system works according to design.
Filter Bags (if applicable)	Filled with Sediment and Debris	Sediment and debris fill bag more than 1/2 full.	Filter bag is replaced or system is redesigned.
Rock Filters	Sediment and Debris	By visual inspection, little or no water flows through filter during heavy rain storms.	Gravel in rock filter is replaced.
Side Slopes of Pond	Erosion	See "Detention Ponds" (No. 1).	See "Detention Ponds" (No. 1).
Emergency Overflow Spillway and Berms over 4 feet in height.	Tree Growth	See "Detention Ponds" (No. 1).	See "Detention Ponds" (No. 1).
	Piping	See "Detention Ponds" (No. 1).	See "Detention Ponds" (No. 1).
Emergency Overflow Spillway	Rock Missing	See "Detention Ponds" (No. 1).	See "Detention Ponds" (No. 1).
	Erosion	See "Detention Ponds" (No. 1).	See "Detention Ponds" (No. 1).
Pre-settling Ponds and Vaults	Facility or sump filled with Sediment and/or debris	6" or designed sediment trap depth of sediment.	Sediment is removed.

No. 5 – Catch Basins

Maintenance Component	Defect	Conditions When Maintenance is Needed	Results Expected When Maintenance is performed
General	Trash & 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 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 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	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.
	Contamination and Pollution	See "Detention Ponds" (No. 1).	No pollution present.

No. 5 – Catch Basins

Maintenance Component	Defect	Conditions When Maintenance is Needed	Results Expected When Maintenance is performed
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 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 basin 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.

No. 6 – Debris Barriers (e.g., Trash Racks)

Maintenance Components	Defect	Condition When Maintenance is Needed	Results Expected When Maintenance is Performed
General	Trash and Debris	Trash or debris that is plugging more than 20% of the openings in the barrier.	Barrier cleared to design flow capacity.
Metal	Damaged/ Missing Bars.	Bars are bent out of shape more than 3 inches.	Bars in place with no bends more than 3/4 inch.
		Bars are missing or entire barrier missing.	Bars in place according to design.
		Bars are loose and rust is causing 50% deterioration to any part of barrier.	Barrier replaced or repaired to design standards.
	Inlet/Outlet Pipe	Debris barrier missing or not attached to pipe	Barrier firmly attached to pipe

No. 15 – Manufactured Media Filters)

Maintenance Component	Defect	Condition When Maintenance is Needed	Results Expected When Maintenance is Performed
Below Ground Vault	Sediment Accumulation on Media.	Sediment depth exceeds 0.25-inches.	No sediment deposits which would impede permeability of the compost media.
	Sediment Accumulation in Vault	Sediment depth exceeds 6-inches in first chamber.	No sediment deposits in vault bottom of first chamber.
	Trash/Debris Accumulation	Trash and debris accumulated on compost filter bed.	Trash and debris removed from the compost filter bed.
	Sediment in Drain Pipes/Clean-Outs	When drain pipes, clean-outs, become full with sediment and/or debris.	Sediment and debris removed.
	Damaged Pipes	Any part of the pipes that are crushed or damaged due to corrosion and/or settlement.	Pipe repaired and/or replaced.
	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 to proper working specifications or replaced.
	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	Baffles corroding, cracking warping, and/or showing signs of failure as determined by maintenance/inspection person.	Baffles repaired or replaced to 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 specifications, and is safe to use as determined by inspection personnel.
Below Ground Cartridge Type	Media	Drawdown of water through the media takes longer than 1 hour, and/or overflow occurs frequently.	Media cartridges replaced.
	Short Circuiting	Flows do not properly enter filter cartridges.	Filter cartridges replaced.

No. 18 – Catchbasin Inserts

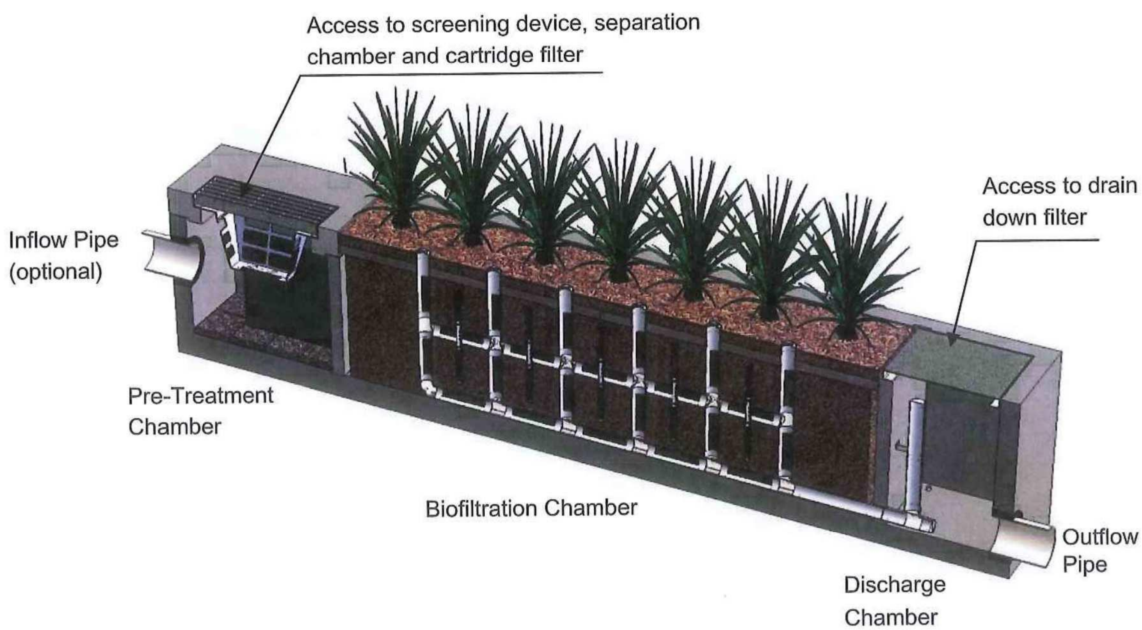
Maintenance Component	Defect	Conditions When Maintenance is Needed	Results Expected When Maintenance is Performed
General	Sediment Accumulation	When sediment forms a cap over the insert media of the insert and/or unit.	No sediment cap on the insert media and its unit.
	Trash and Debris Accumulation	Trash 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.	Remove and replace media insert
	Media Insert-Oil Saturated	Media oil saturated due to petroleum spill that drains into catch basin.	Remove and replace media insert.
	Media Insert Use Beyond Normal Product Life	Media has been used beyond the typical average life of media insert product.	Remove and replace media at regular intervals, depending on insert product.

Maintenance Guidelines for Modular Wetland System - Linear

Maintenance Summary

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

System Diagram



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Maintenance Procedures

Screening Device

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

Separation Chamber

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

Cartridge Filters

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

Drain Down Filter

1. Remove hatch or manhole cover over discharge chamber and enter chamber.
2. Unlock and lift drain down filter housing and remove old media block. Replace with new media block. Lower drain down filter housing and lock into place.
3. Exit chamber and replace hatch or manhole cover.

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Maintenance Notes

1. Following maintenance and/or inspection, it is recommended the maintenance operator prepare a maintenance/inspection record. The record should include any maintenance activities performed, amount and description of debris collected, and condition of the system and its various filter mechanisms.

2. The owner should keep maintenance/inspection record(s) for a minimum of five years from the date of maintenance. These records should be made available to the governing municipality for inspection upon request at any time.

3. Transport all debris, trash, organics and sediments to approved facility for disposal in accordance with local and state requirements.

4. Entry into chambers may require confined space training based on state and local regulations.

5. No fertilizer shall be used in the Biofiltration Chamber.

6. Irrigation should be provided as recommended by manufacturer and/or landscape architect. Amount of irrigation required is dependent on plant species. Some plants may require irrigation.

Maintenance Procedure Illustration

Screening Device

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

Separation Chamber

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

Cartridge Filters

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

Drain Down Filter

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

Inspection Form

Modular Wetland System, Inc.
P. 760.433-7640
F. 760-433-3176
E. Info@modularwetlands.com

www.modularwetlands.com

BIO CLEAN ENVIRONMENTAL SERVICES, INC.

Inspection Report
Modular Wetlands System

MODULAR WETLANDS

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

Project Name ____________________

Project Address ____________________ (city) (Zip Code)

Owner / Management Company ____________________

Contact ____________________ Phone ( ) –

Inspector Name ____________________ Date ___/___/_____ Time ________ AM / PM

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

Weather Condition ____________________ Additional Notes ____________________

Inspection Checklist

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

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

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

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

Plant Information	
Damage to Plants	
Plant Replacement	
Plant Trimming	

Additional Notes: ____________________

MODULAR WETLANDS

Maintenance Report

Modular Wetland System, Inc.
P. 760.433-7640
F. 760-433-3176
E. Info@modularwetlands.com

www.modularwetlands.com

BIO CLEAN ENVIRONMENTAL SERVICES, INC.

Cleaning and Maintenance Report
Modular Wetlands System

MODULAR WETLANDS

Project Name	
Project Address	(city) (Zip Code)
Owner / Management Company	
Contact	Phone ( ) –
Inspector Name	Date / / Time AM / PM
Type of Inspection	☐ Routine ☐ Follow Up ☐ Complaint ☐ Storm Storm Event in Last 72-hours? ☐ No ☐ Yes
Weather Condition	Additional Notes

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

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

Comments:

2972 San Luis Rey Road, Oceanside, CA 92058 P. 760.433.7640 F. 760.433.3176

Ecology's Conditions of Use:

Applicants shall comply with the following conditions:

1. Design, assemble, install, operate, and maintain the MWS – Linear Modular Wetland Stormwater Treatment System units, in accordance with Modular Wetland Systems, Inc. applicable manuals and documents and the Ecology Decision.
2. Each site plan must undergo Modular Wetland Systems, Inc. review and approval before site installation. This ensures that site grading and slope are appropriate for use of a MWS – Linear Modular Wetland Stormwater Treatment System unit.
3. MWS – Linear Modular Wetland Stormwater Treatment System media shall conform to the specifications submitted to, and approved by, Ecology.
4. The applicant tested the MWS – Linear Modular Wetland Stormwater Treatment System with an external bypass weir. This weir limited the depth of water flowing through the media, and therefore the active treatment area, to below the root zone of the plants. This GULD applies to MWS – Linear Modular Wetland Stormwater Treatment Systems whether plants are included in the final product or not.
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, Modular Wetland Systems, Inc. designs MWS - Linear Modular Wetland systems for a target prefilter media life of 6 to 12 months.
   - Indications of the need for maintenance include effluent flow decreasing to below the design flow rate or decrease in treatment below required levels.
   - Owners/operators must inspect MWS - Linear Modular Wetland systems 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:
     - Standing water remains in the vault between rain events, or
     - Bypass occurs during storms smaller than the design storm.
     - If excessive floatables (trash and debris) are present (but no standing water or excessive sedimentation), perform a minor maintenance consisting of gross solids removal, not prefilter media replacement.
     - Additional data collection will be used to create a correlation between pretreatment chamber sediment depth and pre-filter clogging (see *Issues to be Addressed by the Company* section below)
6. Discharges from the MWS - Linear Modular Wetland Stormwater Treatment System units shall not cause or contribute to water quality standards violations in receiving waters.