GEOTECHNICAL ENGINEERING REPORT

PROPOSED MOUNGER RESIDENCE
4006 EAST MERCER WAY
MERCER ISLAND, WASHINGTON

Project No. 20-174
July 2020

Prepared for:

Mr. Mitch Mounger

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PanGEO
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July 7, 2020
File No. 20-174

Mr. Mitch Mounger
4006 East Mercer Way
Mercer Island, WA 98040

Subject: **Geotechnical Engineering Report**
Proposed Mounger Residence
4006 East Mercer Way, Mercer Island, WA

Dear Mr. Mounger,

Attached please find our geotechnical engineering report for the proposed project at the above site in Mercer Island, Washington. This report documents the subsurface conditions at the site and presents our geotechnical engineering design recommendations for the proposed residence.

In summary, the test borings drilled near the proposed house location encountered up to about 10 feet of fill and lake deposit overlying dense Pre-Olympia glacial deposits. Based on the soil conditions and anticipated finish floor elevation, in our opinion, the proposed house should be supported on the small diameter steel pipe piles (pin piles). However, alternatively, the attached garage may be supported on conventional footings in-lieu of pin piles. Unsupported open cuts may be sloped 1H:1V or flatter.

We appreciate the opportunity to be of service. Please call if there are any questions.

Sincerely,

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

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4006 EAST MERCER WAY
MERCER ISLAND, WASHINGTON

1.0 GENERAL

This report presents the results of a geotechnical engineering study that was undertaken to support the design and construction of the proposed residence in Mercer Island, Washington. This study was performed in general accordance with our mutually agreed scope of services outlined in our proposal dated March 26, 2020, which was subsequently approved by you on May 11, 2020. Our scope of services included reviewing readily available geologic and geotechnical data, drilling five test borings, conducting a site reconnaissance, performing engineering analysis, and developing the conclusions and recommendations presented in this report.

2.0 SITE AND PROJECT DESCRIPTION

The project site is approximately 36,116 square foot waterfront lot located at 4006 East Mercer Way in the City of Mercer Island, Washington (see Vicinity Map. Figure 1). The site is approximately rectangular in shape, and is bordered to the west by unimproved 100th Avenue SE ROW, to the north by SE 40th Street, to the east by Lake Washington, and to the south by existing single-family residences. A one-story single-family house currently occupies the eastern portion of the site (see Figure 2). The areas to the west of the existing house are currently covered by medium to big trees. Based on review of the GIS maps, the site generally slopes down from west to east with an average gradient of about 20 percent with a total vertical relief of about 90 feet.

We understand that the proposed project will consist of removing the existing house, and constructing a new single-family residence at approximately the same location. Based on review of the preliminary design plans, the proposed single-family house will be 2-story wood frame structure with an attached garage (see Figure 2). We anticipate that temporary excavations up to 5 feet will likely be needed for the foundation construction.

The site is mapped with potential geologic hazards. As such, a geotechnical report is required as part of the building permitting application.

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. In any case PanGEO should be retained to provide a review of the final design to confirm that our geotechnical recommendations have been correctly interpreted and adequately implemented in the construction documents.

3.0 SUBSURFACE EXPLORATIONS

Our subsurface exploration program consisted of drilling five (5) test borings, designated as PG-1 through PG-5, at the approximate locations shown on Figure 2. The borings were drilled at the site on May 20, 2020 using a CAT track drill rig operated by Geologic Drill Partners, Inc. under a subcontract to PanGEO. The drill rigs were equipped with 6-inch outside diameter hollow stem augers.

Soil samples were obtained from the borings at 2½- and 5-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 using a 140-pound weight falling a distance of 30 inches per stroke until reaching a total penetration of 18 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 test is terminated when refusal (more than 50 blows per 6-inch penetration) is met. The N-value provides an empirical measure of the relative density of cohesionless soil, or the relative consistency of fine-grained soils. The completed borings were backfilled with drill cuttings and bentonite chips.

A geologist from PanGEO was present during the field exploration to observe the drilling, to assist in sampling, and to describe and document the soil samples obtained from the borings. The soils were logged in general accordance with ASTM D-2488 *Standard Practice for Description and Identification of Soils (Visual-Manual Procedure)* and the system summarized on Figure A-1, Terms and Symbols for Boring and Test Pit Logs. Summary test boring logs are included as Figures A-2 through A-6 in Appendix A.

4.0 SITE GEOLOGY AND SUBSURFACE EXPLORATIONS

4.1 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) and Pre-Olympia Glacial Till (Qpogt), with Lake Deposits (Ql) mapped along the lakeshore.

> Lake Deposit (Ql) typically consists of very loose to loose sand to very soft to medium stiff silt and clay with peat and other organic sediments deposited adjacent to Lake Washington.
>
> Pre-Olympia Glacial Till (Qpogt) typically consists of dense, silty sand with gravel that had been overridden by Olympia Interglaciation.
>
> Pre-Olympia Nonglacial deposits (Qpon) are described by Troost, et al. as dense and hard, sand, gravel, silt, clay, and organic deposits of nonglacial origin that had been overridden by Olympia Interglaciation.

4.2 SOIL CONDITIONS

In summary, the soils observed in the borings generally consisted of fill over lake Deposit and Pre-Olympia Deposits. The following is a brief description of the soils encountered in the test borings advanced at the site. Please refer to the boring summary logs (Figures A-2 and A-6) for a detailed description of the conditions encountered at each boring location.

It should be noted the stratigraphic contacts indicated on the boring logs represent the approximate depth to boundaries between soil units. Actual transitions between soil units may be more gradual or occur at different elevations. The descriptions of groundwater conditions and depths are likewise approximate.

> ***UNIT 1: Fill –*** Fill was encountered below the thin topsoil in all test borings except PG-3. The fill encountered generally consisted of very loose to medium dense silty sand with roots, organics, and gravel, and extended to 5 to 7.5 feet below the surface. We interpret this soil unit as fill based on its loose condition, presence of organics, and disturbed appearance.
>
> ***UNIT 2: Like Deposit*** – Below Unit 1, PG-1 encountered medium dense silty sand with oxide staining from about 5 feet to about 10 feet below the surface. We interpret this soil unit as Lake Deposit.

UNIT 3: Pre-Fraser Deposits – Below topsoil at PG-3, Unit 2 at PG-1, and Unit 1 at other locations, all borings encountered medium dense to very dense Pre-Olympia Deposit that extended to the maximum depths drilled at 14 to 21½ feet below the existing grades. The Pre-Olympia Deposits consisted of two sub-units: Pre-Olympia Glacial Till and Pre-Olympia Non-Glacial Deposit. The upper portion of this unit is weathered at some locations.

Our subsurface descriptions are based on the conditions encountered at the specific locations at the time of our exploration. Soil conditions between our exploration locations may vary from those encountered. The nature and extent of variations between our exploratory locations may not become evident until construction. If variations do appear, PanGEO should be requested to reevaluate the recommendations in this report and to modify or verify them in writing prior to proceeding with earthwork and construction.

4.3 GROUNDWATER

Minor perched groundwater seepage was observed between 8.5 to 10 feet in boring PG-1 during drilling. Groundwater was observed at about 15 feet in PG-1 during drilling. However, groundwater was not encountered in other borings within the drilling depths. It should be noted that groundwater conditions at the site are likely to fluctuate depending on seasonal rainfall and the lake level. Generally, the water level is higher and seepage rates are greater in the wetter, winter months (typically October through May).

5.0 GEOLOGIC HAZARDS ASSESSMENT

5.1 POTENTIAL LANDSLIDE HAZARDS

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 20, 2020. During our site reconnaissance, we did not observe obvious evidence of slope instability or ground movement at the site. Based on our field observations 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.

5.2 Erosion Hazards Evaluation

The site is mapped as a potential erosion hazard area in accordance with the City of Mercer Island's Geologic Hazards Map. Based on the USDA Soil Survey data and our test borings, the site soils (Kitsap Silt Loam KpB and KpD) are anticipated to exhibit low to moderate erosion potential when disturbed and left unprotected. However, 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 also be effectively managed with an appropriate erosion and sediment control plan, including but not limited to installing a silt fence at the construction perimeter, placing quarry spalls or hay bales at the disturbed and traffic areas, covering stockpiled soil or cut slopes with plastic sheets, constructing a temporary drainage pond to control surface runoff and sediment trap, placing rocks at the construction entrance, etc.

Permanent erosion control measures should be applied to the disturbed areas as soon as feasible. These measures may include but not limited to planting and hydroseeding. The use of permanent erosion control mat may also be considered in conjunction with planting/hydroseeding to protect the soils from erosion.

5.3 Seismic Hazards

Based on our review of the City of Mercer Island's Geologic Hazards Maps, the eastern portion of 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.

Liquefaction is a process that can occur when soils lose shear strength for short periods of time during a seismic event. Ground shaking of sufficient strength and duration results in the loss of grain-to-grain contact and an increase in pore water pressure, causing the soil to behave as a fluid. Soils with a potential for liquefaction are typically cohesionless, predominately silt and sand sized, must be loose, and be below the groundwater table.

Based on the dense soil conditions below the groundwater table in PG-1, and shallow dense soil conditions and lack of shallow groundwater table in other boring locations, in our opinion, the potential for soil liquefaction during an IBC-code level earthquake at the site is considered low, and special design considerations associated with soil liquefaction is not needed for this project.

6.0 GEOTECHNICAL DESIGN RECOMMENDATIONS

6.1 SEISMIC DESIGN PARAMETERS

The Table 1 below provides seismic design parameters for the site that are in conformance with the 2015 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] S_S	Spectral Acceleration at 1.0 sec. [g] S_1	Site Coefficients		Design Spectral Response Parameters	
			F_a	F_v	S_{DS}	S_{D1}
D	1.391	0.534	1.0	1.5	0.928	0.534

6.2 FOUNDATIONS

Borings PG-1 and PG-2 drilled near the proposed house encountered up to about 10 feet of fill and lake deposit. Based on the subsurface conditions encountered, it is our opinion the proposed house should be supported on small diameter steel piles (pin pile) to reduce the potential for excessive post-construction foundation settlement during both static and seismic loading conditions. However, alternatively, based on the test boring PG-3, the attached garage may be supported on the conventional footings in-lieu of pin piles. The following sections present our recommendation for pin piles foundations and conventional footings.

6.2.1 Pin Pile Foundations

Pin Pile Sizes - In our opinion, 3- or 4-inch diameter, Schedule 40, galvanized steel pipes (pin piles) may be used to support the proposed house. Three or four-inch diameter pin piles are typically installed using small hammers mounted on a small excavator.

Pin Pile Capacity - The number of piles required depends on the magnitude of the design load. Allowable axial compression capacities of 6 and 10 tons may be used for the 3- and 4-inch diameter pin piles, respectively, with an approximate factor of safety of 2. Penetration resistance required to achieve the capacities will be determined based on the hammer used to install the pile. Tensile capacity of pin piles should be ignored in design calculations.

It is our experience that the driven pipe pile foundations should provide adequate support with total settlements on the order of ½-inch.

Estimated Pile Length – The subsurface conditions at the site will likely vary substantially across the site. Based on the soil conditions at the site and our experience in the project area, for planning and cost estimating purposes, we estimate that pile length may range from about 20 to 25 feet.

Lateral Forces - The capacity of pin pipes to resist lateral loads is very limited and should not be used in design. Therefore, lateral forces from wind or seismic loading should be resisted by the passive earth pressures acting against the pile caps and below-grade walls or from battered piles (batter no steeper than 3(H):12(V)). ***Friction at the base of pile-supported concrete grade beam should be ignored in the design calculations.*** Passive resistance values may be determined using an equivalent fluid weight of 250 pounds per cubic foot (pcf). This value includes a safety factor of about 1.5 assuming that properly compacted granular fill will be placed adjacent to and surrounding the pile caps and grade beams.

Pin Pile Driving Criteria - Three- or four-inch diameter piles are typically installed using small (approximately 650 to 2,000 pound) hammers mounted to a small excavator. The criterion for driving refusal is defined as the minimum amount of time (in seconds) required to achieve one inch of penetration, and it varies with the size of hammer used for pile driving. For 3- or 4-inch pin piles, the Table 2 on page 12 provides a summary of driving refusal criteria for different hammer sizes that are commonly used in the Seattle area. Please note that these refusal criteria were established empirically based on previous load tests on 3- and 4-inch pin piles in the region. Contractors may select a different hammer for driving these piles, and propose a different driving criterion. In this case, it is the contractor's responsibility to demonstrate to the Engineer's satisfaction that the design load can be achieved based on their selected equipment and driving criteria.

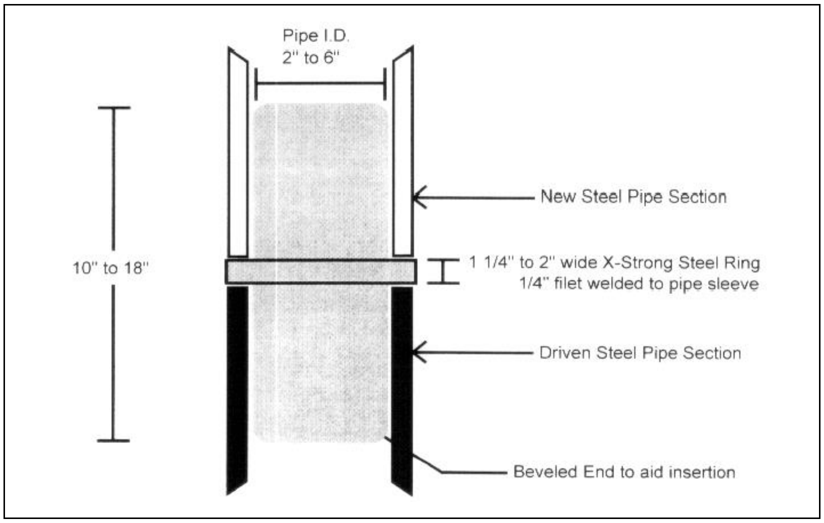
Table 2 - Summary of Commonly-Accepted Driving Criteria for a 3- or 4-inch Pipe with a 6- or 10-ton Allowable Axial Compression Load

Hammer Model	Hammer Weight (lb) / Blows per minute	3" Pile Refusal Criteria (seconds per inch of penetration)	4" Pile Refusal Criteria (seconds per inch of penetration)
Hydraulic TB 225	650 / 550 - 1100	12	20
Hydraulic TB 325	850 / 550 - 1100	10	16
Hydraulic TB 425	1,100 / 550 - 1100	6	10
Hydraulic TB 725X	2,000 / 600	3	4

Pin Pile Specifications - We recommend that the following specifications be included on the foundation plan:

1. Three-inch or four-inch diameter piles should consist of Schedule-40, ASTM A-53 Grade "A" pipe.
2. Three- and four-inch piles shall be driven to refusal with a minimum 650-lb hydraulic hammer. The driving criteria will be determined based on the actual hammer size selected by the contractor, and a static load test program (see Table 2 above and Item 3 below).
3. Load tests should be performed on the selected piles to establish the driving criteria and verify the design pile capacity. All load tests shall be performed in accordance with the procedure outlined in ASTM D1143. The maximum test load shall be 2 times the design load. The objective of the testing program is to verify the adequacy of the driving criteria, and the efficiency of the hammer used for the project.
4. Piles shall be driven in nominal sections and connected with compression fitted sleeve couplers (see typical detail on page 9). We discourage welding of pipe joints, particularly when galvanized pipe is used, as we have frequently observed welds broken during driving.

5. The geotechnical engineer of record or his/her representative shall provide full time observation of pile installation and testing.



The quality of a pin pile foundation is dependent, in part, on the experience and professionalism of the installation company. We recommend that a company with experienced personnel be selected to install the piles.

Grade Beam/Pile Cap Embedment - We recommend that the grade beams and pile caps located around the perimeter of the structure be embedded such that the bottom of the grade beam is at least 16 inches below the adjacent ground surface.

6.2.2 Shallow Footings

As previously indicated, alternatively, the attached garage may be supported on the convention footings in-lieu of pin piles based on boring PG-3 results. In designing the footings, the shape of footings will need to be considered regarding the available space for temporary excavations. Where space may be limited for an unsupported open cut, it may be necessary to use L-shaped perimeter footings in order to conserve space and to allow the temporary excavations to be made within the property limits.

Allowable Bearing Pressure – We recommend that an allowable soil bearing pressure of 2,000 pounds per square feet (psf) be used to size the footings, bearing on the native competent soils or compacted structural fill/lean-mix concrete placed on the native dense soils. 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. Footings should be placed at least 18 inches below final exterior grade. Interior footings should be placed at least 12 inches below the top of slab.

Foundation Performance **–** Total and differential settlements are anticipated to be within tolerable limits for foundation designed and constructed as discussed above. For the proposed building supported by conventional footings bearing on competent native soils and structural fill/lean-mix concrete, the building settlement under static loading conditions is estimated to be approximately one inch, and differential settlement should be on the order of about ½ inch. Most settlement should occur during construction as loads are applied.

Lateral Resistance **–** Lateral forces from wind or seismic loading may be resisted by a combination of passive earth pressures acting against the embedded portions of the foundations and walls, and by friction acting on the base of the foundations. Passive resistance values may be determined using an equivalent fluid weight of 300 pounds per cubic foot (pcf). This value includes a factor safety of at least 1.5 assuming that densely compacted structural fill will be placed adjacent to the sides of the foundation. A friction coefficient of 0.35 may be used to determine the frictional resistance at the base of the foundation. This coefficient includes a factor of safety of approximately 1.5. Unless covered by pavements or slabs, the passive resistance in the upper 12 inches of soil should be neglected.

Footing Subgrade Preparation **–** All footing subgrades should be carefully prepared. The adequacy of footing subgrades should be verified by a representative of PanGEO, prior to placing forms or rebar. The footing subgrades should be in a dense condition prior to concrete pour. Any over-excavations in the footing areas should be backfilled with compacted CSBC/Gravel Borrow or lean-mix concrete/CDF. Footing excavations should be observed by PanGEO to confirm that the exposed footing subgrades are consistent with the expected conditions and adequate to support the design bearing pressure.

It should be noted that site soils are highly moisture sensitive, and can be easily disturbed when exposed to moisture. If footing construction will be constructed during wet weather conditions, the exposed footing subgrade should be adequate protected. This may be accomplished with at least 3 inches of lean-mix concrete, or 4 to 6 inches of crushed surfacing base course (CSBC).

6.3 FLOOR SLABS

The floor slabs for the proposed building may be constructed using conventional concrete slab-on-grade floor construction. The floor slabs should be supported on competent undisturbed native soil or structural fill paced on undisturbed native soils. Any over-excavations, if needed, should be backfilled with structural fill.

Interior concrete slab-on-grade floors should be underlain by a capillary break consisting of at least of 4 inches of pea gravel or compacted ¾-inch, clean crushed rock (less than 3 percent fines). The capillary break material should meet the gradational requirements provided in Table 3, below.

Table 3 – Capillary Break Gradation

Sieve Size	Percent Passing
¾-inch	100
No. 4	0 – 10
No. 100	0 – 5
No. 200	0 – 3

The capillary break should be placed on subgrade soils that have been compacted to a dense and unyielding condition.

A 10-mil polyethylene vapor barrier should also be placed directly below the slab. Construction joints should be incorporated into the floor slab to control cracking.

6.4 RETAINING AND BASEMENT WALL DESIGN PARAMETERS

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

6.4.1 Lateral Earth Parameters

Cantilever walls should be designed for an equivalent fluid pressure of 35 pcf for a level backfill condition behind the walls and assuming the walls are free to rotate. If the walls are restrained at the top from free movement, such as basement walls with a floor diaphragm, an equivalent fluid pressure of 45 pcf should be used for a level backfill condition behind the walls. Permanent walls should be designed for an additional uniform lateral pressure of 8H psf for seismic loading, where H corresponds to the height of the buried depth of the wall.

The recommended lateral pressures assume the backfill behind the walls consists of a free draining and properly compacted fill with adequate drainage provisions.

6.4.2 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 the wall height.

6.4.3 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 wall foundation. Passive resistance values may be determined using an equivalent fluid weight of 250 pcf. This value includes a factor of safety of 1.5, assuming the footing is backfilled with structural fill. A friction coefficient of 0.35 may be used to determine the frictional resistance at the base of the footings. The coefficient includes a factor of safety of 1.5.

6.4.4 Wall Drainage

Provisions for wall drainage should consist of a 4-inch diameter perforated drainpipe placed 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. 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.

6.4.5 Wall Backfill

Retaining wall backfill should consist of free draining granular material. The site soils are relatively silty and would not meet the requirements for wall backfill. We recommend importing a free draining granular material, such as Gravel Borrow as defined in Section 9-03.14(1) of the WSDOT *Standard Specifications for Road, Bridge, and Municipal*

Construction (WSDOT, 2018). In areas where space is limited between the wall and the face of excavation, pea gravel may be used as backfill without compaction.

Wall backfill should be properly moisture conditioned, placed in loose, horizontal lifts less than 12 inches in thickness, and compacted to a dense and unyielding condition. If density tests will be performed, the test results should show at least 95 percent of the maximum dry density, as determined using test method ASTM D-1557 (Modified Proctor). 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.

6.5 Permanent Cut and Fill Slopes

Based on the anticipated soil that will be exposed in the planned excavation, we recommend permanent cut and fill slopes be constructed no steeper than 2H:1V (Horizontal:Vertical).

7.0 CONSTRUCTION CONSIDERATIONS

7.1 Site Preparation

Site preparation for the proposed project includes removing the existing structure, stripping and clearing of surface vegetation, and excavations to the design subgrade. All debris from demolition should be removed from the site prior to the start of excavations or grading. All 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, should also be over-excavated and replaced with compacted structural fill or CDF/lean-mix concrete.

7.2 Temporary Excavation and Shoring

As currently planned, the proposed construction may require excavations up to about 5 feet deep. We anticipate the excavations to mainly encounter loose to dense silty sand. 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.

7.3 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 soils are not suitable to be reused as structural fill. The structural backfill needed should consist of imported, well-graded granular material, such as WSDOT CSBC or Gravel Borrow, or approved equivalent. 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.

7.4 Structural Fill Placement and Compaction

Structural fill should be properly moisture conditioned, placed in loose, horizontal lifts less than 12 inches in thickness, and compacted to a dense and unyielding condition. The adequacy of compaction should be verified by a PanGEO representative. Alternatively, a minimum 95 percent maximum density as determined using ASTM D-1557 (Modified Proctor) maybe used to determine the adequacy of the compacted fill.

The procedure to achieve proper density of a compacted fill depends on the size and type of compaction equipment, the number of passes, thickness of the lifts being compacted, and certain soil properties. If the excavation to be backfilled is constricted and limits the use of heavy equipment, smaller equipment can be used, but the lift thickness will need to be reduced to achieve the required relative compaction.

Generally, loosely compacted soils are a result of poor construction technique or improper moisture content. Soils with high fines contents are particularly susceptible to becoming too wet and coarse-grained materials easily become too dry, for proper compaction. Soils with a moisture content too high for adequate compaction should be dried as necessary, or moisture conditioned by mixing with drier materials, or other methods.

7.5 WET WEATHER CONSTRUCTION

General recommendations relative to earthwork performed in wet weather or in wet conditions are presented below. The following procedures are best management practices recommended for use in wet weather construction:

- Earthwork should be performed in small areas to minimize subgrade exposure to wet weather. Excavation or the removal of unsuitable soil should be followed promptly by the placement and compaction of clean structural fill. The size and type of construction equipment used may have to be limited to prevent soil disturbance.
- During wet weather, the allowable fines content of the structural fill should be reduced to no more than 5 percent by weight based on the portion passing the 0.75-inch sieve. The fines should be non-plastic.
- 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 installed at strategic locations around the site to control erosion and the movement of soil.
- Excavation slopes and soils stockpiled on site should be covered with plastic sheeting.

7.6 EROSION AND 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 leaving the immediate work site. Temporary erosion control may require the use of hay bales on the downhill side of the project to prevent water from leaving the site and potential storm water detention to trap sand and silt before the water is discharged to a suitable outlet. All collected water should be directed under control to a positive and permanent discharge system.

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 collected and directed away from the structure to a suitable outlet. Potential issues associated with erosion may also be reduced by establishing vegetation within disturbed areas immediately following grading operations.

8.0 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.

9.0 CLOSURE

We have prepared this report for Mr. Mitch Mounger 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 services.

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.

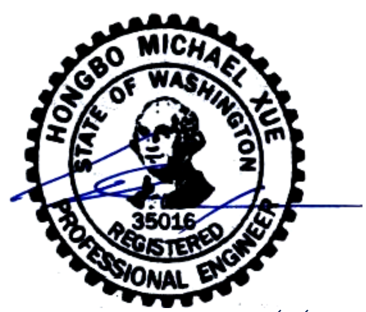
The scope of our work does not include services related to construction safety precautions. Our recommendations are not intended to direct the contractors' methods, techniques, sequences or procedures, except as specifically described in our report for consideration in design. Additionally, the scope of our services 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.

Sincerely,



7/7/2020

John A. Manke, L.G.
Staff Geologist

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

10.0 REFERENCES

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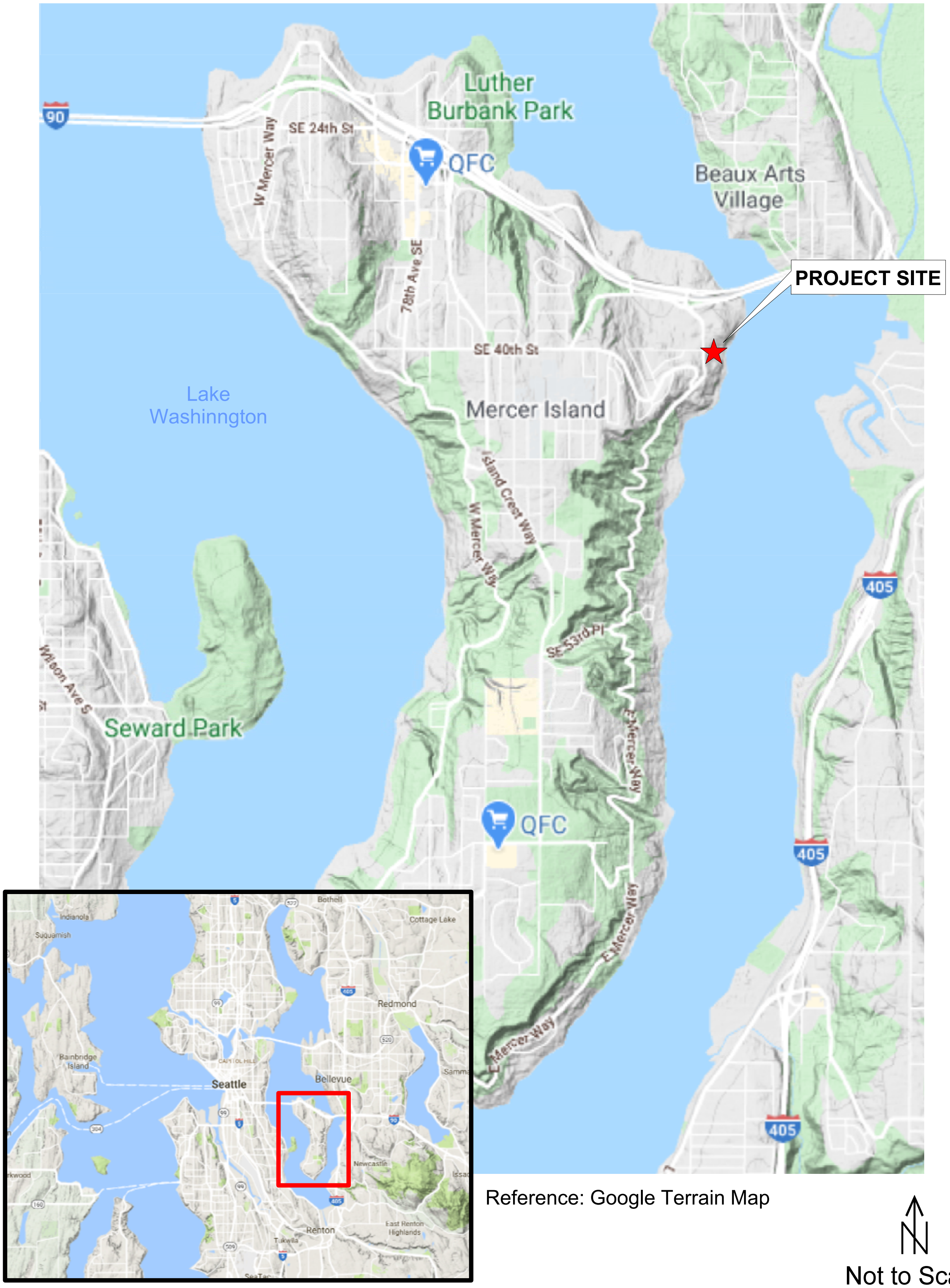
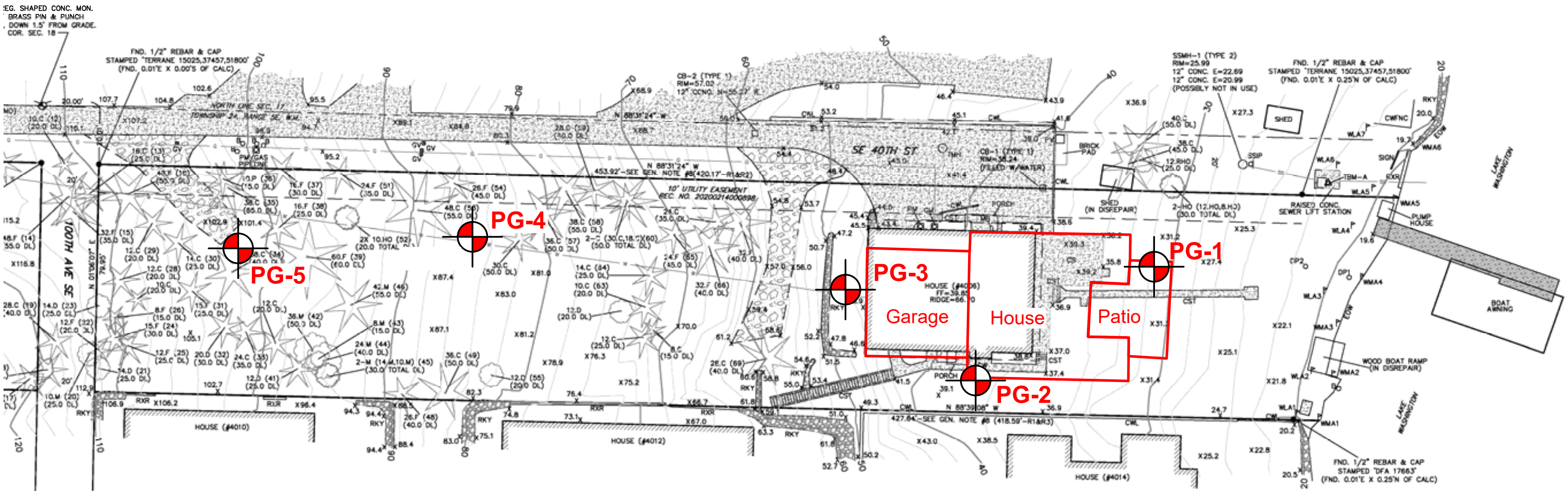


Reference: Google Terrain Map

N

Not to Scale

PanGEO INCORPORATED	**Proposed Mounger Residence** **4006 East Mercer Way** **Mercer Island, Washington**	**VICINITY MAP**	
		Project No. **20-174**	Figure No. **1**



N

Approx. Scale
1" = 60'

Note: Based on Topographic Survey prepared by Tyee Surveyors, dated 6/10/20.

Legend:

PG-1 Approx. Test Boring Locations

Proposed House Location

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Proposed Mounger Residence
4006 East Mercer Way
Mercer Island, Washington

SITE AND EXPLORATION PLAN

Project No. **20-174**

Figure No. **2**

APPENDIX A

SUMMARY 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
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

LOG KEY 13-104_LOGS.GPJ PANGEO.GDT 6/18/13

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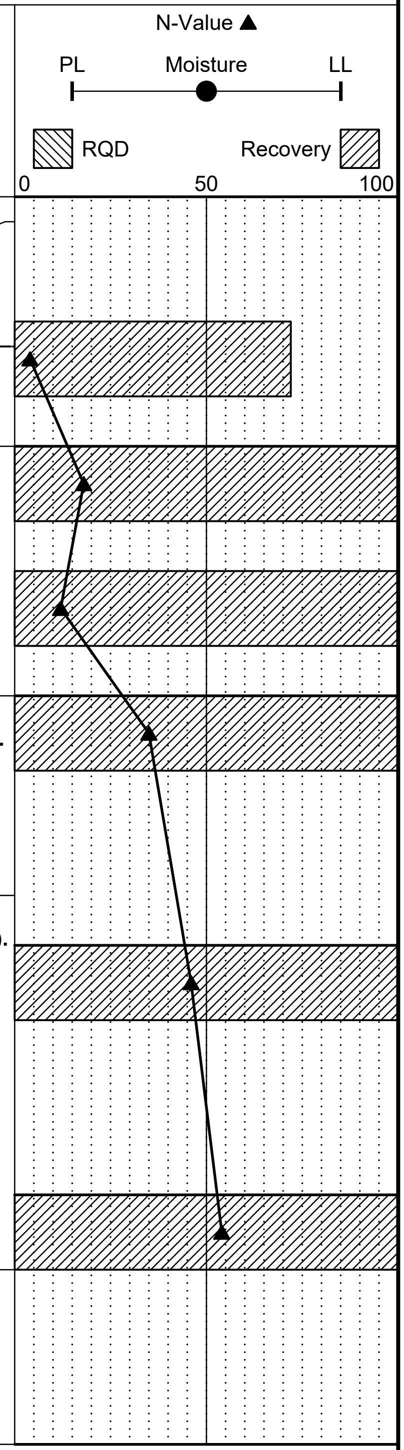
Phone: 206.262.0370

Terms and Symbols for Boring and Test Pit Logs

Figure A-1

Project:	4006 E Mercer Way	Surface Elevation:	32.0ft
Job Number:	20-174	Top of Casing Elev.:	N/A
Location:	2006 E Mercer Way, MI	Drilling Method:	HSA
Coordinates:	Northing: , Easting:	Sampling Method:	SPT

Depth, (ft)	Sample No.	Sample Type	Blows / 6 in.	Other Tests	Symbol	MATERIAL DESCRIPTION
0						Grass and topsoil: 6 inches thick.
						Very loose, moist, brown, silty SAND; pockets of medium sand. **(Fill).**
	S-1		2 1 3			Soft, moist, light brown SILT with sand.
5	S-2		3 8 10			Medium dense, moist, gray-brown, silty SAND; heavy iron oxide staining **(Lake Deposits).**
	S-3		6 5 7			-Becomes gray-brown, silty, fine SAND; minor iron oxide staining. -Becomes wet.
10	S-4		8 16 19			Dense, moist, gray-brown, silty SAND with gravel. **(Pre-Olympia Glacial Till).**
						Dense, wet, light brown, fine to medium SAND. **(Pre-Olympia Non-Glacial Deposits).**
15	S-5		15 21 25			
20	S-6		10 20 34			-Becomes gray-brown.
						Boring terminated at about 21.5 feet below ground surface. Groundwater was observed at about 15 feet during drilling. Perched groundwater was also observed from about 8.5 to 10 feet.
25						



		Remarks: Borings drilled using a small track drill rig. Standard penetration test (SPT) sampler driven with a 140 lb. safety hammer. Hammer operated with a rope and cathead mechanism. Surface elevation estimated based on Google Earth, 2018.
Completion Depth:	21.5ft	
Date Borehole Started:	5/20/20	
Date Borehole Completed:	5/20/20	
Logged By:	J. Manke	
Drilling Company:	Geologic Drill Partners, Inc.	

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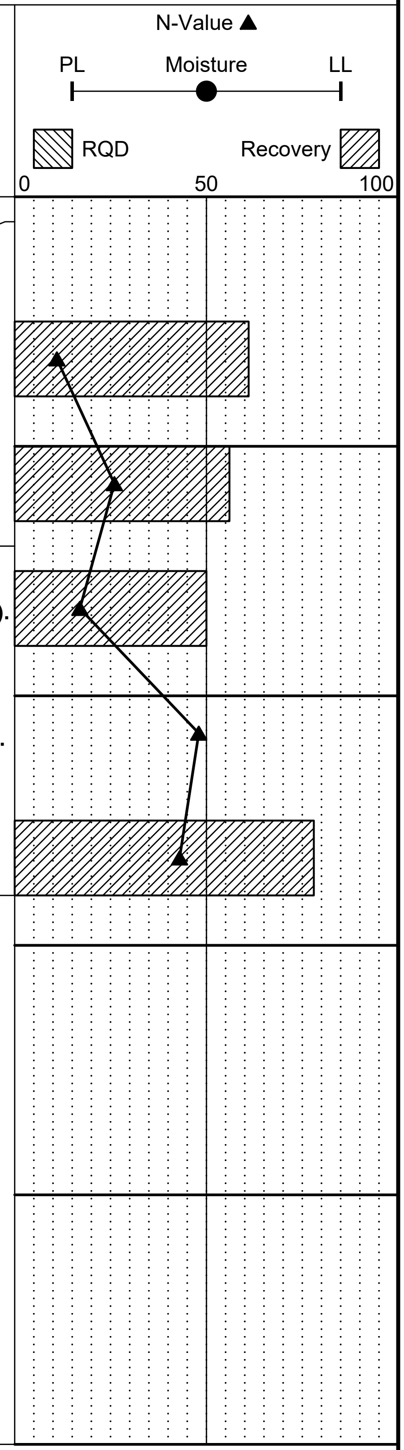
LOG OF TEST BORING PG-1

Figure A-2

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

Project:	4006 E Mercer Way	Surface Elevation:	40.0ft
Job Number:	20-174	Top of Casing Elev.:	N/A
Location:	2006 E Mercer Way, MI	Drilling Method:	HSA
Coordinates:	Northing: , Easting:	Sampling Method:	SPT

Depth, (ft)	Sample No.	Sample Type	Blows / 6 in.	Other Tests	Symbol	MATERIAL DESCRIPTION
0						Grass and topsoil: 6 inches thick.
						Medium dense, moist, light brown silty, fine to medium SAND with gravel. **(Fill).**
	S-1		6 3 8			
5	S-2		10 13 13			-Becomes gravelly, medium to coarse SAND.
						Medium dense, moist, light brown silty, fine to medium SAND with trace gravel. **(Pre-Olympia Till Deposits - Weathered).**
	S-3		8 9 8			
10	S-4		20 23 25			-Becomes very dense, moist, gray-brown, silty SAND with gravel. **(Pre-Olympia Till Deposits).**
	S-5		19 21 22			
						Boring terminated at about 14 feet below ground surface. Groundwater was not observed during drilling.
15						
20						
25						



Completion Depth:	14.0ft
Date Borehole Started:	5/20/20
Date Borehole Completed:	5/20/20
Logged By:	J. Manke
Drilling Company:	Geologic Drill Partners, Inc.

Remarks: Borings drilled using a small track drill rig. Standard penetration test (SPT) sampler driven with a 140 lb. safety hammer. Hammer operated with a rope and cathead mechanism. Surface elevation estimated based on Google Earth, 2018.

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LOG OF TEST BORING PG-2

Figure A-3

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

Project:	4006 E Mercer Way
Job Number:	20-174
Location:	2006 E Mercer Way, MI
Coordinates:	Northing: , Easting:
Surface Elevation:	50.0ft
Top of Casing Elev.:	N/A
Drilling Method:	HSA
Sampling Method:	SPT

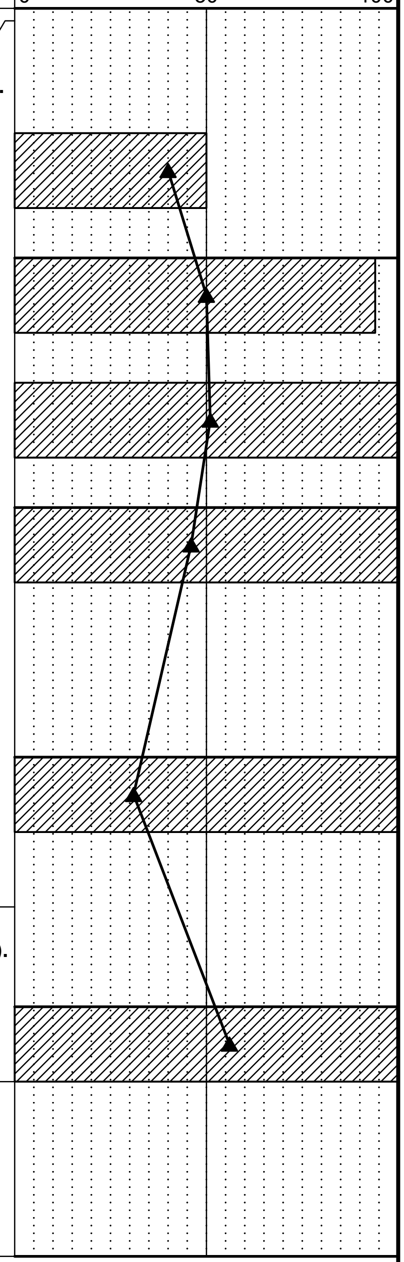
Depth, (ft)	Sample No.	Sample Type	Blows / 6 in.	Other Tests	Symbol	MATERIAL DESCRIPTION
0						Grass and topsoil: 3 inches thick.
						Dense, moist, gray-brown, silty SAND with gravel. **(Pre-Olympia Glacial Till).**
	S-1		13 15 25			
5	S-2		12 21 29			-Becomes very dense.
	S-3		13 23 28			-With pockets of clean, medium sand.
10	S-4		12 20 26			-Becomes dense.
15	S-5		7 12 19			-With decreasing gravel.
						Very dense, moist, clean, fine to medium SAND. **(Pre-Olympia Non-glacial Deposits).**
20	S-6		20 25 31			
						Boring terminated at about 21.5 feet below ground surface. Grounwater was not observed during drilling.
25						

N-Value ▲

PL Moisture LL

RQD Recovery

0 50 100



Completion Depth:	21.5ft
Date Borehole Started:	5/20/20
Date Borehole Completed:	5/20/20
Logged By:	J. Manke
Drilling Company:	Geologic Drill Partners, Inc.

Remarks: Borings drilled using a small track drill rig. Standard penetration test (SPT) sampler driven with a 140 lb. safety hammer. Hammer operated with a rope and cathead mechanism. Surface elevation estimated based on Google Earth, 2018.

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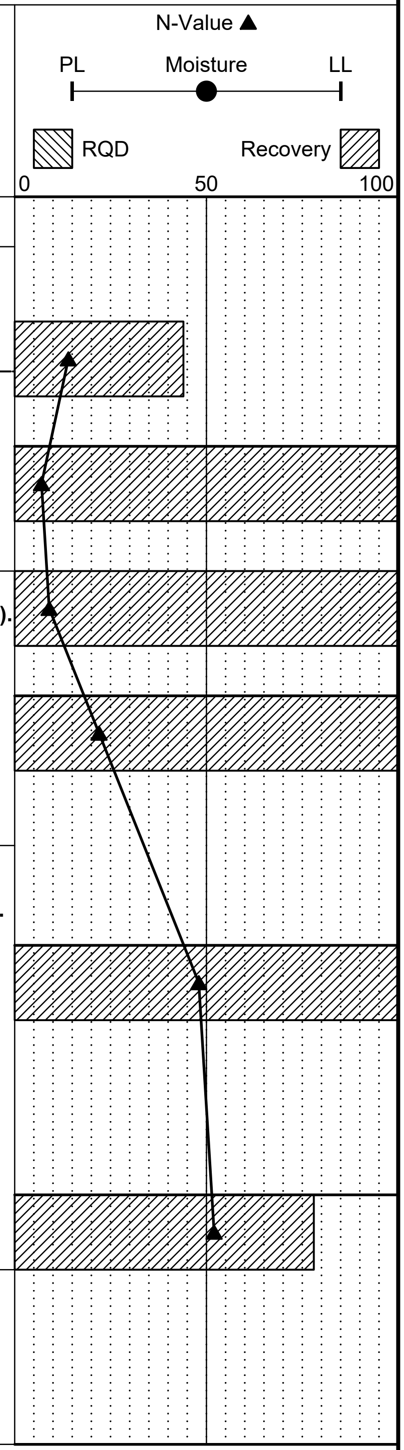
LOG OF TEST BORING PG-3

Figure A-4

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

Project:	4006 E Mercer Way	Surface Elevation:	77.0ft
Job Number:	20-174	Top of Casing Elev.:	N/A
Location:	2006 E Mercer Way, MI	Drilling Method:	HSA
Coordinates:	Northing: , Easting:	Sampling Method:	SPT

Depth, (ft)	Sample No.	Sample Type	Blows / 6 in.	Other Tests	Symbol	MATERIAL DESCRIPTION
0						Topsoil: 12 inches thick.
						Loose, dark brown to brown, silty SAND with gravel; with roots and organics. **(Fill).**
	S-1		5, 6, 8			Medium dense, moist, gray-brown, silty SAND with gravel; numerous roots.
5	S-2		3, 3, 4			
	S-3		4, 4, 5			Loose to medoum dense, moist, gray-brown, clean, medium SAND. **(Pre-Olympia Non-glacial Depostis - Weathered).**
10	S-4		7, 9, 13			
						Dense, moist, gray-brown, silty SAND with trace gravel. **(Pre-Olympia Glacial Till).**
15	S-5		16, 22, 26			
20	S-6		14, 22, 30			-Becomes very dense.
						Boring terminated at about 21.5 feet below ground surface. Groundwater was not observed during drilling.
25						



Completion Depth:	21.5ft
Date Borehole Started:	5/20/20
Date Borehole Completed:	5/20/20
Logged By:	J. Manke
Drilling Company:	Geologic Drill Partners, Inc.

Remarks: Borings drilled using a small track drill rig. Standard penetration test (SPT) sampler driven with a 140 lb. safety hammer. Hammer operated with a rope and cathead mechanism. Surface elevation estimated based on Google Earth, 2018.

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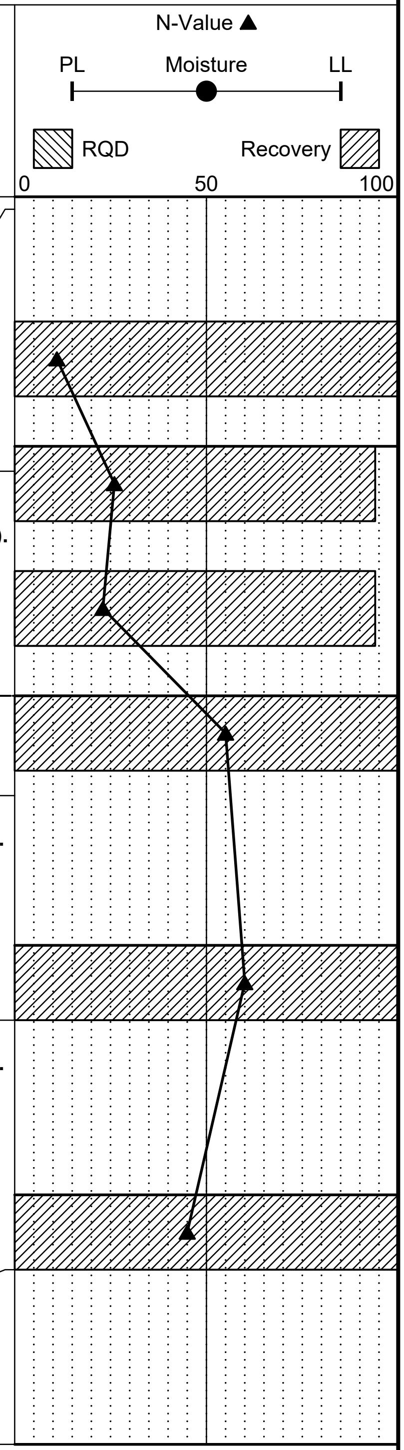
LOG OF TEST BORING PG-4

Figure A-5

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

Project:	4006 E Mercer Way	Surface Elevation:	103.0ft
Job Number:	20-174	Top of Casing Elev.:	N/A
Location:	2006 E Mercer Way, MI	Drilling Method:	HSA
Coordinates:	Northing: , Easting:	Sampling Method:	SPT

Depth, (ft)	Sample No.	Sample Type	Blows / 6 in.	Other Tests	Symbol	MATERIAL DESCRIPTION
0						Topsoil: 3 inches thick.
						Medium dense, moist, light brown, silty, fine SAND. **(Fill).**
	S-1		4 5 6			Occasional rootlets.
5	S-2		7 13 13			Medium dense, moist, light brown, fine SAND. **(Pre-Olympia Non-Glacial Deposits).**
	S-3		8 9 14			
10	S-4		16 25 30			Medium dense, moist, light brown, fine SAND with silt.
						Very dense, moist, gray, very silty, fine SAND. **(Pre-Olympia Glacial Till).**
15	S-5		18 26 34			
						Dense, moist, gray-brown, medium SAND. **(Pre-Olympia Glacial Till).**
20	S-6		16 17 28			Becomes silty SAND.
						Boring terminated at about 21.5 feet below ground surface. Groundwater was not observed during drilling.
25						



Completion Depth:	21.5ft
Date Borehole Started:	5/20/20
Date Borehole Completed:	5/20/20
Logged By:	J. Manke
Drilling Company:	Geologic Drill Partners, Inc.

Remarks: Borings drilled using a small track drill rig. Standard penetration test (SPT) sampler driven with a 140 lb. safety hammer. Hammer operated with a rope and cathead mechanism. Surface elevation estimated based on Google Earth, 2018.

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LOG OF TEST BORING PG-5

Figure A-6

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