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Geotechnical Engineering Report
Mukilteo Elementary School
2600 Mukilteo Speedway
Mukilteo, WA 98275

Prepared For:

Mukilteo School District
Capital Projects Department
9401 Sharon Drive
Everett, WA 98204

Attn: Mr. Phillip LaFranchi
Construction Project Manager

GEOTEST
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June 23, 2023
Project No. 23-0066

Mukilteo School District
Capital Projects Department
9401 Sharon Drive
Everett, WA 98204

Attention: **Mr. Phillip LaFranchi**
Construction Project Manager

Regarding: **Geotechnical Engineering Report**
Mukilteo Elementary School
2600 Mukilteo Speedway
Mukilteo, WA 98275
(Parcel Nos. 28040900104200, 28040900102200, 00591100000102)

Dear Mr. LaFranchi,

GeoTest Services, Inc. [GeoTest] is pleased to submit the following report summarizing the results of our geotechnical engineering evaluation for the proposed improvements to Mukilteo Elementary School in Mukilteo, WA (see *Vicinity Map*, Figure 1). This report has been prepared in general accordance with the terms and conditions established in our services agreement dated May 8, 2023 and authorized by yourself.

GeoTest appreciates the opportunity to provide geotechnical services on this project and looks forward to assisting you during the construction phase. Should you have any further questions regarding the information contained within the report, or if we may be of service in other regards, please contact the undersigned.

Respectfully,
GeoTest Services, Inc.

EDWARDO A. GARCIA
STATE OF WASHINGTON
40819
REGISTERED
PROFESSIONAL ENGINEER
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Enclosure: Geotechnical Engineering Report

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PURPOSE AND SCOPE OF SERVICES

The purpose of this evaluation is to establish general subsurface conditions beneath the site from which recommendations pertaining to project design can be formulated. Our scope of services includes the following tasks:

- Explore soil and groundwater conditions underlying the site by advancing seven test pit explorations and 13 soil borings at predetermined locations using a track-mounted excavator and track-mounted drill rig equipped with a hollow stem auger subcontracted by GeoTest.

- Perform laboratory testing on representative samples to classify and evaluate the engineering characteristics of the soils encountered.

- Provide an assessment of the on-site infiltration capability based on USDA textural classification based on the *Stormwater Management Manual of Western Washington [Manual].* The Manual is the adopted stormwater management manual per Mukilteo Municipal Code 13.12.040.

- Provide a written report containing a description of subsurface conditions and exploration logs. The findings and recommendations in this report pertain to site preparation and earthwork, fill and compaction, seismic design, foundation recommendations, concrete slab-on-grade construction, foundation and site drainage, temporary and permanent slopes, geotechnical consultation, and construction monitoring.

- Assessment of Geologically Hazardous Areas (if present) per the City of Mukilteo Municipal Code (MMC).

PROJECT DESCRIPTION

GeoTest understands that improvements are planned at the existing Mukilteo Elementary School facility in Mukilteo, WA. The facility currently consists of three main buildings, six portable buildings, parking and bus drop off areas, and associated play fields, sport courts, and hard scape surfaces. A preliminary development plan shows the construction of one new building that will be oriented in an east-west direction. GeoTest understands that the design team is still evaluating various site development options, some of which will depend on the subsurface soil explorations performed for this report.

GeoTest generally anticipates that the existing school buildings will be demolished and replaced with a new and improved elementary school facility. GeoTest expects one- or two-story buildings that will utilize shallow conventional foundations with slab-on-grade floors. GeoTest is anticipating a brick or masonry exterior and metal frame construction consistent with similar educational facilities in the area, although GeoTest acknowledges that other materials may be specified by the Architect during the design process.

GeoTest is not aware of any specific stormwater plan for the property, but it is expected that elements of Low Impact Development (LID) paired with detention and/or a stormwater vault are likely to be utilized to address stormwater concerns.

SITE CONDITIONS

This section includes a description of the general surface and subsurface conditions observed at the project site during the time of our field investigation. Interpretations of site conditions are based on a review of available information, site reconnaissance, subsurface explorations, laboratory testing, and previous experience in the project vicinity.

Surface Conditions

The project area currently contains an active elementary school and is relatively flat within the previously developed area. The school is adjacent to a residential neighborhood with single-family housing to the north, east, and west of the property. Olympic View Middle School facilities border the south end of the property. The eastern portion of the project area contains dirt soccer and baseball/softball fields. North of the existing buildings are some impervious basketball courts and a playground. A parking lot and bus loop are located along the southwest end of the existing structures. An outdoor natural learning area is in the northwest corner of the parcel. Many of the areas throughout the school consist of impervious pavement, asphalt, or concrete.

Images 1 and 2: Playground and basketball hardscape in the northern portion of property, facing west (Image 1). Dirt soccer field east of the main school buildings, facing southeast (Image 2). Images 1 through 6 taken on February 22, 2023.

The soccer and baseball/softball fields to the east are higher in elevation than the majority of the rest of the project area. A retaining wall approximately 6 feet tall separates the elevated play fields and the eastern classrooms. The parking lot and bus loop area slopes gently to the southwest. The northwest corner of the property consists of a drainage gulch which is also referred to as the "natural learning area" by school staff. This area is mostly vegetated with deciduous trees, foliage, and a few old growth trees. Slopes adjacent to the school property in proximity to the gulch are west and northwest facing, and are approximately 20 feet tall. Within the lowest portion of the gulch, GeoTest observed a 12-inch-thick cast in place dam that is upwards of 5 feet tall. This dam is currenting retaining water on its south side and is approximately 50 feet across the basin in the southwest direction before elbowing to the south for another 12 or so feet.

Image 3 and 4: Administration/gymnasium building and some portable buildings north of the parking lot in the southern portion of the project area, facing north (Image 3). A concrete dam in the natural learning area (Image 4).

Subsurface Soil Conditions

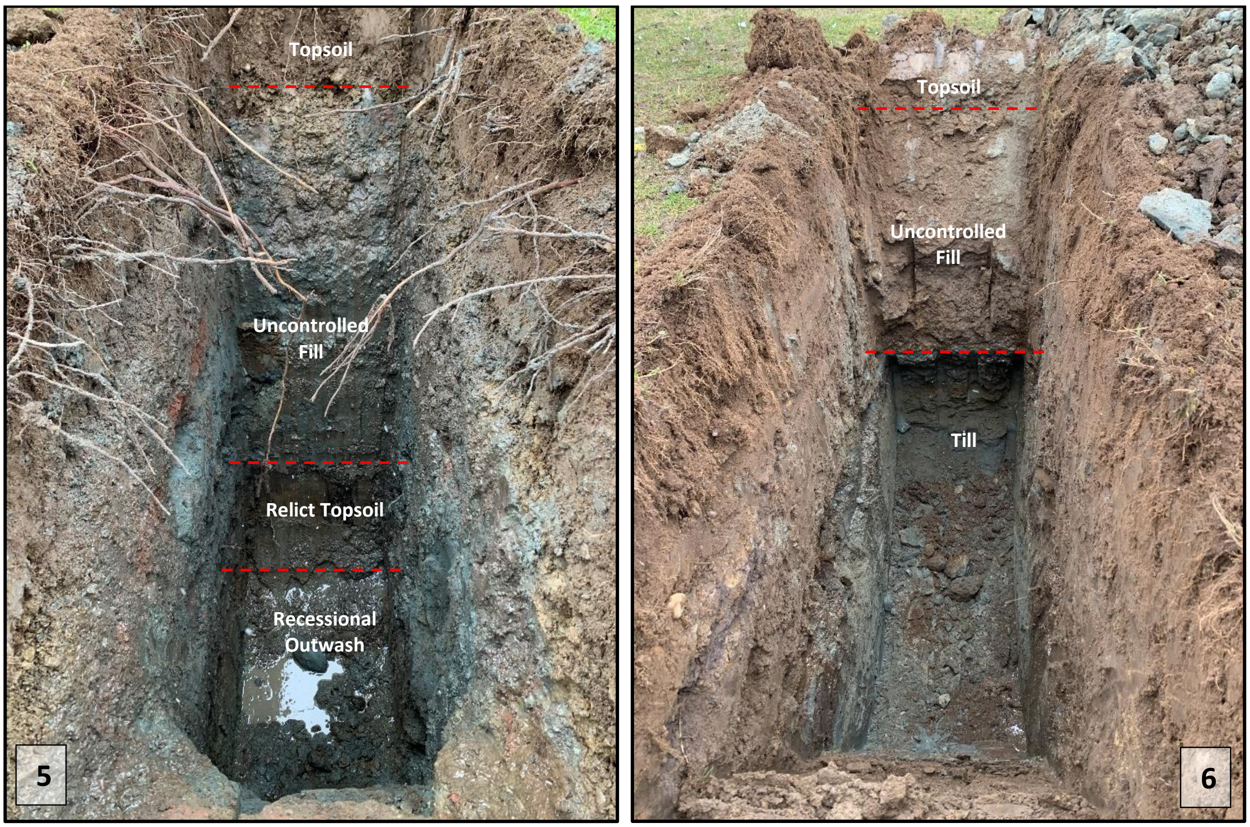
Test Pit Explorations

Subsurface conditions were explored and documented by advancing seven test pits (TP-1 through TP-7) on February 22, 2023, under the direction of a Licensed GeoTest Geologist. Soils were classified in general accordance with the guidelines of the American Society for Testing and Materials (ASTM) D2487 and D2488. Approximate locations of these explorations have been plotted on the *Site and Exploration Plan* (Figures 2A and 2B). A *Soil Classification System and Key* can be found as Figure 7, detailed test pit logs are presented as Figures 8 through 11, with laboratory results as Figures 25 through 28.

Test pit explorations consisted of the excavation of shallow open pits with the use of a rubber tracked mini excavator and operator subcontracted to GeoTest. Grab samples were obtained at approximately 2-foot intervals or upon changes in soil stratigraphy. Depths of the test pit explorations ranged to depths of approximately 8 to 9 feet below the ground surface (BGS).

It should also be noted that a total of eight exploration locations were requested by the project team, but only seven were advanced due to the concentration of underground utilities present within the remaining test pit location. This test pit was located near the northwest corner of the existing school, near the base of a retaining wall.

The on-site subsurface soils in all seven test pits consisted of approximately 3 to 12 inches of topsoil, which was loose, brown, moist, gravelly, silty sand with numerous organics (grass, roots, wood, etc.). Underlying the topsoil was varying thicknesses of uncontrolled fill. The uncontrolled fill ranged from 1.5 to 8 feet thick, with thicker sections of uncontrolled fill generally being in the western portion of the project area. Uncontrolled fill consisted of variable amounts of loose to medium stiff, orange-brown to black, moist, gravelly, silty sands to sandy silts. The uncontrolled fills also contained various amounts of construction debris and large amounts of organics (logs, wood, roots, etc.) in localized areas. At the TP-1 exploration, GeoTest observed what appeared to be relict topsoil consisting of medium dense, brown, moist, slightly gravelly, silty sand with roots, grass, and wood. This relict topsoil was observed from approximately 5.5 to 7 feet BGS.



Images 5 and 6: General soil sequence observed in the test pits explorations where uncontrolled fill sections were generally thicker and contained abundant organics (TP-1 – Image 5). Soil sequence where uncontrolled fill was thinner and native Till was observed in the northern portion of the site (TP-4 – Image 6).

Beneath the uncontrolled fill (when observed) and at depths ranging from 7 to 8 feet BGS with test pits TP-1 to TP-3 was medium dense, gray to brown, moist, gravelly, silty sand with occasional organics, which GeoTest is interpreting to be native Recessional Outwash Sands. Native Till was encountered beneath the uncontrolled fill and/or Recessional Outwash at depths ranging from 5 to 8 feet BGS at test pit locations TP-4 to TP-7. Recessional Outwash was observed overlying the native Till from 3 to 8 feet BGS within test pit TP-6.

The Till was comprised of hard or very dense, gray to brown, moist, gravelly, sandy silt to silty sand with trace cobbles and boulders. As previously mentioned, uncontrolled fill sections were generally thicker to the west. Uncontrolled fill was directly underlain by Recessional Outwash deposits or Till deposits. The very dense, Till soils were encountered to the maximum explored depths of test pit explorations TP-4 to TP-7.

Soil Boring Explorations

Subsurface conditions were also explored by advancing 13 hollow stem auger (HSA) soil borings (B-1 to B-13) on June 3, 2023. Our soil borings were advanced to depths ranging between 7.5 and 25.5 feet below ground surface (BGS), using 4-inch diameter hollow-stem augers, and two soil drills on track-mounted assemblies operated by Geologic Drill. Samples were generally taken at 2.5-foot intervals in the upper 10 feet and transitioned to 5-foot intervals until the terminal depth. Two Geologists directed and observed drilling operations and logged the soils encountered. Soils were classified in general accordance with the guidelines of the American Society for Testing and Materials (ASTM) D2487 and D2488. Upon completion, all the boring locations (B-1 to B-13) were backfilled with bentonite and soil tailings to match pre-existing surface conditions.

Geologic Drill installed two monitoring wells (B-1 and B-10) for wet season monitoring (if needed) in the winter of 2023-2024. These shallow monitoring wells were installed at two locations in the southwestern and northeastern portion of the project area on June 3, 2023. Monitoring wells were installed within the HSA following the completion of the borings at locations B-1 and B-10. The wells were installed to the approximate depth of 25 and 10 feet BGS, respectively. Each well consisted of a 1-inch diameter plastic threaded PVC pipe with the bottom section consisting of a slotted screen. Slotted screen was installed from approximately 25 to 15, and 10 to 5 feet BGS, respectively. The lower portion of the well was then backfilled with silica sand to a depth of approximately 12 and 4 feet BGS, respectively. The upper portion of the wells were backfilled with bentonite chips and some on-site soils.

The approximate locations of the explorations have been plotted on the *Site and Exploration Plan* (Figures 2A and 2B). A *Soil Classification System and Key* can be found as Figure 7, Boring Logs as Figures 12 through 24 *Boring Logs,* and laboratory results as Figures 25 through 28.

Disturbed but representative samples were obtained during drilling by using the Standard Penetration Test (SPT) procedure in accordance with American Society for Testing and Materials (ASTM) D1586 during the explorations. This test and sampling method consists of driving a standard 2-inch outside-diameter, split-barrel sampler a distance of 18 inches into the soil with a 140-pound drop hammer free-falling a height of 30 inches. The number of blows for each 6-inch interval is recorded and the number of blows required to drive the sampler the final 12 inches is known as the Standard Penetration Resistance (“N”) or blow count. If a total of 50 blows is recorded within one 6-inch interval, the blow count is recorded as the number of blows for the corresponding number of inches of penetration. The resistance, or N-value, provides a measure of the relative density of granular soils or the relative consistency of cohesive soils; these values are reported on the attached boring logs.

The on-site subsurface soils consisted of approximately 0.5-foot of loose topsoil in locations not covered by asphalt or gravel (B-1), asphalt thickness was approximately 0.5-foot thick as well. Generally, there was approximately 1 to 10 feet of loose to medium dense, black to brown, moist, slightly gravelly, silty sands to sandy silts with varying percentages of organics (wood, roots, etc.) that was interpreted to be uncontrolled fill. It should be noted that there was approximately 14 feet of fill at the B-5 location, but is thought to be an outlier due to its close proximity to the “natural learning area” slope. Stated differently, it’s likely that thicker sections of fill were pushed out in this area, near the top-of-slope condition, to make a flat area during original construction.

Image 7: Soil sample at a depth of 5 feet BGS at boring location B-11 showing perched water in a more permeable sand lens overlying the less permeable weathered Till.

Underlying the uncontrolled fill (when observed) were 2 to 5 feet of weathered Glacial Till consisting of medium dense to dense, orange-gray, gravelly, very silty sand with orange oxidations staining and occasional mottling. Underlying the Weathered Glacial Till and uncontrolled fill, GeoTest observed dense to very dense and/or hard, gray, slightly gravelly to gravelly, very silts sands to very sandy silts with occasional seams and/or layers of sand, that was interpreted to be Glacial Till.

Refer to Table 1 below for a summary of depths to native soils underlying existing fill observed on site for all explorations.

Table 1. Subsurface Soil Depths and Elevations

Test Pit Exploration ID	Surface Elevation* (ft)	Depth to Recessional Outwash		Depth to Till	
		Depth BGS (ft)	Approximate Elevation (ft)	Depth BGS (ft)	Approximate Elevation (ft)
TP-1	404	7	397	Unknown	
TP-2	396	7	389	Unknown	
TP-3	404	8	396	Unknown	
TP-4	407	N/A	N/A	5	402
TP-5	411	N/A	N/A	7.5	403.5
TP-6	405	3	402	8	397
TP-7	398	N/A	N/A	2	396
B-1	394	N/A	N/A	7	387
B-2	400	N/A	N/A	7	393
B-3	405	N/A	N/A	6.5	398.5
B-4	403	N/A	N/A	7.5	395.5
B-5	402	N/A	N/A	14	388
B-6	402	N/A	N/A	10	392
B-7	399	N/A	N/A	5.5	393.5
B-8	404	N/A	N/A	5	399
B-9	411	N/A	N/A	1	410
B-10	411	N/A	N/A	7.5	403.5
B-11	405	N/A	N/A	5	400
B-12	412	N/A	N/A	11	401
B-13	412	N/A	N/A	8.5	403.5

Notes:
All locations, depths, and elevations are approximate. Surface elevation data is derived from a land survey data available on the Snohomish County *PDS Map Portal*.

General Geologic Conditions

Geologic information for the project site was obtained from the *Distribution and description of geologic units in the Mukilteo quadrangle, Washington* (Minard, J.P., 1982) and from the *Geologic Information Portal*. According to these publications, geology within the vicinity of the project site consists of Recessional Outwash (map unit Qvr) and Till (map unit Qvt) originating from Pleistocene glacial periods.

Recessional Outwash generally consists of well-drained, stratified outwash sand and gravel that was deposited by glaciofluvial processes originating from the stagnating and receding Vashon glacier. Prior to recessional deposition, glaciers advanced south to the vicinity of the project area and the depositional environment transitioned to a subglacial one. Here, the height, weight, and horizontal velocity of the advancing and receding glaciers created a grinding-like, geologic, depositional environment, in which Till is created. These soils generally consist of glacially consolidated clays, silts, sands, and gravels, in which are non-sorted, matrix supported, and rest unconformably on older geologic units. Till can also typically be described as a concrete-like mixture of sediment that is very dense or hard due to very large glaciers overriding and densifying these soils during glacial advance and retreat. The contact between the Recessional Outwash and Till in the project area is difficult to map due to the varying amounts of fill that was brought in during the construction of the elementary school.

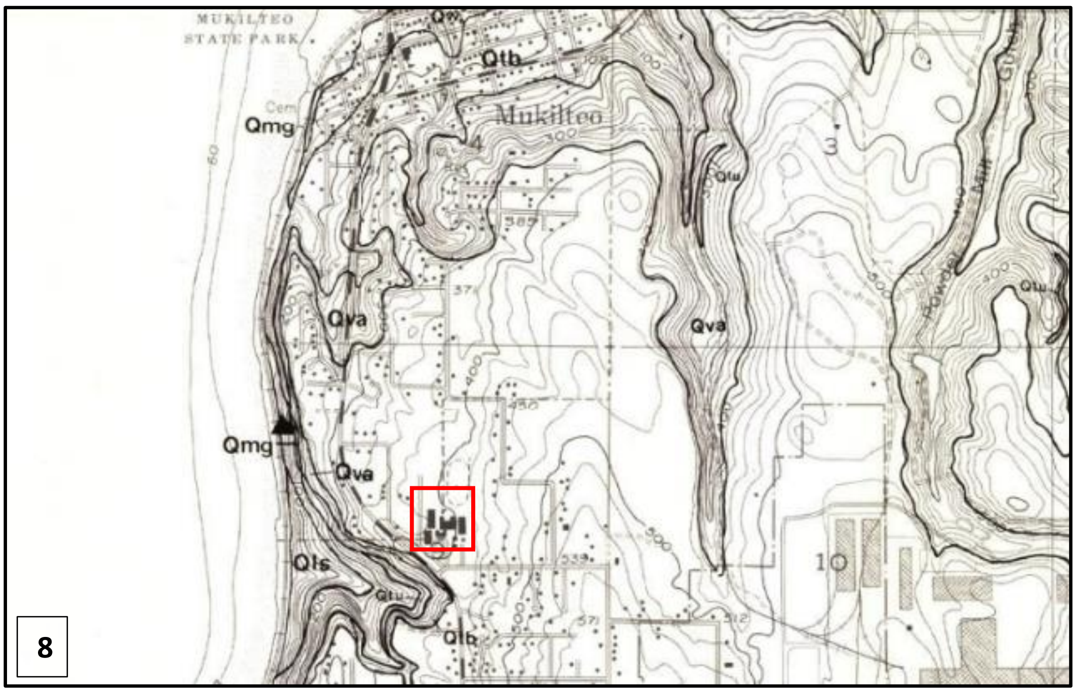


Image 8. Clip from the *Distribution and description of geologic units in the Mukilteo quadrangle, Washington* (Minard, J.P., 1982) illustrating that the subject property is underlain by mapped Till, and the close proximity of the mapped “Recessional Outwash”. Approximate site vicinity encapsulated by the red polygon.

Groundwater

At the time of our site visit on February 22, 2023, perched groundwater seepage was encountered in exploration test pit TP-1, TP-4 and TP-7 between 1 and 3 feet BGS. During our site visit on June 3, 2023, perched groundwater seepage was encountered in borings B-1, B-5, B-6, B-7, B-11, B-12, and B-13 between 2.5 and 20 feet BGS.

Perched groundwater seepage should be anticipated during the wet season or after long periods of precipitation, atop soils with lower permeability, such as Till and uncontrolled fill consisting of a high percentage of fines.

Perched groundwater conditions can occur and should be anticipated in these soil types. Perched groundwater occurs above the regional groundwater table in the unsaturated zone and typically occurs when loose, more permeable soil is underlain by harder, less permeable soil. The vertical movement of water through looser soils is restricted once a hard or less permeable soil is encountered. Perched groundwater conditions typically develop in the wet season or after extended periods of rainfall.

The groundwater conditions reported on the exploration logs are for the specific locations and dates indicated, and therefore may not be indicative of other locations and/or times. Groundwater and seepage levels are variable and groundwater conditions will fluctuate depending on local subsurface conditions, precipitation, and changes in on-site and off-site use. Seasonal groundwater monitoring is not currently part of our scope of services.

Web Soil Survey

According to the United States Department of Agriculture (USDA) Natural Resource Conservation Service (NRCS) *Web Soil Survey* website, two primary soils are present within the vicinity of the subject property.

Table 2
USDA NRCS Soil Classifications

Map Unit Symbol	18	6
Map Unit Name	Everett very gravelly sand loam, 8 to 15 percent slopes	Alderwood-urban land complex, 8 to 15 percent slopes
Soil Description	Very gravelly sand loam to extremely cobbly coarse sand	Gravelly ashy sandy loam to gravelly sandy loam
Landform	Moraines, eskers, kames	Till plains
Parent Material	Sandy and gravelly glacial outwash	Basal till
Land Capability Classification	4s	4s
Erosion K Factor, Whole Soil	.10	0.20

These soils are classified as Alderwood-urban land complex, 8 to 15 percent slopes and Everett very gravelly sandy loam, 8 to 15 percent slopes. See Table 2 for a summary of the USDA *Web Soil Survey* classification information. Values of K range from 0.02 to 0.69; the higher the value, the more susceptible the soil is to sheet and rill erosion by water. It is interpreted that the site has a **low to moderate** erosion factor based on the findings in Table 2.

Bare Earth Imagery Review

GeoTest reviewed bare earth imagery of the site vicinity, subject property, and slopes in the northwest corner of the school property, which is also referred to as the "natural learning area." Based on a review of this imagery (refer to the *Bare Earth Site Plans*, Figures 3 – 4), there does not appear to be visible indications of tension cracks or large-scale head scarps associated with slope stability. Outside of the general topographic profile of the slope, no apparent signs of large-scale "global" instability on the subject property were observed in our bare earth imagery review.

The digital elevation data used for analysis was acquired from the *Washington Lidar Portal.* Please note that not all signs of slope instability can be observed in the bare earth imagery review due to imagery resolution and scale. In addition, any signs of instability on the site slopes that have occurred since 2017, if present, have occurred after original bare earth imagery acquisition.

GEOLOGIC HAZARD ASSESSMENT

Based on City of Mukilteo Municipal Code (MMC) 17B.52A.020, *Geologic Hazard Areas* are referred to as *Geologic Sensitive Areas* and are defined as "areas susceptible to erosion, landslide, seismically induced soil failure, or other geological events and conditions."

The following sections provide a discussion of the "Geologic Sensitive Areas." After careful review of publicly available geologic literature pertaining to the area, it should be noted that geologic hazards associated with "other geologic events" such as volcanic, tsunami events, etc., were not found to be applicable to this project due to the location of the proposed development.

Erosion Hazard Areas

Erosion Hazard Areas are defined by MMC 17.08 as follows: *"Erosion hazard areas" means at least those areas identified by the U.S. Department of Agriculture National Resources Conservation Service as having a "severe" rill and inter-rill erosion hazard.*

Based on the above MMC criteria, it is GeoTest's interpretation that **no Erosion Hazard Areas exist on site**. Due to the generally low gradient of topography, vegetated areas are relatively flat, and preexisting buildings and facilities, the erosion potential for the site is estimated to be relatively low. Similarly, the *Web Soil Survey* indicates the on-site soils have a "low to moderate" erosion susceptibility. While it is true that Till soils are glacially consolidated, considered to be low permeability soils, and can result in erosion when paired with slopes, the risk of erosion on this project site is greatly diminished due to the lack of slopes that exist. GeoTest recommends that typical mitigations and housekeeping items are implemented to prevent excessive erosion from occurring during construction.

Erosion Mitigation

GeoTest recommends that the following be implemented to prevent and mitigate excessive erosion from occurring during clearing and grading for the proposed development:

- All clearing and grading activities for future vegetation management will need to incorporate Best Management Practices (BMPs) for erosion control in compliance with current MMC codes and standards.
- GeoTest recommends that appropriate silt fencing be incorporated into the vegetation management plan for erosion control.
- GeoTest recommends that on-site BMPs be implemented during vegetation management operations and practices. Areas of native vegetation left in place could also be enhanced by adding additional native plant species and/or other vegetation enhancements.
- Removal of vegetation and trees without proper mitigation may increase the risk of failure for the surficial soils during periods of wet weather. Planting additional brush and vegetation within the subject site and in areas disturbed by excavation activities will help maintain near-surface slope stability by providing a stable root base within the near-surface soils.
- Yard waste should not be dumped onto the top or face of existing or developed site slopes. Yard waste can retain water and cause slope instability.
- Proper drainage controls have a significant effect on erosion. All surface water and any collected drainage water should not be allowed to be concentrated and discharged down the face of an existing steep slope. All collected stormwater should be directed to an appropriate collection system during vegetation management.
- All areas disturbed by vegetation management operations should be protected to limit the potential for erosion as soon as practical during and after manipulation. Areas requiring immediate protection from the effects of erosion should be covered with either plastic, mulch, or erosion control netting/blankets. Areas requiring permanent stabilization should be seeded with an approved grass seed mixture, hydroseeded with an approved seed-mulch-fertilizer mixture or landscaped with a suitable planting design.

In addition to the preceding recommendations, typical erosion control measures during vegetation management will be required. These measures can include high visibility fencing, downslope silt fencing, and a proper site entrance, depending on city regulations. No other mitigations are required to address erosion hazards on the property.

Landslide Hazard Areas

Landslide Hazard Areas are defined by MMC 17.08 as follows: *areas that are potentially subject to risk of mass movement due to a combination of geologic, topographic, and hydrologic factors.*

These areas are typically susceptible to landslides because of a combination of factors including: bedrock, soil, slope gradient, slope aspect, geologic structure, ground water, or other factors.

Similarly, per MMC 17.08, "Steep slopes" are naturally occurring slopes that rise ten feet or more for every twenty-five feet horizontal (i.e., forty percent or greater, also represented as a twenty-two-degree angle). A slope is delineated by establishing the toe (bottom) of the slope and the top of the slope, the horizontal and vertical difference between the toe and top can allow the calculation of the slope percent. Existing slopes modified with engineering oversight or in accordance with standard construction industry techniques are not considered steep slopes.

Per the *City of Mukilteo Geological Sensitive Areas Map,* the proposed development falls outside of the *Landslide Hazard* designation area. Similarly, the *City of Mukilteo Geologically Sensitive Areas Map* does not show any steep slopes on the property outside of the retaining wall along the western edge of the neighboring schools play fields. After reviewing the Client-provided proposed development plan, and performing our onsite investigations, it appears that there is a steep slope in the northwest corner of the property in the "natural learning area." The slope appears to be approximately 20 feet tall with a slope between 20 and 30 percent. Based on our research, it appears that **there are no Landslide Hazard Areas within or 200 feet from the proposed development area.** As such, MMC does not require any specific mitigations to address landslide hazard areas for this project. However, GeoTest recommends providing at least a 20-foot setback from the top of the slope in the northwest quadrant of the property for any building footprints, and at least a 7-foot setback from the top of the slope for any fire lanes, parking areas, or auxiliary driving paths.

Seismic Hazard Areas

Seismic Hazard Areas are typically defined as areas that, due to a combination of soil and groundwater conditions, are subject to severe risk of ground shaking, subsidence, or liquefaction of soils during earthquakes. These areas are typically underlain by soft or loose saturated soils (such as alluvium), have a shallow groundwater table, and are typically located on the floors of river valleys.

Seismic Hazard Areas are defined by MMC 17.08 as follows: *areas subject to risk of damage as a result of earthquake induced ground shaking, slope failure, settlement, soil liquefaction, lateral spreading, or surface faulting.*

According to both the *Geologic Information Portal* and the *PDS Map Portal*, the subject property is mapped as having a "very low" potential for seismic liquefaction. According to the *Geologic Information Portal* and USGS, the nearest active fault trenches and mapped folds are located approximately 2 miles southwest of the project location as part of the Southern Whidbey Island Fault Zone. This fault zone runs northwest-southeast from Whidbey Island down through the City of Mukilteo. Based on the existing site conditions, proposed construction, and our understanding of the local geology, it is GeoTest's opinion that **the subject property is not a Seismic Hazard.**

Outside of compliance with current building codes, GeoTest does not recommend specific mitigations for the planned construction to address potential seismic hazards.

Please keep in mind that the Pacific Northwest is seismically active. Large Cascadia subduction zone earthquakes with possible magnitudes of 8 or 9 could produce ground shaking events with the potential to significantly impact the subject property regardless of the topography or subsurface conditions. Cascadia subduction zone earthquakes have occurred 6 times in the last 3,500 years with the most recent taking place in 1700, approximately 322 years ago. They have been determined to have an average recurrence interval of approximately 300 to 700 years (Atwater and Haley, 1997).

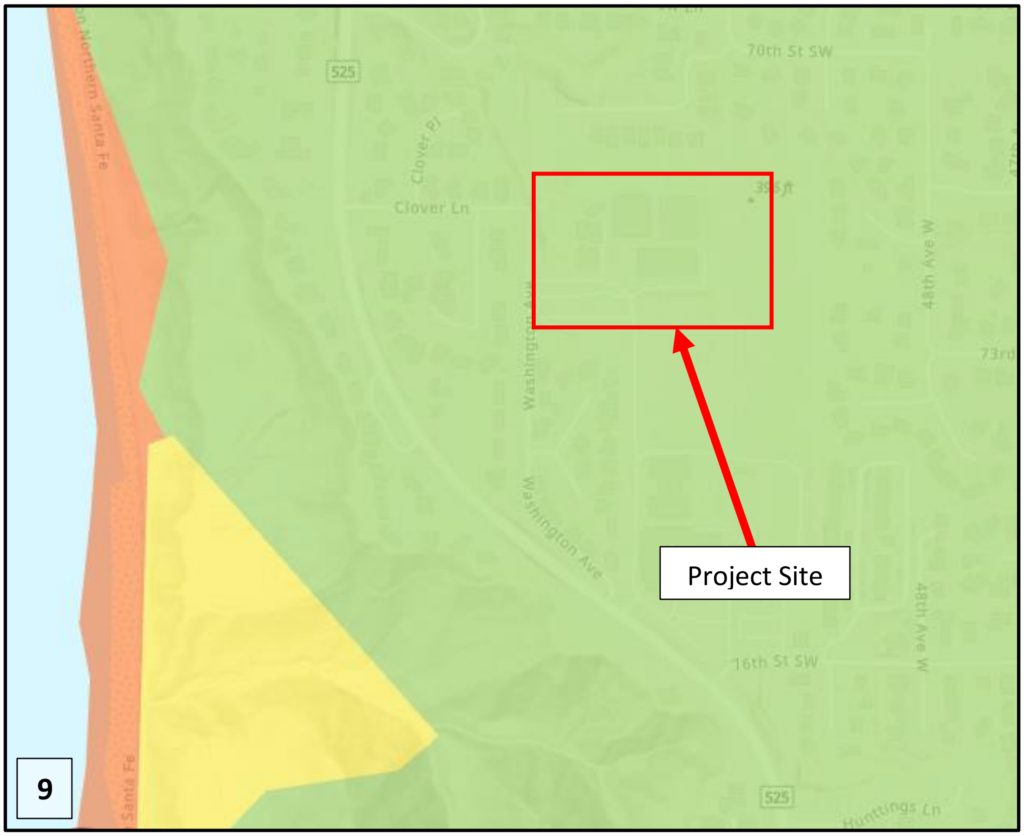


Image 9. Screenshot from the *DNR Geologic Information Portal*, in which the entire project site is considered to possess a “very low” liquefaction susceptibly (shown in green).

CONCLUSIONS AND RECOMMENDATIONS

Based on the evaluation of the data collected during this investigation, it is our opinion that the subsurface conditions at the site are suitable for the proposed development, provided the recommendations contained herein are incorporated into the project design.

Existing fill, organics, and loose/unsuitable portions of native soil (if remedial compaction is infeasible) should be removed and replaced with suitable Structural Fill. Overlying the

Recessional Outwash and Till soils across much of the site is 1 to 14 feet of uncontrolled fill, with the thicker sections observed in the western portions of the project area. These fill soils are not suitable for shallow conventional foundation support as a result of the high percentages of debris and organics. Though as previously mentioned, the approximately 14 feet of fill observed at the B-5 location is thought to be an outlier due to the close proximity to the slope near the "natural learning area." In general, the fill thickness appeared to be approximately 3 to 8 feet thick (as noted in Table 1) in most locations.

As previously mentioned, the site is relatively flat and underlain by medium dense, slightly gravelly, silty sand typical of Recessional Outwash, as well as, medium dense to very dense, gravelly, silty sands to sandy silts typical of Till deposits. The Recessional Outwash were generally observed within 3 to 8 feet of existing site grades in the western and southeastern portions on the site (TP-1 to TP-3, and TP-6). The native Till deposits were generally observed within 1 to 14 feet of existing site grades (TP-4 to TP-7 and B-1 to B-13). Both soil types are suitable for shallow conventional foundation support when recompacted to a firm and unyielding condition. It should be noted Recessional Outwash was observed overlying the Till deposits within test pit exploration TP-6.

The native Recessional Outwash and Till may be suitable for reuse as Structural Fill when placed and compacted as recommended in this report. We recommend the Client plan for a typical stripping depth of 1 to 8 feet for building footprints. Some efficiencies may be achieved if building foundations are "stepped down" along the eastern, middle, and western thirds of the planned building alignment to more naturally connect with native soils. Stated differently, native soils appear to have a natural east-to-west descending gradient in the region. Stripping depths are expected to vary and could be more extensive than anticipated due to inconsistent thicknesses of uncontrolled fill. Uncontrolled fill is not recommended for reuse as Structural Fill due to the high percentage of debris and organics. For ancillary driveways and pavement structures, GeoTest recommends stripping no more than 2 feet of Uncontrolled Fill and preparing the subgrade in accordance with the *Site Preparation and Earthwork* section of this report.

Shallow restriction layers exist on the property that will make the design of infiltration systems challenging. It should also be noted that very dense glacially consolidated Till was encountered as shallow as 1-foot and as deep as 14 feet BGS in some test pits and borings at the time of our investigation. The *Stormwater Management Manual of Western Washington [Manual]* has requirements and limitations for the design of stormwater facilities when shallow restriction layers exist below a facility. Stormwater management strategies that include detention vaults may be feasible but should have a fundamental expectation that there will be shallow restriction layers present that might influence the overall design of stormwater systems. At the time of writing this report, it is our understanding that there are no conceptual stormwater facility designs put together. It should also be noted that two monitoring wells were installed for seasonal groundwater monitoring as "wet season" monitoring may be required by the City of Mukilteo in the future. A Pilot Infiltration Test (PIT) was planned to be performed during our initial site visit on February 22, 2023, however, due to shallow restriction layers and thick deposits of uncontrolled fill, GeoTest was unable to perform the PIT at the originally planned location.

A preliminary site development plan showing the building type and footprint, not including stormwater facilities was available to us at the time of writing this report, but it is not known if the development will incorporate the use of shoring or retaining walls. As a result, GeoTest attempted to get as wide of a range of subsurface data as possible to help with the planning process but was limited in some respects due to encountering utilities during our excavations. It should be expected that additional design services, possibly paired with additional field work and collaboration with the project Civil Engineer, may be needed to complete the grading, shoring, and stormwater design until finalized plans are put in place.

Site Preparation and Earthwork

The portions of the site proposed for foundation(s) and floor slab(s) should be prepared by removing existing pavements, topsoil, deleterious material, and significant accumulations of organics. Based on our explorations, GeoTest anticipates approximately 1 to 14 feet of topsoil and uncontrolled fill removal to expose native soils, depending on where development occurs. For ancillary driveways and pavement structures, GeoTest recommends stripping no more than 2 feet of uncontrolled fill.

Prior to placement of any foundation elements or Structural Fill, the exposed subgrade under all areas to be occupied by soil-supported floor slabs, foundations, ancillary driveways, or pavement structures should be recompacted to a firm and unyielding condition. Verification of compaction can be accomplished through proof rolling with a loaded dump truck, large self-propelled vibrating roller, or similar piece of equipment applicable to the size of the excavation. The purpose of this effort is to identify loose or soft soil deposits so that, if feasible, the soil disturbed during site work can be recompacted.

Proof rolling should be carefully observed by qualified geotechnical personnel. Areas exhibiting significant deflection, pumping, or over-saturation that cannot be readily compacted should be overexcavated to firm soil. Alternatively, Dynamic Cone Penetrometers or soil probing by a qualified GeoTest representative can confirm firm and unyielding conditions in localized areas if a proof roll cannot be performed. Overexcavated areas should be backfilled with compacted granular material placed in accordance with subsequent recommendations for Structural Fill. During periods of wet weather, proof rolling could damage the exposed subgrade. Under these conditions, qualified geotechnical personnel should observe subgrade conditions to determine if proof rolling is feasible.

Fill and Compaction

Structural Fill used to obtain final elevations for footings and soil-supported floor slabs must be properly placed and compacted. In most cases, suitable, non-organic, predominantly granular soil may be used for fill material provided the material is properly moisture conditioned prior to placement and compaction, and the specified degree of compaction is obtained. Material containing topsoil, wood, trash, organic material, or construction debris is not suitable for reuse as Structural Fill and should be properly disposed off-site or placed in nonstructural areas.

Soils containing more than approximately 5 percent fines are considered moisture sensitive and are difficult to compact to a firm and unyielding condition when over the optimum moisture content by more than approximately 2 percent. The optimum moisture content is that which allows the greatest dry density to be achieved at a given level of compactive effort.

Reuse of On-Site Soil – Existing Fill

Due to the high percentage of organics and debris observed in the uncontrolled fill sections GeoTest does not recommend reusing the uncontrolled fill for Structural Fill. If it is desired to use fill soils for Structural Fill, GeoTest would be able to observe the soils in question to determine if it is suitable for Structural Fill. Existing fill soils may be utilized in non-structural applications.

Reuse of On-Site Soil – Native Soil

The non-organic, native Recessional Outwash and Till may be suitable for reuse as Structural Fill when placed at or near optimum moisture contents, as determined by ASTM D1557 and if allowed for in the project plans and specifications. The Till soils found on site contain high percentage of fines and should be considered moisture sensitive. Reuse of Till may be considerably more difficult, if not impossible, to use at or near perched groundwater elevations and during the wet weather season (October 1 – April 30). Furthermore, the silty nature of the Till may limit its use if being considered close to areas where infiltration or a stormwater vault may be planned. If using on-site materials, the Contractor or Owner should be prepared to manage over-optimum moisture content soils. The moisture content of the soils may be difficult to control during periods of wet weather.

During our investigation on-site, in more than one instance, GeoTest observed oversized materials consisting of cobbles and scattered boulders within a few of the test pit excavations. It is GeoTest's opinion that there is a likelihood that cobbles and boulders will be encountered during grading and/or excavation activities. The Client and/or Owner should anticipate their presence and issues associated with them during the construction phase. Screening of oversized materials should be anticipated.

Imported Structural Fill

GeoTest recommends that imported Structural Fill consist of clean, well-graded sandy gravel, gravelly sand, or other approved naturally occurring granular material (pit run) or a well-graded crushed rock. We recommend Structural Fill for dry weather construction meet Washington State

Department of Transportation (WSDOT) Standard Specification 9-03.14(2) for “Select Borrow” with the added requirement than 100 percent pass a 4-inch-square sieve.

Soil containing more than about 5 percent fines (that portion passing the U.S. No. 200 sieve) cannot consistently be compacted to a dense, non-yielding condition when the water content is greater than optimum. Accordingly, GeoTest recommends that imported Structural Fill for wet weather construction meet WSDOT Standard Specification 9-03.14(1) for “Gravel Borrow” with the added requirement that no more that 5 percent pass the U.S. No. 200 sieve. Due to wet weather or wet site conditions, soil moisture contents could be high enough that it may be very difficult to compact even ‘clean’ imported select granular fill to a firm and unyielding condition. Soils with over-optimum moisture contents should be scarified and dried back to more suitable moisture contents during periods of dry weather or removed and replaced with fill soils at a more suitable range of moisture contents.

Based on local availability, the designer may elect to utilize Crushed Surfacing Base Course (CSBC) or Crushed Surfacing Top Course (CSTC) as Structural Fill. As such, we recommend WSDOT Standard Specification 9-03.9(3) be incorporated into the project plans.

Backfill and Compaction

Structural Fill should be placed in horizontal lifts. The Structural Fill must measure 8 to 10 inches in loose thickness and be thoroughly compacted. All Structural Fill placed under load bearing areas should be compacted to at least 95 percent of the maximum dry density, as determined using test method ASTM D1557. The top of the compacted Structural Fill should extend outside all foundations and other structural improvements a minimum distance equal to the thickness of the fill. We recommend that compaction be tested after placement of each lift in the fill pad.

Wet Weather Earthwork

The native soils on site have a significant percentage of fines content. As such, these soils may be susceptible to degradation during wet weather. If construction takes place during wet weather, GeoTest recommends that Structural Fill consist of imported, clean, well-graded sand or sand and gravel as described above. If fill is to be placed or earthwork is to be performed in wet conditions, the contractor may reduce soil disturbance by:

- Limiting the size of areas that are stripped of topsoil and left exposed
- Accomplishing earthwork in small sections
- Limiting construction traffic over unprotected soil
- Sloping excavated surfaces to promote runoff
- Limiting the size and type of construction equipment used
- Providing gravel ‘working mats’ over areas of prepared subgrade
- Removing wet surficial soil prior to commencing fill placement each day

- Sealing the exposed ground surface by rolling with a smooth drum compactor or rubber-tired roller at the end of each working day
- Providing up-gradient perimeter ditches or low earthen berms and using temporary sumps to collect runoff and prevent water from ponding and damaging exposed subgrades

Seismic Design Considerations

The Pacific Northwest is seismically active, and the site could be subject to movement from a moderate or major earthquake. Consequently, moderate levels of seismic shaking should be accounted for during the design life of the project, and the proposed structure should be designed to resist earthquake loading using appropriate design methodology.

For structures designed using the seismic design provisions of the 2018 International Building Code, the medium dense Recessional Outwash are classified as Site Class D, and the dense to very dense Till soils are classified as Site Class C according to ASCE 7-16. The structural engineer should select the appropriate design response spectrum based on Site Class C and D soils and the geographical location of the proposed construction.

Foundation Support

Continuous or isolated spread footings founded on proof-rolled, undisturbed, medium dense to very dense native soils or on properly compacted Structural Fill placed directly over undisturbed native soil can provide foundation support for the proposed improvements. We recommend that qualified geotechnical personnel confirm that suitable bearing conditions have been reached prior to placement of Structural Fill or foundation formwork.

To provide proper support, GeoTest recommends that existing topsoil, existing fill, and/or loose upper portions of the native soil be removed from beneath the building foundation area(s) or be replaced with properly compacted Structural Fill as described in the *Fill and Compaction* section of this report. Localized overexcavation, if necessary, can be backfilled to the design footing elevation with lean concrete, or foundations may be extended to bear on undisturbed native soil. In areas requiring overexcavation to competent native soil, the limits of the overexcavation should extend laterally beyond the edge of each side of the footing a distance equal to the depth of the excavation below the base of the footing. If lean concrete is used to backfill the overexcavation, the limits of the overexcavation need only extend a nominal distance beyond the width of the footing. In addition, GeoTest recommends that foundation elements for the proposed structure(s) bear entirely on similar soil conditions to help prevent differential settlement from occurring.

Continuous and isolated spread footings should be founded 18 inches, minimum, below the lowest adjacent final grade for freeze/thaw protection. The footings should be sized in accordance with the structural engineer's prescribed design criteria and seismic considerations.

Allowable Bearing Capacity

Assuming the above foundation support criteria are satisfied, continuous or isolated spread footings founded directly on medium dense, firm and unyielding native soil or on compacted Structural Fill placed directly over firm and unyielding undisturbed native soils may be proportioned using a net allowable soil bearing pressure of 2,500 pounds per square foot (psf).

The "net allowable bearing pressure" refers to the pressure that can be imposed on the soil at foundation level. This pressure includes all dead loads, live loads, the weight of the footing, and any backfill placed above the footing. The net allowable bearing pressure may be increased by one-third for transient wind or seismic loads.

Foundation Settlement

Settlement of shallow foundations depends on foundation size and bearing pressure, as well as the strength and compressibility characteristics of the underlying soil. If construction is accomplished as recommended and at the maximum allowable soil bearing pressure, GeoTest estimates the total settlement of building foundations to be less than one inch under static conditions. Differential settlement between two adjacent load-bearing components supported on competent soil is estimated to be less than one half the total settlement.

Floor Support

Conventional slab-on-grade floor construction is feasible for the planned site improvements. Floor slabs may be supported on properly prepared native subgrade or on properly placed and compacted Structural Fill placed over properly prepared native soil. Prior to placement of the Structural Fill, the native soil should be proof rolled as recommended in the *Site Preparation and Earthwork* section of this report.

GeoTest recommends that interior concrete slab-on-grade floors be underlain with at least 6 inches of clean, compacted, free-draining crushed gravel to serve as a capillary break. This material should be clear, crushed, ¾-inch rock with no fines or similar. The purpose of this gravel layer is to provide uniform support for the slab, provide a capillary break, and act as a drainage layer. To help reduce the potential for water vapor migration through floor slabs, a continuous 10- to 15-mil minimum thick polyethylene sheet with tape-sealed joints should be installed below the slab to serve as an impermeable vapor barrier. The vapor barrier should be installed and sealed in accordance with the manufacturer’s instructions. American Concrete Institute (ACI) guidelines suggest that the slab may be poured directly on the vapor barrier.

A Subgrade Modulus (k) of 150 pounds per cubic inch (pci) is recommended for use in the design of concrete slab elements placed on near-surface soils remedially compacted to Structural Fill requirements.

Exterior concrete, such as for parking and sidewalks, may be supported directly on properly prepared existing site soils. However, long-term performance will be enhanced if exterior slabs are placed on a layer of clean, durable, well-draining granular material above existing site soils.

Foundation and Site Drainage

Positive surface gradients should be provided adjacent to the proposed building to direct surface water away from the building and toward suitable drainage facilities. Roof drainage should not be introduced into the perimeter footing drains but should be separately discharged directly to the stormwater collection system or similar municipality-approved outlet. Pavement and sidewalk areas, if present, should be sloped and drainage gradients should be maintained to carry surface water away from the building towards an approved stormwater collection system. Surface water should not be allowed to pond and soak into the ground surface near buildings or paved areas during or after construction. Construction excavations should be sloped to drain to sumps where water from seepage, rainfall, and runoff can be collected and pumped to a suitable discharge facility.

The filtering media may consist of open-graded drain rock wrapped in a nonwoven geotextile fabric such as Mirafi 140N (or equivalent) or wrapped with a graded sand and gravel filter. For foundations supporting retaining walls, drainage backfill should be carried up the back of the wall and be at least 12 inches wide. The drainage backfill should extend from the foundation drain to within approximately 1 foot of the finished grade and consist of open-graded drain rock containing less than 3 percent fines by weight passing the U.S. Standard No. 200 sieve (based on a wet sieve analysis of that portion passing the U.S. Standard No. 4 sieve). The invert of the footing drainpipe should be placed at approximately the same elevation as the bottom of the footing or 12 inches below the adjacent floor slab grade (whichever is deeper) so that water will be contained. This process prevents water from seeping through walls or floor slabs. The drain system should include cleanouts to allow for periodic maintenance and inspection.

The drainage backfill should extend from the foundation drain to within approximately 1 foot of the finished grade and consist of open-graded drain rock containing less than 3 percent fines by weight passing the U.S. Standard No. 200 sieve (based on a wet sieve analysis of that portion passing the U.S. Standard No. 4 sieve). The invert of the footing drainpipe should be placed at approximately the same elevation as the bottom of the footing or 12 inches below the adjacent floor slab grade, whichever is deeper, so that water will be contained. This process prevents water from seeping through walls or floor slabs. The drain system should include cleanouts to allow for periodic maintenance and inspection.

Please understand that the above recommendations are intended to assist the design engineer and/or architect in the development of foundation and site drainage parameters and are based on our experience with similar projects in the area. The final foundation and site drainage plan that will be incorporated into the project plans is to be determined by the design team.

Resistance to Lateral Loads

The lateral earth pressures that develop against foundation walls will depend on the method of backfill placement, degree of compaction, slope of backfill, type of backfill material, provisions for drainage, magnitude and location of any adjacent surcharge loads, and the degree to which the wall can yield laterally during or after placement of backfill. If the wall can rotate or yield so the top of the wall moves an amount equal to or greater than about 0.001 to 0.002 times its height (a yielding wall), the soil pressure exerted comprises the active soil pressure. When a wall is restrained against lateral movement or tilting (a nonyielding wall), the soil pressure exerted comprises the at rest soil pressure. Wall restraint may develop if a rigid structural network is constructed prior to backfilling or if the wall is inherently stiff.

GeoTest recommends that yielding walls under drained conditions be designed for an equivalent fluid density of 35 pounds per cubic foot (pcf) for Structural Fill, Recessional Outwash, and native Till in active soil conditions. Nonyielding walls under drained conditions should be designed for an equivalent fluid density of 55 pcf for Structural Fill, Recessional Outwash, and native Till soils in at-rest conditions.

Design of walls should include appropriate lateral pressures caused by surcharge loads located within a horizontal distance equal to or less than the height of the wall. For uniform surcharge pressures, a uniformly distributed lateral pressure equal to 35 percent and 50 percent of the vertical surcharge pressure should be added to the lateral soil pressures for yielding and nonyielding walls, respectively. GeoTest also recommends that a seismic surcharge of 8H be included where H is the wall height. The seismic surcharge should be modeled as a rectangular distribution with the resultant applied at the midpoint of the wall.

Passive earth pressures developed against the sides of building foundations, in conjunction with friction developed between the base of the footings and the supporting subgrade, will resist lateral loads transmitted from the structure to its foundation. For design purposes, the passive resistance of well-compacted fill placed against the sides of foundations is equivalent to a fluid with a density of 350 pcf. The recommended value includes a safety factor of about 1.5 and assumes that the ground surface adjacent to the structure is level in the direction of movement for a distance equal to or greater than twice the embedment depth. The recommended value also assumes drained conditions that will prevent the buildup of hydrostatic pressure in the compacted fill. Retaining walls should include a drain system constructed in general accordance with the recommendations presented in the *Foundation and Site Drainage* section of this report. In design computations, the upper 12 inches of passive resistance should be neglected if the soil is not covered by floor slabs or pavement. If future plans call for the removal of the soil providing resistance, the passive resistance should not be considered.

An allowable coefficient of base friction of 0.35, applied to vertical dead loads only, may be used between the underlying soil and the base of the footing. If passive and frictional resistance are considered together, one half the recommended passive soil resistance value should be used since larger strains are required to mobilize the passive soil resistance as compared to frictional resistance. A safety factor of about 1.5 is included in the base friction design value. GeoTest does not recommend increasing the coefficient of friction to resist seismic or wind loads.

Temporary and Permanent Slopes

The contractor is responsible for construction slope configurations and maintaining safe working conditions, including temporary excavation stability. All applicable local, state, and federal safety codes should be followed. All open cuts should be monitored during and after excavation for any evidence of instability. If instability is detected, the contractor should flatten the side slopes or install temporary shoring.

Temporary excavations in excess of 4 feet should be shored or sloped in accordance with Safety Standards for Construction Work Part N, WAC 296-155-66403. Till soils are classified as Type B soil, while Recessional Outwash soils are classified as Type C soil. According to WAC 296-155-66401, Type B soils may be sloped as steep as 1:1 (Horizontal: Vertical) and Type C soils may be sloped and as steep as 1.5:1. All soils encountered are classified as Type C soil in the presence of groundwater seepage. Flatter slopes or temporary shoring may be required in areas where groundwater flow is present and unstable conditions develop.

Temporary slopes and excavations should be protected as soon as possible using appropriate methods to prevent erosion from occurring during periods of wet weather.

GeoTest recommends that permanent cut or fill slopes be designed for inclinations of 2H:1V or flatter. Permanent cuts or fills used in detention ponds, retention ponds, or earth slopes intended to hold water should be 3H:1V or flatter. All permanent slopes should be vegetated or otherwise protected to limit the potential for erosion as soon as practical after construction.

Utilities

Utility trenches must be properly backfilled and compacted to reduce cracking or localized loss of foundation, slab, or pavement support. Excavations for new shallow underground utilities are expected to be placed within Recessional Outwash, Till, or Structural Fill on the subject parcel.

Trench backfill in improved areas (beneath structures, pavements, sidewalks, etc.) should consist of Structural Fill as defined in the *Fill and Compaction* section of this report. Outside of improved areas, trench backfill may consist of reused native material provided the backfill can be compacted to the project specifications. Trench backfill should be placed and compacted in general accordance with the recommendations presented in the *Fill and Compaction* section of this report.

Surcharge loads on trench support systems due to construction equipment, stockpiled material, and vehicle traffic should be included in the design of any anticipated shoring system. The contractor should implement measures to prevent surface water runoff from entering trenches and excavations. In addition, vibration as a result of construction activity and traffic may cause caving of the trench walls.

The contractor is responsible for trench configurations. All applicable local, state, and federal safety codes should be followed. All open cuts should be monitored by the contractor during excavation for any evidence of instability. If instability is detected, the contractor should flatten the side slopes or install temporary shoring. If groundwater or groundwater seepage is present, and the trench is not properly dewatered, the soil within the trench zone may be prone to caving, channeling, and running. Trench widths may be substantially wider than under dewatered conditions.

Pavement Subgrade Preparation

GeoTest recommends that pavement sections be founded on firm and unyielding native or existing fill soils, or on compacted Structural Fill placed directly over firm and unyielding subgrade. GeoTest recommends stripping no more than 2 feet of Uncontrolled Fill for ancillary driveways and pavement structures**.** Where existing fill soils are present and consist of mineral soil, it should be expected that these fill soils will be scarified to a depth of 18 inches below the bottom of pavement elevations and recompacted to the requirements for Structural Fill. Existing fill with elevated levels of organics should be overexcavated and replaced with Structural Fill.

Site grading plans should include provisions for the sloping of subgrade soils in the proposed pavement areas so that passive drainage of the pavement section(s) can proceed uninterrupted during the life of the project. The discussion below represents typical pavement sections used at similar projects in the site vicinity. The final pavement design is to be determined by the project Civil Engineer.

Flexible Pavement Sections – Light Duty

If utilized within light vehicle parking and lower traffic areas, GeoTest recommends a standard, or "light duty", pavement section that consists of 3 inches of Class ½-inch HMA asphalt above 2 inches of crushed surfacing top course (CSTC) meeting criteria set forth in the Washington State Department of Transportation (WSDOT) Standard Specification 9-03.9[3]. The base material for the pavement section should consist of 6 inches of crushed surface base course (CSBC). This would result in a total of 8 inches of rock (CSTC and CSBC) underlying the asphalt.

Flexible Pavement Sections – Heavy Duty

Fire truck and general heavy access or high-volume lanes will require a thicker asphalt section and should be designed using a paving section consisting of 4 inches of Class ½-inch HMA asphalt above 2 inches of CSTC meeting criteria set forth in the WSDOT Standard Specification 9-03.9[3].

The base material for the road section should consist of 6 inches of CSBC. This would result in a total of 8 inches of rock (CSTC and CSBC) underlying the asphalt.

Concrete Hardscape Sections

Concrete pavements could be used for sidewalks and other features such as parking or access areas. The design of concrete pavements is a function of concrete strength, reinforcement steel, and the anticipated loading conditions for the roads. For design purposes, a vertical modulus of subgrade reaction of 150 pounds per cubic inch (pci) should be expected for concrete elements constructed over properly prepared, firm and unyielding native or existing fill soil, or on properly placed and compacted Structural Fill over properly prepared subgrade. GeoTest expects that concrete pavement sections, if utilized, will be at least 8 inches thick and be founded on a minimum of 8 inches of compacted CSBC. The design of concrete access and parking areas will need to be performed by a Structural Engineer. GeoTest recommends that subgrade soils supporting concrete pavement sections include minor grade changes to allow for passive drainage away from the pavement.

GeoTest is available to further consult, review, and/or modify our pavement section recommendations based on further discussion with the project team/owner. The above pavement sections are initial recommendations and may be accepted and/or modified by the site Civil Engineer based on the actual finished site grading elevations and/or the owner's preferences.

Stormwater Infiltration Potential

The native soils observed underlying the site are medium dense to very dense, contain elevated silt contents (14 to 71 percent), and are expected to exhibit low permeability characteristics. GeoTest also observed perched groundwater seepage atop low permeability Till during our investigation, but also anticipates its presence during the wet season and after extended periods of heavy precipitation. Both groundwater seepage and glacial deposits such as Till are widely regarded as "hydraulic restriction layers" as defined by the Manual. Till, in particular, is used as construction materials in stormwater pond liners and in berm construction where low-permeability soils are required as part of the design. Per the Manual, Till is expected to have a saturated hydraulic conductivity of less than 0.3 inches per hour, which the Manual defines as a "restriction layer."

Shallow restriction layers, as defined by the Manual, exist on the property that will make the design of infiltration systems challenging. The Manual has requirements and limitations for the design of stormwater facilities when shallow restriction layers exist below a facility. At the time of this report, a Stormwater Plan has not been developed for this property. Thus, it should be expected that the Civil Engineer will need to review the contents of this report with a specific focus on soil type, soil density, and/or the amount of vertical separation between the bottom of the facility and the restriction layer.

It is GeoTest's opinion that stormwater infiltration is not feasible for this site. Due to the shallow, low permeability soil, low impact development (LID) features such as pervious pavement or rain gardens may be challenging to incorporate into the stormwater plan that will be prepared for this project. The underlying low permeability soil must be accounted for in the design of stormwater facilities.

Stormwater Treatment

The on-site stormwater facilities may require some form of pollutant pretreatment with an amended soil prior to on-site infiltration or off-site discharge. The reuse of on-site topsoil is often the most sustainable and cost-effective method for pollutant treatment purposes. Cation exchange capacities, organic contents, and pH of site subsurface soils were also tested to determine possible pollutant treatment suitability.

Cation exchange capacity, organic content, and pH tests were performed by Northwest Agricultural Consultants on four soil samples collected from the explorations shown in Table 3. A summary of the laboratory test results is presented in Table 3 below.

Table 3
Cation Exchange Capacity, Organic Content, and pH Laboratory Test Results

Test Pit ID	Sample Depth (ft)	Geologic Unit	Cation Exchange Capacity (meq/100 grams)	Organic Content (%)	pH
TP-2	0.25	Topsoil	10.9	4.49	5.7
TP-2	8.5	Recessional Outwash	7.0	1.84	6.1
TP-6	4.0	Recessional Outwash	8.6	1.21	6.4
TP-7	6.0	Till	8.5	1.05	6.2

Suitability for on-site pollutant treatment is determined in accordance with SSC-6 of the Manual. Soils with an organic content greater than or equal to 1 percent and a cation exchange capacity of greater than or equal to 5 meq/100 grams are characterized as suitable soils for stormwater treatment. Based on the results shown in Table 3, the native soils and topsoil observed on-site are suitable for stormwater treatment purposes.

Geotechnical Consultation and Construction Monitoring

GeoTest recommends that we be involved in the project design review process. The purpose of the review is to verify that the recommendations presented in this report are understood and incorporated in the design and specifications.

We also recommend that geotechnical construction monitoring services be provided. These services should include observation by GeoTest personnel during Structural Fill placement, compaction activities and subgrade preparation operations to confirm that design subgrade conditions are obtained beneath the areas of improvement.

Periodic field density testing should be performed to verify that the appropriate degree of compaction is obtained. The purpose of these services is to observe compliance with the design concepts, specifications, and recommendations of this report. In the event that subsurface conditions differ from those anticipated before the start of construction, GeoTest would be pleased to provide revised recommendations appropriate to the conditions revealed during construction.

GeoTest is available to provide a full range of materials testing and special inspection during construction as required by the local building department and the International Building Code. This may include specific construction inspections on materials such as reinforced concrete, reinforced masonry, wood framing, and structural steel. These services are supported by our fully accredited materials testing laboratories.

USE OF THIS REPORT

GeoTest Services, Inc. has prepared this preliminary report for the exclusive use of the Mukilteo School District Capital Projects Department and their design consultants for specific application to the design of the proposed Mukilteo Elementary School development located at 2600 Mukilteo Speedway in Mukilteo, WA. Use of this report by others is at the user's sole risk. This report is not applicable to other site locations. Our services are conducted in accordance with accepted practices of the geotechnical engineering profession; no other warranty, express or implied, is made as to the professional advice included in this report.

This report is intended to be a preliminary evaluation of the subject property. Thus, additional studies outside of the current scope of work will likely be needed once preliminary design concepts are known.

Our site explorations indicate subsurface conditions at the dates and locations indicated. It is not warranted that these conditions are representative of conditions at other locations and times. The analyses, conclusions, and recommendations contained in this report are based on site conditions to the limited depth and time of our explorations, a geological reconnaissance of the area, and a review of previously published geological information for the site. If variations in subsurface conditions are encountered during construction that differs from those contained within this report, GeoTest should be allowed to review the recommendations and, if necessary, make revisions. If there is a substantial lapse of time between submission of this report and the start of construction, or if conditions change due to construction operations at or adjacent to the project site, we recommend that we review this report to determine the applicability of the conclusions and recommendations contained herein.

The earthwork contractor is responsible for performing all work in conformance with all applicable WISHA/OSHA regulations. GeoTest Services, Inc. is not responsible for job site safety on this project, and this responsibility is specifically disclaimed.

Attachments:	Figure 1	Vicinity Map
	Figure 2A	Site and Exploration Plan
	Figure 2B	Site and Exploration Plan – Soil Groups
	Figure 3	2005 Bare Earth Imagery
	Figure 4	2017 Bare Earth Imagery
	Figure 5	A – A' Fence Diagram
	Figure 6	Conceptual Footing and Wall Drain Section
	Figure 7	Soil Classification System and Key
	Figures 8 – 11	Test Pit Exploration Logs
	Figures 12 – 24	Soil Boring Exploration Logs
	Figures 25 – 28	Grain Size Test Data
	Attachment	NW Agricultural Consultants Test Results
	Attachment	Report Limitations and Guidelines for Its Use (4 pages)

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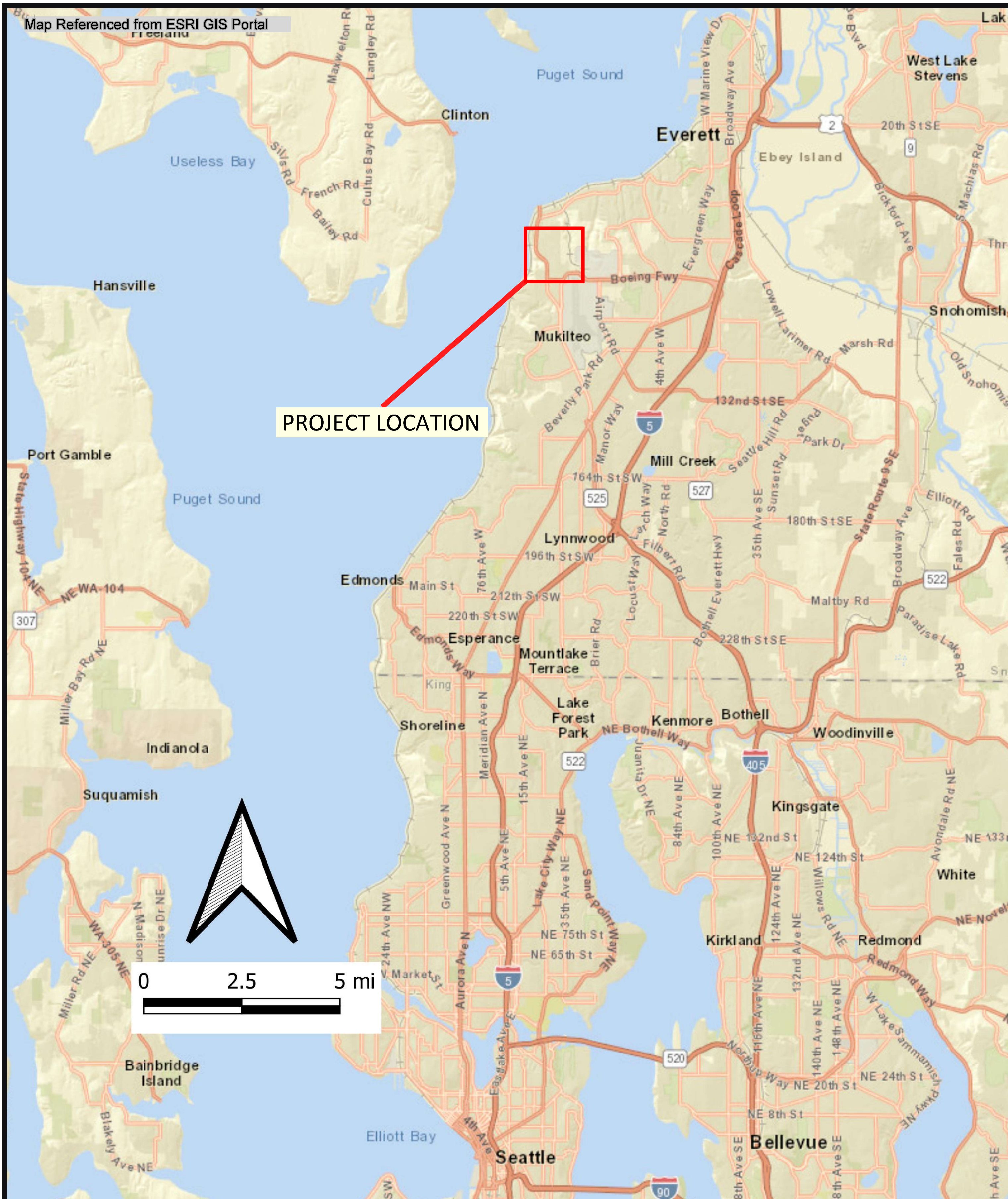
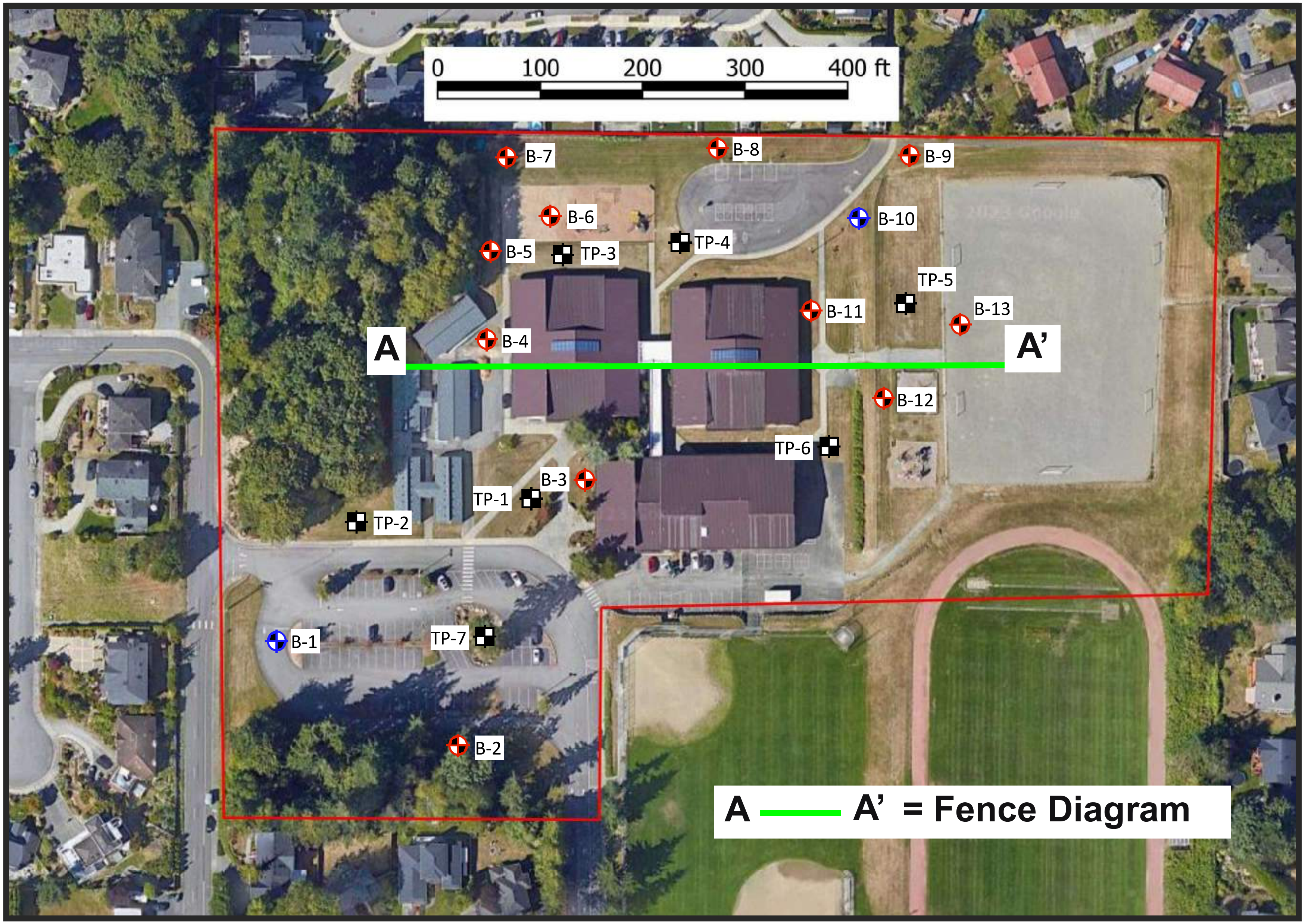


Date: 6-7-2023	By: CM	Scale: As Shown	Project 23-0066

VICINITY MAP
MUKILTEO ELEMENTARY SCHOOL
2600 MUKILTEO SPEEDWAY
MUKILTEO, WASHINGTON

Figure 1



TP-# = Approximate Test Pit Location

B-# = Approximate Boring Location

= Approximate Monitoring Well Location

N

Notes:

1) Parcel shapefile sourced from *Snohomish County PDS Map Portal*

2) Approximate project area outlined in RED

3) Map image created using *QGIS 3.22.6.*

GEOTEST An RMA Company

Date: 2-24-2023	By: CM	Scale: As Shown	Project 23-0066

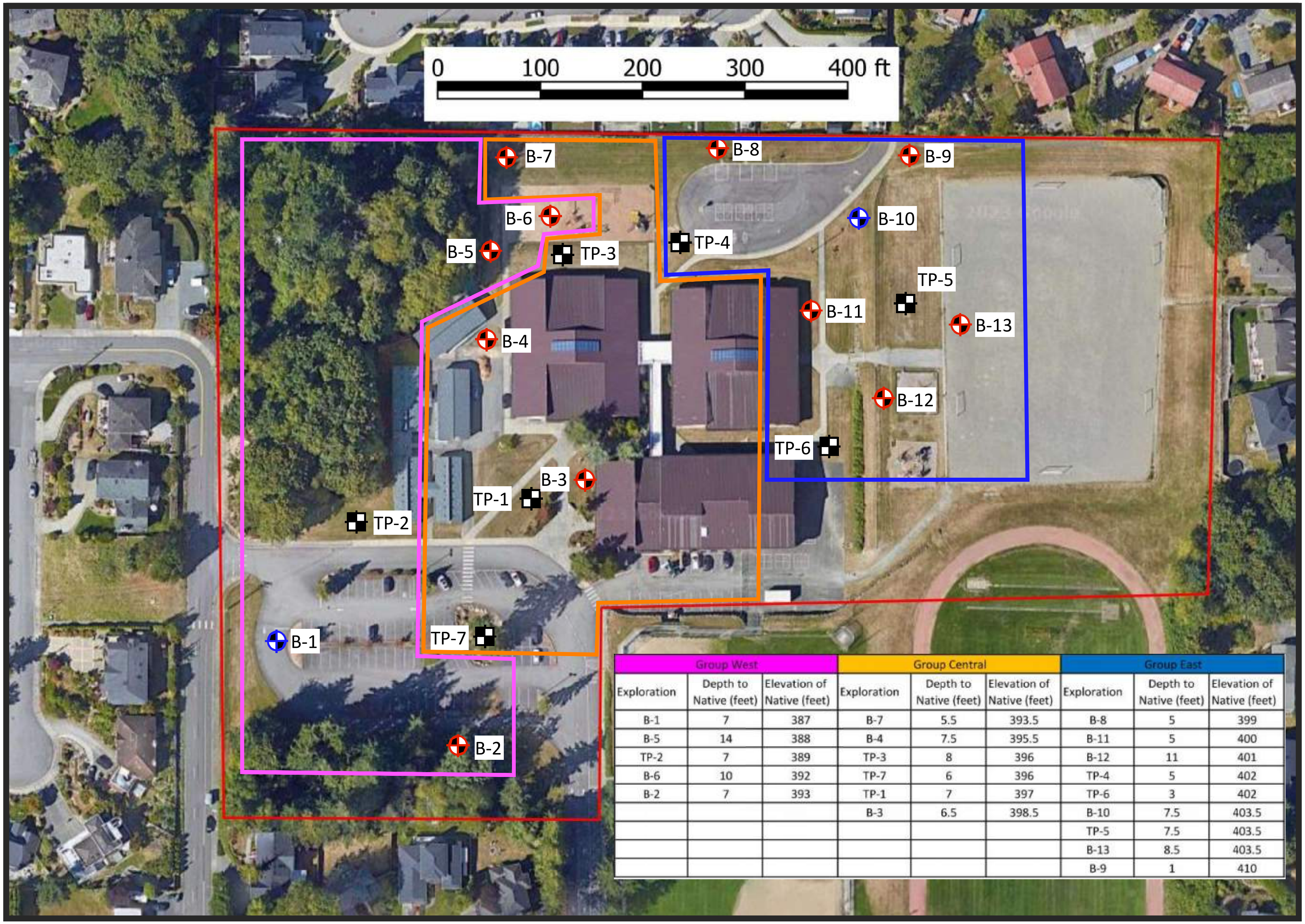
SITE AND EXPLORATION PLAN

MUKILTEO ELEMENTARY SCHOOL

2600 MUKILTEO SPEEDWAY

MUKILTEO, WASHINGTON

Figure 2A



Group West			Group Central			Group East		
Exploration	Depth to Native (feet)	Elevation of Native (feet)	Exploration	Depth to Native (feet)	Elevation of Native (feet)	Exploration	Depth to Native (feet)	Elevation of Native (feet)
B-1	7	387	B-7	5.5	393.5	B-8	5	399
B-5	14	388	B-4	7.5	395.5	B-11	5	400
TP-2	7	389	TP-3	8	396	B-12	11	401
B-6	10	392	TP-7	6	396	TP-4	5	402
B-2	7	393	TP-1	7	397	TP-6	3	402
			B-3	6.5	398.5	B-10	7.5	403.5
						TP-5	7.5	403.5
						B-13	8.5	403.5
						B-9	1	410

N

= Eastern Group of Explorations
= Central Group of Explorations
= Western Group of Explorations

Notes:

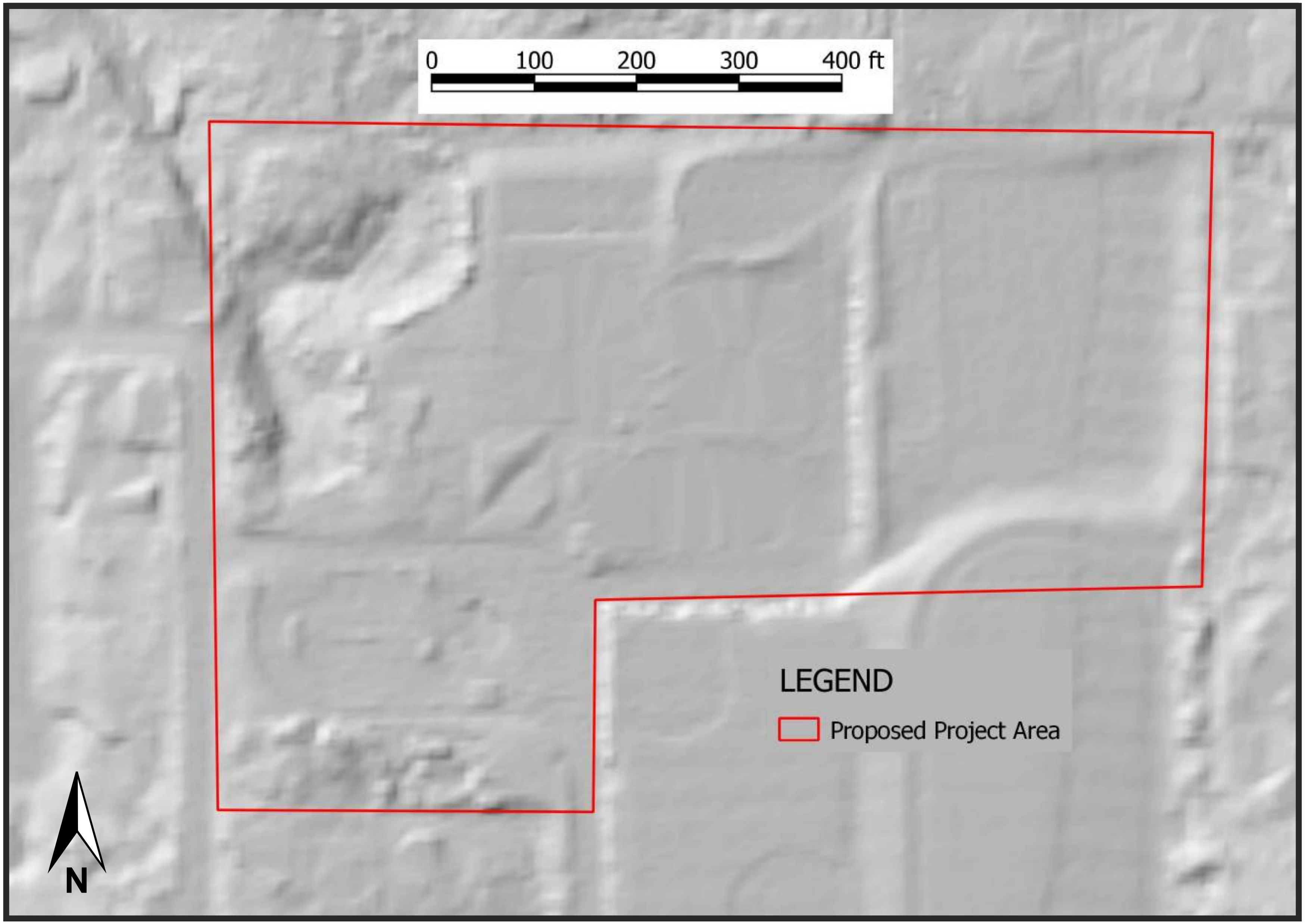
1) Parcel shapefile sourced from *Snohomish County PDS Map Portal*
2) Approximate project area outlined in RED
3) Map image created using *QGIS 3.22.6.*

GEOTEST
An RMA Company

Date: 6-22-2023	By: CM	Scale: As Shown	Project 23-0066

SITE AND EXPLORATION PLAN - SOIL GROUPS
MUKILTEO ELEMENTARY SCHOOL
2600 MUKILTEO SPEEDWAY
MUKILTEO, WASHINGTON

Figure
2B

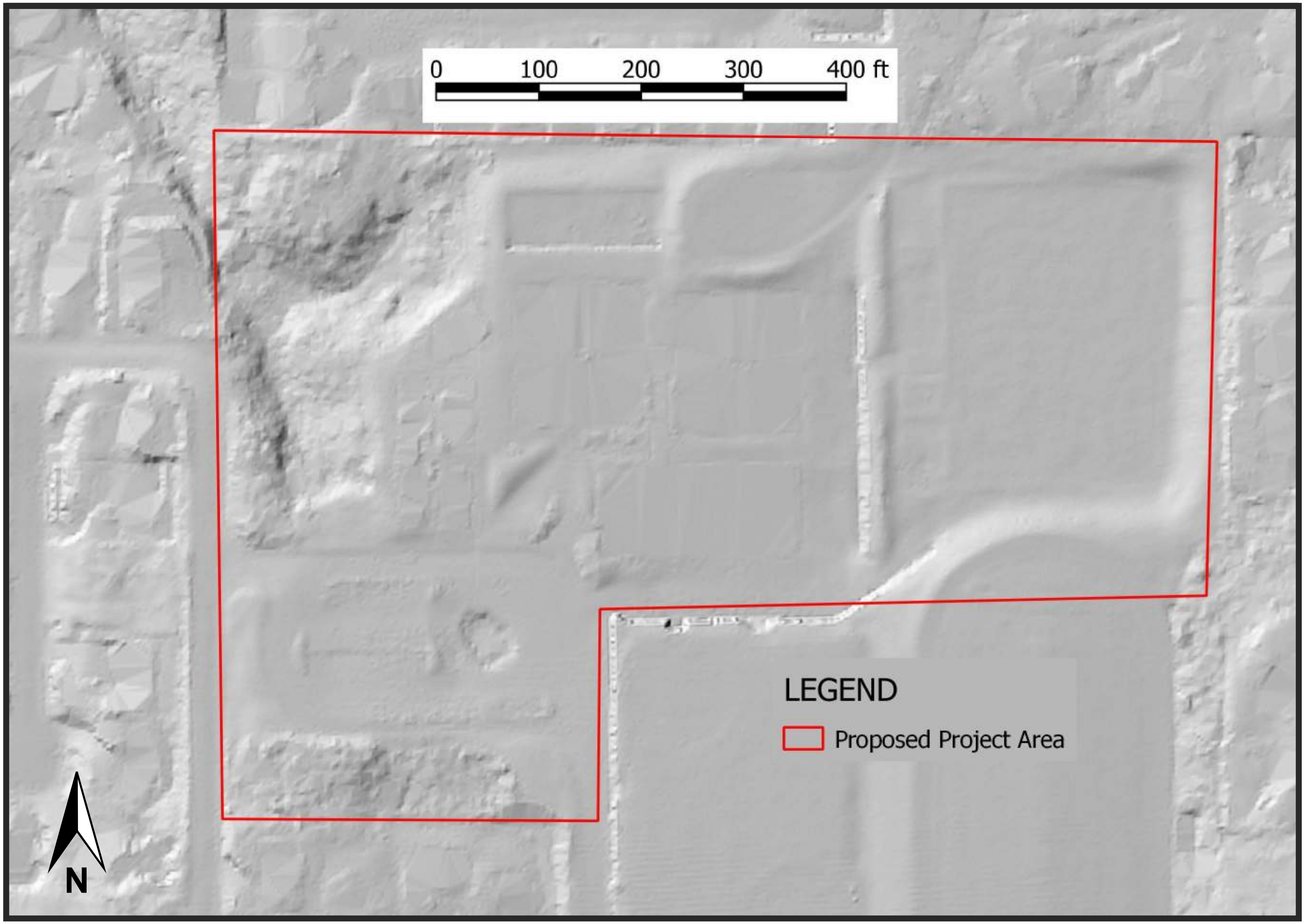


Notes:

1) Map image created using *QGIS 3.22.6*.
2) Hillshade and scale compiled using the *Snohomish County 2005* digital elevation model (Source: *Washington LiDAR Portal*)
3) Parcel shapefile exported from *Snohomish County PDS Map Portal*.
4) All locations and elevations are approximate.

GEOTEST

Date: 2-24-2023	By: CM	Scale: As Shown	Project 23-0066
2005 BARE EARTH SITE PLAN **Mukilteo Elementary School** **2600 Mukilteo Speedway** **Mukilteo, Washington**			Figure 3



Notes:

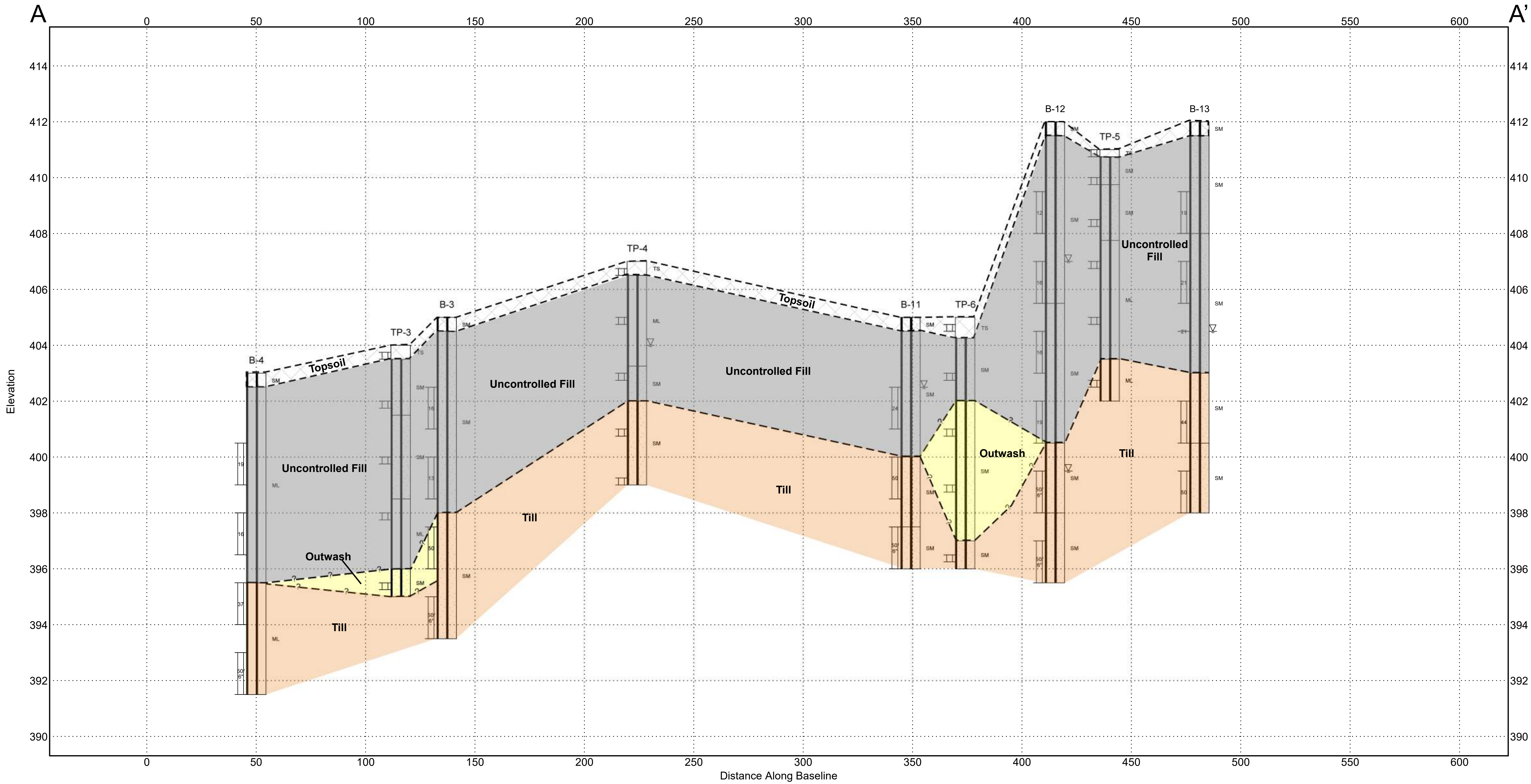
1) Map image created using *QGIS 3.22.6.*
2) Hillshade and scale compiled using the *North Puget Sound 2017* digital elevation model (Source: *Washington LiDAR Portal*)
3) Parcel shapefile exported from *Snohomish County PDS Map Portal*.
4) All locations and elevations are approximate.

GEOTEST

Date: 2-24-2023	By: CM	Scale: As Shown	Project 23-0066

2017 BARE EARTH SITE PLAN
MUKILTEO ELEMENTARY SCHOOL
2600 MUKILTEO SPEEDWAY
MUKILTEO, WASHINGTON

Figure
4



Point	North	East	Elev.	Depth
B-3	-108	137	405.0	11.5
B-4	25	50	403.0	11.5
B-11	58	349	405.0	9.0
B-12	-33	415	412.0	16.5
B-13	50	481	412.0	14.0
TP-3	108	116	404.0	9.0
TP-4	116	224	407.0	8.0
TP-5	66	440	411.0	9.0
TP-6	-133	374	405.0	9.0

= Sample Interval and Associated Blow Counts Per Foot

Fence Position	North	East
Left, Front	0	0
Right, Front	0	600
Left, Back	0	0
Right, Back	0	600

Baseline Distances (ft)
Beginning: 0
Ending: 600
Viewing Angles (deg)
Horizontal: 0.0
Vertical: 0.0

GEOTEST
An RMA Company

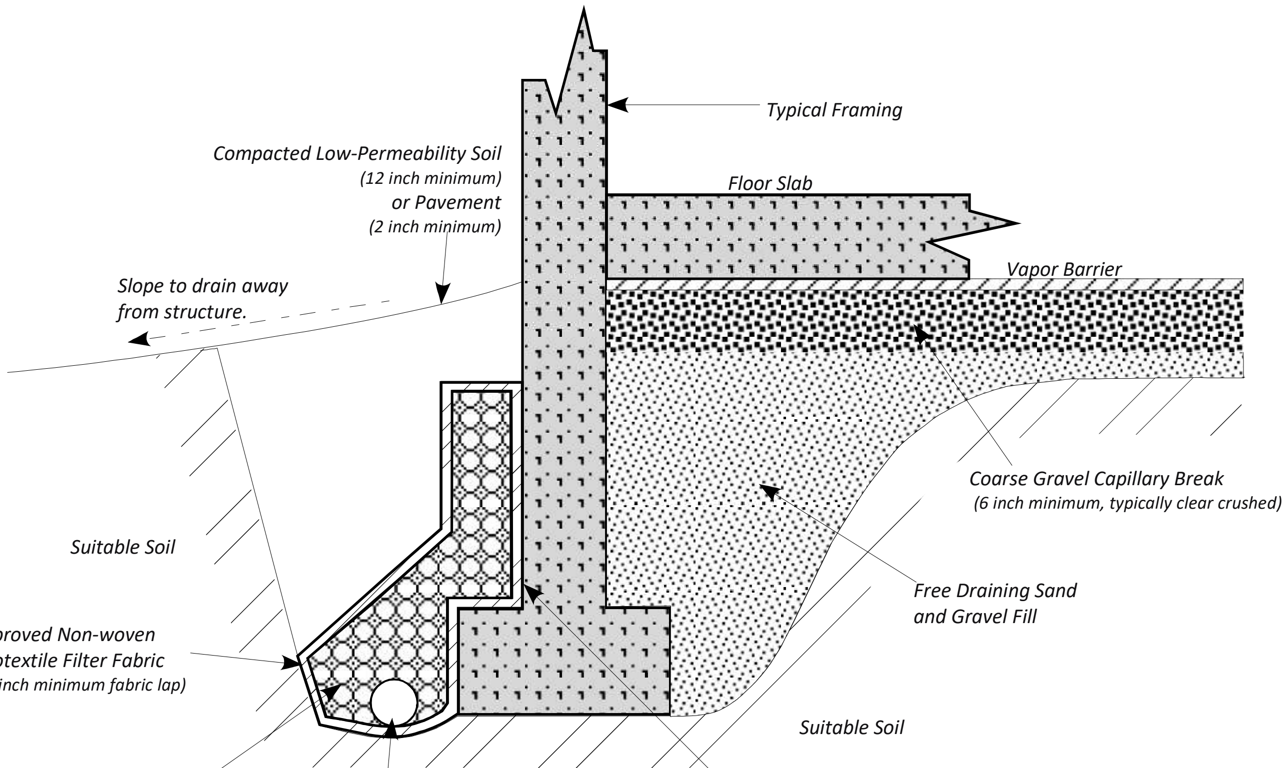
Mukilteo Elementary School
2600 Mukilteo Speedway
Mukilteo, Washington

Subsurface Fence Diagram A-A'

Figure
5

23-0066 6/22/23 C:\USERS\ZACH\DESKTOP\MUKILTEO ELEMENTARY SCHOOL COPY.GPJ LARGE

CONCEPTUAL FOOTINGS WITH INTERIOR SLAB-ON-GRADE



Notes:

This figure is not intended to be representative of a design. This figure is intended to present concepts that can be incorporated into a functional foundation drain designed by a Civil Engineer. In all cases, refer to the Civil plan sheet for drain details and elevations.

Footings should be properly buried for frost protection in accordance with International Building Code or local building codes (Typically 18 inches below exterior finished grades).

The footing drain will need to be modified from this typical drawing to fit the dimensions of the planned footing and slab configuration.

GEOTEST	Date: 3-3-2023	By: CM	Scale: None	Project 23-0066
	CONCEPTUAL FOOTING & WALL DRAIN SECTION MUKILTEO ELEMENTARY SCHOOL 2600 MUKILTEO SPEEDWAY MUKILTEO, WASHINGTON			Figure 6

Soil Classification System

MAJOR DIVISIONS			GRAPHIC SYMBOL	USCS LETTER SYMBOL	TYPICAL DESCRIPTIONS[(1)(2)]
COARSE-GRAINED SOIL (More than 50% of material is larger than No. 200 sieve size)	GRAVEL AND GRAVELLY SOIL (More than 50% of coarse fraction retained on No. 4 sieve)	CLEAN GRAVEL (Little or no fines)		GW	Well-graded gravel; gravel/sand mixture(s); little or no fines
				GP	Poorly graded gravel; gravel/sand mixture(s); little or no fines
		GRAVEL WITH FINES (Appreciable amount of fines)		GM	Silty gravel; gravel/sand/silt mixture(s)
				GC	Clayey gravel; gravel/sand/clay mixture(s)
	SAND AND SANDY SOIL (More than 50% of coarse fraction passed through No. 4 sieve)	CLEAN SAND (Little or no fines)		SW	Well-graded sand; gravelly sand; little or no fines
				SP	Poorly graded sand; gravelly sand; little or no fines
		SAND WITH FINES (Appreciable amount of fines)		SM	Silty sand; sand/silt mixture(s)
				SC	Clayey sand; sand/clay mixture(s)
FINE-GRAINED SOIL (More than 50% of material is smaller than No. 200 sieve size)	SILT AND CLAY (Liquid limit less than 50)			ML	Inorganic silt and very fine sand; rock flour; silty or clayey fine sand or clayey silt with slight plasticity
				CL	Inorganic clay of low to medium plasticity; gravelly clay; sandy clay; silty clay; lean clay
				OL	Organic silt; organic, silty clay of low plasticity
	SILT AND CLAY (Liquid limit greater than 50)			MH	Inorganic silt; micaceous or diatomaceous fine sand
				CH	Inorganic clay of high plasticity; fat clay
				OH	Organic clay of medium to high plasticity; organic silt
	HIGHLY ORGANIC SOIL			PT	Peat; humus; swamp soil with high organic content

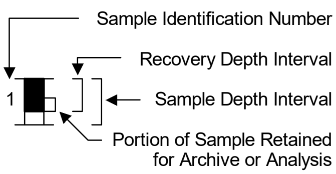
OTHER MATERIALS	GRAPHIC SYMBOL	LETTER SYMBOL	TYPICAL DESCRIPTIONS
PAVEMENT		AC or PC	Asphalt concrete pavement or Portland cement pavement
ROCK		RK	Rock (See Rock Classification)
WOOD		WD	Wood, lumber, wood chips
DEBRIS		DB	Construction debris, garbage

Notes: 1. Soil descriptions are based on the general approach presented in the *Standard Practice for Description and Identification of Soils (Visual-Manual Procedure)*, as outlined in ASTM D 2488. Where laboratory index testing has been conducted, soil classifications are based on the *Standard Test Method for Classification of Soils for Engineering Purposes*, as outlined in ASTM D 2487.
2. Soil description terminology is based on visual estimates (in the absence of laboratory test data) of the percentages of each soil type and is defined as follows:

Primary Constituent:	> 50%	"GRAVEL," "SAND," "SILT," "CLAY," etc.
Secondary Constituents:	> 30% and ≤ 50%	"very gravelly," "very sandy," "very silty," etc.
	> 12% and ≤ 30%	"gravelly," "sandy," "silty," etc.
Additional Constituents:	> 5% and ≤ 12%	"slightly gravelly," "slightly sandy," "slightly silty," etc.
	≤ 5%	"trace gravel," "trace sand," "trace silt," etc., or not noted.

Drilling and Sampling Key

SAMPLE NUMBER & INTERVAL



SAMPLER TYPE

Code	Description
a	3.25-inch O.D., 2.42-inch I.D. Split Spoon
b	2.00-inch O.D., 1.50-inch I.D. Split Spoon
c	Shelby Tube
d	Grab Sample
e	Other - See text if applicable
1	300-lb Hammer, 30-inch Drop
2	140-lb Hammer, 30-inch Drop
3	Pushed
4	Other - See text if applicable

Groundwater

ATD — Approximate water elevation at time of drilling (ATD) or on date noted. Groundwater levels can fluctuate due to precipitation, seasonal conditions, and other factors.

Field and Lab Test Data

Code	Description
PP = 1.0	Pocket Penetrometer, tsf
TV = 0.5	Torvane, tsf
PID = 100	Photoionization Detector VOC screening, ppm
W = 10	Moisture Content, %
D = 120	Dry Density, pcf
-200 = 60	Material smaller than No. 200 sieve, %
GS	Grain Size - See separate figure for data
AL	Atterberg Limits - See separate figure for data
GT	Other Geotechnical Testing
CA	Chemical Analysis

GEOTEST An RMA Company

Mukilteo Elementary School
2600 Mukilteo Speedway
Mukilteo, Washington

Soil Classification System and Key

Figure 7

TP-1

SAMPLE DATA				SOIL PROFILE			GROUNDWATER
Depth (ft)	Sample Number & Interval	Sampler Type	Test Data	Graphic Symbol	USCS Symbol	Excavation Method: Tracked Excavator Ground Elevation (ft): 404 Excavated By: PacNW Excavation/C. McCabe	
0	1	d			TS	Loose, brown, moist, gravelly, silty SAND, numerous roots and grass (Topsoil)	Slight
	2	d			GM	Dense, brown, wet, sandy, silty angular GRAVEL (Uncontrolled Fill)	
2	3	d			SM	Medium dense, purple-gray, moist, gravelly, silty SAND (Uncontrolled Fill)	
4	4	d			SM	Medium dense, blue-gray, moist, gravelly, silty SAND, trace cobbles and boulders (Uncontrolled Fill)	
6	5	d			SM	Medium dense, brown, moist, slightly gravelly, silty SAND, scattered roots and wood (Relict Topsoil)	
8	6	d	W = 13 GS		SM	Medium dense, tan, moist, gravelly, silty SAND (Recessional Outwash)	

Test Pit Completed 02/22/23
Total Depth of Test Pit = 8.5 ft.

TP-2

SAMPLE DATA				SOIL PROFILE			GROUNDWATER
Depth (ft)	Sample Number & Interval	Sampler Type	Test Data	Graphic Symbol	USCS Symbol	Excavation Method: Tracked Excavator Ground Elevation (ft): 396 Excavated By: PacNW Excavation/C. McCabe	
0	7	d			TS	Loose, dark brown, moist, slightly gravelly, silty SAND, numerous roots and grass (Topsoil)	Groundwater not encountered.
2	8	d			SM	Medium dense, brown, moist, gravelly, silty SAND, trace cobbles, occasional roots (Uncontrolled Fill)	
4	9	d				Large log observed at approximately 4.5 feet	
6	10	d	W = 20 GS		SM	Medium stiff, dark brown-gray, moist, gravelly, very silty SAND, occasional roots and wood (Uncontrolled Fill)	
8	11	d			SM	Medium dense, gray-brown, moist to wet, gravelly, silty SAND (Recessional Outwash)	

Test Pit Completed 02/22/23
Total Depth of Test Pit = 9.0 ft.

Notes: Approximate Elevations Obtained from Snohomish County PDS Map Portal

TP-3

SAMPLE DATA				SOIL PROFILE			GROUNDWATER
Depth (ft)	Sample Number & Interval	Sampler Type	Test Data	Graphic Symbol	USCS Symbol	Excavation Method: Tracked Excavator Ground Elevation (ft): 404 Excavated By: PacNW Excavation/C. McCabe	
0	12	d			TS	Loose, brown, moist, gravelly, silty SAND, occasional roots and grass (Topsoil)	Groundwater not encountered.
					SM	Loose, orange-brown, moist, slightly gravelly, silty SAND, trace cobbles and boulders, occasional roots and wood (Uncontrolled Fill)	
2	13	d			SM	Medium dense, dark gray, moist, slightly gravelly, very silty SAND, trace cobbles and boulders, occasional logs and wood (Uncontrolled Fill)	
4	14	d	W = 23 GS				
6	15	d			ML	Medium stiff, dark gray, moist, gravelly, sandy SILT, scattered roots and wood (Uncontrolled Fill)	
8	16	d			SM	Medium dense, brown, moist to wet, gravelly, silty SAND, occasional roots (Recessional Outwash)	
10							

Test Pit Completed 02/22/23
Total Depth of Test Pit = 9.0 ft.

TP-4

SAMPLE DATA				SOIL PROFILE			GROUNDWATER
Depth (ft)	Sample Number & Interval	Sampler Type	Test Data	Graphic Symbol	USCS Symbol	Excavation Method: Tracked Excavator Ground Elevation (ft): 407 Excavated By: PacNW Excavation/C. McCabe	
0	17	d			TS	Loose, brown, moist, slightly gravelly, silty SAND, numerous roots and grass (Topsoil)	
					ML	Medium stiff, brown, moist, gravelly, sandy SILT, trace cobbles and boulders, occasional roots and wood (Uncontrolled Fill)	
2	18	d					▽ Slight
4	19	d	W = 12 GS		SM	Dense, blue-gray to dark gray, slightly gravelly, very silty SAND, trace cobbles and boulders (Uncontrolled Fill)	
					SM	Very stiff to hard, gray, moist, slightly gravelly, silty SAND (Till)	
6	20	d	W = 12 GS				
8	21	d					
10							

Test Pit Completed 02/22/23
Total Depth of Test Pit = 8.0 ft.

Notes: Approximate Elevations Obtained from Snohomish County PDS Map Portal

Mukilteo Elementary School 2600 Mukilteo Speedway Mukilteo, Washington	Log of Test Pits	Figure 9

TP-5

Depth (ft)	Sample Number & Interval	Sampler Type	Test Data	USCS Symbol	Soil Profile	Groundwater
0	22	d		TS	Loose, dark brown, moist, slightly gravelly, silty SAND, numerous roots and grass (Topsoil)	Groundwater not encountered.
	23	d		SM	Loose, gray, moist, silty SAND, occasional roots (Uncontrolled Fill)	
2	24	d		SM	Medium dense, brown, moist, gravelly, silty SAND, trace cobbles and boulders (Uncontrolled Fill)	
4	25	d		ML	Stiff to very stiff, gray, moist, gravelly, sandy SILT, trace cobbles and boulders, occasional roots (Uncontrolled Fill)	
6	26	d				
8	27	d	W = 20 GS	ML	Very stiff, orange-gray, moist, sandy SILT, trace cobbles, mottling present (Till)	

Excavation Method: Tracked Excavator
Ground Elevation (ft): 411
Excavated By: PacNW Excavation/C. McCabe

Test Pit Completed 02/22/23
Total Depth of Test Pit = 9.0 ft.

TP-6

Depth (ft)	Sample Number & Interval	Sampler Type	Test Data	USCS Symbol	Soil Profile	Groundwater
0	28	d		TS	Loose, dark brown, moist, slightly gravelly, silty SAND, numerous roots and grass (Topsoil)	Groundwater not encountered.
2	29	d	W = 9 GS	SM	Medium stiff, brown, moist, slightly gravelly, silty SAND, trace cobbles, occasional roots (Uncontrolled Fill)	
4	30	d		SM	Medium dense, tan, moist, silty SAND (Recessional Outwash)	
6	31	d	W = 12 GS			
8	32	d		SM	Dense, tan, moist, gravelly, silty SAND, trace cobbles and boulders (Till)	

Excavation Method: Tracked Excavator
Ground Elevation (ft): 405
Excavated By: PacNW Excavation/C. McCabe

Test Pit Completed 02/22/23
Total Depth of Test Pit = 9.0 ft.

Notes: Approximate Elevations Obtained from Snohomish County PDS Map Portal

GEOTEST An RMA Company

Mukilteo Elementary School
2600 Mukilteo Speedway
Mukilteo, Washington

Log of Test Pits

Figure 10

TP-7

SAMPLE DATA				SOIL PROFILE			GROUNDWATER
Depth (ft)	Sample Number & Interval	Sampler Type	Test Data	Graphic Symbol	USCS Symbol	Excavation Method: Tracked Excavator Ground Elevation (ft): 398 Excavated By: PacNW Excavation/C. McCabe	
0					TS	Loose, black, moist, slightly gravelly, silty SAND, numerous roots and grass (Topsoil)	
	33	d					
	34	d			SM	Loose, brown, moist, gravelly, silty SAND, occasional roots (Uncontrolled Fill)	Moderate
2					SM	Dense, brown-gray, moist to wet, silty, gravelly SAND with cobbles and boulders (Till)	
	35	d	W = 16 GS				
4							
6	36	d					
					SM/ML	Dense, orange-tan, moist, gravelly, sandy SILT to silty SAND (Till)	
	37	d					
8							

Test Pit Completed 02/22/23
Total Depth of Test Pit = 8.0 ft.

10

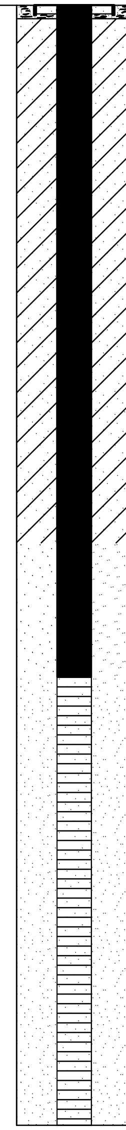
Notes: Approximate Elevations Obtained from Snohomish County PDS Map Portal

GEOTEST An RMA Company

Mukilteo Elementary School 2600 Mukilteo Speedway Mukilteo, Washington	Log of Test Pits	Figure 11

B-01

SAMPLE DATA				SOIL PROFILE			GROUNDWATER	
Depth (ft)	Sample Number & Interval	Sampler Type	Blows/Foot	Test Data	Graphic Symbol / USCS Symbol	Drilling Method: Hollow-stem Auger Ground Elevation (ft): 394 Drilled By: Geologic Drill/CM/AD	Water Level	Detail
0					AC	Approximately 5 inches of asphalt		Flush-mounted monument with locking cap
					SM	Medium dense, tan to brown, moist, slightly gravelly, very silty SAND, mottling present (Fill)		
	1	b2	20					
5	2	b2	37			Increase in density to dense soils		Bentonite chips
	3	b2			SM	Dense, tan-gray, moist, very gravelly, very silty SAND (Till)		2-inch diameter, Schedule 40, PVC well casing
10	4	b2	48					
15	5	b2	50		SM	Very dense, gray-brown, moist, silty SAND with trace gravel (Till)		
							ATD	10/20 Colorado sand pack
20	6	b2	50/6"					2-inch diameter, Schedule 40, PVC screen (0.010-inch slot size)
	7	b2	50/6"	W = 17 GS	ML	Hard, gray, moist, slightly gravelly, sandy SILT (Till)		
25	8	b2	50/6"					



Boring Completed 06/03/23
Total Depth of Boring = 26.5 ft.

Notes: Approximate Elevations Obtained from Snohomish County PDS Map Portal

GEOTEST An RMA Company

Mukilteo Elementary School
2600 Mukilteo Speedway
Mukilteo, Washington

Log of B-01

Figure 12

B-02

SAMPLE DATA						SOIL PROFILE			GROUNDWATER
Depth (ft)	Elevation	Sample Number & Interval	Sampler Type	Blows/Foot	Test Data	Graphic Symbol	USCS Symbol	Drilling Method: Hollow-stem Auger Ground Elevation (ft): 400 Drilled By: Geologic Drill/CM/AD	
0	400						SM	Loose, brown, moist, slightly gravelly, silty SAND with grass and roots (Topsoil)	
							SM	Medium dense, brown to gray, moist, very silty SAND with trace gravel (Fill)	Groundwater not encountered.
2	398								
		1	b2	15					
4	396								
								Mottling present	
		2	b2	17					
6	394								
							ML	Hard, gray, moist, slightly gravelly, sandy SILT (Till)	
8	392								
		3	b2	50/ 6"	W = 13 GS				
10	390								
		4	b2	50/ 6"	W = 9 GS				

12

Boring Completed 06/03/23
Total Depth of Boring = 11.5 ft.

14

Notes: Approximate Elevations Obtained from Snohomish County PDS Map Portal

B-03

SAMPLE DATA						SOIL PROFILE			GROUNDWATER
Depth (ft)	Elevation	Sample Number & Interval	Sampler Type	Blows/Foot	Test Data	Graphic Symbol	USCS Symbol	Drilling Method: Hollow-stem Auger Ground Elevation (ft): 405 Drilled By: Geologic Drill/CM/AD	
0							SM	Loose, brown, moist, slightly gravelly, silty SAND with grass and roots (Topsoil)	Groundwater not encountered.
	404						SM	Medium dense, brown to gray, moist, slightly gravelly to gravelly, very silty SAND (Fill)	
2									
	402	1	b2	16					
4									
	400	2	b2	13					
6									
	398						SM	Very dense, brown, moist, slightly gravelly, very silty SAND (Till)	
8		3	b2	50	W = 13 GS				
	396								
10									
	394	4	b2	50/ 6"					
12									
14									

Boring Completed 06/03/23
Total Depth of Boring = 11.5 ft.

Notes: Approximate Elevations Obtained from Snohomish County PDS Map Portal

B-04

SAMPLE DATA						SOIL PROFILE			GROUNDWATER
Depth (ft)	Elevation	Sample Number & Interval	Sampler Type	Blows/Foot	Test Data	Graphic Symbol	USCS Symbol	Drilling Method: Hollow-stem Auger Ground Elevation (ft): 403 Drilled By: Geologic Drill/CM/AD	
0							SM	Loose, brown, moist, slightly gravelly, silty SAND with grass and roots (Topsoil)	Groundwater not encountered.
	402						ML	Very stiff, gray, moist, gravelly, sandy SILT (Fill)	
2									
	400	1	b2	19					
4									
	398							Wood present in sample	
6		2	b2	16					
	396								
8		3	b2	37			ML	Hard, gray, moist, slightly gravelly, sandy SILT (Till) No recovery	
	394								
10									
	392	4	b2	50/ 6"					
12									
14									

Boring Completed 06/03/23
Total Depth of Boring = 11.5 ft.

Notes: Approximate Elevations Obtained from Snohomish County PDS Map Portal

23-0066 6/23/23 X:\PROJECTS GEO\0-PROJECTS 2023-GEO\GEOTECH EVALUATION\MUKILTEO SD-23-0066-MUKILTEO ELEMENTARY SCHOOL\GINT\MUKILTEO ELEMENTARY SCHOOL.GPJ SOIL BORING LOG W/ ELEV

B-05

Depth (ft)	Elevation	Sample Number & Interval	Sampler Type	Blows/Foot	Test Data	USCS Symbol	Soil Profile	Water Level
0	402					SM	Loose, brown, moist, slightly gravelly, silty SAND with grass and roots (Topsoil)	
						SM	Loose, dark brown, moist, slightly gravelly, very silty SAND with scattered wood (Fill)	
2	400							
		1	b2	6				
4	398							
		2	b2	9				
6	396							
						ML	Stiff, black, wet, slightly gravelly, sandy SILT with scattered wood and roots (Fill)	ATD
8	394	3	b2	9				
10	392							
		4	b2	6				
12	390							
14	388					SM	Very dense, gray, moist, gravelly, silty SAND (Till)	
16	386	5	b2	50/ 6"				

Drilling Method: Hollow-stem Auger

Ground Elevation (ft): 402

Drilled By: Geologic Drill/CM/AD

Boring Completed 06/03/23
Total Depth of Boring = 16.5 ft.

Refusal at 16.5 feet

18

20

Notes: Approximate Elevations Obtained from Snohomish County PDS Map Portal

B-06

SAMPLE DATA / SOIL PROFILE / GROUNDWATER

Drilling Method: Hollow-stem Auger

Ground Elevation (ft): 402

Drilled By: Geologic Drill/CM/AD

Depth (ft)	Elevation	Sample Number & Interval	Sampler Type	Blows/Foot	Test Data	USCS Symbol	Description	Water Level
0	402					SM	Loose, brown, moist, slightly gravelly, silty SAND with grass and roots (Topsoil)	
						ML	Stiff, dark brown to black, moist, sandy SILT with trace gravel and wood debris (Fill)	
2	400							
		1	b2	6				
4	398							
						ML	Stiff, dark brown, moist, sandy SILT with occasional wood No recovery	
6	396	2	b2	9				
8	394	3	b2	9				
10	392					SM	Medium dense, gray to brown, moist to wet, slightly gravelly, silty SAND (Weathered Till)	ATD
		4	b2	6				
12	390							
						ML	Hard, gray-blue, moist, gravelly, sandy SILT (Till)	
		5	b2	50/ 6"				
14	388							
16	386	6	b2	50/ 2"				
18								
20								

Boring Completed 06/03/23
Total Depth of Boring = 16.5 ft.

Notes: Approximate Elevations Obtained from Snohomish County PDS Map Portal

B-07

Depth (ft)	Elevation	Sample Number & Interval	Sampler Type	Blows/Foot	Test Data	USCS Symbol	Soil Profile	Water Level
0	399					SM	Loose wood chips (Landscape Wood Chips)	
						ML	Medium stiff, light to dark brown, moist, gravelly, sandy SILT with occasional wood (Fill)	
	398							
2								
	396	1	b2	6				
4								
	394					ML	Very soft, brown-gray, wet, gravelly, sandy SILT (Fill)	ATD
		2	b2	50				
						SM	Very dense, gray, moist, slightly gravelly, very silty SAND (Till)	
6		3	b2	50/ 6"	W = 8 GS			
	392							
8		4	b2	50/ 6"				
	390							
10								

Drilling Method: Hollow-stem Auger

Ground Elevation (ft): 399

Drilled By: Geologic Drill/CM/AD

Boring Completed 06/03/23
Total Depth of Boring = 9.0 ft.

Notes: Approximate Elevations Obtained from Snohomish County PDS Map Portal

B-08

Depth (ft)	Elevation	Sample Number & Interval	Sampler Type	Blows/Foot	Test Data	USCS Symbol	Soil Profile	Groundwater
0	404					SM	Loose, brown, moist, slightly gravelly, silty SAND with grass and roots (Topsoil)	Groundwater not encountered.
						SM	Loose, brown, moist, slightly gravelly, silty SAND with occasional rootlets (Fill)	
2	402							
		1	b2	10				
4	400							
						SM	Very dense, gray, moist, gravelly, very silty SAND (Till)	
		2	b2	50	W = 11 GS			
6	398							
							Refusal at 8.5 feet	
8	396							
		3	b2	50/ 6"				
10								

Drilling Method: Hollow-stem Auger

Ground Elevation (ft): 404

Drilled By: Geologic Drill/CM/AD

Boring Completed 06/03/23
Total Depth of Boring = 9.0 ft.

Notes: Approximate Elevations Obtained from Snohomish County PDS Map Portal

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Mukilteo Elementary School
2600 Mukilteo Speedway
Mukilteo, Washington

Log of B-08

Figure 19

B-09

SAMPLE DATA						SOIL PROFILE		GROUNDWATER
Depth (ft)	Elevation	Sample Number & Interval	Sampler Type	Blows/Foot	Test Data	USCS Symbol	Drilling Method: Hollow-stem Auger Ground Elevation (ft): 411 Drilled By: Geologic Drill/CM/AD	
0	411					SM	Loose, brown, moist, slightly gravelly, silty SAND with grass and roots (Topsoil)	Groundwater not encountered.
	410					SM	Dense, gray-brown, moist, gravelly, very silty SAND, localized oxidation (Weathered Till)	
2								
	408	1	b2	38	W = 11 GS			
4								
	406					SM	Very dense, brown, moist, silty, very gravelly SAND (Till)	
6		2	b2	50				
	404						No recovery	
8		3	b2	50/ 4"			Refusal at 8 feet	
	402							
10								

Boring Completed 06/03/23
Total Depth of Boring = 9.0 ft.

Notes: Approximate Elevations Obtained from Snohomish County PDS Map Portal

B-10

Depth (ft)	Sample Number & Interval	Sampler Type	Blows/Foot	Test Data	USCS Symbol	Description	Groundwater Detail
0					SM	Loose, brown, moist, slightly gravelly, silty SAND with grass and roots (Topsoil)	Flush-mounted monument with locking cap
					SM	Medium dense, dark brown, moist, gravelly, silty SAND with occasional wood and roots (Fill)	Bentonite chips; 2-inch diameter, Schedule 40, PVC well casing
~3	1	b2	17				
5					ML	Medium stiff, black, moist, sandy SILT with occasional wood (Fill)	
~5.75	2	b2	7				
7.5					SM	Medium dense, gray, moist, silty SAND (Weathered Till)	10/20 Colorado sand pack; 2-inch diameter, Schedule 40, PVC screen (0.010-inch slot size)
~8.25	3	b2	27				
10					SM	Very dense, gray, moist, silty SAND (Till)	
~10.75	4	b2	50/ 6"				
11						Refusal at 11 feet	

Drilling Method: Hollow-stem Auger

Ground Elevation (ft): 411

Drilled By: Geologic Drill/CM/AD

Water Level: Groundwater not encountered.

Boring Completed 06/03/23
Total Depth of Boring = 11.5 ft.

Notes: Approximate Elevations Obtained from Snohomish County PDS Map Portal

Mukilteo Elementary School
2600 Mukilteo Speedway
Mukilteo, Washington

Log of B-10

Figure 21

B-11

SAMPLE DATA / SOIL PROFILE / GROUNDWATER

Drilling Method: Hollow-stem Auger
Ground Elevation (ft): 405
Drilled By: Geologic Drill/CM/AD

Depth (ft)	Elevation	Sample Number & Interval	Sampler Type	Blows/Foot	Test Data	USCS Symbol	Description	Water Level
0						SM	Loose, brown, moist, slightly gravelly, silty SAND with grass and roots (Topsoil)	
	404					SM	Medium dense, gray, moist to wet, gravelly, silty SAND (Fill)	
2							perched water in sandy layer	ATD
	402	1	b2	24				
4								
	400					SM	Very dense, orange-brown, moist, gravelly, very silty SAND, highly oxidized (Weathered Till)	
6		2	b2	50	W = 8 GS			
	398					SM	Very dense, brown, moist, slightly gravelly, silty SAND (Till)	
8		3	b2	50/ 6"				
	396							
10								

Boring Completed 06/03/23
Total Depth of Boring = 9.0 ft.

Notes: Approximate Elevations Obtained from Snohomish County PDS Map Portal

B-12

Depth (ft)	Elevation	Sample Number & Interval	Sampler Type	Blows/Foot	Test Data	USCS Symbol	Soil Profile	Water Level
0	412					SM	Loose, brown, moist, slightly gravelly, silty SAND with grass and roots (Topsoil)	
						SM	Medium dense, brown to gray, moist, slightly gravelly, silty SAND with occasional roots (Fill)	
2	410							
		1	b2	12				
4	408							
							Perched water in sand lenses	ATD
		2	b2	16				
6	406							
						SM	Medium dense, gray-brown, moist, gravelly, silty SAND, oxidation common (Fill)	
8	404							
		3	b2	16				
10	402							
		4	b2	19			Increased drilling resistance at approximately 11 feet	
						SM	Very dense, brown-gray, moist to wet, slightly gravelly, silty SAND (Weathered Till)	
12	400						Perched water in sand lenses	ATD
		5	b2	50/ 6"	W = 9 GS			
14	398					SM	Very dense, brown, moist, slightly gravelly, silty SAND (Till)	
		6	b2	50/ 6"				
16	396							
18								
20								

Drilling Method: Hollow-stem Auger

Ground Elevation (ft): 412

Drilled By: Geologic Drill/CM/AD

Boring Completed 06/03/23
Total Depth of Boring = 16.5 ft.

Notes: Approximate Elevations Obtained from Snohomish County PDS Map Portal

23-0066 6/23/23 X:\PROJECTS GEO\0-PROJECTS 2023-GEO\GEOTECH EVALUATION\MUKILTEO SD-23-0066-MUKILTEO ELEMENTARY SCHOOL\GINT\MUKILTEO ELEMENTARY SCHOOL.GPJ SOIL BORING LOG W/ ELEV

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Mukilteo Elementary School
2600 Mukilteo Speedway
Mukilteo, Washington

Log of B-12

B-13

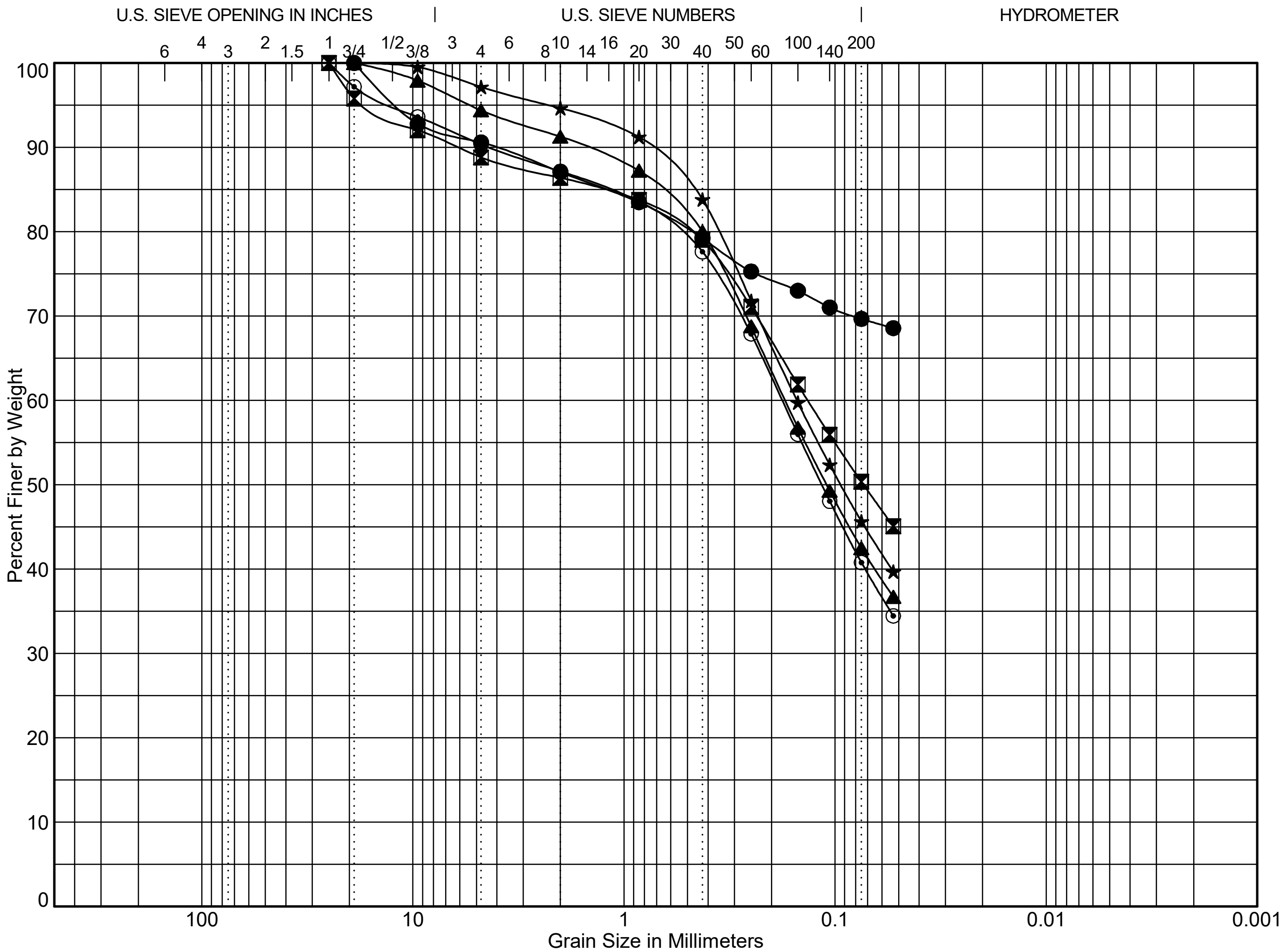
Drilling Method: Hollow-stem Auger
Ground Elevation (ft): 412
Drilled By: Geologic Drill/CM/AD

Depth (ft)	Elevation	Sample Number & Interval	Sampler Type	Blows/Foot	Test Data	USCS Symbol	Soil Profile	Water Level
0	412					SM	Loose, gray, moist, slightly gravelly, silty SAND (Field Sand)	
						SM	Medium dense, gray-dark brown, moist, slightly gravelly, silty SAND with pockets of organics (Fill)	
2	410	1	b2	19				
4	408					SM	Medium dense, gray-brown, moist to wet, silty SAND with pockets and layers of wet sand (Fill)	
6	406	2	b2	21				
		3	b2	21				ATD
8	404							
						SM	Dense, brown, moist, gravelly, silty SAND (Weathered Till)	
10	402	4	b2	44				
						SM	Very dense, orange-brown, moist, slightly gravelly, silty SAND, oxidation throughout (Weathered Till)	
12	400	5	b2	50				
14	398							

Boring Completed 06/03/23
Total Depth of Boring = 14.0 ft.

Refusal at 14 feet

Notes: Approximate Elevations Obtained from Snohomish County PDS Map Portal



Cobbles	Gravel		Sand			Silt or Clay
	coarse	fine	coarse	medium	fine	

Point		Depth	Classification	LL	PL	PI	C_c	C_u
●	B-1	20.5	Slightly gravelly, sandy SILT (ML)					
⧗	B-2	7.5	Slightly gravelly, sandy SILT (ML)					
▲	B-2	10.0	Slightly gravelly, very silty SAND (SM)					
★	B-3	7.5	Very silty SAND with trace gravel (SM)					
⊙	B-7	5.5	Slightly gravelly, very silty SAND (SM)					

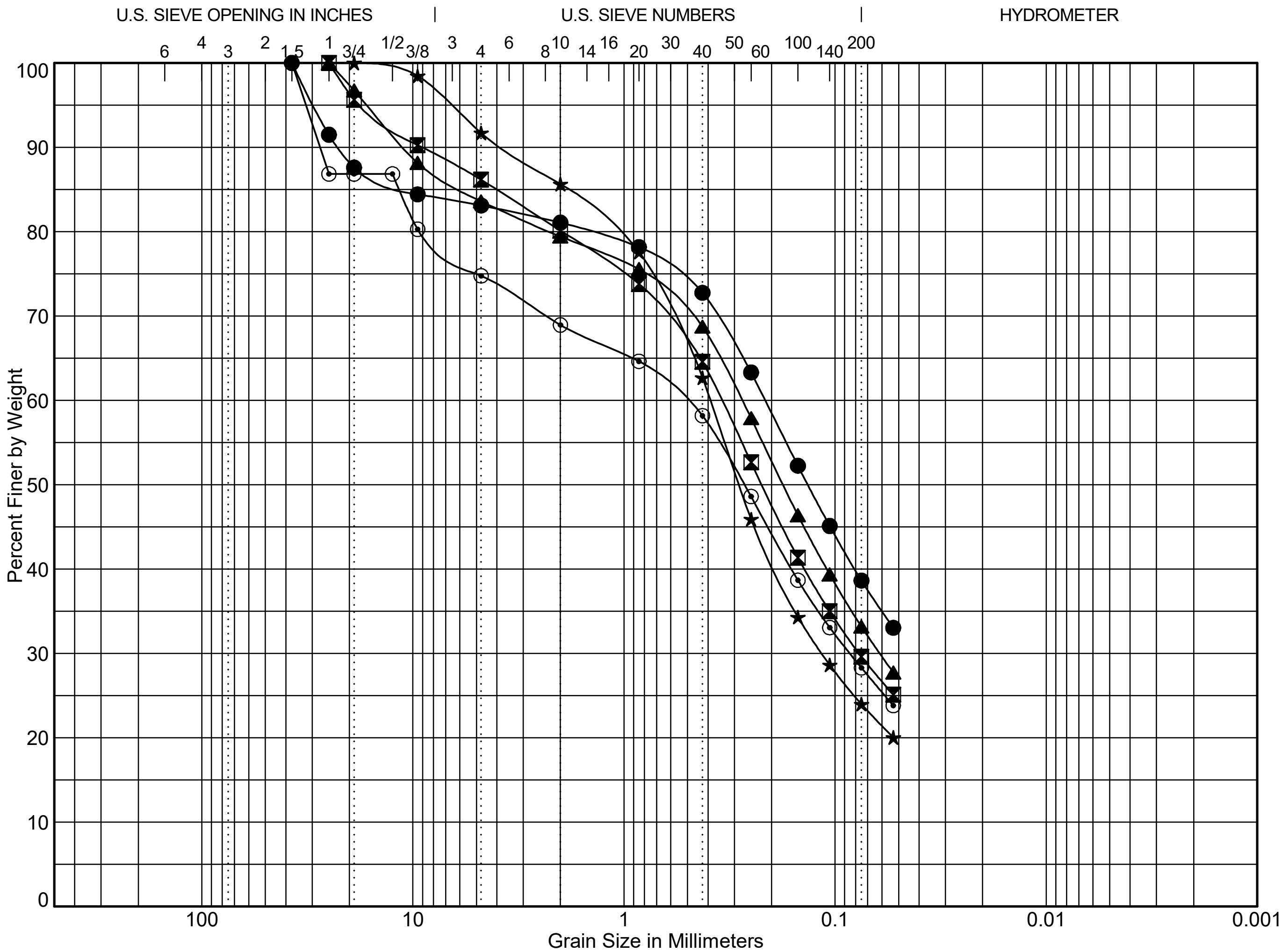
Point		Depth	D_{90}	D_{60}	D_{50}	D_{30}	D_{10}	%Coarse Gravel	% Fine Gravel	% Coarse Sand	% Medium Sand	% Fine Sand	% Fines
●	B-1	20.5	4.122					0.0	9.4	3.5	7.8	9.6	69.7
⧗	B-2	7.5	6.14	0.135	0.073			4.2	7.0	2.4	7.3	28.7	50.3
▲	B-2	10.0	1.53	0.172	0.11			0.0	5.6	3.1	11.2	37.5	42.5
★	B-3	7.5	0.758	0.152	0.094			0.0	2.8	2.5	10.8	38.2	45.6
⊙	B-7	5.5	4.33	0.178	0.115			2.8	6.8	3.2	9.5	36.8	40.8

$C_c = D_{30}^2/(D_{60} * D_{10})$ To be well graded: $1 < C_c < 3$ and

$C_u = D_{60}/D_{10}$ $C_u > 4$ for GW or $C_u > 6$ for SW

GEOTEST An RMA Company

Mukilteo Elementary School 2600 Mukilteo Speedway Mukilteo, Washington	Grain Size Test Data	Figure 25



Cobbles	Gravel		Sand			Silt or Clay
	coarse	fine	coarse	medium	fine	

Point	Depth	Classification	LL	PL	PI	C_c	C_u
● B-8	5.0	Gravelly, very silty SAND (SM)					
⧗ B-9	2.5	Gravelly, very silty SAND (SM)					
▲ B-11	5.0	Gravelly, very silty SAND (SM)					
★ B-12	12.5	Slightly gravelly, silty SAND (SM)					
⊙ TP-1	8.0	Gravelly, silty SAND (SM)					

Point	Depth	D_{90}	D_{60}	D_{50}	D_{30}	D_{10}	%Coarse Gravel	% Fine Gravel	% Coarse Sand	% Medium Sand	% Fine Sand	% Fines
● B-8	5.0	22.513	0.215	0.134			12.4	4.5	2.0	8.3	34.1	38.6
⧗ B-9	2.5	9.087	0.347	0.222	0.077		4.4	9.5	6.0	15.5	35.0	29.6
▲ B-11	5.0	11.032	0.277	0.176	0.061		3.3	13.1	4.2	10.7	35.6	33.2
★ B-12	12.5	3.725	0.39	0.285	0.115		0.0	8.3	6.1	23.0	38.7	24.0
⊙ TP-1	8.0	27.556	0.517	0.27	0.085		13.2	12.1	5.8	10.8	29.9	28.3

$C_c = D_{30}^2/(D_{60} * D_{10})$ To be well graded: $1 < C_c < 3$ and

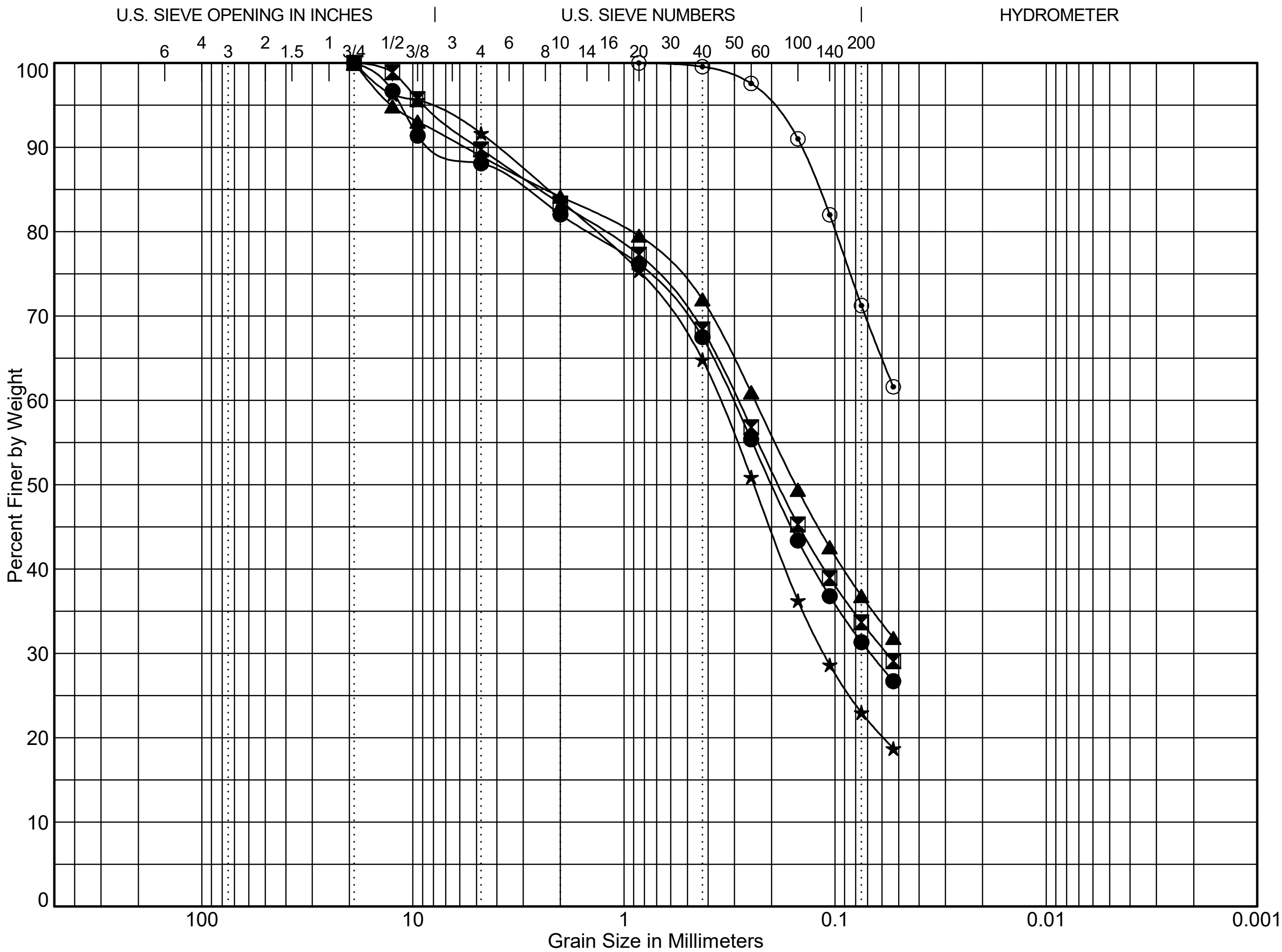
$C_u = D_{60}/D_{10}$ $C_u > 4$ for GW or $C_u > 6$ for SW

GEOTEST An RMA Company

Mukilteo Elementary School
2600 Mukilteo Speedway
Mukilteo, Washington

Grain Size Test Data

Figure 26



Cobbles	Gravel		Sand			Silt or Clay
	coarse	fine	coarse	medium	fine	

Point	Depth	Classification	LL	PL	PI	C_c	C_u
● TP-2	6.0	Gravelly, very silty SAND (SM)					
⧗ TP-3	4.0	Slightly gravelly, very silty SAND (SM)					
▲ TP-4	4.0	Slightly gravelly, very silty SAND (SM)					
★ TP-4	6.0	Slightly gravelly, silty SAND (SM)					
⊙ TP-5	8.3	Sandy SILT (ML)					

Point	Depth	D_{90}	D_{60}	D_{50}	D_{30}	D_{10}	%Coarse Gravel	% Fine Gravel	% Coarse Sand	% Medium Sand	% Fine Sand	% Fines
● TP-2	6.0	7.102	0.306	0.199	0.068		0.0	11.9	6.1	14.5	36.2	31.3
⧗ TP-3	4.0	4.895	0.289	0.185	0.057		0.0	10.3	6.4	14.9	34.7	33.7
▲ TP-4	4.0	5.676	0.24	0.154			0.0	11.1	4.8	12.2	35.1	36.8
★ TP-4	6.0	3.97	0.354	0.242	0.113		0.0	8.4	7.9	18.9	41.8	23.0
⊙ TP-5	8.3	0.144					0.0	0.0	0.0	0.4	28.3	71.2

$C_c = D_{30}^2/(D_{60} * D_{10})$ To be well graded: $1 < C_c < 3$ and

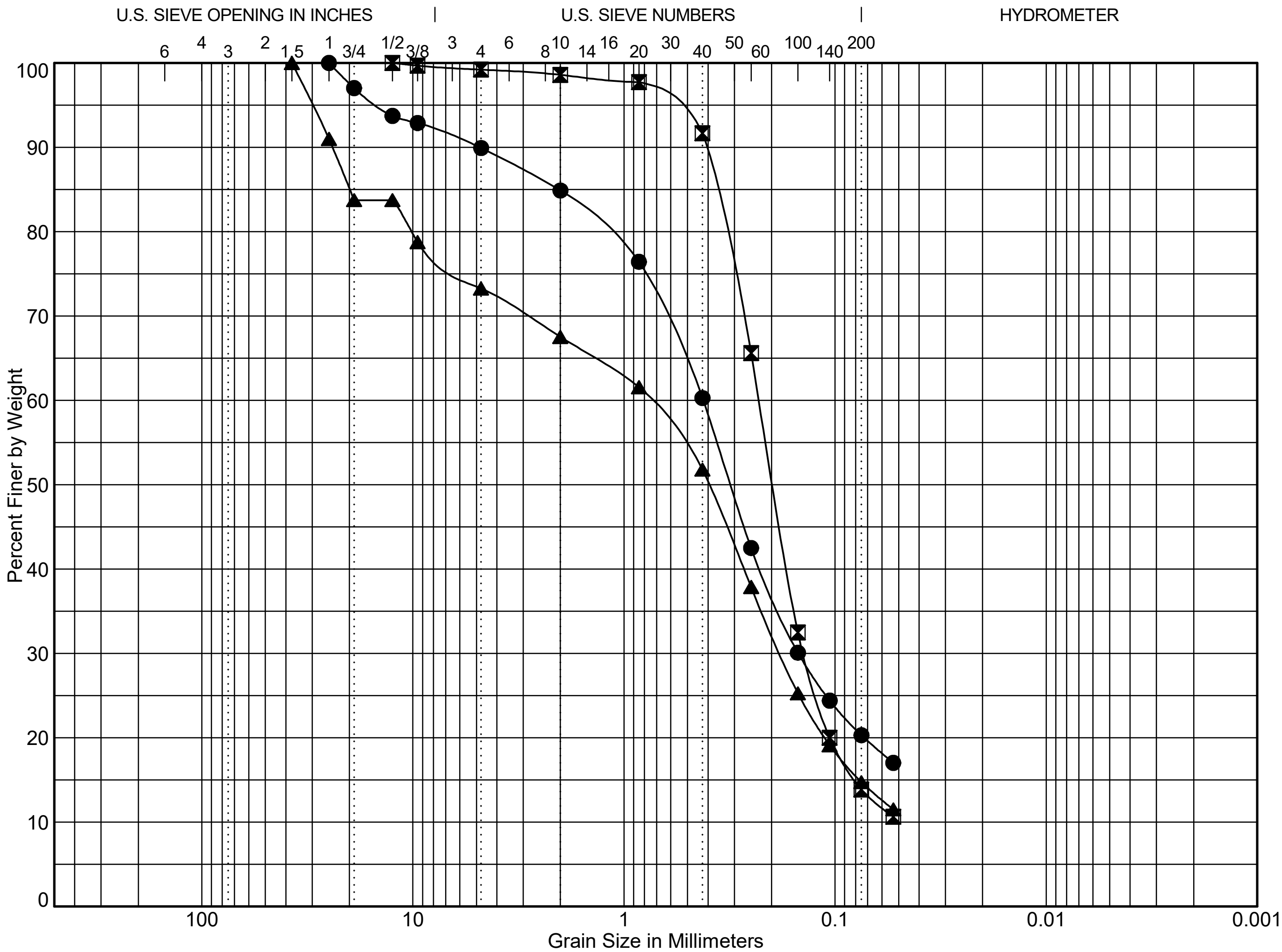
$C_u = D_{60}/D_{10}$ $C_u > 4$ for GW or $C_u > 6$ for SW

GEOTEST

Mukilteo Elementary School
2600 Mukilteo Speedway
Mukilteo, Washington

Grain Size Test Data

Figure 27



Cobbles	Gravel		Sand			Silt or Clay
	coarse	fine	coarse	medium	fine	

Point	Depth	Classification	LL	PL	PI	C_c	C_u
● TP-6	2.0	Slightly gravelly, silty SAND (SM)					
⧗ TP-6	6.0	Silty SAND (SM)					
▲ TP-7	3.5	Silty, gravelly SAND (SM)					

Point	Depth	D_{90}	D_{60}	D_{50}	D_{30}	D_{10}	%Coarse Gravel	% Fine Gravel	% Coarse Sand	% Medium Sand	% Fine Sand	% Fines
● TP-6	2.0	4.84	0.422	0.313	0.149		3.0	7.1	5.0	24.6	40.0	20.3
⧗ TP-6	6.0	0.411	0.229	0.197	0.14		0.0	0.8	0.6	6.9	77.8	13.9
▲ TP-7	3.5	24.079	0.761	0.397	0.182		16.3	10.5	5.8	15.7	37.0	14.7

$C_c = D_{30}^2/(D_{60} * D_{10})$

$C_u = D_{60}/D_{10}$

To be well graded: $1 < C_c < 3$ and $C_u > 4$ for GW or $C_u > 6$ for SW

GEOTEST An RMA Company

Mukilteo Elementary School
2600 Mukilteo Speedway
Mukilteo, Washington

Grain Size Test Data

Figure 28

Northwest Agricultural Consultants

2545 W Falls Avenue
Kennewick, WA 99336
509.783.7450
www.nwag.com
lab@nwag.com

PAP-Accredited
NAPT

GeoTest Services Inc.
741 Marine Drive
Bellingham, WA 98225

Report: 62478-1-1
Date: March 1, 2023
Project No: 23-0066
Project Name: Mukilteo Elementary School

Sample ID	pH	Organic Matter	Cation Exchange Capacity
TP2 @ 0.25’	5.7	4.49 %	10.9 meq/100g
TP2 @ 8.5’	6.1	1.84 %	7.0 meq/100g
TP6 @ 4.0’	6.4	1.21 %	8.6 meq/100g
TP7 @ 6.0’	6.2	1.05 %	8.5 meq/100g
Method	**SM 4500-H^+ B**	**ASTM D2974**	**EPA 9081**

REPORT LIMITATIONS AND GUIDELINES FOR ITS USE[1]

Subsurface issues may cause construction delays, cost overruns, claims, and disputes. While you cannot eliminate all such risks, you can manage them. The following information is provided to help:

Geotechnical Services are Performed for Specific Purposes, Persons, and Projects

At GeoTest our geotechnical engineers and geologists structure their services to meet specific needs of our clients. A geotechnical engineering study conducted for a civil engineer may not fulfill the needs of an owner, a construction contractor or even another civil engineer. Because each geotechnical engineering study is unique, each geotechnical engineering report is unique, prepared solely for the client. No one except you should rely on your geotechnical engineer who prepared it. And no one – not even you – should apply the report for any purpose or project except the one originally contemplated.

Read the Full Report

Serious problems have occurred because those relying on a geotechnical engineering report did not read it all. Do not rely on an executive summary. Do not read selected elements only.

A Geotechnical Engineering Report is Based on a Unique Set of Project-Specific Factors

GeoTest's geotechnical engineers consider a number of unique, project-specific factors when establishing the scope of a study. Typical factors include: the clients goals, objectives, and risk management preferences; the general nature of the structure involved its size, and configuration; the location of the structure on the site; and other planned or existing site improvements, such as access roads, parking lots, and underground utilities. Unless GeoTest, who conducted the study specifically states otherwise, do not rely on a geotechnical engineering report that 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.

1Information in this document is based upon material developed by ASFE, Professional Firms Practicing in the Geosciences(asfe.org)

Typical changes that can erode the reliability of an existing geotechnical engineering report include those that affect:

- the function of the proposed structure, as when it's changed, for example, from a parking garage to an office building, or from a light industrial plant to a refrigerated warehouse,
- elevation, configuration, location, orientation, or weight of the proposed construction,
- alterations in drainage designs; or
- composition of the design team; the passage of time; man-made alterations and construction whether on or adjacent to the site; or by natural alterations and events, such as floods, earthquakes or groundwater fluctuations; or project ownership.

Always inform GeoTest's geotechnical engineer of project changes – even minor ones – and request an assessment of their impact. Geotechnical engineers cannot accept responsibility or liability for problems that occur because their reports do not consider developments of which they were not informed.

Subsurface Conditions Can Change

This geotechnical or geologic report is based on conditions that existed at the time the study was performed. Do not rely on the findings and conclusions of this report, whose adequacy may have been affected by: the passage of time; by man-made events, such as construction on or adjacent to the site; or by natural events, such as floods, earthquakes, or groundwater fluctuations. Always contact GeoTest before applying the report to determine if it is still relevant. A minor amount of additional testing or analysis will help determine if the report remains applicable.

Most Geotechnical and Geologic Findings are Professional Opinions

Our site exploration identifies subsurface conditions only at those points where subsurface tests are conducted or samples are taken. GeoTest's engineers and geologists review field and laboratory data and then apply their professional judgment to render an opinion about subsurface conditions throughout the site. Actual subsurface conditions may differ – sometimes significantly – from those indicated in your report. Retaining GeoTest who developed this report to provide construction observation is the most effective method of managing the risks associated with anticipated or unanticipated conditions.

1Information in this document is based upon material developed by ASFE, Professional Firms Practicing in the Geosciences(asfe.org)

A Report's Recommendations are Not Final

Do not over-rely on the construction recommendations included in this report. Those recommendations are not final, because geotechnical engineers or geologists develop them principally from judgment and opinion. GeoTest's geotechnical engineers or geologists can finalize their recommendations only by observing actual subsurface conditions revealed during construction. GeoTest cannot assume responsibility or liability for the report's recommendations if our firm does not perform the construction observation.

A Geotechnical Engineering or Geologic Report may be Subject to Misinterpretation

Misinterpretation of this report by other design team members can result in costly problems. Lower that risk by having GeoTest confer with appropriate members of the design team after submitting the report. Also, we suggest retaining GeoTest to review pertinent elements of the design teams plans and specifications. Contractors can also misinterpret a geotechnical engineering report. Reduce that risk by having GeoTest participate in pre-bid and preconstruction conferences, and by providing construction observation.

Do not Redraw the Exploration Logs

Our geotechnical engineers and geologists prepare final boring and testing logs based upon their interpretation of field logs and laboratory data. To prevent errors of omissions, the logs included in this report should never be redrawn for inclusion in architectural or other design drawings. Only photographic or electronic reproduction is acceptable; but recognizes that separating logs from the report can elevate risk.

Give Contractors a Complete Report and Guidance

Some owners and design professionals mistakenly 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 report, but preface it with a clearly written letter of transmittal. In that letter, consider advising the 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 GeoTest 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 you be in a position to give contractors the best information available, while requiring them to at least share some of the financial responsibilities stemming from unanticipated conditions.

1Information in this document is based upon material developed by ASFE, Professional Firms Practicing in the Geosciences(asfe.org)

In addition, it is recommended that a contingency for unanticipated conditions be included in your project budget and schedule.

Read Responsibility Provisions Closely

Some clients, design professionals, and contractors do not recognize that geotechnical engineering or geology is far less exact than other engineering disciplines. This lack of understanding can create unrealistic expectations that can lead to disappointments, claims, and disputes. To help reduce risk, GeoTest includes an explanatory limitations section in our reports. Read these provisions closely. Ask questions and we encourage our clients or their representative to contact our office if you are unclear as to how these provisions apply to your project.

Environmental Concerns Are Not Covered in this Geotechnical or Geologic Report

The equipment, techniques, and personnel used to perform an environmental study differ significantly from those used to perform a geotechnical or geologic study. 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 containments, etc. If you have not yet obtained your own environmental information, ask your geotechnical consultant for risk management guidance. Do not rely on environmental report prepared for some one else.

Obtain Professional Assistance to Deal with Biological Pollutants

Diverse strategies can be applied during building design, construction, operation, and maintenance to prevent significant amounts biological pollutants from growing on indoor surfaces. Biological pollutants includes but is not limited to molds, fungi, spores, bacteria and viruses. To be effective, all such strategies should be devised for the express purpose of prevention, integrated into a comprehensive plan, and executed with diligent oversight by a professional biological pollutant prevention consultant. Because just a small amount of water or moisture can lead to the development of severe biological infestations, a number of prevention strategies focus on keeping building surfaces dry. While groundwater, water infiltration, and similar issues may have been addressed as part of this study, the geotechnical engineer or geologist in charge of this project is not a biological pollutant prevention consultant; none of the services preformed in connection with this geotechnical engineering or geological study were designed or conducted for the purpose of preventing biological infestations.

1Information in this document is based upon material developed by ASFE, Professional Firms Practicing in the Geosciences(asfe.org)