PanGEO INCORPORATED
Geotechnical & Earthquake Engineering Consultants

September 7, 2021
File No. 21-004

Elizabeth Huber
C/O Brandt Architects
Attn: Kate Miller
18915 142nd Avenue NE #140
Woodinville, WA 98072

Subject: **Geotechnical Engineering Study - revised**
Proposed New Residence
9611 SE 72nd Street
Mercer Island, Washington

Dear Ms. Huber,

As requested, PanGEO, Inc. has completed a geotechnical engineering study to assist you and the design team with the design and construction of the proposed new residence at the above address. This study was performed in general accordance with our mutually agreed scope of work outlined in our proposal dated January 4, 2021, which was approved by you on January 9. Our service scope included reviewing readily available geologic and geotechnical data in the project vicinity, reviewing preliminary design drawings, conducting a site reconnaissance, drilling test borings, and developing the conclusions and recommendations presented in our initial report. However, revised site plans suggested that further site exploration was warranted. Consequently we drilled one additional boring on the property and our findings are summarized in this revised report.

SITE AND PROJECT DESCRIPTION

The property is located on the southeast side of Mercer Island on a southeasterly facing slope overlooking Lake Washington (see Figure 1). The 15,333 square foot parcel is an irregularly shaped lot (see Figure 2) bounded by SE 72nd Street on the west, by Lake Washington on the east, and by single family residences on the south and north. The lot slopes down from west to east with an average gradient of about 40 percent (see Plate 1), with a more gently sloped lawn area between the house and the lake (see Plate 2). The site is currently occupied with a 2-story house with a daylight basement. We understand that you plan to demolish the existing house and build a new residence on the site.

Based on the July 21, 2021, plan set, the new residence will be located approximately on the footprint of the existing house, but extending further down slope (see Figure 2). The expansion of the garage area from two to three cars means the house will extend further uphill as well. Presently, we anticipate that excavation cuts of up to 10 to 12 feet deep may be required along

Plate 1. View of the project house from above, looking south.

Plate 2. House from the water, looking west.

the west side of the basement and upslope of the expanded garage and up to 12 feet for sections of the planned driveway retaining wall. It may be that the foundation wall of the existing house may provide shoring for the basement area, depending on the final configuration of the new house, but the garage excavation will be a new open cut.

The conclusions and recommendations in this report are based on our understanding of the proposed development, which is in turn based on the provided project information. If the above project description is incorrect, or the project information changes, we should be consulted to review the recommendations contained in this study and make modifications, if needed.

SITE GEOLOGY AND SUBSURFACE CONDITIONS

SITE GEOLOGY

Based on the Geologic Map of Mercer Island (Troost and Wisher, 2006), much of the southeastern side of Mercer Island is mapped as mantled with mass wasting debris from landslide complexes. The project site is located at the northern limit of this area. Mass wasting deposits are described as loose to dense or soft to stiff, colluvium, landslide debris and soil with indistinct morphology. Mass wasting deposits, being disturbed, may be very variable in terms of strength and compressibility. Locally, organic material may be found in the soil.

The predominant near surface, undisturbed soil is mapped as pre-Olympia, non-glacial material. In the project area, the undisturbed geologic unit in the project area below East Mercer Way is mapped as coarse-grained, non-glacial strata (Qponc). Closer to the shoreline, pre-Olympia non-glacial fine-grained beds (Qponf) are mapped. The coarse-grained material is described by Troost, et al. as a very dense soil composed of sand and gravel, sometimes with silt and silt and peat interbeds. The pre-Olympia fine-grained material is described as hard silt and clay, with sand and peat layers, usually oxidized to some degree. Pre-Olympia strata typically exhibit low compressibility and high strength characteristics in an undisturbed state.

SUBSURFACE EXPLORATIONS

Two initial borings were drilled at the site using a hand portable Acker drill equipped with 4-inch diameter, hollow stem augers provided by CN Drilling. The borings were completed on January 27, 2021, and the locations of the borings are shown on Figure 2. Soil samples were obtained from the boring at 2½-foot intervals in general accordance with Standard Penetration Test (SPT) sampling methods (ASTM test method D-1586) in which the samples are obtained using a 2-inch outside diameter split-spoon sampler. The sampler was driven 18” into the soil using a 140-pound weight falling a distance of 30 inches. Following completion of the drilling, boring was backfilled with bentonite chips and drill cuttings.

On August 17, 2021, an additional boring was drilled up slope of the house, to explore soil conditions in the area of the planned garage cut. This boring was drilled to a depth of 21.5 feet below surface

An engineering geologist from our office was present throughout the field exploration program to observe the drilling, assist in sampling, and to document the soil samples obtained from the borings. The soils were described in the field in general accordance with ASTM D 2488-00, following the guidelines of the Unified Soil Classification System, as shown on Figure 3, Terms and Symbols for Boring and Test Pit Logs. Summary logs from the borings are presented in Figures 4 and 5.

SUBSURFACE SOIL AND GROUNDWATER CONDITIONS

The soils observed in the borings were nominally consistent with the mapped and expected geology, with mass wasting deposits at surface followed by fine grained soil at depth. However, based on the textures of the fine grained samples, in our opinion, these deposits are glacial in origin, not non-glacial (see Plate 3). The following is a description of the soils encountered in the borings. Please refer to the summary boring logs (Figures 4 and 5) for a detailed description of the subsurface conditions:

> ***Fill:*** The uppermost layer consisted of loose, brown, silty, fine to medium sand with a trace of gravel and organics. This unit is interpreted as landscaping fill and is roughly 2 feet thick.
>
> ***Mass Wasting Deposit:*** The mass wasting deposit consisted mainly of stiff clayey silt to loose silt with sand. The material was low to medium plastic, with a generally broken or disrupted texture, and angular gray clay clasts. In PG-3 the soil consists of rusty brown, weathered sand with fine gravel and silt and some layering. The unit is interpreted to be mass wasting debris and is about 3 feet thick in both borings. This unit extended to a depth of 5 feet in PG-1 and PG-2, and to 7 feet in PG-3.
>
> ***Pre-Olympia Coarse Grained Deposits:*** The additional boring PG-3 encountered medium dense, brown gray to gray, fine to medium sand with silt below a depth of 7 feet (see Plate 3). The unit was non-plastic, indistinctly laminated, and extended to 10.5 feet below surface.

Glaciolacustrine Fine-Grained Deposits: Below the mass wasting deposits in PG-1 and PG-2 the borings encountered very stiff to hard, silty, lean clay, with low to medium plasticity. The soil was massive to laminated at the top, with occasional light gray lens or parting. This unit was penetrated at 10.5 feet below ground surface in PG-3. We interpret this unit as a Pre-Olympia Fine Grained Deposit, based on the sample textures and structures (see Plate 4). Based on the textures, the unit appears to have been deposited in a glaciolacustrine environment.

Plate 3. SPT sample of pre-Olympia Coarse Grained Deposit, PG-3, S-4, 7.5'.

Plate 4. SPT sample of silty, lean clay, showing glacial structures and light gray lenses, PG-1, S-4, 10'.

Groundwater was not observed in the borings PG-1 and PG-2. We observed number of seeps and springs on the slope above the house, which lead to the drilling of PG-3. PG-3 encountered groundwater in significant quantity at approximately 5 feet below ground surface, on the mass wasting deposit. There is a 6-foot thick layer of saturated sand above the pre-Olympia Fine Grained beds.

We understand there is a groundwater drainage and collection system installed on the slope between the current house and SE 72nd Street. A clear-up for the drainage system was observed just upslope of PG-3, marked by a reflector on a metal rod. The collection system outfall pipe is conducted down the slope to the lake in the vicinity of the existing house. The owner reports that they have not had any evidence of dampness in the crawl space of the existing house. Based on the results of PG-3, the groundwater flows observed at the surface are from a perched water table located along the contact between the fine grained unit on which the house sits and an overlying coarse grained soil.

GEOTECHNICAL DESIGN RECOMMENDATIONS

SEISMIC DESIGN PARAMETERS

Seismic design parameters for the site should conform with the 2018 edition of the International Building Code (IBC), which specifies a design earthquake having a 2% probability of occurrence in 50 years (return interval of 2,475 years), and the 2008 USGS seismic hazard maps. We recommend that seismic design assume a Site Class D for design.

BUILDING FOUNDATIONS

Based on the subsurface conditions encountered at the site and our understanding of the proposed design, it is our opinion that the proposed residence may be supported on conventional spread and continuous footings bearing on undisturbed, stiff to hard native soil and/or on compacted structural fill placed on undisturbed native soil. We recommend that in areas where mass wasting deposits underlay the planned footing grade, the mass wasting soil be over excavated to expose the very stiff to hard, silty, lean clay. Any over-excavation may be brought back to grade with compacted structural fill or lean-mix concrete/Control Density Fill (CDF).

Soil Bearing Pressure

We recommend that an allowable soil bearing pressure of 3,000 pounds per square feet (psf) be used for sizing the footings. The recommended allowable bearing pressure is for dead plus live loads. For allowable stress design, the recommended bearing pressure may be increased by one-third for transient loading, such as wind or seismic forces. Continuous and individual spread footings should have minimum widths of 18 and 24 inches, respectively. Exterior foundation elements should be placed at a minimum depth of 18 inches below final exterior grade. Interior spread foundations should be placed at a minimum depth of 12 inches below the top of slab.

Foundation Performance

Footings designed and constructed in accordance with the above recommendations should experience total settlement of less than one inch and differential settlement of less than ½ inch. Most of the anticipated settlement should occur during construction as dead loads are applied.

Lateral Resistance

Lateral loads on the structures may be resisted by passive earth pressure developed against the embedded faces of the foundation system and by frictional resistance between the bottom of the foundation and the supporting subgrade soils. For footings bearing on the compacted native soil or compacted structural fill, a frictional coefficient of 0.5 may be used to evaluate sliding resistance developed between the concrete and the compacted subgrade soil. Passive soil resistance may be calculated using an equivalent fluid weight of 300 pcf, assuming properly compacted structural fill will be placed against the footings. The above values include a factor of safety of 1.5. Unless covered by pavements or slabs, the passive resistance in the upper 12 inches of soil should be neglected.

Perimeter Footing Drains

Footing drains should be installed around the perimeter of the house, at or just below the invert of the footings. Footing drains are especially important above the garage wall, where groundwater seepage can be expected. Under no circumstances should roof downspout drain lines be connected to the footing drain systems. Roof downspouts must be separately tightlined to appropriate discharge locations. Cleanouts should be installed at strategic locations to allow for periodic maintenance of the footing drain and downspout tightline systems.

Footing Excavation and Subgrade Preparation

All footing excavations should be carefully prepared. Any loose or softened soil should be removed from the footing subgrade prior to concrete placement. Any footing subgrade over-excavations, if required, should be backfilled with lean-mix concrete/Control Density Fill (CDF) or compacted structural fill. Care should be taken to prevent water entry into the footing excavation, as moisture may soften the clayey subgrade soils. Footing excavations should be observed by PanGEO to confirm that the exposed footing subgrade is consistent with the expected conditions and adequate to support the design bearing pressure.

CONCRETE SLABS

Concrete slab-on-grade floors are appropriate for this project. Concrete slab-on-grade floors may be constructed over the native, undisturbed very stiff to hard silty clay, or on compacted structural fill placed on undisturbed native soil. If loose/soft soils are encountered at the slab subgrade elevation that cannot be adequately compacted, the loose or soft soil should be over-excavated to competent native soil and replaced with compacted structural fill.

Slab-on-grade floors should be underlain by a capillary break consisting of at least of 4 inches of ¾-inch, clean crushed rock (less than 3 percent fines) compacted to a firm and unyielding condition. The capillary break should be placed on subgrade that has been compacted to a dense and unyielding condition. The capillary break should be placed on a suitable subgrade as confirmed by PanGEO. A 10-mil polyethylene vapor barrier should also be placed directly below the slab. We also recommend that control joints be incorporated into the floor slab to control cracking.

CONCRETE RETAINING AND BASEMENT WALL DESIGN PARAMETERS

Retaining and basement walls should be properly designed to resist the lateral earth pressures exerted by the soils behind the wall. Proper drainage provisions should also be provided behind the walls to intercept and remove groundwater that may be present behind the wall. Our geotechnical recommendations for the design and construction of the retaining/below-grade walls are presented below.

Lateral Earth Pressures

Concrete cantilever walls should be designed for an active pressure of 35 pcf for level backfills behind the walls assuming the walls are free to rotate or for an equivalent fluid weight of 50 pcf for rigid or unyielding walls. Cantilever walls with a 1(H):1(V) backslope should be designed for an active equivalent fluid weight of 45 pcf. Permanent walls should be designed for an additional uniform lateral pressure of 6H psf for seismic loading, where H corresponds to the buried depth of the wall. These recommendations assume that the wall backfill will consist of a free draining and properly compacted fill with adequate drainage provisions.

Surcharge

Surcharge loads, where present, should also be included in the design of retaining walls. We recommend that a lateral load coefficient of 0.3 be used to compute the lateral pressure on the wall face resulting from surcharge loads located within a horizontal distance of one-half wall height.

Lateral Resistance

Lateral forces from seismic loading and unbalanced lateral earth pressures may be resisted by a combination of passive earth pressures acting against the embedded portions of the foundations and by friction acting on the base of the foundations. Passive resistance values may be determined using an equivalent fluid weight of 300 pcf. This value includes a factor of safety of 1.5, assuming the footing is poured against dense native sand, re-compacted on-site sandy soil or properly compacted structural fill adjacent to the sides of footing. A friction coefficient of 0.5 may be used to determine the frictional resistance at the base of the footings. The coefficient includes a factor safety of 1.5.

Wall Drainage

Provisions for wall drainage should consist of a 4-inch diameter perforated drainpipe behind and at the base of the wall footings, embedded in 12 to 18 inches of clean crushed rock or pea gravel wrapped with a layer of filter fabric. We recommend a composite drainage material, such as Miradrain 6000, be used for drainage on exterior walls. The drainpipe at the base of the wall should be graded to direct water to a suitable outlet.

Wall Backfill

In our opinion, imported structural fill should be used for wall backfill, and should consist of granular material, such as WSDOT Gravel Borrow or approved equivalent. In areas where the space is limited between the wall and the face of excavation, pea gravel or clean crushed rock may be used as backfill without compaction.

Wall backfill should be moisture conditioned to within about 3 percent of optimum moisture content, placed in loose, horizontal lifts less than 8 inches in thickness, and systematically compacted to a dense and relatively unyielding condition and to at least 95 percent of the maximum dry density, as determined using test method ASTM D 1557. Within 5 feet of the wall, the backfill should be compacted with hand-operated equipment to at least 90 percent of the maximum dry density.

PERMANENT AND TEMPORARY SOLDIER PILE WALLS

We understand that permanent soldier pile walls will be required to support the existing driveway (see Figure 2 for approximate pile locations) and that the deep portion of the basement excavation may require construction shoring to support the neighboring property to the north. Because of the groundwater and erodible sand on the slope to the west of the house, we recommend that the driveway wall be extended to support the west side of the garage excavation.

A soldier pile wall consists of vertical steel beams, typically spaced from 6 to 8 feet apart along the proposed excavation wall, with timber lagging spanning between the flanges of the soldier piles to provide lateral restraint to the exposed soil. Prior to the start of excavation, the steel beams are installed into holes drilled to a design depth and then backfilled with lean mix concrete. As the excavation proceeds downward and the steel piles are subsequently exposed, the lagging is installed between the piles to further stabilize the walls of the excavation.

Design Lateral Pressures – For a cantilevered soldier pile wall or a soldier pile wall with one level of tiebacks, the earth pressures depicted on Figure 7 should be used for design. We recommend that tiebacks be used where the wall height exceeds 10 feet. Tiebacks should be designed with an allowable resistance of 1 kip per linear foot, or alternatively helical anchors may be used for tiebacks. The lateral earth pressures shown on Figure 7 should be increased for any surcharge loads resulting from traffic, construction equipment, building loads or excavated soil if they are located within the height dimension of the wall. In addition, if a soldier pile wall is constructed below a basement wall of an adjacent property, the surcharge pressure from the wall and backfill should be used in design of the soldier pile wall. Finally, any walls used for permanent support should also include a uniform pressure of 6H for seismic loading where H represents the exposed height of the wall (in feet).

Vertical Capacity – Soldier piles may be designed using an allowable skin friction value of 1.0 ksf for the portion of the pile below the bottom of the excavation and an allowable end bearing value of 20 ksf.

Casing – The sandy soils present near the driveway wall may erode and cave where groundwater is encountered. Consequently, casing will likely be required to complete drilling of the soldier piles below the water table.

Lagging – Because of the potential for the sandy mass wasting deposits and pre-Olympia coarse grained material to ravel and erode, we recommend that pre-cast concrete panel lagging be used on this site. Such lagging can be placed as excavation proceeds to provide some protection against raveling.

Drainage – We anticipate that significant groundwater flows may be expected near the driveway walls and garage. For soldier pile walls that are placed against concrete walls, drainage strips should be provided to allow the groundwater to be collected and discharged as appropriate. The driveway walls should be provided with weep holes below final grade of the driveway. The weepholes should be connected to a collection system and discharged as appropriate.

CONSTRUCTION CONSIDERATIONS

SITE PREPARATION

Site preparation for the proposed project will include demolition of the existing house, stripping the vegetation as needed and excavation to the construction subgrade elevation. It should be noted that the existing basement foundation wall is located west and up slope of the planned new house location. If left in place, either partially or in full, the wall will be free standing and will present a potential hazard to workers below the wall. Consequently, the existing structure should be demolished and removed or existing basement walls should be supported with temporary rakers.

All demolition rubble and stripped surface materials should be properly disposed off-site or, in the case of vegetation and soil "wasted" on site in non-structural or landscaping areas.

Following site clearing and excavations, the adequacy of the subgrade where structural fill, foundations, slabs, or pavements are to be placed should be observed by a representative of

PanGEO. The subgrade soil in the improvement areas, if recompacted and still yielding, should also be over-excavated and replaced with compacted structural fill or CDF/lean-mix concrete.

We recommend that the existing interception drainage system be maintained or re-routed as needed, and that the groundwater seepage from upslope be controlled and excluded from the construction area.

TEMPORARY EXCAVATIONS

Based on conceptual drawings, we anticipate temporary excavations up to 8 to 10 feet deep may be required for the proposed construction. Temporary excavations should be performed in accordance with Part N of WAC (Washington Administrative Code) 296-155. The contractor is responsible for maintaining safe excavation slopes and/or shoring.

Based on the soil conditions encountered at the site, temporary excavations for the proposed construction generally may be sloped 1H:1V (Horizontal:Vertical). It may be found that at the upslope, western corners of the new house, there is insufficient space for a 1H:1V cut. Should this be found to be that case, we recommend a temporary shoring system with Ultrablocks™, as described below.

The temporary excavations and cut slopes should be re-evaluated in the field during construction based on actual observed soil conditions and may need to be flattened in the wet season. The cut slopes should be covered with plastic sheets in the rainy winter season, generally November to April. We also recommend that heavy construction equipment, building materials, excavated soil, and vehicular traffic should not be allowed within a distance equal to 1/3 the slope height from the top of any excavation.

ULTRABLOCK™ WALL

For areas where there is that insufficient space available for a 1H:1V temporary cut slope, such as along the south side of the excavations, based on the site soils, in our opinion temporary excavations may be retained with an Ultrablock™ wall, as described below. The successful use of Ultrablocks will require stable hillside cuts. The presence of groundwater and potential seepage of excavation cuts may compromise slope stability during construction and may require dewatering to create stable working conditions.

Concrete Blocks – Concrete blocks utilized for the gravity shoring wall shall be constructed out of new concrete (i.e. Ultrablock™) with dimensions of 2.5 feet by 2.5 feet by 5 feet. In addition, a half-height cap block may be used.

Wall Height – We recommend that the wall be no more than two blocks (5 feet) high, plus the cap block. We recommend that the slope above the wall be graded to a 1H:1V slope.

Minimum Embedment & Subgrade Conditions – We recommend that the basal row of blocks be embedded at least 6 inches below foundation grade. The blocks should be founded on competent native soils consisting of dense, undisturbed lean clay, or on a 2" thick leveling course of Crushed Surfacing Top Course (CSTC) as needed. If placed on lean clay without toe embedment, the blocks should be monitored for sliding, and should be pinned with steel spikes if needed.

Construction Sequence – To reduce the potential of instability of the temporary excavation during construction of the temporary shoring wall, we recommend that no excavation shall be made until the blocks are on site, and the maximum unsupported length of the excavation should be limited to 10 feet. The concrete blocks should be placed against the cut immediately after the excavation has been made to reduce the potential of sloughing, and voids behind the blocks should be backfilled immediately after each block is placed. Because there will likely be limited space between the back of the wall and the cut slope, a backfill material which does not require compaction, such as railroad ballast (2-inch crushed rock), should be utilized. If the blocks are not placed against the cut by the end of each workday, any exposed cut shall be buttressed overnight by backfilling the slope with fill place at a 2H:1V slope.

Construction Monitoring – The geotechnical inspector shall continuously monitor the excavation and block placement. If excessive sloughing occurs, the contractor shall immediately backfill the excavation, and the excavation and shoring procedure shall be modified to maintain adequate support of the excavation and adjacent properties.

Survey Monitoring Adjacent Structures – We recommend that survey points be installed on the block wall driveway, and that baseline readings be taken prior to any excavation activities at the site. Subsequent readings should be taken weekly until the permanent basement walls have been installed and backfilled to confirm the site excavations are not adversely affecting the adjacent structures.

Block Removal - In our experience it is typically more cost effective to leave the blocks in the ground and backfill over them once the project is complete, as opposed to removing and disposing of them.

CONSTRUCTION DEWATERING

Excavations into the hillside above the present house, such as are anticipated for the driveway wall and garage, may encountered significant groundwater flows and erodible sand. Dewatering the area of the excavation may make the construction safer and more effective.

For the excavations for the basement area, we anticipate that only minor perched groundwater may be found if a sandy interbed is encountered, especially in the wet season. Based on our understanding of the project and site conditions, we anticipate that a conventional dewatering system consisting of trenches, sumps and pumps will be adequate to dewater the temporary excavation. We also anticipate that any seepage quantities in this area should be relatively small, likely less than 10 gallons per minute.

PERMANENT CUT AND FILL SLOPES

Based on the soil conditions underlying the site, we recommend any permanent cut or fill slopes be constructed no steeper than 2H:1V (Horizontal:Vertical).

MATERIAL REUSE

In the context of this report, structural fill is defined as compacted fill placed under footings, concrete stairs and landings, and slabs, or other load-bearing areas. In our opinion, the on-site silty clay should not be re-used as a resource for structural fill. We recommend that imported, well-grade granular material, such as WSDOT Gravel Borrow (WSDOT 9-03.14(1)) or approved equivalent, should be used as structural fill. The on-site soil can be used as general fill in the non-structural and landscaping areas. If use of the on-site soil is planned, the excavated soil should be stockpiled and protected with plastic sheeting to prevent softening from rainfall in the wet season.

STRUCTURAL FILL PLACEMENT AND COMPACTION

Structural fill should be moisture conditioned to within about 3 percent of optimum moisture content, placed in loose, horizontal lifts less than 8 inches in thickness, and systematically compacted to a dense and unyielding condition and to at least 95 percent of the maximum dry density, as determined using test method ASTM D 1557.

Depending on the type of compaction equipment used and depending on the type of fill material, it may be necessary to decrease lift thicknesses to achieve adequate compaction. PanGEO can provide additional recommendations regarding structural fill and compaction during construction.

WET WEATHER EARTHWORK

Due to the high fines content and previously disturbed condition of the shallow site soils, we recommend that the proposed site construction not be done during wet weather (such as in winter). Also, earthwork construction performed during the drier summer months likely will be more economical. If unavoidable. winter construction will require the implementation of best management erosion and sedimentation control practices to reduce the chance of off-site sediment transport. Most of the site soils contain a high percentage of fines and are moisture sensitive. Any footing subgrade soils that become softened either by disturbance or rainfall should be removed and replaced with structural fill, Controlled Density Fill (CDF), or lean-mix concrete. General recommendations relative to earthwork performed in wet conditions are presented below:

- Site stripping, excavation and subgrade preparation should be followed promptly by the placement and compaction of clean structural fill or CDF;
- The size and type of construction equipment used may have to be limited to prevent soil disturbance;
- The ground surface within the construction area should be graded to promote run-off of surface water and to prevent the ponding of water;
- Bales of straw, straw rolls and/or geotextile silt fences should be strategically located to control erosion and the movement of soil;

- Structural fill should consist of less than 5% fines; and
- Excavation slopes should be covered with plastic sheets.

SURFACE DRAINAGE CONSIDERATIONS

Surface runoff can be controlled during construction by careful grading practices. Typically, this includes the construction of shallow, upgrade perimeter ditches or low earthen berms in conjunction with silt fences to collect runoff and prevent water from entering excavations or to prevent runoff from the construction area from leaving the immediate work site.

Permanent control of surface water should be incorporated in the final grading design. Adequate surface gradients and drainage systems should be incorporated into the design such that surface runoff is directed away from slopes and structures. Water from roof drains and other impervious areas should be properly collected and discharged into a storm drain system or other approved facility.

The existing groundwater interception and drainage system located above the house should be maintained or replaced. The system should be kept separate from the footing and stormwater drainage systems.

ADDITIONAL SERVICES

To confirm that our recommendations are properly incorporated into the design and construction of the proposed residence, PanGEO should be retained to conduct a review of the final project plans and specifications, and to monitor the construction of geotechnical elements. The City of Mercer Island, as part of the permitting process, may also require geotechnical construction inspection services. PanGEO can provide you a cost estimate for construction monitoring services at a later date.

We anticipate that the following additional services will be required:

- Review final project plans and specifications
- Verify implementation of erosion control measures;
- Verify adequacy of footing subgrade;

- Monitor temporary excavation and temporary soldier pile shoring;
- Verify the adequacy of subsurface drainage installation;
- Confirm the adequacy of the compaction of structural backfill; and
- Other consultation as may be required during construction

Modifications to our recommendations presented in this report may be necessary, based on the actual conditions encountered during construction.

CLOSURE

We have prepared this report for Elizabeth Huber, Brandt Architects and the project design team. Recommendations contained in this report are based on a site reconnaissance, a subsurface exploration program, a review of pertinent subsurface information, and our understanding of the project. The study was performed using a mutually agreed-upon scope of work.

Variations in soil conditions may exist between the locations of the explorations and the actual conditions underlying the site. The nature and extent of soil variations may not be evident until construction occurs. If any soil conditions are encountered at the site that are different from those described in this report, we should be notified immediately to review the applicability of our recommendations. Additionally, we should also be notified to review the applicability of our recommendations if there are any changes in the project scope.

The scope of our work does not include services related to construction safety precautions. Our recommendations are not intended to direct the contractors' methods, techniques, sequences, or procedures, except as specifically described in our report for consideration in design. Additionally, the scope of our work specifically excludes the assessment of environmental characteristics, particularly those involving hazardous substances. We are not mold consultants nor are our recommendations to be interpreted as being preventative of mold development. A mold specialist should be consulted for all mold-related issues.

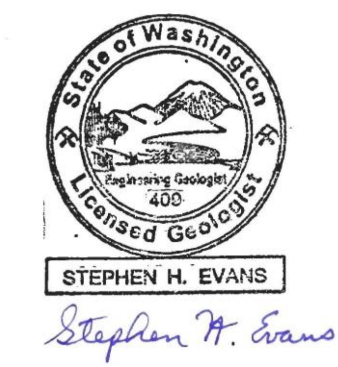
This report has been prepared for planning and design purposes for specific application to the proposed project in accordance with the generally accepted standards of local practice at the time this report was written. No warranty, express or implied, is made.

This report may be used only by the client and for the purposes stated, within a reasonable time from its issuance. Land use, site conditions (both off and on-site), or other factors including advances in our understanding of applied science, may change over time and could materially affect our findings. Therefore, this report should not be relied upon after 24 months from its issuance. PanGEO should be notified if the project is delayed by more than 24 months from the date of this report so that we may review the applicability of our conclusions considering the time lapse.

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 PanGEO of such intended use and for permission to copy this report. Based on the intended use of the report, PanGEO may require that additional work be performed and that an updated report be reissued. Noncompliance with any of these requirements will release PanGEO from any liability resulting from the use this report.

We appreciate the opportunity to be of service.

Sincerely,



Stephen H. Evans, L.E.G.
Senior Engineering Geologist

W. Paul Grant, P.E.
Principal Geotechnical Engineer

Enclosures:

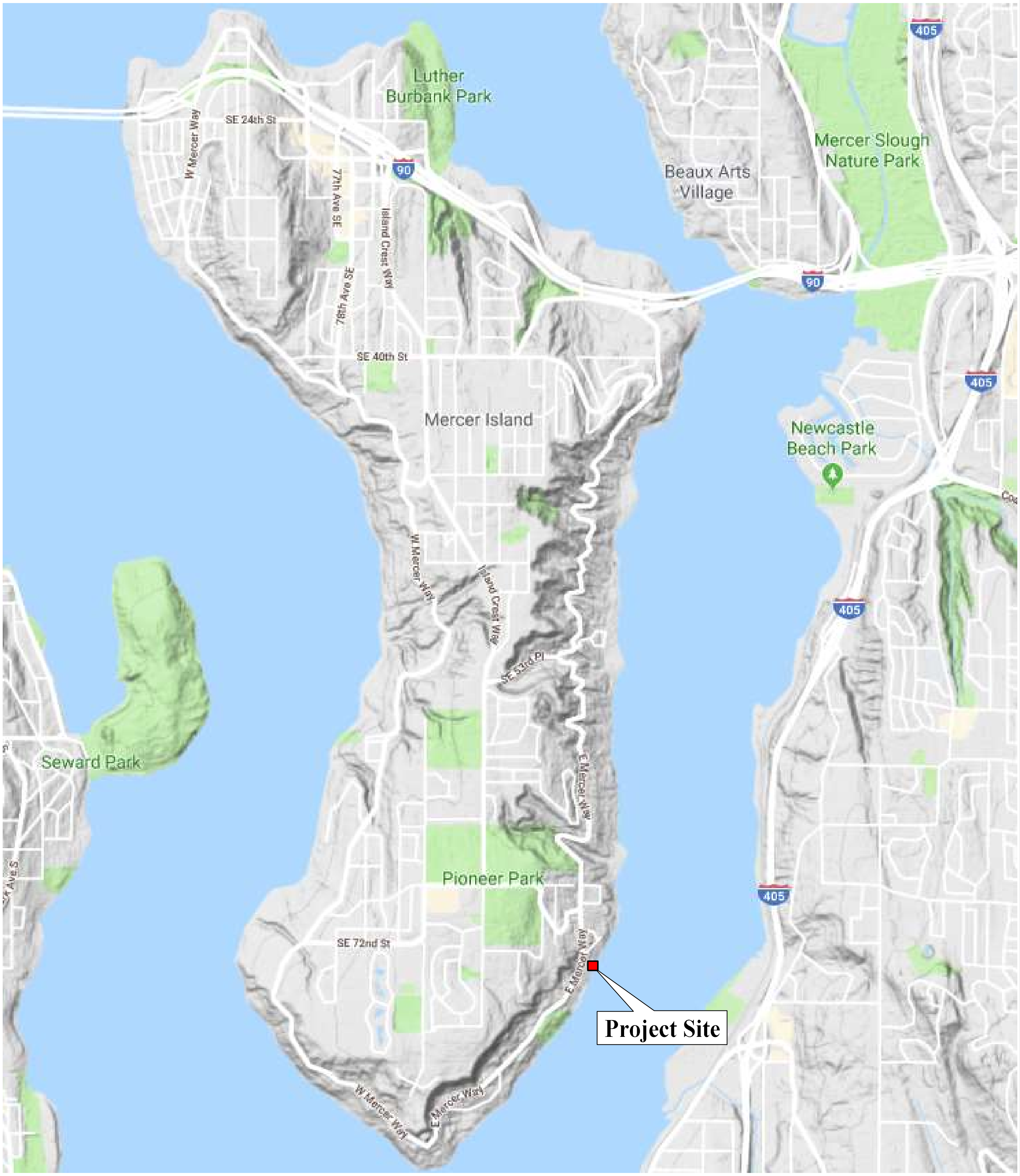
Figure 1 Vicinity Map
Figure 2 Site and Exploration Map
Figure 3 Terms and Symbols for Boring and Test Pit Logs
Figure 4 Summary Log of Boring PG-1
Figure 5 Summary Log of Boring PG-2
Figure 6 Summary Log of Boring PG-3
Figure 7 Shoring Design Parameters, Cantilever Wall/Single Tieback

REFERENCES

International Code Council, 2018, *International Building Code (IBC).*

Troost, K.G., and Wisher, A. P, 2006. *Geologic Map of Mercer Island, Washington, scale 1:12,000*.

WSDOT, 2014, *Standard Specifications for Road, Bridge and Municipal Construction, M 41-10.*



Not to Scale

Reference: Google Terrain Maps

PanGEO INCORPORATED	**Proposed New Residence** **9611 SE 72nd Street** **Mercer Island, Washington**	**VICINITY MAP**
		Project No. **21-004** / Figure No. **1**

Legend:

- Approx. Test Boring Locations
- Proposed Permanent Soldier Pile Wall
- Proposed Soldier Pile Shoring Wall
- Recommended Additional Soldier Piles for Shoring

PanGEO INCORPORATED

Proposed New Residence
9611 SE 72nd Street
Bellevue, Washington

SITE AND EXPLORATION PLAN

Project No.	Figure No.
21-004	2

21-004 Site and Exploration.ppt 9/2/2021(10:12 AM) SHE

RELATIVE DENSITY / CONSISTENCY

SAND / GRAVEL			SILT / CLAY		
Density	SPT N-values	Approx. Relative Density (%)	Consistency	SPT N-values	Approx. Undrained Shear Strength (psf)
Very Loose	<4	<15	Very Soft	<2	<250
Loose	4 to 10	15 - 35	Soft	2 to 4	250 - 500
Med. Dense	10 to 30	35 - 65	Med. Stiff	4 to 8	500 - 1000
Dense	30 to 50	65 - 85	Stiff	8 to 15	1000 - 2000
Very Dense	>50	85 - 100	Very Stiff	15 to 30	2000 - 4000
			Hard	>30	>4000

UNIFIED SOIL CLASSIFICATION SYSTEM

MAJOR DIVISIONS		GROUP DESCRIPTIONS	
Gravel 50% or more of the coarse fraction retained on the #4 sieve. Use dual symbols (eg. GP-GM) for 5% to 12% fines.	GRAVEL (<5% fines)	GW	Well-graded GRAVEL
		GP	Poorly-graded GRAVEL
	GRAVEL (>12% fines)	GM	Silty GRAVEL
		GC	Clayey GRAVEL
Sand 50% or more of the coarse fraction passing the #4 sieve. Use dual symbols (eg. SP-SM) for 5% to 12% fines.	SAND (<5% fines)	SW	Well-graded SAND
		SP	Poorly-graded SAND
	SAND (>12% fines)	SM	Silty SAND
		SC	Clayey SAND
Silt and Clay 50%or more passing #200 sieve	Liquid Limit < 50	ML	SILT
		CL	Lean CLAY
		OL	Organic SILT or CLAY
	Liquid Limit > 50	MH	Elastic SILT
		CH	Fat CLAY
		OH	Organic SILT or CLAY
Highly Organic Soils		PT	PEAT

Notes:

1. Soil exploration logs contain material descriptions based on visual observation and field tests using a system modified from the Uniform Soil Classification System (USCS). Where necessary laboratory tests have been conducted (as noted in the "Other Tests" column), unit descriptions may include a classification. Please refer to the discussions in the report text for a more complete description of the subsurface conditions.

2. The graphic symbols given above are not inclusive of all symbols that may appear on the borehole logs. Other symbols may be used where field observations indicated mixed soil constituents or dual constituent materials.

DESCRIPTIONS OF SOIL STRUCTURES

Layered:	Units of material distinguished by color and/or composition from material units above and below
Laminated:	Layers of soil typically 0.05 to 1mm thick, max. 1 cm
Lens:	Layer of soil that pinches out laterally
Interlayered:	Alternating layers of differing soil material
Pocket:	Erratic, discontinuous deposit of limited extent
Homogeneous:	Soil with uniform color and composition throughout
Fissured:	Breaks along defined planes
Slickensided:	Fracture planes that are polished or glossy
Blocky:	Angular soil lumps that resist breakdown
Disrupted:	Soil that is broken and mixed
Scattered:	Less than one per foot
Numerous:	More than one per foot
BCN:	Angle between bedding plane and a plane normal to core axis

COMPONENT DEFINITIONS

COMPONENT	SIZE / SIEVE RANGE	COMPONENT	SIZE / SIEVE RANGE
Boulder:	> 12 inches	Sand	
Cobbles:	3 to 12 inches	Coarse Sand:	#4 to #10 sieve (4.5 to 2.0 mm)
Gravel		Medium Sand:	#10 to #40 sieve (2.0 to 0.42 mm)
Coarse Gravel:	3 to 3/4 inches	Fine Sand:	#40 to #200 sieve (0.42 to 0.074 mm)
Fine Gravel:	3/4 inches to #4 sieve	Silt	0.074 to 0.002 mm
		Clay	<0.002 mm

TEST SYMBOLS

for In Situ and Laboratory Tests listed in "Other Tests" column.

ATT	Atterberg Limit Test
Comp	Compaction Tests
Con	Consolidation
DD	Dry Density
DS	Direct Shear
%F	Fines Content
GS	Grain Size
Perm	Permeability
PP	Pocket Penetrometer
R	R-value
SG	Specific Gravity
TV	Torvane
TXC	Triaxial Compression
UCC	Unconfined Compression

SYMBOLS

Sample/In Situ test types and intervals

- 2-inch OD Split Spoon, SPT (140-lb. hammer, 30" drop)
- 3.25-inch OD Spilt Spoon (300-lb hammer, 30" drop)
- Non-standard penetration test (see boring log for details)
- Thin wall (Shelby) tube
- Grab
- Rock core
- Vane Shear

MONITORING WELL

- Groundwater Level at time of drilling (ATD)
- Static Groundwater Level
- Cement / Concrete Seal
- Bentonite grout / seal
- Silica sand backfill
- Slotted tip
- Slough
- Bottom of Boring

MOISTURE CONTENT

Dry	Dusty, dry to the touch
Moist	Damp but no visible water
Wet	Visible free water

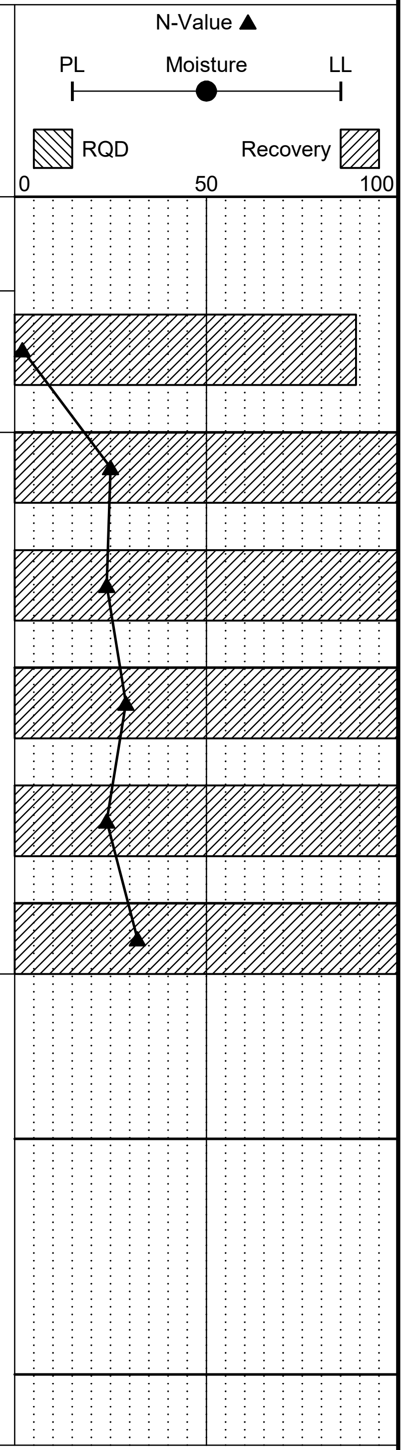
PanGEO INCORPORATED
Phone: 206.262.0370

Terms and Symbols for Boring and Test Pit Logs

Figure 3

Project:	Proposed New Residence	Surface Elevation:	~34 feet
Job Number:	21-004	Top of Casing Elev.:	Not Applicable
Location:	9611 SE 72nd Street, Mercer Island, WA	Drilling Method:	HSA
Coordinates:	Northing: , Easting:	Sampling Method:	SPT

Depth, (ft)	Sample No.	Sample Type	Blows / 6 in.	Other Tests	Symbol	MATERIAL DESCRIPTION
0						~2 inches of beauty bark overlying very loose, brown to gray, silty fine to medium SAND with trace gravel: moist. **(FIll).**
	S-1		1 1 1			Very stiff, gray and brown mixed, silty, lean CLAY: very moist, sub-angular gray clay clasts, mixed texture, low plastic, iron oxide staining, some sand and organics. (Mass Wasting Deposit).
5	S-2		6 10 15			Very stiff, gray, silty, lean CLAY: moist, low to medium plasticity, homogeneous, occasional light gray lens or parting, wavy laminated to massive.. **(Pre-Olympia Fine Grained Deposit).**
	S-3		6 9 15			
10	S-4		7 12 17			
	S-5		7 9 15			Light gray banding / laminae.
15	S-6		7 12 20			--becomes hard.
						Boring terminated at an approximate depth of 16.5 feet below ground surface (bgs). Groundwater was not encountered at the time of drilling. Used post hole digger to about 1.5 feet bgs. Driller added water at about 3 feet to aid with drilling.
20						
25						



Completion Depth:	16.5ft
Date Borehole Started:	1/27/21
Date Borehole Completed:	1/27/21
Logged By:	R. Ragudos
Drilling Company:	CN Drilling

Remarks: Limited access acker drill rig used. Standard Penetration Test (SPT) sampler driven with a 140 lb. safety hammer. Hammer operated with a rope and cathead mechanism. Surface elevation based on Topographic and Boundary Survey by Terrane (01/25/21). Mapped as fine grained non-glacial deposit, but SPT samples appear to be glacial in origin, based on textures.

PanGEO INCORPORATED

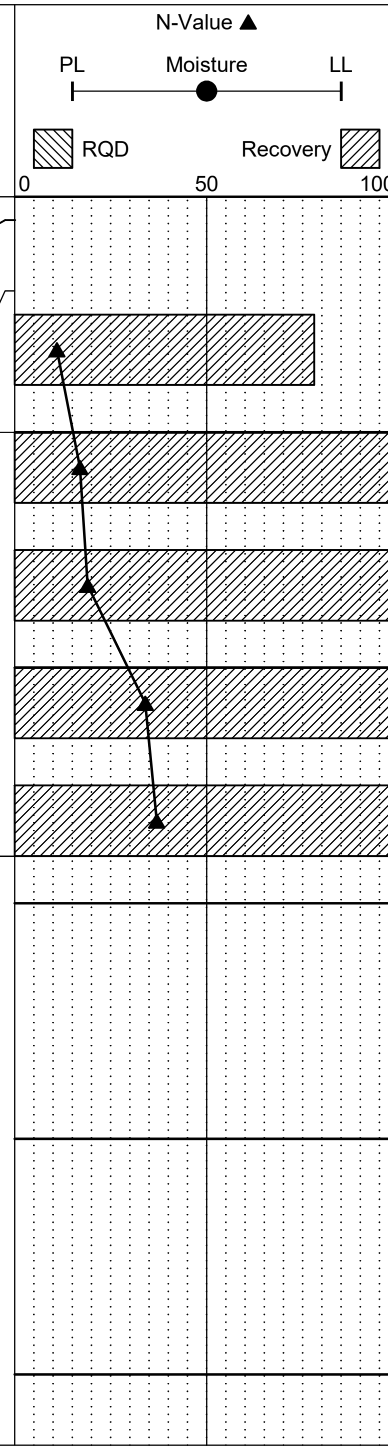
LOG OF TEST BORING PG-1

Figure 4

The stratification lines represent approximate boundaries. The transition may be gradual.

Project:	Proposed New Residence	Surface Elevation:	~50 feet
Job Number:	21-004	Top of Casing Elev.:	Not Applicable
Location:	9611 SE 72nd Street, Mercer Island, WA	Drilling Method:	HSA
Coordinates:	Northing: , Easting:	Sampling Method:	SPT

Depth, (ft)	Sample No.	Sample Type	Blows / 6 in.	Other Tests	Symbol	MATERIAL DESCRIPTION
0						~6 inches of topsoil.
						Brown, silty fine to medium SAND with trace gravel, and trace organics; moist, roots, description based on cuttings. **(Fill).**
	S-1	SPT	6, 6, 5			Stiff, gray, silty, lean CLAY with trace gravel, and trace organics: moist, medium plasticity, rootlets, abundent fractures with iron oxide staining. (Mass Wasting Deposit).
5	S-2	SPT	2, 7, 10			Very stiff, gray, silty, lean CLAY; moist, medium plasticity, homogeneous, laminated to massive, occasional light gray lens or parting. **(Pre-Olympia Fine Grained Deposit).**
	S-3	SPT	6, 7, 12			
10	S-4	SPT	11, 16, 18			--becomes hard.
	S-5	SPT	10, 17, 20			
15						Boring terminated at an approximate depth of 14 feet below ground surface (bgs). Groundwater was not encountered at the time of drilling. Used post hole digger to about 2 feet bgs. Driller added water at about 3 feet to aid with drilling.
20						
25						



Completion Depth: 14.0ft
Date Borehole Started: 1/27/21
Date Borehole Completed: 1/27/21
Logged By: R. Ragudos
Drilling Company: CN Drilling

Remarks: Limited access acker drill rig used. Standard Penetration Test (SPT) sampler driven with a 140 lb. safety hammer. Hammer operated with a rope and cathead mechanism. Surface elevation based on Topographic and Boundary Survey by Terrane (01/25/21). Mapped as fine grained non-glacial deposit, but SPT samples appear to be glacial in origin, based on textures.

PanGEO INCORPORATED

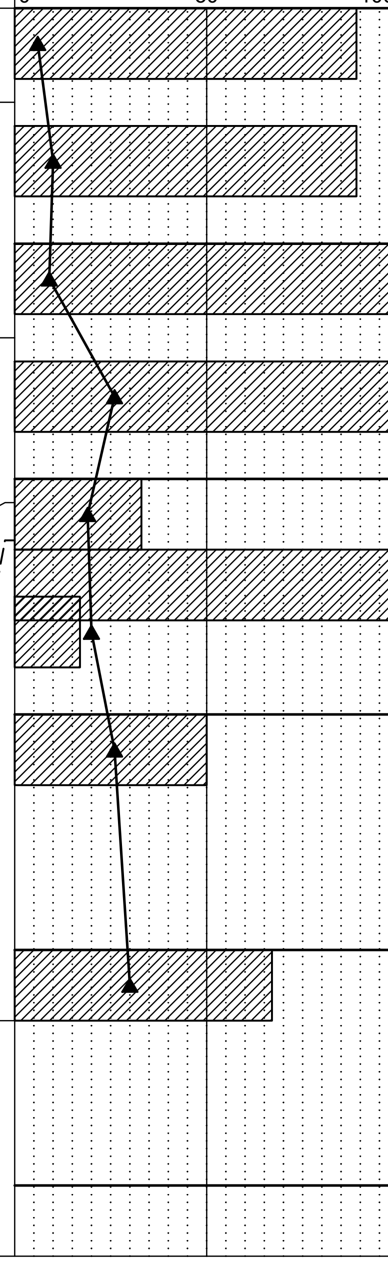
LOG OF TEST BORING PG-2

Figure 5

Project:	Proposed New Residence	Surface Elevation:	~58 feet
Job Number:	21-004	Top of Casing Elev.:	Not Applicable
Location:	9611 SE 72nd Street, Mercer Island, WA	Drilling Method:	HSA
Coordinates:	Northing: , Easting:	Sampling Method:	SPT

Depth, (ft)	Sample No.	Sample Type	Blows / 6 in.	Other Tests	Symbol	MATERIAL DESCRIPTION
0	S-1		2 2 4			Loose, brown, very silty, fine SAND: slightly moist, trace fine gravel, fine organics, roots, massive, homogeneous. **(Colluvium).**
	S-2		2 4 6			Loose, banded rusty brown and brown, silty, fine to medium SAND: slightly moist becoming wet, non-plastic, occasional fine gravel, laminated with finer/coarser bedding, deeply weathered. **(Outwash/Colluvium).**
5	S-3		4 4 5			Becoming wet, red brown, silty, fine ot medium sand, homogeneous, massive, clayey silt interbed at 6.3.
	S-4		11 12 14			Medium dense, brown gray to gray, fine to medium SAND with silt: very moist, non-plastic, homogeneous, indistinctly laminated, coarse gravel in tip. **(Pre-Olympia Coarse Deposit).**
10	S-5		20 10 9			Fine to coarse SAND with silty and fine gravel.
						Medium dense, brown gray SILT: very moist, non-plastic with rapid dilatancy, laminated, homogeneous. **(Pre-Olympia Fine Grained Deposit).**
	S-6		7 9			
	S-7		7 9 11			Very stiff, gray, silty, lean CLAY: moist, low to medium plastic, homogeneous, massive, occasional high angle fracture with rusty surface. **(Pre-Olympia Fine Grained Deposit).**
15	S-8		10 12 14			Very stiff, silty CLAY, very moist, laminated. Gray, silty low to medium plastic CLAY, massive.
20	S-9		13 14 16			Very stiff to hard, gray, silty CLAY, low to medium plastic, massive.
						Boring terminated at an approximate depth of 21.5 feet below ground surface (bgs). Groundwater encountered in 5-foot sample at the time of drilling.
25						

N-Value ▲
PL Moisture LL
RQD Recovery
0 50 100



Completion Depth:	21.5ft
Date Borehole Started:	8/17/21
Date Borehole Completed:	8/17/21
Logged By:	S. Evans
Drilling Company:	CN Drilling

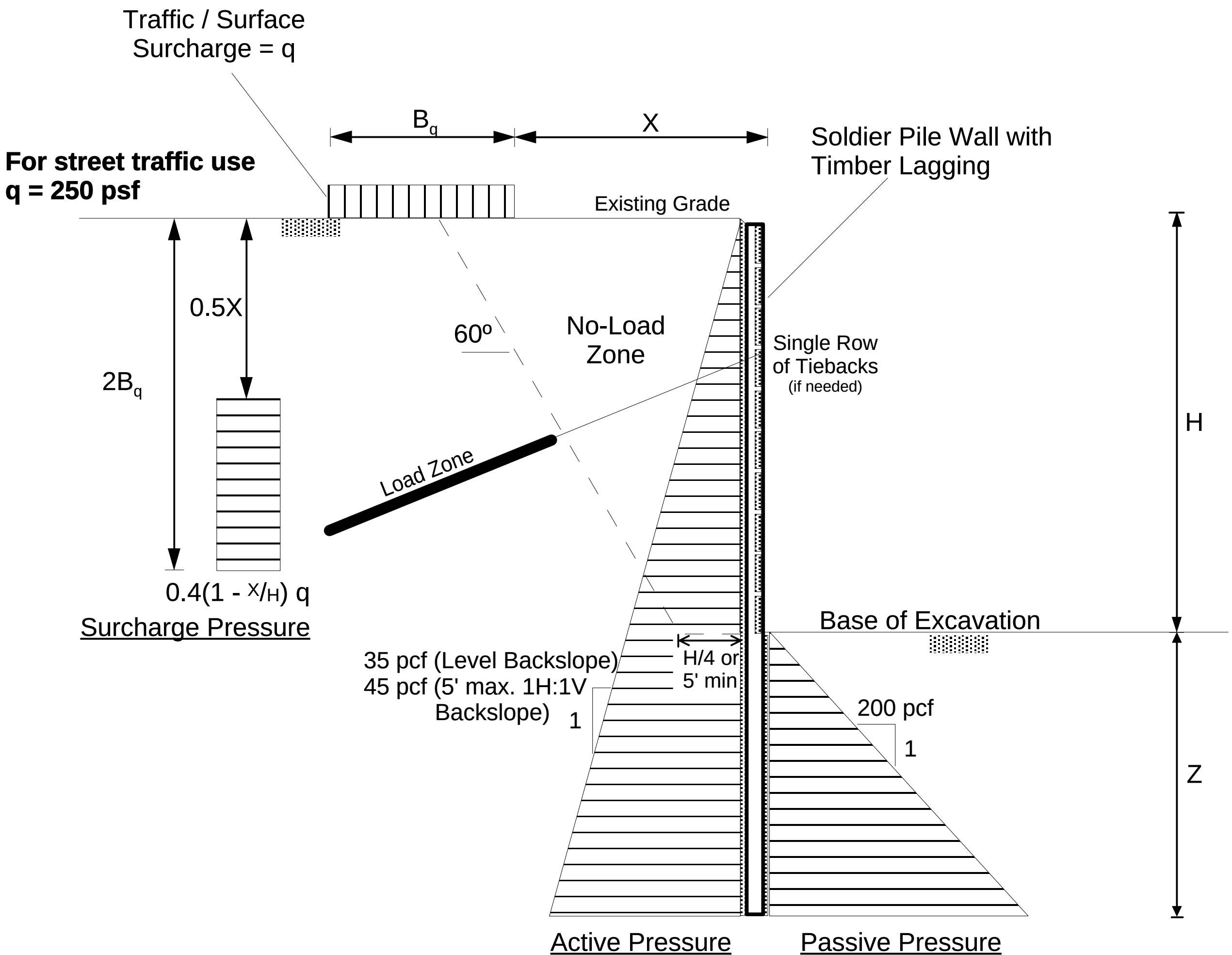
Remarks: Limited access acker drill rig used. Standard Penetration Test (SPT) sampler driven with a 140 lb. safety hammer. Hammer operated with a rope and cathead mechanism. Surface elevation based on Topographic and Boundary Survey by Terrane (01/25/21).

PanGEO INCORPORATED

LOG OF TEST BORING PG-3

Figure 6

The stratification lines represent approximate boundaries. The transition may be gradual.



Notes:

1. Embedment (Z) should be determined by summation of moments at the bottom of the soldier piles or at ground anchor location if present. Minimum pile embedment shall be 10 feet.
2. A factor of safety of 1.5 has been applied to the recommended passive earth pressure value. No factor of safety has been applied to the recommended active earth pressure values.
3. Active and surcharge pressures should be applied over the full width of the pile spacing above the base of the excavation, and over one pile diameter below the base of the excavation.
4. Passive pressure should be applied to two times the diameter of the soldier piles.
5. Use uniform earth pressure of 200 psf and 250 psf for lagging design with soldier piles spaced at less than or equal to 8 feet and greater than 8 feet, respectively.
6. Refer to report text for additional discussions.

21-004 Fig 6 Soldier Pile EP - Cantl - 1 tie.grf 9/7/21 (9:38:30) JCR

PanGEO
INCORPORATED

Proposed New Residence
9611 SE 72nd Street
Mercer Island, Washington

SHORING DESIGN PARAMETERS
CANTILEVER WALL / SINGLE TIEBACK

Project No. **21-004**

Figure No. **7**