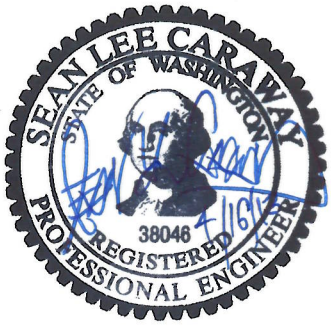
Seattle Public Utilities
Geotechnical Engineering

MEMORANDUM



Date: April 16, 2013

To: Chris Woelfel
Seattle City Light (SCL)

From: Sean Caraway, P.E.
Aaron Clark, L.G.
SPU Geotechnical Engineering

Subject: GEOTECHNICAL MEMORANDUM, DIABO FACILITY- LARGE ONSITE SEWAGE SYSTEMS (LOSS) PROJECT, SUBSURFACE INFILTRATION CHARACTERISTICS

INTRODUCTION

Seattle Public Utilities (SPU) Geotechnical Engineering was retained by Seattle City Light (SCL) to complete a geotechnical memorandum in support of the Diablo Large On-site Sewage System (LOSS) project located in the city of Diablo in Whatcom County, Washington.

We understand that the existing wastewater treatment plant at the Diablo facility is to be replaced due to costs required to upgrade the existing systems and the lower current populations and subsequent sewer demand at this location. The proposed construction includes new on-site sewage systems (OSS) or large on-site sewage systems (LOSS) within the Hollywood and/or Reflector Bar areas of Diablo. These systems would include new sewer laterals, sewer mains, sewage storage tanks, and drain fields. Pre-treatment devices would be required in certain areas.

We understand that the design and permit work for the Diablo facility is scheduled for 2012 and 2013 and the construction is scheduled for 2014. We understand that the project will require approval from the Washington State Department of Health (DOH). The early design work will include review of flow volumes, pollutant loading, and drain field design. Information regarding the infiltration characteristics of the subsurface soils will be needed for the design of the OSS/LOSS. We understand that if the proposed OSS/LOSS is deemed suitable, based on the DOH evaluation of site conditions and recommended system hydraulic loading rates (for residual strength effluent) and available SCL property to install the system, the design work will be completed by SCL.

FIELD INVESTIGATION

SPU Geotechnical Engineering personnel conducted subsurface explorations at the site on November 14 and 15, 2012 by completing nine test pit excavations (TP-1 through TP-9). Two additional test pits (TP-10 and TP-11) were completed on March 13, 2013. The test pits were excavated to depths ranging from 4.0 to 6.5 feet below ground surface (bgs). The test pits were excavated by Seattle City Light (SCL) personnel using a John Deere 85D backhoe. Generally, test pits dimensions were about 4-feet wide by 8-feet long. An SPU Geotechnical Engineering representative was present throughout the field exploration program to observe the explorations, procure soil samples, and prepare descriptive logs of the explorations. Soils were classified in general accordance with American Society of Testing and Materials (ASTM) D-2488 *Standard Practice for Description and Identification of Soils (Visual-Manual Procedure)*. Relative densities of the subsurface soils were evaluated by probing the soil with a ½-inch diameter steel T-probe.

A piezometer, installed by Hart Crowser on October 30, 2012, was instrumented with an In-Situ Level Troll 500 pressure transducer to facilitate ongoing monitoring of groundwater fluctuations. Based on a well log provided by Hart Crowser, a 2-inch diameter PVC well casing was installed to a depth of 19 feet and screened between 9 and 19 feet bgs. Exploration locations are shown on Figures 1 and 2. The summary logs of the subsurface explorations are included as Figures 4 through 9. Figure 3 is a key to the terms and symbols used on the logs.

LABORATORY TESTING

Geotechnical laboratory tests were performed on samples collected during the field exploration. The tests included natural water content and grain-size distribution testing, which help to determine index and engineering properties of the soil units encountered. The laboratory tests were conducted in general accordance with appropriate ASTM test standards. Moisture content results are graphically indicated at the appropriate sample depth on the summary logs in Figures 4 through 9. Results of the grain-size distribution testing are shown on Figures 10 through 12.

SURFACE CONDITIONS

The project site is located in the Hollywood and Reflector Bar districts of Diablo, Washington. Both districts are located on the north bank of the Skagit River and positioned between the Diablo dam and the confluence of Stetattle Creek and the Skagit River. Within each district, the proposed onsite sewage systems will be located in relatively flat lying grass areas between elevation 860 and 910 feet. Elevation data were determined using a handheld Garmin, Oregon 550T GPS device and should only be considered accurate to the degree measurable by the device.

SUBSURFACE CONDITIONS

Based on our exploration program, we have characterized the subsurface conditions as described in the following text. Below are descriptions of the soil deposits encountered in our explorations in the order of stratigraphic sequence, with the youngest unit described first, followed by a description of groundwater conditions.

Fill

With the exception of test pits TP-6 and TP-7, fill soils were encountered at depths extending to between 1 and 5.8 feet bgs. Fill soils generally consisted of silty sand (SM[1]), sand with silt (SP-SM), and sand (SP). Trace debris, generally consisting of wood and charred wood, was encountered in test pits TP-4, TP-5, TP-8, TP-9, and TP-11. Significant wood and ash debris was encountered in the southwest corner of test pit TP-3 between 2.6 and 5.8 feet bgs. Test pits TP-3, TP-4, and TP-11 were completed in fill soils. Where relative densities were evaluated, fill soils were generally loose to dense. Moisture contents for fill samples ranged from 9 to 23 percent.

Alluvium

Alluvium deposits are characterized by loose to dense or soft to stiff sand, silt, gravel, and cobbles deposited by streams and running water. Alluvium deposits were encountered in test pits TP-1, TP-2, TP-5, TP-7, TP-8, TP-9, and TP-10 underlying the fill or just below ground surface and extended to the completion depth of the test pits between 4.0 and 6.1 feet bgs. Alluvium deposits generally consisted of silty sand (SM), sand with silt (SP-SM, SW-SM), and sand (SP, SW) with varying amounts of gravel. Where relative densities were evaluated, alluvium soils were generally very loose to dense. Moisture contents for the alluvial soil samples ranged from 8 to 24 percent, with an average of 15 percent.

Colluvium

Colluvium deposits are characterized by loose to medium dense or soft to stiff poorly sorted sediments ranging in grain size from silt to boulder-sized material. These deposits are transported by gravity and typically deposited at the toe of slopes by landsliding, surficial sloughing, and soil creep processes. Colluvium deposits were encountered in test pit TP-6 from just below the surface to the final depth explored at 5.8 feet bgs. The colluvium consisted of gravel with silt and sand (GP-GM) and few cobbles.

GROUNDWATER CONDITIONS

Groundwater was not encountered within the test pit explorations during the time of our investigation. Groundwater measurements collected between November 15, 2012 and February 19, 2013 from the In-Situ Level Troll 500 pressure transducer installed within piezometer PZ-04 shows groundwater levels ranging between 10 and 13 feet bgs. Groundwater levels and

[1] Soil classification in accordance with the Unified Soil Classification System (USCS).

precipitation data during the monitoring period, indicated above, are presented in Figure 13. Figure 14 presents a plot of groundwater, precipitation, and Gorge Reservoir elevations[2]. Based on available data, groundwater levels appear to be influenced by the constant fluctuations in the Gorge Reservoir water elevations. Rainfall does not appear to be a notable influence. Per our scope of work dated December 12, 2012, groundwater data will be collected one month from the time of our field investigation and then bi-monthly for a total duration of 18 months. The results of the groundwater monitoring will be forwarded to the project team via e-mail.

INFILTRATION CHARACTERISTICS

The purpose of this evaluation is to assist in characterizing the subsurface conditions within the areas proposed for the OSS/LOSS and to determine the feasibility of the system. The final determination regarding the feasibility of the system will be made by SCL and will be based on the sizing of the system that is required using the DOH assigned hydraulic loading rates. SPU Geotechnical Engineering has evaluated the infiltration characteristics of the subsurface soils based on our review of existing soil conditions to supplement the information provided to SCL by the DOH.

Grain size distribution testing was performed on all test pit samples, with the exception of test pit TP-10 and TP-11 samples, in accordance with ASTM D6913, *Standard Test Method for Particle-Size Distribution of Soils*. In addition to the standard sieve set, a number 270 sieve was included in the analysis, in order to determine silt and clay content based on U.S. Department of Agriculture (USDA) particle size specifications. The results of our gradation tests were plotted on the USDA textural triangle in order to determine USDA soil classifications. USDA textural triangle plots are presented as Figure 15. The USDA textural analysis approach forms the basis for the LOSS Regulations in Chapter 246-272B of the Washington Administrative Code (WAC). The referenced WAC regulations are applied by the DOH in the determination of the system feasibility and the assigned hydraulic loading rates.

As part of our evaluation, SPU Geotechnical Engineering has compared our grain size distribution test results and USDA textural classifications to *Table 1: Soil Types and Hydraulic Loading Rates* from the WAC Chapter 246-272B. The results of this comparison are presented in our Table 1, below, which presents the estimated soil type for each sample tested in accordance with the WAC Chapter 246-272B, Table 1. This WAC soil classification system, which designates soils as Type 1 through 7, is the system used by the DOH in their on site evaluation of the soil conditions. The DOH exploration logs and soil classifications are based on visual evaluation of the subsurface conditions. The corresponding hydraulic loading rates and soil textural classifications are also shown on our Table 1, below. These approximate classifications are only presented for the samples tested. The grain size analyses and resulting

[2] Reservoir water surface elevation is referenced to National Geodetic Vertical Datum (NGVD) 1929.

ASTM based soil classifications shown on the test pit logs may not match textural classifications described in the WAC table.

Our estimated classifications do not consider soil origin (fill or various native soil deposits), material that may be present within certain locations and layers (debris, organics or other materials) and proximity to restrictive layers and/or groundwater zones. These items are included in the DOH assessment of system feasibility in the various areas under consideration. Our estimated soil classifications are not intended for use as the final design parameters. The design classifications and corresponding hydraulic loading rates should be confirmed as acceptable by the DOH.

Table 1 – Estimated Soil Types and Hydraulic Loading Rates

Test Pit Sample and Depth	Estimated WAC Soil Type	Maximum Hydraulic Loading Rate for residual strength effluent, gpd/sf*	Soil Textural Classification
TP-1, 1.5 feet	**4**	**0.6**	**Sand**
TP-1, 3.8 feet	**4**	**0.6**	**Sand**
TP-2, 2.0 feet	**4**	**0.6**	**Sand**
TP-2, 3.4 feet	**4**	**0.6**	**Sand**
TP-3, 2.0 feet	**5**	**0.4**	**Loamy Sand**
TP-3, 3.2 feet	**4**	**0.6**	**Sand**
TP-4, 3.9 feet	**4**	**0.6**	**Sand**
TP-5, 2.0 feet	**5**	**0.4**	**Sandy Loam**
TP-6, 2.7 feet	**1**	**1.0**	**Sand**
TP-7, 3.0 feet	**3**	**0.8**	**Sand**
TP-7, 4.5 feet	**3**	**0.8**	**Sand**
TP-8, 3.8 feet	**4**	**0.6**	**Sand**
TP-9, 4.2 feet	**2**	**1.0**	**Sand**

*gpd/sf is gallons per day per square foot

CLOSURE

This geotechnical memorandum is intended to provide information and recommendations to support preliminary engineering activities for this project. The soil types presented in accordance with applicable WAC classifications and the corresponding maximum hydraulic loading rates should only be considered as a guide in evaluating areas of potential for system installation. Actual determinations of soil types, corresponding rates and general feasibility of system installation should be confirmed with the DOH. The conclusions and interpretations presented in this report should not be construed as a warranty of the subsurface conditions.

We recommend that an experienced geotechnical engineer from SPU Geotechnical Engineering review the Project Manual to verify that our recommendations have been interpreted and implemented as intended. Recommendations for design changes will be provided should conditions revealed during construction differ from those anticipated, and to verify that the geotechnical aspects of construction comply with the Project Manual.

If you have any questions, please don't hesitate to contact us: Sean Caraway (615-1547) or Aaron Clark (733-9520).

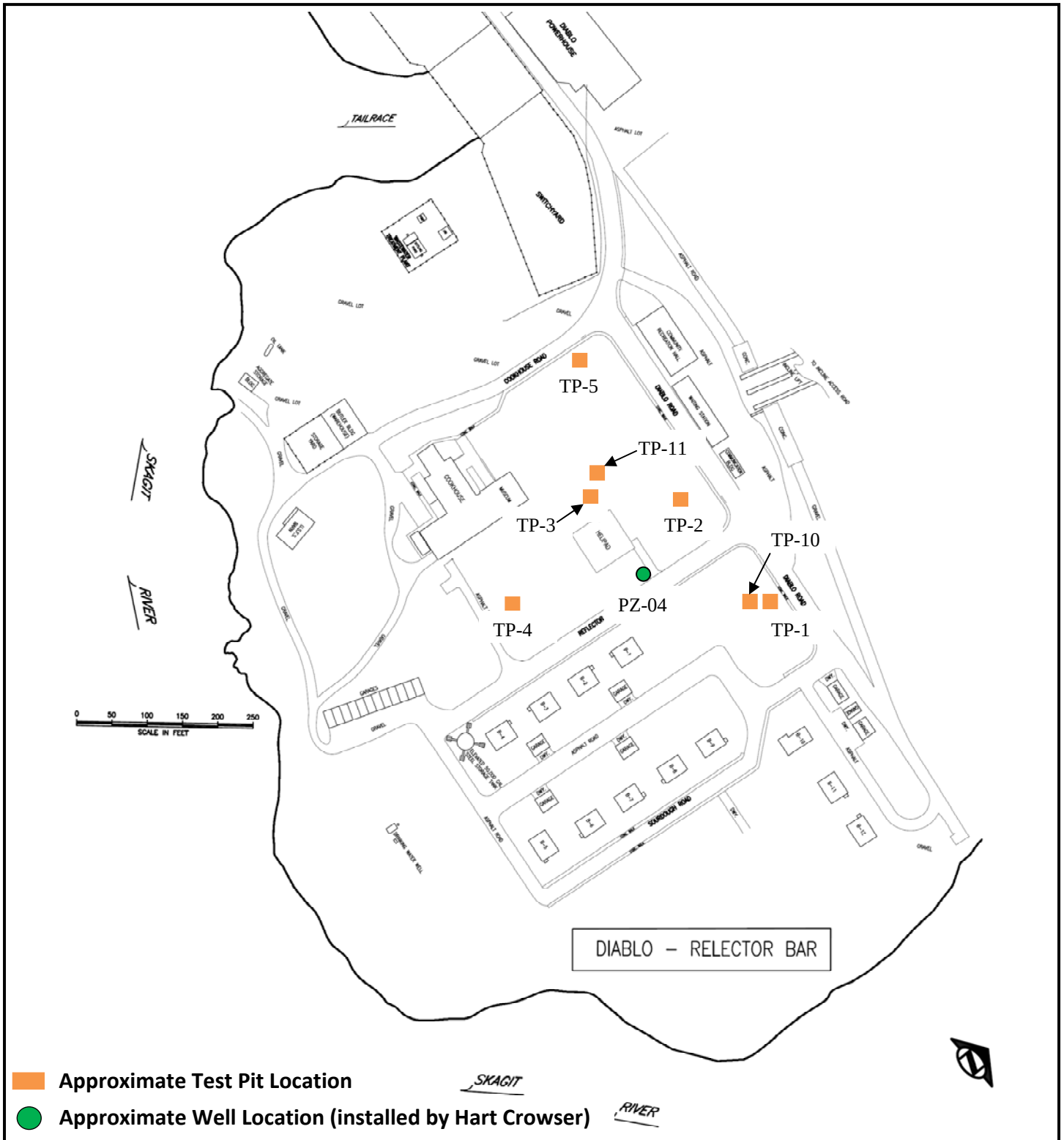
REFERENCES

ASTM, 2007. *American Society of Testing Materials Annual Book of Standards, Vol. 4.08*, West Conshohocken, PA.

Washington State Department of Ecology (Ecology), 2005, *Stormwater Management Manual for Western Washington (Manual): Volume III – Hydrologic analysis and flow control design/BMPs*: Olympia, Wash., Washington State Department of Ecology Water Quality.

Washington Administrative Code, 2011, Large On-site Sewage System Regulations, *Chapter 246-272B WAC.*

United State Department of Agriculture, Natural Resource Conservation Services, Soil Survey Manual, 1993, *Chapter 3, Particle Size Distribution.*



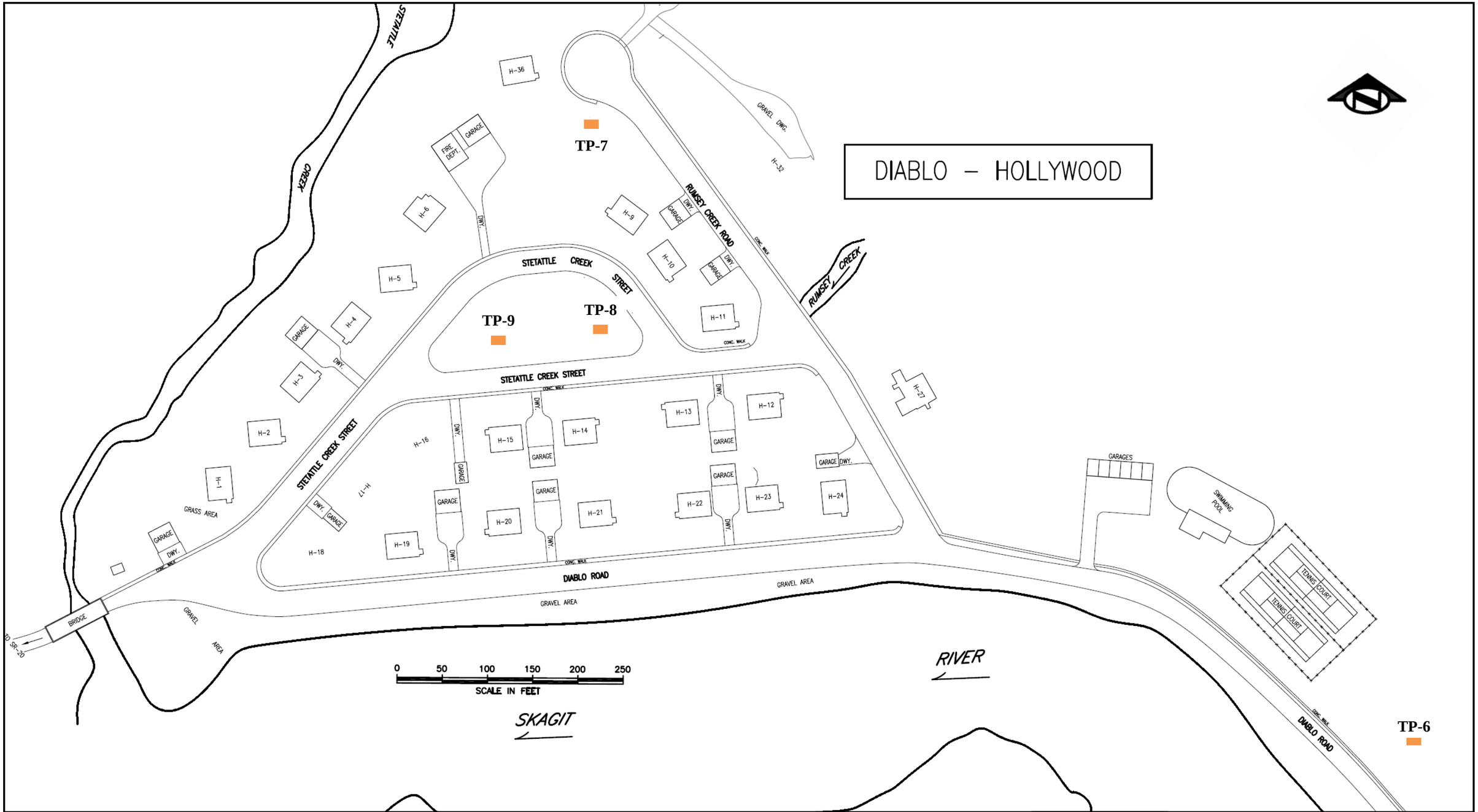
SEATTLE PUBLIC UTILITIES
GEOTECHNICAL ENGINEERING

DIABLO LARGE ONSITE SEWAGE SYSTEM (LOSS)

WHATCOM COUNTY, WASHINGTON

SITE MAP – REFLECTOR BAR

APRIL 2013 **FIGURE 1**



SEATTLE
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GEOTECHNICAL ENGINEERING

WA: NS09065

Approximate Test Pit Location

DIABLO LARGE ONSITE SEWAGE SYSTEM (LOSS)
WHATCOM COUNTY, WASHINGTON

SITE MAP - HOLLYWOOD

APRIL 2013

FIGURE 2

UNIFIED SOIL CLASSIFICATION SYSTEM - ASTM D2488

MAJOR DIVISION			GROUP SYMBOL	LETTER SYMBOL	GROUP NAME
COARSE GRAINED SOILS CONTAINS LESS THAN 50% FINES	**GRAVEL AND GRAVELLY SOILS** MORE THAN 50% OF COARSE FRACTION RETAINED ON NO. 4 SIEVE	GRAVEL WITH ≤ 5% FINES		GW	Well-graded GRAVEL
				GW	Well-graded GRAVEL WITH SAND
				GP	Poorly graded GRAVEL
				GP	Poorly graded GRAVEL WITH SAND
		GRAVEL WITH BETWEEN 5% AND 15% FINES		GW-GM	Well-graded GRAVEL WITH SILT
				GW-GC	Well-graded GRAVEL WITH CLAY
				GP-GM	Poorly graded GRAVEL WITH SILT
				GP-GC	Poorly graded GRAVEL WITH CLAY
		GRAVEL WITH ≥ 15% FINES		GM	SILTY GRAVEL
				GC	CLAYEY GRAVEL
	SAND AND SANDY SOILS MORE THAN 50% OF COARSE FRACTION PASSING ON NO. 4 SIEVE	SAND WITH ≤ 5% FINES		SW	Well-graded SAND
				SW	Well-graded SAND WITH GRAVEL
				SP	Poorly graded SAND
				SP	Poorly graded SAND WITH GRAVEL
		SAND WITH BETWEEN 5% AND 15% FINES		SW-SM	Well-graded SAND WITH SILT
				SW-SC	Well-graded SAND WITH CLAY
				SP-SM	Poorly graded SAND WITH SILT
				SP-SC	Poorly graded SAND WITH CLAY
		SAND WITH ≥ 15% FINES		SM	SILTY SAND
				SC	CLAYEY SAND
FINE GRAINED SOILS CONTAINS MORE THAN 50% FINES	SILT AND CLAY	LIQUID LIMIT LESS THAN 50		ML	Inorganic SILT, low plasticity
				ML	Inorganic SILT WITH SAND, low plasticity
				CL	Lean inorganic CLAY, low plasticity
				CL	Lean inorganic CLAY WITH SAND, low plasticity
				OL	ORGANIC SILT, low plasticity
		LIQUID LIMIT GREATER THAN 50		MH	Elastic inorganic SILT, moderate to high plasticity
				CH	Fat inorganic CLAY, moderate to high plasticity
				OH	ORGANIC SILT or CLAY, moderate to high plasticity
HIGHLY ORGANIC SOILS				PT	PEAT soils with high organic contents
TOPSOIL				TP	TOPSOIL

NOTES:
1) Sample descriptions are based on visual field and laboratory observations using classification methods of ASTM D2488. Where laboratory data are available, classifications are in accordance with ASTM D2487.
2) Solid lines between soil descriptions indicate change in interpreted geologic unit. Dashed lines indicate stratigraphic change within the unit.
3) Fines are material passing the U.S. Std. #200 Sieve.

TEST PIT LOG KEY :

CAVING	SEEPAGE
Slight-Inward extent is generally less than 6 inches.	Slow-A small amount of water collects in the excavation after several minutes.
Moderate-Inward extent is generally more than 6 inches, and less than 12 inches.	Moderate-Water collects in the excavation during digging, some bailing is needed to expose the excavation bottom.
Significant-Inward extent is generally more than 12 inches.	Rapid-Water collects in the excavation when digging is stopped, bailing may be ineffective to observe the bottom of the excavation.

LABORATORY TEST

AL	Atterberg Limits
FC	Fines Content
GSD	Grain Size Distribution (Sieve and/or Hydrometer)
ENV	Environmental Testing
SG	Specific Gravity
MD	Moisture Density Relationship
C	Consolidation
UCS	Unconfined Compression Strength
	Hydraulic Conductivity Test
Perm	Pocket Penetrometer
PP	Torvane
TV	Direct Shear
DS	Organic
O	

COMPONENT DEFINITIONS

COMPONENT	SIZE RANGE
Boulders	Larger than 12 in
Cobbles	3 in to 12 in
Gravel	3 in to No. 4 (4.75 mm)
Coarse gravel	3 in to 3/4 in
Fine gravel	3/4 in to No. 4 (4.75 mm)
Sand	No. 4 (4.75 mm) to No. 200 (0.075 mm)
Coarse Sand	No. 4 (4.75 mm) to No. 10 (2.00 mm)
Medium Sand	No. 10 (2.00 mm) to No. 40 (0.425 mm)
Fine Sand	No. 40 (0.425 mm) to No. 200 (0.075 mm)
Silt and Clay	Smaller than No. 200 (0.075 mm)

COMPONENT PROPORTIONS

DESCRIPTIVE TERMS	RANGE OF PROPORTION
Trace	Less than 5%
Few	5 - 15%
Some	15 - 30%

MOISTURE CONTENT

DRY	Absence of moisture, dusty, dry to the touch
MOIST	No visible water, near optimum moisture content.
WET	Visible free water,usually soil is below water table.
SATURATED	Water content prevents soil from retaining structure.

RELATIVE DENSITY OR CONSISTENCY VERSUS SPT N - VALUE OR PROBE DEPTH

COHESIONLESS SOILS				COHESIVE SOILS			
Density	N (blows/ft)	Approximate Relative Density	Probe Depth (ft)	Consistency	N (blows/ft)	Approximate Undrained Shear Strength (psf)	Probe Depth (ft)
Very Loose	0 to 4	0 - 15	> 3	Very Soft	0 to 2	< 250	> 2
Loose	4 to 10	15 - 35	1- 3	Soft	2 to 4	250 - 500	1- 2
Medium Dense	10 to 30	35 - 65	0.3 - 1	Medium Stiff	4 to 8	500 - 1000	0.5 - 1
Dense	30 to 50	65 - 85	0.1 - 0.3	Stiff	8 to 15	1000 - 2000	0.25 - 0.5
Very Dense	over 50	85 - 100	< 0.1	Very Stiff	15 to 30	2000 - 4000	0.1 - 0.25
				Hard	over 30	> 4000	< 0.1

SOIL STRATIFICATION AND STRUCTURE

STRATA	DESCRIPTION
Parting	Less than 1/16 inch thick
Seam	1/16 to 1/2 inch thick
Layer	1/2 to 12 inch thick
Pockets	Inclusions < 1 inch thick
Occasional	< 1 occurrance per foot
Scattered	> 1 occurrance per foot
Numerous	> 10 occurrances per foot

STRUCTURE	DESCRIPTION
Laminated	Alternating layers of varying material or color with layers less than 1/4 inch thick; note thickness
Stratified	Alternating layers of varying material or color with layers > or = 1/4 inch thick; note thickness
Fissured	Breaks along definite planes of fracture with little resistance to fracturing
Slickensided	Fracture planes appear polished or glossy, sometimes striated
Blocky	Cohesive soil that can be broken down into small angular lumps which resist further breakdown
Lensed	Inclusion of small pockets of different soils, such as small lenses of sand scattered through a mass of clay; note thickness
Homogenous	Same color throughout
Dilatent	Water appears quickly on the surface of the specimen during shaking and disappears quickly upon squeezing

LOG OF TEST PIT TP-1

Approximate Location: Reflector Bar: In grass lawn south of Diablo Road and east of Reflector Bar Road. (N 48 42.812, W 121 08.407)

SOIL DESCRIPTION Surface Elevation: Approx 874

Surface is grass.

FILL

Brown, SILTY fine to medium SAND, trace gravel; moist; scattered roots.

Brown, fine to medium SAND, trace fine gravel, coarse sand, and silt; moist; trace organics.

Brown, SILTY fine to medium SAND; moist; trace roots.

ALLUVIUM

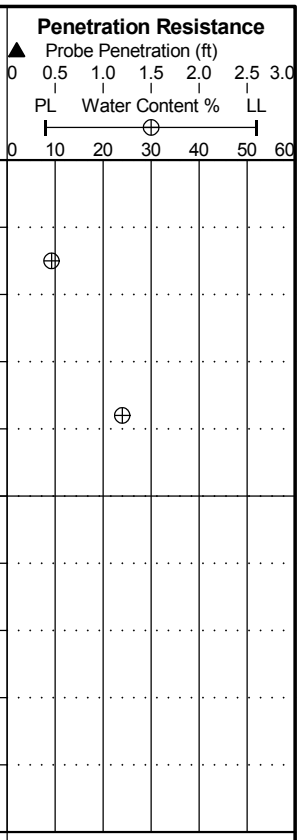
Brown, SAND; moist.

Very loose, brown, SILTY fine SAND, trace medium sand; moist; trace organics.

Brown, SAND; moist.

Test pit completed at 6.0 feet below ground surface. No groundwater or caving encountered at time of excavation. Log of southwest side of test pit.

Depth (ft)	Symbol	USCS	Samples	Probe Penetration (ft)	Lab tests	Groundwater
0		SM				
		SP	1	3	GSD	
		SM				
		SP				
		SM	2		GSD	
5		SP				
10						



LOG OF TEST PIT TP-2

Approximate Location: Reflector Bar: In grass lawn south of Diablo Road, west of Reflector Bar Road, and north of helipad. (N 48 42.835, W 121 08.440)

SOIL DESCRIPTION Surface Elevation: Approx 878

Surface is grass.

FILL

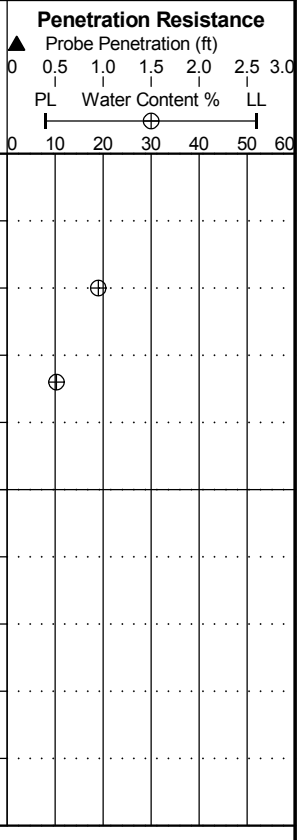
Brown, SILTY fine to medium SAND; moist; trace organics (black matter, roots).
With interbedded layers of reddish-brown silty sand and scattered black organics.

ALLUVIUM

Loose, brown, fine SAND, trace medium sand and silt; moist.

Test pit completed at 4.6 feet below ground surface. No groundwater or caving encountered at time of excavation. Log of northwest side of test pit.

Depth (ft)	Symbol	USCS	Samples	Probe Penetration (ft)	Lab tests	Groundwater
0		SM				
			1		GSD	
		SP	2	1.7	GSD	
5						
10						



Date Completed: 11/14/2012
Operator: Seattle City Light
Equipment: John Deere 85D Backhoe

Seattle Public Utilites
Geotechnical Engineering

Daiblo Large Onsite Sewage System (LOSS)
Whatcom County

NS09065 U29 MG1 **FIGURE 4**

Logged by: AJC Reviewed by: SCL

LOG OF TEST PIT DIABLO AND NEWHALEM LOSS.GPJ TEMPL.GDT 3/20/13

LOG OF TEST PIT TP-3

Approximate Location: Reflector Bar: In grass lawn west of Reflector Bar Road and west of helipad. (N 48 42.835, W 121 08.474)

SOIL DESCRIPTION Surface Elevation: Approx 869

FILL

Brown, SILTY SAND, trace gravel; moist; trace organics (roots).

Very stiff, red-brown, fine SANDY SILT; moist.
(Burnt debris on north pit wall between 2.6 and 5.8 feet.)

Brown, fine to medium SAND, trace silt; moist.

Test pit completed at 5.8 feet below ground surface. No groundwater or caving encountered at time of excavation. Log of southeast side of test pit.

Depth (ft)	Symbol	USCS	Samples	Probe Penetration (ft)	Lab tests	Groundwater
0		SM	1	.25	GSD	
		ML				
		SP	2		GSD	
5						
10						

Penetration Resistance
Probe Penetration (ft) 0 0.5 1.0 1.5 2.0 2.5 3.0
PL Water Content % LL
0 10 20 30 40 50 60

LOG OF TEST PIT TP-4

Approximate Location: Reflector Bar: In grass lawn west of Reflector Bar Road and south of helipad. (N 48 42.810, W 121 08.510)

SOIL DESCRIPTION Surface Elevation: Approx 859

Surface is grass.

FILL

Dark brown, SILTY fine SAND, trace gravel; moist; trace debris (charred wood).

Reddish-brown, SILTY fine SAND; moist; trace organic (roots, charred wood), pockets of sand with silt.

Red-brown, SILT WITH SAND; moist.

Brown, SILTY fine to medium SAND; moist.

Test pit completed at 4.0 feet below ground surface. No groundwater or caving encountered at time of excavation. Log of west side of test pit.

Depth (ft)	Symbol	USCS	Samples	Probe Penetration (ft)	Lab tests	Groundwater
0		SM				
		SM				
		ML				
		SM	1		GSD	
5						
10						

Penetration Resistance
Probe Penetration (ft) 0 0.5 1.0 1.5 2.0 2.5 3.0
PL Water Content % LL
0 10 20 30 40 50 60

Date Completed: 11/14/2012
Operator: Seattle City Light
Equipment: John Deere 85D Backhoe

Seattle Public Utilites
Geotechnical Engineering

Daiblo Large Onsite Sewage System (LOSS)
Whatcom County

NS09065 U29 MG1 **FIGURE 5**

LOG OF TEST PIT DIABLO AND NEWHALEM LOSS.GPJ TEMPL.GDT 3/20/13

LOG OF TEST PIT TP-5

Approximate Location: Reflector Bar: In grass lawn south of Diablo Road and east of Cookhouse Road. (N 48 42.867, W 121 08.476)

SOIL DESCRIPTION Surface Elevation: Approx 871

Surface is grass.

FILL

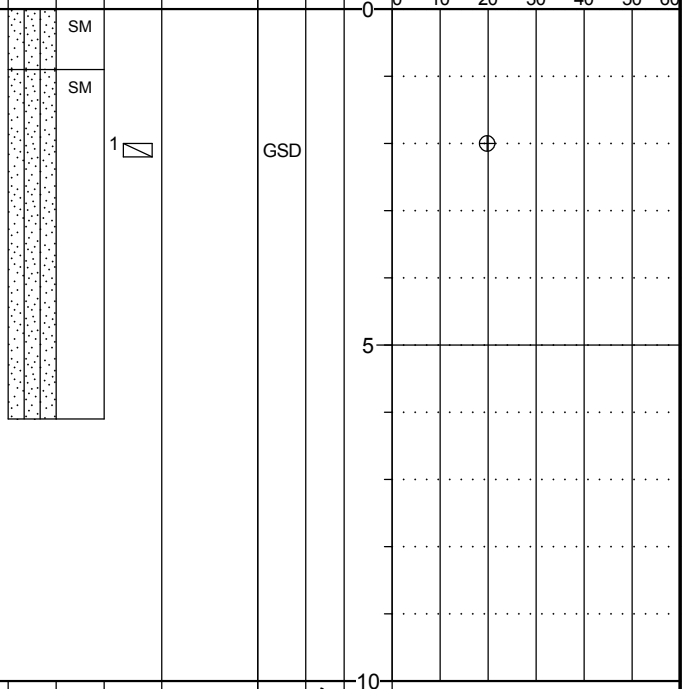
Dark brown, SILTY fine SAND, trace gravel; moist; trace debris (charred wood).

ALLUVIUM

Brown, SILTY fine SAND; moist; trace organics (roots).

No roots.

Test pit completed at 6.1 feet below ground surface. No groundwater or caving encountered at time of excavation. Log of northeast side of test pit.



LOG OF TEST PIT TP-6

Approximate Location: Hollywood: In grass lawn north of Diablo Road and southeast of tennis courts. (N 48 43.033, W 121 08.631)

SOIL DESCRIPTION Surface Elevation: Approx 873

Surface is grass.

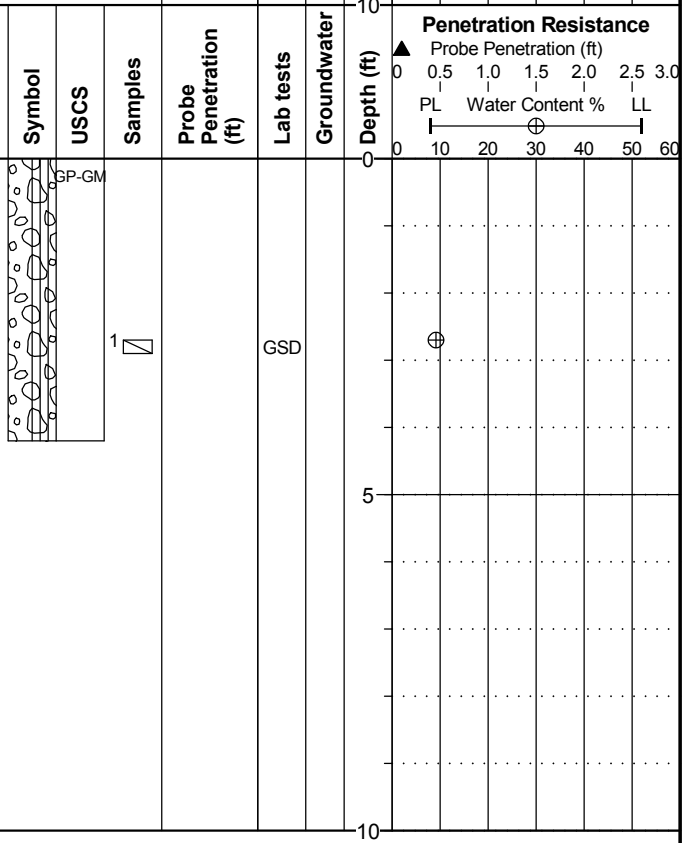
COLLUVIUM

Brown, GRAVEL WITH SILT AND SAND, few cobbles; moist; scattered roots, gravel and cobbles are subangular.

Becomes gray, no roots.

Becomes wet.

Test pit completed at 4.2 feet below ground surface. No groundwater or caving encountered at time of excavation. Log of west side of test pit.



Date Completed: 11/14/2012
Operator: Seattle City Light
Equipment: John Deere 85D Backhoe

Seattle Public Utilites
Geotechnical Engineering

Daiblo Large Onsite Sewage System (LOSS)
Whatcom County

NS09065 U29 MG1 **FIGURE 6**

Logged by: AJC Reviewed by: SCL

LOG OF TEST PIT DIABLO AND NEWHALEM LOSS.GPJ TEMPL.GDT 3/20/13

LOG OF TEST PIT TP-7

Approximate Location: Hollywood: South of Rumsey Creek Road cul-de-sac. (N 48 43.134, W 121 08.867)

SOIL DESCRIPTION Surface Elevation: Approx 908

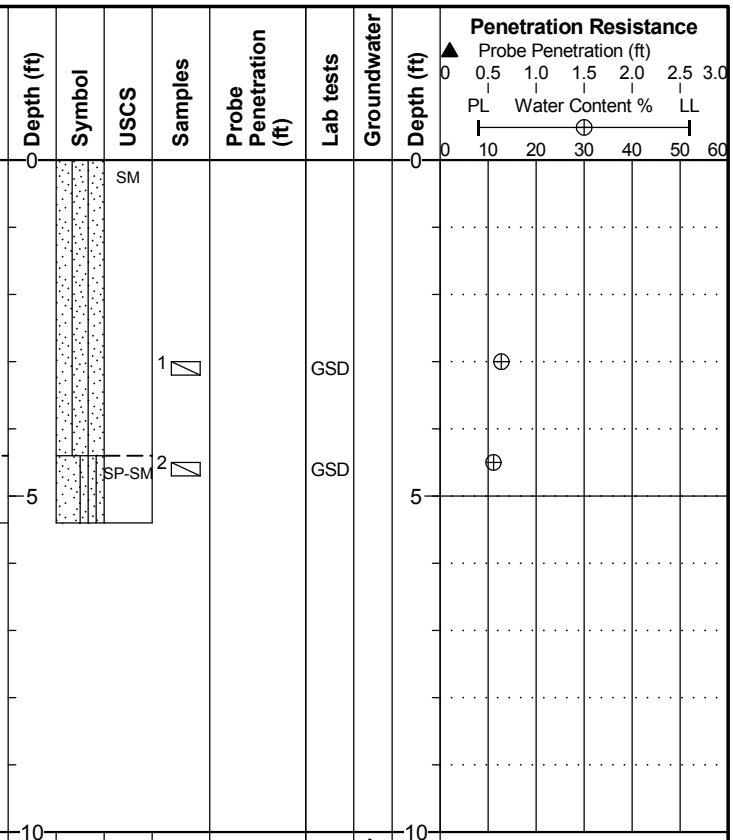
Surface is grass.

ALLUVIUM

Brown, SILTY fine to medium SAND, few coarse sand, gravel and cobbles; moist; scattered roots, occasional rust mottling.

Dense, brown, fine to medium SAND WITH SILT, few coarse sand, gravel, and cobbles; moist.

Test pit completed at 5.4 feet below ground surface. No groundwater or caving encountered at time of excavation. Log of east side of test pit.



LOG OF TEST PIT TP-8

Approximate Location: Hollywood: In east side of grass lawn bounded by Stetattle Creek Street. (N 48 43.083, W 121 08.857)

SOIL DESCRIPTION Surface Elevation: Approx 888

Surface is grass.

FILL

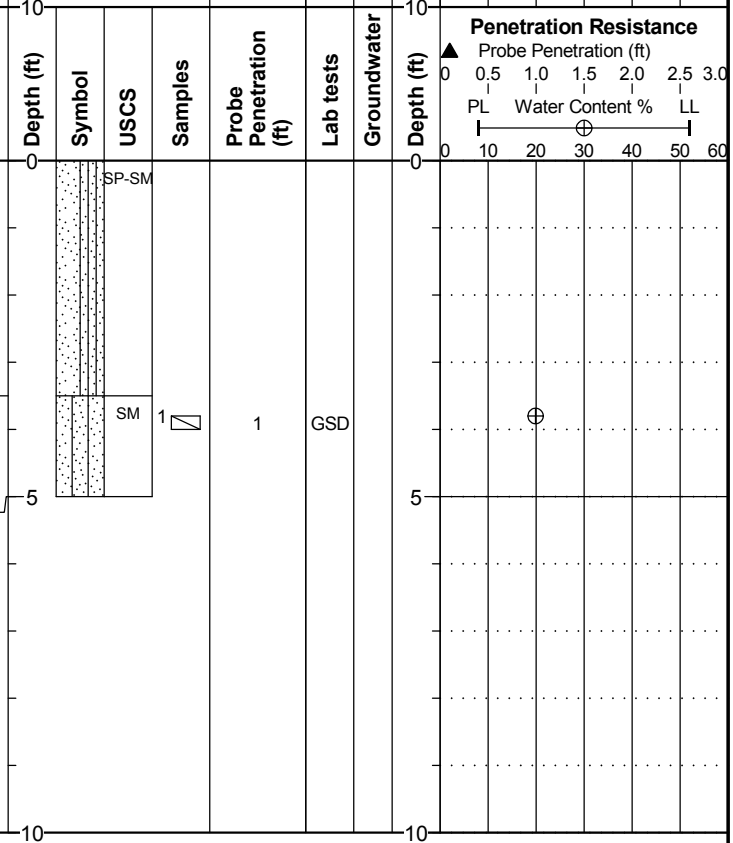
Gray-brown, fine SAND WITH SILT, fine gravel, trace cobbles; moist; scattered woody debris.

ALLUVIUM

Loose, brown, SILTY fine SAND, few medium sand; moist.

Increased cobbles, cobbles are subrounded to rounded.

Test pit completed at 5.0 feet below ground surface. No groundwater or caving encountered at time of excavation. Log of southwest side of test pit.



Date Completed: 11/15/2012
Operator: Seattle City Light
Equipment: John Deere 85D Backhoe

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Daiblo Large Onsite Sewage System (LOSS)
Whatcom County

NS09065 U29 MG1 **FIGURE 7**

LOG OF TEST PIT DIABLO AND NEWHALEM LOSS.GPJ TEMPL.GDT 3/20/13

LOG OF TEST PIT TP-9

Approximate Location: Hollywood: In west side of grass lawn bounded by Stetattle Creek Street. (N 48 43.088, W 121 08.880)

SOIL DESCRIPTION Surface Elevation: Approx 913

Surface is grass.

FILL

Dense, brown mottled gray, fine to medium SAND WITH SILT, trace gravel; moist; scattered roots, woody debris, trace organic matter.

ALLUVIUM

Gray, dense, SAND WITH SILT AND GRAVEL; moist.

Test pit completed at 5.8 feet below ground surface. No groundwater or caving encountered at time of excavation. Log of north side of test pit.

Depth (ft)	Symbol	USCS	Samples	Probe Penetration (ft)	Lab tests	Groundwater
0		SP-SM		.25		
		SW-SM	1	.25	GSD	
5						
10						

Penetration Resistance
Probe Penetration (ft) 0 0.5 1.0 1.5 2.0 2.5 3.0
PL Water Content % LL
0 10 20 30 40 50 60

LOG OF TEST PIT TP-10

Approximate Location: Reflector Bar: In grass lawn 100 feet east of Reflector Bar Road, 55 feet south of Diablo Road. (N 48 42.813, W 121 08.416)

SOIL DESCRIPTION Surface Elevation: Approx 874

Surface is grass.

FILL

Loose, brown, SILTY fine to medium SAND, few coarse sand and fine gravel; moist; trace organics (matter, roots).
Becomes dark brown to black, few fine gravel.

ALLUVIUM

Loose, light brown, SILTY fine to medium SAND, few coarse sand; moist; trace organics (rootlets), scattered rust stained seams.

Brown, SAND WITH GRAVEL, trace silt; moist.

Test pit completed at 6.0 feet below ground surface. No groundwater or caving encountered at time of excavation. Log of northwest side of test pit.

Depth (ft)	Symbol	USCS	Samples	Probe Penetration (ft)	Lab tests	Groundwater
0		SM	1	1		
		SM	2	1.5		
		SW	3			
5						
10						

Penetration Resistance
Probe Penetration (ft) 0 0.5 1.0 1.5 2.0 2.5 3.0
PL Water Content % LL
0 10 20 30 40 50 60

Date Completed: 11/15/2012
Operator: Seattle City Light
Equipment: John Deere 85D Backhoe

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Daiblo Large Onsite Sewage System (LOSS)
Whatcom County

NS09065 U29 MG1 **FIGURE 8**

Logged by: AJC Reviewed by: SCL

LOG OF TEST PIT DIABLO AND NEWHALEM LOSS.GPJ TEMPL.GDT 3/26/13

LOG OF TEST PIT TP-11

Approximate Location: Reflector Bar: In grass lawn 32.5 feet west of west side of helipad, in line with NW corner of helipad. (N 48 42.838 W 121 08.473)

SOIL DESCRIPTION Surface Elevation: Approx 869

Surface is grass.

FILL

Medium dense, brown, SILTY fine to medium SAND, few coarse sand, trace fine gravel; moist; trace organics (roots, burnt wood). Trace coarse sand.

Light brown, fine to medium SAND; moist; trace organics (rootlets).

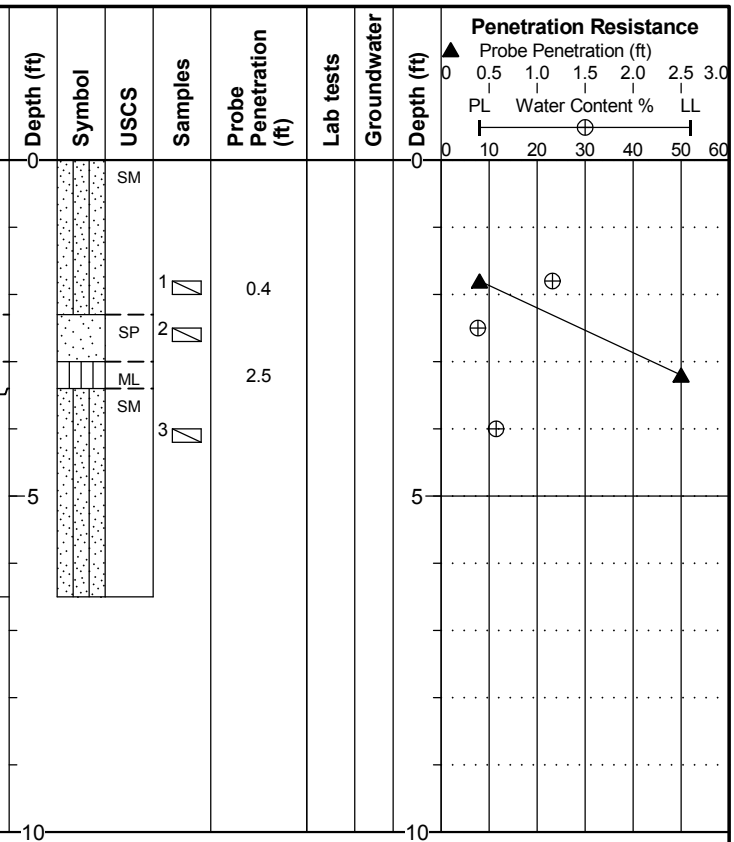
Very soft, reddish brown, SILT; moist.

Loose, brown mottled red, SILTY fine SAND; moist.

Trace organics (burnt wood, matter).

With scattered sandy silt pockets.

Test pit completed at 6.5 feet below ground surface. No groundwater or caving encountered at time of excavation. Log of north side of test pit.



Date Completed: 03/13/2013

Operator: Seattle City Light

Equipment: John Deere 85D Backhoe

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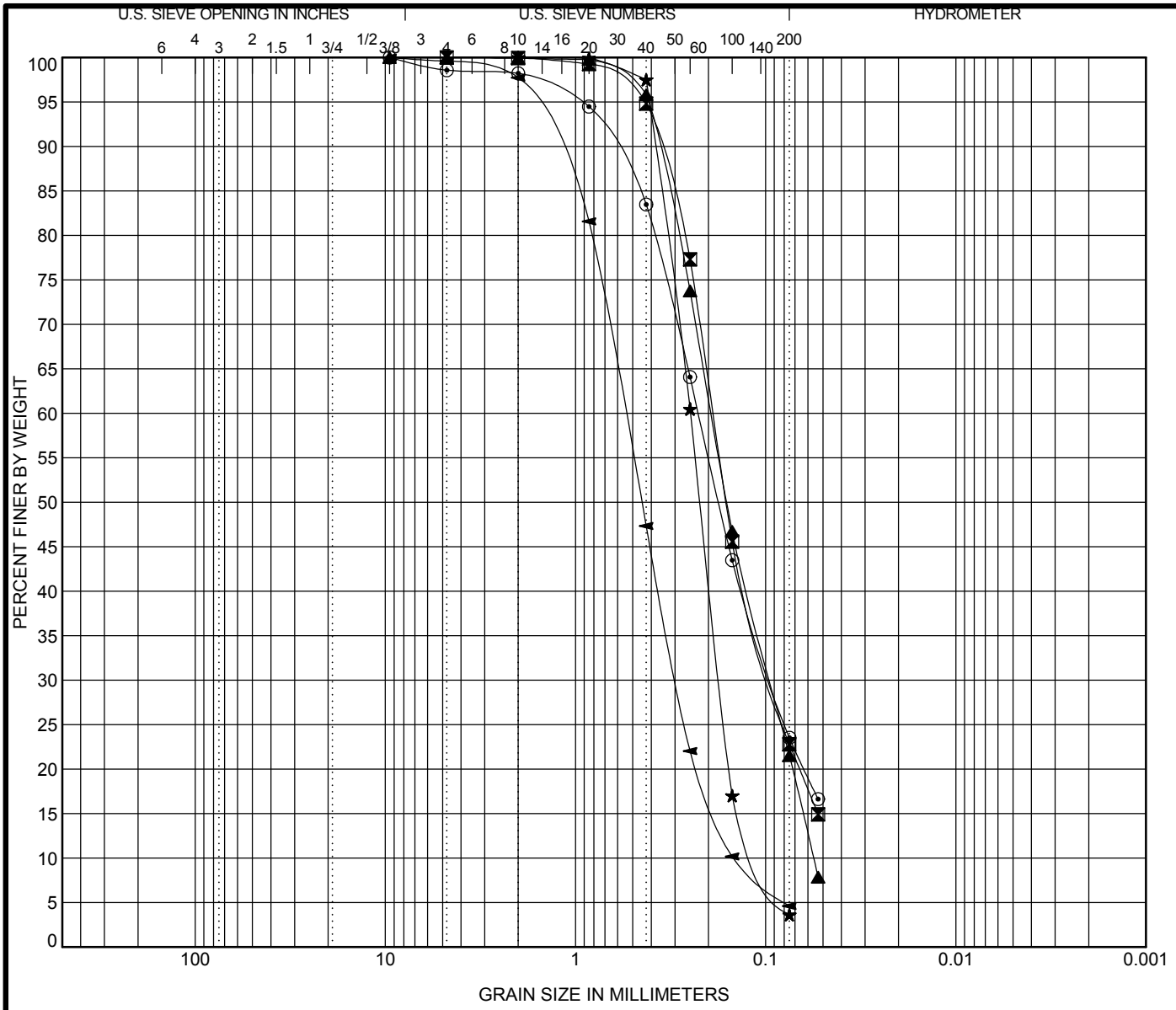
Daiblo Large Onsite Sewage System (LOSS)
Whatcom County

NS09065 U29 MG1 **FIGURE 9**

Logged by: AJC Reviewed by: CAN

LOG OF TEST PIT DIABLO AND NEWHALEM LOSS.GPJ TEMPL.GDT 3/26/13



	Sample ID	Depth	Classification	LL	PL	PI	Cc	Cu
◄	TP-1; 1	1.5	Brown, fine to medium SAND, trace fine gravel, coarse sand, and silt (SP)				1.1	3.7
⊠	TP-1; 2	3.8	Brown, SILTY fine SAND, trace medium sand (SM)					
▲	TP-2; 1	2.0	Brown, SILTY fine SAND, trace medium sand (SM)				0.8	3.4
★	TP-2; 2	3.4	Brown, fine SAND, trace medium sand and silt (SP)				1.2	2.4
⊙	TP-3; 1	2.0	Brown, SILTY fine to medium SAND, trace fine gravel and coarse sand (SM)					

	Sample ID	Depth	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
◄	TP-1; 1	1.5	9.5	0.55	0.3	0.147	0.4	95.0	4.6	
⊠	TP-1; 2	3.8	4.75	0.19	0.09		0.0	77.2	22.8	
▲	TP-2; 1	2.0	9.5	0.19	0.09	0.056	0.0	78.5	21.5	
★	TP-2; 2	3.4	2	0.25	0.17	0.104	0.0	96.4	3.6	
⊙	TP-3; 1	2.0	9.5	0.23	0.09		1.4	75.0	23.5	

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WA No.: NS09065 U29 MG1

GRAIN SIZE DISTRIBUTION (ASTM D422)

Daiblo Large Onsite Sewage System (LOSS)
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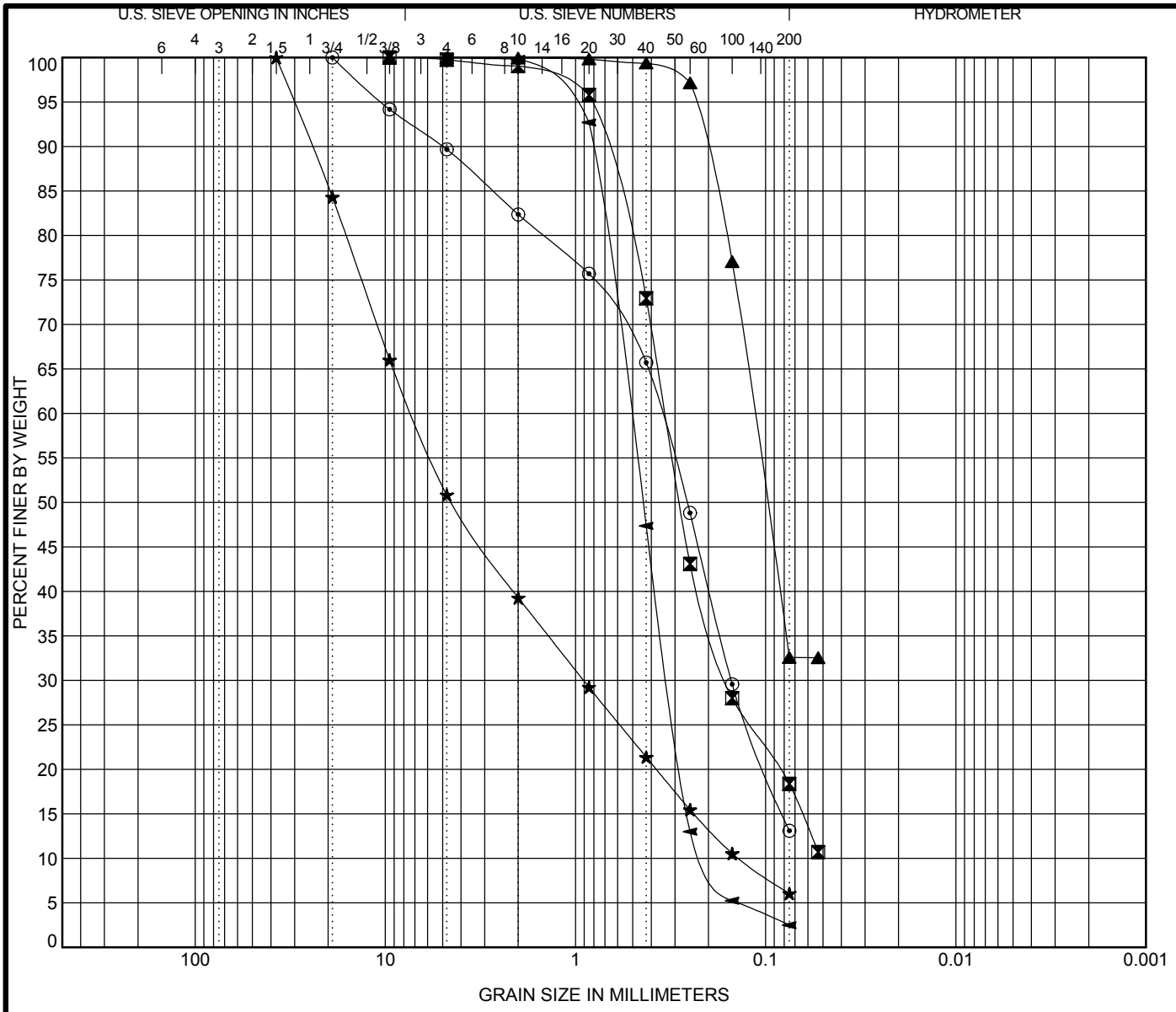
FIGURE: 10

US GRAIN SIZE DIABLO AND NEWHALEM LOSS.GPJ TEMPL.GDT 1/15/13



	Sample ID	Depth	Classification	LL	PL	PI	Cc	Cu
◄	TP-3; 2	3.2	Brown, fine to medium SAND, trace silt (SP)				1.0	2.5
⊠	TP-4; 1	3.9	Brown, SILTY fine to medium SAND (SM)					
▲	TP-5; 1	2.0	Brown, SILTY fine SAND (SM)					
★	TP-6; 1	2.7	Brown, GRAVEL WITH SILT AND SAND (GP-GM)				0.8	52.4
⊙	TP-7; 1	3.0	Brown, SILTY fine to medium SAND, few coarse sand and fine gravel (SM)					

	Sample ID	Depth	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
◄	TP-3; 2	3.2	4.75	0.52	0.33	0.205	0.0	97.5	2.5	
⊠	TP-4; 1	3.9	9.5	0.34	0.16		0.2	81.4	18.4	
▲	TP-5; 1	2.0	9.5	0.11			0.0	67.4	32.6	
★	TP-6; 1	2.7	37.5	7.22	0.91	0.138	49.2	44.8	6.1	
⊙	TP-7; 1	3.0	19	0.36	0.15		10.3	76.6	13.1	

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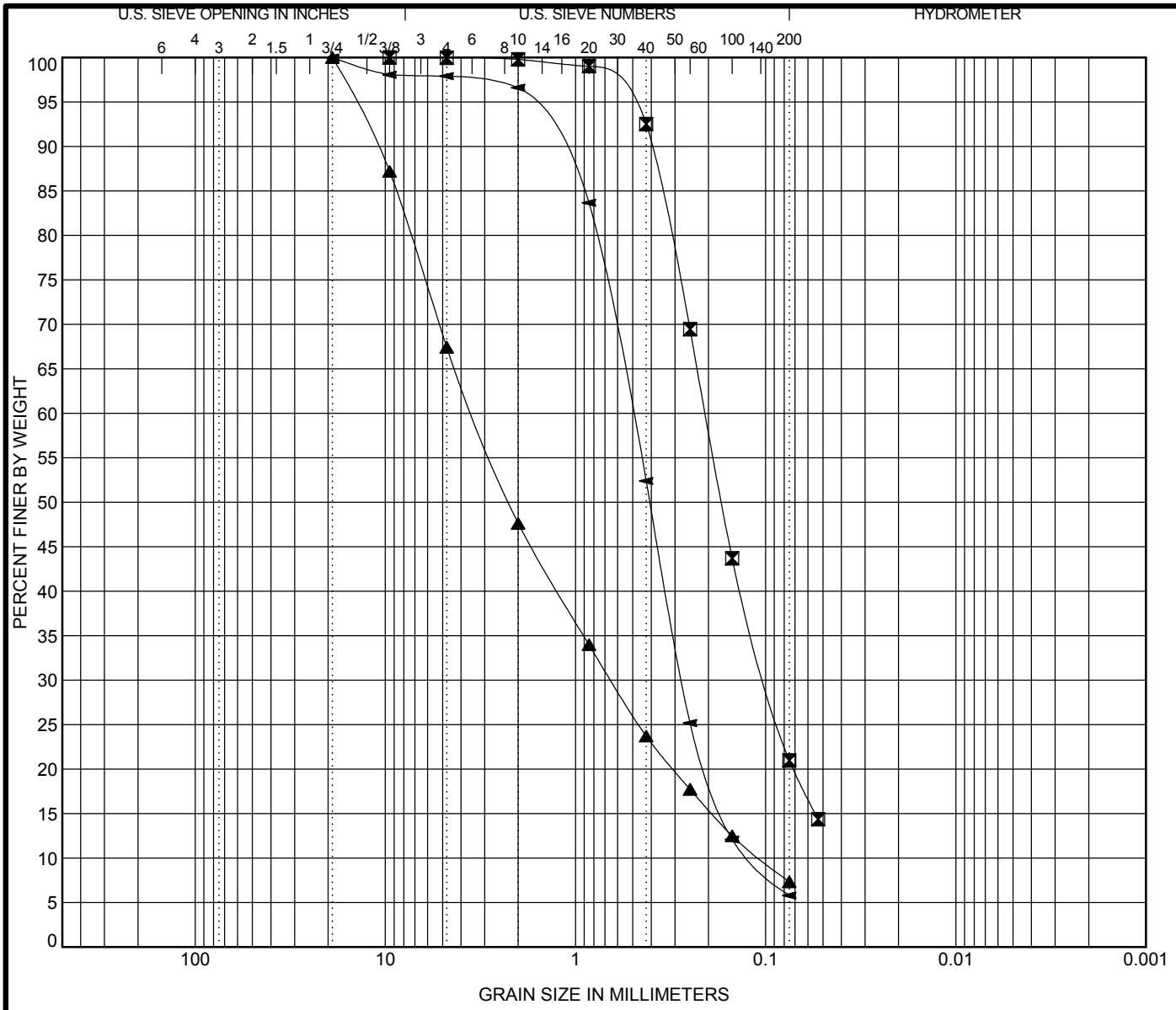
WA No.: NS09065 U29 MG1

GRAIN SIZE DISTRIBUTION (ASTM D422)

Daiblo Large Onsite Sewage System (LOSS)
Whatcom County

FIGURE: 11

US GRAIN SIZE DIABLO AND NEWHALEM LOSS.GPJ TEMPL.GDT 1/15/13



	Sample ID	Depth	Classification	LL	PL	PI	Cc	Cu
◄	TP-7; 2	4.5	Brown, fine to medium SAND WITH SILT, trace coarse sand and fine gravel (SP-SM)				1.3	4.2
⊠	TP-8; 1	3.8	Brown, SILTY fine SAND, few medium sand (SM)					
▲	TP-9; 1	4.2	Gray, SAND WITH SILT AND fine GRAVEL (SW-SM)				1.1	32.0

	Sample ID	Depth	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
◄	TP-7; 2	4.5	19	0.5	0.27	0.119	2.1	92.1	5.8	
⊠	TP-8; 1	3.8	9.5	0.21	0.1		0.0	79.0	21.0	
▲	TP-9; 1	4.2	19	3.44	0.65	0.107	32.6	60.1	7.3	

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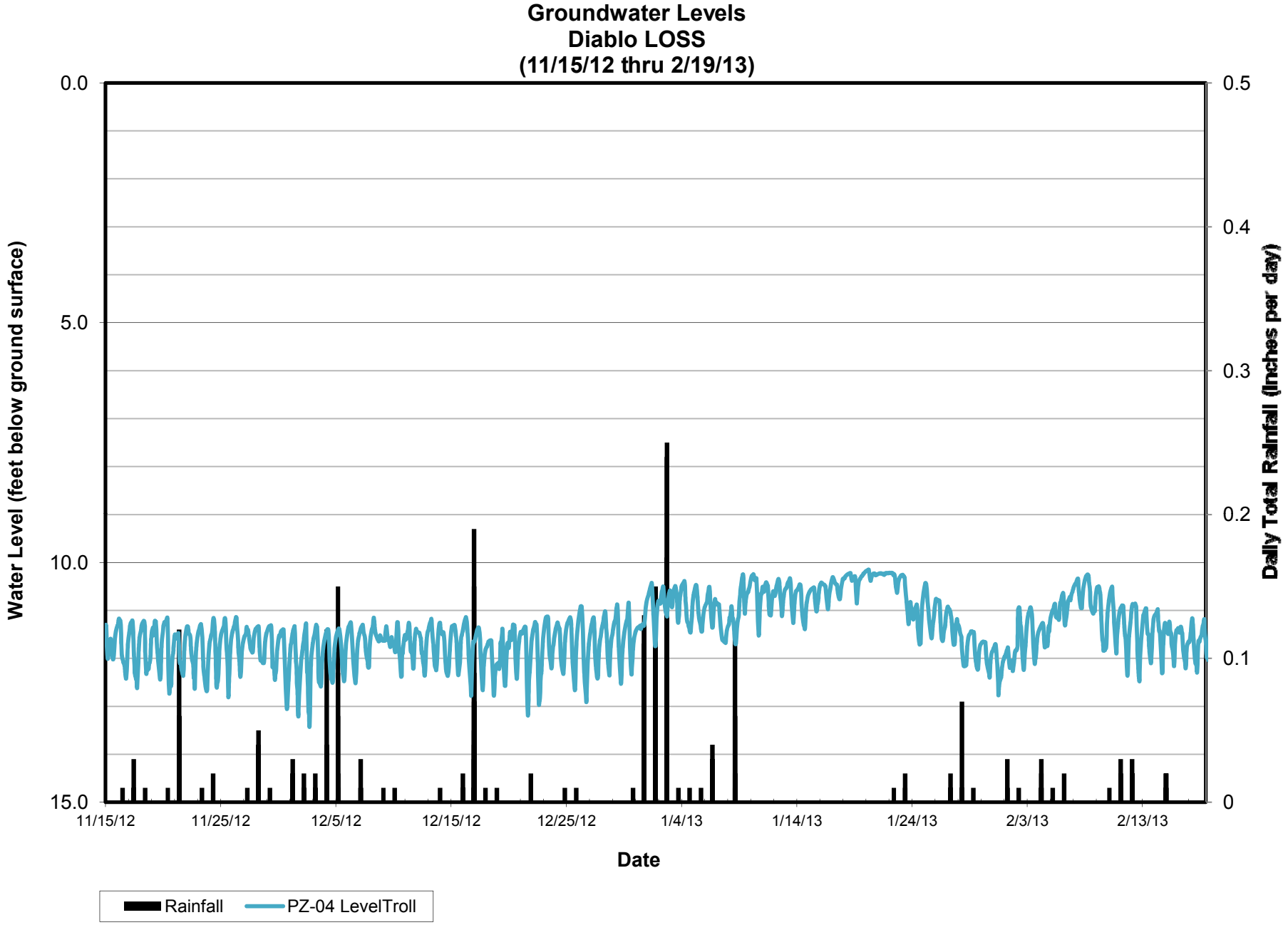
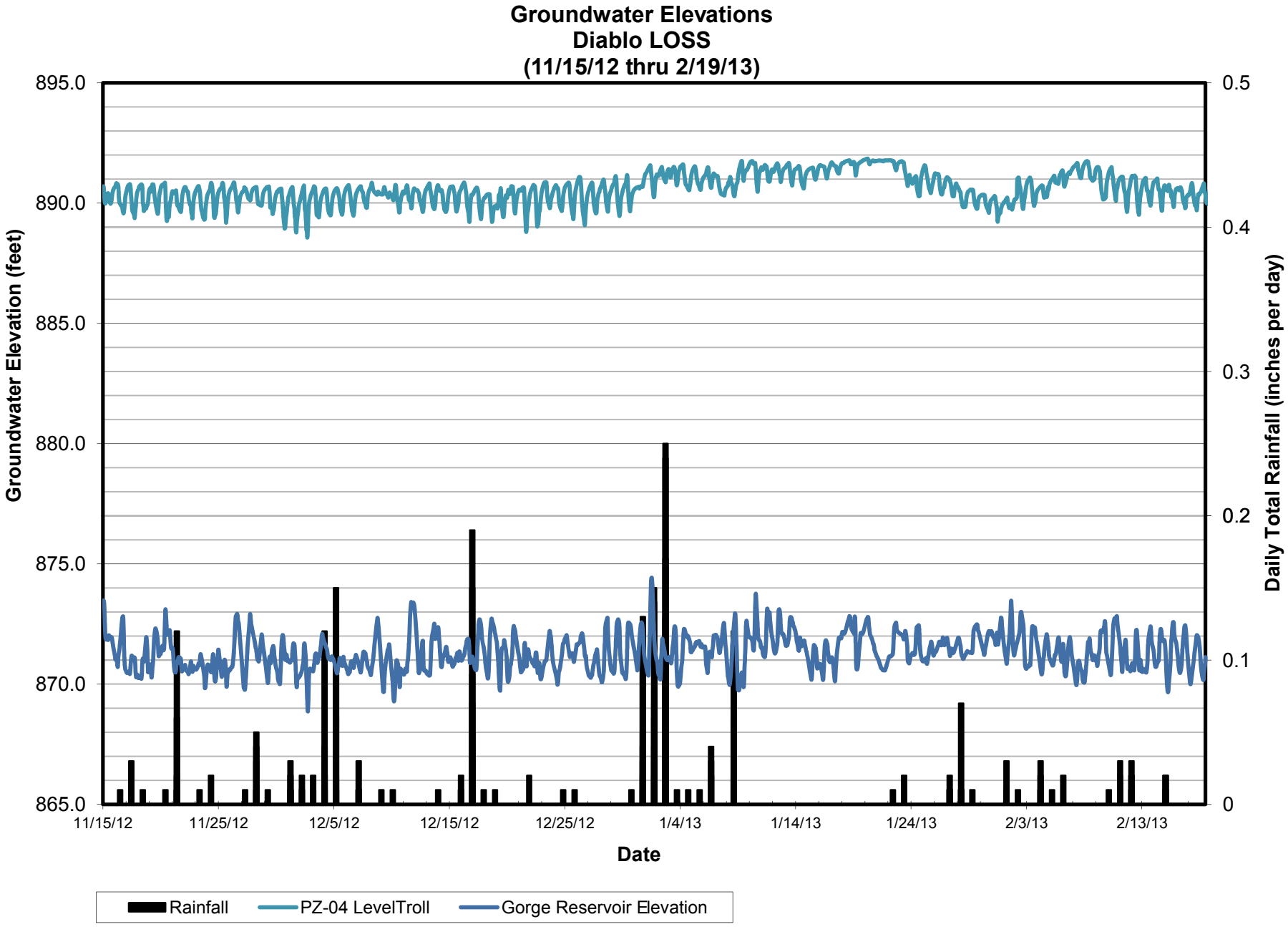
GRAIN SIZE DISTRIBUTION (ASTM D422)

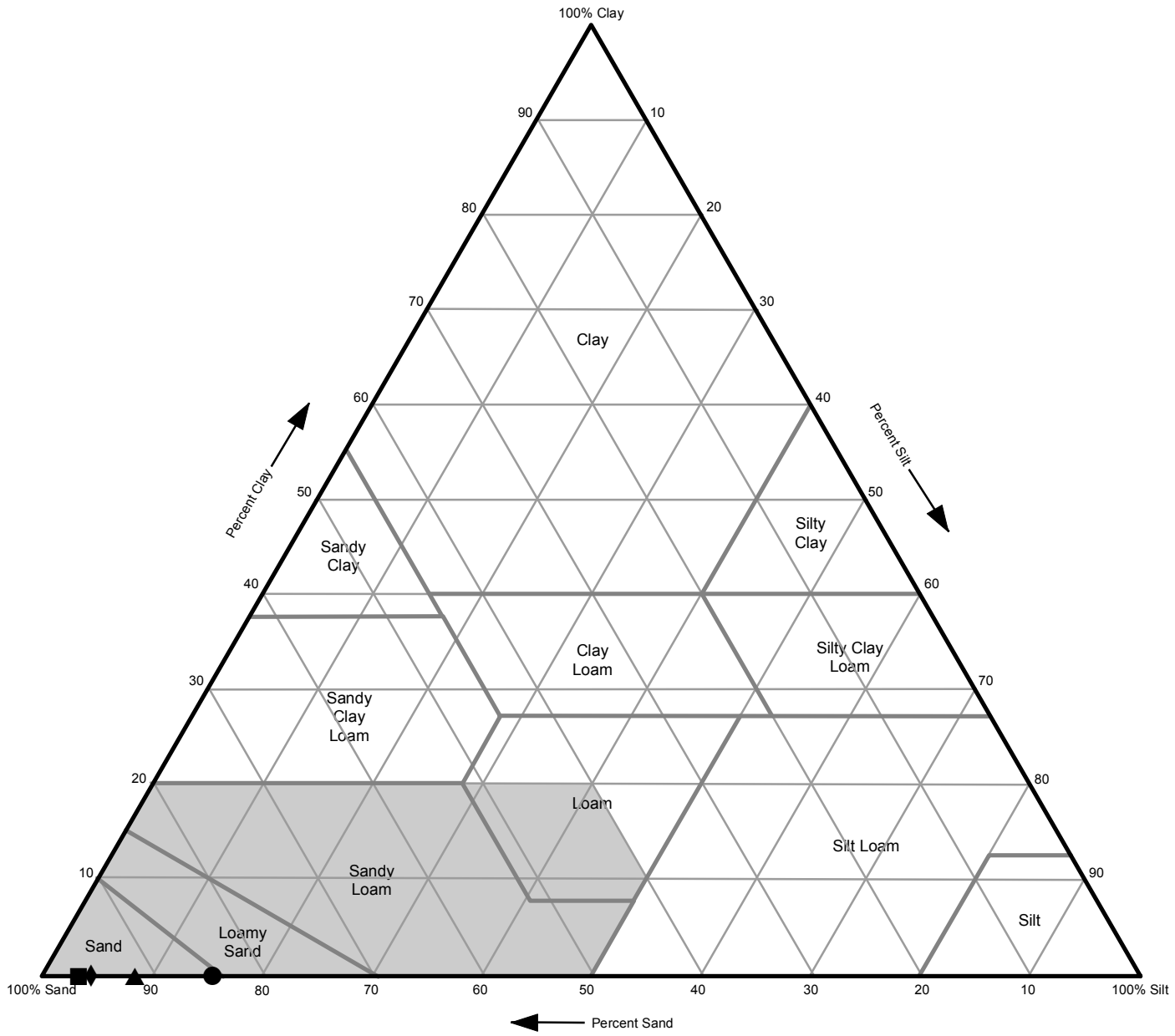
Daiblo Large Onsite Sewage System (LOSS)
Whatcom County

FIGURE: 12

US GRAIN SIZE DIABLO AND NEWHALEM LOSS.GPJ TEMPL.GDT 1/15/13


Groundwater Levels
Diablo LOSS
(11/15/12 thru 2/19/13)
Water Level (feet below ground surface)
0.0
5.0
10.0
15.0
Daily Total Rainfall (Inches per day)
0.5
0.4
0.3
0.2
0.1
0
11/15/12
11/25/12
12/5/12
12/15/12
12/25/12
1/4/13
1/14/13
1/24/13
2/3/13
2/13/13
Date
Rainfall
PZ-04 LevelTroll


Groundwater Elevations
Diablo LOSS
(11/15/12 thru 2/19/13)
Groundwater Elevation (feet)
895.0
890.0
885.0
880.0
875.0
870.0
865.0
Daily Total Rainfall (inches per day)
0.5
0.4
0.3
0.2
0.1
0
11/15/12
11/25/12
12/5/12
12/15/12
12/25/12
1/4/13
1/14/13
1/24/13
2/3/13
2/13/13
Date
Rainfall
PZ-04 LevelTroll
Gorge Reservoir Elevation



Shaded area is applicable for design of infiltration BMPs.

Legend

- ♦ TP-1, S-1, 1.5 ft bgs
- ● TP-1, S-2, 3.8 ft bgs
- ▲ TP-2, S-1, 2.0 ft bgs
- ■ TP-2, S-2, 3.4 ft bgs

NOTE: Adapted from U.S. Department of Agriculture, Figure 3.27 of 2005 Stormwater Management Manual for Western Washington: Volume III - Hydrologic Analysis and Flow Control BMPs.
bgs = below ground surface

Diablo Large Onsite Sewage System (LOSS)
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USDA Textural Triangle

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FIGURE 15
(Sheet 1 of 2)

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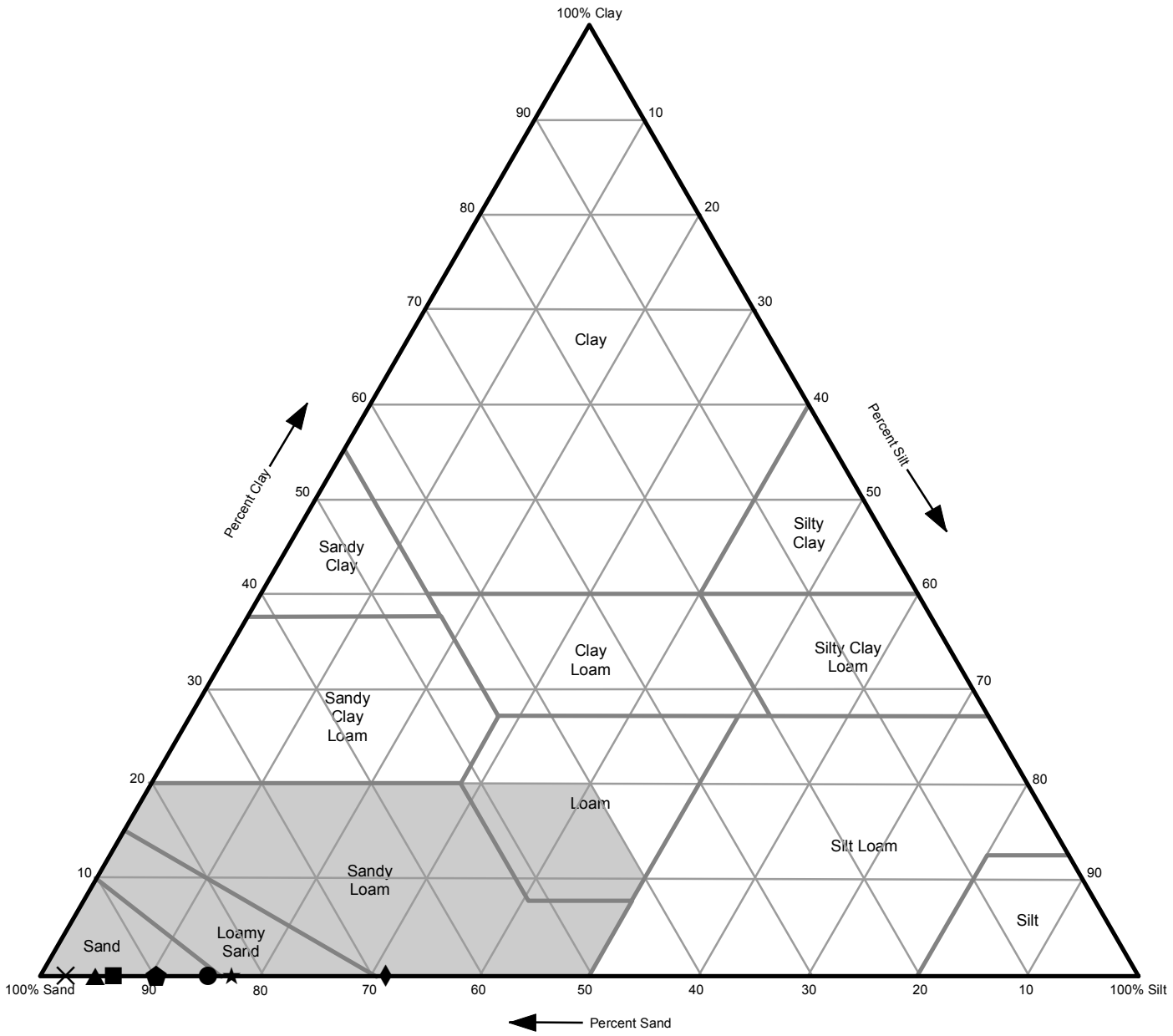

Shaded area is applicable for design of infiltration BMPs.

Legend

- ★ TP-3, S-1, 2.0 ft bgs
- × TP-3, S-2, 3.2 ft bgs
- ⬟ TP-4, S-1, 3.9 ft bgs
- ⧫ TP-5, S-1, 2.0 ft bgs
- ▲ TP-6, S-1, 2.7 ft bgs
- ⬟ TP-7, S-1, 3.0 ft bgs
- ▲ TP-7, S-2, 4.5 ft bgs
- ● TP-8, S-1, 3.8 ft bgs
- ■ TP-9, S-1, 4.2 ft bgs

NOTE: Adapted from U.S. Department of Agriculture, Figure 3.27 of 2005 Stormwater Management Manual for Western Washington: Volume III - Hydrologic Analysis and Flow Control BMPs.
bgs = below ground surface

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USDA Textural Triangle

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FIGURE 15
(Sheet 2 of 2)

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