INSIGHT GEOLOGIC, INC.

March 21, 2022

RB Engineering
PO Box 923
Chehalis, Washington 98532
Attention: Bob Balmelli, P.E.

Report
Geotechnical Investigation
Proposed Wagner Orthodontics Office
1319 & 1327 Bishop Road
Chehalis, Washington
Project No. 369-028-01

INTRODUCTION

Insight Geologic, Inc. is pleased to provide our proposal to conduct an evaluation of site soil conditions at the location of the proposed Wagner Orthodontics office building to be located at 1319 & 1327 Bishop Road in Chehalis, Washington. The location of the site is shown relative to surrounding physical features in the Vicinity Map, Figure 1. The site consists of two parcels (Lewis County Parcel No. 010480000000 and 010479000000) totaling approximately 1 acre. The parcels are currently developed with residential structures.

We understand that the project will include development of a single-story medical office building with appurtenant parking and driveway areas. Stormwater runoff from the new building and parking area is to be detained and released.

SCOPE OF SERVICES

The purpose of our services is to evaluate subsurface soil conditions as they relate to geotechnical properties. The specific tasks to be performed are outlined below:

1. Provided for the location of subsurface utilities on the site. We performed this task by notifying the “One Call” system.
2. Conducted a site reconnaissance to evaluate and mark proposed test pit locations at the site and for access.
3. Excavated three exploratory test pits site in the locations requested by the project engineer. The test pits will be excavated to a depth of approximately 8 feet bgs.
4. Collected representative soil samples from the test pits for laboratory analysis.
5. Logged the soils exposed in the test pits in general accordance with ASTM D2487-06.

6. Provided for laboratory testing of the soils, as appropriate. We performed gradation analyses and Atterberg testing to evaluate soil type, plasticity and bearing capacity.
7. Prepared a report summarizing our field activities including our recommendations for site preparation and grading, bearing capacity, seismic class, temporary and final cut slopes, earth pressures, pavement design and suitability of the on-site soils for use as fill.

FINDINGS

Surface Conditions

The project site is situated at an approximate elevation of 208 feet above mean sea level and consists of two Lewis County tax parcels (Lewis County Parcel No. 010480000000 and 010479000000), which total approximately 1 acre. The property is bounded by Bishop Road to the west, a residential property to the north, medical buildings to the east and an undeveloped parcel to the south. The properties are currently developed with a single-family residence, mobile home, and commercial daycare, along with associated gravel driveways and detached outbuildings. The remainder of the site is grass and landscaped areas.

Geology

Based on our review of available published geologic maps, Pleistocene-age alpine glacial outwash deposits (river terrace and flood plain deposits) of the Hayden Creek Drift underlie the project site. Quaternary alluvium is mapped to the south of the site. The drift material is described as poorly-sorted sands and gravels with units of silt, and varying fractions of organic material and with the upper portions generally being heavily weathered. Soils in this area are known to have the potential for being soft and having moderate plasticity.

Subsurface Explorations

We explored subsurface conditions at the site on February 18. 2022, by excavating three test pits in the locations as shown on the Site Plan, Figure 2. The test pits were excavated using a track-mounted excavator. A geologist from Insight Geologic monitored the test pits and maintained a log of the conditions encountered. The test pits were completed to a depth of 8 feet bgs. The soils were visually classified in general accordance with the system described in ASTM D2487-06. The explorations logs are contained in Attachment A.

Soil Conditions

Soil conditions at the site were generally consistent across the site. Surficial conditions at test pits TP-1 to TP-3 consisted of a sod horizon approximately 6 inches in depth. Underlying this sod horizon, we encountered approximately 2 feet of brown sandy silt to silt with fine to medium sand and fine gravel (ML) in a stiff and moist condition underlain by 2 feet of light brown to yellow-brown fat clay with fine to medium sand (CH) in a stiff and moist condition. Underlying the fine grained soils we encountered yellow-brown to red-brown silty fine to coarse sand with fine to coarse gravel (SM) in a very dense and moist condition to the base of the test pits with one exception. Test pit TP-2 encountered brown silty gravel with sand at a depth of 6 feet bgs.

Groundwater Conditions

Groundwater was not encountered in any of the explorations completed at the site. In addition, no evidence of seasonal high groundwater was encountered.

Laboratory Testing

We selected four samples from our explorations for grain-size analyses in general accordance with ASTM D422, and two samples were evaluated using plasticity index tests in general accordance with ASTM D4318 to define soil class and engineering properties of the soil. Soil testing indicated that, in general, the soils classified as silt with a liquid limit of 40 percent and plasticity of 14 percent, and as fat clay with liquid limit of 73 percent and plasticity of 45 percent. Our laboratory test results are provided in Attachment B.

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 1. 2018 IBC Seismic Design Parameters

Spectral Response Accel. at Short Periods (SS) = 1.161
Spectral Response Accel. at 1 Second Periods (S1) = 0.479
Site Class = D
Site Coefficient (FA) = 1.036
Site Coefficient (FV) = 1.821

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 loose to medium dense, clean to silty sands and non-plastic silts.

Based on our review of the *Washington State Department of Natural Resources Geologic Information Portal*, the majority of the site including the building location is identified to have a very low potential risk for liquefaction. Based on our experience with detailed seismic studies in the area, including areas that are mapped within the same soil deposits as the project site, it is our opinion that the soil profile at the site has a low risk of liquefaction.

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 soil profile at the site has a low to moderate risk for settlement due to seismic compression.

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 at the site, it is our opinion that there is 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 review, subsurface explorations and engineering analyses, it is our opinion that the proposed development is feasible from a geotechnical standpoint. We recommend that any 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).

The soils encountered in our explorations are typically in a stiff condition near ground surface. To limit the potential for structure settlement, we recommend that all shallow foundations and slabs-on-grade be established on a minimum 1-foot thick layer of structural fill or adequately compacted native material. We do not recommend the reuse the on-site soils as structural fill under the foundations/slabs. Reuse of the silt soils will require significant moisture conditioning and compaction efforts, and is unlikely to be sufficiently compacted as structural fill.

Earthwork

General

We anticipate that site development earthwork will include removing existing structures and vegetation, stripping sod/topsoil materials, preparing subgrades, excavating for utility trenches, installing ground improvements, and placing and compacting structural fill. The soils at the site contain a high percentage of fines and will be moisture sensitive through most of the year. These materials may be difficult to operate on or compact during wet weather. Operation of heavy equipment at the site under wet conditions or when the soils are above optimum moisture content can be expected to result in considerable disturbance to the exposed subgrade soils. We recommend that earthwork be undertaken during periods of dry weather to reduce grading costs using tracked, low ground pressure equipment. Compaction of native soils should be conducted using a sheeps-foot roller and not a smooth vibratory drum roller.

Our explorations did not encounter appreciable amounts of debris or unsuitable soils associated with past site development other than the existing structures. Still, it is possible that concrete slabs, abandoned utility lines or other development features 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, 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 were 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 overexcavated and replaced with structural fill.

In areas of porous pavement, if proposed, 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

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 56 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 should 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 with a high moisture content. It is our opinion that this material is not a suitable source for structural fill during a significant portion of the year. It will likely be difficult or impossible to compact this material without significant effort to reduce the moisture content. It is our opinion that the silts encountered during excavation and grading should be wasted and hauled offsite, as it is not reusable as structural fill. All soils used as fill shall be select granular fill as described as follows.

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 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 on Table 2. Structural fill materials should be compacted in accordance with the compaction criteria provided in Table 3.

Table 2. 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 3. 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 overexcavation and replacement with compacted 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 an experienced geotechnical owner-representative 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 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.

Subsurface Drainage

It is our opinion that foundation footing drains are likely necessary for any proposed structure. The site soils consist of silt and are generally poorly draining. Footing drains should be routed to existing on-site or planned storm drainage.

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 (Kp) may be estimated using an equivalent fluid density of 159 pounds per cubic foot (pcf), assuming that the footings are backfilled with structural fill. Active earth pressure (Ka) for the soil is 55 pcf as equivalent fluid density. Frictional resistance may be estimated using 0.20 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 100 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.

Conventional Retaining Walls

General

The following sections provide general guidelines for retaining wall design on this site. Since the site is fairly level, we do not anticipate that retaining walls will be necessary. However, 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 34 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 55 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.

Pavement Design Recommendations

We recommend a pavement section to consist of the following minimum compacted thicknesses placed on a properly prepared subgrade: 8 inches of gravel base, 2 inches of crushed surfacing top course, (CSTC), and 3 inches of compacted commercial asphalt concrete pavement. These thicknesses assume the subgrade can be properly compacted to 95% of MDD. If this cannot be achieved, Insight Geologic should be consulted for other options.

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 silt. Based on our experience with similar soil types, our analysis is based on a California Bearing Ratio (CBR) value of 5 percent. These values assume the upper foot of subgrade soils can be compacted to a minimum of 95 percent of the modified proctor maximum dry density.

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.
- Subbase Course: We recommend that the subbase conform to Section 9-03.10, Gravel Base, of the 2018 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.

- Base Course: We recommend that the crushed aggregate base course conform to Section 9-03.9(3), Crushed Surfacing Top Course, (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 conform to Section 9-02.1(4) for PG 58-22 or PG 64-22 Performance Graded Asphalt Binder as presented in the 2018 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 or to a firm and unyielding condition in accordance with ASTM D1557. 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 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”, 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.

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

LIMITATIONS

We have prepared this geotechnical investigation report for the exclusive use of RB Engineering and their authorized agents, for the proposed Wagner Orthodontics office to be located at 1319 & 1327 Bishop Road in Chehalis, 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.

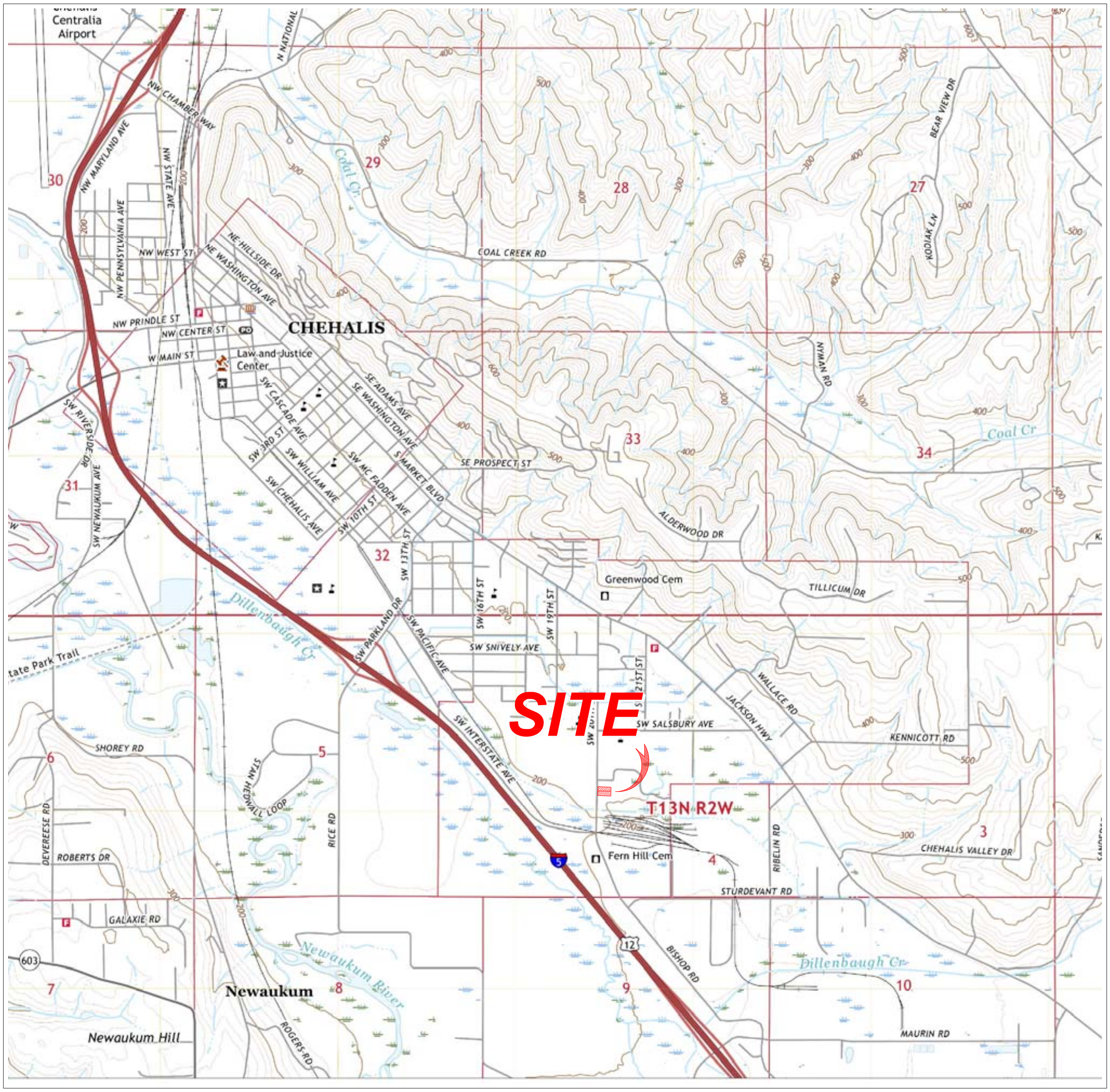
Respectfully Submitted,
INSIGHT GEOLOGIC, INC.

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

State of Washington
Engineering Geologist
816
Licensed Geologist
William E. Halbert

Attachments

FIGURES



Source: USGS (c) 2020

CENTRALIA QUADRANGLE
WASHINGTON - LEWIS COUNTY
7.5-MINUTE SERIES
Year 2020

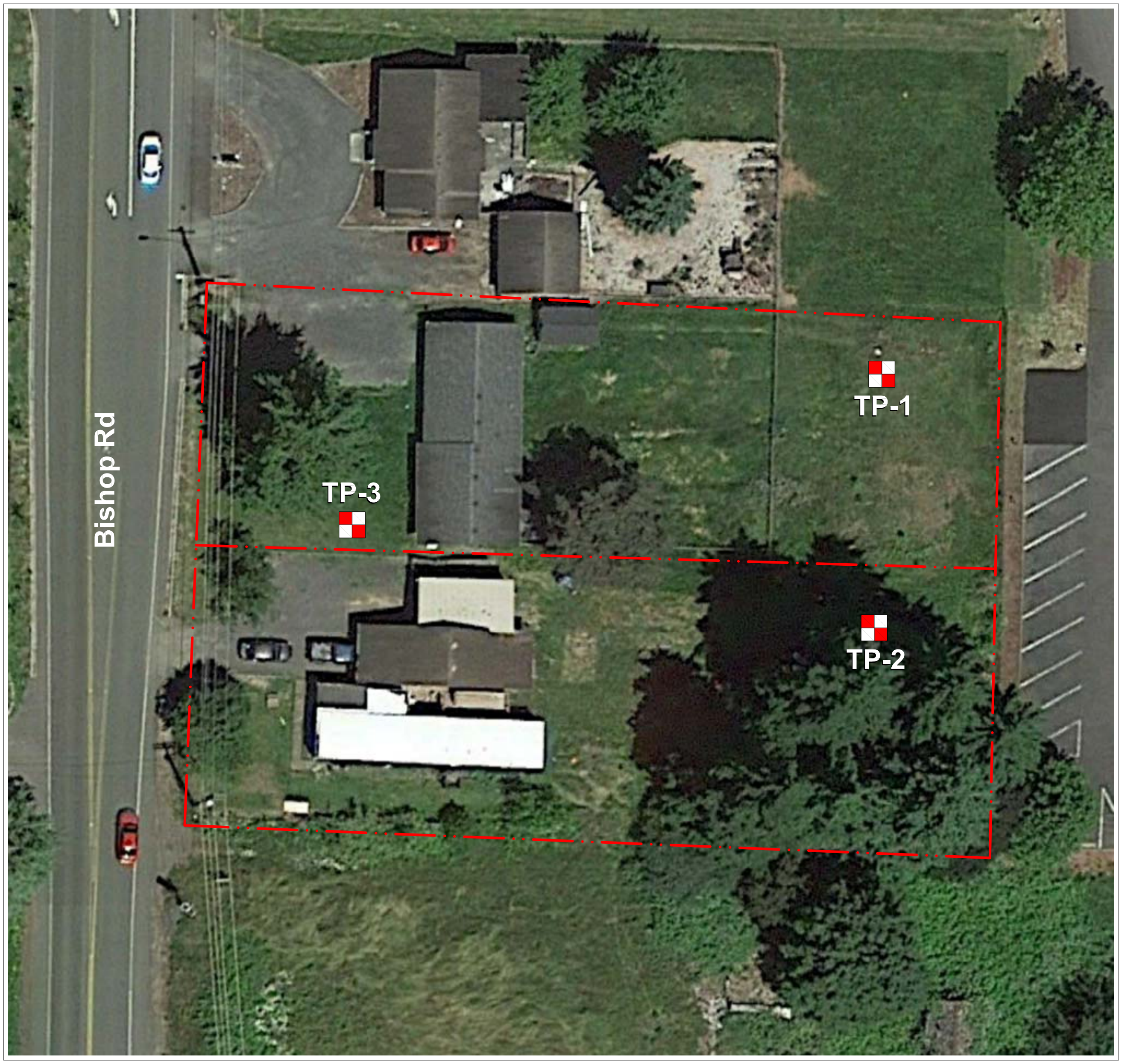
SCALE: 1" = 3000'

WAGNER ORTHODONTICS

CHEHALIS, WASHINGTON

INSIGHT GEOLOGIC, INC.

Figure 1
Vicinity Map



Source: Google Earth

LEGEND:

🟥 **TP-1**	APPROXIMATE TEST PIT LOCATION
— - —	APPROXIMATE PROJECT BOUNDARY

SCALE: 1"= 50'

WAGNER ORTHODONTICS

CHEHALIS, WASHINGTON

INSIGHT GEOLOGIC, INC.

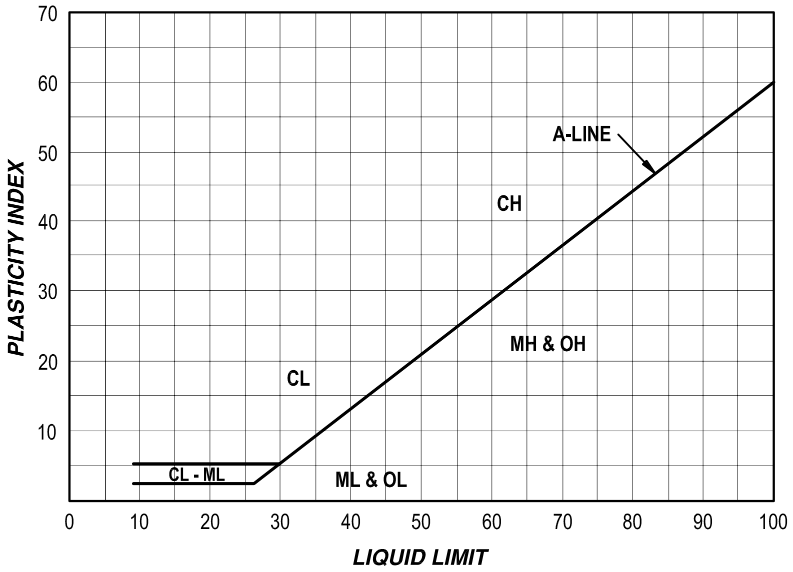
Figure 2
Site Plan

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

INSIGHT GEOLOGIC, INC.

Key to Exploration Logs

PROJECT: Wagner Orthodontics
PROJECT NO.: 369-028-01
LOCATION: Chehalis, Washington

TP-1

DATE: 2/18/22
TOTAL DEPTH: 8

DEPTH (FT)	U.S.C.S.	LITHOLOGY	SOIL DESCRIPTION	REMARKS AND OTHER TESTS
0		🟫	**:** Sod	
1	ML	🟩	**ML:** Brown sandy silt, stiff, moist	
2 3	CH	▨	**CH:** Light brown to yellow-brown fat clay with fine sand, stiff, moist	
4 5 6 7	SM	🟨	**SM:** Light brown to yellow-brown silty fine to coarse sand with fine to coarse gravel, very dense, moist	Test pit completed at 8 feet. No groundwater encountered. No caving observed.
8 9 10				

INSIGHT GEOLOGIC, INC.

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

Figure A-2

PROJECT: Wagner Orthodontics
PROJECT NO.: 369-028-01
LOCATION: Chehalis, Washington

TP-2

DATE: 2/18/22
TOTAL DEPTH: 8

DEPTH (FT)	U.S.C.S.	LITHOLOGY	SOIL DESCRIPTION	REMARKS AND OTHER TESTS
0		🟫	**:** Sod	
1	ML	🟩	**ML:** Brown sandy silt with fine gravel, stiff, moist	
2 3	CH	▨	**CH:** Light brown to yellow-brown fat clay with fine sand, stiff, moist	
4 5	SM	🟨	**SM:** Light brown to yellow-brown silty fine to medium sand with fine to coarse gravel, very dense, moist	
6 7	GM	🟨	**GM:** Brown silty fine to coarse gravel with fine to coarse sand, dense, moist	Test pit completed at 8 feet. No groundwater encountered. No caving observed.
8 9 10				

INSIGHT GEOLOGIC, INC.

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

Figure A-3

PROJECT: Wagner Orthodontics
PROJECT NO.: 369-028-01
LOCATION: Chehalis, Washington

TP-3

DATE: 2/18/22
TOTAL DEPTH: 8

DEPTH (FT)	U.S.C.S.	LITHOLOGY	SOIL DESCRIPTION	REMARKS AND OTHER TESTS
0		▨	**:** Sod	
1	ML	🟩	**ML:** Brown sandy silt with fine gravel, stiff, moist	
2 3	CH	▨	**CH:** Light brown to yellow-brown fat clay with fine to medium sand and fine gravel, stiff, moist	
4 5 6 7	SM	🟨	**SM:** Light brown to yellow-brown silty fine to coarse sand with fine to coarse gravel, dense, moist Red-brown	Test pit completed at 8 feet. No groundwater encountered. No caving observed.
8 9 10				

INSIGHT GEOLOGIC, INC.

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

Figure A-4

ATTACHMENT B

LABORATORY ANALYSES RESULTS

Gradation Analysis Summary Data

Job Name: Wagner Orthodontics
Job Number: 369-028-01
Date Tested: 2/22/22
Tested By: Dalton Prichard

Sample Location: TP-1
Sample Name: TP-1 2.0' - 4.0'
Depth: 2 - 4 Feet

Moisture Content (%) 37.2%

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)	99.9
No. 10 (2.00-mm)	99.3
No. 20 (.850-mm)	98.3
No. 40 (.425-mm)	95.1
No. 60 (.250-mm)	90.0
No. 100 (.150-mm)	84.3
No. 200 (.075-mm)	78.8

Size Fraction	Percent by Weight
Coarse Gravel	0.0
Fine Gravel	0.1
Coarse Sand	0.6
Medium Sand	4.2
Fine Sand	16.3
Fines	78.8
Total	**100.0**

LL - -
PL - -
PI - -

D_{10} 0.00
D_{30} 0.00
D_{60} 0.00
D_{90} 0.25

Cc - -
Cu - -

ASTM Classification
Group Name: **Fat Clay with Sand**
Symbol: **CH**

INSIGHT GEOLOGIC, INC.

Gradation Analysis Summary Data

Job Name: Wagner Orthodontics
Job Number: 369-028-01
Date Tested: 2/22/22
Tested By: Dalton Prichard

Sample Location: TP-2
Sample Name: TP-2 4.0' - 6.0'
Depth: 4 - 6 Feet

Moisture Content (%) 27.7%

Sieve Size	Percent Passing
3.0 in. (75.0)	100.0
1.5 in. (37.5)	100.0
3/4 in. (19.0)	88.6
3/8 in. (9.5-mm)	86.8
No. 4 (4.75-mm)	83.8
No. 10 (2.00-mm)	80.5
No. 20 (.850-mm)	73.5
No. 40 (.425-mm)	60.2
No. 60 (.250-mm)	53.4
No. 100 (.150-mm)	42.5
No. 200 (.075-mm)	30.1

Size Fraction	Percent by Weight
Coarse Gravel	11.4
Fine Gravel	4.8
Coarse Sand	3.2
Medium Sand	20.3
Fine Sand	30.1
Fines	30.1
Total	**100.0**

LL - -
PL - -
PI - -

D_{10} 0.00
D_{30} 0.08
D_{60} 0.43
D_{90} 21.00

Cc - -
Cu - -

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

INSIGHT GEOLOGIC, INC.

Gradation Analysis Summary Data

Job Name:	Wagner Orthodontics	**Sample Location:**	TP-2
Job Number:	369-028-01	**Sample Name:**	TP-2 6.0' - 8.0'
Date Tested:	2/22/22	**Depth:**	6 - 8 Feet
Tested By:	Dalton Prichard		

Moisture Content (%) 17.3%

Sieve Size	**Percent Passing**
3.0 in. (75.0)	100.0
1.5 in. (37.5)	100.0
3/4 in. (19.0)	74.5
3/8 in. (9.5-mm)	55.0
No. 4 (4.75-mm)	48.6
No. 10 (2.00-mm)	40.4
No. 20 (.850-mm)	31.5
No. 40 (.425-mm)	23.2
No. 60 (.250-mm)	19.5
No. 100 (.150-mm)	17.1
No. 200 (.075-mm)	14.2

Size Fraction	**Percent by Weight**
Coarse Gravel	25.5
Fine Gravel	25.9
Coarse Sand	8.2
Medium Sand	17.2
Fine Sand	9.0
Fines	14.2
Total	**100.0**

LL	- -
PL	- -
PI	- -
D_{10}	0.00
D_{30}	0.75
D_{60}	12.00
D_{90}	28.00
Cc	- -
Cu	- -

ASTM Classification

Group Name: **Silty Gravel with Sand**

Symbol: **GM**

INSIGHT GEOLOGIC, INC.

Gradation Analysis Summary Data

Job Name: Wagner Orthodontics
Job Number: 369-028-01
Date Tested: 2/22/22
Tested By: Dalton Prichard

Sample Location: TP-3
Sample Name: TP-3 0.0' - 2.0'
Depth: 0 - 2 Feet

Moisture Content (%) 24.2%

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)	85.8
No. 4 (4.75-mm)	85.8
No. 10 (2.00-mm)	84.9
No. 20 (.850-mm)	81.6
No. 40 (.425-mm)	76.5
No. 60 (.250-mm)	70.1
No. 100 (.150-mm)	63.8
No. 200 (.075-mm)	56.7

Size Fraction	Percent by Weight
Coarse Gravel	0.0
Fine Gravel	14.2
Coarse Sand	0.9
Medium Sand	8.4
Fine Sand	19.7
Fines	56.7
Total	**100.0**

LL - -
PL - -
PI - -

D_{10} 0.00
D_{30} 0.00
D_{60} 0.10
D_{90} 12.00

Cc - -
Cu - -

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

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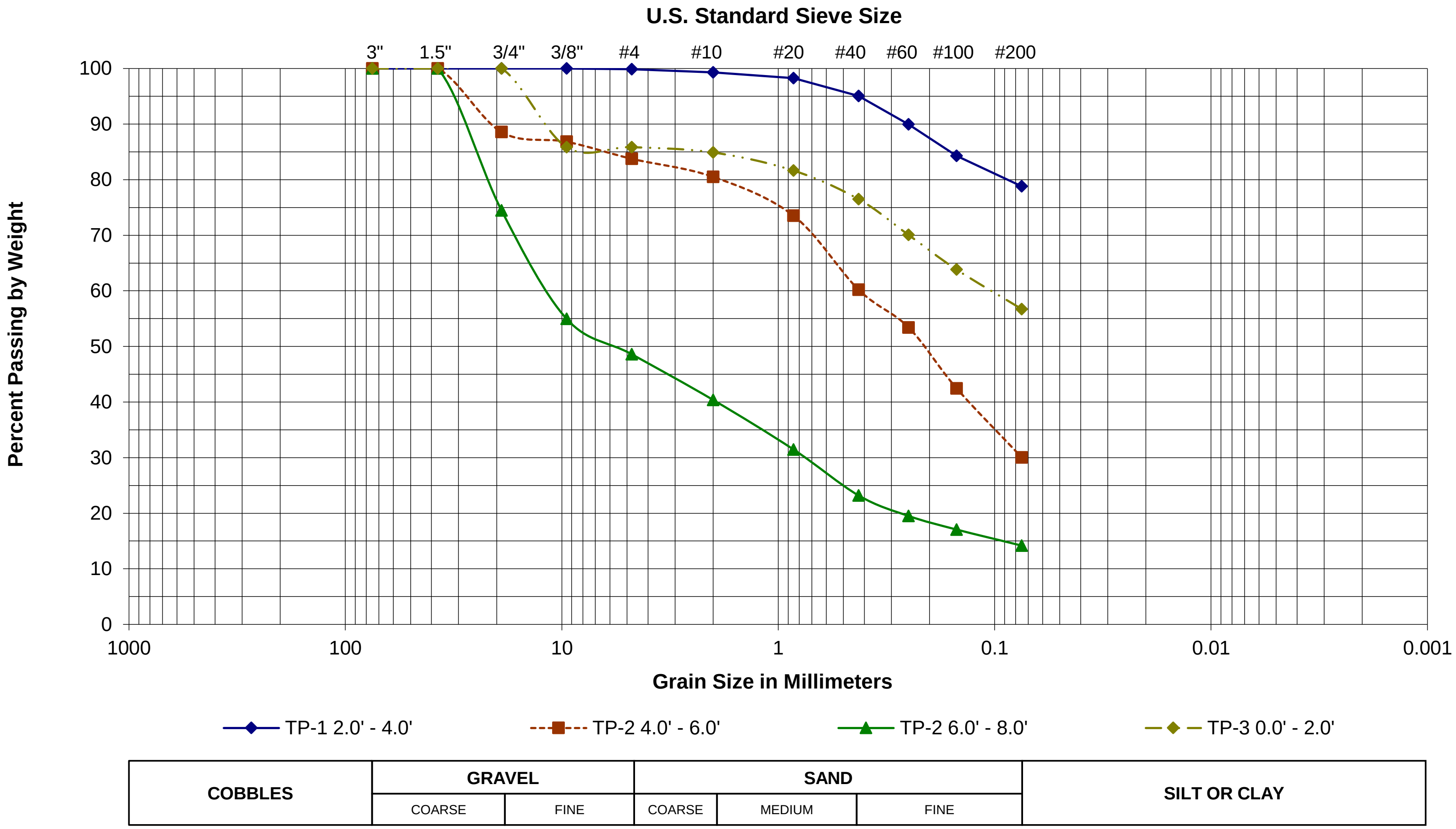
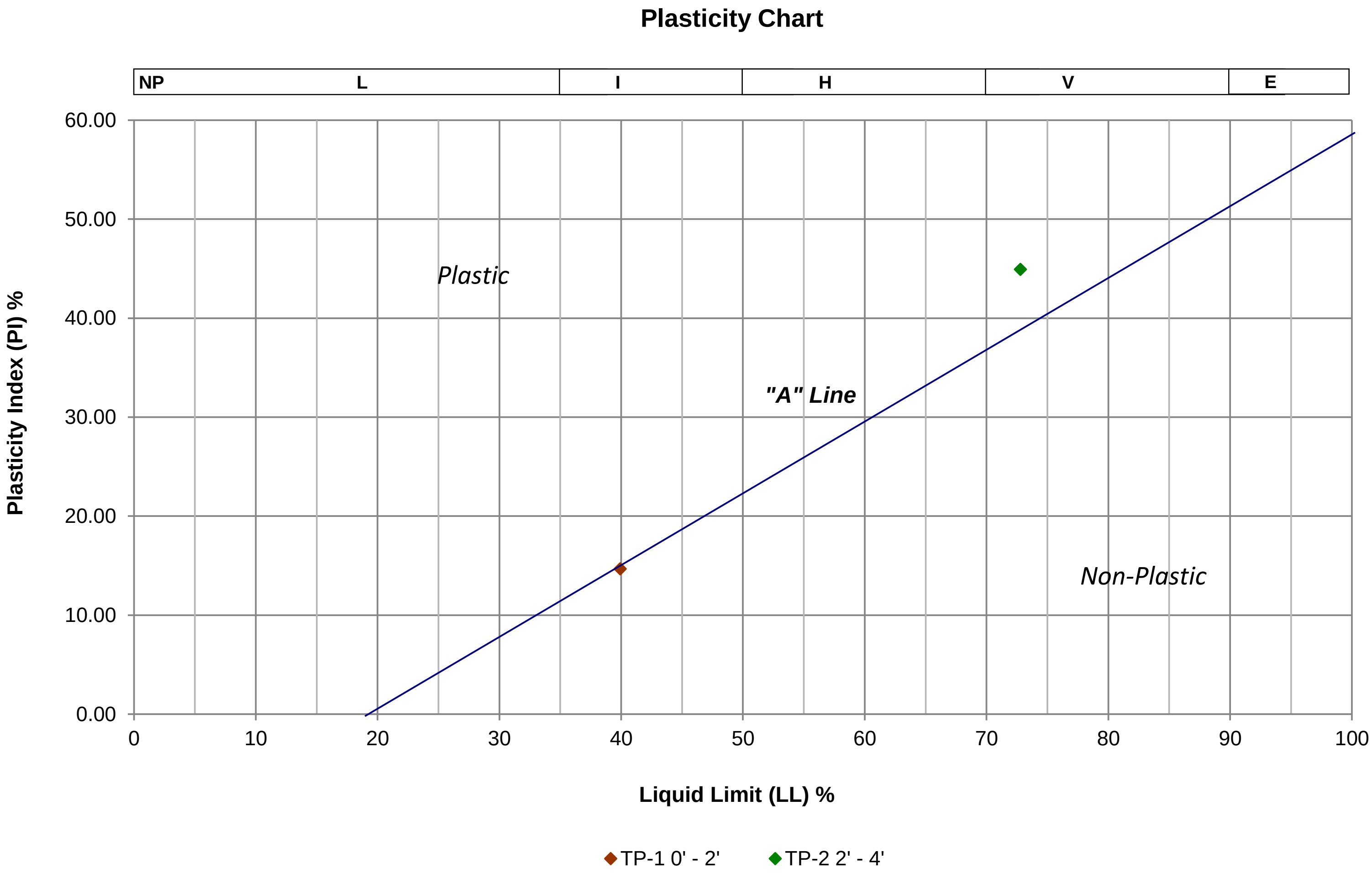


WAGNER ORTHODONTICS

CHEHALIS, WASHINGTON

INSIGHT GEOLOGIC, INC.

Graph 1
Gradation Analysis Results



Key: Plasticity Symbol = **NP** - Non-Plastic **L -** Low **I -** Intermediate **H** - High **V -** Very High **E** - Extremely High

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Graph 2
Plastic Limit Test 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.

HYDROGEOLOGIC SERVICES ARE PERFORMED FOR SPECIFIC PURPOSES, PERSONS AND PROJECTS

This report has been prepared for the exclusive use of RB Engineering (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 structures our services to meet the specific needs of our clients. For example, a hydrogeologic 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 hydrogeologic or geologic study is unique, each hydrogeologic 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 hydrogeologic 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 HYDROGEOLOGIC OR GEOLOGIC REPORT IS BASED ON A UNIQUE SET OF PROJECT-SPECIFIC FACTORS

Insight Geologic 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.

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.

SUBSURFACE CONDITIONS CAN CHANGE

This hydrogeologic 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

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

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 HYDROGEOLOGIC 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.

HYDROGEOLOGIC REPORT RECOMMENDATIONS ARE NOT FINAL

Do not over-rely on the preliminary 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.

A HYDROGEOLOGIC 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 hydrogeologic engineering or geologic report. Reduce that risk by having Insight Geologic participate in pre-bid and preconstruction conferences, and by providing construction observation.

DO NOT REDRAW THE EXPLORATION LOGS

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

READ THESE PROVISIONS CLOSELY

Some clients, design professionals and contractors may not recognize that the geoscience practices (hydrogeologic 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.

HYDROGEOLOGIC, 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 hydrogeologic or geologic study and vice versa. For that reason, a hydrogeologic 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 hydrogeologic or geologic concerns regarding a specific project.