Earth Solutions NW LLC

Geotechnical Engineering
Construction Observation/Testing
Environmental Services

GEOTECHNICAL ENGINEERING STUDY
PROPOSED COMMERCIAL WAREHOUSE
4301 - 78TH STREET SOUTHWEST
MUKILTEO, WASHINGTON

ES-6384

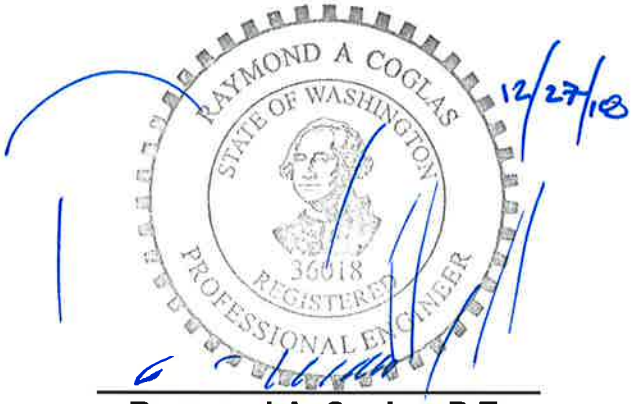
1805 - 136th Place N.E., Suite 201 Bellevue, WA 98005
(425) 449-4704 Fax (425) 449-4711
www.earthsolutionsnw.com

PREPARED FOR

UNDERWOOD NELSON DEVELOPMENT

December 27, 2018

Chase G. Halsen
Staff Geologist



Raymond A. Coglas, P.E.
Principal Engineer

GEOTECHNICAL ENGINEERING STUDY
PROPOSED COMMERCIAL WAREHOUSE
4301 – 78TH STREET SOUTHWEST
MUKILTEO, WASHINGTON

ES-6384

Earth Solutions NW, LLC
1805 – 136th Place Northeast, Suite 201
Bellevue, Washington 98005
Phone: 425-449-4704 | Fax: 425-449-4711
www.earthsolutionsnw.com

Important Information About Your

Geotechnical Engineering Report

Subsurface problems are a principal cause of construction delays, cost overruns, claims, and disputes.

The following information is provided to help you manage your risks.

Geotechnical Services Are Performed for Specific Purposes, Persons, and Projects

Geotechnical engineers structure their services to meet the specific needs of their clients. A geotechnical engineering study conducted for a civil engineer may not fulfill the needs of a construction contractor or even another civil engineer. Because each geotechnical engineering study is unique, each geotechnical engineering report is unique, prepared *solely* for the client. No one except you should rely on your geotechnical engineering report without first conferring with the geotechnical engineer who prepared it. *And no one — not even you* — should apply the report for any purpose or project except the one originally contemplated.

Read the Full Report

Serious problems have occurred because those relying on a geotechnical engineering report did not read it all. Do not rely on an executive summary. Do not read selected elements only.

A Geotechnical Engineering Report Is Based on A Unique Set of Project-Specific Factors

Geotechnical engineers consider a number of unique, project-specific factors when establishing the scope of a study. Typical factors include: the client's goals, objectives, and risk management preferences; the general nature of the structure involved, its size, and configuration; the location of the structure on the site; and other planned or existing site improvements, such as access roads, parking lots, and underground utilities. Unless the geotechnical engineer who conducted the study specifically indicates otherwise, do not rely on a geotechnical engineering report that was:

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

Typical changes that can erode the reliability of an existing geotechnical engineering report include those that affect:

- the function of the proposed structure, as when it's changed from a parking garage to an office building, or from a light industrial plant to a refrigerated warehouse,
- elevation, configuration, location, orientation, or weight of the proposed structure,
- composition of the design team, or
- project ownership.

As a general rule, *always* inform your geotechnical engineer of project changes—even minor ones—and request an assessment of their impact. *Geotechnical engineers cannot accept responsibility or liability for problems that occur because their reports do not consider developments of which they were not informed.*

Subsurface Conditions Can Change

A geotechnical engineering report is based on conditions that existed at the time the study was performed. *Do not rely on a geotechnical engineering report* whose adequacy may have been affected by: the passage of time; by man-made events, such as construction on or adjacent to the site; or by natural events, such as floods, earthquakes, or groundwater fluctuations. *Always* contact the geotechnical engineer before applying the report to determine if it is still reliable. A minor amount of additional testing or analysis could prevent major problems.

Most Geotechnical Findings Are Professional Opinions

Site exploration identifies subsurface conditions only at those points where subsurface tests are conducted or samples are taken. Geotechnical engineers review field and laboratory data and then apply their professional judgment to render an opinion about subsurface conditions throughout the site. Actual subsurface conditions may differ—sometimes significantly—from those indicated in your report. Retaining the geotechnical engineer who developed your report to provide construction observation is the most effective method of managing the risks associated with unanticipated conditions.

A Report's Recommendations Are *Not* Final

Do not overrely on the construction recommendations included in your report. *Those recommendations are not final,* because geotechnical engineers develop them principally from judgment and opinion. Geotechnical engineers can finalize their recommendations only by observing actual

subsurface conditions revealed during construction. *The geotechnical engineer who developed your report cannot assume responsibility or liability for the report's recommendations if that engineer does not perform construction observation.*

A Geotechnical Engineering Report Is Subject to Misinterpretation

Other design team members' misinterpretation of geotechnical engineering reports has resulted in costly problems. Lower that risk by having your geotechnical engineer confer with appropriate members of the design team after submitting the report. Also retain your geotechnical engineer to review pertinent elements of the design team's plans and specifications. Contractors can also misinterpret a geotechnical engineering report. Reduce that risk by having your geotechnical engineer participate in prebid and preconstruction conferences, and by providing construction observation.

Do Not Redraw the Engineer's Logs

Geotechnical engineers prepare final boring and testing logs based upon their interpretation of field logs and laboratory data. To prevent errors or omissions, the logs included in a geotechnical engineering report should *never* be redrawn for inclusion in architectural or other design drawings. Only photographic or electronic reproduction is acceptable, *but recognize that separating logs from the report can elevate risk.*

Give Contractors a Complete Report and Guidance

Some owners and design professionals mistakenly believe they can make contractors liable for unanticipated subsurface conditions by limiting what they provide for bid preparation. To help prevent costly problems, give contractors the complete geotechnical engineering report, *but* preface it with a clearly written letter of transmittal. In that letter, advise contractors that the report was not prepared for purposes of bid development and that the report's accuracy is limited; encourage them to confer with the geotechnical engineer who prepared the report (a modest fee may be required) and/or to conduct additional study to obtain the specific types of information they need or prefer. A prebid conference can also be valuable. *Be sure contractors have sufficient time* to perform additional study. Only then might you be in a position to give contractors the best information available to you, while requiring them to at least share some of the financial responsibilities stemming from unanticipated conditions.

Read Responsibility Provisions Closely

Some clients, design professionals, and contractors do not recognize that geotechnical engineering is far less exact than other engineering disciplines. This lack of understanding has created unrealistic expectations that have led to disappointments, claims, and disputes. To help reduce the risk of such outcomes, geotechnical engineers commonly include a variety of explanatory provisions in their reports. Sometimes labeled "limitations" many of these provisions indicate where geotechnical engineers' responsibilities begin and end, to help others recognize their own responsibilities and risks. *Read these provisions closely.* Ask questions. Your geotechnical engineer should respond fully and frankly.

Geoenvironmental Concerns Are Not Covered

The equipment, techniques, and personnel used to perform a *geoenvironmental* study differ significantly from those used to perform a *geotechnical* study. For that reason, a geotechnical engineering report does not usually relate any geoenvironmental findings, conclusions, or recommendations; e.g., about the likelihood of encountering underground storage tanks or regulated contaminants. *Unanticipated environmental problems have led to numerous project failures.* If you have not yet obtained your own geoenvironmental information, ask your geotechnical consultant for risk management guidance. *Do not rely on an environmental report prepared for someone else.*

Obtain Professional Assistance To Deal with Mold

Diverse strategies can be applied during building design, construction, operation, and maintenance to prevent significant amounts of mold from growing on indoor surfaces. To be effective, all such strategies should be devised for the *express purpose* of mold prevention, integrated into a comprehensive plan, and executed with diligent oversight by a professional mold prevention consultant. Because just a small amount of water or moisture can lead to the development of severe mold infestations, a number of mold prevention strategies focus on keeping building surfaces dry. While groundwater, water infiltration, and similar issues may have been addressed as part of the geotechnical engineering study whose findings are conveyed in this report, the geotechnical engineer in charge of this project is not a mold prevention consultant; ***none of the services performed in connection with the geotechnical engineer's study were designed or conducted for the purpose of mold prevention. Proper implementation of the recommendations conveyed in this report will not of itself be sufficient to prevent mold from growing in or on the structure involved.***

Rely on Your ASFE-Member Geotechncial Engineer for Additional Assistance

Membership in ASFE/The Best People on Earth exposes geotechnical engineers to a wide array of risk management techniques that can be of genuine benefit for everyone involved with a construction project. Confer with you ASFE-member geotechnical engineer for more information.

ASFE
The Best People on Earth

8811 Colesville Road/Suite G106, Silver Spring, MD 20910
Telephone: 301/565-2733 Facsimile: 301/589-2017
e-mail: info@asfe.org www.asfe.org

IIGER06045.0M

Earth Solutions NW LLC

Geotechnical Engineering, Construction
Observation/Testing and Environmental Services

December 27, 2018
ES-6384

Underwood Nelson Development
P.O. Box 1301
Seahurst, Washington 98062

Attention: Mr. Greg Nelson

Dear Mr. Nelson:

Earth Solutions NW, LLC (ESNW) is pleased to present this report titled "Geotechnical Engineering Study, Proposed Commercial Warehouse, 4301 – 78th Street Southwest, Mukilteo, Washington". Based on the results of our investigation, the proposal is feasible from a geotechnical standpoint. Our study indicates the site is underlain by glacial till deposits. Perched groundwater seepage was encountered at test pit location TP-1, at an emergence depth of about one-and-one-half feet below the existing ground surface elevation. Although seepage was not encountered elsewhere, it is our opinion the contractor be prepared to manage discrete zones of groundwater seepage encountered during construction.

The proposed commercial warehouse structure can be constructed on conventional continuous and spread footing foundation system bearing on competent native soil, recompacted native soil, or new structural fill placed directly on competent native soil. Competent native soil suitable for support of foundations will likely be encountered beginning at depths of about two-and-one-half to three feet below the existing ground surface elevation. Where loose or unsuitable soil conditions are exposed at foundation subgrade elevations, compaction of soils to the specifications of structural fill, or overexcavation and replacement with suitable structural fill, will be necessary. It should be noted the recompacted native soils or new structural fill should be protected from water intrusion to help prevent saturation and softening of the subgrade proposed for foundation support.

We understand stormwater management will be provided by a stormwater vault located within the northeastern site corner. Given the presence of perched groundwater seepage and/or unweathered, cemented glacial till at relatively shallow depths, infiltration is considered infeasible for the subject project. In our opinion, the unweathered glacial till present at depth should be considered impermeable for practical design purposes.

Pertinent geotechnical recommendations are provided in this study. We appreciate the opportunity to be of service to you on this project. If you have questions regarding the content of this geotechnical engineering study, please call.

Sincerely,

EARTH SOLUTIONS NW, LLC

Chase G. Halsen
Staff Geologist

Table of Contents

ES-6384

Table of Contents

Cont'd

ES-6384

GEOTECHNICAL ENGINEERING STUDY
PROPOSED COMMERCIAL WAREHOUSE
4301 – 78TH STREET SOUTHWEST
MUKILTEO, WASHINGTON

ES-6384

INTRODUCTION

General

This geotechnical engineering study (study) was prepared for the proposed commercial warehouse to be constructed northeast of the 78th Street Southwest and 44th Avenue West intersection, in Mukilteo, Washington. The purpose of this study was to provide geotechnical recommendations for currently proposed development plans. Our scope of services for completing this study included the following:

- Test pits for the purpose of characterizing site soils;
- Laboratory testing of soil samples collected at the test pit locations;
- Engineering analyses, and;
- Preparation of this report.

The following documents and maps were reviewed as part of our study preparation:

- Site Plan Schematic, Client Provided, undated;
- Snohomish County Liquefaction Susceptibility, endorsed by the Washington State Department of Natural Resources, October 2009;
- Distribution and Description of Geologic Units in the Mukilteo Quadrangle, Washington, by James P. Minard, 1982, and;
- Online Web Soil Survey, provided by the United States Department of Agriculture, Natural Resources Conservation Service.

Project Description

Review of a preliminary site layout plan indicates the subject site will be developed with a commercial warehouse, a stormwater detention vault (vault), and associated infrastructure improvements. Ingress and egress will be provided via 78th Street Southwest. At the time of report submission, specific building load and grading plans were not available for review; however, we understand the proposed structure will be one story in height and constructed utilizing concrete tilt-up walls. We anticipate perimeter footing loads of 4 to 6 kips per lineal foot, column loads of about 120 kips, and slab-on-grade loading of approximately 350 pounds per square foot (psf). Site grading will likely involve cuts and fills utilizing a balanced approach. Site retaining walls will also likely be incorporated into the plans to facilitate grade transitions.

We understand stormwater will be managed by a vault located in the northeastern portion of the site; ESNW should provide specific construction and design recommendations when detention facility plans are available. We understand earthwork activities will primary consist of grade cuts up to five feet within the southern site area and fills up to about 10 to 15 feet within northern site area.

If the above design assumptions are incorrect or change, ESNW should be contacted to review the recommendations provided in this report. ESNW should review final designs to confirm that our geotechnical recommendations been incorporated into the plans.

SITE CONDITIONS

Surface

The subject site is located northeast of the 78th Street Southwest and 44th Avenue West intersection, in Mukilteo, Washington. The approximate location of the property is illustrated on Plate 1 (Vicinity Map). The property is comprised of four adjoining tax parcels (Snohomish County Parcel Nos. 280410-003-001-00, -004-00, -005-00, and -006-00) totaling about 4.0 acres. The site is bordered to the north by undeveloped land, to the east by a church, to the south by 78th Street Southwest, and to the west by 44th Avenue West. The site is currently undeveloped and vegetated with mature forested growth with a dense underbrush. Site topography has a northeasterly declination with about 35 feet of elevation change occurring within the property bounds.

Subsurface

A representative of ESNW observed, logged, and sampled the excavation of eight test pits, at accessible locations of the site on December 5, 2018, using a mini trackhoe and operator retained by our firm. The explorations were completed for purposes of assessment and classification of site soils as well as characterization of groundwater conditions across the site. The approximate locations of the explorations are depicted on Plate 2 (Test Pit Location Plan). Please refer to the test pit logs provided in Appendix A for a more detailed description of subsurface conditions. Representative soil samples collected at the test pit locations were evaluated in general accordance with Unified Soil Classification System and United States Department of Agriculture (USDA) methods and procedures.

Topsoil and Fill

Topsoil was encountered in the upper 6 to 18 inches of existing grades at the test pit locations. The topsoil was characterized by dark brown color, the presence of fine organic material, and small root intrusions. Fill was not encountered at the test pit locations. Given the undeveloped nature of the site, we do not anticipate significant fill soils to be encountered during general earthwork activities. However, past (historic) clearing activities may have produced bury pits where stumps, logs, or other organic debris may have been locally buried.

Native Soil

Underlying topsoil, native deposits were observed primarily as silty sand and sandy silt with or without gravel (USCS: SM and ML, respectively). The upper approximate two to three feet of the deposit was characterized as loose to medium dense, thereafter becoming dense to very dense. The native soils were observed primarily in a moist condition, extending to the maximum exploration depth of about six-and-one-half feet below the existing ground surface elevation where refusal to mechanical excavation was observed.

Geologic Setting

The referenced geologic map resource identifies glacial till (Qvt) deposits as the native soil deposit underlying the subject site. The glacial till, locally referred to as Vashon till, consists of a nonsorted mixture of clay, silt, sand, pebbles, cobbles, and boulders. The referenced WSS resource identifies Alderwood-Urban land complex, 2 to 15 percent slopes (Map Unit Symbol: 5 and 6) as the primary soil unit underlying the subject site. Designations of Urban land complex indicates soils may have been previously modified through earthwork activities. Based on our field observations, site soils are consistent with local geologic mapping and soil survey designations.

Groundwater

During our subsurface exploration completed on December 5, 2018, groundwater seepage was encountered at TP-1, beginning at a depth of about one-and-one-half feet bgs. As such, it is our opinion the contractor should anticipate, and be prepared to respond and manage, zones of perched groundwater seepage during construction, especially within deeper site excavations. Temporary measures to control surface water runoff and groundwater during construction would likely involve interceptor trenches, sumps, and dewatering pumps. It should be noted that seepage rates and elevations fluctuate depending on many factors, including precipitation duration and intensity, the time of year, and soil conditions. In general, groundwater flow rates are higher during the winter, spring, and early summer months.

Geologically Hazardous Areas

Review of the available Snohomish County maintained GIS database does not indicate the presence of geologically hazardous areas. Additionally, no such indicators were observed during our fieldwork or within the test pit locations.

DISCUSSION AND RECOMMENDATIONS

General

Based on the results of our investigation, construction of the proposed commercial development is feasible from a geotechnical standpoint. The primary geotechnical considerations associated with the proposed development include foundation support, subgrade preparation, and the suitability of using native soils as structural fill.

The proposed commercial warehouse structure can be constructed on conventional continuous and spread footing foundation system bearing on competent native soil, recompacted native soil, or new structural fill placed directly on competent native soil. Competent native soil suitable for support of foundations will likely be encountered beginning at depths of about two-and-one-half to three feet below the existing ground surface elevation. Where loose or unsuitable soil conditions are exposed at foundation subgrade elevations, compaction of soils to the specifications of structural fill, or overexcavation and replacement with suitable structural fill, will be necessary. It should be noted the recompacted native soils or new structural fill should be protected from water intrusion to help prevent saturation and softening of the subgrade proposed for foundation support.

We understand stormwater management will be provided by a vault located within the northeastern site corner. Given the presence of perched groundwater seepage and/or unweathered, cemented glacial till at relatively shallow depths, infiltration is considered infeasible for the subject project. In our opinion, the unweathered glacial till present at depth should be considered impermeable for practical design purposes.

This study has been prepared for the exclusive use of Underwood Nelson Development and their representatives. A warranty is neither expressed nor implied. This study has been prepared in a manner consistent with the level of care and skill ordinarily exercised by other members of the profession currently practicing under similar conditions in this area.

Site Preparation and Earthwork

Initial site preparation activities will consist of installing temporary erosion control measures, establishing grading limits, and performing clearing and site stripping. Subsequent earthwork activities will involve mass site grading and related infrastructure improvements.

Temporary Erosion Control

The following temporary erosion control measures are offered:

- Temporary construction entrances and drive lanes, consisting of at least six inches of quarry spalls, should be considered to both minimize off-site soil tracking and provide a stable access entrance surface. Placing geotextile fabric underneath the quarry spalls will provide greater stability, if needed.
- Silt fencing should be placed around the site perimeter.
- When not in use, soil stockpiles should be covered or otherwise protected, especially during periods of wet weather to reduce the potential for soil erosion.
- Temporary measures for controlling surface water runoff, such as interceptor trenches, sumps, or interceptor swales, should be installed prior to beginning earthwork activities.
- Dry soils disturbed during construction should be wetted to minimize dust.
- When appropriate, permanent planting or hydroseeding will help to stabilize site soils.

Additional Best Management Practices (BMPs), as specified by the project civil engineer and indicated on the plans, should be incorporated into construction activities. Temporary erosion control measures may be modified during construction as site conditions require, as approved by the site erosion control lead.

Stripping

Topsoil was encountered within the upper approximately one to six inches of existing grades at the test pit locations. ESNW should be retained to provide site stripping recommendations at the time of construction. Topsoil and/or organic-rich soil is considered suitable for use neither in structural areas nor as structural fill. If desired, topsoil and/or organic-rich soil may be used in non-structural areas. Additionally, due to the undeveloped condition of the site, topsoil thicknesses may vary substantially across the property.

Excavations and Slopes

Excavation activities are likely to expose both medium dense soil (within the upper three to six feet bgs) and denser soils at depth. Based on the soil conditions observed at the test pit locations, the following allowable temporary slope inclinations, as a function of horizontal to vertical (H:V) inclination, may be used. The applicable Federal Occupation Safety and Health Administration (OSHA) and Washington Industrial Safety and Health Act (WISHA) soil classifications are also provided:

- Loose to medium dense soil — 1.5H:1V (Type C)
- Areas containing groundwater seepage — 1.5H:1V (Type C)
- Dense to very dense, undisturbed native soil — 0.75H:1V (Type A)

Steeper temporary slope inclinations within undisturbed, very dense glacial deposits may be feasible based on the soil and groundwater conditions exposed within the excavations. If pursued, ESNW can assist in evaluating the feasibility of utilizing steeper temporary slopes at the time of construction.

The presence of perched groundwater may cause localized sloughing of temporary slopes due to excess seepage forces. An ESNW representative should observe temporary and permanent slopes to confirm the slope inclinations are suitable for the exposed soil conditions and to provide additional excavation and slope recommendations, as necessary. If the recommended temporary slope inclinations cannot be achieved, temporary shoring may be necessary to support excavations. Permanent slopes should be planted with vegetation to enhance stability and to minimize erosion, and should maintain a gradient of 2H:1V or flatter.

In-situ and Imported Soils

On-site soils are moisture sensitive, and successful use of on-site soils as structural fill will largely be dictated by the moisture content at the time of placement and compaction. Remedial measures, such as soil aeration and/or cement treatment (where approved by the local jurisdiction or utility district), may be necessary as part of site grading and earthwork activities. If the on-site soils cannot be successfully compacted, the use of an imported soil may be necessary. In our opinion, a contingency should be provided in the project budget for 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, soils with fines contents greater than 5 percent typically degrade rapidly when exposed to periods of rainfall.

Imported soil intended for use as structural fill should consist of a well-graded, granular soil with a moisture content that is at (or slightly above) the optimum level. 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).

Subgrade Preparation

Foundation and slab subgrade surfaces should consist of competent undisturbed native soil (cut areas) or structural fill placed atop a competent native soil surface. ESNW should observe subgrade areas prior to placing formwork. Supplementary recommendations for subgrade improvement may be provided at the time of construction; such recommendations would likely include further mechanical compaction effort and/or overexcavation and replacement with suitable structural fill. It should be noted the recompacted native soils or new structural fill should be protected from water intrusion to help prevent saturation and softening of the subgrade proposed for foundation support.

Structural Fill

Structural fill is defined as compacted soil placed in foundation, slab-on-grade, roadway areas, permanent slope, retaining wall, and utility trench backfill areas. Soils placed in structural areas should be placed in loose lifts of 12 inches or less and compacted to a relative compaction of 95 percent, based on the laboratory maximum dry density as determined by the Modified Proctor Method (ASTM D1557). For soil placed in utility trenches underlying structural areas, compaction requirements are dictated by the local city, county, or utility district, and are typically specified to a relative compaction of at least 95 percent.

Foundations

The proposed commercial warehouse structure can be constructed on conventional continuous and spread footing foundations bearing on competent native soil, recompacted native soil, or new structural fill placed directly on competent native soil. Competent native soil suitable for support of foundations will likely be encountered beginning at depths of about two-and-one-half to three feet below the existing ground surface elevation. Where loose or unsuitable soil conditions are exposed at foundation subgrade elevations, compaction of soils to the specifications of structural fill, or overexcavation and replacement with suitable structural fill, will be necessary. It should be noted the recompacted native soils or new structural fill should be protected from water intrusion to help prevent saturation and softening of the subgrade proposed for foundation support.

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

- Allowable soil bearing capacity — 2,500 psf
- Passive earth pressure — 350 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, total settlement in the range of one inch and differential settlement of about one-half inch is anticipated across a typical column span. The majority of the settlements should occur during construction, as dead loads are applied. It should be noted, however, that structural fill must be placed and compacted as recommended in the *Structural Fill* section of this report. Saturation and softening of the subgrade must not be allowed to occur.

Seismic Design

The 2015 International Building Code recognizes the American Society of Civil Engineers (ASCE) for seismic site class definitions. In accordance with Table 20.3-1 of the ASCE Minimum Design Loads for Buildings and Other Structures manual, Site Class D should be used for design.

The referenced liquefaction susceptibility map indicates the subject site possesses very low liquefaction susceptibility. Liquefaction is a phenomenon where saturated and loose sandy soils suddenly lose internal strength and behave as a fluid. This behavior is in response to increased pore water pressures resulting from an earthquake or other intense ground shaking. In our opinion, site susceptibility to liquefaction may be considered negligible. The relatively high in-situ densities of the native soils and the absence of a uniformly established, shallow groundwater table were the primary bases for this consideration.

Slab-on-Grade Floors

Slab-on-grade floors for the proposed structure should be supported on competent and well-compacted, firm and unyielding subgrades. 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 the slab should be considered. If a vapor barrier is to be used, 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	350 pcf (equivalent fluid)
• Coefficient of friction	0.40
• Seismic surcharge	6H psf**

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

A factor-of-safety of one and one half has been applied to the friction and passive resistance values. 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 loads should be included in the retaining wall design, where applicable.

Retaining walls should be backfilled with free-draining material or suitable sheet drainage 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 can 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

Zones of perched groundwater seepage should be anticipated in site excavations depending on the time of year grading operations take place, particularly within deeper excavations for utilities; seepage may be heavy if overexcavation of unsuitable soil conditions in building subgrade is pursued. 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 identify areas of seepage and to provide recommendations to reduce the potential for instability related to seepage effects.

Finish grades must be designed to direct surface water away from the new structure for a distance of at least ten feet or as setbacks allow. Water must not be allowed to pond adjacent to the new structure. In our opinion, foundation drains should be installed along the building perimeter footings. A typical foundation drain detail is provided on Plate 4.

Infiltration Feasibility Evaluation

As indicated in the *Subsurface* section of this report, native soils encountered during our fieldwork were characterized primarily as glacial till. In accordance with USDA textural analyses, the native till is classified as slightly gravelly to gravelly loam and slight gravelly fine sandy loam. Disregarding gravel contents at the tested locations, fines contents within the native loam were about 51 to 54 percent, and fines contents within the native sandy loam were about 48 percent, per USDA testing procedures and methods.

Given the high fines contents of the tested soils, dense in-situ conditions, and shallow perched groundwater seepage encountered across the site, it is our opinion that infiltration be considered infeasible for the subject project, from a geotechnical standpoint. The encountered in-situ conditions would likely impede the long-term performance and intended function of any infiltration device.

Detention Vault Feasibility

Construction of a detention vault is feasible within the northeastern site area from a geotechnical standpoint. At the time of this report preparation, it is unclear whether or not the vault will be supported on competent native soils or structural fill placed during site earthwork activities. The final vault design must incorporate adequate buffer space from property boundaries such that temporary excavations to construct the vault structure may be successfully completed. Perimeter drains should be installed around the vault and conveyed to an approved discharge point. Perched groundwater seepage should be anticipated within the vault excavation; however, buoyancy is not expected to influence the vault structure.

Vault retaining walls should be backfilled with free-draining material or suitable sheet drainage that extends along the height of the walls. The upper one foot 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. If the elevation of the vault bottom is such that gravity flow to an outlet is not possible, the portions of the vault below the drain should be designed to include hydrostatic pressure. Soil design parameters can be provided as stormwater and grading plans develop. Improved allowable soil bearing values can be provided if the vault will be supported on the native soils.

ESNW should observe grading operations for the vault and subgrade conditions prior to concrete forming and pouring. If the soil conditions encountered during construction differ from those anticipated, supplementary recommendations may be provided. ESNW should be contacted to review the final vault design to confirm that appropriate geotechnical parameters have been incorporated.

Preliminary Pavement Sections

The performance of site pavements is largely related to the condition of the underlying subgrade. To ensure adequate pavement performance, the subgrade should be in a firm and unyielding condition when subjected to proofrolling with a loaded dump truck. Structural fill in pavement areas should be compacted to the specifications previously detailed in this report. Soft, wet, or otherwise unsuitable subgrade areas may still exist after base grading activities. Areas containing unsuitable or yielding subgrade conditions will require remedial measures, such as overexcavation and/or placement of thicker crushed rock or structural fill sections, prior to pavement.

We anticipate new pavement sections will be subjected primarily to heavy truck traffic. Heavier traffic areas generally require thicker pavement sections depending on site usage, pavement life expectancy, and site traffic. For preliminary design purposes, the following pavement sections for occasional truck traffic and access roadways areas may be considered:

- Three inches of hot-mix asphalt (HMA) placed over six inches of crushed rock base (CRB), or;
- Three inches of HMA placed over four-and-one-half inches of asphalt-treated base (ATB).

A representative of ESNW should be requested to observe subgrade conditions prior to placement of CRB or ATB. As necessary, supplemental recommendations for achieving subgrade stability and drainage can be provided. If on-site roads will be constructed with an inverted crown, additional drainage measures may be recommended to assist in maintaining road subgrade and pavement stability.

Final pavement design recommendations, including recommendations for high frequency heavy traffic areas, access roads, and frontage improvement areas, can be provided once final traffic loading has been determined. Road standards utilized by the governing jurisdiction may supersede the recommendations provided in this report. The HMA, ATB and CRB materials should conform to WSDOT specifications. All soil base material should be compacted to a relative compaction of 95 percent, based on the laboratory maximum dry density as determined by ASTM D1557.

Utility Support and Trench Backfill

Remedial measures may be necessary in some areas to provide support for utilities, such as overexcavation and replacement with structural fill and/or placement of geotextile fabric. Groundwater seepage may be encountered within utility excavations, and caving of trench walls may occur where groundwater is encountered. Depending on the time of year and conditions encountered, dewatering, as well as temporary trench shoring, may be necessary during utility excavation and installation.

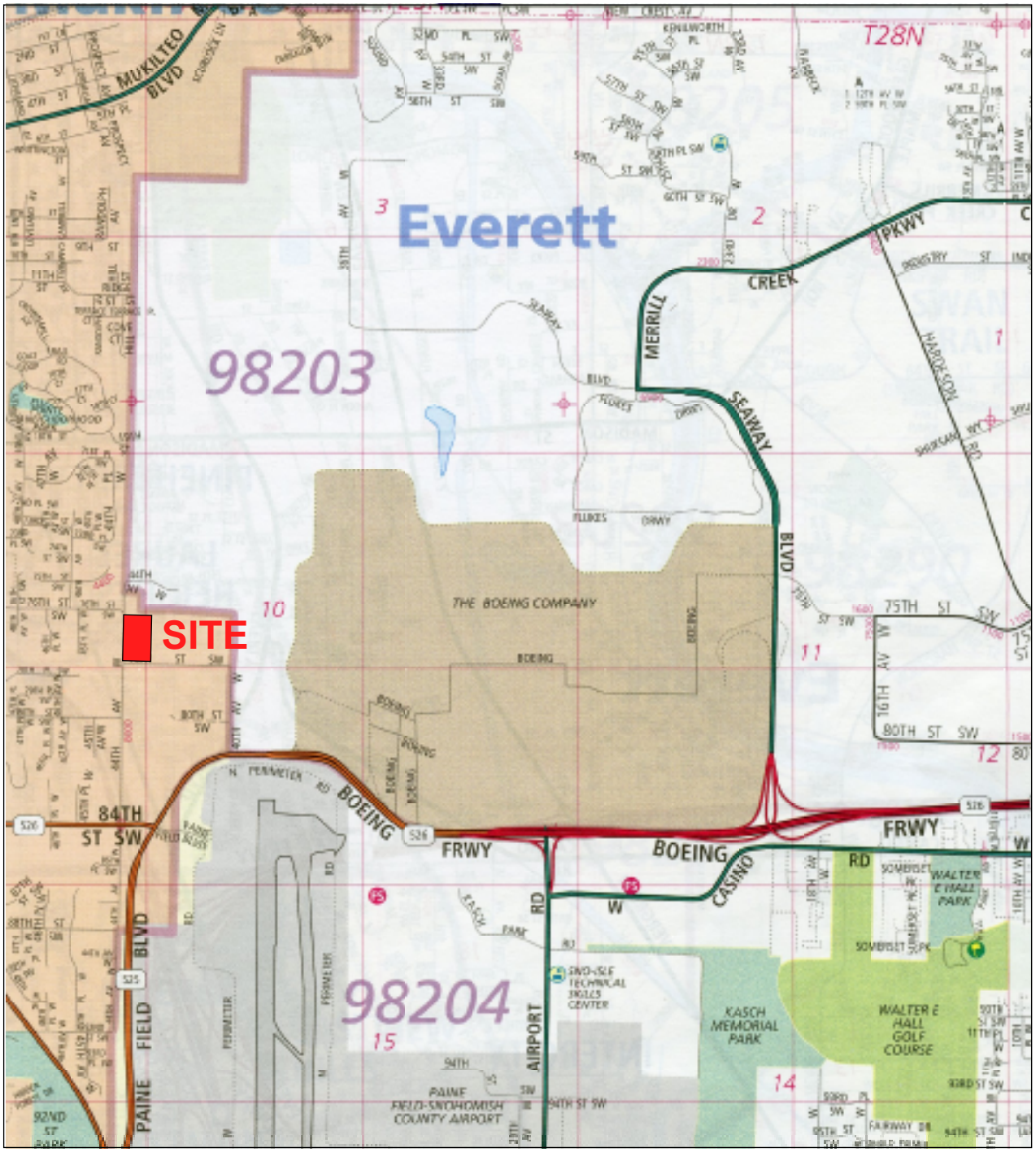
On-site soils may be suitable for use as structural backfill throughout utility trench excavations provided the soil is at (or slightly above) the optimum moisture content at the time of placement and compaction. Moisture conditioning of the soils may be necessary at some locations prior to use as structural fill. Each section of the utility lines must be adequately supported in the bedding material. Utility trench backfill should be placed and compacted to the specifications of structural fill as previously detailed in this report, or to the applicable specifications of responsible jurisdiction or agency.

LIMITATIONS

The recommendations and conclusions provided in this study 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. A warranty is neither expressed nor implied. Variations in the soil and groundwater conditions observed at the test pit locations may exist and may not become evident until construction. ESNW should reevaluate the conclusions provided in this study if variations are encountered.

Additional Services

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.



Reference:
Snohomish County, Washington
Map 415
By The Thomas Guide
Rand McNally
32nd Edition

NORTH

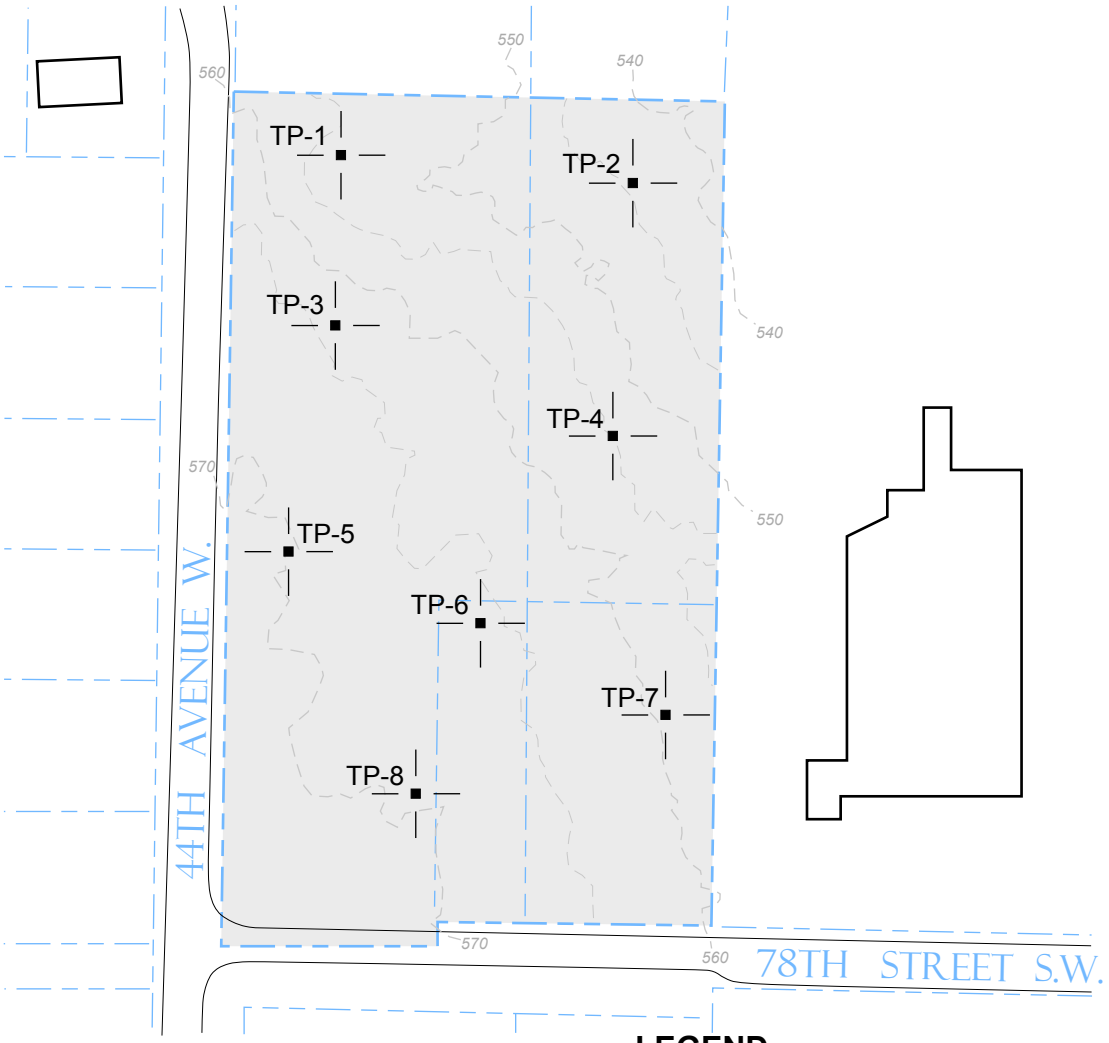
NOTE: This plate may contain areas of color. ESNW cannot be responsible for any subsequent misinterpretation of the information resulting from black & white reproductions of this plate.

Earth Solutions NW LLC

Geotechnical Engineering, Construction Observation/Testing and Environmental Services

Vicinity Map
4301 – 78th Street S.W.
Mukilteo, Washington

Drwn. MRS	Date 12/11/2018	Proj. No. 6384
Checked CGH	Date Dec. 2018	Plate 1



NORTH

NOT - TO - SCALE

LEGEND

TP-1 — Approximate Location of ESNW Test Pit, Proj. No. ES-6384, Dec. 2018

Subject Site

Existing Building

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.

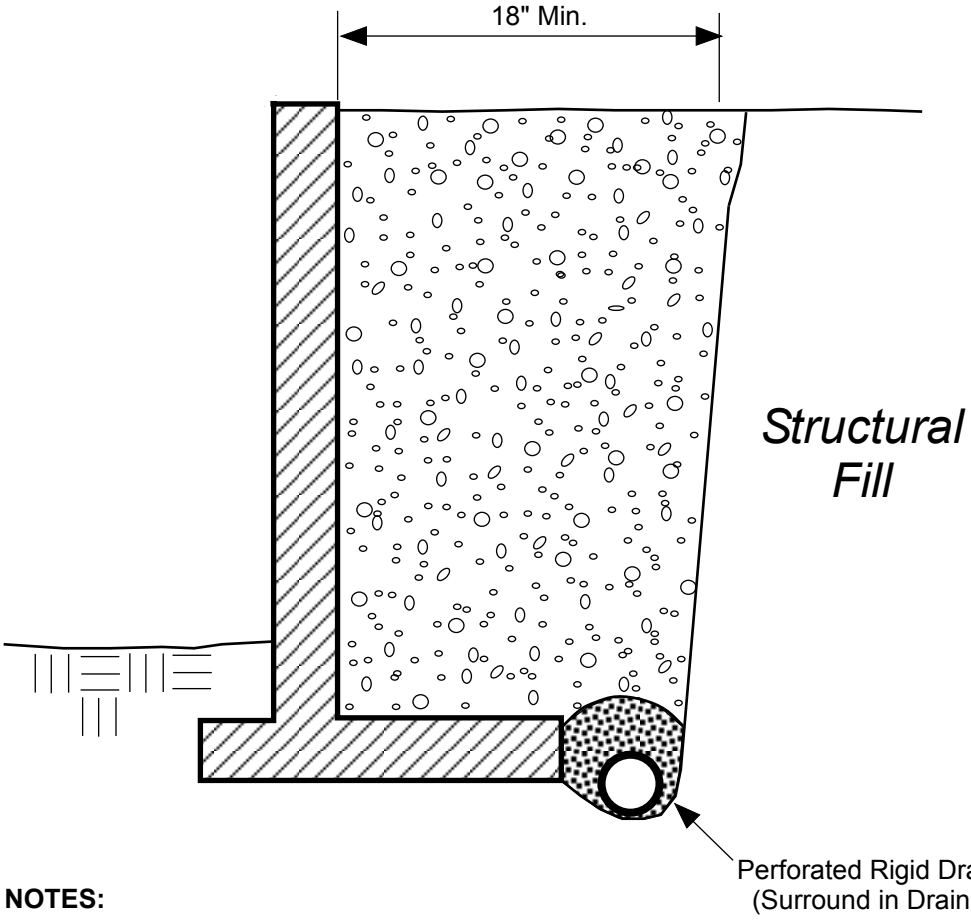
NOTE: This plate may contain areas of color. ESNW cannot be responsible for any subsequent misinterpretation of the information resulting from black & white reproductions of this plate.

Earth Solutions NW LLC

Geotechnical Engineering, Construction Observation/Testing and Environmental Services

Test Pit Location Plan
4301 – 78th Street S.W.
Mukilteo, Washington

Drwn. MRS	Date 12/11/2018	Proj. No. 6384
Checked CGH	Date Dec. 2018	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:

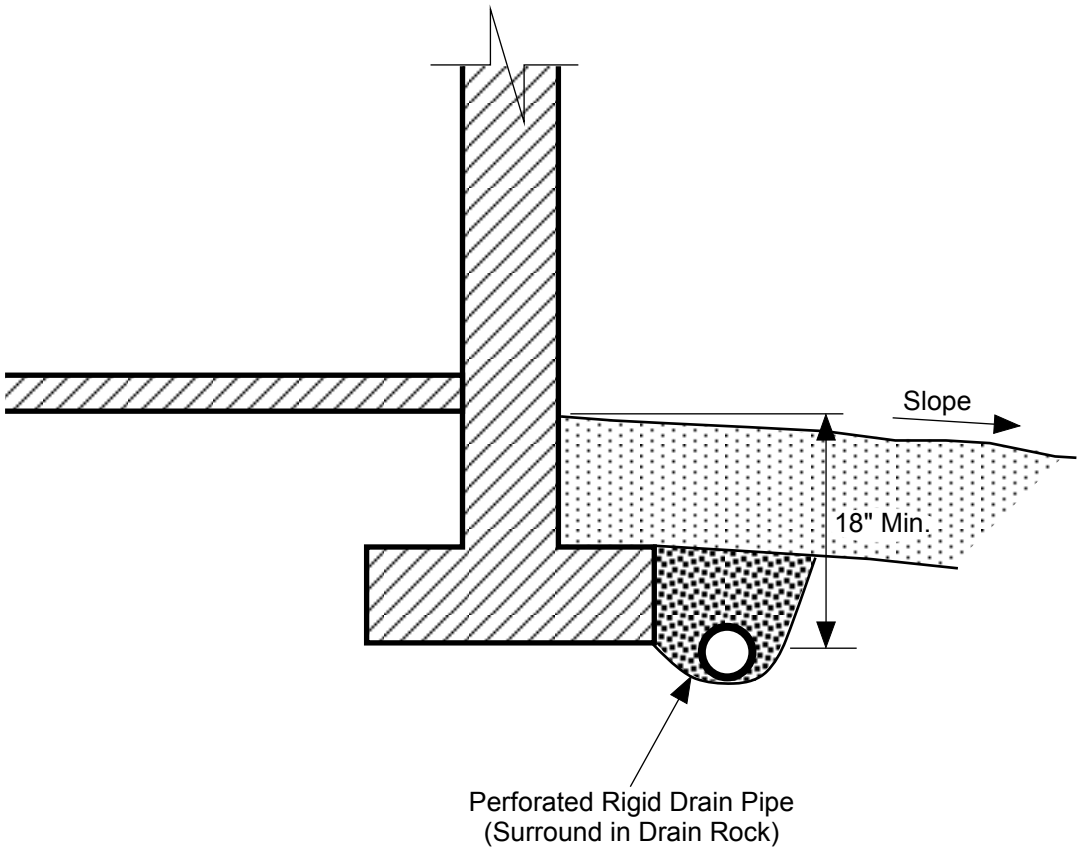
Free-draining Structural Backfill

1-inch Drain Rock

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

Retaining Wall Drainage Detail
4301 – 78th Street S.W.
Mukilteo, Washington

Drwn. MRS	Date 12/11/2018	Proj. No. 6384
Checked CGH	Date Dec. 2018	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
4301 – 78th Street S.W.
Mukilteo, Washington

Drwn. MRS	Date 12/11/2018	Proj. No. 6384
Checked CGH	Date Dec. 2018	Plate 4

Appendix A

Subsurface Exploration
Test Pit Logs

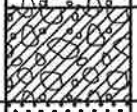
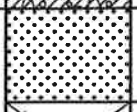
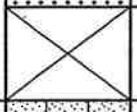
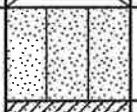
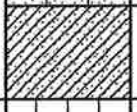
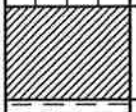
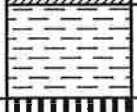
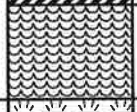
ES-6384

Subsurface conditions at the subject site were explored on December 5, 2018 by excavating eight test pits using a trackhoe and operator retained by ESNW. The approximate locations of the test pits are illustrated on Plate 2 of this study. The test pit logs are provided in this Appendix. The maximum exploration depth was approximately six-and-one-half feet bgs.

The final logs represent the interpretations of the field logs and the results of laboratory analyses. The stratification lines on the logs represent the approximate boundaries between soil types. In actuality, the transitions may be more gradual.

Earth Solutions NW LLC

SOIL CLASSIFICATION CHART

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

DUAL SYMBOLS are used to indicate borderline soil classifications.

The discussion in the text of this report is necessary for a proper understanding of the nature of the material presented in the attached logs.

Earth Solutions NW
1805 - 136th Place N.E., Suite 201
Bellevue, Washington 98005
Telephone: 425-449-4704
Fax: 425-449-4711

TEST PIT NUMBER TP-1

PROJECT NUMBER 6384 **PROJECT NAME** 4301 – 78th Street Southwest

DATE STARTED 12/5/18 **COMPLETED** 12/5/18 **GROUND ELEVATION** _____ **TEST PIT SIZE** _____

EXCAVATION CONTRACTOR NW Excavating **GROUND WATER LEVELS:**

EXCAVATION METHOD _____ **AT TIME OF EXCAVATION** ---

LOGGED BY CGH **CHECKED BY** HTW **AT END OF EXCAVATION** ---

NOTES Depth of Topsoil & Sod 12": heavy brush **AFTER EXCAVATION** ---

DEPTH (ft)	SAMPLE TYPE NUMBER	TESTS	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
0			TPSL		Dark brown TOPSOIL, root intrusions to 3.5'
				1.0	
			ML		Brown sandy SILT, loose, wet
					-heavy perched groundwater seepage to BOH
		MC = 38.80%			-becomes gray, very dense, moist
					-becomes weakly cemented
		MC = 14.00% Fines = 51.10%			
5					[USDA Classification: slightly gravelly LOAM]
		MC = 13.30%		6.5	
					Test pit terminated at 6.5 feet below existing grade. Groundwater seepage encountered at 1.5 feet to BOH during excavation. No caving observed. Bottom of test pit at 6.5 feet.

Earth Solutions NW
1805 - 136th Place N.E., Suite 201
Bellevue, Washington 98005
Telephone: 425-449-4704
Fax: 425-449-4711

TEST PIT NUMBER TP-2

PROJECT NUMBER 6384 **PROJECT NAME** 4301 – 78th Street Southwest

DATE STARTED 12/5/18 **COMPLETED** 12/5/18 **GROUND ELEVATION** _____ **TEST PIT SIZE** _____

EXCAVATION CONTRACTOR NW Excavating **GROUND WATER LEVELS:**

EXCAVATION METHOD _____ **AT TIME OF EXCAVATION** ---

LOGGED BY CGH **CHECKED BY** HTW **AT END OF EXCAVATION** ---

NOTES Depth of Topsoil & Sod 6": heavy brush **AFTER EXCAVATION** ---

DEPTH (ft)	SAMPLE TYPE NUMBER	TESTS	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
0			TPSL	0.5	Dark brown TOPSOIL, root intrusions to 2'
					Brown silty SAND with gravel, loose to medium dense, moist to wet
		MC = 19.90%	SM		
		MC = 12.40%			-becomes gray, very dense, moist and moderately cemented
5		MC = 9.00% Fines = 39.50%		5.0	[USDA Classification: gravelly LOAM]
					Test pit terminated at 5.0 feet below existing grade due to refusal in very dense cemented till. No groundwater encountered during excavation. No caving observed. Bottom of test pit at 5.0 feet.

Earth Solutions NW
1805 - 136th Place N.E., Suite 201
Bellevue, Washington 98005
Telephone: 425-449-4704
Fax: 425-449-4711

TEST PIT NUMBER TP-3

PROJECT NUMBER 6384 **PROJECT NAME** 4301 – 78th Street Southwest

DATE STARTED 12/5/18 **COMPLETED** 12/5/18 **GROUND ELEVATION** _____ **TEST PIT SIZE** _____

EXCAVATION CONTRACTOR NW Excavating **GROUND WATER LEVELS:**

EXCAVATION METHOD _____ **AT TIME OF EXCAVATION** ---

LOGGED BY CGH **CHECKED BY** HTW **AT END OF EXCAVATION** ---

NOTES Depth of Topsoil & Sod 6": heavy brush **AFTER EXCAVATION** ---

DEPTH (ft)	SAMPLE TYPE NUMBER	TESTS	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
0			TPSL		Dark brown TOPSOIL, root intrusions to 3'
				0.5	Brown to tan silty SAND with gravel, loose to medium dense, moist
		MC = 14.60%	SM		-becomes gray, dense, weakly cemented
5		MC = 9.60%		5.0	Test pit terminated at 5.0 feet below existing grade due to refusal in very dense cemented till. No groundwater encountered during excavation. No caving observed. Bottom of test pit at 5.0 feet.

Earth Solutions NW
1805 - 136th Place N.E., Suite 201
Bellevue, Washington 98005
Telephone: 425-449-4704
Fax: 425-449-4711

TEST PIT NUMBER TP-4

PROJECT NUMBER 6384 **PROJECT NAME** 4301 – 78th Street Southwest

DATE STARTED 12/5/18 **COMPLETED** 12/5/18 **GROUND ELEVATION** _____ **TEST PIT SIZE** _____

EXCAVATION CONTRACTOR NW Excavating **GROUND WATER LEVELS:**

EXCAVATION METHOD _____ **AT TIME OF EXCAVATION** ---

LOGGED BY CGH **CHECKED BY** HTW **AT END OF EXCAVATION** ---

NOTES Depth of Topsoil & Sod 12": heavy brush **AFTER EXCAVATION** ---

DEPTH (ft)	SAMPLE TYPE NUMBER	TESTS	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
0			TPSL		Dark brown TOPSOIL, root intrusions to 2'
				1.0	
			SM		Brown silty SAND, loose, moist
		MC = 13.70%			-becomes gray, dense, weakly cemented
					-very light iron oxide staining
5					
		MC = 9.60%		6.5	
					Test pit terminated at 6.5 feet below existing grade due to refusal in very dense cemented till. No groundwater encountered during excavation. No caving observed. Bottom of test pit at 6.5 feet.

Earth Solutions NW
1805 - 136th Place N.E., Suite 201
Bellevue, Washington 98005
Telephone: 425-449-4704
Fax: 425-449-4711

TEST PIT NUMBER TP-5

PROJECT NUMBER 6384 **PROJECT NAME** 4301 – 78th Street Southwest

DATE STARTED 12/5/18 **COMPLETED** 12/5/18 **GROUND ELEVATION** _____ **TEST PIT SIZE** _____

EXCAVATION CONTRACTOR NW Excavating **GROUND WATER LEVELS:**

EXCAVATION METHOD _____ **AT TIME OF EXCAVATION** ---

LOGGED BY CGH **CHECKED BY** HTW **AT END OF EXCAVATION** ---

NOTES Depth of Topsoil & Sod 6": heavy brush **AFTER EXCAVATION** ---

DEPTH (ft)	SAMPLE TYPE NUMBER	TESTS	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
0			TPSL		0.5 Dark brown TOPSOIL, root intrusions to 2'
					Brown silty SAND, loose, moist to wet
		MC = 17.90% Fines = 40.60%	SM		[USDA Classification: slightly gravelly fine sandy LOAM] -becomes gray, medium dense, moist -moderate iron oxide staining -becomes dense to very dense, moderately cemented
5		MC = 13.20%			5.0 Test pit terminated at 5.0 feet below existing grade due to refusal in very dense cemented till. No groundwater encountered during excavation. No caving observed. Bottom of test pit at 5.0 feet.

Earth Solutions NW
1805 - 136th Place N.E., Suite 201
Bellevue, Washington 98005
Telephone: 425-449-4704
Fax: 425-449-4711

TEST PIT NUMBER TP-6

PROJECT NUMBER 6384 **PROJECT NAME** 4301 – 78th Street Southwest

DATE STARTED 12/5/18 **COMPLETED** 12/5/18 **GROUND ELEVATION** _____ **TEST PIT SIZE** _____

EXCAVATION CONTRACTOR NW Excavating **GROUND WATER LEVELS:**

EXCAVATION METHOD _____ **AT TIME OF EXCAVATION** ---

LOGGED BY CGH **CHECKED BY** HTW **AT END OF EXCAVATION** ---

NOTES Surface Conditions: heavy brush **AFTER EXCAVATION** ---

DEPTH (ft)	SAMPLE TYPE NUMBER	TESTS	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
0					Brown to tan silty SAND, loose, wet
					-root intrusions to 2'
		MC = 29.80%			
			SM		-becomes gray, medium dense to dense, moist
		MC = 14.00%			-becomes dense to very dense, weakly cemented
5					
		MC = 12.30%			6.0
					Test pit terminated at 6.0 feet below existing grade due to refusal in very dense cemented till. No groundwater encountered during excavation. No caving observed. Bottom of test pit at 6.0 feet.

Earth Solutions NW
1805 - 136th Place N.E., Suite 201
Bellevue, Washington 98005
Telephone: 425-449-4704
Fax: 425-449-4711

TEST PIT NUMBER TP-7

PROJECT NUMBER 6384 **PROJECT NAME** 4301 – 78th Street Southwest

DATE STARTED 12/5/18 **COMPLETED** 12/5/18 **GROUND ELEVATION** _____ **TEST PIT SIZE** _____

EXCAVATION CONTRACTOR NW Excavating **GROUND WATER LEVELS:**

EXCAVATION METHOD _____ **AT TIME OF EXCAVATION** ---

LOGGED BY CGH **CHECKED BY** HTW **AT END OF EXCAVATION** ---

NOTES Depth of Topsoil & Sod 8": ivy **AFTER EXCAVATION** ---

DEPTH (ft)	SAMPLE TYPE NUMBER	TESTS	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
0			TPSL		Dark brown TOPSOIL, root intrusions to 2'
				0.6	Brown silty SAND, loose, moist to wet
		MC = 18.90%			
					-becomes gray, medium dense, moderate iron oxide staining
			SM		-becomes very dense, cemented
5					
		MC = 10.60% Fines = 48.20%		6.0	[USDA Classification: slightly gravelly LOAM]
					Test pit terminated at 6.0 feet below existing grade due to refusal in very dense cemented till. No groundwater encountered during excavation. No caving observed. Bottom of test pit at 6.0 feet.

Earth Solutions NW
1805 - 136th Place N.E., Suite 201
Bellevue, Washington 98005
Telephone: 425-449-4704
Fax: 425-449-4711

TEST PIT NUMBER TP-8

PROJECT NUMBER 6384 **PROJECT NAME** 4301 – 78th Street Southwest

DATE STARTED 12/5/18 **COMPLETED** 12/5/18 **GROUND ELEVATION** _____ **TEST PIT SIZE** _____

EXCAVATION CONTRACTOR NW Excavating **GROUND WATER LEVELS:**

EXCAVATION METHOD _____ **AT TIME OF EXCAVATION** ---

LOGGED BY CGH **CHECKED BY** HTW **AT END OF EXCAVATION** ---

NOTES Depth of Topsoil & Sod 8": heavy brush **AFTER EXCAVATION** ---

DEPTH (ft)	SAMPLE TYPE NUMBER	TESTS	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
0			TPSL		Dark brown TOPSOIL, root intrusions to 2'
				0.6	Brown silty SAND, loose, moist
		MC = 7.10%	SM		-becomes gray, medium dense
					-becomes dense, weakly cemented
					-light iron oxide staining
		MC = 8.30%		4.5	Test pit terminated at 4.5 feet below existing grade due to refusal in very dense cemented till. No groundwater encountered during excavation. No caving observed. Bottom of test pit at 4.5 feet.

Appendix B

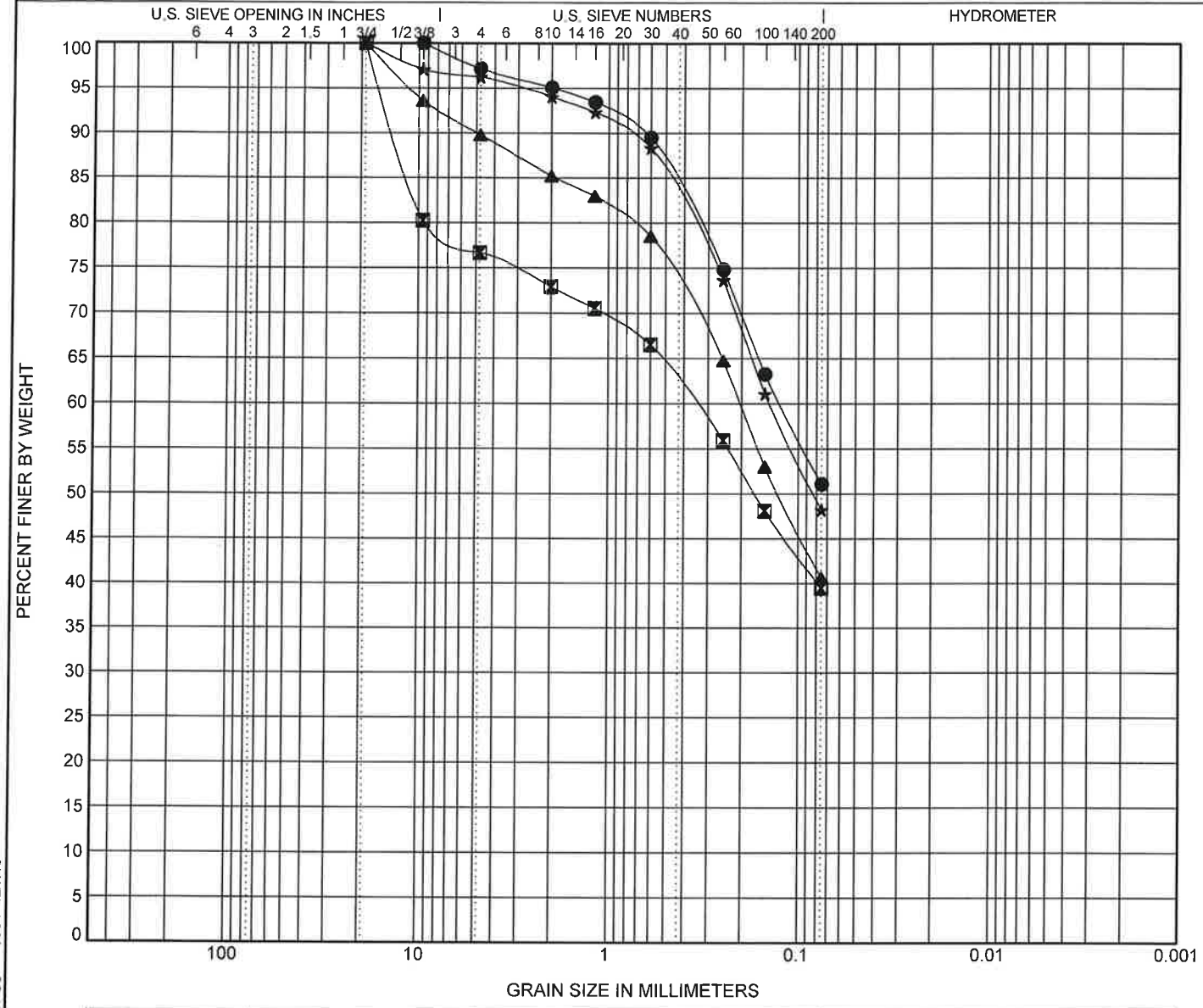
Laboratory Test Results

ES-6384

Earth Solutions NW, LLC
1805 - 136th PL N.E., Suite 201
Bellevue, WA 98005
Telephone: 425-449-4704
Fax: 425-449-4711

GRAIN SIZE DISTRIBUTION

PROJECT NUMBER ES-6384 **PROJECT NAME** 4301 - 78th Street Southwest



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Specimen Identification		Classification	Cc	Cu
● TP-01	4.50ft.	USDA: Gray Slightly Gravelly Loam. USCS: Sandy ML.		
⊠ TP-02	5.00ft.	USDA: Gray Gravelly Loam. USCS: SM with Gravel.		
▲ TP-05	2.50ft.	USDA: Gray Slightly Gravelly Fine Sandy Loam. USCS: SM.		
★ TP-07	6.00ft.	USDA: Gray Slightly Gravelly Loam. USCS: SM.		

Specimen Identification		D100	D60	D30	D10	LL	PL	PI	%Silt	%Clay
● TP-01	4.5ft.	9.5	0.125						51.1	
⊠ TP-02	5.0ft.	19	0.351						39.5	
▲ TP-05	2.5ft.	19	0.204						40.6	
★ TP-07	6.0ft.	19	0.142						48.2	

GRAIN SIZE USDA ES-6384 4301 - 78TH STREET SOUTHWEST.GPJ GINT US LAB.GDT 12/7/18

Report Distribution

ES-6384

EMAIL ONLY

Underwood Nelson Development
P.O. Box 1301
Seahurst, Washington 98062

Attention: Mr. Greg Nelson