Earth Solutions NW LLC

Geotechnical Engineering
Construction Observation/Testing
Environmental Services

UPDATED GEOTECHNICAL ENGINEERING STUDY
PROPOSED KESTREL RIDGE RESIDENTIAL PLAT
CHAIN LAKE ROAD
MONROE, WASHINGTON

ES-5859.01

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PREPARED FOR

TAYLOR DEVELOPMENT, INC.

December 26, 2019

For:

Scott S. Riegel, L.G., L.E.G.
Senior Project Manager

12/26/19

Kyle R. Campbell, P.E.
Principal Engineer

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Important Information about This

Geotechnical-Engineering Report

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

While you cannot eliminate all such risks, you can manage them. The following information is provided to help.

The Geoprofessional Business Association (GBA) has prepared this advisory to help you – assumedly a client representative – interpret and apply this geotechnical-engineering report as effectively as possible. In that way, you can benefit from a lowered exposure to problems associated with subsurface conditions at project sites and development of them that, for decades, have been a principal cause of construction delays, cost overruns, claims, and disputes. If you have questions or want more information about any of the issues discussed herein, contact your GBA-member geotechnical engineer. Active engagement in GBA exposes geotechnical engineers to a wide array of risk-confrontation techniques that can be of genuine benefit for everyone involved with a construction project.

Understand the Geotechnical-Engineering Services Provided for this Report

Geotechnical-engineering services typically include the planning, collection, interpretation, and analysis of exploratory data from widely spaced borings and/or test pits. Field data are combined with results from laboratory tests of soil and rock samples obtained from field exploration (if applicable), observations made during site reconnaissance, and historical information to form one or more models of the expected subsurface conditions beneath the site. Local geology and alterations of the site surface and subsurface by previous and proposed construction are also important considerations. Geotechnical engineers apply their engineering training, experience, and judgment to adapt the requirements of the prospective project to the subsurface model(s). Estimates are made of the subsurface conditions that will likely be exposed during construction as well as the expected performance of foundations and other structures being planned and/or affected by construction activities.

The culmination of these geotechnical-engineering services is typically a geotechnical-engineering report providing the data obtained, a discussion of the subsurface model(s), the engineering and geologic engineering assessments and analyses made, and the recommendations developed to satisfy the given requirements of the project. These reports may be titled investigations, explorations, studies, assessments, or evaluations. Regardless of the title used, the geotechnical-engineering report is an engineering interpretation of the subsurface conditions within the context of the project and does not represent a close examination, systematic inquiry, or thorough investigation of all site and subsurface conditions.

Geotechnical-Engineering Services are Performed for Specific Purposes, Persons, and Projects, and At Specific Times

Geotechnical engineers structure their services to meet the specific needs, goals, and risk management preferences of their clients. A geotechnical-engineering study conducted for a given civil engineer will not likely meet the needs of a civil-works constructor or even a different civil engineer. Because each geotechnical-engineering study is unique, each geotechnical-engineering report is unique, prepared *solely* for the client.

Likewise, geotechnical-engineering services are performed for a specific project and purpose. For example, it is unlikely that a geotechnical-engineering study for a refrigerated warehouse will be the same as one prepared for a parking garage; and a few borings drilled during a preliminary study to evaluate site feasibility will not be adequate to develop geotechnical design recommendations for the project.

Do not rely on this report if your geotechnical engineer prepared it:

- for a different client;
- for a different project or purpose;
- for a different site (that may or may not include all or a portion of the original site); or
- before important events occurred at the site or adjacent to it; e.g., man-made events like construction or environmental remediation, or natural events like floods, droughts, earthquakes, or groundwater fluctuations.

Note, too, the reliability of a geotechnical-engineering report can be affected by the passage of time, because of factors like changed subsurface conditions; new or modified codes, standards, or regulations; or new techniques or tools. *If you are the least bit uncertain* about the continued reliability of this report, contact your geotechnical engineer before applying the recommendations in it. A minor amount of additional testing or analysis after the passage of time – if any is required at all – could prevent major problems.

Read this Report in Full

Costly problems have occurred because those relying on a geotechnical-engineering report did not read the report in its entirety. Do not rely on an executive summary. Do not read selective elements only. *Read and refer to the report in full.*

You Need to Inform Your Geotechnical Engineer About Change

Your geotechnical engineer considered unique, project-specific factors when developing the scope of study behind this report and developing the confirmation-dependent recommendations the report conveys. Typical changes that could erode the reliability of this report include those that affect:

- the site's size or shape;
- the elevation, configuration, location, orientation, function or weight of the proposed structure and the desired performance criteria;
- the composition of the design team; or
- project ownership.

As a general rule, *always* inform your geotechnical engineer of project or site changes – even minor ones – and request an assessment of their impact. *The geotechnical engineer who prepared this report cannot accept* *responsibility or liability for problems that arise because the geotechnical engineer was not informed about developments the engineer otherwise would have considered.*

Most of the "Findings" Related in This Report Are Professional Opinions

Before construction begins, geotechnical engineers explore a site's subsurface using various sampling and testing procedures. *Geotechnical engineers can observe actual subsurface conditions only at those specific locations where sampling and testing is performed.* The data derived from that sampling and testing were reviewed by your geotechnical engineer, who then applied professional judgement to form opinions about subsurface conditions throughout the site. Actual sitewide-subsurface conditions may differ – maybe significantly – from those indicated in this report. Confront that risk by retaining your geotechnical engineer to serve on the design team through project completion to obtain informed guidance quickly, whenever needed.

This Report's Recommendations Are Confirmation-Dependent

The recommendations included in this report – including any options or alternatives – are confirmation-dependent. In other words, they are <u>not</u> final, because the geotechnical engineer who developed them relied heavily on judgement and opinion to do so. Your geotechnical engineer can finalize the recommendations *only after observing actual subsurface conditions* exposed during construction. If through observation your geotechnical engineer confirms that the conditions assumed to exist actually do exist, the recommendations can be relied upon, assuming no other changes have occurred. *The geotechnical engineer who prepared this report cannot assume responsibility or liability for confirmation-dependent recommendations if you fail to retain that engineer to perform construction observation.*

This Report Could Be Misinterpreted

Other design professionals' misinterpretation of geotechnical-engineering reports has resulted in costly problems. Confront that risk by having your geotechnical engineer serve as a continuing member of the design team, to:

- confer with other design-team members;
- help develop specifications;
- review pertinent elements of other design professionals' plans and specifications; and
- be available whenever geotechnical-engineering guidance is needed.

You should also confront the risk of constructors misinterpreting this report. Do so by retaining your geotechnical engineer to participate in prebid and preconstruction conferences and to perform construction-phase observations.

Give Constructors a Complete Report and Guidance

Some owners and design professionals mistakenly believe they can shift unanticipated-subsurface-conditions liability to constructors by limiting the information they provide for bid preparation. To help prevent the costly, contentious problems this practice has caused, include the complete geotechnical-engineering report, along with any attachments or appendices, with your contract documents, *but be certain to note conspicuously that you've included the material for information purposes only.* To avoid misunderstanding, you may also want to note that "informational purposes" means constructors have no right to rely on the interpretations, opinions, conclusions, or recommendations in the report. Be certain that constructors know they may learn about specific project requirements, including options selected from the report, *only* from the design drawings and specifications. Remind constructors that they may perform their own studies if they want to, and *be sure to allow enough time* to permit them to do so. Only then might you be in a position to give constructors the information available to you, while requiring them to at least share some of the financial responsibilities stemming from unanticipated conditions. Conducting prebid and preconstruction conferences can also be valuable in this respect.

Read Responsibility Provisions Closely

Some client representatives, design professionals, and constructors do not realize that geotechnical engineering is far less exact than other engineering disciplines. This happens in part because soil and rock on project sites are typically heterogeneous and not manufactured materials with well-defined engineering properties like steel and concrete. That lack of understanding has nurtured unrealistic expectations that have resulted in disappointments, delays, cost overruns, claims, and disputes. To confront that risk, geotechnical engineers commonly include 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 <u>Not</u> Covered

The personnel, equipment, and techniques used to perform an environmental study – e.g., a "phase-one" or "phase-two" environmental site assessment – differ significantly from those used to perform a geotechnical-engineering study. For that reason, a geotechnical-engineering report does not usually provide environmental findings, conclusions, or recommendations; e.g., about the likelihood of encountering underground storage tanks or regulated contaminants. *Unanticipated subsurface environmental problems have led to project failures.* If you have not obtained your own environmental information about the project site, ask your geotechnical consultant for a recommendation on how to find environmental risk-management guidance.

Obtain Professional Assistance to Deal with Moisture Infiltration and Mold

While your geotechnical engineer may have addressed groundwater, water infiltration, or similar issues in this report, the engineer's services were not designed, conducted, or intended to prevent migration of moisture – including water vapor – from the soil through building slabs and walls and into the building interior, where it can cause mold growth and material-performance deficiencies. Accordingly, ***proper implementation of the geotechnical engineer's recommendations will <u>not</u> of itself be sufficient to prevent moisture infiltration. Confront the risk of moisture infiltration*** by including building-envelope or mold specialists on the design team. ***Geotechnical engineers are <u>not</u> building-envelope or mold specialists.***

GEOPROFESSIONAL BUSINESS ASSOCIATION

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Earth Solutions NW LLC

Geotechnical Engineering, Construction Observation/Testing and Environmental Services

December 26, 2019
ES-5859.01

Taylor Development, Inc.
15 Lake Bellevue Drive, Suite 102
Bellevue, Washington 98005

Attention: Mr. Robert Fitzmaurice

Dear Mr. Fitzmaurice:

Earth Solutions NW, LLC (ESNW) is pleased to present this geotechnical report to support your proposed project. Based on the results of our investigation, construction of the proposed residential structures is feasible from a geotechnical standpoint. Our explorations indicate the site is underlain predominately by glacial till deposits with areas of alluvial/outwash sand toward the eastern portion of the overall site. During our subsurface exploration completed on February 2, 2018 and December 6, 2019, groundwater seepage was encountered at shallow depths across much of the site. Mitigation of this groundwater prior to site excavation will be critical during the grading process, and is discussed in greater detail later in this report.

The proposed structures may 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. In general, competent native soil, suitable for support of the new foundations, will likely be encountered beginning at depths of two to three feet below existing grades. 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 a suitable structural fill material, will be necessary.

In accordance with the Department of Ecology's Stormwater Management Manual adopted by the City of Monroe, infiltration is not feasible from a geotechnical standpoint. Weakly cemented glacial till deposits were observed roughly two feet below ground surface, as well as heavy groundwater flow at shallow depths.

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

For: Scott S. Riegel, L.G., L.E.G.
Senior Project Manager

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INTRODUCTION

General

This geotechnical engineering study (study) was prepared for the proposed residential development to be constructed along the north side of Chain Lake Road, in Monroe, 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:

- Excavation, logging, and sampling of test pits for purposes 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:

- CP | H Consultants, Conceptual Site Plan dated November 7, 2019;
- Surficial geologic map of the Skykomish and Snoqualmie Rivers area, Snohomish and King Counties, Washington, prepared by Booth, 1990;
- Online Web Soil Survey (WSS) resource, provided by the United States Department of Agriculture (USDA), Natural Resources Conservation Service.

Project Description

Preliminary site layout indicates the subject site will be developed with a total of 70 single-family residences, a tract road, stormwater detention areas, and associated infrastructure improvements. At the time of this report submission, specific building load and grading plans were not available for review; however, we anticipate the proposed structures will be two to three stories in height and constructed utilizing relatively lightly loaded wood framing supported on a conventional foundation system. Perimeter footing loads will likely be 1 to 2 kips per lineal foot, and slab-on-grade loading is anticipated to be approximately 150 pounds per square foot (psf).

Stormwater will be managed primarily by two detention facilities located along the southern portion of the site, designated Tract A and Tract F on the referenced site plan. Given the moderate topography and elevation on the site, cuts and fills ranging up to about ten feet are expected.

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 north of Chain Lake Road approximately 300 feet east of the intersection with Brown Road, in Monroe, Washington. The approximate location of the property is illustrated on Plate 1 (Vicinity Map). The property is comprised of three adjoining tax parcels (Snohomish County Parcel Nos. 2807310020-600, -2500 and -2700) totaling about nine acres. The site is bordered to the north, east, and west by residential houses, and to the south by Chain Lake Road. Each parcel is currently occupied by single family residence and associated improvements. The site topography descends gently to the east and vegetation consists of forested areas, open pastures, brambles and landscaping.

Subsurface

A representative of ESNW observed, logged, and sampled five test pits, excavated at accessible locations within the site boundaries, on February 2, 2018 and again on December 6, 2019 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 within areas proposed for new development. 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 (USCS) and United States Department of Agriculture (USDA) methods and procedures.

Topsoil and Fill

Topsoil was observed extending to depths of about 3 to 12 inches. The topsoil was characterized by the observed dark brown hue, the presence of fine organics, and small root intrusions.

Fill was not encountered at any of the test pit locations. Fill encountered during grading should be evaluated by ESNW during grading activities.

Native Soil

Underlying topsoil, native soils consisted primarily of medium dense to dense silty sand with gravel (USCS: SM). Native soils were primarily encountered in a moist to wet condition. The maximum exploration depth was approximately seven feet below the existing ground surface (bgs). Isolated layers of sand (USCS: SP, SP-SM) were encountered at several test pit explorations located along the eastern areas of the site.

Geologic Setting

The referenced geologic map resource identifies glacial till (Qvt) deposits as the primary native soil unit underlying the subject site. The till was deposited directly from the glacier as it advanced over bedrock and older Quaternary sediment and is often characterized as a silty sand with gravel. The referenced WSS resource identifies Tokul Medially Gravelly Loam (Map Unit Symbols: 72 and 73) as the primary soil units underlying the subject site. The Tokul was formed in glacial drift settings. Based on our field observations, on-site native soils are generally consistent with glacial till (Qvt) deposits.

Groundwater

During our subsurface exploration completed on February 2, 2018 heavy groundwater seepage was encountered at most locations. During our December 6, 2019 fieldwork, moderate groundwater seepage was observed at test pit location TP-109 perched at a depth of about two and one-half feet below existing grades. Moderate to heavy seepage was encountered from about one to three feet bgs across the site and likely represents interflow where groundwater travels within the shallow weathered zone. Water was observed to be entering excavations from a general northwestern direction, and is likely entering the site from the north side of the 13217 property. It is our opinion the contractor should anticipate and be prepared to respond to perched groundwater seepage during construction, especially within site excavations located within the northern half of the site. Groundwater seepage is common within relatively permeable soil lenses located above dense native soil deposits. 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 wet season (October through April).

Geologically Hazardous Areas

Based on review of geologically hazardous areas in the Monroe Municipal Code 20.05.120, the subject site does not appear to be within, or immediately adjacent to, geologically hazardous areas, with the exception of potentially erodible geology. In our opinion, site susceptibility to erosion hazards may be considered low, provided that groundwater seepage is mitigated appropriately during construction, and temporary erosion control measures are included during grading activities.

DISCUSSION AND RECOMMENDATIONS

General

Based on the results of our investigation, construction of the proposed residential development is feasible from a geotechnical standpoint. The primary geotechnical considerations associated with the proposed development include foundation support, slab-on-grade subgrade support, groundwater/interflow drainage, and the suitability of using native soils as structural fill.

The proposed structures may 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. In general, competent native soil, suitable for support of the new foundations, will likely be encountered beginning at depths of two to three feet below existing grades. 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 a suitable structural fill material, will be necessary.

Due to the heavy seepage present across most of the subject site, groundwater mitigation should be addressed prior to grading and sitework taking place. In our opinion, an interceptor trench along the upslope margins of the development envelope should be installed prior to the commencement of mass grading.

Glacial till was observed to be in a dense condition and weakly cemented roughly two feet below ground surface. Heavy groundwater flow was observed throughout the site of shallow depths. Given the shallow depths to groundwater and dense, native soils, infiltration is not recommended for this site.

This study has been prepared for the exclusive use of Taylor Development, Inc., 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, performing site clearing and site stripping and installation of interceptor drains. Subsequent earthwork procedures will involve grading and related infrastructure improvements.

Temporary Erosion Control

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 surface for construction vehicles. Geotextile fabric may be placed below the quarry spalls for greater stability of the temporary construction entrances. Erosion control measures should consist of silt fencing placed around appropriate portions of the site perimeter. Soil stockpiles should be covered or otherwise protected to reduce the potential for soil erosion during periods of wet weather. Temporary approaches for controlling surface water runoff should be established prior to beginning earthwork activities. Additional Best Management Practices (BMPs), as specified by the project civil engineer and indicated on the plans, should be incorporated into construction activities.

Construction Dewatering

Diversion of shallow groundwater should be implemented prior to mass grading and excavations on this site. An interception trench installed along the northern and western site boundaries will help control groundwater and should reduce the effects of on-site seepage. Completion of this trench as early as possible into the project will be key to reducing seepage onsite. The interceptor trench should be installed at a minimum depth of four feet below ground surface within dense, native till. A temporary detention pond, Baker tank, or another means of adequate water treatment and storage will be necessary due to the estimated high volume of groundwater. An ESNW representative should be onsite during trench construction and drainage program to confirm that groundwater is being managed adequately and to provide additional recommendations. A typical interceptor trench detail is provided on Plate 3. We recommend that prior to construction of the trench, ESNW should meet on-site with the client and contractor to finalize trench direction and locations. Additional drainage measures may be necessary on the site depending on the groundwater conditions at the time of construction.

Stripping

Topsoil was encountered within the upper approximately 3 to 12 inches of existing grades at the test pit locations. The organic-rich topsoil should be stripped and segregated into a stockpile for later use on site or to export. The material remaining immediately below the topsoil may have some root zones and will likely be variable in composition, density, and/or moisture content. The material exposed after initial topsoil stripping will likely not be suitable for direct structural support and will likely need to either be compacted in place or stripped and stockpiled for reuse as fill; depending on the time of year stripping occurs, the soil exposed below the topsoil may be too wet to compact adequately and may need to be aerated or otherwise treated. ESNW should observe initial stripping activities to provide recommendations regarding stripping depths and material suitability.

Excavations and Slopes

Reduction of groundwater flow will be critical to ensure that overall stability of site excavations remain in good condition while open. 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 and medium dense soil or fill 1.5H:1V (Type C)
- Areas exposing groundwater seepage 1.5H:1V (Type C)
- Medium dense to dense native soil 1H:1V (Type B)

Permanent slopes should be planted with vegetation to enhance stability and to minimize erosion and should maintain a gradient of 2H:1V or flatter. 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. This is particularly important where detention vault excavations may be made near property lines.

In-situ and Imported Soils

In-situ soils are highly moisture sensitive and may not be suitable for use in structural fill applications unless the moisture content of the soil is at (or slightly above) the optimum moisture content at the time of placement and compaction. Successful use of native soils as structural fill will largely be dictated by in-situ moisture contents during construction. A contingency should be added to the budget in the event export of native soil and import of compactible fill is necessary.

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. 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

Following site stripping, cuts and fills will be completed to establish proposed subgrade elevations across the site. ESNW should observe the subgrade areas during initial site preparation activities to confirm soil conditions are as anticipated and to provide supplementary recommendations for subgrade preparation. Complete restoration of voids resulting from previous grading activities must be executed as part of overall subgrade and building pad preparation activities.

The following guidelines for preparing building subgrade areas should be incorporated into the final design:

- Where voids and grading disturbances extend below planned subgrade elevations, restoration of these areas should be completed. Structural fill should be used to restore voids or unstable areas resulting from previous grading.
- Recompact, or over-excavate and replace, areas of existing fill exposed at building subgrade elevations. Over-excavations should extend into competent native soils and structural fill should be utilized to restore subgrade elevations as necessary.
- ESNW should confirm subgrade conditions, as well as the required level of recompaction and/or over-excavation and replacement, during site preparation activities. ESNW should also evaluate the overall suitability of prepared subgrade areas following site preparation activities.

Structural Fill

Structural fill is defined as compacted soil placed in foundation, slab-on-grade, and roadway areas. Fill placed to construct permanent slopes and throughout retaining wall and utility trench backfill areas is considered structural fill as well. Soils placed in structural areas, including slab-on-grade, utility trench, and pavement areas, should consist of a material devoid of organics or otherwise deleterious debris, 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).

Foundations

The proposed structures may be supported 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. In general, competent native soil, suitable for support of the new foundations, will likely be encountered at depths of about two to three feet below existing grades. 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 a suitable structural fill material, will be necessary. 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 — 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 earth 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. The majority of the settlements should occur during construction, as dead loads are applied.

Seismic Design

The 2015 International Building Code recognizes the American Society of Civil Engineers (ASCE) for seismic site class definitions. Based on the soil conditions encountered at the test pit locations, 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 site maintains a "very low to low" liquefaction susceptibility. Liquefaction is a phenomenon where saturated and loose sandy soils suddenly lose internal strength 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 low. The relative density and gradation of the site soils is the primary basis for this consideration.

Slab-on-Grade Floors

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

A capillary break, consisting of a minimum of four inches of free-draining crushed rock or gravel, should be placed below the slabs. 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 vapor barriers below the slabs 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 (yielding 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 — 6H 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 loads should be included in the retaining wall design, where applicable.

Retaining walls should be backfilled with free-draining material or suitable sheet drain 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 4. If drainage is not provided, hydrostatic pressures should be included in the wall design.

Drainage

Heavy seepage was observed across the site during our fieldwork, in our opinion, zones of perched groundwater seepage should be anticipated in general site excavations; however, installing an interceptor trench, as described in this report, will help manage the effects of shallow interflow groundwater. 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 structures and/or slopes. Water must not be allowed to pond adjacent to the new structure and/or slopes. In our opinion, foundation drains should be installed along the building perimeter footings. A typical foundation drain detail is provided on Plate 5. If structures will include crawlspace configurations, we recommend installing conveyance measures to allow water to exit the building perimeter in the event water enters the foundation area.

Interception trenches built on-site should be considered as permanent installations. Civil engineering designs for the site must account for shallow groundwater conditions.

Infiltration Evaluation

As indicated in the *Subsurface* section of this study, native soils encountered during our fieldwork were characterized primarily as medium dense to dense, glacial till deposits. Given the cemented nature to the glacial till and shallow depths to heavy, pervasive seepage across the site, infiltration is not feasible from a geotechnical standpoint.

Preliminary Detention Vault Recommendations

Final storm detention design plans had not been finalized at the time of writing this report; however, we understand a detention vault will be constructed in the eastern area of the property. Vault foundations should be supported on competent native soil or crushed rock placed atop competent native soil. Final stormwater vault designs must incorporate adequate buffer space from property boundaries such that temporary excavations to construct the vault structure can be successfully completed or shoring will be required. Adequate buffer space is particularly important on this site given groundwater conditions and the adverse impacts to temporary slope inclinations. The presence of perched groundwater seepage should be anticipated during excavation activities for the vault.

The following parameters can be used for preliminary stormwater vault design:

• Allowable soil bearing capacity (dense native soil)	5,000 psf
• Active earth pressure	35 pcf
• Active earth pressure (hydrostatic)	80 pcf
• At-rest earth pressure (restrained)	55 pcf
• At-rest earth pressure (restrained, hydrostatic)	100 pcf
• Coefficient of friction	0.40
• Passive earth pressure	300 pcf
• Seismic surcharge	6H*

* *Where H equals the retained height*

Vault walls should be backfilled with at least 18 inches of free-draining material or suitable sheet drainage that extends along the height of the walls. The upper one foot of the wall backfill can consist of a less permeable soil, if desired. A perforated drain pipe should be placed along the base of the vault 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 portion of the vault below the drain must be designed to include hydrostatic pressure. Design values accounting for hydrostatic pressure are included above.

ESNW should observe grading operations for the vault and the subgrade conditions prior to concrete forming and pouring to confirm conditions are as anticipated, and to provide supplemental recommendations as necessary. Additionally, ESNW should be contacted to review final vault designs to confirm that appropriate geotechnical parameters have been incorporated.

Utility Support and Trench Backfill

In our opinion, native soils will generally be suitable for support of utilities. Organic-rich soils are not considered suitable for direct support of utilities and may require removal at utility grades if encountered. Remedial measures, such as overexcavation and replacement with structural fill and/or installation of geotextile fabric, may be necessary in some areas in order to provide support for utilities. Groundwater will likely be encountered within utility excavations, and caving of trench walls may occur where groundwater is encountered. Temporary construction dewatering, as well as temporary trench shoring, may be necessary during utility excavation and installation as conditions warrant.

Native soils will not be suitable for use as structural backfill throughout utility trench excavations, unless the soils are at (or slightly above) the optimum moisture content at the time of placement and compaction. Structural trench backfill should not be placed dry of the optimum moisture content. Each section of the site utility lines must be adequately supported in appropriate 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 the City of Monroe or other responsible jurisdiction or agency.

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 proof rolling 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 over-excavation and/or placement of thicker crushed rock or structural fill sections, prior to pavement. Cement treatment of the subgrade soil can also be considered for stabilizing pavement subgrade areas if allowed by local jurisdictions.

For lightly loaded pavement areas subjected primarily to passenger vehicles, the following preliminary pavement sections may be considered:

- A minimum of two inches of hot mix asphalt (HMA) placed over four inches of crushed rock base (CRB), or;
- A minimum of two inches of HMA placed over three inches of asphalt treated base (ATB).

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 areas may be considered:

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

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. Final pavement design recommendations, including recommendations for heavy traffic areas, access roads, and frontage improvement areas, can be provided once final traffic loading has been determined. Road standards utilized by the City of Monroe may supersede the recommendations provided in this report.

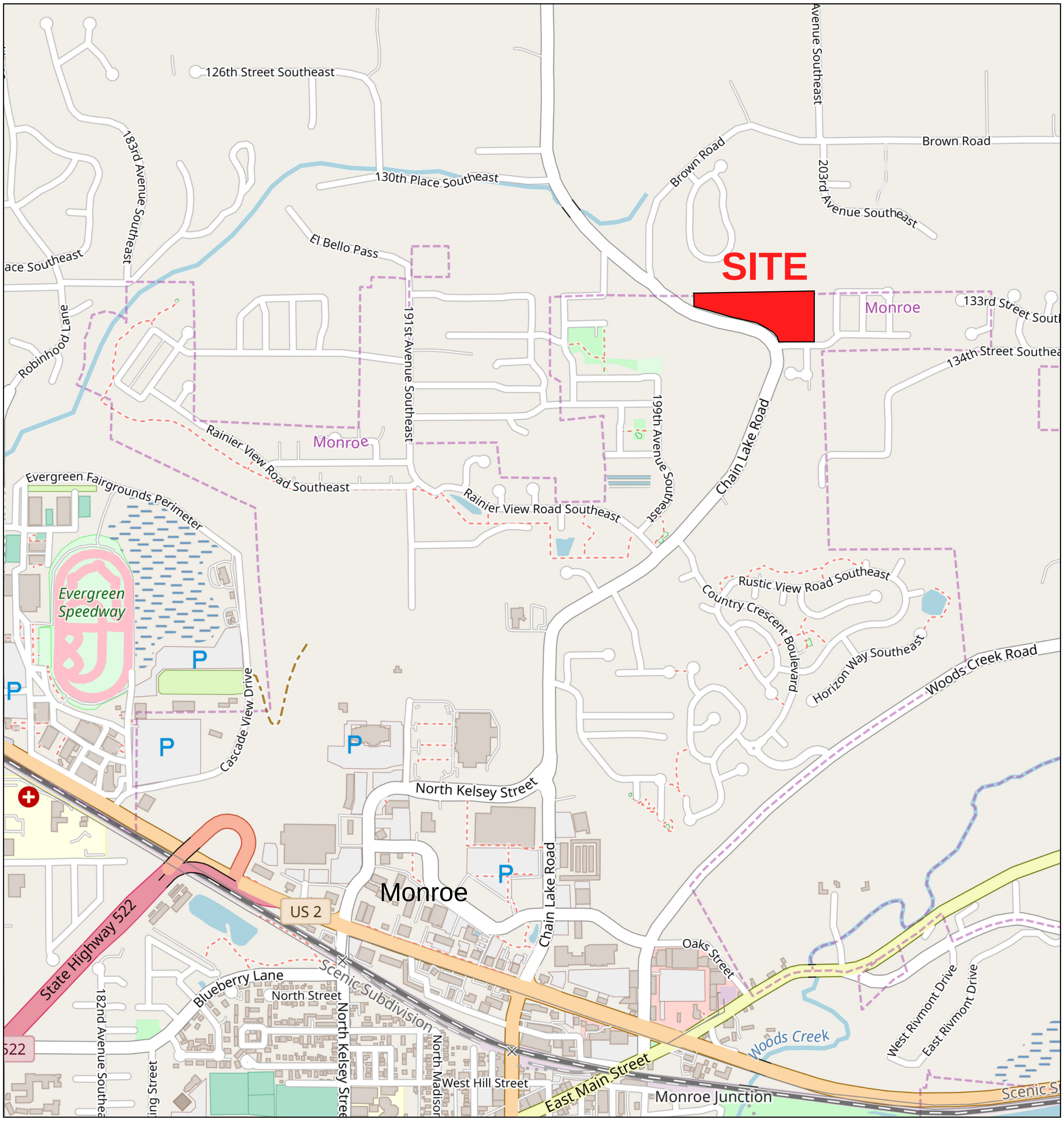
Given the groundwater conditions at site, it may be warranted to install a subgrade drainage system beneath roadways particularly if an inverted crown will be used. The need for such a system should be evaluated at the time of construction.

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 study. ESNW should also be retained to provide testing and consultation services during construction.



Reference:
Snohomish County, Washington
OpenStreetMaps.org

NORTH

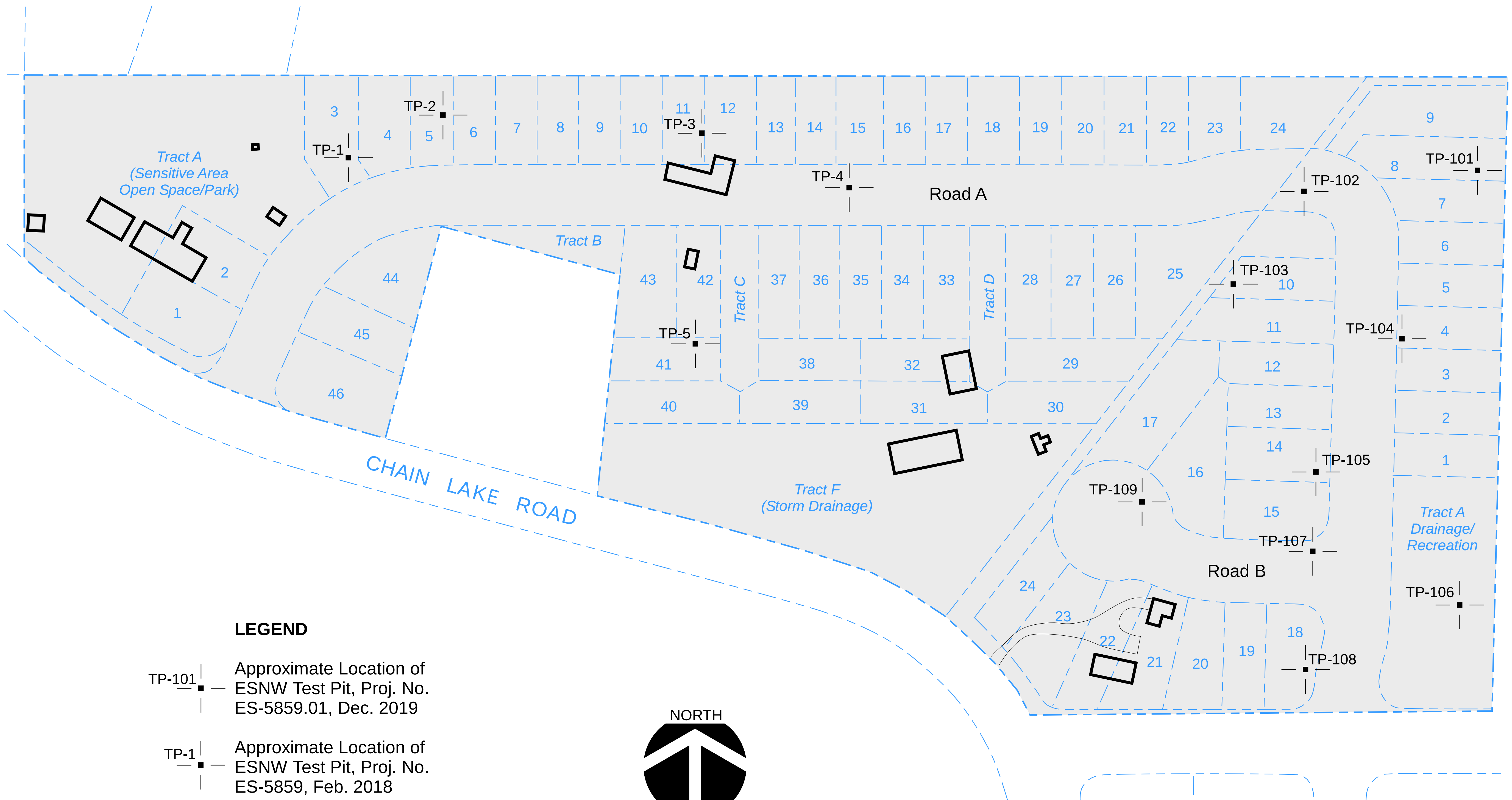
NOTE: This plate may contain areas of color. ESNW cannot be responsible for any subsequent misinterpretation of the information resulting from black & white reproductions of this plate.

Earth Solutions NW LLC

Geotechnical Engineering, Construction Observation/Testing and Environmental Services

Vicinity Map
Kestrel Ridge
Monroe, Washington

Drwn. MRS	Date 12/24/2019	Proj. No. 5859.01
Checked SSR	Date Dec. 2019	Plate 1



LEGEND

TP-101 — Approximate Location of ESNW Test Pit, Proj. No. ES-5859.01, Dec. 2019

TP-1 — Approximate Location of ESNW Test Pit, Proj. No. ES-5859, Feb. 2018

Subject Site

Existing Building

10 — Proposed Lot Number

0 50 100 200
1"=100' 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.

Test Pit Location Plan
Kestrel Ridge
Monroe, Washington

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

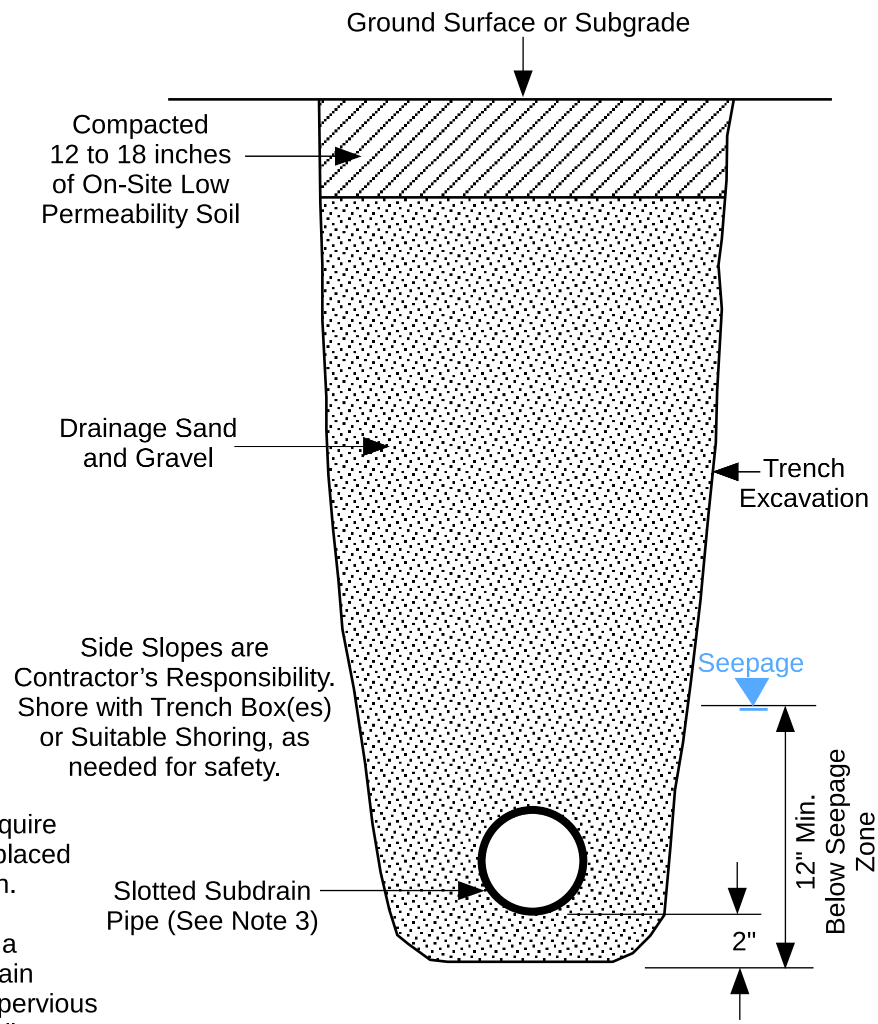
Drwn. By	MRS
Checked By	SSR
Date	12/23/2019
Proj. No.	5859.01
Plate	2

MATERIALS:

Drainage Sand and Gravel should meet the following gradation (Modified City of Seattle Mineral Aggregate Type 26):

Sieve Size	% Passing by Weight
1 - inch	100
3/4 - inch	85 to 95
1/4 - inch	30 to 60
No. 8	20 to 50
No. 50	3 to 12
No. 200 (by wet sieving)	0 to 1 (non-plastic fines)

An alternative to drainage sand and gravel is a 50-50 mixture of washed pea gravel (Mineral Aggregate Type 9) and washed sand (Mineral Aggregate Type 6).



NOTES:

1. Possible caving soil conditions may require that the subdrain pipe and backfill be placed concurrently with the trench excavation.

2. Extend pipe by means of a tightline to a suitable discharge point. Where subdrain pipe changes to a tightline, provide impervious dam (concrete or clay) so as to force all water into the tightline.

3. Slotted subdrain pipe; tight joints; sloped to drain (6"/100' min. slope); provide clean-outs; min. diameter: 6".

4. Slotted pipe to have 1/8" maximum slot width.

TYPICAL CROSS SECTION

NOT - TO - SCALE

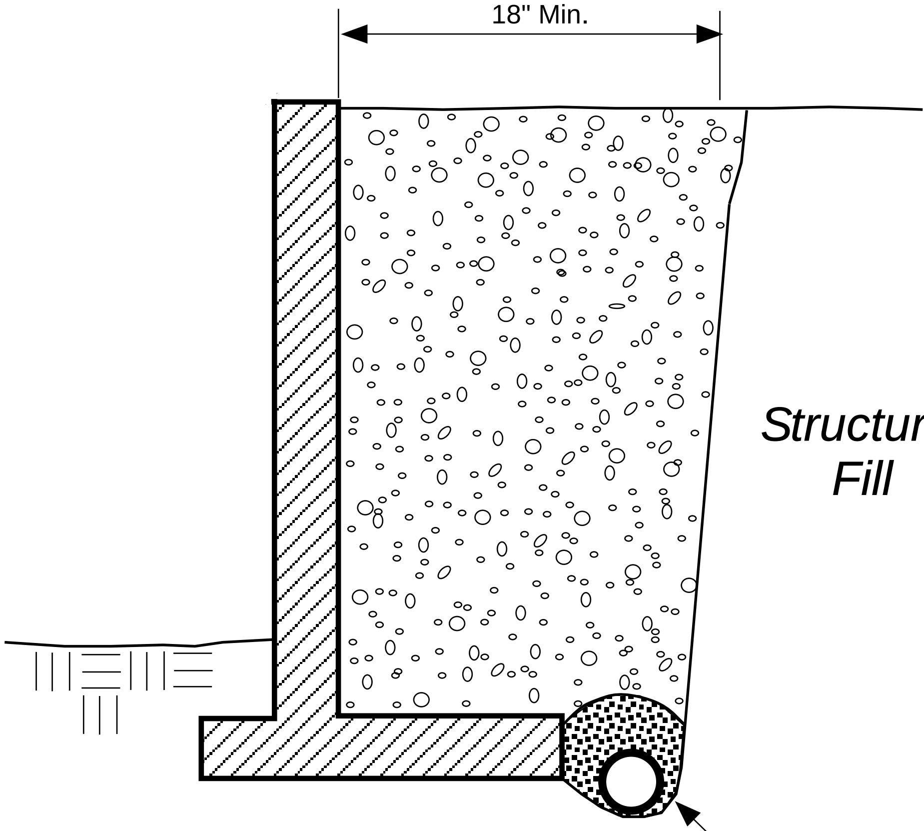
Reference: Seattle Landslide Study

Earth Solutions NW LLC

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

Typical Interceptor Trench Detail
Kestrel Ridge
Monroe, Washington

Drwn. MRS	Date 12/24/2019	Proj. No. 5859.01
Checked SSR	Date Dec. 2019	Plate 3

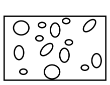


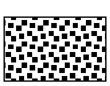
NOTES:

- 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

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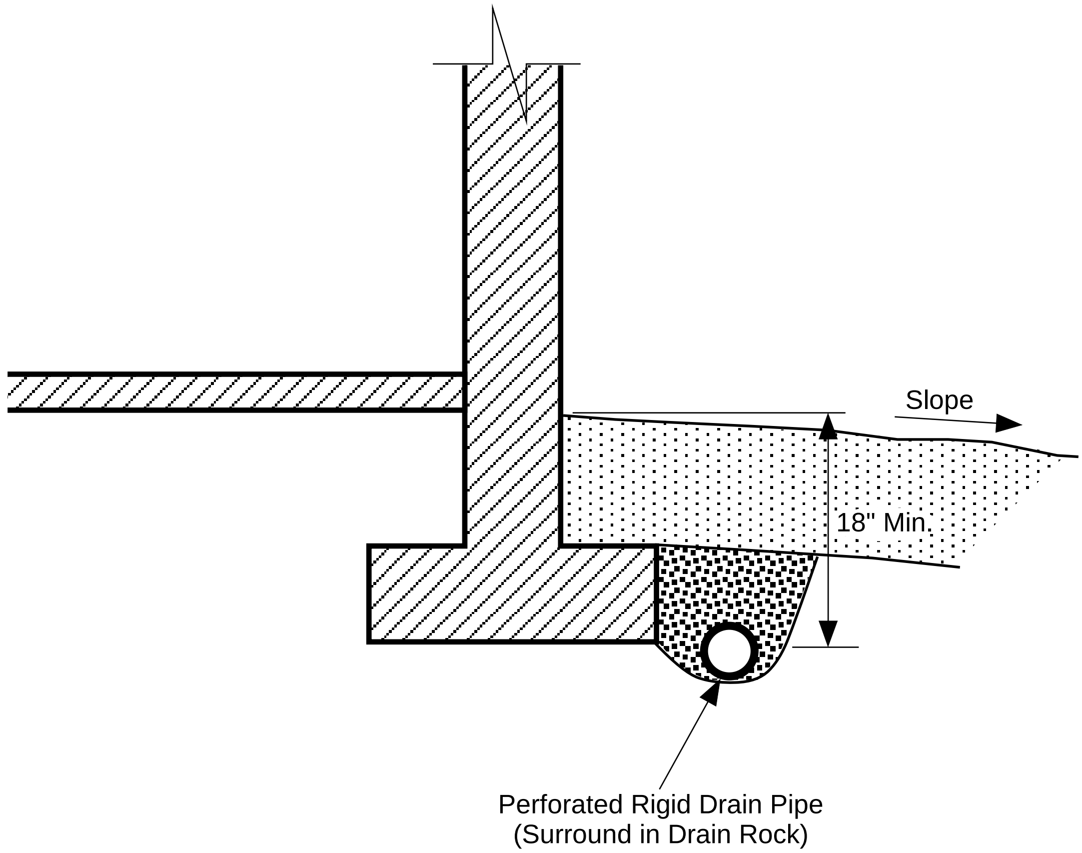
Retaining Wall Drainage Detail
Kestrel Ridge
Monroe, Washington

Drwn. MRS	Date 12/24/2019	Proj. No. 5859.01
Checked SSR	Date Dec. 2019	Plate 4



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
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Footing Drain Detail
Kestrel Ridge
Monroe, Washington

Drwn. MRS	Date 12/24/2019	Proj. No. 5859.01
Checked SSR	Date Dec. 2019	Plate 5

Appendix A

Subsurface Exploration
Test Pit Logs

ES-5859.01

Subsurface conditions at the subject site were explored on February 2, 2018 by excavating five test pits and December 6, 2019 by excavating nine test pits using a trackhoe and operator retained by our firm. 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 nine 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.

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SOIL CLASSIFICATION CHART

MAJOR DIVISIONS			SYMBOLS		TYPICAL DESCRIPTIONS
			GRAPH	LETTER	
COARSE GRAINED SOILS MORE THAN 50% OF MATERIAL IS LARGER THAN NO. 200 SIEVE SIZE	GRAVEL AND GRAVELLY SOILS MORE THAN 50% OF COARSE FRACTION RETAINED ON NO. 4 SIEVE	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
		GRAVELS WITH FINES (APPRECIABLE AMOUNT OF FINES)		GM	SILTY GRAVELS, GRAVEL - SAND - SILT MIXTURES
				GC	CLAYEY GRAVELS, GRAVEL - SAND - CLAY MIXTURES
	SAND AND SANDY SOILS MORE THAN 50% OF COARSE FRACTION PASSING ON NO. 4 SIEVE	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
		SANDS WITH FINES (APPRECIABLE AMOUNT OF FINES)		SM	SILTY SANDS, SAND - SILT MIXTURES
				SC	CLAYEY SANDS, SAND - CLAY MIXTURES
FINE GRAINED SOILS MORE THAN 50% OF MATERIAL IS SMALLER THAN NO. 200 SIEVE SIZE	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
	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 ES-5859 **PROJECT NAME** Chain Lake PRD

DATE STARTED 2/2/18 **COMPLETED** 2/2/18 **GROUND ELEVATION** 390 ft **TEST PIT SIZE**

EXCAVATION CONTRACTOR Client Provided **GROUND WATER LEVELS:**

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

LOGGED BY SES **CHECKED BY** SSR **AT END OF EXCAVATION** ---

NOTES Depth of Topsoil & Sod 12": grass, duff **AFTER EXCAVATION** ---

DEPTH (ft)	SAMPLE TYPE NUMBER	TESTS	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
0			TPSL		Dark brown saturated TOPSOIL
1.0		MC = 71.50%			389.0
			SM		Brown silty SAND with gravel, medium dense, wet -heavy groundwater seepage at 1'
2.0					388.0
		MC = 37.00% Fines = 72.70%	ML		Brown sandy SILT with gravel, medium dense, wet [USDA Classification: slightly gravelly LOAM]
5 / 5.0		MC = 29.70%			385.0
					Test pit terminated at 5.0 feet below existing grade due to heavy seepage. Groundwater seepage encountered at 1.0 foot during excavation. No caving observed. Bottom of test pit at 5.0 feet.

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Fax: 425-449-4711

TEST PIT NUMBER TP-2

PROJECT NUMBER ES-5859 **PROJECT NAME** Chain Lake PRD

DATE STARTED 2/2/18 **COMPLETED** 2/2/18 **GROUND ELEVATION** 385 ft **TEST PIT SIZE**

EXCAVATION CONTRACTOR Client Provided **GROUND WATER LEVELS:**

EXCAVATION METHOD

AT TIME OF EXCAVATION ---

LOGGED BY SES **CHECKED BY** SSR **AT END OF EXCAVATION** —

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

DEPTH (ft)	SAMPLE TYPE NUMBER	TESTS	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
0			TPSL	0.5	Dark brown highly organic TOPSOIL 384.5
		MC = 53.20%	SM		Brown silty SAND with gravel, medium dense, moist
		MC = 25.20%			-heavy groundwater seepage from 2' to 2.5'
					-becomes gray, dense, weakly cemented
5					
		MC = 18.40%		6.0	379.0
					Test pit terminated at 6.0 feet below existing grade. Groundwater seepage encountered from 2.0 to 2.5 feet during excavation. No caving observed. Bottom of test pit at 6.0 feet.

Earth Solutions NW LLC

Earth Solutions NW
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Bellevue, Washington 98005
Telephone: 425-449-4704
Fax: 425-449-4711

TEST PIT NUMBER TP-3

PROJECT NUMBER ES-5859
PROJECT NAME Chain Lake PRD
DATE STARTED 2/2/18 **COMPLETED** 2/2/18
GROUND ELEVATION 385 ft **TEST PIT SIZE**
EXCAVATION CONTRACTOR Client Provided
GROUND WATER LEVELS:
EXCAVATION METHOD
AT TIME OF EXCAVATION ---
LOGGED BY SES **CHECKED BY** SSR
AT END OF EXCAVATION ---
NOTES Depth of Topsoil & Sod 6": grass
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'	384.5
		MC = 106.10%	SM	3.0	Brown silty SAND, medium dense, wet -heavy groundwater seepage at 2'	382.0
		MC = 23.30%	GM	4.0	Brown silty GRAVEL with sand, dense, wet	381.0
					Test pit terminated at 4.0 feet below existing grade due to seepage. Groundwater seepage encountered at 2.0 feet during excavation. No caving observed. Bottom of test pit at 4.0 feet.	

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TEST PIT NUMBER TP-4

PROJECT NUMBER ES-5859 **PROJECT NAME** Chain Lake PRD

DATE STARTED 2/2/18 **COMPLETED** 2/2/18 **GROUND ELEVATION** 380 ft **TEST PIT SIZE**

EXCAVATION CONTRACTOR Client Provided **GROUND WATER LEVELS:**

EXCAVATION METHOD

AT TIME OF EXCAVATION ---

LOGGED BY SES **CHECKED BY** SSR

AT END OF EXCAVATION ---

NOTES Surface Conditions: grass

AFTER EXCAVATION ---

DEPTH (ft)	SAMPLE TYPE NUMBER	TESTS	U.S.C.S.	GRAPHIC LOG		MATERIAL DESCRIPTION	
0			TPSL		0.5	Dark brown highly organic TOPSOIL	379.5
		MC = 32.90%	SM			Brown silty SAND, medium dense, damp	
						-light groundwater seepage at 3'	
						-becomes gray, dense to very dense, weakly cemented	
5		MC = 15.90%					
		MC = 12.60% Fines = 24.00%			7.0	[USDA Classification: very gravelly sandy LOAM]	373.0

Test pit terminated at 7.0 feet below existing grade. Groundwater seepage encountered at 3.0 feet during excavation. No caving observed.

Bottom of test pit at 7.0 feet.

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

TEST PIT NUMBER TP-5

PROJECT NUMBER ES-5859 **PROJECT NAME** Chain Lake PRD

DATE STARTED 2/2/18 **COMPLETED** 2/2/18 **GROUND ELEVATION** 385 ft **TEST PIT SIZE**

EXCAVATION CONTRACTOR Client Provided **GROUND WATER LEVELS:**

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

LOGGED BY SES **CHECKED BY** SSR **AT END OF EXCAVATION** ---

NOTES Depth of Topsoil & Sod 3": grass **AFTER EXCAVATION** ---

DEPTH (ft)	SAMPLE TYPE NUMBER	TESTS	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION	
0			TPSL	0.3	Dark brown highly organic TOPSOIL	384.7
		MC = 36.90% MC = 15.20% Fines = 33.70%	SM	4.0	Brown silty SAND, medium dense, wet -heavy groundwater seepage at 2' -becomes gray, dense, unweathered [USDA Classification: gravelly fine sandy LOAM]	381.0

Test pit terminated at 4.0 feet below existing grade. Groundwater seepage encountered at 2.0 feet during excavation. No caving observed.

Bottom of test pit at 4.0 feet.

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

TEST PIT NUMBER TP-101

PROJECT NUMBER ES-5859.01 **PROJECT NAME** Kestrel Ridge

DATE STARTED 12/6/19 **COMPLETED** 12/6/19 **GROUND ELEVATION** **TEST PIT SIZE**

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

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

LOGGED BY SES **CHECKED BY** SSR **AT END OF EXCAVATION** ---

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

DEPTH (ft)	SAMPLE TYPE NUMBER	TESTS	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
0			TPSL	0.5	Dark brown TOPSOIL
		MC = 5.10%	SM		Brown silty SAND with gravel, loose to medium dense, damp -moderate caving to BOH
				3.0	
5		MC = 7.10% Fines = 2.70%	SP		Gray poorly graded SAND with gravel, medium dense, damp [USDA Classification: very gravelly SAND] -increasing sand
		MC = 3.70%		7.0	Test pit terminated at 7.0 feet below existing grade. No groundwater encountered during excavation. Caving observed from 2.0 feet to BOH. Bottom of test pit at 7.0 feet.

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

TEST PIT NUMBER TP-102

PROJECT NUMBER ES-5859.01 **PROJECT NAME** Kestrel Ridge

DATE STARTED 12/6/19 **COMPLETED** 12/6/19 **GROUND ELEVATION** **TEST PIT SIZE**

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

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

LOGGED BY SES **CHECKED BY** SSR **AT END OF EXCAVATION** ---

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

DEPTH (ft)	SAMPLE TYPE NUMBER	TESTS	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
0			TPSL	0.5	Dark brown TOPSOIL, shallow root intrusions
		MC = 16.50%	SM		Brown silty SAND with gravel, medium dense, damp -becomes gray -caving to BOH
5				5.0	
		MC = 3.60%	SP	7.0	Gray poorly graded SAND with gravel, medium dense, damp
					Test pit terminated at 7.0 feet below existing grade. No groundwater encountered during excavation. Caving observed from 4.0 feet to BOH. Bottom of test pit at 7.0 feet.

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Redmond, Washington 98052
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Fax: 425-449-4711

TEST PIT NUMBER TP-103

PROJECT NUMBER ES-5859.01 **PROJECT NAME** Kestrel Ridge

DATE STARTED 12/6/19 **COMPLETED** 12/6/19 **GROUND ELEVATION** ______ **TEST PIT SIZE** ______

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

EXCAVATION METHOD ______ **AT TIME OF EXCAVATION** ---

LOGGED BY SES **CHECKED BY** SSR **AT END OF EXCAVATION** ---

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

DEPTH (ft)	SAMPLE TYPE NUMBER	TESTS	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
0			TPSL	1.0	Dark brown TOPSOIL, root intrusions to 3'
			SM		Gray silty SAND with gravel, medium dense, damp
		MC = 15.60%			-mottled texture
					-becomes gray
5					
					-becomes dense
		MC = 20.00% Fines = 17.40%		7.5	[USDA Classification: very gravelly sandy LOAM]
					Test pit terminated at 7.5 feet below existing grade. No groundwater encountered during excavation. No caving observed.
					Bottom of test pit at 7.5 feet.

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Redmond, Washington 98052
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Fax: 425-449-4711

TEST PIT NUMBER TP-104

PROJECT NUMBER ES-5859.01 **PROJECT NAME** Kestrel Ridge

DATE STARTED 12/6/19 **COMPLETED** 12/6/19 **GROUND ELEVATION** **TEST PIT SIZE**

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

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

LOGGED BY SES **CHECKED BY** SSR **AT END OF EXCAVATION** ---

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

DEPTH (ft)	SAMPLE TYPE NUMBER	TESTS	U.S.C.S.	GRAPHIC LOG		MATERIAL DESCRIPTION
0			TPSL		0.5	TOPSOIL
			SM			Brown silty SAND with gravel, medium dense, damp
		MC = 33.70%				
						-becomes gray
5						-becomes moist
						-caving to BOH
		MC = 14.20%				
		MC = 10.90% Fines = 13.20%			7.0	[USDA Classification: loamy coarse SAND]
						Test pit terminated at 7.0 feet below existing grade. No groundwater encountered during excavation. Caving observed from 5.0 feet to BOH. Bottom of test pit at 7.0 feet.

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Redmond, Washington 98052
Telephone: 425-449-4704
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TEST PIT NUMBER TP-105

PROJECT NUMBER ES-5859.01 **PROJECT NAME** Kestrel Ridge

DATE STARTED 12/6/19 **COMPLETED** 12/6/19 **GROUND ELEVATION** **TEST PIT SIZE**

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

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

LOGGED BY SES **CHECKED BY** SSR **AT END OF EXCAVATION** ---

NOTES Depth of Topsoil & Sod 3": duff **AFTER EXCAVATION** ---

DEPTH (ft)	SAMPLE TYPE NUMBER	TESTS	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
0			SM		Brown silty SAND with gravel, loose to medium dense, damp
		MC = 31.90%			-becomes gray
					-becomes medium dense
5		MC = 10.50%			
					-becomes dense
		MC = 12.50%		8.0	Test pit terminated at 8.0 feet below existing grade. No groundwater encountered during excavation. No caving observed. Bottom of test pit at 8.0 feet.

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Redmond, Washington 98052
Telephone: 425-449-4704
Fax: 425-449-4711

TEST PIT NUMBER TP-106

PROJECT NUMBER ES-5859.01 **PROJECT NAME** Kestrel Ridge
DATE STARTED 12/6/19 **COMPLETED** 12/6/19 **GROUND ELEVATION** **TEST PIT SIZE**
EXCAVATION CONTRACTOR NW Excavating **GROUND WATER LEVELS:**
EXCAVATION METHOD **AT TIME OF EXCAVATION** ---
LOGGED BY SES **CHECKED BY** SSR **AT END OF EXCAVATION** ---
NOTES Depth of Topsoil & Sod 6": duff **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 1.5'
					Brown silty SAND with gravel, loose to medium dense, damp
					-becomes gray, medium dense
		MC = 6.30%			
5			SM		-slight caving to BOH
					-decrease silt content
					-becomes very dense
		MC = 6.60% Fines = 12.80%		9.0	[USDA Classification: very gravelly sandy LOAM]
					Test pit terminated at 9.0 feet below existing grade. No groundwater encountered during excavation. Caving observed from 4.5 feet to BOH. Bottom of test pit at 9.0 feet.

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

TEST PIT NUMBER TP-107

PROJECT NUMBER ES-5859.01 **PROJECT NAME** Kestrel Ridge

DATE STARTED 12/6/19 **COMPLETED** 12/6/19 **GROUND ELEVATION** **TEST PIT SIZE**

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

EXCAVATION METHOD

AT TIME OF EXCAVATION ---

LOGGED BY SES **CHECKED BY** SSR **AT END OF EXCAVATION** ---

NOTES Depth of Topsoil & Sod 6": duff **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 1.5'
		MC = 24.00%	SM	4.0	Brown silty SAND with gravel, medium dense, moist -becomes wet -becomes gray
5		MC = 8.50%	SP-SM	6.5	Gray poorly graded SAND with silt and gravel, medium dense, damp to moist
					Test pit terminated at 6.5 feet below existing grade. No groundwater encountered during excavation. No caving observed. Bottom of test pit at 6.5 feet.

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TEST PIT NUMBER TP-108

PROJECT NUMBER ES-5859.01 **PROJECT NAME** Kestrel Ridge

DATE STARTED 12/6/19 **COMPLETED** 12/6/19 **GROUND ELEVATION** **TEST PIT SIZE**

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

EXCAVATION METHOD

AT TIME OF EXCAVATION ---

LOGGED BY SES **CHECKED BY** SSR **AT END OF EXCAVATION** ---

NOTES Depth of Topsoil & Sod 6": duff **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 1'
			SM		Brown silty SAND with gravel, medium dense, moist
					-becomes wet
		MC = 24.10% Fines = 38.00%			-becomes gray, dense [USDA Classification: slightly gravelly fine sandy LOAM]
5					-becomes moist -becomes very dense
		MC = 8.50%		7.0	Test pit terminated at 7.0 feet below existing grade. No groundwater encountered during excavation. No caving observed. Bottom of test pit at 7.0 feet.

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TEST PIT NUMBER TP-109

PROJECT NUMBER ES-5859.01 **PROJECT NAME** Kestrel Ridge

DATE STARTED 12/6/19 **COMPLETED** 12/6/19 **GROUND ELEVATION** **TEST PIT SIZE**

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

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

LOGGED BY SES **CHECKED BY** SSR **AT END OF EXCAVATION** ---

NOTES Depth of Topsoil & Sod 6": duff **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 1'
			SM		Brown silty SAND, medium dense, moist
		MC = 14.80%			-becomes wet -groundwater seepage -becomes gray, dense
5					
		MC = 11.60%		7.5	Test pit terminated at 7.5 feet below existing grade. Groundwater seepage encountered at 2.5 feet during excavation. No caving observed. Bottom of test pit at 7.5 feet.

Appendix B

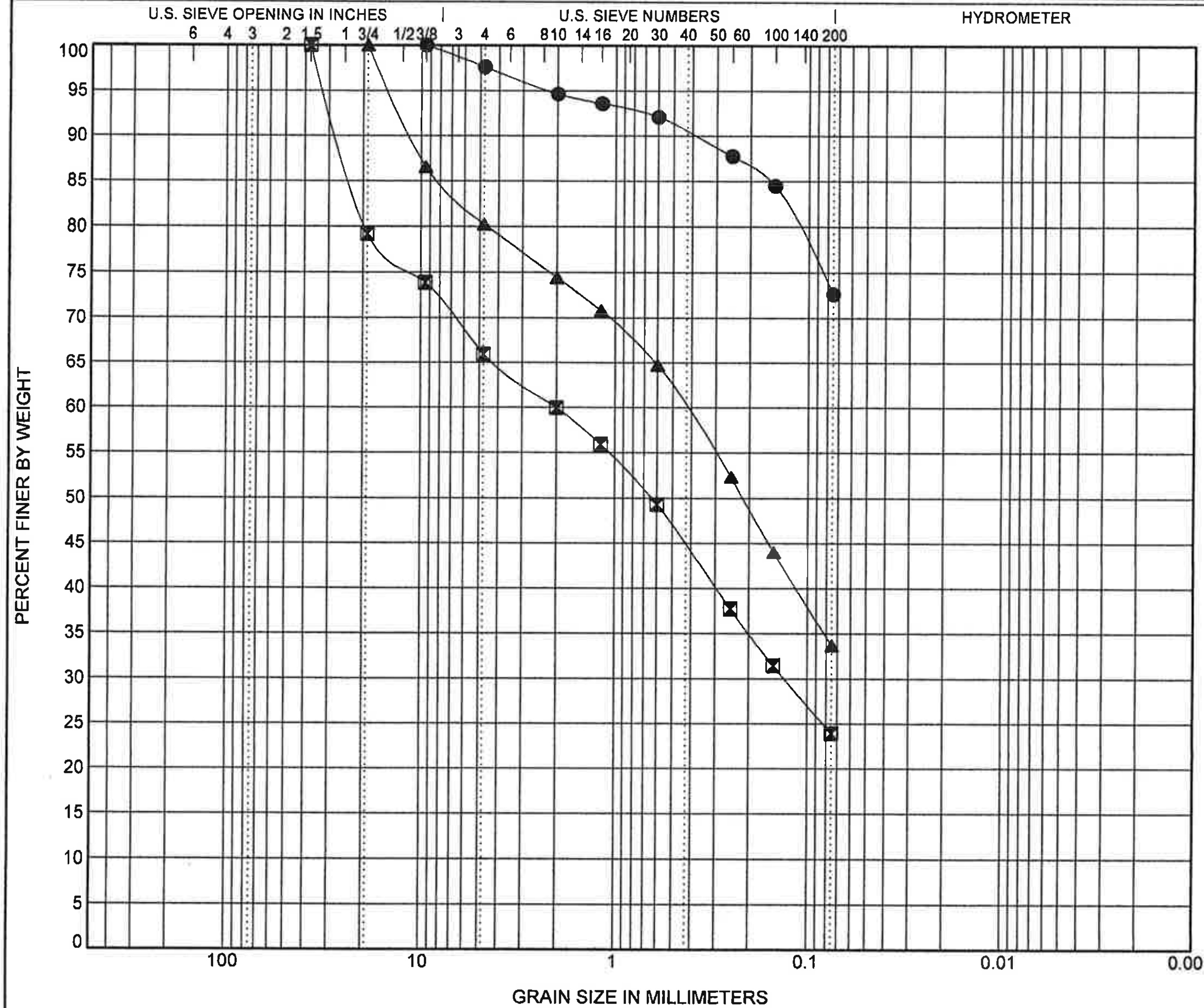
Laboratory Test Results

ES-5859.01

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-5859 **PROJECT NAME** Chain Lake PRD



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Specimen Identification		Classification	Cc	Cu
●	**TP-1**	**3.00ft.**	**USDA: Brown Slightly Gravelly Loam. USCS: ML with Sand.**		
⊠	**TP-4**	**7.00ft.**	**USDA: Gray Very Gravelly Sandy Loam. USCS: SM with Gravel.**		
▲	**TP-5**	**4.00ft.**	**USDA: Gray Gravelly Fine Sandy Loam. USCS: SM with Gravel.**		

	Specimen Identification		D100	D60	D30	D10	LL	PL	PI	%Silt	%Clay
●	**TP-1**	**3.0ft.**	**9.5**							**72.7**	
⊠	**TP-4**	**7.0ft.**	**37.5**	**2.018**	**0.131**					**24.0**	
▲	**TP-5**	**4.0ft.**	**19**	**0.429**						**33.7**	

Earth Solutions NW, LLC
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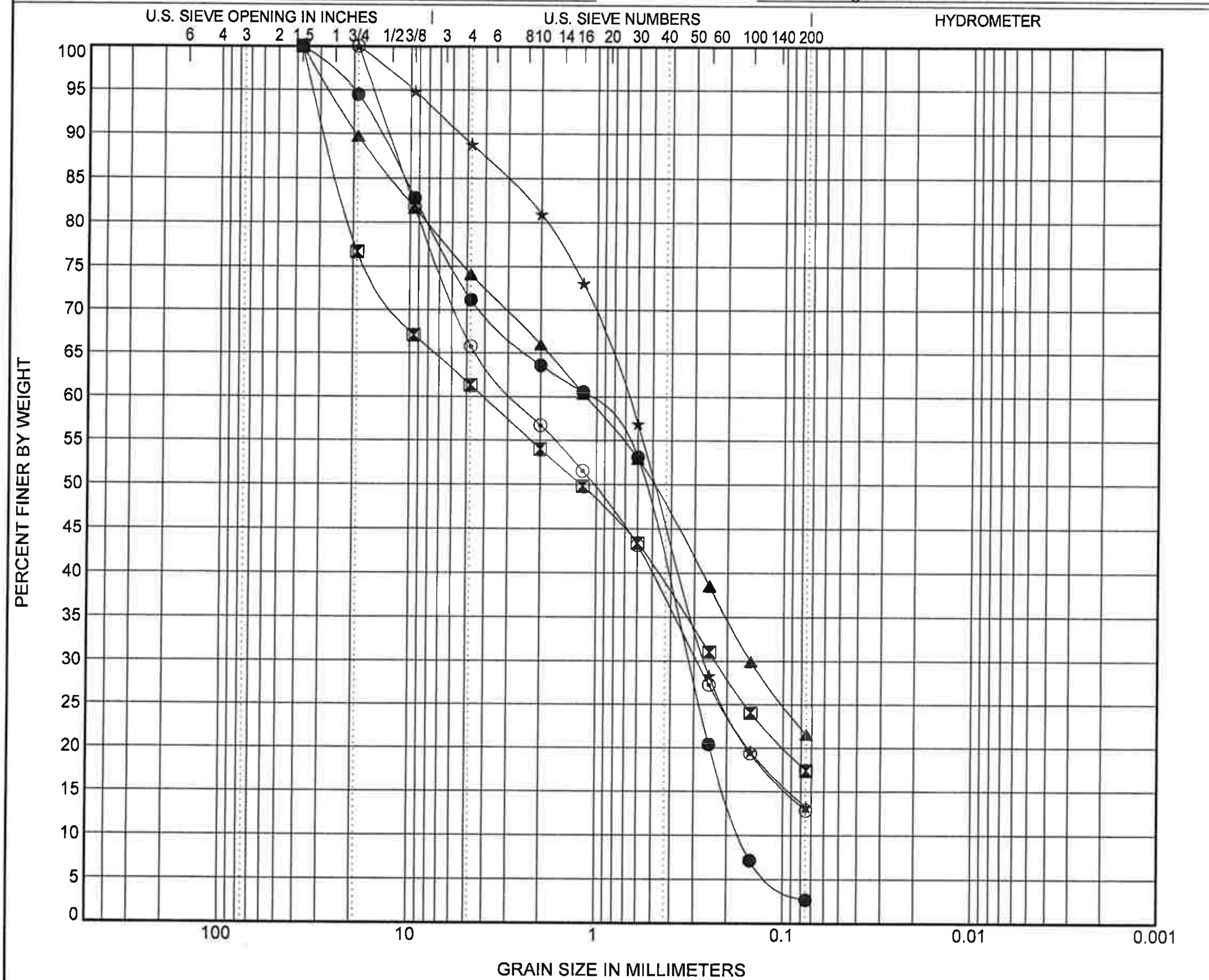
Redmond, Washington 98052
Telephone: 425-449-4704
Fax: 425-449-4711

GRAIN SIZE DISTRIBUTION

PROJECT NUMBER ES-5859.01 **PROJECT NAME** Kestrel Ridge



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Specimen Identification			Classification	Cc	Cu
●	TP-101	4.00ft.	USDA: Brown Very Gravelly Sand. USCS: SP with Gravel.	0.56	6.71
⊠	TP-103	3.00ft.	USDA: Brown Very Gravelly Sandy Loam. USCS: SM with Gravel.		
▲	TP-103	7.50ft.	USDA: Gray Gravelly Sandy Loam. USCS: SM with Gravel.		
★	TP-104	7.00ft.	USDA: Gray Gravelly Loamy Coarse Sand. USCS: SM.		
⊙	TP-106	9.00ft.	USDA: Gray Very Gravelly Sandy Loam. USCS: SM with Gravel.		

Specimen Identification			D100	D60	D30	D10	LL	PL	PI	%Silt	%Clay
●	TP-101	4.0ft.	37.5	1.124	0.323	0.168				2.7	
⊠	TP-103	3.0ft.	37.5	4.07	0.232					17.4	
▲	TP-103	7.5ft.	37.5	1.143	0.151					21.5	
★	TP-104	7.0ft.	19	0.683	0.264					13.2	
⊙	TP-106	9.0ft.	19	2.74	0.291					12.8	

GRAIN SIZE USDA ES-5859.01 KESTREL RIDGE.GPJ GINT US LAB.GDT 12/13/19

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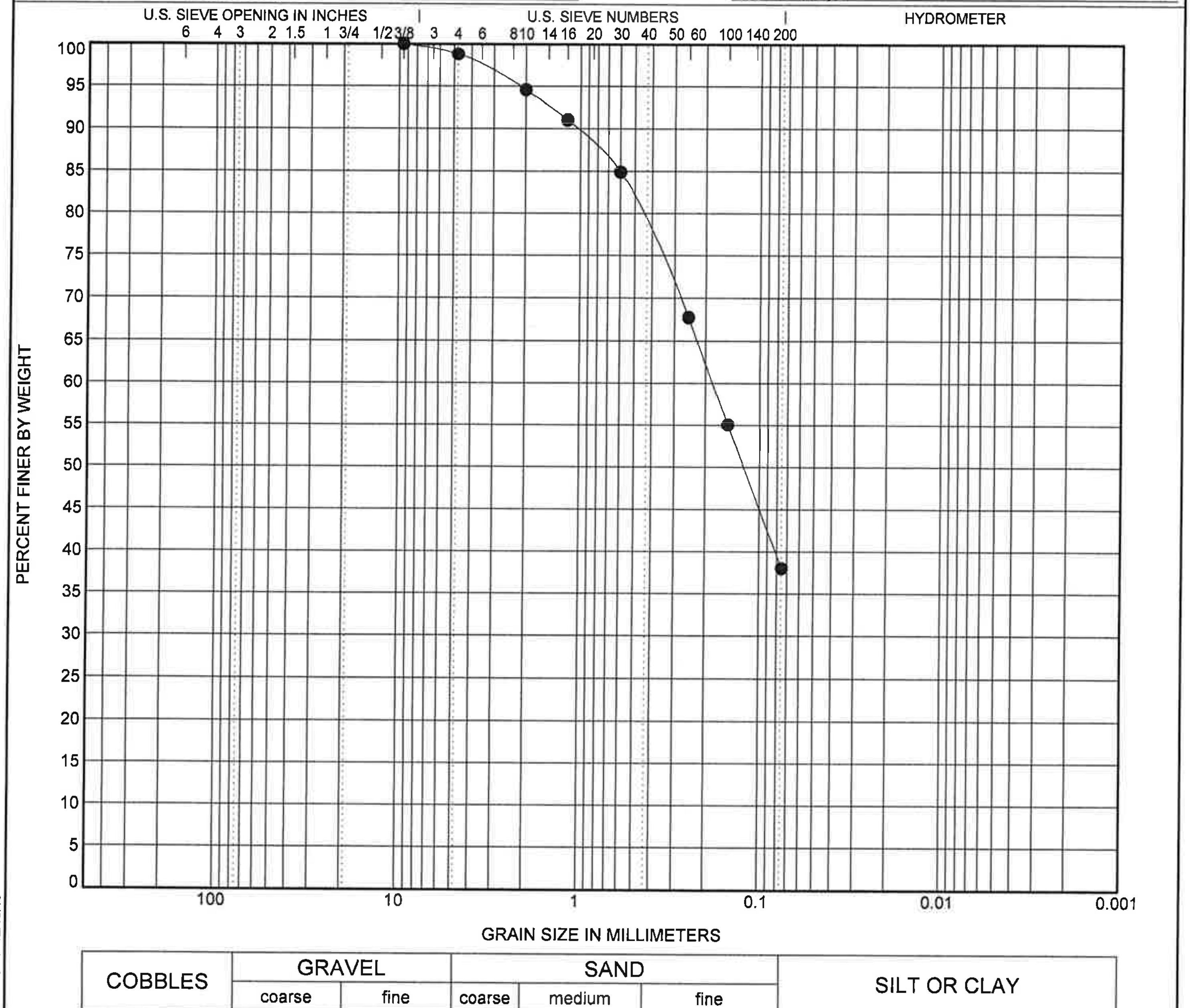
GRAIN SIZE DISTRIBUTION

PROJECT NUMBER ES-5859.01 **PROJECT NAME** Kestrel Ridge



Specimen Identification		Classification	Cc	Cu
● TP-108	3.00ft.	USDA: Gray Slightly Gravelly Fine Sandy Loam. USCS: SM.		

Specimen Identification		D100	D60	D30	D10	LL	PL	PI	%Silt	%Clay
● TP-108	3.0ft.	9.5	0.183						38.0	

GRAIN SIZE USDA ES-5859.01 KESTREL RIDGE.GPJ GINT US LAB.GDT 12/13/19

Report Distribution

ES-5859.01

EMAIL ONLY

Taylor Development, Inc.
15 Lake Bellevue Drive, Suite 102
Bellevue, Washington 98005

Attention: Mr. Robert Fitzmaurice