civil & structural
engineering & planning

MEMORANDUM

To: City of Arlington CED
18204 59th Ave NE
Arlington, WA 98223

Project #: 23118

Date: August 14, 2023

Subject: SnoPUD North County Energy Storage Drainage Memorandum

---

Section I: Project Overview

The purpose of this memorandum is to provide drainage information for an additional development to the ongoing commercial construction taking place at the North County Facility in Arlington, WA. The project address is 17601 59th Ave NE. The project site is approximately 26.5 acres and mostly developed with access roads and various commercial uses. The additional development will consist of the construction of a new solar array on a south-central portion of the site.

The development proposes 45,054 sf (1.03 sf) of new impervious surface and will adhere to the Minimum Requirements #1-9 of the 2019 Stormwater Management Manual for Western Washington (SWMMWW). Since the project site has several permits which have been approved for construction and one project currently in construction, this report is provided to supplement the existing permit, providing additional flow control discussion for the new areas.

Site soils consist of advance outwash with a design infiltration rate of 17 in/hr. Groundwater was discovered approximately 5 feet below grade, but groundwater is not expected to be an issue so long as the vertical separation requirements are met. The geotechnical report for the project is provided in Section IV. The project proposes to install several surface infiltration swales located under the proposed solar array.

Figure I-1 – Project Site (Google Maps)

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

Section II: Minimum Requirements

Stormwater requirements were determined from the 2019 SWMMWW. This report is based on the steps recommended in Chapter 3 of Volume I in the SWMMWW. The project will comply with 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 1 of the SWMMWW.

Minimum Requirement #2: Construction Stormwater Pollution Prevention Plan (SWPPP): The SWPPP shall include a narrative and drawings. The SWPPP narrative shall include documentation that addresses the 13 elements of Construction Stormwater Pollution Prevention. A SWPPP and Construction Stormwater General Permit have been approved for the current construction.

Minimum Requirement #3: Source Control of Pollution: Source control BMPs during construction have been addressed in previous reports and are implemented in the current construction.

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 site is naturally very flat and infiltrates at a high rate. The project will infiltrate in the proposed condition. A full off-site analysis has been completed as part of past projects and is not required for additional development.

Minimum Requirement #5: On-Site Stormwater Management: New development projects on any parcel inside the Urban Growth Area that trigger Minimum Requirements #1 through #9 must demonstrate compliance with the Low Impact Development Performance Standard and BMP T5.13; or use On-Site Stormwater Management BMPs from List #2. The project will meet the LID performance standard with infiltration swales. See Section III.

Minimum Requirement #6: Runoff Treatment: This requirement applies to projects that add more than 5,000 sf of new/replaced Pollution Generating Hard Surface (PGHS) or 3/4 of an acre of Pollution Generating Pervious Surface (PGPS). The project hard surface is not subject to regular vehicular use and is not considered pollution generating. See Section III for further explanation.

Minimum Requirement #7: Flow Control: Projects must provide flow control to reduce the impacts of stormwater runoff from hard surfaces and land cover conversions. The project will meet the flow control duration standard using infiltration swales. See Section III.

Minimum Requirement #8: Wetlands Protection: There are no wetlands near the project site.

Minimum Requirement #9: Operation and Maintenance**:** Operation and maintenance manuals are included in pervious reports which include maintenance procedures for the BMPs the project is proposing.

Section III: Permanent Stormwater Control Plan

On-Site Stormwater Management: The project will meet the LID performance standard by providing a system of fully infiltrating surface infiltration swales. These swales are designed to take on sheet flow from the surrounding impervious asphalt. The swale section consists of uncompacted native soils with a design infiltration rate of 17 in/hr. This infiltration rate is provided by the geotechnical engineer in their “Stormwater Management Analysis Considerations” report. Refer to Section IV for this report and the infiltration WWHM report.

Runoff Treatment: The project proposes to be exempt from the runoff treatment requirements since the site impervious areas are not considered pollution generating. The SWMMWW defines PGIS as impervious surfaces subject to vehicular use. Per the SWMMWW definition, infrequently used maintenance access roads are not considered as being subject to regular vehicular use. Since the road will only be used for infrequent maintenance, the site impervious is not considered pollution generating, and runoff treatment is not required.

Flow Control: The project adds greater than 10,000 sf of new impervious surface, and flow control is required. The project proposes to meet the flow control standard with the infiltration system as described above. Refer to Section IV for the WWHM report.

Section IV: Attachments

- WWHM Infiltration Report
- Stormwater Management Analysis Considerations Report
- Geotechnical Engineering Report

Please reach out to us with any questions.

Sincerely,
CG Engineering

Greg Guillen

Greg Guillen, PE, SE
Principal

DISCLAIMER

This recommendation is the professional opinion of CG Engineering PLLC based on the information provided. This memo was prepared subject to the standard of care applicable to professional services at the time the services were provided.

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

WWHM2012
PROJECT REPORT

Project Name: SnoPUD North County Infiltration 08.02.23
Site Name:
Site Address:
City :
Report Date: 8/2/2023
Gage : Everett
Data Start : 1948/10/01
Data End : 2009/09/30
Precip Scale: 1.20
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	1.03
Pervious Total	1.03

Impervious Land Use	acre
Impervious Total	0
Basin Total	1.03

Element Flows To:

Surface	Interflow	Groundwater

MITIGATED LAND USE

Name : Lateral I Basin 1
Bypass: No

Impervious Land Use	acre
ROADS FLAT LAT	0.48

Element Flows To:
Outlet 1 **Outlet 2**
Gravel Trench Bed 1

Name : Gravel Trench Bed 1
Bottom Length: 1676.00 ft.
Bottom Width: 11.50 ft.
Trench bottom slope 1: 0 To 1
Trench Left side slope 0: 0.33 To 1
Trench right side slope 2: 0.33 To 1
Material thickness of first layer: 0.5
Pour Space of material for first layer: 1
Material thickness of second layer: 0
Pour Space of material for second layer: 0
Material thickness of third layer: 0
Pour Space of material for third layer: 0
Infiltration On
Infiltration rate: 17
Infiltration safety factor: 1
Total Volume Infiltrated (ac-ft.): 167.549
Total Volume Through Riser (ac-ft.): 0
Total Volume Through Facility (ac-ft.): 167.549
Percent Infiltrated: 100
Total Precip Applied to Facility: 79.401
Total Evap From Facility: 4.358
Discharge Structure
Riser Height: 0 ft.
Riser Diameter: 0 in.

Element Flows To:
Outlet 1 **Outlet 2**

Gravel Trench Bed Hydraulic Table

Stage(feet)	Area(ac.)	Volume(ac-ft.)	Discharge(cfs)	Infilt(cfs)
0.0000	0.442	0.000	0.000	0.000
0.0056	0.442	0.002	0.000	7.584
0.0111	0.442	0.004	0.000	7.584
0.0167	0.442	0.007	0.000	7.584
0.0222	0.443	0.009	0.000	7.584
0.0278	0.443	0.012	0.000	7.584
0.0333	0.443	0.014	0.000	7.584
0.0389	0.443	0.017	0.000	7.584
0.0444	0.443	0.019	0.000	7.584
0.0500	0.443	0.022	0.000	7.584
0.0556	0.443	0.024	0.000	7.584
0.0611	0.444	0.027	0.000	7.584
0.0667	0.444	0.029	0.000	7.584
0.0722	0.444	0.032	0.000	7.584
0.0778	0.444	0.034	0.000	7.584

0.0833	0.444	0.037	0.000	7.584
0.0889	0.444	0.039	0.000	7.584
0.0944	0.444	0.041	0.000	7.584
0.1000	0.445	0.044	0.000	7.584
0.1056	0.445	0.046	0.000	7.584
0.1111	0.445	0.049	0.000	7.584
0.1167	0.445	0.051	0.000	7.584
0.1222	0.445	0.054	0.000	7.584
0.1278	0.445	0.056	0.000	7.584
0.1333	0.445	0.059	0.000	7.584
0.1389	0.446	0.061	0.000	7.584
0.1444	0.446	0.064	0.000	7.584
0.1500	0.446	0.066	0.000	7.584
0.1556	0.446	0.069	0.000	7.584
0.1611	0.446	0.071	0.000	7.584
0.1667	0.446	0.074	0.000	7.584
0.1722	0.446	0.076	0.000	7.584
0.1778	0.447	0.079	0.000	7.584
0.1833	0.447	0.081	0.000	7.584
0.1889	0.447	0.084	0.000	7.584
0.1944	0.447	0.086	0.000	7.584
0.2000	0.447	0.089	0.000	7.584
0.2056	0.447	0.091	0.000	7.584
0.2111	0.447	0.094	0.000	7.584
0.2167	0.448	0.096	0.000	7.584
0.2222	0.448	0.099	0.000	7.584
0.2278	0.448	0.101	0.000	7.584
0.2333	0.448	0.103	0.000	7.584
0.2389	0.448	0.106	0.000	7.584
0.2444	0.448	0.108	0.000	7.584
0.2500	0.448	0.111	0.000	7.584
0.2556	0.449	0.113	0.000	7.584
0.2611	0.449	0.116	0.000	7.584
0.2667	0.449	0.118	0.000	7.584
0.2722	0.449	0.121	0.000	7.584
0.2778	0.449	0.123	0.000	7.584
0.2833	0.449	0.126	0.000	7.584
0.2889	0.449	0.128	0.000	7.584
0.2944	0.449	0.131	0.000	7.584
0.3000	0.450	0.133	0.000	7.584
0.3056	0.450	0.136	0.000	7.584
0.3111	0.450	0.138	0.000	7.584
0.3167	0.450	0.141	0.000	7.584
0.3222	0.450	0.143	0.000	7.584
0.3278	0.450	0.146	0.000	7.584
0.3333	0.450	0.148	0.000	7.584
0.3389	0.451	0.151	0.000	7.584
0.3444	0.451	0.153	0.000	7.584
0.3500	0.451	0.156	0.000	7.584
0.3556	0.451	0.158	0.000	7.584
0.3611	0.451	0.161	0.000	7.584
0.3667	0.451	0.163	0.000	7.584
0.3722	0.451	0.166	0.000	7.584
0.3778	0.452	0.169	0.000	7.584
0.3833	0.452	0.171	0.000	7.584
0.3889	0.452	0.174	0.000	7.584
0.3944	0.452	0.176	0.000	7.584

0.4000	0.452	0.179	0.000	7.584
0.4056	0.452	0.181	0.000	7.584
0.4111	0.452	0.184	0.000	7.584
0.4167	0.453	0.186	0.000	7.584
0.4222	0.453	0.189	0.000	7.584
0.4278	0.453	0.191	0.000	7.584
0.4333	0.453	0.194	0.000	7.584
0.4389	0.453	0.196	0.000	7.584
0.4444	0.453	0.199	0.000	7.584
0.4500	0.453	0.201	0.000	7.584
0.4556	0.454	0.204	0.000	7.584
0.4611	0.454	0.206	0.000	7.584
0.4667	0.454	0.209	0.000	7.584
0.4722	0.454	0.211	0.000	7.584
0.4778	0.454	0.214	0.000	7.584
0.4833	0.454	0.216	0.000	7.584
0.4889	0.454	0.219	0.000	7.584
0.4944	0.455	0.221	0.000	7.584
0.5000	0.455	0.224	0.000	7.584

ANALYSIS RESULTS

Stream Protection Duration

Predeveloped Landuse Totals for POC #1
Total Pervious Area:1.03
Total Impervious Area:0

Mitigated Landuse Totals for POC #1
Total Pervious Area:0
Total Impervious Area:0.48

Flow Frequency Return Periods for Predeveloped. POC #1

Return Period	Flow(cfs)
2 year	0.001182
5 year	0.002564
10 year	0.004113
25 year	0.007184
50 year	0.010615
100 year	0.015398

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	0.001	0.000
1950	0.002	0.000
1951	0.002	0.000
1952	0.001	0.000
1953	0.001	0.000
1954	0.006	0.000
1955	0.004	0.000
1956	0.001	0.000
1957	0.001	0.000
1958	0.001	0.000
1959	0.002	0.000
1960	0.002	0.000
1961	0.004	0.000
1962	0.001	0.000
1963	0.001	0.000
1964	0.003	0.000
1965	0.001	0.000
1966	0.001	0.000
1967	0.002	0.000
1968	0.001	0.000
1969	0.001	0.000
1970	0.001	0.000
1971	0.004	0.000
1972	0.001	0.000
1973	0.001	0.000
1974	0.002	0.000
1975	0.001	0.000
1976	0.002	0.000
1977	0.001	0.000
1978	0.001	0.000
1979	0.002	0.000
1980	0.001	0.000
1981	0.001	0.000
1982	0.001	0.000
1983	0.001	0.000
1984	0.001	0.000
1985	0.001	0.000
1986	0.007	0.000
1987	0.005	0.000
1988	0.001	0.000
1989	0.001	0.000
1990	0.001	0.000
1991	0.001	0.000
1992	0.001	0.000
1993	0.001	0.000
1994	0.001	0.000
1995	0.001	0.000
1996	0.009	0.000
1997	0.025	0.000
1998	0.001	0.000
1999	0.001	0.000
2000	0.002	0.000
2001	0.001	0.000

2002	0.001	0.000
2003	0.001	0.000
2004	0.001	0.000
2005	0.001	0.000
2006	0.027	0.000
2007	0.001	0.000
2008	0.001	0.000
2009	0.001	0.000

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

Rank	**Predeveloped**	**Mitigated**
1	0.0274	0.0000
2	0.0255	0.0000
3	0.0093	0.0000
4	0.0072	0.0000
5	0.0057	0.0000
6	0.0048	0.0000
7	0.0043	0.0000
8	0.0040	0.0000
9	0.0039	0.0000
10	0.0027	0.0000
11	0.0024	0.0000
12	0.0022	0.0000
13	0.0019	0.0000
14	0.0019	0.0000
15	0.0017	0.0000
16	0.0016	0.0000
17	0.0016	0.0000
18	0.0015	0.0000
19	0.0015	0.0000
20	0.0014	0.0000
21	0.0012	0.0000
22	0.0012	0.0000
23	0.0010	0.0000
24	0.0008	0.0000
25	0.0008	0.0000
26	0.0008	0.0000
27	0.0008	0.0000
28	0.0008	0.0000
29	0.0008	0.0000
30	0.0008	0.0000
31	0.0008	0.0000
32	0.0008	0.0000
33	0.0008	0.0000
34	0.0008	0.0000
35	0.0008	0.0000
36	0.0008	0.0000
37	0.0008	0.0000
38	0.0008	0.0000
39	0.0008	0.0000
40	0.0008	0.0000
41	0.0008	0.0000
42	0.0008	0.0000
43	0.0008	0.0000
44	0.0008	0.0000

45	0.0008	0.0000
46	0.0008	0.0000
47	0.0008	0.0000
48	0.0008	0.0000
49	0.0008	0.0000
50	0.0008	0.0000
51	0.0008	0.0000
52	0.0008	0.0000
53	0.0008	0.0000
54	0.0008	0.0000
55	0.0008	0.0000
56	0.0008	0.0000
57	0.0008	0.0000
58	0.0008	0.0000
59	0.0008	0.0000
60	0.0007	0.0000
61	0.0006	0.0000

Stream Protection Duration
POC #1
The Facility PASSED

The Facility PASSED.

Flow(cfs)	Predev	Mit	Percentage	Pass/Fail
0.0006	2357	0	0	Pass
0.0007	1329	0	0	Pass
0.0008	437	0	0	Pass
0.0009	112	0	0	Pass
0.0010	102	0	0	Pass
0.0011	89	0	0	Pass
0.0012	77	0	0	Pass
0.0013	66	0	0	Pass
0.0014	61	0	0	Pass
0.0015	58	0	0	Pass
0.0016	54	0	0	Pass
0.0017	50	0	0	Pass
0.0018	49	0	0	Pass
0.0019	47	0	0	Pass
0.0020	43	0	0	Pass
0.0021	40	0	0	Pass
0.0022	36	0	0	Pass
0.0023	36	0	0	Pass
0.0024	32	0	0	Pass
0.0025	31	0	0	Pass
0.0026	31	0	0	Pass
0.0027	29	0	0	Pass
0.0028	29	0	0	Pass
0.0029	27	0	0	Pass
0.0030	26	0	0	Pass
0.0031	26	0	0	Pass
0.0032	26	0	0	Pass
0.0033	25	0	0	Pass
0.0034	23	0	0	Pass
0.0035	23	0	0	Pass
0.0036	23	0	0	Pass

0.0037	23	0	0	Pass
0.0038	23	0	0	Pass
0.0039	21	0	0	Pass
0.0040	19	0	0	Pass
0.0041	18	0	0	Pass
0.0042	17	0	0	Pass
0.0043	16	0	0	Pass
0.0044	16	0	0	Pass
0.0045	15	0	0	Pass
0.0046	15	0	0	Pass
0.0047	14	0	0	Pass
0.0048	13	0	0	Pass
0.0049	13	0	0	Pass
0.0050	13	0	0	Pass
0.0051	13	0	0	Pass
0.0052	13	0	0	Pass
0.0053	13	0	0	Pass
0.0055	13	0	0	Pass
0.0056	13	0	0	Pass
0.0057	13	0	0	Pass
0.0058	11	0	0	Pass
0.0059	11	0	0	Pass
0.0060	11	0	0	Pass
0.0061	11	0	0	Pass
0.0062	11	0	0	Pass
0.0063	11	0	0	Pass
0.0064	11	0	0	Pass
0.0065	11	0	0	Pass
0.0066	11	0	0	Pass
0.0067	11	0	0	Pass
0.0068	11	0	0	Pass
0.0069	11	0	0	Pass
0.0070	11	0	0	Pass
0.0071	10	0	0	Pass
0.0072	10	0	0	Pass
0.0073	9	0	0	Pass
0.0074	9	0	0	Pass
0.0075	8	0	0	Pass
0.0076	8	0	0	Pass
0.0077	8	0	0	Pass
0.0078	8	0	0	Pass
0.0079	8	0	0	Pass
0.0080	8	0	0	Pass
0.0081	8	0	0	Pass
0.0082	8	0	0	Pass
0.0083	8	0	0	Pass
0.0084	8	0	0	Pass
0.0085	8	0	0	Pass
0.0086	8	0	0	Pass
0.0087	8	0	0	Pass
0.0088	8	0	0	Pass
0.0089	8	0	0	Pass
0.0090	7	0	0	Pass
0.0091	7	0	0	Pass
0.0092	7	0	0	Pass
0.0093	7	0	0	Pass
0.0094	6	0	0	Pass

0.0095	6	0	0	Pass
0.0096	6	0	0	Pass
0.0097	6	0	0	Pass
0.0098	6	0	0	Pass
0.0099	6	0	0	Pass
0.0100	6	0	0	Pass
0.0101	6	0	0	Pass
0.0102	6	0	0	Pass
0.0103	6	0	0	Pass
0.0104	6	0	0	Pass
0.0105	5	0	0	Pass
0.0106	5	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.**

LID Report

LID Technique   Used for   Total Volume   Volume   Infiltration Cumulative
Percent   Water Quality Percent   Comment
                                 Treatment? Needs   Through   Volume   Volume
Volume   Water Quality
                                             Treatment   Facility (ac-ft.)   Infiltration
Infiltrated   Treated
                                             (ac-ft)   (ac-ft)   Credit

Gravel Trench Bed 1 POC   N   152.47   N
100.00
Total Volume Infiltrated   152.47   0.00   0.00
100.00   0.00   0%   No Treat. Credit
Compliance with LID Standard 8
Duration Analysis Result = Passed

Perlnd and Implnd Changes

No changes have been made.

Stormwater Management Analysis Considerations

The site is underlain by permeable native granular soil and is characterized by a relatively shallow seasonal groundwater condition. Conclusions regarding stormwater infiltration feasibility can be drawn from subsurface conditions disclosed by the subsurface explorations, groundwater observations, and laboratory testing completed to date.

We understand that stormwater management improvements will be designed in accordance with the Washington State Department of Ecology 2019 *Stormwater Management Manual for Western Washington* (*Manual*). We collected representative samples of shallow soils and completed mechanical grain size tests as part of assessing the soils' saturated hydraulic conductivity, as summarized below.

<u>Saturated Hydraulic Conductivity</u>

The *Manual* allows a determination of soil saturated hydraulic conductivity to be estimated based on grain size distribution characteristics in accordance with the following formula:

$$\text{Log10}\,(K_{sat,\,initial}) = -1.57 + 1.9D_{10} + 0.015D_{60} - 0.013D_{90} - 2.08f_{fines} \text{ where:}$$

$K_{sat,\ initial}$ = initial saturated hydraulic conductivity in centimeters/second prior to the application of correction factors

D_{10} = grain size diameter (mm) for which 10 percent of the sample by weight is finer

D_{60} = grain size diameter (mm) for which 60 percent of the sample by weight is finer

D_{90} = grain size diameter (mm) for which 90 percent of the sample by weight is finer

f_{fines} = fraction of the sample by weight that passes the US No. 200 sieve.

The calculated hydraulic conductivity values for representative soils that we tested are listed in the table below. Grain size distribution curves for the samples are presented in Appendix B.

Table 9: Saturated Hydraulic Conductivity Summary

Exploration / Sample	Approximate sample depth (feet)	Unfactored Saturated Hydraulic Conductivity (inches per hour)
B-1 / S-5	10	41.3
B-2 / S-3	5	50.6
TP-1 / S-1	2.5	48.5
TP-1 / S-2	4	59.2
TP-1 / S-3	6-1/2	80.3

Table 9: Saturated Hydraulic Conductivity Summary		
Exploration / Sample	**Approximate sample depth (feet)**	**Unfactored Saturated Hydraulic Conductivity (inches per hour)**
TP-6 / S-1	1	34.7
TP-6 / S-2	4	58.5
TP-6 / S-3	7-1/2	105.8

Design Saturated Hydraulic Conductivity Rate

The *Manual* requires applying correction factors to the baseline saturated hydraulic conductivity rate. Table 3.3.1 *Correction Factors to be Used with In-Situ Saturated Hydraulic Conductivity Measurements to Estimate Design Rates* of the *Manual* calls for 40 percent reduction of the baseline rate determined via the grain size method (CF_T). Table 3.3.1 also requires applying correction factors for site variability and number of locations tested (CF_V) and the degree of influent control to prevent siltation and bio-buildup (CF_M). Based upon the site conditions, testing, and our experience with projects of a similar nature, we applied values of 0.5, 0.4, and 0.9 for CF_V, CF_T, and CF_M, respectively. We recommend using a factored rate (K_{sat}) of 17 inches/hour for the *in situ* native outwash sand and gravel for purposes of stormwater infiltration analysis.

Construction of the substation will include selective removal of existing uncontrolled fill material prior to placing imported granular fill to foundation and slab subgrade elevations as necessary. This densification will reduce the site soil's infiltration rate compared to the underlying less dense *in situ* soils. However, this process is only recommended for below foundations and slabs; it is not recommended for the balance of the yard in order to promote stormwater infiltration.

Groundwater Considerations

Previous groundwater monitoring by GeoEngineers included recording a seasonal high elevation of approximately 130-1/2 feet, or about 5-1/2 feet below existing grade and likely about 6-1/2 feet below substation finished grade. The depth of groundwater is not likely to adversely affect the substation's ability to adequately infiltrate stormwater falling on the site, in our opinion.

Storage Considerations

The substation yard will be mantled with a 4-inch compacted thickness of "substation rock" underlain by WSDOT CSBC per Specification 9-03.9(3). The substation rock is used for safety purposes as it has a very high void ratio and electrical resistivity and its use reduces the likelihood of step potentials developing. The high void ratio of the substation rock and the CSBC are also beneficial from the stormwater management perspective because over the course of design and construction of numerous substations and switching stations it has been shown that these materials provide useful storage capacity.

As part of previous District substation projects, ZGA and others have tested CSBC sourced from the Iron Mountain Quarry in Granite Falls, Washington. Samples of this material, when compacted to approximately 95 percent density per ASTM D 1557, have been shown to have a permeability of 130 inches/hour and void ratio of over 40 percent. In contrast to some other locally available CSBC, the Iron Mountain Quarry products are 100 percent crushed rock and no naturally occurring bank run sand is blended with the crushed rock to produce the finished product. Based on the testing, the crushed products from Iron Mountain Quarry tend to have a high permeability and void ratio compared to some other locally available products that combine crushed rock and bank run sand and this is a function of the overall low fine to medium sand content and the fines content (the fraction of soil particles finer than the US No. 200 sieve) and angularity of the products. Below we have excerpted a section from the 30 November 2012 geotechnical engineering report prepared by Terracon Consultants, Inc. which summarizes testing completed on a sample of CSBC sourced from the Iron Mountain Quarry.

Geotechnical Engineering Report
Cedar Valley Substation ▪ Snohomish County, Washington
30 November 2012 ▪ Terracon Project No.: 81125096

Terracon

We collected a sample of material meeting the criteria for WSDOT Specification 9-03.9(3) *Crushed Surfacing* (base course gradation). The sample was compacted to 95 percent of the modified Proctor maximum dry density (ASTM D 1557) and the permeability determined. Test results are summarized below.

Summary of Crushed Surfacing Laboratory Testing

Supplier / Location	Dry Density (ASTM D 1557)	Compaction (percent)	Specific Gravity (data provided by WSDOT)	Void Ratio	Permeability (inches/hour)
Iron Mountain Quarry / Granite Falls	120.6	95.0	2.75	0.424	130

It should be noted that the testing was completed on the sample fraction passing the US No. ¾-inch sieve for compliance with ASTM D 1557. Actually field values will vary slightly from the reported values due to the presence of aggregate larger than ¾-inch and also due to variations in loads. Material placement procedures can also result in aggregate segregation which can produce variable void ratio and permeability values.

It has been our experience that the crushed rock base course that is produced completely from crushed rock and not including any bank-run material is generally "clean" (lacking finer particles) and this is reflected in the test results.

We recently received from Iron Mountain Quarry the results of recent permeability testing of their CSBC completed by Krazan & Associates, Inc. The test results, which are included in Appendix B, were conducted on full samples of the CSBC, i.e., the plus 3/4-inch fraction was not removed prior to testing. Consistent with our conclusion pointed out above, the tests indicated permeability rates for two samples of 168.5 to 170.5 inches/hour when compacted to 98 percent of the modified Proctor maximum dry density.

In 2013, ZGA tested what Iron Mountain Quarry was selling as "substation rock" at the time. This was a 1.5-inch minus product, all crushed, and just slightly coarser than the 1.25-inch minus CSBC. The tested material had a void ratio of 45 percent. A photograph of this substation rock is shown below as a means to illustrate its angularity and obvious functional high void ratio even when compacted.

We recommend that imported crushed rock used for both structural fill in the yard and stormwater management purposes have the gradation show in the table below provided that fill with a high void ratio and permeability are required.

Table 10: Recommended Crushed Rock Fill Gradation	
US Standard Sieve Size	**Percent Passing by Dry Weight Basis**
1.25 inch	100
1 inch	80 - 100
5/8 inch	50 - 80
No. 4	25 - 45
No. 40	3 - 18
No. 200	< 3

Groundwater Mounding Analysis

Plans provided for our review indicate that the substation footprint encompasses slightly less than one acre. It appears that groundwater mounding analysis is not necessary per the *Manual* given the documented groundwater depth relative to the anticipated site improvements.

GEOTECHNICAL ENGINEERING REPORT - DRAFT
NORTH COUNTY SPECIAL USE PERMIT
17601 – 59th Avenue NE
Arlington, Washington

Project No. 2679.01
1 June 2023

Prepared for:
Snohomish County PUD No. 1

Prepared by:

ZipperGeo

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

ZipperGeo
Geoprofessional Consultants

Project No. 2679.01
1 June 2023

Snohomish County PUD No. 1
Distribution & Engineering Services Division, PO Box 1107
Everett, Washington 98206-1107

Attention: Mr. Jerome Drescher, Engineer

Subject: Geotechnical Engineering Report - **DRAFT**
North County Special Use Permit
17601 – 59th Avenue NE
Arlington, Washington

Dear Mr. Drescher:

In accordance with your request, Zipper Geo Associates, LLC (ZGA) has completed the subsurface exploration and geotechnical engineering evaluation for the proposed North County Special Use Permit project. 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 Professional Services Contract No. CW2250618 Amendment No. 1. Written authorization to proceed was provided by the District on 15 April 2023. 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.

Sincerely,
Zipper Geo Associates LLC

DRAFT

Justin L. Brooks, LG
Project Geologist

DRAFT

David C. Williams, LG, LEG
Principal Engineering Geologist

DRAFT

Robert A. Ross, PE
Managing Principal

Distribution: Addressee (1 electronic)
Cover photo courtesy Google Earth

TABLE OF CONTENTS

GEOTECHNICAL ENGINEERING REPORT - DRAFT
NORTH COUNTY SPECIAL USE PERMIT
17601 – 59th AVENUE NE
ARLINGTON, WASHINGTON
Project No. 2679.01
1 June 2023

INTRODUCTION

This report summarizes the geotechnical engineering exploration and analysis completed for the proposed North County Special Use Permit project in Arlington, Washington. Eleven test pits (TP-1 through TP-11), and one hand auger boring (HA-1) were completed by ZGA to depths ranging from approximately 6.5 to 10.5 feet below the existing ground surface to evaluate subsurface conditions. We also relied upon subsurface information developed as part of completing the geotechnical exploration and analysis for the planned Crosswind substation in the southeastern portion of the site earlier this year, as well as explorations completed by GeoEngineers as described subsequently. Descriptive logs of the explorations are included in Appendix A while Appendix B contains a summary of laboratory testing procedures and results.

PROJECT INFORMATION

Site Description

The project site is located in the southern portion of the District's Arlington Microgrid facility. The site is located 0.2 miles south of 180th Street NE and 0.4 miles east of 59th Avenue NE and near the BNSF Railroad right-of-way. The railroad right-of-way adjoins the site at the east, industrial/commercial buildings and lots are to the south, and District facilities lie north and east. An asphalt-paved access drive (63rd Avenue NE) roughly bisects the site. The site currently includes a previously graded grassy field at the west, a solar array to the east, a gravel-surfaced lot at the southeast (future home of the Crosswind substation), and a District crew training facility at the northeast. A large battery structure is located at the northwest corner of the existing solar array and is part of the power backup storage system. The site and immediate vicinity are illustrated on the *Site and Exploration Plan*, Figure 1.

Project Description

Site improvements planned as part of the Special Use Permit program that are addressed in this report include the following:

- Relocation of a portion of the existing solar array to the open field in the western portion of the site.

- Construction of additional paved parking and materials storage space north of the east end of the relocated solar array and west of 63rd Avenue NE.

- Construction of a paved access road that will extend along the southeastern, eastern, and northeastern portions of the site east of 63rd Street.

- Stormwater system improvements to accommodate runoff from the new paved access road and parking/storage areas.

- We understand that a new battery backup system will be installed in a portion of the existing solar array facility. However, addressing geotechnical considerations associated with this project element was not included in our scope of services.

Site History

The District retained GeoEngineers to completed multiple phases of geotechnical exploration and analysis since the District began development of the Microgrid property, and we have relied upon information provided in some of the GeoEngineers reports to supplement ZGA's Special Use Permit-specific exploration and analysis. The GeoEngineers reports that we reviewed are listed below, and selected exploration logs are included in Appendix A:

- GeoEngineers, *Hydrogeologic Assessment, Proposed Pole Yard, Arlington, Washington*, File No. 0482-051-03, dated 26 April 2016;

- GeoEngineers*, Geotechnical Engineering Services, North County Project, Arlington, Washington*, File No. 0482-051-03, dated 29 December 2017;

- GeoEngineers, *Updated Groundwater Monitoring Data (Addendum No. 2), North County Project, Arlington, Washington*, File 0482-051-04, dated 20 June 2018;

- GeoEngineers*, Geotechnical Engineering Services, Update 1 – Revision 1, North County Community Office Project, Early Site Development Phase, Arlington, Washington*, Field Nol 0482-051-04, dated 5 February 2021.

SITE CONDITIONS

Surface Conditions

The new solar array site and parking/storage area in the western portion of the site is a relatively level area with ground surface elevations between about 128 and 131 feet. The site is irregularly vegetated with grasses. Water mains have been installed on site and two fire hydrants are located at some distance from each other along the southern border of the site. A pre-cast concrete and steel vault in the north-central portion of the lot contains a groundwater monitoring well monument (GEB-3) installed by GeoEngineers. The District has a large pile of soil material stored at the eastern side of the site. The adjoining 63rd Avenue NE to the east side is asphalt-paved, two lanes, and in a serviceable condition.

During our site visits we observed some isolated puddles following heavy rain, but these drained relatively quickly.

The existing solar array to the east occupies a relatively level area with ground surface elevations ranging from about 133 to 137 feet. The area is vegetated with grasses and supports single-lane gravel-surfaced access drives between the rows of solar panels. Numerous power and fiber optic vaults are located along the west side and adjacent to 63rd Avenue NE.

The future Crosswind substation site at the southeast is a relatively level area with ground surface elevations ranging from about 135 to 136 feet. The site is mantled with about 4 to 6 inches of ¾-inch crushed gravel over a non-woven geotextile. A pre-cast concrete and steel vault in the north-central portion of the lot contains a groundwater monitoring well monument (B-9) installed by GeoEngineers in 2017. A fire hydrant is located near the northeast corner along 63rd Avenue NE. The District has material stored to the north, east, and south of the gravel pad. We observed standing water throughout the lot during a site visit on 14 February 2023 following previous heavy rain, but it drained relatively quickly.

The line crew training area to the northeast is relatively level and mostly bare ground, although some areas have been mantled with hog fuel. The area is used for excavator training, pole and line setting, and equipment operator training. We observed isolated puddles in high vehicle traffic areas following heavy rain.

It should be noted that almost the entire Special Use Permit area has been disturbed by previous grading activity. Underground utilities have been installed throughout the site, including in the open field where the solar array will be moved and also along the south, east, and north perimeter of the area east of 63rd Avenue NE where the new road is planned. These include water, power, and fiber optic cabling. Consequently, disturbance of the upper soil horizon has occurred and fill material is present as well.

Subsurface Conditions

Local Geologic Conditions

We assessed the geologic setting of site and the surrounding vicinity by reviewing the *Geologic Map of the Arlington West 7.5 Minute Quadrangle, Snohomish County, Washington* (US Geological Survey, Map MF-1740, 1985). The published geologic mapping indicates the site is underlain by Vashon Recessional Outwash, Marysville Sand Member (Qvrm). The Marysville Sand is described as mostly well-drained, stratified to massive outwash sand, some fine gravel, and some areas of silt and clay. The sediments were deposited by meltwater flowing south from the stagnating and receding Vashon glacier. The outwash is reported to have a minimum thickness of about 65 feet. Subsurface conditions disclosed by the explorations advanced by ZGA and others are consistent with the published mapping. ZGA's explorations disclosed recent fill material above the native soils.

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. Undocumented fill material is present and it should be recognized that the nature of undocumented fill material is such that its composition and depth may vary over relatively short distances. Subsurface conditions at specific locations are summarized below.

Our understanding of subsurface conditions is based upon observation of eleven test pits and one hand boring. In addition, we reviewed the logs of borings and test pits completed by GeoEngineers through most of the site and explorations recently completed by ZGA at the Crosswind substation site. Approximate exploration locations, as well as pertinent surface features, are shown on Figure 1. Soil conditions are summarized below.

Fill

With the exception of test pit TP-7, we did not observe fill material in the explorations completed in the field at the western side of the site. However, we did observe fill in all the explorations completed along the planned access road east of 63rd Avenue NE. The fill observed at the TP-7 location extended about 1.5 feet below ground surface (bgs) and consisted of woody debris with a maximum dimension of about 12 inches as well as glass and other deleterious debris. The fill material in the eastern portion of the site contained much more woody debris in addition to metal pipe, glass, and solid waste and extended to depths ranging from about 1 to 3.5 feet bgs. Please note that the nature of undocumented fill is such that its composition and thickness can vary over relatively short distances.

We submitted twelve samples of the fill material to an analytical laboratory to test for the presence of asbestos. The test results were negative.

Topsoil

We observed about 1 to 1.5 feet of loose, moist, red-brown, silty sand and sandy silt with fine organic material and fine to medium roots and roots hairs at the locations of the test pits completed west of 63rd Avenue NE. We have interpreted this material as topsoil. The area east of 63rd Avenue NE has been graded in order to prepare the existing pad where the Crosswind substation will be located and along the southern, eastern, and northern perimeter of the site where underground fiber optic utilities have been installed. We observed some relic topsoil between about 1 and 2 feet in depth below some fill material at the hand auger HA-1 location. We did not observe topsoil at the locations of the other explorations in this portion of the site.

ZipperGeo
Geoprofessional Consultants

Recessional Outwash

The test pits and explorations disclosed that the native recessional outwash soils consisted of loose to dense sand with gravel and a low fines content (the soil fraction passing the US No. 200 sieve). The soils above the water table were generally in a moist condition. The test pits were terminated at depths of approximately 6 to 10.5 feet. Mild to moderate caving with no groundwater seepage was observed in the test pits completed west of 63rd Avenue NE, while we observed moderate caving with rapid groundwater seepage as shallow as about 5 feet at the locations of test pits to the east.

Groundwater

We did not observe groundwater seepage while excavating the test pits located west of 63rd Avenue NE. The soil was moist to depths of about 10.5 fee. East of 63rd Avenue NE, we observed groundwater seepage at depths of approximately 5 to 8.5 feet while excavating the test pits and the hand auger boring.

Our recent groundwater observations, including a recent measurement made in boring GEB-9 at the Crosswind substation site, are summarized in the table below. It should be noted that groundwater conditions will likely vary seasonally and in response to precipitation events, land use, and other factors. ZGA is currently monitoring groundwater and will forward results in memorandum format on a quarterly basis.

Table 1: Recent Groundwater Observations

Exploration	Approximate Groundwater Depth/Elevation (feet)	Observation Date
HA-1	5.5 / 129.5	4.25.23
TP-1 through TP-8	Not observed	4.24.23
TP-9	5.5 / 129.5	4.25.23
TP-10	5 / 131	4.25.23
TP-11	8 / 128	4.25.23
GEB-9	7.2 / 129.7	3.29.23

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 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 native recessional outwash soils are generally favorable from the site grading and shallow foundation support perspectives. Selective removal of the existing shallow organic topsoil, disturbed native soils, or undocumented fill material from below foundations is recommended.

- Re-use of the existing non-organic native soil during grading will be feasible provided that the soil moisture content can be adequately controlled prior to compaction. The native recessional outwash likely to be encountered during grading has a relatively low fines content and may be considered moderately moisture-sensitive relative to grading.

- We anticipate that deeper excavations for vaults and conduits may encounter groundwater during the wetter time of year, possibly necessitating dewatering.

- The granular nature of the shallow native recessional outwash soils is favorable from the stormwater infiltration, although it appears that the likely relatively high infiltration rate will preclude relying on the shallow native soils for treatment purposes unless they are amended.

- The non-organic native soils are favorable for pavement support. Pavement longevity will be improved by removing shallow organic soils prior to grading paved areas.

- Based on our analyses, we estimate total settlement resultant from seismically-induced liquefaction of approximately 1 to 3 inches. We estimate differential seismic settlement of approximately ½ to 1½ inches over a horizontal distance of 40 feet. We anticipate that this degree of potential settlement can be adequately accommodated by the new solar array foundations.

Geotechnical engineering recommendations for site grading, drainage, foundations, 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 reports by others, and our current understanding of the proposed project design. ASTM testing methods and WSDOT specifications co 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).

Regulated Geologic Hazard Areas

Part V of Chapter 20.93.600 of the Arlington Municipal Code (AMC) defines regulated geologic hazard areas as follows:

"Geologic hazard areas" means lands or areas susceptible to erosion, sliding, earthquakes, liquefaction, or other geological events.

ZipperGeo
Geoprofessional Consultants

Landslide Hazard Areas

"Landslide hazard areas" include areas subject to severe risk of landslide based on a combination of geologic, topographic, and hydrologic factors. Landslide hazard include any of the following:

- *(A) Areas characterized by slopes greater than fifteen percent and impermeable soils (typically silt and clay) frequently interbedded with permeable granular soils (predominantly sand and gravel) or impermeable soils overlain with permeable soils or springs or groundwater seepage; Low Hazard. Areas with slopes of less than 15 percent.*
- *(B) Any area that has exhibited movement during the Holocene epoch (from ten thousand years ago to present) or which is underlain by mass wastage debris of that epoch;*
- *(C) Any area potentially unstable due to rapid stream incision, stream bank erosion or undercutting by wave action;*
- *(D) Any area located on an alluvial fan presently subject to or potentially subject to inundation by debris flows or deposition of stream-transported sediments;*
- *(E) Any area with a slope of thirty-three percent or greater and a vertical relief of ten or more feet except areas composed of consolidated rock;*
- *(F) Any area with slope defined by the United States Department of Agriculture Soil Conservation Service as having a severe limitation for building site development; and,*
- *(G) Any shoreline designated or mapped as class U, UOS, or URS by the Department of Ecology Coastal Zone Atlas.*

As described above, the project site is essentially level and lacks significant slopes, including slopes 15 percent or steeper. It is our opinion that the site presents a low landslide hazard per the AMC definition.

Seismic Hazard Areas

Seismic Design Considerations: The seismic performance of the proposed site improvements was evaluated in accordance with the 2018 International Building Code (IBC). The seismic basis of design for the 2018 IBC, which refers to the American Society of Civil Engineers (ASCE) 7-16, is a risk-targeted maximum considered earthquake (MCE_R), which represents an earthquake with a 2 percent probability of exceedance in 50 years (2,475-year return period).

Ground Fault Rupture: Based on review of the United States Geological Survey *Quaternary Fault and Fold Database of the United States* the nearest fault to the site is the South Whidbey Island Fault Zone mapped about 17 miles south-southwest of the site. Based on the mapped location of the fault relative to the site, it is our opinion that the risk associated with fault surface rupture at the site is low.

Liquefaction: Liquefaction is a phenomenon wherein saturated cohesionless soils build up excess pore water pressures during earthquake loading. Liquefaction typically occurs in loose soils, but may occur in denser soils if the ground shaking is sufficiently strong. ZGA completed a liquefaction analysis in general accordance with the 2018 IBC and ASCE 7-16. Specifically, our analysis used the following primary seismic ground motion parameters.

- A Modified Peak Ground Acceleration (PGA_M) of 0.52g based on Site Class D, per Section 11.8.3 of ASCE 7-16 (Site Class modification to MCE_G without regard to liquefaction in accordance with Sections 11.4.8 and 20.3.1 of ASCE 7-16).

- A Geometric Mean Magnitude of 7.03 based on 2014 USGS National Seismic Hazard Mapping Project deaggregation data for a seismic event with a 2% probability of exceedance in 50 years (2,475-year return period).

Our liquefaction analysis was completed using the computer program CLiq (Version 3.5.2.10) developed by GeoLogismiki. Our analysis was based on CPT-01 completed to a depth of about 60 feet below existing grade within the proposed development area and assumed a conservative groundwater depth of 2 feet during the design earthquake. The approximate exploration location is shown on the enclosed *Site and Exploration Plan, Figure 1*. Based on our analysis, a generally non-liquefiable crust of material exists in the upper 15 feet of the site. Below this crust, portions of the Marysville Sand Member have a moderate to high liquefaction potential during the design earthquake down to the full depth of the CPT exploration.

Liquefaction Settlement: The site is mantled by a generally dense and non-liquefiable crust on the order of 15 feet thick. As such, liquefaction-indicated settlements observed at the surface will initiate from potentially liquefiable layers present below the non-liquefiable crust. Research and case histories have shown that the expression of liquefaction-induced settlement at the ground surface is a function of the depth of the liquefiable layers, with deeper liquefiable layers contributing less to ground surface settlement than similar thickness shallow liquefiable layers (Cetin et al., 2009). Cetin proposed use of a "depth weighting factor" (DF_i) that reduces the impact of deep liquefiable layers on the estimated surface settlement. This factor is included in the CLiq program and was used in our settlement analysis.

Based on our analyses, we estimate a total seismic settlement of approximately 1 to 3 inches. We estimate a differential seismic settlement of approximately ½ to 1½ inches over a horizontal distance of 40 feet. Appendix C contains selected seismic analysis data sheets.

Lateral Spread: Lateral spreading is a phenomenon in which soil deposits which underlie a site can experience significant lateral displacements associated with the reduction in soil strength caused by soil liquefaction. This phenomenon tends to occur most commonly at sites where the soil deposits can flow toward a "free-face", such as a water body. Given the relatively level nature of the site, lack of a free-face condition, and 15-foot-thick non-liquefiable crust, it is our opinion that the potential for distress at the site from lateral spreading is low.

Additional Liquefaction Analysis: The District retained Hart Crowser to complete a liquefaction analysis at the Microgrid site, and their conclusions and recommendations are summarized in the report titled *Geotechnical Engineering Design Study, North County Development, Arlington, Washington* (Project No.

19583-00, dated 20 January 2022). Hart Crowser's analysis was based on subsurface information provided in the GeoEngineers reports described earlier. Similar to the results of ZGA analysis, Hart Crowser concluded that liquefaction-induced settlement on the order of 2 to 4 inches resultant from the modeled maximum credible seismic event was likely, and recommended designing project structures for 2 inches of differential settlement over a distance of 30 feet.

Table 2: IBC Seismic Design Criteria

Parameter	Value
2018 International Building Code Site Classification (IBC) [1]	Site Class F [2,3]
Site Latitude/Longitude	48.1560 /-122.1422
Spectral Short-Period Acceleration, S_S	1.050g
Spectral 1-Second Acceleration, S_1	0.375g
Site Coefficient for a Short Period, F_A	1.080
Site Coefficient for a 1-Second Period, F_V	See ASCE Section 11.4.8
Spectral Acceleration for a 0.2-Second Period, S_{MS}	1.134g
Spectral Acceleration for a 1-Second Period, S_{M1}	See ASCE Section 11.4.8
Design Short-Period Spectral Acceleration, S_{DS}	0.756g
Design 1-Second Spectral Acceleration, S_{D1}	See ASCE Section 11.4.8

1. IBC Site Class is based on the average characteristics of the upper 100 feet of the subsurface profile.
2. CPT-01 completed by ZGA for this study extended to a maximum depth of about 60 feet below grade. Therefore ZGA reviewed logs for CPT-1 and CPT-2 completed by GeoEngineers in 2017 (including shear wave velocity test results) about 2,000 and 1,200 feet west of the site, respectively, to determine IBC site class with and without regard to liquefaction.
3. Per the *2018 International Building Code* and *ASCE 7-16*, Chapter 20, any profile containing soils vulnerable to potential failure or collapse under seismic loading such as liquefiable soils.

IBC Seismic Design Parameters

Per the 2018 IBC seismic design procedures and ASCE 7-16, the presence of liquefiable soils requires a Site Class definition of F. However, through reference to Sections 11.4.8 and 20.3.1 of ASCE 7-16, the 2018 IBC allows site coefficients F_a and F_v to be determined assuming that liquefaction does not occur for structures with fundamental periods of vibration less than 0.5 seconds. Based on the results of the field evaluation, Site Class D may be used to determine the values of F_a and F_v in accordance with Sections 11.4.8 and 20.3.1 of ASCE 7-16. If exceptions for Site Class D presented in Section 11.4.8 of ASCE 7-16 do not apply, a ground motion hazard analysis may be required. Site Class D describes soils that are considered stiff with a shear wave velocity between 600 and 1,200 feet per second, average Standard Penetration Test values between 15 and 50, and an undrained shear strength between 1,000 and 2,000 psf.

Engineering Soil Units

For purposes of describing soil conditions observed at the exploration locations and for reference in other sections of this report, soils with similar engineering characteristics were grouped together into

Engineering Stratigraphic Units or ESUs. The following paragraphs provide our interpretation of ESUs encountered at the exploration locations. ESUs are described in a top down stratigraphic sequence described in the logs. The reader is referred to the logs attached in Appendix A for information regarding subsurface conditions.

ESU 1 – Topsoil: Soils located in the western relocated solar area between about 1 and 1.5 feet deep are interpreted to be topsoil characterized as loose, silty sand and sandy silt with trace gravel and a high organic content. Engineering properties of ESU 1 soils are characterized as low strength and compressible materials.

ESU 2 –Undocumented fill/disturbed native soil: We observed soils interpreted to be undocumented fill at one test pit location (TP-7) west of 63rd Avenue NE to a depth of about 1.5 feet below existing site grade. Along the rail line at the eastern area of the site, ESU-2 soils were observed from about 1 to 1.5 feet bgs. ESU 2 fill soils generally consisted of loose silt, sand, gravel, cobbles, and deleterious material such as glass, metal pipes, branches, and plastic debris. The disturbed native soils were of similar density and composition but lacked the deleterious debris and are related to previous site grading. Engineering properties of ESU 2 soils are characterized as low strength and compressible materials. Please note that while we only observed fill material at the test pit TP-7 location in the western portion of the site, additional fill material is present in the form of backfilled underground utility trenches across the entire site.

ESU 3 – Loose to medium dense recessional outwash (Qvrm – Marysville Sand Member): Soils interpreted to be shallow loose to medium dense recessional outwash soils were observed at most of the exploration locations. These loose to medium dense materials tend to be moderately weathered and extend from about 1.5 feet to 4 feet bgs. Engineering properties of ESU 3 soils are characterized as low to moderate strength low compressibility materials.

ESU 4 – Medium dense to dense recessional outwash (Qvrm – Marysville Sand Member): Soils interpreted to be medium dense recessional outwash soils were generally observed at depths below about 4 feet. Engineering properties of ESU 4 soils are characterized as moderate to high strength low compressibility materials. ESU 4 soils include structural fill compacted to at least 95 percent density per ASTM D 1557.

Earthwork

The following sections present recommendations for site preparation, subgrade preparation, and placement of engineered fills on the project. The recommendations presented in this report for design and construction of embankments, foundations, pavements, and slabs are contingent upon following the recommendations outlined in this section.

Earthwork on the project should be observed and evaluated by a ZGA representative. Evaluation of earthwork should include observation and testing of structural fill, subgrade preparation, foundation bearing soils, deep foundations, and subsurface drainage installations.

Site Preparation

Stripping: In preparation for grading, we recommend removal of any existing surficial vegetation, root mass, organic topsoil, and deleterious debris if present. These materials should be wasted from the substation footprint. We also recommend selective removal of existing undocumented fill material or disturbed native soils containing substantial organics or deleterious debris and any relic organic topsoil from below solar array foundations, pavements, or other settlement-sensitive project improvements.

Variation in the undocumented fill and disturbed native soil depth and composition should be expected. 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 possibly some that may be re-used as structural fill. Soil with no more than about 3 percent organic material and lacking deleterious material may generally be left in place. The resultant excavations should be backfilled in accordance with the subsequent recommendations for structural fill placement and compaction. The amount of soil removed during the stripping process may be reduced if root rakes are employed. Root rakes allow segregation of roots from the surrounding mineral soil, and can be beneficial in terms of reducing the amount of soil likely removed during stripping.

Site Preparation and Grading Scheduling: Most of the native soils likely to be exposed during grading consist of sand and gravel with a variable fines content. It will be feasible from the geotechnical perspective to grade these soils under a relatively wide weather band, although even with favorable granular soils it may be difficult or impossible to grade the site during very wet weather. If this concerns the District, we recommend that site preparation and grading take place in the drier summer and early fall months if possible. Completion of site preparation and grading under drier site and weather conditions will reduce the potential for disturbance of moisture-sensitive soils that may be disclosed during grading and the need to replace disturbed soils with imported fill material. Completing the work during the drier summer and early fall months will also allow the grading to coincide with the seasonal low groundwater condition and this would reduce the extent of construction dewatering.

Structural Fill Placement and Compaction

A grading plan was not available at the time this report was prepared. However, we anticipate that substantial grading will not be required in association with construction of the relocated solar array, new parking/materials storage, perimeter road, and stormwater management elements. 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, they 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. In the event that the soils cannot be adequately compacted, they should be moisture condition as necessary or 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 soils 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 include predominantly native soil typically consisting of sand and gravel with a variable fines content. The fines content of soil samples that we tested (as deep as about 12 feet and likely to be encountered in excavations) ranged at the western portion of the site from about 2 to 11 percent with an outlier at TP-8 of 23 percent and, in the eastern portion of the site, from about 1 to 18 percent. Please note that the samples with the higher fines contents were the shallow weathered soils. We observed the highest fines content in the very shallow soils; the fines content generally decreased with depth. Using the shallow soils with the higher fines content as structural fill during wet weather could be difficult due to the soils' increased moisture sensitivity.

Imported Structural Fill: We recommend that structural fill consist of well-graded sand and gravel with a low fines content. An example gradation is shown in the table below.

Table 3: Recommended Gradation of Imported Structural Fill	
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. A means of reducing the moisture sensitivity of the imported fill would be to base the fines content to less than 5 percent based on the soil fraction passing the ½ inch sieve. 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 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. Recommended compaction criteria for structural fill materials, including trench backfill, are as follows:

Table 4: Recommended Soil Compaction Levels	
Location	**Minimum Percent Compaction***
Below foundations and slabs	95
Below pavements and concrete hardscapes	95
General fill embankments	90 – 95 (refer to report text)
Utility trenches, foundation, and slab backfill	95
* ASTM D 1557 Modified Proctor Maximum Dry Density	

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 rock ballast over these areas would further protect the soils from construction traffic.

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, placement and compaction of structural fill, backfilling of excavations, and prior to construction of foundations.

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

Excavation Quantities: It has been our experience that grading calculations need to accommodate a "shrink or swell" factor when comparing in-place soil volumes to truck volumes. We recommend considering that the in-place volume of soil removed from excavations will increase by approximately 25 to 40 percent when measured on a loose cubic yards basis (truck yards). Likewise, loose truck yards delivered to the site will shrink on the order of 25 to 30 percent when compared to the in-place compacted volume of the soil. Truck yards are also subject to other discrepancies when correlating to bank yards, including "rounding errors" that can be significant.

Utility Installation Recommendations

Below-grade utilities are expected to include conduits 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 substation footprint are generally expected to be adequate for support of utilities.

All trenches should be wide enough to allow for compaction around the haunches of the pipe. If water is encountered in the excavations, it should be removed prior to fill placement. Materials, placement and compaction of utility trench backfill exclusive of CDF 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 1 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: Groundwater observations and measurements made as of the time that this report was prepared are described in Table 1 on Page 5. In summary, we did not observe groundwater while excavating test pits in the future relocated solar array area in the western portion of the site, although we did observe groundwater seepage at depths of about 5 to 8 feet in explorations in the eastern portion of the site. ZGA is continuing to monitoring groundwater at the Microgrid property and quarterly summaries will be provided to the District.

Depending upon the time of year that the work takes place and the depth of the utilities, groundwater seepage could be expected in excavations and certainly during the wetter time of year. Seepage could be heavy enough to require temporary dewatering measures and flattening the sidewalls of excavations to reduce the risk of caving. The contractor should be prepared to pump water from excavations into a nearby storm sewer or Baker tank. We recommend that dewatering effectively lower the water table at least 2 feet below the bottoms of excavations until they are backfilled.

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 1.5H:1V (Horizontal:Vertical) slope under fully drained conditions. Much shallower temporary slope inclinations will be required under saturated soil conditions. 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 difficult 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 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 the shallow granular soils have a low fines content and that unsupported excavation sidewalls in these soils may slough or cave readily.

Solar Array Foundation Recommendations

Based upon our review of RBI Solar design documents associated with the existing solar array (dated 18 February 2019) and provided by the District, it appears that the relocated solar array components may be supported by either cast-in-place drilled pier foundations, conventional shallow column foundations, or by small driven C-piles or H-piles. Our conclusions and recommendations regarding foundations for the relocated array are summarized below.

Drilled Pier Foundations

Drilled Pier End Bearing and Settlement: The existing array design called for 18-inch diameter drilled piers installed to a depth of 6 feet. Based on conditions disclosed by the GeoEngineers and ZGA explorations completed in the relocated solar array location, we recommend using an allowable end bearing value of 9 kips per square foot (ksf) for drilled piers installed into the dense recessional outwash soils. This value incorporates a factor of safety of three and may be increased by one third for short-term transient loading. Foundation settlement is expected to be less than one-half inch.

Drilled Pier Uplift Capacity: Uplift forces acting on the drilled piers may be counteracted by the weight of the piers and skin friction between the piers and the surrounding soil. An allowable uplift capacity of 2.8 tons due to skin friction may be considered. This value incorporates a factor of safety of 2.5.

Open Shaft Construction Considerations: Given the soil conditions encountered at the explorations locations, we anticipate that construction of the shafts can be accomplished with standard drilling equipment. We observed undisturbed native soils, as well as some likely disturbed native soils and some undocumented fill material to depths of about 1.5 feet below existing grade. The contractor should be prepared to deal with the presence of cobbles, concrete clasts, and wood over the drilled depth interval. In the event that obstructions cannot be removed, it will be necessary to excavate them and then backfill the excavation with either compacted structural fill or Controlled Density Fill (CDF) prior to attempting to re-drill the shafts.

We anticipate that sidewall caving may occur while drilling the granular soils, some of which have a relatively low fines content. We recommend that the contractor be prepared to case the drilled shaft boreholes to reduce sidewall sloughing. We recommend that the contractor be required to have on site sufficient material to case the entire drilled depth of the drilled pier foundations. The drilling contractor should be prepared to clean out the bottom of the shafts if loose soil is observed or suspected. We recommend that the drilling contractor have a cleanout bucket on site to remove loose soils from the bottom of the borings.

Concrete Placement: We recommend that the foundation concrete be tremied from the bottom of the hole to displace water and to reduce the risk of contaminating or segregating the concrete mix should any accumulate in the shafts. A minimum 5-foot head of concrete should be maintained above the tremie. The *Drilled Shaft Manual* published by the Federal Highway Administration recommends that concrete be placed by tremie methods if more than 3 inches of water has accumulated in the excavation. Otherwise, if the shafts are dry or nearly dry, concrete may be placed via conventional chute delivery.

We recommend that a ZGA representative observe construction of the drilled pier foundations in order to verify that the bearing conditions are consistent with those described in this report.

Conventional Shallow Foundations

The existing array design called for 5.3-foot square isolated cast-in-place spread foundations to be constructed a depth of 1.5 feet. Our shallow foundation recommendations are summarized below.

Net allowable bearing pressure: 3,500 psf for ESU 4 soils. This value incorporates a factor of safety of 3. A one-third increase may be applied for short-term wind or seismic loading.

Minimum base dimension for standard column foundation per previous design: 5.3 feet

Minimum embedment for frost protection: 18 inches

Approximate total settlement: 1 inch

Estimate differential settlement: One half of total settlement

Ultimate passive resistance: 480 pcf. This value assumes that foundations are backfilled with native sand and gravel compacted to 95 percent density and does not include a factor of safety. Neglect the upper 18 inches of embedment when calculating passive resistance.

Ultimate coefficient of base friction: 0.55. This value assumes the foundations are formed above compacted CSBC and does not include a factor of safety.

Shallow Foundation Construction Considerations: The base of all foundation excavations should be free of water, loose soil, or debris prior to placing concrete, and loose soil disturbed during excavation should be compacted as recommended in this report. Concrete should be placed soon after excavating and form and reinforcing installation to reduce bearing soil disturbance. Should the bearing subgrade become excessively disturbed or frozen, the affected material should be removed prior to placing concrete. We recommend that a ZGA representative observe foundation subgrade conditions prior to form and reinforcing steel placement.

Driven Pile Foundation Considerations

We understand that RBI Solar installed six test piles (five C8X3 piles and one W6X9 piles) during the existing solar array design process. The test pile program included the use of a proprietary hammer system, and the tests indicated that adequate capacities could be achieved by installing the piles at a maximum depth of 8 feet below grade. Soil conditions at the test piles locations are similar to those observed in the area where the relocated solar array will be installed, and we anticipate that the use of driven piles installed as described in the RBI Solar design documentation will be adequate at the new array location as well.

Stormwater Infiltration Feasibility

Construction of the new parking/materials storage area north of the relocated solar array and the new perimeter access road east of 63rd Avenue NE will introduce impervious surfaces, and the stormwater runoff will need to be accommodated by new stormwater management features. The site is underlain by permeable native granular soil and is characterized by a variable depth seasonal groundwater condition. Conclusions regarding stormwater infiltration feasibility can be drawn from subsurface conditions disclosed by the subsurface explorations, groundwater observations, and laboratory testing completed to date.

We understand that stormwater management improvements will be designed in accordance with the Washington State Department of Ecology 2019 *Stormwater Management Manual for Western Washington* (*Manual*). We collected representative samples of shallow soils and completed mechanical grain size tests as part of assessing the soils' saturated hydraulic conductivity, as summarized below.

<u>Saturated Hydraulic Conductivity</u>

The *Manual* allows a determination of soil saturated hydraulic conductivity to be estimated based on grain size distribution characteristics in accordance with the following formula:

$$\text{Log10}\,(K_{sat,\ initial}) = -1.57 + 1.9D_{10} + 0.015D_{60} - 0.013D_{90} - 2.08f_{fines} \text{ where:}$$

$K_{sat,\ initial}$ = initial saturated hydraulic conductivity in centimeters/second prior to the application of correction factors

D_{10} = grain size diameter (mm) for which 10 percent of the sample by weight is finer

D_{60} = grain size diameter (mm) for which 60 percent of the sample by weight is finer

D_{90} = grain size diameter (mm) for which 90 percent of the sample by weight is finer

f_{fines} = fraction of the sample by weight that passes the US No. 200 sieve.

The calculated hydraulic conductivity values for representative soils that we tested are listed in the table below. Grain size distribution curves for the samples are presented in Appendix B.

Table 5: Saturated Hydraulic Conductivity Summary			
Exploration / Sample	**Approximate Sample Depth (feet)**	**Unfactored Saturated Hydraulic Conductivity (inches per hour)**	**Factored Saturated Hydraulic Conductivity (inches per hour)**
Location: West of 63rd Avenue NE			
TP-1 / S-3	3.5	63.4	9.4
TP-2 / S-3	3.0	80.7	12
TP-4 / S-2	1.5	170.9	25.4
TP-5 / S-2	2.5	23	3.4
TP-6 / S-2	2.5	30.2	4.5
TP-7 / S-2	3.0	14.7	2.2
TP-8 / S-2	2.0	14.6	2.2
TP-8 / S-3	3.0	69.4	10.3
Location: East of 63rd Avenue NE			
HA-1 / S-2	1.5	18	2.7
HA-1 / S-4	3.5	34.5	5.1
TP-9 / S-2	3.0	42.7	6.3
TP-10 / S-2	2.5	43.8	6.5
TP-10 / S-3	5.0	151.9	22.6
TP-11 / S-1	0.5	20.2	3
TP-11 / S-3	8.0	104.3	15.5

Design Saturated Hydraulic Conductivity Rate

The *Manual* requires applying correction factors to the baseline (initial) saturated hydraulic conductivity rate. Table 3.3.1 *Correction Factors to be Used with In-Situ Saturated Hydraulic Conductivity Measurements to Estimate Design Rates* of the *Manual* calls for 40 percent reduction of the baseline rate determined via the grain size method (CF_T). Table 3.3.1 also requires applying correction factors for site variability and number of locations tested (CF_v) and the degree of influent control to prevent siltation and bio-buildup (CF_M). Based upon the observed site conditions, testing results, and our experience with projects of a similar nature, we applied values of 0.33, 0.5, and 0.9 for CF_V, CF_T, and CF_M, respectively. Factored rates are included in Table 5 above.

We anticipate that runoff from the new road east of 63rd Avenue NE may be accommodated by relatively shallow infiltration features, such as bioswales or trenches. Based upon this condition, we recommend applying an allowable long-term infiltration rate of 5.3 inches/hour for facilities constructed east of 63rd Avenue NE. We recommend applying an allowable long-term infiltration rate of 4.7 inches/hour for facilities west of 63rd Avenue NE.

ZipperGeo Geoprofessional Consultants

In Situ Stormwater Treatment

To assess the feasibility of using shallow native soils to provide stormwater runoff treatment, five shallow soil samples were tested for Cation Exchange Capacity (CEC) as well as organic content. The *Manual* requires that the infiltration receptor soil possess a minimum CEC value of 5 meq/100g of dry soil determined in accordance with the USEPA Method 9081 and an organic content of 1 percent or greater as determined via the ASTM D2974-07 test method in order to provide adequate *in situ* treatment of stormwater. Four of the five samples had CEC values greater than 5 meq/100g; only the sample from test pit TP-10 along the far east side of the site had a lesser value of 3.3 meq/100g. Each of the samples had an organic content exceeding 1 percent. Based on the test results and our observation of shallow soils, it appears that overall shallow soil conditions are favorable for *in situ* treatment provided that some soil amendment is completed in the vicinity of test pit TP-10.

SSC-4 Soil Infiltration Rate/Drawdown Time from the *Manual* indicates that the measured (initial/unfactored) soil infiltration should be 9 inches/hour or less for *in situ* treatment to be effective. However, the unfactored infiltration rates we determined exceeded 9 inches/hour. Consequently, it appears that some form of soil amendment of the native soils will be necessary to reduce the soil infiltration rate, or that treatment may be provided by using an imported soil mix that has been demonstrated to meet the *Manual* requirements.

It would be necessary to complete additional laboratory testing of amended site soils in order to determine the type and quantity of amendments necessary for the treated on-site soil to meet the relatively low infiltration rate described in the *Manual* for effective treatment. We can assist the District in this regard if requested. Alternatively, it would be feasible to import ready-made manufactured amended soil rather than attempting to amend the site soils. In the event that imported material is used for treatment purposes, we recommend considering the grain size distribution shown in the table below.

Table 6: Recommended Imported Treatment Fill Gradation	
US Standard Sieve Size	**Percent Passing by Dry Weight Basis**
3/8 inch	100
No. 4	95 - 100
No. 10	75 - 90
No. 40	25 - 40
No. 100	4 - 10
No. 200	< 5

In addition to the gradation criteria list in the table above, we recommend that the material have a Coefficient of Uniformity (Cu) = D_{60}/D_{10} greater than or equal to 4 and a Coefficient of Curve (Cc) = $(D_{30})^2/(D_{60} \times D_{10})$ greater than or equal to 1 and less than or equal to 3. This material may be amended with compost. Please note that the imported fill gradation criteria are taken from the bioretention mix material described in the WDOE *Stormwater Management Manual for Western Washington.*

Groundwater Considerations

Groundwater conditions observed while completing the test pits and hand auger boring advanced for this evaluation are presented in Table 1 on Page 5. The reported seasonal high groundwater observations at the site described in GeoEngineers' two-year groundwater monitoring effort undertaken in 2017 and 2018 are summarized in the table below. These observations illustrate that the depth to groundwater increased from east to west during the monitoring period. Our recent observations confirmed this condition.

Table 7: GeoEngineers Reported Historical Seasonal High Groundwater			
Exploration/Well	**Reported Seasonal High Groundwater Depth/Elevation* (feet)**	**Observation Date**	**Ground Surface Elevation* (feet)**
GEB-3	7.2 / 126.7	4.20.28	133.9
GEB-4	2.6 / 132.0	4.18.18	134.6
GEB-8	6.1 / 129.9	2.18.18	136.0
GEB-9	1.0 / 135.2	4.17.18	136.2
GEB-10	7.5 / 125.5	4.20.18	133
GEB-11	6.1 / 127.9	4.20.18	134
*Ground surface elevations reported on North County Community Office survey (9 sheets), by David Evans & Associates, Inc., dated 3.22.22.			

The previously observed shallow depth to seasonal high groundwater report by GeoEngineers for borings GEB-4 and GEB-9 east of 63rd Avenue NE suggest that a shallow stormwater infiltration feature, such as a bioretention swale, may be required in order to meet the minimum separation distance between the bottom of infiltration BMPs and seasonal high groundwater. Separation as low as 1 foot may be permissible when using bioretention features. Alternatively, some other form of shallow infiltration, such as permeable pavement, may be necessary.

Flexible Pavement Section Recommendations

Improvement plans include constructing an asphalt-paved access road along the perimeter of the eastern portion of the site as well as constructing paved parking and materials storage to the north of the relocated solar array. When developing our recommendations, we considered that the pavements will be subject to passenger vehicles, typical District service vehicles, and occasional heavy trucks. Our recommended minimum pavement section may be inadequate in the event that the District plans to operate heavily loaded solid-tire forklifts in the new material storage area. If this is the case, please confirm the anticipated equipment to be used in this area and its frequency so that we can evaluate alternative pavement sections. Our recommendations for flexible pavement section are summarized below.

Pavement Life and Maintenance: It should be realized that asphaltic pavements such as hot mix asphalt (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.

Soil Design Values: Shallow pavement subgrade soils are anticipated to consist of well-compacted sand with a variable fines content and generally low gravel content. This condition may be considered "fair" relative to pavement support. Our analysis assumes the pavement section subgrade will have a minimum California Bearing Ratio (CBR) value of 10.

Recommended Pavement Section: We recommend that the pavement section, at a minimum, consist of 3 inches of asphalt concrete over 3 inches of asphalt-treated base (ATB) over 6 inches (compacted thickness) of crushed surfacing base course (CSBC).

We recommend the following regarding flexible pavement materials and pavement construction.

Subgrade Preparation and Compaction: We anticipate that the pavement subgrade will consist of non-organic native soil and structural fill that has been prepared in accordance with the recommendations presented in the *Subgrade Preparation* section of this report. All subgrade soils should be compacted in accordance with the recommendations presented in the *Structural Fill* section of this report.

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 CSBC 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 an all-weather quarry spall construction site entrance.

- 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 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, structural fill, foundations, and pavements 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 Snohomish County PUD No. 1, and its 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

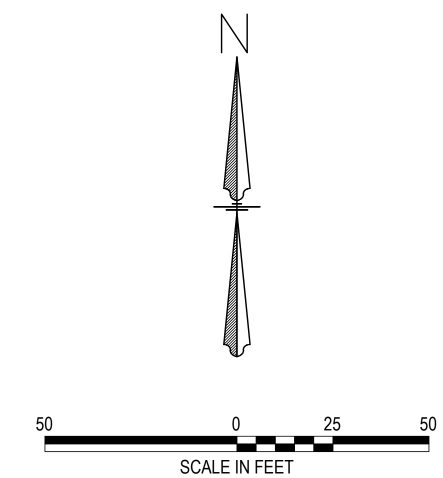
HA-1 HAND AUGER NUMBER AND APPROXIMATE LOCATION

TP-1 TEST PIT NUMBER AND APPROXIMATE LOCATION

TP-1 FEB 2023 ZIPPER GEO TEST PIT NUMBER AND APPROXIMATE LOCATION

GEB-1 2012 GEO ENGINEERS BORING NUMBER AND APPROXIMATE LOCATION

CPT-1 FEB 2023 ZIPPER GEO CPT NUMBER AND APPROXIMATE LOCATION



NORTH COUNTY SPECIAL USE PERMIT
17601 59th Avenue NE
Arlington, WA

SITE AND EXPLORATION PLAN

June 2, 2023	Job No.	2679.01
Zipper Geo Associates, LLC 19019 36th Ave. W.,Suite E Lynnwood, WA, 98036	FIGURE SHT. 1 of 1	1

REFERENCE: SNOHOMISH COUNTY PUD SITE PLAN PRELIMINARY, SHEET A1.1. DATED 12/20/22

APPENDIX A
FIELD EXPLORATION PROCEDURES AND LOGS

FIELD EXPLORATION AND TESTING PROCEDURES AND LOGS

Our field exploration program for this project included completing a visual reconnaissance of the site, excavating eleven test pits (TP-1 through TP-11) and advancing one hand auger boring (HA-1). 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 *Site Plan Preliminary* plan, Sheet A1.1, dated 20 December 2022, provided by the District. The approximate ground surface elevation at the exploration locations was interpolated from contours shown on Sheet SV1.08, *North County Community Office*, dated 22 March 2022. As such, the exploration locations and elevations should be considered accurate to the degree implied by the measurement method. The following sections describe our procedures associated with the explorations. Descriptive logs of the explorations are enclosed in this appendix.

Test Pit Procedures

An independent contractor (Northwest Excavation & Trucking) working under subcontract to ZGA excavated the test pits through the use of a tracked excavator. An engineering geologist 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.

Hand Auger

Hand auger boring HA-1 was advanced using a post hole digger and 3.25-inch diameter hand auger. An engineering geologist from ZGA performed the exploration. Samples were obtained as cuttings when the soil composition changed, stored in moisture-tight containers, and transported to our laboratory for further visual classification and testing.

The enclosed hand auger log indicates the vertical sequence of soils and materials encountered in the hand auger, 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. Our log also indicates the approximate depths of groundwater observed in the exploration, as well as all sample numbers and sampling locations.

Sample Screening

The boring and test pit logs also include the results of sample container headspace measurements taken with a RAE Systems photoionization detector (PID). The measurements indicate the relative concentration of petroleum hydrocarbons in the headspace air, but do not identify the type of hydrocarbon. The sample headspace readings, recorded as hydrocarbon concentration in parts per million (ppm) are presented on the logs in this appendix. The sample screening did not detect hydrocarbon levels of concern.

Cone Penetrometer Testing

Cone penetrometer test CPT-1 was completed by a ZGA subcontractor (In Situ Engineering) using a truck-mounted rig during a geotechnical exploration of the proposed Crosswind substation site, located in the southeastern portion of the Special Use Permit site. The testing was completed in general accordance with ASTM D 5778-12 procedures. The cone penetrometer testing involves advancing 35.7-millimeter diameter rods equipped with a friction sleeve, standard area cone, load cell, and pressure transducer. The apparatus is advanced via hydraulic pressure and the tip resistance and friction are recorded continuously. Pore pressure measurements and shear wave and compression wave testing may be taken at selected intervals. The enclosed cone penetrometer test log indicates the recorded tip resistance, friction, friction ratio, pore pressure, correlation to the Standard Penetration Test, and a graphic representation of the soil type.

Exploration Logs by Others

The 29 December 2017 GeoEngineers report *Geotechnical Engineering Services, North County Project, Arlington, Washington* (File No. 0482-051-03) includes the logs of numerous explorations completed at the Microgrid site. This appendix includes the logs of six borings/monitoring wells that GeoEngineers completed within the limits of the Special Use Permit site, the approximate locations of which are illustrated on Figure 1.

ZipperGeo
Geoprofessional Consultants

Hand Auger HA-1

Location: See Site and Exploration Plan, Figure 1

Approximate GSE: 135 feet

Project: North County SUP

Project Number: 2679.01A

Date Excavated: 4.25.2023

Depth (ft)	Material Description	Sample	PID	% M	Testing
1	Loose, moist,red-brown, silty SAND with gravel, trace organics, root hairs; subrounded gravel. ESU-2 (FILL)	S-1 @ 0.5 feet	0.0		ACM
2	Loose, moist, brown, SILT with sand, some gravel, some organics, root hairs; fine subrounded gravel. ESU-2 (Relic Topsoil) CEC = 6.7	S-2 @ 1.5 feet	0.0	30	GSA CEC
3	Loose to medium dense, moist, yellow-brown, SAND with gravel, some silt; fine subrounded gravel. ESU-3 (Qvrm)	S-3 @ 2.5 feet	0.0		
4		S-4 @ 3.5 feet	0.0	11	GSA
5	Medium dense, wet to saturated, grey, poorly graded SAND with gravel; fine subangular to subrounded gravel. ESU-4				
6		S-5 @ 5 feet	0.0		
7	Exploration completed at approximately 6.5 feet. Rapid groundwater seepage observed at 5.5 feet at time of excavation	S-6 @ 6 feet	0.0		
8					
9					
10					
11					
12					
13					
14					

Note: PID is the displayed hydrocarbon concentration in parts per million (ppm).

ZipperGeo
Geoprofessional Consultants

	Test Pit TP-1	**Project:** North County SUP			
	Location: See Site and Exploration Plan, Figure 1	**Project Number:** 2679.01A			
	Approximate GSE: 133 feet	**Date Excavated:** 4.24.2023			
Depth (ft)	**Material Description**	**Sample**	**PID**	**% M**	**Testing**
1	Loose, moist, red-brown, silty SAND to sandy SILT, fine roots, root hairs. ESU-1 (Topsoil)	S-1 @ 0.5 feet	0.0		ACM
2	Loose, moist, orange, silty SAND trace organics, roots, root hairs; some Fe; moderately weathered. ESU-3 (Qvrm) Organic Content = 5.6%				
3		S-2 @ 2 feet	0.0		OC
4	Loose to medium dense, moist, tan, poorly graded SAND, trace silt, trace gravel; subrounded gravel. ESU-3	S-3 @ 3.5 feet	0.0	7.7	GSA
5					
6					
7	Medium dense, moist, grey brown, poorly graded GRAVEL with sand; subrounded gravel; medium dense to dense at 8.5 feet. ESU-4	S-6 @ 6 feet	0.0		
8					
9					
10	Exploration completed at approximately 9 feet.				
11	No groundwater seepage observed at time of excavation				
12	Slight caving observed from approximately 3 feet.				
13					
14					

Note: PID is the displayed hydrocarbon concentration in parts per million (ppm).

ZipperGeo
Geoprofessional Consultants

	Test Pit TP-2	**Project:** North County SUP				
	Location: See Site and Exploration Plan, Figure 1	**Project Number:** 2679.01A				
	Approximate GSE: 133 feet	**Date Excavated:** 4.24.2023				
Depth (ft)	**Material Description**	**Sample**	**PID**	**% M**	**Testing**
1	Loose, moist, red-brown, silty SAND to sandy SILT, roots, root hairs. ESU-1 (Topsoil)	S-1 @ 0.5 feet	0.0		ACM
2	Loose, moist, orange, silty SAND trace coarse gravel; some Fe; moderately weathered. ESU-3 (Qvrm)				
3		S-2 @ 2 feet	0.0		
4	Medium dense, moist, tan, poorly graded SAND trace to some gravel; becomes medium dense to dense poorly graded SAND with gravel, trace silt at 3 feet; subrounded gravel. ESU-4	S-3 @ 3.5 feet	0.0	5.4	GSA
5					
6					
7					
8					
9		S-4 @ 9 feet	0.0		
10	Exploration completed at approximately 9.5 feet.				
11	No groundwater seepage observed at time of excavation				
12	Moderate caving observed from approximately 3 feet.				
13					
14					

Note: PID is the displayed hydrocarbon concentration in parts per million (ppm).

ZipperGeo
Geoprofessional Consultants

Test Pit TP-3

Location: See Site and Exploration Plan, Figure 1

Approximate GSE: 134 feet

Project: North County SUP

Project Number: 2679.01A

Date Excavated: 4.24.2023

Depth (ft)	Material Description	Sample	PID	% M	Testing
1	Loose, moist, brown, sandy SILT to silty SAND, roots, root hairs. ESU-1 (Topsoil)	S-1 @ 0.5 feet	0.0		ACM
2					
3	Loose, moist, orange, silty SAND trace coarse gravel; some Fe; moderately weathered. ESU-3 (Qvrm)	S-2 @ 2 feet	0.0		
4					
5	Medium dense, moist, grey, poorly graded SAND with gravel; subrounded gravel. ESU-4	S-3 @ 4.5 feet	0.0		
6					
7					
8					
9		S-4 @ 9 feet	0.0		
10	Exploration completed at approximately 9.5 feet.				
11	No groundwater seepage observed at time of excavation				
12	Moderate caving observed from approximately 3 feet.				
13					
14					

Note: PID is the displayed hydrocarbon concentration in parts per million (ppm).

	Test Pit TP-4		Project:	North County SUP	
	Location: See Site and Exploration Plan, Figure 1		**Project Number:**	2679.01A	
	Approximate GSE: 134 feet		**Date Excavated:**	4.24.2023	

Depth (ft)	Material Description	Sample	PID	% M	Testing
1	Loose, moist, brown, sandy SILT, fine to medium roots, root hairs. ESU 1 (Topsoil)	S-1 @ 0.5 feet	0.0		ACM
2	Loose, moist, orange, SAND with silt, fine roots, root hairs, some Fe; moderately weathered. ESU 3 (Qvrm)	S-2 @ 1.5 feet	0.0		GSA
3					
4	Medium dense, moist, yellow-grey, poorly graded SAND trace gravel; with gravel at 6 feet, trace silt at 9.5 feet, with cobbles at 9.5 feet; subrounded cobbles; subrounded gravel. ESU 4	S-3 @ 3.5 feet	0.0		
5					
6					
7		S-4 @ 6 feet	0.0		
8					
9					
10		S-5 @ 9.5 feet	0.0		
11	Exploration completed at approximately 10 feet.				
12	No groundwater seepage observed at time of excavation				
13	Moderate caving observed from approximately 3 feet.				
14					

Note: PID is the displayed hydrocarbon concentration in parts per million (ppm).

ZipperGeo
Geoprofessional Consultants

Test Pit TP-5

Location: See Site and Exploration Plan, Figure 1

Approximate GSE: 134 feet

Project: North County SUP

Project Number: 2679.01A

Date Excavated: 4.24.2023

Depth (ft)	Material Description	Sample	PID	% M	Testing
1	Loose, moist, brown, sandy SILT trace gravel, fine roots, root hairs; coarse subrounded gravel. ESU -1 (Topsoil)	S-1 @ 0.5 feet	0.0		ACM
2					
3	Loose, moist, orange, poorly graded SAND with silt, trace gravel, with organics, roots, root hairs, some Fe; moderately weathered. ESU -3 (Qvrm)	S-2 @ 2.5 feet	0.0		GSA
4					
5	Medium dense, moist, grey-brown, poorly graded SAND with gravel, becomes medium dense to dense at 10 feet, becomes moist to wet at 10 feet; subrounded gravel. ESU-4	S-3 @ 4.5 feet	0.0		
6					
7					
8		S-4 @ 8 feet	0.0		
9					
10		S-5 @ 10 feet	0.0		
11	Exploration completed at approximately 10.5 feet.				
12	No groundwater seepage observed at time of excavation				
13	Moderate caving observed from approximately 3 feet.				
14					

Note: PID is the displayed hydrocarbon concentration in parts per million (ppm).

ZipperGeo
Geoprofessional Consultants

Test Pit TP-6

Location: See Site and Exploration Plan, Figure 1

Approximate GSE: 134 feet

Project: North County SUP

Project Number: 2679.01A

Date Excavated: 4.24.2023

Depth (ft)	Material Description	Sample	PID	% M	Testing
1	Loose, moist, brown, silty SAND with gravel, fine roots, root hairs; coarse subrounded gravel. ESU-1 (Topsoil)	S-1 @ 0.5 feet	0.0		ACM
2	Loose, moist, orange, SAND some silt, trace gravel, trace organics, roots, root hairs, some Fe; moderately weathered. ESU-3 (Qvrm)				
3		S-2 @ 2.5 feet	0.0	14.9	GSA
4	Medium dense, moist, grey-brown, poorly graded SAND trace to some gravel, trace silt at 4 feet; subrounded gravel. ESU-4				
5		S-3 @ 4 feet	0.0		
6					
7		S-4 @ 6 feet	0.0		
8					
9		S-5 @ 8.5 feet	0.0		
10	Exploration completed at approximately 9 feet.				
11	No groundwater seepage observed at time of excavation				
12	Mild caving observed from approximately 3 feet.				
13					
14					

Note: PID is the displayed hydrocarbon concentration in parts per million (ppm).

ZipperGeo
Geoprofessional Consultants

Test Pit TP-7

Location: See Site and Exploration Plan, Figure 1

Approximate GSE: 134 feet

Project: North County SUP

Project Number: 2679.01A

Date Excavated: 4.24.2023

Depth (ft)	Material Description	Sample	PID	% M	Testing
1	Loose, moist, dark brown, sandy SILT, fine roots, root hairs, some glass and plastic debris. ESU-2 (FILL)	S-1 @ 0.5 feet	0.0		ACM
2					
3	Loose, moist, orange, sandy SILT to silty SAND trace to some organics, fine roots, root hairs, some Fe; moderately weathered. ESU-3 (Qvrm) Organic Content = 6.7% CEC = 12				
4		S-2 @ 3 feet	0.0	23.6	GSA/CEC/OC
5					
6	Medium dense, moist, grey, SAND with silt, trace gravel; subrounded gravel. ESU-4				
7					
8		S-3 @ 7 feet	0.0		
9					
10		S-5 @ 9.5 feet	0.0		
11	Exploration completed at approximately 10 feet.				
12	No groundwater seepage observed at time of excavation				
13	Moderate caving observed from approximately 4 feet.				
14					

Note: PID is the displayed hydrocarbon concentration in parts per million (ppm).

ZipperGeo
Geoprofessional Consultants

	Test Pit TP-8	**Project:** North County SUP			
	Location: See Site and Exploration Plan, Figure 1	**Project Number:** 2679.01A			
	Approximate GSE: 134 feet	**Date Excavated:** 4.24.2023			
Depth (ft)	**Material Description**	**Sample**	**PID**	**% M**	**Testing**
1	Loose, moist, dark brown, sandy SILT, medium to fine roots, root hairs. ESU-1 (Topsoil)	S-1 @ 0.5 feet	0.0		ACM
2	Loose, moist, orange, SAND with silt, trace gravel, trace to some organics, fine roots, root hairs, some Fe; moderately weathered. ESU-3 (Qvrm) Organic Content = 3.4% CEC = 5.2				
3		S-2 @ 2 feet	0.0	20.1	GSA/CEC/OC
4	Loose to medium dense, moist, grey-brown, poorly graded SAND some gravel, trace silt; subrounded gravel. ESU-3	S-3 @ 3 feet	0.0	6.8	GSA
5					
6					
7	Medium dense, moist, grey-brown, poorly graded SAND with gravel with cobbles at 10 feet; subrounded cobbles; subrounded gravel. ESU-4	S-4 @ 6.5 feet	0.0		
8					
9					
10					
11	Exploration completed at approximately 10.5 feet.	S-5 @ 10 feet	0.0		
12	No groundwater seepage observed at time of excavation				
13	Severe caving observed from approximately 3-3.5 feet.				
14					

Note: PID is the displayed hydrocarbon concentration in parts per million (ppm).

ZipperGeo
Geoprofessional Consultants

Test Pit TP-9

Location: See Site and Exploration Plan, Figure 1

Approximate GSE: 135 feet

Project: North County SUP

Project Number: 2679.01A

Date Excavated: 4.24.2023

Depth (ft)	Material Description	Sample	PID	% M	Testing
1	Loose, moist, red-brown, silty SAND with gravel; subrounded gravel. ESU-2 (FILL)	S-1 @ 0.5 feet	0.0		ACM
2	Loose, moist, yellow-brown, poorly graded SAND with gravel, some silt; subrounded gravel; slightly weathered. ESU-3 (Qvrm)				
3					
4		S-2 @ 3 feet	0.0		GSA
5					
6	Loose to medium dense, wet, grey, poorly graded SAND with gravel; subrounded gravel. ESU -3	S-3 @ 5.5 feet	0.0		
7	Loose to medium dense, saturated, grey, poorly graded GRAVEL with sand; subrounded gravel. ESU-3				
8		S-4 @ 7 feet	0.0		
9	Exploration completed at approximately 8 feet. Rapid groundwater seepage observed at 5.5 feet at time of excavation Moderate caving observed from approximately 5.5 feet.				
10					
11					
12					
13					
14					

Note: PID is the displayed hydrocarbon concentration in parts per million (ppm).

Depth (ft)	Test Pit TP-10	Project: North County SUP			
	Location: See Site and Exploration Plan, Figure 1	**Project Number:** 2679.01A			
	Approximate GSE: 136 feet	**Date Excavated:** 4.24.2023			
Depth (ft)	**Material Description**	**Sample**	**PID**	**% M**	**Testing**
1	Loose, moist to wet, black, sandy SILT with cobbles, wood, branches, plastic, glass, metal; subrounded cobbles. ESU-2 (FILL)	S-1 @ 0.5 feet	0.0		ACM
2					
3	Loose, moist to wet, yellow-brown, poorly graded SAND with gravel, some silt, some wood, branches; subrounded gravel. ESU-2 (FILL) Organic Content = 1.6% CEC = 3.3	S-2 @ 2.5 feet	0.0	9.3	GSA OC
4					
5	Medium dense, wet to saturated, yellow-brown, gravelly SAND trace silt; subrounded gravel. ESU-4 (Qvrm)				
6		S-3 @ 5.5 feet	0.0	8.2	GSA
7	Exploration completed at approximately 6 feet.				
8	Rapid groundwater seepage observed at 5 feet at time of excavation				
9	Slight caving observed from approximately 3 feet.				
10					
11					
12					
13					
14					

Note: PID is the displayed hydrocarbon concentration in parts per million (ppm).

ZipperGeo

Geoprofessional Consultants

Test Pit TP-11

Location: See Site and Exploration Plan, Figure 1

Approximate GSE: 136 feet

Project: North County SUP

Project Number: 2679.01A

Date Excavated: 4.24.2023

Depth (ft)	Material Description	Sample	PID	% M	Testing
1	Loose, moist, brown to tan, SAND with silt, with gravel, fine to medium roots, root hairs, plastic, metal pipes. ESU-2 (FILL) Organic Content = 4.7% CEC = 6.2	S-1 @ 0.5 feet	0.0	17.6	ACM/GSA/ CEC/OC
2					
3	Loose, moist to wet, grey-brown, poorly graded SAND with gravel, some Fe; subrounded gravel; moderately weathered. ESU-3 (Qvrm)	S-2 @ 2.5 feet	0.0		
4					
5	Medium dense, wet to saturated, grey-brown, poorly graded SAND with gravel to gravelly SAND trace silt; subrounded gravel. ESU-4				
6					
7					
8					
9		S-3 @ 8 feet	0.0	10.3	GSA
10	Exploration completed at approximately 8.5 feet.				
11	Rapid groundwater seepage observed at 8 feet at time of excavation				
12	Mild to moderate caving observed from approximately 4.5 feet.				
13					
14					

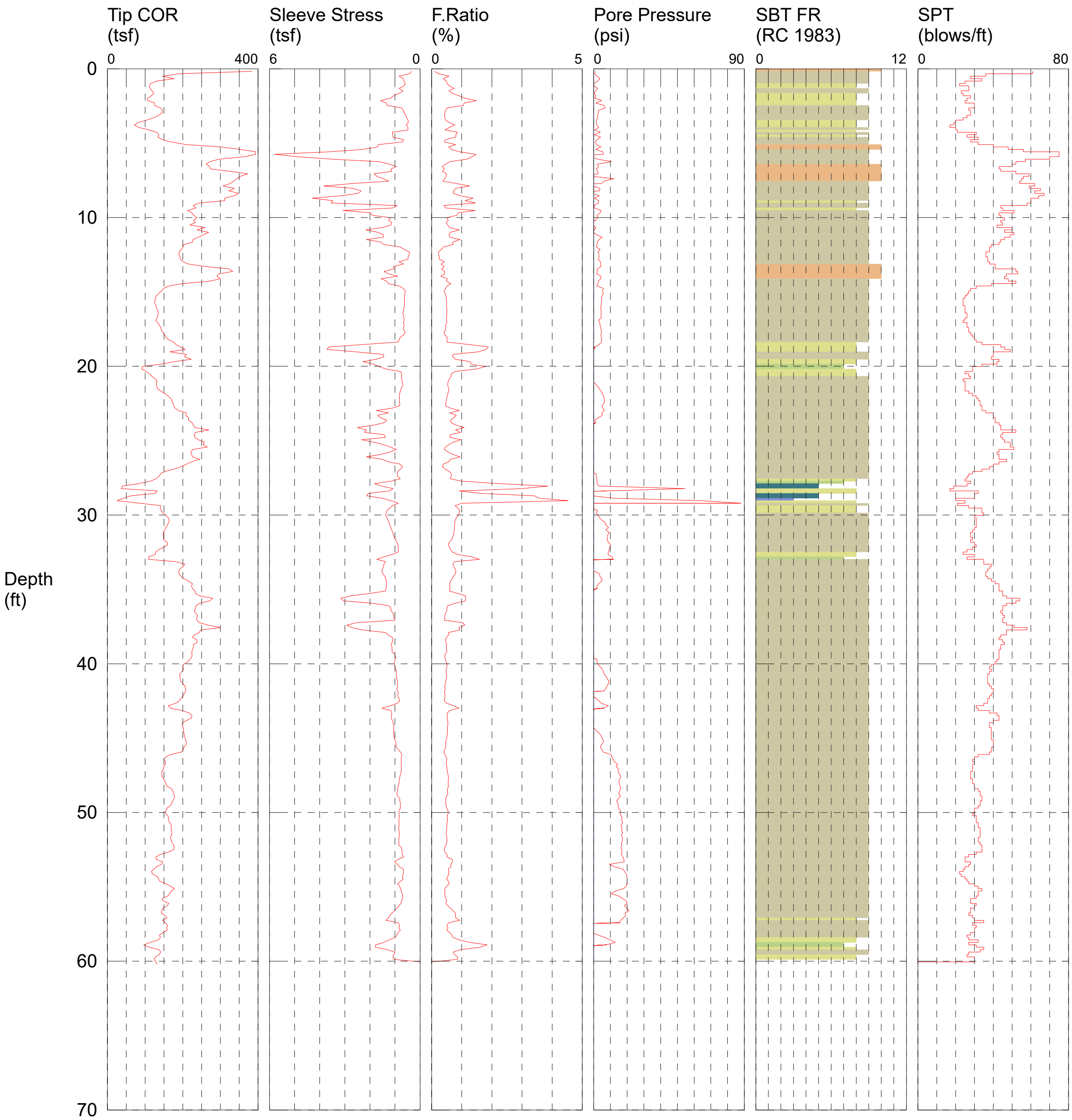
Note: PID is the displayed hydrocarbon concentration in parts per million (ppm).

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

CPT-01

CPT Contractor: In Situ Engineering
CUSTOMER: ZipperGeo
LOCATION: Arlington
JOB NUMBER: 2679.01

OPERATOR: Forinash
CONE ID: DDG1351
TEST DATE: 2/24/2023 9:46:02 AM
Coring: 0ft
Backfill: 20% Bentonite Slurry + Bentonite Chip
Surface Patch: None



TOTAL DEPTH: 60.203 ft

1 sensitive fine grained	4 silty clay to clay	7 silty sand to sandy silt	10 gravelly sand to sand
2 organic material	5 clayey silt to silty clay	8 sand to silty sand	11 very stiff fine grained (*)
3 clay	6 sandy silt to clayey silt	9 sand	12 sand to clayey sand (*)

*SBT/SPT CORRELATION: UBC-1983

GeoEngineers Exploration Logs

Drilled	Start 6/14/2012	End 6/14/2012	Total Depth (ft) 51.5	Logged By SMJ Checked By BPD	Driller Geologic Drill Explorations, Inc.	Drilling Method Hollow-stem Auger

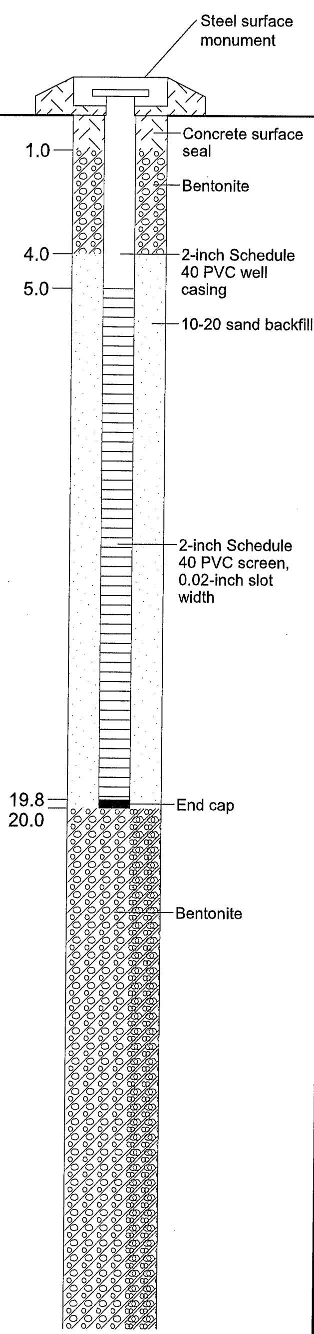
Hammer Data: Autohammer 140 (lbs) / 30 (in) Drop	Drilling Equipment: Diedrich D-50 Track Rig	DOE Well I.D.: BHJ197 A 2 (in) well was installed on to a depth of 20 (ft).
Surface Elevation (ft): 134 Vertical Datum: NAVD88	Top of Casing Elevation (ft)	
Easting (X) Northing (Y)	Horizontal Datum	

Groundwater Date Measured	Depth to Water (ft)	Elevation (ft)
6/25/2012	9.7	124.3

Notes: Elevation estimated from base survey map

Elevation (feet)	Depth (feet)	Recovered (in)	Blows/foot	Sample Name / Testing	Water Level	Group Classification	MATERIAL DESCRIPTION	Moisture Content (%)	Fines Content (%)
134	0					TS	6 inches topsoil and roots		
						SM	Light brown silty fine to medium sand with gravel, trace organic matter (medium dense, moist)		
		16	14	1 SA				11	13
130									
	5	12	14	2		SP	Light brown and gray fine to medium sand with trace gravel (loose, moist) (recessional outwash)	5	
		12	30	3		SP-SM	Grayish brown fine to medium sand with silt and gravel (medium dense, moist)	7	
125					▼	SW-SM	Brown fine to coarse sand with silt and gravel (medium dense, wet)		
	10	5	25	4					
						SP-SM	Grayish brown fine to medium sand with silt and occasional gravel (medium dense, wet)		
120									
	15	18	29	5			Driller added drilling mud at 15 feet		
115									
	20	9	23	6 %F				12	6
110									
	25	16	25	7					
						SM	Grayish brown silty fine to medim sand with occasional gravel (medium dense, wet)		
105									
	30	14	25	8					
						ML	Grayish brown silt with occasional interbedded fine to medium sand with gravel (medium dense, wet)		
100									
	35								

WELL LOG



Notes: See Figure A-1 for explanation of symbols.
Elevation estimated from base survey map

Log of Boring B-3

GeoEngineers

Project: Arlington Site Development
Project Location: Arlington, Washington
Project Number: 0482-051-03

Drilled	Start 6/14/2012	End 6/14/2012	Total Depth (ft) 26.5	Logged By SMJ Checked By BPD	Driller Geologic Drill Explorations, Inc.	Drilling Method Hollow-stem Auger

Hammer Data	Autohammer 140 (lbs) / 30 (in) Drop	Drilling Equipment	Diedrich D-50 Track Rig
Surface Elevation (ft) Vertical Datum	134.5 NAVD88	Top of Casing Elevation (ft)	
Easting (X) Northing (Y)		Horizontal Datum	

DOE Well I.D.: BHJ196
A 2 (in) well was installed on to a depth of 20 (ft).

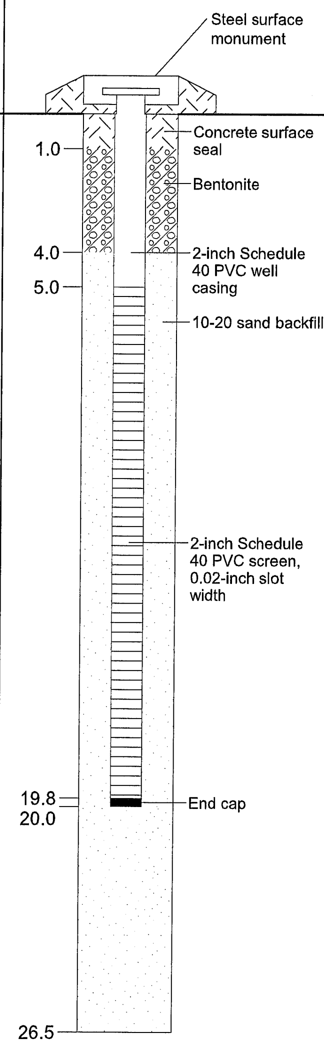
Groundwater Date Measured	Depth to Water (ft)	Elevation (ft)
6/25/2012	5.7	128.8

Notes: Elevation estimated from base survey map

FIELD DATA

Elevation (feet)	Depth (feet)	Recovered (in)	Blows/foot	Sample Name / Testing	Water Level	Group Classification	MATERIAL DESCRIPTION	Moisture Content (%)	Fines Content (%)
	0					TS	9 inches topsoil and roots		
						SM	Light brown silty fine to medium sand with gravel, trace organic matter (loose, moist)		
		18	8	1 MC				11	
130						SP-SM	Light brown fine to medium sand with silt and gravel (medium dense, moist) (recessional outwash)		
	5	18	22	2 MC	▼			6	
		12	22	3			Becomes wet		
125						SP	Grayish brown fine to medium sand with gravel (medium dense, wet)		
	10	18	23	4					
						SP-SM	Grayish brown fine to medium sand with silt , and occasional gravel (medium dense, wet) Driller added drilling mud at 13 feet		
120	15	18	21	5					
						SM	Grayish brown silty fine to medium sand (medium dense to dense, wet)		
115	20	18	30	6 MC			1 foot heave at 20 feet	12	
110	25	18	12	7					

WELL LOG



Notes: See Figure A-1 for explanation of symbols.
Elevation estimated from base survey map

Seattle: Date:5/4/16 Path:P:\0\0482051\GINT\048205103.GPJ DBTemplate/LibTemplate:GEOENGINEERS8.GDT/GEI8_GEOTECH_WELL

Log of Boring B-4

GeoEngineers

Project: Arlington Site Development
Project Location: Arlington, Washington
Project Number: 0482-051-03

Figure A-5
Sheet 1 of 1

Drilled	Start 3/8/2017	End 3/8/2017	Total Depth (ft)	26.5	Logged By NS / Checked By KMS	Driller	Holocene Drilling, Inc.	Drilling Method	Hollow-stem Auger

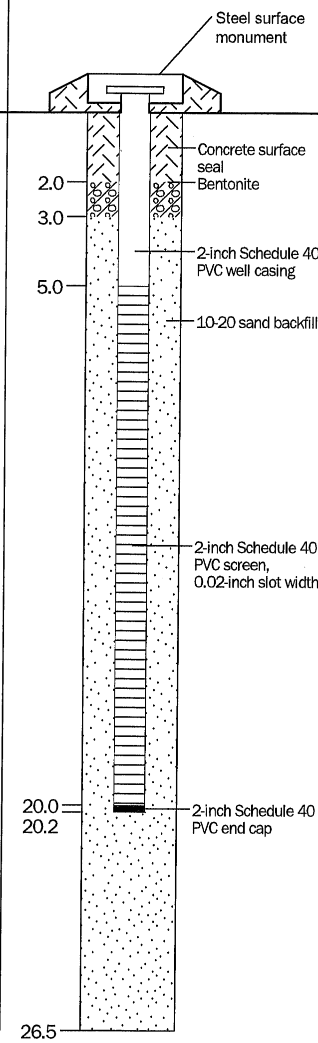
Hammer Data	Autohammer 140 (lbs) / 30 (in) Drop	Drilling Equipment	Diedrich D50 Track-mounted	DOE Well I.D.: BJY257 A 2 (in) well was installed on 3/8/2017 to a depth of 20 (ft).
Surface Elevation (ft) Vertical Datum	137 NAVD88	Top of Casing Elevation (ft)	137	Groundwater Date Measured: 4/13/2017; Depth to Water (ft): 7.4; Elevation (ft): 129.6
Easting (X) Northing (Y)	1320413 424926	Horizontal Datum	WA State Plane North NAD83 (feet)	

Notes: Environmental field screening was completed on each soil sample. Sheen and head space vapor were not observed unless otherwise noted.

Elevation (feet)	Depth (feet)	Recovered (in)	Blows/foot	Sample Name / Testing	Water Level	Group Classification	MATERIAL DESCRIPTION	Moisture Content (%)	Fines Content (%)
137	0					TS	Topsoil with roots (upper 6 inches)		
135		16	13	1 MC		SM	Reddish brown silty fine to medium sand with occasional organic matter (medium dense, moist)	7	
132	5	4	62*	2		SP-SM	Light brown fine to medium sand with silt and occasional gravel and cobbles (medium dense to dense, moist) (recessional outwash)		
130		8	36*	3 SA	▼	SP-SM	Light brown fine to coarse sand with silt, gravel and occaional cobbles (medium dense, wet)	7	9
	10	10	23	4					
125		9	23	5 %F		SP	Light gray fine to coarse sand with gravel (medium dense, wet)	15	4
	15	18	21	6			Becomes gray		
120						SP-SM	Gray fine to medium sand with silt and occasional gravel (medium dense, wet)		
115	20	18	19	7 %F		SP	Gray fine to medium sand (medium dense, wet)	20	4
	25	18	18	8					

* Sampler bouncing on rock, blow count not representative.

WELL LOG



Note: See Figure A-1 for explanation of symbols.
Coordinates Data Source: Horizontal approximated based on Hand-held GPS (±18 ft), Vertical approximated based on Survey Basemap (±1 ft)

Log of Boring B-8

GEOENGINEERS

Project: Arlington Local Office Replacement
Project Location: Arlington, Washington
Project Number: 0482-051-03

Figure A-3
Sheet 1 of 1

Drilled	Start 3/8/2017	End 3/8/2017	Total Depth (ft) 26.5	Logged By NS / Checked By KMS	Driller Holocene Drilling, Inc.	Drilling Method Hollow-stem Auger

Hammer Data	Autohammer 140 (lbs) / 30 (in) Drop	Drilling Equipment	Diedrich D50 Track-mounted
Surface Elevation (ft) / Vertical Datum	136 / NAVD88	Top of Casing Elevation (ft)	137
Easting (X) / Northing (Y)	1321085 / 424465	Horizontal Datum	WA State Plane North NAD83 (feet)

DOE Well I.D.: BJY258
A 2 (in) well was installed on 3/8/2017 to a depth of 20 (ft).

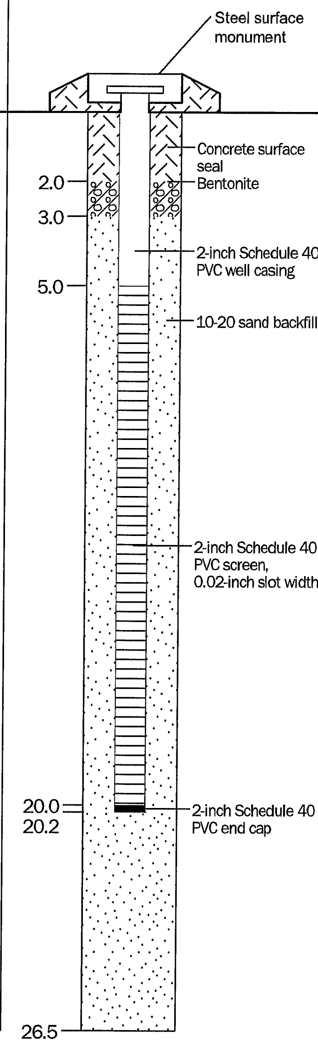
Groundwater Date Measured	Depth to Water (ft)	Elevation (ft)
4/13/2017	2.7	133.3

Notes: Environmental field screening was completed on each soil sample. Sheen and head space vapor were not observed unless otherwise noted.

FIELD DATA

Elevation (feet)	Depth (feet)	Recovered (in)	Blows/foot	Sample Name / Testing	Water Level	Group Classification	MATERIAL DESCRIPTION	Moisture Content (%)	Fines Content (%)
135	0					TS	Topsoil with roots (upper 6 inches)		
						SP-SM	Brown fine to coarse sand with silt and occasional gravel (loose, wet) (recessional outwash)		
		10	8	1 / %F	▼			14	5
130	5	12	12	2 / SA		SP	Brown fine to coarse sand with gravel (medium dense, wet)	20	2
		14	20	3					
125	10	12	26	4 / %F		SP-SM	Brown fine to medium sand with silt and occasional gravel (medium dense, wet)	15	6
		8	29	5					
120	15	18	28	6					
115	20	18	40	7 / %F			Becomes dense	14	7
110	25	18	24	8		SP-SM	Brown fine sand with silt (medium dense, wet)		

WELL LOG



Note: See Figure A-1 for explanation of symbols.
Coordinates Data Source: Horizontal approximated based on Hand-held GPS (±18 ft), Vertical approximated based on Survey Basemap (±1 ft)

Log of Boring B-9

GEOENGINEERS

Project: Arlington Local Office Replacement
Project Location: Arlington, Washington
Project Number: 0482-051-03

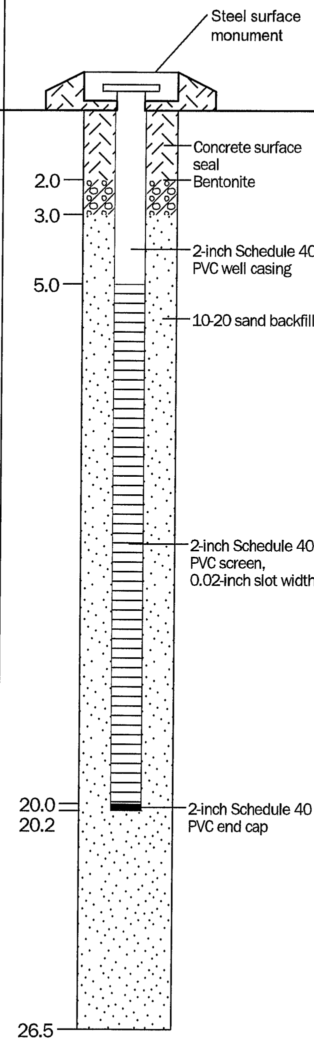
Drilled	Start 3/8/2017	End 3/8/2017	Total Depth (ft)	26.5	Logged By NS Checked By KMS	Driller	Holocene Drilling, Inc.	Drilling Method	Hollow-stem Auger

Hammer Data	Autohammer 140 (lbs) / 30 (in) Drop	Drilling Equipment	Diedrich D50 Track-mounted	DOE Well I.D.: BJY260 A 2 (in) well was installed on 3/8/2017 to a depth of 20 (ft).	
Surface Elevation (ft) Vertical Datum	133 NAVD88	Top of Casing Elevation (ft)	133	Groundwater Date Measured: 4/13/2017	Depth to Water (ft): 8.3 Elevation (ft): 124.7
Easting (X) Northing (Y)	1319707 424320	Horizontal Datum	WA State Plane North NAD83 (feet)		

Notes: Environmental field screening was completed on each soil sample. Sheen and head space vapor were not observed unless otherwise noted.

Elevation (feet)	Depth (feet)	Recovered (in)	Blows/foot	Sample Name / Testing	Water Level	Group Classification	MATERIAL DESCRIPTION	Moisture Content (%)	Fines Content (%)
133	0					TS	Topsoil with roots		
						SM	Dark brown silty fine sand with organic matter, roots (topsoil)		
130		18	16	1 (B-10-2.5) %F; CA		SP-SM	Light brown fine to medium sand with silt (medium dense, moist) (recessional outwash) (Slight sheen)	8	5
	5	12	36	2 (B-10-5.0) SA; CA		SP-SM	(Moderate sheen; PID 2.8 ppm) Brown fine to medium sand with silt and occasional gravel (dense, moist)	6	7
125		14	45	3 (B-10-7.5) MC; CA	▼	SP	Gravel in shoe (Slight sheen, PID <1 ppm) Gray fine to coarse sand with gravel (dense, moist)	4	
	10	17	41	4 %F			Becomes wet	11	3
120		18	34	5					
	15	17	55	6			Becomes very dense		
115									
	20	6	25	7					
110						SP-SM	Brown fine to medium sand with silt (medium dense, wet)		
	25		36	8 %F			Becomes dense	19	11

WELL LOG



Note: See Figure A-1 for explanation of symbols.
Coordinates Data Source: Horizontal approximated based on Hand-held GPS (±18 ft), Vertical approximated based on Survey Basemap (±1 ft)

Log of Boring B-10

GeoEngineers

Project: Arlington Local Office Replacement
Project Location: Arlington, Washington
Project Number: 0482-051-03

Drilled	Start 3/8/2017	End 3/8/2017	Total Depth (ft) 26.5	Logged By NS / Checked By KMS	Driller: Holocene Drilling, Inc.	Drilling Method: Hollow-stem Auger

Hammer Data	Autohammer 140 (lbs) / 30 (in) Drop	Drilling Equipment	Diedrich D50 Track-mounted
Surface Elevation (ft) / Vertical Datum	134 / NAVD88	Top of Casing Elevation (ft)	134
Easting (X) / Northing (Y)	1320129 / 424309	Horizontal Datum	WA State Plane North NAD83 (feet)

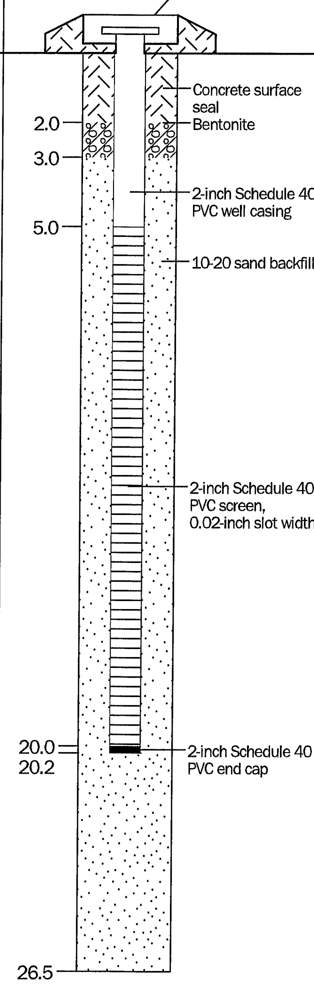
DOE Well I.D.: BJY259
A 2 (in) well was installed on 3/8/2017 to a depth of 20 (ft).

Groundwater Date Measured	Depth to Water (ft)	Elevation (ft)
4/13/2017	7.4	126.6

Notes: Environmental field screening was completed on each soil sample. Sheen and head space vapor were not observed unless otherwise noted.

Elevation (feet)	Depth (feet)	Recovered (in)	Blows/foot	Sample Name / Testing	Group Classification	MATERIAL DESCRIPTION	Moisture Content (%)	Fines Content (%)
	0				TS	Topsoil with roots (upper 6 inches)		
130		18	13	1 %F	SM	Dark brown silty fine to medium sand with occasional organic matter, roots (loose, moist)	25	13
	5	16	12	2 (B-11-5.0) SA; CA	SP	Light brown fine to medium sand (medium dense, moist) (recessional outwash)	7	4
					SP-SM	With occasional gravel (Slight sheen; PID 2.8 ppm)		
						Brown fine to medium sand with silt (loose, moist)		
125		17	33	3 (B-11-7.5) MC; CA		With occasoinal gravel (Moderate sheen; PID 7.6 ppm)	5	
					SP-SM	Gray fine to coarse sand with silt and occasional gravel (dense, moist)		
	10	18	30	4 (B-11-10.0) %F; CA	SP	Gray fine to coarse sand with gravel (dense, wet)	7	4
120		12	46	5				
	15	18	34	6				
115								
	20	11	24	7 %F			27	47
					SM	Brown silty fine sand with thin silt lenses, horizontal bedding (medium dense, wet)		
110								
	25	18	24	8	SP-SM	Gray fine to medium sand with silt (medium dense, wet)		

WELL LOG



Note: See Figure A-1 for explanation of symbols.
Coordinates Data Source: Horizontal approximated based on Hand-held GPS (±18 ft), Vertical approximated based on Survey Basemap (±1 ft)

Log of Boring B-11

GEOENGINEERS

Project: Arlington Local Office Replacement
Project Location: Arlington, Washington
Project Number: 0482-051-03

Figure A-6
Sheet 1 of 1

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.

Atterberg Limits
Atterberg limits are used primarily for classification and indexing of cohesive soils. The liquid and plastic limits are two of the five Atterberg limits and are defined as the moisture content of a cohesive soil at arbitrarily established limits for liquid and plastic behavior, respectively. Liquid and plastic limits were established for selected samples in general accordance with ASTM D 423 and ASTM D 424, respectively. The results of the Atterberg limits are presented on a plasticity chart in this appendix where the plasticity index (liquid limit minus plastic limit) is related to the liquid limit. The plastic limits and liquid limits are also presented adjacent to appropriate samples on the exploration logs in Appendix A.

Asbestos Containing Material (ACM)
Five samples of existing fill material were collected from the test pits and borings in order to test for the presence of ACM. Examination of these samples was conducted for the presence of identifiable asbestos fibers using polarized light microscopy (PLM) with dispersion staining in accordance with both EPA 600/M4-82-020, Interim Method for the Determination of Asbestos in Bulk Insulation Samples and EPA 600/R-93/116 Method for the Determination of Asbestos in Bulk Building Materials. Results of the tests

are presented in the attached NVL report in this appendix. The ACM was not detected in any of the samples.

Cation Exchange Capacity

Selected samples were tested for Cation Exchange Capacity (CEC) by a subcontract analytical testing laboratory (AmTest Laboratories of Kirkland, Washington). The tests were completed in general accordance with the EPA Laboratory Method 9081 testing procedure. The test results are presented in this appendix and discussed in the report text.

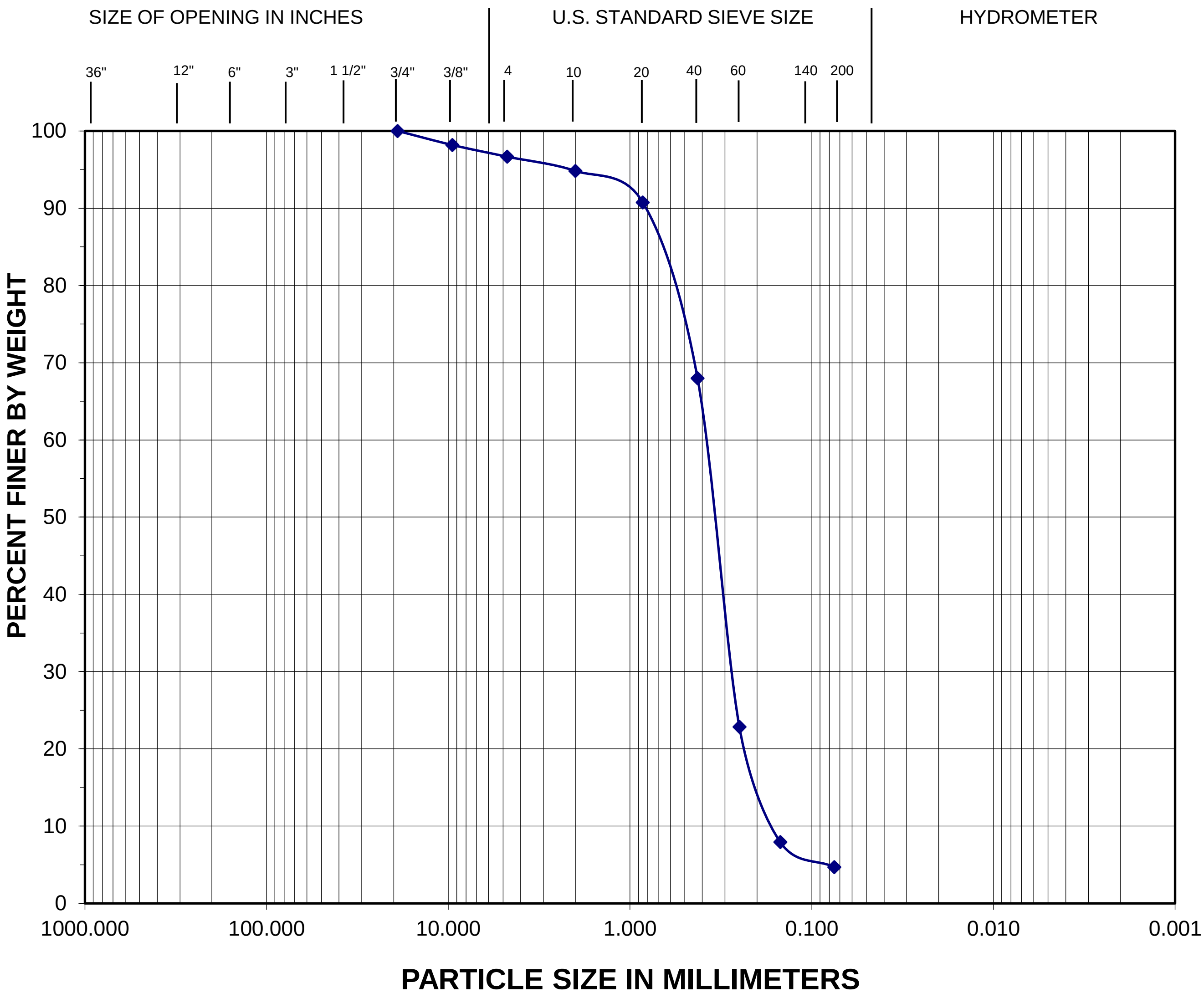
Organic Content

The organic content of selected samples was determined in general accordance with ASTM D 2974. The results of the tests are discussed in the report text.

GRAIN SIZE ANALYSIS

Test Results Summary

ASTM D6913



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

Comments:

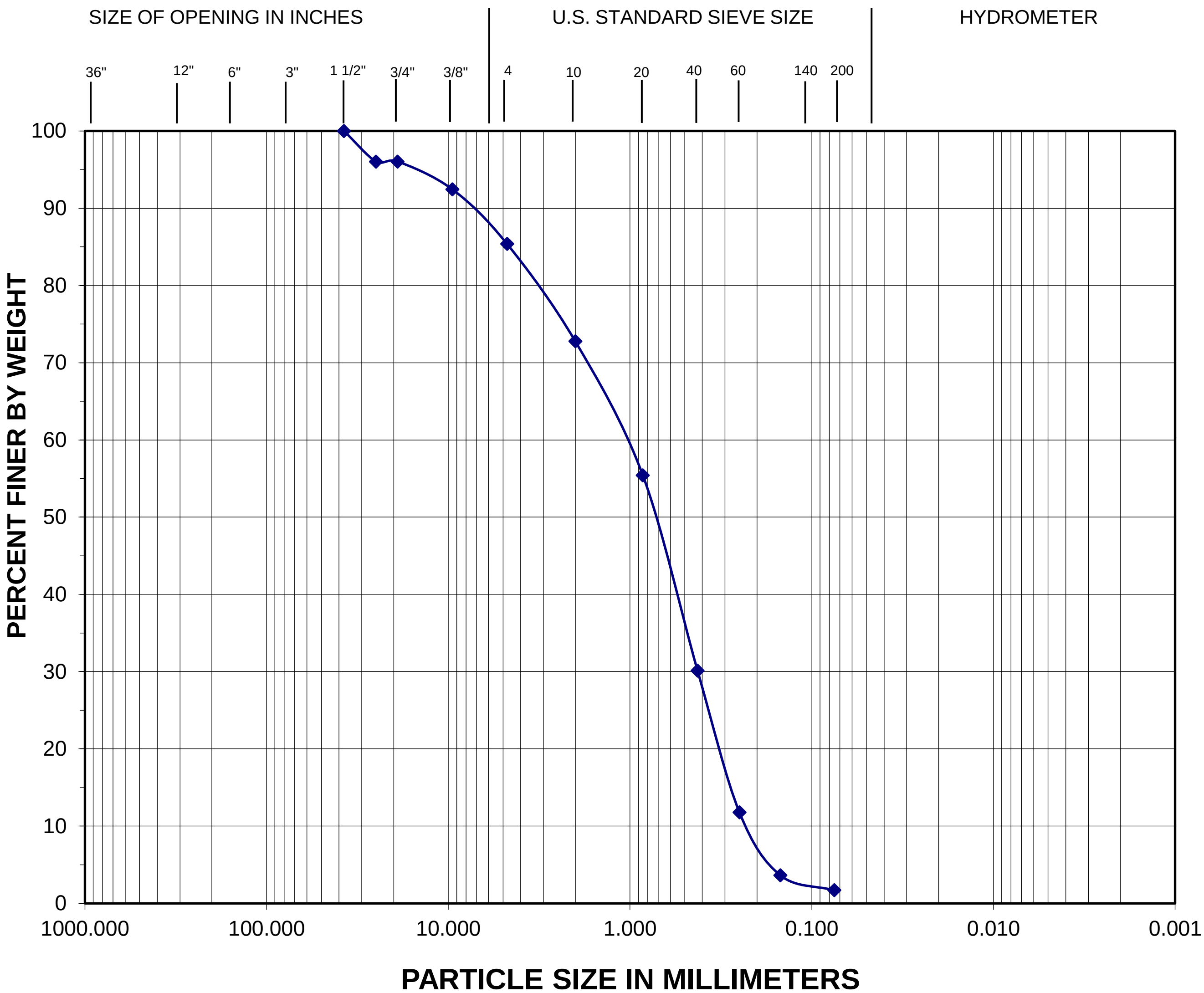
Exploration	Sample	Depth (feet)	Moisture (%)	Fines (%)	Description
TP-1	S-3	3.5	7.7	4.7	SAND, trace silt and gravel

Zipper Geo Associates, LLC Geotechnical and Environmental Consultants	PROJECT NO: 2679.01 DATE OF TESTING: 5/5/2023	PROJECT NAME: Special Use Permit

GRAIN SIZE ANALYSIS

Test Results Summary

ASTM D6913



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

Comments:

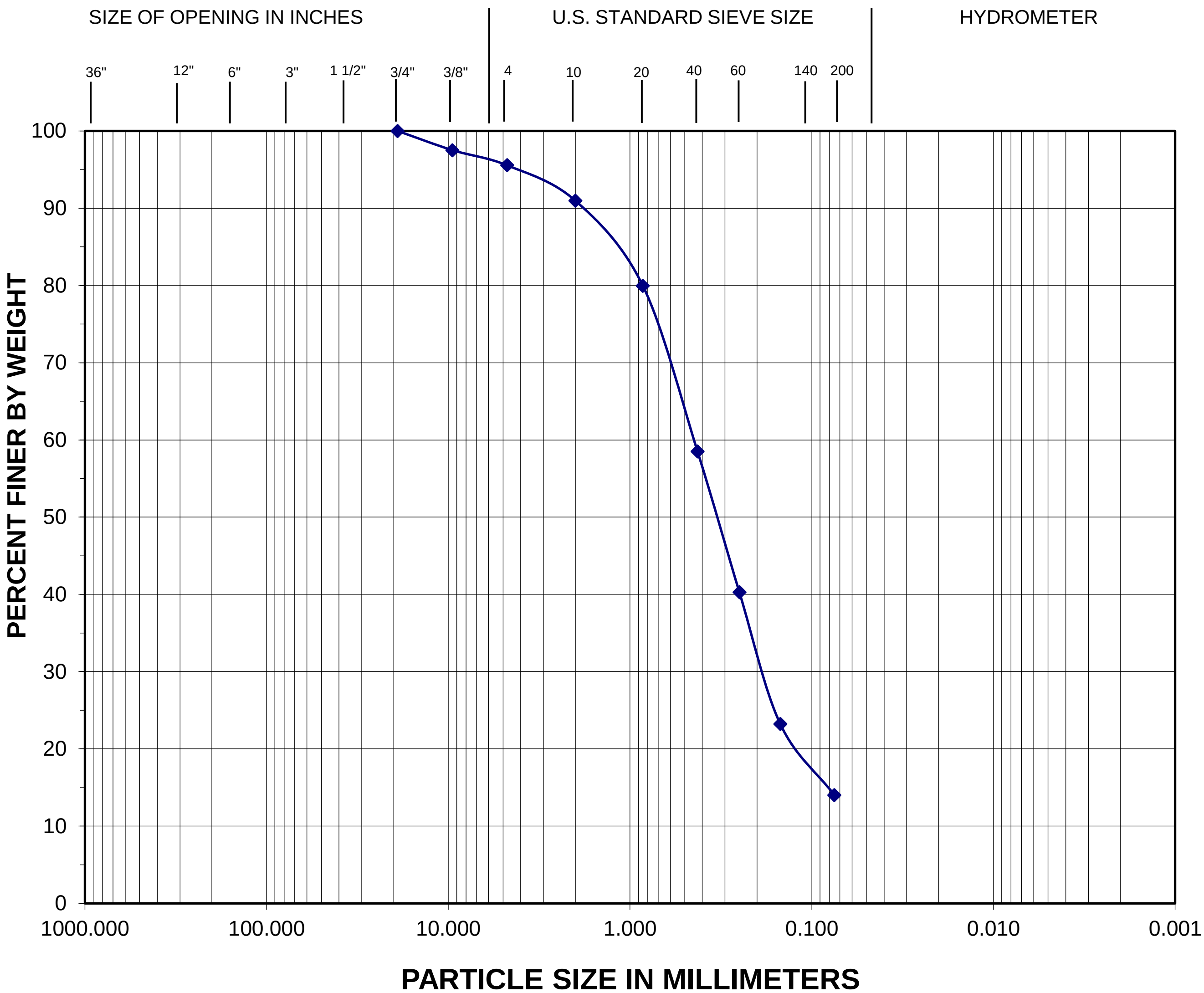
Exploration	Sample	Depth (feet)	Moisture (%)	Fines (%)	Description
TP-2	S-3	3	5.4	1.7	SAND, with gravel, trace silt

Zipper Geo Associates, LLC Geotechnical and Environmental Consultants	PROJECT NO: 2679.01A DATE OF TESTING: 5/5/2023	PROJECT NAME: Special Use Permit

GRAIN SIZE ANALYSIS

Test Results Summary

ASTM D6913



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

Comments:

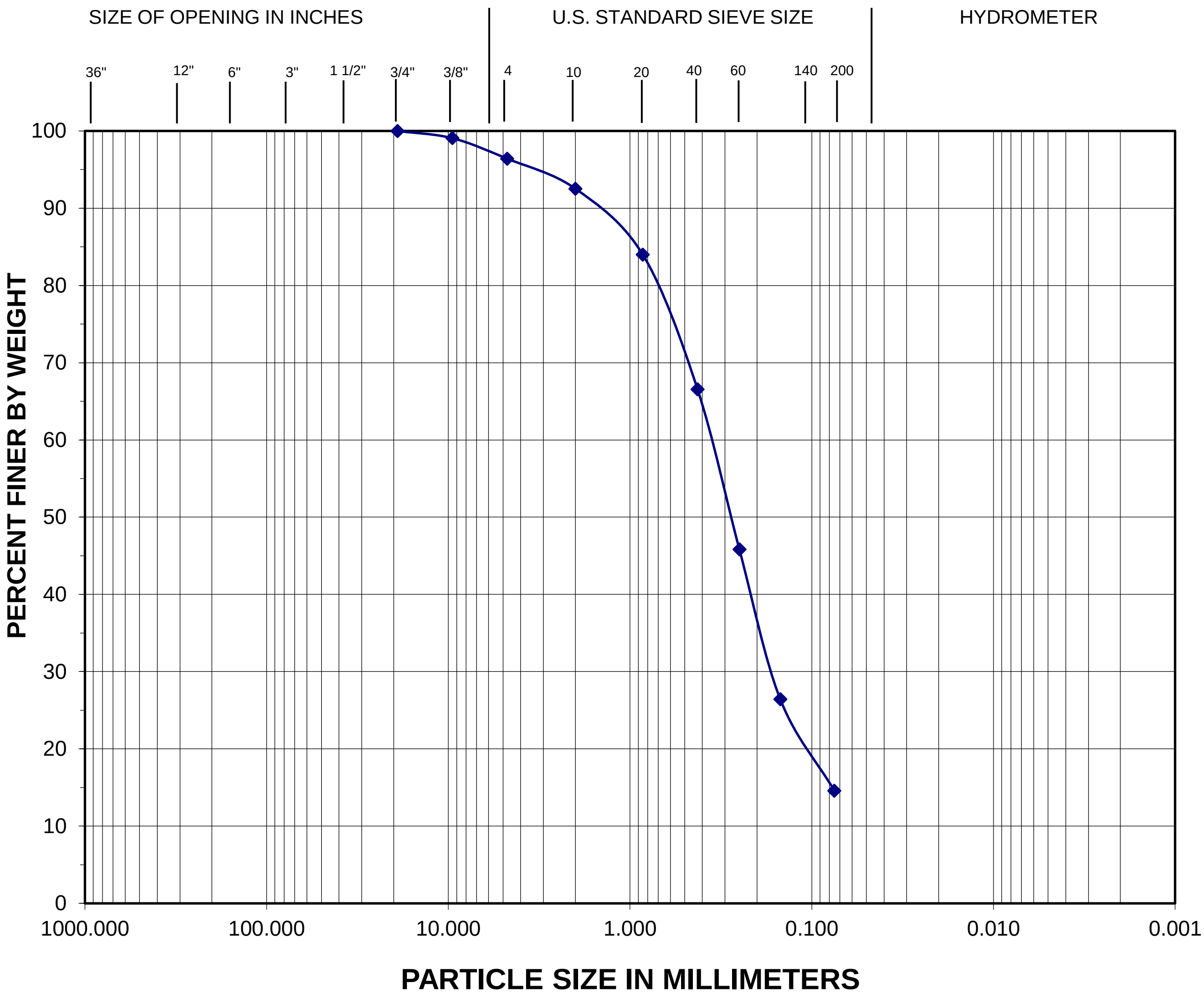
Exploration	Sample	Depth (feet)	Moisture (%)	Fines (%)	Description
TP-4	S-2	1.5	16.2	14.0	SAND with silt, trace gravel

Zipper Geo Associates, LLC Geotechnical and Environmental Consultants	PROJECT NO: 2679.01 DATE OF TESTING: 5/22/2023	PROJECT NAME: Special Use Permit

GRAIN SIZE ANALYSIS

Test Results Summary

ASTM D6913



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

Comments:

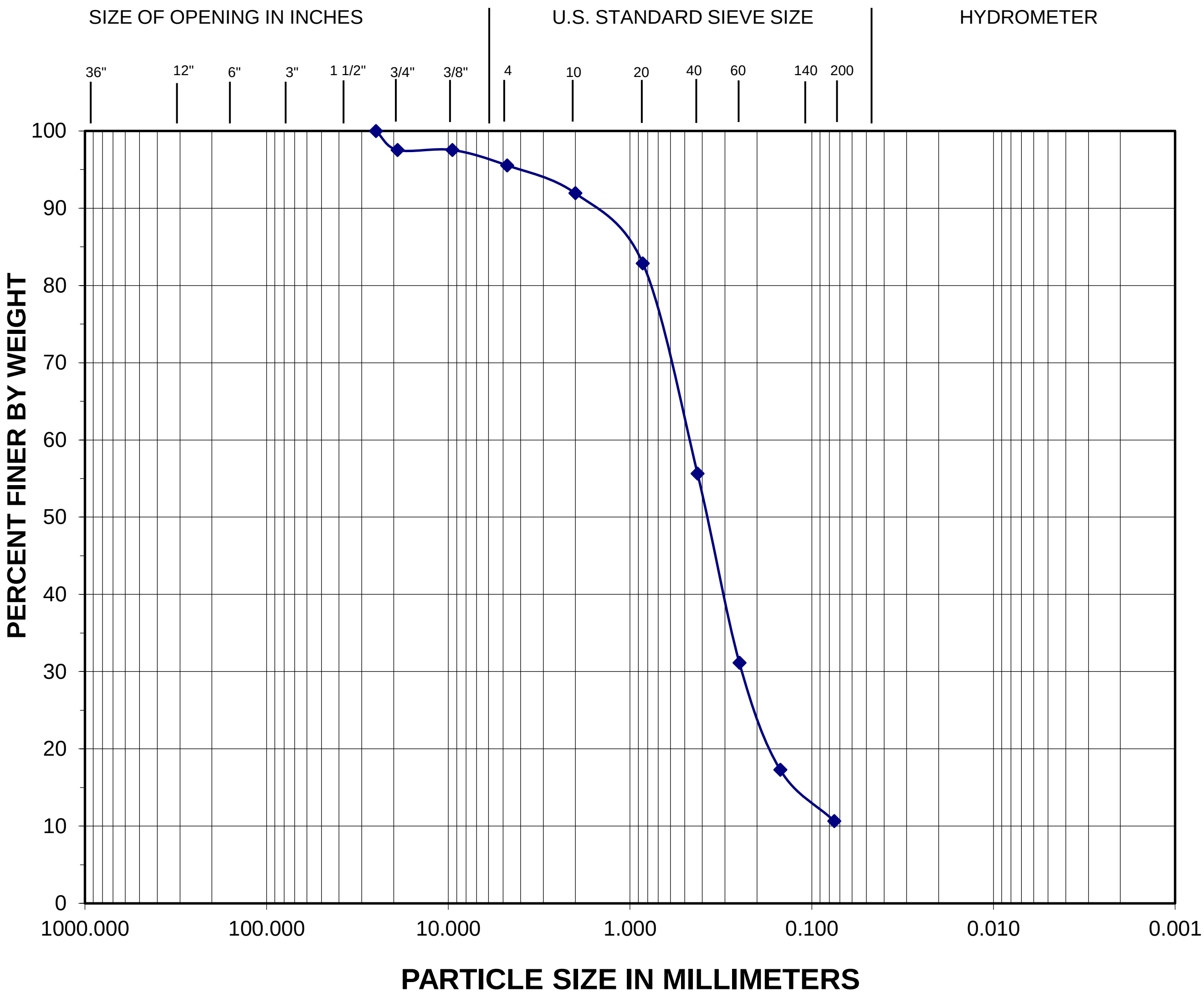
Exploration	Sample	Depth (feet)	Moisture (%)	Fines (%)	Description
TP-5	S-2	2.5	16.7	14.6	SAND with silt, trace gravel

Zipper Geo Associates, LLC Geotechnical and Environmental Consultants	PROJECT NO: 2679.01 DATE OF TESTING: 5/22/2023	PROJECT NAME: Special Use Permit

GRAIN SIZE ANALYSIS

Test Results Summary

ASTM D6913



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

Comments:

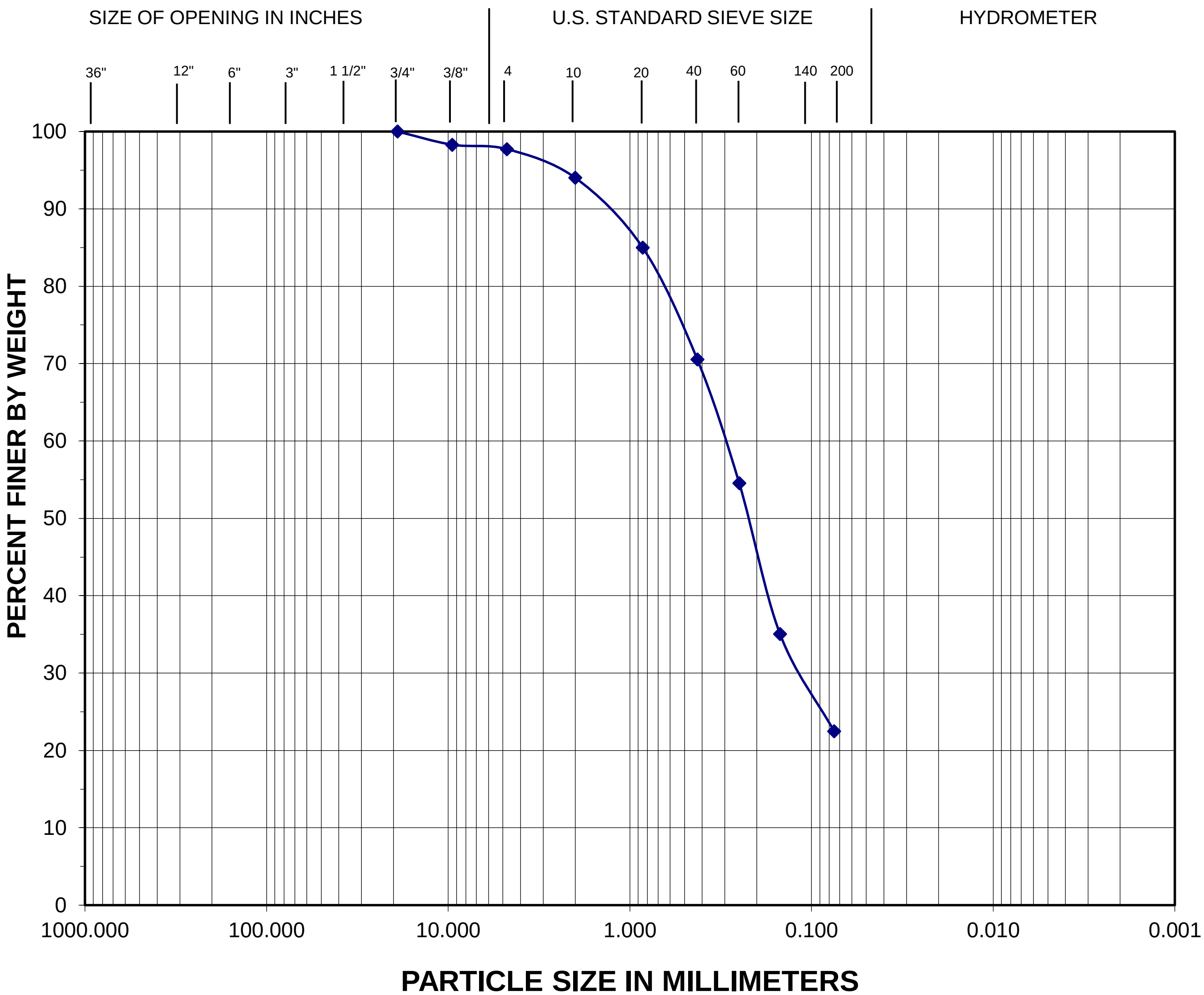
Exploration	Sample	Depth (feet)	Moisture (%)	Fines (%)	Description
TP-6	S-2	2.5	14.9	10.6	SAND, some silt, trace gravel

Zipper Geo Associates, LLC Geotechnical and Environmental Consultants	PROJECT NO: 2679.01A DATE OF TESTING: 5/5/2023	PROJECT NAME: Special Use Permit

GRAIN SIZE ANALYSIS

Test Results Summary

ASTM D6913



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

Comments:

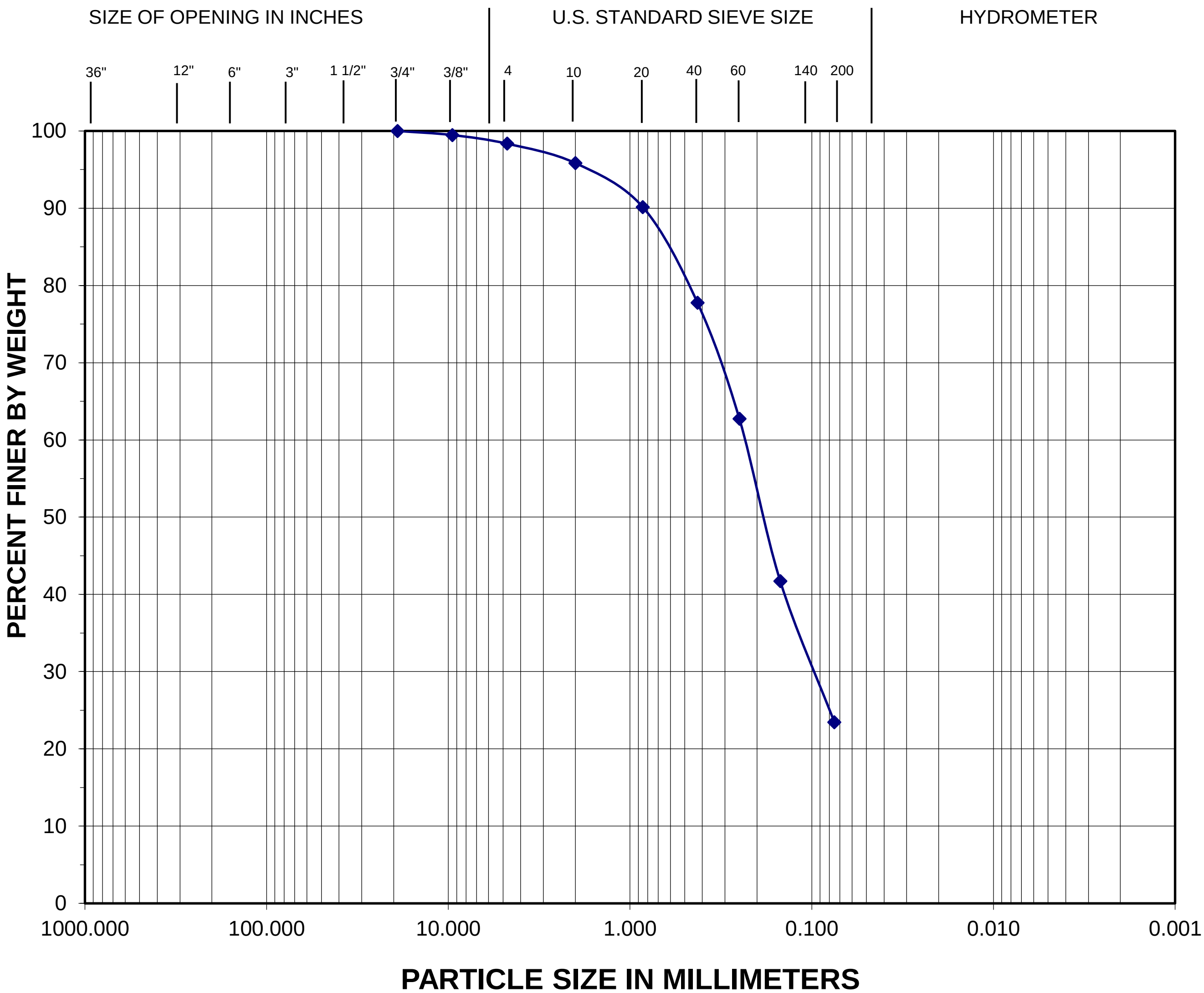
Exploration	Sample	Depth (feet)	Moisture (%)	Fines (%)	Description
TP-7	S-2	3	23.6	22.5	SAND, with silt, trace gravel

Zipper Geo Associates, LLC Geotechnical and Environmental Consultants	PROJECT NO: 2679.01A DATE OF TESTING: 5/5/2023	PROJECT NAME: Special Use Permit

GRAIN SIZE ANALYSIS

Test Results Summary

ASTM D6913



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

Comments:

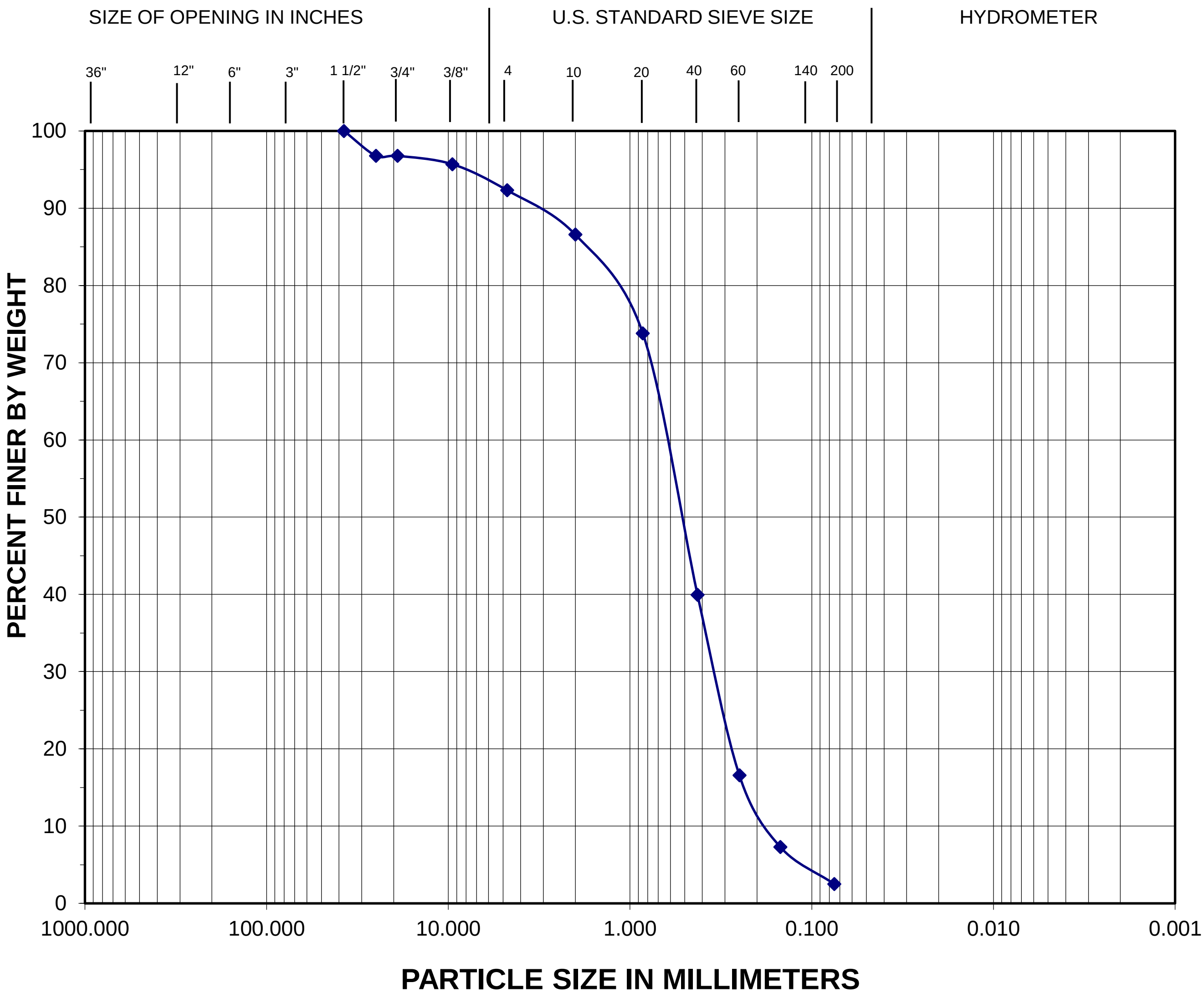
Exploration	Sample	Depth (feet)	Moisture (%)	Fines (%)	Description
TP-8	S-2	2	20.1	23.4	SAND, with silt, trace gravel

Zipper Geo Associates, LLC Geotechnical and Environmental Consultants	PROJECT NO: 2679.01A DATE OF TESTING: 5/5/2023	PROJECT NAME: Special Use Permit

GRAIN SIZE ANALYSIS

Test Results Summary

ASTM D6913



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

Comments:

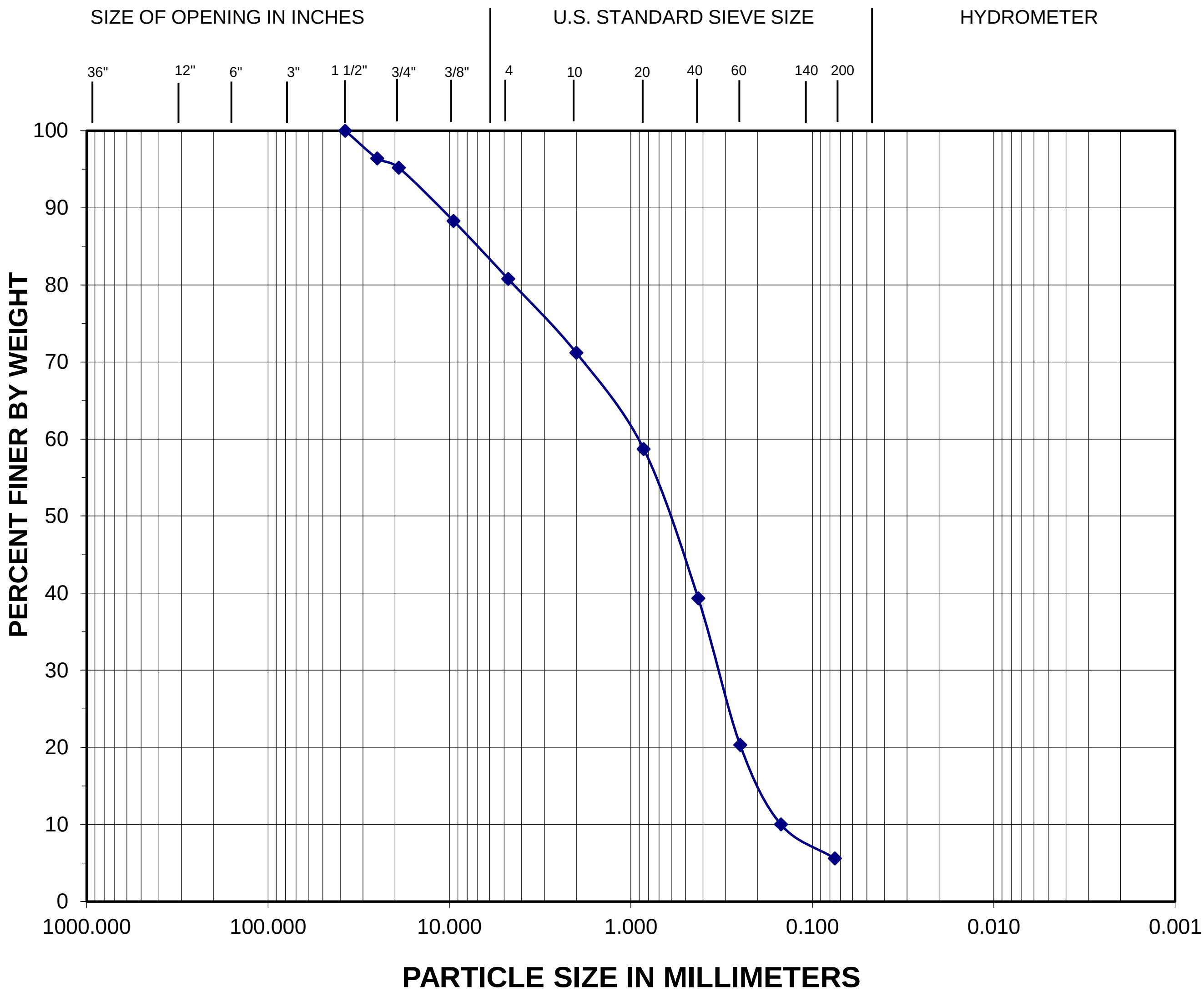
Exploration	Sample	Depth (feet)	Moisture (%)	Fines (%)	Description
TP-8	S-3	3	6.8	2.5	SAND, some gravel, trace silt

Zipper Geo Associates, LLC Geotechnical and Environmental Consultants	PROJECT NO: 2679.01A DATE OF TESTING: 5/5/2023	PROJECT NAME: Special Use Permit

GRAIN SIZE ANALYSIS

Test Results Summary

ASTM D6913



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

Comments:

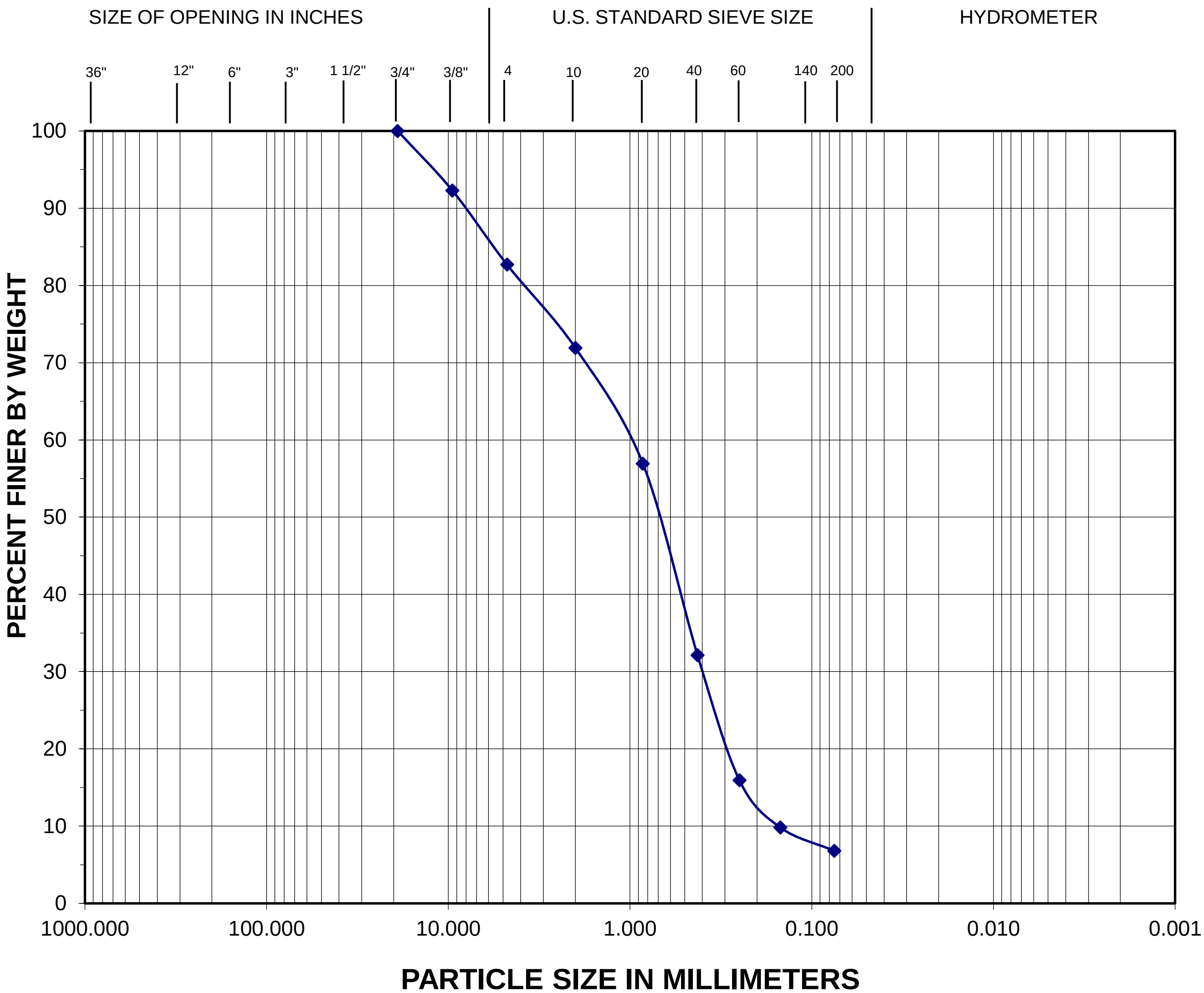
Exploration	Sample	Depth (feet)	Moisture (%)	Fines (%)	Description
TP-9	S-2	3	8.2	5.6	SAND with gravel,some silt

Zipper Geo Associates, LLC Geotechnical and Environmental Consultants	PROJECT NO: 2679.01 DATE OF TESTING: 5/22/2023	PROJECT NAME: Special Use Permit

GRAIN SIZE ANALYSIS

Test Results Summary

ASTM D6913



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

Comments:

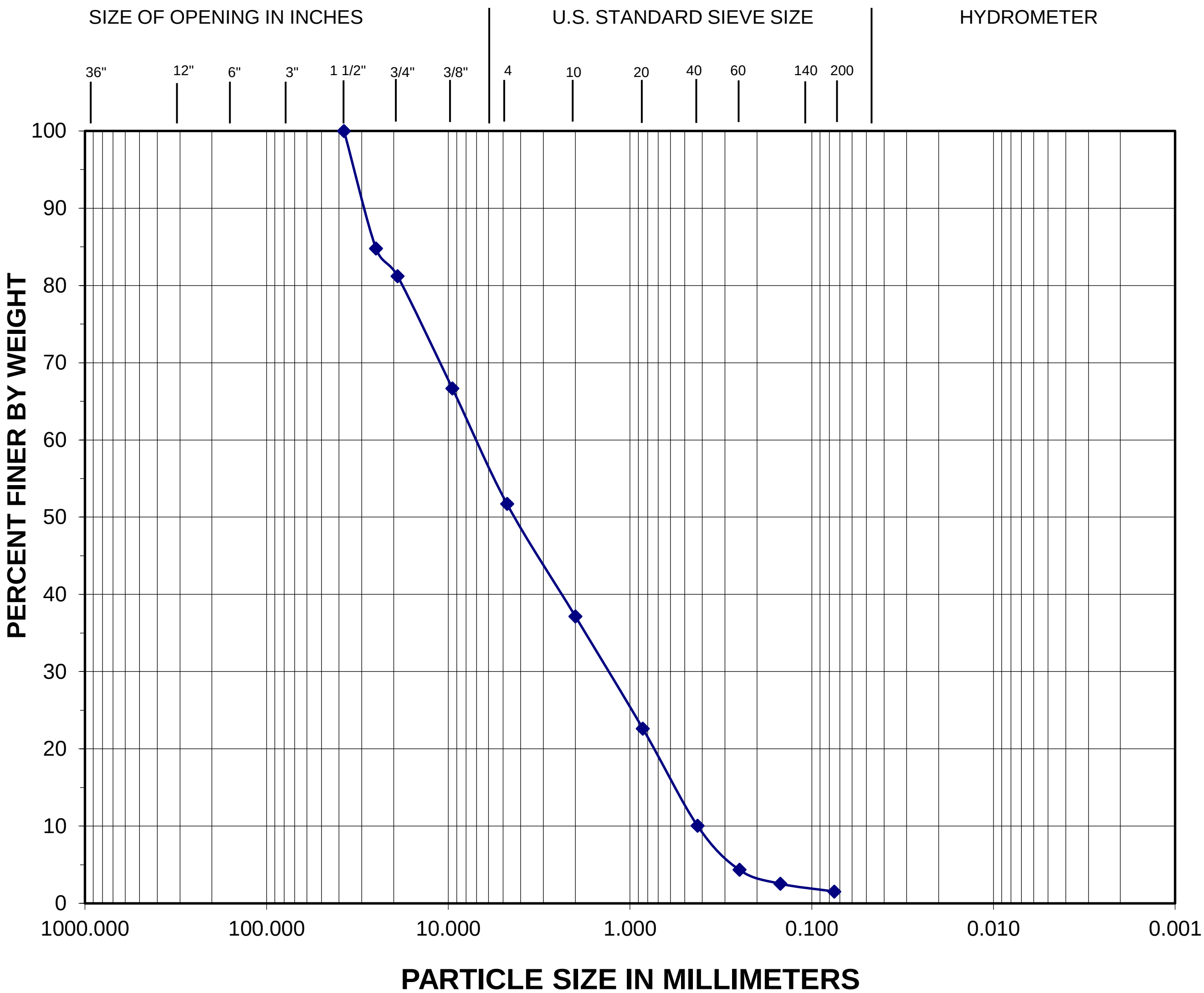
Exploration	Sample	Depth (feet)	Moisture (%)	Fines (%)	Description
TP-10	S-2	2.5	9.3	6.8	SAND, with gravel, some silt

Zipper Geo Associates, LLC Geotechnical and Environmental Consultants	PROJECT NO: 2679.01A DATE OF TESTING: 5/5/2023	PROJECT NAME: Special Use Permit

GRAIN SIZE ANALYSIS

Test Results Summary

ASTM D6913



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

Comments:

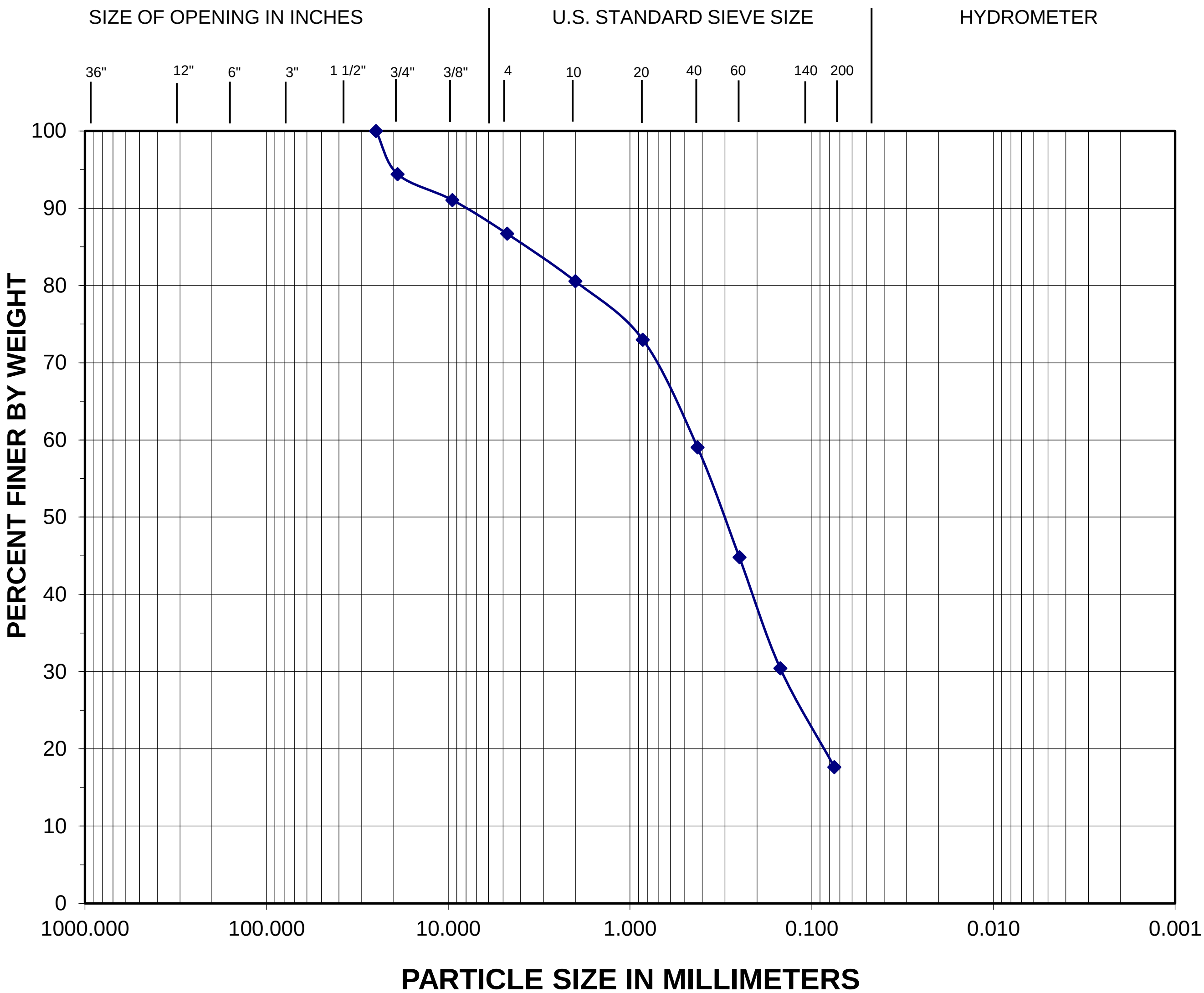
Exploration	Sample	Depth (feet)	Moisture (%)	Fines (%)	Description
TP-10	S-3	5	8.2	1.5	Gravelly SAND, trace silt

Zipper Geo Associates, LLC Geotechnical and Environmental Consultants	PROJECT NO: 2679.01A DATE OF TESTING: 5/5/2023	PROJECT NAME: Special Use Permit

GRAIN SIZE ANALYSIS

Test Results Summary

ASTM D6913



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

Comments:

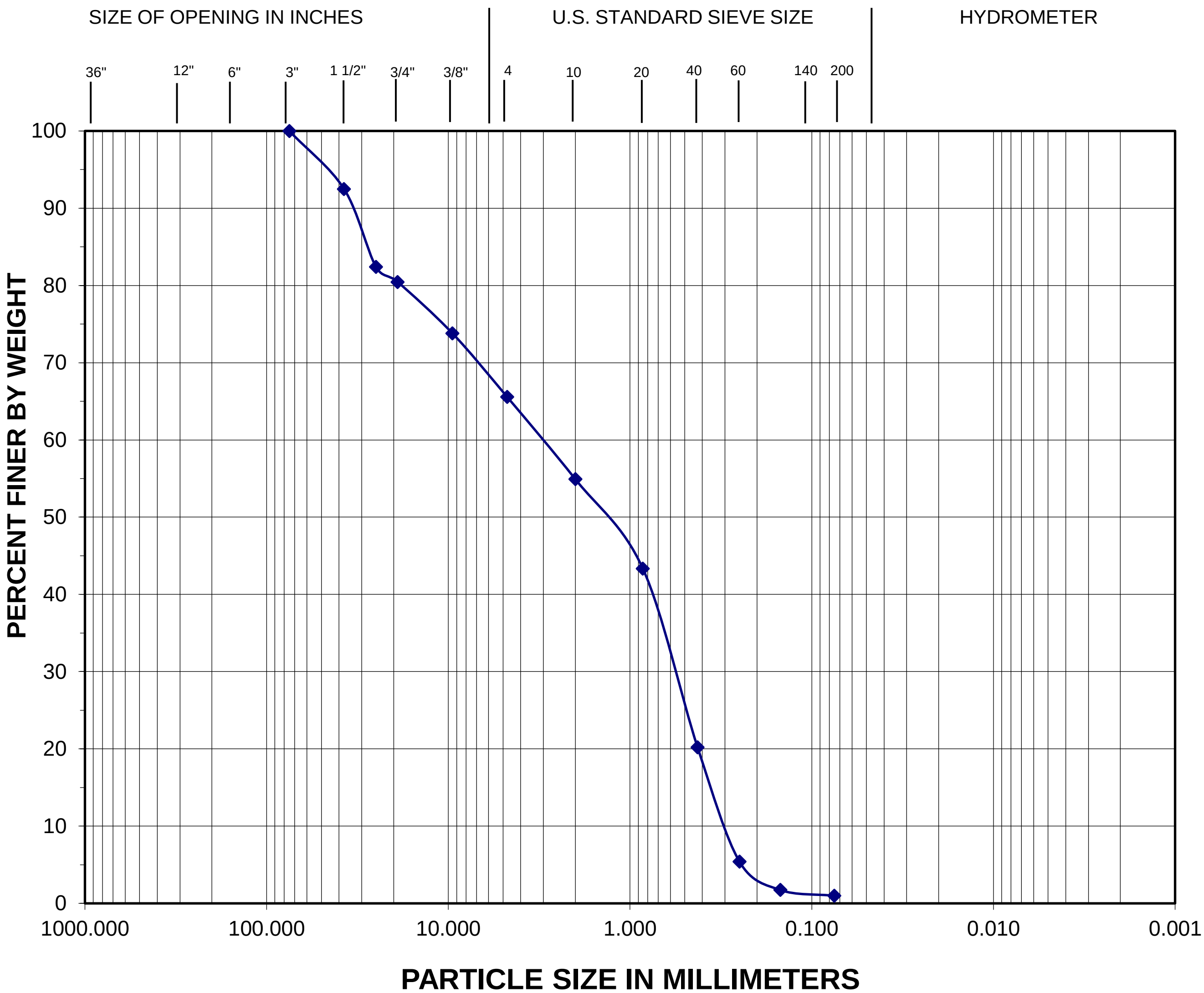
Exploration	Sample	Depth (feet)	Moisture (%)	Fines (%)	Description
TP-11	S-1	0.5	17.6	17.6	SAND, with silt and gravel

Zipper Geo Associates, LLC Geotechnical and Environmental Consultants	PROJECT NO: 2679.01A DATE OF TESTING: 5/5/2023	PROJECT NAME: Special Use Permit

GRAIN SIZE ANALYSIS

Test Results Summary

ASTM D6913



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

Comments:

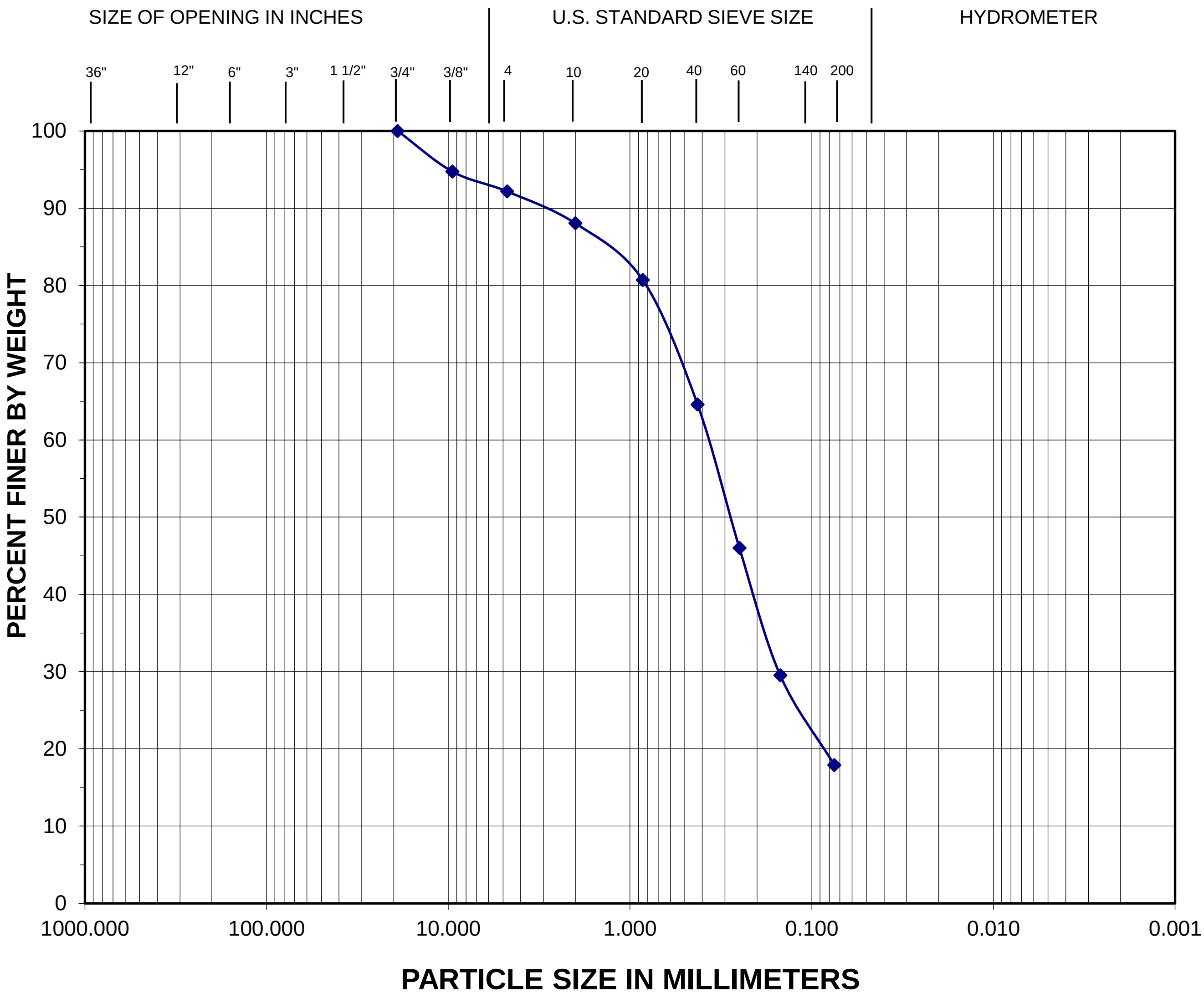
Exploration	Sample	Depth (feet)	Moisture (%)	Fines (%)	Description
TP-11	S-3	8	10.3	1.0	Gravelly SAND, trace silt

Zipper Geo Associates, LLC Geotechnical and Environmental Consultants	PROJECT NO: 2679.01A DATE OF TESTING: 5/5/2023	PROJECT NAME: Special Use Permit

GRAIN SIZE ANALYSIS

Test Results Summary

ASTM D6913



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

Comments:

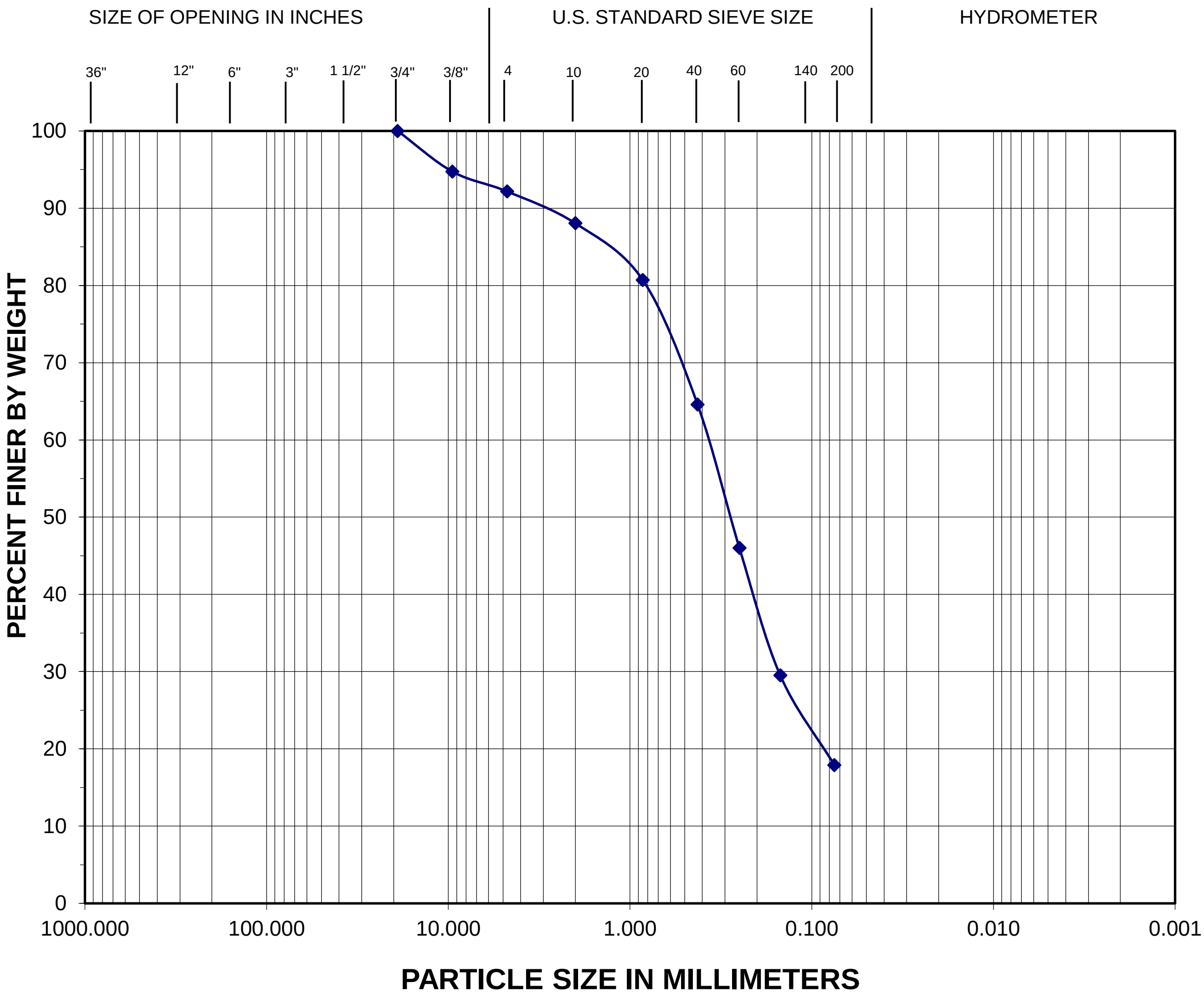
Exploration	Sample	Depth (feet)	Moisture (%)	Fines (%)	Description
HA-1	S-2	1.5	30.0	17.9	SAND with silt, some gravel

Zipper Geo Associates, LLC Geotechnical and Environmental Consultants	PROJECT NO: 2679.01A DATE OF TESTING: 5/5/2023	PROJECT NAME: Special Use Permit

GRAIN SIZE ANALYSIS

Test Results Summary

ASTM D6913



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

Comments:

Exploration	Sample	Depth (feet)	Moisture (%)	Fines (%)	Description
HA-1	S-2	1.5	30.0	17.9	SAND with silt, some gravel

Zipper Geo Associates, LLC Geotechnical and Environmental Consultants	PROJECT NO: 2679.01A DATE OF TESTING: 5/5/2023	PROJECT NAME: Special Use Permit

Krazan & ASSOCIATES, INC.

GEOTECHNICAL ENGINEERING • ENVIRONMENTAL ENGINEERING
CONSTRUCTION TESTING & INSPECTION

May 10, 2023

KA No. 096-23255
Lab Report No. 01

Mr. David Williams(E-Mail)
ZIPPER GEO ASSOCIATES LLC
19019 36th Avenue W, Suite E
Lynnwood, WA 98036

RE: SOILS LABORATORY TESTING
Crosswind
4303 198th Street SW
Lynnwood, Washington

Dear Mr. Williams,

In accordance with your request and authorization, we have performed laboratory tests for the above referenced project.

Laboratory testing was performed in accordance with ASTM standards. The results of the laboratory tests are presented on the following pages. If you have any questions; or if we can be of further assistance, please do not hesitate to contact our office.

Sample ID No:	82504-A	82504-B	82504-C	82504-D	82504-E
Test Date:	**5/8/2023**				
Sample Location:	**Substation: 2679.01**				
	TP-A-1 / S-2	**TP-8 / S-2**	**TP-10 / S-2**	**TP-7 / S-2**	**TP-11 / S-1**
Organic Content:	**5.6%**	**3.4%**	**1.6%**	**6.7%**	**4.7%**
Moisture, Ash, and Organic Matter of Peat and Other Organic Soils (ASTM D2974)					

Respectfully submitted,
KRAZAN & ASSOCIATES, INC.

Jeffrey S. Mercer
Operations Manager
Pacific Northwest Division

JSM/lkj

AMTEST LABORATORIES

AmTest Chain of Custody Record

13600 NE 126th PL, Suite C, Kirkland, WA 98034
Ph (425) 885-1664 Fx (425) 820-0245
www.amtestlab.com

Chain of Custody No. 5000

Client Name & Address: Zipper Geo Associates, 19019 36th Avenue W, Suite E, Lynnwood, WA 98036	Invoice To: Zipper Geo Associates, 19019 36th Avenue W, Suite E, Lynnwood WA 98036
Contact Person: David Williams	Invoice Contact: David Williams
Phone No: 425-218-4619	PO Number: 425-218-4619
Fax No:	Invoice Ph/Fax:
E-mail: dwilliams@zippergeo.com	Invoice E-mail: dwilliams@zippergeo.com
Report Delivery: (Choose all that apply) Mail / Fax / Email / Posted Online	Data posted to online account: YES / NO Web Login ID:

Special Instructions:

Requested TAT: **(Rush must be pre-approved by lab)** Standard RUSH (5 Day / 3 Day / 48 HR / 24 HR)

Temperature upon Receipt: 3.2°C

Project Name: Crosswind Substation

Project Number: 2679.01

AmTest ID	Client ID (35 characters max)	Date Sampled	Time Sampled	Matrix	No. of containers	CEC									QA/QC
7661	TP-7, S-2	4/24/23			1	X									
7662	TP-8, S-2	4/24/23			1	X									
7663	TP-10, S-2	4/24/23			1	X									
7664	TP-11, S-1	4/24/23			1	X									
7665	HA-1, S-2	4/25/23			1	X									

Analysis Requested: CEC

Collected/Relinquished By:	Date	Time	Received By:	Date	Time
D Williams	4.28.23	4:30 PM	KH	4/28/23	1630
Relinquished By:	Date	Time	Received By:	Date	Time
Relinquished By:	Date	Time	Received By:	Date	Time

COMMENTS:

Am Test Inc.
13600 NE 126TH PL
Suite C
Kirkland, WA 98034
(425) 885-1664
www.amtestlab.com

Professional Analytical Services

ANALYSIS REPORT

ZIPPER GEO ASSOCIATES, LLC
19019 36TH AVENUE W
LYNNWOOD, WA 98036
Attention: DAVID WILLIAMS
Project Name: CROSSWIND SUBSTATION
Project #: 2679.01
All results reported on an as received basis.

Date Received: 04/28/23
Date Reported: 5/ 9/23

AMTEST Identification Number **23-A007661**
Client Identification **TP-7,S-2**
Sampling Date **04/24/23**

Conventionals

PARAMETER	RESULT	UNITS	Q	D.L.	METHOD	ANALYST	DATE
Cation Exchange Capacity	12.	meq/100g		0.5	SW-846 9081	CM	05/03/23

AMTEST Identification Number **23-A007662**
Client Identification **TP-8,S-2**
Sampling Date **04/24/23**

Conventionals

PARAMETER	RESULT	UNITS	Q	D.L.	METHOD	ANALYST	DATE
Cation Exchange Capacity	5.2	meq/100g		0.5	SW-846 9081	CM	05/03/23

AMTEST Identification Number 23-A007663
Client Identification TP-10,S-2
Sampling Date 04/24/23

Conventionals

PARAMETER	RESULT	UNITS	Q	D.L.	METHOD	ANALYST	DATE
Cation Exchange Capacity	3.3	meq/100g		0.5	SW-846 9081	CM	05/03/23

AMTEST Identification Number 23-A007664
Client Identification TP-11,S-1
Sampling Date 04/24/23

Conventionals

PARAMETER	RESULT	UNITS	Q	D.L.	METHOD	ANALYST	DATE
Cation Exchange Capacity	6.2	meq/100g		0.5	SW-846 9081	CM	05/03/23

AMTEST Identification Number 23-A007665
Client Identification HA-1,S-2
Sampling Date 04/24/23

Conventionals

PARAMETER	RESULT	UNITS	Q	D.L.	METHOD	ANALYST	DATE
Cation Exchange Capacity	6.7	meq/100g		0.5	SW-846 9081	CM	05/03/23

Kathy Fugiel
President

Am Test Inc.
13600 NE 126th PL
Suite C
Kirkland, WA, 98034
(425) 885-1664
www.amtestlab.com

Professional Analytical Services

QC Summary for sample numbers: 23-A007661 to 23-A007665

DUPLICATES

SAMPLE #	ANALYTE	UNITS	SAMPLE VALUE	DUP VALUE	RPD
23-A007665	Cation Exchange Capacity	meq/100g	6.7	7.0	4.4

STANDARD REFERENCE MATERIALS

ANALYTE	UNITS	TRUE VALUE	MEASURED VALUE	RECOVERY
Cation Exchange Capacity	meq/100g	2.0	2.0	100. %

BLANKS

ANALYTE	UNITS	RESULT
Cation Exchange Capacity	meq/100g	< 0.2

April 28, 2023

NVL
INDUSTRIAL HYGIENE SERVICES
LABORATORY + MANAGEMENT + TRAINING

Justin Brooks
Zipper Geo Associates, LLC
19019 36th Avenue West, Suite E
Lynnwood, WA 98036

RE: Bulk Asbestos Fiber Analysis; NVL Batch # 2306722.00

Client Project: 2679 Crosswind SubStation
Location: Arlington

Dear Mr. Brooks,

Enclosed please find test results for the 12 sample(s) submitted to our laboratory for analysis on 4/26/2023.

Examination of these samples was conducted for the presence of identifiable asbestos fibers using polarized light microscopy (PLM) with dispersion staining in accordance with **U. S. EPA 40 CFR Appendix E to Subpart E of Part 763**, Interim Method for the Determination of Asbestos in Bulk Insulation Samples and **EPA 600/R-93/116**, Method for the Determination of Asbestos in Bulk Building Materials.

For samples containing more than one separable layer of materials, the report will include findings for each layer (labeled Layer 1 and Layer 2, etc. for each individual layer). The asbestos concentration in the sample is determined by calibrated visual estimation.

For those samples with asbestos concentrations between 1 and 10 percent based on visual estimation, the EPA recommends a procedure known as point counting (NESHAPS, 40 CFR Part 61). Point counting is a statistically more accurate means of quantification for samples with low concentrations of asbestos.

The detection limit for the calibrated visual estimation is <1%, 400 point counts is 0.25% and 1000 point counts is 0.1%

Samples are archived for two weeks following analysis. Samples that are not retrieved by the client are discarded after two weeks.

Thank you for using our laboratory services. Please do not hesitate to call if there is anything further we can assist you with.

Sincerely,

Nick Ly, Technical Director

NVLAP
Testing
Lab Code: 102063-0

Enc.: Sample Results

Bulk Asbestos Fibers Analysis

By Polarized Light Microscopy

Client: Zipper Geo Associates, LLC
Address: 19019 36th Avenue West, Suite E
Lynnwood, WA 98036

Attention: Mr. Justin Brooks
Project Location: Arlington

Batch #: 2306722.00
Client Project #: 2679 Crosswind SubStation
Date Received: 4/26/2023
Samples Received: 12
Samples Analyzed: 12
Method: EPA/600/R-93/116

Lab ID: 23041630 **Client Sample #: TP.1**

Location: Arlington

Comments: Qualitative analysis was conducted for the presence of asbestos fibers in this sample.

Layer 1 of 1 **Description:** Loose brown crumbly material with debris

Non-Fibrous Materials:	Other Fibrous Materials:%	**Asbestos Type: %**
Binder/Filler, Fine particles, Fine grains	Cellulose	**None Detected ND**
Mineral grains, Organic debris		

Lab ID: 23041631 **Client Sample #: TP.2**

Location: Arlington

Comments: Qualitative analysis was conducted for the presence of asbestos fibers in this sample.

Layer 1 of 1 **Description:** Loose tan crumbly material with debris

Non-Fibrous Materials:	Other Fibrous Materials:%	**Asbestos Type: %**
Binder/Filler, Fine grains, Fine particles	Cellulose	**None Detected ND**
Mineral grains, Organic debris		

Lab ID: 23041632 **Client Sample #: TP.3**

Location: Arlington

Comments: Qualitative analysis was conducted for the presence of asbestos fibers in this sample.

Layer 1 of 1 **Description:** Loose brown crumbly material with debris

Non-Fibrous Materials:	Other Fibrous Materials:%	**Asbestos Type: %**
Binder/Filler, Mineral grains, Fine particles	Cellulose	**None Detected ND**
Fine grains, Organic debris	Wood fibers	

Lab ID: 23041633 **Client Sample #: TP.4**

Location: Arlington

Comments: Qualitative analysis was conducted for the presence of asbestos fibers in this sample.

Sampled by: Client
Analyzed by: Hilary Crumley **Date:** 04/28/2023
Reviewed by: Nick Ly **Date:** 04/28/2023

Nick Ly, Technical Director

Note: If samples are not homogeneous, then subsamples of the components were analyzed separately. All bulk samples are analyzed using both EPA 600/R-93/116 and EPA 40 CFR Appendix E to Subpart E of Part 763 with the following measurement uncertainties for the reported % Asbestos (1%=0-3%, 5%=1-9%, 10%=5-15%, 20%=10-30%, 50%=40-60%). This report relates only to the items tested. If sample was not collected by NVL personnel, then the accuracy of the results is limited by the methodology and acuity of the sample collector. This report shall not be reproduced except in full, without written approval of NVL Laboratories, Inc. It shall not be used to claim product endorsement by NVLAP or any other agency of the US Government

Bulk Asbestos Fibers Analysis

By Polarized Light Microscopy

Client: Zipper Geo Associates, LLC
Address: 19019 36th Avenue West, Suite E
Lynnwood, WA 98036

Attention: Mr. Justin Brooks
Project Location: Arlington

Batch #: 2306722.00
Client Project #: 2679 Crosswind SubStation
Date Received: 4/26/2023
Samples Received: 12
Samples Analyzed: 12
Method: EPA/600/R-93/116

Layer 1 of 1 **Description:** Loose brown crumbly material with debris

Non-Fibrous Materials:	Other Fibrous Materials:%	**Asbestos Type: %**
Binder/Filler, Fine particles, Mineral grains	Wood fibers	**None Detected ND**
Fine grains, Organic debris	Cellulose	

Lab ID: 23041634 **Client Sample #: TP.5**

Location: Arlington

Comments: Qualitative analysis was conducted for the presence of asbestos fibers in this sample.

Layer 1 of 1 **Description:** Loose dark brown crumbly material with debris

Non-Fibrous Materials:	Other Fibrous Materials:%	**Asbestos Type: %**
Binder/Filler, Fine grains, Mineral grains	Cellulose	**None Detected ND**
Fine particles, Organic debris		

Lab ID: 23041635 **Client Sample #: TP.6**

Location: Arlington

Comments: Qualitative analysis was conducted for the presence of asbestos fibers in this sample.

Layer 1 of 1 **Description:** Loose brown crumbly material with debris

Non-Fibrous Materials:	Other Fibrous Materials:%	**Asbestos Type: %**
Binder/Filler, Mineral grains, Fine grains	Cellulose	**None Detected ND**
Fine particles, Organic debris		

Lab ID: 23041636 **Client Sample #: TP.7**

Location: Arlington

Comments: Qualitative analysis was conducted for the presence of asbestos fibers in this sample.

Layer 1 of 1 **Description:** Loose dark brown crumbly material with debris

Non-Fibrous Materials:	Other Fibrous Materials:%	**Asbestos Type: %**
Binder/Filler, Fine particles, Fine grains	Cellulose	**None Detected ND**
Mineral grains, Organic debris	Wood fibers	

Sampled by: Client
Analyzed by: Hilary Crumley **Date:** 04/28/2023
Reviewed by: Nick Ly **Date:** 04/28/2023

Nick Ly, Technical Director

Bulk Asbestos Fibers Analysis

By Polarized Light Microscopy

Client: Zipper Geo Associates, LLC
Address: 19019 36th Avenue West, Suite E
Lynnwood, WA 98036

Attention: Mr. Justin Brooks
Project Location: Arlington

Batch #: 2306722.00
Client Project #: 2679 Crosswind SubStation
Date Received: 4/26/2023
Samples Received: 12
Samples Analyzed: 12
Method: EPA/600/R-93/116

Lab ID: 23041637 **Client Sample #: TP.8**

Location: Arlington

Comments: Qualitative analysis was conducted for the presence of asbestos fibers in this sample.

Layer 1 of 1 **Description:** Loose brown crumbly material with debris

Non-Fibrous Materials:	Other Fibrous Materials:%	**Asbestos Type: %**
Binder/Filler, Fine grains, Fine particles Mineral grains, Organic debris	Cellulose	**None Detected ND**

Lab ID: 23041638 **Client Sample #: TP.9**

Location: Arlington

Comments: Qualitative analysis was conducted for the presence of asbestos fibers in this sample.

Layer 1 of 1 **Description:** Loose tan crumbly material with debris

Non-Fibrous Materials:	Other Fibrous Materials:%	**Asbestos Type: %**
Binder/Filler, Fine grains, Mineral grains Fine particles, Debris	Cellulose	**None Detected ND**

Lab ID: 23041639 **Client Sample #: TP.10**

Location: Arlington

Comments: Qualitative analysis was conducted for the presence of asbestos fibers in this sample.

Layer 1 of 1 **Description:** Loose brown crumbly material with debris

Non-Fibrous Materials:	Other Fibrous Materials:%	**Asbestos Type: %**
Binder/Filler, Mineral grains, Fine grains Fine particles, Organic debris	Cellulose	**None Detected ND**

Lab ID: 23041640 **Client Sample #: TP.11**

Location: Arlington

Comments: Qualitative analysis was conducted for the presence of asbestos fibers in this sample.

Sampled by: Client
Analyzed by: Hilary Crumley **Date:** 04/28/2023
Reviewed by: Nick Ly **Date:** 04/28/2023

Nick Ly, Technical Director

Note: If samples are not homogeneous, then subsamples of the components were analyzed separately. All bulk samples are analyzed using both EPA 600/R-93/116 and EPA 40 CFR Appendix E to Subpart E of Part 763 with the following measurement uncertainties for the reported % Asbestos (1%=0-3%, 5%=1-9%, 10%=5-15%, 20%=10-30%, 50%=40-60%). This report relates only to the items tested. If sample was not collected by NVL personnel, then the accuracy of the results is limited by the methodology and acuity of the sample collector. This report shall not be reproduced except in full, without written approval of NVL Laboratories, Inc. It shall not be used to claim product endorsement by NVLAP or any other agency of the US Government

Bulk Asbestos Fibers Analysis

By Polarized Light Microscopy

Client: Zipper Geo Associates, LLC
Address: 19019 36th Avenue West, Suite E
Lynnwood, WA 98036

Attention: Mr. Justin Brooks
Project Location: Arlington

Batch #: 2306722.00
Client Project #: 2679 Crosswind SubStation
Date Received: 4/26/2023
Samples Received: 12
Samples Analyzed: 12
Method: EPA/600/R-93/116

Layer 1 of 1 **Description:** Loose brown crumbly material with debris

Non-Fibrous Materials:	Other Fibrous Materials:%	**Asbestos Type: %**
Binder/Filler, Fine particles, Fine grains	Cellulose	**None Detected ND**
Mineral grains, Organic debris		

Lab ID: 23041641 **Client Sample #: HA.1**

Location: Arlington

Comments: Qualitative analysis was conducted for the presence of asbestos fibers in this sample.

Layer 1 of 1 **Description:** Loose tan crumbly material with debris

Non-Fibrous Materials:	Other Fibrous Materials:%	**Asbestos Type: %**
Binder/Filler, Mineral grains, Fine particles	Cellulose	**None Detected ND**
Fine grains, Organic debris		

Sampled by: Client
Analyzed by: Hilary Crumley **Date:** 04/28/2023
Reviewed by: Nick Ly **Date:** 04/28/2023

Nick Ly, Technical Director

Note: If samples are not homogeneous, then subsamples of the components were analyzed separately. All bulk samples are analyzed using both EPA 600/R-93/116 and EPA 40 CFR Appendix E to Subpart E of Part 763 with the following measurement uncertainties for the reported % Asbestos (1%=0-3%, 5%=1-9%, 10%=5-15%, 20%=10-30%, 50%=40-60%). This report relates only to the items tested. If sample was not collected by NVL personnel, then the accuracy of the results is limited by the methodology and acuity of the sample collector.

ASBESTOS LABORATORY SERVICES

Company	Zipper Geo Associates, LLC	**NVL Batch Number**	**2306722.00**
Address	19019 36th Avenue West, Suite E Lynnwood, WA 98036	**TAT**	3 Days **AH** No
		Rush TAT	
Project Manager	Mr. Justin Brooks	**Due Date**	5/1/2023 **Time** 9:00 AM
Phone	(425) 582-9928	**Email**	jbrooks@zippergeo.com
Cell	(813) 205-3481	**Fax**	(425) 582-9930

Project Name/Number: 2679 Crosswind SubStation **Project Location:** Arlington

Subcategory PLM Bulk

Item Code ASB-02 EPA 600/R-93-116 Asbestos by PLM <bulk>

Total Number of Samples 12 Rush Samples

	Lab ID	Sample ID	Description	A/R
1	23041630	TP.1		A
2	23041631	TP.2		A
3	23041632	TP.3		A
4	23041633	TP.4		A
5	23041634	TP.5		A
6	23041635	TP.6		A
7	23041636	TP.7		A
8	23041637	TP.8		A
9	23041638	TP.9		A
10	23041639	TP.10		A
11	23041640	TP.11		A
12	23041641	HA.1		A

	Print Name	Signature	Company	Date	Time
Sampled by	Client				
Relinquished by	Client				

Office Use Only	Print Name	Signature	Company	Date	Time
Received by	Rachelle Miller		NVL	4/26/23	900
Analyzed by	Hilary Crumley		NVL	4/28/23	
Results Called by					
☐ **Faxed** ☐ **Emailed**					

Special Instructions: Samples were dried prior to analysis.

Date: 4/26/2023
Time: 8:49 AM
Entered By: Rachelle Miller

ASBESTOS LABORATORY SERVICES

NVL

Company Zipper Geo Associates, LLC
Address 19019 36th Avenue West, Suite E
Lynnwood, WA 98036
Project Manager Mr. Justin Brooks
Phone (425) 582-9928
Cell (813) 205-3481

NVL Batch Number 2306722.00
TAT 3 Days **AH** No
Rush TAT
Due Date 5/1/2023 **Time** 9:00 AM
Email jbrooks@zippergeo.com
Fax (425) 582-9930

Project Name/Number: 2679 Crosswind SubStation **Project Location:** Arlington

Subcategory PLM Bulk
Item Code ASB-02 **Method** EPA 600/R-93-116 Asbestos by PLM <bulk>

Total Number of Samples 12 Rush Samples

	Lab ID	Sample ID	Description	A/R
1	23041630	TP.1		A
2	23041631	TP.2		A
3	23041632	TP.3		A
4	23041633	TP.4		A
5	23041634	TP.5		A
6	23041635	TP.6		A
7	23041636	TP.7		A
8	23041637	TP.8		A
9	23041638	TP.9		A
10	23041639	TP.10		A
11	23041640	TP.11		A
12	23041641	HA.1		A

	Print Name	Signature	Company	Date	Time
Sampled by	Client			4.26.23	0850
Relinquished by	Client	Justin Broo[illegible]			

Office Use Only

	Print Name	Signature	Company	Date	Time
Received by	Rachelle Miller	[signature]	NVL	4/26/23	900
Analyzed by			NVL		
Results Called by					
☐ Faxed ☐ Emailed					

Special Instructions:

Entered By: Rachelle Miller Date: 4/26/2023 Time: 8:49 AM 1 of 1

APPENDIX C
LIQUEFACTION ANALYSIS OUTPUT PLOT

ZipperGeo
Geoprofessional Consultants

Zipper Geo Associates, LLC
19019 36th Avenue West, Suite E
Lynnwood, Washington
(425) 582-9928

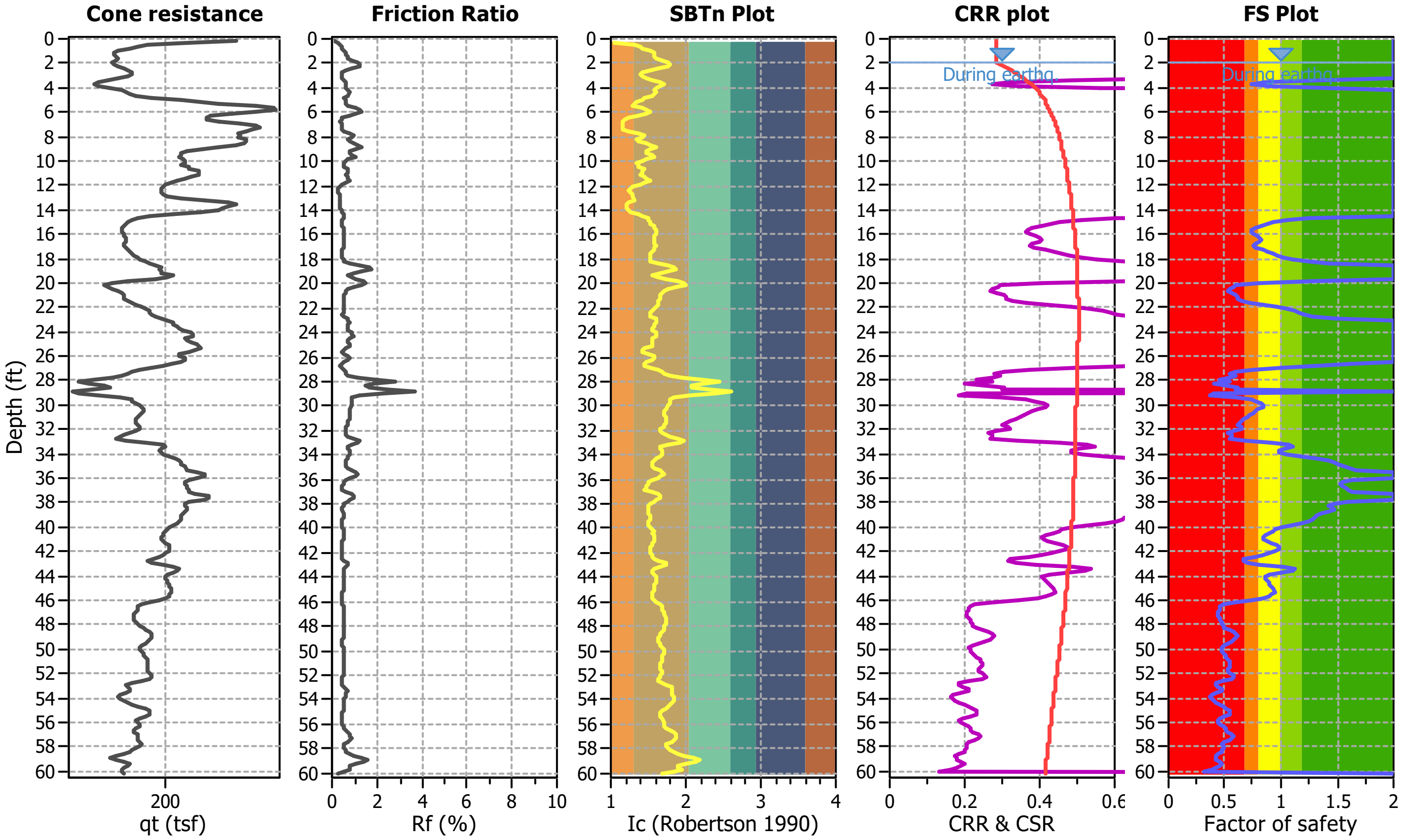
LIQUEFACTION ANALYSIS REPORT

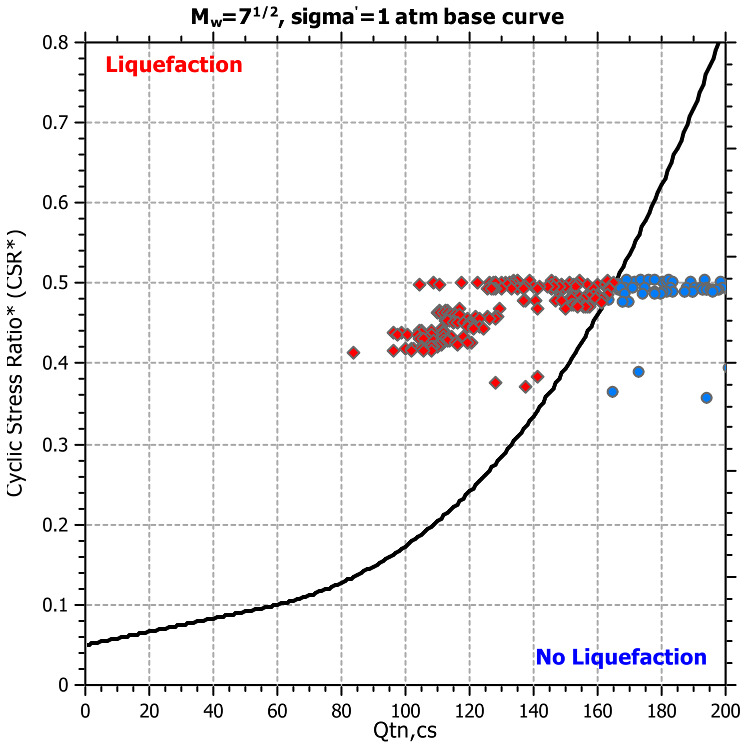
Project title : Crosswind Substation **Location : Arlington, Washington**

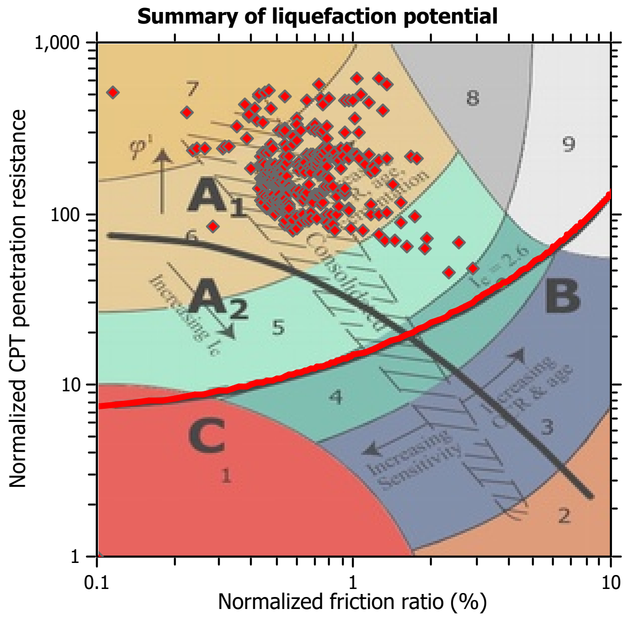
CPT file : CPT-01

Input parameters and analysis data

Analysis method:	NCEER (1998)	G.W.T. (in-situ):	7.00 ft	Use fill:	No	Clay like behavior applied:	Sands only
Fines correction method:	NCEER (1998)	G.W.T. (earthq.):	2.00 ft	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	7.03	Ic cut-off value:	2.60	Trans. detect. applied:	No	MSF method:	Method based
Peak ground acceleration:	0.52	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

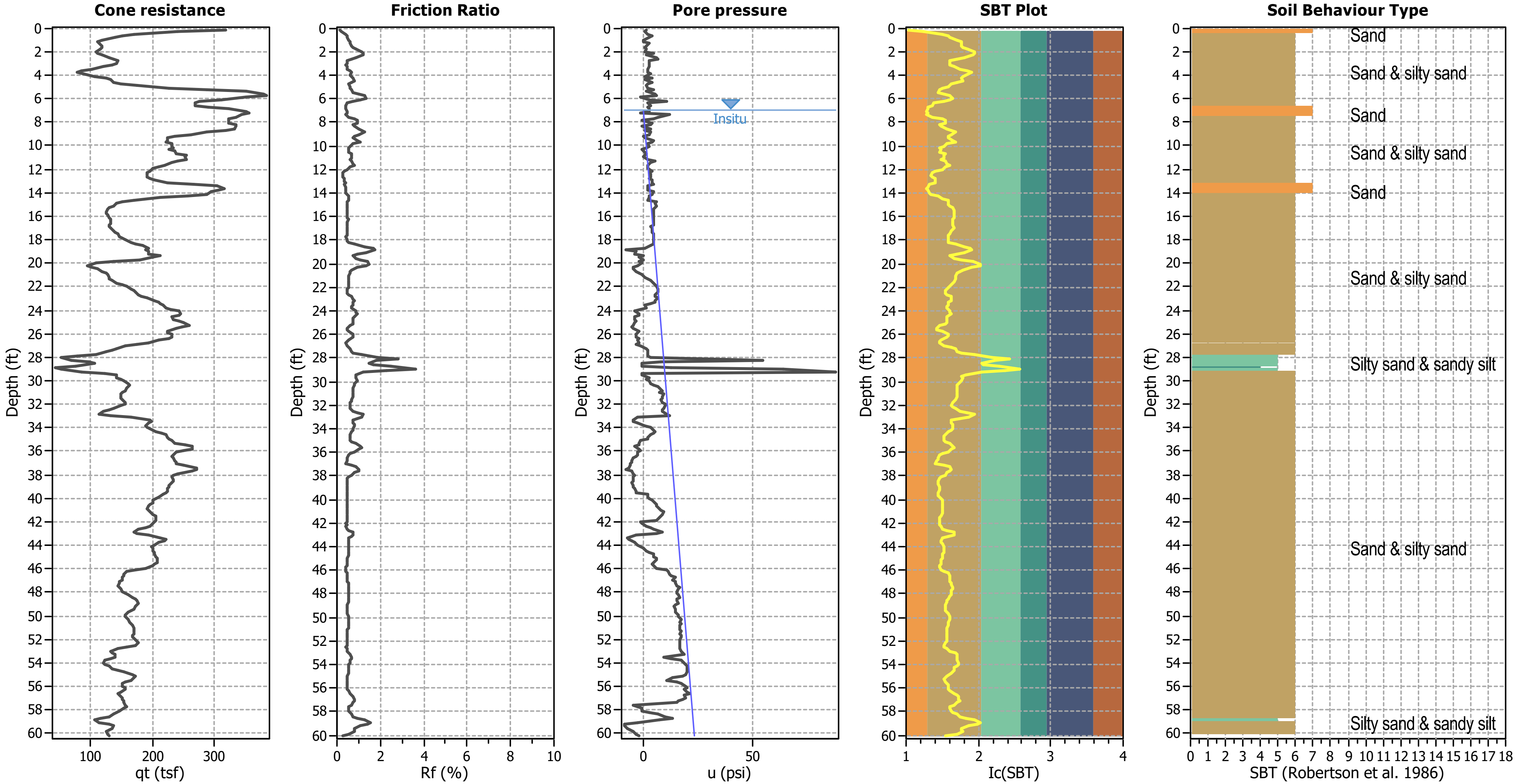






Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and strength loss possible depending on soil plasticity, brittleness/sensitivity, strain to peak undrained strength and ground geometry

CPT basic interpretation plots



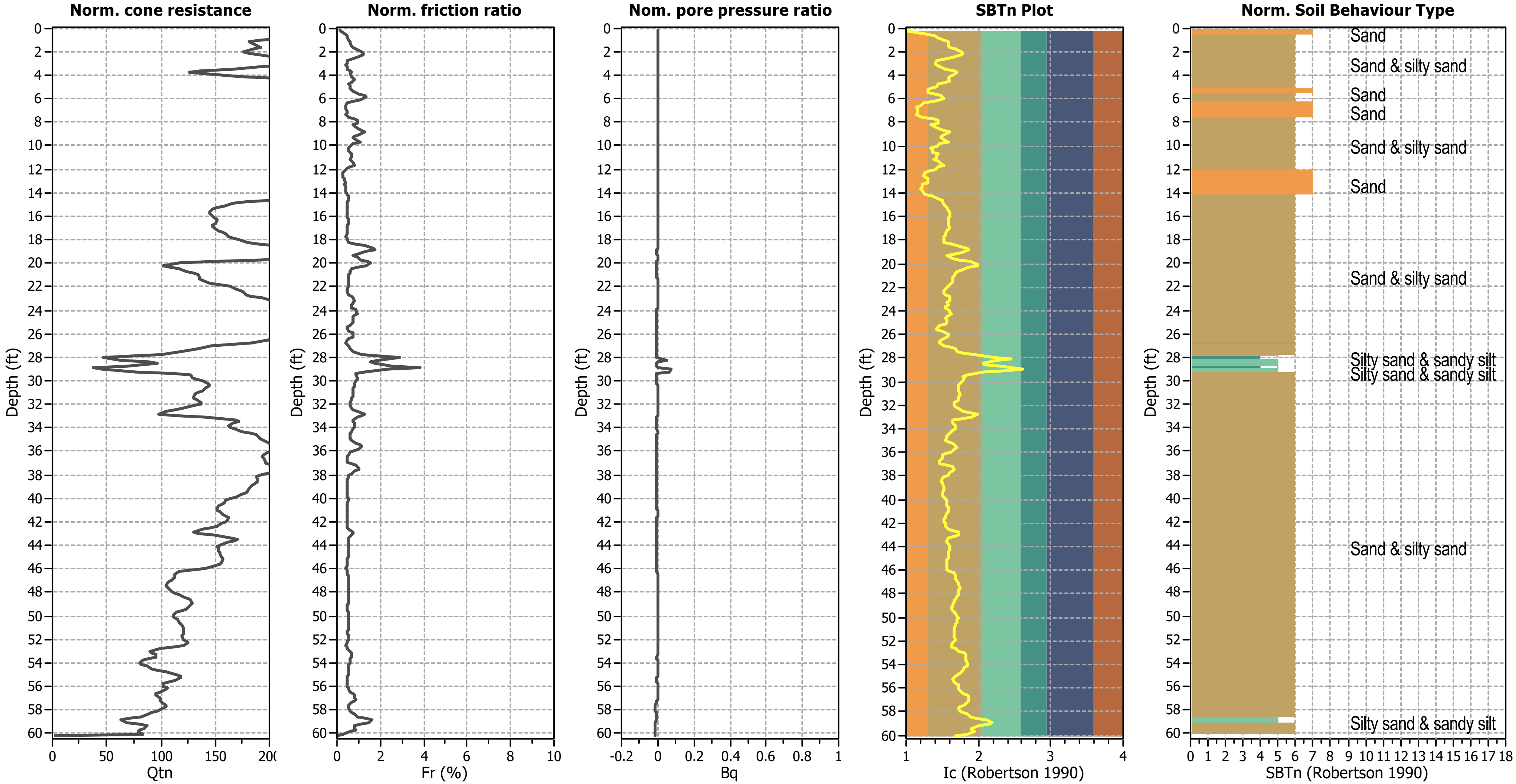
Input parameters and analysis data

Analysis method:	NCEER (1998)	Depth to water table (erthq.):	2.00 ft	Fill weight:	N/A
Fines correction method:	NCEER (1998)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	7.03	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.52	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	7.00 ft	Fill height:	N/A	Limit depth:	N/A

SBT legend

- 1. Sensitive fine grained
- 2. Organic material
- 3. Clay to silty clay
- 4. Clayey silt to silty
- 5. Silty sand to sandy silt
- 6. Clean sand to silty sand
- 7. Gravely sand to sand
- 8. Very stiff sand to
- 9. Very stiff fine grained

CPT basic interpretation plots (normalized)



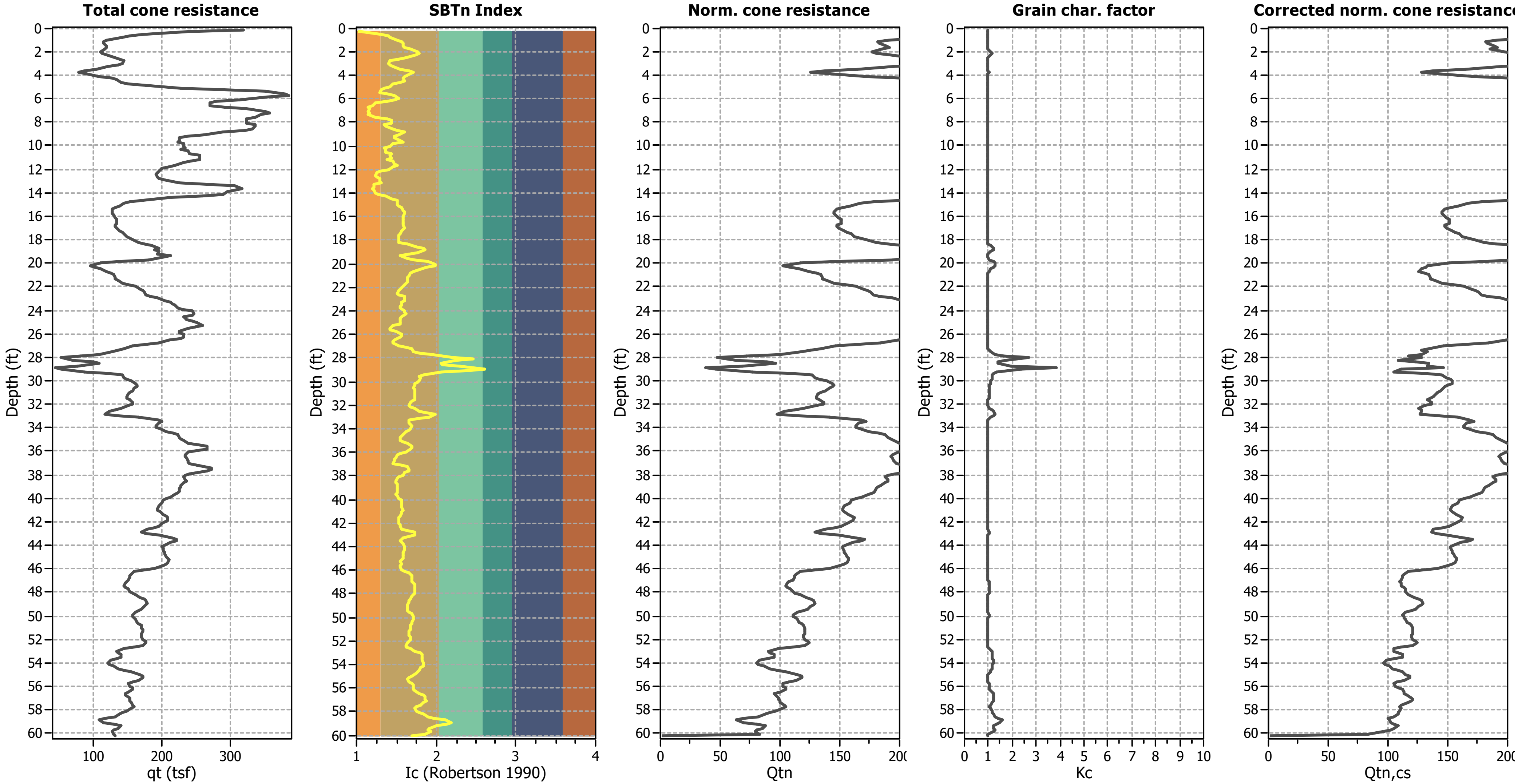
Input parameters and analysis data

Analysis method:	NCEER (1998)	Depth to water table (erthq.):	2.00 ft	Fill weight:	N/A
Fines correction method:	NCEER (1998)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	7.03	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.52	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	7.00 ft	Fill height:	N/A	Limit depth:	N/A

SBTn legend

1. Sensitive fine grained	4. Clayey silt to silty	7. Gravely sand to sand
2. Organic material	5. Silty sand to sandy silt	8. Very stiff sand to
3. Clay to silty clay	6. Clean sand to silty sand	9. Very stiff fine grained

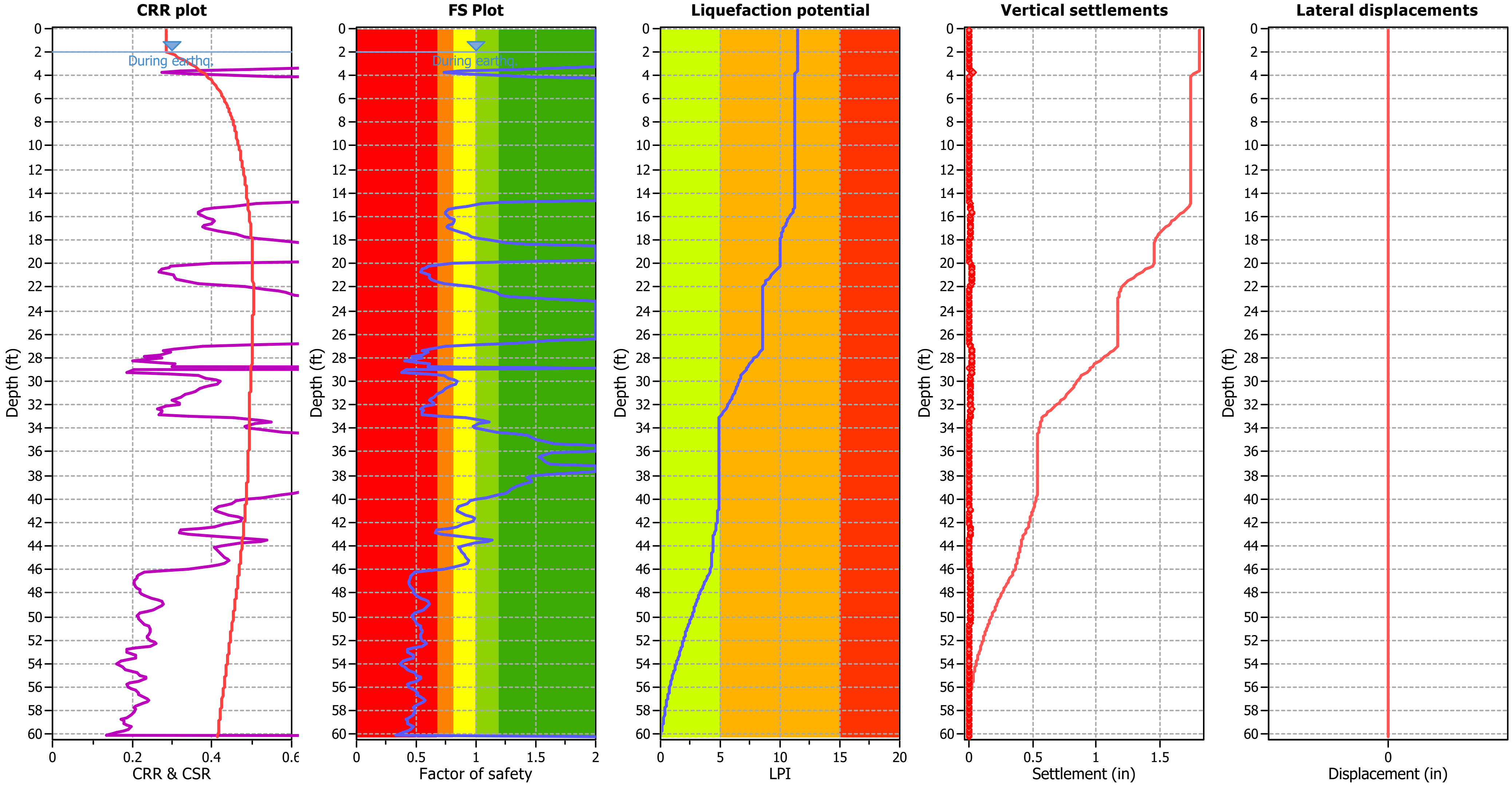
Liquefaction analysis overall plots (intermediate results)



Input parameters and analysis data

Analysis method:	NCEER (1998)	Depth to water table (erthq.):	2.00 ft	Fill weight:	N/A
Fines correction method:	NCEER (1998)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	7.03	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.52	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	7.00 ft	Fill height:	N/A	Limit depth:	N/A

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	NCEER (1998)	Depth to water table (erthq.):	2.00 ft	Fill weight:	N/A
Fines correction method:	NCEER (1998)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	7.03	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.52	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	7.00 ft	Fill height:	N/A	Limit depth:	N/A

F.S. color scheme

- Almost certain it will liquefy
- Very likely to liquefy
- Liquefaction and no liq. are equally likely
- Unlike to liquefy
- Almost certain it will not liquefy

LPI color scheme

- Very high risk
- High risk
- Low risk