Earth Solutions NW LLC

Geotechnical Engineering
Construction Observation/Testing
Environmental Services

GEOTECHNICAL ENGINEERING STUDY
PROPOSED SINGLE-FAMILY RESIDENCE
73XX WEST MERCER WAY
MERCER ISLAND, WASHINGTON

ES-6947.01

15365 N.E. 90th Street, Suite 100 Redmond, WA 98052
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PREPARED FOR

RKK VILLA MARBELLA, LLC

November 14, 2019

Chase G. Halsen
Senior Staff Geologist

KEVEN D. HOFFMANN
STATE OF WASHINGTON
53734
REGISTERED
PROFESSIONAL ENGINEER

11/14/2019

Keven D. Hoffmann, P.E.
Senior Project Manager

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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 not 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 Not 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 not 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 not building-envelope or mold specialists.***

GEOPROFESSIONAL BUSINESS ASSOCIATION

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Earth Solutions NW LLC

Geotechnical Engineering, Construction Observation/Testing and Environmental Services

November 14, 2019
ES-6947.01

RKK Villa Marbella, LLC
7330 West Mercer Way
Mercer Island, Washington 98040

Attention: Mr. Mason Helms

Greetings, Mr. Helms:

Earth Solutions NW, LLC (ESNW) is pleased to present this geotechnical report to support your project. Based on the results of our investigation, construction of the proposed single-family residence is feasible from a geotechnical standpoint. Our study indicates the site is underlain by glacial deposits of sand and silt.

Based on our findings, the proposed single-family home structure may be constructed on conventional continuous and spread footing foundation 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 foundation elements will likely be encountered beginning at a depth of about two feet below the existing ground surface. Where loose or unsuitable soil conditions are exposed at foundation subgrade elevations, compaction of the soil to the specifications of structural fill or overexcavation and replacement with suitable structural fill will be necessary.

Review of the Mercer Island infiltration feasibility map indicates the site is within an area that precludes the use of infiltration devices. In addition, the presence of glacially consolidated deposits and nearby sloping features will further restrict the feasibility of infiltration.

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

Sincerely,

EARTH SOLUTIONS NW, LLC

Chase G. Halsen
Senior Staff Geologist

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GEOTECHNICAL ENGINEERING STUDY
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INTRODUCTION

General

This geotechnical engineering study (study) was prepared for the proposed single-family residence to be completed about 570 feet southwest of the West Mercer Way and West Ridge Road intersection, on Mercer Island, Washington. This study was prepared to provide geotechnical recommendations for currently proposed development plans and included the following geotechnical services:

- Subsurface characterization of soil and groundwater conditions;
- Laboratory testing of representative soil samples collected at the test pit locations, and;
- Engineering analyses.

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

- Chapter 19 of the Mercer Island City Code;
- Mercer Island Erosion, Landslide, and Seismic Hazard Assessment Maps, prepared by Kathy G. Troost and Aaron P. Wisher, April 2009;
- Low Impact Development Infiltration Feasibility on Mercer Island Map, prepared by Herrera Environmental Consultants, 2009;
- Soil Survey of King County Area, Washington, prepared by Dale E. Snyder, Philip S. Gale, and Russell F. Pringle, in association with the Soil Conservation Service, November 1973;
- Geologic Map of Mercer Island, Washington, prepared by Kathy G. Troost and Aaron P. Wisher, October 2006, and;
- Online Web Soil Survey (WSS) resource, maintained by the Natural Resources Conservation Service under the United States Department of Agriculture (USDA).

Project Description

We understand a single-family residence and associated improvements have been proposed for the site. Site access will be provided by a private road serving homes of the 7400 block along the western edge of West Mercer Way. We presume detention, connection to existing public systems, or some other means of stormwater management (besides infiltration) will be incorporated into the plans.

At the time of report submission, specific building load plans were not available for review; however, based on our experience with similar developments, the proposed structure will likely be two to three stories in height and constructed using relatively lightly loaded wood framing supported on conventional foundations. Perimeter footing loads will likely be about 1 to 2 kips per lineal foot. Slab-on-grade loading is anticipated to be approximately 150 pounds per square foot (psf).

We anticipate grade cuts or fills of five feet or less will be necessary to establish design elevations. Retaining walls may be incorporated into final designs to accommodate grade transitions where necessary.

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 appropriate geotechnical recommendations have been incorporated into the plans.

SITE CONDITIONS

Surface

The subject site is located about 570 feet southwest of the West Mercer Way and West Ridge Road intersection, on Mercer Island, Washington. The approximate site location is depicted on Plate 1 (Vicinity Map). The site consists of one tax parcel (King County Parcel No. 8944225-0060), totaling about 0.41 acres.

The site is bordered on all sides by residential development and/or associated infrastructure improvements. Topography descends to the south and southwest, with about 45 feet of elevation change occurring within the property confines. The majority of the elevation change occurs within the central and western property areas. The eastern site area is relatively level. The site is surfaced with landscaping features and mature forest and brush growth.

Subsurface

An ESNW representative observed, logged, and sampled two test pits on September 19, 2019, using a mini trackhoe and operator retained by you. The test pits were completed to assess and classify soil and groundwater conditions within an accessible and relevant site area. The approximate locations of the test pits 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 analyzed in general accordance with both Unified Soil Classification System (USCS) and USDA methods and procedures.

Topsoil and Fill

In general, topsoil was encountered within the upper 6 to 10 inches of existing grades at the test pit locations. The topsoil was characterized by a dark brown color, root intrusions, and increased organic content. Fill was not encountered at the test pit locations.

Native Soil

Underlying topsoil, the native soil was classified as poorly graded sand with silt, silty sand, and silt (USCS: SP-SM, SM, and ML, respectively). The native soil was encountered in a medium dense to very dense and moist condition, extending to a maximum exploration depth of about six feet below the existing ground surface (bgs).

Geologic Setting

The referenced geologic map resource identifies Vashon till (Qvt), pre-Olympia glacial till (Qpgot), or some combination thereof as underlying the site and adjacent areas. Both deposits are relatively similar in composition and consist of a compact mixture of silt, sand, and gravel. Large sand and gravel bodies are also common within the deposits. The referenced WSS resource identifies Kitsap silt loam (Map Unit Symbol: KpB) as underlying the site and immediately surrounding area. The Kitsap series is associated with terrace landforms and is derived from a lacustrine parent material. In our opinion, the native soil encountered on site is consistent with local geologic mapping designations of glacial till.

Groundwater

Groundwater seepage zones were not exposed at the test pit locations during our September 2019 subsurface exploration. However, zones of perched groundwater seepage should be expected during general earthwork activities. Seepage exposures, 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.

Geologic Hazard Areas Review

We reviewed the referenced Mercer Island Landslide, Erosion, and Seismic Hazard Assessment maps, as well as readily available online topographic information, to determine the presence of geologic hazard areas on or in proximity to the site. Review of these publications indicate the potential presence of landslide hazard and erosion hazard areas within the confines of the subject site. Our evaluation of these hazards is provided below.

Landslide Hazard Area

Per Mercer Island City Code (MICC) 19.16.010, a landslide hazard is defined as any area that exhibits any of the follow characteristics:

1. Historic failures;

2. Slopes in excess of 15 percent that contain both permeable sediments overlying impermeable sediments and groundwater seepage;

3. Evidence of past movement or is underlain by mass wastage debris;

4. Potentially unstable due to incision and/or stream bank erosion, and;

5. Slopes over 30 feet in height with a gradient of 40 percent or greater (steep slope).

Review of readily available topographic information indicates the presence of a slope within the central and western site areas that contains gradients in excess of 40 percent over an elevation change of at least 30 feet. Additionally, review of the referenced Mercer Island Landslide Hazard map indicates the presence of a known, historical slide event and associated scarp either on or immediately off site. In this respect, the central and western site slope may be considered a regulated geologic hazard per MICC definitions.

The MICC defines landslide hazards into two categories: deep-seated landslides (when the failure depth is greater than 15 feet) and shallow landslides (when the failure depth is 15 feet or less). Limited information was available for review with respect to age, failure mode, and extent of the identified slide event. However, based on our field observations of competent, glacially consolidated native soil, it is our opinion the historical landslide was likely a shallow failure.

Shallow landslide hazards typically require a 25-foot buffer be incorporated into the plans. Per MICC 19.07.160.B.2, alteration of a landslide hazard and its associated buffer may occur if the proposed alteration:

a) Will not adversely impact other critical areas;

b) Will not adversely impact the subject property or adjacent properties;

c) Will mitigate impacts to the geologically hazardous area consistent with best available science to the maximum extent reasonably possible such that the site is determined to be safe, and;

d) Includes the landscaping of all disturbed areas outside of building footprints and installation of hardscape prior to final inspection.

In our opinion, given the absence of obvious surficial indications of recent movement and the presence of glacially consolidated sediments at the test pit locations, it is our opinion that a reduced buffer setback of 10 feet is feasible from a geotechnical standpoint and will satisfy criteria a through c above. Satisfying criterion "d" can be achieved through proper landscaping plans. In our opinion, a setback of 10 feet should provide an adequate buffer for the regulated hazard and minimize potential disturbances that could adversely affect stability both on site and immediately off site.

It should be noted the measurements outlined above are based on information obtained from King County iMap. ESNW should be provided with topographic surveys and site layout plans as they become available to confirm measurements and provide updated recommendations as necessary.

Erosion Hazard Area

Per MICC 19.16.010, an erosion hazard is defined as any area containing slopes in excess of 15 percent that are subject to erosion and/or soils that have been identified by the USDA Natural Resources Conservation Service (NRCS) as having a severe or very severe rill and inter-rill erosion hazard.

Review of the reference soil survey suggests the Kitsap silt loam series (which has been mapped across the site) possess a slow to medium runoff classification and is slightly to moderately susceptible to rilling. However, given the presence of sloping areas in excess of 15 percent, the subject site may be considered an erosion hazard per MICC 19.16.010. In our experience, temporary erosion and sediment control (TESC) measures that are actively upkept during construction, combined with the installation of permanent landscaping post-construction, can adequately mitigate the potential hazard.

Statement of Risk

Per MICC 19.07.160(B)(3), alterations of landslide hazards areas, seismic hazard areas, and associated buffers may occur if the conditions listed in MICC 19.07.160(B)(2) are satisfied and the geotechnical professional provides a statement of risk matching one of the following:

a. An evaluation of site-specific subsurface conditions demonstrates that the proposed development is not located in a landslide hazard area or seismic hazard area.

b. The landslide hazard area or seismic hazard area will be modified, or the development has been designed, so that the risk to the site and adjacent property is eliminated or mitigated, such that the site is determined to be safe.

c. Construction practices are proposed for the alteration that would render the development as safe as if it were not located in a geologically hazardous area and do not adversely impact adjacent properties.

d. The development is so minor as not to pose a threat to public health, safety, and welfare.

In our opinion, criterion "c" is met. Provided that appropriate construction methods relating to earthwork and erosion control are incorporated into the project design and execution, as outlined in this report, it is our opinion the proposed development be considered as safe as if it were not located in a geologically hazardous area. The proposed construction only affects the subject site and will not impact adjacent properties adversely.

DISCUSSION AND RECOMMENDATIONS

General

Based on the results of our investigation, construction of the proposed residence is feasible from a geotechnical standpoint. The primary geotechnical considerations for the proposal are in reference to foundation design and stormwater management.

Based on our findings, the proposed single-family home structure may be constructed on conventional continuous and spread footing foundation 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 foundation elements will likely be encountered beginning at a depth of about two feet bgs. Where loose or unsuitable soil conditions are exposed at foundation subgrade elevations, compaction of the soil to the specifications of structural fill or overexcavation and replacement with suitable structural fill will be necessary.

Review of the Mercer Island infiltration feasibility map indicates the site is within an area that precludes the use of infiltration devices. In addition, the presence of glacially consolidated deposits and nearby sloping features will further restrict the feasibility of infiltration.

This study has been prepared for the exclusive use of RKK Villa Marbella, LLC, and its representatives. No warranty, expressed or implied, is made. 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 site clearing and stripping. Subsequent earthwork activities will involve minor site grading for new home construction and infrastructure improvements.

Temporary Erosion Control

The following temporary erosion control measures are offered:

- Temporary construction entrances and drive lanes should be constructed with at least six inches of quarry spalls to both minimize off-site soil tracking and provide a stable access entrance surface. A woven geotextile fabric can be placed underneath the quarry spalls to 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.
- 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 reduce dust.
- When appropriate, permanent planting or hydroseeding will help to stabilize site soils.

Additional Best Management Practices (BMPs), as specified on the TESC plans, should be incorporated into construction activities. Temporary erosion control measures must be upkept and may require modification during construction to ensure proper function.

Stripping

Topsoil was generally encountered in the upper 6 to 10 inches of existing grades at the exploration locations. Where encountered, organic-rich topsoil should be stripped and segregated into a stockpile either for later use on site or to be exported.

The underlying "weathered zone" may contain remnant roots and will likely be variable in composition, density, and moisture content. Where exposed at subgrade elevations, the weathered zone may require mechanical compaction or other means of preparation to establish competent structural bearing conditions. If the weathered zone cannot be adequately prepared, removal will likely be necessary. ESNW should observe initial stripping activities to provide recommendations for stripping depths.

Excavations and Slopes

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 exposing groundwater seepage — 1.5H:1V (Type C)
- Medium dense to dense native soil — 1H:1V (Type B)
- Dense to very dense native soil — 1H:1V (Type A)

Steeper temporary slope inclinations within undisturbed, very dense native soil may be feasible based on the soil and groundwater conditions exposed within the excavations. If pursued, ESNW can evaluate the feasibility of utilizing steeper temporary slopes at the time of construction. In any case, an ESNW representative should observe temporary slopes to confirm inclinations are suitable for the exposed soil conditions and to provide additional excavation and slope stability recommendations as necessary. If the recommended temporary slope inclinations cannot be achieved, temporary shoring may be necessary to support excavations. Permanent slopes should be graded to 2H:1V (or flatter) and planted with vegetation to enhance stability and minimize erosion potential. Permanent slopes should be observed by ESNW prior to vegetation and landscaping.

In-situ and Imported Soil

Successful use of the on-site soil as structural fill will largely be dictated by the moisture content at the time of placement and compaction. Based on the conditions observed during our subsurface exploration, the on-site soil is moisture sensitive. Depending on the time of year construction occurs, remedial measures (such as soil aeration) may be necessary as part of site grading and earthwork activities. If the on-site soil 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 structural fill should consist of a well-graded, granular soil that is capable of achieving a suitable working moisture content. 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).

Wet-Season Grading

Earthwork activities that occur during wet weather conditions may require additional measures to protect structural subgrades and soil intended for use as structural fill. Site-specific recommendations can be provided at the time of construction and may include delaying final grade cuts to subgrade elevations (depending on weather or the construction sequence), covering working surfaces with crushed rock, protecting structural fill from adverse moisture conditions, and additional TESC recommendations. ESNW can assist in obtaining a wet-season grading extension if required by the governing jurisdiction.

Subgrade Preparation

Foundation and slab subgrade surfaces should consist of competent, undisturbed native soil or structural fill placed atop competent native soil. 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 or overexcavation and replacement with suitable structural fill.

Structural subgrade surfaces should be protected from rainfall and disturbance once the subgrade elevations have been achieved. Placement of crushed rock should be considered to maintain a suitable working surface and suitable bearing conditions. If subgrade excavations will be completed significantly ahead of formwork and concrete placement, the contractor should consider leaving the subgrade areas several inches above grade to protect the subgrade from moisture and disturbance until final grade cuts are made.

Structural Fill

Structural fill is defined as compacted soil placed in foundation, slab-on-grade, roadway, permanent slope, retaining wall, and utility trench backfill areas. The following recommendations are provided for soils intended for use as structural fill:

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

The on-site soil may only be considered suitable for use as structural fill if a suitable moisture content is achieved at the time of placement and compaction. If the on-site soil cannot achieve the above specifications, use of an imported structural fill material will likely be necessary. With respect to underground utility installations and backfill, local jurisdictions will likely dictate soil type(s) and compaction requirements.

<u>Foundations</u>

In our opinion, the proposed single-family home structure may be constructed on conventional continuous and spread footing foundation 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 foundation elements will likely be encountered beginning at a depth of about two feet bgs. 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.

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 0.4

The above passive pressure and friction values include a factor-of-safety (FOS) of 1.5. A one-third increase in the allowable soil bearing capacity may be assumed for short-term wind and seismic loading conditions. 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 when dead loads are applied.

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.

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. The referenced liquefaction susceptibility map indicates the proposed development area possesses very low liquefaction susceptibility. In our opinion, site susceptibility to liquefaction should be considered low given the dense in-situ nature of the native soil and the absence of a uniformly established groundwater table.

Slab-on-Grade Floors

Slab-on-grade floors for the proposed residential structure should be supported on competent, 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 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	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 passive pressure and friction values include a FOS of 1.5 and are based on a level backfill condition and level grade at the wall toe. Revised design values will be necessary if sloping grades are to be used above or below retaining walls. Additional surcharge loading from adjacent foundations, sloped backfill, or other relevant loads should be included in the retaining wall design.

Retaining walls should be backfilled with free-draining material that extends along the height of the wall and a distance of at least 18 inches behind the wall. The upper 12 inches of the wall backfill may consist of a less permeable soil if desired. A sheet drain may be used in lieu of free-draining material 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 must be included in the wall design.

Drainage

Discrete zones of perched groundwater seepage should be anticipated in site excavations depending on the time of year grading operations take place. Temporary measures to control surface water runoff and groundwater during construction would likely involve interceptor trenches, interceptor swales, and sumps. ESNW should be consulted during preliminary grading to both identify areas of seepage and provide recommendations to reduce the potential for seepage-related instability.

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

Infiltration Feasibility

Per the referenced infiltration feasibility map, low-impact development facilities are precluded within the proposed site area. Given the presence of glacially consolidated soil and adjacent slope features, it is our opinion that infiltration is not feasible from a geotechnical standpoint.

Utility Support and Trench Backfill

In our opinion, the native soil will generally be suitable for support of utilities. 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 or temporary trench shoring may be necessary during utility excavation and installation.

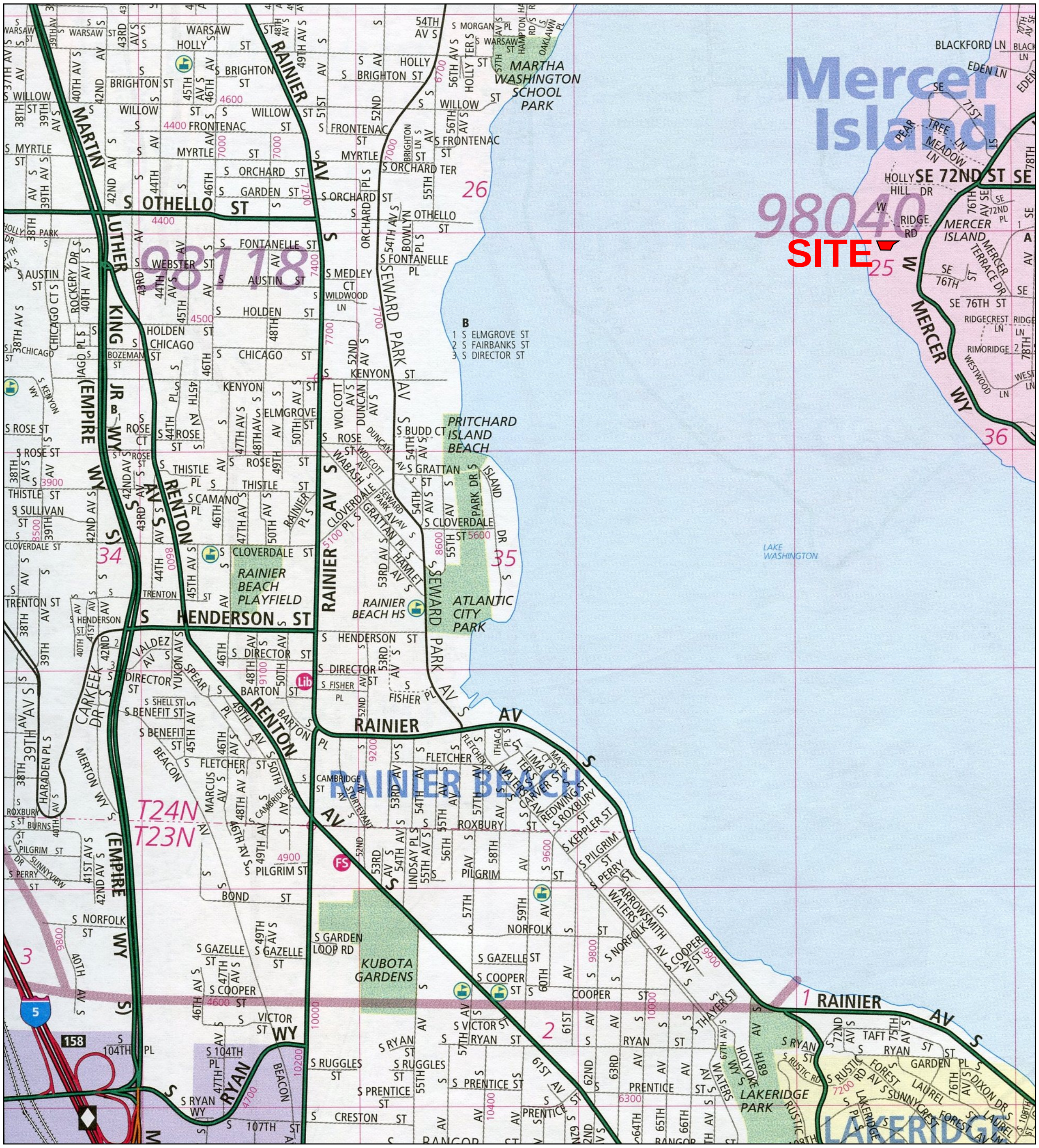
The on-site soil may be suitable for use as structural backfill throughout the utility trench excavations provided the soil is at (or slightly above) the optimum moisture content at the time of placement and compaction. Moisture conditioning of the soil may be necessary at some locations prior to use 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 structural fill specifications previously detailed in this report or to the applicable specifications of the responsible jurisdiction or agency.

LIMITATIONS

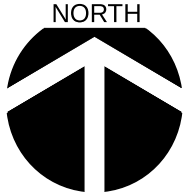
The recommendations and conclusions provided in this study are professional opinions consistent with the level of care and skill that is typical of other members in the profession currently practicing under similar conditions in this area. A warranty is neither expressed nor implied. Variations in the 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:
King County, Washington
Map 625
By The Thomas Guide
Rand McNally
32nd Edition

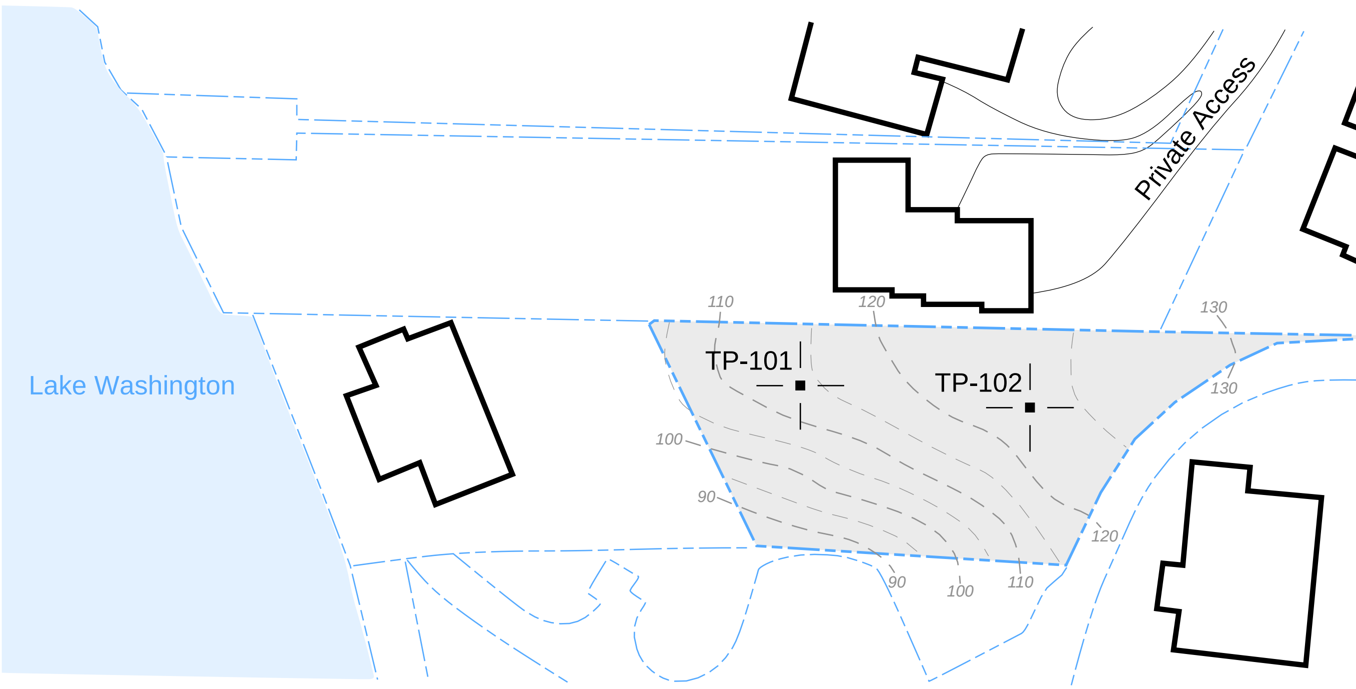


NOTE: This plate may contain areas of color. ESNW cannot be responsible for any subsequent misinterpretation of the information resulting from black & white reproductions of this plate.

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

Vicinity Map
RKK Villa Marbella SFR (Helms South)
Mercer Island, Washington

Drwn. CAM	Date 10/17/2019	Proj. No. 6947.01
Checked CGH	Date Oct. 2019	Plate 1



LEGEND

TP-101 — Approximate Location of ESNW Test Pit, Proj. No. ES-6947.01, Sept. 2019

Subject Site

Existing Building

NORTH

NOT - TO - SCALE

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.

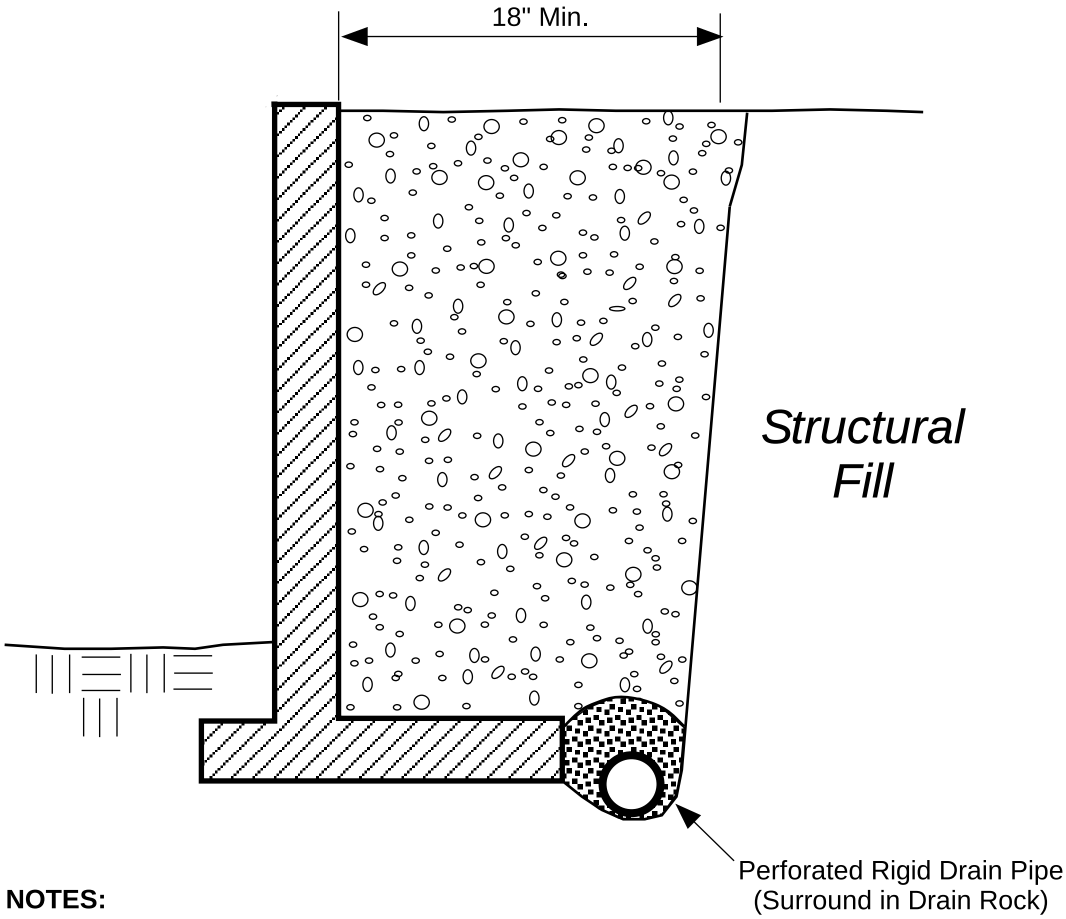
NOTE: This plate may contain areas of color. ESNW cannot be responsible for any subsequent misinterpretation of the information resulting from black & white reproductions of this plate.

Earth Solutions NW LLC

Geotechnical Engineering, Construction Observation/Testing and Environmental Services

Test Pit Location Plan
RKK Villa Marbella SFR (Helms South)
Mercer Island, Washington

Drwn. CAM	Date 10/17/2019	Proj. No. 6947.01
Checked CGH	Date Oct. 2019	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

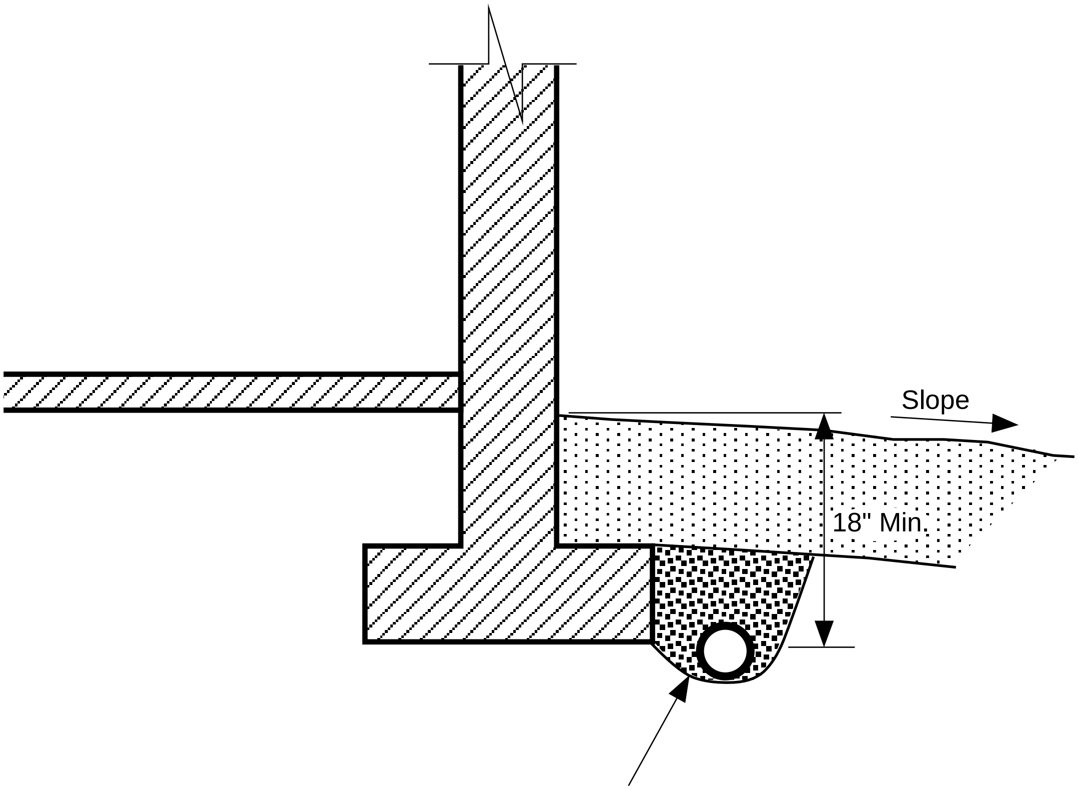
1-inch Drain Rock

Earth Solutions NWLLC

Geotechnical Engineering, Construction Observation/Testing and Environmental Services

Retaining Wall Drainage Detail
RKK Villa Marbella SFR (Helms South)
Mercer Island, Washington

Drwn. CAM	Date 10/17/2019	Proj. No. 6947.01
Checked CGH	Date Oct. 2019	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 NWLLC
Geotechnical Engineering, Construction Observation/Testing and Environmental Services

Footing Drain Detail
RKK Villa Marbella SFR (Helms South)
Mercer Island, Washington

Drwn. CAM	Date 10/17/2019	Proj. No. 6947.01
Checked CGH	Date Oct. 2019	Plate 4

Appendix A

Subsurface Exploration
Test Pit Logs

ES-6947.01

Subsurface conditions at the subject site were explored on September 19, 2019. Two test pits were excavated using a mini trackhoe and operator retained by the client. 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 test pits were advanced to a maximum depth of approximately six 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 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
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-6947.01 **PROJECT NAME** RKK Villa Marbella SFR (Helms South)

DATE STARTED 9/19/19 **COMPLETED** 9/19/19 **GROUND ELEVATION** 112 ft **TEST PIT SIZE**

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

EXCAVATION METHOD

AT TIME OF EXCAVATION ---

LOGGED BY CGH **CHECKED BY** KDH **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 3.5'	111.5
		MC = 8.80% Fines = 11.10%	SP-SM		4.0	Brown poorly graded SAND with silt, loose to medium dense, moist -becomes gray, medium dense [USDA Classification: slightly gravelly SAND]	108.0
5		MC = 30.20% MC = 17.10% Fines = 50.80%	ML		6.0	Gray SILT, very dense, moist -trace iron oxide staining and organic inclusions -becomes sandy silt [USDA Classification: slightly gravelly LOAM]	106.0

Test pit terminated at 6.0 feet below existing grade. No groundwater encountered during excavation. No caving observed.

Bottom of test pit at 6.0 feet.

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TEST PIT NUMBER TP-102

PROJECT NUMBER ES-6947.01
PROJECT NAME RKK Villa Marbella SFR (Helms South)
DATE STARTED 9/19/19 **COMPLETED** 9/19/19
GROUND ELEVATION 122 ft **TEST PIT SIZE**
EXCAVATION CONTRACTOR Client-Provided
GROUND WATER LEVELS:
EXCAVATION METHOD
AT TIME OF EXCAVATION ---
LOGGED BY CGH **CHECKED BY** KDH
AT END OF EXCAVATION ---
NOTES Depth of Topsoil & Sod 10": grass
AFTER EXCAVATION ---

DEPTH (ft)	SAMPLE TYPE NUMBER	TESTS	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
0			TPSL		Dark brown TOPSOIL, root intrusions to 1' (0.9 / 121.1)
		MC = 14.70% Fines = 34.60%	SM		Brown silty SAND, medium dense, moist -moderate iron oxide staining -becomes gray, dense to very dense, weakly cemented [USDA Classification: slightly gravelly very fine sandy LOAM]
5		MC = 10.80%			(5.5 / 116.5)
					Test pit terminated at 5.5 feet below existing grade due to refusal in dense glacial till. No groundwater encountered during excavation. No caving observed. Bottom of test pit at 5.5 feet.

Appendix B

Laboratory Test Results

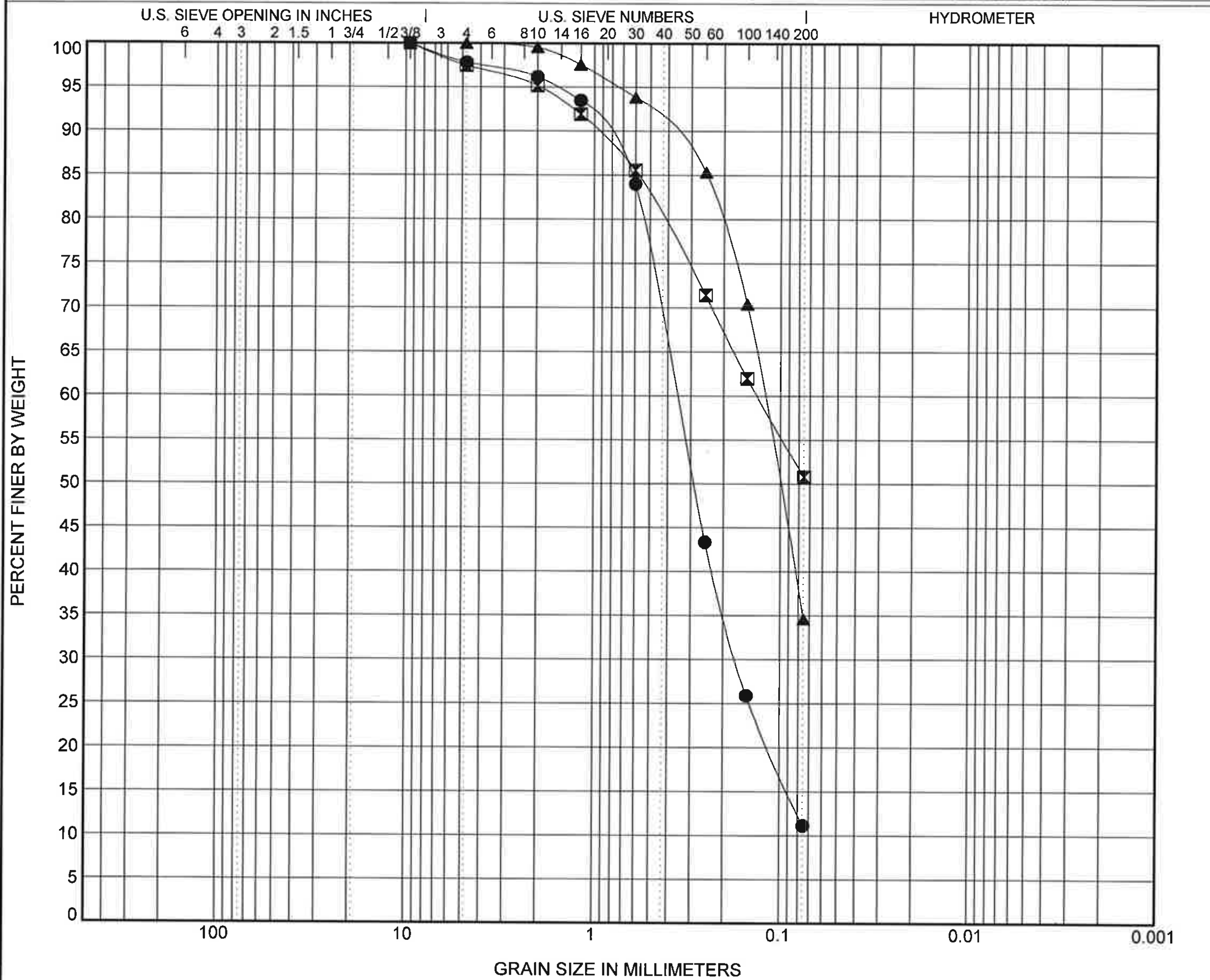
ES-6947.01

Earth Solutions NW LLC

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

GRAIN SIZE DISTRIBUTION

PROJECT NUMBER ES-6947.01 **PROJECT NAME** RKK Villa Marbella SFR (Helms South)



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Specimen Identification			Classification	Cc	Cu
●	TP-101	2.00ft.	USDA: Brown Slightly Gravelly Sand. USCS: SP-SM.	1.13	5.04
☒	TP-101	6.00ft.	USDA: Gray Slightly Gravelly Loam. USCS: Sandy ML.		
▲	TP-102	2.00ft.	USDA: Gray Slightly Gravelly Very Fine Sandy Loam. USCS: SM.		

Specimen Identification			D100	D60	D30	D10	LL	PL	PI	%Silt	%Clay
●	TP-101	2.0ft.	9.5	0.358	0.169					11.1	
☒	TP-101	6.0ft.	9.5	0.133						50.8	
▲	TP-102	2.0ft.	4.75	0.123						34.6	

GRAIN SIZE USDA ES-6947.01 RKK VILLA MARBELLA SFR (HELMS SOUTH).GPJ GINT US LAB.GDT 10/16/19

Report Distribution

ES-6947.01

<u>EMAIL ONLY</u>	**RKK Villa Marbella, LLC** **7330 West Mercer Way** **Mercer Island, Washington 98040** **Attention: Mr. Mason Helms**