MP ENGINEERING

GEOTECHNICAL ENGINEERING REPORT

9734 SE 40TH STREET
MERCER ISLAND, WA 98040

JANUARY 28, 2025

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GEOTECHNICAL ENGINEERING STUDY
PROPOSED RESIDENTIAL DEVELOPMENT
9734 SE 40TH STREET
MERCER ISLAND, WA 98040
PROJECT NO. 24-0145

1.0 SUMMARY

The following summary of project geotechnical considerations is presented for introductory purposes and should be used only in conjunction with the full text of this report.

- Project Description: The subject site is located at 9734 SE 40th Street, Mercer Island, Washington, as shown in Figure 1, Vicinity Map. The property consists of one tax parcel (King County Parcel No. 265550-0176) totaling about 0.30 acres. The proposed development includes a 522-square-foot deck addition, a new residential dwelling of 2,805 square feet, and associated site improvements.

- Exploratory Methods: MPE investigated subsurface conditions on January 20, 2025, by drilling one boring (designated B-01) at strategic location across the project site to a depth of up to 15 feet below the existing grade.

- Site Conditions: The site slopes generally downward south to north, with elevations ranging from approximately 170 feet to 155 feet. The property is bordered by residential dwellings to the north, west, and east, with SE 40th Street to the south.

- Soil Conditions: The subsurface exploration indicated that the encountered soils primarily consist of Glacial Drift deposits, with a 6-inch thick surficial layer of loose sandy silt containing organics, which is unsuitable for foundation support or use as structural fill. Beneath the topsoil, fill was encountered to a depth of approximately 2.5 feet, consisting of sandy silt with gravel and scattered organics. The Glacial Drift deposits extended to a depth of about 15 feet, consisting of non-stratified mixtures of silt, sand, and gravel. The upper 12.5 feet of Glacial Drift were characterized by stiff to hard sandy silt, transitioning to very dense silty sand (Till) between 12.5 and 15 feet, with hard drilling conditions observed at 13 feet. Laboratory testing revealed a moisture content of 13%, a fines content of 23%, and Plasticity Index values of 3.8 and 5.6 for the Glacial Drift soils.

- Groundwater Conditions: Groundwater seepage was not encountered during our investigation on January 20, 2025. However, it should be noted that perched groundwater can occur atop dense silty sand soils as downward percolation of groundwater is inhibited by the less permeable soils. Groundwater levels may fluctuate throughout the year in response to precipitation patterns, on- or off-site construction, irrigation activities, and site utilization.

- Landslide Hazard Areas: MPE conducted a geologic hazard review of the site per MICC Chapter 19.07.160 and Chapter 19.16, which define landslide hazard areas based on factors such as slope steepness, geologic contacts, groundwater seepage, and historical slope failures. Using GIS mapping, geologic resources, historical data, and a site reconnaissance on January 20, 2025, MPE found no evidence of slope instability, such as cracks, disturbed vegetation, or past landslide activity. Subsurface investigation revealed the hard to very dense nature of native Glacial Drift deposits with no weak planes, groundwater, or erosion risks from nearby watercourses. Based on these findings, it is our opinion that the proposed construction will not increase geological hazards to neighboring properties or critical areas and that the site does not meet the MICC definition of a landslide hazard area.

- Seismic Hazard Areas: Seismic hazard areas, as defined by MICC Chapter 19.16, are regions at risk of damage from earthquake-induced ground shaking, slope failure, settlement, soil liquefaction, or surface faulting. Liquefaction occurs when increased pore water pressure reduces the effective stress between soil particles, particularly in loose, saturated sands with low silt and clay content. To evaluate the site's liquefaction susceptibility, a subsurface investigation was conducted at Boring B-01, and liquefaction analysis was performed using Rocscience's SETTLE3 software. The analysis compared the earthquake loading (CSR) with the liquefaction resistance (CRR). Results indicate that, apart from a layer of stiff, moist, sandy silt with some gravel (ML) found between 2.5 and 5 feet below the surface, the soils beneath the site are not susceptible to liquefaction. While there is a slight potential for liquefaction in this layer, the calculated settlement is negligible. Given the observed conditions, mitigation measures are not warranted.

- Erosion Hazard Areas: Erosion hazard areas, as defined by MICC Chapter 19.16, are those with slopes greater than 15% and a severe erosion risk due to natural agents or specific soil types identified by NRCS. Our assessment classifies the property as Kitsap silt loam with 2–8% slopes, which does not meet these criteria. While undisturbed soils have slight erosion potential, this risk increases to slight or moderate when disturbed, depending on slope magnitude. The project is not expected to increase surface water discharge, compromise slope stability, or adversely impact critical areas if recommended mitigation measures are implemented. These measures include installing silt fencing, scheduling earthwork during dry periods, promptly revegetating disturbed areas, mulching, hydroseeding, managing soil stockpiles, constructing stormwater diversion features, providing rock construction entrances, and properly directing stormwater. Adhering to these practices will minimize erosion risks and ensure compliance with best management practices.

- Foundations: Conventional spread footings can be supported either on adequately compacted structural fill placed directly above undisturbed Glacial Drift or on the dense, undisturbed Glacial Drift itself. The maximum allowable pressures for these options are 2,000 psf for footings on compacted structural fill and 2,500 psf for footings on dense, undisturbed Glacial Drift.
- Floors: Soil-supported slab-on-grade floors can be used for the proposed residence structures contingent on proper subgrade preparation. The concrete slab would need to be supported on capillary break material overlying firm, unyielding native soils or on suitable structural fill soils.
- On-site Soil Considerations: The majority of on-site soils exhibit high sensitivity to moisture, making them prone to disturbance when wet. The contractor should implement suitable temporary drainage systems at the construction site and minimize traffic over exposed subgrades. Ideally, scheduling earthwork during the summer and fall months, when drier weather prevails, will optimize the feasibility of reusing on-site soils. Additionally, these seasons coincide with lower groundwater levels, further aiding construction efforts.

2.0 SITE AND PROJECT DESCRIPTION

The subject site is located at 9734 SE 40th Street, Mercer Island, Washington, as shown in Figure 1, Vicinity Map. The property consists of one tax parcel (King County Parcel No. 265550-0176) totaling about 0.30 acres. The property is bordered by residential dwellings to the north, west, and east, with SE 40th Street to the south. The site slopes generally downward south to north, with elevations ranging from approximately 170 feet to 155 feet[1]. The site layout is shown in Figure 2. Currently, the site is developed with a single-family residence. Images 1 and 2 illustrate the general site conditions. The proposed development includes a 522-square-foot deck addition, a new residential dwelling of 2,805 square feet, and associated site improvements.

The conclusions and recommendations in this report are based on our understanding of the currently proposed utilization of the project site, as derived from preliminary layout drawings, written information, and verbal information supplied to us. If any changes are made to the proposed project, we may need to modify our conclusions and recommendations to reflect those changes.

Image 1. Overall view from northwest to southeast.

[1] Site plan by ALDOR, LLC dated November 4th, 2024

Image 2. Overall view from southeast to northwest.

3.0 SUBSURFACE EXPLORATIONS

3.1 EXPLORATORY METHODS

Surface and subsurface conditions at the project site were evaluated on January 20, 2025. The study consisted of the following activities:

- Visual surface reconnaissance of the site.
- Review of published geologic and seismologic maps and literature relevant to the area.
- Advancement of one boring (B-01) at a strategic location across the site.
- Laboratory testing, including:
    - One grain-size analysis
    - One moisture content test
    - Two Atterberg limits determinations

Table 1 summarizes the approximate functional locations, surface elevations, and termination depths of the explorations, while Figure 2 shows their relative positions. Field exploration procedures are detailed in Appendix A, and laboratory testing procedures are provided in Appendix B.

Table 1. Approximate Location, Elevation, and Depth of Exploration.

Exploration	Functional Location	Surface Elevation (feet)	Termination Depth (feet)
B-01	Middle of the property	170	15

Elevation datum: Site plan by ALDOR, LLC dated November 4th, 2024

The specific number, locations, and depths of our explorations were selected in relation to the existing and proposed site features, under the constraints of surface access, underground utility conflicts, and budget considerations. We estimated the relative location of each exploration by measuring from existing features and scaling these measurements onto a site plan. Consequently, the locations depicted on Figure 2 should be considered accurate only to the degree permitted by our data sources and implied by our measuring methods.

It should be realized that the explorations utilized for this evaluation reveal subsurface conditions only at discrete locations across the project site and that actual conditions in other areas could vary. In addition, the nature and extent of any such variations would not become evident until additional explorations are performed or until construction activities have begun. If significant variations are observed at that time, we may need to modify our conclusions and recommendations contained in this report to reflect the actual site conditions.

3.2 SITE GEOLOGY

General geologic information for the project area was obtained by reviewing the Preliminary Geologic map of Seattle and vicinity, Washington (USGS)[2] and Interactive Geologic Hazard Maps (WSDNR)[3]. Based on our review of the geologic map, the primary geologic unit in the vicinity of the site is Pleistocene Continental Glacial Drift deposits (Geologic Map Unit Qgd). Specifically, Glacial Drift deposits consist of till and outwash clay, silt, sand, gravel, cobbles, and boulders deposited by or originating from continental glaciers. We encountered till-like sediments and gravelly outwash deposits. Our

[2] Waldron, H.H., Leisch, B.A., Mullineaux, D.R., and Crandell, D.R., 1961, Preliminary geologic map of Seattle and vicinity, Washington, U.S. Geological Survey, Open-File Report OF-61-168, 1:24,000.
[3] https://www.dnr.wa.gov/geologyportal

interpretation of the sediments encountered in our explorations is in general agreement with the regional geologic mapping.

3.3 SOIL CONDITIONS

The enclosed exploration boring log in Appendix A provide a detailed description of the encountered soil strata. In general, the soils encountered during our investigation consist of Glacial Drift deposits. The following is a generalized description of the soils encountered in our exploration program.

Topsoil – A surficial layer of topsoil was encountered in our subsurface exploration. The topsoil consisted of loose sandy silt soil with organics and was generally about 6-inches thick. The topsoil was characterized by its dark yellow color and a dense mat of roots. This soil layer is not considered suitable for support of foundations, slab-on-grade floors, or pavements. In addition, it is not suitable for use as structural fill, nor should it be mixed with materials to be used as structural fill.

Fill – Fill was encountered to a depth up to 2.5 feet below existing grade. The fill was likely placed during construction of the existing residential dwelling. The fill consisted of sandy silt with gravel, which was characterized by its medium stiff condition and the presence of scattered organics.

Glacial Drift Deposits – Glacial drift deposits were encountered to a depth of approximately 15 feet below the existing grade. These deposits consisted of a non-stratified mixture of grayish light brown silt, sand, and gravel. The upper 12.5 feet were characterized by stiff to hard sandy silt (ML), transitioning to very dense silty sand (SM) Till soils between 12.5 and 15 feet. Hard drilling conditions were observed at a depth of 13 feet below ground surface, indicating increased soil density.

Geotechnical laboratory testing determined that the moisture content of the Glacial Drift soils at the time of exploration was 13 percent, with a fines content (percent passing the U.S. No. 200 sieve) of 23 percent. To assist in soil classification, Atterberg Limits tests were conducted in accordance with ASTM D4318. The tests yielded Plasticity Index (PI) values of 3.8 and 5.6. Detailed laboratory test results are presented graphically in Appendix B.

3.4 GROUNDWATER CONDITIONS

Groundwater seepage was not encountered during our investigation on January 20, 2025. However, it should be noted that perched groundwater can occur atop dense silty sand soils as downward percolation of groundwater is inhibited by the less permeable soils. Groundwater levels may fluctuate throughout the year in response to precipitation patterns, on- or off-site construction, irrigation activities, and site utilization.

3.5 SUBSURFACE CONTAMINATION

During our exploration program, we did not visually identify any contaminated soil within the subject site.

4.0 CRITICAL AREAS CONSIDERATIONS

4.1 LANDSLIDE HAZARD AREAS

MPE conducted a review of potential geologic hazards at the subject site as defined in the Mercer Island City Code (MICC) Chapter 19.07.160 Geologically Hazardous Areas, and Chapter 19.16 Definitions. Based on the City of Mercer Island GIS map[4] and Chapter 19 of the MICC, a Landslide Hazard Area is applicable to the subject site.

The MICC defines landslide hazard areas as follows:

Those areas subject to landslides based on a combination of geologic, topographic, and hydrologic factors, including:

1. Areas of historic failures;
2. Areas with all three of the following characteristics:
- *a. Slopes steeper than 15 percent; and*
- *b. Hillsides intersecting geologic contacts with a relatively permeable sediment overlying a relatively impermeable sediment or bedrock; and*

c. Springs or ground water seepage;
3. Areas that have shown evidence of past movement or that are underlain or covered by mass wastage debris from past movements;
4. Areas potentially unstable because of rapid stream incision and stream bank erosion; or
5. Steep slope. Any slope of 40 percent or greater calculated by measuring the vertical rise over any 30-foot horizontal run.

[4] https://city-of-mercer-island-gis-hub-mercerislandgis.hub.arcgis.com/

To assess the landslide hazard at the subject site, we conducted a thorough review, encompassing the Preliminary Geologic map of Seattle and vicinity, Washington (USGS), the State of Washington DNR Geologic Hazard Map, as well as historical slope stability information stored within our library and files. Furthermore, a site reconnaissance was undertaken on January 20, 2025, encompassing an evaluation of the site and its slopes. The objective of this reconnaissance was to appraise the state of the site's slopes and detect signs of historical slope instability, encompassing:

- Bowl-shaped topography;
- Irregular or hummocky topography;
- Tension cracks, scarps, or other indicators of ground movement;
- Leaning or pistol-butted trees;
- Distressed vegetation;
- Vegetation of markedly different ages or types;
- “Fresh” looking soil deposited at the base of steep slopes;
- Disturbed or destroyed anthropogenic features, such as fence lines that have been displaced;
- Hillside seeps or springs; and
- Ponding water/sag ponds.

After conducting a comprehensive reconnaissance and examination of the site conditions, we found no evidence of historical slope instability. Additionally, our boring revealed no soils indicative of landslide deposits. The site's underlying native soils comprise Glacial Drift deposits, characterized by their robust strength. Importantly, no indications of weak planes or preferential failure surfaces were identified. Furthermore, the absence of nearby watercourses or bodies eliminates the risk of erosion or slope undercutting. During our exploration on January 20, 2025, we did not encounter groundwater.

After meticulous review of the observed site conditions, we hold the opinion that the proposed construction will not amplify the geological hazard risk to neighboring properties beyond pre-development status. Furthermore, it will not adversely affect other critical areas. Therefore, in our opinion, the development can be securely integrated into the site and does not align with MICC's definition of a Landslide Hazard Areas.

4.2 SEISMIC HAZARD AREAS

Seismic hazard areas are defined by MICC Chapter 19.16 as:

“Seismic hazard areas are areas subject to severe risk of damage as a result of earthquake induced ground shaking, slope failure, settlement, soil liquefaction or surface faulting.”

Liquefaction occurs due to a rapid increase in pore water pressure, leading to a near-zero effective stress between soil particles. Granular soil, reliant on interparticle friction for strength, is particularly vulnerable to liquefaction until excess pore pressures dissipate. Loose, saturated sand with low silt and clay content is most susceptible, while silty soil with low plasticity can also experience liquefaction or strain softening under higher ground shaking intensities.

To evaluate the susceptibility of the soil beneath the site to liquefaction during seismic events, we conducted a borehole investigation at Boring B-01 to explore subsurface conditions and perform a liquefaction analysis. Rocscience's SETTLE3 software was utilized to calculate the liquefaction resistance factor of safety and the probability of liquefaction. The analysis compared earthquake loading (CSR) with liquefaction resistance (CRR). The SETTLE3 results are provided in Appendix C for reference.

Based on our investigations and our comprehensive analysis, the soils beneath the site are generally not susceptible to liquefaction, with the exception of a layer of stiff, moist, brown, sandy SILT with some gravel (ML) encountered between approximately 2.5 and 5 feet below ground surface. Although there is a slight potential for liquefaction within this layer, the calculated total liquefaction settlement is negligible. Considering the project scope, it is our opinion that mitigation of liquefaction potential is not warranted based on the observed conditions.

Table 2 provides liquefaction settlement predictions at the ground surface, confirming negligible settlement estimates at boring location B-01 (Figure 2).

Table 2. Soil Liquefaction Settlement at the Ground Surface

Location	Total Liquefaction Settlement Estimate (inches)
B-01	Negligible[5]

4.3 EROSION HAZARD AREAS

Erosion hazard areas are defined by MICC Chapter 19.16 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 U.S. Department of Agriculture's Natural Resources Conservation Service as having a "severe" or "very severe" rill and inter-rill erosion hazard."

[5] Ishihara & Yoshimine (1992), Tokimatsu & Seed (1984), Shamato (1998), and Cetin (2009)

Our assessment of the NRCS Soil Survey[6] indicates that the property is classified as Kitsap silt loam with 2 to 8 percent slopes. While these soils have a slight erosion potential in their undisturbed state, their erosion potential increases to slight to moderate when disturbed, depending on slope magnitude.

Based on this analysis, the property does not meet the strict MICC criteria of having slopes greater than 15 percent or soils identified as having a "severe" or "very severe" erosion hazard. However, erosion risks remain present under disturbed conditions. Mitigation recommendations to address these risks are provided in the following section.

Based on our professional opinion and adherence to the recommendations outlined in this report:

- The project will not increase surface water discharge or sedimentation to adjacent properties or stormwater systems beyond predevelopment conditions.
- The project will not compromise slope stability on adjacent properties.
- The project will not adversely affect other critical areas.

To minimize sediment transport from the site during construction, the following recommendations should be followed:

- Silt Fencing: Install silt fencing around the lower perimeter of all cleared areas, conducting periodic inspections and maintenance to ensure proper functioning.
- Scheduling and Vegetation: Conduct earthwork during drier periods of the year whenever possible, and promptly revegetate disturbed areas. Maintain temporary erosion control measures until permanent erosion control measures are established.
- Mulching and Hydroseeding: Mulch and hydroseed areas stripped of vegetation as soon as possible. For winter construction, cover hydroseeded areas with clear plastic to facilitate grass growth.
- Soil Stockpiles: If excavated soils are stockpiled on-site for reuse, minimize erosion by covering the pile with plastic sheeting, using low stockpiles in flat areas, and placing straw bales or silt fencing around pile perimeters.
- Stormwater Diversion: Construct interceptor swales with rock check dams to divert stormwater from construction areas and route collected stormwater to an appropriate discharge location.
- Rock Construction Entrance: Provide a rock construction entrance to minimize sediment transport off-site via truck tires.

[6] https://websoilsurvey.nrcs.usda.gov/app/WebSoilSurvey.aspx

- Stormwater Management: Direct all stormwater from impermeable surfaces, such as driveways and roofs, into approved facilities rather than onto or above steeply sloping areas.
- City Street Protection: Implement measures to avoid sediment track-out onto City streets.

These measures will ensure effective erosion control during construction and align with best management practices for minimizing impacts on the site and surrounding areas.

5.0 CONCLUSIONS AND RECOMMENDATIONS

The conclusions and recommendations contained in this report are based on our understanding of the currently proposed utilization of the project site, as derived from layout drawings, written information, and verbal information supplied to us. Consequently, if any changes are made in the currently proposed project, we may need to modify our conclusions and recommendations contained herein to reflect those changes.

5.1 SITE PREPARATION

Preparation of the project site will involve temporary drainage, excavations, erosion control, dewatering, and subgrade compaction. The paragraphs below discuss our geotechnical comments and recommendations concerning site preparation.

<u>Temporary Drainage</u>

We recommend intercepting and diverting any potential sources of surface or near surface water within the construction zones before stripping begins. Because the selection of an appropriate drainage system will depend on the water quantity, season, weather conditions, construction sequence, and contractor's methods, final decisions regarding drainage systems are best made in the field at the time of construction. Nonetheless, we anticipate that curbs, berms, or ditches placed around the work areas will adequately intercept surface water runoff.

<u>Erosion Control Measures</u>

Because stripped surfaces and soil stockpiles are typically a source of runoff sediments, they should be given particular attention. If earthwork occurs during wet weather, we recommend all stripped surfaces be covered with straw to reduce runoff erosion. Similarly, soil stockpiles and cut slopes should be covered with plastic sheeting for erosion protection. We also recommend a staked silt fence be installed around the area to be disturbed. The base of the silt fence should be buried so that sediment cannot pass beneath it, and the silt fence should be inspected and maintained during the time that the site soils are exposed, on a periodic basis, and after any major rainstorm event. It may be prudent to maintain a berm and swale around the downslope side of stripped areas and stockpiles to capture runoff water, thereby reducing the downslope sediment transport. In addition, the stripped areas should be revegetated as soon as possible, also reducing the potential for erosion.

Clearing and Stripping

After surface and near-surface water sources have been controlled, the construction areas should be cleared and stripped of all trees, bushes, sod, organic soils, and debris. It should be realized that if the stripping operation proceeds during wet weather, a generally greater stripping depth might be necessary to remove disturbed moisture-sensitive soils; therefore, stripping is best performed during a period of dry weather.

Subgrade Compaction

Exposed subgrades for footings, floors, pavements, and other structures should be compacted to a firm, unyielding state before concrete elements or fill soils are placed. Any localized zones of loose soils observed within a subgrade should be compacted to a dense condition. In contrast, any organic, soft, or pumping soils observed within a subgrade should be over-excavated and replaced with a suitable structural fill material.

Reuse of On-site Soils

Provided it is free of vegetation, organics, debris, and deleterious matter, the upper 4-feet below existing grade of the on-site soil maybe used as general fill and backfill during grading for the project. It should be noted that most of the on-site soils have a relatively high percentage of fines and are expected to be difficult to handle, place, and compact if they become excessively wet. During periods of wet weather, the contractor should make provisions to dry portions of the excavated material such as by discing/air drying, as necessary, prior to compaction to an acceptable moisture content as determined by the Geotechnical Engineer. At this time, we recommend wherever possible minimizing the on-site soil's duration of exposure to weather conditions; cut soils should be placed as fill as soon as possible once they are excavated, with stockpiling of on-site soil minimized where construction permits. Stockpiled soil should be protected from rain/snow when practical.

The contractor's ability to successfully work the site soils, combined with the weather conditions and the time of year during the site preparation and filling phases of construction, will have a significant impact on timely project completion. Care should be taken to prevent disturbance of the proof-rolled areas and softening of these materials prior to finished construction. At a minimum, all subgrade areas should be temporarily sloped and sealed by rolling with a smooth drum roller at the end of each working day, as necessary, so as to maximize surface water runoff, and minimize potential ponding and infiltration.

5.2 EXCAVATION AND SLOPES

Our comments and recommendations concerning excavations are presented below.

Soil Conditions

Based on our explorations, we anticipate that site excavations will encounter medium stiff Uncontrolled Fill or Glacial Drift material. In our opinion, these soils can be readily excavated with conventional earth-working equipment. Although our explorations did not reveal rubble within the fill soils or boulders within the native soils, such obstacles could be present at random locations within these deposits.

Groundwater Conditions

Groundwater seepage was not observed during our site exploration program. However, a perched groundwater seepage might occur from infiltration of surface water during rain events. Ideally, the excavations would be performed during the summer or early fall, when groundwater levels will tend to be at a yearly low.

Dewatering

We anticipate that the excavation can be adequately dewatered by means of a series of internal ditches, sump holes, and pumps. In all cases, the specific design of a dewatering system should be completed by the contractor using groundwater level data appropriate for the time of earthwork.

Temporary Slopes and Excavations

Configuration and maintenance of safe working conditions, including temporary excavation stability, is the responsibility of the contractor. All applicable local, state, and federal safety codes should be followed. Temporary excavation should either be shored or sloped in accordance with Safety Standards for Construction Work, Part N, Washington Administrative Code (WAC) 296-155-650 through 66411. The soil type classification and maximum inclination based on Part N of the Safety Standards for Construction Work, WAC 296-155-66401 and 66403 is provided below.

Soil Unit	WAC Soil Type	Maximum Inclination
Glacial Drift Soils	Type C	1 ½ H:1 V

If groundwater seepage is encountered in site excavations, the excavation should be sloped to an inclination of 2H:1V or flatter to reduce caving or sloughing of the excavation face or sidewalls. In addition, the contractor may need to install temporary drainage measures to protect the cut face and to prevent degradation of the excavation area until permanent drainage measures can be installed.

Safety Considerations

The stability of temporary excavation slopes is a function of many factors, including soil type, soil density, slope inclination, slope height, the presence of groundwater, and the duration of exposure. Generally, the likelihood of slope failure increases as the cut is deepened and as the duration of exposure increases. For this reason, we recommend the contractor maintain adequate slopes and/or setbacks. Temporary slope safety should remain the responsibility of the contractor, who is continually present at the site and is able to monitor the performance of the excavation and modify his activities to reflect varying conditions. In all cases, cut-slope inclinations should conform to applicable governmental safety guidelines.

Slope Protection

Regardless of inclination, temporary slopes should be protected from surface-runoff erosion. Typically, this can be accomplished by means of berms or swales located along the top of the slope, and possibly by means of plastic tarpaulins placed over the slope.

5.3 SEISMIC DESIGN PARAMETERS

The ASCE 7-16 standard serves as the basis for the seismic design of structures. The computation of seismic design forces according to this code is derived from seismological input and site-specific soil response factors. The ground motions considered in these guidelines represent events with approximately a 2 percent probability of exceedance in 50 years, corresponding to a 2,500-year return period.

The ASCE 7-16 requires the characterization of soil profile types to determine the site class definition. Based on the dense nature of the Glacial Drift deposits and soil classifications obtained from site explorations, the site can be classified as Site Class D. The spectral response accelerations were determined using the ASCE Hazard Tool, based on the project's latitude and longitude. Table 3 below presents the seismic design parameters for the site in accordance with ASCE 7-16.

Table 3. Seismic Design Parameters

Site location	Latitude =	47.574826
	Longitude =	-122.209931
Recommended Site Class	D	
Seismic Design Code	ASCE 7-16	
Structural Analysis: Risk-targeted MCE (MCE_R)		
	Short-Period, S_S =	1.403 g

Mapped Spectral Response Acceleration Parameters (Site Class B)	1-second Period, S_1 =	0.488 g
Site Coefficients	Short-Period, F_a =	1.0
	Long-Period, F_v =	*null
Spectral Response Acceleration Parameters Adjusted for Site Class	$S_{MS} = F_a \times S_S$ =	1.403 g
	$S_{M1} = F_v \times S_1$ =	*null
Design Spectral Response Acceleration Parameters	$S_{DS} = 2/3 \times S_{MS}$ =	0.935 g
	$S_{D1} = 2/3 \times S_{M1}$ =	*null

*ASCE 7-16 Section 11.4.8

5.4 LIQUEFACTION POTENTIAL

Soil liquefaction results from loss of strength during cyclic loading, such as imposed by earthquakes. Soils most susceptible to liquefaction are clean, loose, saturated, uniformly graded sand below the groundwater table. Empirical evidence indicates that silts and low plasticity clays (fine-grained soils) are also potentially liquefiable, though this phenomenon is commonly referred to as cyclic softening. When seismic ground shaking occurs, the soil is subjected to cyclic shear stresses that can cause excess hydrostatic pressures to develop. If excess hydrostatic pressures exceed the effective confining stress from the overlying soil, the soil may undergo deformation. If the soil consolidates or vents to the surface during and following liquefaction, ground settlement and surface deformation may occur.

The subject site is underlain by very stiff to hard Glacial Drift deposits, with no groundwater observed during the site exploration program on January 20, 2025. MPE performed a liquefaction analysis using SETTLE3 software (refer to Section 4.0, Critical Areas Considerations, for additional details). Based on the observed site conditions, it is our professional opinion that the liquefaction potential at the site is relatively low, and no specific design considerations related to soil liquefaction are required for this project.

5.5 BUILDING FOUNDATIONS

Based on the subsurface conditions encountered at the site and our understanding of the planned development, it is our opinion that shallow conventional isolated or continuous footings may be employed across the site, provided they are established on the undisturbed native soil or on suitably compacted structural fill placed directly over these soils. The ensuing comments and recommendations are offered to guide the footing design and construction process.

Footing Depths and Widths

For frost and erosion protection, exterior footings should be embedded at least 18 inches below adjacent outside grade, whereas interior footings need extend only 12 inches below the surrounding slab surface level. For the purpose of reducing post-construction settlements, we recommend that continuous (wall) footings should have a minimum width of 18 inches, while isolated (column) footings should be at least 24 inches wide.

Bearing Pressures

We recommend that all footings bear on the undisturbed Glacial Drift or on properly compacted structural fill placed directly over these soils. Footings that bear on properly prepared native or structural fill subgrades can be designed for the following maximum allowable soil bearing pressures for static loadings:

Footing Subgrade	**Allowable Bearing Capacity**
	Static
Compacted Structural Fill over Undisturbed Glacial Drift Deposits	2,000 psf
Undisturbed Glacial Drift Deposits	2,500 psf

These static bearing pressures can be increased by one-third when used with alternative basic load combinations that include wind or earthquake loads. This recommendation is in accordance with the International Building Code (IBC) 2021, Section 1806.

Subgrade Verification

All footing subgrades should consist of firm, unyielding, non-organic, native soils or compacted structural fill materials. Under no circumstances should footings be cast atop loose, soft, or frozen soil, slough, debris, existing uncontrolled fill, or surfaces covered by standing water. We recommend that the condition of all subgrades be verified by a MPE geotechnical engineer before any fill or concrete is placed.

Footing Settlements:

We estimate that the total post-construction settlement of properly sized footings bearing on properly prepared subgrades will not exceed 1 inch. Differential settlements may approach one-half of the total settlement over horizontal distances on the order of 50 feet.

5.6 SLAB-ON-GRADE FLOORS

In our opinion, if subgrades are prepared as described in the Site Preparation section of this report, a soil-supported slab-on-grade floor may be used for the proposed residence. We offer the following comments and recommendations concerning slab-on-grade floors.

Subgrade Conditions and Verification

All soil-supported slab-on-grade floors should bear on firm, unyielding native soils or on suitable structural fill soils. We recommend that the condition of all subgrades and overlying layers be verified by a MPE geotechnical engineer prior to any fill or concrete is placed.

Floor Subbase

Structural fill subbases do not appear to be needed under soil-supported slab-on-grade floors at the site. However, the final decision regarding the need for subbases should be based on actual subgrade conditions observed at the time of construction.

Capillary Break

To retard the upward wicking of groundwater beneath the floor slab, we recommend that a capillary break be placed over the subgrade. Ideally, this capillary break would consist of a 4-inch-thick layer of pea gravel or other clean, uniform, gravel, such as “Gravel Backfill for Drains” per 2024 WSDOT Standard Specification 9-03.12(4).

Vapor Retarder

We recommend that a layer of plastic sheeting (such as Visqueen or Moistop) be placed directly between the capillary break and the floor slab to prevent ground moisture vapors from migrating upward through the slab. During subsequent casting of the concrete slab, the contractor should exercise care to avoid puncturing this vapor barrier.

5.7 DRAINAGE SYSTEMS

In our opinion, the proposed structure should be provided with permanent drainage systems to minimize the risk of future moisture problems. We offer the following recommendations and comments for drainage design and construction purposes.

Grading and Capping

Final site grades should slope downward away from the structure so that runoff water will flow by gravity to suitable collection points, rather than ponding near the structure. Ideally, the area surrounding the structure would be capped with concrete, asphalt, or low-permeability (silty) soils to reduce surface-water infiltration.

Perimeter Drains

We recommend that the structure be encircled with a perimeter drain system to collect seepage water. This drain should consist of a 4-inch diameter PVC perforated pipe within an envelope of pea gravel or washed rock, extending at least 6 inches on all sides of the pipe, and the gravel envelope should be wrapped with filter fabric to reduce the migration of fines from the surrounding soils. The perimeter drain should be located near the base of the footings.

Runoff Water

Roof-runoff and surface-runoff water should *not* be allowed to flow into the perimeter foundation drainage systems. Instead, these sources should flow into separate tightline pipes and be routed away from the structure to a storm drain or other appropriate location.

5.8 SITE UTILITIES

The following sections provide geotechnical recommendations for design and construction of new site utilities. Geotechnical recommendations include trench excavation and support, construction dewatering, pipe foundation support, pipe bedding, and trench backfill and compaction criteria. Please note, for any new utilities within public right-of-way, local standards will supersede the recommendations below.

Trench Excavation and Support

We anticipate excavations for underground utilities will primarily be within loose to medium dense fill/native soils. A heavy-duty, hydraulic excavator with sufficient reach should be able to excavate the proposed trenches to the expected depths. Upon reaching the trench bottom, we suggest that a smooth-bladed bucket be used to clean the bottom of loose and/or disturbed soil. The final trench bottom should be firm and free of loose and disturbed soil.

Trench configurations and maintenance of safe working conditions, including temporary excavation stability, should be the responsibility of the contractor. All applicable local, state, and federal safety codes should be followed. Temporary excavations for utilities should meet the requirements detailed in Section 5.2 of this report. If groundwater seepage is present, flatter slopes, temporary shoring, and/or dewatering may be required. Appropriately sized trench boxes should provide adequate support for shallow excavations, provided the trench is properly dewatered and settlement-sensitive structures and utilities are not situated immediately adjacent to the excavation. Trench boxes should meet the requirements in Safety Standards for Construction Work, Part N (WAC Chapter 296-155).

Construction Dewatering

We anticipate perched groundwater may be encountered within the trench zone, particularly during winter and spring. If perched, water-bearing zones are encountered, construction dewatering can be achieved following the procedures in Section 5.2 of this report.

Pipe Foundation Support

Based on the conditions observed in our explorations, dense soils are anticipated at the base of utility trenches. The soil will provide adequate foundation support for utilities, provided the foundation soil remains in a relatively undisturbed condition. If the bottom of the trench becomes disturbed due to excavation and/or foot traffic during the laying of the pipe, the disturbed material should be overexcavated to expose undisturbed foundation soil. The overexcavation should be backfilled with suitable foundation material to provide a firm trench bottom. Foundation material should be free of roots, topsoil, lumps of silt and clay, and organic and inorganic debris.

Pipe Bedding

Pipe zone bedding material should consist of crushed, processed, or naturally occurring granular material, free of organic matter and other deleterious material, and should meet the gradation requirements of Gravel Backfill for Pipe Zone Bedding per Section 9-03.12(3) of the 2024 WSDOT Standard Specifications.

Trench Backfill and Compaction

Trench backfill material should meet the material and compaction requirements as described in Section 5.9 of this report.

5.9 STRUCTURAL FILL

The term "structural fill" refers to any materials placed under foundations, slab-on-grade floors, sidewalks, pavements, and other structures. Our comments, conclusions, and recommendations concerning structural fill are presented in the following paragraphs.

Materials

Typical structural fill materials include gravel, crushed rock, quarry spalls, CDF, LMC, well-graded mixtures of sand and gravel (commonly called "gravel borrow" or "pit-run"), and miscellaneous mixtures of silt, sand, and gravel. Soils used for structural fill should not contain any organic matter or debris, or any individual particles greater than approximately 6 inches in diameter.

Fill Placement

Generally, quarry spalls, CDF, and LMC do not require special placement and compaction procedures. In contrast, gravel, crushed rock, soil mixtures, and recycled materials should be placed in horizontal lifts not exceeding 8 inches in loose thickness, and each lift should be thoroughly compacted with a mechanical vibratory compactor.

Compaction Criteria

Using the Modified Proctor test (ASTM D1557) as a standard, we recommend structural fill be used for various on-site applications and compacted to the following minimum densities:

Fill Application	**Minimum Compaction**
Footing subgrade and bearing pad	95 percent
Footing and stemwall backfill	90 percent
Slab-on-grade floor subgrade	95 percent
Concrete sidewalk subgrade	90 percent
Utility trench backfill (below 4 feet)	90 percent
Utility trench backfill (above 4 feet)	95 percent
Utility trench backfill (under building footings or structures)	95 percent

Subgrade Verification and Compaction Testing

Regardless of material or location, all structural fill should be placed over firm, unyielding subgrades prepared in accordance with the Site Preparation section of this report. The condition of all subgrades should be verified by a MPE representative before filling or construction begins. In addition, fill soil compaction should be verified by means of in-place density tests performed during fill placement so adequacy of the soil compaction efforts may be evaluated as earthwork progresses.

Soil Moisture Considerations

The suitability of soils used for structural fill depends primarily on their grain-size distribution and moisture content when they are placed. As the "fines" content (the soil fraction passing the U.S. No. 200 Sieve) increases, soils become more sensitive to small changes in moisture content. Soils containing more than about 5 percent fines (by weight) cannot be consistently compacted to a firm, unyielding condition when the moisture content is more than 2 percentage points above or below optimum. For fill placement during wet-weather site work, we recommend using "clean" fill, which refers to soils that have a fines content of 5 percent or less (by weight) based on the soil fraction passing the U.S. No. 4 Sieve.

CDF Strength Considerations

Controlled Density Fill (CDF) is normally specified in terms of its compressive strength, which typically ranges from 50 to 200 pounds per square inch (psi). CDF having a strength of 50 psi (7,200 psf) provides adequate support for most structural applications and can be readily excavated with hand shovels. A strength of 100 psi (14,400 psf) provides additional support for special applications but greatly increases the difficulty of hand-excavation. In general, CDF having a strength greater than about 100 psi requires power equipment to excavate and should not be used where future hand-excavation might be needed.

6.0 ADDITIONAL SERVICES

MPE should be retained to review the final design plans and specifications so comments can be made regarding interpretation and implementation of our geotechnical recommendations in the design and specifications. MPE also should be retained to provide monitoring services during site preparations and grading, and other earth-related construction phases of the project.

7.0 CLOSURE

This report has been prepared for the exclusive use of Russell Palanchuck and their consultants for specific application to this project, in accordance with generally accepted geotechnical engineering practices. No warranties, either expressed or implied, are intended or made. Site safety, excavation support, and dewatering requirements are the responsibility of others. In the event that changes in the nature, design, or location of the project as outlined in this report are planned, the conclusions and recommendations contained in this report shall not be considered valid unless MPE reviews the changes and either verifies or modifies the conclusions of this report in writing.

The recommendations presented herein have been developed on the basis of the subsurface conditions encountered during the field investigation and our understanding of the proposed construction. Should changes in the project criteria occur or additional loading information becomes available, a review must be made by MPE to determine if modifications to our recommendations will be required.

The analysis and recommendations presented in this report are based upon the data obtained from the test pits performed at the indicated locations and from other information discussed in this report. This report does not reflect variations that may occur between borings, across the site, or due to the modifying effects of construction or weather. The nature and extent of such variations may not become evident until during or after construction. If variations appear, we should be immediately notified so that further evaluation and supplemental recommendations can be provided. We are available to provide geotechnical engineering throughout the design process, and construction and quality assurance monitoring during construction.

It is the client's responsibility to see that all parties to this project, including the designer, contractor, subcontractors, etc., are made aware of this report in its entirety. The use of information contained in this report for bidding purposes should be done at the contractor's option and risk. Any party other than the client who wishes to use this report shall notify MPE of such intended use and for permission to copy this report. Based on the intended use of the report, MPE may require that additional work be performed and that an updated report be reissued. Noncompliance with any of these requirements will release MPE from any liability resulting from the use this report.

Sincerely,

MP Engineering, PLLC

MINJAE PARK
STATE OF WASHINGTON
52161
REGISTERED
PROFESSIONAL ENGINEER

Date: 1-28-2025

Minjae Park, P.E.
Principal Geotechnical Engineer

JINTAE LEE
STATE OF WASHINGTON
51939
REGISTERED
PROFESSIONAL ENGINEER

Date: 1-28-2025

Jintae Lee, Ph.D., P.E.
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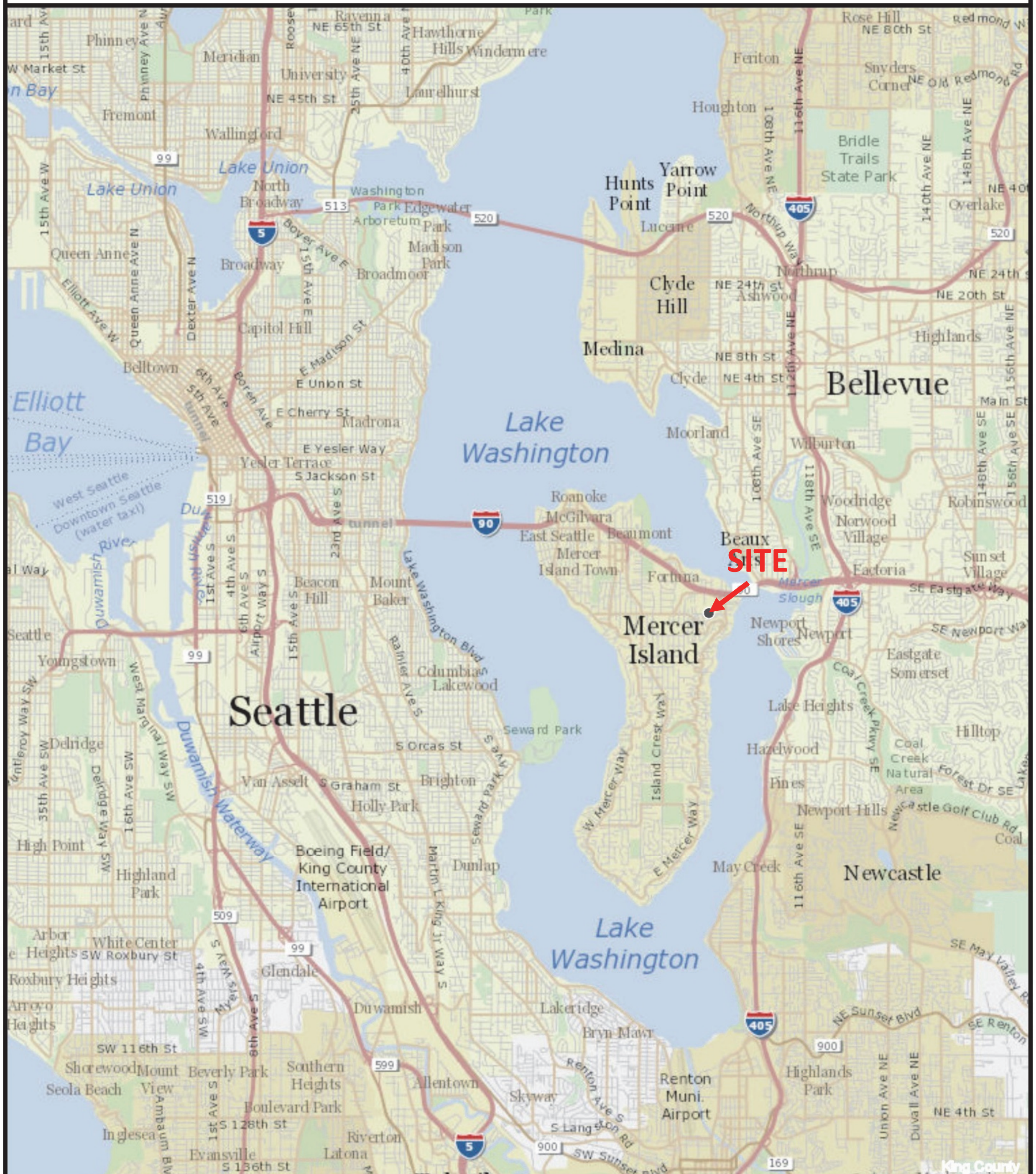
9734 SE 40th St, Mercer Island, WA 98040



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Date: 11/9/2024 Notes:

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King County

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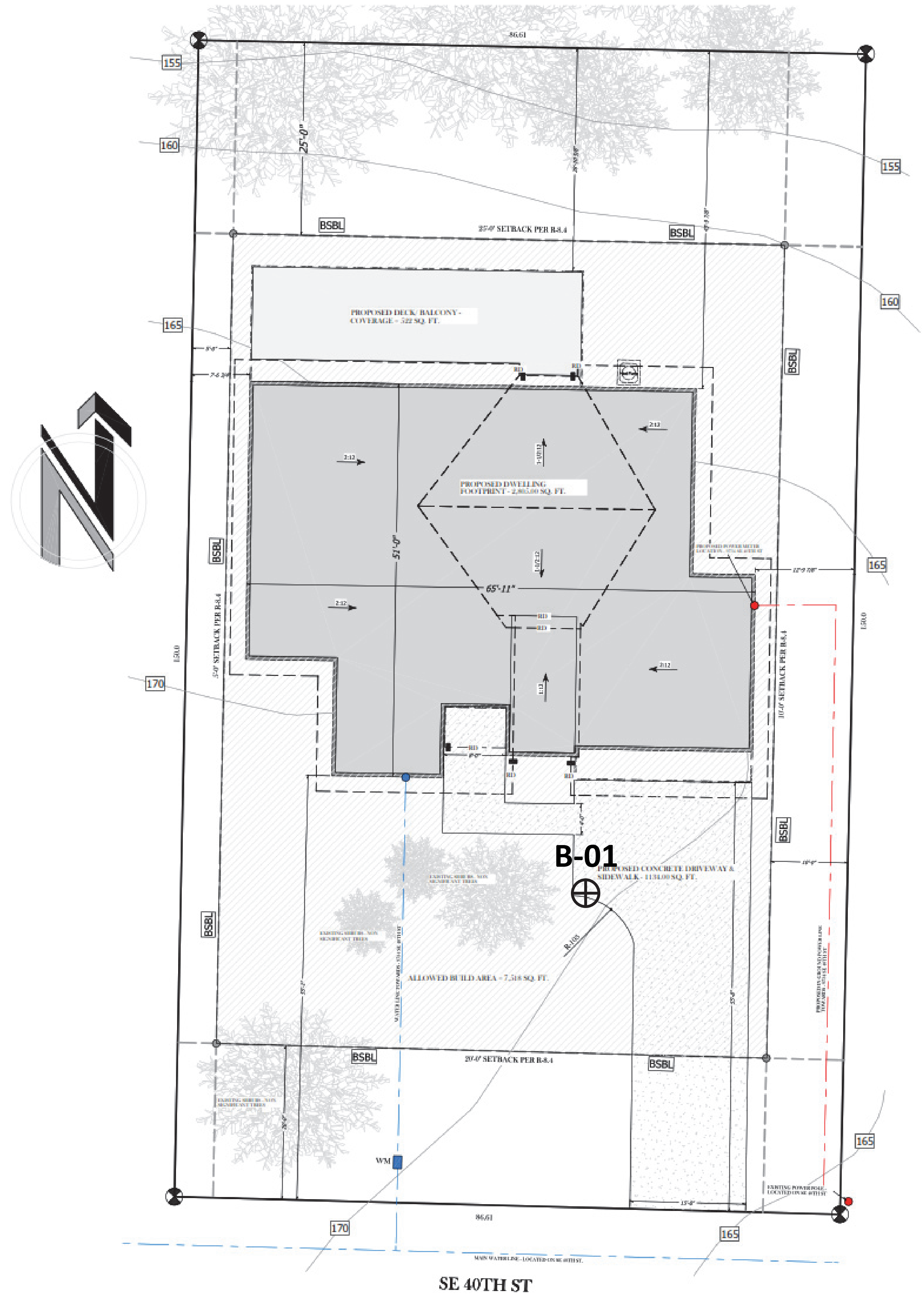
9734 SE 40TH STREET
MERCER ISLAND, WA 98040

VICINITY MAP

PROJECT NO.	FIGURE NO.
24-0145	**1**



Approximate Proposed Boring Location B-01 ⊕

MP ENGINEERING	**9734 MERCER ISLAND** 9734 SE 40TH STREET MERCER ISLAND, WA 98040	**SITE AND EXPLORATION PLAN** PROJECT NO. 24-0145 FIGURE NO. 2

APPENDIX A

FIELD EXPLORATION PROCEDURES AND LOGS

APPENDIX A
FIELD EXPLORATION PROCEDURES AND LOGS
PROJECT NO. 24-0145

The following paragraphs describe the procedures used for field explorations and field tests that MPE conducted for this project. Descriptive logs of our explorations are enclosed in this appendix.

AUGER BORING PROCEDURES

Our exploratory borings were advanced with a hollow-stem auger, using a truck-mounted drill rig operated by an independent drilling firm working under subcontract to MPE. A geotechnical engineer from MPE continuously observed the borings, logged the subsurface conditions, and collected representative soil samples. All samples were stored in watertight containers and later transported to our laboratory for further visual examination and testing. After each boring was completed, the borehole was backfilled with a mixture of bentonite chips and soil cuttings, and the surface was patched with concrete.

Throughout the drilling operation, soil samples were obtained at 2.5- or 5-foot depth intervals by means of the Standard Penetration Test (SPT) per American Society for Testing and Materials (ASTM) D-1586. This testing and sampling procedure consists of driving a standard 2-inch diameter steel split-spoon sampler 18 inches into the soil with a 140-pound hammer free-falling 30 inches. The number of blows required to drive the sampler through each 6-inch interval is counted, and the total number of blows struck during the final 12 inches is recorded as the Standard Penetration Resistance, or "SPT blow count." If a total of 50 blows are struck within any 6-inch interval, the driving is stopped and the blow count is recorded as 50 blows for the actual penetration distance. The resulting Standard Penetration Resistance values indicate the relative density of granular soils and the relative consistency of cohesive soils.

The enclosed Boring Log describe the vertical sequence of soils and materials encountered in each boring, based primarily on our field classifications and supported by our subsequent laboratory examination and testing. Where a soil contact was observed to be gradational, our logs indicate the average contact depth. Where a soil type changed between sample intervals, we inferred the contact depth. Our logs also graphically indicate the blow count, sample type, sample number, and approximate depth of each soil sample obtained from the borings, as well as any laboratory tests performed on these soil samples. If any groundwater was encountered in a borehole, the approximate groundwater depth is depicted on the boring log. Groundwater depth estimates are typically based on the moisture content of soil samples, the wetted height on the drilling rods, and the water level measured in the borehole after the auger has been extracted.

PROJECT: *9734 MERCER ISLAND* JOB No. *24-0145* BORING No. *B-01*

Page 1 of 1

Location: 47.574709, -122.209902
Approximate ground surface elevation: 170.0 feet

DEPTH (feet)	Soil Description	USCS/USGS GRAPHICS	SAMPLE TYPE	SAMPLE NUMBER	GROUND WATER	PENETRATION RESISTANCE (Blows per foot)	TESTING
0	2-inches of sod over medium stiff, moist, light brown, sandy SILT with trace gravel and scattered organics (FILL)				N/E		
2.5	Stiff, moist, brown, sandy SILT with some gravel (ML)		Split-spoon	S-1		12	
5	Very stiff, moist, brown, sandy SILT with some gravel (ML)		Split-spoon	S-2		24	3.8 (Atterberg PI)
7.5	Hard, moist, brown, sandy SILT with some gravel (ML)		Split-spoon	S-3		41	
10	Hard, moist, brown to dark gray, sandy SILT with some gravel (ML)		Split-spoon	S-4		59	5.6 (Atterberg PI)
12.5	Very dense, moist, dark gray, silty SAND with some gravel (SM) — Hard Drilling		Split-spoon	S-5		50/6"	23 (% fines)
15	Boring terminated at approximately 15 feet						

PENETRATION RESISTANCE: ▲ Standard; #/# Blows over inches; △ Other. Scale: 0, 10, 20, 30, 40, 50 (Blows per foot)

MOISTURE CONTENT: 0, 20, 40, 60, 80, 100 — Plastic Limit, Liquid Limit

LEGEND

- 2.00-inch OD split-spoon sampler
- N/E No groundwater encountered
- Atterberg Test (PI shown)
- Grain Size Analysis (% fines shown)

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Drilling Method: HSA	Hammer Type: Automatic	Date drilled: *January 20, 2025*	Logged By: *JTL*
			Drilled by: *CN DRILLING*

APPENDIX B

LABORATORY TESTING PROCEDURES AND RESULTS

APPENDIX B
LABORATORY TESTING PROCEDURES AND RESULTS
PROJECT NO. 24-0145

The following paragraphs describe procedures associated with the laboratory tests conducted for this project. Graphical results of certain laboratory tests are enclosed in this appendix.

VISUAL CLASSIFICATION PROCEDURES

Visual soil classifications were conducted on all samples in the field and on selected samples in the laboratory. All soils were classified in general accordance with the Unified Soil Classification System, which includes color, relative moisture content, primary soil type (based on grain size), and any accessory soil types. The resulting soil classifications are presented on the exploration logs contained in Appendix A.

MOISTURE CONTENT DETERMINATION PROCEDURES

Moisture content determinations were performed on representative samples to aid in identification and correlation of soil types. All determinations were made in general accordance with ASTM D-2216. The results of these tests are shown on the exploration logs in Appendix A.

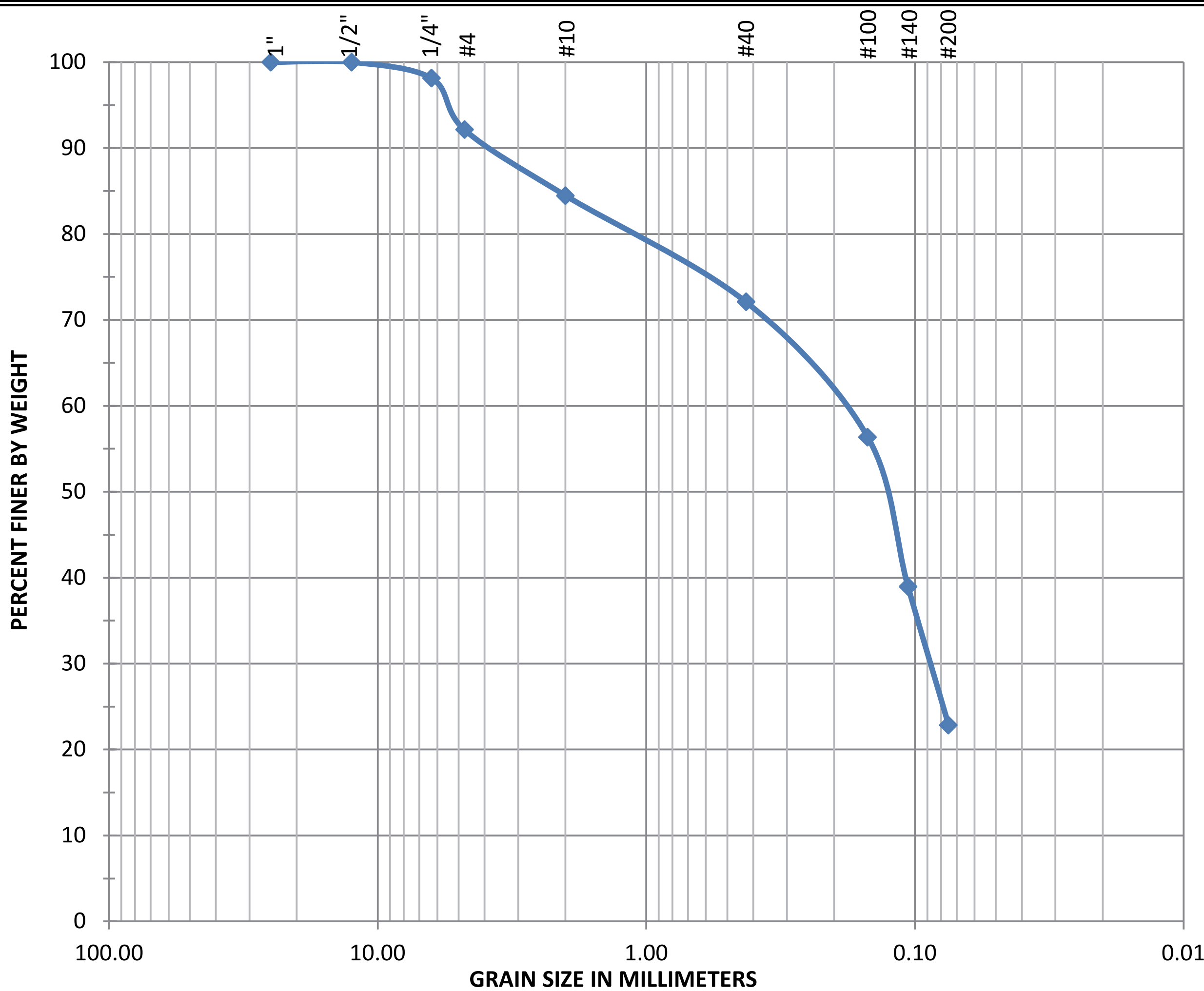
GRAIN-SIZE ANALYSIS PROCEDURES

A grain-size analysis indicates the range of soil particle diameters included in a particular sample. Grain-size analyses were performed on representative samples in general accordance with ASTM D-422. The results of these tests are presented on the enclosed grain-size distribution graphs and were used in soil classifications shown on the exploration logs in Appendix A.

ATTERBERG LIMITS

Atterberg limits test was completed on a representative sample at B-01. The test was used to classify the soil as well as to aid in evaluating index properties and consolidation characteristics of the fine-grained soil deposits. The liquid limit and the plastic limit were obtained in general accordance with ASTM D 4318. The results of the Atterberg limits are presented on the enclosed Atterberg Limit graph and on the exploration logs contained in Appendix A.

MP Engineering Sieve Analysis



% +3"	% GRAVEL	% SAND			% FINES
		coarse	medium	fine	(Silt or Clay)
0	7.9	7.7	12.4	49.3	22.8

Sieve Size	Percent Finer
1.25"	100.0
1"	100.0
1/2"	100.0
1/4"	98.1
#4	92.1
#10	84.5
#40	72.1
#100	56.4
#140	39.0
#200	22.8

Sample Name: B-01 / S-5
Sample Description: Silty SAND
Depth: 12.5' - 15.0'
Test Date: January 5, 2025
USCS (D-2487): SM
Natural Moisture Content: 12.5% ASTM D-2216

D_{60}: 0.17mm
D_{30}: 0.09mm
D_{10}:

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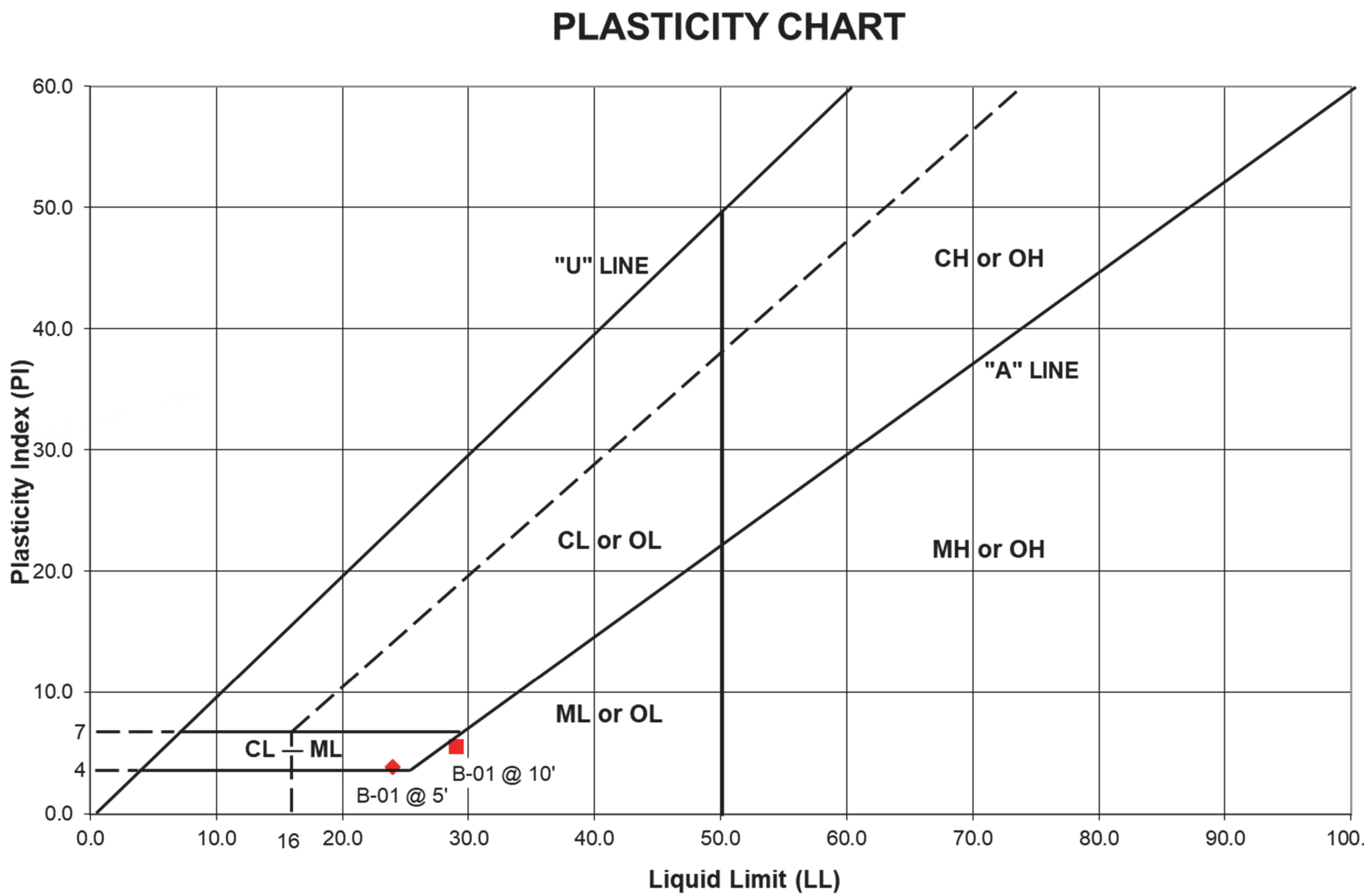
PROJECT #24-0145



Symbol	Test Pit Number	Depth (feet)	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	Soil Description
◆	B-01	5	24.0	20.2	3.8	Very stiff, moist, brown, sandy SILT with some gravel (ML)
■	B-01	10	29.0	23.4	5.6	Hard, moist, brown to dark gray, sandy SILT with some gravel (ML)

Note: Test results are applicable only to the specific sample on which they were performed and should not be interpreted as representative of any other samples obtained at other times, depths or locations, or generated by separate operations or processes.
The liquid limit and plasticity index were obtained in general accordance with ASTM D 4318.

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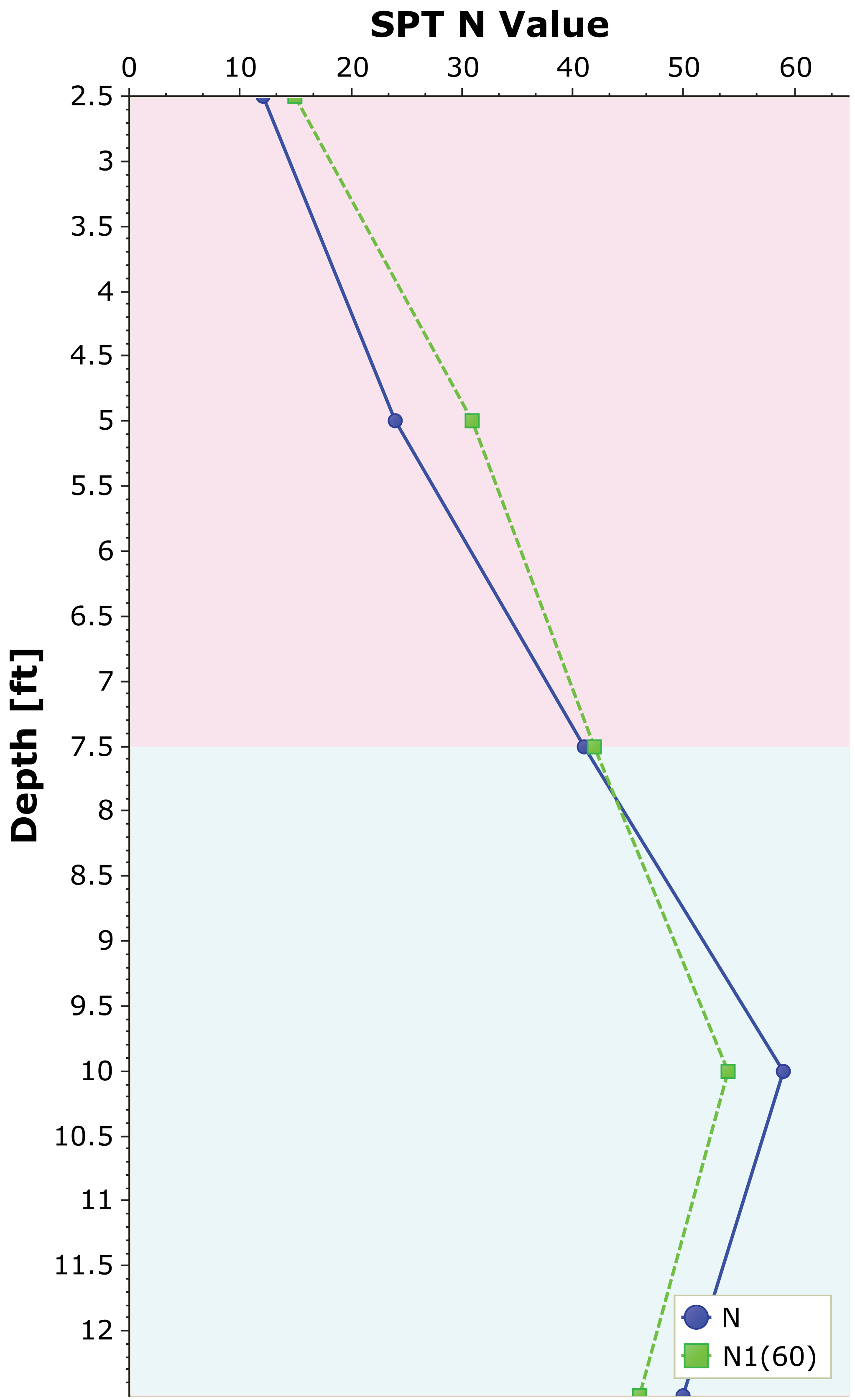
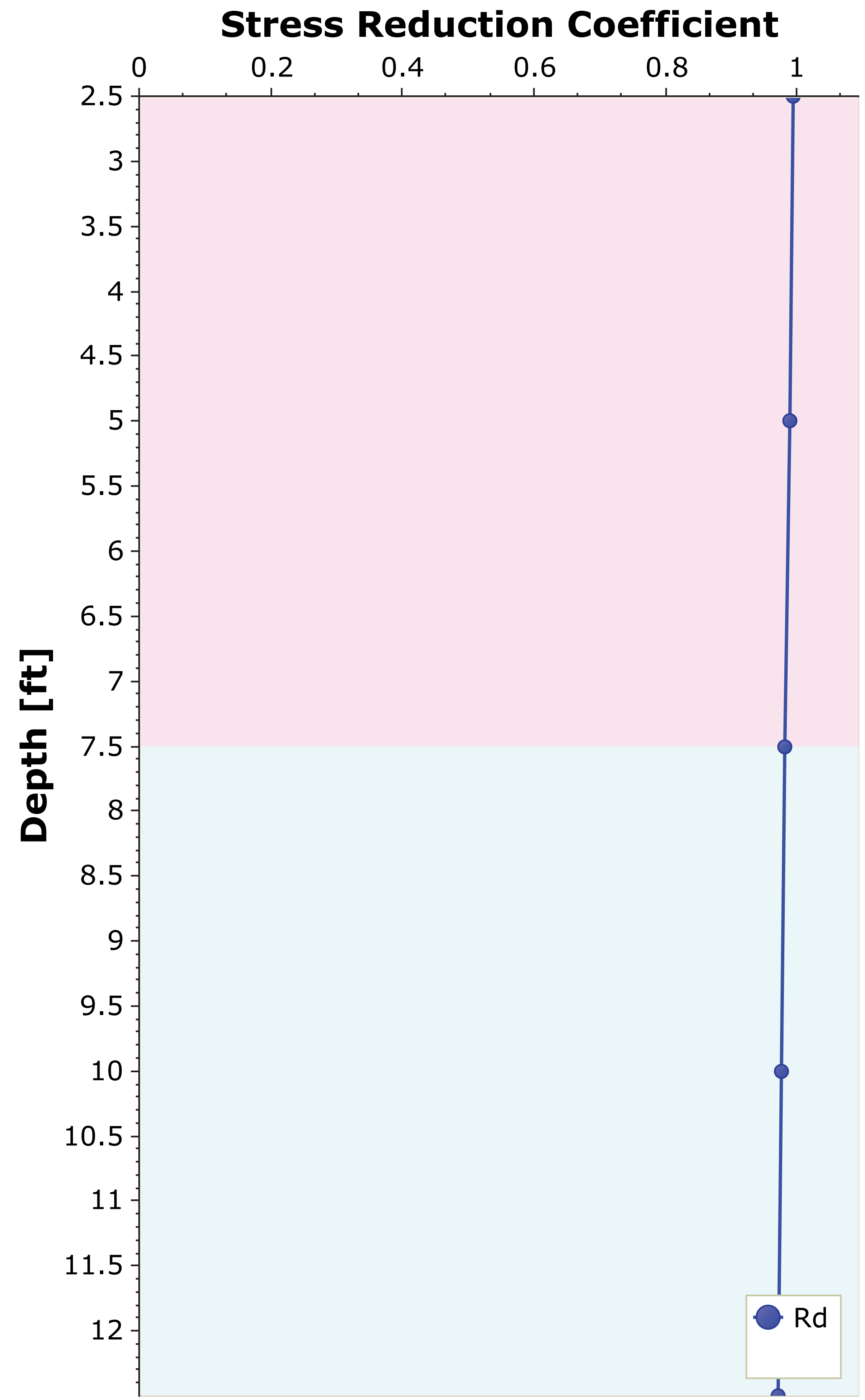
Atterberg Limits Test Results

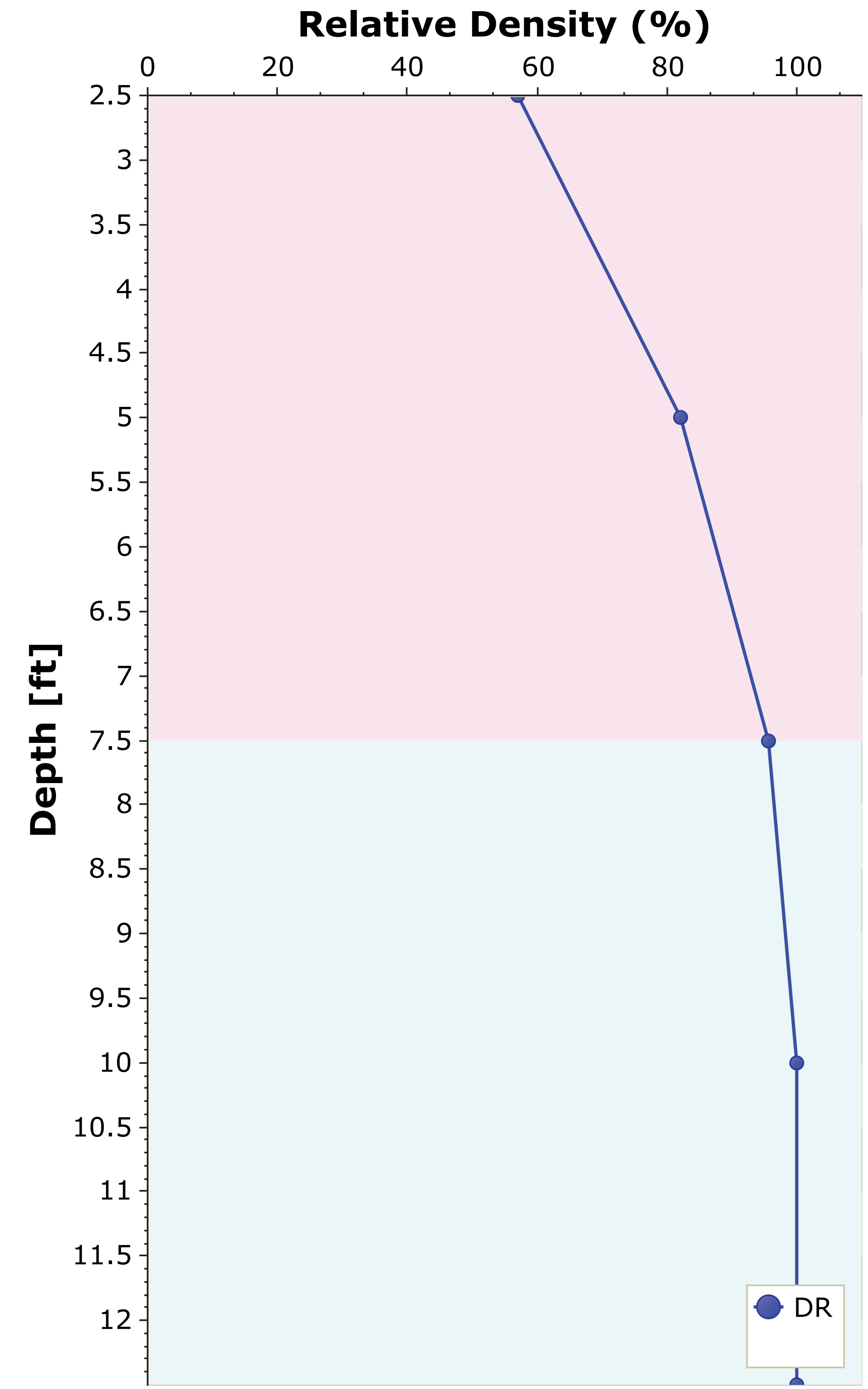
PROJECT NO.
24-0145

APPENDIX C

SETTLE3 LIQUEFACTION ANALYSIS



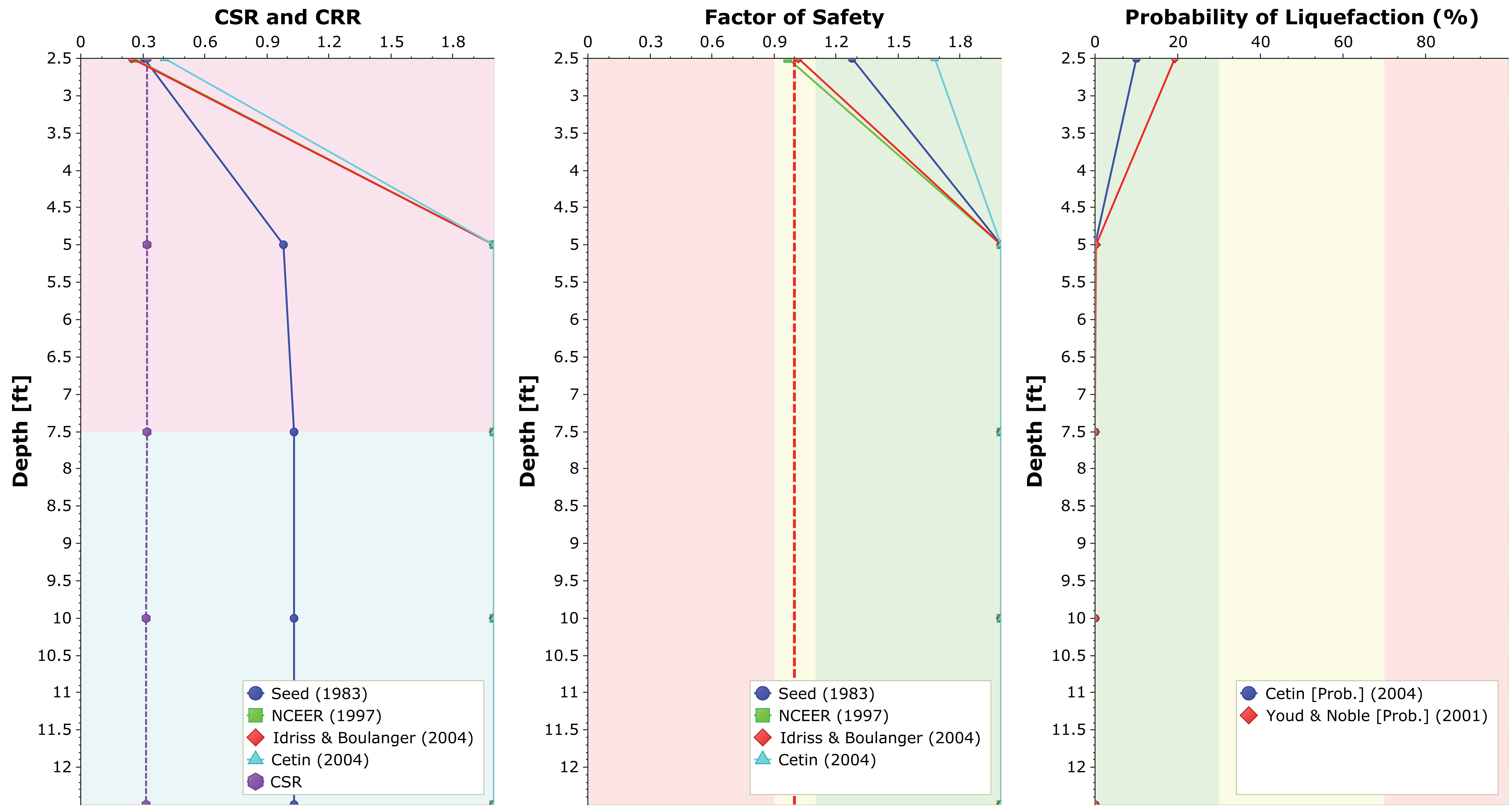




rocscience

SETTLE3 5.015

Project 9734 Mercer Island	
Analysis Description Liquefaction Analysis	
Drawn By	*Company* MP ENGINEERING
Date 01/27/2025	*File Name* Liquefaction Analysis 9734 Mercer Island.s3z



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SETTLE3 5.015

Project	9734 Mercer Island
Analysis Description	Liquefaction Analysis
Drawn By	
Company	MP ENGINEERING
Date	01/27/2025
File Name	Liquefaction Analysis 9734 Mercer Island.s3z