CITY OF MUKILTEO
Received by Email
05/02/2022

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August 11, 2021

JN 20255

SR'S Construction
9910 Marine View Drive
Mukilteo, Washington 98275

Attention: Shawn Roten
via email: seattlerestaurantbuilders@gmail.com

Subject: **Transmittal Letter – Geotechnical Engineering Study**
Proposed Residence
4th Street and Park Avenue
Mukilteo, Washington

Greetings:

Attached to this transmittal letter is our geotechnical engineering report for the single-family residence to be constructed in Mukilteo, Washington. The scope of our services consisted of exploring site surface and subsurface conditions, and then developing this report to provide recommendations for general earthwork and design considerations for foundations, retaining walls, subsurface drainage, and slope considerations. This work was authorized by your acceptance of our proposal, P-10644, dated July 23, 2020.

The attached report contains a discussion of the study and our recommendations. Please contact us if there are any questions regarding this report, or for further assistance during the design and construction phases of this project.

Respectfully submitted,

GEOTECH CONSULTANTS, INC.

D. Robert Ward, P.E.
Principal

DRW:kg

GEOTECHNICAL ENGINEERING STUDY
Proposed Residence Development
4th Street and Park Avenue
Mukilteo, Washington

This report presents the findings and recommendations of our geotechnical engineering study for the site of the proposed residential project to be located at 4th Street and Park Avenue in Mukilteo.

We were recently provided with a site plan of the project, as well as a topographic map of the site. The site plan was undated, but the topographic map is dated June 21, 2021 and was prepared by Group Four. Based on information we have received, we understand that the upper, flatter, southeastern portion of the site will be developed with a single-family residence. The northern side of the residence building will be located at or near an existing steep slope (which is discussed in detail in this report). We understand that the main floor and garage level of the residence will be close to the street grade, and it is unlikely that a basement will be included in the residence. Thus, the main floor level could be 4 to 8 feet above the outside grade at the northern side of the residence.

If the scope of the project changes from what we have described above, we should be provided with revised plans in order to determine if modifications to the recommendations and conclusions of this report are warranted.

SITE CONDITIONS

SURFACE

The Vicinity Map, Plate 1, illustrates the general location of the site in Mukilteo relatively close to the ferry terminal. The rectangular property has approximately 90 feet of frontage on its southern side along the right-of-way of 4th Street and a length of approximately 120 feet. The property is undeveloped and mostly densely covered with low growing vegetation. It slopes overall downward to the north/northwest (mostly northwest). At the northeastern corner of the site, the slope inclination is gentle to moderate. However, there is a very steep portion, that is about 12 to 15 feet tall and inclined around 90 percent, that extends northeasterly through the central portion of the site. The slope inclination declines from the base of the very steep slope down to approximately the northwestern corner of site with mostly a moderate inclination. The upper elevation at the southeastern corner of the site is approximately 92 feet based on available topographic information, while the lower elevation at the northwestern corner is near elevation 55 feet based on Snohomish County GIS information. A ravine is adjacent to the western edge of the property, and it appears the lowest portion of the ravine is at about elevation 50 feet just northwest of the site based on the GIS information.

Only little development surrounds the site. Most notably is a paved parking lot adjacent to the eastern edge of the site.

SUBSURFACE

The subsurface conditions were explored by drilling three test borings at the approximate locations shown on the Site Exploration Plan, Plate 2. Our exploration program was based on the proposed construction, anticipated subsurface conditions and those encountered during exploration, and the scope of work outlined in our proposal.

The test borings were drilled on August 6, 2020 using a small track-mounted, hollow-stem auger drill. Samples were taken at approximate 5-foot intervals with a standard penetration sampler. This split-spoon sampler, which has a 2-inch outside diameter, is driven into the soil with a 140-pound hammer falling 30 inches. The number of blows required to advance the sampler a given distance is an indication of the soil density or consistency. A geotechnical engineer from our staff observed the drilling process, logged the test borings, and obtained representative samples of the soil encountered. The Test Boring Logs are attached as Plates 3 through 5.

Soil Conditions

The uppermost soil revealed in the three test borings consisted of about 3 to 7 feet of loose, unengineered fill. Native sand soil that is in a medium-dense condition was revealed below the fill. In two of the test borings, the sand became medium-dense to dense at approximately 20 feet. In the third test boring, this soil was revealed closer to 10 feet and a lens of silt/silty sand was revealed in the sand around 15 feet. The sand soil was revealed to the maximum explored depth of approximately 40 feet.

Groundwater Conditions

Groundwater seepage was observed in the test borings at approximately elevation 48 feet to 53 feet. However, the test borings were left open for only a short time period. Therefore, the seepage levels on the logs represent the location of transient water seepage and may not indicate the static groundwater level. Groundwater levels encountered during drilling can be deceptive, because seepage into the boring can be blocked or slowed by the auger itself. It should be noted that groundwater levels vary seasonally with rainfall and other factors.

The stratification lines on the logs represent the approximate boundaries between soil types at the exploration locations. The actual transition between soil types may be gradual, and subsurface conditions can vary between exploration locations. The logs provide specific subsurface information only at the locations tested. Where a transition in soil type occurred between samples in the borings, the depth of the transition was interpreted. The relative densities and moisture descriptions indicated on the test boring logs are interpretive descriptions based on the conditions observed during drilling.

CONCLUSIONS AND RECOMMENDATIONS

GENERAL

THIS SECTION CONTAINS A SUMMARY OF OUR STUDY AND FINDINGS FOR THE PURPOSES OF A GENERAL OVERVIEW ONLY. MORE SPECIFIC RECOMMENDATIONS AND CONCLUSIONS ARE CONTAINED IN THE REMAINDER OF THIS REPORT. ANY PARTY RELYING ON THIS REPORT SHOULD READ THE ENTIRE DOCUMENT.

The test borings conducted for this study encountered native, mostly sand soil at depths of approximately 3 to 7 feet below a surficial layer of loose fill soil. The sand was initially medium-dense, but became denser at depths ranging from about 10 to 20 feet (in two of the three test borings, the denser sand was revealed at approximately the 20-foot range). Due to the inconsistent depth to the denser sand, the loose condition of the near-surface soil, and the steep, approximate 12- to 15-foot-tall steep slope that borders the northern side of the proposed residence building, we recommend that the building be founded on deep foundations that embed into the denser sand soil. Small-diameter pipe piles driven to refusal, which are somewhat common for the loads of the proposed building and soil conditions, could be utilized, but the depths to reach refusal could be very deep (potentially greater than 40 feet). Another, possibly more viable deep foundation option, is helical anchors; these need only to be embedded approximately 25 feet below the ground surface where the dense sand was consistently revealed. Information regarding helical anchors is given in a subsequent section of this report.

With the exception of the steep, approximate 12- to 15-foot-tall steep slope that traverses the site (and will border the northern end of the proposed building), the site inclination is only moderate (in the range of 25 to 30 percent inclination). Therefore, because of the condition of the native sand soils revealed in the test borings, we believe the site stability is generally suitable with the exception of the steep slope. There is a potential of instability of the steep portion of the site, but we believe that such potential is mitigated for this development because the proposed building will be founded on the deep, helical anchor foundation that will be embedded at least 25 feet below the existing ground. Therefore, we believe that extending the northern side of the building to or near the steep slope is suitable – no buffer or building setback is needed in our professional opinion if the recommendations in this report are followed. Water from permanent impermeable surfaces should not be allowed to flow uncontrolled over the top of or onto the steep onsite slope.

As noted earlier, the lowest floor of the residence will likely be the main floor, and this floor could be situated 4 to 8 feet above the outside ground level at the northern side of the residence. We recommend that a crawl space be left under the main floor; a slab should not be used because that would require a large amount of fill soil be placed on the site which would impose a load on the steep onsite slope.

The erosion control measures needed during the site development will depend heavily on the weather conditions that are encountered. We anticipate that a silt fence will be needed around the downslope sides of any cleared areas. Existing pavements, ground cover, and landscaping should be left in place wherever possible to minimize the amount of exposed soil. Rocked staging areas and construction access roads should be provided to reduce the amount of soil or mud carried off the property by trucks and equipment. Wherever possible, the access roads should follow the alignment of planned pavements. Trucks should not be allowed to drive off of the rock-covered areas. Cut slopes and soil stockpiles should be covered with plastic during wet weather. Following clearing or rough grading, it may be necessary to mulch or hydroseed bare areas that will not be immediately covered with landscaping or an impervious surface. On most construction projects, it is necessary to periodically maintain or modify temporary erosion control measures to address specific site and weather conditions.

The drainage and/or waterproofing recommendations presented in this report are intended only to prevent active seepage from flowing through concrete walls or slabs. Even in the absence of active seepage into and beneath structures, water vapor can migrate through walls, slabs, and floors from the surrounding soil, and can even be transmitted from slabs and foundation walls due to the concrete curing process. Water vapor also results from occupant uses, such as cooking, cleaning, and bathing. Excessive water vapor trapped within structures can result in a variety of undesirable conditions, including, but not limited to, moisture problems with flooring systems, excessively moist air within occupied areas, and the growth of molds, fungi, and other biological organisms that may be harmful to the health of the occupants. The designer or architect must consider the potential vapor sources and likely occupant uses, and provide sufficient ventilation, either passive or mechanical, to prevent a build up of excessive water vapor within the planned structure.

Geotech Consultants, Inc. should be allowed to review the final development plans to verify that the recommendations presented in this report are adequately addressed in the design. Such a plan review would be additional work beyond the current scope of work for this study, and it may include revisions to our recommendations to accommodate site, development, and geotechnical constraints that become more evident during the review process.

We recommend including this report, in its entirety, in the project contract documents. This report should also be provided to any future property owners so they will be aware of our findings and recommendations.

SEISMIC CONSIDERATIONS

In accordance with the International Building Code (IBC), the site class within 100 feet of the ground surface is best represented by Site Class Type D (Stiff Soil). As noted in the USGS website, the mapped spectral acceleration value for a 0.2 second (S_s) and 1.0 second period (S_1) equals 1.40g and 0.50g, respectively.

The IBC and ASCE 7 require that the potential for liquefaction (soil strength loss) during an earthquake be evaluated for the peak ground acceleration of the Maximum Considered Earthquake (MCE), which has a probability of occurring once in 2,475 years (2 percent probability of occurring in a 50-year period). The MCE peak ground acceleration adjusted for site class effects (F_{PGA}) equals 0.67g. The soils beneath the site that are below the water table have a very low potential for seismic liquefaction under the ground motions of the MCE.

Sections 1803.5 of the IBC and 11.8 of ASCE 7 require that other seismic-related geotechnical design parameters (seismic surcharge for retaining wall design and slope stability) include the potential effects of the Design Earthquake. The peak ground acceleration for the Design Earthquake is defined in Section 11.2 of ASCE 7 as two-thirds (2/3) of the MCE peak ground acceleration, or 0.44g.

HELICAL ANCHORS

Helical anchors consist of single or multiple helixes that are rotated into the ground on the end of round or square metal shafts. These anchors can be used to support both compression and tension loads, but their lateral capacity is negligible due to the relatively small diameter of the metal shafts. The design capacity of single helix anchors is the allowable soil bearing capacity on the helix area. Multiple-helix anchors are typically assumed to have a design capacity equal to the sum of the allowable bearing capacity on each helix, if they are separated more than three helix diameters.

The minimum diameter of a single helix anchor is 8 inches. The ultimate capacity of the anchor in tension or compression can be estimated roughly by multiplying the installation torque by 10. We recommend that the helix be installed at least 5 feet into competent native soil or to a depth of 25 feet, whichever is deeper. A typical anchor capacity for small to mid-size anchors in the site soils is 15 to 20 kips. The anchors should be installed by a specialty contractor familiar with design and installation of chance systems. The contractor can assist with refining the anchor design and details and estimating capacities for different soil and anchor conditions. At least one anchor should be load tested to at least 200 percent of the design load to verify the allowable capacity. Due to the moderate depth that the helical anchors will be embedded and the existence of the steep slope at the northern edge of the proposed buildings, we recommend that a shaft diameter of at least 3.5 inches be used for this project.

Lateral loads imposed on the residence building may be resisted by passive earth pressure acting on the vertical, embedded portions of the foundation. For this condition, the foundation must be either poured directly against relatively level, undisturbed soil or surrounded by level structural fill. We recommend using a passive earth pressure of 350 pounds per cubic foot (pcf) for this resistance. If the ground in front of a foundation is loose or sloping, such as along the northern edge of the buildings, the passive earth pressure given above will not be appropriate. We recommend a safety factor of at least 1.5 for the foundation's resistance to lateral loading, when using the above ultimate passive value. If additional lateral resistance is needed, the helical anchors can be angled and used in tension.

Pile caps and grade beams should be used to transmit loads to the piles. A minimum of two piles should be used in isolated pile caps, in order to prevent eccentric loading on individual piles.

FOUNDATION AND RETAINING WALLS

Retaining walls backfilled on only one side should be designed to resist the lateral earth pressures imposed by the soil they retain. The following recommended parameters are for walls that restrain level backfill:

PARAMETER	VALUE
Active Earth Pressure *	40 pcf
Passive Earth Pressure	300 pcf
Coefficient of Friction	0.45
Soil Unit Weight	XX0 pcf

Where: pcf is Pounds per Cubic Foot, and Active and Passive Earth Pressures are computed using the Equivalent Fluid Pressures.

*** For a restrained wall that cannot deflect at least 0.002 times its height, a uniform lateral pressure equal to 10 psf times the height of the wall should be added to the above active equivalent fluid pressure. This applies only to walls with level backfill.**

The design values given above do not include the effects of any hydrostatic pressures behind the walls and assume that no surcharges, such as those caused by slopes, vehicles, or adjacent foundations will be exerted on the walls. If these conditions exist, those pressures should be added to the above lateral soil pressures. Where sloping backfill is desired behind the walls, we will need to be given the wall dimensions and the slope of the backfill in order to provide the appropriate design earth pressures. The surcharge due to traffic loads behind a wall can typically be accounted for by adding a uniform pressure equal to 2 feet multiplied by the above active fluid density. Heavy construction equipment should not be operated behind retaining and foundation walls within a distance equal to the height of a wall, unless the walls are designed for the additional lateral pressures resulting from the equipment.

The values given above are to be used to design only permanent foundation and retaining walls that are to be backfilled, such as conventional walls constructed of reinforced concrete or masonry. It is not appropriate to use the above earth pressures and soil unit weight to back-calculate soil strength parameters for design of other types of retaining walls, such as soldier pile, reinforced earth, modular or soil nail walls. We can assist with design of these types of walls, if desired.

The passive pressure given is appropriate only for a shear key poured directly against undisturbed native soil, or for the depth of level, well-compacted fill placed in front of a retaining or foundation wall. The values for friction and passive resistance are ultimate values and do not include a safety factor. Restrained wall soil parameters should be utilized the wall and reinforcing design for a distance of 1.5 times the wall height from corners or bends in the walls, or from other points of restraint. This is intended to reduce the amount of cracking that can occur where a wall is restrained by a corner.

Wall Pressures Due to Seismic Forces

Per IBC Section 1803.5.12, a seismic surcharge load need only be considered in the design of walls over 6 feet in height. A seismic surcharge load would be imposed by adding a uniform lateral pressure to the above-recommended active pressure. The recommended seismic surcharge pressure for this project is 9**H** pounds per square foot (psf), where **H** is the design retention height of the wall. Using this increased pressure, the safety factor against sliding and overturning can be reduced to 1.2 for the seismic analysis.

Retaining Wall Backfill and Waterproofing

Backfill placed behind retaining or foundation walls should be coarse, free-draining structural fill containing no organics. This backfill should contain no more than 5 percent silt or clay particles and have no gravel greater than 4 inches in diameter. The percentage of particles passing the No. 4 sieve should be between 25 and 70 percent. If the native sand is used as backfill, a drainage composite similar to Miradrain 6000 should be placed against the backfilled retaining walls. The drainage composite should be hydraulically connected to the foundation drain system. The later section entitled ***Drainage Considerations*** should also be reviewed for recommendations related to subsurface drainage behind foundation and retaining walls.

The purpose of these backfill requirements is to ensure that the design criteria for a retaining wall are not exceeded because of a build-up of hydrostatic pressure behind the wall. Also, subsurface drainage systems are not intended to handle large volumes of water from surface runoff. The top 12 to 18 inches of the backfill should consist of a compacted, relatively impermeable soil or topsoil, or the surface should be paved. The ground surface must also slope away from backfilled walls at one to 2 percent to reduce the potential for surface water to percolate into the backfill.

Water percolating through pervious surfaces (pavers, gravel, permeable pavement, etc.) must also be prevented from flowing toward walls or into the backfill zone. Foundation drainage and waterproofing systems are not intended to handle large volumes of infiltrated water. The compacted subgrade below pervious surfaces and any associated drainage layer should therefore be sloped away. Alternatively, a membrane and subsurface collection system could be provided below a pervious surface.

It is critical that the wall backfill be placed in lifts and be properly compacted, in order for the above-recommended design earth pressures to be appropriate. The recommended wall design criteria assume that the backfill will be well-compacted in lifts no thicker than 12 inches. The compaction of backfill near the walls should be accomplished with hand-operated equipment to prevent the walls from being overloaded by the higher soil forces that occur during compaction. The section entitled ***General Earthwork and Structural Fill*** contains additional recommendations regarding the placement and compaction of structural fill behind retaining and foundation walls.

The above recommendations are not intended to waterproof below-grade walls, or to prevent the formation of mold, mildew or fungi in interior spaces. Over time, the performance of subsurface drainage systems can degrade, subsurface groundwater flow patterns can change, and utilities can break or develop leaks. Therefore, waterproofing should be provided where future seepage through the walls is not acceptable. This typically includes limiting cold-joints and wall penetrations, and using bentonite panels or membranes on the outside of the walls. There are a variety of different waterproofing materials and systems, which should be installed by an experienced contractor familiar with the anticipated construction and subsurface conditions. Applying a thin coat of asphalt emulsion to the outside face of a wall is not considered waterproofing, and will only help to reduce moisture generated from water vapor or capillary action from seeping through the concrete. As with any project, adequate ventilation of basement and crawl space areas is important to prevent a buildup of water vapor that is commonly transmitted through concrete walls from the surrounding soil, even when seepage is not present. This is appropriate even when waterproofing is applied to the outside of foundation and retaining walls. We recommend that you contact an experienced envelope consultant if detailed recommendations or specifications related to waterproofing design, or minimizing the potential for infestations of mold and mildew are desired.

The ***General***, ***Slabs-On-Grade***, and ***Drainage Considerations*** sections should be reviewed for additional recommendations related to the control of groundwater and excess water vapor for the anticipated construction.

SLABS-ON-GRADE

A slab-on-grade can be used a building floor if 2 feet or less of structural fill is used above the existing ground. The slabs-on-grade can be constructed on the structural fill or on firm existing soil. The subgrade soil must be in a firm, non-yielding condition at the time of slab construction or underslab fill placement. Any soft areas encountered should be excavated and replaced with select, imported structural fill.

Even where the exposed soils appear dry, water vapor will tend to naturally migrate upward through the soil to the new constructed space above it. This can affect moisture-sensitive flooring, cause imperfections or damage to the slab, or simply allow excessive water vapor into the space above the slab. All interior slabs-on-grade should be underlain by a capillary break drainage layer consisting of a minimum 4-inch thickness of clean gravel or crushed rock that has a fines content (percent passing the No. 200 sieve) of less than 3 percent and a sand content (percent passing the No. 4 sieve) of no more than 10 percent. Pea gravel or crushed rock are typically used for this layer.

As noted by the American Concrete Institute (ACI) in the *Guides for Concrete Floor and Slab Structures*, proper moisture protection is desirable immediately below any on-grade slab that will be covered by tile, wood, carpet, impermeable floor coverings, or any moisture-sensitive equipment or products. ACI recommends a minimum 10-mil thickness vapor retarder for better durability and long term performance than is provided by 6-mil plastic sheeting that has historically been used. A vapor retarder is defined as a material with a permeance of less than 0.3 perms, as determined by ASTM E 96. It is possible that concrete admixtures may meet this specification, although the manufacturers of the admixtures should be consulted. Where vapor retarders are used under slabs, their edges should overlap by at least 6 inches and be sealed with adhesive tape. The sheeting should extend to the foundation walls for maximum vapor protection.

If no potential for vapor passage through the slab is desired, a vapor *barrier* should be used. A vapor barrier, as defined by ACI, is a product with a water transmission rate of 0.01 perms when tested in accordance with ASTM E 96. Reinforced membranes having sealed overlaps can meet this requirement.

We recommend that the contractor, the project materials engineer, and the owner discuss these issues and review recent ACI literature and ASTM E-1643 for installation guidelines and guidance on the use of the protection/blotter material.

The ***General***, ***Permanent Foundation and Retaining Walls***, and ***Drainage Considerations*** sections should be reviewed for additional recommendations related to the control of groundwater and excess water vapor for the anticipated construction.

EXCAVATIONS AND SLOPES

Temporary excavation slopes should not exceed the limits specified in local, state, and national government safety regulations. Also, temporary cuts should be planned to provide a minimum 2 to 3 feet of space for construction of foundations, walls, and drainage. Temporary cuts to a maximum overall depth of about 4 feet may be attempted vertically in unsaturated soil, if there are no indications of slope instability. However, vertical cuts should not be made near property boundaries, or existing utilities and structures. Based upon Washington Administrative Code (WAC) 296, Part N, the soil at the subject site would generally be classified as Type B. Therefore, temporary cut slopes greater than 4 feet in height should not be excavated at an inclination steeper than 1:1 (Horizontal:Vertical), extending continuously between the top and the bottom of a cut.

The above-recommended temporary slope inclination based on the conditions exposed in our explorations, and on what has been successful at other sites with similar soil conditions. It is possible that variations in soil and groundwater conditions will require modifications to the inclination at which temporary slopes can stand. Temporary cuts are those that will remain unsupported for a relatively short duration to allow for the construction of foundations, retaining walls, or utilities. Temporary cut slopes should be protected with plastic sheeting during wet weather. It is also important that surface runoff be directed away from the top of temporary slope cuts. Cut slopes should also be backfilled or retained as soon as possible to reduce the potential for instability. Please note that loose soil can cave suddenly and without warning. Excavation, foundation, and utility contractors should be made especially aware of this potential danger. These recommendations may need to be modified if the area near the potential cuts has been disturbed in the past by utility installation, or if settlement-sensitive utilities are located nearby.

<u>Water from permanent impermeable surfaces should not be allowed to flow uncontrolled over the top of or onto the steep onsite slope.</u> The surfaced water should be directed away from the slope. In addition, all permanently exposed areas on the site that are not covered with the buildings or

impermeable surfaces should be seeded with an appropriate species of vegetation to reduce erosion and improve the stability of the surficial layer of soil.

DRAINAGE CONSIDERATIONS

Footing drains should be used for this project where: (1) crawl spaces or basements will be below a structure; (2) a slab is below the outside grade; or, (3) the outside grade does not slope downward from a building. Drains should also be placed at the base of all earth-retaining walls. These drains should be surrounded by at least 6 inches of 1-inch-minus, washed rock that is encircled with non-woven, geotextile filter fabric (Mirafi 140N, Supac 4NP, or similar material). At its highest point, a perforated pipe invert should be at least 6 inches below the bottom of a slab floor or the level of a crawl space. The discharge pipe for subsurface drains should be sloped for flow to the outlet point. Roof and surface water drains must not discharge into the foundation drain system. For the best long-term performance, perforated PVC pipe is recommended for all subsurface drains. Clean-outs should be provided for potential future flushing or cleaning of footing drains.

As a minimum, a vapor retarder, as defined in the ***Slabs-On-Grade*** section, should be provided in any crawl space area to limit the transmission of water vapor from the underlying soils. Crawl space grades are sometimes left near the elevation of the bottom of the footings. As a result, an outlet drain is recommended for all crawl spaces to prevent an accumulation of any water that may bypass the footing drains. Providing a few inches of free draining gravel underneath the vapor retarder is also prudent to limit the potential for seepage to build up on top of the vapor retarder.

No shallow groundwater was observed during our field work. If seepage is encountered in an excavation, it should be drained from the site by directing it through drainage ditches, perforated pipe, or French drains, or by pumping it from sumps interconnected by shallow connector trenches at the bottom of the excavation.

The excavation and site should be graded so that surface water is directed off the site and away from the tops of slopes. Water should not be allowed to stand in any area where foundations, slabs, or pavements are to be constructed. Water from permanent impermeable surfaces should not be allowed to flow uncontrolled over the top of or onto the steep onsite slope. Final site grading in areas adjacent to residences should slope away at least one to 2 percent, except where the area is paved. Surface drains should be provided where necessary to prevent ponding of water behind foundation or retaining walls. A discussion of grading and drainage related to pervious surfaces near walls and structures is contained in the ***Foundation and Retaining Walls*** section.

GENERAL EARTHWORK AND STRUCTURAL FILL

All building and pavement areas should be stripped of surface vegetation, topsoil, organic soil, and other deleterious material. The stripped or removed materials should not be mixed with any materials to be used as structural fill, but they could be used in non-structural areas, such as landscape beds.

Structural fill is defined as any fill, including utility backfill, placed under, or close to, a building, or in other areas where the underlying soil needs to support loads. All structural fill should be placed in horizontal lifts with a moisture content at, or near, the optimum moisture content. The optimum moisture content is that moisture content that results in the greatest compacted dry density. The moisture content of fill is very important and must be closely controlled during the filling and compaction process.

The allowable thickness of the fill lift will depend on the material type selected, the compaction equipment used, and the number of passes made to compact the lift. The loose lift thickness should not exceed 12 inches, but should be thinner if small, hand-operated compactors are used. We recommend testing structural fill as it is placed. If the fill is not sufficiently compacted, it should be recompacted before another lift is placed. This eliminates the need to remove the fill to achieve the required compaction. The following table presents recommended levels of relative compaction for compacted fill:

LOCATION OF FILL PLACEMENT	MINIMUM RELATIVE COMPACTION
Beneath slabs or walkways	95%
Filled slopes and behind retaining walls	90%
Beneath pavements	95% for upper 12 inches of subgrade; 90% below that level

Where: Minimum Relative Compaction is the ratio, expressed in percentages, of the compacted dry density to the maximum dry density, as determined in accordance with ASTM Test Designation D 1557-91 (Modified Proctor).

The ***General*** section should be reviewed for considerations related to the reuse of on-site soils. Structural fill that will be placed in wet weather should consist of a coarse, granular soil with a silt or clay content of no more than 5 percent. The percentage of particles passing the No. 200 sieve should be measured from that portion of soil passing the three-quarter-inch sieve.

LIMITATIONS

The conclusions and recommendations contained in this report are based on site conditions as they existed at the time of our exploration and assume that the soil and groundwater conditions encountered in the test borings are representative of subsurface conditions on the site. If the subsurface conditions encountered during construction are significantly different from those observed in our explorations, we should be advised at once so that we can review these conditions and reconsider our recommendations where necessary. Unanticipated conditions are commonly encountered on construction sites and cannot be fully anticipated by merely taking samples in test borings. Subsurface conditions can also vary between exploration locations. Such unexpected conditions frequently require making additional expenditures to attain a properly constructed project. It is recommended that the owner consider providing a contingency fund to accommodate such potential extra costs and risks. This is a standard recommendation for all projects.

The recommendations presented in this report are directed toward the protection of only the proposed structures from damage due to slope movement. Predicting the future behavior of steep slopes and the potential effects of development on their stability is an inexact and imperfect science that is currently based mostly on the past behavior of slopes with similar characteristics. Landslides and soil movement can occur on steep slopes before, during, or after the development of property. The owner of any property containing, or located close to steep slopes must ultimately accept the possibility that some slope movement could occur, resulting in possible loss of ground downslope of the structures. However, because of the use of deep foundations, such potential movement would not affect the stability of the structures.

This report has been prepared for the exclusive use of SR'S Construction and their representatives, for specific application to this project and site. Our conclusions and recommendations are professional opinions derived in accordance with our understanding of current local standards of practice, and within the scope of our services. No warranty is expressed or implied. The scope of our services does not include services related to construction safety precautions, and our recommendations are not intended to direct the contractor's methods, techniques, sequences, or procedures, except as specifically described in our report for consideration in design. Our services also do not include assessing or minimizing the potential for biological hazards, such as mold, bacteria, mildew and fungi in either the existing or proposed site development.

ADDITIONAL SERVICES

In addition to reviewing the final plans, Geotech Consultants, Inc. should be retained to provide geotechnical consultation, testing, and observation services during construction. This is to confirm that subsurface conditions are consistent with those indicated by our exploration, to evaluate whether earthwork and foundation construction activities comply with the general intent of the recommendations presented in this report, and to provide suggestions for design changes in the event subsurface conditions differ from those anticipated prior to the start of construction. However, our work would not include the supervision or direction of the actual work of the contractor and its employees or agents. Also, job and site safety, and dimensional measurements, will be the responsibility of the contractor.

During the construction phase, we will provide geotechnical observation and testing services when requested by you or your representatives. Please be aware that we can only document site work we actually observe. It is still the responsibility of your contractor or on-site construction team to verify that our recommendations are being followed, whether we are present at the site or not.

The following plates are attached to complete this report:

Plate 1	Vicinity Map
Plate 2	Site Exploration Plan
Plates 3 - 5	Test Boring Logs

We appreciate the opportunity to be of service on this project. Please contact us if you have any questions, or if we can be of further assistance.

Respectfully submitted,

GEOTECH CONSULTANTS, INC.

D. ROBERT WARD
STATE OF WASHINGTON
19740
REGISTERED
PROFESSIONAL ENGINEER

08/11/2021

D. Robert Ward, P.E.
Principal

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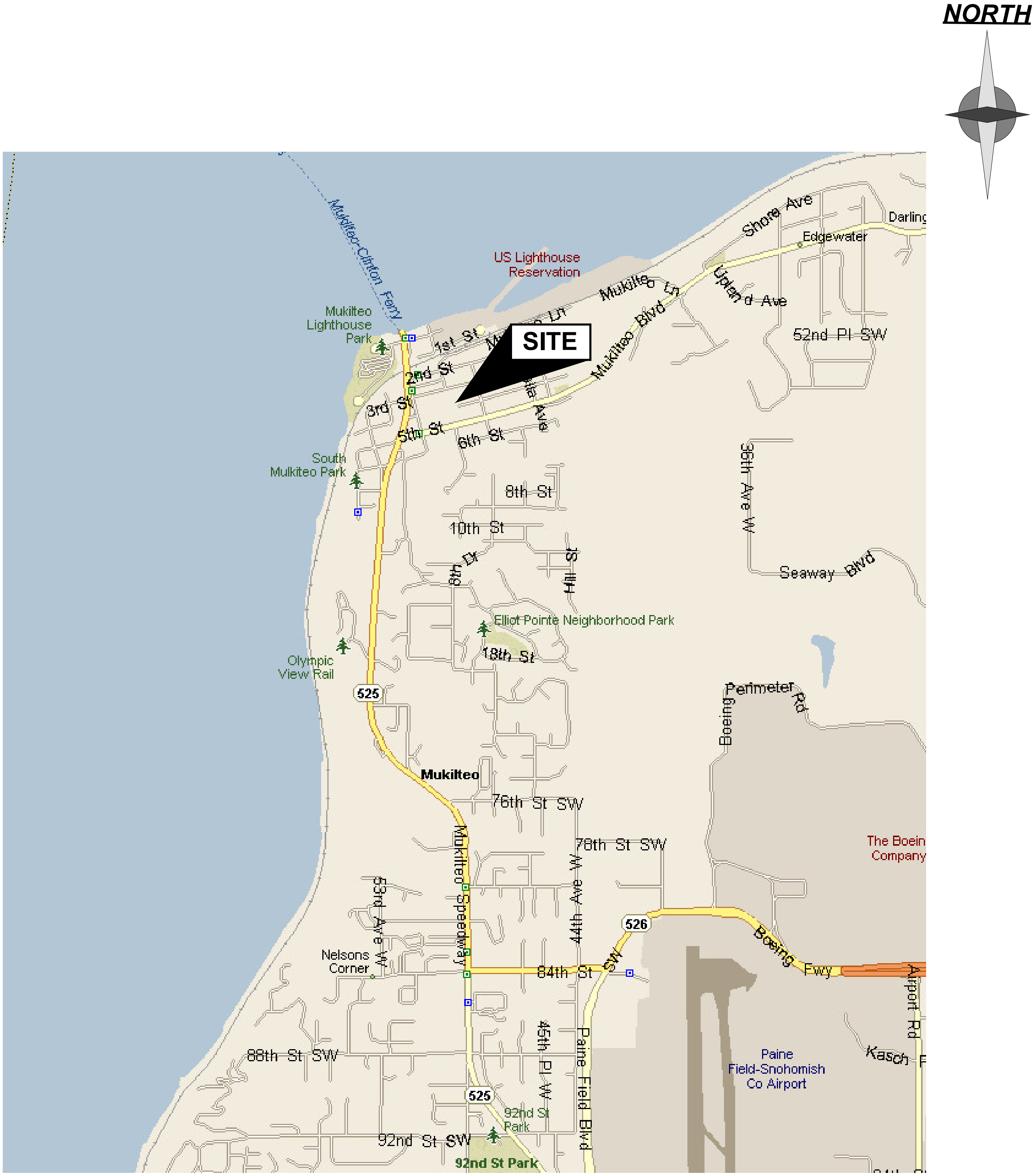


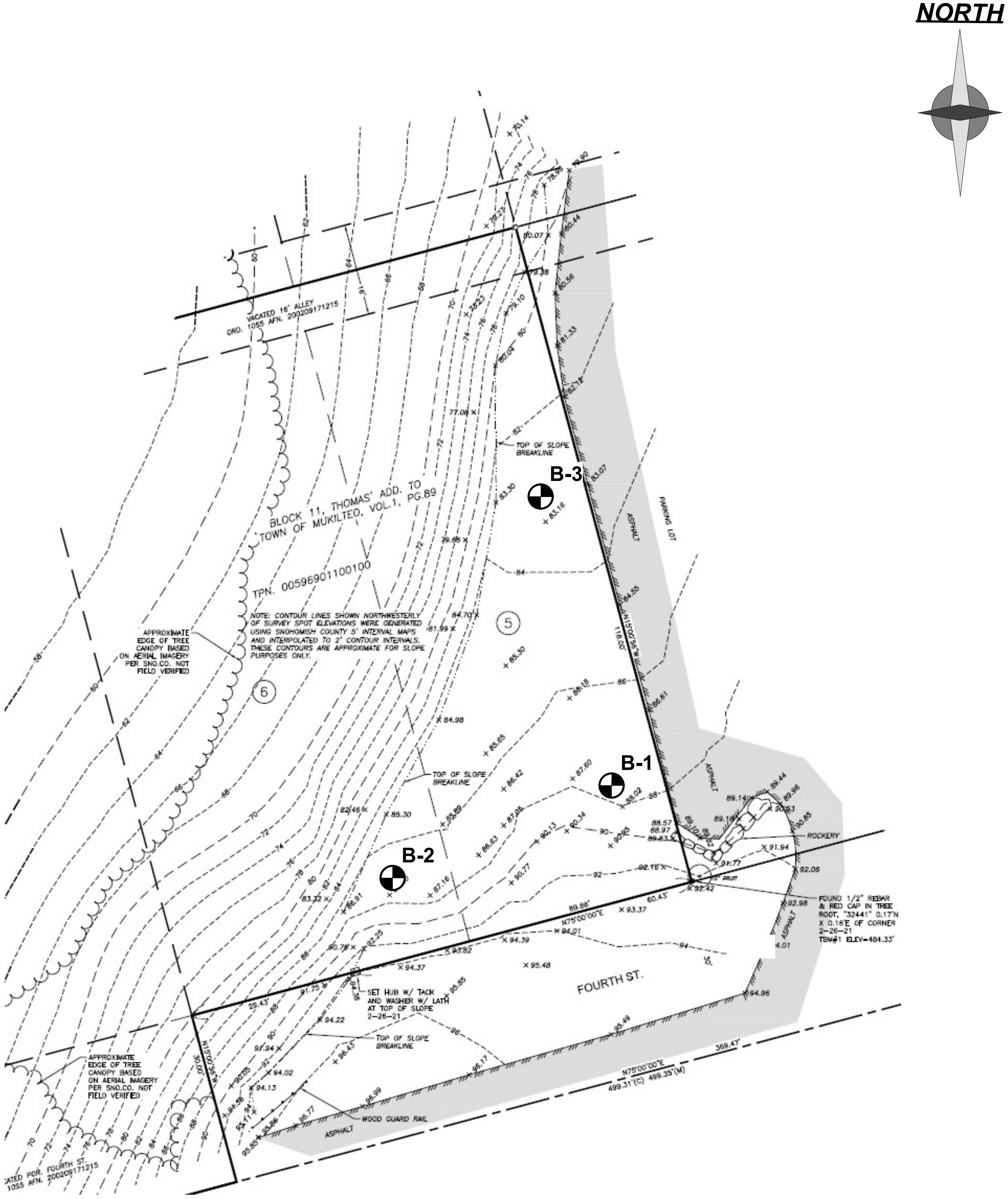
(Source: Microsoft MapPoint, 2013)

GEOTECH
CONSULTANTS, INC.

VICINITY MAP

4th Street and Park Avenue
Parcel No. 00596901100100
Mukilteo, Washington

Job No: 20255	*Date:* June 2021		*Plate:* 1



Legend:

⊕ Test Boring Location

GEOTECH
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SITE EXPLORATION PLAN

4th Street and Park Avenue
Parcel No. 00596901100100
Mukilteo, Washington

Job No: 20255	Date: June 2021	No Scale	Plate: 2

BORING 1

	Moisture	Water Table	Blows per Foot	Sample	USCS	Description
					FILL	Dark-brown silty SAND with gravel and occasional concrete, porcelain and brick debris, fine to medium-grained, dry, loose (**FILL**)
			12	1		Tan, slightly silty SAND, fine to medium-grained, moist, medium-dense -with occasional rust-brown laminations
5			16	2	SM/SP	
			12	3		-with 2-inch sand seam, becomes fine-grained, very moist
10			15	4		-grades to SAND with silt in part
			21	5		Brown SAND with silt, fine to medium-grained, moist, medium-dense
15			23	6		-with occasional very fine-grained lenses
20			32	7		-with occasional fine-grained gravel, becomes medium-dense to dense
25		▼	18	8	SP	-becomes gray-brown, wet
30			29	9		
35			32	10		
40			19	11		-with a 2-inch silt lense
45						

*** Test boring was terminated at 41.5 feet on August 6, 2020.**
*** Groundwater seepage was encountered at 25 feet during drilling.**

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BORING LOG

4th Street and Park Avenue
Parcel No. 00596901100100
Mukilteo, Washington

Job No:	Date:	Logged by:	Plate:
20255	June 2021	ASM	3

BORING 2

	Moisture	Water Table	Blows per Foot	Sample	USCS	Description
					FILL	Dark-brown, silty SAND with organics, gravel and wood debris, fine to medium-grained, dry, loose (**FILL**)
			10	1		Brown SAND with silt, fine-grained, moist, loose to medium-dense
5			13	2		-with occasional thin rust-brown laminations, becomes medium-dense
			21	3		-with occasional thin slightly silty seams and trace gravel
10			14	4		
			28	5		-with 4-inch gravelly seam, becomes medium dense to dense
15			21	6		-grades to very fine-grained, slightly silty SAND
					SP	
20			29	7		-reduced silt and silty seams, becomes very moist
		▼				
25			27	8		-becomes very fine-grained, wet, with occasional slightly silty seams
30			32	9		-with thin gravelly seam
35			21	10		
40			18	11		-with 6-inch silt seam
45						

*** Test boring was terminated at 41.5 feet on August 6, 2020.**
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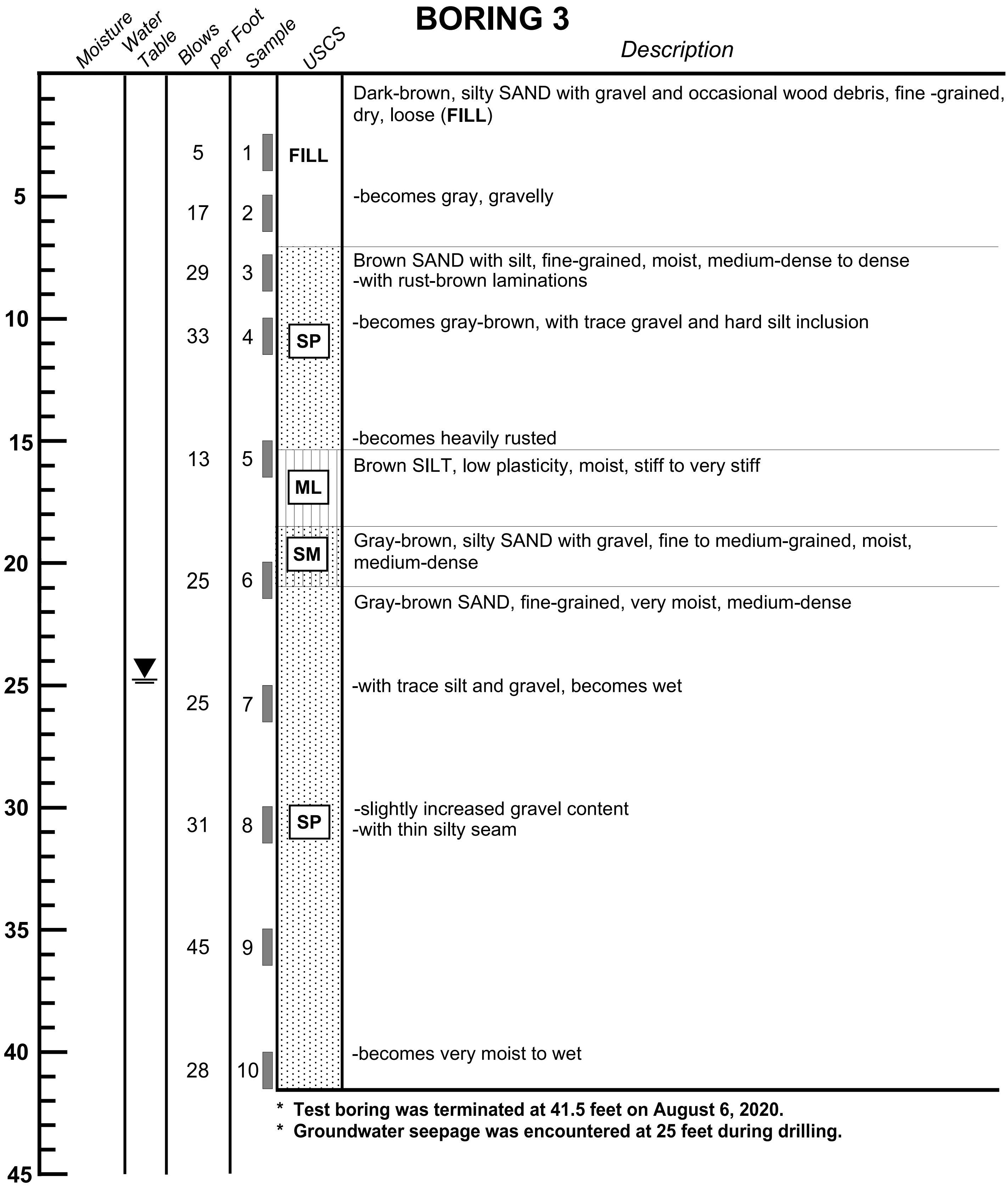
GEOTECH
CONSULTANTS, INC.

BORING LOG

4th Street and Park Avenue
Parcel No. 00596901100100
Mukilteo, Washington

Job No:	*Date:*	*Logged by:*	*Plate:*
20255	June 2021	ASM	4

BORING 3



Depth	Moisture	Water Table	Blows per Foot	Sample	USCS	Description
						Dark-brown, silty SAND with gravel and occasional wood debris, fine -grained, dry, loose (**FILL**)
			5	1	**FILL**	
5			17	2		-becomes gray, gravelly
			29	3		Brown SAND with silt, fine-grained, moist, medium-dense to dense -with rust-brown laminations
10			33	4	**SP**	-becomes gray-brown, with trace gravel and hard silt inclusion
15						-becomes heavily rusted
			13	5	**ML**	Brown SILT, low plasticity, moist, stiff to very stiff
					SM	Gray-brown, silty SAND with gravel, fine to medium-grained, moist, medium-dense
20			25	6		Gray-brown SAND, fine-grained, very moist, medium-dense
25		▼	25	7		-with trace silt and gravel, becomes wet
30			31	8	**SP**	-slightly increased gravel content -with thin silty seam
35			45	9		
40			28	10		-becomes very moist to wet
45						

*** Test boring was terminated at 41.5 feet on August 6, 2020.**

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GEOTECH
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BORING LOG

4th Street and Park Avenue
Parcel No. 00596901100100
Mukilteo, Washington

Job No:	***Date:***	***Logged by:***	***Plate:***
20255	June 2021	ASM	5