INSIGHT GEOLOGIC, INC.

Attachment 7

August 2, 2018

Kapa Construction
8411 Old Highway 99 SE
Tumwater, Washington 98501
Attn: Pawel Oberc

Proposal
Geotechnical, Stormwater and Limited Environmental Investigation
Proposed Boulevard Road Residential Development
2817 Boulevard Road SE
Olympia, Washington
Project No. 1065-001-01

INTRODUCTION

Insight Geologic, Inc. is pleased to provide our report regarding our investigation of subsurface conditions for your proposed residential development to be located at 2817 Boulevard Road SE in Olympia, Washington. The location of the site is shown relative to surrounding physical features in the Vicinity Map, Figure 1. We understand that you are proposing a 16-lot residential development, along with appurtenant roadway, parking and driveway areas. Stormwater runoff will be routed to individual lot drywells for disposal. The site is currently undeveloped and vegetated with low-growing plants such as scotch broom and black berry, along with scattered alder, maple, and fir trees. A steep slope is located on the western portion of the property, which may qualify as a landslide hazard in accordance with the City of Olympia Critical Area Ordinance Chapter 18.32. Further, it is our understanding the City of Olympia Site Plan Review Committee has requested a limited environmental screening due to historic car-storage activities at the site.

Our services were performed in general accordance with our proposal dated June 25, 2018 and authorized on July 18, 2018.

SCOPE OF SERVICES

The purpose of our services was to evaluate subsurface conditions as they pertain to stormwater infiltration and geotechnical parameters. We proposed to conduct our stormwater services in general accordance with the guidelines outlined in the City of Olympia's 2016 Drainage Design and Erosion Control Manual (DDECM). Our specific scope of services included the following tasks:

1. Excavated 10 exploratory test pits on the site using a small, track-mounted excavator. The test pits were excavated to a depth of 8 to 9 feet below ground surface (bgs) to evaluate shallow soils for the purposes of developing geotechnical recommendations for the project, as well as for stormwater infiltration from roadways and from individual residences. The test pits were backfilled using the excavated soil at the end of the field day.

2. Logged the soils encountered in the test pits in general accordance with ASTM D2487-06.
3. Conducted grain-size analyses on six (6) soil samples collected from the test pits. The grain-size analyses were used to derive design infiltration rates for the stormwater system in accordance with the DDECM.
4. Collected representative soil samples from the area of suspected vehicle storage for environmental analysis. Samples were collected into laboratory-supplied glass containers appropriate for the requested analyses.
5. Provided for the analysis of soil samples for the presence of petroleum hydrocarbons using Ecology method NWTPH-HCID with quantitative follow-up using NWTPH-Gx, Dx, and for MTCA 5 Metals using EPA method 7000/8000 series.
6. Evaluated the results of the laboratory analyses with respect to current cleanup levels as published by the Washington State Department of Ecology for unrestricted residential land use.
7. Prepared a report summarizing our field activities and containing recommendations for site grading, use of native material as structural fill, soil values for retaining wall design, seismic design parameters, and steep slope and landslide hazards, along with design infiltration rate for the proposed stormwater infiltration system. In addition, we have provided a summary of our limited environmental screening activities.

FINDINGS

Surface Conditions

The project site is situated at an elevation of between 160 and 204 feet above mean sea level (MSL). The site is bounded by Boulevard Road SE to the east, residential properties to the south, undeveloped land to the west, and a church to the north. The site is currently undeveloped and vegetated with low-growing plants, such as scotch broom and blackberry, along with scattered alder, maple, and fir trees. A moderate slope is located on the western portion of the property, leading down to a wetland area within a glacial kettle.

Steep Slope Assessment

We conducted a site reconnaissance of the slope descending approximately 30 feet to the base of the glacial kettle and the associated wetlands. Based on multiple measurements made using a hand-held clinometer, the steepest slopes are approximately 26 percent along the east side of the kettle formation.

No evidence of bedding planes or geologic contact zones were noted during our site reconnaissance. We did not observe the presence of groundwater seeps but did observe the presence of hydric vegetation within the wetland at the base of the slope, indicating the presence of groundwater. We did not observe the presence of historical soil failures or landslide features such as butt-bowed trees, hummocky or back-tilted topography, or ponded drainage on the slope.

Based on our evaluation of the slopes on the site, it is our opinion that no portion of the slope represents a landslide hazard area as per the City of Olympia Critical Area Ordinance. The slope does not exceed a slope of 40 percent and the site does not contain interbedded geology with groundwater seeps along the slope. As a result, no buffer is required.

Geology

Based on our review of available published geologic maps, Vashon age glacial recessional outwash deposits underlie the project site and surrounding area. The outwash material is described as fine to medium sand with few fines. This material was deposited around the margins of glacially-formed kettle lakes, during the waning stages of the most recent glacial period in the Puget Sound lowlands; the Fraser Stade of the Vashon glaciation. The outwash is typically found in a loose to moderately dense condition and is not glacially consolidated.

Subsurface Explorations

We explored subsurface conditions at the site on July 18, 2018 by excavating 10 test pits in the locations as shown on the Site Plan, Figure 2. The test pits were excavated using a track-mounted excavator owned and operated by Kapa Construction. A geologist from Insight Geologic monitored the explorations and maintained a log of the conditions encountered. The test pits were completed between 8 and 9 feet bgs. The soils were visually classified in general accordance with the system described in ASTM D2487-06. The exploration logs are contained in Attachment A.

Soil Conditions

Soil conditions encountered were generally consistent across the site. Underlying approximately 6 inches of sod or forest duff, we encountered approximately 2 to 3 feet of orange-brown silt to silt with sand (ML) in a soft and moist condition. Underlying this upper unit, soils graded to a brown color, which extended to the base of the test pits at 8 to 9 feet bgs. One exception to this description was encountered in test pit TP-10, excavated near the base of the kettle formation. Soils in TP-10 graded to a sandy silt at a depth of 6.5 feet bgs.

The surficial soils encountered are generally consistent with Giles silt loam, which is mapped for the eastern half of the site. These soils are generally formed from volcanic ash and glacial outwash and generally have restrictive layers occurring at depths greater than 7 feet below grade, according to the U.S. Department of Agriculture Soil Survey. Soils on the west half of the site are mapped as Yelm fine sandy loam, however soils encountered in this area had a significantly higher silt content and more closely resemble a silt loam.

Groundwater Conditions

Groundwater was encountered in test pit TP-10, excavated near the base of the glacial kettle, at a depth of 8 feet bgs or an approximate elevation of 152 feet MSL.

Laboratory Testing

We selected 12 soil samples for laboratory testing. Six of the samples obtained were sent to an outside laboratory, Libby Environmental, Inc. of Olympia, Washington, for petroleum hydrocarbon and MTCA 5 Metals analyses by NWTPH-HCID and EPA Method 7000/8000 series, respectively. The remaining six soil samples were analyzed in general accordance with ASTM D422 to define soil class, obtain geotechnical parameters and develop stormwater infiltration rates. Our geotechnical laboratory test results are presented in Attachment B.

ENVIRONMENTAL SCREENING

Six soil samples were delivered to Libby Environmental, Inc. of Olympia, Washington, for analysis of

petroleum hydrocarbon and MTCA 5 Metals using NWTPH-HCID and EPA Method 7000/8000 series methods, respectively.

Petroleum hydrocarbons were not detected within any of the six samples submitted for analysis. Lead and chromium were detected in each of the samples at concentrations less than the corresponding MTCA Method A cleanup level of 250 mg/kg and 2,000 mg/kg, respectively. A summary of the analytical data is presented in Table 1. Laboratory analytical reports are contained in Attachment B. The sampling locations are shown on the Site Plan, Figure 2.

Table 1. Summary of Environmental Screening

Sample Name	Sample Date	Petroleum Hydrocarbons	Lead (mg/kg)	Chromium (mg/kg)
S-1	7/18/2018	Not Detected	40	11
S-2	7/18/2018	Not Detected	73	25
S-3	7/18/2018	Not Detected	42	15
S-4	7/18/2018	Not Detected	64	8.6
S-5	7/18/2018	Not Detected	57	19
S-6	7/18/2018	Not Detected	16	26
MTCA Method A Cleanup Level (mg/kg)			250	2,000

STORMWATER INFILTRATION

We completed a stormwater infiltration rate evaluation in general accordance with the 2016 City of Olympia Drainage Design and Erosion Control Manual (2016 Manual). The 2016 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 gradation analyses, we estimate that the long-term design infiltration rate (F_{design}) for the proposed stormwater infiltration is approximately 0.1 inches per hour, after applying the appropriate correction factors. Our calculations assume that the stormwater infiltration will occur at a depth of at least 3 feet bgs. We further assumed that winter groundwater rises to within 40 feet of ground surface, or at about the elevation of the bottom of the kettle. Changes to these infiltration rates are possible depending on soil conditions at deeper depths and further determination of depth to groundwater.

Table 2. Design Infiltration Rates – Detailed Method

Exploration	Unit	Depth Range (feet)	D_{10} Value	D_{60} Value	D_{90} Value	Long Term Design Infiltration Rate (Inches per hour)
TP-3	ML	0.5 – 3.0	0.0	0.0	0.14	0.1
TP-3	ML	3.0 – 8.0	0.0	0.0	0.14	0.13
TP-5	ML	0.5 – 3.0	0.0	0.0	0.16	0.1
TP-5	ML	3.0 – 8.0	0.0	0.0	0.1	0.06
TP-10	ML	4.0 – 6.5	0.0	0.0	0.13	0.05
TP-10	ML	6.5 – 8.0	0.0	0.08	0.15	0.1

SEISMIC DESIGN CONSIDERATIONS

General

We understand that seismic design will likely be performed using the 2015 IBC standards. The following parameters may be used in computing seismic base shear forces:

Table 3. 2015 IBC Seismic Design Parameters

Spectral Response Accel. at Short Periods (SS) = 1.32
Spectral Response Accel. at 1 Second Periods (S1) = 0.54
Site Class = D
Site Coefficient (FA) = 1.0
Site Coefficient (FV) = 1.5

A full report for the seismic design parameters is presented in Attachment C.

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 outwash 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 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 to moderate 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 recessional outwash soil deposits as the project site, we concur with the reviewed map. It is our opinion that there is a moderate 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 upper 9 feet of the soil profile at the site has a moderate 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.

Seismic Slope Instability

The maximum inclination of the slope on the western portion of the site is about 26 percent and we did not observe signs of slope instability during our site work. In our opinion, there is a low to moderate risk of seismic slope instability at the project site under current conditions. If slope instability due to a seismic event did occur, it could result in damage to the residential structures or infrastructure depending on final site layout and proximity to the slope edge.

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 limited understanding of the subsurface conditions along the northeastern site slope, it is our opinion that there could be a low to moderate risk for the development of lateral spreading as a result of an IBC design level earthquake.

Seismic Slope Deformation Discussion

In our experience, it is unlikely that the potential slope deformations described above (seismic compression or lateral spreading) would be mitigated for in the typical design of a residential buildings. If necessary, we are available to perform detailed slope stability/lateral spreading evaluations to include deep borings and/or CPT soundings at the site.

CONCLUSIONS AND RECOMMENDATIONS

General

Based on the results of our review, 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 1,500 pounds per square foot (psf). If higher loads are anticipated, compacted stone columns, small diameter pilings, or a robust structural fill section may be used to increase the bearing strength of the soils beneath the building.

The soils encountered in our explorations are typically in a soft condition near ground surface. To limit the potential for structure settlement, we recommend that shallow foundations and slabs-on-grade be established on a minimum 1-foot thick layer of structural fill. Depending on final grading plans and the time of year earthwork is performed; it could be practical to reuse the on-site soils granular soils as structural fill under the foundations/slabs if adequate compaction can be achieved. Due to the fine nature of the soils, the use of a sheeps-foot roller will be critical to obtaining proper compaction. Smooth-drum, vibratory rollers are not recommended.

Stormwater infiltration at the site is not feasible. Soils located near the surface can effectively be considered impermeable with estimated infiltration rates of 0.05 to 0.13 inches per hour. We recommend that stormwater be collected and routed to a designed stormwater system. Soils with higher infiltration rates may exist on-site but would take further determination of soil conditions at depth and depth to groundwater.

Earthwork

General

We anticipate that site development earthwork will include clearing and stripping of existing vegetation and asphalt, 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. Still, it is possible that concrete slabs, abandoned utility lines or other development features from the existing onsite development could be encountered during construction. The contractor should be prepared to deal with these conditions during site grading activities.

Clearing and Stripping

Clearing and stripping should consist of removing surface and subsurface deleterious materials including sod/topsoil, 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 6 inches will be required to remove the vegetation encountered in our explorations. Deeper stripping depths may be required if additional unsuitable soils are exposed during stripping operations.

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 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 over-excavated and replaced with structural fill. In areas selected for infiltration of roof runoff or permeable pavement, the subgrade should be either non-compacted or minimally compacted to maximize infiltration into the subsurface.

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 it 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

Permanent slopes will be utilized for the proposed project on the western side of the parcel. Where 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 sand bags 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

The majority of the near surface soils are predominantly silts. 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 be 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 silt located at or near the surface of the site. It is our opinion that this material is a suitable source for structural fill during a limited portion of the year due to the fines content and moisture sensitivity. We anticipate that thin lifts (6-inches or less) will likely be needed to obtain structural fill compaction specifications on native soils. Proper moisture conditioning will be critical for use of these soils. 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 2018 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 a sheep's-foot vibratory roller. A sheep's-foot vibratory roller is better suited to compact silty soils than a traditional smooth-drum vibratory roller. The maximum lift thickness will vary depending on the material and compaction equipment used, but should generally not exceed the loose thicknesses provided on 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 proposed structures be founded on continuous wall or isolated column footings, bearing on a minimum 1-foot thick over-excavation and replacement with compacted structural fill. The structural fill zone should extend to a horizontal distance equal to the over-excavation depth on each side of the footing. The actual over-excavation depth will vary, depending on the conditions encountered.

We recommend that an experienced geotechnical owner-representative observe the foundation surfaces before over-excavation, and before placing structural fill in over-excavations. 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 1,500 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.

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 total settlement of footings that are designed and constructed as recommended should be less than 1 inch. We estimate that differential settlements 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 200 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 125 pounds per cubic inch (pci) for 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 a 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 and underslab drains are likely necessary for the proposed structure. The site soils consisting of silt are generally poorly draining. Footing drains should be routed to existing on-site or planned storm drainage. Drains for surface water, such as downspout and area drains, should not be connected to the footing drain system.

Conventional Retaining Walls

General

The following sections provide general guidelines for retaining wall design on this site. 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 3/4-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 29 pcf 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 39 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 will be operated within one-half 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.

DOCUMENT REVIEW AND CONSTRUCTION OBSERVATION

We recommend that we be 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”, 2015.

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.

Washington State Department of Transportation (WSDOT), Standard Specifications for Road, Bridge and Municipal Construction Manual, 2018.

LIMITATIONS

We have prepared this geotechnical, stormwater and limited environmental investigation report for the exclusive use of Kapa Construction and their authorized agents for the proposed residential development project to be located at 2817 Boulevard Road SE in Olympia, Washington.

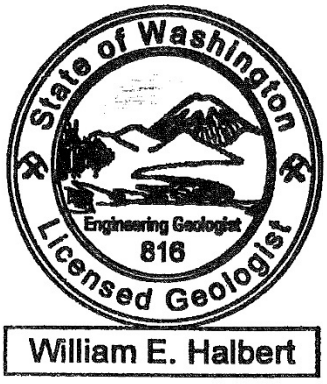
Within the limitations of scope, schedule and budget, our services have been executed in accordance with generally accepted practices in the field of geotechnical engineering in this area at the time this report was prepared. No warranty or other conditions, expressed or implied, should be understood.

Please refer to Attachment D titled "Report Limitations and Guidelines for Use" for additional information pertaining to use of this report.

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

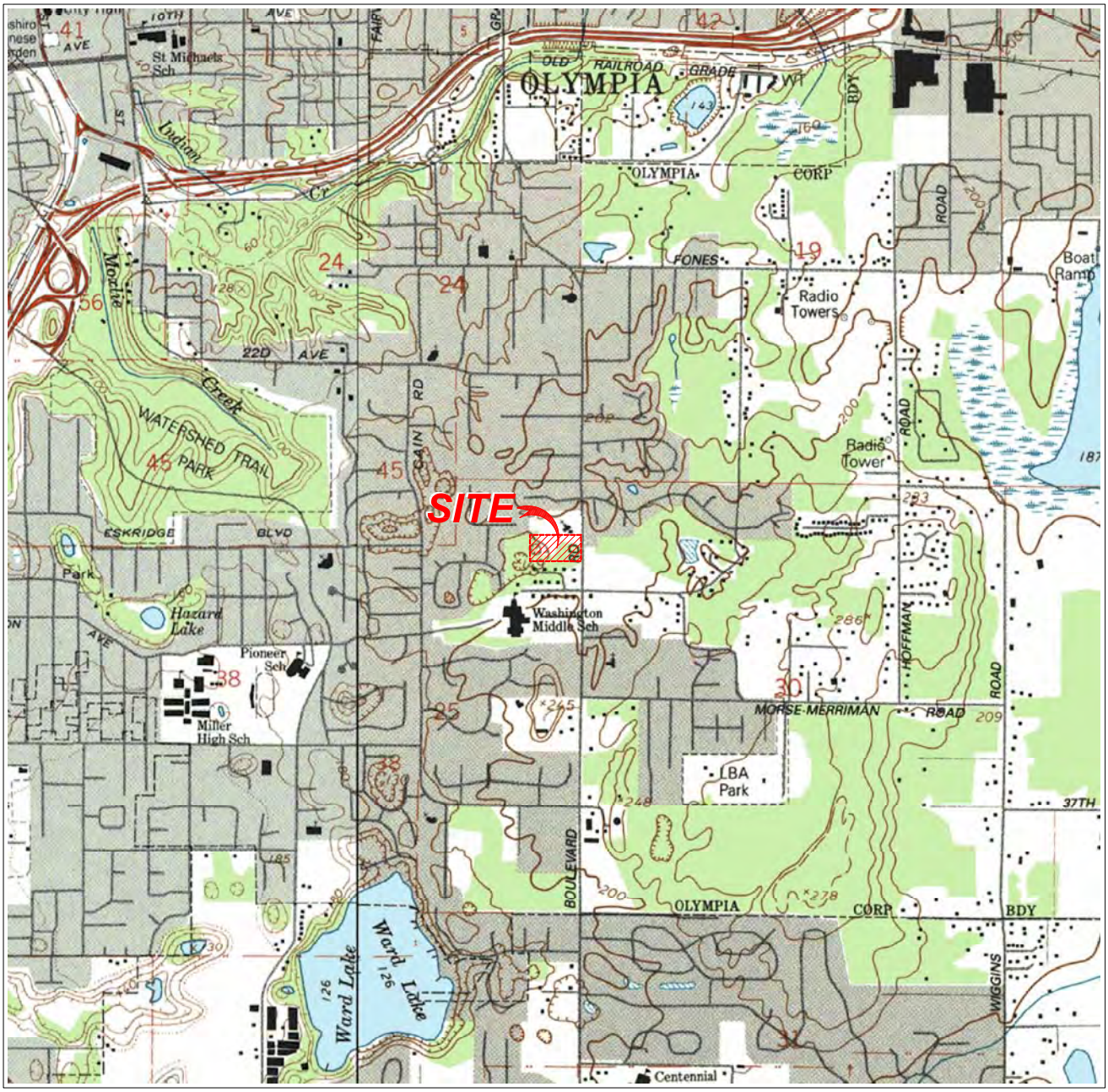
Respectfully Submitted,
INSIGHT GEOLOGIC, INC.

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



Attachments

FIGURES



LACEY, WASHINGTON
7.5 MINUTE QUADRANGLE
Year 1994

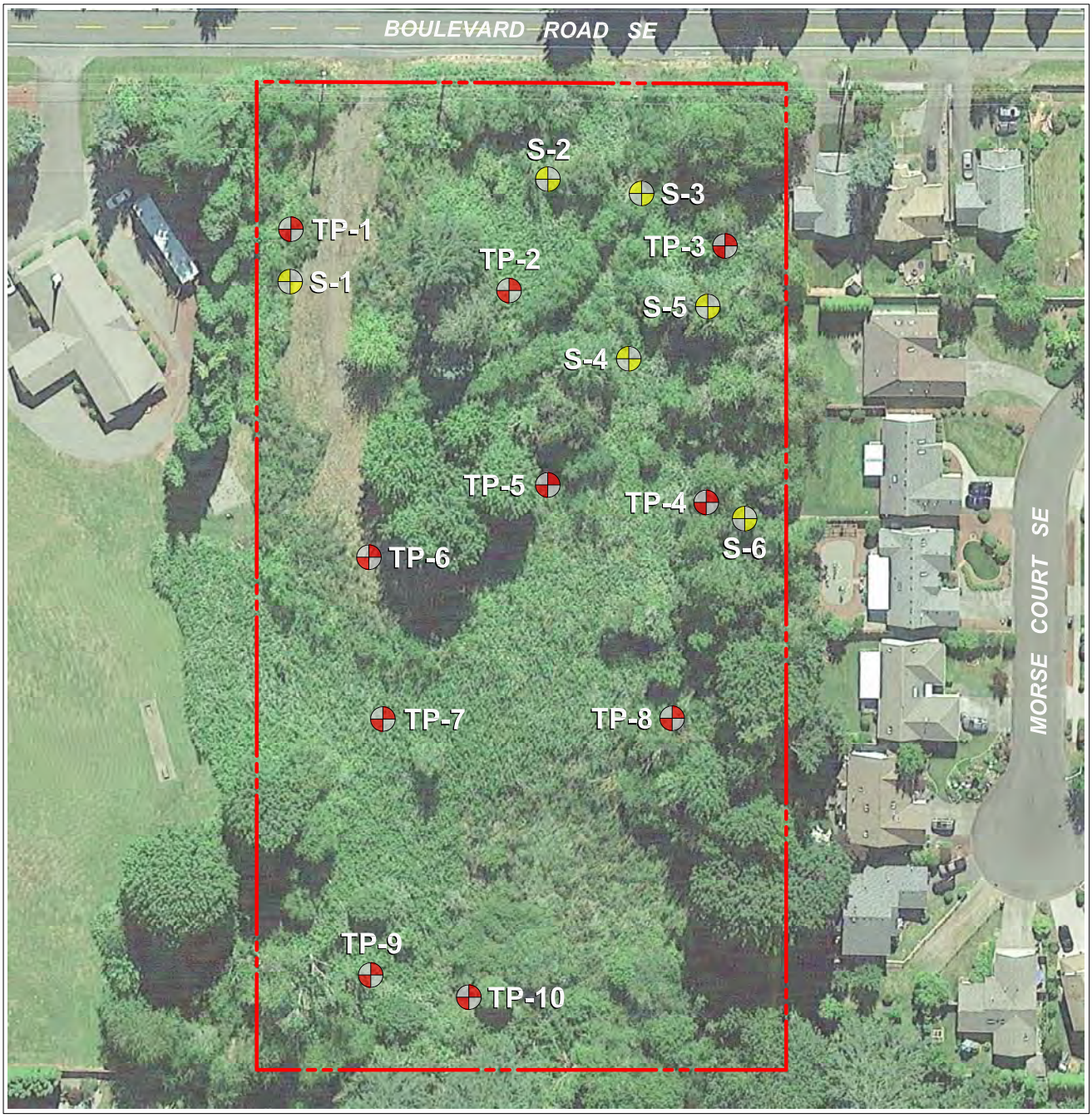
SCALE: 1: 24000

2817 BOULEVARD ROAD SE

OLYMPIA, WASHINGTON

INSIGHT GEOLOGIC, INC.

Figure 1
Vicinity Map



LEGEND:

S-1	APPROXIMATE SAMPLE LOCATION
TP-1	APPROXIMATE TEST PIT LOCATION
	APPROXIMATE PROJECT BOUNDARY

SCALE" 1" = 100'

2817 BOULEVARD ROAD SE

OLYMPIA, WASHINGTON

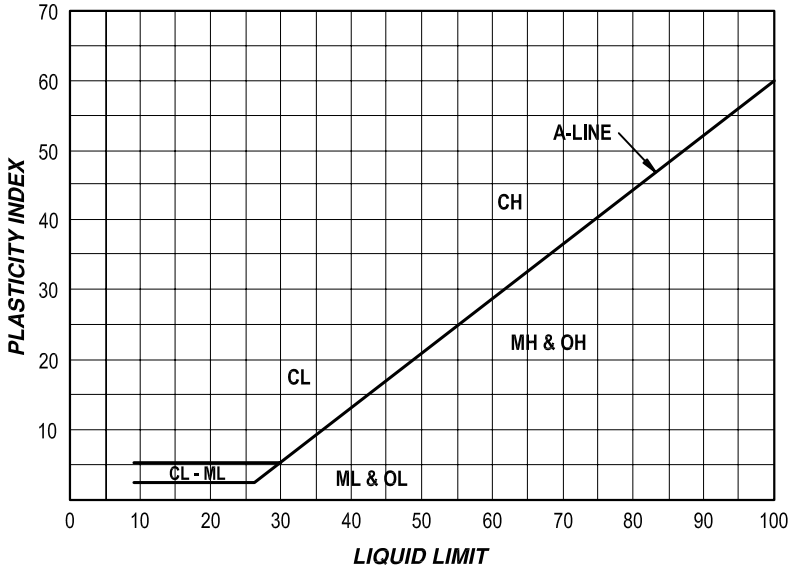
INSIGHT GEOLOGIC, INC.

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 BELOW WATER TABLE

ADDITIONAL MATERIAL SYMBOLS

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

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

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

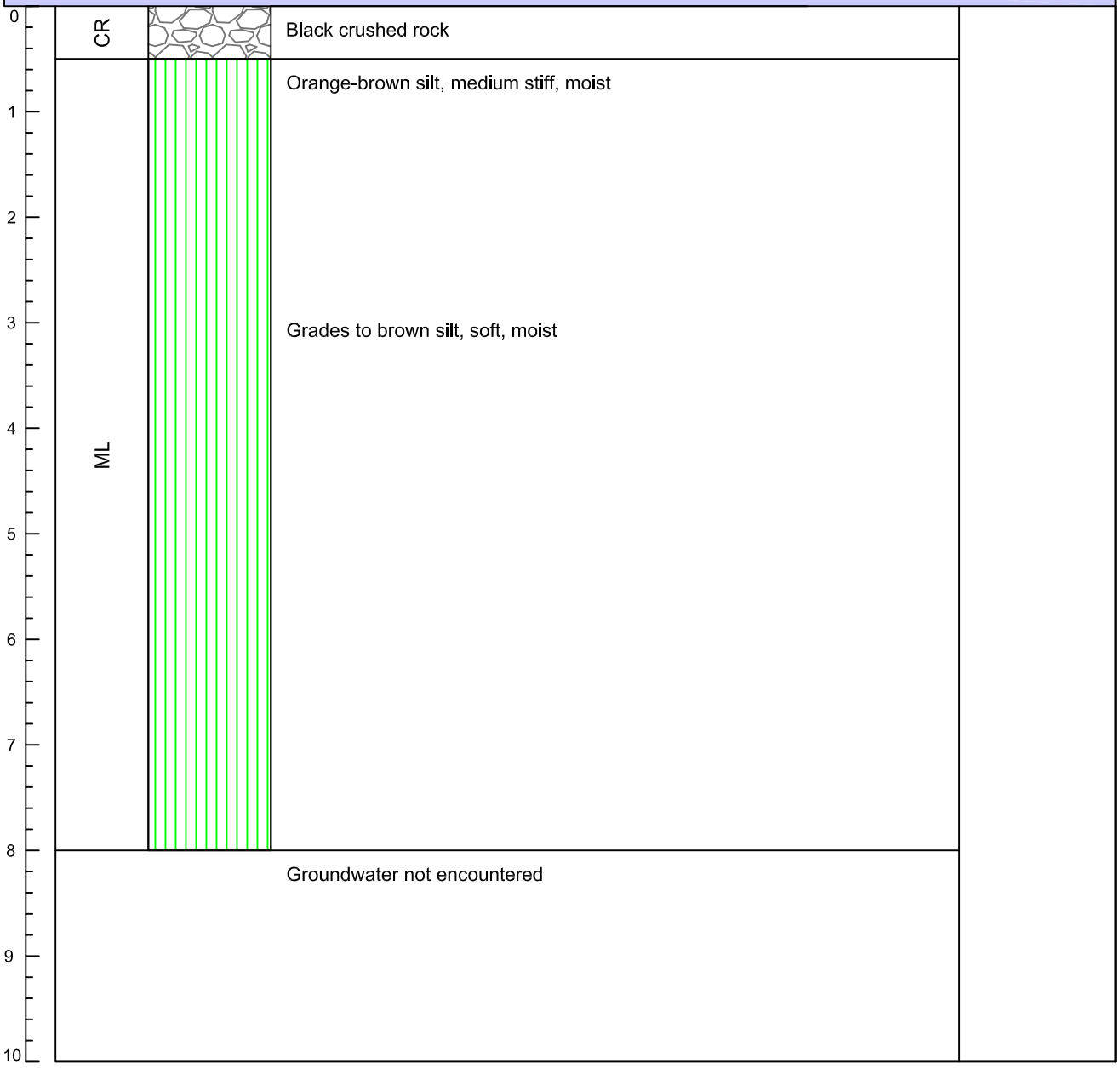
SAMPLER SYMBOLS

- 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

TP-1



LEGEND:

PROJECT NO.: 1065-001-01
DATE: JULY 18, 2018
TOTAL DEPTH: 8 FEET
DRILLING EQUIPMENT: EXCAVATOR
LOGGED BY: KEVIN VANDEHEY

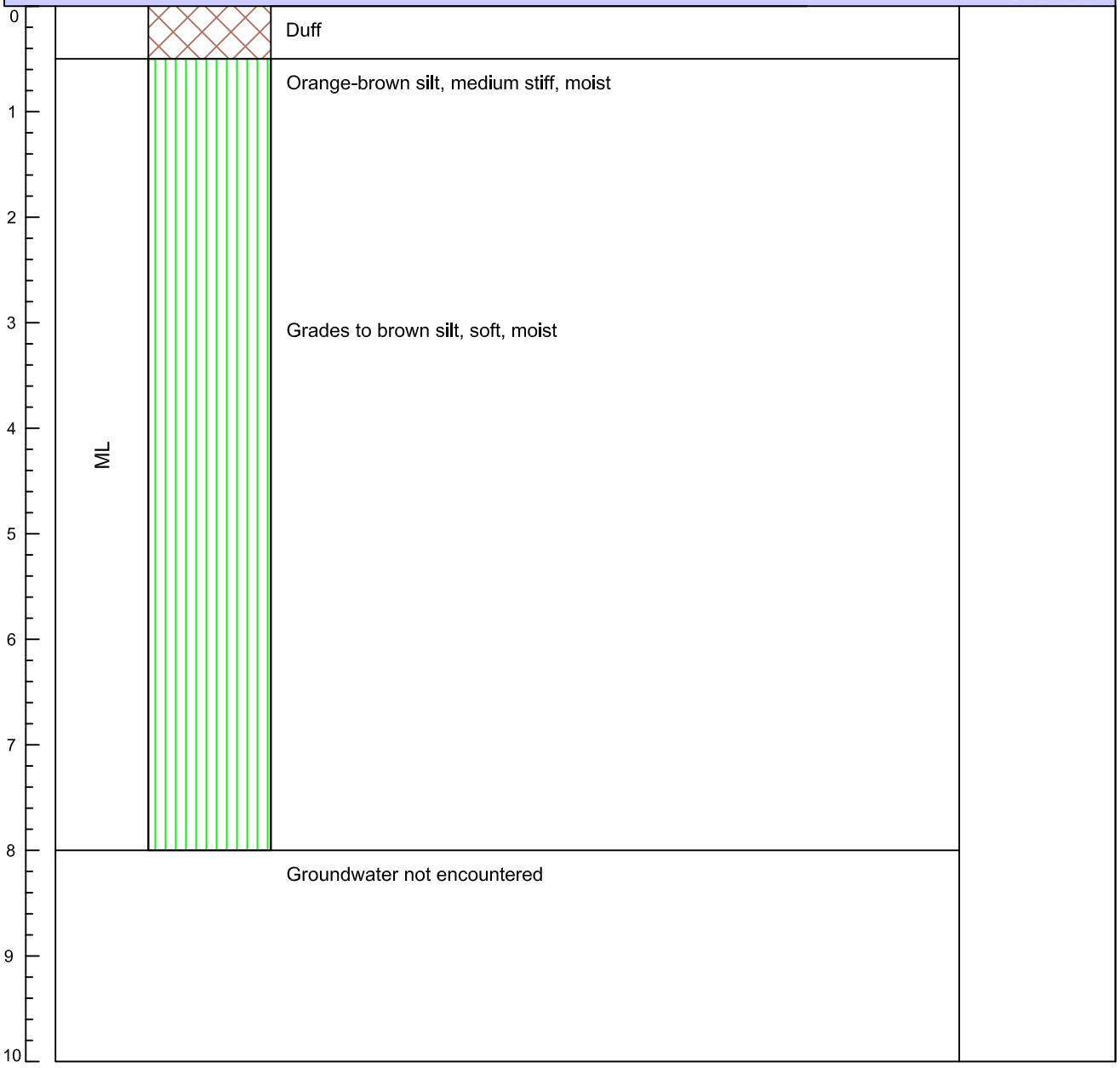
2817 BOULEVARD ROAD SE

OLYMPIA, WASHINGTON

INSIGHT GEOLOGIC, INC.

Exploration Log TP-1

TP-2



LEGEND:

PROJECT NO.: 1065-001-01
DATE: JULY 18, 2018
TOTAL DEPTH: 8 FEET
DRILLING EQUIPMENT: EXCAVATOR
LOGGED BY: KEVIN VANDEHEY

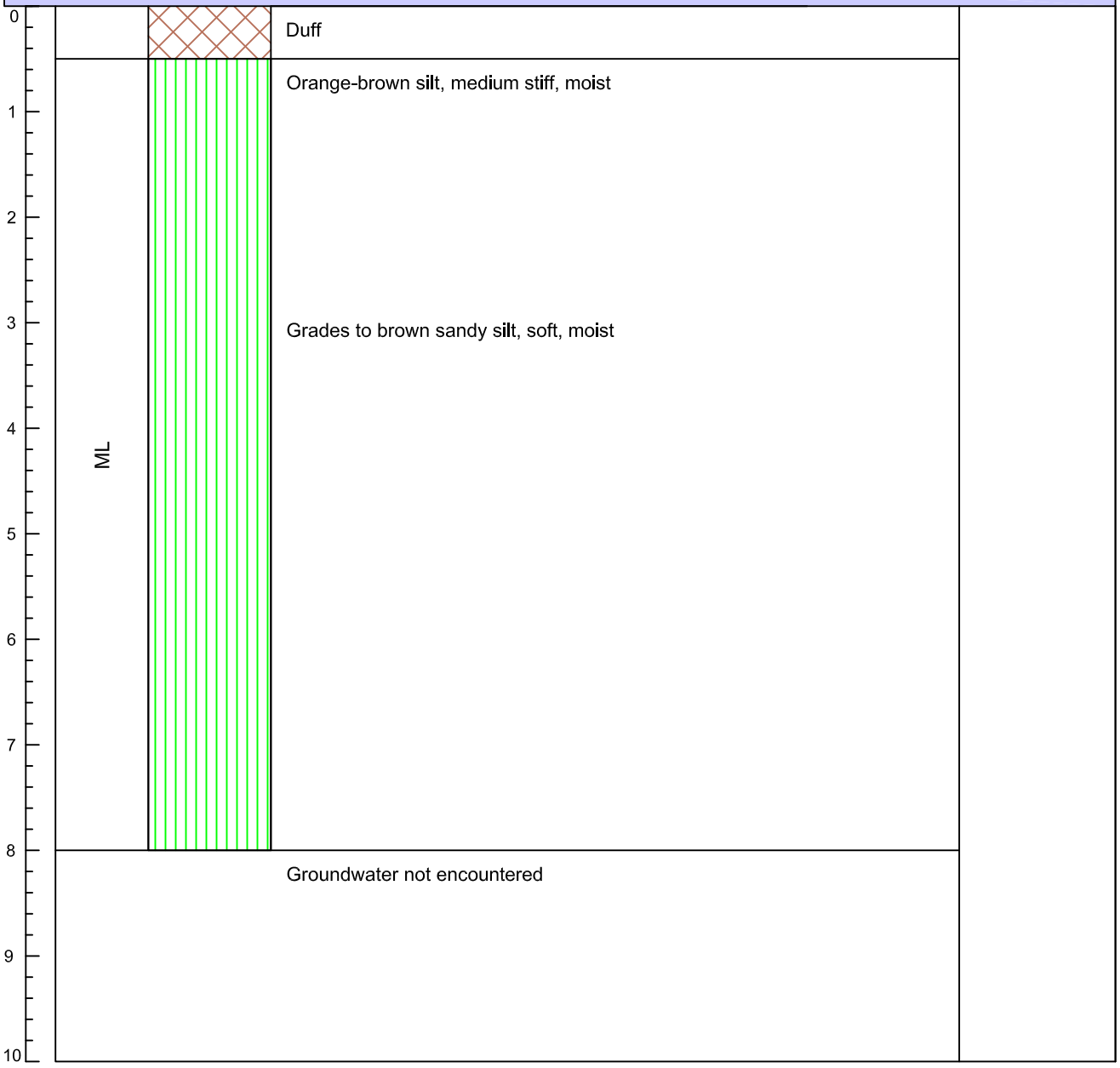
2817 BOULEVARD ROAD SE

OLYMPIA, WASHINGTON

INSIGHT GEOLOGIC, INC.

Exploration Log TP-2

TP-3



LEGEND:

PROJECT NO.: 1065-001-01
DATE: JULY 18, 2018
TOTAL DEPTH: 8 FEET
DRILLING EQUIPMENT: EXCAVATOR
LOGGED BY: KEVIN VANDEHEY

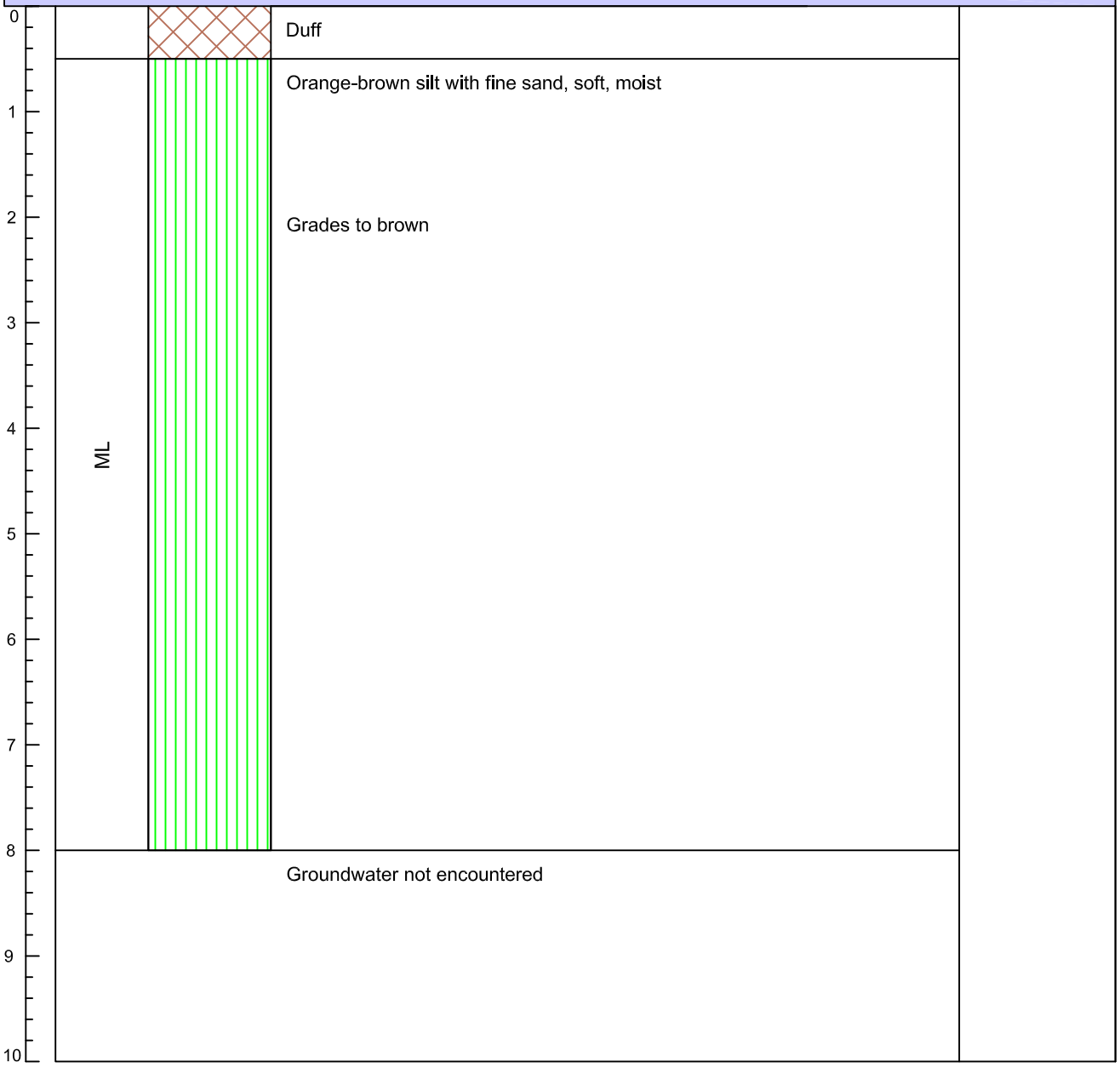
2817 BOULEVARD ROAD SE

OLYMPIA, WASHINGTON

INSIGHT GEOLOGIC, INC.

Exploration Log TP-3

TP-4



LEGEND:

PROJECT NO.: 1065-001-01
DATE: JULY 18, 2018
TOTAL DEPTH: 8 FEET
DRILLING EQUIPMENT: EXCAVATOR
LOGGED BY: KEVIN VANDEHEY

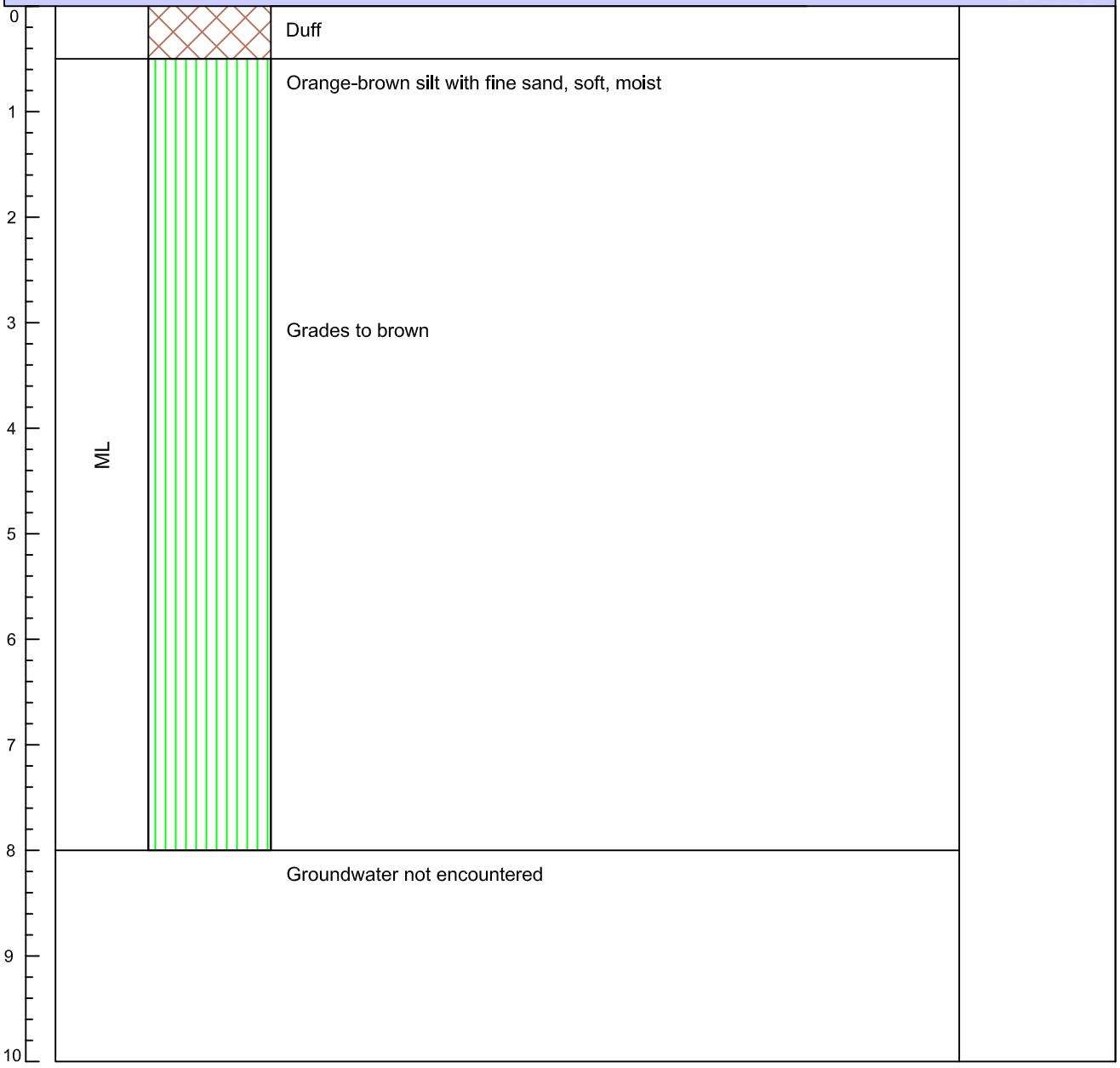
2817 BOULEVARD ROAD SE

OLYMPIA, WASHINGTON

INSIGHT GEOLOGIC, INC.

Exploration Log TP-4

TP-5



LEGEND:

PROJECT NO.: 1065-001-01
DATE: JULY 18, 2018
TOTAL DEPTH: 8 FEET
DRILLING EQUIPMENT: EXCAVATOR
LOGGED BY: KEVIN VANDEHEY

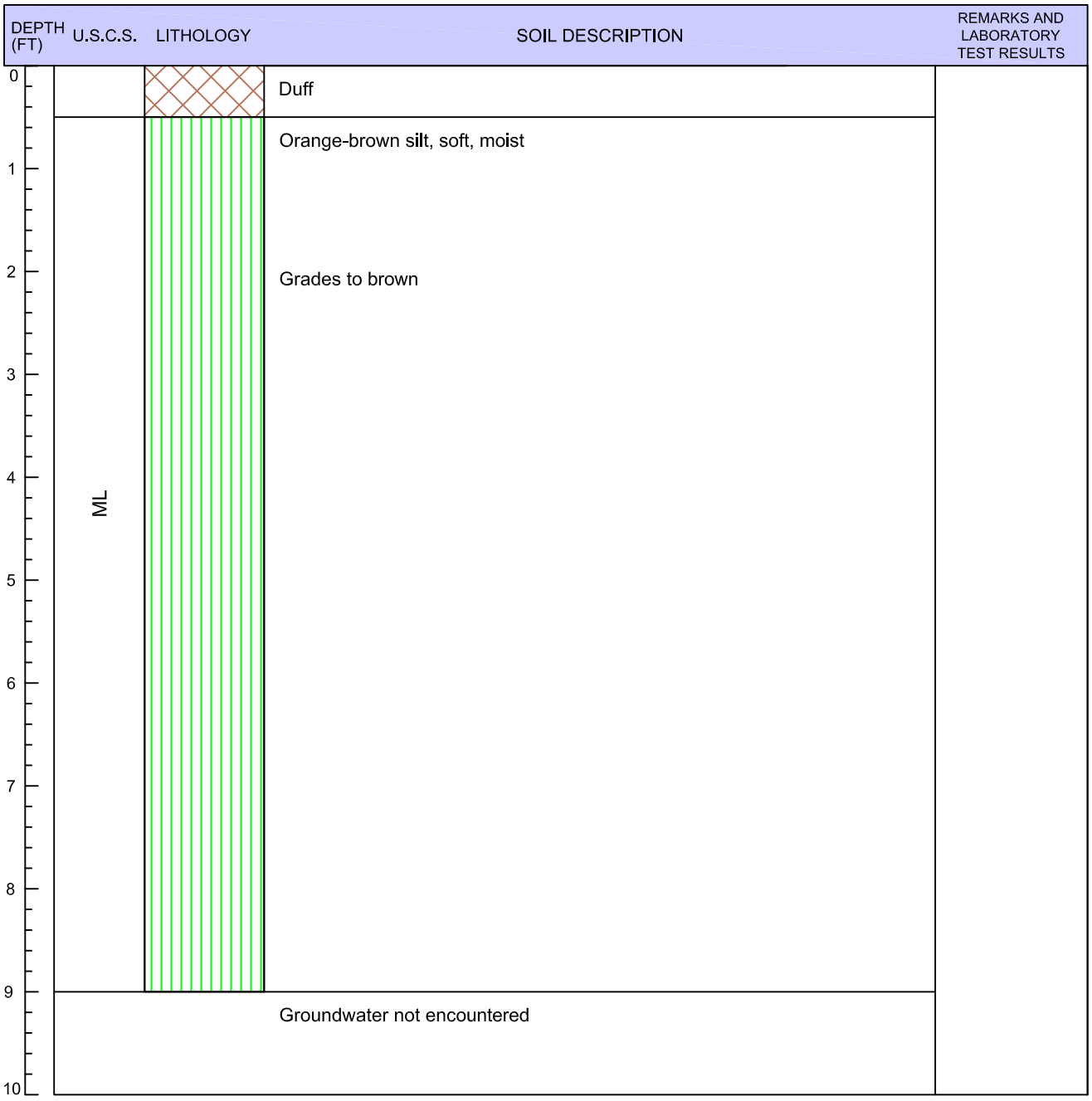
2817 BOULEVARD ROAD SE

OLYMPIA, WASHINGTON

INSIGHT GEOLOGIC, INC.

Exploration Log TP-5

TP-6



LEGEND:

PROJECT NO.: 1065-001-01
DATE: JULY 18, 2018
TOTAL DEPTH: 9 FEET
DRILLING EQUIPMENT: EXCAVATOR
LOGGED BY: KEVIN VANDEHEY

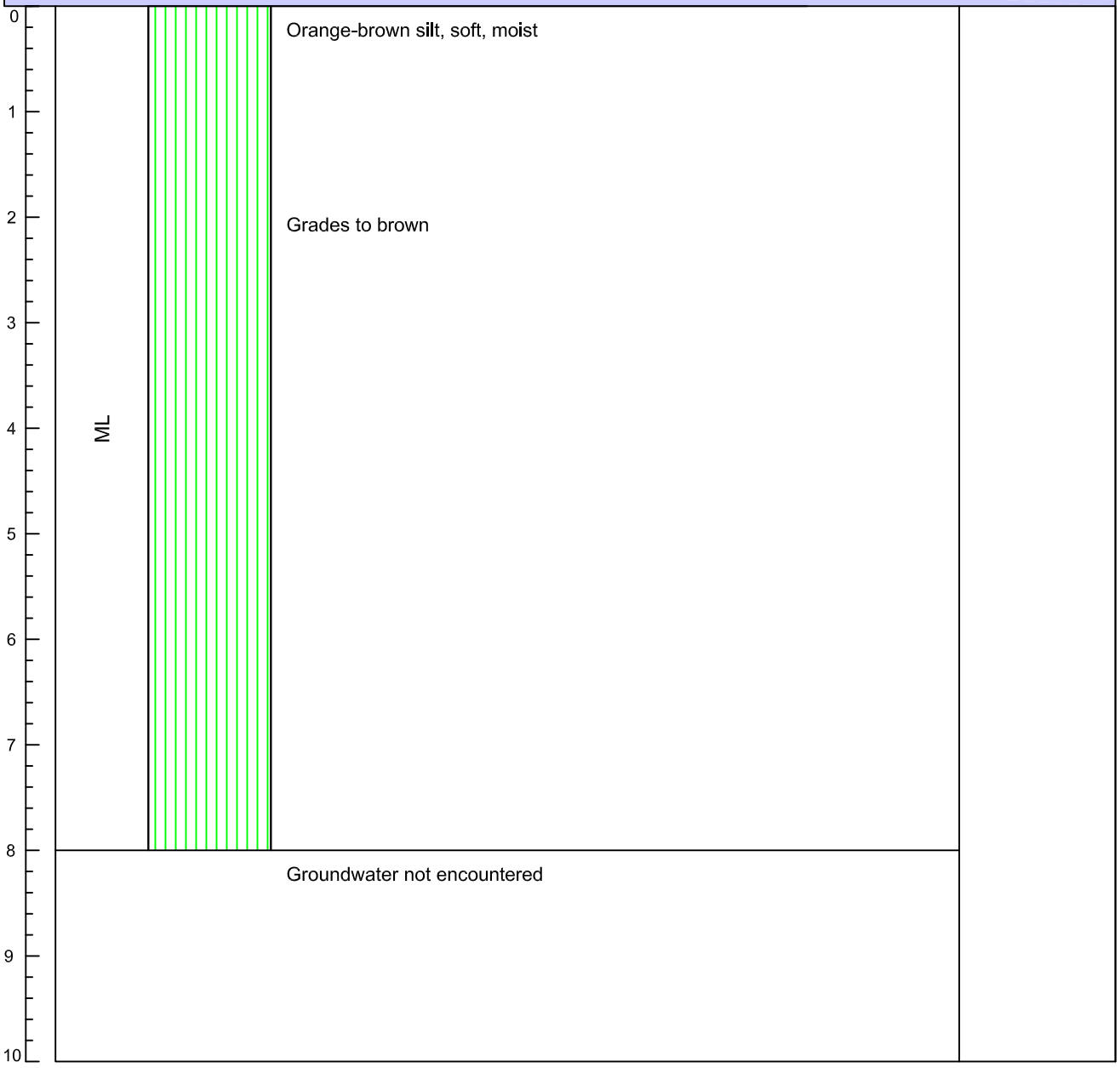
2817 BOULEVARD ROAD SE

OLYMPIA, WASHINGTON

INSIGHT GEOLOGIC, INC.

Exploration Log TP-6

TP-7



LEGEND:

PROJECT NO.: 1065-001-01
DATE: JULY 18, 2018
TOTAL DEPTH: 8 FEET
DRILLING EQUIPMENT: EXCAVATOR
LOGGED BY: KEVIN VANDEHEY

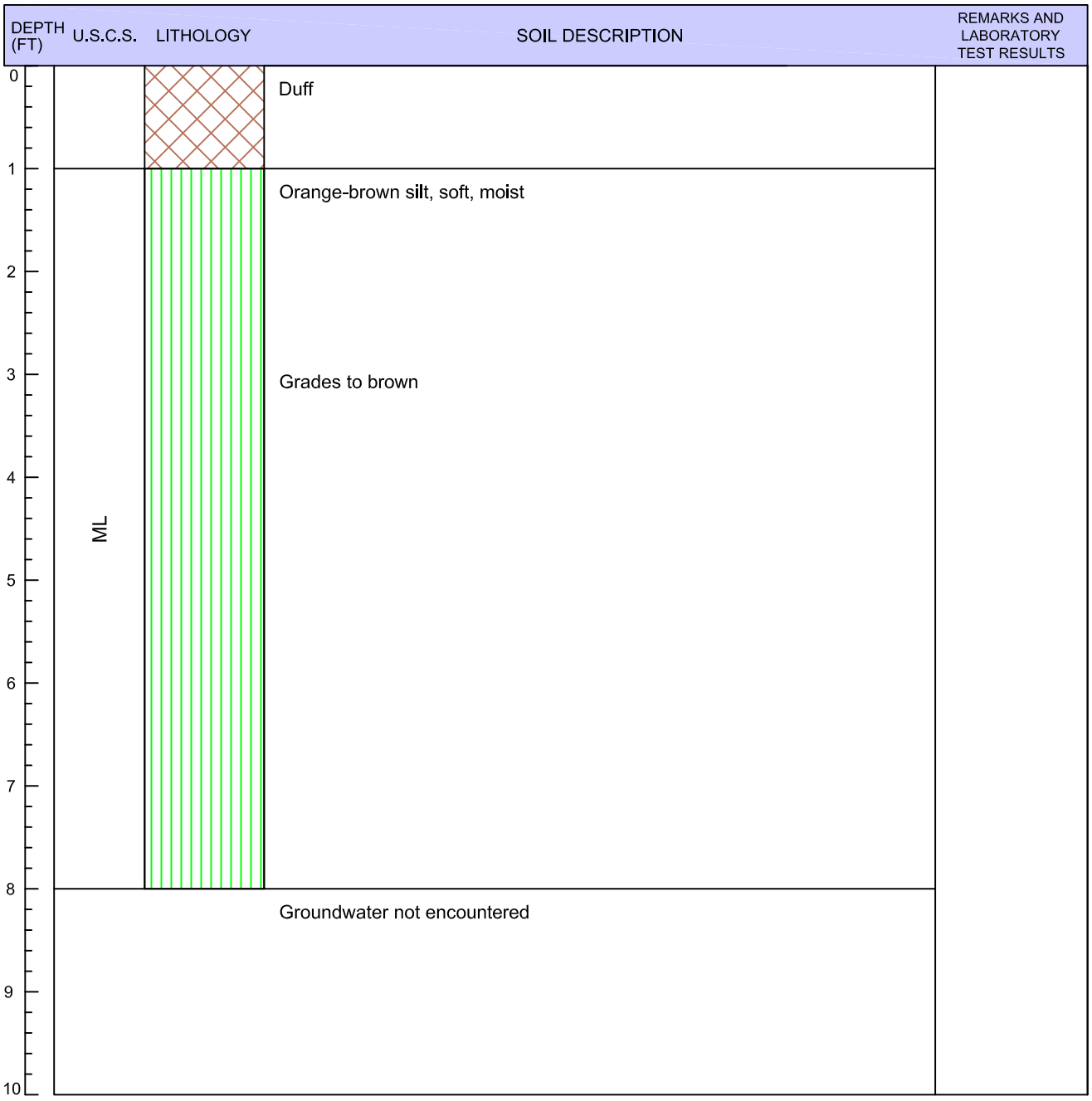
2817 BOULEVARD ROAD SE

OLYMPIA, WASHINGTON

INSIGHT GEOLOGIC, INC.

Exploration Log TP-7

TP-8



LEGEND:

PROJECT NO.: 1065-001-01
DATE: JULY 18, 2018
TOTAL DEPTH: 8 FEET
DRILLING EQUIPMENT: EXCAVATOR
LOGGED BY: KEVIN VANDEHEY

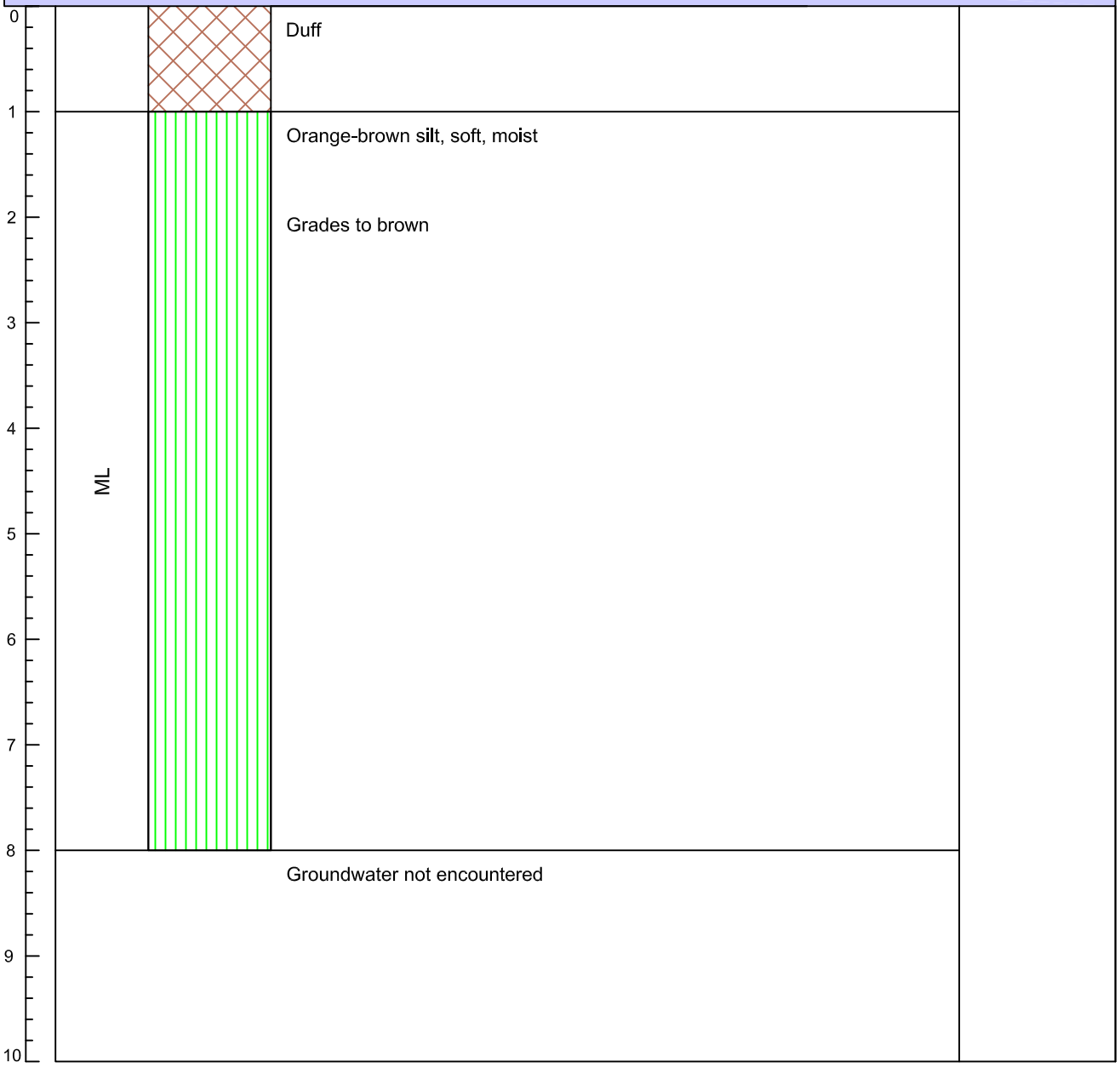
2817 BOULEVARD ROAD SE

OLYMPIA, WASHINGTON

INSIGHT GEOLOGIC, INC.

Exploration Log TP-8

TP-9



LEGEND:

PROJECT NO.: 1065-001-01
DATE: JULY 18, 2018
TOTAL DEPTH: 8 FEET
DRILLING EQUIPMENT: EXCAVATOR
LOGGED BY: KEVIN VANDEHEY

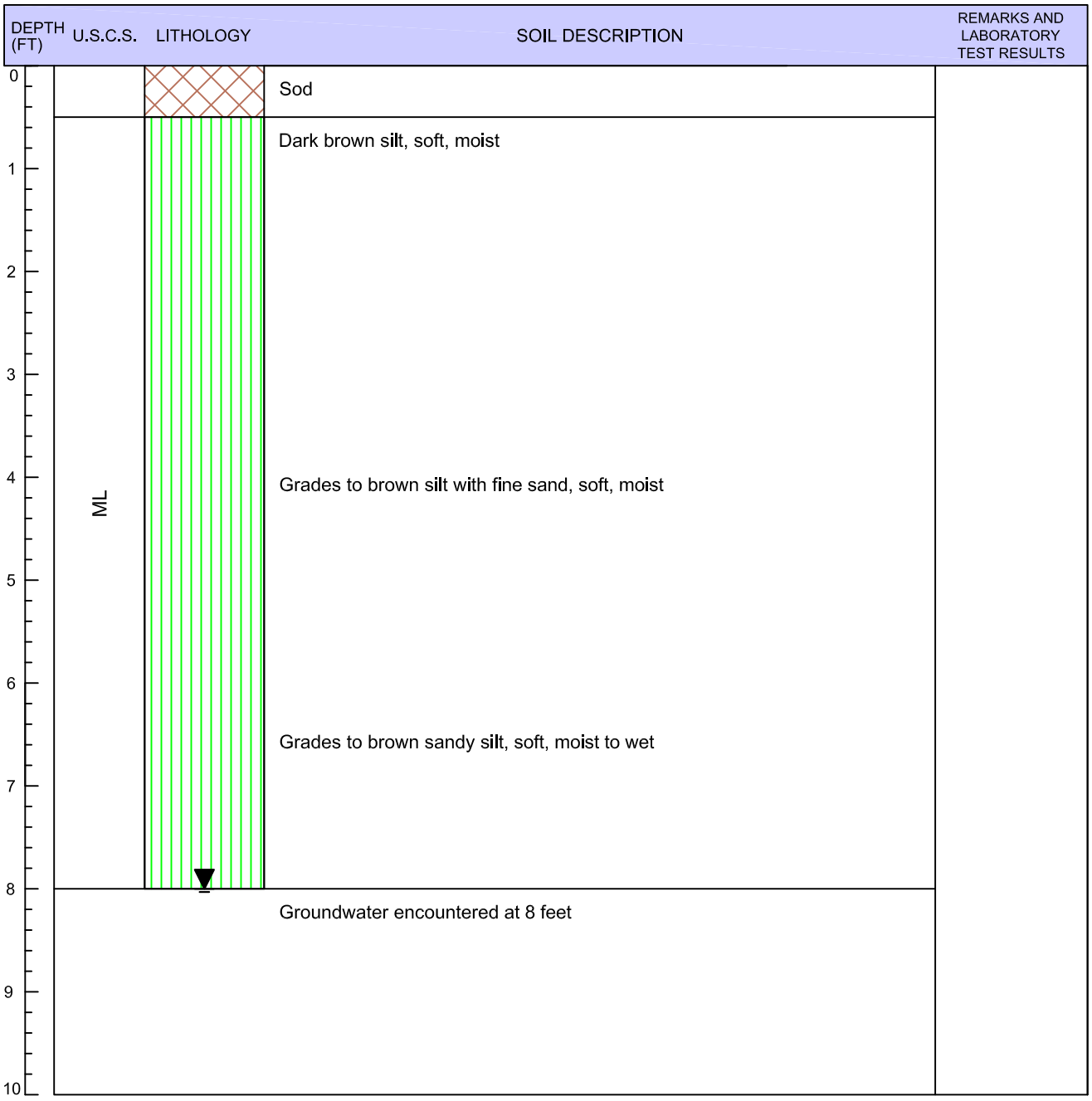
2817 BOULEVARD ROAD SE

OLYMPIA, WASHINGTON

INSIGHT GEOLOGIC, INC.

Exploration Log TP-9

TP-10



LEGEND:

PROJECT NO.: 1065-001-01
DATE: JULY 18, 2018
TOTAL DEPTH: 8 FEET
DRILLING EQUIPMENT: EXCAVATOR
LOGGED BY: KEVIN VANDEHEY

2817 BOULEVARD ROAD SE

OLYMPIA, WASHINGTON

INSIGHT GEOLOGIC, INC.

Exploration Log TP-10

ATTACHMENT B
LABORATORY ANALYSES RESULTS

Gradation Analysis Summary Data

Job Name: 2817 Boulevard Road SE
Job Number: 1065-001-01
Date Tested: 7/19/18
Tested By: Kevin Vandehey

Sample Location: TP-3
Sample Name: TP-3 0.5'-3.0'
Depth: 0.5 - 3 Feet

Moisture Content (%) 19.4%

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)	100.0
No. 4 (4.75-mm)	99.6
No. 10 (2.00-mm)	98.6
No. 20 (.850-mm)	97.4
No. 40 (.425-mm)	96.5
No. 60 (.250-mm)	95.5
No. 100 (.150-mm)	94.1
No. 200 (.075-mm)	74.7

Size Fraction	Percent by Weight
Coarse Gravel	0.0
Fine Gravel	0.4
Coarse Sand	1.0
Medium Sand	2.1
Fine Sand	21.9
Fines	74.7
Total	**100.0**

LL	- -
PL	- -
PI	- -
D_{10}	0.00
D_{30}	0.00
D_{60}	0.00
D_{90}	0.14
Cc	- -
Cu	- -

ASTM Classification
Group Name: **Silt with Sand**
Symbol: **ML**

INSIGHT GEOLOGIC, INC.

Gradation Analysis Summary Data

Job Name: 2817 Boulevard Road SE
Job Number: 1065-001-01
Date Tested: 7/19/18
Tested By: Kevin Vandehey

Sample Location: TP-3
Sample Name: TP-3 3.0'-8.0'
Depth: 3 - 8 Feet

Moisture Content (%) 21.6%

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)	100.0
No. 4 (4.75-mm)	100.0
No. 10 (2.00-mm)	99.9
No. 20 (.850-mm)	99.6
No. 40 (.425-mm)	98.9
No. 60 (.250-mm)	97.4
No. 100 (.150-mm)	95.5
No. 200 (.075-mm)	68.0

Size Fraction	Percent by Weight
Coarse Gravel	0.0
Fine Gravel	0.0
Coarse Sand	0.1
Medium Sand	1.0
Fine Sand	30.9
Fines	68.0
Total	**100.0**

LL	- -
PL	- -
PI	- -
D_{10}	0.00
D_{30}	0.00
D_{60}	0.00
D_{90}	0.14
Cc	- -
Cu	- -

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

INSIGHT GEOLOGIC, INC.

Gradation Analysis Summary Data

Job Name: 2817 Boulevard Road SE
Job Number: 1065-001-01
Date Tested: 7/19/18
Tested By: Kevin Vandehey

Sample Location: TP-5
Sample Name: TP-5 0.5'-3.0'
Depth: 0.5 - 3 Feet

Moisture Content (%) 18.8%

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)	100.0
No. 4 (4.75-mm)	98.3
No. 10 (2.00-mm)	94.8
No. 20 (.850-mm)	92.6
No. 40 (.425-mm)	91.5
No. 60 (.250-mm)	90.6
No. 100 (.150-mm)	89.5
No. 200 (.075-mm)	75.4

Size Fraction	Percent by Weight
Coarse Gravel	0.0
Fine Gravel	1.7
Coarse Sand	3.5
Medium Sand	3.3
Fine Sand	16.1
Fines	75.4
Total	**100.0**

LL	- -
PL	- -
PI	- -
D_{10}	0.00
D_{30}	0.00
D_{60}	0.00
D_{90}	0.16
Cc	- -
Cu	- -

ASTM Classification
Group Name: **Silt with Sand**
Symbol: **ML**

INSIGHT GEOLOGIC, INC.

Gradation Analysis Summary Data

Job Name: 2817 Boulevard Road SE
Job Number: 1065-001-01
Date Tested: 7/19/18
Tested By: Kevin Vandehey

Sample Location: TP-5
Sample Name: TP-5 3.0'-8.0'
Depth: 3 - 8 Feet

Moisture Content (%) 20.2%

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)	100.0
No. 4 (4.75-mm)	100.0
No. 10 (2.00-mm)	99.9
No. 20 (.850-mm)	99.5
No. 40 (.425-mm)	98.8
No. 60 (.250-mm)	97.8
No. 100 (.150-mm)	96.6
No. 200 (.075-mm)	85.7

Size Fraction	Percent by Weight
Coarse Gravel	0.0
Fine Gravel	0.0
Coarse Sand	0.1
Medium Sand	1.2
Fine Sand	13.1
Fines	85.7
Total	**100.0**

LL - -
PL - -
PI - -

D_{10} 0.00
D_{30} 0.00
D_{60} 0.00
D_{90} 0.099

Cc - -
Cu - -

ASTM Classification
Group Name: **Silt with Sand**
Symbol: **ML**

INSIGHT GEOLOGIC, INC.

Gradation Analysis Summary Data

Job Name: 2817 Boulevard Road SE
Job Number: 1065-001-01
Date Tested: 7/19/18
Tested By: Kevin Vandehey

Sample Location: TP-10
Sample Name: TP-10 4.0'-6.5'
Depth: 4 - 6 Feet

Moisture Content (%) 37.4%

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)	100.0
No. 4 (4.75-mm)	100.0
No. 10 (2.00-mm)	99.7
No. 20 (.850-mm)	99.2
No. 40 (.425-mm)	98.9
No. 60 (.250-mm)	98.2
No. 100 (.150-mm)	95.8
No. 200 (.075-mm)	74.3

Size Fraction	Percent by Weight
Coarse Gravel	0.0
Fine Gravel	0.0
Coarse Sand	0.3
Medium Sand	0.8
Fine Sand	24.5
Fines	74.3
Total	**100.0**

LL	- -
PL	- -
PI	- -
D_{10}	0.00
D_{30}	0.00
D_{60}	0.00
D_{90}	0.13
Cc	- -
Cu	- -

ASTM Classification
Group Name: **Silt with Sand**
Symbol: **ML**

INSIGHT GEOLOGIC, INC.

Gradation Analysis Summary Data

Job Name: 2817 Boulevard Road SE
Job Number: 1065-001-01
Date Tested: 7/19/18
Tested By: Kevin Vandehey

Sample Location: TP-10
Sample Name: TP-10 6.5'-8.0'
Depth: 6.5 - 8 Feet

Moisture Content (%) 30.4%

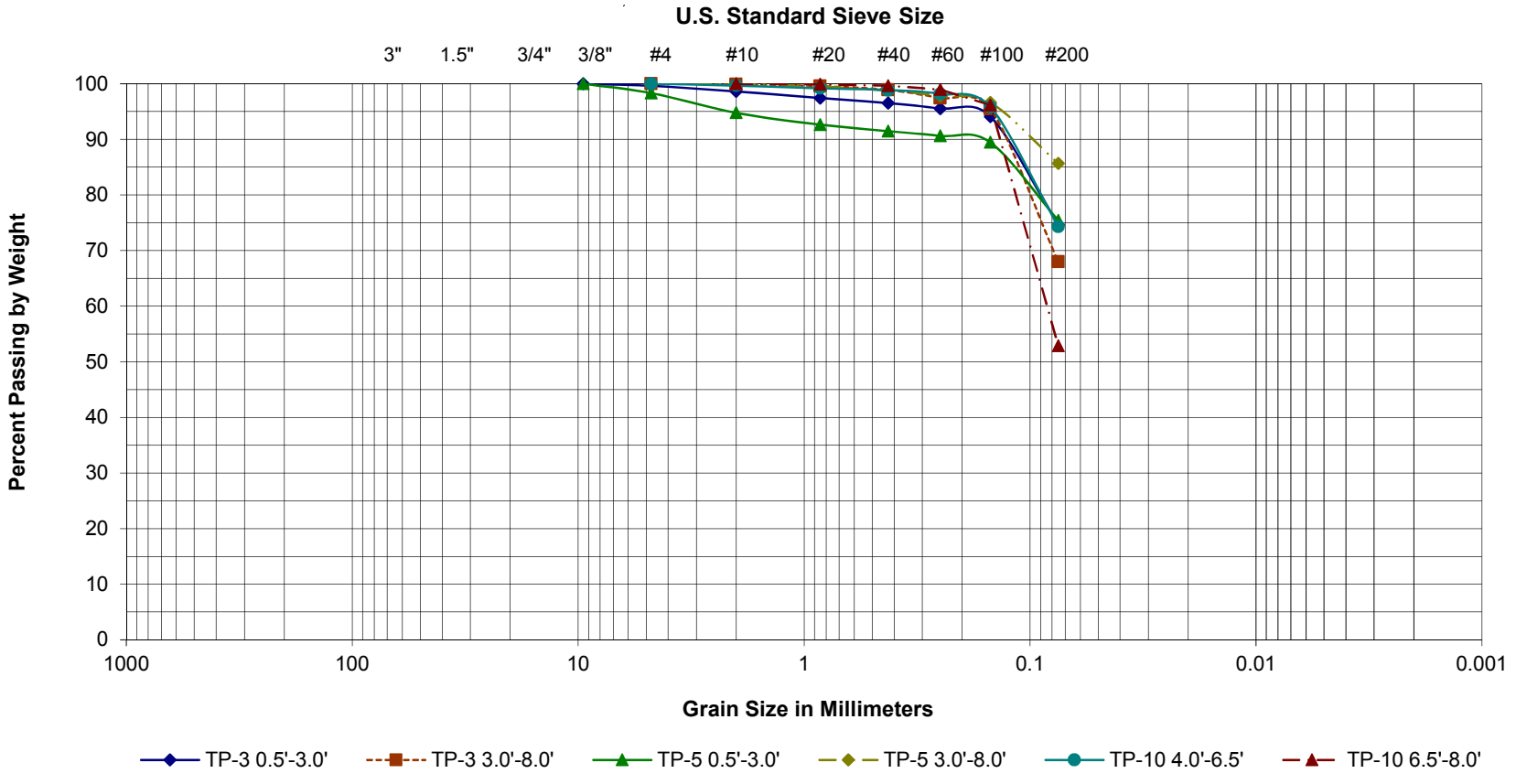
Sieve Size	Percent Passing
3.0 in. (75.0)	100.0
1.5 in. (37.5)	100.0
3/4 in. (19.0)	100.0
3/8 in. (9.5-mm)	100.0
No. 4 (4.75-mm)	100.0
No. 10 (2.00-mm)	100.0
No. 20 (.850-mm)	99.9
No. 40 (.425-mm)	99.6
No. 60 (.250-mm)	98.9
No. 100 (.150-mm)	96.1
No. 200 (.075-mm)	52.9

Size Fraction	Percent by Weight
Coarse Gravel	0.0
Fine Gravel	0.0
Coarse Sand	0.0
Medium Sand	0.4
Fine Sand	46.8
Fines	52.9
Total	**100.0**

LL	- -
PL	- -
PI	- -
D_{10}	0.00
D_{30}	0.00
D_{60}	0.084
D_{90}	0.15
Cc	- -
Cu	- -

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

INSIGHT GEOLOGIC, INC.



COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	

2817 BOULEVARD ROAD SE

OLYMPIA, WASHINGTON

INSIGHT GEOLOGIC, INC.

Graph 1
Gradation Analysis Results

Libby Environmental, Inc.
4139 Libby Road NE • Olympia, WA 98506-2518

July 27, 2018

Bill Halbert
Insight Geologic, Inc.
1015 East Fourth Ave
Olympia, WA 98506

Dear Mr. Halbert:

Please find enclosed the analytical data report for the Kapa Const. Blvd. Rd. Res. Dev. Project located in Olympia, Washington.

The results of the analyses are summarized in the attached tables. Applicable detection limits and QA/QC data are included. The sample(s) will be disposed of in 30 days unless we are contacted to arrange long term storage.

Libby Environmental, Inc. appreciates the opportunity to have provided analytical services for this project. If you have any further questions about the data report, please give me a call. It was a pleasure working with you on this project, and we are looking forward to the next opportunity to work together.

Sincerely,

Sherry L. Chilcutt
Senior Chemist
Libby Environmental, Inc.

Phone (360) 352-2110 • Fax (360) 352-4154 • libbyenv@aol.com

Libby Environmental, Inc.

Chain of Custody Record

www.LibbyEnvironmental.com

4139 Libby Road NE
Olympia, WA 98506
Ph: 360-352-2110
Fax: 360-352-4154

Client: Insight Geologic
Address: 1015 East 4th Ave
City: Olympia State: WA Zip: 98506
Phone: 360-754-2128 Fax:
Client Project # 1065-001-01

Date: 7/18/18 Page: 1 of 1
Project Manager: Bill Halbert
Project Name: Kapa Const. Blvd. Rd. Res. Dev.
Location: Olympia City, State: WA
Collector: Kevin Vandehey Date of Collection: 7/18/18
Email: BillH@InsightGeologic.com

	Sample Number	Depth	Time	Sample Type	Container Type	VOC 8260	NWTPH-Gx	BTEX 8021	NWTPH-HCID	NWTPH-Dx	NWTPH-Dx/Dx	c PAH 8270	PAH 8270	Semi Vol 8270	PCB 8082	MTCA 5 Metals	RCRA 8 Metals	Field Notes
1	S-1	6"	13:00	Soil	4oz, 2VOA			X							X			
2	S-2	6"	13:10	↓	↓			X							X			
3	S-3	6"	13:25					X							X			
4	S-4	6"	13:35					X							X			
5	S-5	6"	13:50					X							X			
6	S-6	6"	14:00	↓	↓			X							X			
7																		
8																		
9																		
10																		
11																		
12																		
13																		
14																		
15																		
16																		
17																		

Relinquished by:	Date / Time	Received by:	Date / Time
Kevin Vandehey	7/18/18 15:40	Melissa Taft	7/19/18 15:40

Sample Receipt

Good Condition? (Y) N
Temp. 23.2 °C
Seals Intact? (Y) N N/A
Total Number of Containers 18

Remarks: Call if hits on HCID

TAT: 24HR 48HR (5-DAY)

LEGAL ACTION CLAUSE: *In the event of default of payment and/or failure to pay, Client agrees to pay the costs of collection including court costs and reasonable attorney fees to be determined by a cout of law.*

Distribution: White - Lab, Yellow - File, Pink - Originator

Libby Environmental, Inc.

4139 Libby Road NE
Olympia, WA 98506
Phone: (360) 352-2110
FAX: (360) 352-4154
Email: libbyenv@aol.com

KAPA CONST. BLVD. RD. RES. DEV. PROJECT
Insight Geologic, Inc.
Olympia, Washingon
Libby Project # L180719-3
Client Project # 1065-001-01

Hydrocarbon Identification by NWTPH-HCID for Soil

Sample Number	Date Analyzed	Surrogate Recovery (%)	Gasoline (mg/kg)	Diesel (mg/kg)	Oil (mg/kg)
Method Blank	7/20/18	100	nd	nd	nd
S1	7/20/18	106	nd	nd	nd
S2	7/20/18	106	nd	nd	nd
S3	7/20/18	109	nd	nd	nd
S4	7/20/18	117	nd	nd	nd
S5	7/20/18	114	nd	nd	nd
S6	7/20/18	110	nd	nd	nd
S6 Dup	7/20/18	117	nd	nd	nd
Practical Quantitation Limit			20	50	250

"nd" Indicates not detected at listed detection limits.
"D" Indicates detected above the listed detection limit.
"int" Indicates that interference prevents determination.

ACCEPTABLE RECOVERY LIMITS FOR SURROGATE (2-F Biphenyl): 65% TO 135%

ANALYSES PERFORMED BY: Melissa Harrington

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Analyses of Total Metals in Soil by EPA Method 7010 Series

Sample Number	Date Analyzed	Lead (mg/kg)	Cadmium (mg/kg)	Chromium (mg/kg)	Arsenic (mg/kg)
Method Blank	7/21/18	nd	nd	nd	nd
S1	7/21/18	40	nd	11	nd
S2	7/21/18	73	nd	25	nd
S3	7/21/18	42	nd	15	nd
S4	7/21/18	64	nd	8.6	nd
S5	7/21/18	57	nd	19	nd
S6	7/21/18	16	nd	26	nd
Practical Quantitation Limit		5.0	1.0	5.0	5.0

"nd" Indicates not detected at the listed detection limits.

ANALYSES PERFORMED BY: Dirk Peterson

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Insight Geologic, Inc.
Olympia, Washingon
Libby Project # L180719-3
Client Project # 1065-001-01

QA/QC for Total Metals in Soil by EPA Method 7010 Series

Sample Number	Date Analyzed	Lead (% Recovery)	Cadmium (% Recovery)	Chromium (% Recovery)	Arsenic (% Recovery)
LCS	7/21/18	95%	90%	90%	108%
L180718-3 MS	7/21/18	93%	90%	86%	
L180718-3 MSD	7/21/18	97%	92%	89%	93%
RPD	7/21/18	4%	2%	3%	100%

ACCEPTABLE RECOVERY LIMITS FOR MATRIX SPIKES: 75%-125%
ACCEPTABLE RPD IS 20%

ANALYSES PERFORMED BY: Dirk Peterson

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Olympia, Washingon
Libby Project # L180719-3
Client Project # 1065-001-01

Analyses of Total Mercury in Soil by EPA Method 7471

Sample Number	Date Analyzed	Mercury (mg/kg)
Method Blank	7/22/18	nd
S1	7/22/18	nd
S2	7/22/18	nd
S3	7/22/18	nd
S4	7/22/18	nd
S5	7/22/18	nd
S6	7/22/18	nd
Practical Quantitation Limit		0.5

"nd" Indicates not detected at the listed detection limits.

ANALYSES PERFORMED BY: Sherry Chilcutt

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KAPA CONST. BLVD. RD. RES. DEV. PROJECT
Insight Geologic, Inc.
Olympia, Washingon
Libby Project # L180719-3
Client Project # 1065-001-01

QA/QC for Total Mercury by EPA Method 7471

Sample Number	Date Analyzed	Mercury (% Recovery)
LCS	7/22/18	96%
L180718-3 MS	7/22/18	109%
L180718-3 MSD	7/22/18	102%
RPD	7/22/18	6%

ACCEPTABLE RECOVERY LIMITS FOR MATRIX SPIKES: 75%-125%
ACCEPTABLE RPD IS 20%

ANALYSES PERFORMED BY: Sherry Chilcutt

Libby Environmental, Inc.

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Email: libbyenv@aol.com

KAPA CONST. BLVD. RD. RES. DEV. PROJECT
Insight Geologic, Inc.
Libby Project # L180719-3
Date Received 7/19/2018
Time Received 3:40 PM

Received By MH

Sample Receipt Checklist

Chain of Custody

1. Is the Chain of Custody is complete?	☑	Yes	☐	No		
2. How was the sample delivered?	☑	Hand Delivered	☐	Picked Up	☐	Shipped

Log In

3. Cooler or Shipping Container is present.	☐	Yes	☑	No	☐	N/A
4. Cooler or Shipping Container is in good condition.	☐	Yes	☐	No	☑	N/A
5. Cooler or Shipping Container has Custody Seals present.	☐	Yes	☐	No	☑	N/A
6. Was an attempt made to cool the samples?	☐	Yes	☑	No	☐	N/A
7. Temperature of cooler (0°C to 8°C recommended)	N/A °C					
8. Temperature of sample(s) (0°C to 8°C recommended)	23.2 °C					
9. Did all containers arrive in good condition (unbroken)?	☑	Yes	☐	No		
10. Is it clear what analyses were requested?	☑	Yes	☐	No		
11. Did container labels match Chain of Custody?	☑	Yes	☐	No		
12. Are matrices correctly identified on Chain of Custody?	☑	Yes	☐	No		
13. Are correct containers used for the analysis indicated?	☑	Yes	☐	No		
14. Is there sufficient sample volume for indicated analysis?	☑	Yes	☐	No		
15. Were all containers properly preserved per each analysis?	☑	Yes	☐	No		
16. Were VOA vials collected correctly (no headspace)?	☑	Yes	☐	No	☐	N/A
17. Were all holding times able to be met?	☑	Yes	☐	No		

Discrepancies/ Notes

18. Was client notified of all discrepancies?	☐	Yes	☐	No	☑	N/A

Person Notified: _____ Date: _____

By Whom: _____ Via: _____

Regarding: _____

19. Comments. _____

ATTACHMENT C
SEISMIC DESIGN PARAMETERS

USGS Design Maps Summary Report

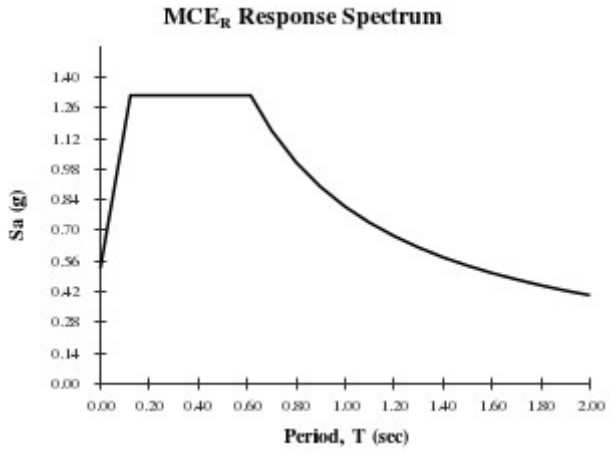
User–Specified Input

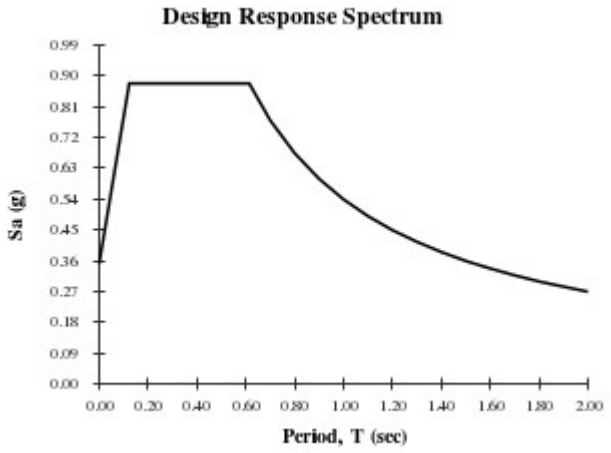
Report Title	Boulevard Road Residential Development Thu July 26, 2018 18:21:38 UTC
Building Code Reference Document	2012/2015 International Building Code (which utilizes USGS hazard data available in 2008)
Site Coordinates	47.0232°N, 122.8666°W
Site Soil Classification	Site Class D – "Stiff Soil"
Risk Category	I/II/III

USGS–Provided Output

S_S =	1.316 g	S_{MS} =	1.316 g	S_{DS} =	0.878 g
S_1 =	0.539 g	S_{M1} =	0.808 g	S_{D1} =	0.539 g

For information on how the SS and S1 values above have been calculated from probabilistic (risk-targeted) and deterministic ground motions in the direction of maximum horizontal response, please return to the application and select the "2009 NEHRP" building code reference document.





USGS Design Maps Detailed Report

2012/2015 International Building Code (47.0232°N, 122.8666°W)

Site Class D – "Stiff Soil", Risk Category I/II/III

Section 1613.3.1 — Mapped acceleration parameters

Note: Ground motion values provided below are for the direction of maximum horizontal spectral response acceleration. They have been converted from corresponding geometric mean ground motions computed by the USGS by applying factors of 1.1 (to obtain S_S) and 1.3 (to obtain S_1). Maps in the 2012/2015 International Building Code are provided for Site Class B. Adjustments for other Site Classes are made, as needed, in Section 1613.3.3.

From Figure 1613.3.1(1) [1] S_S = 1.316 g

From Figure 1613.3.1(2) [2] S_1 = 0.539 g

Section 1613.3.2 — Site class definitions

The authority having jurisdiction (not the USGS), site-specific geotechnical data, and/or the default has classified the site as Site Class D, based on the site soil properties in accordance with Section 1613.

2010 ASCE-7 Standard – Table 20.3-1
SITE CLASS DEFINITIONS

Site Class	$\bar{v}_s$	$\bar{N}$ or $\bar{N}_{ch}$	$\bar{s}_u$
A. Hard Rock	>5,000 ft/s	N/A	N/A
B. Rock	2,500 to 5,000 ft/s	N/A	N/A
C. Very dense soil and soft rock	1,200 to 2,500 ft/s	>50	>2,000 psf
D. Stiff Soil	600 to 1,200 ft/s	15 to 50	1,000 to 2,000 psf
E. Soft clay soil	<600 ft/s	<15	<1,000 psf
	Any profile with more than 10 ft of soil having the characteristics: • Plasticity index PI > 20, • Moisture content w ≥ 40%, and • Undrained shear strength $\bar{s}_u$ < 500 psf		

F. Soils requiring site response analysis in accordance with Section 21.1	See Section 20.3.1

For SI: 1ft/s = 0.3048 m/s 1lb/ft² = 0.0479 kN/m²

Section 1613.3.3 — Site coefficients and adjusted maximum considered earthquake spectral response acceleration parameters

TABLE 1613.3.3(1)
VALUES OF SITE COEFFICIENT F_a

Site Class	Mapped Spectral Response Acceleration at Short Period				
	$S_S \leq 0.25$	$S_S = 0.50$	$S_S = 0.75$	$S_S = 1.00$	$S_S \geq 1.25$
A	0.8	0.8	0.8	0.8	0.8
B	1.0	1.0	1.0	1.0	1.0
C	1.2	1.2	1.1	1.0	1.0
D	1.6	1.4	1.2	1.1	1.0
E	2.5	1.7	1.2	0.9	0.9
F	See Section 11.4.7 of ASCE 7				

Note: Use straight–line interpolation for intermediate values of S_S

For Site Class = D and S_S = 1.316 g, F_a = 1.000

TABLE 1613.3.3(2)
VALUES OF SITE COEFFICIENT F_v

Site Class	Mapped Spectral Response Acceleration at 1–s Period				
	$S_1 \leq 0.10$	$S_1 = 0.20$	$S_1 = 0.30$	$S_1 = 0.40$	$S_1 \geq 0.50$
A	0.8	0.8	0.8	0.8	0.8
B	1.0	1.0	1.0	1.0	1.0
C	1.7	1.6	1.5	1.4	1.3
D	2.4	2.0	1.8	1.6	1.5
E	3.5	3.2	2.8	2.4	2.4
F	See Section 11.4.7 of ASCE 7				

Note: Use straight–line interpolation for intermediate values of S_1

For Site Class = D and S_1 = 0.539 g, F_v = 1.500

Equation (16-37): $S_{MS} = F_a S_S = 1.000 \times 1.316 = 1.316$ g

Equation (16-38): $S_{M1} = F_v S_1 = 1.500 \times 0.539 = 0.808$ g

Section 1613.3.4 — Design spectral response acceleration parameters

Equation (16-39): $S_{DS} = ⅔ S_{MS} = ⅔ \times 1.316 = 0.878$ g

Equation (16-40): $S_{D1} = ⅔ S_{M1} = ⅔ \times 0.808 = 0.539$ g

Section 1613.3.5 — Determination of seismic design category

TABLE 1613.3.5(1)
SEISMIC DESIGN CATEGORY BASED ON SHORT-PERIOD (0.2 second) RESPONSE ACCELERATION

VALUE OF S_{DS}	**RISK CATEGORY**		
	I or II	**III**	**IV**
$S_{DS} < 0.167g$	A	A	A
$0.167g \le S_{DS} < 0.33g$	B	B	C
$0.33g \le S_{DS} < 0.50g$	C	C	D
$0.50g \le S_{DS}$	D	D	D

For Risk Category = I and S_{DS} = 0.878 g, Seismic Design Category = D

TABLE 1613.3.5(2)
SEISMIC DESIGN CATEGORY BASED ON 1-SECOND PERIOD RESPONSE ACCELERATION

VALUE OF S_{D1}	**RISK CATEGORY**		
	I or II	**III**	**IV**
$S_{D1} < 0.067g$	A	A	A
$0.067g \le S_{D1} < 0.133g$	B	B	C
$0.133g \le S_{D1} < 0.20g$	C	C	D
$0.20g \le S_{D1}$	D	D	D

For Risk Category = I and S_{D1} = 0.539 g, Seismic Design Category = D

Note: When S_1 is greater than or equal to 0.75g, the Seismic Design Category is **E** for buildings in Risk Categories I, II, and III, and **F** for those in Risk Category IV, irrespective of the above.

Seismic Design Category ≡ "the more severe design category in accordance with Table 1613.3.5(1) or 1613.3.5(2)" = D

Note: See Section 1613.3.5.1 for alternative approaches to calculating Seismic Design Category.

References

1. *Figure 1613.3.1(1)*: https://earthquake.usgs.gov/hazards/designmaps/downloads/pdfs/IBC-2012-Fig1613p3p1(1).pdf

2. *Figure 1613.3.1(2)*: https://earthquake.usgs.gov/hazards/designmaps/downloads/pdfs/IBC-2012-Fig1613p3p1(2).pdf

ATTACHMENT D

REPORT LIMITATIONS AND GUIDELINES FOR USE

ATTACHMENT D

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 of Kapa Construction (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.

---

[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.