Earth Solutions NW LLC

Geotechnical Engineering
Construction Observation/Testing
Environmental Services

GEOTECHNICAL ENGINEERING STUDY
PROPOSED SINGLE-FAMILY RESIDENCE
7208 NORTH MERCER WAY
MERCER ISLAND, WASHINGTON

ES-7855

15365 N.E. 90th Street, Suite 100 | Redmond, WA 98052
(425) 449-4704 Fax (425) 449-4711
www.earthsolutionsnw.com

PREPARED FOR

MR. ROBERT MASIN
c/o RKK CONSTRUCTION, INC.

June 3, 2021

Adam Z. Shier, L.G.
Project Geologist

06/03/2021

Keven D. Hoffmann, P.E.
Geotechnical Engineering Services 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 <u>not</u> 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 <u>not</u> be adequate to develop geotechnical design recommendations for the project.

Do <u>not</u> 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 <u>not</u> rely on an executive summary. Do <u>not</u> 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

Telephone: 301/565-2733
e-mail: info@geoprofessional.org www.geoprofessional.org

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

June 3, 2021
ES-7855

Mr. Robert Masin
c/o RKK Construction, Inc.
3056 – 70th Avenue Southeast
Mercer Island, Washington 98040

Attention: Mr. Jason Koehler

Dear Mr. Koehler:

Earth Solutions NW, LLC (ESNW) is pleased to present this geotechnical report for the subject project. Based on the results of our study, the proposed single-family residence and related improvements are feasible from a geotechnical standpoint.

Based on the conditions observed during our fieldwork, the subject site is underlain primarily by native soil consisting of dense to very dense glacial till deposits. The proposed structure can be supported on conventional spread and continuous foundations bearing on undisturbed competent native soil, recompacted native soil, or new structural fill. We anticipate competent native soil, suitable for support of foundations, will be encountered beginning at depths of about two to three feet below existing grades.

This report provides recommendations for foundation subgrade preparation, foundation and retaining wall design parameters, drainage, infiltration feasibility, the suitability of on-site soils for use as structural fill, and other pertinent geotechnical recommendations. The opportunity to be of service to you is appreciated. If you have any questions regarding the content of this geotechnical engineering study, please call.

Sincerely,

EARTH SOLUTIONS NW, LLC

Adam Z. Shier, L.G.
Project Geologist

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GEOTECHNICAL ENGINEERING STUDY
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MERCER ISLAND, WASHINGTON

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INTRODUCTION

General

This geotechnical engineering study (study) was prepared for the proposed single-family residence to be constructed at 7208 North Mercer Way, in Mercer Island, Washington. To complete the scope of services outlined in our proposal, we completed the following:

- Subsurface exploration for purposes of characterizing soil and groundwater conditions.
- Laboratory testing of soil samples collected at the boring location.
- Engineering analyses.
- Preparation of this report.

The following documents and resources were reviewed as part of our report preparation:

- Geologic Map of Mercer Island, Washington, by Kathy G. Troost and Aaron P. Wisher, October 2006.
- Mercer Island Seismic Hazard Assessment, Landslide Hazard Assessment, and Erosion Hazard Assessment maps, by Kathy G. Troost and Aaron P. Wisher, April 2009.
- Low Impact Development Infiltration Feasibility on Mercer Island, prepared by Herrera Environmental Consultants, Inc., undated.
- Liquefaction Susceptibility Map of King County, Washington, endorsed by the King County Flood Control District, May 2010.
- Mercer Island City Code (MICC).
- Online Web Soil Survey (WSS) resource, provided by the Natural Resources Conservation Service under the United States Department of Agriculture.

Project Description

ESNW understands the site will be redeveloped with a new single-family residence and associated infrastructure improvements. We anticipate the new building footprint will be located within the central portion of the lot. As outlined in the *Infiltration Evaluation* section of this report, the site is mapped within an area of Mercer Island where infiltrating low-impact development (LID) facilities are not permitted. As such, we anticipate conventional and/or detention-type stormwater management will be used for this project.

At the time of report submission, specific grading and building load values were not available for review. However, due to relatively gentle grade change across the site, we do not anticipate substantial grading activities will be necessary. We anticipate the proposed residential structure will be two or three stories and will consist of relatively lightly loaded wood framing supported on a conventional foundation system. Based on our experience with similar developments, we estimate wall loads of about 1 to 2 kips per linear foot and slab-on-grade loading of about 150 pounds per square foot (psf) will be incorporated into final designs.

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

SITE CONDITIONS

Surface

The subject site is located east of the intersection between 72nd Avenue Southeast and North Mercer Way, in Mercer Island, Washington, as illustrated on the Vicinity Map (Plate 1). The property is comprised of two tax parcels (King County Parcel Nos. 531510-0025 and -0026), totaling roughly 0.31 acres.

The site is surrounded to the north, south, and east by single-family residences, and to the west by North Mercer Way. The existing topography descends generally from southwest to northeast, and we estimate about 15 to 20 feet of elevation change occurs across the site.

Subsurface

An ESNW representative observed, logged, and sampled one boring on April 28, 2021. The boring was advanced at an accessible location within the property boundaries, using a limited access drill rig and operators retained by ESNW. The boring was completed to assess and classify site soils as well as to characterize relatively shallow groundwater conditions. The approximate location of the boring is depicted on Plate 2 (Boring Location Plan). Please refer to the boring log provided in Appendix A for a more detailed description of subsurface conditions. Representative soil samples collected at the test pit locations were analyzed in accordance with both Unified Soil Classification System (USCS) and USDA methods and procedures.

Native Soil Profile

Underlying the topsoil, the native soil encountered at the boring location consisted mainly of silt with varying amounts of sand (USCS: ML), generally consistent with the typical makeup of glacial till. The in-situ density of the native soil was characterized as loose to medium dense within the upper two to three feet of existing grades, becoming dense to very dense thereafter. The native soil was encountered primarily in a damp to moist condition, extending to the maximum exploration depth of about 21.5 feet bgs.

It is noted that fill was not encountered at the boring location.

Geologic Setting

The referenced geologic map identifies Vashon till deposits (Qvt) as the primary native soil unit underlying the subject site. As described on the geologic map resource, Vashon till is typically a compact diamict of subrounded to well-rounded clasts which were glacially transported and deposited. The diamict is largely composed of sand, silt, gravel, pebbles, and cobbles.

The referenced WSS resource identifies Kitsap silt loam (Map Unit Symbol: KpB) as the primary soil unit underlying the subject site. The Kitsap series was formed in terraces with a parent material of lacustrine deposits.

Based on our field observations, native soils on the subject site are generally consistent with the Vashon till geologic setting, as outlined in this section.

Groundwater

During our subsurface exploration completed on April 28, 2021, groundwater seepage was not encountered at the boring location. It is noted groundwater seepage rates and elevations fluctuate depending on many factors, including precipitation duration and intensity, the time of year, and soil conditions. In general, groundwater flow rates are higher during the winter, spring, and early summer months.

GEOLOGICALLY HAZARDOUS AREAS ASSESSMENT

We evaluated the presence of geologic hazards, as defined by the City of Mercer Island (City), within the bounds of the subject property and the adjacent area. According to the referenced City maps, the subject site is mapped either directly within or within 200 feet of erosion and landslide hazard areas.

Landslide Hazard

MICC 19.16.010 defines landslide hazard areas as "those areas subject to landslides based on a combination of geologic, topographic, and hydrologic factors", which includes:

- Areas of historic failures.
- Areas with all three of the following characteristics:
  - Slopes steeper than 15 percent.
  - Hillsides intersecting geologic contacts with a relatively permeable sediment overlying a relatively impermeable sediment or bedrock.
  - Springs or groundwater seepage.
- Areas that have shown evidence of past movement or that are underlain or covered by mass wastage debris from past movements.
- Areas potentially unstable because of rapid stream incision and stream bank erosion.
- Any slope of 40 percent or greater calculated by measuring the vertical rise over any 30-foot horizontal run.

Review of King County iMap indicates the slope within the site area is inclined at less than 15 percent over a vertical rise of about 20 feet. Provided that the topographic information on iMap is representative of site conditions, the site slope does not meet the MICC definition of a landslide hazard area. Additionally, obvious indications of landslide hazard were not observed on site during the April 2021 subsurface exploration and site reconnaissance. It is noted that a topographic survey was not available for review at the time of this report.

Erosion Hazard

Erosion hazard areas are defined by MICC 19.16.010 as "those areas greater than 15 percent slope and subject to a severe risk of erosion due to wind, rain, water, slope, and other natural agents including those soil types and/or areas identified by the USDA NRCS as having a 'severe' or 'very severe' rill and inter-rill erosion hazard". Soils typically associated with rill and inter-rill erosion hazard include Kitsap silt loam, which is mapped on site (2 to 8 percent slopes; Map Unit Symbol: KpB).

Because the site is inclined at less than 15 percent, the MICC definition of an erosion hazard area is not met for the subject site. Nonetheless, in our experience, Kitsap series soils are typically associated with moderate to high erosion hazard potential, especially during the winter, spring, and early summer months. It is our opinion the potential for erosion hazard can be adequately mitigated during construction from a geotechnical standpoint as long as appropriate measures for controlling erosion are incorporated into final designs. Based on our experience with similar projects in similar settings, permanent landscaping and drainage control measures can successfully mitigate long-term erosion potential.

DISCUSSION AND RECOMMENDATIONS

General

Based on the results of our investigation, construction of the proposed single-family residence is feasible from a geotechnical standpoint. The primary geotechnical considerations associated with the proposed development include foundation support, slab-on-grade subgrade support, and the suitability of using on-site soils as structural fill.

In our opinion, the proposed residential structure may be constructed on a conventional continuous and spread footing foundation bearing upon competent native soil, recompacted native soil, or new structural fill. In general, competent native soil suitable for support of the foundations will likely be encountered within the upper two to three feet of 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 suitable structural fill will be necessary.

Site Preparation and Earthwork

Initial site preparation activities will consist of installing temporary erosion control measures, establishing grading limits, and performing clearing and site stripping (as necessary). Grading for the project will likely be minimal, as we anticipate the new building footprint will be located within the central portion of the subject site. Site improvements will also include underground utility installations.

Temporary Erosion Control

The following temporary erosion and sediment control (TESC) Best Management Practices (BMPs) are offered:

- Temporary construction entrances and drive lanes, consisting of at least six inches of quarry spalls, should be considered to both minimize off-site soil tracking and provide a stable access entrance surface. Placing geotextile fabric underneath the quarry spalls will provide greater stability, if needed.
- Silt fencing should be placed around the construction 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 swales, should be installed prior to beginning earthwork activities.
- Dry soils disturbed during construction should be wetted to minimize dust and airborne soil erosion.
- When appropriate, permanent planting or hydroseeding will help to stabilize on-site soil.

Additional TESC BMPs, as specified by the project civil engineer and indicated on the plans, should be incorporated into construction activities. TESC BMPs may be modified during construction as site conditions require but should be completed in consultation with the site erosion control lead (where applicable).

In-situ Soils

From a geotechnical standpoint, on-site soils expected to be exposed during grading activities are considered moisture sensitive and will degrade rapidly if exposed to wet weather and construction traffic. Compaction of the soil to the level necessary for use as structural fill will be difficult or impossible during wet weather conditions. Soils encountered during site excavations that are excessively over the optimum moisture content will require aeration or treatment prior to placement and compaction. Conversely, soils that are below the optimum moisture content will require moisture conditioning through the addition of water prior to use as structural fill. An ESNW representative should determine the suitability of in-situ soils for use as structural fill at the time of construction.

Imported soil intended for use as structural fill should consist of a well-graded, granular soil with a moisture content that is at (or slightly above) the optimum level. During wet weather conditions, imported soil intended for use as structural fill should consist of a well-graded, granular soil with a fines content of 5 percent or less (where the fines content is defined as the percent passing the Number 200 sieve, based on the minus three-quarter-inch fraction).

Structural Fill

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

- Structural fill material — Granular soil*****
- Moisture content — At or slightly above optimum†
- Relative compaction (minimum) — 90 percent (Modified Proctor)
- Loose lift thickness (maximum) — 12 inches

* *The on-site soil is not suitable for use as structural fill unless the soil is at (or slightly above) the optimum moisture content at the time of placement and compaction. The soil must also be free of deleterious inclusions.*
† *Soil shall not be placed dry of optimum and should be evaluated by ESNW during construction.*

With respect to underground utility installations and backfill, local jurisdictions may dictate the soil type(s) and compaction requirements. Areas of otherwise unsuitable material and debris should be removed from structural areas and replaced with structural fill.

Excavations and Slopes

Excavation activities across the site are likely to expose loose to medium dense native soil within the upper two to three feet of existing grades, with dense to very dense native soil below. Based on the soil conditions observed at the boring location, 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 and Washington Industrial Safety and Health Act soil classifications are also provided:

- Areas exposing groundwater seepage 1.5H:1V (Type C)
- Loose to medium dense native soil 1.5H:1V (Type C)
- Dense to very dense "hardpan" native soil 0.75H:1V (Type A)

Permanent slopes should be planted with vegetation to both enhance stability and 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.

Foundations

The proposed residential structure can be supported on conventional spread and continuous footings bearing on undisturbed competent native soil, recompacted native soil, or new structural fill. We anticipate competent native soils, suitable for support of foundations, will be encountered beginning at depths of about two to three feet bgs. Where loose or unsuitable soil conditions are observed at foundation subgrade elevations, compaction of the soils to the specifications of structural fill or overexcavation and replacement with granular structural fill will be necessary.

Provided the structure will be supported as described above, the following parameters may be used for design of the new foundation:

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

The passive earth pressure and coefficient of friction values include a safety factor 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 of about one inch is anticipated, with differential settlement of about one-half inch. Most of the anticipated settlement should occur during construction as dead loads are applied.

Seismic Design

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

Parameter	**Value**
Site Class	C*
Mapped short period spectral response acceleration, S_S (*g*)	1.381
Mapped 1-second period spectral response acceleration, S_1 (*g*)	0.481
Short period site coefficient, F_a	1.2
Long period site coefficient, F_v	1.5
Adjusted short period spectral response acceleration, S_{MS} (*g*)	1.658
Adjusted 1-second period spectral response acceleration, S_{M1} (*g*)	0.722
Design short period spectral response acceleration, S_{DS} (*g*)	1.105
Design 1-second period spectral response acceleration, S_{D1} (*g*)	0.481

* *Assumes very dense native soil conditions, encountered to a maximum depth of 21.5 feet bgs during the April 2021 field exploration, remain dense to at least 100 feet bgs. Based on our experience with the project geologic setting (glacial till) across the Puget Sound region, soil conditions are likely consistent with this assumption.*

Further discussion between the project structural engineer, the project owner (or their representative), and ESNW may be prudent to determine the possible impacts to the structural design due to increased earthquake load requirements under the 2018 IBC. ESNW can provide additional consulting services to aid with design efforts, including supplementary geotechnical and geophysical investigation, upon request.

Liquefaction is a phenomenon where saturated or loose soil suddenly loses internal strength and behaves as a fluid. This behavior is in response to increased pore water pressures resulting from an earthquake or another intense ground shaking. In our opinion, site susceptibility to liquefaction may be considered negligible. The absence of a uniformly established, shallow groundwater table and the relatively dense characteristics of the native soil were the primary bases for this opinion.

Slab-on-Grade Floors

Slab-on-grade floors for the proposed residential structure should be supported on a well-compacted, firm, and unyielding subgrade. Where feasible, the native soils likely to be exposed at the slab-on-grade subgrade level can be compacted in place to the specifications of structural fill. Unstable or yielding areas of the subgrade should be recompacted or overexcavated and replaced with suitable structural fill (as previously detailed in this report) prior to slab construction.

A capillary break consisting of at least four inches of free-draining crushed rock or gravel should be placed below the slab. The free-draining material should have a fines content of 5 percent or less (percent passing the Number 200 sieve, based on the minus three-quarter-inch fraction). In areas where slab moisture is undesirable, installation of a vapor barrier below the slab should be considered. If a vapor barrier is to be 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 retaining wall design:

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

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

The passive earth pressure and coefficient of friction values include a safety factor of 1.5. Additional surcharge loading from adjacent foundations, sloped backfill, retaining walls, or other loads should be included in the retaining wall design. Drainage should be provided behind retaining walls such that hydrostatic pressures do not develop. If drainage is not provided, hydrostatic pressures should be included in the wall design.

Retaining walls should be backfilled with at least 18 inches of free-draining material or suitable sheet drainage that extends along the height of the wall. The upper one foot of the wall backfill may consist of a less permeable soil, if desired. A perforated drainpipe should be placed along the base of the wall and connected to an approved discharge location. A typical retaining wall drainage detail is provided on Plate 3.

Drainage

The presence of groundwater seepage should be expected in excavations, especially in a perched condition at the contact between weathered and unweathered till. Where zones of groundwater seepage are encountered, temporary measures to control groundwater seepage may be needed. Temporary measures to control groundwater seepage and surface water runoff during construction will likely involve passive elements such as interceptor trenches and sumps.

Surface grades must be designed to direct water away from slopes and buildings. The grade adjacent to buildings should be sloped away from the buildings at a gradient of at least 2 percent for a horizontal distance of 4 feet (minimum) to 10 feet (maximum) as building and property setbacks allow. In our opinion, perimeter footing drains should be installed at or below the invert of the building footings. A typical footing drain detail is provided on Plate 4 of this report.

Infiltration Evaluation

Review of the referenced infiltration feasibility map indicates the site lies within an area where LID facilities are not permitted. As summarized in the *Subsurface* section of this report, site soils consist of dense to very dense glacial till deposits beginning at a depth of roughly three feet bgs. From a geotechnical standpoint, it is our opinion the native silt represents a hydraulically restrictive soil layer and renders the native silt impervious for practical design purposes.

Considering the soil types, potential off-site impacts, and City of Mercer Island mapping, it is our opinion the site is not feasible for infiltration, BMP, or dispersion designs from a geotechnical standpoint. We recommend alternative means of stormwater management be utilized.

Utility Support and Trench Backfill

In our opinion, the soils observed at the boring location are generally suitable for support of utilities. The native soils are moisture sensitive, and successful use of native soils as structural backfill in utility trench excavations will largely depend on in-situ moisture contents at the time of placement and compaction. Conditioning of the soils may be necessary at some locations prior to use as structural fill. If utility backfill occurs during wet weather, either cement treatment (where allowed by the presiding jurisdiction) of native soils or import of suitable structural fill will be necessary. Utility trench backfill should be placed and compacted to either the specifications of structural fill provided in this report or to the applicable requirements of the presiding jurisdiction.

LIMITATIONS

This study has been prepared for the exclusive use of Mr. Robert Masin and his representatives. No warranty, express 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. Variations in the soil and groundwater conditions observed at the boring location 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 designs 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
OpenStreetMap.org

NORTH

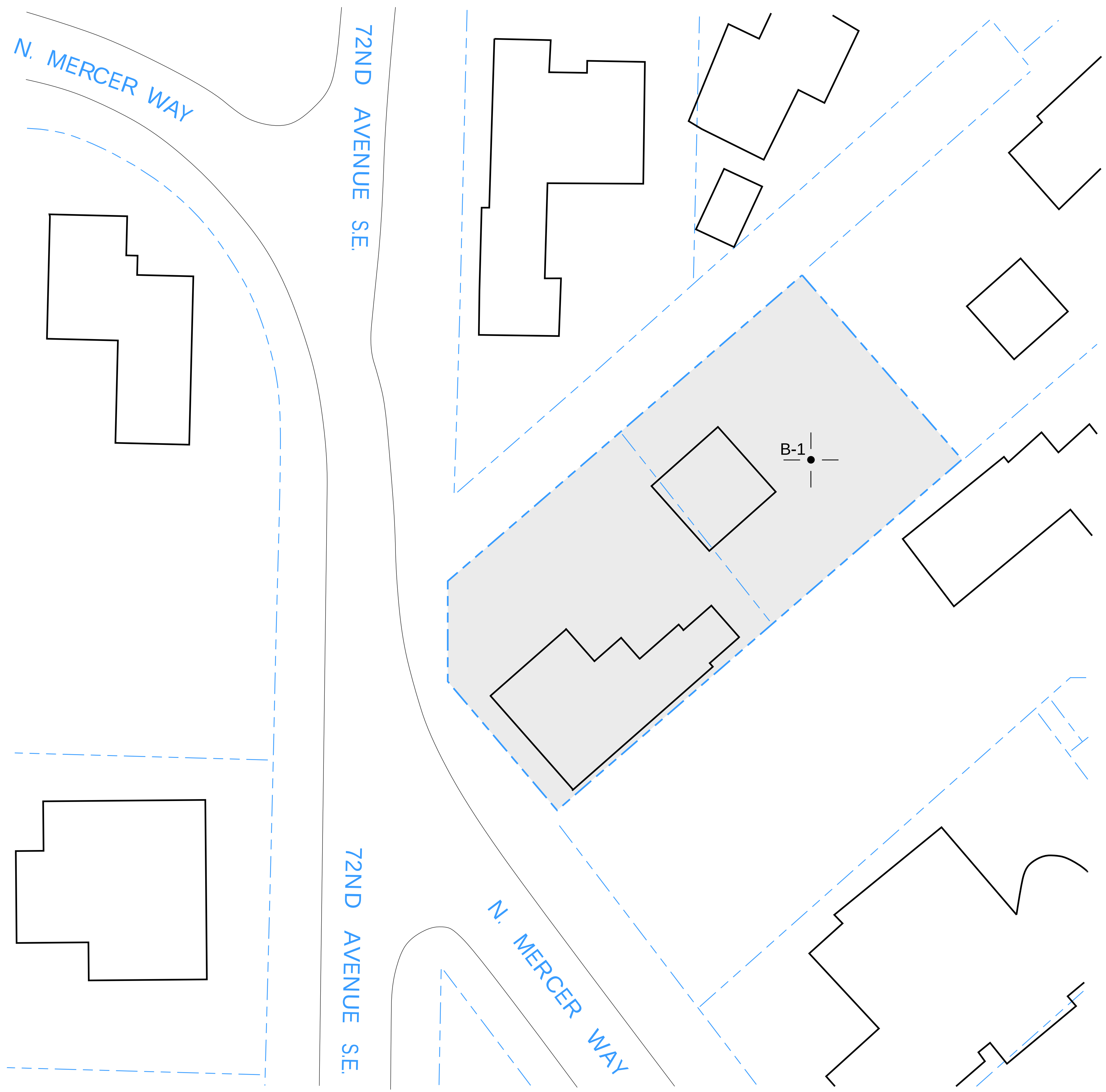
NOTE: This plate may contain areas of color. ESNW cannot be responsible for any subsequent misinterpretation of the information resulting from black & white reproductions of this plate.

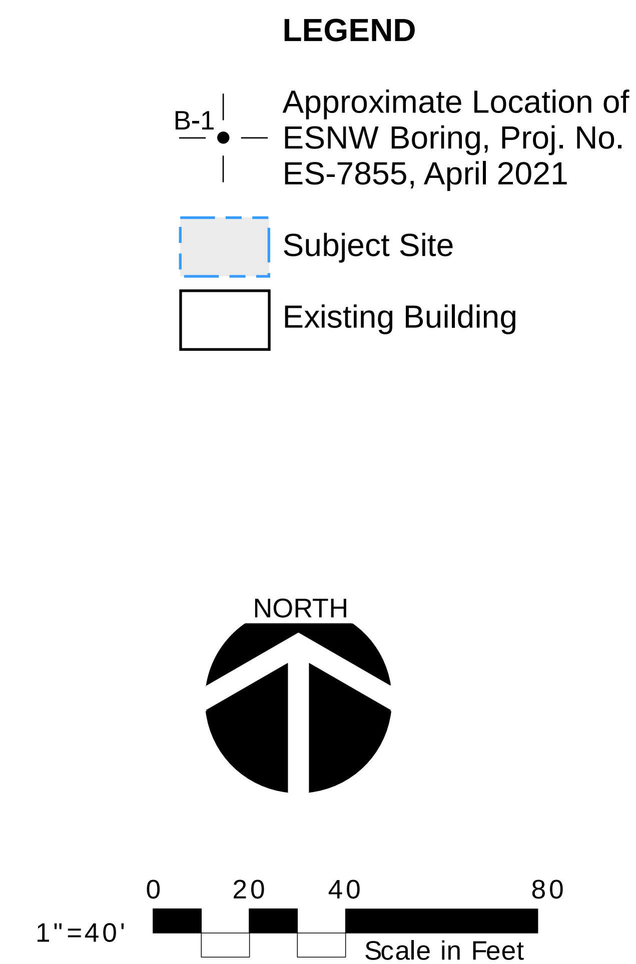
Earth Solutions NW LLC

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

Vicinity Map
7208 N. Mercer Way SFR
Mercer Island, Washington

Drwn. MRS	Date 06/03/2021	Proj. No. 7855
Checked AZS	Date June 2021	Plate 1





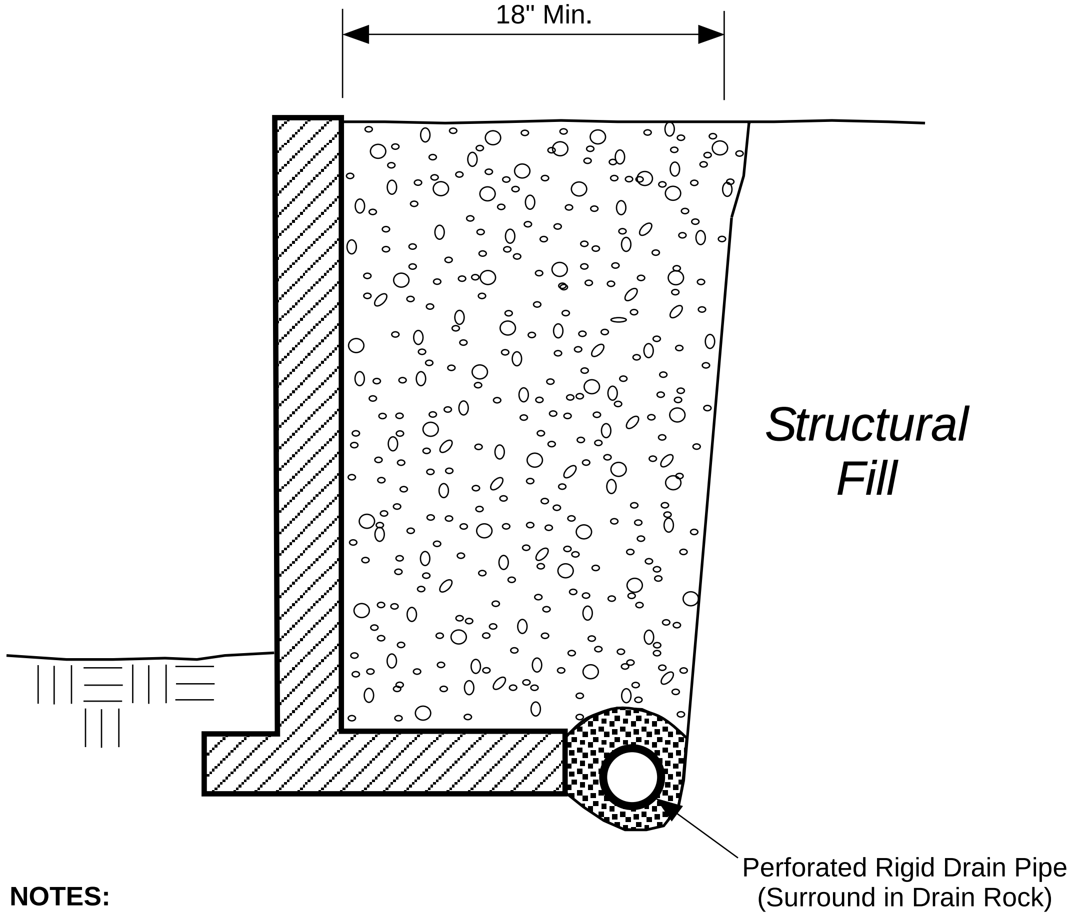
NOTE: The graphics shown on this plate are not intended for design purposes or precise scale measurements, but only to illustrate the approximate test locations relative to the approximate locations of existing and / or proposed site features. The information illustrated is largely based on data provided 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.

Boring Location Plan
7208 N. Mercer Way SFR
Mercer Island, Washington

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

Drwn. By	MRS
Checked By	AZS
Date	06/03/2021
Proj. No.	7855
Plate	2



NOTES:

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

SCHEMATIC ONLY - NOT TO SCALE
NOT A CONSTRUCTION DRAWING

LEGEND:

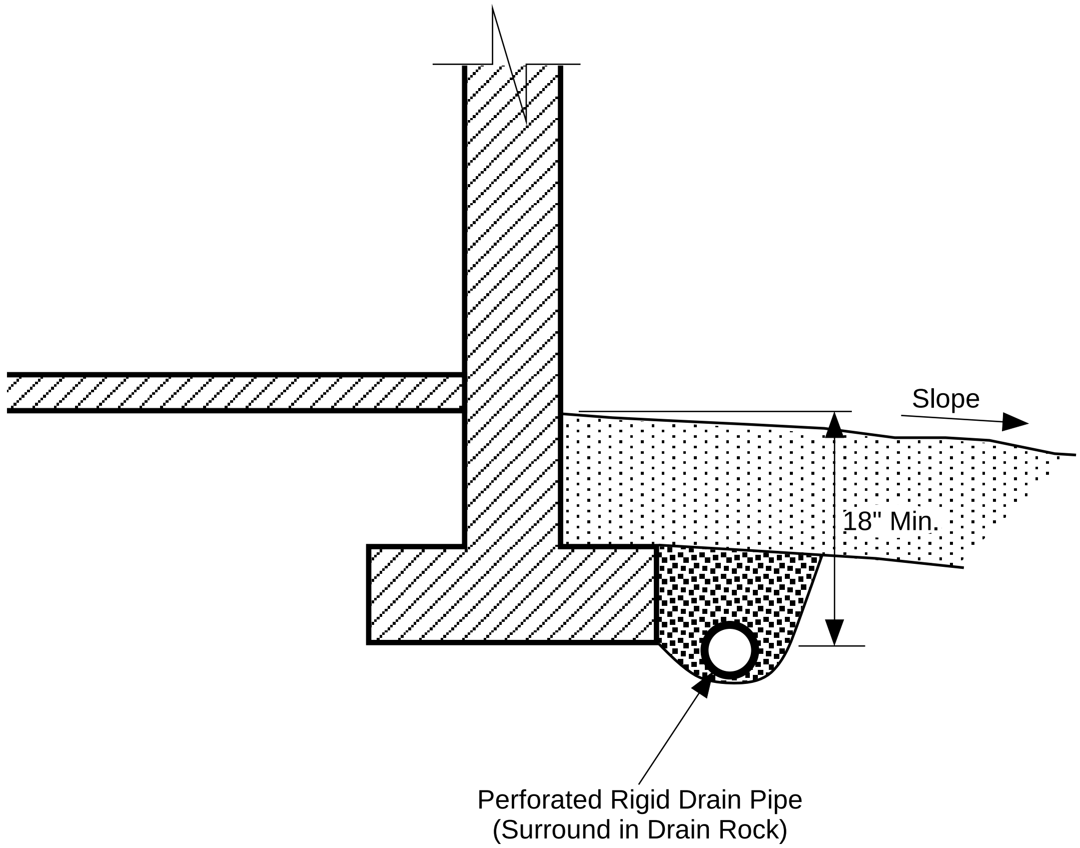
Free-draining Structural Backfill

1-inch Drain Rock

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

Retaining Wall Drainage Detail
7208 N. Mercer Way SFR
Mercer Island, Washington

Drwn. CAM	Date 06/03/2021	Proj. No. 7855
Checked AZS	Date June 2021	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
7208 N. Mercer Way SFR
Mercer Island, Washington

Drwn. CAM	Date 06/03/2021	Proj. No. 7855
Checked AZS	Date June 2021	Plate 4

Appendix A

Subsurface Exploration
Boring Log

ES-7855

Subsurface conditions at the subject site were explored on April 28, 2021, by advancing one boring at an accessible location on site. The approximate location of the boring is illustrated on Plate 2 of this study. The boring log are provided in this Appendix. The boring was advanced to a maximum depth of approximately 21.5 feet bgs.

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

DUAL SYMBOLS are used to indicate borderline soil classifications.

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

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

BORING NUMBER B-1

PROJECT NUMBER ES-7855
PROJECT NAME 7208 N. Mercer Way SFR
DATE STARTED 4/28/21 **COMPLETED** 4/28/21
GROUND ELEVATION 80 ft **HOLE SIZE**
DRILLING CONTRACTOR Geologic Drill Partners
LATITUDE 47.59449 **LONGITUDE** -122.24247
DRILLING METHOD HSA
GROUND WATER LEVELS:
LOGGED BY SSR **CHECKED BY** KDH
AT TIME OF DRILLING
NOTES Surface Conditions: grass yard

DEPTH (ft)	SAMPLE TYPE NUMBER	RECOVERY %	BLOW COUNTS (N VALUE)	TESTS	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
0					SM		Brown silty SAND, loose, moist -becomes medium dense
2.5							2.5 / 77.5
	SS	100	18-16-32 (48)	MC = 11.4% Fines = 62.9%	ML		Gray sandy SILT, dense to very dense, damp to moist [USDA Classification: gravelly LOAM] -massive texture
5	SS	100	34-50/6"	MC = 10.3%			
	SS	100	28-38-50/5"	MC = 13.5% Fines = 62.9%			-becomes silt with sand -trace gravel [USDA Classification: gravelly LOAM]
10	SS	100	9-27-36 (63)	MC = 12.9%			
15	SS	100	17-33-50/4"	MC = 12.8%			
20							20.0 / 60.0

(Continued Next Page)

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Telephone: 425-449-4704
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BORING NUMBER B-1

PROJECT NUMBER ES-7855 **PROJECT NAME** 7208 N. Mercer Way SFR

DEPTH (ft)	SAMPLE TYPE NUMBER	RECOVERY %	BLOW COUNTS (N VALUE)	TESTS	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
20	SS	100	18-27-38 (65)	MC = 15.8% Fines = 81.9%	ML	21.5	Gray SILT with sand, very dense, damp to moist [USDA Classification: slightly gravelly LOAM] 58.5
							Boring terminated at 21.5 feet below existing grade. No groundwater encountered during drilling. Boring backfilled with bentonite.

Appendix B

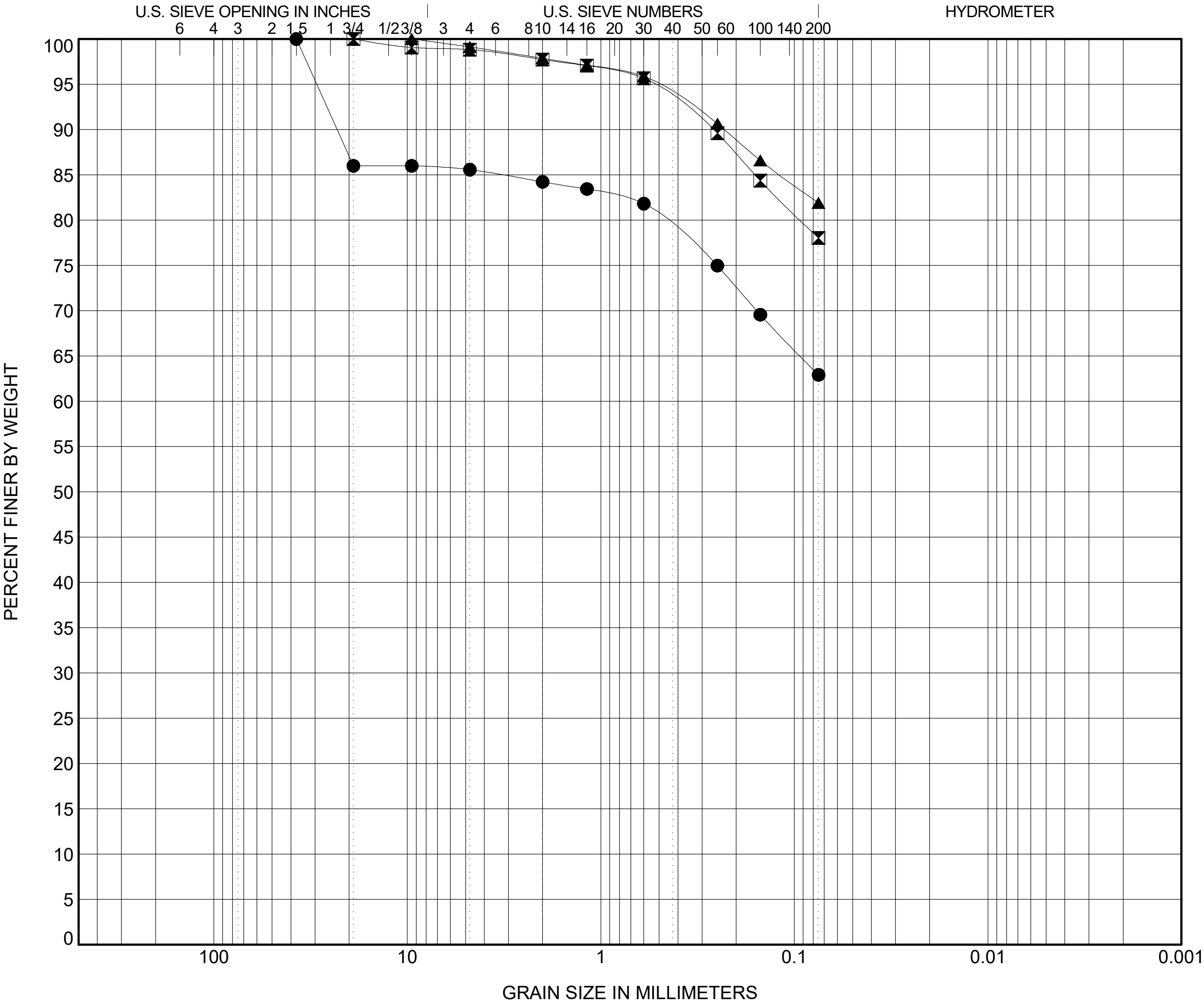
Laboratory Test Results

ES-7855

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-7855 **PROJECT NAME** 7208 N. Mercer Way SFR



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Specimen Identification		Classification	Cc	Cu
●	B-01	2.50ft.	**USDA: Gray Gravelly Loam. USCS: Sandy ML.**		
⧗	B-01	7.50ft.	**USDA: Gray Slightly Gravelly Loam. USCS: ML with Sand.**		
▲	B-01	20.00ft.	**USDA: Gray Slightly Gravelly Loam. USCS: ML with Sand.**		

	Specimen Identification		D100	D60	D30	D10	LL	PL	PI	%Silt	%Clay
●	B-01	2.5ft.	37.5							62.9	
⧗	B-01	7.5ft.	19							78.0	
▲	B-01	20.0ft.	9.5							81.9	

GRAIN SIZE USDA ES-7855 7208 N. MERCER WAY SFR.GPJ GINT US LAB.GDT 5/5/21

Report Distribution

ES-7855

EMAIL ONLY

Mr. Robert Masin
c/o RKK Construction, Inc.
3056 – 70th Avenue Southeast
Mercer Island, Washington 98040

Attention: Mr. Jason Koehler