INSIGHT GEOLOGIC, INC.

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RJ Development
401 Central St SE
Olympia, Washington 98501
Attention: Caleb Perkins

Report
Geotechnical and Stormwater Investigation
Proposed Multi-Family Development
2000 24th Avenue NW
Olympia, Washington
Project No. 901-003-01

INTRODUCTION

Insight Geologic is pleased to present our report on the subsurface conditions as they pertain to geotechnical properties and the infiltration of stormwater at the site of your proposed multi-family residential development to be located at 2000-24th Avenue NW in unincorporated Thurston County, Washington. The location of the site is shown relative to surrounding physical features in the Vicinity Map, Figure 1.

We understand that the project site consists of a single parcel of property totaling approximately 11 acres. The site is wooded in the western portion and used for pasture and livestock holding in the eastern portion. The eastern portion also contains a single-family residence.

SCOPE OF SERVICES

The purpose of our services was to evaluate subsurface conditions as they pertain to stormwater infiltration and geotechnical parameters for the proposed project. The specific tasks conducted are as follows:

Stormwater Investigation

1. Provide for the location of subsurface utilities on the site. We performed this task by notifying the "One Call" system.
2. Drilled four borings across the site to evaluate depth to groundwater using a track-mounted drilling rig. The borings were extended to a depth of about 16 feet or until the underlying glacial till was encountered.
3. Installed four 1-inch diameter monitoring wells constructed of PVC casing. The wells were finished inside locking steel covers installed flush with the surrounding grade.
4. Collected soil samples continuously during drilling to the full depth of the borings.

5. Maintained logs of the soils encountered in the boreholes and provided well construction details. Soils were described in general accordance with the Unified Soil Classification System and presented on the field logs.
6. Conducted laboratory testing on selected soil samples for determination of a design stormwater infiltration rate for the site.
7. Conducted an evaluation of stormwater infiltration rates using the detailed method outlined in the 2022 Thurston County Drainage Design and Erosion Control Manual and provide a design infiltration rate for stormwater infiltration.

Geotechnical Investigation

8. Excavated a series of eight exploratory test pits across the site using a small, track-mounted excavator. The test pits were excavated to a depth of between 4 to 9 feet below ground surface and backfilled with the excavated soil.
9. Logged the soils encountered in the test pits in general accordance with the Unified Soil Classification System and presented on the field logs.
10. Obtained representative soil samples from the test pits for laboratory testing.
11. Conducted laboratory testing on selected soil samples. We performed grain size analysis and moisture content to evaluate geotechnical parameters of the soil.
12. Prepared a report summarizing our field activities and providing our recommendations as to clearing activities, suitability of onsite soil for use as fill, Seismic Class, bearing capacity, foundation recommendations, retaining wall recommendations, infiltration rates and paving recommendations.

FINDINGS

Surface Conditions

The project site consists of a single rectangular parcel of land with an area of approximately 11.28 acres. The site is situated at an elevation of approximately 212 to 226 feet above mean sea level and the east half of the site is developed with a residential structure, barns, associated outbuildings, and fenced paddocks for sheep and goats. The west half of the site is undeveloped woodland and wetland. The site is accessed by 24th Avenue NW along the southeast corner of the parcel. Other residential properties abut the subject property on all sides. The site is gently sloping from elevated areas on the east half and west edge of the site to a low area near the central portion of the site containing a mapped wetland.

Geology

Based on our review of available published geologic maps, Vashon age glacial till underlie the project site and surrounding area. The glacial till consists of an unsorted mixture of silt, sands, and gravel that was deposited at the base of the advancing glacier, and was subsequently glacially compacted.

Subsurface Explorations

We explored subsurface conditions at the site on January 6 and February 3, 2023, by excavating eight test pits and advancing four borings in the locations as shown on the Site Plan, Figure 2. The test pits

were excavated using a track-mounted excavator. The exploratory borings were completed by Standard Environmental Probe using a track-mounted, direct-push drill rig. A geologist from Insight Geologic monitored the explorations and maintained a log of the conditions encountered. The test pits were completed at depths of between 4.5 and 9 feet bgs and the borings were completed to a depth of between 8 and 16 feet bgs. Test pits completed prior to reaching a depth of 8 feet bgs and borings completed prior to a depth of 10 feet were terminated after encountering underlying glacial till or after encountering shallow groundwater at the site. The soils were visually classified in general accordance with the system described in ASTM D2487-06. A copy of the explorations is contained in Attachment A.

Monitoring wells, consisting of a 1-inch diameter casing and screen, were installed in each of the four borings to a depth of between 8 to 15 feet bgs. The monitoring wells were completed within locking, tamper-resistant steel covers, and installed flush with the surrounding grade. The monitoring well construction details are included in Attachment A. For the purposes of this report, groundwater elevations were based on estimated ground surface elevations obtained from the Thurston County Geodata website digital elevation model.

Soil Conditions

Soil conditions encountered within the explorations were generally consistent across the site. Underlying approximately 6 inches of sod or forest duff, we encountered 1.5 to 3 feet of brown to red-brown silty sand and gravel with roots (SM) in a medium dense and moist condition overlying approximately 0.5 to 4 feet of brown well- to poorly graded gravel with fine to coarse sand (GP, GW) in a medium dense and moist condition. In general, this gravel unit was thicker on the east half of the site. Underlying these upper units, we encountered either gray-brown poorly graded sand with gravel with silt or poorly graded sand with gravel (SP-SM, SP) in a medium dense to dense and moist to wet condition. We identified this sand with silt unit as the underlying glacial till which was encountered in test pits TP-1, TP-4, and TP-8. One exception to this general description was noted. Test pit TP-7 encountered 3 feet of silt in a medium stiff and moist condition instead of the gravel unit at a depth of 2 feet bgs.

The surficial soils encountered are consistent with Alderwood gravelly sandy loam, which is mapped for the area. This soil is generally formed on glacial drift or glacial outwash and generally has restrictive layers occurring at 2 to 3 feet below grade. Percolation is generally moderately low to very low, according to the U.S. Department of Agriculture Soil Survey.

Groundwater Conditions

Groundwater was encountered in test pits TP-5 to TP-7 completed on the site. These test pits are located closest to the mapped wetland at the site. Due to the relatively shallow glacial till at the site, perched water likely develops on the till surface at least briefly during the winter months. Additional groundwater monitoring in the infiltration areas will likely be needed to further define the existence of perched groundwater.

Laboratory Testing

We selected ten soil samples for gradation analyses in general accordance with ASTM D422 to define soil class and obtain parameters for stormwater infiltration calculations. Our geotechnical laboratory tests are presented in Attachment B.

STORMWATER INFILTRATION

We completed a stormwater infiltration rate evaluation in general accordance with the 2022 Thurston County Drainage Design and Erosion Control Manual (2022 Manual). The 2022 Manual uses a detailed method that utilizes the relationship between the D_{10}, D_{60}, and D_{90} results of the ASTM grain-size distribution analyses, along with site-specific correction factors to estimate long-term design infiltration rates.

Based on our analyses, the shallow glacial till and/or groundwater identified will present a significant restriction to the majority of infiltration systems that can be used at the site as there is limited room to allow for the required separation from the base of most infiltration systems. Based on our gradation analyses, we estimate that the initial long-term design infiltration rate (F_{design}) for the proposed stormwater infiltration galleries is 0.6 to 2.6 inches per hour, after applying the appropriate correction factors. Our calculations assume that the stormwater infiltration will occur within stormwater galleries at a depth of approximately 4 to 5 feet bgs. We further assumed that the underlying glacial till units are relatively impermeable. This preliminary infiltration rate takes into account the glacial till horizon encountered at the site, but does not account for perched groundwater that may develop during the winter months. The results of our stormwater infiltration evaluation are presented in Table 1.

Table 2. Design Infiltration Rates – Grain Size Analysis Method

Exploration Location	Unit	Depth Range (feet)	D_{10} Value	D_{60} Value	D_{90} Value	Design Infiltration Rate (inches per hour)
TP-2	GP	2.5 – 9.0	0.28	11.5	19.0	2.6
TP-5	SP	4.0 – 8.0	0.12	0.43	19.0	0.7
TP-6	SP	4.0 – 7.0	0.18	2.1	27.5	0.6

SEISMIC DESIGN CONSIDERATIONS

General

We understand that seismic design will likely be performed using the 2018 IBC standards. The following parameters may be used in computing seismic base shear forces:

Table 3. 2018 IBC Seismic Design Parameters

Spectral Response Accel. at Short Periods (S_S) = 1.428
Spectral Response Accel. at 1 Second Periods (S_1) = 0.53
Site Class = D
Site Coefficient (F_A) = 1.0
Site Coefficient (F_V) = 1.77

Ground Rupture

Because of the location of the site with respect to the nearest known active crustal faults, and the presence of a relatively thick layer of glacial till deposits, it is our opinion that the risk of ground rupture at the site due to surface faulting is low.

Soil Liquefaction

Liquefaction refers to a condition where vibration or shaking of the ground, usually from earthquake forces, results in the development of excess pore water pressures in saturated soils, and a subsequent loss of stiffness in the soil occurs. Liquefaction also causes a temporary reduction of soil shear strength and bearing capacity, which can cause settlement of the ground surface above the liquefied soil layers. In general, soils that are most susceptible to liquefaction include saturated, loose to medium dense, clean to silty sands, and non-plastic silts within 50 feet of the ground surface.

Based on our review of the *Liquefaction Susceptibility Map of Thurston County (Palmer, 2004)*, the project site is identified to have a low potential risk for soil liquefaction. Based on our experience with detailed seismic studies in the Olympia area, including areas that are mapped within the same glacial outwash and till soil deposits as the project site, we concur with the reviewed map. It is our opinion that there is a low risk for soil liquefaction at the site. Additional investigation and evaluation would be needed to further define this risk.

Seismic Compression

Seismic compression is defined as the accrual of contractive volumetric strains in unsaturated soils during strong shaking from earthquakes (Stewart et al., 2004). Loose to medium-dense clean sands and non-plastic silts are particularly prone to seismic compression settlement. Seismic compression settlement is most prevalent on slopes, but it can also occur on flat ground. It is our opinion that the site has a low risk for seismic compression settlement.

Seismic Settlement Discussion

Based on the materials encountered in our explorations, it is our preliminary opinion that seismic settlements (liquefaction-induced plus seismic compression) could potentially total a few inches at the site as the result of an IBC design-level earthquake. We are available upon request to perform deep subsurface explorations and detailed seismic settlement estimates during the design phase.

Lateral Spreading

Lateral spreading involves the lateral displacement of surficial blocks of non-liquefied soil when an underlying soil layer liquefies. Lateral spreading generally develops in areas where sloping ground or large grade changes are present. Based on our understanding of the subsurface conditions along the minimal slope, it is our opinion that there could be a low risk for the development of lateral spreading as a result of an IBC design-level earthquake.

CONCLUSIONS AND RECOMMENDATIONS

General

Based on the results of our subsurface explorations and engineering analyses, it is our opinion that the proposed development is feasible from a geotechnical standpoint. We recommend that the proposed structures be supported on shallow concrete foundations that are designed using an allowable soil-bearing capacity of 2,500 pounds per square foot (psf).

The soils encountered in our explorations are typically in a medium-dense condition near the ground surface. To limit the potential for structural settlement, we recommend that shallow foundations and slabs-on-grade be established on a minimum 1-foot thick layer of structural fill. Depending on the final grading plans and the time of year earthwork is performed; it may be possible to reuse the on-site soils as structural fill under the foundations/slabs.

Based on the result of our study, it appears that soils have a limited capacity for stormwater infiltration at the site. Our evaluations based on the 2022 Manual indicated an infiltration rate of between 0.6 and 2.6 inches per hour for the soils located above the glacial till unit. This does not take into account the potential for perched groundwater which may develop above the till unit during the winter months, and the potential mounding of the stormwater on the water table. In addition, the shallow depth of the glacial till soils may represent an additional restriction to most infiltration methods. It may be prudent to investigate the use of low-impact development (LID) methods such as pervious pavement or other shallow infiltration options as a part of this project.

Earthwork

General

We anticipate that site development earthwork will include removing the vegetation and existing hardscape, stripping sod/topsoil materials, preparing subgrades, excavating for utility trenches, and placing and compacting structural fill. We expect that the majority of site grading can be accomplished with conventional earthmoving equipment in proper working order.

Our explorations did not encounter appreciable amounts of debris or unsuitable soils associated with past site development other than the existing asphalt located on-site. Still, it is possible that additional concrete slabs, abandoned utility lines or other development features from the existing development could be encountered during construction. The contractor should be prepared to deal with these conditions.

Clearing and Stripping

Clearing and stripping should consist of removing surface and subsurface deleterious materials including sod/topsoil, asphalt, trees, brush, debris, and other unsuitable loose/soft or organic materials. Stripping and clearing should extend at least 5 feet beyond all structures and areas to receive structural fill.

We estimate that a stripping depth of about 0.5 feet will be required to remove the vegetation encountered in several of our explorations. Deeper stripping depths may be required if additional unsuitable soils are exposed during stripping operations. We recommend that trees be removed by

overturning so that the majority of roots are also removed. Depressions created by tree or stump removal should be backfilled with structural fill and properly compacted.

Subgrade Preparation

After stripping and excavating to the proposed subgrade elevation, and before placing structural fill or foundation concrete, the exposed subgrade should be thoroughly compacted to a firm and unyielding condition. The exposed subgrade should then be proof-rolled using loaded, rubber-tired heavy equipment. We recommend that Insight Geologic be retained to observe the proof-rolling prior to the placement of structural fill or foundation concrete. Areas of limited access that cannot be proof-rolled can be evaluated using a steel probe rod. If soft or otherwise unsuitable areas are revealed during proof-rolling or probing, that cannot be compacted to a stable and uniformly firm condition, we generally recommend that: 1) the subgrade soils be scarified (e.g., with a ripper or farmer's disc), aerated and recompacted; or 2) the unsuitable soils be overexcavated and replaced with structural fill.

Temporary Excavations and Groundwater Handling

Excavations deeper than 4 feet should be shored or laid back at a stable slope if workers are required to enter. Shoring and temporary slope inclinations must conform to the provisions of Title 296 Washington Administrative Code (WAC), Part N, "Excavation, Trenching and Shoring." Regardless of the soil type encountered in the excavation, shoring, trench boxes or sloped sidewalls were required under the Washington Industrial Safety and Health Act (WISHA). The contract documents should specify that the contractor is responsible for selecting excavation and dewatering methods, monitoring the excavations for safety and providing shoring, as required, to protect personnel and structures.

In general, temporary cut slopes should be inclined no steeper than about 1.5H:1V (horizontal: vertical). This guideline assumes that all surface loads are kept at a minimum distance of at least one-half the depth of the cut away from the top of the slope, and that significant seepage is not present on the slope face. Flatter cut slopes were necessary where significant seepage occurs or if large voids are created during excavation. Some sloughing and raveling of cut slopes should be expected. Temporary covering with heavy plastic sheeting should be used to protect slopes during periods of wet weather.

We anticipate that if perched groundwater is encountered during construction can be handled adequately with sumps, pumps, and/or diversion ditches. Groundwater handling needs will generally be lower during the late summer and early fall months. We recommend that the contractor performing the work be made responsible for controlling and collecting groundwater encountered during construction.

Permanent Slopes

We do not anticipate that permanent slopes will be utilized for the proposed project. If permanent slopes are necessary, we recommend the slopes be constructed at a maximum inclination of 2H:1V. Where 2H:1V permanent slopes are not feasible, protective facings and/or retaining structures should be considered.

To achieve uniform compaction, we recommend that fill slopes be overbuilt and subsequently cut back to expose well-compacted fill. Fill placement on slopes should be benched into the slope face and include keyways. The configuration of the bench and keyway depends on the equipment being used. Bench excavations should be level and extend into the slope face. We recommend that a vertical cut of about 3 feet be maintained for benched excavations. Keyways should be about 1-1/2 times the width of the equipment used for grading or compaction.

Erosion Control

We anticipate that erosion control measures such as silt fences, straw bales and sandbags will generally be adequate during development. Temporary erosion control should be provided during construction activities and until permanent erosion control measures are functional. Surface water runoff should be properly contained and channeled using drainage ditches, berms, swales, and tightlines, and should not discharge onto sloped areas. Any disturbed sloped areas should be protected with a temporary covering until new vegetation can take effect. Jute or coconut fiber matting, excelsior matting or clear plastic sheeting is suitable for this purpose. Graded or disturbed slopes should be tracked in-place with the equipment running perpendicular to the slope contours so that the track marks provide a texture to help resist erosion. Ultimately, erosion control measures should be in accordance with local regulations and should be clearly described on project plans.

Wet Weather Earthwork

Some of the near-surface soils contain up to about 35 percent fines. When the moisture content of the soil is more than a few percent above the optimum moisture content, the soil will become unstable and it may become difficult or impossible to meet the required compaction criteria. Disturbance of near-surface soils should be expected if earthwork is completed during periods of wet weather.

The wet weather season in this area generally begins in October and continues through May. However, periods of wet weather may occur during any month of the year. If wet weather earthwork is unavoidable, we recommend that:

- The ground surface is sloped so that surface water is collected and directed away from the work area to an approved collection/dispersion point.
- Earthwork activities not take place during periods of heavy precipitation.
- Slopes with exposed soil are covered with plastic sheeting or otherwise protected from erosion.
- Measures are taken to prevent on-site soil and soil stockpiles from becoming wet or unstable. Sealing the surficial soil by rolling with a smooth-drum roller prior to periods of precipitation should reduce the extent that the soil becomes wet or unstable.
- Construction traffic is restricted to specific areas of the site, preferably areas that are surfaced with materials not susceptible to wet weather disturbance.
- A minimum 1-foot thick layer of 4- to 6-inch quarry spalls is used in high traffic areas of the site to protect the subgrade soil from disturbance.
- Contingencies are included in the project schedule and budget to allow for the above elements.

Structural Fill Materials

General

Material used for structural fill should be free of debris, organic material and rock fragments larger than 3 inches. The workability of material for use as structural fill will depend on the gradation and moisture content of the soil. As the amount of fines increases, soil becomes increasingly more sensitive to small changes in moisture content and adequate compaction becomes more difficult or impossible to achieve.

On-Site Soil

We anticipate that the majority of the on-site soils encountered during construction will consist of silty sand, located at or near the surface of the site. It is our opinion, that this material may be a suitable source for structural fill during an extremely limited portion of the year. However, we anticipate that thin lifts (6 inches thick or less) will likely be needed to obtain structural fill compaction specifications. During the winter season, these materials may be over-optimum moisture and will require drying back to obtain suitable compaction. On-site materials used as structural fill should be free of roots, organic matter, and other deleterious materials and particles larger than 3 inches in diameter.

Select Granular Fill

Select granular fill should consist of imported, well-graded sand and gravel or crushed rock with a maximum particle size of 3 inches and less than 5 percent passing a U.S. Standard No. 200 sieve based on the minus ¾-inch fraction. Organic matter, debris or other deleterious material should not be present. In our experience, “gravel borrow” as described in Section 9-03.14(1) of the 2022 WSDOT Standard Specifications is typically a suitable source for select granular fill during periods of wet weather, provided that the percent passing a U.S. Standard No. 200 sieve is less than 5 percent based on the minus ¾-inch fraction.

Structural Fill Placement and Compaction

General

Structural fill should be placed on an approved subgrade that consists of uniformly firm and unyielding inorganic native soils or compacted structural fill. Structural fill should be compacted at a moisture content near optimum. The optimum moisture content varies with the soil gradation and should be evaluated during construction.

Structural fill should be placed in uniform, horizontal lifts and uniformly densified with vibratory compaction equipment. The maximum lift thickness will vary depending on the material and compaction equipment used but should generally not exceed the loose thicknesses provided in Table 4. Structural fill materials should be compacted in accordance with the compaction criteria provided in Table 5.

Table 4. Recommended Uncompacted Lift Thickness

Compaction Equipment	Recommended Uncompacted Fill Thickness (inches)	
	Granular Materials Maximum Particle Size ≤ 1 1/2 inch	Granular Materials Maximum Particle Size > 1 1/2 inch
Hand Tools (Plate Compactors and Jumping Jacks)	4 – 8	Not Recommended
Rubber-tire Equipment	10 – 12	6 – 8
Light Roller	10 – 12	8 – 10
Heavy Roller	12 – 18	12 – 16
Hoe Pack Equipment	18 – 24	12 – 16

Note: The above table is intended to serve as a guideline and should not be included in the project specifications.

Table 5. Recommended Compaction Criteria in Structural Fill Zones

Fill Type	Percent Maximum Dry Density Determined by ASTM Test Method D 1557 at ±3% of Optimum Moisture		
	0 to 2 Feet Below Subgrade	> 2 Feet Below Subgrade	Pipe Zone
Imported or On-site Granular, Maximum Particle Size < 1-1/4-inch	95	95	-----
Imported or On-site Granular, Maximum Particle Size >1-1/4-inch	N/A (Proof-roll)	N/A (Proof-roll)	-----
Trench Backfill[1]	95	92	90

Note: [1]Trench backfill above the pipe zone in nonstructural areas should be compacted to at least 85 percent.

Shallow Foundation Support

General

We recommend that the proposed structures be founded on continuous wall or isolated column footings, bearing on a minimum 1-foot thick overexcavation and replacement with compacted structural fill where underlying soils are not able to be compacted as structural fill. The structural fill zone should extend to a horizontal distance equal to the overexcavation depth on each side of the footing. The actual overexcavation depth will vary, depending on the conditions encountered.

We recommend that a representative from Insight Geologic observe the foundation surfaces before overexcavation, and before placing structural fill in overexcavations. This representative should confirm that adequate bearing surfaces have been prepared and that the soil conditions are as anticipated. Unsuitable foundation bearing soils should be recompacted or removed and replaced with compacted structural fill, as recommended by the geotechnical engineer.

Bearing Capacity and Footing Dimensions

We recommend an allowable soil bearing pressure of 2,500 psf for shallow foundations that are supported as recommended. This allowable bearing pressure applies to long-term dead and live loads exclusive of the weight of the footing and any overlying backfill. The allowable soil bearing pressure

can be increased by one-third when considering total loads, including transient loads such as those induced by wind and seismic forces. If higher bearing values are required, we should be consulted to evaluate appropriate methods to increase bearing in the subsurface.

We recommend a minimum width of 18 inches for continuous wall footings and 2 feet for isolated column footings. For settlement considerations, we have assumed a maximum width of 4 feet for continuous wall footings and 6 feet for isolated column footings.

Perimeter footings should be embedded at least 12 inches below the lowest adjacent grade where the ground is flat. Interior footings should be embedded a minimum of 6 inches below the nearest adjacent grade.

Settlement

We estimate that the total settlement of footings that are designed and constructed as recommended should be less than 1 inch. We estimate that differential settlement should be ½ inch or less between comparably loaded isolated footings or along 50 feet of continuous footing. We anticipate that the settlement will occur essentially as loads are applied during construction.

Lateral Load Resistance

Lateral loads on shallow foundation elements may be resisted by passive resistance on the sides of footings and by friction on the base of footings. Passive resistance may be estimated using an equivalent fluid density of 303 pounds per cubic foot (pcf), assuming that the footings are backfilled with structural fill. Frictional resistance may be estimated using 0.2 for the coefficient of base friction.

The lateral resistance values provided above incorporate a factor of safety of 1.5. The passive earth pressure and friction components can be combined, provided that the passive component does not exceed two-thirds of the total. The top foot of soil should be neglected when calculating passive resistance unless the foundation perimeter area is covered by a slab-on-grade or pavement.

Slabs-On-Grade

Slabs-on-grade should be established on a minimum 1-foot thick section of structural fill extending to an approved bearing surface. A modulus of vertical subgrade reaction (subgrade modulus) can be used to design slabs-on-grade. The subgrade modulus varies based on the dimensions of the slab and the magnitude of applied loads on the slab surface; slabs with larger dimensions and loads are influenced by soils to a greater depth. We recommend a modulus value of 200 pounds per cubic inch (pci) for the design of on-grade floor slabs with floor loads up to 500 psf. We are available to provide alternate subgrade modulus recommendations during design, based on specific loading information.

We recommend that slabs-on-grade in interior spaces be underlain by a minimum 4-inch thick capillary break layer to reduce the potential for moisture migration into the slab. The capillary break material should consist of well-graded sand and gravel or crushed rock containing less than 5 percent fines based on the fraction passing the ¾-inch sieve. The 4-inch thick capillary break layer can be included when calculating the minimum 1-foot thick structural fill section beneath the slab. If dry slabs are

required (e.g., where adhesives are used to anchor carpet or tile to the slab), a waterproofing liner should be placed below the slab to act as a vapor barrier.

Subsurface Drainage

It is our opinion that foundation footing drains are necessary for the proposed structures. The site soils are underlain by shallow glacial till which are generally poorly draining. Footing drains should be routed to existing on-site or planned storm drainage.

Conventional Retaining Walls

General

We do not anticipate that retaining walls will be utilized for the proposed project. We should be contacted during the design phase to review retaining wall plans and provide supplemental recommendations, if needed.

Drainage

Positive drainage is imperative behind any retaining structure. This can be accomplished by using a zone of free-draining material behind the wall with perforated pipes to collect water seepage. The drainage material should consist of coarse sand and gravel containing less than 5 percent fines based on the fraction of material passing the ¾-inch sieve. The wall drainage zone should extend horizontally at least 12 inches from the back of the wall. If a stacked block wall is constructed, we recommend that a barrier such as a non-woven geotextile filter fabric be placed against the back of the wall to prevent loss of the drainage material through the wall joints.

A perforated smooth-walled rigid PVC pipe, having a minimum diameter of 4 inches, should be placed at the bottom of the drainage zone along the entire length of the wall. Drainpipes should discharge to a tightline leading to an appropriate collection and disposal system. An adequate number of cleanouts should be incorporated into the design of the drains in order to provide access for regular maintenance. Roof downspouts, perimeter drains or other types of drainage systems should not be connected to retaining wall drain systems.

Design Parameters

We recommend an active lateral earth pressure of 31 pcf (equivalent fluid density) for a level backfill condition. This assumes that the top of the wall is not structurally restrained and is free to rotate. For restrained walls that are fixed against rotation (at-rest condition), an equivalent fluid density of 45 pcf can be used for the level backfill condition. For seismic conditions, we recommend a uniform lateral pressure of 14H psf (where H is the height of the wall) be added to the lateral pressures. This seismic pressure assumes a peak ground acceleration of 0.32 g. Note that if the retaining system is designed as a braced system but is expected to yield a small amount during a seismic event, the active earth pressure condition may be assumed and combined with the seismic surcharge.

The recommended earth pressure values do not include the effects of surcharges from surface loads or structures. If vehicles were operated within one-half of the height of the wall, a traffic surcharge should be added to the wall pressure. The traffic surcharge can be approximated by the equivalent

weight of an additional 2 feet of backfill behind the wall. Other surcharge loads, such as construction equipment, staging areas, and stockpiled fill, should be considered on a case-by-case basis.

Pavement Design Recommendations

The recommended pavement section for parking and drive areas consists of 6 inches of compacted granular base course, 2 inches of compacted crushed rock top course, and 2 compacted inches of asphalt concrete pavement. High traffic and driveway areas should have a minimum of 8 inches of compacted granular subbase, 2 inches of compacted crushed rock top course, and 3 inches of asphalt concrete pavement. Native soils are appropriate for use as granular fill subbase if properly compacted. Recommended Pavement Sections: The following table presents our recommended asphalt pavement sections.

Recommended Asphalt Pavement Sections*

Service Level	Base Course (in)	Top Course (in)	Asphalt (in)
Light-duty	6	2	2
Heavy-duty	8	2	3

It should be realized that asphaltic pavements are not maintenance-free. Our recommended pavement section represents our minimum recommendation for an average level of performance during a 20-year design life; therefore, an average level of maintenance will likely be required. A 20-year pavement life typically assumes that an overlay will be placed after about 12 years. Thicker asphalt, base, and subbase courses would offer better long-term performance but would cost more initially. Conversely, thinner courses would be more susceptible to “alligator” cracking and other failure modes. As such, pavement design can be considered a compromise between a high initial cost and low maintenance costs versus a low initial cost and higher maintenance costs.

The native subgrade soils are anticipated to consist mostly of sands with gravel. Based on our experience with similar soil types, our analysis is based on a California Bearing Ratio (CBR) value of 30 percent. These values assume the upper foot of subgrade soils will be compacted to a minimum of 95 percent of the modified proctor maximum dry density or a firm or unyielding condition.

We recommend the following regarding asphalt pavement materials and pavement construction:

- Subgrade Preparation: Upper 12 inches of pavement subgrade should be proof-rolled and inspected for deflection. Areas showing more than ½-inch deflection during proof rolling should be over-excavated and replaced with gravel base.
- Base Course: We recommend that the base conforms to Section 9-03.10, Gravel Base, of the 2022 WSDOT/APWA Standard Specifications for Road, Bridge and Municipal Construction (Standard Specifications). The gravel base shall be placed and compacted in accordance with Section 4-02 of the Standard Specifications.
- Crushed Surfacing Top Course: We recommend that the crushed aggregate top course conforms to Section 9-03.9(3), CSTC of the WSDOT Standard Specifications. The CSTC shall be placed and compacted in accordance with Section 4-04 of the Standard Specifications.

- Asphalt Concrete: We recommend that the asphalt concrete conforms to Section 9-02.1(4) for PG 58-22 or PG 64-22 Performance Graded Asphalt Binder as presented in the 2022 WSDOT Standard Specifications. We also recommend that the gradation of the asphalt aggregate conform to the aggregate gradation control points for ½-inch mixes as presented in Section 9-03.8(6), HMA Proportions of Materials. We also recommend that the Commercial Asphalt be placed and compacted in accordance with Section 5-04 of the Standard Specifications.
- Compaction: All base material should be compacted to at least 95 percent of the maximum dry density determined in accordance with ASTM D1557 or a firm and unyielding condition. We recommend that asphalt be compacted to a minimum of 92 percent of the Rice (theoretical maximum) density or 96 percent of Marshall (maximum laboratory) density.

DOCUMENT REVIEW AND CONSTRUCTION OBSERVATION

We recommend that we are retained to review the portions of the plans and specifications that pertain to earthwork construction and stormwater infiltration. We recommend that monitoring, testing and consultation be performed during construction to confirm that the conditions encountered are consistent with our explorations and our stated design assumptions. Insight Geologic would be pleased to provide these services upon request.

REFERENCES

International Code Council, International Building Code, 2018.

Seismic Compression of As-compacted Fill Soils with Variable Levels of Fines Content and Fines Plasticity, Department of Civil and Environmental Engineering, University of California, Los Angeles, July 2004.

Thurston County, Drainage Design and Erosion Control Manual, 2022.

Washington State Department of Transportation (WSDOT), Standard Specifications for Road, Bridge and Municipal Construction Manual, 2022.

LIMITATIONS

We have prepared this geotechnical and stormwater evaluation report for the exclusive use of RJ Development and their authorized agents, for the proposed development located at 2000 24th Avenue NW in unincorporated Thurston County, Washington.

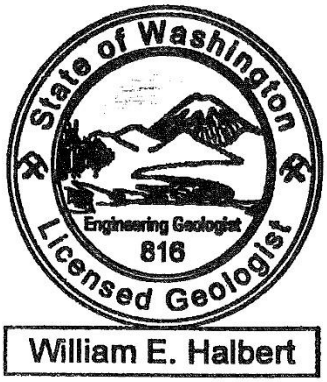
Within the limitations of scope, schedule and budget, our services have been executed in accordance with generally accepted practices in the field of geotechnical engineering in this area at the time this report was prepared. No warranty or other conditions, expressed or implied, should be understood.

Please refer to Attachment C titled “Report Limitations and Guidelines for Use” for additional information pertaining to the use of this report.

We appreciate the opportunity to be of service to you on this project. Please contact us if you have any questions or require additional information.

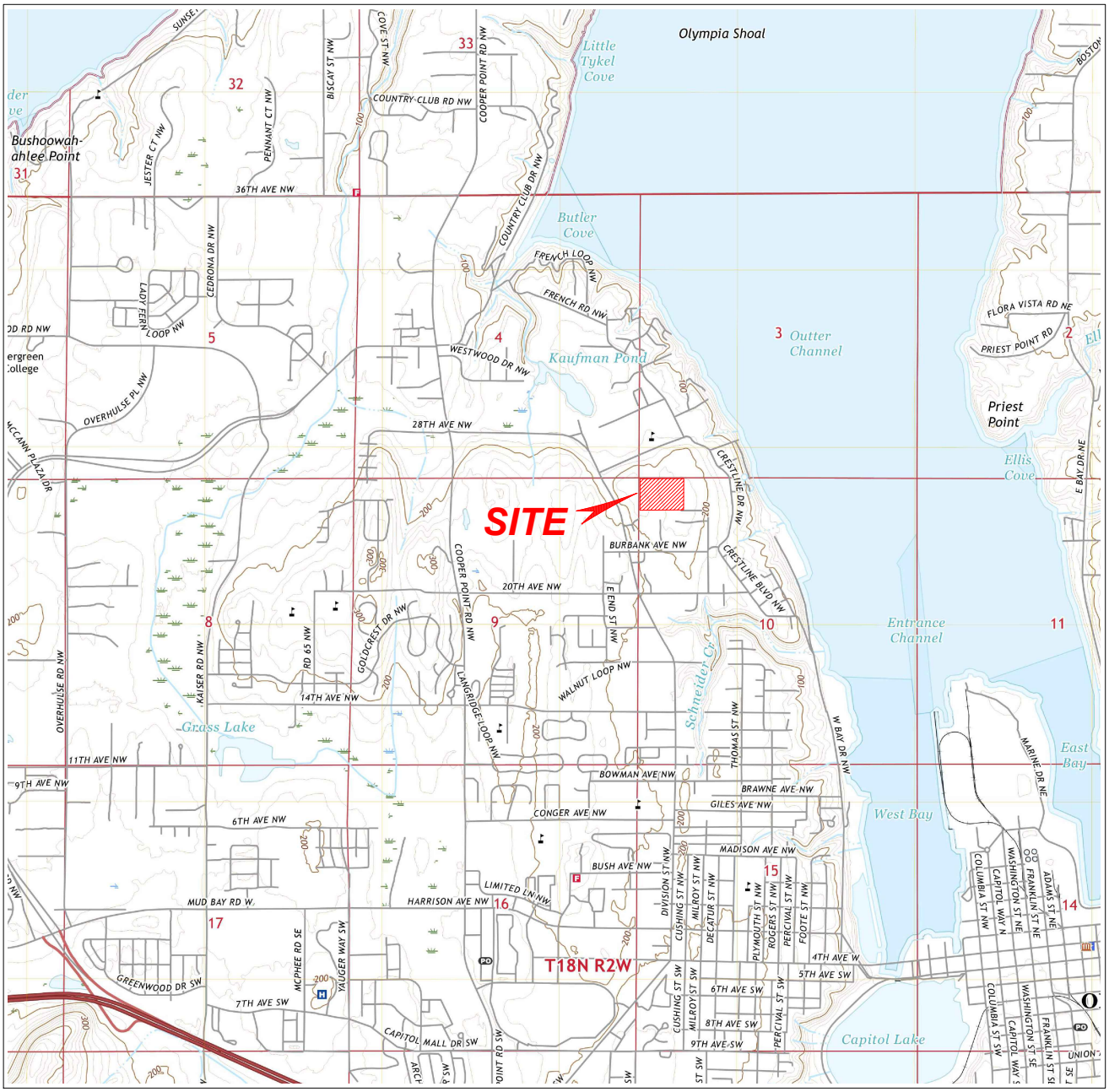
Respectfully Submitted,
INSIGHT GEOLOGIC, INC.

William E. Halbert, L.E.G., L.HG.
Principal



Attachments

FIGURES



Source: USGS (c) 2020

TUMWATER QUADRANGLE
WASHINGTON - THURSTON COUNTY
7.5-MINUTE SERIES
Year 2020

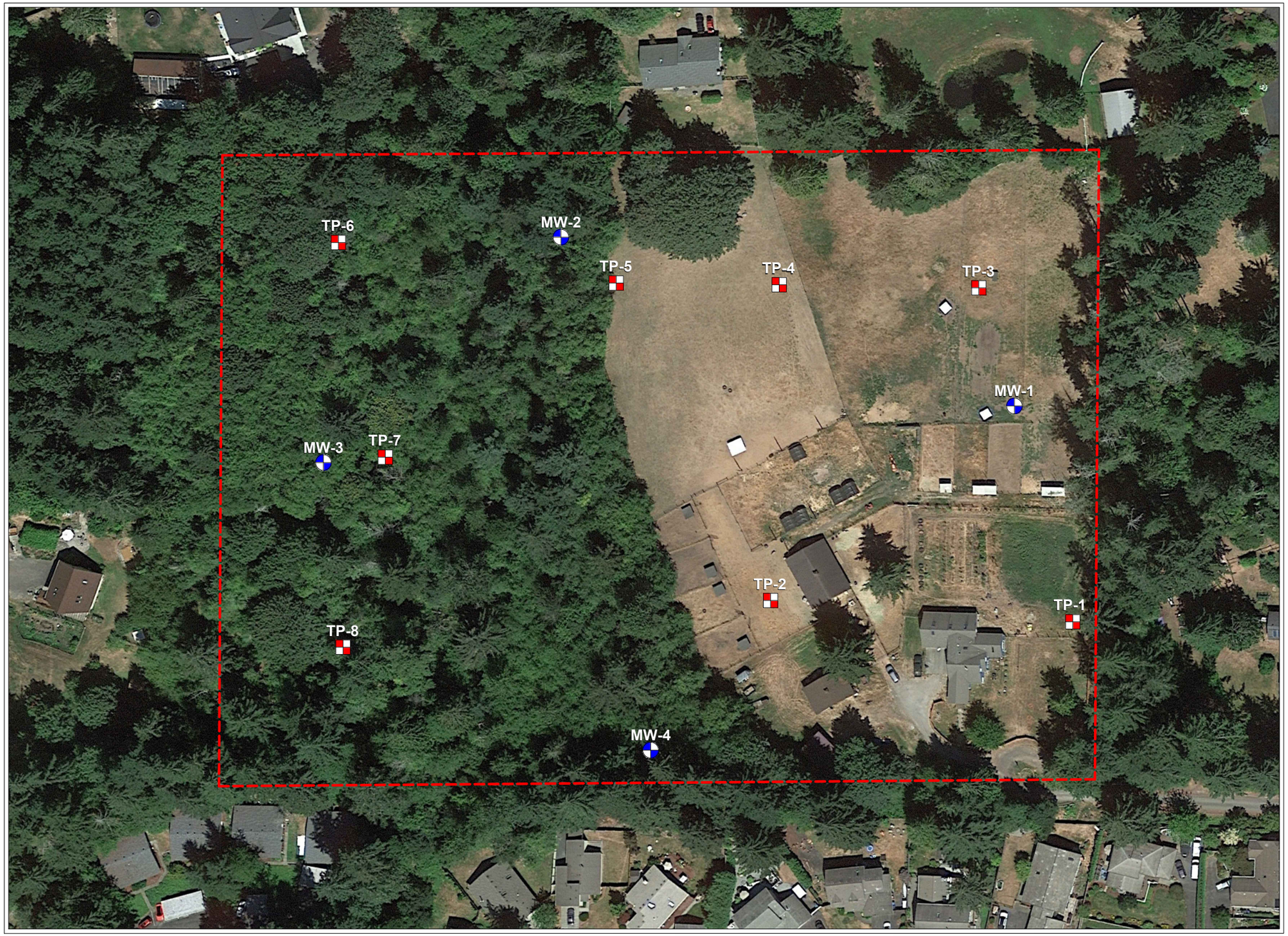
SCALE: 1" = 3000'

2000 24th AVENUE NW

OLYMPIA, WASHINGTON

INSIGHT GEOLOGIC, INC.

Figure 1
Vicinity Map



LEGEND:

- APPROXIMATE PROJECT BOUNDARY
- **TP-1** APPROXIMATE TEST PIT LOCATION
- **MW-1** APPROXIMATE MONITORING WELL LOCATION

0 50 100

SCALE: 1" = 100'

Source: kpff Consulting Engineers

2000 24th AVENUE NW

OLYMPIA, WASHINGTON

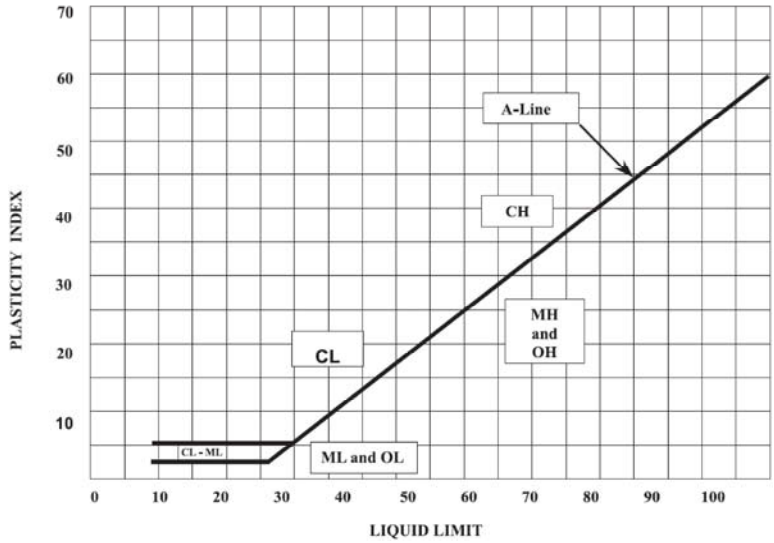
INSIGHT GEOLOGIC, INC.

Figure 2
SITE PLAN

ATTACHMENT A
EXPLORATION LOGS

SOIL CLASSIFICATION CHART

MAJOR DIVISIONS			SYMBOLS		GROUP NAME
COARSE GRAINED SOILS (MORE THAN 50% RETAINED ON NO. 200 SIEVE)	GRAVEL AND GRAVELLY SOILS (MORE THAN 50% OF COARSE FRACTION RETAINED ON NO. 4 SIEVE)	CLEAN GRAVEL <5% FINES		GW	WELL-GRADED GRAVEL, FINE TO COARSE GRAVEL
				GP	POORLY GRADED GRAVEL
		GRAVEL WITH FINES >12% FINES		GM	SILTY GRAVEL
				GC	CLAYEY GRAVEL
	SAND AND SANDY SOILS (MORE THAN 50% OF COARSE FRACTION PASSING NO. 4 SIEVE)	CLEAN SAND <5% FINES		SW	WELL-GRADED SAND, FINE TO COARSE SAND
				SP	POORLY GRADED SAND
		SAND WITH FINES >12% FINES		SM	SILTY SAND
				SC	CLAYEY SAND
FINE GRAINED SOILS (MORE THAN 50% PASSING NO. 200 SIEVE)	SILTS AND CLAYS (LIQUID LIMIT LESS THAN 50)	INORGANIC		ML	SILT
				CL	CLAY
		ORGANIC		OL	ORGANIC SILT, ORGANIC CLAY
	SILTS AND CLAYS (LIQUID LIMIT 50 OR MORE)	INORGANIC		MH	SILT OF HIGH PLASTICITY, ELASTIC SILT
				CH	CLAY OF HIGH PLASTICITY, FAT CLAY
		ORGANIC		OH	ORGANIC CLAY, ORGANIC SILT
HIGHLY ORGANIC SOILS				PT	PEAT



SOIL MOISTURE MODIFIERS:
DRY - ABSENCE OF MOISTURE, DUSTY, DRY TO THE TOUCH
MOIST - DAMP, BUT NO VISIBLE WATER
WET - VISIBLE FREE WATER OR SATURATED, USUALLY SOIL IS OBTAINED FROM BELOW WATER TABLE

ADDITIONAL MATERIAL SYMBOLS

SYMBOLS		TYPICAL DESCRIPTION
	CC	CEMENT CONCRETE
	AC	ASPHALT CONCRETE
	CR	CRUSHED ROCK / QUARRY SPALLS
	TS	TOPSOIL / FOREST DUFF / SOD

GROUNDWATER EXPLORATION SYMBOLS

- MEASURED GROUNDWATER LEVEL IN EXPLORATION, WELL, OR PIEZOMETER
- GROUNDWATER OBSERVED AT TIME OF EXPLORATION
- PERCHED WATER OBSERVED AT TIME OF EXPLORATION
- MEASURED FREE PRODUCT IN WELL OR PIEZOMETER

STRATIGRAPHIC CONTACT

- DISTINCT CONTACT BETWEEN SOIL STRATA OR GEOLOGIC UNITS
- GRADUAL CHANGE BETWEEN SOIL STRATA OR GEOLOGIC UNITS
- APPROXIMATE LOCATION OF SOIL STRATA CHANGE WITHIN GEOLOGIC SOIL UNIT

LABORATORY / FIELD TEST CLASSIFICATIONS

- **%F** PERECENT FINES
- **AL** ATTERBERG LIMITS
- **CA** CHEMICAL ANALYSIS
- **CP** LABORATORY COMPACTION TEST
- **CS** CONSOLIDATION TEST
- **DS** DIRECT SHEAR
- **HA** HYDROMETER ANALYSIS
- **MC** MOISTURE CONTENT
- **MD** MOISTURE CONTENT AND DRY DENSITY
- **OC** ORGANIC COMPOUND
- **PM** PERMEABILITY OR HYDRAULIC CONDUCTIVITY
- **PP** POCKET PENETROMETER
- **SA** SIEVE ANALYSIS
- **TX** TRIAXIAL COMPRESSION
- **UC** UNCONFINED COMPRESSION
- **VS** VANE SHEAR

SAMPLER SYMBOLS

- 2.4 INCH I.D. SPLIT BARREL
- DIRECT-PUSH
- STANDARD PENETRATION TEST
- SHELBY TUBE
- PISTON
- BULK OR GRAB

SHEEN CLASSIFICATIONS

- **NS** NO VISIBLE SHEEN
- **SS** SLIGHT SHEEN
- **MS** MODERATE SHEEN
- **HS** HEAVY SHEEN
- **NT** NOT TESTED

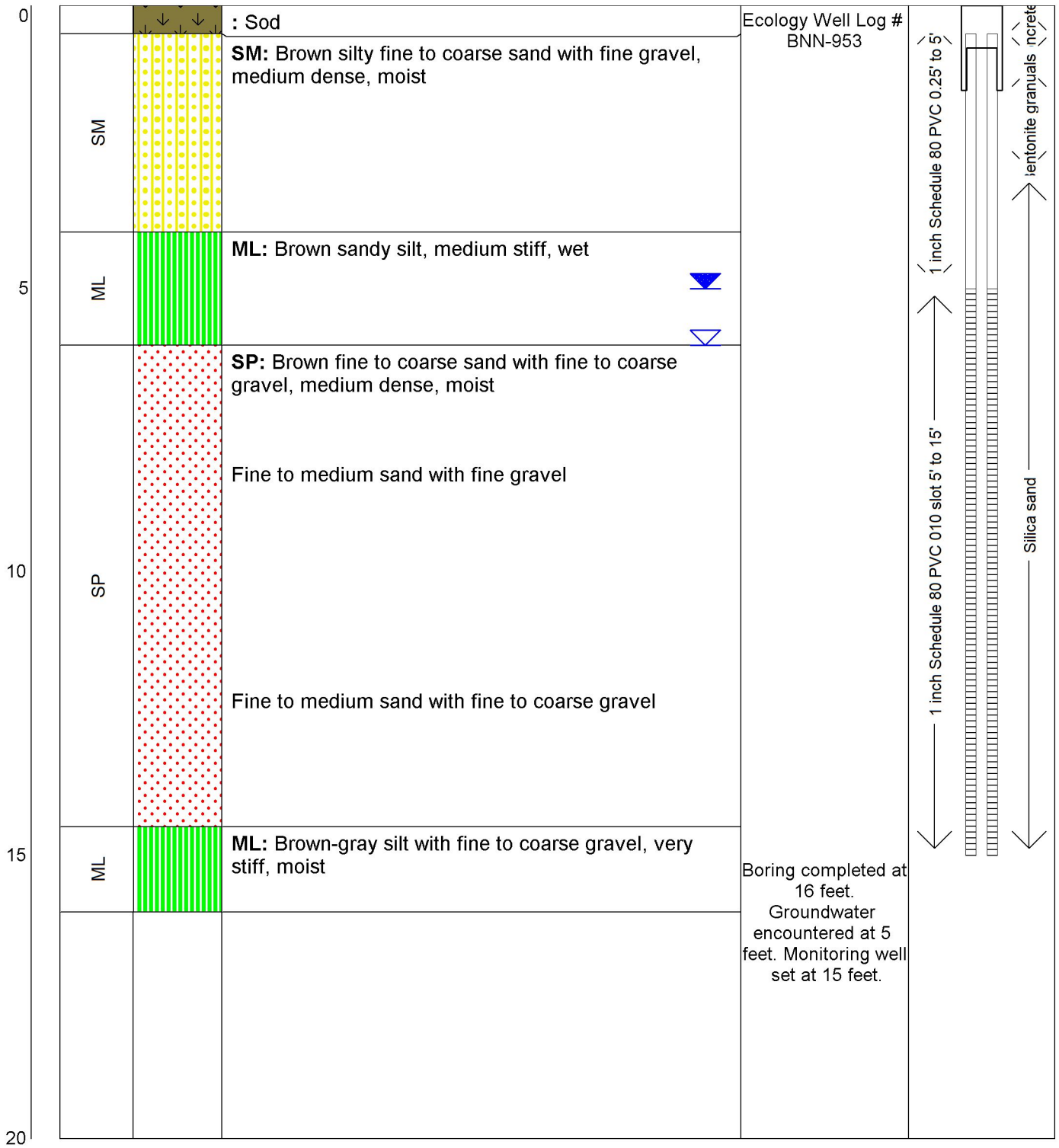
INSIGHT GEOLOGIC, INC.

Figure A-1
Key to Exploration Logs

PROJECT: **2000 24th Avenue NW**
PROJECT NO.: **901-003-01**
LOCATION: **Thurston County, Washington**

MW-1

DATE: **January 6, 2023**
TOTAL DEPTH: **16**



INSIGHT GEOLOGIC, INC.

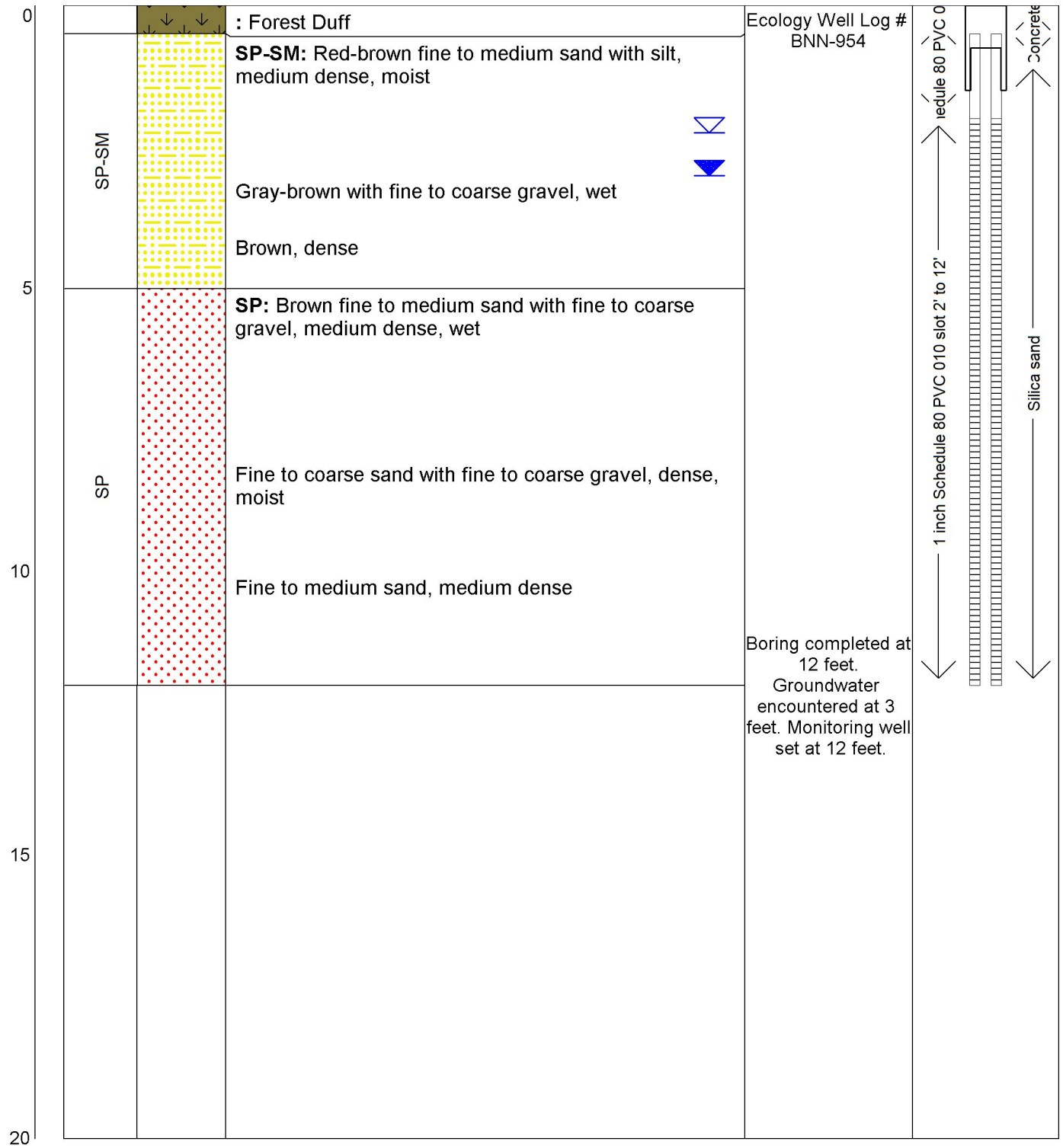
Drilling Contractor: **Standard**
Drilling Equipment: **Geoprobe 54 LT**
Logged By: **Neal Graham**

Figure A-2

PROJECT: **2000 24th Avenue NW**
PROJECT NO.: **901-003-01**
LOCATION: **Thurston County, Washington**

MW-2

DATE: **January 6, 2023**
TOTAL DEPTH: **12**



INSIGHT GEOLOGIC, INC.

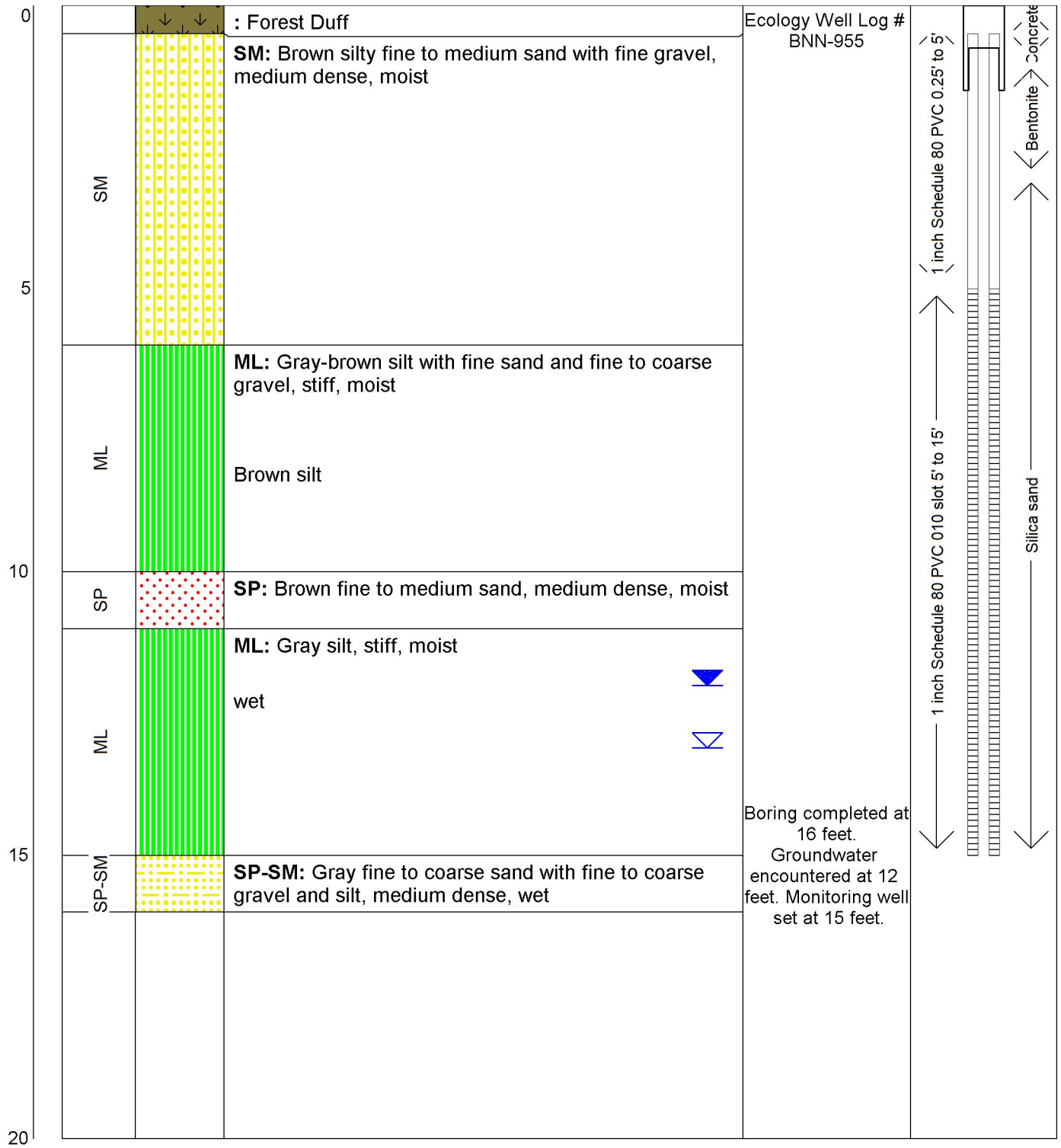
Drilling Contractor: **Standard**
Drilling Equipment: **Geoprobe 54 LT**
Logged By: **Neal Graham**

Figure A-3

PROJECT: **2000 24th Avenue NW**
PROJECT NO.: **901-003-01**
LOCATION: **Thurston County, Washington**

MW-3

DATE: **January 6, 2023**
TOTAL DEPTH: **16**



INSIGHT GEOLOGIC, INC.

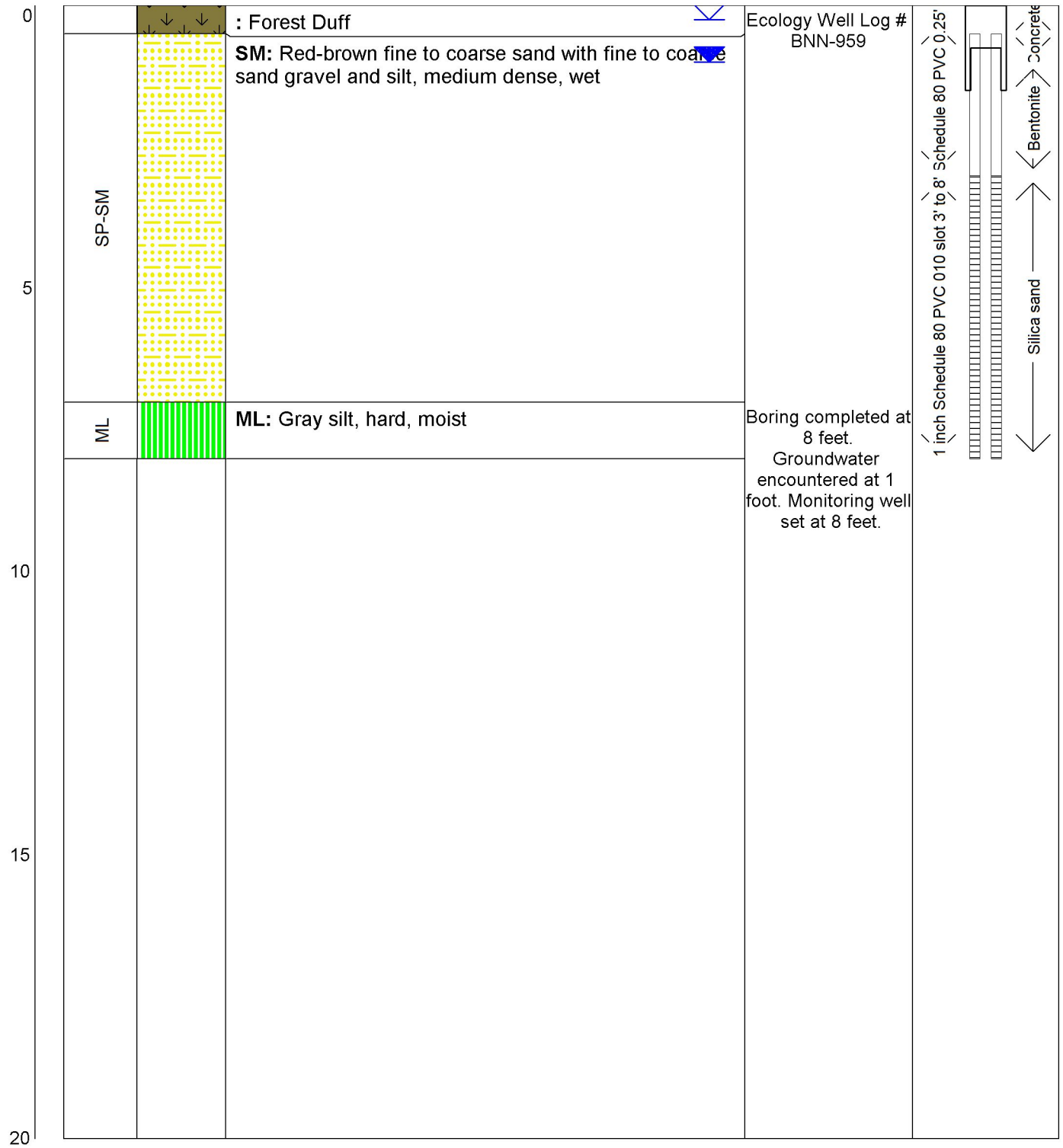
Drilling Contractor: **Standard**
Drilling Equipment: **Geoprobe 54 LT**
Logged By: **Neal Graham**

Figure A-4

PROJECT: **2000 24th Avenue NW**
PROJECT NO.: **901-003-01**
LOCATION: **Thurston County, Washington**

MW-4

DATE: **January 6, 2023**
TOTAL DEPTH: **8**



INSIGHT GEOLOGIC, INC.

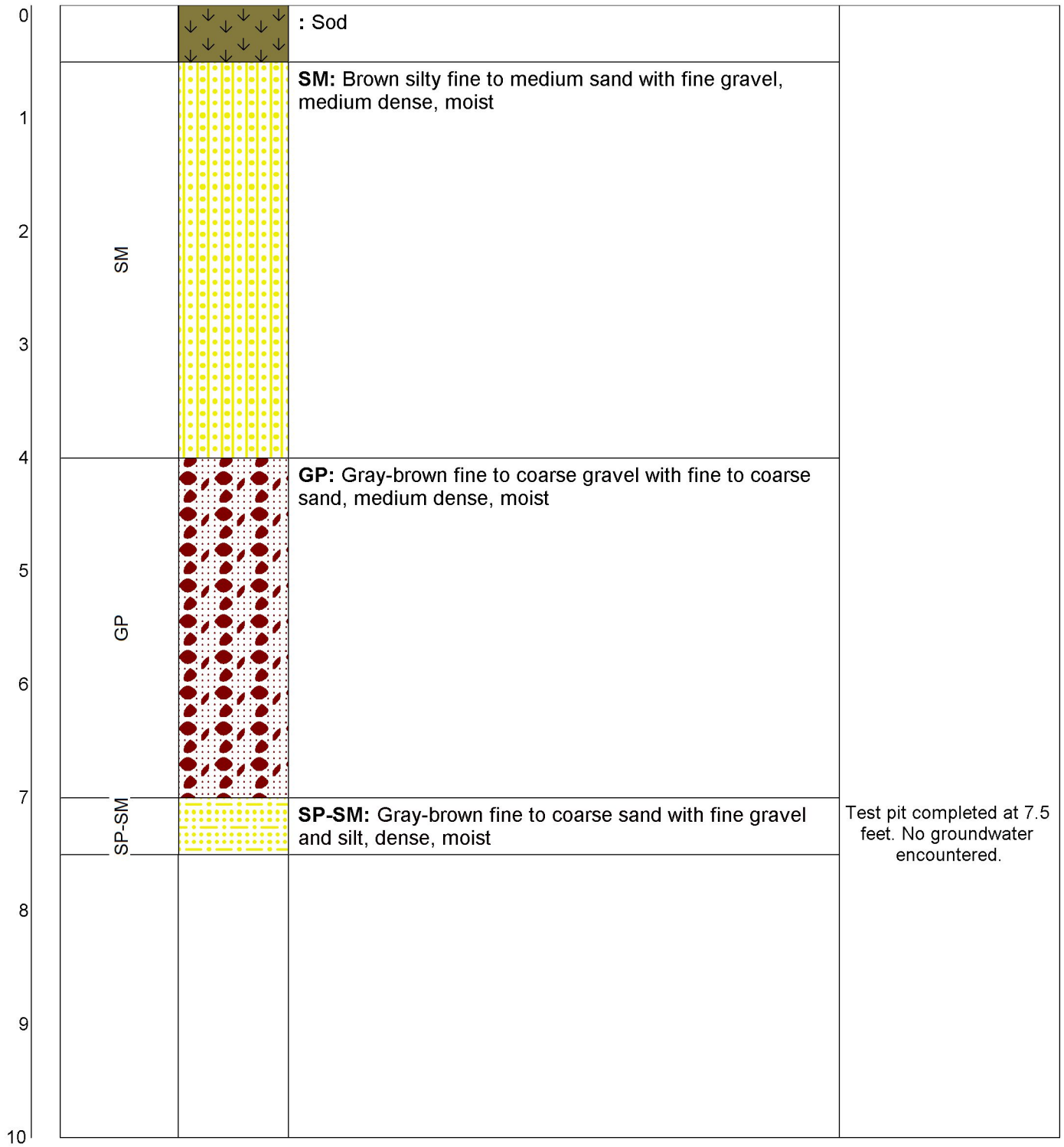
Drilling Contractor: **Standard**
Drilling Equipment: **Geoprobe 54 LT**
Logged By: **Neal Graham**

Figure A-5

PROJECT: 2000 24th Avenue NW
PROJECT NO.: 901-003-01
LOCATION: Thurston County, Washington

TP-1

DATE: February 3, 2023
TOTAL DEPTH: 7.5



INSIGHT GEOLOGIC, INC.

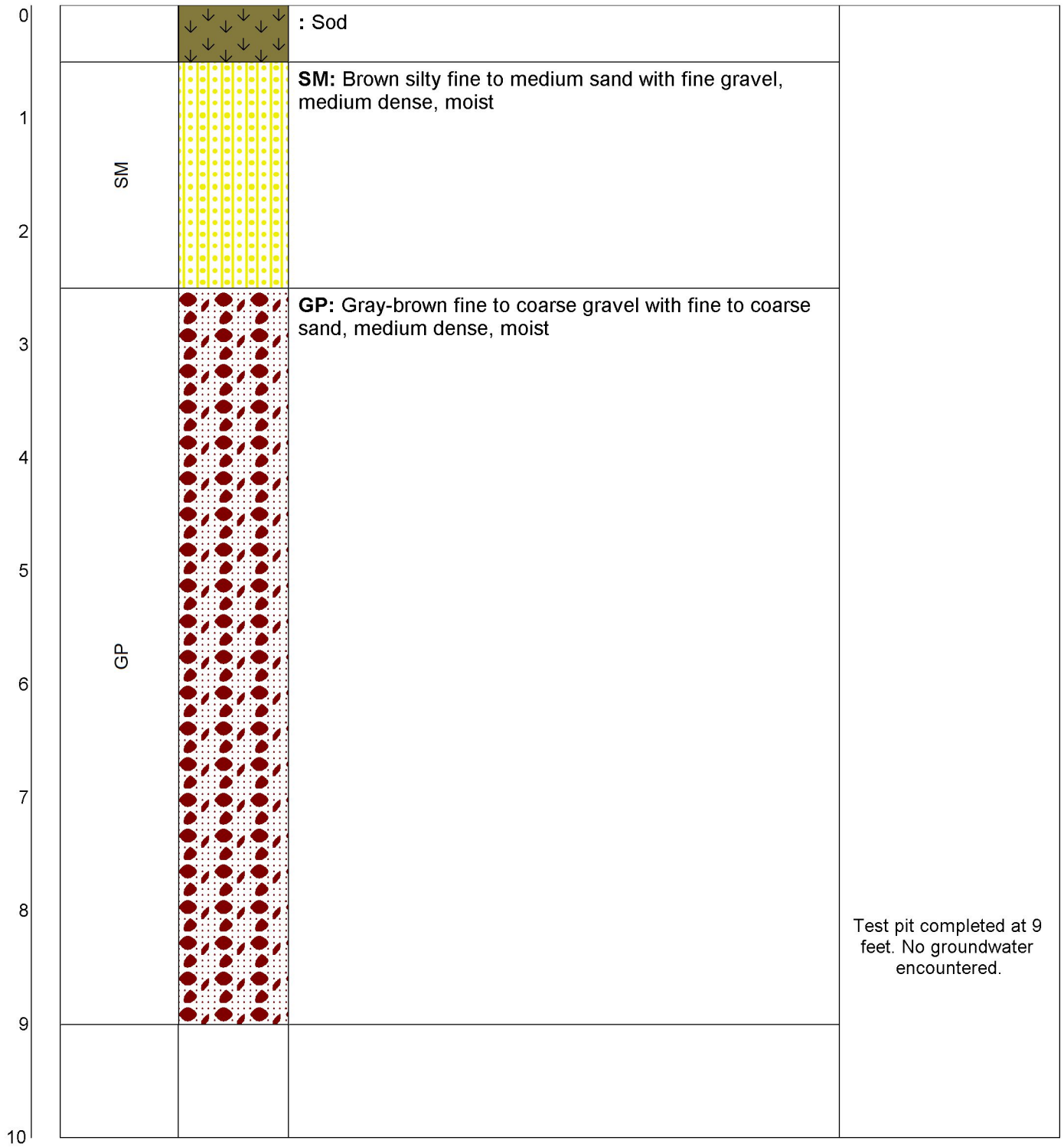
Operator Neal Graham
Equipment: Yanmar 35C
Logged By: Neal Graham

Figure A-6

PROJECT: 2000 24th Avenue NW
PROJECT NO.: 901-003-01
LOCATION: Thurston County, Washington

TP-2

DATE: February 3, 2023
TOTAL DEPTH: 9



INSIGHT GEOLOGIC, INC.

Operator Neal Graham
Equipment: Yanmar 35C
Logged By: Neal Graham

Figure A-7

PROJECT: 2000 24th Avenue NW
PROJECT NO.: 901-003-01
LOCATION: Thurston County, Washington

TP-3

DATE: February 3, 2023
TOTAL DEPTH: 8

DEPTH (FT)	U.S.C.S.	LITHOLOGY	SOIL DESCRIPTION	REMARKS AND OTHER TESTS
0			: Sod	
1	SM		**SM:** Brown silty fine to medium sand with fine gravel, medium dense, moist	
2	GW		**GW:** Red-brown fine to coarse gravel with medium to coarse sand, medium dense, moist	
4	SP		**SP:** Gray-brown fine to medium sand with fine to coarse gravel, medium dense, moist	Test pit completed at 8 feet. No groundwater encountered.
8				
10				

INSIGHT GEOLOGIC, INC.

Operator **Neal Graham**
Equipment: **Yanmar 35C**
Logged By: **Neal Graham**

Figure A-8

PROJECT: 2000 24th Avenue NW
PROJECT NO.: 901-003-01
LOCATION: Thurston County, Washington

TP-4

DATE: February 3, 2023
TOTAL DEPTH: 5.5

DEPTH (FT)	U.S.C.S.	LITHOLOGY	SOIL DESCRIPTION	REMARKS AND OTHER TESTS
0			: Sod	
1	SM		**SM:** Brown silty fine to medium sand with fine gravel, medium dense, moist	
2	GP		**GP:** Red-brown fine to coarse gravel with fine to coarse sand, medium dense, moist	
3				
4				Test pit completed at 5 feet. No groundwater encountered.
5	SP-SM		**SP-SM:** Gray-brown fine to coarse sand with fine to coarse gravel and silt, dense, moist	
6				
7				
8				
9				
10				

INSIGHT GEOLOGIC, INC.

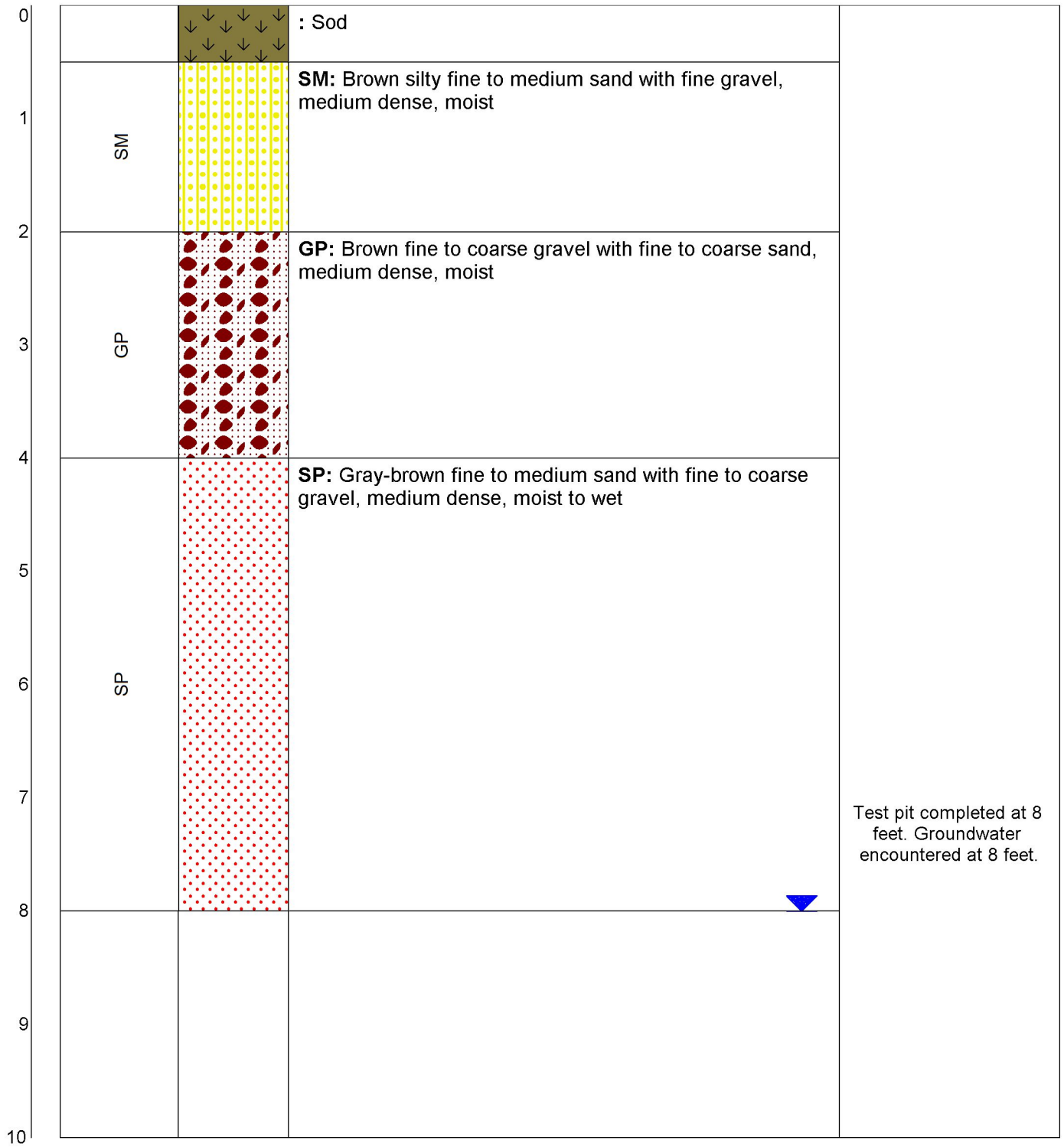
Operator **Neal Graham**
Equipment: **Yanmar 35C**
Logged By: **Neal Graham**

Figure A-9

PROJECT: 2000 24th Avenue NW
PROJECT NO.: 901-003-01
LOCATION: Thurston County, Washington

TP-5

DATE: February 3, 2023
TOTAL DEPTH: 8



INSIGHT GEOLOGIC, INC.

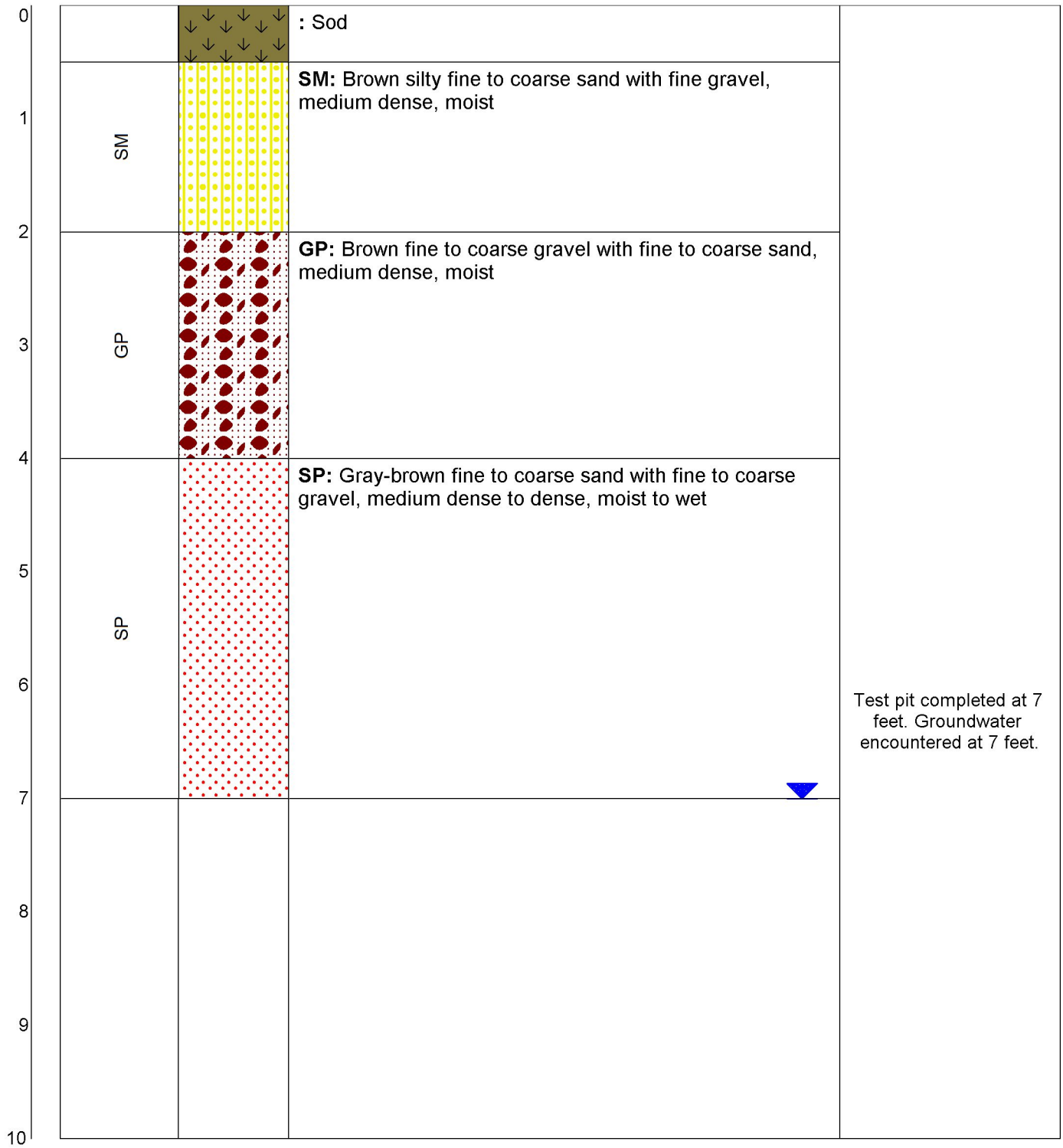
Operator Neal Graham
Equipment: Yanmar 35C
Logged By: Neal Graham

Figure A-10

PROJECT: 2000 24th Avenue NW
PROJECT NO.: 901-003-01
LOCATION: Thurston County, Washington

TP-6

DATE: February 3, 2023
TOTAL DEPTH: 7



INSIGHT GEOLOGIC, INC.

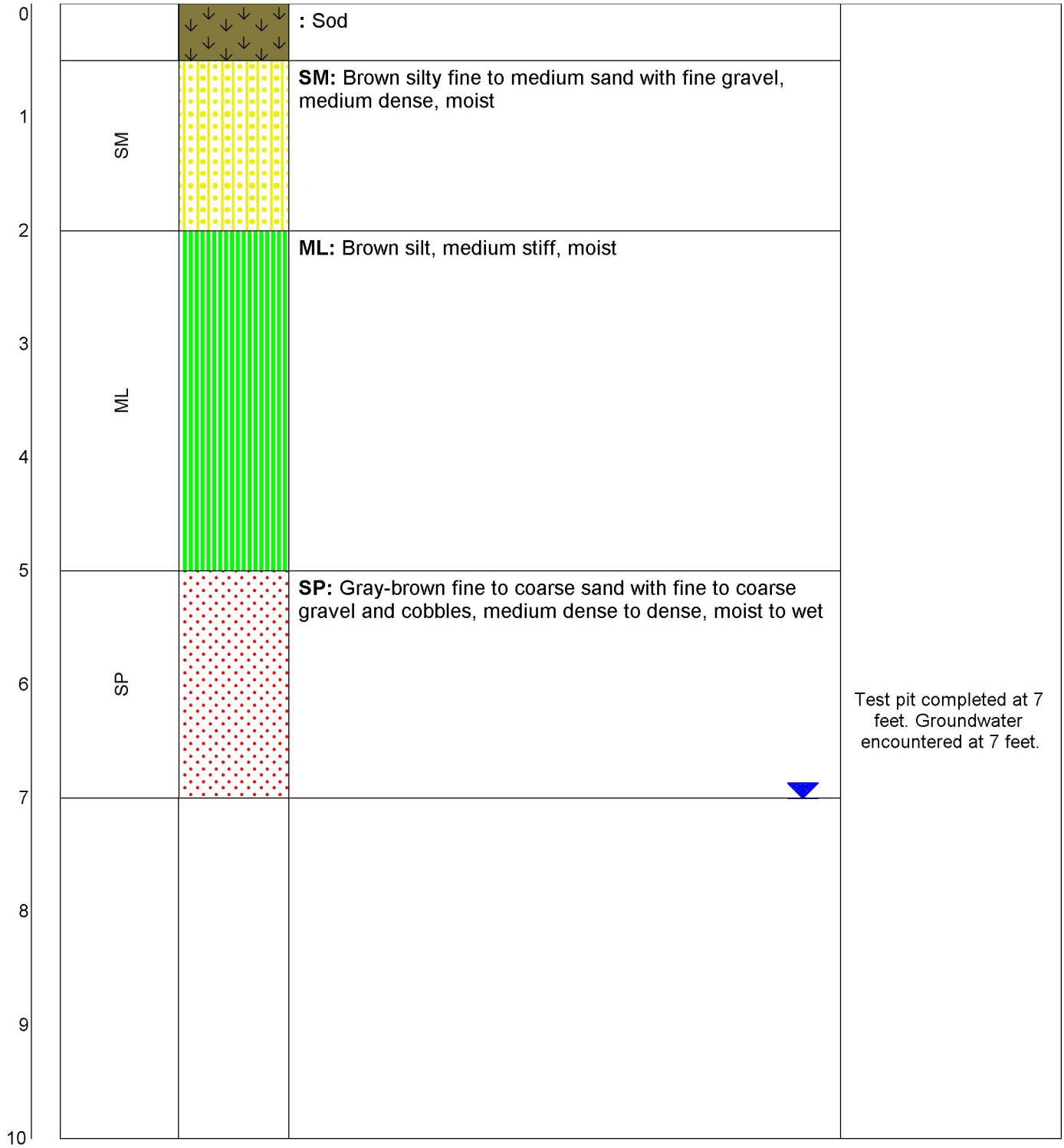
Operator Neal Graham
Equipment: Yanmar 35C
Logged By: Neal Graham

Figure A-11

PROJECT: 2000 24th Avenue NW
PROJECT NO.: 901-003-01
LOCATION: Thurston County, Washington

TP-7

DATE: February 3, 2023
TOTAL DEPTH: 7



INSIGHT GEOLOGIC, INC.

Operator Neal Graham
Equipment: Yanmar 35C
Logged By: Neal Graham

Figure A-12

PROJECT: 2000 24th Avenue NW
PROJECT NO.: 901-003-01
LOCATION: Thurston County, Washington

TP-8

DATE: February 3, 2023
TOTAL DEPTH: 4.5

DEPTH (FT)	U.S.C.S.	LITHOLOGY	SOIL DESCRIPTION	REMARKS AND OTHER TESTS
0			: Sod	
1	SM		**SM:** Brown silty fine to medium sand with fine gravel, medium dense, moist	
2				
3				
4	GP		**GP:** Gray-brown fine to coarse gravel with fine to coarse sand, medium dense, moist	
	SP-SM		**SP-SM:** Gray-brown fine to coarse sand with fine to coarse gravel and silt, dense, moist	Test pit completed at 4.5 feet. No groundwater encountered.
5				
6				
7				
8				
9				
10				

INSIGHT GEOLOGIC, INC.

Operator **Neal Graham**
Equipment: **Yanmar 35C**
Logged By: **Neal Graham**

Figure A-13

ATTACHMENT B
LABORATORY ANALYSES RESULTS

Gradation Analysis Summary Data

Job Name: 2000 24th Ave NW
Job Number: 901-003-01
Date Tested: 2/9/23
Tested By: Andrew Johnson

Sample Location: TP-1
Sample Name: TP-1 0.0' - 4.0'
Depth: 0 - 4 Feet

Moisture Content (%) 21.7%

Sieve Size	Percent Passing
3.0 in. (75.0)	100.0
1.5 in. (37.5)	100.0
3/4 in. (19.0)	100.0
3/8 in. (9.5-mm)	81.8
No. 4 (4.75-mm)	71.1
No. 10 (2.00-mm)	61.6
No. 20 (.850-mm)	54.7
No. 40 (.425-mm)	48.5
No. 60 (.250-mm)	43.4
No. 100 (.150-mm)	39.5
No. 200 (.075-mm)	30.5

Size Fraction	Percent by Weight
Coarse Gravel	0.0
Fine Gravel	28.9
Coarse Sand	9.5
Medium Sand	13.1
Fine Sand	18.0
Fines	30.5
Total	**100.0**

LL	- -
PL	- -
PI	- -
D_{10}	0.00
D_{30}	0.07
D_{60}	1.75
D_{90}	14.00
Cc	- -
Cu	- -

ASTM Classification
Group Name: **Silty Sand with Gravel**
Symbol: **SM**

INSIGHT GEOLOGIC, INC.

Gradation Analysis Summary Data

Job Name: 2000 24th Ave NW
Job Number: 901-003-01
Date Tested: 2/9/23
Tested By: Andrew Johnson

Sample Location: TP-2
Sample Name: TP-2 2.5' - 9.0'
Depth: 2.5 - 9 Feet

Moisture Content (%) 8.9%

Sieve Size	Percent Passing
3.0 in. (75.0)	100.0
1.5 in. (37.5)	100.0
3/4 in. (19.0)	89.9
3/8 in. (9.5-mm)	51.0
No. 4 (4.75-mm)	40.3
No. 10 (2.00-mm)	35.3
No. 20 (.850-mm)	29.4
No. 40 (.425-mm)	18.8
No. 60 (.250-mm)	8.5
No. 100 (.150-mm)	3.5
No. 200 (.075-mm)	1.5

Size Fraction	Percent by Weight
Coarse Gravel	10.1
Fine Gravel	49.7
Coarse Sand	5.0
Medium Sand	16.4
Fine Sand	17.3
Fines	1.5
Total	**100.0**

LL	- -
PL	- -
PI	- -
D_{10}	0.28
D_{30}	0.86
D_{60}	11.50
D_{90}	19.00
Cc	0.23
Cu	41.82

ASTM Classification
Group Name: **Poorly Graded Gravel with Sand**
Symbol: **GP**

INSIGHT GEOLOGIC, INC.

Gradation Analysis Summary Data

Job Name: 2000 24th Ave NW
Job Number: 901-003-01
Date Tested: 2/9/23
Tested By: Andrew Johnson

Sample Location: TP-3
Sample Name: TP-3 1.5' - 4.0'
Depth: 1.5 - 4 Feet

Moisture Content (%) 2.9%

Sieve Size	Percent Passing
3.0 in. (75.0)	100.0
1.5 in. (37.5)	100.0
3/4 in. (19.0)	78.7
3/8 in. (9.5-mm)	63.0
No. 4 (4.75-mm)	40.3
No. 10 (2.00-mm)	18.5
No. 20 (.850-mm)	7.8
No. 40 (.425-mm)	3.1
No. 60 (.250-mm)	1.8
No. 100 (.150-mm)	1.5
No. 200 (.075-mm)	1.1

Size Fraction	Percent by Weight
Coarse Gravel	21.3
Fine Gravel	38.4
Coarse Sand	21.9
Medium Sand	15.3
Fine Sand	2.1
Fines	1.1
Total	**100.0**

LL	- -
PL	- -
PI	- -
D_{10}	1.10
D_{30}	3.20
D_{60}	8.50
D_{90}	28.00
Cc	1.10
Cu	7.73

ASTM Classification
Group Name: **Well Graded Gravel with Sand**
Symbol: **GW**

INSIGHT GEOLOGIC, INC.

Gradation Analysis Summary Data

Job Name: 2000 24th Ave NW
Job Number: 901-003-01
Date Tested: 2/9/23
Tested By: Andrew Johnson

Sample Location: TP-4
Sample Name: TP-4 1.5' - 5.0'
Depth: 1.5 - 5 Feet

Moisture Content (%) 5.5%

Sieve Size	Percent Passing
3.0 in. (75.0)	100.0
1.5 in. (37.5)	100.0
3/4 in. (19.0)	76.7
3/8 in. (9.5-mm)	56.3
No. 4 (4.75-mm)	41.8
No. 10 (2.00-mm)	30.1
No. 20 (.850-mm)	18.9
No. 40 (.425-mm)	10.3
No. 60 (.250-mm)	6.0
No. 100 (.150-mm)	4.3
No. 200 (.075-mm)	2.9

Size Fraction	Percent by Weight
Coarse Gravel	23.3
Fine Gravel	34.9
Coarse Sand	11.7
Medium Sand	19.8
Fine Sand	7.4
Fines	2.9
Total	**100.0**

LL	- -
PL	- -
PI	- -
D_{10}	0.42
D_{30}	2.00
D_{60}	11.00
D_{90}	28.00
Cc	0.87
Cu	26.19

ASTM Classification
Group Name: **Poorly Graded Gravel with Sand**
Symbol: **GP**

INSIGHT GEOLOGIC, INC.

Gradation Analysis Summary Data

Job Name: 2000 24th Ave NW
Job Number: 901-003-01
Date Tested: 2/9/23
Tested By: Andrew Johnson

Sample Location: TP-5
Sample Name: TP-5 4.0' - 8.0'
Depth: 4 - 8 Feet

Moisture Content (%) 14.9%

Sieve Size	Percent Passing
3.0 in. (75.0)	100.0
1.5 in. (37.5)	100.0
3/4 in. (19.0)	90.0
3/8 in. (9.5-mm)	86.6
No. 4 (4.75-mm)	81.9
No. 10 (2.00-mm)	76.2
No. 20 (.850-mm)	72.0
No. 40 (.425-mm)	59.2
No. 60 (.250-mm)	35.4
No. 100 (.150-mm)	14.1
No. 200 (.075-mm)	4.6

Size Fraction	Percent by Weight
Coarse Gravel	10.0
Fine Gravel	8.2
Coarse Sand	5.7
Medium Sand	17.0
Fine Sand	54.6
Fines	4.6
Total	**100.0**

LL	- -
PL	- -
PI	- -
D_{10}	0.12
D_{30}	0.21
D_{60}	0.43
D_{90}	19.00
Cc	0.85
Cu	3.58

ASTM Classification
Group Name: **Poorly Graded Sand with Gravel**
Symbol: **SP**

INSIGHT GEOLOGIC, INC.

Gradation Analysis Summary Data

Job Name: 2000 24th Ave NW
Job Number: 901-003-01
Date Tested: 2/9/23
Tested By: Andrew Johnson

Sample Location: TP-6
Sample Name: TP-6 0.0' - 2.0'
Depth: 0 - 2 Feet

Moisture Content (%) 26.1%

Sieve Size	Percent Passing
3.0 in. (75.0)	100.0
1.5 in. (37.5)	100.0
3/4 in. (19.0)	100.0
3/8 in. (9.5-mm)	91.4
No. 4 (4.75-mm)	88.4
No. 10 (2.00-mm)	82.1
No. 20 (.850-mm)	76.7
No. 40 (.425-mm)	68.4
No. 60 (.250-mm)	61.3
No. 100 (.150-mm)	54.6
No. 200 (.075-mm)	34.7

Size Fraction	Percent by Weight
Coarse Gravel	0.0
Fine Gravel	11.6
Coarse Sand	6.3
Medium Sand	13.7
Fine Sand	33.6
Fines	34.7
Total	**100.0**

LL	- -
PL	- -
PI	- -
D_{10}	0.00
D_{30}	0.07
D_{60}	0.23
D_{90}	6.75
Cc	- -
Cu	- -

ASTM Classification
Group Name: **Silty Sand**
Symbol: **SM**

INSIGHT GEOLOGIC, INC.

Gradation Analysis Summary Data

Job Name: 2000 24th Ave NW
Job Number: 901-003-01
Date Tested: 2/9/23
Tested By: Andrew Johnson

Sample Location: TP-6
Sample Name: TP-6 4.0' - 7.0'
Depth: 4 - 7 Feet

Moisture Content (%) 13.6%

Sieve Size	Percent Passing
3.0 in. (75.0)	100.0
1.5 in. (37.5)	100.0
3/4 in. (19.0)	79.3
3/8 in. (9.5-mm)	70.0
No. 4 (4.75-mm)	64.8
No. 10 (2.00-mm)	59.4
No. 20 (.850-mm)	55.1
No. 40 (.425-mm)	40.0
No. 60 (.250-mm)	17.5
No. 100 (.150-mm)	7.5
No. 200 (.075-mm)	3.5

Size Fraction	Percent by Weight
Coarse Gravel	20.7
Fine Gravel	14.6
Coarse Sand	5.4
Medium Sand	19.4
Fine Sand	36.4
Fines	3.5
Total	**100.0**

LL	- -
PL	- -
PI	- -
D_{10}	0.18
D_{30}	0.32
D_{60}	2.10
D_{90}	27.50
Cc	0.27
Cu	11.67

ASTM Classification
Group Name: **Poorly Graded Sand with Gravel**
Symbol: **SP**

INSIGHT GEOLOGIC, INC.

Gradation Analysis Summary Data

Job Name: 2000 24th Ave NW
Job Number: 901-003-01
Date Tested: 2/9/23
Tested By: Andrew Johnson

Sample Location: MW-1
Sample Name: MW-1 4.0' - 6.0'
Depth: 4 - 6 Feet

Moisture Content (%) 29.3%

Sieve Size	Percent Passing
3.0 in. (75.0)	100.0
1.5 in. (37.5)	100.0
3/4 in. (19.0)	100.0
3/8 in. (9.5-mm)	96.0
No. 4 (4.75-mm)	93.0
No. 10 (2.00-mm)	88.3
No. 20 (.850-mm)	84.6
No. 40 (.425-mm)	81.2
No. 60 (.250-mm)	78.2
No. 100 (.150-mm)	75.4
No. 200 (.075-mm)	64.3

Size Fraction	Percent by Weight
Coarse Gravel	0.0
Fine Gravel	7.0
Coarse Sand	4.7
Medium Sand	7.1
Fine Sand	16.9
Fines	64.3
Total	**100.0**

LL	- -
PL	- -
PI	- -
D_{10}	0.00
D_{30}	0.00
D_{60}	0.06
D_{90}	2.80
Cc	- -
Cu	- -

ASTM Classification
Group Name: **Sandy Silt**
Symbol: **ML**

INSIGHT GEOLOGIC, INC.

Gradation Analysis Summary Data

Job Name: 2000 24th Ave NW
Job Number: 901-003-01
Date Tested: 2/9/23
Tested By: Andrew Johnson

Sample Location: MW-2
Sample Name: MW-2 2.0' - 4.0'
Depth: 2 - 4 Feet

Moisture Content (%) 16.8%

Sieve Size	Percent Passing
3.0 in. (75.0)	100.0
1.5 in. (37.5)	100.0
3/4 in. (19.0)	88.4
3/8 in. (9.5-mm)	83.3
No. 4 (4.75-mm)	79.5
No. 10 (2.00-mm)	75.3
No. 20 (.850-mm)	68.8
No. 40 (.425-mm)	39.7
No. 60 (.250-mm)	19.2
No. 100 (.150-mm)	13.3
No. 200 (.075-mm)	7.6

Size Fraction	Percent by Weight
Coarse Gravel	11.6
Fine Gravel	8.9
Coarse Sand	4.2
Medium Sand	35.6
Fine Sand	32.1
Fines	7.6
Total	**100.0**

LL	- -
PL	- -
PI	- -
D_{10}	0.10
D_{30}	0.32
D_{60}	0.65
D_{90}	21.00
Cc	1.58
Cu	6.50

ASTM Classification
Group Name: **Poorly Graded Sand with Gravel and Silt**
Symbol: **SP-SM**

INSIGHT GEOLOGIC, INC.

Gradation Analysis Summary Data

Job Name: 2000 24th Ave NW
Job Number: 901-003-01
Date Tested: 2/9/23
Tested By: Andrew Johnson

Sample Location: MW-3
Sample Name: MW-3 4.0' - 6.0'
Depth: 4 - 6 Feet

Moisture Content (%) 13.6%

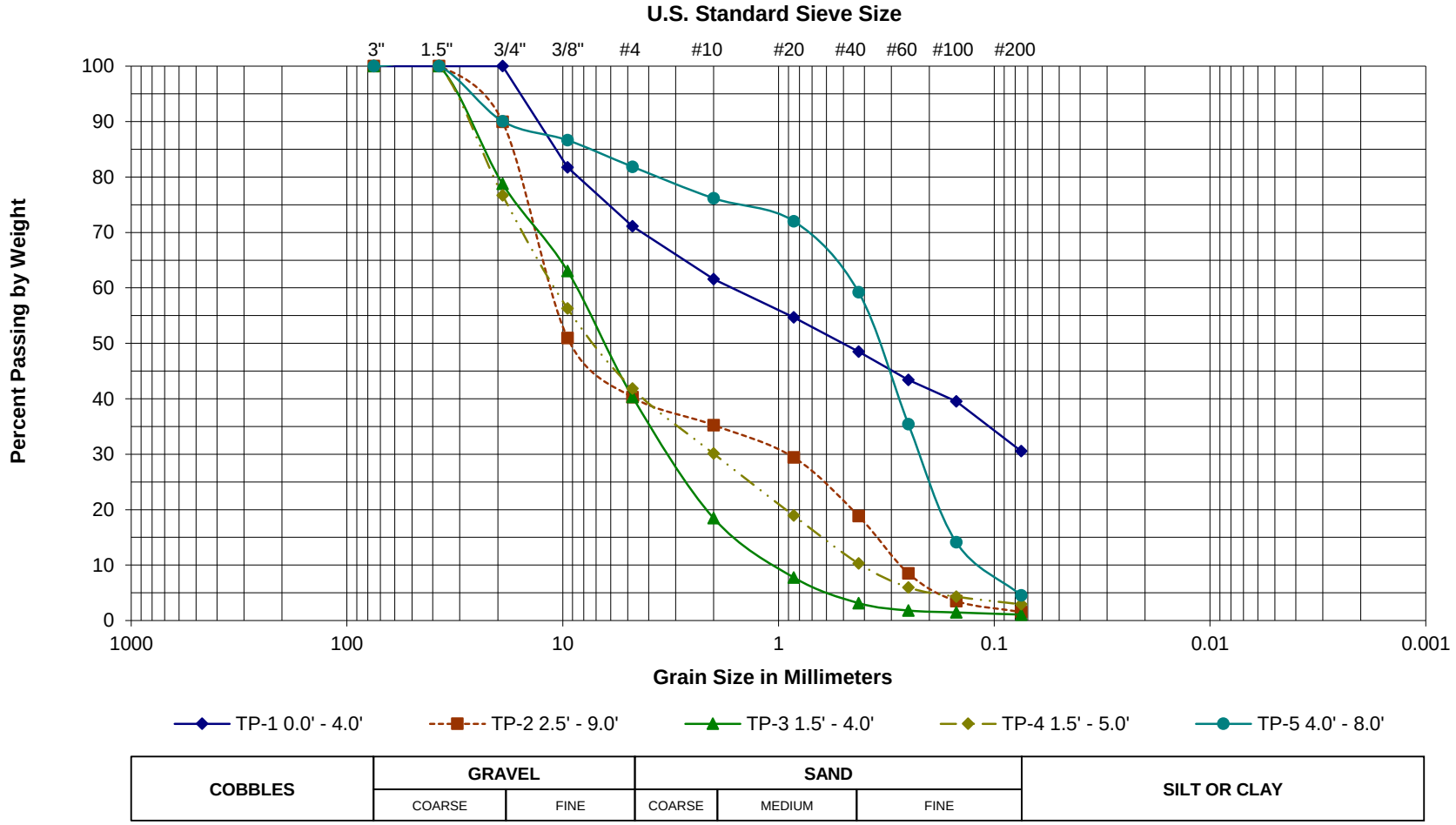
Sieve Size	Percent Passing
3.0 in. (75.0)	100.0
1.5 in. (37.5)	100.0
3/4 in. (19.0)	100.0
3/8 in. (9.5-mm)	91.8
No. 4 (4.75-mm)	85.1
No. 10 (2.00-mm)	78.9
No. 20 (.850-mm)	73.0
No. 40 (.425-mm)	54.8
No. 60 (.250-mm)	42.0
No. 100 (.150-mm)	32.1
No. 200 (.075-mm)	15.3

Size Fraction	Percent by Weight
Coarse Gravel	0.0
Fine Gravel	14.9
Coarse Sand	6.2
Medium Sand	24.1
Fine Sand	39.5
Fines	15.3
Total	**100.0**

LL	- -
PL	- -
PI	- -
D_{10}	0.06
D_{30}	0.14
D_{60}	0.50
D_{90}	8.00
Cc	0.64
Cu	8.20

ASTM Classification
Group Name: **Silty Sand**
Symbol: **SM**

INSIGHT GEOLOGIC, INC.



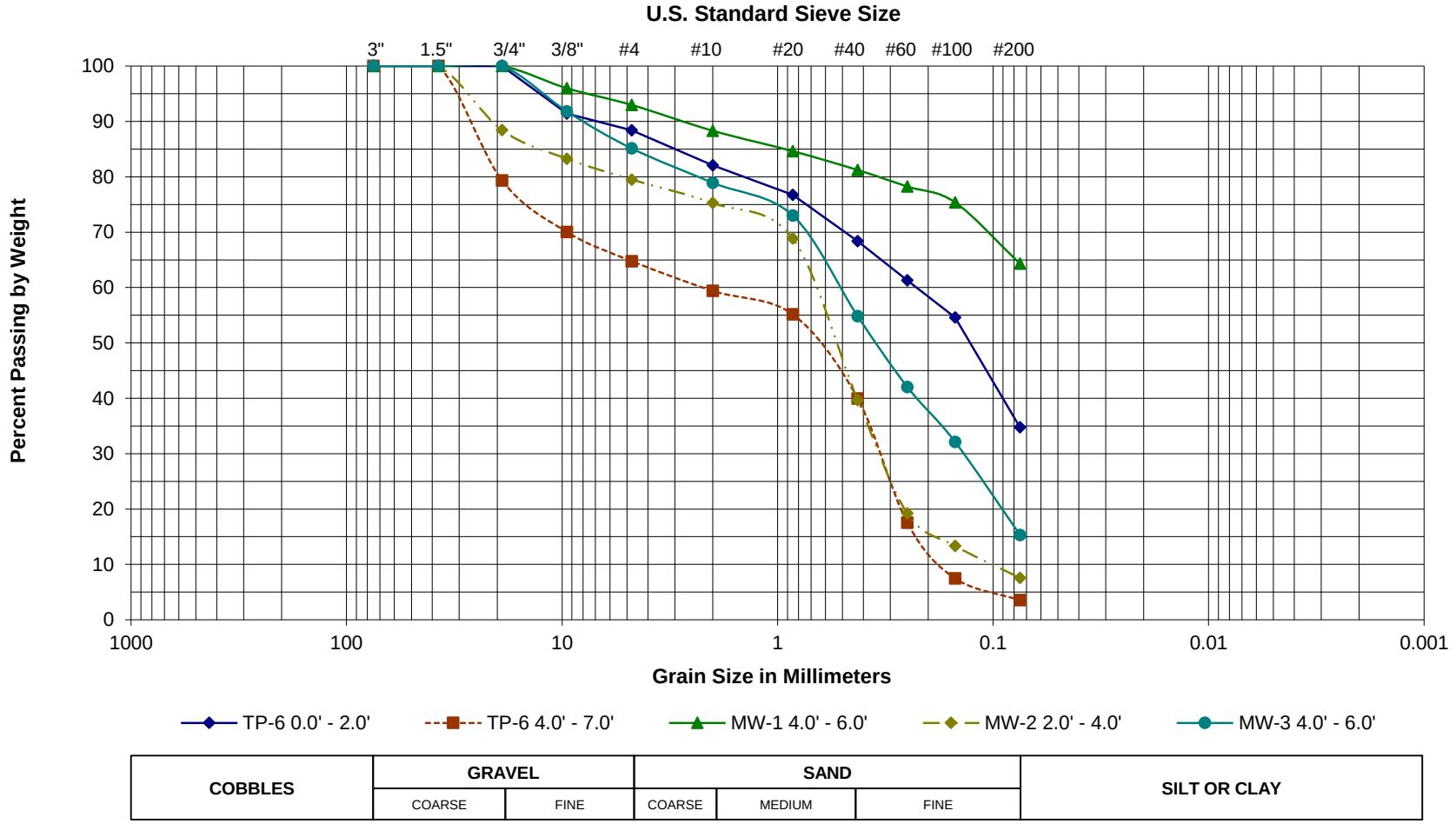
COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	

2000 24TH AVENUE NW

OLYMPIA, WASHINGTON

INSIGHT GEOLOGIC, INC.

Graph 1
Gradation Analysis Results



COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	

2000 24TH AVENUE NW

OLYMPIA, WASHINGTON

INSIGHT GEOLOGIC, INC.

Graph 2
Gradation Analysis Results

ATTACHMENT C
REPORT LIMITATIONS AND GUIDELINES FOR USE

ATTACHMENT C

REPORT LIMITATIONS AND GUIDELINES FOR USE[1]

This attachment provides information to help you manage your risks with respect to the use of this report.

GEOTECHNICAL SERVICES ARE PERFORMED FOR SPECIFIC PURPOSES, PERSONS AND PROJECTS

This report has been prepared for the exclusive use by RJ Development (Client) and their authorized agents. This report may be made available to regulatory agencies for review. This report is not intended for use by others, and the information contained herein is not applicable to other sites.

Insight Geologic Inc. structures our services to meet the specific needs of our clients. For example, a geotechnical or geologic study conducted for a civil engineer or architect may not fulfill the needs of a construction contractor or even another civil engineer or architect that are involved in the same project. Because each geotechnical or geologic study is unique, each geotechnical engineering or geologic report is unique, prepared solely for the specific client and project site. Our report is prepared for the exclusive use of our Client. No other party may rely on the product of our services unless we agree in advance to such reliance in writing. This is to provide our firm with reasonable protection against open-ended liability claims by third parties with whom there would otherwise be no contractual limits to their actions. Within the limitations of scope, schedule and budget, our services have been executed in accordance with our Agreement with the Client and generally accepted geotechnical practices in this area at the time this report was prepared. This report should not be applied for any purpose or project except the one originally contemplated.

A GEOTECHNICAL ENGINEERING OR GEOLOGIC REPORT IS BASED ON A UNIQUE SET OF PROJECT-SPECIFIC FACTORS

Insight Geologic, Inc. considered a number of unique, project-specific factors when establishing the scope of services for this project and report. Unless Insight Geologic specifically indicates otherwise, do not rely on this report if it was:

- not prepared for you,
- not prepared for your project,
- not prepared for the specific site explored, or
- completed before important project changes were made.

For example, changes that can affect the applicability of this report include those that affect:

- the function of the proposed structure;
- elevation, configuration, location, orientation or weight of the proposed structure;
- composition of the design team; or
- project ownership.

If important changes are made after the date of this report, Insight Geologic should be given the opportunity to review our interpretations and recommendations and provide written modifications or confirmation, as appropriate.

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[1] Developed based on material provided by ASFE, Professional Firms Practicing in the Geosciences; www.asfe.org .

SUBSURFACE CONDITIONS CAN CHANGE

This geotechnical or geologic report is based on conditions that existed at the time the study was performed. The findings and conclusions of this report may be affected by the passage of time, by manmade events such as construction on or adjacent to the site, or by natural events such as floods, earthquakes, slope instability or ground water fluctuations. Always contact Insight Geologic before applying a report to determine if it remains applicable.

MOST GEOTECHNICAL AND GEOLOGIC FINDINGS ARE PROFESSIONAL OPINIONS

Our interpretations of subsurface conditions are based on field observations from widely spaced sampling locations at the site. Site exploration identifies subsurface conditions only at those points where subsurface tests are conducted or samples are taken. Insight Geologic reviewed field and laboratory data and then applied our professional judgment to render an opinion about subsurface conditions throughout the site. Actual subsurface conditions may differ, sometimes significantly, from those indicated in this report. Our report, conclusions and interpretations should not be construed as a warranty of the subsurface conditions.

GEOTECHNICAL ENGINEERING REPORT RECOMMENDATIONS ARE NOT FINAL

Do not over-rely on the preliminary construction recommendations included in this report. These recommendations are not final, because they were developed principally from Insight Geologic's professional judgment and opinion. Insight Geologic's recommendations can be finalized only by observing actual subsurface conditions revealed during construction. Insight Geologic cannot assume responsibility or liability for this report's recommendations if we do not perform construction observation.

Sufficient monitoring, testing and consultation by Insight Geologic should be provided during construction to confirm that the conditions encountered are consistent with those indicated by the explorations, to provide recommendations for design changes should the conditions revealed during the work differ from those anticipated, and to evaluate whether or not earthwork activities are completed in accordance with our recommendations. Retaining Insight Geologic for construction observation for this project is the most effective method of managing the risks associated with unanticipated conditions.

A GEOTECHNICAL ENGINEERING OR GEOLOGIC REPORT COULD BE SUBJECT TO MISINTERPRETATION

Misinterpretation of this report by other design team members can result in costly problems. You could lower that risk by having Insight Geologic confer with appropriate members of the design team after submitting the report. Also retain Insight Geologic to review pertinent elements of the design team's plans and specifications. Contractors can also misinterpret a geotechnical engineering or geologic report. Reduce that risk by having Insight Geologic participate in pre-bid and pre-construction conferences, and by providing construction observation.

DO NOT REDRAW THE EXPLORATION LOGS

Geotechnical engineers and geologists prepare final boring and testing logs based upon their interpretation of field logs and laboratory data. To prevent errors or omissions, the logs included in a

geotechnical engineering or geologic report should never be redrawn for inclusion in architectural or other design drawings. Only photographic or electronic reproduction is acceptable, but recognize that separating logs from the report can elevate risk.

GIVE CONTRACTORS A COMPLETE REPORT AND GUIDANCE

Some owners and design professionals believe they can make contractors liable for unanticipated subsurface conditions by limiting what they provide for bid preparation. To help prevent costly problems, give contractors the complete geotechnical engineering or geologic report, but preface it with a clearly written letter of transmittal. In that letter, advise contractors that the report was not prepared for purposes of bid development and that the report's accuracy is limited; encourage them to confer with Insight Geologic and/or to conduct additional study to obtain the specific types of information they need or prefer. A pre-bid conference can also be valuable. Be sure contractors have sufficient time to perform additional study. Only then might an owner be in a position to give contractors the best information available, while requiring them to at least share the financial responsibilities stemming from unanticipated conditions. Further, a contingency for unanticipated conditions should be included in your project budget and schedule.

CONTRACTORS ARE RESPONSIBLE FOR SITE SAFETY ON THEIR OWN CONSTRUCTION PROJECTS

Our geotechnical recommendations are not intended to direct the contractor’s procedures, methods, schedule or management of the work site. The contractor is solely responsible for job site safety and for managing construction operations to minimize risks to on-site personnel and to adjacent properties.

READ THESE PROVISIONS CLOSELY

Some clients, design professionals and contractors may not recognize that the geoscience practices (geotechnical engineering or geology) are far less exact than other engineering and natural science disciplines. This lack of understanding can create unrealistic expectations that could lead to disappointments, claims and disputes. Insight Geologic includes these explanatory “limitations” provisions in our reports to help reduce such risks. Please confer with Insight Geologic if you are unclear how these “Report Limitations and Guidelines for Use” apply to your project or site.

GEOTECHNICAL, GEOLOGIC AND ENVIRONMENTAL REPORTS SHOULD NOT BE INTERCHANGED

The equipment, techniques and personnel used to perform an environmental study differ significantly from those used to perform a geotechnical or geologic study and vice versa. For that reason, a geotechnical engineering or geologic report does not usually relate any environmental findings, conclusions or recommendations; e.g., about the likelihood of encountering underground storage tanks or regulated contaminants. Similarly, environmental reports are not used to address geotechnical or geologic concerns regarding a specific project.