PanGEO
INCORPORATED
Geotechnical & Earthquake
Engineering Consultants

April 28, 2016
PanGEO Project No. 16-106

Mr. Tim Gabelein
Davido Consulting Group, Inc.
15029 Bothell Way Northeast
Lake Forest Park, Washington 98155

Subject: **GEOTECHNICAL REPORT**
Proposed Short Plat
7233-80th Avenue Southeast
Mercer Island, Washington

Dear Mr. Gabelein,

As requested, PanGEO has completed a geotechnical study for the proposed short plat at 7233-80th Avenue Southeast in Mercer Island, Washington. The results of our study are presented in the attached report. In summary, the site is underlain by dense glacial till at relatively shallow depths. It is our opinion that the new residences may be constructed using conventional spread footings supported on competent glacial till or on newly placed structural fill, provided the recommendations in the attached geotechnical report are incorporated into the design and construction of the project.

We appreciate the opportunity to work on this project. Should you have any questions, please do not hesitate to call.

Sincerely,

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

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GEOTECHNICAL REPORT
7233-80TH AVENUE SOUTHEAST SHORT PLAT
MERCER ISLAND, WASHINGTON

1.0 GENERAL

PanGEO completed a geotechnical engineering study to assist the project team with the design of a proposed short plat at 7233-80th Avenue Southeast in Mercer Island, Washington. Our work was performed in general accordance with our proposal dated March 9, 2016, which was subsequently authorized on March 30, 2016. The purpose of our geotechnical study was to evaluate subsurface conditions at the site and to provide geotechnical engineering recommendations pertinent to the proposed development. Our services included a site reconnaissance, excavating six test pits, and developing the conclusions and recommendations contained in this report.

2.0 SITE AND PROJECT DESCRIPTION

The subject site consists of an approximately 94,525 square foot single-family residence lot located at 7233-80th Avenue Southeast in Mercer Island, Washington (see Figure 1, Vicinity Map). The site is bound to the north, south, east, and west by single-family residence lots. Access to the site is off of an existing gravel private drive on the east side of the site and off of 78th Avenue Southeast on the west side of the site. Existing onsite structures include a single-family residence with a daylight basement and two detached structures. The existing residence and detached buildings are located in the eastern portion of the site. Topography at the site generally slopes down to the west with an average gradient of about 8 percent. Vegetation at the site is largely grass. Please refer to Plate 1, below, to view the site conditions at the time of our reconnaissance on March 8, 2016.

Plate 1. Partial site view facing west from west side of existing residence.

We understand it is planned to subdivide the subject site into seven single-family residence lots. We anticipate the new residences will be of relatively lightly-loaded wood frame construction. At this time, it is not known if the new residences will have basements. Grading to establish the new lots is anticipated to be minimal, with cuts and fills likely of 5 feet or less.

We understand a stormwater facility is planned in the topographically low western portion of the site. If feasible, surface water runoff from the short plat will be accommodated by an infiltration facility. If the subsurface conditions at the site are found to not be conducive to infiltration, a detention facility will likely be needed. Our infiltration feasibility assessment is provided in Section 5.6 of this report.

According to the City of Mercer Island geologic hazards maps, the site is not mapped within an erosion, seismic, or landslide hazard area.

3.0 SUBSURFACE EXPLORATIONS

Six test pits (TP-1 through TP-6) were excavated at the approximate locations shown on Figure 2. The test pits were excavated on April 6, 2016, with a Yanmar Universal Vi035 rubber tracked mini excavator provided by others. The test pits were excavated to depths ranging from 3 to 7 feet below the existing ground surface. Practical excavation refusal was encountered at test pits TP-3 and TP-5.

A geologist from PanGEO was present during the field explorations to observe the test pit excavations, obtain representative samples, and to describe and document the soils encountered in the explorations. Summary test pit logs are presented in Appendix A which provide descriptions of the materials encountered, depths to soil contacts, and depths of seepage or caving, if present, observed in the test pit sidewalls. The relative in-situ density of cohesionless soils, or the relative consistency of fine-grained soils, was estimated from the excavating action of the excavator, probing the sidewalls with a ½-inch diameter steel rod, and the stability of the test pit sidewalls. Where soil contacts were gradual or undulating, the average depth of the contact was recorded in the log. After each test pit was logged, the excavation was backfilled with the excavated soils and the surface was tamped and re-graded smooth.

4.0 SUBSURFACE CONDITIONS

4.1 Soil Conditions

Review of the Geologic Map of Mercer Island (Troost, 2006) indicates that the surficial geologic unit in the vicinity of the subject site is Vashon glacial till (Map Unit Qvt). Glacial till is a very dense heterogeneous mixture of silt, sand, and gravel laid down at the base of an advancing glacial ice sheet. Glacial till typically exhibits low compressibility, high strength characteristics, and very low permeability.

The soil conditions encountered in our test pits were quite consistent, and generally encountered material that we interpret to be glacial till consisting of dense to very dense silty sand with a varying gravel and cobble content. The upper 1 to 2 feet of the glacial till was weathered to a loose to medium dense condition. In general, an increase in relative density was noted at the test pits. This soil unit was encountered to the maximum exploration depth at all of our test pits. We interpret the soils encountered at our test pits to be consistent with the mapped glacial till.

4.2 Groundwater

Perched groundwater was encountered at depths ranging from 1 to 5½ feet below grade in test pits TP-2 through TP-5 at the time of excavation. In addition, iron oxide staining and mottling were observed within the near surface weathered glacial till soils. The iron oxide staining and mottling were typically noted near the transition from weathered glacial till to fresh glacial till and is likely indicative of a seasonal perched groundwater condition in which groundwater collects above the low permeability glacial till.

Groundwater elevations and seepage rates are likely to vary depending on the season, local subsurface conditions, and other factors. Groundwater levels are normally highest during the winter and early spring.

5.0 GEOTECHNICAL RECOMMENDATIONS

5.1 Seismic Design Considerations

The seismic design of the residences may be accomplished using the 2012 or later editions 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). Table 1 below presents the seismic design parameters in accordance with the 2012 IBC, which are consistent with the 2008 USGS seismic hazard maps.

Site Class	Spectral Acceleration at 0.2 sec. (g)	Spectral Acceleration at 1.0 sec. (g)	Site Coefficients		Design Spectral Response Parameters		Control Periods (sec.)	
	S_S	S_1	F_a	F_v	S_{DS}	S_{D1}	T_O	T_S
C	1.46	0.56	1.00	1.30	0.98	0.48	0.10	0.50

Soil liquefaction is a condition where saturated cohesionless soils undergo a substantial loss of strength due to the build-up of excess pore water pressures resulting from cyclic stress applications induced by earthquakes. Soils most susceptible to liquefaction are loose, uniformly graded sands and loose silts with little cohesion. Based on the geologic setting of the site and the presence of glacially overridden soils at shallow depths at our subsurface exploration locations, it is our opinion that the susceptibility of the site to earthquake-induced soil liquefaction is considered to be negligible. Special design considerations associated with soil liquefaction are not necessary for this project.

5.2 EARTHWORK CONSIDERATIONS

5.2.1 Site Preparation

Site preparation includes striping and clearing of topsoil and sod, surface vegetation, root balls, existing foundations, and any other deleterious materials within the proposed development areas and excavating to the design subgrade. All stripped materials should be properly disposed off-site or be "wasted" onsite in non-structural landscaping areas. Based on the thickness of topsoil and sod observed at the test pit locations, we estimate stripping depths will be in the range of 6 to 12 inches. Soil disturbed during stripping and clearing activities should be compacted to a firm and unyielding condition.

Following the removal of deleterious and unsuitable materials, the exposed subgrade within the development area, such as building foundation, slab, and pavement areas, should be proof-rolled with a fully loaded dump truck or a smooth roller compactor. The proof-rolling operation should be observed by a representative of PanGEO. If loose or unstable subgrade soils are observed during the proof roll, the soil should be over-excavated and replaced with structural fill.

5.2.2 Temporary and Permanent Slopes

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. Excavations more than 4 feet deep should be properly shored or sloped. For planning purposes, it is our opinion that temporary excavations may be sloped as steep as 1H:1V (Horizontal:Vertical) in loose to medium dense weathered glacial and temporary excavations in very dense unweathered glacial till may be sloped as steep as ¾H:1V. However, if wet conditions are present in the excavations, flatter side slopes may be necessary. The inclination of temporary slopes should be re-evaluated in the field during construction based on actual observed soil conditions.

Permanent cut and fill slopes, except the side slopes for stormwater ponds (if applicable), should be graded no steeper than 2H:1V and should promptly be planted with an appropriate species of vegetation. Fill slopes should be constructed using 8- to 12-inch thick lifts with each lift compacted to a dense and unyielding condition prior to placing a subsequent lift.

5.2.3 Material Reuse

The contractor should be aware that the soils expected to be encountered during construction have a relatively high fines content and may be difficult to compact to the requirements of structural fill. As a result, the excavated site materials may not be suitable for use as structural backfill, particularly during periods of wet weather. Stockpiles of onsite soils should be protected with plastic sheeting to reduce the potential of softening or erosion resulting from rainfall. If imported structural fill is needed, it should consist of a well-graded granular material, such as crushed rock or Gravel Borrow (WSDOT 9-03.14(1)).

5.2.4 Structural Fill and Compaction

In the context of this report, structural fill is defined as non-organic compacted fill placed under buildings, roadways, slabs, pavements, or other load-bearing areas. It may be possible to reuse some of existing site soils for structural backfill during periods of dry weather, provided the soil can be properly moisture conditioned and adequately compacted. However, due to the generally high fines content of the onsite soils, the soils are moisture sensitive and in our opinion unsuitable for use during wet weather.

Structural fill should be moisture conditioned to within about 3 percent of its optimum moisture content, placed in loose, horizontal lifts less than 8 inches in thickness, and systematically compacted to a dense and relatively unyielding condition. Structural fill placed for lot fill should be compacted to at least 90 percent of the materials maximum dry density, as determined using ASTM test method D1557 (Modified Proctor). Structural fill in road, curb, and sidewalk areas should be compacted to at least 90 percent of the materials maximum dry density except for the upper 1-foot, which should be compacted to at least 95 percent of its maximum dry density.

Imported structural fill, if needed, should consist of well-graded granular soils such as Gravel Borrow (WSDOT 9-03.14(1)), or an approved equivalent. PanGEO should review import material intended for use as structural fill prior to placement.

The procedure to achieve proper density of a compacted fill depends on the size and type of compacting equipment, the number of passes, thickness of the layer being compacted, and certain soil properties. When size of the excavation restricts the use of heavy equipment, smaller equipment can be used, but the soil must be placed in thin enough layers to achieve the required compaction.

Generally, loosely compacted soils result from poor workmanship or soils placed at an improper moisture content. Soils with a high percentage of silt or clay are particularly susceptible to becoming too wet, and coarse-grained materials easily become too dry for proper compaction.

5.3 Foundation Support

Based on our understanding of the proposed development, it is our opinion that conventional spread footings are appropriate for this project. We anticipate the new residences may be constructed on a combination of competent native soil and newly placed structural fill. Based on the results of our subsurface exploration, we anticipate competent glacial till to be present within 1 to 3 feet below the existing grade. Onsite soils should not be used as structural fill to support footings.

> ***Allowable Bearing Pressure*** – We recommend that an allowable soil bearing pressure of 3,000 psf be used to size the footings bearing on structural fill or on competent glacial till. For allowable stress design, the recommended bearing pressure may be increased by one-third for transient loading, such as wind or seismic forces.

Footing Embedment – For frost heave considerations, exterior footings 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.

Lateral Load Resistance - Lateral loads acting on footings may be resisted by passive earth pressure developed against the embedded portion of the footings and by frictional resistance developed at the base of the footings. For footings bearing on competent native soil or on structural fill, a frictional coefficient of 0.35 may be used to evaluate sliding resistance. Passive soil resistance may be calculated using an equivalent fluid pressure of 350 pcf, assuming the footings are backfilled and the backfill is adequately compacted. 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.

Estimated Settlement - Total and differential settlements under service loads are anticipated to be within tolerable limits for footings designed and constructed as discussed above. Under static loads, we anticipate the footings to settle less than 1 inch and differential settlement should be less than about ½ inch. Most of the anticipated settlement should occur during construction as dead loads are applied.

Footing Drains - We recommend that a 4-inch diameter, schedule 40 PVC or SDR 35, perforated pipe embedded in pea gravel or clean crushed rock and wrapped in filter fabric be installed at the base of the footings to direct collected water to an appropriate outlet. Under no circumstances should roof downspout drain lines be connected to the footing drain system. Roof downspouts must be separately tightlined to an appropriate discharge. Cleanouts should be installed to allow for periodic maintenance of the footing drain and downspout tightline systems.

Footing Excavation - All footing excavations should be carefully prepared. Any loose or softened soil should be removed from the footing excavations, and the subgrade should be compacted prior to footing construction. If loose soils cannot be adequately compacted, the soil should be overexcavated and replaced with a granular structural fill. Onsite soils should not be used as structural fill below the footings. 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 proposed building.

Footing Subgrade Protection **–** It should be noted that the site soils are highly moisture sensitive, and can be easily disturbed when exposed to moisture. If the earthwork will be performed during wet weather conditions, the contractor should consider protecting the exposed footing subgrade from inclement weather with about 3 inches of CDF, or about 6 inches of crushed rock.

5.4 RETAINING WALL DESIGN PARAMETERS

Retaining walls should be properly designed to resist the lateral earth pressures exerted by the soils behind the wall. Adequate 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 new retaining walls are presented below.

Wall Foundation- The recommendations outlined in the *Foundation Support* section of this report remain applicable for retaining wall design and construction.

Lateral Earth Pressures – Cantilevered walls with level backslope should be designed for a static lateral earth pressure based upon an equivalent fluid weight of 35 pcf. For basement walls, we recommend 50 pcf for wall design.

Permanent walls should be designed for an incremental uniform lateral pressure of 7H psf for seismic loading, where H corresponds to the exposed wall height. 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 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.

Wall Drainage – Provisions for wall drainage should consist of a rigid 4-inch diameter perforated drainpipe behind and at the base of the wall footings. The drainpipe should be embedded in 12 to 18 inches of pea gravel or clean crushed rock. A minimum 12-inch wide layer of free draining granular soils (i.e. pea gravel or washed rock) is recommended 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 a vertical free draining granular soil layer. The composite drainage material should be installed per the manufacturer's recommendations. The drainpipe at the base of the wall should be graded to direct water to a suitable outlet.

Wall Backfill –Wall backfill should consist of free draining sand and gravel such as Gravel Borrow (WSDOT 9-03.14(1)). Onsite glacial till should not be used as wall backfill due to its poor drainage characteristics.

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 to 90 percent of the maximum dry density.

Damp Proofing – The exterior of all foundation walls should be protected with a damp proofing compound.

5.5 CONCRETE SLAB-ON-GRADE FLOORS

Concrete slab-on-grade floors may be supported on glacial till or on newly placed and compacted structural fill placed on glacial till. If loose/soft existing fill soils are encountered at the slab subgrade elevation, the existing fill should be compacted in-place to a firm and unyielding condition or overexcavated to competent glacial till and replaced with Gravel Borrow.

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 a 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 control joints be incorporated into the floor slab to control cracking.

5.6 INFILTRATION CONSIDERATIONS

We understand a stormwater facility is planned in the topographically low western portion of the site. Test pits TP-3 through TP-5 were excavated in the western portion of the site to assess the feasibility of infiltrating surface water runoff in this area. Perched groundwater was encountered between 1 and 5½ feet below grade in TP-3 through TP-5 at the time of excavation. Furthermore, iron oxide staining and mottling were observed near the ground surface at these test pit locations. In addition, standing water was observed in the western limits of the site during our cursory site reconnaissance on March 8th, 2016. The seasonal high groundwater in the western portion of the site appears to be at or near the existing ground surface. Therefore, it is our opinion that infiltration in the western portion of the site is considered infeasible.

5.7 Surface Drainage

Adequate drainage provisions are imperative to improve the performance of the structures and other site improvements. We recommend both short and long term drainage measures be incorporated into the project design and construction. 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 to collect runoff and prevent water from entering excavations or from flowing over the site slopes. All collected water should be directed under control to a positive and permanent discharge system.

Post-construction erosion control can be accomplished by revegetating disturbed areas and controlling surface water runoff. 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 structures and away from site slopes. All collected water from surface runoff and from downspouts should be routed into a suitable storm water sewer line, and should *not* drain into retaining wall or footing drain systems.

5.8 Construction Timing and Erosion Control

In our opinion, the potential for erosion at the site can be adequately mitigated by employing best management practices (BMPs). During construction, erosion control should include measures for reducing concentrated surface runoff and for reducing the potential of off-site sediment transport by protecting disturbed or exposed surfaces. The temporary erosion and sediment control (TESC) plan should include the following:

- Where practical, maintain vegetation buffers around cleared areas.

- The ground surface within the construction area should be graded to prevent ponding of water and to prevent runoff from reaching temporary excavation slopes.
- Adequately cover soil stockpiles and temporary excavation slopes with plastic sheeting.
- Hydroseed or place straw in areas where grading is completed.
- Divert water away from the top of slopes and excavations.
- Use silt fencing on the down slope side of grading areas.
- If possible, stage construction such that the amount of exposed soil and exposure time is minimized.

PanGEO should review the TESC plan to verify our recommendations are incorporated into the design. The erosion control measures should be inspected on a regular basis to verify they are functioning as intended.

6.0 UNCERTAINTY AND LIMITATIONS

We have prepared this report for use by Davido Consulting Group, Inc. and their project 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 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 onsite), 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 request 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 of this report.

Within the limitation of scope, schedule, and budget, PanGEO engages in the practice of geotechnical engineering and endeavors to perform its services in accordance with generally accepted professional principles and practices at the time the Report or its contents were prepared. No warranty, express or implied, is made.

We appreciate the opportunity to be of service to you on this project. Please feel free to contact our office with any questions you have regarding our study, this report, or any geotechnical engineering related project issues.

Sincerely,

PanGEO, Inc.

4/28/2016

Steven T. Swenson, L.G.
Project Geologist

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

7.0 REFERENCES

International Building Code (IBC), 2012, International Code Council.

Troost, Kathy G., Wisher, Aaron P., 2006, *Geologic Map of Mercer Island, Washington.,*

Washington State Department of Transportation/American Public Works Association, 2016, *Standard Specifications for Road, Bridges, and Municipal Construction*.

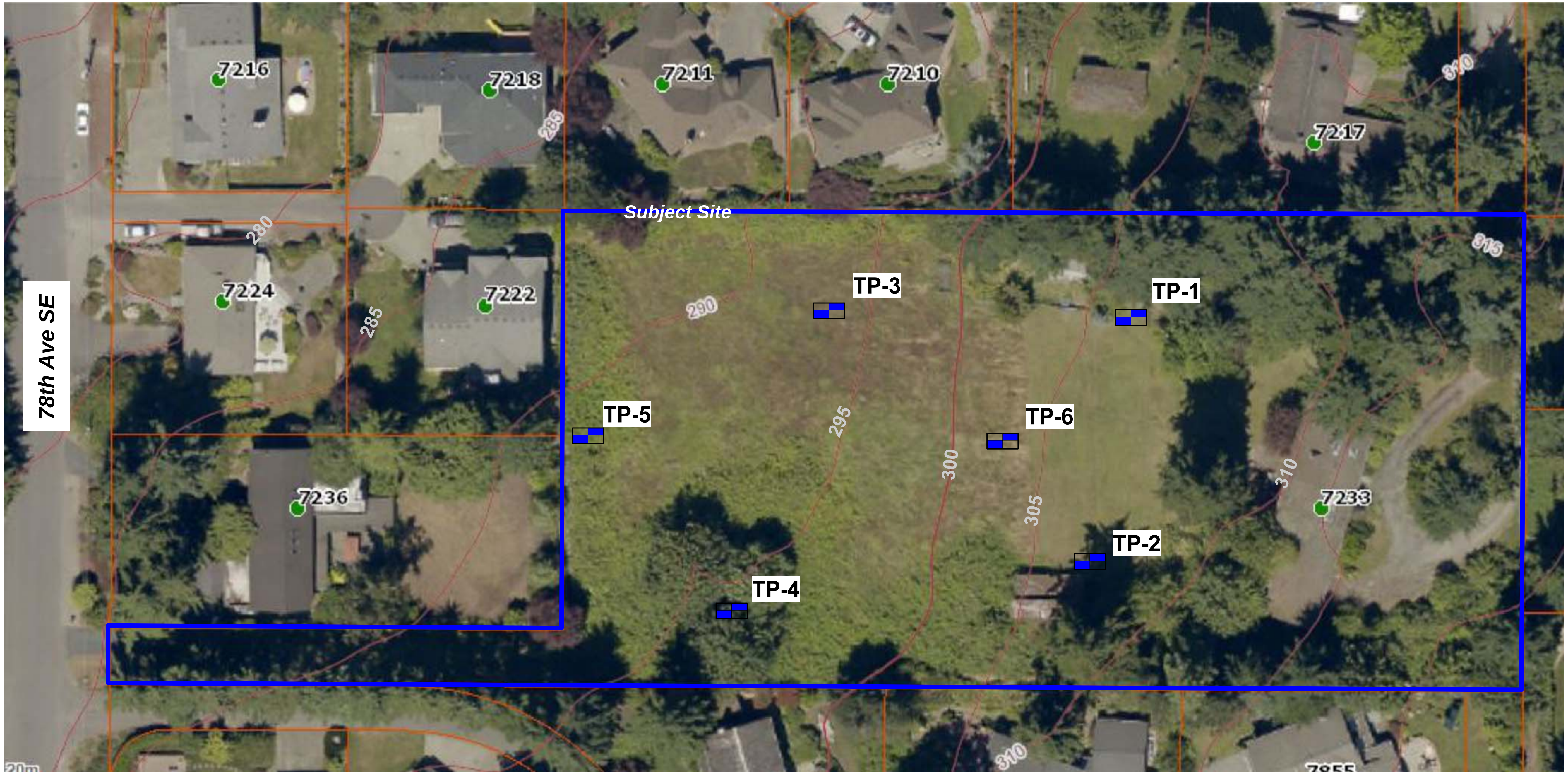
Note: Base map obtained and modified from Google Maps.

N

Not to Scale

16-106 Fig 1 Vicinity Map.grf 4/28/16 (09:47) STS

PanGEO INCORPORATED	**Proposed Short Plat** **7233-80th Avenue Southeast** **Mercer Island, Washington**	**VICINITY MAP**	
		Project No. **16-106**	Figure No. **1**



Approx. Scale
1" = 50'
0' 25' 50'

Legend:

Approx. Test Pit Location

Note: Base map modified from King County iMAP website imagery.

PanGEO INCORPORATED	Proposed Short Plat 7233-80th Avenue Southeast Mercer Island, Washington	SITE AND EXPLORATION PLAN	
		Project No. 16-106	Figure No. 2

16-106 Fig 2 Site Plan.grf 4/28/16 (16:59) STS

APPENDIX A

SUMMARY TEST PIT 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
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 A-1

LOG KEY 09-118 LOG.GPJ PANGEO.GDT 11/12/13

Test Pit TP-1

Ground Surface Conditions: Grass

Depth (ft)	Material Description
0 – ½	Loose, dark brown to black, SILT with sand, moist. **(Topsoil & Sod)** -Abundant roots
½ – 1½	Loose to medium dense, brown, silty SAND with gravel, moist. **(Weathered Glacial Till)**
1½ – 6	Dense, gray, silty SAND with gravel, moist. **(Glacial Till)** -Iron oxide staining near top of unit -Contains cobbles
	Test Pit terminated approximately 6 feet below ground surface. Groundwater was not encountered at the time of excavation.

Test Pit TP-2

Ground Surface Conditions: Grass

Depth (ft)	Material Description
0 – ½	Loose, dark brown to black, SILT with sand, moist. **(Topsoil & Sod)** -Abundant fine roots
½ – 2	Loose to medium dense, orangish-brown, silty SAND with gravel, moist. **(Weathered Glacial Till)** -Contains charcoal fragments -Numerous roots
2 – 7	Medium dense to dense, brownish-gray, silty SAND with gravel, moist. **(Glacial Till)** -Iron oxide staining near top of unit -Contains pockets of clean sand and cobbles -Becomes dense to very dense around 5 feet -Groundwater seepage at 5 feet, slight caving
	Test Pit terminated approximately 7 feet below ground surface. Groundwater was encountered at 5 feet below grade at the time of excavation.

Test Pit TP-3

Ground Surface Conditions: Grass

Depth (ft)	Material Description
0 – 1	Loose, dark brown to black, SILT with sand, moist. **(Topsoil & Sod)** -Abundant fine roots
1 – 2½	Loose to medium dense, orangish-brown, silty SAND with gravel, moist. **(Weathered Glacial Till)** **-**Groundwater seepage at 1-foot **-**Heavy mottling
2½ – 5	Very dense, gray, silty SAND with gravel, moist. **(Glacial Till)**
	Test Pit terminated approximately 5 feet below ground surface due to practical excavation refusal. Groundwater was encountered at 1 foot below grade at the time of excavation.

Test Pit TP-4

Ground Surface Conditions: Blackberry brambles

Depth (ft)	Material Description
0 – ½	Loose, dark brown to black, SILT with sand, moist. **(Topsoil & Duff)** -Abundant fine roots
½ – 1½	Loose to medium dense, orangish-brown, silty SAND with gravel, moist. **(Weathered Glacial Till)** -Iron oxide staining -Contains charcoal fragments -Numerous roots
1½ – 6	Dense, light gray, silty SAND with gravel, moist to wet. **(Glacial Till)** -Heavy mottling to 3 feet -Becomes moist around 3 feet -Contains cobbles -Groundwater seepage at 5½ feet
	Test Pit terminated approximately 6 feet below ground surface. Groundwater was encountered at 5½ feet below grade at the time of excavation.

Test Pit TP-5

Ground Surface Conditions: Grass

Depth (ft)	Material Description
0 – ½	Loose, dark brown to black, SILT with sand, moist. **(Topsoil & Sod)** -Abundant fine roots
½ – 1½	Loose to medium dense, orangish-brown, silty SAND with gravel, moist. **(Weathered Glacial Till)** **-**Heavy iron oxide staining **-**Groundwater seepage at 1½ feet
1½ – 3	Very dense, gray, silty SAND with gravel, moist to wet. **(Glacial Till)**
	Test Pit terminated approximately 3 feet below ground surface due to practical excavation refusal. Groundwater was encountered at 1½ feet below grade at the time of excavation.

Test Pit TP-6

Ground Surface Conditions: Grass

Depth (ft)	Material Description
0 – ¾	Loose, dark brown to black, SILT with sand, moist. **(Topsoil & Sod)** -Abundant fine roots
¾ – 2¾	Loose to medium dense, orangish-brown, silty SAND with gravel, moist. **(Weathered Glacial Till)** **-**Becomes moist to wet around 2 feet
2¾ - 6	Medium dense to dense, gray, silty SAND with gravel, moist. **(Glacial Till)** **-**Iron oxide staining near top of unit -Becomes very dense around 5 feet
	Test Pit terminated approximately 6 feet below ground surface. Groundwater was not encountered at the time of excavation.

Date Test Pits Excavated: April 6, 2016 using a Yanmar Universal Vio35 mini excavator.

Test Pits Logged by: STS