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

GEOTECHNICAL ENGINEERING STUDY
PROPOSED SINGLE-FAMILY RESIDENCE
7615 EAST MERCER WAY
MERCER ISLAND, WASHINGTON

ES-9607.01

15365 NE 90th Street, Suite 100 • Redmond, WA 98052 • (425) 449-4704
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PREPARED FOR

DEREK & EILEEN CHESHIRE

April 22, 2024
Updated November 1, 2024

2561

11/01/2024

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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

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Geotechnical Engineering, Construction
Observation/Testing and Environmental Services

April 22, 2024
Updated November 1, 2024
ES-9607.01

Derek & Eileen Cheshire
7615 East Mercer Way
Mercer Island, Washington 98040

Dear Derek & Eileen:

Earth Solutions NW, LLC (ESNW) is pleased to present this geotechnical report to support the proposed single-family residential development. Based on the results of this study, the proposed construction is preliminarily feasible from a geotechnical standpoint. This update addresses the current site layout.

The proposed structure can be supported on conventional spread and continuous foundations bearing on a structural fill mat consisting of at least two feet of crushed rock structural fill, overlying a woven geotextile (Mirafi 500X or approved alternative) placed on a firm subgrade. An ESNW representative should be contacted to confirm suitability of foundation subgrades at the time of construction and to provide supplementary recommendations, as necessary.

In our opinion, a contingency should be provided in the budget for the export of fine-grained soil cuttings and import of suitable structural fill material, as needed.

Review of the City of Mercer Island GIS portal and the referenced mapping resources indicates that the site is located within an area designated as infeasible for infiltration, and infiltrating LID facilities are not permitted at the subject site.

We appreciate the opportunity to be of service to you on this project. If you have any questions about this geotechnical engineering study, please call.

Sincerely,

EARTH SOLUTIONS NW, LLC

Scott S. Riegel, L.G., L.E.G.
Associate Principal Geologist

cc: Plus Permit
Attention: Marianne Stover

Pat Lynch

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PROPOSED SINGLE-FAMILY RESIDENCE
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INTRODUCTION

General

This geotechnical engineering study was prepared for the proposed residential construction to be located at 7615 East Mercer Way, in Mercer Island, Washington. The purpose of this study was to provide geotechnical recommendations to support the current development plans, as understood at the time of this study. To complete this study, ESNW performed the following services:

- Reviewed subsurface information provided in the referenced geotechnical report prepared for the site.
- Review of on-site geologically hazardous areas and applicable Mercer Island Code.
- Recommendations for the proposed construction.
- Preparation of this report.

Project Description

The subject site is located at 7615 East Mercer Way in the southeastern area of Mercer Island, Washington which is situated near the southeastern portion of the island. LiDar imagery indicates this portion of the island includes a large head scarp and ancient landslide deposits to the east, which are currently developed with a variety public roadways and residential buildings of various ages. Site topography on the overall slope in the parcel and immediately adjacent properties consists of a series of steps and slopes, some of which are associated with ancient landslide activity and some associated with roadway alignments. The topography on the subject site consists of a moderate to steep slope off the west side of the site that is interpreted to represent a portion of the ancient head scarp which then somewhat levels out across the building envelope.

Specific grading and development plans were not available at the time of this report; however, we understand the site will be redeveloped with a new single-family residence and associated improvements. Based on our understanding of preliminary design concepts, the proposed residence will essentially replace the existing footprint with some minor modifications. The current house includes a partial basement and we understand the plans are to fill that level to create a slab on grade for the new home, generally, less than about four feet. The new home will be two stories in height.

At the time of report submission, specific building load values were not available for review; however, we anticipate the proposed residential structure will be two stories in height and will consist of relatively lightly loaded wood framing. Based on our experience with similar developments, we estimate perimeter wall loads of about 2 to 3 kips per linear foot and slab-on-grade loading of 150 pounds per square foot (psf) will be incorporated into the final design. However, in terms of new loading, the proposed building will impose insignificant increase in overall loading compared to existing conditions.

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 at 7615 East Mercer Way, between Southeast 76th street and Southeast 77th Place, in Mercer Island, Washington. The approximate site location is depicted on Plate 1 (Vicinity Map). The site is comprised of a single tax parcel (King County Parcel No. 3024059036) currently occupied by a single-family residence and associated improvements built in the 1970s. The site is generally surrounded by existing residential development. Undeveloped portions of the site primarily consist of grassy lawn areas and landscaping elements.

Based on review of the referenced topographic survey, surface topography within the parcel includes a topographic high at the western boundary at about elevation 260 feet that descends moderately to steeply to the east to an elevation of about 150 feet through the current building pad area. Slopes then descend moderately to steeply further to the east toward East Mercer Way with another approximately 40 to 50 feet of elevation change. A natural drainage ravine is present off the northeast property corner, and the GIS portal indicates the ravine contains both piped and un-piped watercourses.

Subsurface

Subsurface conditions were explored by Geotech Consultants, Inc., and results were presented in the referenced geotechnical report. ESNW was granted use of the subsurface information for preparation of this report. Borings B-1, B-2 and B-6 were advanced near the project area and the maximum exploration depth was approximately 56.5 feet below the existing ground surface (bgs).

The approximate locations of the borings are depicted on Plate 2 (Boring Location Plan). Please refer to the boring logs provided in Appendix A for a more detailed description of subsurface conditions.

Topsoil and Fill

Topsoil was not reported in the subsurface exploration logs. However, due to the sampling methods utilized in hollow-stem auger drilling (first sample collected at two-and-one-half feet bgs), there is potential that relatively thin sections of topsoil or fill are present.

Fill was reported at boring B-6 within the upper approximately four feet, described as silty sand with washed rock in a loose condition. Based on the existing site conditions and our experience with similar sites in the project vicinity, roughly 6 to 12 inches of topsoil and/or fill may be assumed. Minor fills should be expected where existing site improvements have been made.

Native Soil

Native soils observed at the exploration sites chiefly consisted of loose to medium dense colluvial and ancient landslide deposits that were characterized as sand (USCS: SM, SP-SM and SP) and silt (USCS: ML). The silt was described as low to moderate plasticity. The upper soils were described as colluvium due to chaotic texture and the presence of organic debris.

Geologic Setting

The referenced geologic map identifies pre-Olympia glacial diamict (Qpogd) as the native soil unit and landslide deposits (Qls) on this property and adjacent parcels.

The online WSS resource identifies Kitsap silt loam (Map Unit Symbol: KpD) as the primary soil unit underlying the site. Kitsap series soils formed over glacial lake deposits under a cover of conifer trees and shrubs. Per the referenced soil survey report, runoff over this soil unit is characterized as fast and the erosion hazard is severe.

Based on conditions encountered during the fieldwork, we interpret the native soils to be representative of landslide deposits.

Groundwater

Groundwater was reported at boring location B-6 from about 14 to 21 feet and again at about 28 to 35.5 feet below grade during the June 2023 subsurface exploration. However, in our experience, groundwater seepage is typical of the local geologic deposits and should be expected within site excavations, particularly during the wet season. Groundwater flow rates and elevations may 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 – MICC 19.07.160

We reviewed Mercer Island City Code (MICC) Chapter 19.07.160 – Geologically Hazardous Areas – to evaluate the presence of geologically hazardous areas at the subject site. Per the MICC, geologically hazardous areas within the City of Mercer Island (City) include areas susceptible to erosion, sliding, earthquake, or other geological events based on a combination of slope (gradient or aspect), soils, geologic material, hydrology, vegetation, or alterations, including landslide hazard areas, erosion hazard areas, and seismic hazard areas.

Review of the City's online GIS portal and critical area maps available in the City's online Map Gallery indicates the site contains landslide, erosion and seismic hazard areas. An evaluation of each identified hazard is provided below.

Landslide Hazard Areas

Landslide hazard areas are those areas subject to landslides based on a combination of geologic, topographic, and hydrologic factors. The referenced mapping resources indicate the site is within a landslide hazard area, and known landslide deposits are mapped within the property boundaries associated with an ancient landslide.

Steep slopes include any slope of 40 percent or greater calculated by measuring the vertical rise over any 30-foot horizontal run. Steep slopes do not include artificially created cut slopes or rockeries. Based on our review of topographic data prepared for this site, slope gradients across the building envelope are gentle, with areas exceeding 40 percent for at least 30 feet of horizontal distance along the eastern and western building pad margins. Steep slopes are included as a subclassification of landslide hazard areas, and as such, the steep slope descending off the northeast corner of the existing residence is classified as a landslide hazard area. With respect to buffer designation, the ancient landslide feature is considered deep; therefore, a 75-foot buffer would apply to the ascending slope off the east side of the building area and a 25-foot buffer would extend off the top of the steep slope located to the east of the building pad. Plate 2 provides a rough outline of the applicable buffers, which envelope the entirety of the existing building pad.

Per MICC 19.07.160(B)(2), "alteration of landslide hazard areas […] and associated buffers may occur" pending the results of a critical area study. The critical areas study must determine that the project proposal: (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.

MICC section 19.07.160(B)(3) requires a statement of risk from the geotechnical professional in order to allow alteration of landslide hazard areas and associated buffers. In our opinion, based on site conditions and slope stability analyses attached to this report, **“The development is so minor as not to pose a threat to the public health, safety and welfare.”** As noted in the Project Description, the new construction will essentially replace the same footprint area as the existing structure and will be of similar height; therefore, no significant increase in loading is expected from the project. Improved drainage controls will improve the overall stability of this site. Further discussion regarding landslide susceptibility is provided in the *Slope Stability Analysis* section of this report.

Slope Stability Analysis

We evaluated slope stability across the subject site with primary focus on areas likely to be influenced or affected by the proposed modifications. Global slope stability analyses were completed using the 2021 GeoStudio Slope/W modeling program to reflect both static and seismic scenarios, including foundation loading where applicable. The analyses focused primarily on deep-seated rotational failures and were completed using topographic data on the referenced survey. We focused the failure search to start at the base of the steep slope located to the west, because this feature represents a more resistant head scarp of glacially consolidated soils and the likelihood of failure within this mass is considerably lower than the ancient landslide deposits. The cross-section is depicted on Plate 2 (Boring Location Plan).

The soil stratigraphy was modeled as two distinct soil units based on conditions observed during the subsurface exploration. We utilized relatively conservative strength parameters in our slope models, outlined in the table below. Additional modeling parameters are attached to this letter report (see Appendix B). Groundwater was included in the modeling based on conditions described in boring B-6 of the referenced geotechnical report.

Soil Unit	**Density or Consistency**	**Unit Weight (pcf)**	**Cohesion (psf)**	**Internal Friction Angle (deg)**
Upper Silt/Sand	Loose to medium dense	115	150 (static) 375 (seismic)	30
Silty Sand	Medium dense	125	175 (static) 325 (seismic)	32

Our analyses indicate the site soils are stable when subjected to the maximum credible earthquake loading of 0.35g (minimum FOS of 1.07) and increases when subjected to a horizontal force of 0.3g (FOS of at least 1.15). The modeled cohesion value within the silt and silty sand units were reduced for the static condition to represent a nearly drained condition, although it is reasonable to assume this soil type remains in a partially undrained condition which reflects a reasonable modeling approach. It is important to note that the subsurface conditions on this site consist of a mixture of silt, silty sand and sand deposits that do not exhibit a clear failure plane; therefore, in our opinion the analysis is relatively conservative and overall slope stability may be more resistant than modeling suggests.

In our opinion, the proposed development and positioning of the new residential structure is considered feasible from a geotechnical standpoint and the analysis indicates no additional mitigation is required to provide an adequate level of safety.

Seismic Hazards

MICC section 19.07.160-D provides development standards and conditions within mapped seismic hazard areas. The entire parcel is mapped within a seismic hazard. To evaluate the site in terms of seismic hazard potential, ESNW utilized SlopeW and failure surfaces generated to gain insight into the risk of instability resulting from a large seismic event. The output is included in Appendix C which demonstrates that the site will maintain an adequate minimum FOS value for shallow and deep-seated rotational failure under the maximum design earthquake acceleration of 0.35g.

Erosion Hazard Areas

Erosion hazard areas are those areas greater than 15 percent slope and subject to severe risk of erosion due to wind, rain, water, slope, and other natural agents including those soil types and/or areas identified by the U.S. Department of Agriculture’s Natural Resources Conservation Service as having a “severe” or “very severe” rill and inter-rill erosion hazard.

The referenced mapping resources indicate the site contains mapped areas of known or suspected erosion hazard areas, with supplemental data indicating mixed infiltration potential (interbedded or mixed fine and coarse-grained deposits) and areas of estimated slope gradients ranging from 15 to 39 percent.

Infiltration potential can influence erosivity by loosening surface material for removal by erosion. Where sandy soils (with relatively high inferred infiltration rates) are exposed at the surface, the City’s Erosion Hazard Assessment map delineates areas of potential erosion hazard. Based on our observations of predominantly silty sand soils with relatively high fines content near the surface, infiltration potential at the surface is considered low and not recommended.

In any case, surface grades at the subject site generally exceed 15 percent gradient and, as indicated in the *Geologic Setting* section of this report, the native Kitsap silt loam soils are characterized by the USDA with slight to moderate erosion hazard. The site is therefore not classified as an erosion hazard area per city definition criteria.

Given the moderate erosion potential of the native soils, typical construction stormwater management methods are anticipated to be adequate for mitigating erosion potential during the earthwork and construction phases of the project. At a minimum, silt fencing should be placed along the downslope site margins, and soil stockpiles should be covered with plastic sheeting when not in use. If construction occurs during periods of wet weather, methods to control surface water runoff will be necessary. Construction stormwater should neither be allowed to collect at the top of slope nor flow over steeply sloping areas. Final drainage plans should be designed such that stormwater is collected and diverted away from slopes exceeding 15 percent to an approved discharge location. Erosion control measures should be actively maintained to ensure proper performance.

Watercourses

Based on our review of the Mercer Island GIS Portal, piped and un-piped watercourses are present within the site that appear to be conveyed by the property immediately to the north and also the property to the west. During our fieldwork, we performed a visual site reconnaissance to assess the presence of piped and/or un-piped water courses. During our reconnaissance, no piping was obvious; however, exposed surface water flows were observed within the drainage site that likely represents the mapped watercourse.

Per the GIS Portal, a watercourse buffer is applied at about 60 feet from the centerline of the un-piped watercourse, indicating a stream type Np or Ns. However, as the geotechnical professional, watercourse designation, typing, and buffer delineation is outside of our area of expertise, and the watercourse should be evaluated by the appropriate professional.

It is noted that, per MICC 19.07.180(C)(3), any watercourse adjoined by a […] contiguous critical area shall have the buffer required for the stream type involved or the buffer that applies to the […] other critical area, whichever is greater.

Based on the results of our slope stability analysis, the proposed site configuration is acceptable from a global stability and geotechnical standpoint.

DISCUSSION AND RECOMMENDATIONS

General

Based on the results of this study, the proposed construction is feasible from a geotechnical standpoint. 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. Based on review of the referenced design concepts, the proposed residence will essentially replace the existing footprint with minor extensions. Based on conditions observed during the fieldwork, we recommend new foundations be supported on a structural fill mat consisting of at least two feet of crushed rock structural fill placed on a woven geotextile (Mirafi 500X or approved alternative) that is underlain by a firm subgrade. An ESNW representative should be contacted to confirm suitability of foundation subgrades at the time of construction and to provide supplementary recommendations, as necessary.

The fine-grained soils generated from excavations should be removed from the site and should not be used as structural fill. In our opinion, a contingency should be provided in the budget for the export of fine-grained soil cuttings and import of suitable structural fill material, as needed.

Review of the City of Mercer Island GIS portal and the referenced mapping resources indicates that the site is located within an area designated as infeasible for infiltration, and infiltrating LID facilities are not permitted at the subject site. In our opinion, based on the fine-grained native soil textures, sloping surface grades, and the reviewed city mapping resources, on-site infiltration should be considered infeasible from a geotechnical standpoint.

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

Site Preparation and Earthwork

Site preparation activities should consist of installing temporary erosion control measures and performing site stripping within the designated clearing limits. Subsequent earthwork activities will likely involve demolition, grading, subgrade preparation, drainage improvements, and infrastructure and utility installations.

Temporary Erosion Control

The following temporary erosion and sediment control (TESC) 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 stable surfaces at site entrances. Placing geotextile fabric underneath the quarry spalls will provide greater stability, if needed; however, we anticipate the existing driveway will serve as a construction entrance/staging feature.

- Silt fencing should be placed around appropriate portions of the site perimeter.

- When not in use, soil stockpiles should be covered or otherwise protected to reduce the potential for soil erosion, especially during periods of wet weather.

- Temporary measures for controlling surface water runoff, such as interceptor trenches, sumps, or interceptor swales, should be installed prior to beginning earthwork activities.

Additional TESC BMPs, as specified by the project civil engineer and indicated on the plans, should be incorporated into construction activities, as necessary. Temporary erosion control measures must be actively managed and may be modified during construction as site conditions require, as approved by the site erosion control lead to ensure the BMPs are performing as intended.

Given the sloping surface grades and the slight to moderate erosion potential of the native soils, enhanced erosion control measures may be required to provide an adequate level of protection for adjacent properties during construction. The contractor must be prepared to employ additional TESC BMPs during construction depending on soil conditions encountered and actively manage BMPs to ensure proper performance.

Excavations and Slopes

Based on the soil conditions described at the subsurface exploration locations, the following maximum allowable temporary slope inclinations 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 or previously disturbed soil, fill	1.5H:1V (Type C)
Medium dense native soil	1H:1V (Type B)

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; groundwater seepage should be expected within site excavations, particularly if excavations take place during the wet season. 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.

In-situ and Imported Soil

The soils on the subject site have a high to very high sensitivity to moisture and were generally in a moist to wet condition at the time of exploration. Soils anticipated to be exposed on site will degrade rapidly if exposed to wet weather and construction traffic. Compaction of the soils to the levels necessary for use as structural fill may be difficult or impossible during wet weather conditions. Soils may be encountered during site excavations that are excessively over the optimum moisture content, and will likely require aeration or treatment prior to placement and compaction. Conversely, soils that are substantially 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 be evaluated by ESNW during construction. The imported soil must be workable to the optimum moisture content, as determined by the Modified Proctor Method (ASTM D1557), at the time of placement and compaction. During wet weather conditions, imported soil intended for use as structural fill should consist of a well-graded, granular soil with a fines content of 5 percent or less (where the fines content is defined as the percent passing the Number 200 sieve, based on the minus three-quarter-inch fraction).

Subgrade Preparation

Subgrade preparation will consist of demolition of the existing building, filling to the structural fill mat subgrade and restoring grades for new foundations. Following site demolition and foundation subgrade excavation activities, ESNW should observe the subgrade to confirm soil conditions are as anticipated and to provide supplementary recommendations for subgrade preparation, as necessary.

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.

In general, the soils anticipated to be generated from site excavations should be removed from the site and should not be used as structural fill. The soils described in the attached boring logs note fine-grained soils and silty sand with abundant organic debris. Fill placement should not occur along sloping areas of this site.

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)	95 percent (Modified Proctor)
• Loose lift thickness (maximum)	12 inches

* *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. Unsuitable material or debris must be removed from structural areas if encountered.

Foundations

The proposed structure can be supported on conventional spread and continuous foundations bearing on a structural fill mat consisting of at least two feet of crushed rock structural fill overlying a woven geotextile such as Mirafi 500X (or approved alternative) that is placed on a firm subgrade. Based on our understanding of preliminary design concepts, the existing basement will be filled, and the proposed residence will have either a slab on grade or crawl space configuration. A representative of ESNW should confirm suitability of foundation subgrades at the time of construction.

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

• Allowable soil bearing capacity	2,000 psf
• Passive earth pressure	250 pcf
• Coefficient of friction	0.30

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

Slab-on-Grade Floors

Slab-on-grade floors should be supported on a firm and unyielding subgrade consisting of competent native soil or at least 18 inches of crushed rock structural fill. Unstable or yielding areas of the subgrade should be recompacted, or overexcavated and replaced with suitable structural fill, prior to slab construction. If the slab will be part of the structural support, the structural fill mat described in the *Foundations* section of this report should be used.

A capillary break consisting of a minimum of four inches of free-draining crushed rock or gravel should be placed below the slab. The free-draining crushed rock or gravel material should have a fines content of 5 percent or less (defined as the percent passing the No. 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 used, the vapor barrier should consist of a material specifically designed to function as a vapor barrier and should be installed in accordance with the manufacturer’s specifications.

Seismic Design

Based on the soil conditions described at the boring locations attached to this report, the parameters and values provided below are recommended for seismic design per the 2018 IBC/ASCE 7-22.

Parameter	**Value**
Site Class	D/E*
Mapped short period spectral response acceleration, S_S (g)	1.63
Mapped 1-second period spectral response acceleration, S_1 (g)	0.62
Adjusted short period spectral response acceleration, S_{MS} (g)	1.67
Adjusted 1-second period spectral response acceleration, S_{M1} (g)	1.61
Design short period spectral response acceleration, S_{DS} (g)	1.11
Design 1-second period spectral response acceleration, S_{D1} (g)	1.07

* *Assumes medium dense to dense native soil conditions, encountered to a maximum depth of 26.5 feet bgs during the September 2023 field exploration, remain dense to at least 100 feet bgs.*

Liquefaction is a phenomenon that can occur within a soil profile as a result of an intense ground shaking or loading condition. Most commonly, liquefaction is caused by ground shaking during an earthquake. Soil profiles that are loose, cohesionless, and present below the groundwater table are most susceptible to liquefaction. During the ground shaking, the soil contracts, and porewater pressure increases. The increased porewater pressure occurs quickly and without sufficient time to dissipate, resulting in water flowing upward to the ground surface and a liquefied soil condition. Soil in a liquefied condition possesses very little shear strength in comparison to the drained condition, which can result in a loss of foundation support for structures.

In our opinion, site susceptibility to liquefaction may be considered low to moderate. The absence of a uniformly established shallow groundwater table and the relatively dense, fine-grained characteristics of the native soil were the primary bases for this opinion.

Retaining Walls

New 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)	45 pcf
At-rest earth pressure (restrained condition)	65 pcf
Traffic surcharge (passenger vehicles)	70 psf (rectangular distribution)
Passive earth pressure	250 pcf (level surface for at least 10 feet)
Coefficient of friction	0.30
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, or other 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.

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. 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

Groundwater seepage will likely be encountered within site excavations, particularly during the wet season. Temporary measures to control surface water runoff and groundwater during construction would likely involve passive elements such as interceptor trenches, interceptor swales, and sumps. ESNW should be consulted during preliminary grading to identify areas of seepage and provide recommendations to reduce the potential for seepage-related instability.

Finish grades must be designed to direct surface water away from the new structures and/or slopes for a distance of at least 10 feet or as setbacks allow. Water must not be allowed to pond adjacent to the new structures and/or slopes. In our opinion, drainage should be provided along the building perimeter footings. A typical foundation drain detail is provided on Plate 4.

If buildings will incorporate crawl spaces rather than slab-on-grade, in our opinion, a crawl space drain system will provide adequate drainage in lieu of perimeter footing drains. The crawl space drain must provide positive drainage to an appropriate outlet.

Interceptor Drain

During our site visit, water was observed flowing onto the site from the adjacent steep slope area to the west. To improve site conditions related to stability, ESNW recommends installing an interceptor drain as close to the toe of the ascending slope as feasible and provide a positive gravity conveyance to an approved discharge location. ESNW is available to coordinate design with the project team.

Utility Support and Trench Backfill

The silty sand soils observed at the subsurface exploration locations are generally suitable for support of utilities; however, the silt soils are not suitable for use as utility trench backfill. Use of the native soil as structural backfill in the utility trench excavations will depend on the in-situ moisture content at the time of placement and compaction. If native soil is placed below the optimum moisture content, settlement will likely occur once wet weather impacts the trenches. As such, backfill soils should be properly moisture conditioned, as necessary, to ensure acceptability of the soil moisture content at the time of placement and compaction. Native soil will be difficult or impossible to use as utility trench backfill during extended wet weather conditions. In this respect, aeration or treatment of the soils may be necessary prior to use as structural fill. Utility trench backfill should be placed and compacted to the specifications of structural fill provided in this report or to the applicable requirements of the presiding jurisdiction. In any case, utility trench backfill should consist of a granular material devoid of deleterious debris and organics.

LIMITATIONS

This study has been prepared for the exclusive use of Eileen & Derek Cheshire, and their representatives. No warranty, express or implied, is made. 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. Variations in the soil and groundwater conditions observed at the test locations may exist and may not become evident until construction. ESNW should reevaluate the conclusions provided in this geotechnical engineering 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. The geotechnical recommendations provided in this report are considered preliminary, are intended to support initial feasibility consideration, and should be reviewed and/or updated as project plans develop. ESNW should also be retained to provide testing and consultation services during construction.

REFERENCES

The following documents and maps were reviewed in preparation of this study:

- Design Development Coordination Drawings, prepared by Patrick D Lynch, LLC, dated September 8, 2024

- Geologic Map of Mercer Island, Washington, compiled by Kathy G. Troost and Aaron P. Wisher, dated October 2006

- Geotechnical Engineering Study, prepared by GeoTech Consultants, Inc., dated September 15, 2023

- Mercer Island City Code (MICC) Chapter 19.07

- Mercer Island Erosion Hazard Assessment, by Troost, K.G. and Wisher, A.P., dated April 2009

- Mercer Island Landslide Hazard Assessment, by Troost, K.G. and Wisher, A.P., dated April 2009

- Mercer Island Seismic Hazard Assessment, by Troost, K.G. and Wisher, A.P., dated April 2009

- Site Survey, prepared by Core Design, dated October 23, 2020

- Web Soil Survey (WSS) online resource, maintained by the Natural Resources Conservation Service (NRCS) under the United States Department of Agriculture (USDA)

Reference:
King County, Washington
OpenStreetMap.org

NORTH

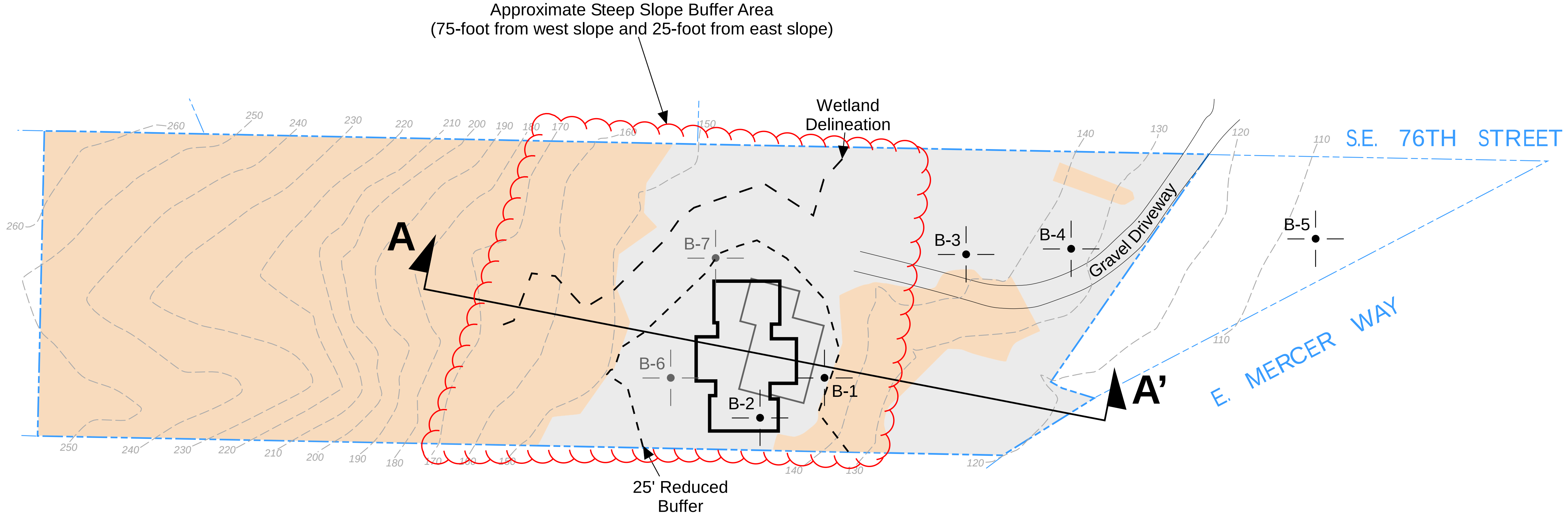
NOTE: This plate may contain areas of color. ESNW cannot be responsible for any subsequent misinterpretation of the information resulting from black & white reproductions of this plate.

Earth Solutions NW LLC

Geotechnical Engineering, Construction Observation/Testing and Environmental Services

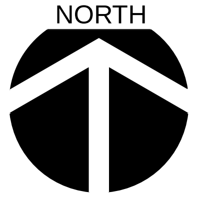
Vicinity Map
Cheshire Property
Mercer Island, Washington

Drawn CAM	Date 04/19/2024	Proj. No. 9607.01
Checked SSR	Date April 2024	Plate 1



LEGEND

B-1 ●	Approximate Location of Geotech Consultants, Inc. Boring, Job 16095, March 2016
B-6 ●	Approximate Location of Geotech Consultants, Inc. Boring, Job 23177, June 2023
▨	Subject Site
▭	Proposed Building
▭	Existing Building
▲ ▲	Cross-Section
🟧	Approximate Location of 40% or Greater Steep Slope



NOT - TO - SCALE

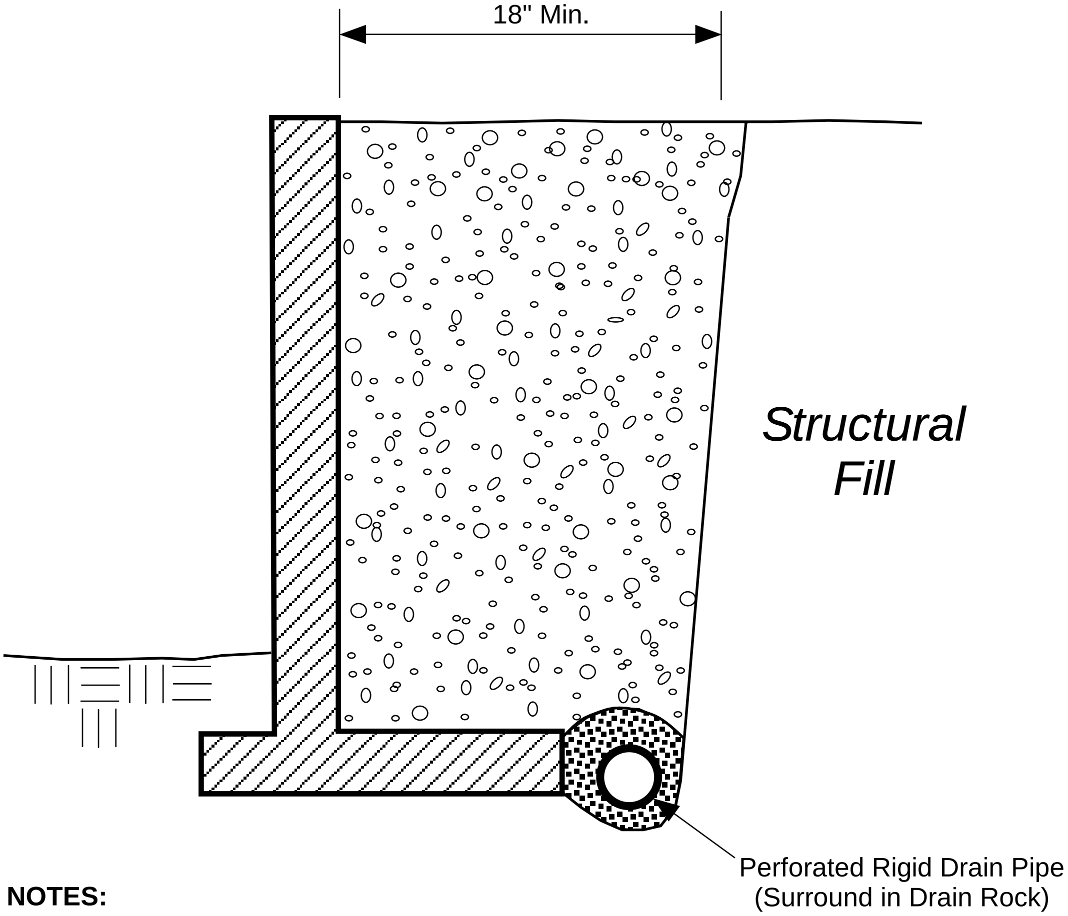
NOTE: The graphics shown on this plate are not intended for design purposes or precise scale measurements, but only to illustrate the approximate test locations relative to the approximate locations of existing and / or proposed site features. The information illustrated is largely based on data provided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

Boring Location Plan
Cheshire Property
Mercer Island, Washington

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

Drawn	CAM
Checked	SSR
Date	11/01/2024
Proj. No.	9607.01
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:

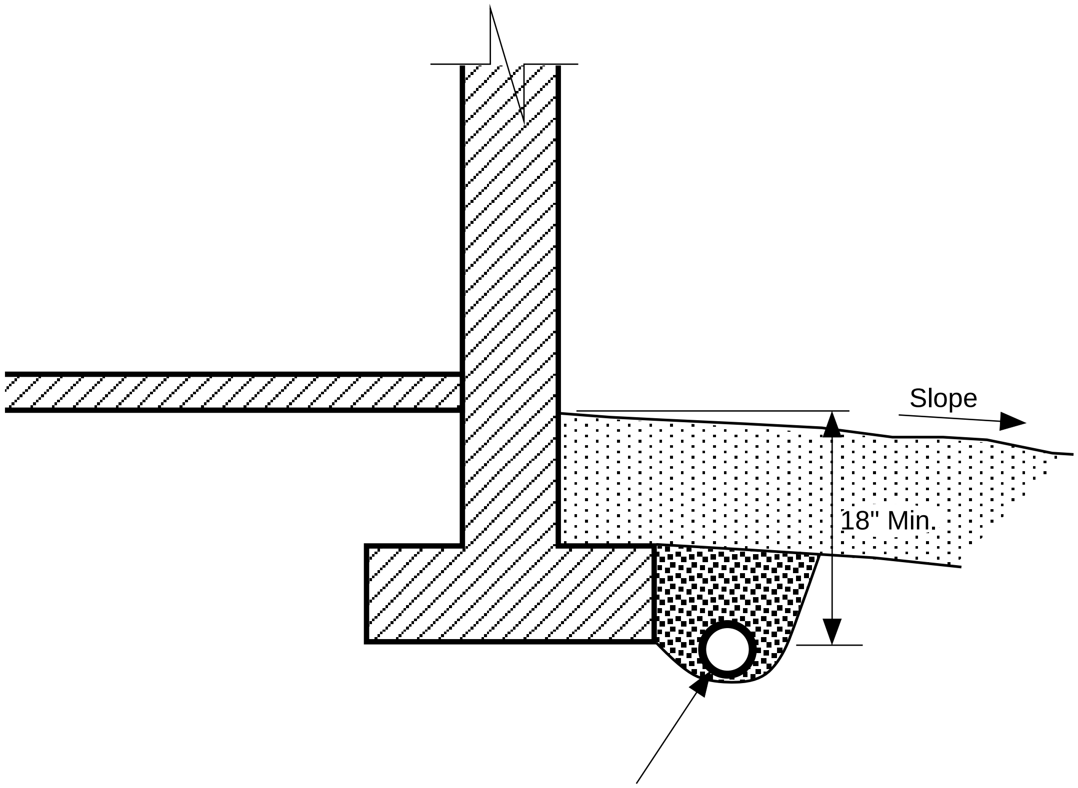
○ Free-draining Structural Backfill

▨ 1-inch Drain Rock

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

Retaining Wall Drainage Detail
Cheshire Property
Mercer Island, Washington

Drawn CAM	Date 04/19/2024	Proj. No. 9607.01
Checked SSR	Date April 2024	Plate 3



Perforated Rigid Drain Pipe
(Surround in Drain Rock)

NOTES:

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

SCHEMATIC ONLY - NOT TO SCALE
NOT A CONSTRUCTION DRAWING

LEGEND:

░	Surface Seal: native soil or other low-permeability material.
▓	1-inch Drain Rock

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

Footing Drain Detail
Cheshire Property
Mercer Island, Washington

Drawn CAM	Date 04/19/2024	Proj. No. 9607.01
Checked SSR	Date April 2024	Plate 4

Appendix A

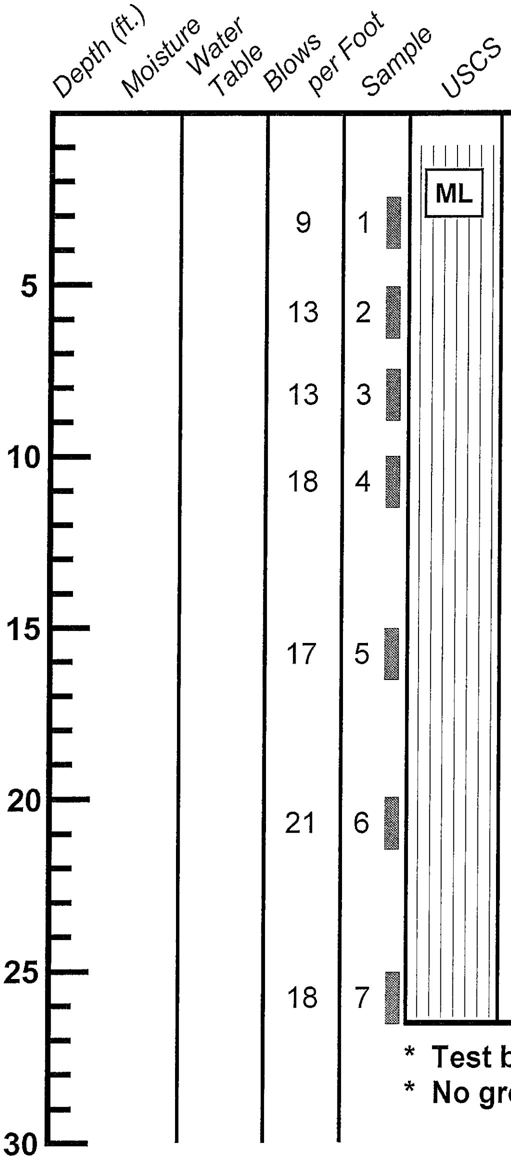
Subsurface Exploration Logs
(by Others)

ES-9607.01

Subsurface conditions on site were explored by GeoTech Consultants, Inc., by advancing a series of test borings at accessible locations within the property boundaries. The approximate locations of the borings located within the project area are illustrated on Plate 2 of this study. The subsurface exploration logs are provided in this Appendix. The borings were advanced to a maximum depth of about 56.5 feet bgs.

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

BORING 1



Description

Topsoil over;

Gray-brown SILT with clay, slightly plastic, moist, stiff

-becomes medium-dense and non-plastic, reduced clay content

-becomes gray, increased sand content

*** Test boring was terminated at 26.5 feet on March 31, 2016.**

*** No groundwater was encountered during drilling.**

GEOTECH
CONSULTANTS, INC.

TEST BORING LOG

7615 East Mercer Way
Mercer Island, Washington

Job 16095	***Date:*** March 2016	***Logged by:*** TRC	***Plate:*** 3

BORING 2

Depth (ft.)	Moisture	Water Table	Blows per Foot	Sample	USCS	Description
					SM	Grass and topsoil over; Brown silty SAND, fine to coarse-grained, moist, medium-dense
			19	1		
5			7	2	ML	Gray-brown SILT with clay, slightly plastic, moist, medium-stiff
			18	3		-becomes stiff
10			25	4		-reduced clay content
15						
20						
25						
30						

*** Test boring was terminated at 11.5 feet on March 31, 2016.**
*** No groundwater was encountered during drilling.**

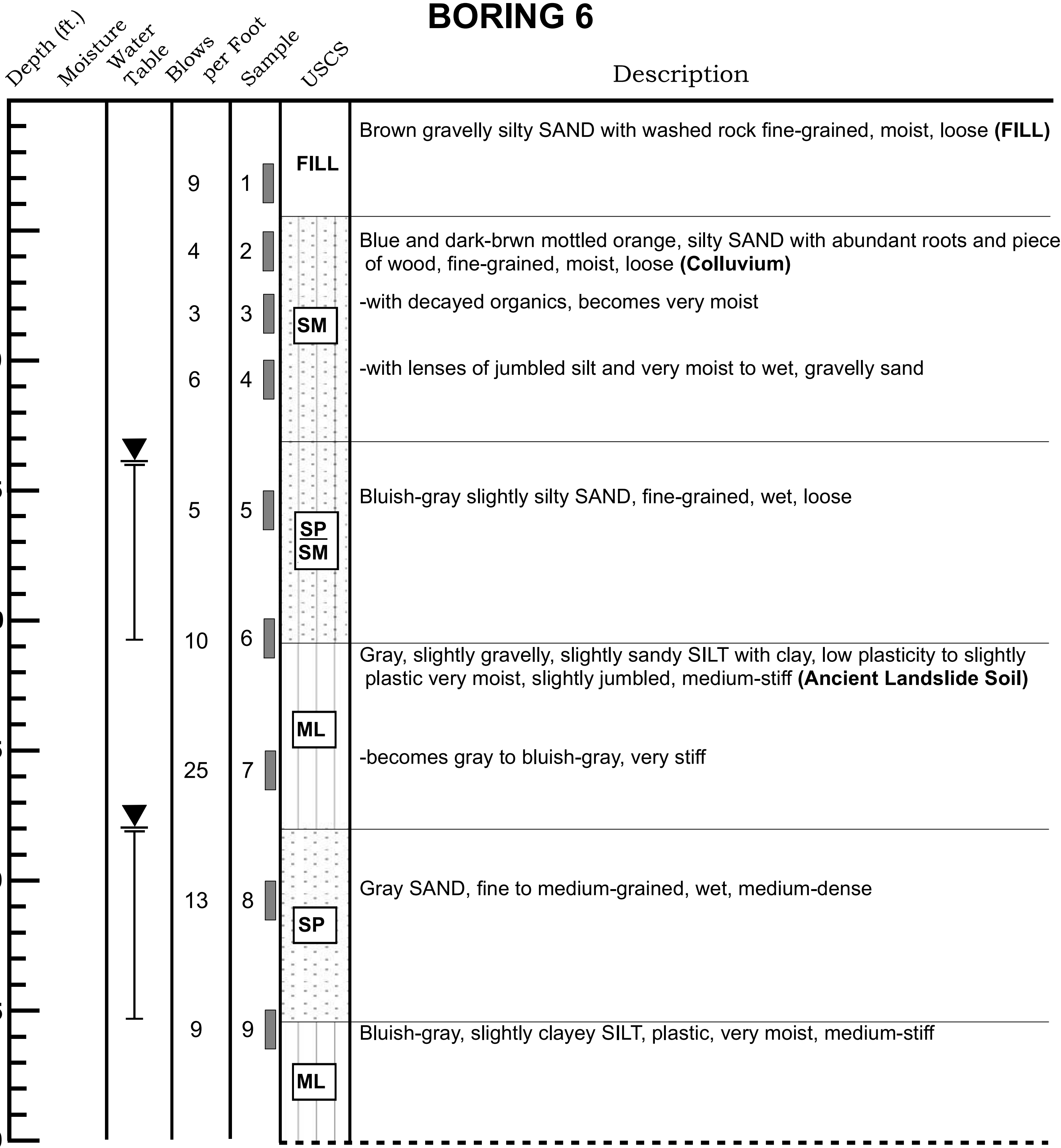
GEOTECH
CONSULTANTS, INC.

TEST BORING LOG

7615 East Mercer Way
Mercer Island, Washington

Job	Date:	Logged by:	Plate:
16095	March 2016	TRC	4

BORING 6



Blows per Foot	Sample
9	1
4	2
3	3
6	4
5	5
10	6
25	7
13	8
9	9

Brown gravelly silty SAND with washed rock fine-grained, moist, loose **(FILL)**

Blue and dark-brwn mottled orange, silty SAND with abundant roots and pieces of wood, fine-grained, moist, loose **(Colluvium)**

-with decayed organics, becomes very moist

-with lenses of jumbled silt and very moist to wet, gravelly sand

Bluish-gray slightly silty SAND, fine-grained, wet, loose

Gray, slightly gravelly, slightly sandy SILT with clay, low plasticity to slightly plastic very moist, slightly jumbled, medium-stiff **(Ancient Landslide Soil)**

-becomes gray to bluish-gray, very stiff

Gray SAND, fine to medium-grained, wet, medium-dense

Bluish-gray, slightly clayey SILT, plastic, very moist, medium-stiff

*** Test Boring 6 is continued on Plate 12.**

GEOTECH
CONSULTANTS, INC.

TEST BORING LOG

7615 East Mercer Way
Mercer Island, Washington

Job	Date:	Logged by:	Plate:
23177	June 2023	MKM	11

BORING 6 (Continued)

Depth (ft.)	Moisture	Water Table	Blows per Foot	Sample	USCS	Description
40			13	10	ML	Gray clayey, slighty sandy SILT, plastic moist, slightly jumbled, medium-stiff to stiff -driller noted increased output pressure past 42 feet
45			21	11		Gray slightly clayey SILT, plastic moist, intact, very stiff
50			20	12	ML	
55			17	13		
60						

*** Test boring was terminated at 56.5 feet on June 14, 2023.**

*** Perched groundwater was encountered from 14 to 21 feet and from 28 to 35.5 feet during drilling.**

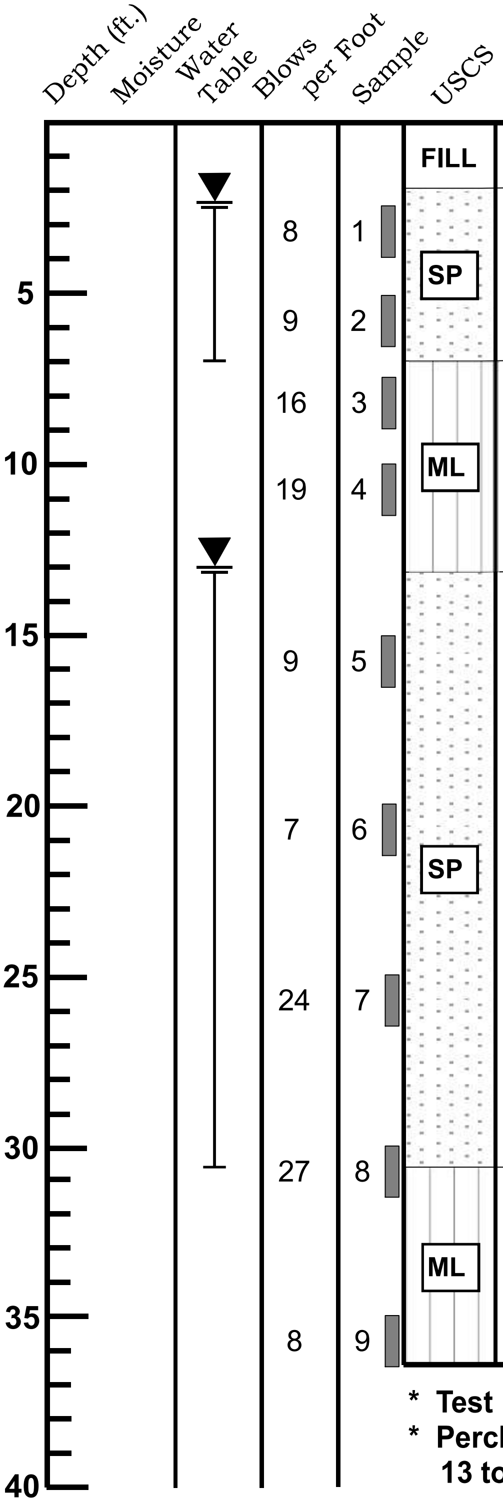
GEOTECH
CONSULTANTS, INC.

TEST BORING LOG

7615 East Mercer Way
Mercer Island, Washington

Job	Date:	Logged by:	Plate:
23177	June 2023	MKM	12

BORING 7



Description

Dark-brown silty SAND with gravel, fine-grained, moist, loose **(FILL)**

Grayish-brown, heavily rusted, gravelly SAND, fine to medium-grained, wet, loose **(Colluvium/Stream Deposits)**

-becomes gray, very wet, loose to medium-dense

Gray, blue-gray, and dark-brown, slightly sandy SILT with organics, low plasticity, moist, stiff **(Colluvium)**

-with rusted streaks, becomes very sandy

Dark-gray very gravelly SAND, fine to coarse-grained very wet, loose

-becomes medium-dense

Bluish-gray slightly clayey SILT, plastic, moist, stiff

-becomes clayey, very moist medium-stiff to stiff

*** Test boring was terminated at 36.5 feet on June 14, 2023.**

*** Perched groundwater was encountered from 2.5 to 7 feet and from 13 to 31 feet during drilling.**

GEOTECH
CONSULTANTS, INC.

TEST BORING LOG

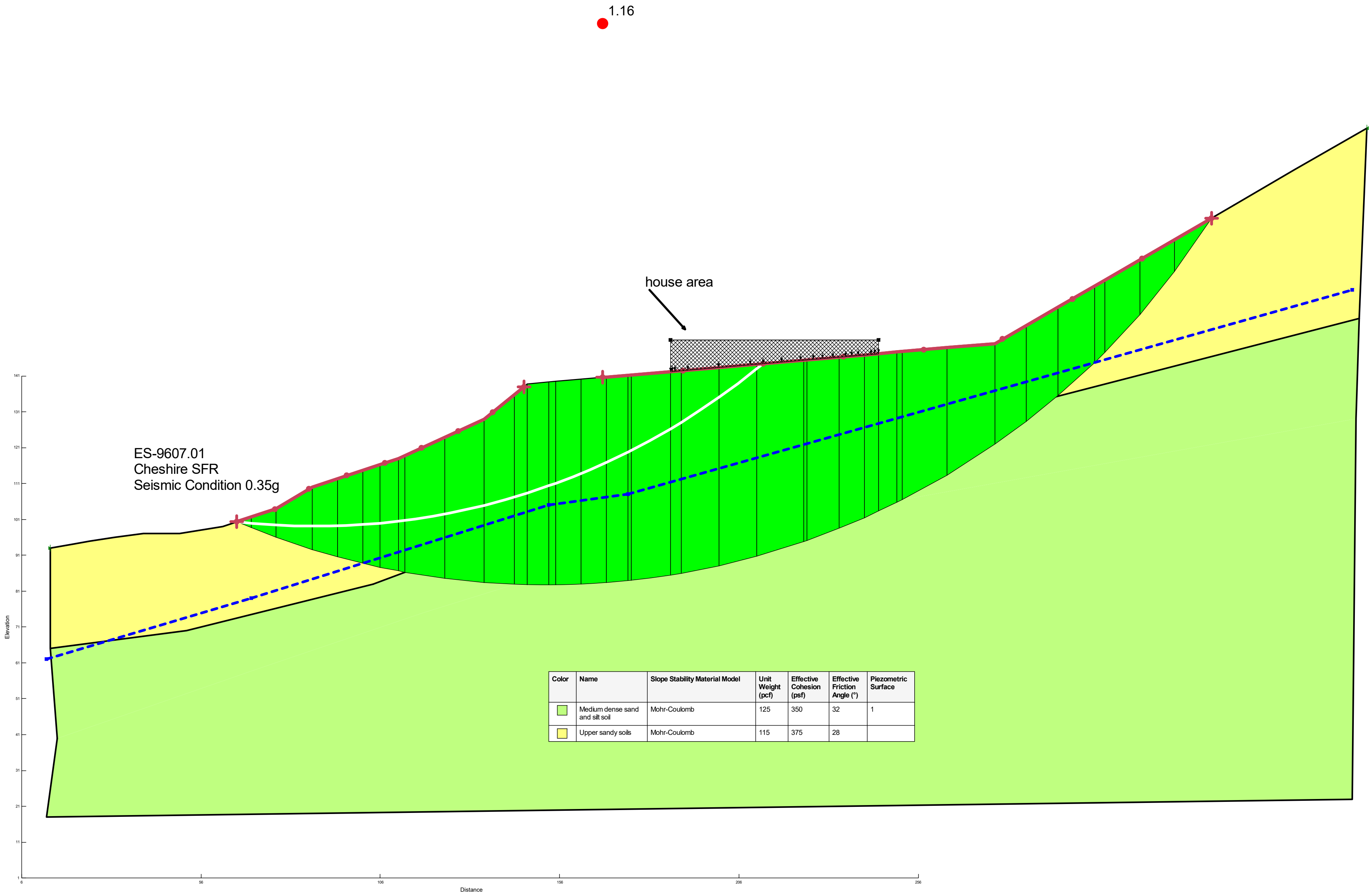
7615 East Mercer Way
Mercer Island, Washington

Job	Date:	Logged by:	Plate:
23177	June 2023	MKM	13

Appendix B

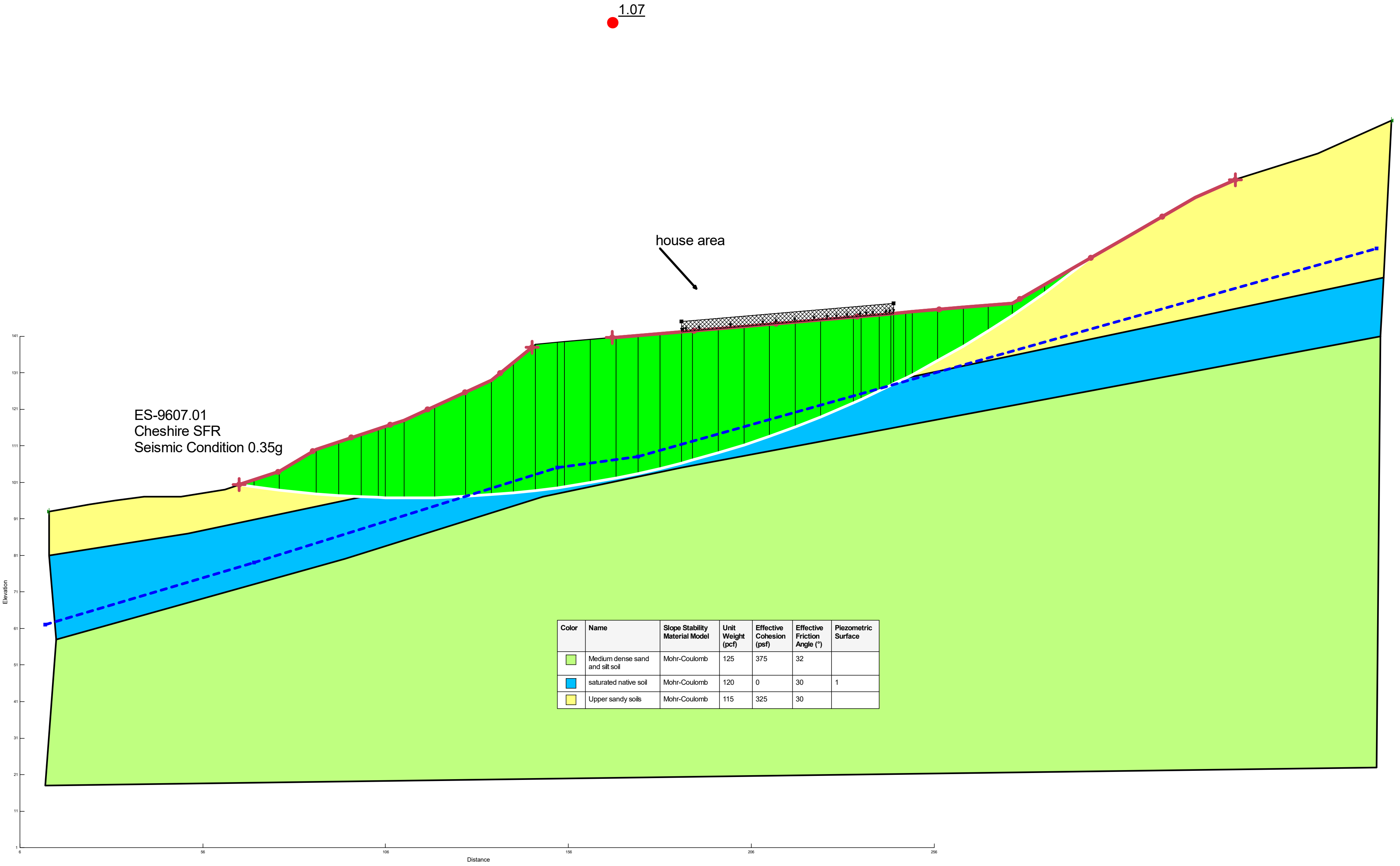
Slope/W Computer Output

ES-9607.01

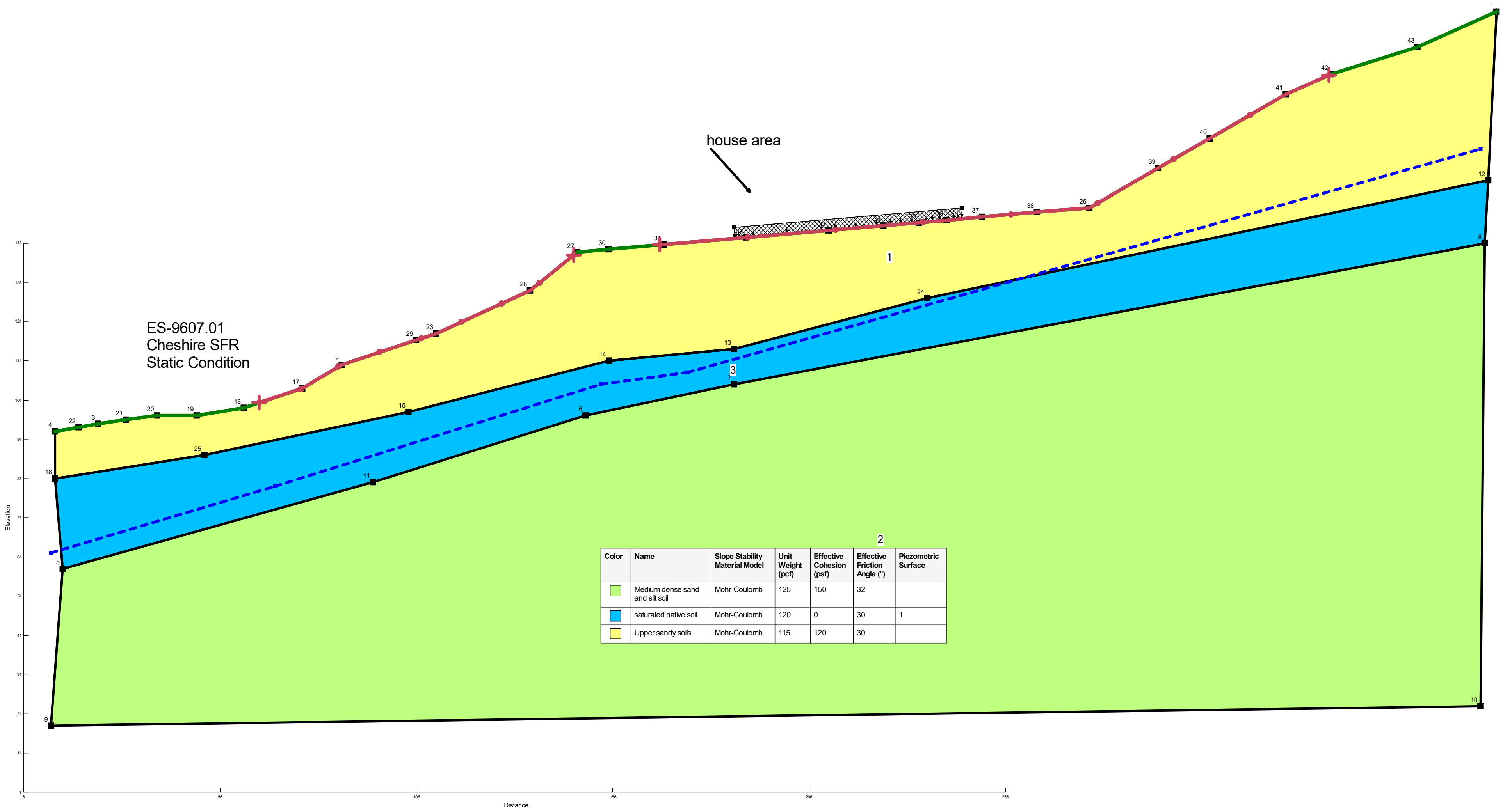


ES-9607.01
Cheshire SFR
Seismic Condition 0.35g

Color	Name	Slope Stability Material Model	Unit Weight (pcf)	Effective Cohesion (psf)	Effective Friction Angle (°)	Piezometric Surface
🟩	Medium dense sand and silt soil	Mohr-Coulomb	125	350	32	1
🟨	Upper sandy soils	Mohr-Coulomb	115	375	28	



Color	Name	Slope Stability Material Model	Unit Weight (pcf)	Effective Cohesion (psf)	Effective Friction Angle (°)	Piezometric Surface
🟩	Medium dense sand and silt soil	Mohr-Coulomb	125	375	32	
🟦	saturated native soil	Mohr-Coulomb	120	0	30	1
🟨	Upper sandy soils	Mohr-Coulomb	115	325	30	



ES-9607.01
Cheshire SFR
Static Condition

house area

Color	Name	Slope Stability Material Model	Unit Weight (pcf)	Effective Cohesion (psf)	Effective Friction Angle (°)	Piezometric Surface
🟩	Medium dense sand and silt soil	Mohr-Coulomb	125	150	32	
🟦	saturated native soil	Mohr-Coulomb	120	0	30	1
🟨	Upper sandy soils	Mohr-Coulomb	115	120	30	