Earth Solutions NW LLC
Geotechnical Engineering, Construction
Observation/Testing and Environmental Services

March 30, 2023
ES-8303

HC Homes, Inc.
P.O. Box 7707
Bonney Lake, Washington 98391

Attention: Mr. Roger Hebert

Subject: Infiltration Evaluation and Seasonal Groundwater Monitoring
Proposed Duplexes
433 and 409 – 43rd Avenue Southwest
Puyallup, Washington

Reference: CES NW, Inc.
Site Plan, dated January 20, 2022

J.E. Schuster et al.
Geologic Map of the Tacoma 1:100,000-scale Quadrangle, Washington, 2015

United States Department of Agriculture (USDA)
Natural Resources Conservation Service (NRCS)
Online Web Soil Survey (WSS) resource

Puyallup Municipal Code (PMC) Chapter 21.06 – Critical Areas

Liquefaction Susceptibility Map of Pierce County, dated September 2004

Washington State Department of Ecology
2014 Stormwater Management Manual for Western Washington (2014 SWMMWW)

Dear Mr. Hebert:

As requested, Earth Solutions NW, LLC (ESNW) has prepared this letter for the proposed project. The letter was prepared in general accordance with the scope of services outlined in our proposal dated November 15, 2021, which was authorized by you on November 19, 2021. A summary of the subsurface explorations on site and geotechnical recommendations to aid with site design are provided in this letter.

Project Description

According to the referenced site plan, the currently unimproved site will be developed with two duplex structures, proposed within roughly the southern quarter of the site, along with associated improvements. Each duplex will be two stories. Four dispersion trenches (with 50-foot flowpaths toward the wetland) and an infiltration gallery are proposed. It is noted that, per discussion with the civil engineer, certain elements of design and/or the site layout (as shown on the referenced site plan) had not been finalized as of the date of this letter, including the driveway layout and the locations of the dispersion trenches and infiltration gallery. A 60-foot wetland buffer has been incorporated into the site plan.

Surface Conditions

The subject site is located on the north side of 43rd Avenue Southwest, between 98th Avenue East and 99th Avenue Court East, in Puyallup, Washington. The approximate location of the property is illustrated on Plate 1 (Vicinity Map). The site consists of two adjacent tax parcels (Pierce County Parcel No. 041909-5003 and -5022), totaling roughly 2.5 acres. The existing topography descends generally from south to north, with an estimated 10 to 15 feet of elevation change across the parcels. A wetland and associated buffer encompass most of the site, with only the southern site area and eastern site margin located outside of the wetland and buffer. The site is moderately to heavily vegetated and undeveloped.

Subsurface Conditions

An ESNW representative observed, logged, and sampled five test pits on December 8, 2021. Four additional test pits, three of which had standpipe piezometers installed for seasonal groundwater monitoring purposes, were excavated on January 13, 2022. The test pits were excavated within accessible site areas, using a mini trackhoe and operator retained by ESNW. The test pits were completed to evaluate and classify site soils, characterize groundwater conditions within accessible site areas, and perform in-situ infiltration testing.

The approximate locations of the test pits are depicted on Plate 2 (Test Pit Location Plan). Please refer to the attached test pit logs for a more detailed description of subsurface conditions. Representative soil samples collected at the test pit locations were analyzed in general accordance with both Unified Soil Classification System (USCS) and USDA methods and procedures.

Topsoil and Fill

Where encountered at surface grades, the topsoil was about six to eight inches thick. The topsoil was characterized by the observed dark brown hue, the presence of fine organics, and small root intrusions.

Fill was encountered at test pit locations TP-2, TP-3, TP-4, TP-5, TP-8, and TP-9 to depths of about six to nine-and-one-half feet below the existing ground surface (bgs). The fill was characterized as silty sand with and without gravel, primarily in a loose to medium dense and damp to moist condition. Small pieces of asphalt, wood, and plastic were observed in the fill.

Native Soil

Underlying the topsoil and fill, native soil consisted primarily of silty sands with gravel (USCS: SM), with well-graded gravels with sand (USCS: GW) present along the western end of the site. The in-situ density of the native soil was characterized primarily as medium dense to dense, and the in-situ moisture content was observed to be damp to wet at the time of exploration. The maximum exploration depth was approximately 11 feet bgs.

Geologic Setting

The referenced geologic map resource identifies recessional outwash (Qgo) as the primary native soil unit underlying the subject site and proximate areas. As reported on the geologic map resource, recessional outwash is typically composed of silts, sands, and gravels deposited by glacial meltwater. The referenced WSS resource identifies Everett very gravelly sandy loam as the primary soil unit underlying the subject development area. The Everett series was formed in glacial drift plains. Based on our field observations, the on-site native soil is consistent with the local geologic mapping of recessional outwash.

Groundwater

The groundwater table was encountered at test pits TP-1, TP-2, TP-4, and TP-7 during the December 2021 and January 2022 explorations. At the time of the explorations, the groundwater table was observed at depths of about 8 to 11 feet bgs. Shallow groundwater seepage was observed at TP-6 at a depth of roughly seven feet bgs during the January 2022 exploration.

To supplement the field observations, ESNW was contracted to complete a groundwater monitoring program through most of the 2021–2022 wet season. The program consisted of installing three standpipe piezometers (at TP-6, TP-8, and TP-9) for groundwater monitoring purposes. The piezometers were arranged in a triangular array across the proposed development area.

After the installation of the groundwater wells on January 13, 2022, ESNW personnel visited the site periodically (about twice per month), through the end of the wet season, to collect data and perform manual measurements at each monitoring location using a depth-to-water meter. Upon review of the data collected at the piezometers using dataloggers, it was determined the data was corrupt and unreliable, e.g., the dataloggers were indicating groundwater levels far shallower than those measured manually. As such, the manual measurements were relied upon for purposes of evaluating the seasonal high groundwater table. The tables below summarize the groundwater data collected during the monitoring program.

Test Pit	Depth of Test Pit (ft)	Ground Elevation* (ft)	Peak GWT Depth (ft bgs)	Peak GWT Elevation* (ft)	Peak Date
TP-6	8.0	434	6.75	427.25	03/17/2022
TP-8	7.5	435	N/A	N/A	N/A
TP-9	9.0	435	N/A	N/A	N/A

* *Ground elevations are approximate and based on readily available topographic survey data. The test pit locations were not surveyed.*

Date of Manual Measurement	TP-6 GWT (ft bgs)	TP-8 GWT (ft bgs)	TP-9 GWT (ft bgs)
01/13/2022	(Dry)	(Dry)	(Dry)
02/04/2022	7.1	(Dry)	(Dry)
02/24/2022	7.0	(Dry)	(Dry)
03/17/2022	6.7	(Dry)	(Dry)
04/07/2022	6.9	(Dry)	(Dry)

Based on our field observations and monitoring, the following recommendations are offered:

- Groundwater was not observed within the monitored depths of the standpipe piezometers at TP-8 and TP-9. Therefore, it is our opinion the seasonal high groundwater table elevation occurs at a depth of not higher than 7.5 feet bgs in the south-central and southeast areas of the site.

- The recommended seasonal high groundwater table elevation within the southwest site area (near TP-6) is 6.7 feet bgs.

Geologically Hazardous Areas

ESNW reviewed the referenced Puyallup Municipal Code (PMC) chapter and the City of Puyallup interactive GIS resource to evaluate the presence of geologically hazardous areas on site. PMC 21.06.1210 recognizes erosion, landslide, seismic, and volcanic hazard areas as geologically hazardous. Based on our review, a small area of moderate (shallow) landslide hazard is mapped on site. The location of the mapped hazard area appears to coincide with the location of the wetland. No other geologically hazardous areas are recognized or mapped on site.

Landslide hazard areas are defined in PMC 21.06.1210(3)(b) as areas subject to landslides based on a combination of geologic, topographic, and hydrologic factors. The most relevant hazard criteria to the subject site include PMC 21.06.1210(3)(b)(ii) and 21.06.1210(3)(b)(ix), which characterize landslide hazard (in part) by slope gradient. Based on review of the referenced site plan, the site does not contain slopes steeper than 15 percent over a vertical relief of 10 feet. As such, it is our opinion the site does not meet the PMC definition of a landslide hazard area.

According to PMC 21.06.1210(3)(c), seismic hazard areas are defined as "areas subject to severe risk of damage as a result of earthquake-induced ground shaking, slope failure, settlement or subsidence, soil liquefaction, or tsunamis." The referenced liquefaction susceptibility map indicates the site and surrounding areas possess very low liquefaction susceptibility. Based on our field observations, it is our opinion that the site is correctly mapped as not located within a seismic hazard area.

Geotechnical Recommendations

Based on our investigation, the proposed residential development is feasible from a geotechnical standpoint. The primary geotechnical considerations for the proposal are associated with structural fill placement and compaction, earthwork and grading activities, foundation support, stormwater management, and drainage. Based on our field observations and understanding of the proposed development, pertinent geotechnical recommendations and design parameters are presented in the following sections.

In-situ and Imported Soil

From a geotechnical standpoint, in general, our field observations indicate on-site soils likely to be encountered during construction will not be suitable for use as structural fill unless the in-situ soil moisture content is at (or slightly above) the optimum level at the time of placement and compaction. Successful use of on-site soils as structural fill will largely be dictated by the moisture content at the time of placement and compaction. It should be noted that most of the on-site soil is moisture sensitive (silty sand). However, areas of well-drained gravels, where encountered, are not considered moisture sensitive.

As discussed in the *Topsoil and Fill* section above, artificial fill soils were encountered at several test locations. Various amounts of debris, including asphalt, wood, and plastic were observed in the fill. To be suitable for reuse as structural fill, the existing fill must be primarily free of debris (both organic and inorganic) and deleterious material; as such, efforts to screen and remove the observed debris should be incorporated into construction activities if the existing fill will be considered for reuse as structural fill. ESNW should be retained to observe earthwork, grading, and/or screening activities pertaining to the existing fill during construction, as necessary.

Performing grading activities during summer months of relatively low rainfall activity is recommended to minimize site degradation. In our opinion, a contingency should be provided in the project budget for the export of soil that cannot be successfully compacted as structural fill, particularly if grading activities take place during periods of extended rainfall activity. In general, soil with an appreciable fines content (greater than 5 percent) typically degrades rapidly when exposed to periods of rainfall.

Imported soil intended for use as structural fill should be evaluated by ESNW during construction. The imported soil must be able to achieve the necessary moisture content, as determined by the Modified Proctor Method (ASTM D1557), at the time of placement and compaction. During wet weather conditions, imported soil intended for use as structural fill should consist of a well-graded, granular soil with a fines content of 5 percent or less (where the fines content is defined as the percent passing the Number 200 sieve, based on the minus three-quarter-inch fraction).

Structural Fill

Structural fill is defined as compacted soil placed in foundation, slab-on-grade, roadway, permanent slope, retaining wall, and utility trench backfill areas. Structural fill placed and compacted during site grading activities should meet the following specifications:

- Structural fill material — Granular soil
- Moisture content — At or slightly above optimum
- Relative compaction (minimum) — 95 percent (Modified Proctor)
- Loose lift thickness (maximum) — 12 inches

The existing soil may not be suitable for use as structural fill unless the in-situ moisture content is at (or slightly above) the optimum moisture content at the time of placement and compaction. Soil shall not be placed dry of the optimum moisture content and should be evaluated by ESNW during construction. With respect to underground utility installations and backfill, local jurisdictions may dictate the soil type(s) and compaction requirements. Unsuitable material or debris must be removed from structural areas, if encountered.

Foundations

The proposed residential structures may be supported on conventional continuous and spread footing foundations bearing on either suitably compact structural fill or competent native soil. Because the existing fill thicknesses across the site are relatively significant, it is difficult to estimate a consistent depth where suitable bearing soil is likely to be encountered. For preliminary design purposes, ESNW recommends an overexcavation depth of two feet as well as placement of a biaxial geotextile at the overexcavated subgrade elevation be incorporated into the plans.

Existing fill intended for reuse as structural fill must be free of debris and should be evaluated by ESNW prior to use. In general, if loose or unsuitable soil conditions are exposed at foundation subgrade elevations, additional mechanical compactive effort or overexcavation and replacement with suitable structural fill will likely be necessary.

Provided foundations will be supported as prescribed, the following parameters may be used for design:

- Allowable soil bearing capacity 2,500 psf
- Passive earth pressure 300 pcf (equivalent fluid)
- Coefficient of friction 0.40

A one-third increase in the allowable soil bearing capacity may be assumed for short-term wind and seismic loading conditions. The above passive pressure and friction values include a factor-of-safety of 1.5. With structural loading as expected, about one inch of total static settlement and about one-half inch of differential static settlement is anticipated. Most of the anticipated settlement should occur during construction when dead loads are applied.

Seismic Design

The 2018 International Building Code (2018 IBC) recognizes the most recent edition of the Minimum Design Loads for Buildings and Other Structures manual (ASCE 7-16) for seismic design, specifically with respect to earthquake loads. Based on the soil conditions encountered at the test pit locations, the parameters and values provided below are recommended for seismic design per the 2018 IBC.

Parameter	**Value**
Site Class	D*
Mapped short period spectral response acceleration, S_S (*g*)	1.262
Mapped 1-second period spectral response acceleration, S_1 (*g*)	0.436
Short period site coefficient, F_a	1.0
Long period site coefficient, F_v	1.864†
Adjusted short period spectral response acceleration, S_{MS} (*g*)	1.262
Adjusted 1-second period spectral response acceleration, S_{M1} (*g*)	0.813†
Design short period spectral response acceleration, S_{DS} (*g*)	0.841
Design 1-second period spectral response acceleration, S_{D1} (*g*)	0.542†

* *Assumes dense native soil conditions, encountered to a maximum depth of 11 feet bgs during the December 2021 and January 2022 field explorations, remain dense to at least 100 feet bgs.*

† *Values assume F_v may be determined using linear interpolation per Table 11.4-2 in ASCE 7-16.*

As indicated in the table footnote, several of the seismic design values provided above are dependent on the assumption that site-specific ground motion analysis (per Section 11.4.8 of ASCE 7-16) will not be required for the subject project. ESNW recommends the validity of this assumption be confirmed at the earliest available opportunity during the planning and early design stages of the project. Further discussion between the project structural engineer, the project owner, and ESNW may be prudent to determine the possible impacts to the structural design due to increased earthquake load requirements under the 2018 IBC. ESNW can provide additional consulting services to aid with design efforts, including supplementary geotechnical and geophysical investigation, upon request.

Liquefaction is a phenomenon where saturated or loose soil suddenly loses internal strength and behaves as a fluid. This behavior is in response to increased pore water pressures resulting from an earthquake or another source of intense ground shaking. As mentioned in the *Geologically Hazardous Areas* section of this letter, it is our opinion site susceptibility to liquefaction is low. The relatively consistent density of the native soils was the primary basis for this opinion.

Slab-on-Grade Floors

Slab-on-grade floors for the proposed residential structure should be supported on firm and unyielding subgrades comprised of competent native soil, compacted structural fill, or new structural fill. Unstable or yielding subgrade areas should be recompacted or overexcavated and replaced with suitable structural fill prior to slab construction.

A capillary break, consisting of at least four inches of free-draining crushed rock or gravel, should be placed below each slab. The free-draining material should have a fines content of 5 percent or less (where the fines content is defined as the percent passing the Number 200 sieve, based on the minus three-quarter-inch fraction). In areas where slab moisture is undesirable, installation of a vapor barrier below each slab should be considered. If a vapor barrier is to be utilized, it should be a material specifically designed for use as a vapor barrier and should be installed in accordance with the specifications of the manufacturer.

Retaining Walls

Retaining walls must be designed to resist earth pressures and applicable surcharge loads. The following parameters may be used for design:

- Active earth pressure (unrestrained condition) 35 pcf (equivalent fluid)
- At-rest earth pressure (restrained condition) 55 pcf
- Traffic surcharge* (passenger vehicles) 70 psf (rectangular distribution)
- Passive earth pressure 300 pcf (equivalent fluid)
- Coefficient of friction 0.40
- Seismic surcharge 8H psf†

* *Where applicable.*
† *Where H equals the retained height (in feet).*

The above design parameters are based on a level backfill condition and level grade at the wall toe. Revised design values will be necessary if sloping grades are to be used above or below retaining walls. Additional surcharge loading from adjacent foundations, sloped backfill, or other relevant loads should be included in the retaining wall design.

Retaining walls should be backfilled with free-draining material that extends along the height of the wall and a distance of at least 18 inches behind the wall. The upper 12 inches of the wall backfill may consist of a less permeable soil, if desired. A perforated drainpipe should be placed along the base of the wall and connected to an approved discharge location. A typical retaining wall drainage detail is provided on Plate 3. If drainage is not provided, hydrostatic pressures should be included in the wall design.

Drainage

Groundwater will likely be encountered in site excavations, especially those necessary to construct utility trenches. Temporary measures to control surface water runoff and groundwater during construction would likely involve interceptor trenches and sumps. ESNW should be consulted during preliminary grading to both identify areas of seepage and provide recommendations to reduce the potential for seepage-related instability.

Finish grades must be designed to direct surface drain water away from structures and slopes. Water must not be allowed to pond adjacent to structures. In our opinion, foundation drains should be installed along building perimeter footings. A typical foundation drain detail is provided on Plate 4.

Infiltration Evaluation

In accordance with the requirements of the referenced 2014 SWMMWW, which is adopted by the City of Puyallup, one small-scale Pilot Infiltration Test (PIT) was completed during the January 2022 fieldwork. The PIT was completed at TP-7 at a depth of about four feet bgs. Per the 2014 SWMMWW, the measured infiltration rate must be reduced by correction factors that account for site variability and number of locations tested (CF_v), test method (CF_t), and the degree of influent control to prevent siltation and bio-buildup (CF_m). The following is a summary of the measured rate, applicable correction factors, and the recommended design rate:

- K_{sat} initial (measured rate at TP-7) — 600 inches per hour (in/hr)
- CF_t — 0.5 (small-scale PIT)
- CF_v — 0.7
- CF_m — 0.9
- K_{sat} design (calculated rate) — 30 in/hr*

* *Recommended maximum (capped) design infiltration rate.*

Based on the field investigations, the above infiltration rate is applicable only within the southwest site corner (in the area of TP-1, TP-6, and TP-7). Elsewhere on site, infiltration is not feasible from a geotechnical standpoint given the widespread existing fill and the presence of relatively impermeable native soil at depth.

ESNW should be contacted to review stormwater management plans if infiltration is used for design. Supplementary recommendations and/or testing may be necessary depending on the size, depth, and siting of infiltration facilities.

Dispersion Feasibility

Based on our field observations of on-site conditions and the subsurface makeup, it is our opinion that dispersion is feasible from a geotechnical standpoint. The erosion potential of the vegetated flow paths can be considered low provided proper vegetation is maintained and/or reestablished (as needed). This opinion is based on the depicted siting of the dispersion trenches (per the referenced site plan) and the relatively stable nature of the native soils, which are not likely to be adversely affected from a dispersion scheme. Where fill will be present underlying dispersion systems, ESNW should be contacted to review the proposed layouts and provide recommendations, as necessary, to ensure adequate long-term performance. We anticipate a portion of the outflow will infiltrate into the substratum as interflow.

Limitations & Additional Services

This letter has been prepared for the exclusive use of HC Homes, Inc., and its representatives. No warranty, express or implied, is made. The recommendations and conclusions provided in this letter are professional opinions consistent with the level of care and skill that is typical of other members in the profession currently practicing under similar conditions in this area. Variations in the soil and groundwater conditions encountered at the test pit locations may exist and may not become evident until construction. ESNW should reevaluate the contents of this letter if variations are encountered during construction, or if the design assumptions outlined herein either change or are incorrect.

ESNW should have an opportunity to review final project plans with respect to the geotechnical recommendations provided in this report. ESNW should also be retained to provide testing and consultation services during construction. Provided that ESNW is retained during construction, we can provide supplementary geotechnical recommendations, as necessary, where differing soil conditions are encountered.

We trust this letter meets your current needs. Please call if you have any questions about this letter or if we can be of further assistance.

Sincerely,

EARTH SOLUTIONS NW, LLC

Steven K. Hartwig, G.I.T.
Staff Geologist

Keven D. Hoffmann, P.E.
Associate Principal Engineer

Attachments: Plate 1 – Vicinity Map
Plate 2 – Test Pit Location Plan
Plate 3 – Retaining Wall Drainage Detail
Plate 4 – Footing Drain Detail
Test Pit Logs
Grain Size Distribution

cc: CES NW, Inc.
Attention: Mr. Craig Deaver (Email only)
Mr. Eric Oehler, P.E. (Email only)
Ms. Dawn Markakis (Email only)

HC Homes, Inc.
Attention: Mr. Gregg Johnson (Email only)

Reference:
Pierce County, Washington
OpenStreetMap.org

NORTH

NOTE: This plate may contain areas of color. ESNW cannot be responsible for any subsequent misinterpretation of the information resulting from black & white reproductions of this plate.

Earth Solutions NW LLC

Geotechnical Engineering, Construction Observation/Testing and Environmental Services

Vicinity Map
Puyallup Duplex
Puyallup, Washington

Drwn. CAM	Date 02/18/2022	Proj. No. 8303
Checked SKH	Date Feb. 2022	Plate 1

LEGEND

TP-1 — Approximate Location of ESNW Test Pit, Proj. No. ES-8303, Dec. 2021 & Jan. 2022

Subject Site

Proposed Building

Existing Building

Wetland (Delineated by Others)

NORTH

1"=100'

0 50 100 200

Scale in Feet

NOTE: The graphics shown on this plate are not intended for design purposes or precise scale measurements, but only to illustrate the approximate test locations relative to the approximate locations of existing and / or proposed site features. The information illustrated is largely based on data provided by the client at the time of our study. ESNW cannot be responsible for subsequent design changes or interpretation of the data by others.

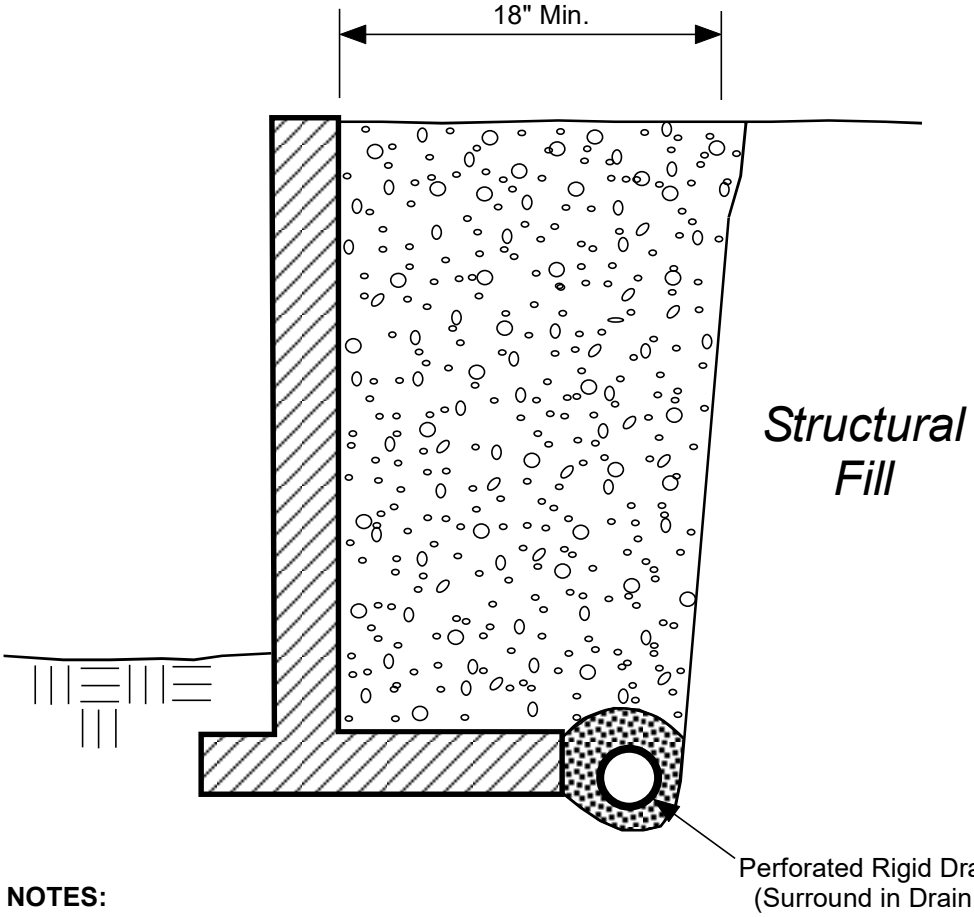
NOTE: This plate may contain areas of color. ESNW cannot be responsible for any subsequent misinterpretation of the information resulting from black & white reproductions of this plate.

Earth Solutions NW LLC

Geotechnical Engineering, Construction Observation/Testing and Environmental Services

Test Pit Location Plan
Puyallup Duplex
Puyallup, Washington

Drwn. CAM	Date 03/27/2023	Proj. No. 8303
Checked SKH	Date Mar. 2023	Plate 2



NOTES:

- Free-draining Backfill should consist of soil having less than 5 percent fines. Percent passing No. 4 sieve should be 25 to 75 percent.
- Sheet Drain may be feasible in lieu of Free-draining Backfill, per ESNW recommendations.
- Drain Pipe should consist of perforated, rigid PVC Pipe surrounded with 1-inch Drain Rock.

SCHEMATIC ONLY - NOT TO SCALE
NOT A CONSTRUCTION DRAWING

LEGEND:

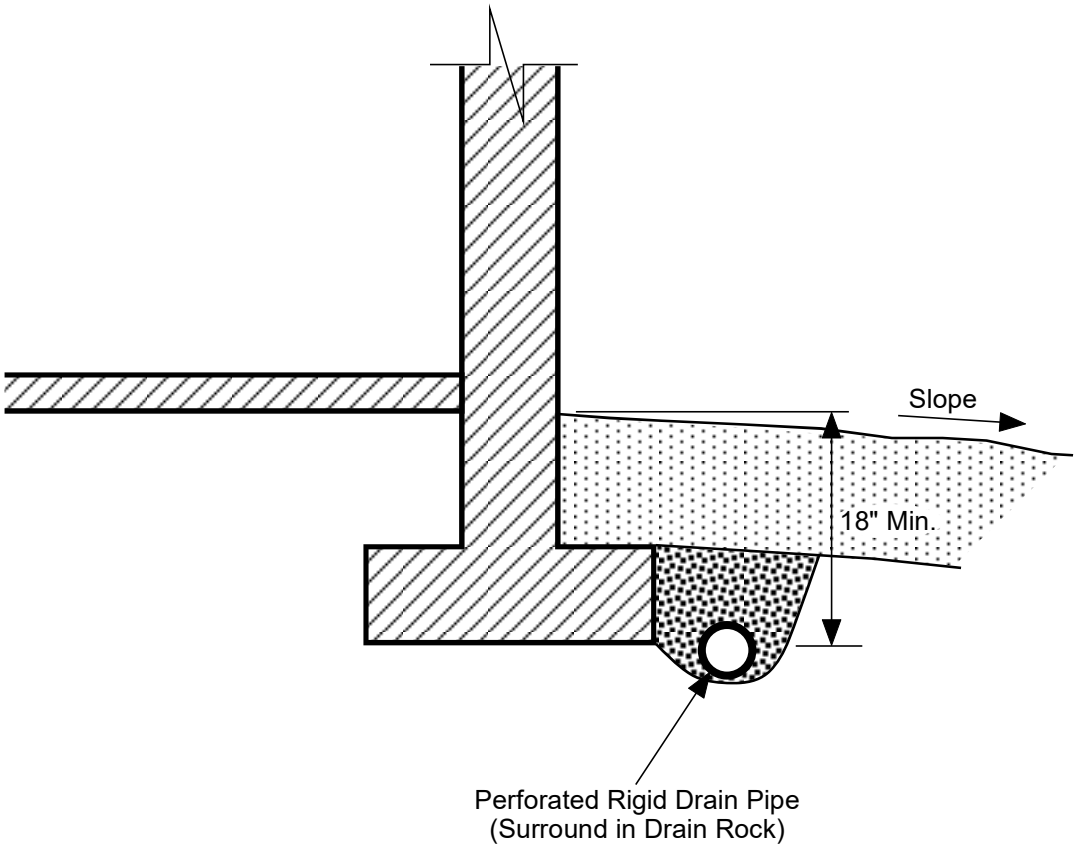
Free-draining Structural Backfill

1-inch Drain Rock

Earth Solutions NW LLC
Geotechnical Engineering, Construction Observation/Testing and Environmental Services

Retaining Wall Drainage Detail
Puyallup Duplex
Puyallup, Washington

Drwn. CAM	Date 02/18/2022	Proj. No. 8303
Checked SKH	Date Feb. 2022	Plate 3



NOTES:

- Do NOT tie roof downspouts to Footing Drain.
- Surface Seal to consist of 12" of less permeable, suitable soil. Slope away from building.

SCHEMATIC ONLY - NOT TO SCALE
NOT A CONSTRUCTION DRAWING

LEGEND:

Surface Seal: native soil or other low-permeability material.

1-inch Drain Rock

Earth Solutions NW LLC
Geotechnical Engineering, Construction Observation/Testing and Environmental Services

Footing Drain Detail
Puyallup Duplex
Puyallup, Washington

Drwn. CAM	Date 02/18/2022	Proj. No. 8303
Checked SKH	Date Feb. 2022	Plate 4

Coarse-Grained Soils - More Than 50% Retained on No. 200 Sieve	Gravels - More Than 50% of Coarse Fraction Retained on No. 4 Sieve	< 5% Fines	GW	Well-graded gravel with or without sand, little to no fines
			GP	Poorly graded gravel with or without sand, little to no fines
		> 12% Fines	GM	Silty gravel with or without sand
			GC	Clayey gravel with or without sand
	Sands - 50% or More of Coarse Fraction Passes No. 4 Sieve	< 5% Fines	SW	Well-graded sand with or without gravel, little to no fines
			SP	Poorly graded sand with or without gravel, little to no fines
		> 12% Fines	SM	Silty sand with or without gravel
			SC	Clayey sand with or without gravel
Fine-Grained Soils - 50% or More Passes No. 200 Sieve	Silts and Clays Liquid Limit Less Than 50		ML	Silt with or without sand or gravel; sandy or gravelly silt
			CL	Clay of low to medium plasticity; lean clay with or without sand or gravel; sandy or gravelly lean clay
			OL	Organic clay or silt of low plasticity
	Silts and Clays Liquid Limit 50 or More		MH	Elastic silt with or without sand or gravel; sandy or gravelly elastic silt
			CH	Clay of high plasticity; fat clay with or without sand or gravel; sandy or gravelly fat clay
			OH	Organic clay or silt of medium to high plasticity
Highly Organic Soils			PT	Peat, muck, and other highly organic soils
Fill			FILL	Made Ground

Moisture Content

Dry - Absence of moisture, dusty, dry to the touch

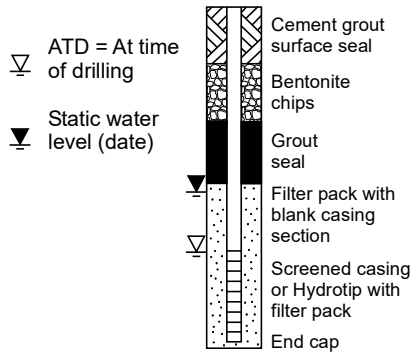
Damp - Perceptible moisture, likely below optimum MC

Moist - Damp but no visible water, likely at/near optimum MC

Wet - Water visible but not free draining, likely above optimum MC

Saturated/Water Bearing - Visible free water, typically below groundwater table

Symbols



Terms Describing Relative Density and Consistency

Coarse-Grained Soils:

Density	SPT blows/foot
Very Loose	< 4
Loose	4 to 9
Medium Dense	10 to 29
Dense	30 to 49
Very Dense	≥ 50

Fine-Grained Soils:

Consistency	SPT blows/foot
Very Soft	< 2
Soft	2 to 3
Medium Stiff	4 to 7
Stiff	8 to 14
Very Stiff	15 to 29
Hard	≥ 30

Test Symbols & Units

Fines = Fines Content (%)

MC = Moisture Content (%)

DD = Dry Density (pcf)

Str = Shear Strength (tsf)

PID = Photoionization Detector (ppm)

OC = Organic Content (%)

CEC = Cation Exchange Capacity (meq/100 g)

LL = Liquid Limit (%)

PL = Plastic Limit (%)

PI = Plasticity Index (%)

Component Definitions

Descriptive Term	Size Range and Sieve Number
Boulders	Larger than 12"
Cobbles	3" to 12"
Gravel	3" to No. 4 (4.75 mm)
Coarse Gravel	3" to 3/4"
Fine Gravel	3/4" 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)

Modifier Definitions

Percentage by Weight (Approx.)	Modifier
< 5	Trace (sand, silt, clay, gravel)
5 to 14	Slightly (sandy, silty, clayey, gravelly)
15 to 29	Sandy, silty, clayey, gravelly
≥ 30	Very (sandy, silty, clayey, gravelly)

Classifications of soils in this geotechnical report and as shown on the exploration logs are based on visual field and/or laboratory observations, which include density/consistency, moisture condition, grain size, and plasticity estimates, and should not be construed to imply field or laboratory testing unless presented herein. Visual-manual and/or laboratory classification methods of ASTM D2487 and D2488 were used as an identification guide for the Unified Soil Classification System.

Earth Solutions NW LLC

Geotechnical Engineering, Construction Observation/Testing and Environmental Services

EXPLORATION LOG KEY

Earth Solutions NW, LLC
15365 N.E. 90th Street, Suite 100
Redmond, Washington 98052
Telephone: 425-449-4704
Fax: 425-449-4711

TEST PIT NUMBER TP-1

PROJECT NUMBER ES-8303 **PROJECT NAME** Puyallup Duplex

DATE STARTED 12/8/21 **COMPLETED** 12/8/21 **GROUND ELEVATION** 432 ft

EXCAVATION CONTRACTOR NW Excavating **LATITUDE** 47.15143 **LONGITUDE** -122.2983

LOGGED BY SKH **CHECKED BY** KDH **GROUND WATER LEVEL:**

NOTES Depth of Topsoil & Sod 8": forest duff ▽ **AT TIME OF EXCAVATION** 8.0 ft

SURFACE CONDITIONS **AFTER EXCAVATION**

DEPTH (ft)	SAMPLE TYPE NUMBER	TESTS	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
0			TPSL		Dark brown TOPSOIL, roots to 1.5'
0.7					431.3
		MC = 16.3 Fines = 12.8	SM		Brown silty SAND with gravel, loose to medium dense, damp -slight caving to BOH [USDA Classification: gravelly loamy SAND]
3.0					429.0
		MC = 4.5	GW		Brown well-graded GRAVEL with sand, medium dense, damp (Qgo: recessional outwash)
5					
		MC = 12.1 Fines = 0.7			-becomes moist [USDA Classification: extremely gravelly coarse SAND]
8.0		MC = 11.7			▽ -moderate groundwater at BOH 424.0
					Test pit terminated at 8.0 feet below existing grade. Groundwater table encountered at BOH during excavation. Caving observed from 1.0 foot to BOH.

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TEST PIT NUMBER TP-2

PROJECT NUMBER ES-8303 **PROJECT NAME** Puyallup Duplex

DATE STARTED 12/8/21 **COMPLETED** 12/8/21 **GROUND ELEVATION** 434 ft

EXCAVATION CONTRACTOR NW Excavating **LATITUDE** 47.15139 **LONGITUDE** -122.2979

LOGGED BY SKH **CHECKED BY** KDH **GROUND WATER LEVEL:**

NOTES Depth of Topsoil & Sod 6": forest duff ▽ **AT TIME OF EXCAVATION** 10.0 ft

SURFACE CONDITIONS **AFTER EXCAVATION**

DEPTH (ft)	SAMPLE TYPE NUMBER	TESTS	U.S.C.S.	GRAPHIC LOG		MATERIAL DESCRIPTION	
0			TPSL		0.5	Dark brown TOPSOIL, roots to 18"	433.5
			SM			Brown silty SAND with gravel, medium dense, damp (Fill) -asphalt debris, slight caving to BOH -wood debris	
5			SM			-wood/asphalt/concrete debris	
		MC = 32.5			8.0		426.0
			SM			Brown silty SAND with gravel, dense, moist to wet -becomes gray	
10			SM		10.0 ▽	-moderate groundwater at 10'	424.0
			GP		10.5	Gray poorly graded GRAVEL, medium dense, wet (Qgo: recessional outwash)	423.5
		MC = 17.5				Test pit terminated at 10.5 feet below existing grade. Groundwater table encountered at 10.0 feet during excavation. Caving observed from 1.0 foot to BOH.	

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TEST PIT NUMBER TP-3

PROJECT NUMBER ES-8303 **PROJECT NAME** Puyallup Duplex

DATE STARTED 12/8/21 **COMPLETED** 12/8/21 **GROUND ELEVATION** 435 ft

EXCAVATION CONTRACTOR NW Excavating **LATITUDE** 47.15159 **LONGITUDE** -122.29784

LOGGED BY SKH **CHECKED BY** KDH **GROUND WATER LEVEL:**

NOTES Depth of Topsoil & Sod 6": brush ▽ **AT TIME OF EXCAVATION**

SURFACE CONDITIONS **AFTER EXCAVATION**

DEPTH (ft)	SAMPLE TYPE NUMBER	TESTS	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION	
0			TPSL		Dark brown TOPSOIL, roots to 2'	434.5
				0.5	Brown silty SAND, loose to medium dense, damp (Fill)	
					-asphalt debris, slight to moderate caving to BOH	
		MC = 11.9	SM			
5					-plastic debris	
				6.0		429.0
		MC = 17.4 Fines = 22.9			Brown silty SAND with gravel, medium dense, damp [USDA Classification: gravelly sandy LOAM]	
			SM			
10		MC = 44.9		10.0		425.0

Test pit terminated at 10.0 feet below existing grade due to caving. No groundwater encountered during excavation. Caving observed from 1.0 foot to BOH.

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TEST PIT NUMBER TP-4

PROJECT NUMBER ES-8303 **PROJECT NAME** Puyallup Duplex

DATE STARTED 12/8/21 **COMPLETED** 12/8/21 **GROUND ELEVATION** 437 ft

EXCAVATION CONTRACTOR NW Excavating **LATITUDE** 47.1514 **LONGITUDE** -122.2977

LOGGED BY SKH **CHECKED BY** KDH **GROUND WATER LEVEL:**

NOTES Depth of Topsoil & Sod 6": brush ▽ **AT TIME OF EXCAVATION** 11.0 ft

SURFACE CONDITIONS **AFTER EXCAVATION**

DEPTH (ft)	SAMPLE TYPE NUMBER	TESTS	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION	
0			TPSL		0.5 Dark brown TOPSOIL, roots to 2'	436.5
			SP		1.5 Brown poorly graded SAND, loose to medium dense, damp (Fill)	435.5
			GP-GM		Brown poorly graded GRAVEL with silt and sand, loose to medium dense, damp (Fill) -wood and plastic debris -slight caving to BOH	
5		MC = 16.7 Fines = 9.4			[USDA Classification: extremely gravelly loamy SAND]	
					9.5	427.5
10		MC = 28.5	SM		Brown silty SAND with gravel, medium dense, moist to wet	
		MC = 28.0			11.0 ▽ -moderate groundwater at BOH	426.0
					Test pit terminated at 11.0 feet below existing grade due to caving. Groundwater table encountered at BOH during excavation. Caving observed from 4.0 feet to BOH.	

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TEST PIT NUMBER TP-5

PROJECT NUMBER ES-8303 **PROJECT NAME** Puyallup Duplex

DATE STARTED 12/8/21 **COMPLETED** 12/8/21 **GROUND ELEVATION** 435 ft

EXCAVATION CONTRACTOR NW Excavating **LATITUDE** 47.1513 **LONGITUDE** -122.29755

LOGGED BY SKH **CHECKED BY** KDH **GROUND WATER LEVEL:**

NOTES Depth of Topsoil & Sod 6": brush ▽ **AT TIME OF EXCAVATION**

SURFACE CONDITIONS **AFTER EXCAVATION**

DEPTH (ft)	SAMPLE TYPE NUMBER	TESTS	U.S.C.S.	GRAPHIC LOG		MATERIAL DESCRIPTION	
0			TPSL		0.5	Dark brown TOPSOIL, roots to 1.5'	434.5
			SM			Brown silty SAND with gravel, loose to medium dense, moist (Fill)	
						-plastic debris	
						-slight caving to 5'	
5		MC = 14.3				-moderate caving to BOH	
					7.0		428.0
			SP			Brown poorly graded SAND, medium dense, damp to moist	
		MC = 7.4 Fines = 0.5			8.0	[USDA Classification: slightly gravelly SAND]	427.0
						Test pit terminated at 8.0 feet below existing grade due to caving. No groundwater encountered during excavation. Caving observed from 3.0 feet to BOH.	

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TEST PIT NUMBER TP-6

PROJECT NUMBER ES-8303 **PROJECT NAME** Puyallup Duplex
DATE STARTED 1/13/22 **COMPLETED** 1/13/22 **GROUND ELEVATION** 434 ft
EXCAVATION CONTRACTOR NW Excavating **LATITUDE** 47.1514 **LONGITUDE** -122.29831
LOGGED BY SKH **CHECKED BY** KDH **GROUND WATER LEVEL:**
NOTES Depth of Topsoil & Sod 6": bare soil/light brush ▽ **AT TIME OF EXCAVATION**
SURFACE CONDITIONS **AFTER EXCAVATION**

DEPTH (ft)	SAMPLE TYPE NUMBER	TESTS	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
0			TPSL		Dark brown TOPSOIL, roots to 12" 433.5
		MC = 5.4 Fines = 2.5	GW	0.5	Brown well-graded GRAVEL with sand, medium dense, damp (Qgo: recessional outwash) [USDA Classification: extremely gravelly coarse SAND] -becomes gray, moist
5		MC = 10.1			-slight caving to BOH -light to moderate groundwater seepage
		MC = 7.0		8.0	426.0

Test pit terminated at 8.0 feet below existing grade. Groundwater seepage encountered at 7.0 feet during excavation. Caving observed from 4.0 feet to BOH.

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TEST PIT NUMBER TP-7

PROJECT NUMBER ES-8303 **PROJECT NAME** Puyallup Duplex

DATE STARTED 1/13/22 **COMPLETED** 1/13/22 **GROUND ELEVATION** 435 ft

EXCAVATION CONTRACTOR NW Excavating **LATITUDE** 47.15134 **LONGITUDE** -122.29838

LOGGED BY SKH **CHECKED BY** KDH **GROUND WATER LEVEL:**

NOTES Depth of Topsoil & Sod 6": light brush ▽ **AT TIME OF EXCAVATION** 8.0 ft

SURFACE CONDITIONS **AFTER EXCAVATION**

DEPTH (ft)	SAMPLE TYPE NUMBER	TESTS	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION	
0			TPSL		Dark brown TOPSOIL, roots to 12"	
0.5						434.5
			GW		Brown well-graded GRAVEL with sand, loose to medium dense, damp (Qgo: recessional outwash)	
		MC = 3.3			-becomes gray	
					-slight caving to 6'	
		MC = 5.2 Fines = 1.5			[USDA Classification: extremely gravelly coarse SAND]	
5						
					-moderate caving to BOH	
7.0						428.0
			GP		Gray poorly graded GRAVEL with sand, medium dense, damp to moist	
					▽ -becomes wet	
					-groundwater table	
8.5		MC = 10.1 Fines = 0.5			[USDA Classification: extremely gravelly coarse SAND]	426.5

Test pit terminated at 8.5 feet below existing grade. Groundwater table encountered at 8.0 feet during excavation. Caving observed from 2.0 feet to BOH.

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TEST PIT NUMBER TP-8

PROJECT NUMBER ES-8303 **PROJECT NAME** Puyallup Duplex

DATE STARTED 1/13/22 **COMPLETED** 1/13/22 **GROUND ELEVATION** 435 ft

EXCAVATION CONTRACTOR NW Excavating **LATITUDE** 47.15147 **LONGITUDE** -122.29737

LOGGED BY SKH **CHECKED BY** KDH **GROUND WATER LEVEL:**

NOTES Depth of Topsoil & Sod 6": brush ▽ **AT TIME OF EXCAVATION**

SURFACE CONDITIONS **AFTER EXCAVATION**

DEPTH (ft)	SAMPLE TYPE NUMBER	TESTS	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION	
0			TPSL		Dark brown TOPSOIL, roots to 12"	434.5
				0.5	Brown silty SAND, loose to medium dense, damp to moist (Fill)	
					-wood debris throughout	
			SM		-slight caving to BOH	
5					-becomes moist to wet	
		MC = 24.3		7.5		427.5

Test pit terminated at 7.5 feet below existing grade due to buried debris (large stump). No groundwater encountered during excavation. Caving observed from 3.5 feet to BOH.

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TEST PIT NUMBER TP-9

PROJECT NUMBER ES-8303 **PROJECT NAME** Puyallup Duplex

DATE STARTED 1/13/22 **COMPLETED** 1/13/22 **GROUND ELEVATION** 435 ft

EXCAVATION CONTRACTOR NW Excavating **LATITUDE** 47.15162 **LONGITUDE** -122.29777

LOGGED BY SKH **CHECKED BY** KDH **GROUND WATER LEVEL:**

NOTES Depth of Topsoil & Sod 6": brush ▽ **AT TIME OF EXCAVATION**

SURFACE CONDITIONS **AFTER EXCAVATION**

DEPTH (ft)	SAMPLE TYPE NUMBER	TESTS	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION	
0			TPSL		Dark brown TOPSOIL, roots to 12"	434.5
				0.5	Brown silty SAND, loose to medium dense, damp (Fill)	
			SM		-asphalt debris	
					-moderate caving to BOH	
5				6.0		429.0
		MC = 10.7	SP-SM		Brown poorly graded SAND with silt, medium dense, damp	
		MC = 21.2		9.0	-becomes moist to wet	426.0
					Test pit terminated at 9.0 feet below existing grade. No groundwater encountered during excavation. Caving observed from 2.5 feet to BOH.	

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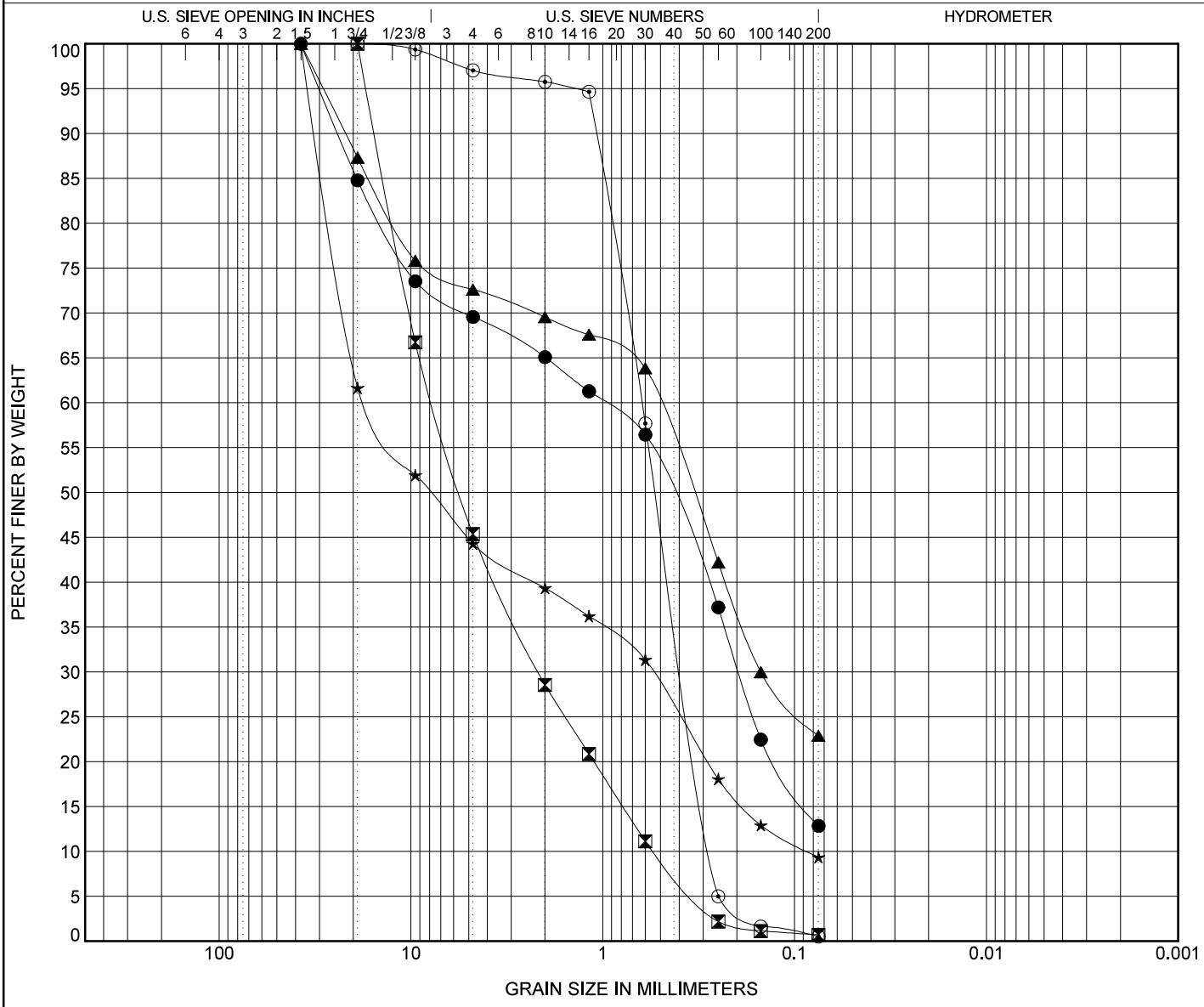
GRAIN SIZE DISTRIBUTION

PROJECT NUMBER ES-8303 **PROJECT NAME** Puyallup Duplex



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Specimen Identification			Classification	Cc	Cu
●	TP-01	1.00ft.	USDA: Brown Gravelly Loamy Sand. USCS: SM with Gravel.		
⊠	TP-01	7.00ft.	USDA: Brown Extremely Gravelly Coarse Sand. USCS: GW with Sand.	1.13	14.21
▲	TP-03	6.50ft.	USDA: Brown Gravelly Sandy Loam. USCS: SM with Gravel.		
★	TP-04	6.00ft.	USDA: Brown Extremely Gravelly Loamy Sand. USCS: GP-GM with Sand.	0.21	198.62
⊙	TP-05	8.00ft.	USDA: Brown Slightly Gravelly Sand. USCS: SP.	0.84	2.30

Specimen Identification			D100	D60	D30	D10	LL	PL	PI	%Silt	%Clay
●	TP-01	1.0ft.	37.5	0.988	0.195					12.8	
⊠	TP-01	7.0ft.	19	7.637	2.154	0.537				0.7	
▲	TP-03	6.5ft.	37.5	0.514	0.15					22.9	
★	TP-04	6.0ft.	37.5	16.884	0.548	0.085				9.4	
⊙	TP-05	8.0ft.	19	0.626	0.379	0.272				0.5	

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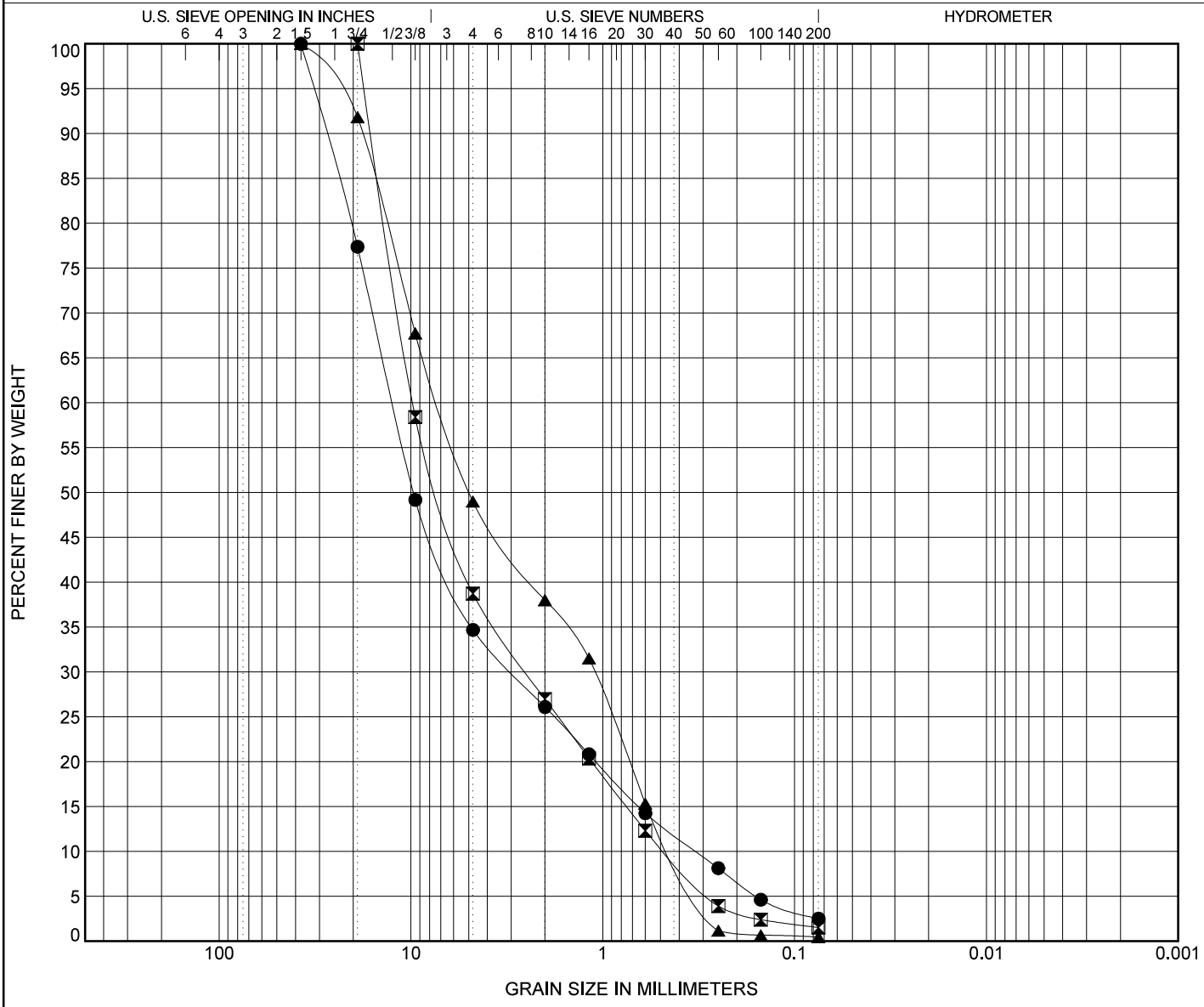
GRAIN SIZE DISTRIBUTION

PROJECT NUMBER ES-8303 **PROJECT NAME** Puyallup Duplex



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Specimen Identification			Classification	Cc	Cu
●	TP-06	1.50ft.	USDA: Brown Extremely Gravelly Coarse Sand. USCS: GW with Sand.	2.17	37.93
⊠	TP-07	4.00ft.	USDA: Gray Extremely Gravelly Coarse Sand. USCS: GW with Sand.	1.36	20.71
▲	TP-07	8.50ft.	USDA: Gray Extremely Gravelly Coarse Sand. USCS: GP with Sand.	0.40	16.54

Specimen Identification			D100	D60	D30	D10	LL	PL	PI	%Silt	%Clay
●	TP-06	1.5ft.	37.5	12.396	2.966	0.327				2.5	
⊠	TP-07	4.0ft.	19	9.76	2.501	0.471				1.5	
▲	TP-07	8.5ft.	37.5	7.139	1.108	0.432				0.5	