civil & structural
engineering & planning

STORMWATER SITE PLAN REPORT

Snohomish PUD Twin City Substation

7212 Pioneer Highway
Stanwood, WA 98292

04/15/2022

CG Project No.: 21328.20

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Section I – Project Overview

Section I Summary

Narrative
Existing Conditions
Developed Conditions
Minimum Requirements

The proposed project consists of the addition of approximately 39,205 sf (0.90 ac) of new gravel pavement at an existing electrical substation site.

Site Address: 7212 Pioneer Highway, Stanwood, WA 98292
Parcel Numbers: 32042900-201100 & 32042900-301000

Existing Conditions

The existing site is made up of two parcels of approximately 19.05 acres. The site contains an access road and the electrical substation area, but is mostly covered by flat areas around the rest of the site and steep slopes that slope inward/towards the site.

The existing lot areas were considered as follows:

Access Road	32,890 sf (0.76 ac)
Substation	39,704 sf (0.91 ac)
Pervious Areas	757,161 sf (17.38 ac)
Total:	829,755 sf (19.05 ac)

Developed Conditions

In the developed condition, the project will add new gravel pavement for driveway use, district and employee parking, job staging, and temporary pole storage. The civil plans and this report were prepared in accordance with the 2012 (amended 2014) *Department of Ecology Stormwater Management Manual for Western Washington* (herein referred to as the SWMMWW). This report is based on the steps recommended in Volume 1, Section 3.1 of the SWMMWW. The project is classified as New Development and must meet Minimum Requirements #1-9 because the project exceeds 5,000 sf of new and replaced hard surfaces. See Minimum Requirements later in this section for more.

The proposed new plus replaced hard surface areas were considered as follows:

New Gravel Pavement	39,205 sf (0.90 ac)
Total:	39,205 sf (0.90 ac)

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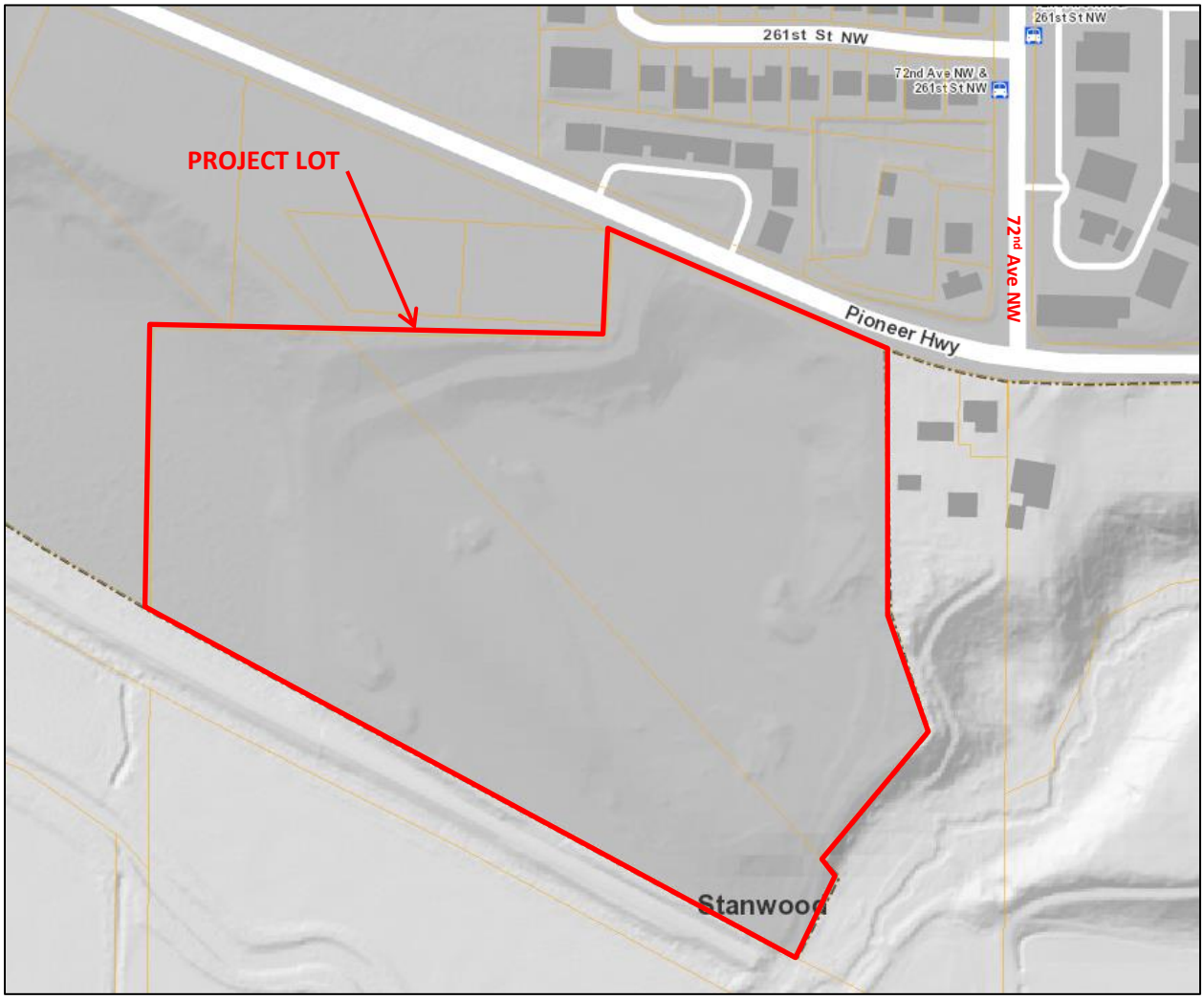

Figure I-1: Vicinity map (from Snohomish County PDS Map Portal)

Figure I-2: Aerial image (from Snohomish County PDS Map Portal)

Minimum Requirements

The project must meet the Minimum Requirements for stormwater management per Section 2.4 of the SWMMWW. Since the project proposes to add more than 5,000 sf of hard surfaces, the project is required to address Minimum Requirements #1-9.

Minimum Requirement #1: Preparation of Stormwater Site Plans: The stormwater site plan consists of this report and the civil drawings and is prepared in accordance with Chapter 3 of Volume I of the SWMMWW.

Minimum Requirement #2: **Construction Stormwater Pollution Prevention Plan (SWPPP)**: The SWPPP shall include a narrative and drawings. DOE's SWPPP template was used because proposed site disturbance is more than one acre. See Section IV and the civil drawings.

Minimum Requirement #3: Source Control of Pollution: All known, available and reasonable source control BMPs are required for all projects approved by the City. BMPs for Landscaping and Lawn/Vegetation Management (S411 from Section 2.2 of Volume IV of the SWMMWW) should be used at a minimum for source control measures on this site. The Operation & Maintenance Manual found in Section VII contains guide sheets for Lawn/Vegetation management.

Minimum Requirement #4: Preservation of Natural Drainage Systems and Outfalls: Natural drainage patterns shall be maintained, and discharges from the project site shall occur at the natural location, to the maximum extent practicable. The manner by which runoff is discharged from the project site must not cause a significant adverse impact to downstream receiving waters and down-gradient properties. The proposed discharge point on this project is infiltration into groundwater. Much of the site is flat and appears to pool in some areas based on existing contours. Therefore, the natural drainage pattern will be maintained.

Minimum Requirement #5: On-Site Stormwater Management: Per Section 2.5.5 of the SWMMWW, the project must implement BMP T5.13 Post-Construction Soil Quality and Depth and evaluate Other Hard Surfaces BMPs per List #3 or use any Flow control BMP to achieve the LID Performance Standard. On-site Stormwater Management feasibility is evaluated in Section III.

Minimum Requirement #6: Runoff Treatment: This requirement applies to the new plus replaced hard surfaces and the converted vegetation areas. The following require construction of stormwater treatment facilities: i.) Projects in which the total of pollution-generating hard surface (PGHS) is 5,000 square feet or more in a threshold discharge area of the project, or ii.) projects in which the total of pollution-generating pervious surfaces (PGPS) – not including permeable pavements is 0.75 acres or more in a threshold discharge area, and from which there will be a surface discharge in a natural or man-made conveyance system from the site. Because the proposed gravel pavement is all drivable surface, it is considered PGHS and Basic Runoff Treatment is required. Basic treatment will be provided by Basic Biofiltration Swales. See Section III for more.

Minimum Requirement #7: Flow Control: Projects must provide flow control to reduce the impacts of stormwater runoff from hard surfaces and land cover conversions. Flow control is required for projects in which the total of effective impervious surfaces is 5,000 sf or more in a threshold discharge area, convert ¾ acres or more of vegetation to lawn or landscape, or cause a 0.15 cfs or more increase in the 100-year flow frequency between the existing and developed conditions. The project proposes to fully infiltrate all surface runoff and the project is, therefore, exempt from Flow Control. See Section III.

Minimum Requirement #8: Wetlands Protection: This requirement applies only to projects whose stormwater discharges into a wetland, either directly or indirectly through a conveyance system. There is no wetland in the project site vicinity, and wetlands protection is not required.

Minimum Requirement #9: Operation and Maintenance: An operation and maintenance manual that is consistent with the provisions in Volume I and Volume V of the SWMMWW is required for proposed Stormwater Treatment and Flow Control BMPs/facilities. The party (or parties) responsible for maintenance and operation shall be identified in the operation and maintenance manual. For private facilities approved by the City, a copy of the operation and maintenance manual shall be retained on-site or within reasonable access to the site and shall be transferred with the property to future owners. For public facilities, a copy of the operation and maintenance manual shall be retained in the appropriate department. A log of maintenance activity that indicates what actions were taken shall be kept and be available for inspection. See Section VIII.

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Section II – Off-Site Analysis

Section II Summary

Narrative
Task 1 – Define and map the study area
Task 2 – Review all available information on the study area
Task 3 – Field inspect the study area
Task 4 – Describe the drainage system, and its existing and predicted problems

The site and surrounding areas were investigated on December 21, 2021 on a cloudy day.

Task 1 – Define and map the study area

An initial qualitative analysis shall document potential off-site impacts of stormwater discharges for each upstream drainage system entering a site, and each downstream drainage system leaving a site according to Section I-2.6.2 of the 2014 SWMMWW. The downstream analysis shall extend from the project site to the receiving water, or up to one-quarter mile, whichever is less.

Task 2 – Review all available information on the study area

Existing stormwater improvements were determined from the site survey and Snohomish County's PDS Map Portal. The site is mostly flat in the area of work, but topography gently descends from the NW to the SE. Based on topography from the survey, runoff from the site would appear to pool in an area just to the SE of the existing substation. The study area and downstream flow path are outlined on the following page in Figure II-1.

Task 3 – Field inspect the study area

The site is surrounded largely by a combination of pasture and forested steep slopes. Runoff is assumed to infiltrate if it makes its way to the flat areas of the site. Photos from the site visit can be seen in Figures II-2 through II-6.

Task 4 – Describe the drainage system, and its existing and predicted problems

The proposed drainage system consists of overland sheet flow conveyance from the new gravel pavement to either one of two proposed conveyance swales located east and west of the existing substation. The conveyance swales will convey stormwater to the N/NE and become basic biofiltration swales before finally ending up in the proposed infiltration pond. The pond was designed to fully infiltrate all flows for a much larger development in case PUD decides to utilize more site area for storage in the future. See Section III for more.

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Figure II-1: Study area (from Snohomish County PDS Map Portal)

Figure II-2: Photo of existing site, facing SE from access road

Figure II-3: Photo facing N/NE towards forested/steep slope area

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Figure II-4: Photo facing E/NE towards forested/pasture/steep slope areas

Figure III-5: Photo facing east, substation on the right

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Figure III-6: Photo facing N/NE from SE corner of substation

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Section III – Permanent Stormwater Control Plan

Section III Summary:

Narrative

On-site Stormwater Management

The project triggers Minimum Requirements #1-9 of the SWMMWW. This section addresses SWMMWW MRs #5: On-site Stormwater Management, #6: Runoff Treatment, and #7: Flow Control.

On-site Stormwater Management

As explained in the *Flow Control* Section, the project is exempt from MR #7: Flow Control. Therefore, to meet MR #5, the project must either use On-site Stormwater Management BMPs from List #3 (for Flow Control Exempt Projects) or demonstrate compliance with the LID performance standard per Section 3.4.5 of Volume I of the SWMMWW. The project will implement on-site stormwater management BMPs from List #3 to the maximum extent feasible for the proposed site areas per Minimum Requirement #5.

BMPs for Lawn and Landscaped Areas:

1. Post-Construction Soil Quality and Depth in accordance with BMP T5.13 in Volume V, Chapter 5 of the Drainage Manual: This BMP will be used for all disturbed landscaped areas.

BMPs for Roofs: Not applicable for this project.

BMPs for Other Hard Surfaces:

1. Sheet Flow Dispersion in accordance with BMP T5.12 is **feasible** and will be used for the new gravel pavement areas around the site.

Runoff Treatment

Since infiltration on the site is feasible, an Infiltration Pond was selected to provide stormwater control and the project, therefore, needs only to select a Pretreatment BMP to provide runoff treatment. A Basic Biofiltration Swale was selected to provide runoff treatment for the new PGHS on the site. The site has been graded such that approximately half the area slopes to the W/NW and the other half slopes E/NE. Therefore, two Basic Biofiltration Swales were designed for each pavement area. It should be noted that the water quality flows were determined based on the potential future full site development. Therefore, the calculations are very conservative for the proposed project. See Attachment III-1 and the civil plans for more about the runoff treatment sizing and calculations.

Flow Control

The project proposes to fully infiltrate all runoff from the new hard surfaces and, therefore, there are no effective new hard surfaces and flow control is not required. The infiltration pond was designed to fully infiltrate stormwater from potential future full site development. Therefore, the areas seen in the WWHM report far exceed this project's proposed hard surfaces. See the end of this Section for WWHM reports for the infiltration pond.

Attachment III-1: Basic Biofiltration Swale Calculations.
See attached pages.

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West Swale

Basic Biofiltration Swale (BMP T9.10, 2019 SWMMWW)

P1. WQ Design Flow Rate (Q) 0.156 cfs (from WWHM, 701 inflow to POC 1 Mitigated)

P2. Bottom Slope (S) 0.015 (slope must be between 1% and 5%)

1. Flow Depth (y) 0.33 ft (4 inches if mowed infrequently)

2. Manning's n 0.24 (0.24 assumed if mowed infrequently)

3. Shape of Swale trapezoidal

4. Bottom Width (B)

$$b \approx \frac{2.5Qn}{1.49y^{1.67}s^{0.5}} - Zy$$

z = 4 (side slope, 4:1)

b= 1.946824

b= 2 ft (2 ft min width)

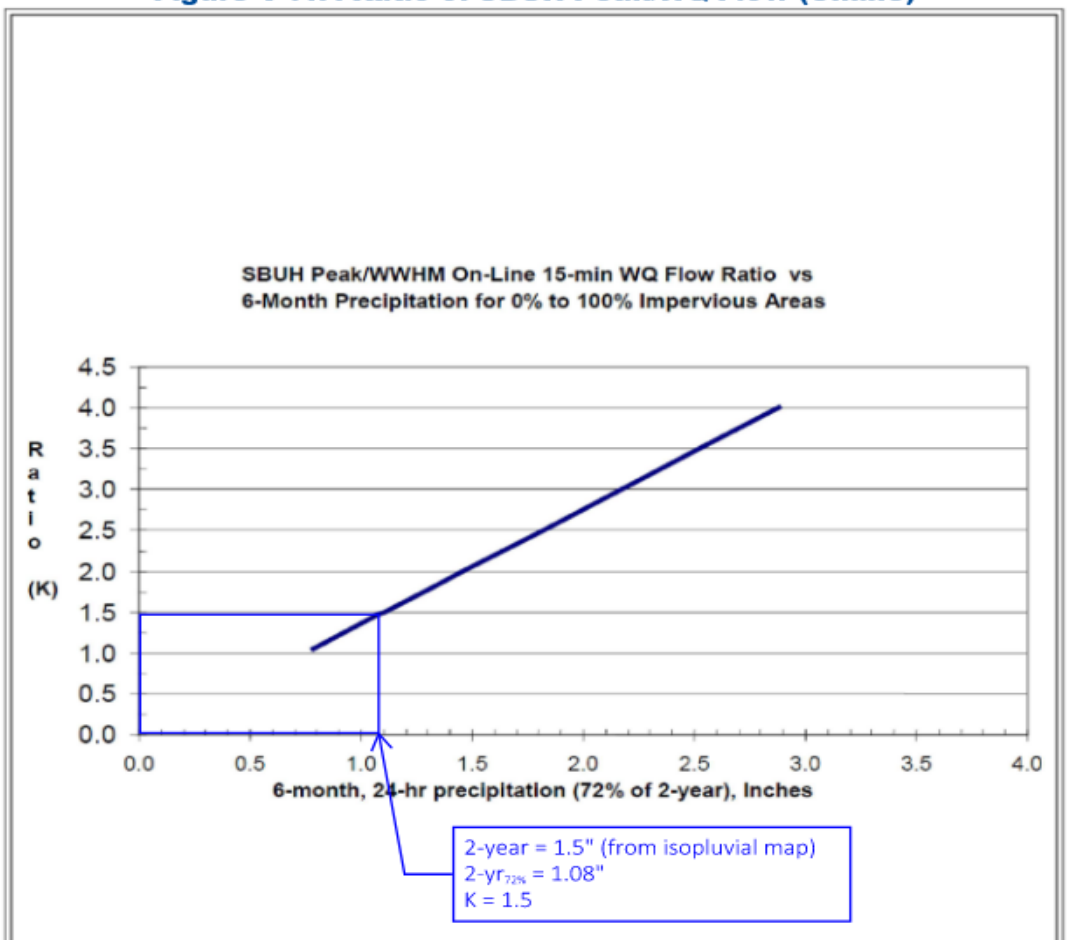
5. Area x-section (A) $A_{trapazoid} = by + Zy^2$ A = 1.0956 sq ft

6. Velocity at WQ flow rate V= KQ/A K = 1.5 (see figure next page)

V = 0.213582 ft/s

7. Length of swale = L = Vt t = 9 min per DOE L = 115.3 ft

Figure V-7.7: Ratio of SBUH Peak/WQ Flow (Online)



East Swale

Basic Biofiltration Swale (BMP T9.10, 2019 SWMMWW)

P1. WQ Design Flow Rate (Q)	0.180 cfs	(from WWHM, 701 inflow to POC 1 Mitigated)
P2. Bottom Slope (S)	0.015	(slope must be between 1% and 5%)
1. Flow Depth (y)	0.33 ft	(4 inches if mowed infrequently)
2. Manning's n	0.24	(0.24 assumed if mowed infrequently)
3. Shape of Swale	trapezoidal	

4. Bottom Width (B)

$$b \approx \frac{2.5Qn}{1.49y^{1.67}s^{0.5}} - Zy$$

z = 4 (side slope, 4:1)

b= 2.449412

b= 2.5 ft (2 ft min width)

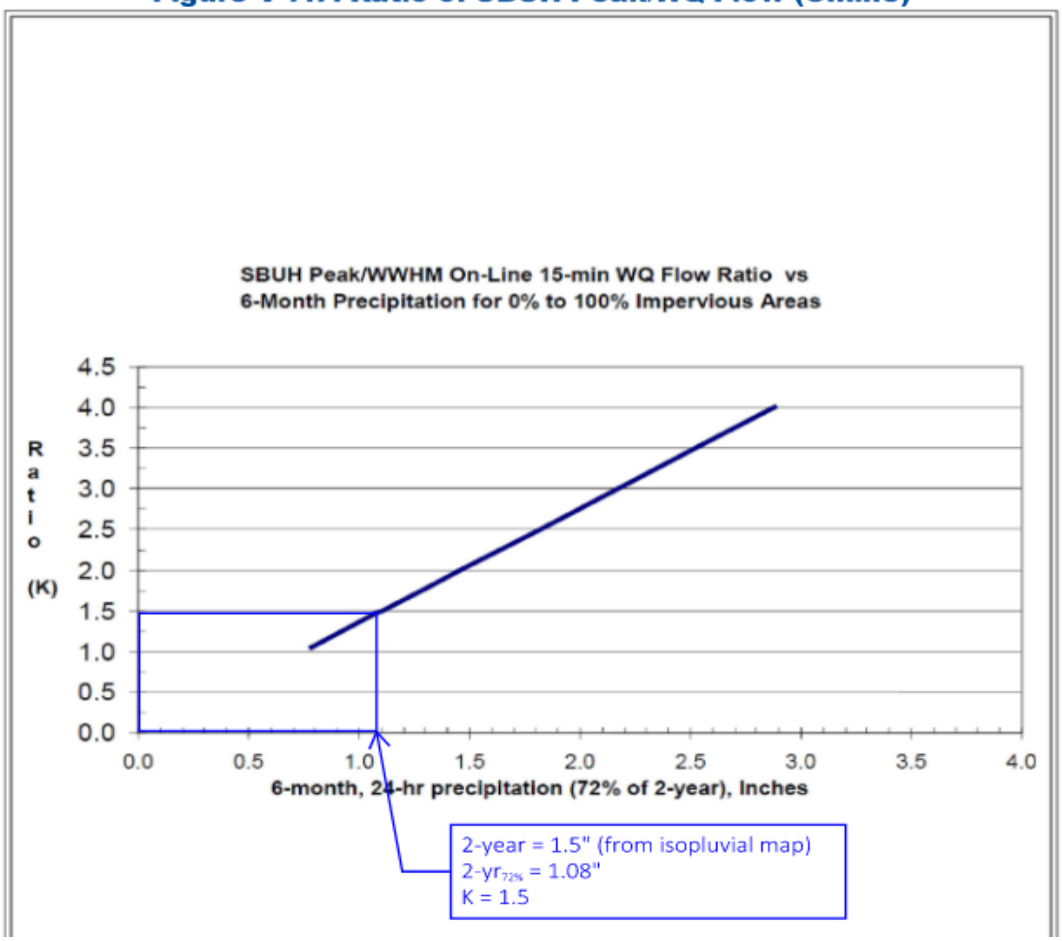
5. Area x-section (A) $A_{trapazoid} = by + Zy^2$ A = 1.2606 sq ft

6. Velocity at WQ flow rate V= KQ/A K = 1.5 (see figure next page)

V = 0.214184 ft/s

7. Length of swale = L = Vt t = 9 min per DOE L = 115.7 ft

Figure V-7.7: Ratio of SBUH Peak/WQ Flow (Online)



Attachment III-2: WWHM Report for Infiltration Pond.
See attached pages.

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WWHM2012
PROJECT REPORT

Project Name: Twin City Infil Pond with steep forest 02.12.22
Site Name: SnoPUD Twin City Substation
Site Address: 7212 Pioneer Highway
City : Stanwood
Report Date: 2/12/2022
Gage : Everett
Data Start : 1948/10/01
Data End : 2009/09/30
Precip Scale: 1.00
Version Date: 2019/09/13
Version : 4.2.17

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

High Flow Threshold for POC 1: 50 year

PREDEVELOPED LAND USE

Name : Basin 1
Bypass: No

GroundWater: No

Pervious Land Use	acre
A B, Forest, Flat	2.33
A B, Forest, Steep	2.21
Pervious Total	4.54

Impervious Land Use	acre
Impervious Total	0
Basin Total	4.54

Element Flows To:

Surface	Interflow	Groundwater

MITIGATED LAND USE

Name : Basin 1
Bypass: No

GroundWater: No

Pervious Land Use	acre
A B, Forest, Steep	2.21
A B, Lawn, Flat	.15
Pervious Total	2.36

Impervious Land Use	acre
ROADS MOD	0.06
DRIVEWAYS FLAT	2.12
Impervious Total	2.18
Basin Total	4.54

Element Flows To:

Surface	Interflow	Groundwater
Trapezoidal Pond 1	Trapezoidal Pond 1	

Name : Trapezoidal Pond 1
Bottom Length: 100.00 ft.
Bottom Width: 37.00 ft.
Depth: 4 ft.
Volume at riser head: 0.3373 acre-feet.
Infiltration On
Infiltration rate: 2.6
Infiltration safety factor: 1
Total Volume Infiltrated (ac-ft.): 339.878
Total Volume Through Riser (ac-ft.): 0
Total Volume Through Facility (ac-ft.): 339.878
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: 2.9 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	0.084	0.000	0.000	0.000
0.0444	0.085	0.003	0.000	0.222

0.0889	0.086	0.007	0.000	0.222
0.1333	0.087	0.011	0.000	0.222
0.1778	0.088	0.015	0.000	0.222
0.2222	0.089	0.019	0.000	0.222
0.2667	0.090	0.023	0.000	0.222
0.3111	0.090	0.027	0.000	0.222
0.3556	0.091	0.031	0.000	0.222
0.4000	0.092	0.035	0.000	0.222
0.4444	0.093	0.039	0.000	0.222
0.4889	0.094	0.043	0.000	0.222
0.5333	0.095	0.048	0.000	0.222
0.5778	0.096	0.052	0.000	0.222
0.6222	0.097	0.056	0.000	0.222
0.6667	0.097	0.060	0.000	0.222
0.7111	0.098	0.065	0.000	0.222
0.7556	0.099	0.069	0.000	0.222
0.8000	0.100	0.074	0.000	0.222
0.8444	0.101	0.078	0.000	0.222
0.8889	0.102	0.083	0.000	0.222
0.9333	0.103	0.087	0.000	0.222
0.9778	0.104	0.092	0.000	0.222
1.0222	0.105	0.097	0.000	0.222
1.0667	0.106	0.101	0.000	0.222
1.1111	0.106	0.106	0.000	0.222
1.1556	0.107	0.111	0.000	0.222
1.2000	0.108	0.116	0.000	0.222
1.2444	0.109	0.120	0.000	0.222
1.2889	0.110	0.125	0.000	0.222
1.3333	0.111	0.130	0.000	0.222
1.3778	0.112	0.135	0.000	0.222
1.4222	0.113	0.140	0.000	0.222
1.4667	0.114	0.145	0.000	0.222
1.5111	0.115	0.150	0.000	0.222
1.5556	0.116	0.156	0.000	0.222
1.6000	0.117	0.161	0.000	0.222
1.6444	0.118	0.166	0.000	0.222
1.6889	0.119	0.171	0.000	0.222
1.7333	0.120	0.177	0.000	0.222
1.7778	0.121	0.182	0.000	0.222
1.8222	0.122	0.187	0.000	0.222
1.8667	0.123	0.193	0.000	0.222
1.9111	0.124	0.198	0.000	0.222
1.9556	0.125	0.204	0.000	0.222
2.0000	0.126	0.209	0.000	0.222
2.0444	0.127	0.215	0.000	0.222
2.0889	0.128	0.221	0.000	0.222
2.1333	0.129	0.226	0.000	0.222
2.1778	0.130	0.232	0.000	0.222
2.2222	0.131	0.238	0.000	0.222
2.2667	0.132	0.244	0.000	0.222
2.3111	0.133	0.250	0.000	0.222
2.3556	0.134	0.256	0.000	0.222
2.4000	0.135	0.262	0.000	0.222
2.4444	0.136	0.268	0.000	0.222
2.4889	0.137	0.274	0.000	0.222
2.5333	0.138	0.280	0.000	0.222
2.5778	0.139	0.286	0.000	0.222

2.6222	0.140	0.292	0.000	0.222
2.6667	0.141	0.298	0.000	0.222
2.7111	0.142	0.305	0.000	0.222
2.7556	0.143	0.311	0.000	0.222
2.8000	0.144	0.317	0.000	0.222
2.8444	0.145	0.324	0.000	0.222
2.8889	0.146	0.330	0.000	0.222
2.9333	0.147	0.337	0.096	0.222
2.9778	0.148	0.343	0.344	0.222
3.0222	0.149	0.350	0.677	0.222
3.0667	0.150	0.357	1.074	0.222
3.1111	0.151	0.363	1.519	0.222
3.1556	0.152	0.370	1.999	0.222
3.2000	0.153	0.377	2.501	0.222
3.2444	0.154	0.384	3.009	0.222
3.2889	0.155	0.391	3.509	0.222
3.3333	0.157	0.398	3.988	0.222
3.3778	0.158	0.405	4.433	0.222
3.4222	0.159	0.412	4.832	0.222
3.4667	0.160	0.419	5.178	0.222
3.5111	0.161	0.426	5.468	0.222
3.5556	0.162	0.433	5.703	0.222
3.6000	0.163	0.440	5.892	0.222
3.6444	0.164	0.448	6.052	0.222
3.6889	0.165	0.455	6.294	0.222
3.7333	0.166	0.463	6.469	0.222
3.7778	0.168	0.470	6.639	0.222
3.8222	0.169	0.477	6.805	0.222
3.8667	0.170	0.485	6.967	0.222
3.9111	0.171	0.493	7.125	0.222
3.9556	0.172	0.500	7.280	0.222
4.0000	0.173	0.508	7.432	0.222
4.0444	0.174	0.516	7.581	0.222

ANALYSIS RESULTS

Stream Protection Duration

Predeveloped Landuse Totals for POC #1
Total Pervious Area:4.54
Total Impervious Area:0

Mitigated Landuse Totals for POC #1
Total Pervious Area:2.36
Total Impervious Area:2.18

Flow Frequency Return Periods for Predeveloped. POC #1

Return Period	Flow(cfs)
2 year	0.00364
5 year	0.004672

10 year	0.005367
25 year	0.006262
50 year	0.006943
100 year	0.007637

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

Stream Protection Duration

Annual Peaks for Predeveloped and Mitigated. POC #1

Year	Predeveloped	Mitigated
1949	0.003	0.000
1950	0.004	0.000
1951	0.004	0.000
1952	0.003	0.000
1953	0.004	0.000
1954	0.004	0.000
1955	0.004	0.000
1956	0.003	0.000
1957	0.004	0.000
1958	0.004	0.000
1959	0.004	0.000
1960	0.003	0.000
1961	0.004	0.000
1962	0.004	0.000
1963	0.003	0.000
1964	0.004	0.000
1965	0.004	0.000
1966	0.003	0.000
1967	0.004	0.000
1968	0.003	0.000
1969	0.004	0.000
1970	0.004	0.000
1971	0.004	0.000
1972	0.004	0.000
1973	0.003	0.000
1974	0.004	0.000
1975	0.004	0.000
1976	0.004	0.000
1977	0.003	0.000
1978	0.003	0.000
1979	0.004	0.000
1980	0.003	0.000
1981	0.004	0.000
1982	0.004	0.000
1983	0.004	0.000
1984	0.004	0.000
1985	0.003	0.000
1986	0.003	0.000
1987	0.004	0.000

1988	0.004	0.000
1989	0.003	0.000
1990	0.004	0.000
1991	0.004	0.000
1992	0.004	0.000
1993	0.003	0.000
1994	0.004	0.000
1995	0.003	0.000
1996	0.009	0.000
1997	0.025	0.000
1998	0.004	0.000
1999	0.003	0.000
2000	0.003	0.000
2001	0.003	0.000
2002	0.004	0.000
2003	0.003	0.000
2004	0.003	0.000
2005	0.003	0.000
2006	0.005	0.000
2007	0.004	0.000
2008	0.004	0.000
2009	0.003	0.000

Stream Protection Duration
Ranked Annual Peaks for Predeveloped and Mitigated. POC #1

Rank	Predeveloped	Mitigated
1	0.0253	0.0000
2	0.0089	0.0000
3	0.0045	0.0000
4	0.0043	0.0000
5	0.0039	0.0000
6	0.0037	0.0000
7	0.0037	0.0000
8	0.0037	0.0000
9	0.0036	0.0000
10	0.0036	0.0000
11	0.0036	0.0000
12	0.0036	0.0000
13	0.0036	0.0000
14	0.0036	0.0000
15	0.0036	0.0000
16	0.0036	0.0000
17	0.0036	0.0000
18	0.0036	0.0000
19	0.0036	0.0000
20	0.0036	0.0000
21	0.0036	0.0000
22	0.0036	0.0000
23	0.0036	0.0000
24	0.0036	0.0000
25	0.0036	0.0000
26	0.0036	0.0000
27	0.0036	0.0000
28	0.0036	0.0000
29	0.0036	0.0000
30	0.0036	0.0000

31	0.0036	0.0000
32	0.0036	0.0000
33	0.0036	0.0000
34	0.0036	0.0000
35	0.0036	0.0000
36	0.0036	0.0000
37	0.0035	0.0000
38	0.0035	0.0000
39	0.0035	0.0000
40	0.0035	0.0000
41	0.0035	0.0000
42	0.0035	0.0000
43	0.0035	0.0000
44	0.0034	0.0000
45	0.0034	0.0000
46	0.0034	0.0000
47	0.0034	0.0000
48	0.0034	0.0000
49	0.0034	0.0000
50	0.0034	0.0000
51	0.0034	0.0000
52	0.0034	0.0000
53	0.0034	0.0000
54	0.0033	0.0000
55	0.0033	0.0000
56	0.0033	0.0000
57	0.0031	0.0000
58	0.0031	0.0000
59	0.0031	0.0000
60	0.0031	0.0000
61	0.0028	0.0000

Stream Protection Duration
POC #1
The Facility PASSED

The Facility PASSED.

Flow(cfs)	Predev	Mit	Percentage	Pass/Fail
0.0018	0	0	0	Pass
0.0019	0	0	0	Pass
0.0019	0	0	0	Pass
0.0020	0	0	0	Pass
0.0020	0	0	0	Pass
0.0021	0	0	0	Pass
0.0021	0	0	0	Pass
0.0022	0	0	0	Pass
0.0022	0	0	0	Pass
0.0023	0	0	0	Pass
0.0023	0	0	0	Pass
0.0024	0	0	0	Pass
0.0024	0	0	0	Pass
0.0025	0	0	0	Pass
0.0025	0	0	0	Pass
0.0026	0	0	0	Pass
0.0026	0	0	0	Pass

0.0027	0	0	0	Pass
0.0028	0	0	0	Pass
0.0028	0	0	0	Pass
0.0029	0	0	0	Pass
0.0029	0	0	0	Pass
0.0030	0	0	0	Pass
0.0030	0	0	0	Pass
0.0031	0	0	0	Pass
0.0031	0	0	0	Pass
0.0032	0	0	0	Pass
0.0032	0	0	0	Pass
0.0033	0	0	0	Pass
0.0033	0	0	0	Pass
0.0034	0	0	0	Pass
0.0034	0	0	0	Pass
0.0035	0	0	0	Pass
0.0035	0	0	0	Pass
0.0036	0	0	0	Pass
0.0036	0	0	0	Pass
0.0037	0	0	0	Pass
0.0037	0	0	0	Pass
0.0038	0	0	0	Pass
0.0038	0	0	0	Pass
0.0039	0	0	0	Pass
0.0039	0	0	0	Pass
0.0040	0	0	0	Pass
0.0040	0	0	0	Pass
0.0041	0	0	0	Pass
0.0041	0	0	0	Pass
0.0042	0	0	0	Pass
0.0043	0	0	0	Pass
0.0043	0	0	0	Pass
0.0044	0	0	0	Pass
0.0044	0	0	0	Pass
0.0045	0	0	0	Pass
0.0045	0	0	0	Pass
0.0046	0	0	0	Pass
0.0046	0	0	0	Pass
0.0047	0	0	0	Pass
0.0047	0	0	0	Pass
0.0048	0	0	0	Pass
0.0048	0	0	0	Pass
0.0049	0	0	0	Pass
0.0049	0	0	0	Pass
0.0050	0	0	0	Pass
0.0050	0	0	0	Pass
0.0051	0	0	0	Pass
0.0051	0	0	0	Pass
0.0052	0	0	0	Pass
0.0052	0	0	0	Pass
0.0053	0	0	0	Pass
0.0053	0	0	0	Pass
0.0054	0	0	0	Pass
0.0054	0	0	0	Pass
0.0055	0	0	0	Pass
0.0055	0	0	0	Pass
0.0056	0	0	0	Pass

0.0056	0	0	0	Pass
0.0057	0	0	0	Pass
0.0058	0	0	0	Pass
0.0058	0	0	0	Pass
0.0059	0	0	0	Pass
0.0059	0	0	0	Pass
0.0060	0	0	0	Pass
0.0060	0	0	0	Pass
0.0061	0	0	0	Pass
0.0061	0	0	0	Pass
0.0062	0	0	0	Pass
0.0062	0	0	0	Pass
0.0063	0	0	0	Pass
0.0063	0	0	0	Pass
0.0064	0	0	0	Pass
0.0064	0	0	0	Pass
0.0065	0	0	0	Pass
0.0065	0	0	0	Pass
0.0066	0	0	0	Pass
0.0066	0	0	0	Pass
0.0067	0	0	0	Pass
0.0067	0	0	0	Pass
0.0068	0	0	0	Pass
0.0068	0	0	0	Pass
0.0069	0	0	0	Pass
0.0069	0	0	0	Pass

Water Quality BMP Flow and Volume for POC #1
On-line facility volume: 0 **acre-feet**
On-line facility target flow: 0 **cfs.**
Adjusted for 15 min: 0 **cfs.**
Off-line facility target flow: 0 **cfs.**
Adjusted for 15 min: 0 **cfs.**

Perlnd and Implnd Changes

No changes have been made.

Section IV – Construction Stormwater Pollution Prevention Plan (CSWPPP)

Section IV Summary

Narrative

Erosion control details are provided consistent with the SWMMWW and the City of Stanwood. Erosion control plan sheets are provided in full size as a part of the civil drawing set.

A full Construction SWPPP has been prepared using DOE's template because site disturbance is more than an acre. The SWPPP can be found attached in this section.

250 4th Avenue South, Suite 200
Edmonds, WA 98020
ph. 425.778.8500 | f. 425.778.5536
www.cgengineering.com

Construction Stormwater General Permit

Stormwater Pollution Prevention Plan (SWPPP)

for

SnoPUD Twin City Substation

Prepared for:

The Washington State Department of Ecology

Northwest Regional Office

Permittee / Owner	Developer	Operator / Contractor
Snohomish County PUD	Facility Planning Services	TBD

72XX Pioneer Hwy, Stanwood, WA 98292. Tax Parcel Numbers: 320429-003-007-00, 320429-002-011-00, 320429-003-010-00

Certified Erosion and Sediment Control Lead (CESCL)

Name	Organization	Contact Phone Number
TBD	TBD	TBD

SWPPP Prepared By

Name	Organization	Contact Phone Number
Bennett Lanners	CG Engineering	425.778.8500

SWPPP Preparation Date

April 2022

Project Construction Dates

Activity / Phase	Start Date	End Date
Construction	TBD	TBD

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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: SnoPUD Twin City Substation
Street/Location: 72XX Pioneer Hwy
City: Stanwood State: WA Zip code: 98292
Subdivision: N/A
Receiving waterbody: Church Creek

1.1 Existing Conditions

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

Total acreage: 19.05 ac
Disturbed acreage: 5.56 ac
Existing structures: 1.67 ac
Landscape topography: 16.48 ac landscaping
Drainage patterns: Flat areas in and around the site area, steep slopes outside the site which slope inward.
Existing Vegetation: Maintained lawn on flat areas, tall grass and trees on steep slopes.
Critical Areas (wetlands, streams, high erosion risk, steep or difficult to stabilize slopes):
Wetland Type 1, Soil Erosion Hazard Area, Site Class D Seismic Hazard Area, Glacier Peak Lahar, Flood Zone X

List of known impairments for 303(d) listed or Total Maximum Daily Load (TMDL) for the receiving waterbody: Dissolved Oxygen, pH

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

No known or suspected contaminants are associated with the site.

Table 1 – Summary of Site Pollutant Constituents

Constituent (Pollutant)	Location	Depth	Concentration

1.2 Proposed Construction Activities

Description of site development (example: subdivision):
Addition of 0.90 ac of new gravel pavement at an existing electrical substation.

Description of construction activities (example: site preparation, demolition, excavation):
Excavation, grading, paving, final stabilization.

Description of site drainage including flow from and onto adjacent properties. Must be consistent with Site Map in Appendix A:
The site generally slopes towards a low point at the southeast corner of the site, where pooling was observed. In the developed condition, runoff will be routed to an infiltration pond at the northeast corner of the site.

Description of final stabilization (example: extent of revegetation, paving, landscaping):
Disturbed pervious area will be revegetated per DOE Manual BMP T5.13.

Contaminated Site Information:
Proposed activities regarding contaminated soils or groundwater (example: on-site treatment system, authorized sanitary sewer discharge):
N/A

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. Trees that are to be preserved, as well as all sensitive areas and their buffers, shall be clearly delineated in the field. In general, natural vegetation and native topsoil shall be retained in an undisturbed state to the maximum extent possible.

High Visibility Fence will be placed around the downstream extents of the project site.

List and describe BMPs:

- High Visibility Fence (BMP C103)

Installation Schedules: Install BMPs prior to clearing and grading.

Inspection and Maintenance plan: As needed.

Responsible Staff: CESCL.

2.1.2 Element 2: Establish Construction Access

Limit vehicle access to one route, if possible.

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, street cleaning, or wheel wash/tire baths may be necessary if the stabilized construction access is not effective. If sediment is tracked off site, clean the affected roadway thoroughly at the end of each day, or more necessary as needed. All wheel wash wastewater shall be controlled on-site and CANNOT be discharged into waters of the State.

One stabilized construction entrance will be installed from the access road to the north of the existing substation. An existing gravel driveway to the south of the substation will be used as a second construction entrance. This will help to prevent sediment tracking into the Right of Way (ROW).

List and describe BMPs:

- Stabilized Construction Entrance/Exit

Installation Schedules: Install BMPs prior to clearing and grading.

Inspection and Maintenance plan: As needed.

Responsible Staff: CESCL.

2.1.3 Element 3: Control Flow Rates

The project site is generally flat, sloping from southwest to northeast at less than 5%. Stormwater will be directed to a temporary sediment trap. The sediment trap must be completed as one of the first steps in grading. Flow rates around the rest of the site will be controlled by silt fence.

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 Trap
- Check Dams
- Silt Fence

Installation Schedules: Install BMPs prior to grading.

Inspection and Maintenance plan: As needed.

Responsible Staff: CESCL.

2.1.4 Element 4: Install Sediment Controls

Stormwater must be filtered prior to being discharged to an infiltration system or leaving the construction site. Sediment control BMPs will be installed as one of the first steps of grading. These BMPs must be functional before other land-disturbing activities, especially grading and filling, take place.

A silt fence will be installed around the downstream perimeter of the site. A sediment traps will be installed at the northeast corner of the site to allow for sediment to settle prior to discharging to the proposed infiltration pond.

If sediment controls are ineffective and turbid water is observed discharging from the site, additional energy dissipation BMPs and sediment control BMPs should be installed such as wattles. It may also be necessary to stabilize soils per Element 5 that are not being worked on.

List and describe BMPs:

- Silt Fence
- Temporary Sediment Pond
- Wattles

Installation Schedules: Install BMPs prior to clearing and grading.

Inspection and Maintenance plan: Repair sediment controls as needed. Remove sediment from trap as needed.

Responsible Staff: CESCL.

2.1.5 Element 5: Stabilize Soils

Stabilize exposed and unworked soils by the BMPs listed below to prevent erosion. Protect stockpiles with plastic covering or other approved sediment trapping measures. Stabilize exposed soils with Temporary and Permanent Seeding, Mulching, Sodding, Topsoiling/Compost, or Surface Roughening. Minimize soil compaction by applying gravel base early on areas to be paved.

The ESC Supervisor shall be familiar with BMPs for soil stabilization and dust control and implement these BMPs where needed on the proposed site.

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: TBD End date: TBD

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

List and describe BMPs:

- Temporary and Permanent Seeding
- Mulching
- Nets and Blankets
- Plastic Covering
- Sodding
- Topsoiling/Composting
- Surface Roughening
- Dust Control

Installation Schedules: As needed as soil is exposed.

Inspection and Maintenance plan: End of the shift before a holiday or weekend and prior to forecasted rain events.

Responsible Staff: CESCL.

2.1.6 Element 6: Protect Slopes

All cut and fill slopes will be designed, constructed, and protected in a manner that minimizes erosion. The interceptor swale and check dams will be located along the north and south edges of the site.

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

List and describe BMPs:

- Temporary and Permanent Seeding
- Interceptor Dike and Swale
- Check Dams

Installation Schedules: Install BMPs prior to grading and as needed to minimize erosion.

Inspection and Maintenance plan: As needed.

Responsible Staff: CESCL.

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 street wash water separate from entering storm drains until treatment can be provided.

No drain inlets are located on site or downstream of the site.

List and describe BMPs:

- N/A

Installation Schedules: N/A

Inspection and Maintenance plan: N/A

Responsible Staff: N/A

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.

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

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:

- Channel Lining
- Check Dams
- Outlet Protection

Installation Schedules: Install BMPs prior to grading.

Inspection and Maintenance plan: As needed.

Responsible Staff: CESCL.

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)
Gravel paving materials

List and describe BMPs:

- Material Delivery, Storage and Containment

Installation Schedules: As needed as pollutant source materials are used on-site.

Inspection and Maintenance plan: As needed.

Responsible Staff: CESCL.

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

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

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:]

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

2.1.10 Element 10: Control Dewatering

Dewatering is not anticipated to be associated with this construction project.

If necessary, only clean, non-turbid dewatering water (such as well-point groundwater) may be discharged to systems tributary to, or directly into, surface waters of the State, provided the dewatering flow does not cause erosion or flooding of receiving waters.

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: N/A.

Installation Schedules: N/A.

Inspection and Maintenance plan: N/A.

Responsible Staff: CESCL.

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
Pre-construction	High Visibility Fence	TBD	Dry
Pre-construction	Silt Fence	TBD	Dry
Land disturbance	Stabilized Construction Entrance/Exit	TBD	Dry
Land disturbance	Sediment Trap	TBD	Dry
Land disturbance	Temporary and Permanent Seeding	TBD	Dry
Land disturbance	Mulching	TBD	Dry
Land disturbance	Nets and Blankets	TBD	Dry
Land disturbance	Plastic Covering	TBD	Dry
Land disturbance	Sodding	TBD	Dry
Land disturbance	Topsoiling/Composting	TBD	Dry
Land disturbance	Surface Roughening	TBD	Dry
Land disturbance	Dust Control	TBD	Dry
Land disturbance	Interceptor Dike and Swale	TBD	Dry
Land disturbance	Channel Lining	TBD	Dry
Land disturbance	Check Dams	TBD	Dry
Land disturbance	Outlet protection	TBD	Dry
Construction	Wattle	TBD	Dry
Construction	Concrete handling	TBD	Dry
Construction	Sawcutting and Surfacing Pollution Prevention	TBD	Dry
Construction	Material Delivery, Storage and Containment	TBD	Dry

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

The proposed perforated pipe connection for the hangar should be protected during construction with high visibility fencing.

3 Pollution Prevention Team

Table 7 – Team Information

Title	Name(s)	Phone Number
Certified Erosion and Sediment Control Lead (CESCL)	TBD	TBD
Resident Engineer	CG Engineering	425.778.8500
Emergency Ecology Contact	Larry Altose	425.649.7009
Emergency Permittee/ Owner Contact	Ben Davis	425.783.8465
Non-Emergency Owner Contact	Ben Davis	425.783.8465
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): pH

5.2 TMDL Waterbodies

Waste Load Allocation for CSWGP discharges: 0 lb of ammonia per day.

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 one (1) acre or larger; therefore, Discharge Monitoring Reports (DMRs) will be submitted to Ecology monthly. If there was no discharge during a given monitoring period the DMR will be submitted as required, reporting "No Discharge". The DMR due date is fifteen (15) days following the end of each calendar month.

DMRs will be reported online through Ecology's WQWebDMR System.

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

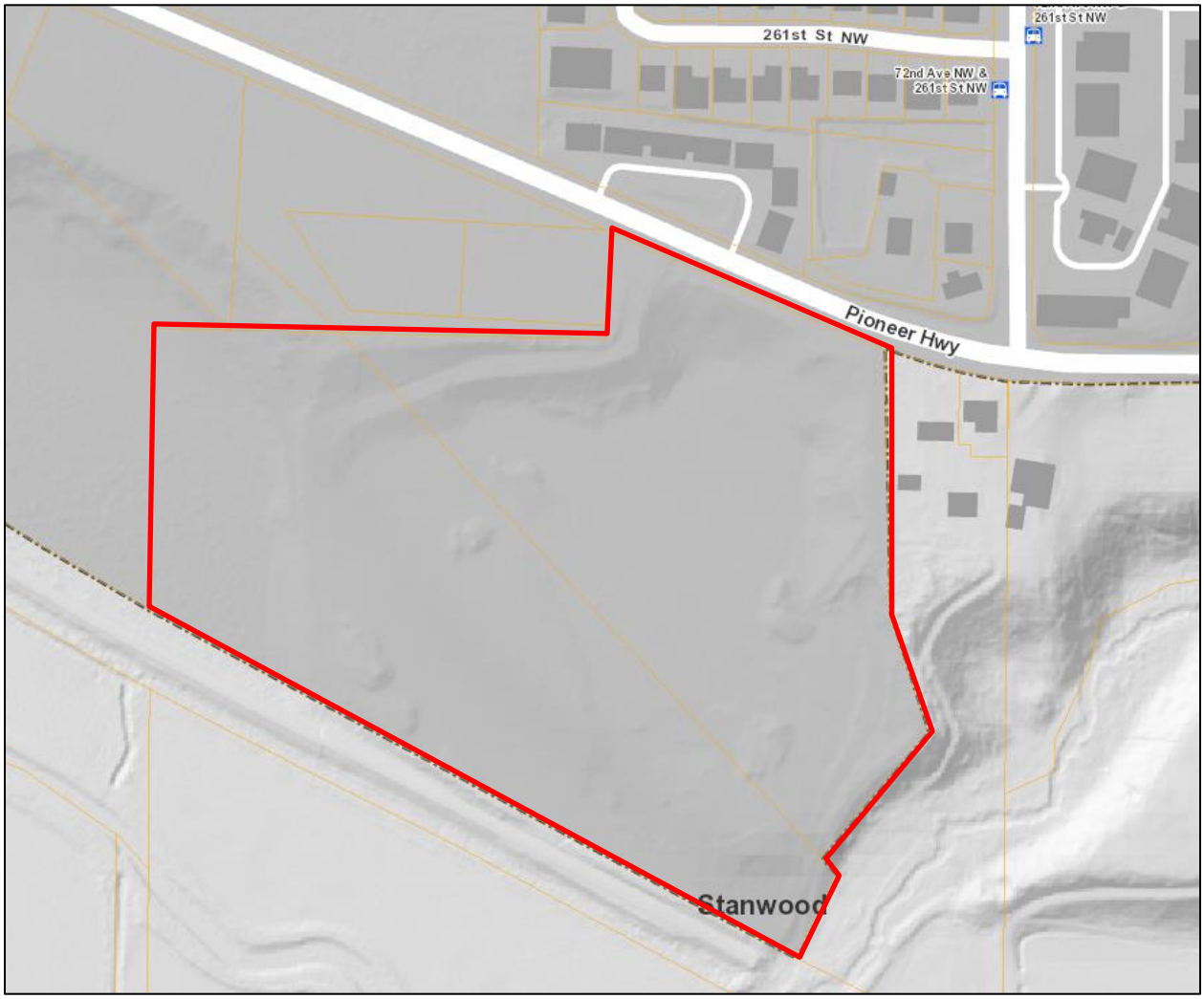

Figure A-1. Site map.

B. BMP Detail

BMP details are shown on the approved TESC plan. Additional/alternative BMPs are listed below and available for download from the Ecology Construction Stormwater website:

http://www.ecy.wa.gov/programs/wq/stormwater/construction/index.html

Element #1 - Mark Clearing Limits

- BMP C101: Preserving Natural Vegetation
- BMP C102: Buffer Zones
- BMP C103: High Visibility Plastic or Metal Fence
- BMP C233: Silt Fence

Element #2 - Establish Construction Access

- BMP C105: Stabilized Construction Entrance/Exit
- BMP C106: Wheel Wash
- BMP C107: Construction Road/Parking Area Stabilization

Element #3 - Control Flow Rates

- BMP C203: Water Bars
- BMP C207: Check Dams
- BMP C209: Outlet Protection
- BMP C235: Wattles
- BMP C240: Sediment Trap
- BMP C241: Temporary Sediment Pond

Element #4 - Install Sediment Controls

- BMP C231: Brush Barrier
- BMP C232: Gravel Filter Berm
- BMP C233: Silt Fence
- BMP C234: Vegetated Strip
- BMP C235: Wattles
- BMP C240: Sediment Trap
- BMP C241: Temporary Sediment Pond
- BMP C250: Construction Stormwater Chemical Treatment
- BMP C251: Construction Stormwater Filtration

Element #5 - Stabilize Soils

- BMP C120: Temporary and Permanent Seeding
- BMP C121: Mulching
- BMP C122: Nets and Blankets
- BMP C123: Plastic Covering
- BMP C124: Sodding
- BMP C125: Topsoiling/Composting
- BMP C126: Polyacrylamide for Soil Erosion Protection
- BMP C130: Surface Roughening
- BMP C131: Gradient Terraces
- BMP C140: Dust Control

Element #6 - Protect Slopes

- BMP C120: Temporary and Permanent Seeding

- BMP C121: Mulching
- BMP C122: Nets and Blankets
- BMP C123: Plastic Covering
- BMP C124: Sodding
- BMP C130: Surface Roughening
- 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 C207: Check Dams
- 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 C202: Channel Lining
- BMP C122: Nets and Blankets
- BMP C207: Check Dams
- BMP C209: Outlet Protection

Element #9 – Control Pollutants

- BMP C151: Concrete Handling
- BMP C152: Sawcutting and Surfacing Pollution Prevention
- BMP C153: Material Delivery, Storage and Containment
- BMP C154: Concrete Washout Area
- BMP C250: Construction Stormwater Chemical Treatment
- BMP C251: Construction Stormwater Filtration
- BMP C252: High pH Neutralization Using CO2
- BMP C253: pH Control for High pH Water
- See Volume IV – Source Control BMPs

Element #10 - Control Dewatering

- BMP C203: Water Bars
- BMP C236: Vegetative Filtration

Element #11: Maintain BMPs

- BMP C150: Materials On Hand
- BMP C160: Certified Erosion and Sediment Control Lead

Element #12: Manage the Project

- BMP C150: Materials On Hand
- BMP C160: Certified Erosion and Sediment Control Lead
- BMP C162: Scheduling

Element #13: Protect LID BMPs

- BMP C103: High Visibility Fence

C. Correspondence

D. Site Inspection Form

	Permit #	Inspection Date	Time
Project Name			

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?						
	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?						
	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

Sign the following certification:

"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)

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

G. Contaminated Site Information

H. Engineering Calculations

Sediment Trap Design Calculations
for: SnoPUD Twin City Substation

SA=FS(Q/Vs) Water surface area

FS=	2		Factor of Safety
Q2=	0.901	cfs	2-yr developed peak from WWHM
Q10=	1.452	cfs	10-yr developed peak from WWHM
Vs=	0.00096	ft/s	Settling Velocity
Side Slopes=	3	H:1V	
Depth=	3.5	ft	Minimum

2-year Trap Geometry

SA=	1877	sf			
Min. Pond Dimensions=	43	by	43	ft	(Assumed square trap)
Incl. 1 ft Freeboard=	49	by	49	ft	

10-year Trap Geometry

SA=	3025	sf			
Min. Pond Dimensions	55	by	55	ft	(Assumed square trap)
Incl. 1 ft Freeboard=	61	by	61	ft	

CG ENGINEERING 250 4th Ave. South, Ste. 200 Edmonds, WA 98020	Sediment Trap Calculations Trap Geometry **SnoPUD Twin City Substation**	By TAF Chkd Scale N.T.S. Job No. 21328.20	Date 4/14/2022 Date Sheet No. 1

Figure H-1. Sediment Trap Calculations

Section V – Special Reports and Studies

Section V Summary:

Narrative

The following reports are included in this section:

1. Geotechnical Engineering Report by ZipperGeo, dated April 15, 2022.
2. Soil Resource Report from USDA's Web Soil Survey, dated April 13, 2022.

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GEOTECHNICAL ENGINEERING REPORT

TWIN CITY SUBSTATION POLE YARD
7212 Pioneer Highway
Stanwood, Washington

Project No. 2470.01
15 April 2022

Prepared for:
CG Engineering, Inc. and Snohomish County PUD No. 1

Prepared by:

ZipperGeo
Geotechnical and Environmental Consultants
19019 36th Avenue W., Suite E
Lynnwood, WA 98036

ZipperGeo
Geoprofessional Consultants

15 April 2022
Project No. 2470.01

CG Engineering, Inc.
250 – 4th Avenue South, Suite 200
Edmonds, Washington 989020

Attention: Mr. Jared Underbrink, PE, Project Manager

Subject: Geotechnical Engineering Report
Twin City Substation Pole Yard
7212 Pioneer Highway
Stanwood, Washington

Dear Jared:

In accordance with your request, Zipper Geo Associates, LLC (ZGA) has completed the subsurface exploration and geotechnical engineering evaluation for the proposed Twin City Substation Pole Yard. This report presents the findings of the subsurface exploration and geotechnical recommendations for the project. Our work was completed in general accordance with the scope of services described in our *Scope of Services and Fee Estimate – Revised*, dated 20 July 2021 which is contained in our consulting agreement that was authorized on 18 August 2021. We appreciate the opportunity to be of service to you on this project. If you have any questions concerning this report, or if we may be of further assistance, please contact us.

Respectfully submitted,
Zipper Geo Associates LLC

Signed 4.15.22

David C. Williams, LG, LEG
Principal Engineering Geologist

Signed 4.15.22

Robert A. Ross, PE
Managing Principal

Distribution: Addressee (1 electronic)

Cover photo courtesy Google Earth

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FIGURES

Figure 1 – Site and Exploration Plan

APPENDICES

Appendix A – Subsurface Exploration Procedures and Logs

Appendix B – Laboratory Testing Procedures and Results

GEOTECHNICAL ENGINEERING REPORT
TWIN CITY SUBSTATION POLE YARD
7212 PIONEER HIGHWAY
STANWOOD, WASHINGTON

Project No. 2470.01
15 April 2022

INTRODUCTION

The geotechnical engineering exploration and analysis have been completed for the proposed Twin City Substation Pole Yard in Stanwood, Washington. Two borings and 12 test pit explorations were completed to depths ranging from approximately 8 to 26-1/2 feet below the existing ground surface to evaluate subsurface conditions. Descriptive logs of the explorations are included in Appendix A and Appendix B contains a summary of laboratory testing procedures and results.

PROJECT INFORMATION

Site Location

The project site comprises two adjoining parcels containing the Twin City substation located at 7212 Pioneer Highway in Stanwood. The site is located south of Pioneer Highway at a transition between the Stillaguamish River valley at the south and an upland terrace at the north. The property encompasses approximately 19 acres that includes a forested upland at the north and the substation at the south. The site is bordered by a BNSF railroad right-of-way and agricultural property at the southwest, south, and southeast, a cemetery at the northwest, and developed residential property to the north and northeast. The project site is illustrated on the *Site and Exploration Plan*, Figure 1.

Project Description

Site work for the substation was largely completed at the end of 2020. Site work included removing trees and stripping vegetation from the substation development area, and excess soil and shredded vegetation were spread in these areas prior to hydroseeding. The District plans to construct a new pole yard in the area north and east of the substation. Plans available at the time this report was prepared indicate that proposed improvements will include both paved and gravel-surfaced access roads and material storage areas, as well as stormwater management features. Access to the pole yard will be along the existing paved road to the substation from the north along with new drive lanes in and around the pole yard. Traffic is expected to include heavily loaded vehicles, including dump trucks. Finished grades are expected to be very close to existing grades.

ZipperGeo
Geoprofessional Consultants

SITE HISTORY

According to documents provided by the District for our review, surface mining of sand and gravel took place on the property since at least the 1940s. Review of these documents and available aerial photographs suggests that past operations included mining and screening, but apparently not washing of mined materials. The photographs and documents clearly illustrate that fill material was placed in portions of the mined area as part of reclamation efforts. The design phase geotechnical exploration for the substation completed by ZGA in 20018 and 2019 included advancing borings and test pits that disclosed fill material of varied composition above native outwash sand/gravelly sand that was underlain by fine grained Transitional Beds.

SITE CONDITIONS

Surface Conditions

Ground surface elevations in the pole yard expansion area range from approximately 21 to 25 feet and reflect grading completed during the recent substation construction as well as during prior mine reclamation. The pole yard supports a sparse grass and weed growth but lacks trees as they were removed during substation construction. It is not unusual to see scattered ponded water after rain events and this is a reflection of the low infiltration rate of some of the fill material placed during mine reclamation.

Subsurface Conditions

Local Geologic Conditions

The publication *Geologic Map of the Stanwood Quadrangle, Snohomish County, Washington* (USGS, MF-1741, 1985) indicates that the site has been mapped as containing glacially consolidated granular advance outwash deposits (Qva) above fine-grained Transitional Beds (Qtb). The advance outwash consists of sand and gravelly sand and was the material extracted during previous mining. The advance outwash generally has a low fines content (the soil fraction passing the US No. 200 sieve) overall, although discrete silt and silty sand horizons are not unusual, and the facies with a low fines content may have a moderate to high permeability. The underlying Transitional Beds consist of silt and clay with secondary sand, gravel, and cobbles. The Transitional Beds are characterized by a relatively high density and low permeability, and groundwater within the advance outwash is frequently perched above the less permeable Transitional Beds.

Subsurface conditions disclosed by the borings and test pits completed for this current evaluation as well as for the substation design phase are consistent with the published mapping. Our explorations also disclosed undocumented fill material above the native soils at the substation site.

ZipperGeo
Geoprofessional Consultants

Soil Conditions

The soil descriptions presented below have been generalized for ease of report interpretation. Please refer to the exploration logs for detailed soil descriptions at the exploration locations. Variations in subsurface conditions may exist between the exploration locations and the nature and extent of variations between the explorations may not become evident until additional explorations are completed or until construction. Significant fill material is present in the floor of the former mine, much of it resultant from reclamation activity. It should be recognized that the nature and depth of fill material is such that its composition and depth may vary over relatively short distances. Subsurface conditions at specific locations are summarized below.

Subsurface conditions were evaluated during design of the substation by advancing five exploratory borings and by excavating 44 test pits. Explorations completed for this current evaluation include borings B-6 and B-7 as well as test pits TP-45 through TP-56. Approximate exploration locations, as well as pertinent surface features, are shown on Figure 1. Appendix A contains descriptive logs of the borings and test pits completed recently, as well as logs of selected borings and test pits completed during the substation design phase. Observed soil conditions are summarized below.

Each of the explorations disclosed some surficial fill with fine, fibrous, and/or woody organic material, some of which was placed during substation construction. For convenience, we describe this material as topsoil on the logs. The approximate thickness of the organics observed at the recently completed explorations, which will need to be stripped from the pole yard footprint, ranged from approximately 4 to 18 inches.

We observed non-organic fill material to depths of approximately 2 to 10.5 feet at the explorations completed in and near the proposed pole yard improvements. The fill was largely composed of soil with only minor amounts of debris; we observed minor pieces of plastic, one spray paint can, some wire, some rebar, and some concrete clasts at the locations of test pits TP-5 and TP-45 while some minor wood debris and fine organics were observed on a scattered basis. The fill typically consisted of loose to medium dense silty sand and soft to medium stiff sandy silt with a variable gravel and cobble content.

We observed native granular advance outwash below the fill at each of the exploration locations. The outwash typically consisted of sand with a variable gravel content and, overall, a relatively low fines content (the soil fraction passing the US No. 200 sieve). The approximate depth and elevation, as well as the minimum thickness, of the outwash are listed on Table 1 on the following page. The Transitional Beds consisted of both weathered brown and unweathered gray silt with secondary clay and a variable sand, gravel, and cobble content.

Table 1: Subsurface Conditions Summary				
Exploration No.	**Approximate Ground Surface Elevation (feet)**	**Approximate Depth to / Elevation of Advance Outwash (feet)**	**Approximate Advance Outwash Thickness (feet)**	**Approximate Organic Material Stripping Depth (inches)**
TP-3	21	* / 13	>2	**
TP-4	21	* / 10.5	>3.5	**
TP-5	23	* / 10	>2	**
TP-6	26	* / 19	>1	**
TP-18	22	* / 14	>5	**
TP-19	22	* / 19.5	>7.5	**
TP-45	25	14 / 11	>3	18
TP-46	24	12 / 12	>6	6
TP-47	24	9.5 / 14.5	>9	12
TP-48	23	11 / 12	>7	14
TP-49	23	6 / 17	>12	10
TP-50	23	11 / 12	5	6
TP-51	23	8.5 / 14.5	>6.5	6
TP-52	22	4 / 18	>12.5	6
TP-53	22	3 / 19	>12	10
TP-54	22	2 / 20	>15.5	12
TP-55	22	10.5 / 11.5	>4.5	6
TP-56	21	9.5 / 11.5	>7.5	6
B-6	23	10.5 / 12.5	>16.5	6
B-7	22	8 / 14	15	4

*The approximate depth of the advance outwash is not provided for the test pits completed for the substation design phase exploration as grades were changed during construction.

**Approximate stripping depths are not provided for the test pits completed for the substation design phase exploration as grades were changed during construction.

Groundwater

We observed groundwater seepage within the old fill material at approximate depths of 1.5 to 7 feet while excavating test pits TP-3, TP-4, and TP-5, and at approximately 16.5 feet in the outwash while excavating test pit TP-54. Groundwater was measured previously at elevations of about 6 to 7 feet (roughly 15 to 19 feet) in the monitoring well installed at the substation location. We observed groundwater at approximate elevations of slightly less than 7 feet in the pole yard expansion area while advancing borings B-6 and B-7, and subsequently measured groundwater at the depths and elevations listed in the table

below in October and December 2021. Given the extremely wet weather in October and November, it is our opinion that the groundwater levels measured in December may be interpreted as a reasonable approximation of the annual high. Groundwater tends to perch above the fine grained Transitional Bed deposits that underlie the native granular outwash and the existing fill material, as well as within the fill.

Table 2: Groundwater Measurement Summary (depth/elevation in feet)*

Boring	Date		
	10.4.21 (after drilling)	10.26.21	12.2.21
B-6	16.57/6.69	15.11/7.72	13.52/9.31
B-7	15.3/6.7	14.98/6.62	12.24/9.36

It should be noted that groundwater conditions will likely vary seasonally and in response to precipitation events, land use, and other factors, and its occurrence will be influenced by the composition and density/consistency of the fill material, in particular.

CONCLUSIONS AND RECOMMENDATIONS

General Geotechnical Considerations

Based on information gathered during the field exploration, laboratory testing, and analysis, we conclude that construction of the proposed pole yard improvements is feasible from the geotechnical perspective provided that the recommendations presented herein are followed during design and construction. Selected aspects of the site conditions that should be considered during design and construction are summarized below.

- The site is mantled with a variable thickness of organic-laden fill placed during substation construction. It will be necessary to strip this material from the footprint of the proposed site improvements.

- Some of the fill material placed as part of the mine reclamation and below the recently placed surficial organics is in a loose/soft condition and will need to be densified below access roads and material storage areas.

- Much of the existing fill material has a relatively high fines content and should be considered highly moisture-sensitive. Attempting to grade the soils with a high fines content will be difficult, if not impossible, during wet weather.

- The relatively clean nature of the native advance outwash soils and some of the fill material is such that caving in excavations may occur.

- The relatively low fines content of the native outwash soils is favorable from the stormwater management perspective in that the soils have a relatively high permeability and would function well as infiltration receptor soils.

Geotechnical engineering recommendations for site grading, drainage, and other geotechnically-related aspects of the project are presented in the following sections. The recommendations contained in this report are based upon the results of and the field exploration, laboratory testing, engineering analyses, review of substation construction documents, and our current understanding of the proposed project design. ASTM and WSDOT specification codes cited herein refer to the current manual published by the American Society for Testing & Materials and the current edition of the WSDOT *Standard Specifications for Road, Bridge, and Municipal Construction* (Publication M41-10).

Geologically Hazardous Areas

Chapter 17.115.030 of the Stanwood Municipal Code (SMC) defines regulated geologically hazardous areas as follows in italics, and our conclusions regarding such areas are presented in regular text:

*(1) **Geologically Hazardous Areas**. Geologically hazardous areas include areas susceptible to erosion, sliding, earthquake, or other geological events. They pose a threat to the health and safety of citizens when incompatible development is sited in areas of significant hazard. Such incompatible development may not only place itself at risk, but also may increase the hazard to surrounding development and use. Areas susceptible to one or more of the following types of hazards shall be designated as a geologically hazardous area:*

(a) Erosion hazard;

(b) Landslide hazard;

(c) Seismic hazard; and

(d) Other geological events including tsunamis, volcanic hazards, and differential settlement.

*(2) **Erosion Hazard Areas**. Erosion hazard areas are at least those areas identified by the U.S. Department of Agriculture's Natural Resources Conservation Service as having a "moderate to severe," "severe," or "very severe" rill and inter-rill erosion hazard. On the city's critical areas maps, these are shown as areas of moderate or steep slopes. Erosion hazard areas are also those areas impacted by shore land and/or stream bank erosion.*

The proposed pole yard is nearly level and does not meet the prescriptive definition of an erosion hazard, in our opinion. However, the slope below the south side of the substation access road does meet the definition. A 25-foot buffer from the toe of the access road south slope was established during design of the substation and the proposed pole yard improvements will not require alteration of the buffer.

*(3) **Landslide Hazard Areas**. Landslide hazard areas are areas potentially subject to landslides based on a combination of geologic, topographic, and hydrologic factors. They include areas susceptible because of any combination of bedrock, soil, slope (gradient), slope aspect, structure, hydrology, or other factors. Examples of these may include, but are not limited to, the following:*

(a) Areas of historic failures, such as those areas delineated by the U.S. Department of Agriculture's Natural Resources Conservation Service as having a "severe" limitation for building site development;

(b) Areas with all three of the following characteristics:

(i) Slopes steeper than 15 percent; and

(ii) Hillsides intersecting geologic contacts with a relatively permeable sediment overlying a relatively impermeable sediment or bedrock; and

(iii) Springs or groundwater seepage;

(c) Areas that have shown movement during the Holocene epoch (from 10,000 years ago to the present) or that are underlain or covered by mass wastage debris of that epoch;

(d) Slopes that are parallel or subparallel to planes of weakness (such as bedding planes, joint systems, and fault planes) in subsurface materials;

(e) Areas potentially unstable because of rapid stream incision, stream bank erosion, and undercutting by wave action;

(f) Areas located in a canyon or on an active alluvial fan, presently or potentially subject to inundation by debris flows or catastrophic flooding; and

(g) Any area with a slope of 40 percent or steeper and with a vertical relief of 10 or more feet except areas composed of consolidated rock. A slope is delineated by establishing its toe and top and measured by averaging the inclination over at least 10 feet of vertical relief.

The proposed pole yard is nearly level and does not meet the SMC definition of a landslide hazard, in our opinion. However, the slope below the existing substation access road does meet the SMC definition of

a landslide hazard. The slope is composed of well-drained granular soils and groundwater seepage has not been observed on these slopes during several site visits made during the wet winter and spring months. The access road south slope lacks surficial evidence of previous or ongoing instability.

SMC 17.115.080(1)(a)(iii) calls for a minimum 25-foot buffer from landslide hazards, and a 25-foot buffer from the toe of the access road slope was established during the substation permitting phase. The proposed pole yard improvements do not include alteration of the access road south slope or the 25-foot buffer.

*(4) **Seismic Hazard Areas**. Seismic hazard areas are areas subject to severe risk of damage as a result of earthquake-induced ground shaking, slope failure, settlement, soil liquefaction, lateral spreading, or surface faulting. One indicator of potential for future earthquake damage is a record of earthquake damage in the past. Ground shaking is the primary cause of earthquake damage in Washington. The strength of ground shaking is primarily affected by:*

(a) The magnitude of an earthquake;

(b) The distance from the source of an earthquake;

(c) The type of thickness of geologic materials at the surface; and

(d) The type of subsurface geologic structure.

Settlement and soil liquefaction conditions occur in areas underlain by cohesionless, loose, or soft-saturated soils of low density, typically in association with a shallow groundwater table.

Based upon the observed soil conditions at the proposed pole yard location, it is our opinion that the site does not meet the SMC criteria for a seismic hazard. The site is underlain at shallow depths by glacially consolidated fine grained soils and laterally discontinuous perched groundwater that is relatively deep in the granular soil section. Consequently, the risk of significant liquefaction occurring at the pole yard site is low, in our opinion. It should also be recognized that no structures are proposed for construction in the pole yard.

*(5) **Tsunami Hazard Areas**. Tsunami hazard areas are coastal areas and large lake shoreline areas susceptible to flooding and inundation as the result of excessive wave action derived from seismic or other geologic events.*

We did not evaluate the risk that a tsunami may present to the site.

*(6) **Lahar Hazard Areas**. Areas susceptible to mud or debris flows from volcanic eruptions (Glacier Peak).*

The southwestern portion of the site is depicted within an area potentially susceptible to lahars (mudflows composed of volcanic debris and water) on the City of Stanwood Figure NF-7b, *Seismic/Volcanic/Lahar Hazards* map.

(7) ***Other Hazard Areas****. Geologically hazardous areas shall also include areas determined by the city to be susceptible to other geological events including mass wasting, debris flows, rock falls, and differential settlement.*

Site conditions are such that the risk of mass wasting and debris flows affecting the site is negligible, in our opinion. The existing uncontrolled fill material at the site presents a risk of differential settlement, but this can be mitigated through appropriate grading. Such methods would typically include excavation of loose uncontrolled fill material and replacing it with adequately compacted structural fill.

Earthwork

The following sections present recommendations for site preparation, subgrade preparation and placement of engineered fills on the project. Earthwork on the project should be observed and evaluated by a ZGA representative. Evaluation of earthwork should include observation and testing of structural fill, road section subgrade preparation, and subsurface drainage installations.

Site Preparation

Stripping: In preparation for grading we recommend removal of the surficial organic fill and vegetation, as well as any deleterious debris that may be encountered, from the footprint of the proposed improvements. These materials could be wasted in the areas north, east, and southeast of the site.

Existing Fill Removal: Site preparation is recommended to include selective removal of existing undocumented fill material containing deleterious debris or that is too wet to be compacted to the recommended density. Variation in the fill depth and composition should be expected, along with the moisture content (this will vary seasonally and in response to weather conditions). These materials should be evaluated during construction and removed as necessary under the observation of a ZGA representative. Our representative will identify unsuitable materials that should be removed and those that may be improved in place or re-used as structural fill. The resultant excavations should be backfilled in accordance with the subsequent recommendations for structural fill placement and compaction.

The existing undocumented fill with no more than about 3 percent organic material and lacking deleterious material may be left in place provided that it can be compacted as subsequently recommended. Existing fill that is excavated as part of construction activity may be re-used as structural fill provided that at the time of placement and compaction it is at a moisture content that allows its compaction to the required density, has no more than about 3 percent organics, and lacks deleterious debris.

Site Preparation Scheduling: We recommend that site preparation and grading take place in the drier summer and early fall months if possible. Operating wheeled and tracked equipment when the existing moisture-sensitive fill material is wet will result in significant disturbance of the soil and this will likely require its removal. This will increase construction costs. Completion of site preparation and grading under drier site and weather conditions will reduce the potential for disturbance of the moisture-sensitive soils and reduce the likelihood of subgrade disturbance and the need to replace disturbed soils with other granular fill material.

Structural Fill Placement and Compaction

All fill material should be placed in accordance with the recommendations herein for structural fill. Prior to placement, the surfaces to receive structural fill should be observed by a ZGA representative in order to verify that at least medium dense properly prepared fill or native soil is present. In the event that soft or loose soils are present at the subgrade elevation, and we expect that this will locally be the case given the nature of undocumented fill material, the soils should be compacted to a firm and non-yielding condition and to at least 95 percent of the modified Proctor maximum dry density (ASTM D 1557) prior to placing structural fill. This may require partial to complete removal of existing fill material and replacing it with compacted structural fill. In the event that the soils cannot be adequately compacted, they should be removed as necessary and replaced with other granular fill material at a moisture content that allows its compaction to the recommended density.

The suitability of soil for use as structural fill depends primarily on the gradation and moisture content of the soil when it is placed. As the amount of fines (that soil fraction passing the US No. 200 sieve) increases, soil becomes increasingly sensitive to small changes in moisture content and adequate compaction becomes more difficult, or impossible, to achieve. Generally, soils containing more than about 5 percent fines by weight (based on that soil fraction passing the US No. 4 sieve) cannot be compacted to a firm, non-yielding condition when the moisture content is more than a few percent from optimum. The optimum moisture content is that which yields the greatest soil density under a given compactive effort.

Re-use of On-site Soils: Soil expected to be encountered in excavations in the pole yard and new access road locations consists of sand and gravel with a variable silt content as well as silt with a variable sand and gravel content. We anticipate that it will be feasible to re-use the soils with a lower fines content under a relatively wide variety of weather conditions, but use of soils with more than about 5 percent fines will depend on the weather conditions at the time of placement and compaction. The native outwash, and the cleaner fill materials, are well-suited for use as structural fill. Please note that some of the fill material and the native soil (Transitional Beds) contain a high silt content. Using these materials as structural fill could be difficult due to the high fines content and moisture sensitivity.

Imported Structural Fill: We recommend that structural fill consist of a well-graded sand and gravel with a low fines content, such as the District's standard substation fill, the gradation of which is presented in the table below.

Table 3: Snohomish County PUD No. 1 Substation Import Granular Fill Gradation	
US Standard Sieve Size	**Percent Passing by Dry Weight Basis**
2 inch	100
½ inch	56 - 100
¼ inch	40 - 78
No. 10	22 - 57
No. 40	8 - 32
No. 200	< 5

This material may be considered slightly to moderately moisture-sensitive relative to placement and compaction. It would be feasible to use other granular soils with a higher fines content as structural fill, but it should be recognized that soils with a higher fines content will be more moisture-sensitive and this may limit their use during wet weather or wet site conditions. Another advantage of using granular fill with a relatively low fines content is that it will drain better than fill with a higher fines content. The use of other fill types should be reviewed and approved by ZGA prior to their use on site.

Compaction Recommendations: Structural fill should be placed in horizontal lifts and compacted to a firm and non-yielding condition and to at least 95 percent of the modified Proctor maximum dry density using equipment and procedures that will produce the recommended moisture content and densities throughout the fill. Fill lifts should generally not exceed 10 inches in loose thickness, although the nature of the compaction equipment in use and its effectiveness will influence functional fill lift thicknesses.

Earthwork may be difficult or impossible during periods of elevated soil moisture and wet weather. If soils are stockpiled for future use and wet weather is anticipated, the stockpile should be protected with plastic sheeting that is securely anchored.

Subgrade soils that become disturbed due to elevated moisture conditions should be overexcavated to expose firm, non-yielding, non-organic soils and backfilled with compacted structural fill. We recommend that the earthwork portion of this project be completed during extended periods of dry weather if possible. If earthwork is completed during the wet season (typically November through June) it will be necessary to take extra precautionary measures to protect subgrade soils. Wet season earthwork may require additional mitigative measures beyond that which would be expected during the drier summer and fall months. This could include diversion of surface runoff around exposed soils and draining of ponded water. Once subgrades are established, it will be necessary to protect the exposed subgrade soils from construction traffic during wet weather. Placing quarry spalls or crushed recycled concrete over

these areas would further protect the soils from construction traffic. Protection of subgrades should be expected in the portions of the site where silt is present at shallow depths.

If earthwork takes place during freezing conditions, we recommend allowing the exposed subgrade to thaw and then recompacting the subgrade prior to placing subsequent lifts of engineered fill. Frozen soil should not be used as structural fill.

We recommend that a ZGA representative be present during the construction phase of the project to observe earthwork operations and to perform necessary tests and observations during subgrade preparation and placement and compaction of structural fill.

Drainage: Positive drainage should be provided during construction and maintained throughout the life of the project. Uncontrolled movement of water into trenches or foundation and slab excavations during construction should be prevented.

Utility Installation Recommendations

Below-grade utilities are expected to include conduit and storm drain piping and structures. We recommend that utility trenching conform to all applicable federal, state, and local regulations, such as OSHA and WISHA, for open excavations. The existing shallow native and fill soils in the pole yard footprint are generally expected to be adequate for support of utilities. Given the site's history of mine reclamation using a variety of materials, localized removal of undocumented fill containing debris or load-sensitive organics may be necessary.

All trenches should be wide enough to allow for compaction around the haunches of pipe or conduit. If water is encountered in the excavations, it should be removed prior to fill placement. Materials, placement and compaction of utility trench backfill should be in accordance with the recommendations presented in the *Structural Fill* section of this report. In our opinion, the initial lift thickness should not exceed one foot unless recommended by the manufacturer to protect utilities from damage by compacting equipment. Light, hand operated compaction equipment may be utilized directly above utilities if damage resulting from heavier compaction equipment is of concern.

Dewatering: Depending upon the time of year that the work takes place and the depth of the utilities, excavations may encounter perched water. The contractor should be prepared to pump water from excavations as necessary to maintain a relatively dry trench condition. We anticipate that the likelihood of encountering water in excavations will be highest in areas containing fill with a high fines content and during the wetter times of year.

Temporary Excavation Slopes: We recommend that utility trenching, installation, and backfilling conform to all applicable Federal, State, and local regulations such as WISHA and OSHA regulations for open excavations. In order to maintain the function of any existing utilities that may be located near

excavations, we recommend that temporary excavations not encroach upon the bearing splay of existing utilities, foundations, or slabs. The bearing splay of structures and utilities should be considered to begin at the edge of the utility, foundation, or slab and extend downward at a 1H:1V (Horizontal:Vertical) slope. If, due to space constraints, an open excavation cannot be completed without encroaching on a utility, we recommend shoring the new utility excavation with a slip box or other suitable means that provide for protection of workers and that maintain excavation sidewall integrity to the depth of the excavation.

Temporary slope stability is a function of many factors, including the following:

- The presence and abundance of groundwater;
- The type and density of the various soil strata;
- The depth of cut;
- Surcharge loadings adjacent to the excavation;
- The length of time the excavation remains open.

It is exceedingly difficult under the variable circumstances presented by uncontrolled fill material to pre-establish a safe and "maintenance-free" temporary cut slope angle. Therefore, it should be the responsibility of the contractor to maintain safe slope configurations since the contractor is continuously at the job site, able to observe the nature and condition of the cut slopes, and able to monitor the subsurface materials and groundwater conditions encountered. It may be necessary to drape temporary slopes with plastic or to otherwise protect the slopes from the elements and minimize sloughing and erosion. We do not recommend vertical slopes or cuts deeper than 4 feet if worker access is necessary. The cuts should be adequately sloped or supported to prevent injury to personnel from local sloughing and spalling. The excavation should conform to applicable Federal, State, and local regulations.

Based upon our review of WAC Chapter 296-155-66401 (Appendix A – Soil Classification), we have interpreted the existing granular fill and granular outwash soils disclosed by the explorations and likely to be present in most excavations as consistent with the Type C definition. The contractor should be responsible for determining soil types in all excavations at the time of construction and should be prepared to adequately shore or slope all excavations. Please note that some of the granular soils have a low fines content and that unsupported excavation sidewalls in these soils may slough or cave readily.

Stormwater Infiltration Considerations

The substation and access roads rely upon a small pond and three trenches for infiltration of stormwater into the site's permeable granular soils, and we anticipate that the pole yard improvements will include similar features. We understand that stormwater management improvements for the pole yard will be

designed in accordance with the Washington State Department of Ecology 2005 *Stormwater Management Manual for Western Washington* (*Manual*). Based on the findings of the field exploration, laboratory testing, our analysis, and observation of the effective existing infiltration facilities it is our opinion that stormwater infiltration for the pole yard is feasible from the geotechnical perspective as well. Geotechnical considerations regarding infiltration system analysis and design are presented below.

Current and previous explorations completed in the vicinity of the proposed pole yard encountered native outwash sand below a variable depth of fill material placed as part of previous mine reclamation activity. The outwash largely consists of sand with a variable gravel content and a relatively low fines content. The outwash serves as a receptor soil for water directed to the infiltration pond constructed northwest of the substation, and will be able to fulfill a similar role for the pole yard.

We observed the outwash at depths of approximately 2 to 14 feet below existing grade at the exploration locations. The variation can likely be attributed, in our opinion, to the non-uniform excavation that appears to have taken place when the site was operated as a sand and gravel borrow pit. The approximate thickness of the outwash observed at the test pit and boring locations ranged from at least 1 foot to greater than about 16.5 feet.

Long-term Infiltration Rate

The 2005 Ecology *Manual* describes the use of ASTM mechanical grain size distribution data to evaluate allowable long-term infiltration rates. Table 3.8 *Alternative Recommended Infiltration Rates based on ASTM Gradation Testing* lists allowable long-term infiltration rates based on studies that correlated receptor soil grain size distribution with actual infiltration system performance. The correlative values are based upon the receptor soil D_{10} values and the provenance of the soil. The D_{10} values for representative granular soil samples collected from the explorations are listed in the table below.

Table 4: Receptor Soil D_{10} Summary

Exploration / Sample	Approximate sample depth / elevation (feet)	D_{10} (mm)	Allowable long-term infiltration rate (inches/hour)*
B-6 / S-6	15 / 8	0.2	3.5
B-7 / S-5	12.5 / 9.5	0.17	3.0
TP-51 / S-4	11 / 12	0.1	2.0
TP-52/S-3	4 / 18	0.42	9.0
TP-54 / S-5	14.5 / 7.5	0.1	2.0
TP-56 / S-5	9.5 / 11.5	0.14	2.5

*Per Table 3.8 *Alternative Recommended Infiltration Rates base on ASTM Gradation Testing* per WDOE 2005 *Stormwater Management Manual for Western Washington*

Based upon the results of the grain size analysis and our experience with other projects (including the substation which has successfully operating infiltration elements), a long-term design infiltration rate of 2.6 inches/hour is recommended for the granular outwash soils. This infiltration rate is slightly lower than the value used for design of the existing infiltration pond and reflects the somewhat finer character of the outwash disclosed by the explorations completed in the pole yard expansion area.

Groundwater Considerations

Groundwater was measured at elevations of about 6 to 7 feet (roughly 15 to 19 feet below the Phase 2 expansion area grade) in 2019 and 2020 at the monitoring well installed at the substation location. We observed groundwater at approximate elevations of slightly less than 7 feet in the Phase 2 expansion area while advancing borings B-6 and B-7, and subsequently measured groundwater at the depths and elevations listed in the table below in October and December 2021. Given the extremely wet weather in October and November, it is our opinion that the groundwater levels measured in December may be interpreted as a reasonable approximation of the annual high. Groundwater tends to perch above the fine grained Transitional Bed deposits that underlie the native granular outwash and the existing fill material. It is our opinion that stormwater infiltration is feasible from the geotechnical perspective given the site's soil and groundwater conditions.

Table 5: Groundwater Observations (depth/elevation in feet)*

Boring	Date		
	10.4.21 (after drilling)	10.26.21	12.2.21
B-6	16.57/6.69	15.11/7.72	13.52/9.31
B-7	15.3/6.7	14.98/6.62	12.24/9.36

Access Road Recommendations

The pole yard will be accessed from an extension of the existing unpaved road along the south side of the substation as well as a new short road near the north side of the substation. Internal roads will be provided as well. Both paved and unpaved roads are being considered. Vehicle traffic is expected to range from light vehicles up to heavily loaded trucks.

Unpaved Access Road Section Recommendations

Explorations disclosed variable shallow fill soils that include silty sand with a variable gravel content and silt with a variable sand and gravel content. These soils can be expected to have variable drainage characteristics and are considered to have fair to moderate support characteristics. The existing unpaved substation access road section consists of 5 inches of compacted crushed surfacing top course (CSTC) over 8 inches of compacted crushed surfacing base course (CSBC). We anticipate that this section will be

adequate for areas with regular light to moderate vehicle loading. We recommend increasing the CSBC thickness to 12 inches in areas of regular heavy truck traffic (such as loaded dump trucks). We recommend that the crushed surfacing conform to criteria described in Section 9-03.9(3) of the WSDOT *Standard Specifications*. The access road subgrade should be prepared in accordance with the recommendations presented in the *Structural Fill Placement and Compaction* section of this report. We recommend compacting the subgrade soils to a depth of 12 inches to at least 95 percent of the modified Proctor maximum dry density along with the crushed surfacing.

Maintenance: Periodic maintenance in the form of grading and compaction will likely be necessary over the life of the unpaved access roads. Maintenance should be expected to also include edge delineation, cleaning drainage ditches, and removing driving surface irregularities.

Pavement Life and Maintenance: It should be realized that asphaltic pavements such as HMA are not maintenance-free. The following pavement sections represent our minimum recommendations for an average level of performance during a 20-year design life; therefore, an average level of maintenance will likely be required. Thicker asphalt, base, and subbase courses would offer better long-term performance, but would cost more initially. Conversely, thinner courses would be more susceptible to "alligator" cracking and other failure modes. As such, pavement design can be considered a compromise between a high initial cost and low maintenance costs versus a low initial cost and higher maintenance costs.

Recommended Pavement Section: The existing substation access road section consists of 3 inches of HMA over 2 inches of CSTC over 8 inches of CSBC. Pavement subgrade soils along the paved access road consist of very well-drained gravelly sand and are considered very good from the pavement support perspective. As described previously, the pole yard access road subgrade conditions will be more variable and should be considered fair, largely because of sub-section drainage characteristics. We recommend that the pavement section consist, at a minimum, of 3 inches of HMA over 2 inches (compacted thickness) of CSTC over 12 inches (compacted thickness) of CSBC.

Flexible Pavement Access Road Recommendations

Subgrade Preparation and Compaction: The subgrade should be prepared in accordance with the recommendations presented in the *Structural Fill Placement and Compaction* section of this report, and the subgrade should be compacted to at least 95 percent of the modified Proctor maximum dry density per ASTM D 1557.

HMA: We recommend that the HMA conform to Section 9-02.1(4) for PG 58-22 or PG 64-22 Performance Graded Asphalt Binder as presented in the WSDOT *Standard Specifications*. We also recommend that the gradation of the HMA aggregate conform to the aggregate gradation control points for ½-inch mixes as presented in Section 9-03.8(6), HMA Proportions of Materials.

Base Course: We recommend that the crushed surfacing conform to Section 9-03.9(3) of the WSDOT *Standard Specifications*.

Compaction and Paving: We recommend compacting the HMA to a minimum of 92 percent of the Rice (theoretical maximum) density. Placement and compaction of HMA should conform to requirements of Section 5-04 of the *Standard Specifications*.

Erosion Control

Construction phase erosion control activities are recommended to include measures intended to reduce erosion and subsequent sediment transport. We recommend that the project incorporate the following erosion and sedimentation control measures during construction:

- Capturing water from low permeability surfaces and directing it away from bare soil exposures.
- Erosion control BMP inspection and maintenance: The contractor should be aware that inspection and maintenance of erosion control BMPs is critical toward their satisfactory performance. Repair and/or replacement of dysfunctional erosion control elements should be anticipated.
- Undertake site preparation, excavation, and filling during periods of little or no rainfall.
- Cover excavation surfaces with anchored plastic sheeting if surfaces will be left exposed during wet weather.
- Cover soil stockpiles with anchored plastic sheeting.
- Provide for street cleaning on an as-needed basis.
- Protect exposed soil surfaces that will be subject to vehicle traffic with crushed rock or crushed recycled concrete to reduce the likelihood of subgrade disturbance and sediment generation during wet weather or wet site conditions.
- Install perimeter siltation control fencing on the lower perimeter of work areas.

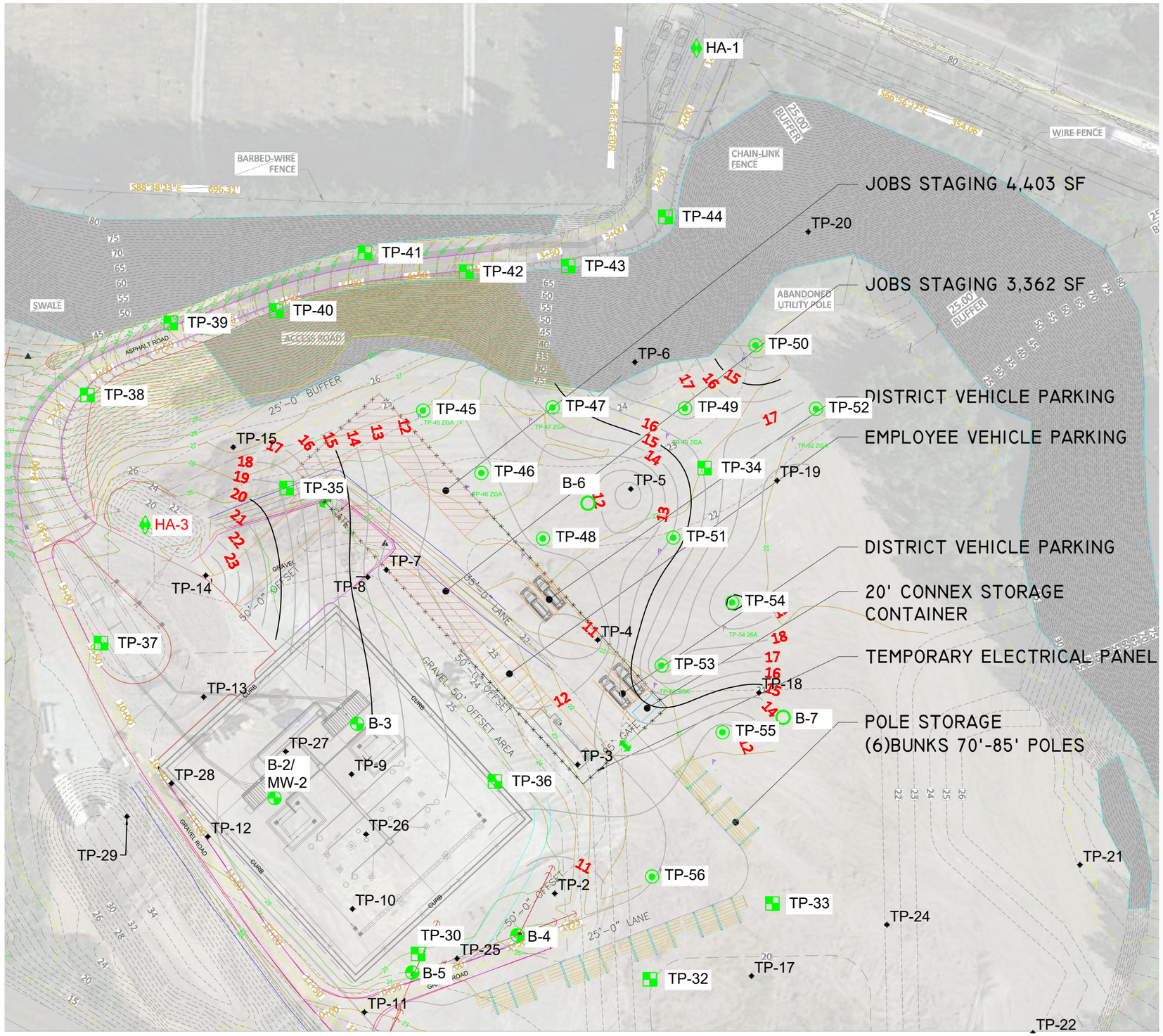
CLOSURE

The analysis and recommendations presented in this report are based, in part, on the explorations completed for this study. The number, location, and depth of the explorations were completed within the constraints of budget and site access so as to yield the information to formulate our

recommendations. Project plans were in the preliminary stage at the time this report was prepared. We therefore recommend we be provided an opportunity to review the final plans and specifications when they become available in order to assess that the recommendations and design considerations presented in this report have been properly interpreted and implemented into the project design.

The performance of earthwork, pavements, and drainage features depends greatly on proper site preparation and construction procedures. We recommend that Zipper Geo Associates, LLC be retained to provide geotechnical engineering services during the earthwork-related construction phases of the project. If variations in subsurface conditions are observed at that time, a qualified geotechnical engineer could provide additional geotechnical recommendations to the contractor and design team in a timely manner as the project construction progresses.

This report has been prepared for the exclusive use of CG Engineering, Inc. the District, and their agents, for specific application to the project discussed and has been prepared in accordance with generally accepted geotechnical engineering practices. No warranties, express or implied, are intended or made. Site safety, excavation support, and dewatering requirements are the responsibility of others. In the event that changes in the nature, design, or location of the project as outlined in this report are planned, the conclusions and recommendations contained in this report shall not be considered valid unless ZGA reviews the changes and either verifies or modifies the conclusions of this report in writing.



LEGEND

HA-1	HAND AUGER NUMBER AND APPROXIMATE LOCATION EXCAVATED MARCH 20, 2020
B-1	TEST BORING NUMBER AND APPROXIMATE LOCATION DRILLED MARCH 2019
TP-30	TEST PIT NUMBER AND APPROXIMATE LOCATION EXCAVATED MARCH 2019
TP-1	TEST PIT NUMBER AND APPROXIMATE LOCATION EXCAVATED NOVEMBER 2017
TP-1	TEST PIT NUMBER AND APPROXIMATE LOCATION EXCAVATED SEPTEMBER 2021
B-6	TEST BORING NUMBER AND APPROXIMATE LOCATION DRILLED OCTOBER 2021
PHASE 1	CONTOUR LINES INDICATING APPROXIMATE ELEVATION OF ADVANCE GLACIAL OUTWASH (Qva) CONTOUR INTERVAL OF 1 FOOT

N

80 0 40 80

SCALE IN FEET

NOTES

Site plan provided by Snohomish County PUD, "Twin City Substation Satellite Storage Site, "Q-1-101", on date: 4/15/22.

The interpreted outwash soil surface contours should be considered approximate and are based upon interpretation of availble subsurface information and variation between the interpreted and actual conditions may not become apparent until construction.

Twin City Substation Pole Yard
7400 Pioneer Highway
Stanwood, Washington 98292

SITE AND EXPLORATION PLAN

Date: April 2022 Job No. 2470.01

Zipper Geo Associates, LLC
19019 36th Ave. W.,Suite E
Lynnwood, WA 98036

FIGURE 1

SHT.1 of 1

APPENDIX A
FIELD EXPLORATION AND TESTING PROCEDURES AND LOGS

FIELD EXPLORATION AND TESTING PROCEDURES AND LOGS

ZGA originally completed a design phase exploration for the Twin City substation consisting of advancing five borings (B-1 through B-5) and excavating 44 test pits (TP-1 through TP-44). Our field exploration program for this current site evaluation included completing a visual reconnaissance of the site, advancing two borings (B-6 and B-7) and excavating 12 test pits (TP-45 through TP-56). The approximate exploration locations are presented on Figure 1, the *Site and Exploration Plan*. Exploration locations were determined in the field using steel and fiberglass tapes by measuring distances from existing site features shown on the *2019 0319 Twin City Working Dwg* (dated 22 June 2021) provided by CG Engineering, Inc. The ground surface elevation at each exploration location was determined by ZGA using a laser level referenced to the north corner elevation of the substation curb. As such, the exploration locations and elevations should be considered accurate to the degree implied by the measurement methods. The following sections describe our procedures associated with the explorations. Descriptive logs of the explorations are enclosed in this appendix.

Boring Procedures

The borings were advanced using a track-mounted drill rig operated by an independent drilling company working under subcontract to ZGA. The borings were advanced using hollow stem auger drilling methods. A geotechnical engineer from our firm continuously observed the borings, logged the subsurface conditions encountered, and obtained representative soil samples. All samples were stored in moisture-tight containers and transported to our laboratory for further evaluation and testing. Samples were generally obtained by means of the Standard Penetration Test at 2.5-foot to 5-foot intervals throughout the drilling operation.

The Standard Penetration Test (ASTM D 1586) procedure consists of driving a standard 2-inch outside diameter steel split spoon sampler 18 inches into the soil with a 140-pound hammer free falling 30 inches. The number of blows required to drive the sampler through each 6-inch interval is recorded, and the total number of blows struck during the final 12 inches is recorded as the Standard Penetration Resistance, or “blow count” (N value). If a total of 50 blows are struck within any 6-inch interval, the driving is stopped and the blow count is recorded as 50 blows for the actual penetration distance. The resulting Standard Penetration Resistance values indicate the relative density of granular soils and the relative consistency of cohesive soils.

A groundwater observation well was installed at the boring B-6 and B-7 locations location following completion of drilling and sampling. The wells consist of a 10-foot long section of 2-inch inside-diameter PVC screen section with machined 0.020-inch wide slots. Washed silica sand was placed in the annular space between the screen and the boreholes. A non-machined riser was installed to the ground surface, and bentonite clay was placed around the riser. The well were finished with flush-mount metal monuments set in concrete.

The enclosed boring logs describe the vertical sequence of soils and materials encountered in each boring, based primarily upon our field classifications. Where a soil contact was observed to be gradational, our logs indicate the average contact depth. Where a soil type changed between sample intervals, we inferred

the contact depth. Our logs also graphically indicate the blow count, sample type, sample number, and approximate depth of each soil sample obtained from the boring. If groundwater was encountered in a borehole, the approximate groundwater depth and date of observation are depicted on the log.

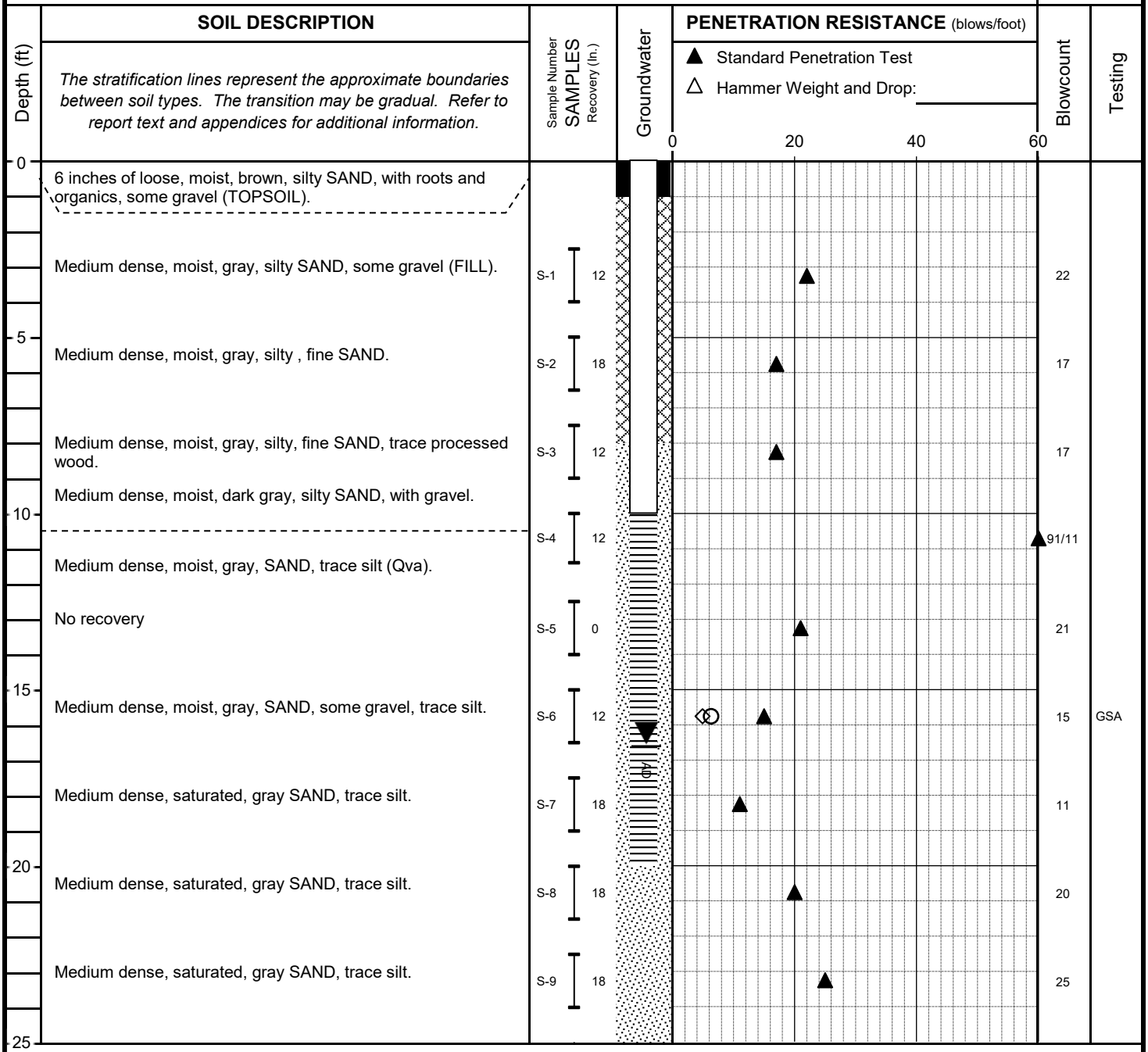
Test Pit Procedures

An independent contractor working under subcontract to ZGA excavated the test pits through the use of a tracked excavator. A geotechnical engineer from ZGA continuously observed the test pit excavations, logged the subsurface conditions, and obtained representative soil samples. The samples were stored in moisture tight containers and transported to our laboratory for further visual classification and testing.

The enclosed test pit logs indicate the vertical sequence of soils and materials encountered in each test pit, based primarily on our field classifications and supported by our subsequent laboratory testing. Where a soil contact was observed to be gradational or undulating, our logs indicate the average contact depth. We estimated the relative density and consistency of *in situ* soils by means of the excavation characteristics and by the sidewall stability. Our logs also indicate the approximate depths of any sidewall caving or groundwater seepage observed in the test pits, as well as all sample numbers and sampling locations.

We have included the logs of test pits TP-3 through TP-6, TP-18, and TP-19 from the original Twin City substation geotechnical report along with the logs of the explorations recently completed for the pole yard.

Boring Location: See Figure 1, Site and Exploration Plan	Drilling Company: Bortec 1	Bore Hole Dia.: 8-inch	**B-6**
Top Elevation: 23 Feet	Drilling Method: Hollow Stem Auger	Hammer Type: Cathead	
Date Drilled: 10/4/2021	Drill Rig: EC95	Logged by: TLW	



SAMPLE LEGEND
- 2-inch O.D. split spoon sample
- 3-inch I.D. Shelby tube sample

GROUNDWATER LEGEND
- Clean Sand
- Bentonite
- Grout/Concrete
- Screened Casing
- Blank Casing
- Groundwater level at time of drilling (ATD) or on date of measurement.

TESTING KEY
- GSA = Grain Size Analysis
- 200W = 200 Wash Analysis
- Consol. = Consolidation Test
- Att. = Atterberg Limits

◇ % Fines (<0.075 mm)
○ % Water (Moisture) Content
Plastic Limit — Liquid Limit
Natural Water Content

Twin City Substation Pole Yard
7400 Pioneer Hwy
Stanwood, Washington 98292

Project No.: 2470.01

ZipperGeo Geoprofessional Consultants
19019 36th Ave. W, Suite E
Lynnwood, WA 98036

BORING LOG: B-6

Boring Location: See Figure 1, Site and Exploration Plan	Drilling Company: Bortec 1	Bore Hole Dia.: 8-inch	**B-6**
Top Elevation: 23 Feet	Drilling Method: Hollow Stem Auger	Hammer Type: Cathead	
Date Drilled: 10/4/2021	Drill Rig: EC95	Logged by: TLW	

Depth (ft)	SOIL DESCRIPTION	Sample Number	SAMPLES Recovery (In.)	Ground Water	PENETRATION RESISTANCE (blows/foot) ▲ Standard Penetration Test △ Hammer Weight and Drop: 0 20 40 60	Blow Counts	Testing
25	*The stratification lines represent the approximate boundaries between soil types. The transition may be gradual. Refer to report text and appendices for additional information.*						
	Medium dense, saturated, gray SAND, trace silt.	S-10	18		▲	27	
	Boring terminated at approximately 26 1/2 feet below existing grade. Groundwater was observed at about 16 1/2 feet below existing grade.						
30							
35							
40							
45							
50							

SAMPLE LEGEND

- 2-inch O.D. split spoon sample
- 3-inch I.D. Shelby tube sample

GROUNDWATER LEGEND

- Clean Sand
- Bentonite
- Grout/Concrete
- Screened Casing
- Blank Casing
- ▼ 11/2/12 Groundwater level at time of drilling (ATD) or on date of measurement.

TESTING KEY

GSA = Grain Size Analysis

200W = 200 Wash Analysis

Consol. = Consolidation Test

Att. = Atterberg Limits

◇ % Fines (<0.075 mm)

○ % Water (Moisture) Content

Plastic Limit ⊣—○—⊢ Liquid Limit

Natural Water Content

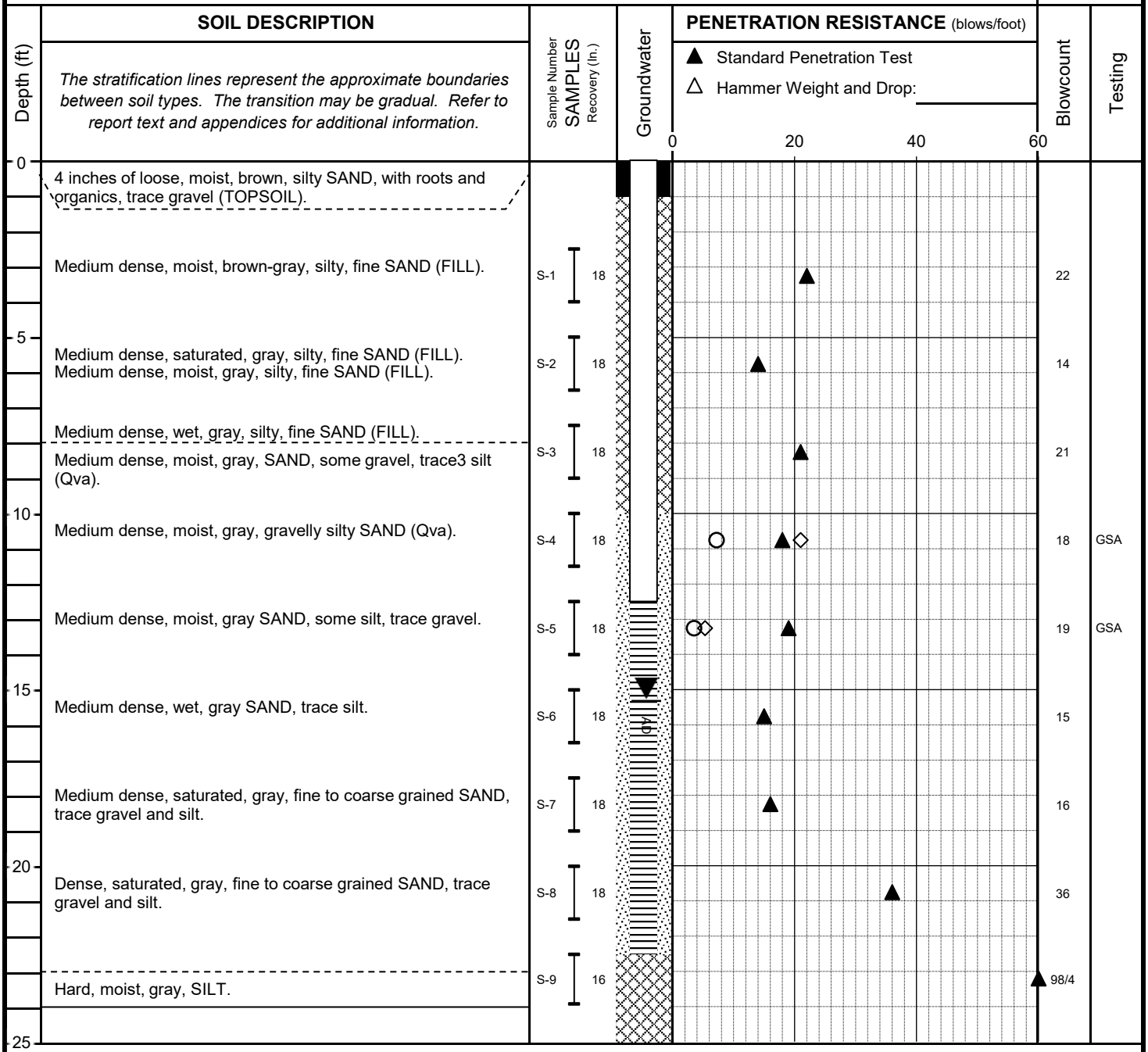
Twin City Substation Pole Yard
7400 Pioneer Hwy
Stanwood, Washington 98292

Project No.: 2470.01

ZipperGeo Geoprofessional Consultants
19019 36th Ave. W, Suite E
Lynnwood, WA

BORING LOG: B-6

Boring Location: See Figure 1, Site and Exploration Plan	Drilling Company: Bortec 1	Bore Hole Dia.: 8-inch	**B-7**
Top Elevation: 22 Feet	Drilling Method: Hollow Stem Auger	Hammer Type: Cathead	
Date Drilled: 10/4/2021	Drill Rig: EC95	Logged by: TLW	



SAMPLE LEGEND
- 2-inch O.D. split spoon sample
- 3-inch I.D. Shelby tube sample

GROUNDWATER LEGEND
- Clean Sand
- Bentonite
- Grout/Concrete
- Screened Casing
- Blank Casing
- Groundwater level at time of drilling (ATD) or on date of measurement. 11/2/12

◇ % Fines (<0.075 mm)

○ % Water (Moisture) Content

Plastic Limit — Liquid Limit

Natural Water Content

TESTING KEY

GSA = Grain Size Analysis

200W = 200 Wash Analysis

Consol. = Consolidation Test

Att. = Atterberg Limits

Twin City Substation Pole Yard
7400 Pioneer Hwy
Stanwood, Washington 98292

Project No.: 2470.01

ZipperGeo
Geoprofessional Consultants
19019 36th Ave. W, Suite E
Lynnwood, WA 98036

BORING LOG: B-7

Boring Location: See Figure 1, Site and Exploration Plan	Drilling Company: Bortec 1	Bore Hole Dia.: 8-inch	**B-7**
Top Elevation: 22 Feet	Drilling Method: Hollow Stem Auger	Hammer Type: Cathead	
Date Drilled: 10/4/2021	Drill Rig: EC95	Logged by: TLW	

Depth (ft)	SOIL DESCRIPTION	Sample Number / SAMPLES / Recovery (In.)	Ground Water	PENETRATION RESISTANCE (blows/foot) ▲ Standard Penetration Test △ Hammer Weight and Drop: 0 20 40 60	Blow Counts	Testing
25	*The stratification lines represent the approximate boundaries between soil types. The transition may be gradual. Refer to report text and appendices for additional information.*					
	Boring terminated at approximately 24 feet below existing grade. Groundwater observed at about 15 1/2 feet below existing grade at time of drilling.					
30						
35						
40						
45						
50						

SAMPLE LEGEND

- 2-inch O.D. split spoon sample
- 3-inch I.D. Shelby tube sample

GROUNDWATER LEGEND

- Clean Sand
- Bentonite
- Grout/Concrete
- Screened Casing
- Blank Casing
- Groundwater level at time of drilling (ATD) or on date of measurement. 11/2/12

◇ % Fines (<0.075 mm)

○ % Water (Moisture) Content

Plastic Limit ⊣—○—⊢ Liquid Limit

Natural Water Content

TESTING KEY

GSA = Grain Size Analysis

200W = 200 Wash Analysis

Consol. = Consolidation Test

Att. = Atterberg Limits

Twin City Substation Pole Yard
7400 Pioneer Hwy
Stanwood, Washington 98292

Project No.: 2470.01

ZipperGeo Geoprofessional Consultants
19019 36th Ave. W, Suite E
Lynnwood, WA

BORING LOG: B-7

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	Test Pit TP-18 **Location:** See Site and Exploration Plan, Figure 1 **Approx. Ground Surface Elevation (feet):** 22	**Project:** Twin City Substation **Project No:** 1784.01 **Date Excavated:** 30 November 2017			
Depth (ft)	**Material Description**	**Sample**	**N_C**	**%M**	**Testing**
1	1 inch TOPSOIL and fine roots above loose to medium dense, wet, mixed gray and brown, gravelly silty SAND with silt clasts and scattered cobbles (Fill)				
2					
3					
4		S-1 @ 3 feet			GSA
5					
6					
7					
8					
9	Loose to medium dense, damp to moist, brown, gravelly SAND grading to fine SAND at 10 feet (Qva)	S-2 @ 8 feet			
10					
11					
12					
13					
14	Test pit completed at approximately 13 feet. Groundwater not observed while excavating. Slight to moderate caving observed throughout.				
15					
16					
17					
	Note: N_C is the Dynamic Cone Penetrometer blow count per ASTM Special Technical Publication #399.				

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	Test Pit TP-19 **Location:** See Site and Exploration Plan, Figure 1 **Approx. Ground Surface Elevation (feet):** 22	**Project:** Twin City Substation **Project No:** 1784.01 **Date Excavated:** 30 November 2017			
Depth (ft)	**Material Description**	**Sample**	**N_C**	**%M**	**Testing**
1	1 inch TOPSOIL and fine roots above loose to medium dense, wet, brown, silty SAND and sandy SILT with gravel (Fill)				
2		S-1 @ 1 foot			
3					
4	Loose to medium dense, moist to wet, gray-brown, gravelly SAND grading to sandy GRAVEL at 4 feet (Qva)	S-2 @ 3.5 feet			
5					
6					
7					
8					
9					
10					
11	Test pit completed at approximately 10 feet. Groundwater not observed while excavating. Substantial caving observed throughout.				
12					
13					
14					
15					
16					
17					
	Note: N_C is the Dynamic Cone Penetrometer blow count per ASTM Special Technical Publication #399.				

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	Test Pit TP-45 **Location:** See Site and Exploration Plan, Figure 1 **Approx. Ground Surface Elevation**: __25 feet___	**Project:** Twin City Sub. Pole Yard **Project No:** 2470.01 **Date Excavated:** September 20, 2021			
Depth (ft)	**Material Description**	**Sample**	**%Fines**	**%M**	**Testing**
1	6 inches of loose, moist, brown, SAND, with gravel, some silt, trace fine roots (TOPSOIL).	S-1 @ 0 feet			
2					
3	Soft, moist, gray, SILT, with sand and roots at 2 feet to silty SAND, trace gravel (FILL).	S-2 @ 1½ feet			
4		S-3 @ 3½ feet			
5					
6	Medium dense, moist, gray, silty SAND, with concrete and rebar, trace gravel (FILL).				
7					
8	Medium dense, moist, gray-brown, SAND, with to some gravel, trace silt (FILL).	S-4 @ 6½ feet			
9					
10					
11	-trace asphalt at about 10 feet.	S-5 @ 10 feet			
12					
13					
14					
15	Medium dense to dense, moist, gray, GRAVEL, with sand, cobbles, trace silt (Qva).	S- 6@ 14 feet			
16					
17	Medium dense to dense, moist, gray, SAND, trace gravel (Qva).	S-7 @ 16½ feet			
18	Test pit completed at approximately 17 feet. Groundwater not observed while excavating. Severe caving at about 13 ½ feet.				

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	Test Pit TP-46 **Location:** See Site and Exploration Plan, Figure 1 **Approx. Ground Surface Elevation**: __24 feet___	**Project:** Twin City Sub. Pole Yard **Project No:** 2470.01 **Date Excavated:** September 20, 2021			
Depth (ft)	**Material Description**	**Sample**	**%Fines**	**%M**	**Testing**
1	6 inches of loose, moist, brown SAND, with silt, some gravel and lenses of clay, trace roots to 6 inches (TOPSOIL).	S-1 @ 0 feet			
2	Medium dense, moist, gray-brown SAND, with silt and gravel (Fill).				
3		S-2 @ 1½ feet			
4	Loose, moist, gray, silty SAND, with pockets of sandy SILT trace gravel (FILL).	S-3 @ 3½ feet			
5					
6	Medium dense, moist, gray-brown, SAND, with gravel and clasts of silt, trace cobbles (FILL).	S-4 @ 5½ feet			
7					
8					
9		S-5 @ 8½ feet			
10					
11					
12					
13					
14	Medium dense, wet, gray SAND, trace gravel (Qva).	S- 6@ 13½ feet			
15					
16					
17					
18		S-7 @ 17½ feet			
19	Test pit completed at approximately 18 feet. Groundwater not observed while excavating. Severe caving at about 12feet				

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	Test Pit TP-47 **Location:** See Site and Exploration Plan, Figure 1 **Approx. Ground Surface Elevation**: __24 feet___	**Project:** Twin City Sub. Pole Yard **Project No:** 2470.01 **Date Excavated:** September 20, 2021			
Depth (ft)	**Material Description**	**Sample**	**%Fines**	**%M**	**Testing**
1	12 inches of soft, wet, gray, sandy SILT, trace roots and organics (TOPSOIL).	S-1 @ 0 feet			
2					
3	Loose, moist, gray, SAND, with gravel and boulders (FILL).	S-2 @ 2 feet			
4					
5	Medium dense, moist, gray, silty SAND, some gravel (FILL).	S-3 @ 3½ feet			
6					
7					
8					
9					
10	Medium dense, damp, gray-brown gravelly SAND, trace silt and cobbles (Qva).	S-4 @ 9 feet	3.7	3.2	GSA
11					
12					
13					
14					
15		S-5 @ 14 feet	1.0	3.0	GSA
16					
17					
18	-wet at about 18 feet.	S-6 @ 18 feet			
19	Test pit completed at approximately 18½ feet. Groundwater not observed while excavating. Severe caving at about 9 feet				

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	Test Pit TP-48 **Location:** See Site and Exploration Plan, Figure 1 **Approx. Ground Surface Elevation**: __23 feet___	**Project:** Twin City Sub. Pole Yard **Project No:** 2470.01 **Date Excavated:** September 20, 2021			
Depth (ft)	**Material Description**	**Sample**	**%Fines**	**%M**	**Testing**
1	Grass over 1.2 feet of mulched trees/brush (TOPSOIL).				
2	Loose, moist, gray-brown, silty SAND, with gravel and silt (FILL).	S-1 @ 1½ feet			
3					
4	Medium dense, moist, gray-brown, silty SAND, with to some gravel (FILL).	S-2 @ 3½ feet			
5					
6					
7					
8					
9		S-3 @ 8 feet			
10					
11					
12	Medium dense, gray, moist, SAND, with to trace gravel, trace cobbles and silt (Qva).				
13		S-4 @ 12 feet			
14					
15					
16					
17					
18	-wet at about 17½ feet.	S-5 @ 17½ feet			
19	Test pit completed at approximately 18 feet. Groundwater not observed. Severe caving at about 11 feet.				

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Test Pit TP-49

Location: See Site and Exploration Plan, Figure 1
Approx. Ground Surface Elevation: 23 feet

Project: Twin City Sub. Pole Yard
Project No: 2470.01
Date Excavated: September 20, 2021

Depth (ft)	Material Description	Sample	%Fines	%M	Testing
1	Loose, moist, brown, SAND, with silt and gravel, trace roots and organics (TOPSOIL).	S-1 @ 0 feet			
2					
3	Medium dense, moist, gray-brown, SAND, with silt and gravel (FILL).	S-2 @ 2½ feet			
4		S-3 @ 3½ feet			
5	Medium dense, moist, gray-brown, silty SAND, with gravel (FILL).				
6					
7	Medium dense, moist, gray, SAND, with to trace gravel, trace silt (Qva).	S-4 @ 6 feet			
8					
9					
10					
11					
12					
13					
14					
15					
16					
17					
18	-wet at about 17½ feet.	S-5 @ 17½ feet			
19	Test pit completed at approximately 18 feet. Groundwater not observed while excavating. Severe caving at about 6 feet.				

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	Test Pit TP-50 **Location:** See Site and Exploration Plan, Figure 1 **Approx. Ground Surface Elevation**: 23 feet	**Project:** Twin City Sub. Pole Yard **Project No:** 2470.01 **Date Excavated:** September 20, 2021			
Depth (ft)	**Material Description**	**Sample**	**%Fines**	**%M**	**Testing**
1	2-6 inches of loose, wet, brown, silty SNAD, some gravel, trace roots and organics (TOPSOIL).	S-1 @ 0 feet			
2					
3	Medium dense, moist, brown, SAND, with to some silt, with gravel, trace cobbles (FILL).	S-2 @ 2 feet			
4					
5		S-3 @ 4 feet			
6					
7					
8	- with silt and silt lenses at about 7½ feet.	S-5 @ 7½ feet			
9					
10	Medium dense, moist, dark gray, silty SAND, with gravel (FILL).				
11		S-6 @ 10 feet			
12					
13					
14					
15	Medium dense, moist, gray, SAND, with silt and gravel pockets of silty SAND (Qva).	S-7 @ 14 feet			
16					
17					
18	Dense to Hard, wet, dark gray, silty SAND, some gravel to SILT, with sand.	S-8 @ 17½ feet			
19	Test pit completed at approximately 18 feet. Groundwater not observed while excavating. Caving was not observed while excavating.				

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	Test Pit TP-51 **Location:** See Site and Exploration Plan, Figure 1 **Approx. Ground Surface Elevation**: __23 feet___	**Project:** Twin City Sub. Pole Yard **Project No:** 2470.01 **Date Excavated:** September 20, 2021			
Depth (ft)	**Material Description**	**Sample**	**%Fines**	**%M**	**Testing**
1	Loose, wet, brown, silty SAND, with roots and mulch up to ½ inch in diameter (TOPSOIL).	S-1 @ 0 feet			
2					
3	Loose, moist, brown-gray, SAND, with silt, some gravel (FILL).	S-2 @ 2½ feet			
4					
5					
6					
7					
8	Medium dense, moist, dark gray, silty SAND, with gravel (FILL).	S-3 @ 7½ feet			
9					
10					
11					
12	Medium dense, damp, gray, gravelly SAND, trace silt (Qva).	S-4 @ 11 feet	3.4	4.0	GSA
13					
14					
15		S-5 @ 14½ feet			
16	Test pit completed at approximately 15 feet. Groundwater not observed while excavating.				
17	Severe caving at about 9 feet.				
18					

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	Test Pit TP-52 **Location:** See Site and Exploration Plan, Figure 1 **Approx. Ground Surface Elevation**: __22 feet___	**Project:** Twin City Sub. Pole Yard **Project No:** 2470.01 **Date Excavated:** September 20, 2021			
Depth (ft)	**Material Description**	**Sample**	**%Fines**	**%M**	**Testing**
1	2-6 inches of loose, moist, brown SAND, with gravel, some silt, trace roots and organics (TOPSOIL).	S-1 @ 0 feet			
2					
3	Loose, moist, gray-brown, SAND, with silt and gravel (FILL).	S-2 @ 2½ feet			
4					
5	Medium dense, moist, gray, gravelly to trace gravel SAND, trace silt (Qva).	S-3 @ 4 feet			
6					
7					
8					
9					
10					
11	-dense and silty at about 10 to 13 feet.	S-4 @ 10 feet			
12					
13					
14					
15		S-5 @ 14 feet			
16					
17		S-6 @ 16 feet			
18	Test pit completed at approximately 16½ feet. Groundwater not observed. Severe caving at about 8 feet.				

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19019 36th Avenue West, Suite E, Lynnwood, Washington 98036

	Test Pit TP-53 **Location:** See Site and Exploration Plan, Figure 1 **Approx. Ground Surface Elevation**: __22 feet___	**Project:** Twin City Sub. Pole Yard **Project No:** 2470.01 **Date Excavated:** September 20, 2021			
Depth (ft)	**Material Description**	**Sample**	**%Fines**	**%M**	**Testing**
1	2-6 inches of loose, wet, brown, silty SAND, with gravel and organics (TOPSOIL).	S-1 @ 0 feet			
2					
3	Medium dense, light brown, silty SAND, with gravel (FILL).	S-2 @ 2 feet			
4					
5	Medium dense, moist, gray, SAND, with to some gravel, trace silt (Qva).	S-3 @ 4 feet			
6					
7					
8					
9					
10					
11		S-4 @ 10 feet			
12					
13					
14					
15		S-2 @ 14½ feet			
16	Test pit completed at approximately 15 feet. Groundwater not observed. Severe caving at about 4 feet.				
17					
18					

ZIPPER GEO ASSOCIATES, LLC

19019 36th Avenue West, Suite E, Lynnwood, Washington 98036

	Test Pit TP-54 **Location:** See Site and Exploration Plan, Figure 1 **Approx. Ground Surface Elevation**: __22 feet___	**Project:** Twin City Sub. Pole Yard **Project No:** 2470.01 **Date Excavated:** September 20, 2021			
Depth (ft)	**Material Description**	**Sample**	**%Fines**	**%M**	**Testing**
1	Grass over, loose, wet, brown, silty SAND, with gravel and mulch and organics (TOPSOIL).	S-1 @ 0.5 feet			
2	Medium dense, moist, gray SAND, with silt and gravel (FILL).	S-2 @ 1½ feet			
3					
4	Medium dense, moist, gray, SAND, trace silt and gravel to SAND, with gravel (Qva).	S-3 @ 3½ feet			
5					
6					
7					
8					
9					
10	-sandy GRAVEL at about 9½ feet to about 12 feet.	S-4 @ 9½ feet	0.6	2.5	GSA
11					
12					
13					
14					
15	-grades to gravelly SAND, some silt	S-5 @ 14½ feet	8.4	4.1	GSA
16					
17		S-6 @ 16½ feet			
18	Test pit completed at approximately 17 feet. Groundwater was observed at about 16½ ft. while excavating.				
19	Moderate caving at about 3 feet.				

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	Test Pit TP-55 **Location:** See Site and Exploration Plan, Figure 1 **Approx. Ground Surface Elevation**: __22 feet___	**Project:** Twin City Sub. Pole Yard **Project No:** 2470.01 **Date Excavated:** September 20, 2021			
Depth (ft)	**Material Description**	**Sample**	**%Fines**	**%M**	**Testing**
1	6 inches of loose, moist, brown, silty SAND, with roots, organics, gravel (TOPSOIL).	S-1 @ 0 feet			
2					
3	Medium dense, moist, gray-brown, silty SAND to SAND with silt and gravel (FILL)	S-2 @ 2½ feet			
4					
5	Medium dense, moist, gray-brown, SAND, with gravel, trace silt (FILL).	S-3 @ 4 feet			
6					
7					
8					
9	Loose to medium dense, wet, dark gray, silty SAND (FILL).	S-4 @ 8½ feet			
10					
11					
12					
13					
14	Medium dense, wet, gray, SAND, with gravel, trace silt (Qva).				
15		S-5 @ 14½ feet			
16	Test pit completed at approximately 15 feet. Groundwater not observed while excavating. Caving was not observed.				
17					
18					

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	Test Pit TP-56 **Location:** See Site and Exploration Plan, Figure 1 **Approx. Ground Surface Elevation**: __21 feet___	**Project:** Twin City Sub. Pole Yard **Project No:** 2470.01 **Date Excavated:** September 20, 2021			
Depth (ft)	**Material Description**	**Sample**	**%Fines**	**%M**	**Testing**
1	Grass over 6 inches of loose, wet, brown, silty SAND, with gravel, roots, and organics (TOPSOIL).	S-1 @ 0 feet			
2					
3	Medium dense, moist, gray SAND, with silt to silty, with to some gravel, and pockets of hard silt (FILL).	S-2 @ 2 feet			
4					
5		S-3 @ 4 feet			
6					
7					
8	Hard, dark gray, moist, SILT, with sand (FILL).	S-4 @ 7½ feet			
9					
10	Medium dense to dense, moist, brown SAND, trace silt (Qva).	S-5 @ 9½ feet	2.1	4.3	GSA
11					
12					
13					
14					
15	-gray at about 14½ feet.	S-6 @ 14½ feet			
16	-dense at about 16 feet.				
17		S-7 @ 16½ feet			
18	Test pit completed at approximately 17 feet. Groundwater not observed while excavating.				
19	Caving was not observed.				

APPENDIX B
LABORATORY TESTING PROCEDURES AND RESULTS

LABORATORY PROCEDURES AND RESULTS

A series of laboratory tests were performed during the course of this study to evaluate the index and geotechnical engineering properties of the subsurface soils. Descriptions of the types of tests performed are given below.

Visual Classification

Samples recovered from the exploration locations were visually classified in the field during the exploration program. Representative portions of the samples were carefully packaged in moisture tight containers and transported to our laboratory where the field classifications were verified or modified as required. Visual classification was generally done in accordance with ASTM D 2488. Visual soil classification includes evaluation of color, relative moisture content, soil type based upon grain size, and accessory soil types included in the sample. Soil classifications are presented on the exploration logs in Appendix A.

Moisture Content Determinations

Moisture content determinations were performed on representative samples obtained from the explorations in order to aid in identification and correlation of soil types. The determinations were made in general accordance with the test procedures described in ASTM D 2216. The results are shown on the exploration logs in Appendix A.

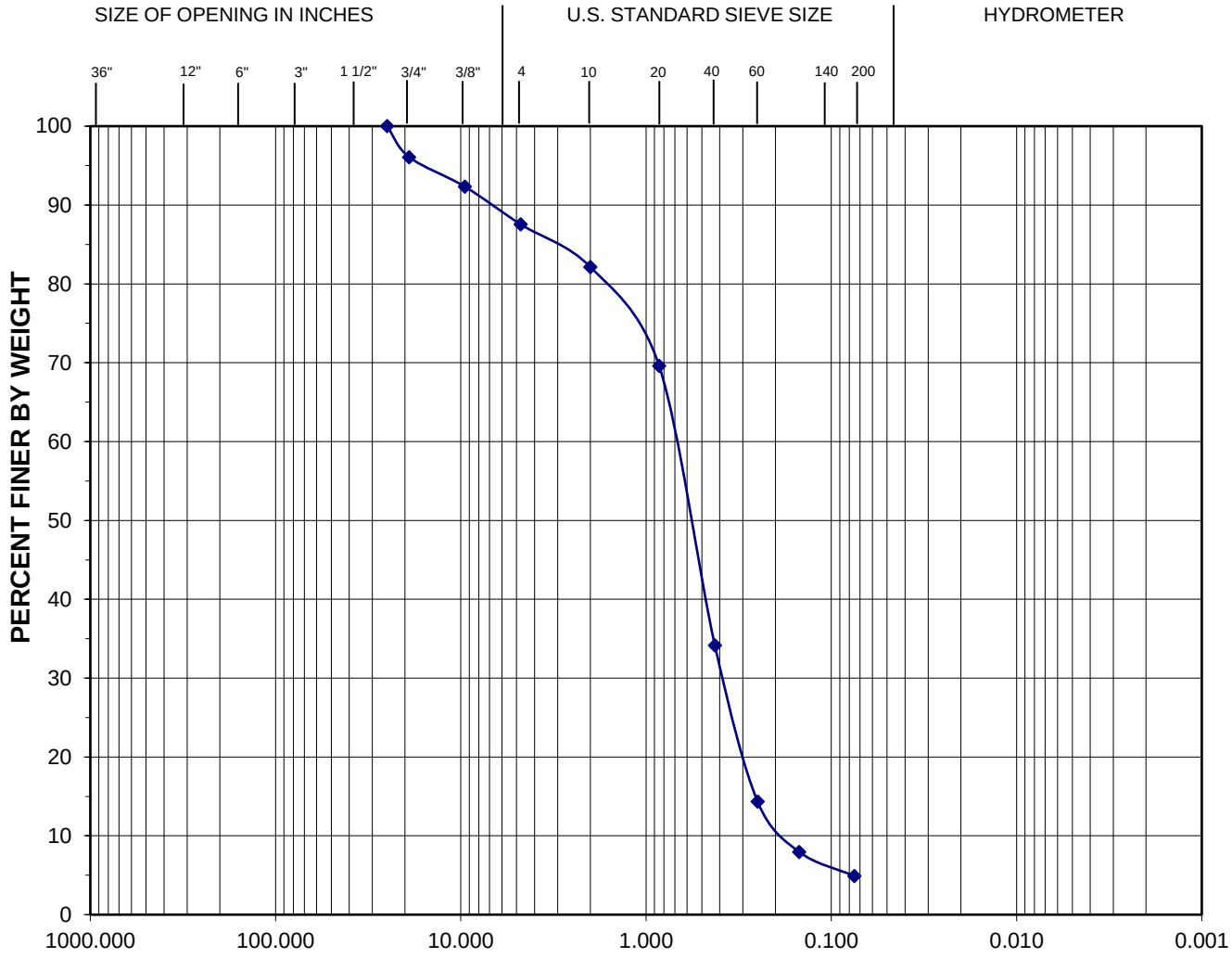
Grain Size Analysis

A grain size analysis indicates the range in diameter of soil particles included in a particular sample. Grain size analyses were performed on representative samples in general accordance with ASTM D 6913. The results of the grain size determinations for the samples were used in classification of the soils, and are presented in this appendix.

GRAIN SIZE ANALYSIS

Test Results Summary

ASTM D6913



		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
BOULDERS	COBBLES	GRAVEL		SAND			FINE GRAINED	

Comments:

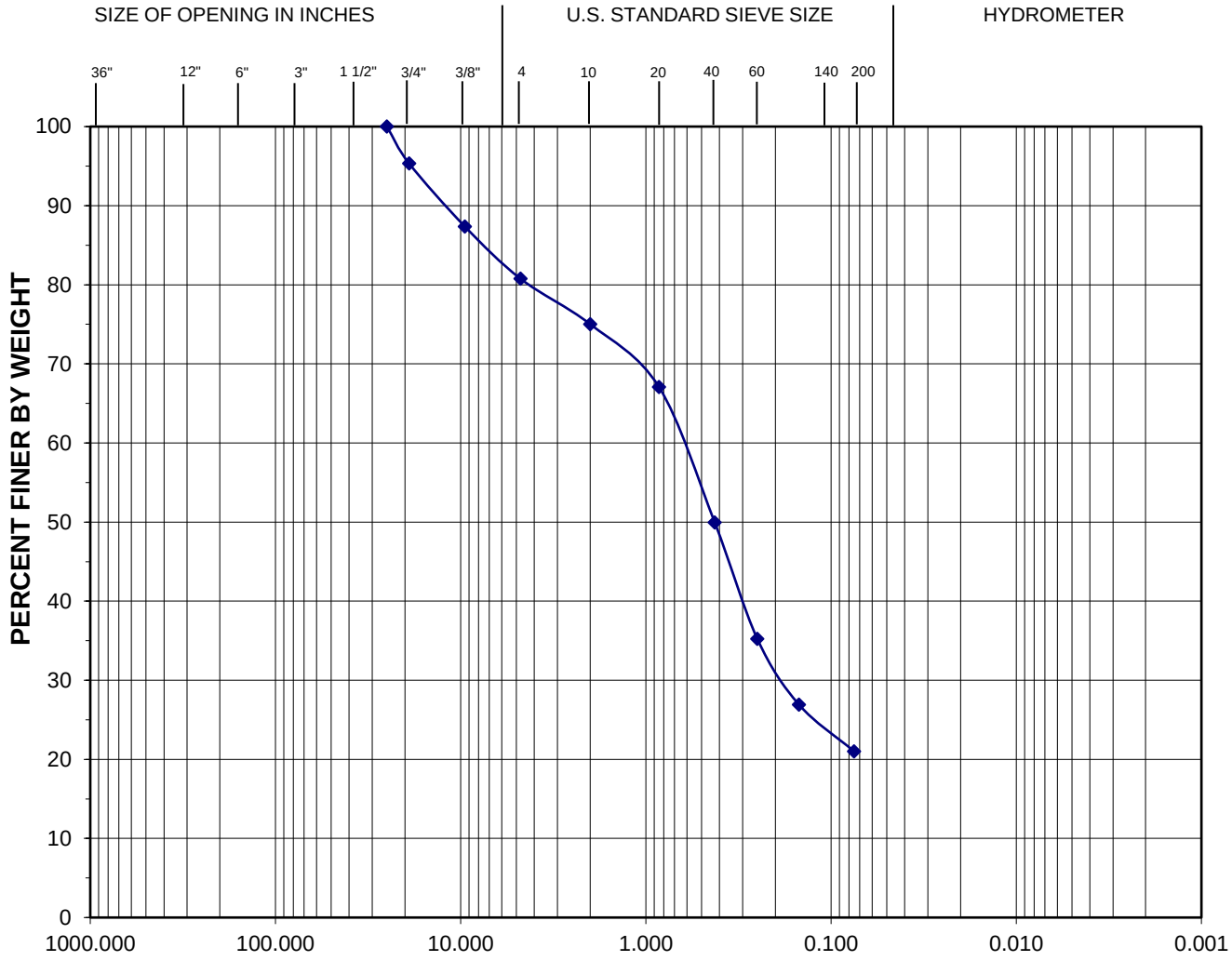
Exploration	Sample	Depth (feet)	Moisture (%)	Fines (%)	Description
B-6	S-6	15-16.5	6.3	4.9	SAND, with gravel, trace silt

Zipper Geo Associates, LLC Geotechnical and Environmental Consultants	PROJECT NO: 2470.01 DATE OF TESTING: 10/6-10/11	PROJECT NAME: Twin City Pole Yard

GRAIN SIZE ANALYSIS

Test Results Summary

ASTM D6913



		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
BOULDERS	COBBLES	GRAVEL		SAND			FINE GRAINED	

Comments:

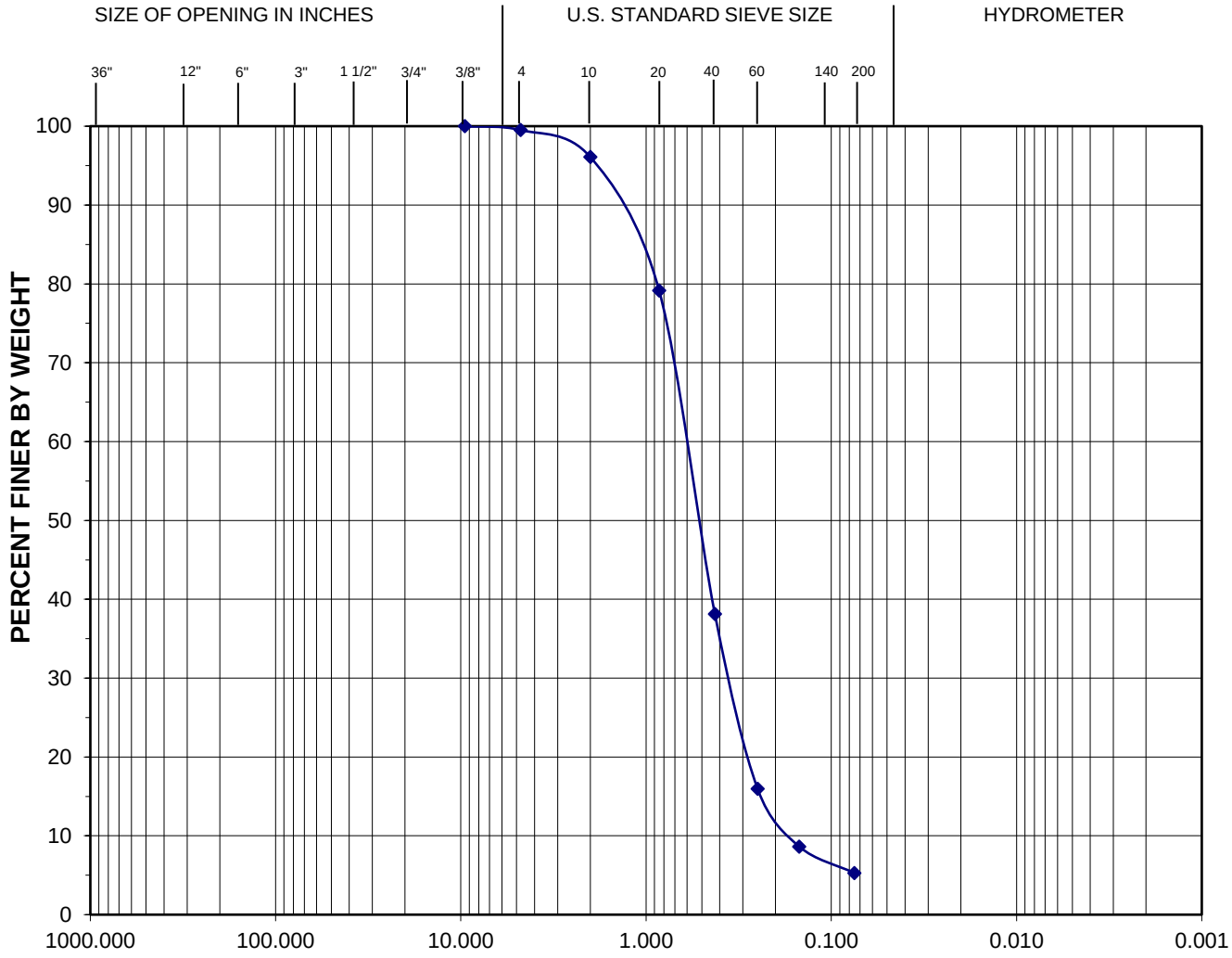
Exploration	Sample	Depth (feet)	Moisture (%)	Fines (%)	Description
B-7	S-4	10-11.5	7.2	21.0	SAND, with silt and gravel

Zipper Geo Associates, LLC Geotechnical and Environmental Consultants	PROJECT NO: 2470.01 DATE OF TESTING: 10/6-10/11	PROJECT NAME: Twin City Pole Yard

GRAIN SIZE ANALYSIS

Test Results Summary

ASTM D6913



		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
BOULDERS	COBBLES	GRAVEL		SAND			FINE GRAINED	

Comments:

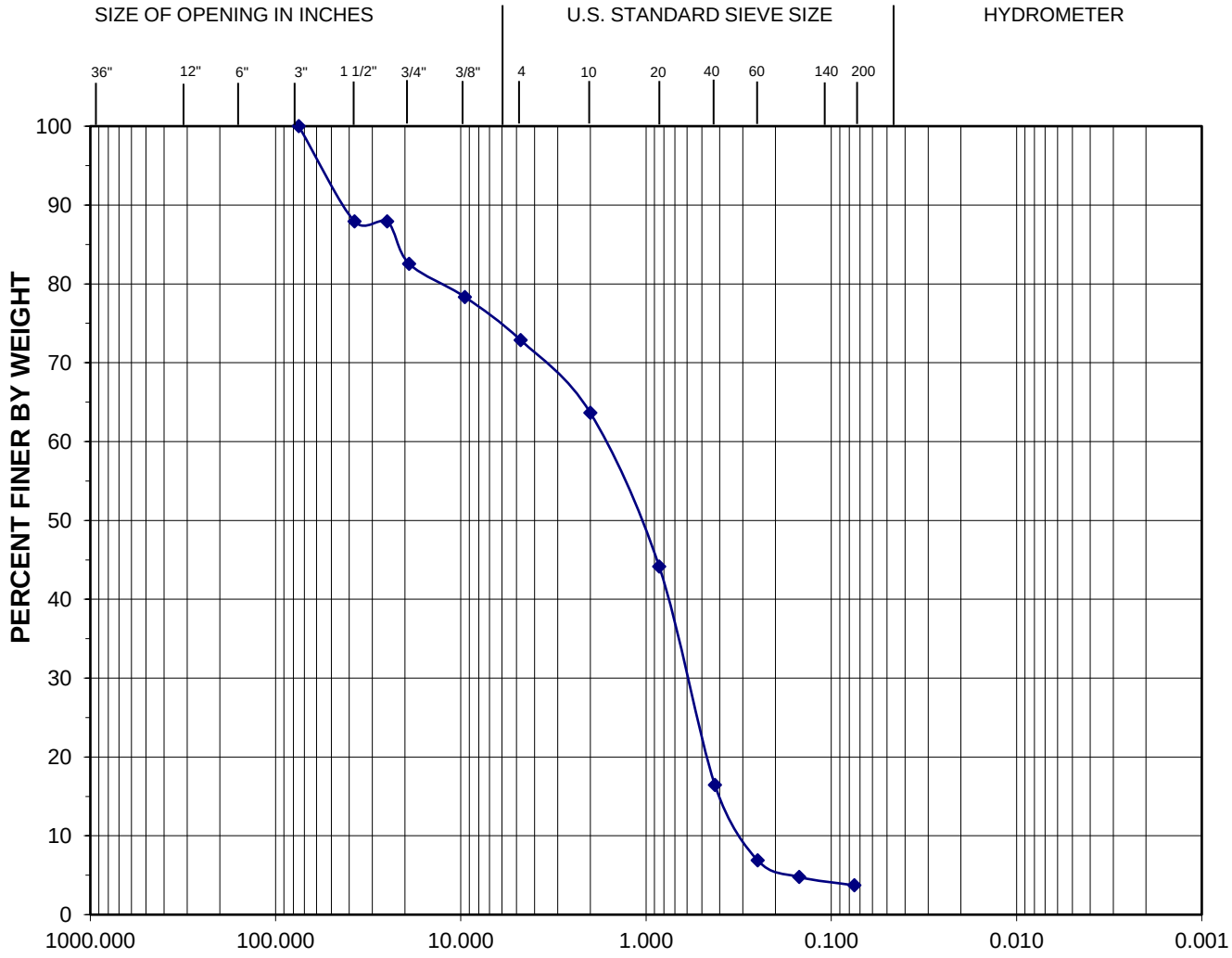
Exploration	Sample	Depth (feet)	Moisture (%)	Fines (%)	Description
B-7	S-5	12.5-14	3.5	5.3	SAND, some silt, trace gravel

Zipper Geo Associates, LLC Geotechnical and Environmental Consultants	PROJECT NO: 2470.01 DATE OF TESTING: 10/6-10/11	PROJECT NAME: Twin City Pole Yard

GRAIN SIZE ANALYSIS

Test Results Summary

ASTM D6913



		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
BOULDERS	COBBLES	GRAVEL		SAND			FINE GRAINED	

Comments:

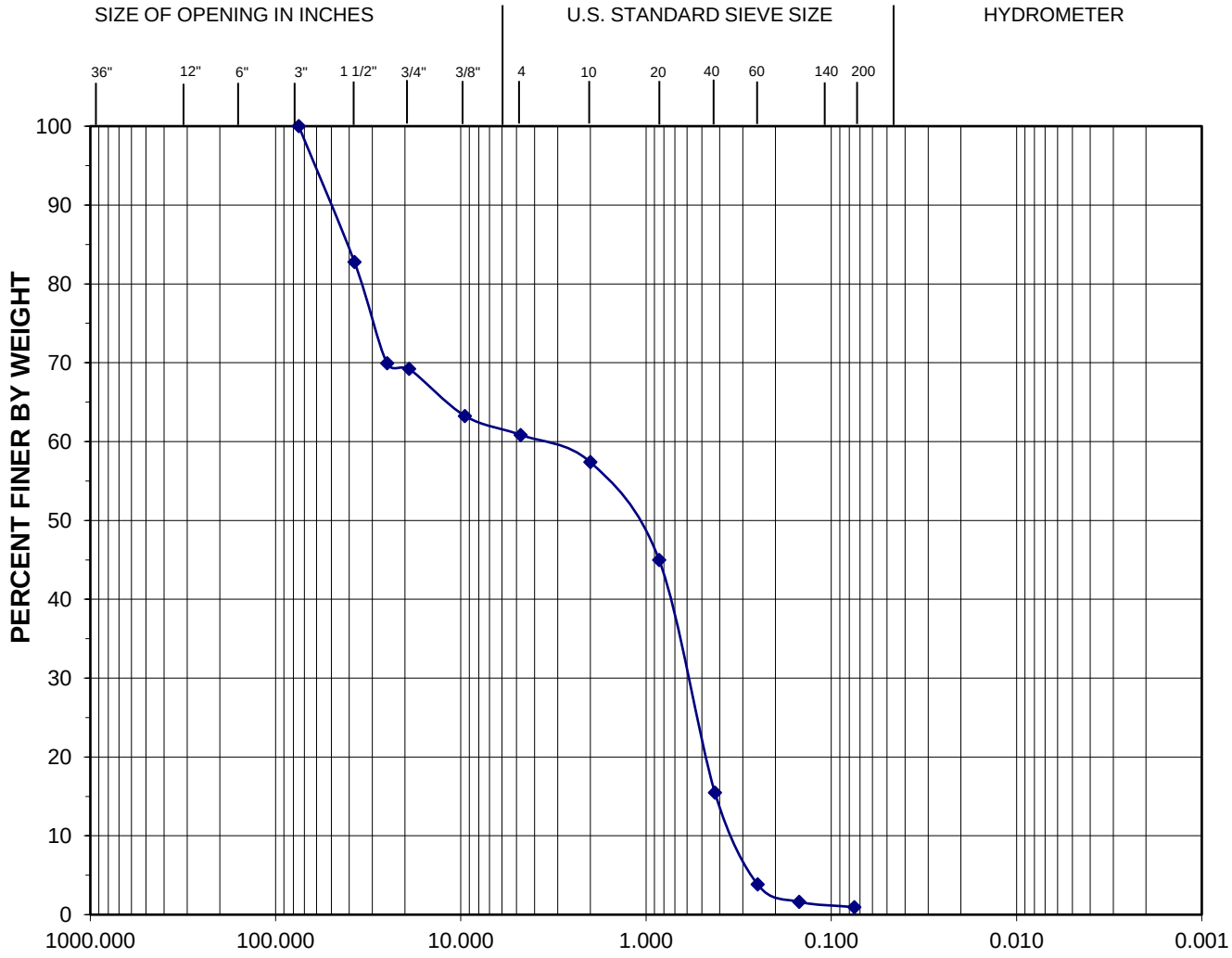
Exploration	Sample	Depth (feet)	Moisture (%)	Fines (%)	Description
TP-47	S-4	9-9.5	3.2	3.7	Gravelly SAND, trace silt

Zipper Geo Associates, LLC Geotechnical and Environmental Consultants	PROJECT NO: 2470.01 DATE OF TESTING: 10/4-10/6/21	PROJECT NAME: Twin City Pole Yard

GRAIN SIZE ANALYSIS

Test Results Summary

ASTM D6913



		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
BOULDERS	COBBLES	GRAVEL		SAND			FINE GRAINED	

Comments:

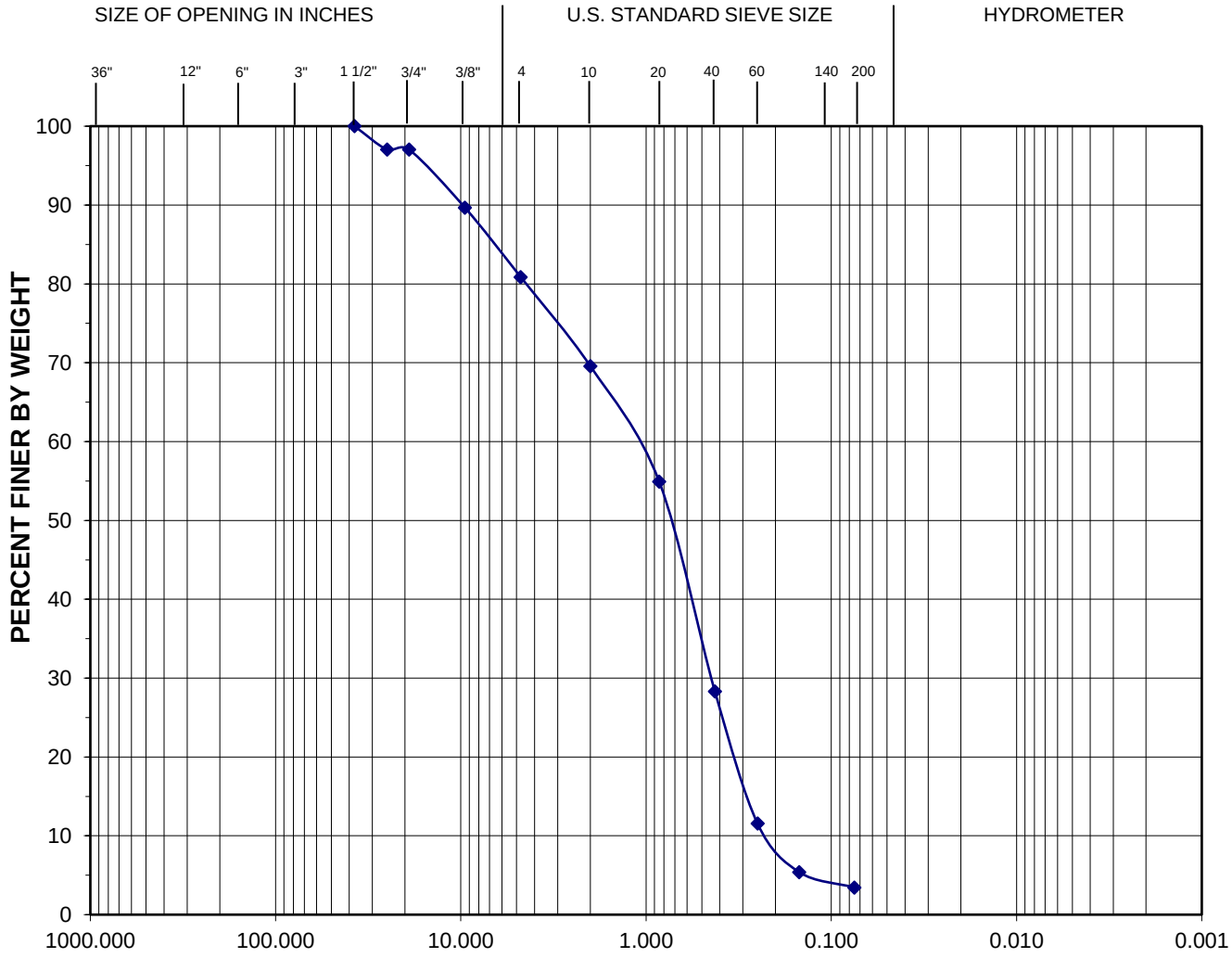
Exploration	Sample	Depth (feet)	Moisture (%)	Fines (%)	Description
TP-47	S-5	14-14.5	3.0	1.0	Gravelly SAND, trace silt

Zipper Geo Associates, LLC Geotechnical and Environmental Consultants	PROJECT NO: 2470.01 DATE OF TESTING: 10/4-10/6/21	PROJECT NAME: Twin City Pole Yard

GRAIN SIZE ANALYSIS

Test Results Summary

ASTM D6913



		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
BOULDERS	COBBLES	GRAVEL		SAND			FINE GRAINED	

Comments:

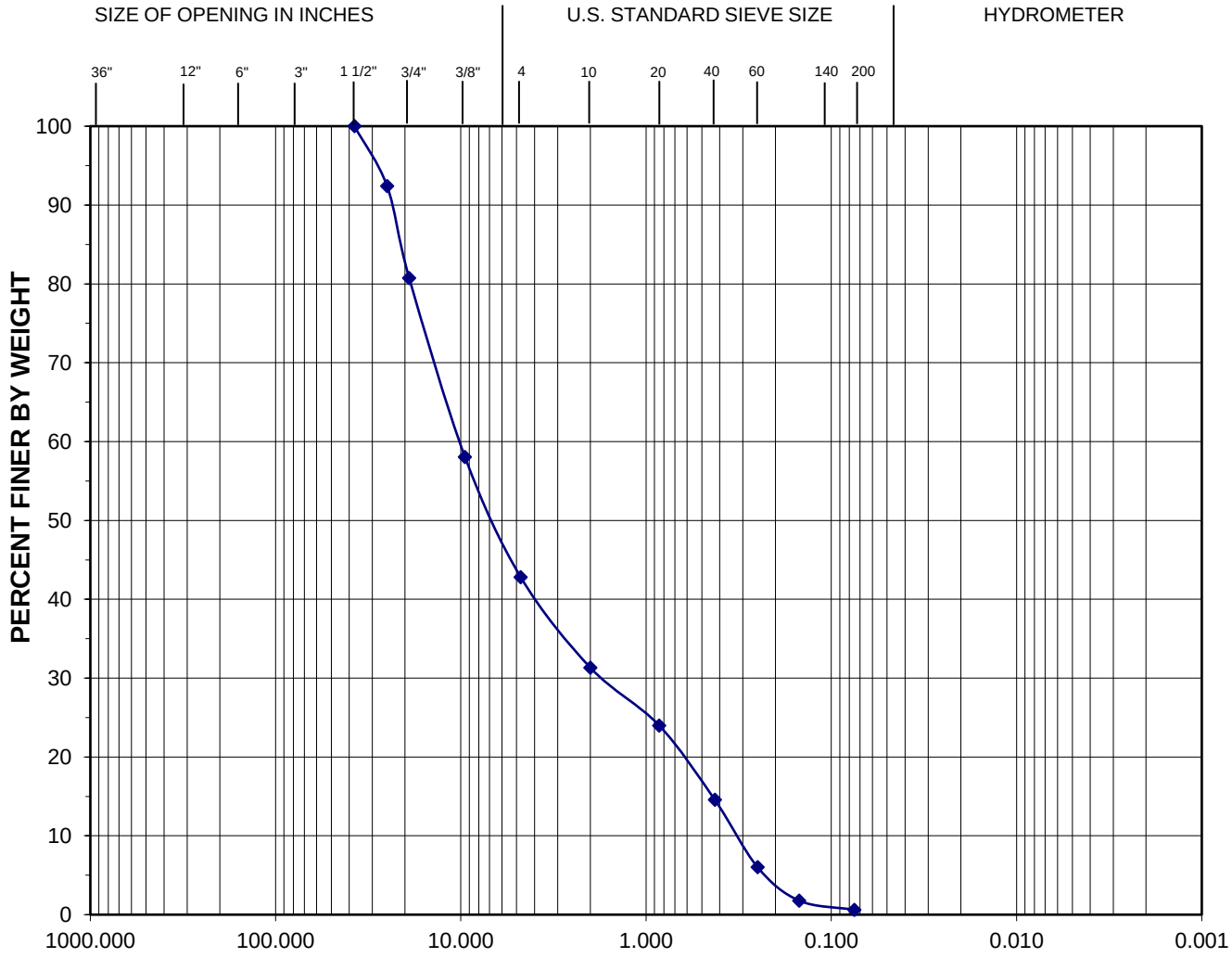
Exploration	Sample	Depth (feet)	Moisture (%)	Fines (%)	Description
TP-51	S-4	11-11.5	4.0	3.4	Gravelly SAND, trace silt

Zipper Geo Associates, LLC Geotechnical and Environmental Consultants	PROJECT NO: 2470.01 DATE OF TESTING: 10/4-10/6/21	PROJECT NAME: Twin City Pole Yard

GRAIN SIZE ANALYSIS

Test Results Summary

ASTM D6913



		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
BOULDERS	COBBLES	GRAVEL		SAND			FINE GRAINED	

Comments:

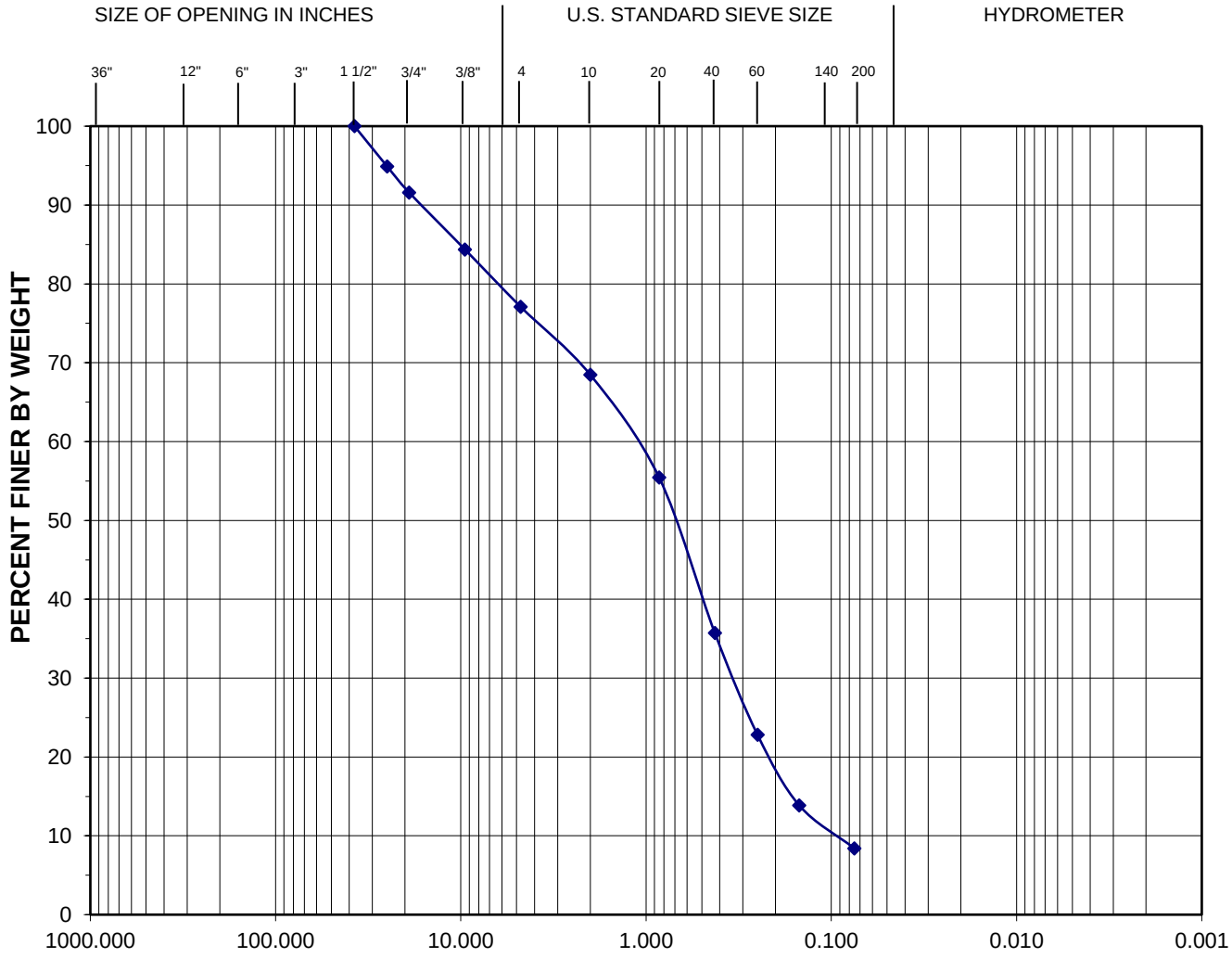
Exploration	Sample	Depth (feet)	Moisture (%)	Fines (%)	Description
TP-54	S-4	9.5-10	2.5	0.6	Sandy GRAVEL, trace silt

Zipper Geo Associates, LLC Geotechnical and Environmental Consultants	PROJECT NO: 2470.01 DATE OF TESTING: 10/4-10/6/21	PROJECT NAME: Twin City Pole Yard

GRAIN SIZE ANALYSIS

Test Results Summary

ASTM D6913



		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
BOULDERS	COBBLES	GRAVEL		SAND			FINE GRAINED	

Comments:

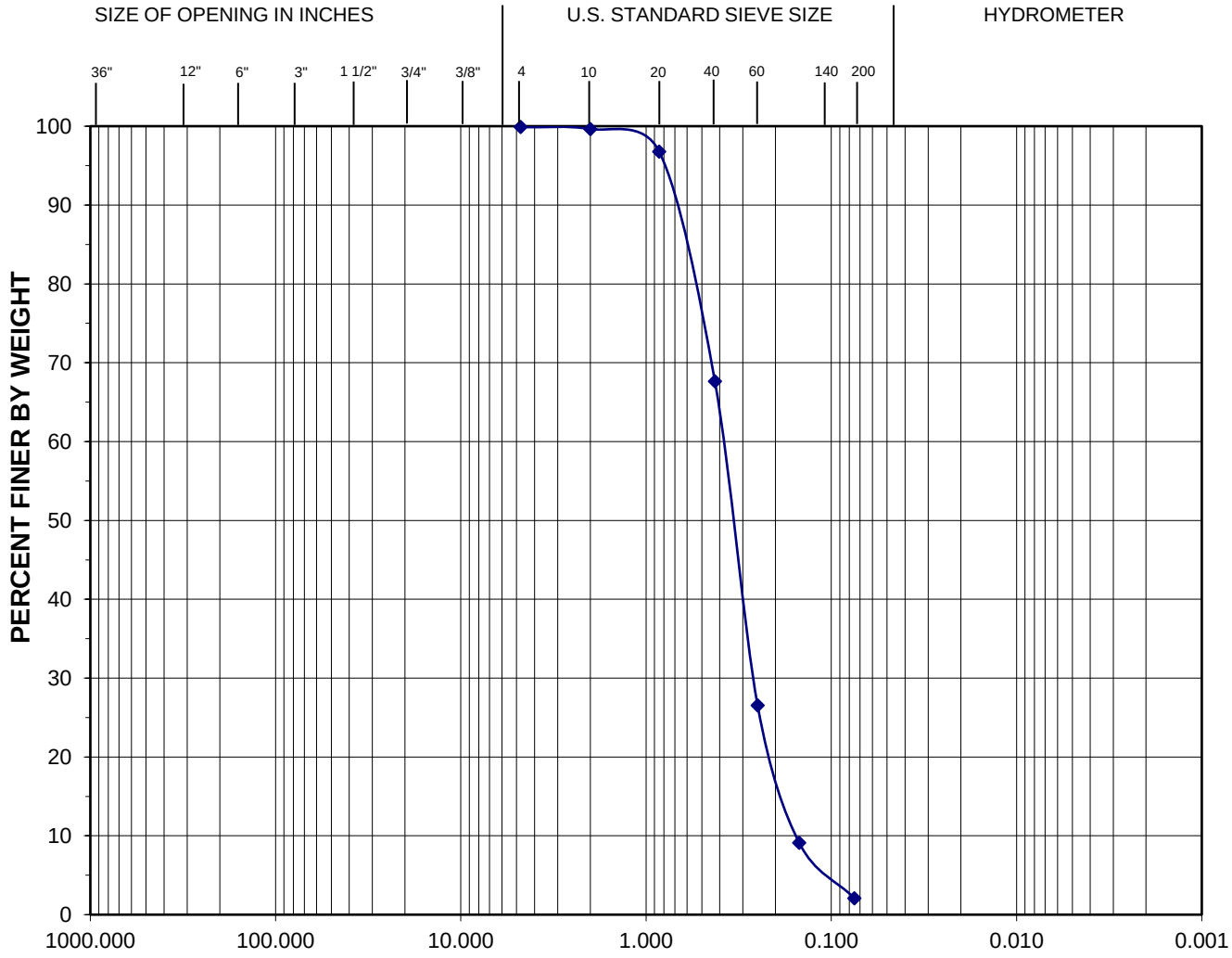
Exploration	Sample	Depth (feet)	Moisture (%)	Fines (%)	Description
TP-54	S-5	14.5-15	4.1	8.4	Gravelly SAND, some silt

Zipper Geo Associates, LLC Geotechnical and Environmental Consultants	PROJECT NO: 2470.01 DATE OF TESTING: 10/4-10/6/21	PROJECT NAME: Twin City Pole Yard

GRAIN SIZE ANALYSIS

Test Results Summary

ASTM D6913



		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
BOULDERS	COBBLES	GRAVEL		SAND			FINE GRAINED	

Comments:

Exploration	Sample	Depth (feet)	Moisture (%)	Fines (%)	Description
TP-56	S-5	9.5-10	4.3	2.1	SAND, trace silt

Zipper Geo Associates, LLC Geotechnical and Environmental Consultants	PROJECT NO: 2470.01 DATE OF TESTING: 10/4-10/6/21	PROJECT NAME: Twin City Pole Yard

Section VI – Other Permits

Section VI Summary:

Narrative

DOE's Construction Stormwater General Permit will be applied for at a future submittal.

ENGINEERING

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www.cgengineering.com

Section VII – Bond Quantities & Operation & Maintenance Manual

Section VII Summary:

Narrative

A Bond Quantity is a standalone document that can also be submitted to the City, if required, separately from this report.

The Operation and Maintenance Manual is a standalone document that will be given to the property's maintenance manager following the construction of the project. The contractor will be responsible for the maintenance and operation of all stormwater structures and BMPs requiring maintenance during construction and, after construction, responsibility will pass to the maintenance manager. A copy of the maintenance and operations manual shall be retained on-site or within reasonable access to the site and shall be transferred with the property to any new owner. A log of maintenance activities that indicate what actions were taken shall be kept and be available for inspection by the City of Stanwood upon request. It is generally expected that few to none of these defects will be present upon the yearly inspection of each facility.

Snohomish PUD Twin City Substation
7212 Pioneer Highway
Stanwood, WA 98292

OPERATION AND MAINTENANCE MANUAL

Date: April 2022

ENGINEERING

250 4th Avenue South, Suite 200
Edmonds, WA 98020
ph. 425.778.8500 | f. 425.778.5536
www.cgengineering.com

Operation and Maintenance Manual

This Operation and Maintenance Manual has been created for Snohomish PUD Twin City Substation, a new pavement development project located at 7212 Pioneer Highway, Stanwood, WA 98292. The proposed stormwater management system consists of conveyance swales, biofiltration swales, conveyance pipes, and an infiltration pond.

Included in this Operation and Maintenance Manual is an 11" x 17" grading and drainage plan sheet showing the locations of the existing stormwater infrastructure. Please note that this map is generated during the design phase and may not reflect all changes made in permitting and construction. CG Engineering may be contacted for an updated copy of this map once the as-built drawings are completed for the site. The contractor will be responsible for the maintenance and operation of all stormwater structures and BMPs requiring maintenance during construction and, after construction, responsibility will pass to the building owner. A copy of the maintenance and operations manual shall be retained on-site or within reasonable access to the site and shall be transferred with the property to any new owner. A log of maintenance activities that indicate what actions were taken shall be kept and be available for inspection by the City of Stanwood upon request.

Included in this manual are maintenance/guide sheets taken from the 2014 Stormwater Management Manual for Western Washington. Maintenance/guide sheets are included for the following facilities/activities:

Swale: A shallow drainage conveyance with relatively gentle side slopes, generally with flow depths less than one foot.

Biofiltration: The process of reducing pollutant concentrations in water by filtering the polluted water through biological materials.

Infiltration Facility: A drainage facility designed to use the hydrologic process of surface and stormwater runoff soaking into the ground, commonly referred to as a percolation, to dispose of surface and stormwater runoff.

Facilities shall be inspected for defects listed in the following facility sheets. Most maintenance tasks are generally reactionary to a defect being found, rather than a matter of constant upkeep. It is generally expected that few to none of these defects will be present upon the yearly inspection of each facility. The facility sheets list the potential conditions warranting maintenance and the expected result following any maintenance. Several engineer's notes for specific tasks are provided within the facility sheets. **Unless otherwise noted on the facility sheets the maintenance tasks should be performed on an "as needed" basis:**

(a) When the described defect is visible to whomever performs the yearly inspection,

(b) Should any defect become apparent between inspections.

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www.cgengineering.com

SAMPLE ACTIVITY LOG

DATE	FACILITY	MAINTENANCE PERFORMED	RESULTS / NOTES

ENGINEERING
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Edmonds, WA 98020
ph. 425.778.8500 | f. 425.778.5536
www.cgengineering.com

Appendix V-A: BMP Maintenance Tables

Ecology intends the facility-specific maintenance standards contained in this section to be conditions for determining if maintenance actions are required as identified through inspection. Recognizing that Permittees have limited maintenance funds and time, Ecology does not require that a Permittee perform all these maintenance activities on all their stormwater BMPs. We leave the determination of importance of each maintenance activity and its priority within the stormwater program to the Permittee. We do expect, however, that sufficient maintenance will occur to ensure that the BMPs continue to operate as designed to protect ground and surface waters.

Ecology doesn't intend that these measures identify the facility's required condition at all times between inspections. In other words, exceedance of these conditions at any time between inspections and/or maintenance does not automatically constitute a violation of these standards. However, based upon inspection observations, the Permittee shall adjust inspection and maintenance schedules to minimize the length of time that a facility is in a condition that requires a maintenance action.

Table V-A.1: Maintenance Standards - Detention Ponds

Maintenance Component	Defect	Conditions When Maintenance Is Needed	Results Expected When Maintenance Is Performed
General	Trash & Debris	Any trash and debris which exceed 1 cubic feet per 1,000 square feet. In general, there should be no visual evidence of dumping. If less than threshold all trash and debris will be removed as part of next scheduled maintenance.	Trash and debris cleared from site
	Poisonous Vegetation and noxious weeds	Any poisonous or nuisance vegetation which may constitute a hazard to maintenance personnel or the public. Any evidence of noxious weeds as defined by State or local regulations. (Apply requirements of adopted IPM policies for the use of herbicides).	No danger of poisonous vegetation where maintenance personnel or the public might normally be. (Coordinate with local health department) Complete eradication of noxious weeds may not be possible. Compliance with State or local eradication policies required
	Contaminants and Pollution	Any evidence of oil, gasoline, contaminants or other pollutants (Coordinate removal/cleanup with local water quality response agency).	No contaminants or pollutants present.
	Rodent Holes	Any evidence of rodent holes if facility is acting as a dam or berm, or any evidence of water piping through dam or berm via rodent holes.	Rodents destroyed and dam or berm repaired. (Coordinate with local health department; coordinate with Ecology Dam Safety Office if pond exceeds 10 acre-feet.)
	Beaver Dams	Dam results in change or function of the facility.	Facility is returned to design function. (Coordinate trapping of beavers and removal of dams with appropriate permitting agencies)
	Insects	When insects such as wasps and hornets interfere with maintenance activities.	Insects destroyed or removed from site. Apply insecticides in compliance with adopted IPM policies
	Tree Growth and Hazard Trees	Tree growth does not allow maintenance and inspection access or interferes with maintenance activity (i.e., slope mowing, silt removal, vactoring, or equipment movements). If trees are not interfering with access or maintenance, do not remove If dead, diseased, or dying trees are identified (Use a certified Arborist to determine health of tree or removal requirements)	Trees do not hinder maintenance activities. Harvested trees should be recycled into mulch or other beneficial uses (e.g., alders for firewood). Remove hazard Trees
Side Slopes of Pond	Erosion	Eroded damage over 2 inches deep where cause of damage is still present or where there is potential for continued erosion. Any erosion observed on a compacted berm embankment.	Slopes should be stabilized using appropriate erosion control measure(s); e.g.,rock reinforcement, planting of grass, compaction. If erosion is occurring on compacted berms a licensed engineer in the state of Washington should be consulted to resolve source of erosion.
Storage Area	Sediment	Accumulated sediment that exceeds 10% of the designed pond depth unless otherwise specified or affects inletting or outletting condition of the facility.	Sediment cleaned out to designed pond shape and depth; pond reseeded if necessary to control erosion.

Table V-A.1: Maintenance Standards - Detention Ponds (continued)

Maintenance Component	Defect	Conditions When Maintenance Is Needed	Results Expected When Maintenance Is Performed
	Liner (if Applicable)	Liner is visible and has more than three 1/4-inch holes in it.	Liner repaired or replaced. Liner is fully covered.
Ponds Berms (Dikes)	Settlements	Any part of berm which has settled 4 inches lower than the design elevation If settlement is apparent, measure berm to determine amount of settlement Settling can be an indication of more severe problems with the berm or outlet works. A licensed engineer in the state of Washington should be consulted to determine the source of the settlement.	Dike is built back to the design elevation.
	Piping	Discernable water flow through pond berm. Ongoing erosion with potential for erosion to continue. (Recommend a Goethechnical engineer be called in to inspect and evaluate condition and recommend repair of condition.	Piping eliminated. Erosion potential resolved.
Emergency Overflow/ Spillway and Berms over 4 feet in height	Tree Growth	Tree growth on emergency spillways creates blockage problems and may cause failure of the berm due to uncontrolled overtopping. Tree growth on berms over 4 feet in height may lead to piping through the berm which could lead to failure of the berm.	Trees should be removed. If root system is small (base less than 4 inches) the root system may be left in place. Otherwise the roots should be removed and the berm restored. A licensed engineer in the state of Washington should be consulted for proper berm/spillway restoration.
	Piping	Discernable water flow through pond berm. Ongoing erosion with potential for erosion to continue. (Recommend a Geotechnical engineer be called in to inspect and evaluate condition and recommend repair of condition.	Piping eliminated. Erosion potential resolved.
Emergency Overflow/Spillway	Emergency Overflow/Spillway	Only one layer of rock exists above native soil in area five square feet or larger, or any exposure of native soil at the top of out flow path of spillway. (Rip-rap on inside slopes need not be replaced.)	Rocks and pad depth are restored to design standards.
	Erosion	See "Side Slopes of Pond"	

Table V-A.2: Maintenance Standards - Infiltration

Maintenance Component	Defect	Conditions When Maintenance Is Needed	Results Expected When Maintenance Is Performed
General	Trash & Debris	See Table V-A.1: Maintenance Standards - Detention Ponds	See Table V-A.1: Maintenance Standards - Detention Ponds
	Poisonous/Noxious Vegetation	See Table V-A.1: Maintenance Standards - Detention Ponds	See Table V-A.1: Maintenance Standards - Detention Ponds
	Contaminants and Pollution	See Table V-A.1: Maintenance Standards - Detention Ponds	See Table V-A.1: Maintenance Standards - Detention Ponds
	Rodent Holes	See Table V-A.1: Maintenance Standards - Detention Ponds	See Table V-A.1: Maintenance Standards - Detention Ponds
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.	Sediment is removed and/or facility is cleaned so that infiltration system works according to design.

Table V-A.2: Maintenance Standards - Infiltration (continued)

Maintenance Component	Defect	Conditions When Maintenance Is Needed	Results Expected When Maintenance Is Performed
		(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).	
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 Table V-A.1: Maintenance Standards - Detention Ponds	See Table V-A.1: Maintenance Standards - Detention Ponds
Emergency Overflow Spillway and Berms over 4 feet in height.	Tree Growth	See Table V-A.1: Maintenance Standards - Detention Ponds	See Table V-A.1: Maintenance Standards - Detention Ponds
	Piping	See Table V-A.1: Maintenance Standards - Detention Ponds	See Table V-A.1: Maintenance Standards - Detention Ponds
Emergency Overflow Spillway	Rock Missing	See Table V-A.1: Maintenance Standards - Detention Ponds	See Table V-A.1: Maintenance Standards - Detention Ponds
	Erosion	See Table V-A.1: Maintenance Standards - Detention Ponds	See Table V-A.1: Maintenance Standards - Detention Ponds
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.

Table V-A.3: Maintenance Standards - Closed Detention Systems (Tanks/Vaults)

Maintenance Component	Defect	Conditions When Maintenance is Needed	Results Expected When Maintenance is Performed
Storage Area	Plugged Air Vents	One-half of the cross section of a vent is blocked at any point or the vent is damaged.	Vents open and functioning.
	Debris and Sediment	Accumulated sediment depth exceeds 10% of the diameter of the storage area for 1/2 length of storage vault or any point depth exceeds 15% of diameter. (Example: 72-inch storage tank would require cleaning when sediment reaches depth of 7 inches for more than 1/2 length of tank.)	All sediment and debris removed from storage area.
	Joints Between Tank/Pipe Section	Any openings or voids allowing material to be transported into facility. (Will require engineering analysis to determine structural stability).	All joint between tank/pipe sections are sealed.
	Tank Pipe Bent Out of Shape	Any part of tank/pipe is bent out of shape more than 10% of its design shape. (Review required by engineer to determine structural stability).	Tank/pipe repaired or replaced to design.
	Vault Structure Includes Cracks in Wall, Bottom, Damage to Frame and/or Top Slab	Cracks wider than 1/2-inch and any evidence of soil particles entering the structure through the cracks, or maintenance/inspection personnel determines that the vault is not structurally sound. Cracks wider than 1/2-inch at the joint of any inlet/outlet pipe or any evidence of soil particles entering the vault through the walls.	Vault replaced or repaired to design specifications and is structurally sound. No cracks more than 1/4-inch wide at the joint of the inlet/outlet pipe.

Table V-A.6: Maintenance Standards - 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

Table V-A.7: Maintenance Standards - Energy Dissipators

Maintenance Components	Defect	Conditions When Maintenance is Needed	Results Expected When Maintenance is Performed
External:			
Rock Pad	Missing or Moved Rock	Only one layer of rock exists above native soil in area five square feet or larger, or any exposure of native soil.	Rock pad replaced to design standards.
	Erosion	Soil erosion in or adjacent to rock pad.	Rock pad replaced to design standards.
Dispersion Trench	Pipe Plugged with Sediment	Accumulated sediment that exceeds 20% of the design depth.	Pipe cleaned/flushed so that it matches design.
	Not Discharging Water Properly	Visual evidence of water discharging at concentrated points along trench (normal condition is a "sheet flow" of water along trench). Intent is to prevent erosion damage.	Trench redesigned or rebuilt to standards.
	Perforations Plugged.	Over 1/2 of perforations in pipe are plugged with debris and sediment.	Perforated pipe cleaned or replaced.
	Water Flows Out Top of "Distributor" Catch Basin.	Maintenance person observes or receives credible report of water flowing out during any storm less than the design storm or its causing or appears likely to cause damage.	Facility rebuilt or redesigned to standards.
	Receiving Area Over-Saturated	Water in receiving area is causing or has potential of causing landslide problems.	No danger of landslides.
Internal:			
Manhole/Chamber	Worn or Damaged Post, Baffles, Side of Chamber	Structure dissipating flow deteriorates to 1/2 of original size or any concentrated worn spot exceeding one square foot which would make structure unsound.	Structure replaced to design standards.
	Other Defects	See Table V-A.5: Maintenance Standards - Catch Basins	See Table V-A.5: Maintenance Standards - Catch Basins

Table V-A.8: Maintenance Standards - Typical Biofiltration Swale

Maintenance Component	Defect or Problem	Condition When Maintenance is Needed	Recommended Maintenance to Correct Problem
General	Sediment Accumulation on Grass	Sediment depth exceeds 2 inches.	Remove sediment deposits on grass treatment area of the bio-swale. When finished, swale should be level from side to side and drain freely toward outlet. There should be no areas of standing water once inflow has ceased.
	Standing Water	When water stands in the swale between storms and does not drain freely.	Any of the following may apply: remove sediment or trash blockages, improve grade from head to foot of swale, remove clogged check dams, add underdrains or convert to a wet biofiltration swale.
	Flow spreader	Flow spreader uneven or clogged so that flows are not uniformly distributed through entire swale width.	Level the spreader and clean so that flows are spread evenly over entire swale width.

Table V-A.8: Maintenance Standards - Typical Biofiltration Swale (continued)

Maintenance Component	Defect or Problem	Condition When Maintenance is Needed	Recommended Maintenance to Correct Problem
	Constant Baseflow	When small quantities of water continually flow through the swale, even when it has been dry for weeks, and an eroded, muddy channel has formed in the swale bottom.	Add a low-flow pea-gravel drain the length of the swale or by-pass the baseflow around the swale.
	Poor Vegetation Coverage	When grass is sparse or bare or eroded patches occur in more than 10% of the swale bottom.	Determine why grass growth is poor and correct that condition. Re-plant with plugs of grass from the upper slope: plant in the swale bottom at 8-inch intervals. Or re-seed into loosened, fertile soil.
	Vegetation	When the grass becomes excessively tall (greater than 10-inches); when nuisance weeds and other vegetation starts to take over.	Mow vegetation or remove nuisance vegetation so that flow not impeded. Grass should be mowed to a height of 3 to 4 inches. Remove grass clippings.
	Excessive Shading	Grass growth is poor because sunlight does not reach swale.	If possible, trim back over-hanging limbs and remove brushy vegetation on adjacent slopes.
	Inlet/Outlet	Inlet/outlet areas clogged with sediment and/or debris.	Remove material so that there is no clogging or blockage in the inlet and outlet area.
	Trash and Debris Accumulation	Trash and debris accumulated in the bio-swale.	Remove trash and debris from bioswale.
	Erosion/Scouring	Eroded or scoured swale bottom due to flow channelization, or higher flows.	For ruts or bare areas less than 12 inches wide, repair the damaged area by filling with crushed gravel. If bare areas are large, generally greater than 12 inches wide, the swale should be re-graded and re-seeded. For smaller bare areas, overseed when bare spots are evident, or take plugs of grass from the upper slope and plant in the swale bottom at 8-inch intervals.

Table V-A.9: Maintenance Standards - Wet Biofiltration Swale

Maintenance Component	Defect or Problem	Condition When Maintenance is Needed	Recommended Maintenance to Correct Problem
General	Sediment Accumulation	Sediment depth exceeds 2-inches in 10% of the swale treatment area.	Remove sediment deposits in treatment area.
	Water Depth	Water not retained to a depth of about 4 inches during the wet season.	Build up or repair outlet berm so that water is retained in the wet swale.
	Wetland Vegetation	Vegetation becomes sparse and does not provide adequate filtration, OR vegetation is crowded out by very dense clumps of cattail, which do not allow water to flow through the clumps.	Determine cause of lack of vigor of vegetation and correct. Replant as needed. For excessive cattail growth, cut cattail shoots back and compost off-site. Note: normally wetland vegetation does not need to be harvested unless die-back is causing oxygen depletion in downstream waters.
	Inlet/Outlet	Inlet/outlet area clogged with sediment and/or debris.	Remove clogging or blockage in the inlet and outlet areas.
	Trash and Debris Accumulation	See Table V-A.1: Maintenance Standards - Detention Ponds	Remove trash and debris from wet swale.
	Erosion/Scouring	Swale has eroded or scoured due to flow channelization, or higher flows.	Check design flows to assure swale is large enough to handle flows. By-pass excess flows or enlarge swale. Replant eroded areas with fibrous-rooted plants such as Juncus effusus (soft rush) in wet areas or snowberry (Symphoricarpos albus) in dryer areas.