APPENDIX C - GEOTECHNICAL REPORTS

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INSIGHT GEOLOGIC, INC.

July 18, 2023

Mason County PUD 1
North 21971 Hwy. 101
Shelton, Washington 98584
Attention: James Reyes

Report
Geotechnical Assessment
Parcel No. 324235001003
Eldon, Washington
Project No. 1171-003-01

INTRODUCTION

Insight Geologic is pleased to provide this report of our investigation of subsurface conditions at the site of your proposed 24,000-gallon capacity concrete water tank. We understand that Mason County PUD 1 is looking to install a water tank to serve the Eldon water system in Eldon, Washington. The proposed location of the water tank installation is the northwest portion of Mason County parcel no. 32423-50-01003 which is accessed from Highway 101. The location of the property is shown relative to surrounding physical features in the Vicinity Map, Figure 1.

We understand that the proposed water tank is to be 20 feet in diameter with a height of 10 feet. Soil loads by the structure are estimated to be on the order of 1,000 pounds per square foot. The proposed location of the tank is at the foot of a steep slope behind the parcel which may contain slopes that designate as landslide hazard areas under Mason County's Critical Areas Ordinance for Geologically Hazardous Areas.

SCOPE OF SERVICES

The purpose of our services was to evaluate subsurface conditions in the area of the proposed concrete tank with regard to geotechnical parameters and evaluate the slopes as potential landslide hazard areas. We performed our evaluation in general accordance with the procedures outlined in Mason County's Critical Areas Ordinance. The specific tasks performed for this project are outlined below:

1. Conducted a site reconnaissance to evaluate and mark proposed test pit locations.
2. Excavated five exploratory test pits in the area of the proposed water tank using a backhoe and operator provided by PUD 1. The test pits were excavated to a depth of approximately 4 feet below ground surface.
3. Collected representative soil samples from the test pits for laboratory analysis.

4. Logged the soils exposed in the test pits in general accordance with ASTM D2487-06.
5. Provided for laboratory testing of selected soil samples for grain size analysis to be used for soil classification.
6. Conducted a geological assessment of the steep slope with respect to potential landslide and erosion hazards in general accordance with Mason County's Critical Areas Ordinance Chapter 8.52.
7. Prepared a report summarizing our field activities including our recommendations for bearing capacity, earth pressures, and structural fill as well as our opinion of slope stability.

GEOLOGICALLY HAZARDOUS AREAS

The regulations established in the Mason County Resource Ordinance, Title 8, Chapter 8.52 Geologically Hazardous Areas are intended to "identify areas that present potential dangers to public health and safety, to prevent the acceleration of natural geological hazards, to address off-site impacts, and to minimize the risk to the property owner or adjacent property owners from development activities." Pertinent landslide and erosion hazard issues related to the site are addressed in the remainder of this report.

The purpose of this study and report is to evaluate the slope stability of the site in accordance with Mason County Resource Ordinance, Title 8, and Chapter 8.52. "Geologically Hazardous Areas" means those areas with any indications of earth movement such as debris slides, earth flows, slumps and rock falls; areas with artificial over-steepened or unengineered slopes; areas containing soft or liquefiable soils; areas over-steepened or otherwise unstable as a result of stream incision, stream bank erosion and undercutting by wave action; slopes greater than 15 percent (8.5 degrees) or having the following: a.) hillsides intersecting geologic contacts with relatively permeable sediment overlying relatively impermeable sediment or bedrock and having springs or groundwater seepage; b.) any area with a slope of 40 percent (21.8 degrees), or steeper and a vertical relief of ten or more feet, except areas composed of consolidated rock.

Surface Conditions

The project site consists of the south half of Mason County parcel no. 32423-50-01003 consisting of approximately 0.57 acres and is roughly triangular in shape. The site is bounded by undeveloped residential properties to the west and east, Highway 101 to the south and North Will Webb Road to the north. Topographically, the parcel is situated along the toe of the south facing slope that descends to a relatively level bench at Highway 101 before descending to Hood Canal. The southern half of the parcel consists of a relatively level portion of the site situated at an elevation of approximately 95 feet above mean sea level (MSL). The remainder of the parcel ascends to the north along a series of slopes that are approximately 60 to 65 percent to an elevation of approximately 155 feet MSL along the northeast corner of the parcel. The slopes on the property are wooded and the level area at the toe of the slope is generally cleared. The existing water tank is located at the toe of the slope.

Geology

We reviewed the Washington State Department of Natural Resources (DNR) Interactive Geologic Map (https://geologyportal.dnr.wa.gov/) to evaluate the geology of the area and landslide potential. Based on our review, the site appears to be underlain by glacially derived Quaternary sediments, which are described as ice contact deposits, but interpreted as friable, but compact, subglacial melt-out till. The soils are generally described as pebbly sands and gravels with varying quantities of silt that were deposited in association with stagnant ice features such as kettles, hummocky topography, eskers, and outwash channels. The hillsides are mapped as Vashon age glacial till with occasional outcrops of the underlying Crescent formation basalts. The glacial till material is described as very dense, poorly-sorted silty, fine to coarse sand, with gravel and occasional boulders. The sediments were deposited and overridden by glacial actions during the last advance of the most recent glacial period in the Puget Sound and has been glacially consolidated. No upland wetlands were identified by Mason County within 1,500 feet of the site.

The closest landslide deposit mapped by the Washington State Department of Natural Resources Division of Geology and Earth Resources Costal Landslide Mapping Project is located approximately 1,900 feet to the west of the site. The landslide is located near the toe of the slope and within Pre-Fraser Olympic-source glacial and nonglacial deposits stratigraphically below the Vashon age advance outwash deposits located on the site and do not represent soils located at the subject site.

FINDINGS

General

Site Exploration

We excavated five test pits in the locations as shown on the Site Plan, Figure 2. The test pits were excavated using a backhoe and operator provided by PUD 1. A geologist from Insight Geologic maintained a log of the conditions encountered. The test pits were completed to a depth of 4 feet below ground surface. The soils were visually classified in general accordance with the system described in ASTM D2487-06. The exploration logs are contained in Attachment B.

Soil

Soil conditions encountered in the test pits were generally consistent between exploration locations. The soils consisted of dark brown to brown, well graded, fine to coarse gravel with fine to coarse sand to the base of the test pits. The surficial covering consisted of a thin grass with weeds. A generalized geologic cross section is shown in Figure 3.

The surficial soils encountered are consistent with Grove gravelly sandy loam, which is mapped for the area. These soils are generally formed from glacial outwash and generally have restrictive layers occurring at depths greater than 7 feet below grade. Permeability is moderately rapid, runoff is slow, and the hazard of water erosion is slight.

Groundwater

Groundwater was not encountered in any of the test pits at the subject site. In addition, no seeps were identified along the slopes above the site. It is likely that during periods of heavy rainfall limited

perched groundwater temporarily develops along the underlying glacial till contact along the steep slopes before draining from the site.

Laboratory Testing

We selected three soil samples for gradation analyses in general accordance with ASTM D422 to define soil class and assist with geotechnical recommendations. Our geotechnical 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. In addition, we are assuming risk category IV due to the nature of the facility. 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 (S_S) = 1.525
Spectral Response Accel. at 1 Second Periods (S_1) = 0.562
Site Class = C
Site Coefficient (F_A) = 1.2
Site Coefficient (F_V) = 1.438

Ground Rupture

Because of the location of the site with respect to the nearest known active crustal faults, and the presence of a layer of well compacted ice contact 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 loose to medium dense, clean to silty sands and non-plastic silts.

Based on our review of the Washington State Department of Natural Resources (DNR) Interactive Geologic Map, the project site is identified to have a low potential risk for soil liquefaction. Based on our experience with detailed seismic studies in the project area, including areas that are mapped within the same till soil deposits as the project site, we concur with the reviewed map.

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 glacial till soils at the site have a low risk for seismic compression settlement.

Seismic Settlement Discussion

Based on the materials encountered in our explorations, it is our preliminary opinion that seismic settlements (liquefaction-induced plus seismic compression) could potentially total a few inches at the site as the result of an IBC design level earthquake.

Seismic Slope Instability

The maximum slope inclination of the site approximately 65 percent, however we did not observe signs of slope instability during our site visit. In our opinion, there is a low risk of seismic slope instability at the project site under current conditions.

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 RECOMENDATIONS

General

Based on the results of our review, subsurface explorations and engineering analyses, it is our opinion that the proposed structure is feasible from a geotechnical standpoint. We understand that the proposed addition of a 24,000-gallon capacity water tank structure will be supported on a concrete mat foundation. We recommend that the foundation is designed using an allowable soil bearing capacity of 3,000 pounds per square foot (psf) if the foundation is supported by the well graded gravel unit at the site.

The soils encountered in our explorations are typically in a medium dense condition near ground surface. To limit the potential for structure settlement, we recommend that the tank slab be established on the underlying very dense glacial till. If the base of the proposed concrete mat foundation is not founded on the underlying glacial till we recommend removing the unconsolidated surficial soils to the top of the glacial till horizon and replacing it with a minimum 12-inch thick layer of compacted structural fill extending a minimum of 1 foot beyond the edge of the slab. A completed Geotechnical Report Checklist is attached, Attachment C. Proposed development areas are shown on Figure 4.

Geologically Hazardous Areas

Based on the site visit observations and published information of soils in the area of subject parcel, it is our opinion that the steep slopes of the subject site meet the definition of a “Geologically Hazardous Area” due to the angle of the measured slopes. The slopes located north of the proposed development area exceed the 40 percent inclination criteria as outlined in the Mason

County Resource Ordinance. The remainder of the slopes on the property are all less than 10 percent and do not exhibit geologic contacts, springs or seeps as outlined in the ordinance. No evidence of past landslides was observed.

Based on Mason County's Critical Areas Ordinance, the required prescriptive buffer for the property would be a 50-foot setback from the edges of the Geologically Hazardous Areas. However, based on our evaluation and understanding of the project, it is our opinion that the slopes are stable in their current condition and construction activities are unlikely to negatively impact on-site or off-site slope conditions. The steep slopes are underlain by a very dense glacial till soils with occasional outcrops of the underlying basalt unit. The glacial till has a high bearing capacity and is not prone to deep-seated failure. In addition, the prescriptive buffer would preclude development at the site due to the size of the property.. Therefore, it is our opinion that, since the proposed development consists of a non-habitable water tank, the geologically hazardous areas buffer may be reduced to a width of 25 feet from the base of the slopes. No other setbacks are required. Geologically hazardous areas and buffers are shown in Figure 4.

Earthwork

General

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

Our explorations did not encounter appreciable amounts of debris or unsuitable soils associated with past site development. 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 6 inches will be required to remove the thin vegetation layer encountered in our explorations. Deeper stripping depths may be required if additional unsuitable soils are exposed during stripping operations. We recommend that trees be removed by overturning so that the majority of roots are also removed. Depressions created by tree or stump removal should be backfilled with structural fill and properly compacted.

Native vegetation should be maintained whenever possible and exposed soil protected from rainfall. Detailed clearing and grading plans and temporary erosion control plans should be prepared and submitted by an appropriate contractor.

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.

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 will be 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 will be necessary where significant seepage occurs or if large voids are created during excavation. Some sloughing and raveling of cut slopes should be expected. Temporary covering with heavy plastic sheeting should be used to protect slopes during periods of wet weather.

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

Permanent Slopes

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

To achieve uniform compaction, we recommend that fill slopes be overbuilt and subsequently cut back to expose well-compacted fill. Fill placement on slopes should be benched into the slope face

and include keyways. The configuration of the bench and keyway depends on the equipment being used. Bench excavations should be level and extend into the slope face. We recommend that a vertical cut of about 3 feet be maintained for benched excavations. Keyways should be about 1-1/2 times the width of the equipment used for grading or compaction.

Erosion Control

We anticipate that erosion control measures such as silt fences, straw bales and 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

Some of the near-surface soils contain up to about 3 percent fines. While this soil is generally considered to be well-drained, significant rainfall may increase the moisture content of this soil more than a few percent above the optimum moisture content, increasing the likelihood that 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 gravel and sand, 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 significant portion of the year. 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. Significant quantities of material greater than 3 inches in diameter were observed during our site explorations. This material will cause difficulties in soil grading and compaction efforts. We recommend that the material greater than 3 inches in diameter be screened and removed or crushed for reuse on-site.

Select Granular Fill

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

Structural Fill Placement and Compaction

General

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

Structural fill should be placed in uniform, horizontal lifts and uniformly densified with vibratory compaction equipment. The maximum lift thickness will vary depending on the material and compaction equipment used but should generally not exceed the loose thicknesses provided 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 Lift 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 the proposed structure be founded on a minimum of 1-foot thick section of compacted structural fill sitting on compacted native subgrade soils. 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

We recommend an allowable soil bearing pressure of 3,000 psf for reinforced mat 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.

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 330 pounds per cubic foot (pcf), assuming that the footings are backfilled with structural fill. Frictional resistance may be estimated using 0.35 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 300 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 unnecessary for the proposed structures. The majority of subsurface site soils are well-draining and it is unlikely that subsurface drains would produce water.

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

The recommended earth pressure values do not include the effects of surcharges from surface loads or structures. If vehicles 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. 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 evaluation services report for the exclusive use by Mason County PUD 1 and their authorized agents for the proposed water tank project located on the northwest portion of Mason County parcel no. 32423-50-01003 in Mason County, Washington.

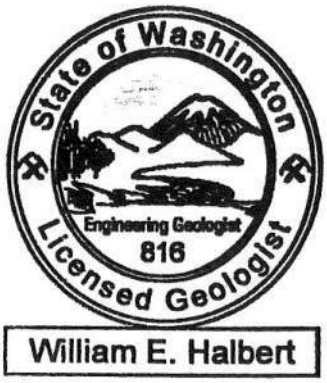
Within the limitations of scope, schedule and budget, our services have been executed in accordance with generally accepted practices in the field of geotechnical engineering in this area at the time this report was prepared. No warranty or other conditions, expressed or implied, should be understood.

Please refer to Attachment 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.

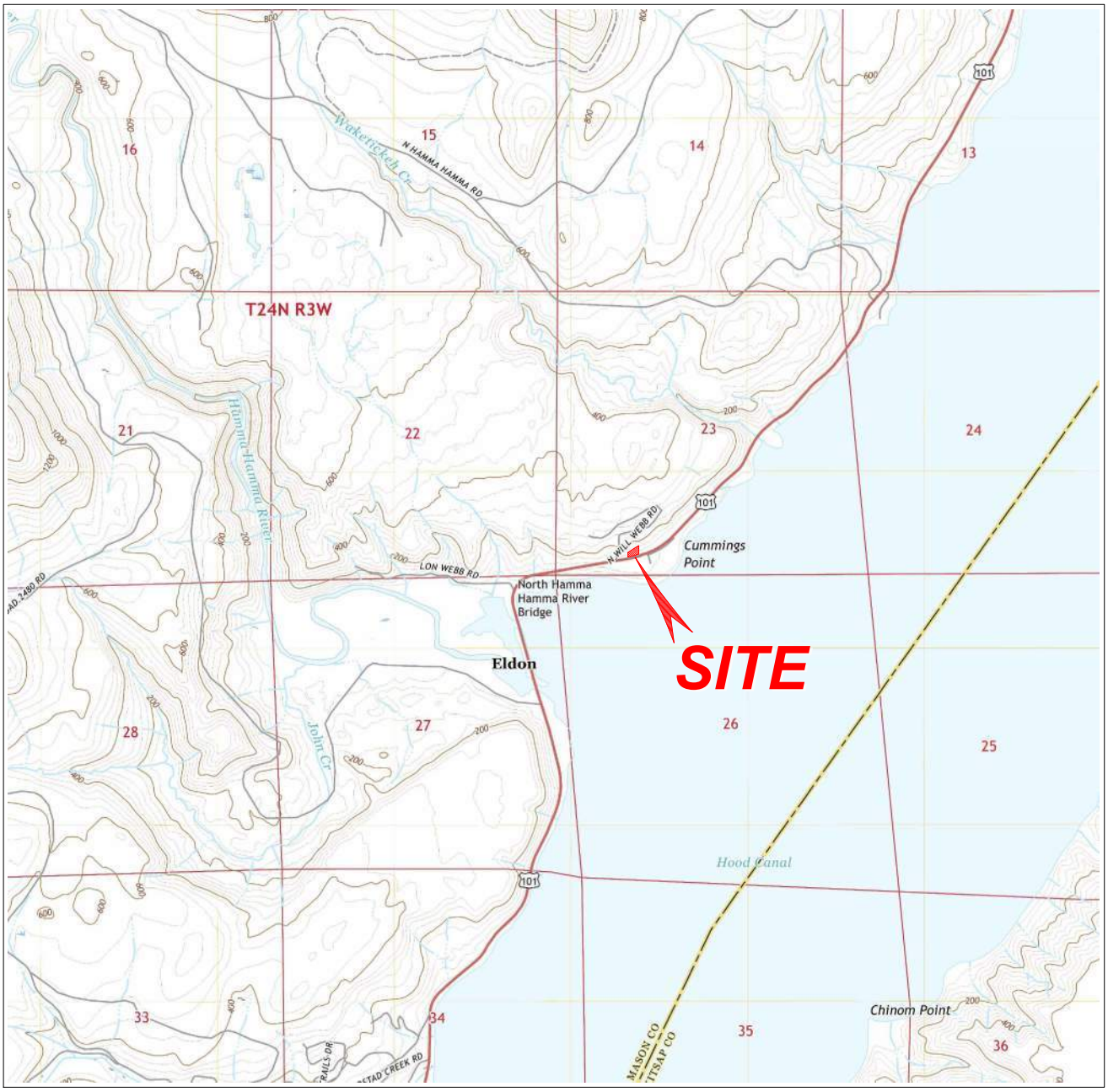
Respectfully Submitted,
INSIGHT GEOLOGIC, INC.

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



Attachments

FIGURES



Source: USGS (c) 2020

ELDON QUADRANGLE
WASHINGTON
7.5-MINUTE SERIES
Year 2020

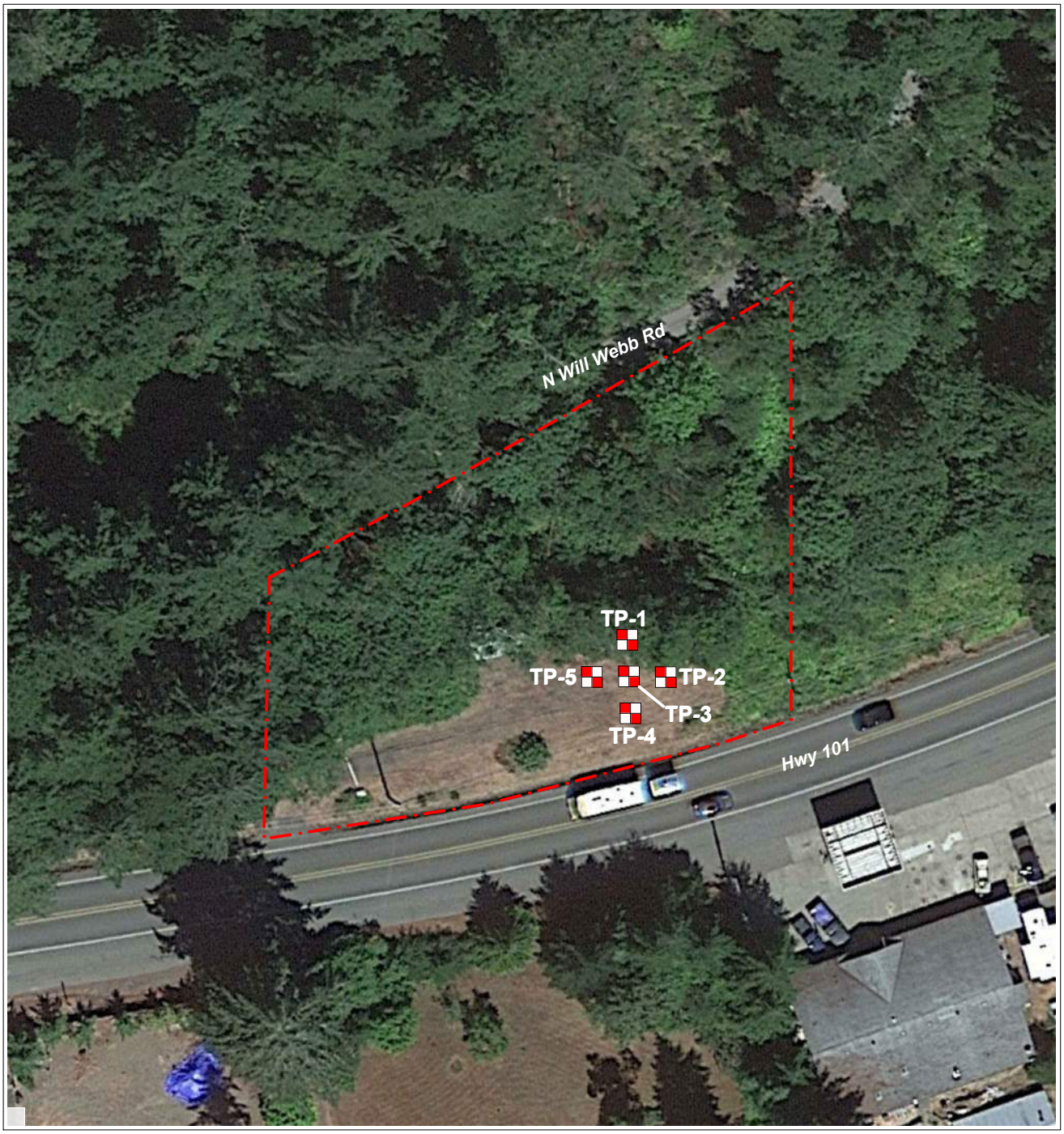
SCALE: 1" = 3000'

MASON COUNTY PUD 1

ELDON, WASHINGTON

INSIGHT GEOLOGIC, INC.

Figure 1
Vicinity Map



Source: Google Earth (c) 2023

LEGEND:

TP-1 APPROXIMATE TEST PIT LOCATION

APPROXIMATE PROJECT BOUNDARY

SCALE: 1"= 60'

MASON COUNTY PUD 1

ELDON, WASHINGTON

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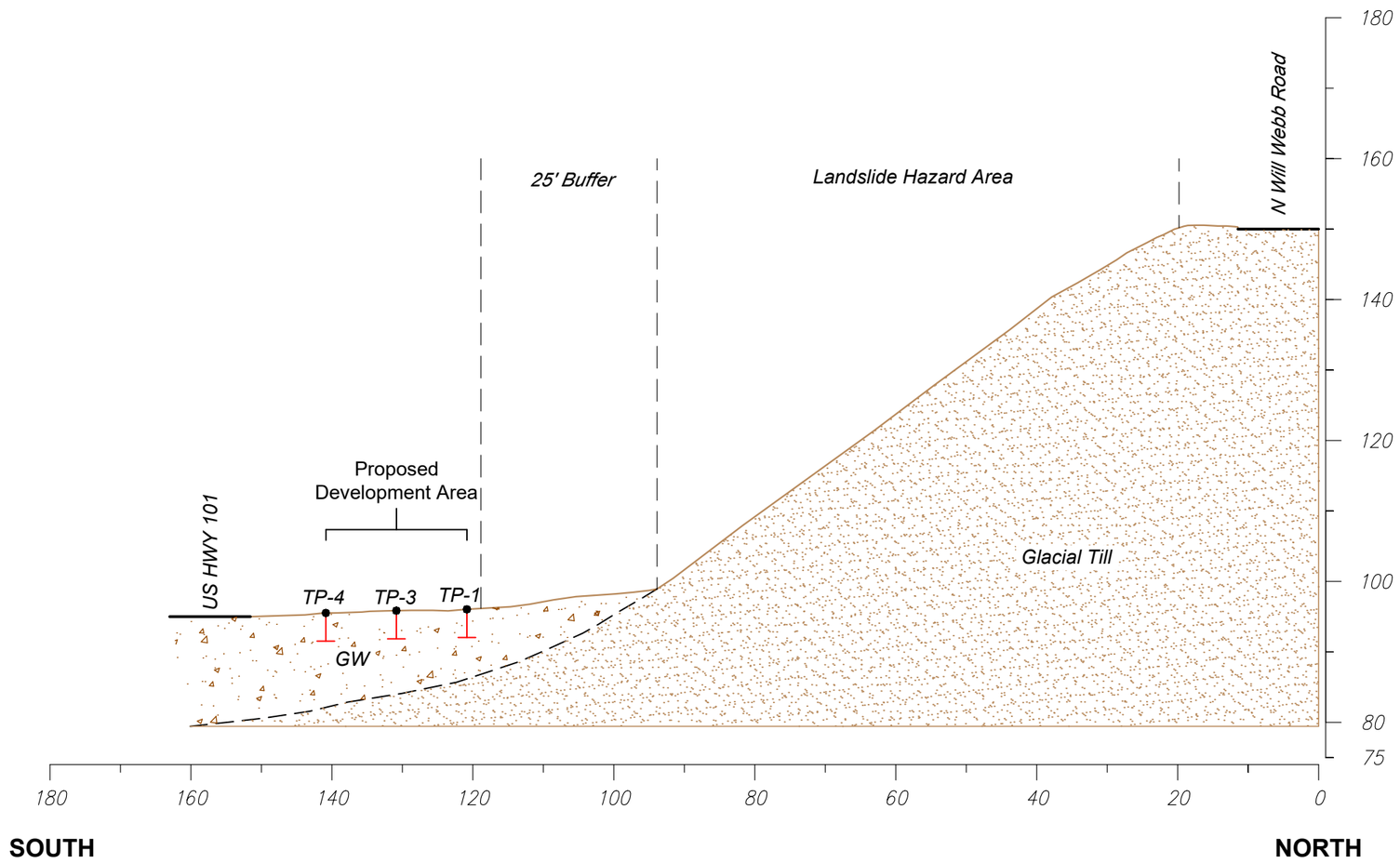
Figure 2
Site Plan



VIEW WEST

LEGEND:

0 5 10 20 40

HORIZONTAL & VERTICAL SCALE: 1" = 20'

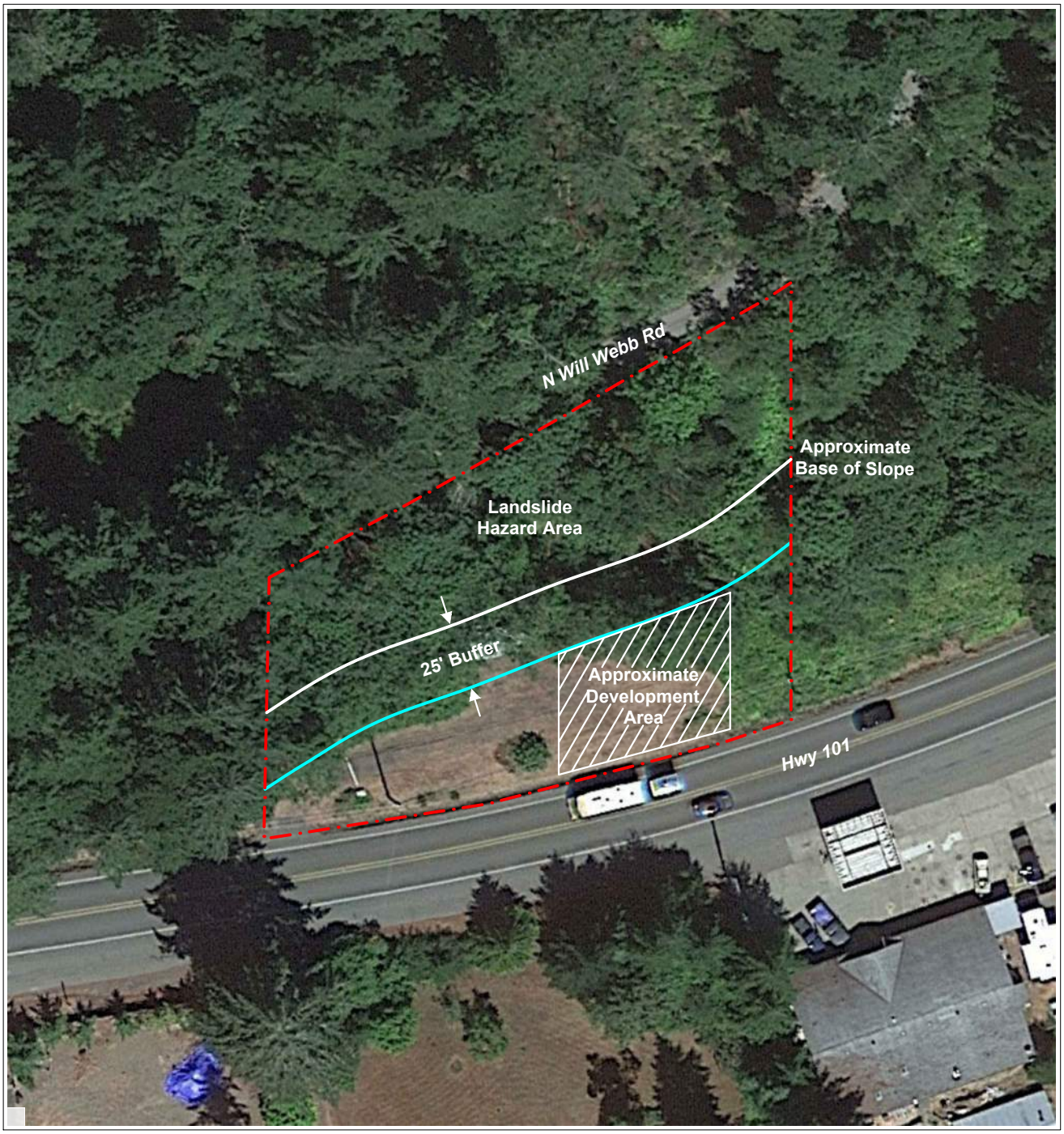
NOTE: GENERALIZED CROSS SECTION.
MEASUREMENTS ARE APPROXIMATE

MASON COUNTY PUD 1

ELDON, WASHINGTON

INSIGHT GEOLOGIC, INC.

Figure 3
Cross Section



Source: Google Earth (c) 2023

LEGEND:

APPROXIMATE PROJECT BOUNDARY

SCALE: 1"= 60'

MASON COUNTY PUD 1

ELDON, WASHINGTON

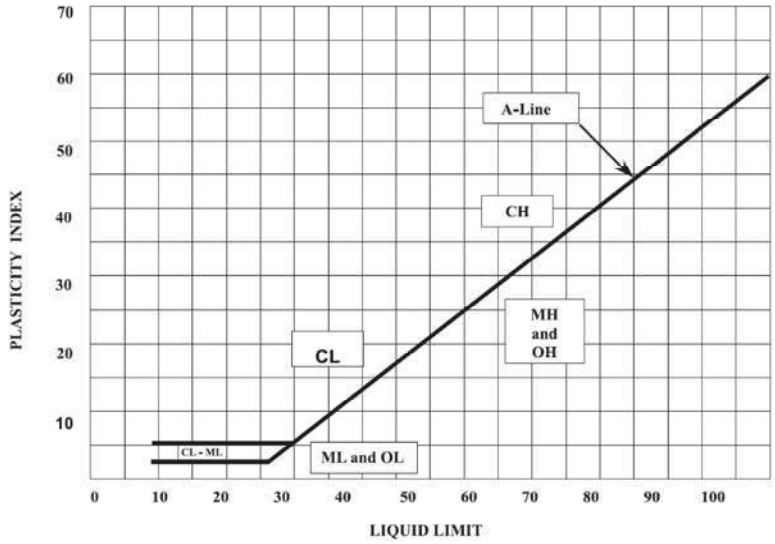
INSIGHT GEOLOGIC, INC.

Figure 4
Proposed Building Area and Buffer Map

ATTACHMENT A
EXPLORATION LOGS

SOIL CLASSIFICATION CHART

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



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

ADDITIONAL MATERIAL SYMBOLS

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

GROUNDWATER EXPLORATION SYMBOLS

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

STRATIGRAPHIC CONTACT

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

LABORATORY / FIELD TEST CLASSIFICATIONS

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

SAMPLER SYMBOLS

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

SHEEN CLASSIFICATIONS

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

INSIGHT GEOLOGIC, INC.

Figure A-1
Key to Exploration Logs

PROJECT: Mason County PUD #1 - Eldon Water Tank
PROJECT NO.: 1171-003-01
LOCATION: Eldon, Washington

TP-1

DATE: June 21, 2023
TOTAL DEPTH: 4

DEPTH (FT)	U.S.C.S.	LITHOLOGY	SOIL DESCRIPTION	REMARKS AND OTHER TESTS
0	GW		**GW:** Dark brown fine to coarse gravel with fine to coarse sand, medium dense, moist	Test pit completed at 4 feet. No groundwater encountered. No caving observed.
1			Brown with cobbles and boulders, medium dense to dense	
2				
3				
4				
5				
6				
7				
8				
9				
10				

INSIGHT GEOLOGIC, INC.

Operator **Mason County PUD #1**
Equipment: **Backhoe**
Logged By: **Neal Graham**

Figure A-2

PROJECT: Mason County PUD #1 - Eldon Water Tank
PROJECT NO.: 1171-003-01
LOCATION: Eldon, Washington

TP-2

DATE: June 21, 2023
TOTAL DEPTH: 4

DEPTH (FT)	U.S.C.S.	LITHOLOGY	SOIL DESCRIPTION	REMARKS AND OTHER TESTS
0	GW		**GW:** Dark brown fine to coarse gravel with fine to coarse sand, medium dense, moist Brown with cobbles and boulders, medium dense to dense	Test pit completed at 4 feet. No groundwater encountered. No caving observed.
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				

INSIGHT GEOLOGIC, INC.

Operator **Mason County PUD #1**
Equipment: **Backhoe**
Logged By: **Neal Graham**

Figure A-3

PROJECT: Mason County PUD #1 - Eldon Water Tank
PROJECT NO.: 1171-003-01
LOCATION: Eldon, Washington

TP-3

DATE: June 21, 2023
TOTAL DEPTH: 4

DEPTH (FT)	U.S.C.S.	LITHOLOGY	SOIL DESCRIPTION	REMARKS AND OTHER TESTS
0	GW		**GW:** Dark brown fine to coarse gravel with fine to coarse sand, medium dense, moist	Test pit completed at 4 feet. No groundwater encountered. No caving observed.
1			Brown with cobbles and boulders, medium dense to dense	
2				
3				
4				
5				
6				
7				
8				
9				
10				

INSIGHT GEOLOGIC, INC.

Operator **Mason County PUD #1**
Equipment: **Backhoe**
Logged By: **Neal Graham**

Figure A-4

PROJECT: Mason County PUD #1 - Eldon Water Tank
PROJECT NO.: 1171-003-01
LOCATION: Eldon, Washington

TP-4

DATE: June 21, 2023
TOTAL DEPTH: 4

DEPTH (FT)	U.S.C.S.	LITHOLOGY	SOIL DESCRIPTION	REMARKS AND OTHER TESTS
0	GW		**GW:** Dark brown fine to coarse gravel with fine to coarse sand, medium dense, moist	Test pit completed at 4 feet. No groundwater encountered. No caving observed.
1			Brown with cobbles and boulders, medium dense to dense	
2				
3				
4				
5				
6				
7				
8				
9				
10				

INSIGHT GEOLOGIC, INC.

Operator **Mason County PUD #1**
Equipment: **Backhoe**
Logged By: **Neal Graham**

Figure A-5

PROJECT: Mason County PUD #1 - Eldon Water Tank
PROJECT NO.: 1171-003-01
LOCATION: Eldon, Washington

TP-5

DATE: June 21, 2023
TOTAL DEPTH: 4

DEPTH (FT)	U.S.C.S.	LITHOLOGY	SOIL DESCRIPTION	REMARKS AND OTHER TESTS
0	GW		**GW:** Dark brown fine to coarse gravel with fine to coarse sand, medium dense, moist Brown with cobbles and boulders, medium dense to dense	Test pit completed at 4 feet. No groundwater encountered. No caving observed.
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				

INSIGHT GEOLOGIC, INC.

Operator **Mason County PUD #1**
Equipment: **Backhoe**
Logged By: **Neal Graham**

Figure A-6

ATTACHMENT B
LABORATORY TEST RESULTS

Gradation Analysis Summary Data

Job Name: Mason County PUD 1 - Eldon Water Tank
Job Number: 1171-003-01
Date Tested: 7/11/23
Tested By: Andrew Johnson

Sample Location: TP-1
Sample Name: TP-1 0.5' - 4.0'
Depth: 0.5 - 4 Feet

Moisture Content (%) 6.4%

Sieve Size	Percent Passing
3.0 in. (75.0)	100.0
1.5 in. (37.5)	100.0
3/4 in. (19.0)	60.6
3/8 in. (9.5-mm)	44.4
No. 4 (4.75-mm)	33.4
No. 10 (2.00-mm)	22.8
No. 20 (.850-mm)	15.2
No. 40 (.425-mm)	9.5
No. 60 (.250-mm)	5.7
No. 100 (.150-mm)	3.6
No. 200 (.075-mm)	2.0

Size Fraction	Percent by Weight
Coarse Gravel	39.4
Fine Gravel	27.2
Coarse Sand	10.5
Medium Sand	13.3
Fine Sand	7.5
Fines	2.0
Total	**100.0**

LL	- -
PL	- -
PI	- -
D_{10}	0.44
D_{30}	3.70
D_{60}	18.00
D_{90}	31.00
Cc	1.73
Cu	40.91

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

INSIGHT GEOLOGIC, INC.

Gradation Analysis Summary Data

Job Name: Mason County PUD 1 - Eldon Water Tank
Job Number: 1171-003-01
Date Tested: 7/11/23
Tested By: Andrew Johnson

Sample Location: TP-3
Sample Name: TP-3 0.0' - 0.5'
Depth: 0 - 0.5 Feet

Moisture Content (%) 7.2%

Sieve Size	Percent Passing
3.0 in. (75.0)	100.0
1.5 in. (37.5)	64.1
3/4 in. (19.0)	54.9
3/8 in. (9.5-mm)	44.6
No. 4 (4.75-mm)	33.9
No. 10 (2.00-mm)	23.6
No. 20 (.850-mm)	16.5
No. 40 (.425-mm)	12.2
No. 60 (.250-mm)	8.4
No. 100 (.150-mm)	5.2
No. 200 (.075-mm)	2.7

Size Fraction	Percent by Weight
Coarse Gravel	45.1
Fine Gravel	21.0
Coarse Sand	10.3
Medium Sand	11.4
Fine Sand	9.5
Fines	2.7
Total	**100.0**

LL	- -
PL	- -
PI	- -
D_{10}	0.30
D_{30}	3.60
D_{60}	21.00
D_{90}	62.00
Cc	2.06
Cu	70.00

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

INSIGHT GEOLOGIC, INC.

Gradation Analysis Summary Data

Job Name: Mason County PUD 1 - Eldon Water Tank
Job Number: 1171-003-01
Date Tested: 7/11/23
Tested By: Andrew Johnson

Sample Location: TP-5
Sample Name: TP-5 0.5' - 4.0'
Depth: 0.5 - 4 Feet

Moisture Content (%) 4.8%

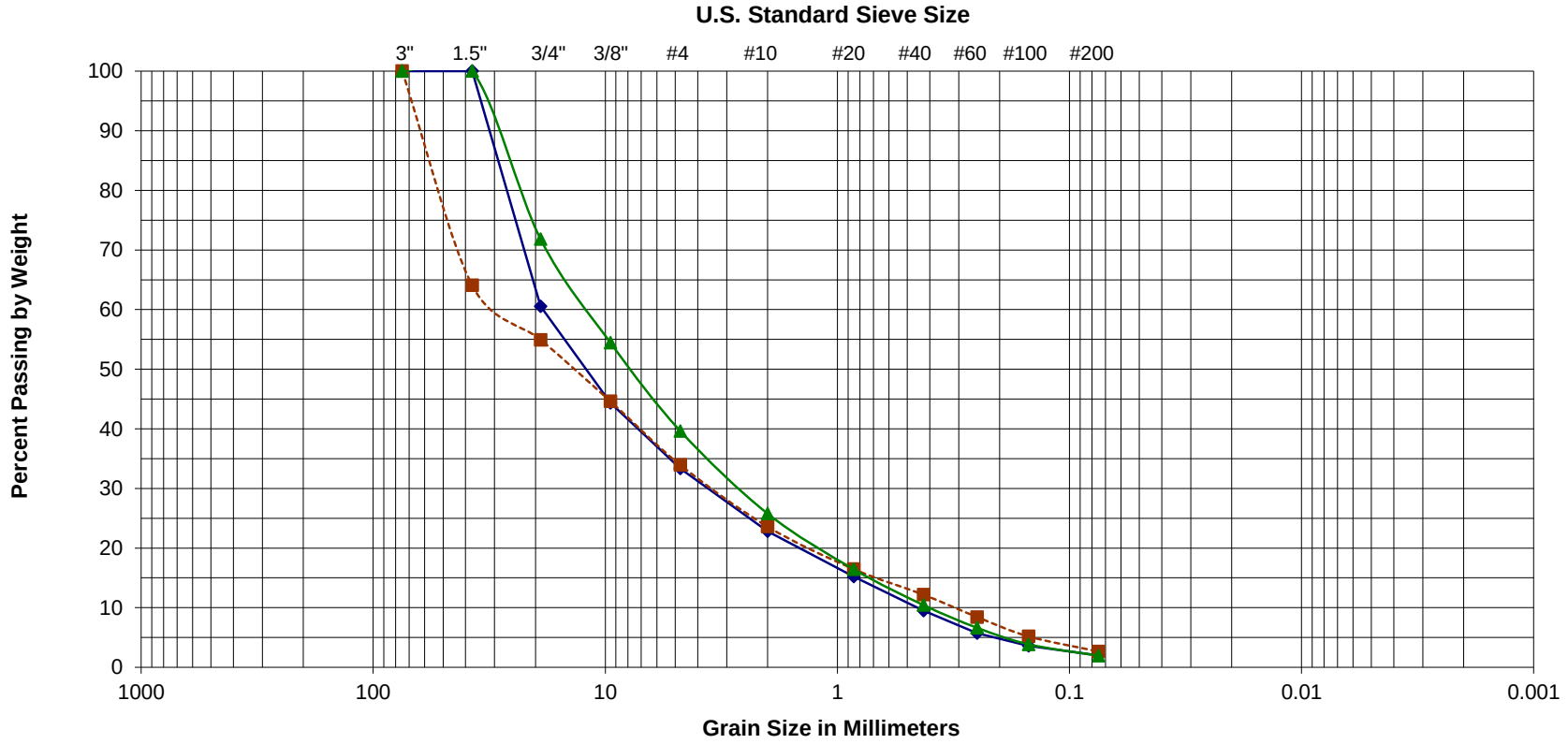
Sieve Size	Percent Passing
3.0 in. (75.0)	100.0
1.5 in. (37.5)	100.0
3/4 in. (19.0)	71.8
3/8 in. (9.5-mm)	54.4
No. 4 (4.75-mm)	39.6
No. 10 (2.00-mm)	25.8
No. 20 (.850-mm)	16.4
No. 40 (.425-mm)	10.4
No. 60 (.250-mm)	6.6
No. 100 (.150-mm)	3.9
No. 200 (.075-mm)	1.9

Size Fraction	Percent by Weight
Coarse Gravel	28.2
Fine Gravel	32.2
Coarse Sand	13.8
Medium Sand	15.4
Fine Sand	8.5
Fines	1.9
Total	**100.0**

LL	- -
PL	- -
PI	- -
D_{10}	0.40
D_{30}	2.70
D_{60}	13.00
D_{90}	28.00
Cc	1.40
Cu	32.50

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

INSIGHT GEOLOGIC, INC.



COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	

MASON COUNTY PUD 1 - ELDON WATER TANK

MASON COUNTY, WASHINGTON

INSIGHT GEOLOGIC, INC.

Graph 1
Gradation Analysis Results

ATTACHMENT C

MASON COUNTY COMMUNITY SERVICES

SUBMITTAL CHECKLIST GEOTEHCNICAL REPORT

MASON COUNTY
COMMUNITY SERVICES
Building, Planning, Environmental Health, Community Health

Submittal Checklist

Geotechnical Report

Instructions:

This checklist must be submitted with a Geotechnical Report and completed, signed, and stamped by the licensed professional(s) who prepared the Geotechnical Report for review by Mason County pursuant to the Mason County Resource Ordinance. If an item is found not applicable, the report should explain the basis for the conclusion.

Note: *Unless specifically documented, this report does not provide compliance to the International Residential Code Sections R403.1.7 for foundations on or adjacent to slopes, Section R403.1.8 for expansive soils or section 1808.7.1 of the International Building Code Section for Foundations on or adjacent to slopes.*

Applicant/Owner Mason County PUD 1 Parcel # 32423-50-01003

Site Address N/A

(1) (a) A discussion of general geologic conditions in the vicinity of the proposed development,

Located on page(s) 3

(b) A discussion of specific soil types,

Located on page(s) 3

(c) A discussion of ground water conditions,

Located on page(s) 3-4

(d) A discussion of the upslope geomorphology,

Located on page(s) 2

(e) A discussion of the location of upland waterbodies and wetlands,

Located on page(s) 3

(f) A discussion of history of landslide activity in the vicinity, as available in the referenced maps and records.

Located on page(s) 3

(2) A site plan which identifies the important development and geologic features.

Located on Map(s) Figures 3,4

(3) Locations and logs of exploratory holes or probes.

Located on Map(s) Figure 2

(4) The area of the proposed development, the boundaries of the hazard, and associated buffers and setbacks shall be delineated (top, both sides, and toe) on a geologic map of the site.

Located on Map(s) Figure 3,4

(5) A minimum of one cross section at a scale which adequately depicts the subsurface profile, and which incorporates the details of proposed grade changes.

Located on Map(s) Figure 3

(6) A description and results of slope stability analyses performed for both static and seismic loading conditions. Analysis should examine worst case failures. The analysis should include the Simplified Bishop's Method of Circles. The minimum static safety factor is 1.5, the minimum seismic safety factor is 1.1, and the quasi-static analysis coefficients should be a value of 0.15.

Located on page(s) N/A Seismic Discussion page 4 and 5

(7) (a) Appropriate restrictions on placement of drainage features,

Located on page(s) 8, 12

(b) Appropriate restrictions on placement of septic drain fields,

Located on page(s) N/A

(c) Appropriate restrictions on placement of compacted fills and footings,

Located on page(s) N/A

(d) Recommended buffers from the landslide hazard areas shoreline bluffs and the tops of other slopes.

Located on page(s) 6

(e) Recommended setbacks from the landslide hazard areas shoreline bluffs and the tops of other slopes.

Located on page(s) 6

(8) Recommendations for the preparation of a detailed clearing and grading plan which specifically identifies vegetation to be removed, a schedule for vegetation removal and replanting, and the method of vegetation removal.

Located on page(s) 6,7

(9) Recommendations for the preparation of a detailed temporary erosion control plan which identifies the specific mitigating measures to be implemented during construction to protect the slope from erosion, landslides and harmful construction methods.

Located on page(s) 8

(10) An analysis of both on-site and off-site impacts of the proposed development.

Located on page(s) 6

(11) Specifications of final development conditions such as, vegetative management, drainage, erosion control, and buffer widths.

Located on page(s) 6-8

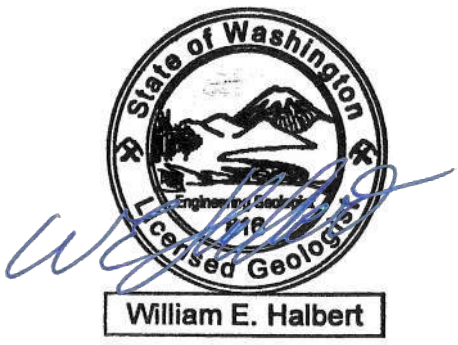
(12) Recommendations for the preparation of structural mitigation or details of other proposed mitigation.

Located on page(s) 5

(13) A site map drawn to scale showing the property boundaries, scale, north arrow, and the location and nature of existing and proposed development on the site.

Located on Map(s) Figure 4

I, William E. Halbert hereby certify under penalty of perjury that I am a civil engineer licensed in the State of Washington with specialized knowledge of geotechnical/geological engineering or a geologist or engineering geologist licensed in the State of Washington with special knowledge of the local conditions. I also certify that the



(Signature and Stamp)

Geotechnical Report, dated July 18, 2023, and entitled Geotechnical Assessment Report, Mason County PUD 1, July 18, 2023 meets all the requirements of the Mason County Resource Ordinance, Geologically Hazardous Areas Section, is complete and true, that the assessment demonstrates conclusively that the risks posed by the landslide hazard can be mitigated through the included geotechnical design recommendations, and that all hazards are mitigated in such a manner as to prevent harm to property and public health and safety.

Disclaimer: *Mason County does not certify the quality of the work done in this Geotechnical Report.*

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 by Mason County PUD 1 (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.

---

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

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 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.

INSIGHT GEOLOGIC, INC.

1015 East 4th Avenue
Olympia, Washington 98506
Telephone: (360) 754-2128
Fax: (360) 754-9299

MEMORANDUM

TO: James Reyes

FROM: William Halbert, L.E.G., L.Hg.

DATE: August 3, 2023

PROJECT: Eldon Water Tank

SUBJECT: Infiltration Rate

The infiltration rate for the soils at the Eldon water tank site is 9 inches per hour for soils between 1 and 4 feet below grade.

Using the Department of Ecology Stormwater Management Manual for Western Washington (2005) as adopted by Mason County, we derived the infiltration rate using the methodology described in Vol. III, Section 3.3.6, Table 3.8 (page 3-77). Based on our ASTM gradation of soils in this depth interval (TP-1 and TP-5), the D_{10} value was greater than or equal to 0.4 millimeters (0.44 and 0.4, respectively). Using this measurement against the information presented in Table 3.8, resulted in an infiltration rate of 9 inches per hour.

Laboratory data may be found in our geotechnical report for the project, previously submitted.

INSIGHT GEOLOGIC, INC.

1015 East 4th Avenue
Olympia, Washington 98506
Telephone: (360) 754-2128
Fax: (360) 754-9299

MEMORANDUM

TO: Brandy Millroy, MPUD#1, Ravyn Whitewolf, P.E., Whitewolf Engineering

FROM: William Halbert, L.E.G.

DATE: February 12, 2024

PROJECT: Canal View Well Site

SUBJECT: Reduced Slope Buffer

Insight Geologic is pleased to this memorandum pertaining to the issue of a reduced toe-of-slope buffer for the water system improvement project being undertaken at the Canal View water system site in Eldon, Washington.

Insight Geologic conducted a geotechnical and slope evaluation of the property in 2023. We concluded that a reduced slope buffer was appropriate on the back (west) portion of the property due to the slope inclination and lack of evidence of movement. In our report we recommended a buffer of 25 feet from the toe of the slope. Due to site constraints, we understand that you are requesting a further-reduced buffer of 20 feet. It is our opinion that this reduced buffer can be achieved if a barrier is constructed along the toe of slope to intercept runout of shallow soil failures that might originate on the slope.

The barrier can consist of concrete ecology blocks stacked 2 high along the toe of slope. The base course of blocks shall be established on a minimum of 6-inches of compacted structural fill over compacted native soil. We recommend that the blocks be stacked in a “running bond” pattern so that adjacent joints between blocks do not coincide with the joints on the base course of blocks. The interception barrier shall extend 15 feet to either side of infrastructure (well house and water tank) measured perpendicular to the slope.

INSIGHT GEOLOGIC, INC.

May 13, 2024

Mason County PUD 1
North 21971 Highway 101
Shelton, Washington 98584
Attention: Brandy Milroy

Report
Geotechnical Services
Eldon Water System Water Main
Highway 101
Eldon, Washington
Project No. 1171-001-02

INTRODUCTION

Insight Geologic, Inc. is pleased to provide our report of geotechnical services in support of a proposed water main to be directionally drilled beneath US Highway 101 in Eldon, Washington. The new water main is a part of a more comprehensive upgrade of the Eldon water system being conducted by Mason County PUD 1. The location of the project site is shown in the Vicinity Map, Figure 1.

SCOPE OF SERVICES

Our specific tasks performed are outlined below:

1. Conducted a site reconnaissance to evaluate site conditions and access.
2. Drilled a series of 3 shallow borings along the proposed water main alignment in the locations provided by White Wolf Engineering Services. The borings were drilled using a small, hollow-stem auger drilling rig to a depths of about 10 feet below ground surface.
3. Collected relatively undisturbed soil samples from the borings at 2.5-foot intervals during drilling. The samples were collected using a SPT split-spoon sampler and transferred to sample containers following collection. Blow counts which provide an estimate of the relative density of the soils were collected for each 6-inch interval over the 18-inch sampling interval and recorded on the boring logs.
4. Classified the soils in general accordance with the Unified Soil Classification System.
5. Prepared a report of our findings including soil descriptions, our boring logs and relative density.

FINDINGS

The project site consists of the right margin of the northbound lane of US Highway 101 extending 800 feet south from the Eldon Store in unincorporated Mason County, Washington. The site elevations range between 90 feet above mean sea level in the northern portion, rising to approximately 100 feet

in the southern portion. Residential properties abut the subject site on the east.

Geology

Based on our review of available published geologic maps, Vashon age glacial deposits underlie the project site and surrounding area. The glacial deposits consist of dense glacial till and outwash sand and gravel deposited at the end of the last glaciation.

Subsurface Explorations

We explored subsurface conditions at the site on April 5, 2024, by drilling three borings in the locations as shown on the Site Plan, Figure 2. The test pits were excavated using a small, track-mounted drilling rig operated by Boretec, Inc. A geologist from Insight Geologic monitored the explorations and maintained a log of the conditions encountered. The borings were completed at depths of between 10 and 11.5 feet bgs. The soils were visually classified in general accordance with the system described in ASTM D2487-06. Exploration logs are contained in Attachment A.

Soil Conditions

Soil conditions encountered within the explorations were somewhat consistent across the site. Underlying surficial asphalt or crushed rock, we encountered brown to red-brown, silty fine to medium sand with gravel (SM) or silty gravel with sand (GM) in a medium dense and moist condition to a depth of about 5 feet below grade. Beyond this depth, soils graded to dense to very dense to the full depth of the test pits. We interpret the upper 5 feet of material to be weathered till or glacial outwash, overlying the dense to very dense glacial till.

Groundwater Conditions

Groundwater was encountered at a depth of 10 feet in B-1 and at a depth of 7 feet in B-3. Groundwater was not encountered in B-2. We anticipate that groundwater levels will fluctuate between winter and summer months.

Laboratory Testing

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

OPINION

We have performed this geotechnical investigation in general conformance with our proposed scope of services. Based on our subsurface investigation, it appears that the subject site is underlain by medium dense to very dense, weathered to unweathered glacial till and outwash deposits. Directional drilling is possible in the geologic materials encountered. We recommend a drilling depth of about 5 feet for the new water line. This depth should be sufficient to contain drilling mud, while being close enough to ground surface for maintenance. The driller should plan on a soil density of about 120 pounds per cubic foot in the weathered materials and 125 psf in the unweathered materials. Drilling

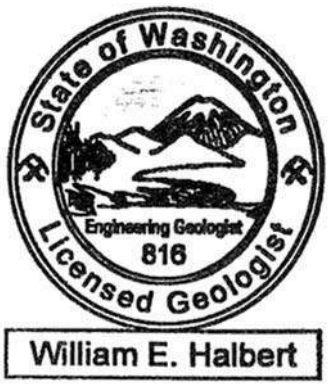
pressures will need to be kept low to prevent breakout of drilling mud to the surface.

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

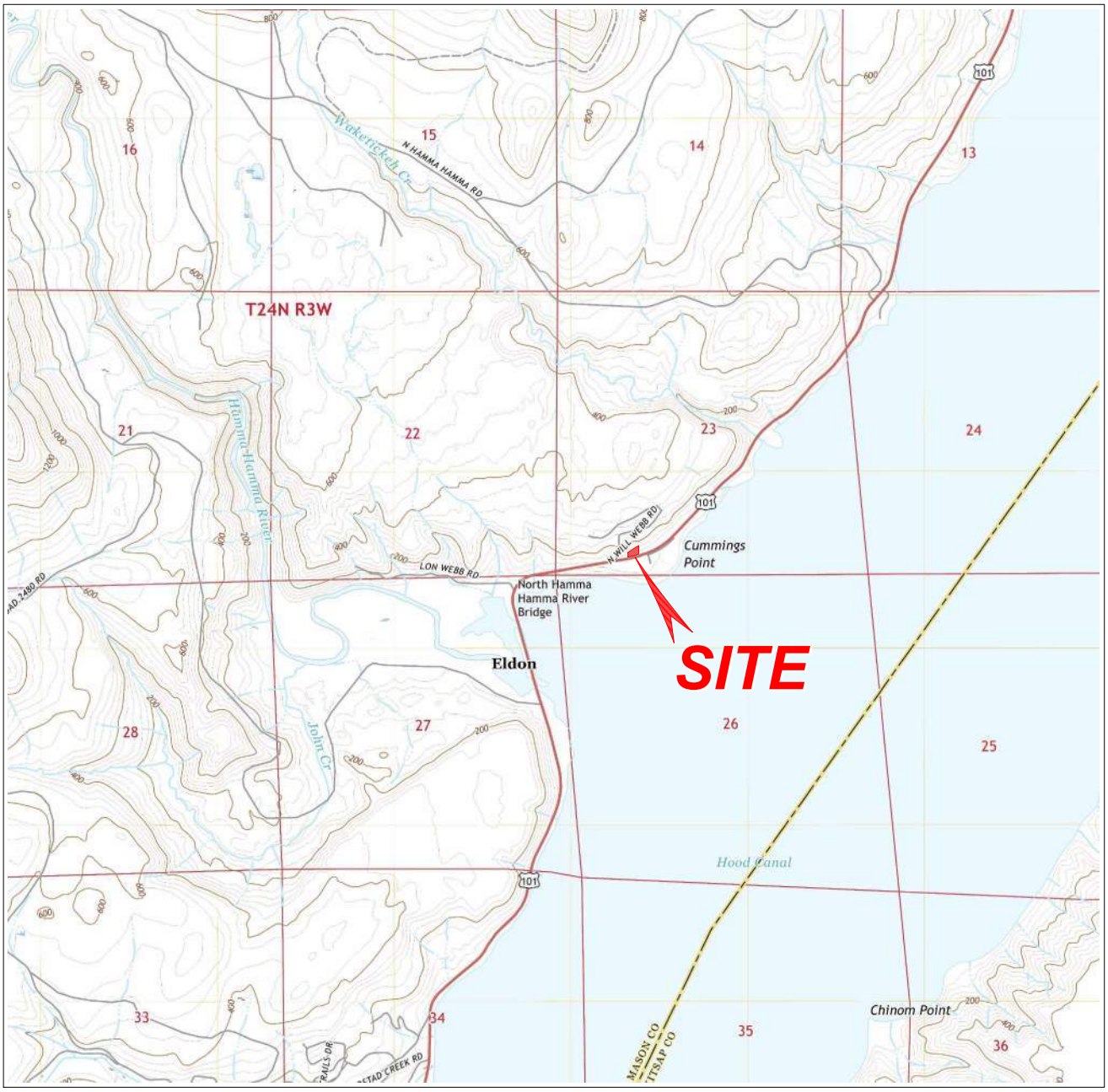
Respectfully Submitted,
INSIGHT GEOLOGIC, INC.

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

Attachments



FIGURES



Source: USGS (c) 2020

ELDON QUADRANGLE
WASHINGTON
7.5-MINUTE SERIES
Year 2020

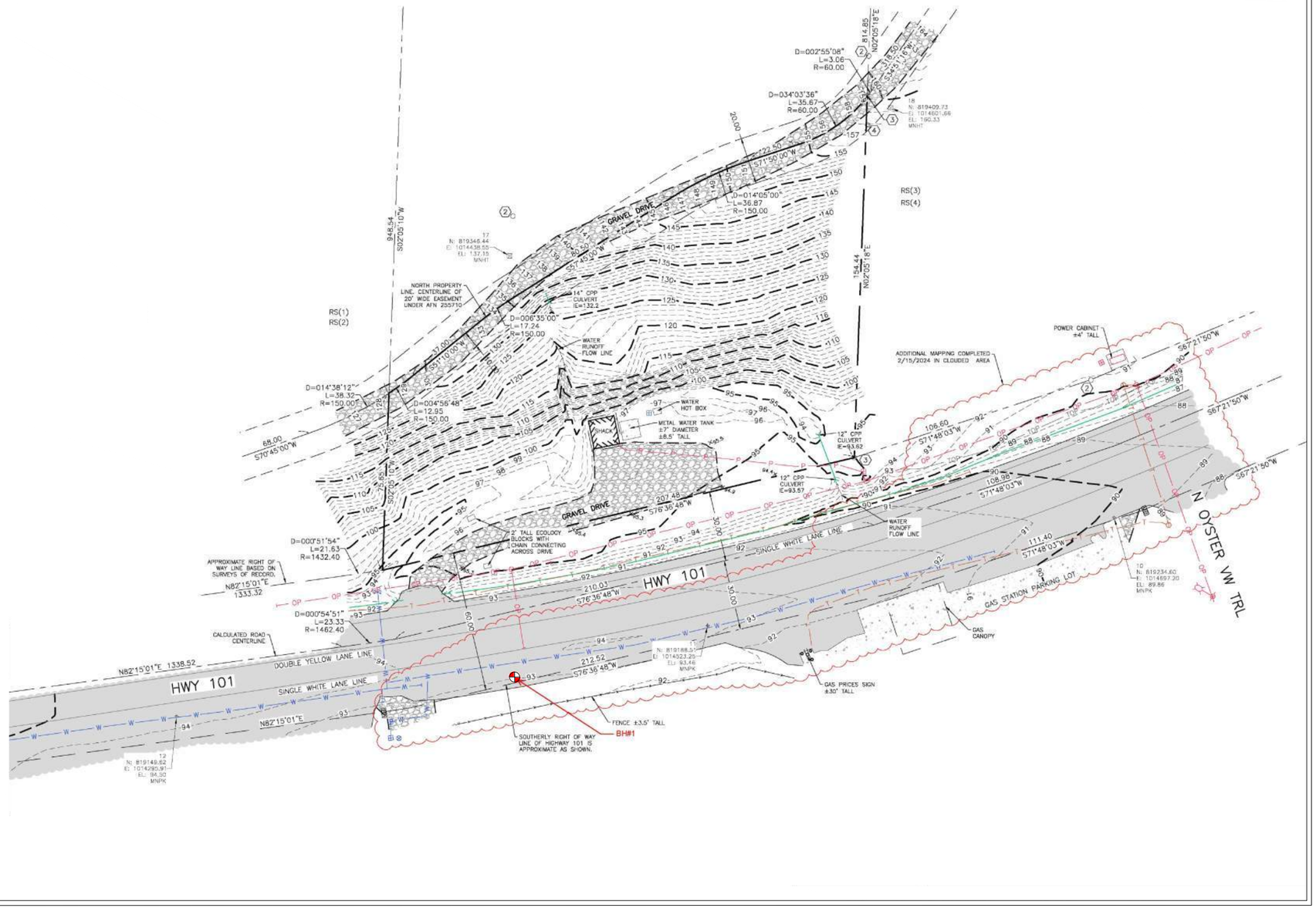
SCALE: 1" = 3000'

MASON COUNTY PUD 1

ELDON, WASHINGTON

INSIGHT GEOLOGIC, INC.

Figure 1
Vicinity Map



LEGEND:

BH#1 APPROXIMATE SOIL BORING LOCATION

0 25 50

SCALE: 1" = 50'

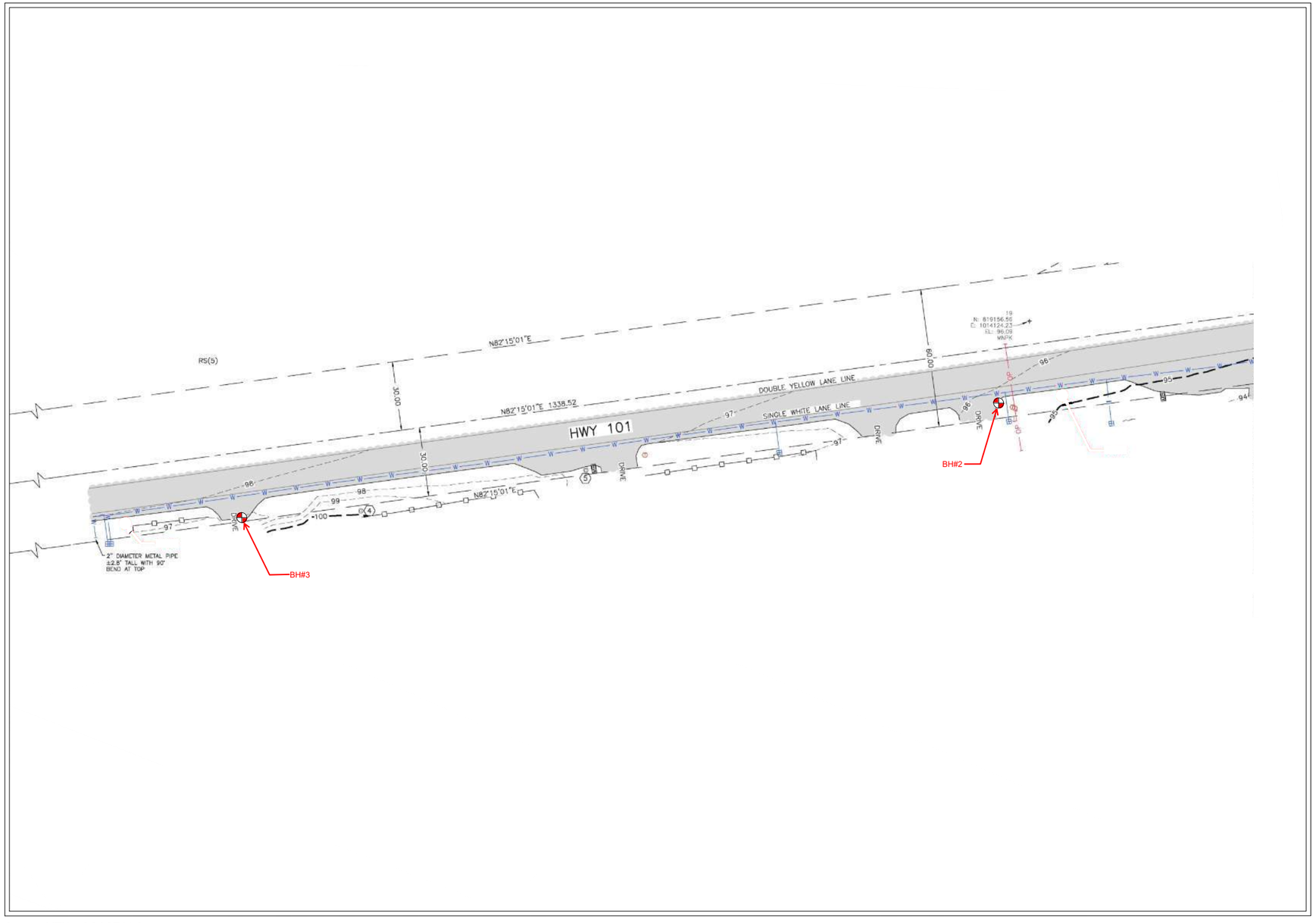
Source: MTN 2 COAST LLC

MASON COUNTY PUD

ELDON, WASHINGTON

INSIGHT GEOLOGIC, INC.

Figure 2
Boring Location



Source: MTN 2 COAST LLC

LEGEND:

BH#2 APPROXIMATE SOIL BORING LOCATION

0 25 50

SCALE: 1" = 50'

MASON COUNTY PUD

ELDON, WASHINGTON

INSIGHT GEOLOGIC, INC.

Figure 3
Boring Locations

ATTACHMENT A
EXPLORATION LOGS

PROJECT: **Mason PUD #1**
PROJECT NO.: **1171-002-02**
LOCATION: **Eldon, Washington**

BH-1

DATE: **April 5, 2024**
TOTAL DEPTH: **11.5**

DEPTH (FT)	SAMPLE NUMBER/ INTERVAL	INCHES DRIVEN/ RECOVERED	SPT "N" VALUE	U.S.C.S.	LITHOLOGY	SOIL DESCRIPTION	REMARKS AND OTHER TESTS
0						**Asphalt:** Asphaltic concrete	
						: Crushed rock base course	
	1	6/18	6	ML		**ML:** Gray silt, soft, wet	
5	2	8/12	50-4	GM		**GP:** Reddish brown poorly graded gravel with sand, trace silt, dense, moist.	
	3	12/18	63	SW-SM		**SP-SM:** Brown, poorly graded sand with silt and gravel	
10	4	13/18	62				Borehole completed @ 11.5 feet. Groundwater encountered at 10 feet. No caving.
15							

INSIGHT GEOLOGIC, INC.

Drilling Contractor: **Boretec, Inc.**
Drill Equipment: **EC - 95 Track Drill**
Logged By: **W. Halbert**
Driller: **Joseph**
Drill Method: **Hollow-stem Auger**

Figure A-2

PROJECT: **Mason PUD #1**
PROJECT NO.: **1171-002-02**
LOCATION: **Eldon, Washington**

BH-2

DATE: **April 5, 2024**
TOTAL DEPTH: **11.5**

DEPTH (FT)	SAMPLE NUMBER/ INTERVAL	INCHES DRIVEN/ RECOVERED	SPT "N" VALUE	U.S.C.S.	LITHOLOGY	SOIL DESCRIPTION	REMARKS AND OTHER TESTS
0	1		Grab	SM		**SM:** Reddish brown silty sand with fine to medium gravel, loose to medium dense, moist	
5	2	16/18	86	GP		**GP:** Gray sandy gravel, fine to coarse, trace silt, dense, moist	
	3	3/18	50-5				
10	4	4/18	50-4				Boring completed at 11.5 feet. No groundwater encountered. No caving observed.
15							

INSIGHT GEOLOGIC, INC.

Drilling Contractor: **Boretec, Inc.**
Drill Equipment: **EC - 95 Track Drill**
Logged By: **W. Halbert**
Driller: **Joseph**
Drill Method: **Hollow-stem Auger**

Figure A-3

PROJECT: **Mason PUD #1**
PROJECT NO.: **1171-002-02**
LOCATION: **Eldon, Washington**

BH-3

DATE: **April 5, 2024**
TOTAL DEPTH: **11.5**

DEPTH (FT)	SAMPLE NUMBER/ INTERVAL	INCHES DRIVEN/ RECOVERED	SPT "N" VALUE	U.S.C.S.	LITHOLOGY	SOIL DESCRIPTION	REMARKS AND OTHER TESTS
0				Gravel		**Gravel:** Crushed Gravel	
	1		Grab	SM		**SM:** Brown silty fine to coarse sand with fine gravel, medium dense, moist	
5	2	16/18	59	SM		**SM:** Grades reddish brown, coarser gravel	Wet
	3	3/18	50-1	SP-SM		**SP-SM:** Gray, silty fine to medium sand with fine to medium gravel, trace silt, dense, moist	
10	4	4/18	50-4				Boring completed on 4/5/24 at 11.5 feet. Water encountered at 7 feet during drilling (perched). No caving.
15							

INSIGHT GEOLOGIC, INC.

Drilling Contractor: **Boretec, Inc.**
Drill Equipment: **EC - 95 Track Drill**
Logged By: **W. Halbert**
Driller: **Joseph**
Drill Method: **Hollow-stem Auger**

Figure A-4

ATTACHMENT B
LABORATORY ANALYSES RESULTS

Gradation Analysis Summary Data

Job Name: Eldon Water Line
Job Number: 1171-002-02
Date Tested: 4/21/24
Tested By: Halbert

Sample Location: B-1
Sample Name: B-1-10
Depth: 10 Feet

Moisture Content (%) 3.9%

Sieve Size	Percent Passing
3.0 in. (75.0)	100.0
1.5 in. (37.5)	100.0
3/4 in. (19.0)	84.7
3/8 in. (9.5-mm)	66.6
No. 4 (4.75-mm)	50.2
No. 10 (2.00-mm)	37.2
No. 20 (.850-mm)	27.9
No. 40 (.425-mm)	21.1
No. 60 (.250-mm)	16.7
No. 100 (.150-mm)	14.0
No. 200 (.075-mm)	11.4

Size Fraction	Percent by Weight
Coarse Gravel	15.3
Fine Gravel	34.5
Coarse Sand	13.0
Medium Sand	16.0
Fine Sand	9.7
Fines	11.4
Total	**100.0**

LL	- -
PL	- -
PI	- -
D_{10}	0.1
D_{30}	1.0
D_{60}	7.0
D_{90}	15.0
Cc	2.9
Cu	140.0

ASTM Classification
Group Name: **Well graded sand with silt and gravel**
Symbol: **SW-SM**

INSIGHT GEOLOGIC, INC.

Gradation Analysis Summary Data

Job Name: Eldon Water Line
Job Number: 1171-002-02
Date Tested: 4/21/24
Tested By: Halbert

Sample Location: B-2
Sample Name: B-2-2.5
Depth: 2.5 Feet

Moisture Content (%) 21.7%

Sieve Size	Percent Passing
3.0 in. (75.0)	100.0
1.5 in. (37.5)	100.0
3/4 in. (19.0)	100.0
3/8 in. (9.5-mm)	81.7
No. 4 (4.75-mm)	68.6
No. 10 (2.00-mm)	55.0
No. 20 (.850-mm)	43.4
No. 40 (.425-mm)	34.6
No. 60 (.250-mm)	27.8
No. 100 (.150-mm)	21.7
No. 200 (.075-mm)	14.0

Size Fraction	Percent by Weight
Coarse Gravel	0.0
Fine Gravel	31.4
Coarse Sand	13.6
Medium Sand	20.4
Fine Sand	20.6
Fines	14.0
Total	**100.0**

LL - -
PL - -
PI - -

D_{10} 0.4
D_{30} 1.0
D_{60} 7.0
D_{90} 25.0

Cc 0.4
Cu 17.5

ASTM Classification
Group Name: **Silty sand with gravel**
Symbol: **SM**

INSIGHT GEOLOGIC, INC.

Gradation Analysis Summary Data

Job Name: Eldon Water Line
Job Number: 1171-002-02
Date Tested: 4/21/24
Tested By: Halbert

Sample Location: B-2
Sample Name: B-2-5.0
Depth: 5.0 Feet

Moisture Content (%) 4.9%

Sieve Size	Percent Passing
3.0 in. (75.0)	100.0
1.5 in. (37.5)	100.0
3/4 in. (19.0)	88.3
3/8 in. (9.5-mm)	67.6
No. 4 (4.75-mm)	50.7
No. 10 (2.00-mm)	36.8
No. 20 (.850-mm)	27.3
No. 40 (.425-mm)	20.9
No. 60 (.250-mm)	14.1
No. 100 (.150-mm)	8.7
No. 200 (.075-mm)	4.8

Size Fraction	Percent by Weight
Coarse Gravel	11.7
Fine Gravel	37.6
Coarse Sand	13.9
Medium Sand	15.9
Fine Sand	16.1
Fines	4.8
Total	**100.0**

LL	- -
PL	- -
PI	- -
D_{10}	0.2
D_{30}	1.0
D_{60}	7.0
D_{90}	15.0
Cc	0.7
Cu	35.0

ASTM Classification
Group Name: **Poorly graded gravel with sand**
Symbol: **GP**

INSIGHT GEOLOGIC, INC.

Gradation Analysis Summary Data

Job Name: Eldon Water Line
Job Number: 1171-002-02
Date Tested: 4/21/24
Tested By: Halbert

Sample Location: B-3
Sample Name: B-3-2.5
Depth: 2.5 Feet

Moisture Content (%) 8.1%

Sieve Size	Percent Passing
3.0 in. (75.0)	100.0
1.5 in. (37.5)	100.0
3/4 in. (19.0)	95.6
3/8 in. (9.5-mm)	81.4
No. 4 (4.75-mm)	66.3
No. 10 (2.00-mm)	42.0
No. 20 (.850-mm)	26.7
No. 40 (.425-mm)	19.7
No. 60 (.250-mm)	15.4
No. 100 (.150-mm)	12.2
No. 200 (.075-mm)	9.5

Size Fraction	Percent by Weight
Coarse Gravel	4.4
Fine Gravel	29.3
Coarse Sand	24.3
Medium Sand	22.2
Fine Sand	10.2
Fines	9.5
Total	**100.0**

LL	- -
PL	- -
PI	- -
D_{10}	0.1
D_{30}	1.0
D_{60}	2.0
D_{90}	15.0
Cc	6.3
Cu	25.0

ASTM Classification
Group Name: **Poorly graded sand with silt and gravel**
Symbol: **SP-SM**

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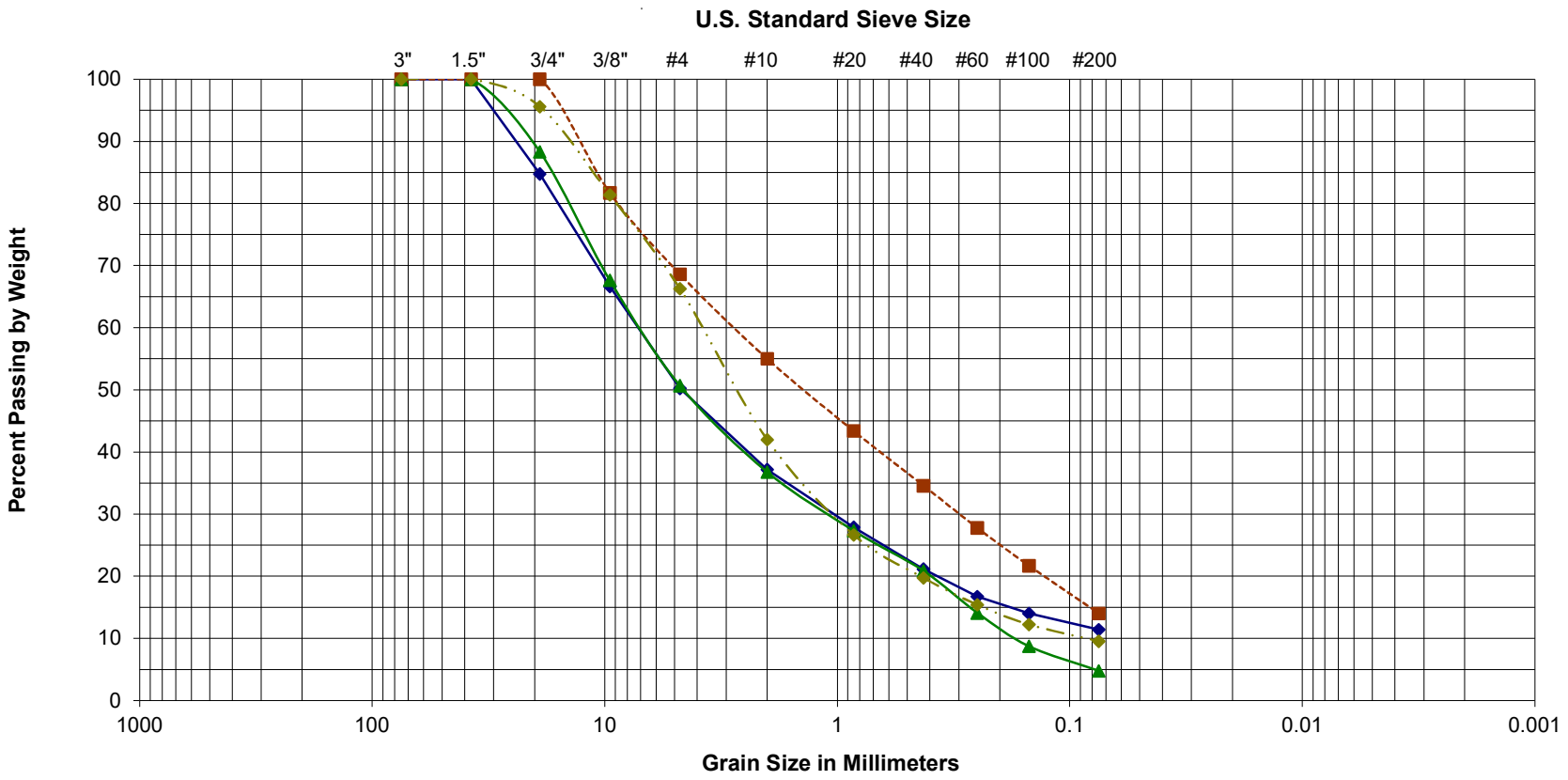

COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	

Eldon Water System

Eldon, WASHINGTON

INSIGHT GEOLOGIC, INC.

Graph 1
Gradation Analysis Results

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