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September 21, 2021

JN 21384

Upright Construction – Brian Highberger
18827 53rd Avenue Northeast
Lake Forest Park, WA 98155

Subject: **Geotechnical Engineering Study**
Proposed Driveway and Residence
3211 Northeast 185th Street
Lake Forest Park, Washington

Dear Mr. Highberger: via email:

This report presents the findings and recommendations of our geotechnical engineering study for the proposed residence and driveway to be constructed at 3211 Northeast 185th Street. The undersigned associate visited the subject site on March 2, 2021. The purpose of this visit was to observe the existing site conditions, observe shallow test pits, and to develop opinions regarding the soil, slope, and the new residence that will be constructed on the site. The recommendations and conclusions presented in this report are professional opinions based on the visual observations made during our site visit and on previous experience with similar projects. We excavated shallow test holes during our visit, but no deep subsurface explorations were conducted for our work.

Planning for the project is in the early planning stages, so plans were not available. Based on discussions with you, we understand that a new driveway will be constructed near the center of the site along NE 185th Street. The existing house on the western portion of the lot will remain.

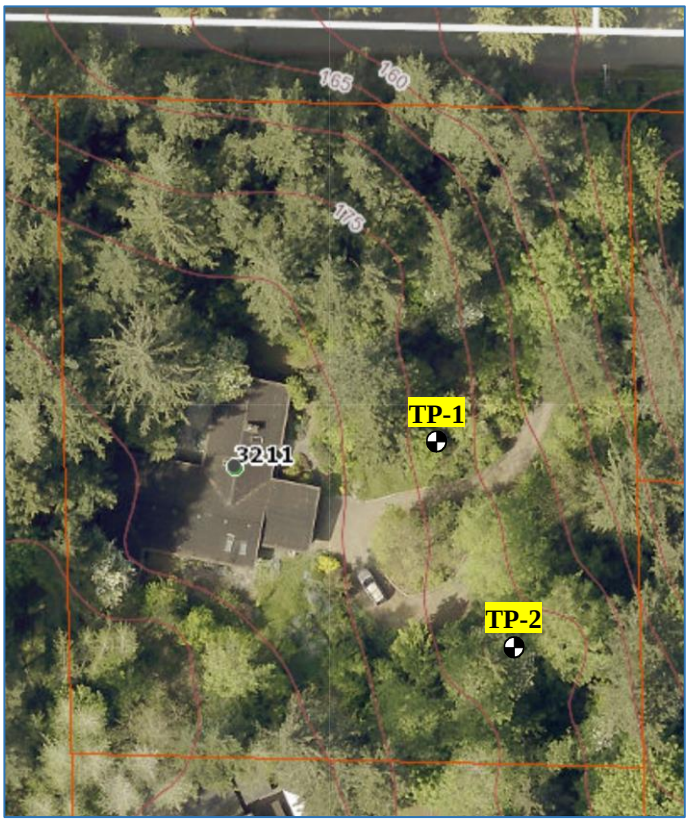
If the scope of the project changes from what we have described above, we should be provided with revised plans in order to determine if modifications to the recommendations and conclusions of this report are warranted.

SITE CONDITIONS

The rectangular-shaped subject site slopes gently downward from south to north, but there is a steep slope section along the northern edge of the site where the street cut (retained by a rockery) exists and along the northern portion of the eastern property line. The northern steep slope appears to be less than 10 feet in height and was created by the street cut. The eastern steep slope section is about 12 to 18 feet tall and is inclined at about 45 to 50 percent. We did not observe any evidence of large scale slope movement in either of the slopes during our site visit.

The subject property is currently developed with a single-family residence located on the central western portion of the site. The existing house is not part of the proposed development and the remainder of the lot is well vegetated with mature trees and undergrowth. An existing gravel driveway ascends to the house from the north along the eastern property line and along the top of the steep slope area. The adjacent properties east, west and south are low density residential lots.

Our understanding of the subsurface conditions at the site is based on the observations made during our recent site visit and on experience gained from other projects in the site vicinity. During our visits, we excavated two test pits at site. (as depicted below):



TP-1
0.0'–0.5' Topsoil
0.5'-3.0' Brown, slightly silty sand, fine- to medium-grained, damp, loose. **[SP/SM]**
3.0'–6.0' Gray-brown SAND, medium-grained, moist, medium-dense to dense **[SP]**
- becomes gray, dense at 5 feet.
Test Hole terminated at 6.0 feet.
No groundwater seepage encountered.

TP-2
0.0'–3.0' Brown, slightly silty sand, fine- to medium-grained, damp, loose. **[FILL]**
3.0'-5.0' Brown, slightly silty sand, fine- to medium-grained, damp, loose to medium-dense. **[SP/SM]**
5.0'–7.0' Gray SAND, medium-grained, moist, medium-dense to dense **[SP]**
Test Hole terminated at 7.0 feet.
No groundwater seepage encountered.

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 holes were excavated on March 2, 2021 with a rubber tracked backhoe. A geotechnical engineer from our staff conducted the excavation process, logged the test holes, and obtained representative samples of the soil encountered.

Soil and Groundwater Conditions

The test pits revealed clean Esperance sands with a relatively thin layer of fill overburden. The sands became medium-dense at 3 to 4 feet.

No obstructions were revealed by our explorations; but debris, buried utilities, and old foundation and slab elements are commonly encountered on sites that have had previous development.

No groundwater was observed in our explorations, but groundwater levels vary seasonally with rainfall and other factors. During the wetter winter months, we anticipate that groundwater could be heavier.

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. The relative densities and moisture descriptions indicated on the test hole logs are interpretive descriptions based on the conditions observed during excavation.

CONCLUSIONS AND RECOMMENDATIONS

GENERAL

The test pits conducted for this study encountered medium-dense, native, sands beneath a variable depth of existing fill soils and a layer of loose weathered sands. The medium-dense sands will supply adequate support for the proposed footings. The on-site soils can be excavated at a temporary inclination of 1:1 (Horizontal:Vertical). Due to the friable nature of the clean sands, vertical cut sections should not be planned. Steeper cuts or cuts within a 2:1 (H:V) of any of the neighboring structure foundations will require temporary shoring.

No fill should be placed in the 25-foot steep slope buffer or within 10 feet of the northern rockeries as it would add weight to the slope soils.

The erosion control measures needed during the site development will depend heavily on the weather conditions that are encountered. Where bare soil areas are created outside of the excavation, they should be immediately covered with coarse compost, mulch, hog fuel or gravel. Existing vegetation, pavement and landscaping should be left undisturbed wherever possible. We anticipate that a wire-backed silt fence will be needed around the downslope sides of any cleared areas. Cut slopes and soil stockpiles should be covered with plastic during wet weather. Extra straw rolls and plastic sheeting should be stockpiled at the site for immediate use in the event of erosion control problems. Following rough grading, it may be necessary to mulch or hydroseed bare areas that will not be immediately covered with landscaping or an impervious surface.

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.

The erosion control measures needed during the site development will depend heavily on the weather conditions that are encountered. While site clearing will expose a large area of bare soil, the erosion potential on the site is relatively low due to the gentle slope of the ground and the very sandy soils. We anticipate that a silt fence will be needed around the downslope sides of any cleared areas. Rocked construction access roads should be extended into the site to reduce the amount of soil or mud carried off the property by trucks and equipment. Wherever possible, these roads should follow the alignment of planned pavements, and trucks should not be allowed to drive off of the rock-covered areas. Existing catch basins in, and immediately downslope of, the planned work areas should be protected with pre-manufactured silt socks. Cut slopes and soil stockpiles should be covered with plastic during wet weather. Following rough grading, it may be necessary to mulch or hydroseed bare areas that will not be immediately covered with landscaping or an impervious surface.

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 Table 1613.5.2 of the (Seattle) International Building Code (SBC) (IBC), the site soil profile within 100 feet of the ground surface is best represented by Soil Profile Type D (Stiff Soil). As required by the SBC, the design criteria presented in this report consider the effects of a one-in-100-years seismic event for slope stability.

The site soils in the area of the proposed structures are not susceptible to seismic liquefaction because of their dense or the absence of groundwater. This statement regarding liquefaction includes the knowledge of the determined peak ground acceleration noted above.

PERMANENT 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 *	30 pcf
Passive Earth Pressure	350 pcf
Coefficient of Friction	0.50
Soil Unit Weight	125 pcf

Where: (i) pcf is pounds per cubic foot, and (ii) 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.**

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. The passive pressure given is appropriate for the depth of level structural fill placed in front of a retaining or foundation wall only. The values for friction and passive resistance are ultimate values and do not include a safety factor. We recommend a safety factor of at least 1.5 for overturning and sliding, when using the above values to design the walls. Restrained wall soil parameters should be utilized for a distance of 1.5 times the wall height from corners or bends in the walls. This is intended to reduce the amount of cracking that can occur where a wall is restrained by a corner.

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.

Wall Pressures Due to Seismic Forces

The surcharge wall loads that could be imposed by the design earthquake can be modeled by adding a uniform lateral pressure to the above-recommended active pressure. The recommended surcharge pressure is 8**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 slightly silty sand is used as backfill, a minimum 12-inch width of free-draining gravel or a drainage composite similar to Miradrain 6000 should be placed against the backfilled retaining walls. The drainage composites should be hydraulically connected to the foundation drain system. Free-draining backfill or gravel should be used for the entire width of the backfill where seepage is encountered. For increased protection, drainage composites should be

placed along cut slope faces, and the walls should be backfilled entirely with free-draining soil. 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. 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 to reduce the potential for surface water to percolate into the backfill.

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 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.

EXCAVATIONS AND SLOPES

Excavation slopes should not exceed the limits specified in local, state, and national government safety regulations. Temporary cuts to a 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. Steeper cuts or cuts within a 2:1 (H:V) of any of the neighboring structure foundations will require temporary shoring. For shoring below neighboring foundations soldier piles are recommended, but for cuts that do not support a building surcharge, pin pile slough protection could be possible to allow local vertical cuts.

The above-recommended temporary slope inclination is 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 water be directed away from temporary slope cuts. The cut slopes should also be backfilled or retained as soon as possible to reduce the potential for instability. Please note that sand 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.

All permanent cuts into native soil should be inclined no steeper than 2:1 (H:V). Fill slopes should not be constructed with an inclination greater than 2:1 (H:V). To reduce the potential for shallow sloughing, fill must be compacted to the face of these slopes. This can be accomplished by overbuilding the compacted fill and then trimming it back to its final inclination. Adequate compaction of the slope face is important for long-term stability and is necessary to prevent excessive settlement of patios, slabs, foundations, or other improvements that may be placed near the edge of the slope.

Water should not be allowed to flow uncontrolled over the top of any temporary or permanent slope. All permanently exposed slopes should be seeded with an appropriate species of vegetation to reduce erosion and improve the stability of the surficial layer of soil.

DRAINAGE CONSIDERATIONS

We recommend that foundation drains be used at the base of all foundation and earth-retaining walls. These drains should be surrounded by at least 6 inches of 1-inch-minus, washed rock and then wrapped in 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, and it should be sloped for drainage. All roof and surface water drains must be kept separate from the foundation drain system. For the best long-term performance, perforated PVC pipe is recommended for all subsurface drains. The City of Seattle typically requires that Schedule 40 PVC pipe be used beneath structures. Additionally, 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. Final site grading in areas adjacent to buildings should slope away at least 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.

GENERAL EARTHWORK AND STRUCTURAL FILL

All building areas should be stripped of surface vegetation, topsoil, organic soil, and other deleterious material. It is important that existing foundations be removed before site development. 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, behind permanent retaining or foundation walls, 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. We recommend testing the fill as it is placed. If the fill is not sufficiently compacted, it can 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 relative compactions for structural fill:

Location of Fill Placement	Minimum Relative Compaction
Beneath footings, slabs or walkways	**95%**
Filled slopes and behind retaining walls	**90%**

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).

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.

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.

LIMITATIONS

The analyses, conclusions, and recommendations contained in this report are based on site conditions, as they existed at the time of our site visit. If the subsurface conditions encountered during construction are significantly different from those anticipated, we should be advised at once so that we can review these conditions and reconsider our recommendations where necessary. Unanticipated soil conditions are commonly encountered on construction sites. Such unexpected conditions frequently require making additional expenditures to attain a properly constructed project.

This report has been prepared for the exclusive use of Upright Construction and their representatives for specific application to this project and site. Our recommendations and conclusions are based on the site materials observed and on previous experience with sites that have similar observed conditions. The conclusions and recommendations are professional opinions derived in accordance with current standards of practice within the limited scope of our services. No warranty is expressed or implied.

We trust that this report meets your immediate needs for the proposed development. Please contact us if we can be of further service.

Respectfully submitted,

GEOTECH CONSULTANTS, INC.

James H. Strange, Jr., P.E.
Associate

JHS: jhs