PanGEO
INCORPORATED
Geotechnical & Earthquake Engineering Consultants

Revised September 11, 2017
File No. 14-128

Barcelo Homes, LLC
32505 138th Place SE
Auburn, WA 98092
Attn: Bogdan Maksimchuk

Subject: **Geotechnical Engineering Study (Revised)**
Proposed Development
4634 E Mercer Way, Mercer Island, WA

Dear Mr. Maksimchuk,

As requested, PanGEO, Inc. has completed a geotechnical engineering study for the proposed development at the above-referenced site. This study was performed in general accordance with our mutually agreed scope of work outlined in our proposal dated May 6, 2014, and was subsequently approved by you on May 7, 2014. Our service scope included reviewing readily-available geologic and geotechnical data in the project vicinity, reviewing preliminary design plans, drilling three test borings, conducting a site reconnaissance, and developing the conclusions and recommendations presented in this report.

SITE AND PROJECT DESCRIPTION

The subject site is an approximately 21,350 square foot vacant lot located immediately south of 4624 E Mercer Way, and setback approximately 120 feet east of East Mercer Way, in the City of Mercer Island, Washington (see Vicinity Map, Figure 1). The subject lot is bordered by existing single-family residences on all four sides. The site grade generally slopes down from west to east with an average gradient of approximately 25 percent. The site is currently covered with ivy, bushes, and some mature trees.

We understand that you plan to construct a single-family residence in the eastern portion of the lot (see Figure 2). Based on review of preliminary design information provided to us, we understand that the proposed residence will be a wood frame, three-story structure with an attached garage (see Plate 1 on page 2). We anticipate that site grading for the proposed construction will likely include cuts up to 10 to 12 feet deep along the west building wall and retaining walls, and fill on the order of 5 to 6 feet or less for retaining wall construction.

According to the City of Mercer Island, the subject property contains several mapped geologic hazards, including steeps lopes, potential landslide, seismic, and erosion hazards. As such, a geotechnical report will be required as part of the building permit application.

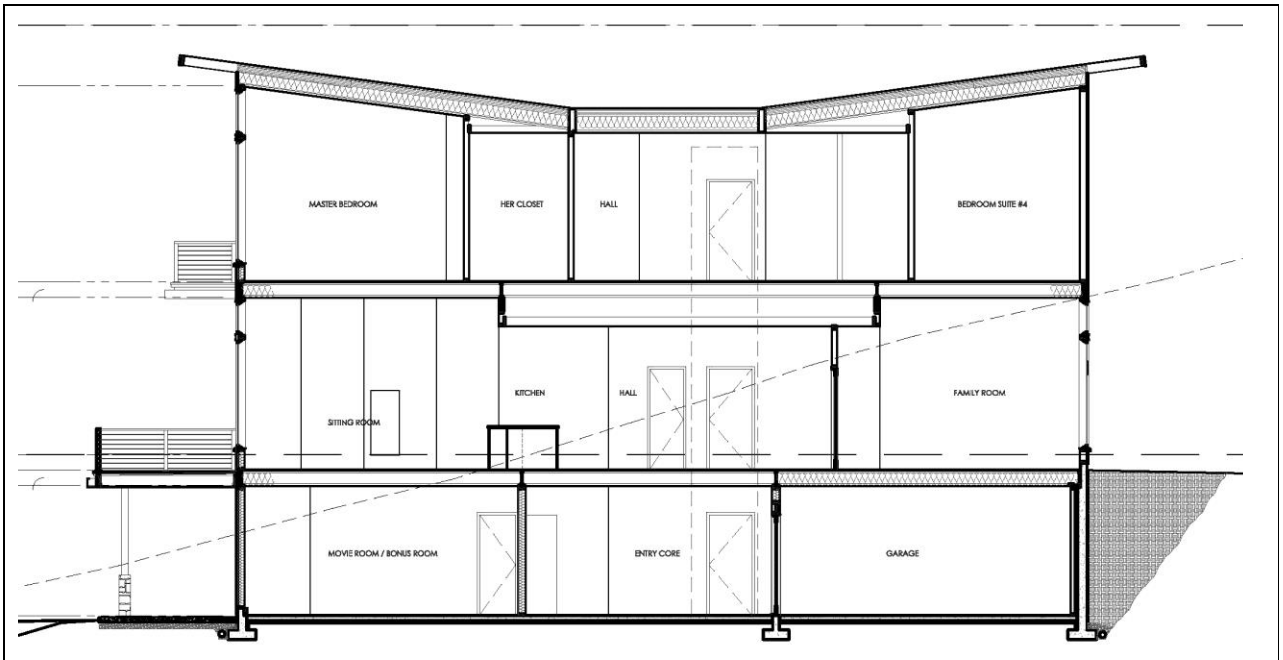


Plate 1. East-West building section.

The conclusions and recommendations in this report are based on our understanding of the proposed development, which is in turn based on the project information provided. 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.

SUBSURFACE EXPLORATIONS

Three borings (BH-1 through BH-3) were drilled at the site on May 16 and June 2, 2014, using a hand-operated portable drill rig owned and operated by CN Drilling of Seattle, Washington. The approximate boring locations were taped in the field from on-site features and are shown on Figure 2. The borings were drilled to depths of about 16½ to 21½ feet.

The drill rig was equipped with 4-inch outside diameter hollow stem augers. Soil samples were obtained from the borings at 2½-foot depth 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 into the soil a distance of 18 inches using a 140-pound weight freely falling a distance of 30 inches. The number of blows required for each 6-inch increment of sampler penetration was recorded. The number of blows required to achieve the last 12 inches of sample penetration is defined as the SPT N-value. The N-value provides an empirical measure of the relative density of cohesionless soil, or the relative consistency of fine-grained soils.

A geologist and an engineer from PanGEO were present to observe the drilling, assist in sampling, and to describe and document the soil samples obtained from the borings. The soil samples were described and field classified in general accordance with the symbols and terms outlined in Figure A-1, and the summary boring logs are included as Figures A-2 through A-4.

SITE GEOLOGY AND SUBSURFACE CONDITIONS

SITE GEOLOGY

The Geologic Map of Mercer Island (Troost and Wisher, 2006) mapped the surficial geologic unit at the subject site as Pre-Olympia Nonglacial Deposits (Qpon). Lawton Clay (Qvlc) and Advance Outwash (Qva) deposits were mapped wet of East Mercer Way, approximately 120 feet west and upslope of the site. Pre-Olympia Nonglacial deposits are described by Troost, et al. as laminated to massive, silt and clay with sand interbeds to clean to silty sand and gravel with silt and peat interbeds that had been overridden by Olympia Interglaciation. Lawton Lay (Qvlc) typically consists of very stiff to hard, laminated to massive, silt, clayey silt, and silty clay that deposited in Puget Lowland proglaicial lakes. Advance Outwash (Qva) typically consists of dense, well-sorted sand and gravel deposited by streams issuing from advancing ice sheet.

SUBSURFACE AND GROUNDWATER CONDITIONS

The soils encountered in the borings are interpreted as colluvium overlying Pre-Olympia deposits. The following is a description of the soils encountered in the test borings advanced at the site. Please refer to the boring summary logs (Figures A-2 through A-4) for a detailed description of the conditions encountered at each boring location.

UNIT 1: Colluvium – Very loose to medium dense, slightly silty sand to sand with silt with trace to some gravel were encountered from the surface to about 4½ to 11 feet in the borings. Based on the blow-counts and structure of the soil samples, we interpret this unit to be colluvium or slope wash deposits.

UNIT 2: Pre-Olympia Deposits **–** Below Colluvium/Slope Wash, both borings encountered medium dense to very dense silty sand to sand with silt that extended to the maximum depths drilled of about 16½ to 21½ feet below the surface. This unit appears to be consistent with the mapped Pre-Olympia Nonglacial deposits.

Groundwater was not encountered during drilling. However, very moist to wet soil sample was observed at about 20 feet in boring BH-1, suggesting approaching the groundwater table. It should be noted that groundwater elevations and seepage rates are likely to vary depending on the season, local subsurface conditions, and other factors. Groundwater levels and seepage rates are normally highest during the winter and early spring.

GEOLOGY HAZARDS ASSESSMENT

LANDSLIDE HAZARDS AND STEEP SLOPES

The subject site is mapped within a potential landslide hazard area according to the City of Mercer Island's Geologic Hazards Map. A site reconnaissance of the subject property was conducted on May 16, 2014. During our site reconnaissance, we did not observe obvious evidence of slope instability or ground movement at the site. Based on our field observations, the general topography at the site and vicinity, and the results of our subsurface explorations, in our opinion, the subject site appears to be globally stable in its current configuration. Furthermore, it is our opinion that the proposed development as currently planned is feasible from a geotechnical engineering standpoint and in our opinion will not adversely affect the overall stability of the site or adjacent properties, provided the recommendations outlined herein are followed and the proposed development is properly design and constructed.

SEISMIC HAZARDS

Based on our review of the City of Mercer Island's Geologic Hazards Maps, the subject site is mapped within a seismic hazard area. The City of Mercer Island Code defines seismic hazard areas as those areas subject to risk of damage as a result of earthquake-induced ground shaking, slope failure, and soil liquefaction or surface faulting. Based on the soil conditions encountered and lack of shallow groundwater table, in our opinion, the potential for soil liquefaction during an IBC-code level earthquake is considered low. It is also our opinion that the potential for seismic-induced landslidng is low at the site due to the relatively mild slope gradient. Therefore, special design considerations associated with soil liquefaction and seismic-induced landsliding are not necessary for this project.

EROSION HAZARDS

The subject site is mapped within a potential erosion hazard area according to the City of Mercer Island's Geologic Hazards Map. Based on soil conditions encountered in the borings, the near-surface site soils are likely to exhibit moderate erosion potential. In our opinion, the erosion hazards at the site can be effectively mitigated with the best management practice during construction and with properly designed and implemented landscaping for permanent erosion control. During construction, the temporary erosion hazard can be effectively managed with an appropriate erosion and sediment control plan, including but not limited to installing silt fence at the construction perimeter, limiting removal of vegetation to the construction area, placing rocks or hay bales at the disturbed/traffic areas and on the downhill side of the project, covering stockpile soil or cut slopes with plastic sheets, constructing a temporary drainage pond to control surface runoff and sediment trap, placing quarry spalls at the construction entrance, etc. Permanent erosion control measures should include establishing vegetation, landscape plants, and hardscape established at the end of project, and reducing surface runoff to the minimum extent possible.

GEOTECHNICAL DESIGN RECOMMENDATIONS

SEISMIC DESIGN PARAMETERS

The Table 1 on page 6 provides seismic design parameters for the site that are in conformance with the 2012 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:

Table 1 – Seismic Design Parameters

Site Class	Spectral Acceleration at 0.2 sec. (g)	Spectral Acceleration at 1.0 sec. (g)	Site Coefficients		Design Spectral Response Parameters	
	S_S	S_1	F_a	F_v	S_{DS}	S_{D1}
D	1.419	0.545	1.00	1.50	0.946	0.545

BUILDING FOUNDATIONS

Based on the subsurface conditions encountered and the building design foundation elevations, it is our opinion that conventional shallow footings may be used to support the proposed building. Conventional footings should bear on the recompacted medium dense to dense undisturbed Pre-Olympia Deposits, or structural fill placed on competent native soils. Fill and colluvium should be removed from the footing subgrade and backfilled with structural fill. We anticipate that over-excavations will be required in the eastern portion of the building footprint to reach native competent soil. 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.

We recommend that an allowable soil bearing pressure of 2,500 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.

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 dense native soil or compacted sand/structural fill, a frictional coefficient of 0.4 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 Drain – Footing drains should be installed around the perimeter of the building, at or just below the invert of the footings. 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 subgrades should be carefully prepared. Any fill, colluvium, loose/soft, or organic-rich subgrade soil should be removed from the footing excavations. The footing subgrade may need to be recompacted to a dense, unyielding condition using a jumping jack or other heavy compaction equipment, prior to form setting and rebar placement. The adequacy of footing subgrade should be verified by a representative of PanGEO, prior to placing forms or rebar. We anticipate that over-excavations up to 3 to 4 feet may be required in the eastern portion of the building footprint to reach native competent soil. The over-excavation should be backfilled with compacted structural fill or lean-mix concrete. The over-excavation width should extend at least one-half the over-excavation depth beyond the edge of footing.

FLOORS SLABS

The floor slabs for the proposed building may be constructed using conventional concrete slab-on-grade floors construction. The floor slabs may be supported on recompacted native sandy soil or structural fill placed on properly compacted on-site sandy soil. Organic-rich soil or loose soil that cannot be compacted to a dense condition at the slab subgrade level should be over-excavated and replaced with compacted structural fill.

Interior concrete slab-on-grade floors should be underlain by at least of 4 inches capillary break. The capillary break material should be clean crushed rocks that have no more than 10 percent passing the No. 4 sieve and less than 5 percent by weight of the material passing the U.S. Standard No. 100 sieve. The capillary break should be placed on the subgrade that has been compacted to a dense and unyielding condition. A 10-mil polyethylene vapor barrier should also be placed directly below the slab. We also recommend that construction joints be incorporated into the floor slab to control cracking.

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/basement walls are presented below.

Lateral Earth Pressures

Concrete cantilever walls should be designed for an equivalent fluid pressure of 35 pcf for level backfills behind the walls assuming the walls are free to rotate. If walls are to be restrained at the top from free movement, such as below-grade building walls, equivalent fluid pressures of 45 pcf should be used for level backfills behind the walls. Walls with a maximum 2H:1V backslope should be designed for an active and at rest earth pressure of 45 and 55 pcf, respectively.

Permanent walls should be designed for an additional uniform lateral pressure of 7H psf for seismic loading, where H corresponds to the buried depth of the wall. The recommended lateral pressures assume that the backfill behind the wall consists 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 0.4 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 and pea gravel wrapped with a layer of filter fabric. A minimum 18-inch wide zone of free draining granular soils (i.e. pea gravel or washed rock) is recommended to be placed adjacent to the wall for the full height of the wall. Alternatively, a composite drainage material, such as Miradrain 6000, may be used in lieu of the clean crushed rock or pea gravel. The drainpipe at the base of the wall should be graded to direct water to a suitable outlet.

The exterior of all basement walls should be protected with a damp proofing compound. We also recommend the designers consider utilizing a waterproofing material, such as prefabricated clay mats, on the exterior of all below grade walls to reduce the potential for moisture intrusion into the below-grade portion of the building.

Wall Backfill

In our opinion, the relatively clean on-site sandy soil may be re-used as wall backfill. Imported wall backfill, if needed, 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.

SOLDIER PILE SHORING WALLS

We understand that soldier pile walls may be needed as temporary shoring walls to support the excavations or as permanent site retaining walls to retain the cuts. We recommend that the following design parameters be used for the design of soldier pile shoring walls:

Active Earth Pressure:	35 pcf for level backslope 48 pcf for maximum 2H:1V backslope
Passive Resistance:	300 pcf (allowable)
Lagging:	250 psf (uniform distribution)
Surcharges:	A lateral load coefficient of 0.3 should be used to compute the lateral pressure on the shoring wall resulting from surcharge loads located within a horizontal distance of one-half wall height
Seismic Pressure:	If the soldier pile walls will be designed as permanent walls, a uniform lateral earth pressure of 8H psf (where H is the wall height) should be added to the static pressure for evaluating the seismic condition
Wall Deflection:	Soldier pile walls should be designed with less than one inch of top of wall deflection

The active earth pressure should be applied over the full width of pile spacing above the base of excavation, and over one pile diameter (i.e. diameter of drilled hole) below the base of excavation. The passive resistance should be applied over two pile diameter or one pile spacing, whichever is less. The minimum soldier pile embedment should be determined by the shoring wall designer, and should extend at least 10 feet below the bottom of the proposed excavation. For lower wall located within the influence zone of the passive pressure of the upper wall, additional surcharge should be included in the design of lower wall in addition to the active earth pressure of the lower wall.

The recommended passive earth pressure assumes level ground surface at the bottom of the excavation, and the level bench extends at least 15 feet in front of the wall. If the ground surface in front of the wall needs to be sloped to accommodate the difference in finish floor elevation, the passive resistance in the sloped portion of the ground should be ignored or reduced for design calculations.

We recommend that any voids behind the timber lagging be backfilled with 5/8” clean crushed rock or Controlled Density Fill (CDF), depending on the soil conditions.

CONSTRUCTION CONSIDERATIONS

SITE PREPARATION

Site preparation for the proposed project mainly includes site clearing and excavations to the design subgrade. All debris resulted from site clearing should be hauled away from the site. The stripped surface materials should be properly disposed off-site or be “wasted” on site in non-structural 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 verified by a representative of PanGEO. The subgrade soil in the improvement areas, if recompacted and still yielding, may need to be over-excavated and replaced with compacted structural fill or lean-mix concrete. The need for overexcavation should be determined by PanGEO.

TEMPORARY EXCAVATIONS

As currently planned, the proposed development may require excavations up to about 10 to 12 feet deep. The deepest excavation will occur at the west side of the building. We anticipate the excavations to mainly encounter loose to very dense sand with variable amounts of silt and gravel (colluvium and Pre-Olympia Deposits). All 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.

All temporary excavations with a total overall depth greater than 4 feet should be sloped or shored. Based on the soil conditions at the site, for planning purposes, it is our opinion that temporary excavations for the proposed construction may be sloped 1H:1V or flatter. Based on our conceptual building layout, in our opinion, unsupported open cut excavation is likely feasible for the proposed development, and temporary shoring to support excavations is likely not needed.

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 modified in the wet reasons. The cut slopes should be covered with plastic sheets in the raining season. 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.

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 sandy soil may be used as structural fill, provided they can be compacted to a dense condition. Imported structural fill, if needed, should consist of well-grade, granular material, such as WSDOT Gravel Borrow (WSDOT 9-03.14(1)) or approved equivalent. Well-graded recycled concrete may also be considered as a source of structural fill. Use of recycled concrete as structural fill should be approved by the geotechnical engineer. The on-site fill may 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 relatively 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 the thickness of each lift in order to achieve adequate compaction. PanGEO can provide additional recommendations regarding structural fill and compaction during construction.

WET WEATHER EARTHWORK

In our opinion, the proposed site construction may be accomplished during wet weather (such as in winter) without adversely affecting the site stability. However, earthwork construction performed during the drier summer months likely will be more economical. Winter construction will require the implementation of best management erosion and sedimentation control practices to reduce the risk of off-site sediment transport. Most of the site soils within the anticipated depth of excavation 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;
- 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, and should not be discharged on to the slope areas.

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, will 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 pin pile driving and testing;
- Monitor temporary excavation;
- 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 Barcelo Homes, LLC and the project design team. Recommendations contained in this report are based on a site reconnaissance, a subsurface exploration program, 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,

9/11/2017

Michael H. Xue, P.E.
Senior Geotechnical Engineer

Siew L. Tan, P.E.
Principal Geotechnical Engineer

Enclosures:

Figure 1 Vicinity Map
Figure 2 Site and Exploration Plan

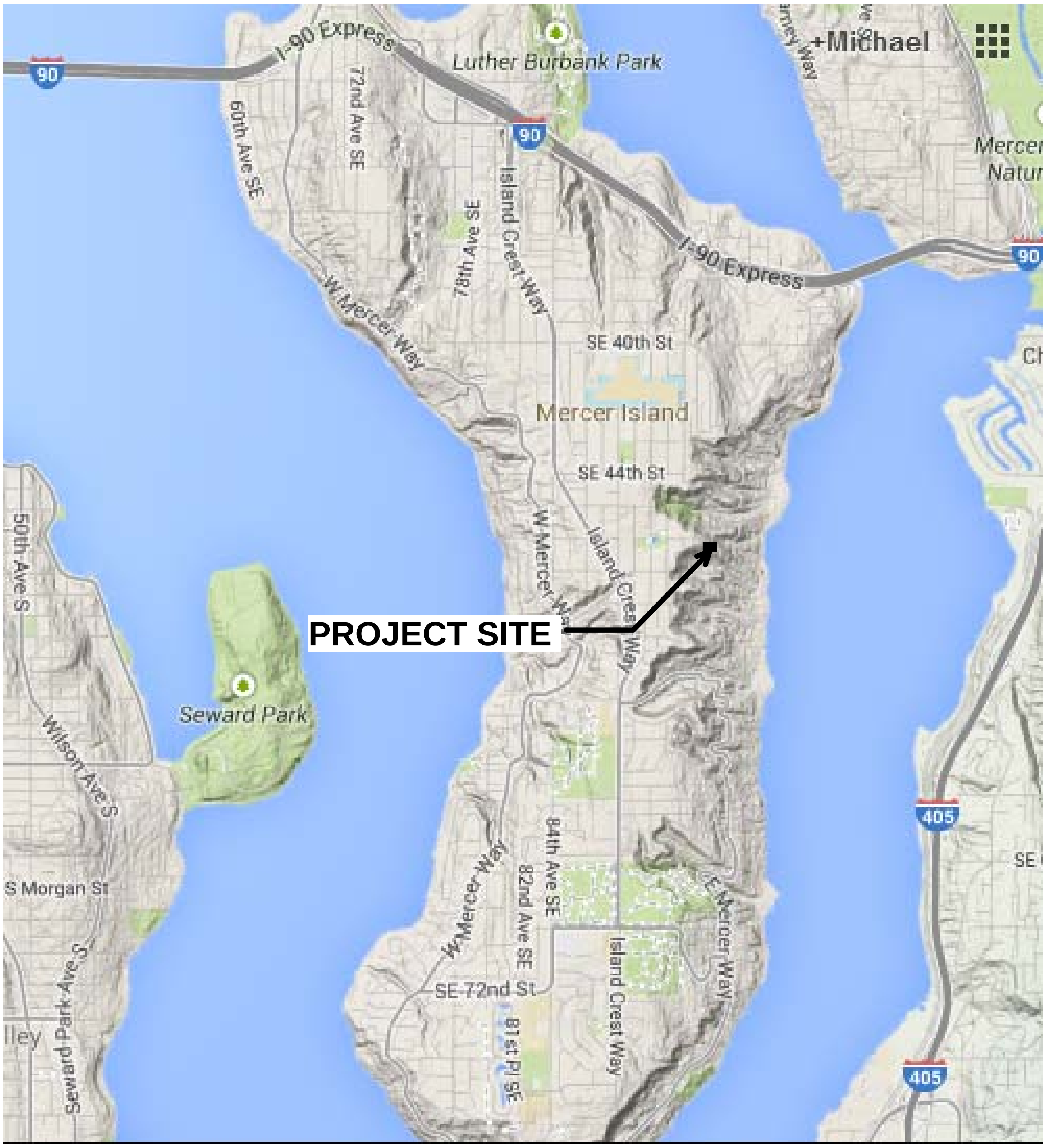
Appendix A Summary Boring Logs
- Figure A-1 Terms and Symbols for Boring and Test Pit Logs
- Figure A-2 Log of Test Boring BH-1
- Figure A-3 Log of Test Boring BH-2
- Figure A-4 Log of Test Boring BH-3

REFERENCES

International Code Council, 2015, *International Building Code (IBC).*

Troost, K.G., and Wisher, A. P, 2006. *Geologic Map of Mercer Island, Washington, scale 1:24,000*.

WSDOT, 2016, *Standard Specifications for Road, Bridge and Municipal Construction, M 41-10.*



Not to Scale

Base Map: Google Maps

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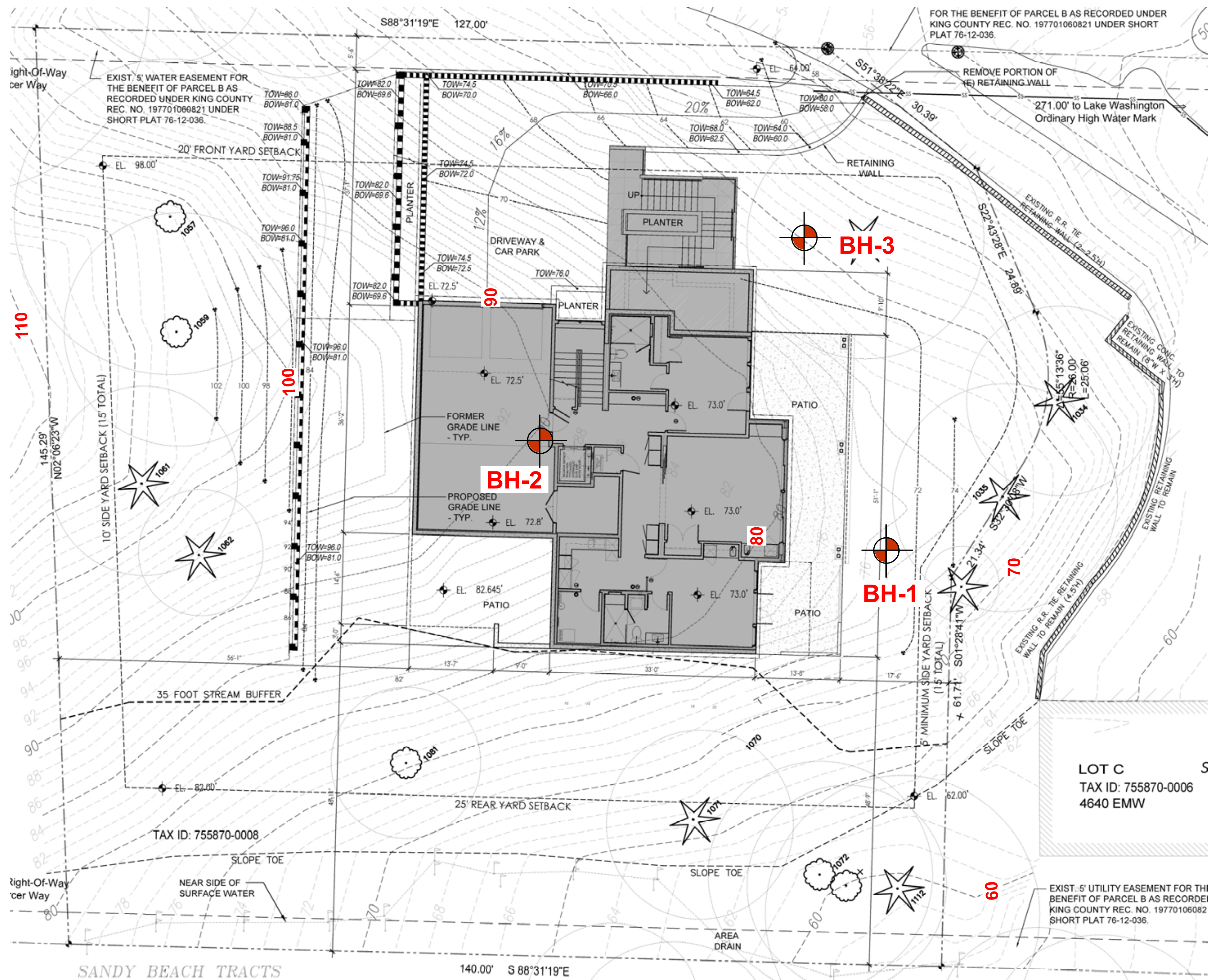
PanGEO INCORPORATED	Proposed Development 4634 E Mercer Way Mercer Island, WA	VICINITY MAP
		Project No. **14-128** Figure No. **1**



Approx. Scale 1"=20"

Basemap based on Site Plan by Studio 19 Architects dated June 5, 2017.

Legend:

BH-1 Approx. Boring Location

PanGEO INCORPORATED

Proposed Development
4634 E Mercery Way
Mercer Island, Washington

SITE AND EXPLORATION PLAN

Project No.	Figure No.
14-128	2

12-095 Site Plan Fig 2.grf 9/7/17 (14:14) SHE

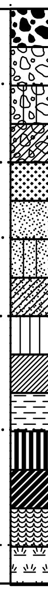
APPENDIX A

SUMMARY TEST BORING LOGS

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	Fissured:	Breaks along defined planes
Laminated:	Layers of soil typically 0.05 to 1mm thick, max. 1 cm	Slickensided:	Fracture planes that are polished or glossy
Lens:	Layer of soil that pinches out laterally	Blocky:	Angular soil lumps that resist breakdown
Interlayered:	Alternating layers of differing soil material	Disrupted:	Soil that is broken and mixed
Pocket:	Erratic, discontinuous deposit of limited extent	Scattered:	Less than one per foot
Homogeneous:	Soil with uniform color and composition throughout	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)

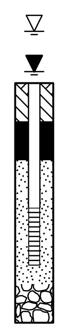
Thin wall (Shelby) tube

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

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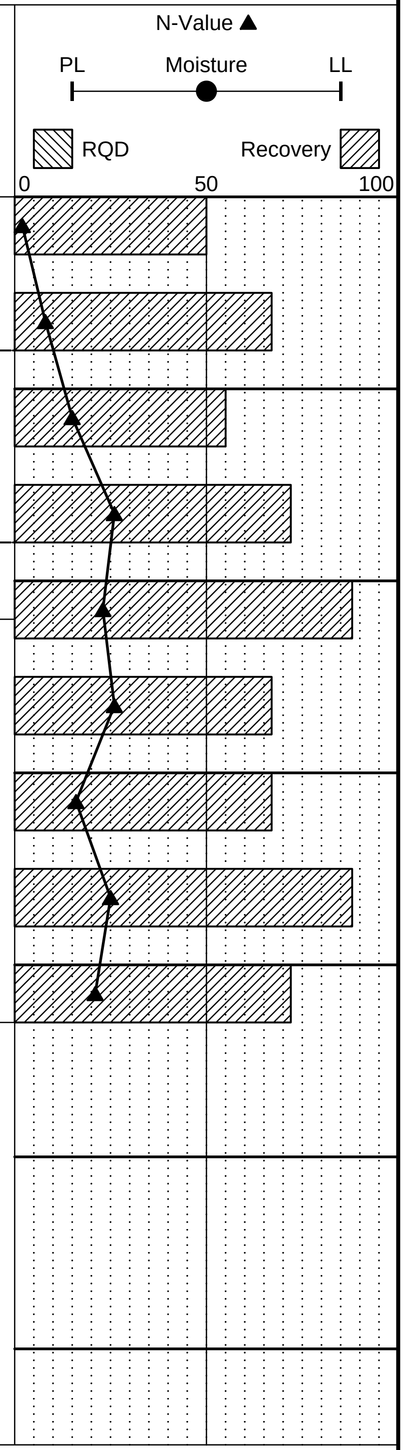
Terms and Symbols for Boring and Test Pit Logs

Figure A-1

Project:	Proposed Development	Surface Elevation:	75.0ft
Job Number:	14-128	Top of Casing Elev.:	
Location:	4632 East Mercer Way, 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		1 1 1			Loose, reddish brown, fine to medium SAND with silt: moist, non-plastic fines, some fine gravel, massive, trace organics. (Colluvium).
	S-2		2 3 5			
5	S-3		3 6 9			Medium dense, brown, fine to coarse SAND: moist, trace silt, scattered gravel to with fine gravel, homogeneous, massive, occasional reddish mottles. (Colluvium).
	S-4		9 12 14			Grading to fine bedded with finer/coarser beds, gravelly beds.
10	S-5		5 9 14			Medium dense, brown gray, silty, fine to coarse SAND with gravel: moist, laminated, trace weathering, trace wood fragment, sharp contact with unit below. (Colluvium).
						Medium dense, brown-gray, slightly silty, fine SAND: moist, trace fine gravel, non-plastic fines, massive to laminated. (Pre-Olympia Deposit?).
	S-6		12 12 14			Laminated with finer/coarser laminae.
15	S-7		6 7 9			Grading to laminated SAND and SILT, non-plastic, dip 30°.
	S-8		9 11 14			Grading to slightly silty fine SAND with fine to medium SAND interbeds, dip 20°.
20	S-9		9 11 10			Interbedded fine to coarse SAND and brown SILT, very moist to wet, folded bedding with dips to 45°.
						Bottom of Boring.
25						
30						



Completion Depth:	21.5ft
Date Borehole Started:	5/16/14
Date Borehole Completed:	5/16/14
Logged By:	S.Evans
Drilling Company:	CN Drilling

Remarks:

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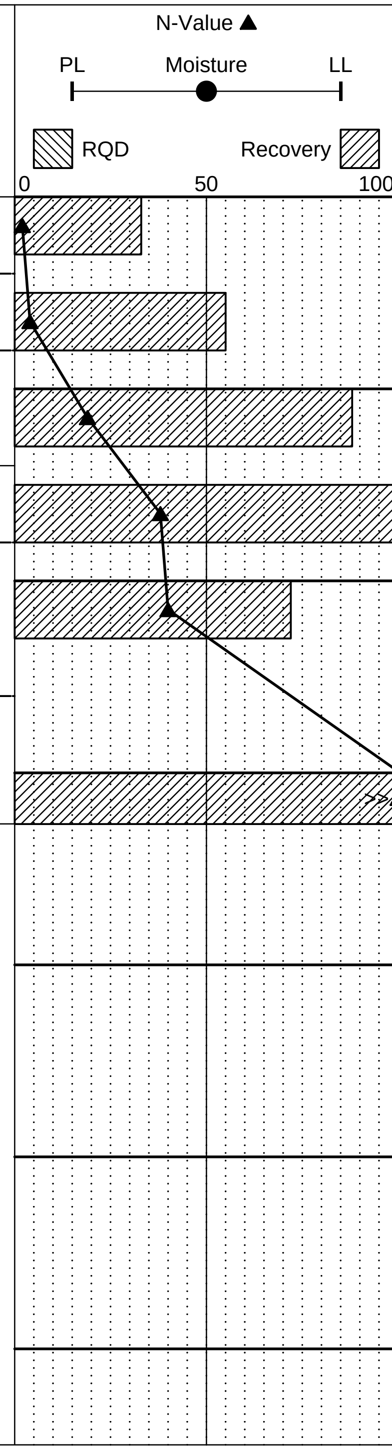
LOG OF TEST BORING BH-1

Figure A-2

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

Project:	Proposed Development	Surface Elevation:	89.0ft
Job Number:	14-128	Top of Casing Elev.:	
Location:	4632 East Mercer Way, 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		1 1 1			Loose, reddish brown, fine to medium SAND with silt: moist, non-plastic fines, homogeneous. (Colluvium).
	S-2		1 1 3			Loose, brown gray, fine to coarse SAND: very moist, trace silt and gravel, laminated with organic lens in middle of sample. (Colluvium).
5	S-3		6 9 10			Medium dense, brown-gray, silty fine SAND: moist, non-plastic, laminated with sandy lenses. (Colluvium).
	S-4		13 18 20			Dense, brown gray, silty, fine SAND: moist, non-plastic, some sub-rounded gravel, trace weathering, massive, till-like. (Pre-Olympia Deposit).
10	S-5		18 17 23			Dense, light gray, sandy SILT/Silty SAND: moist, non-plastic, well laminated with sandy laminae and occasional gravel lens, trace weathering. (Pre-Olympia Deposit).
						Very dense, brown gray, silty SAND: moist, non-plastic, trace to some gravel, till-like texture with sand lenses, grading to silty sand. (Pre-Olympia Deposit).
15	S-6		34 30 20/4			
						Bottom of Boring.
20						
25						
30						



Completion Depth:	16.3ft	Remarks:
Date Borehole Started:	5/16/14	
Date Borehole Completed:	5/16/14	
Logged By:	S.Evans	
Drilling Company:	CN Drilling	

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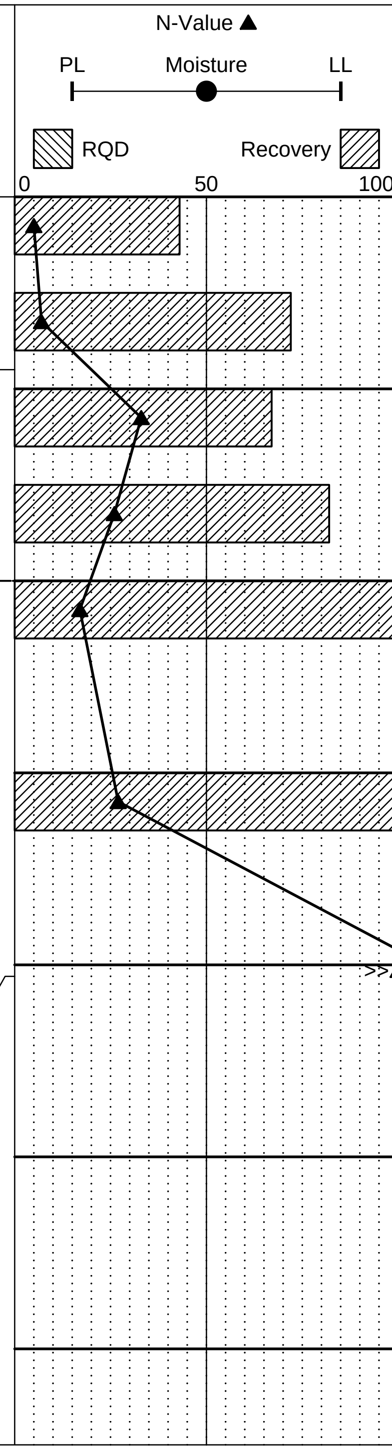
LOG OF TEST BORING BH-2

Figure A-3

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

Project:	Proposed Development	Surface Elevation:	70.0ft
Job Number:	14-128	Top of Casing Elev.:	
Location:	4632 East Mercer Way, 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		1 2 3			Loose, brown, slightly silty SAND: moist, trace to some fine gravel, massive, trace organics near surafce. (Colluvium).
	S-2		1 3 4			-Becomes gray, medium SAND withe some gravel, trace silt, loose, moist.
5	S-3		10 16 17			Dense, gray, medium SAND: moist, trace to some silt, some gravel (Pre-Olympia Deposit?).
	S-4		9 12 14			-Becomes medium to coarse SAND woth trace to some gravel, medium dense.
10	S-5		9 7 10			Medium dense, gray, fine to coarse slight silty SAND: Very moist, trace gravel (Pre-Olympia Deposit).
15	S-6		10 12 15			Driller notes increasing gravel between 16'-17'.
20	S-7		50/3.5			No recovery. Gravel stuck in the sampler tip.
						Bottom of Boring.
25						
30						



Completion Depth:	20.3ft
Date Borehole Started:	6/2/14
Date Borehole Completed:	6/2/14
Logged By:	HMX
Drilling Company:	CN Drilling

Remarks:

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LOG OF TEST BORING BH-3

Figure A-4

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