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January 31, 2011

JN 08125

[redacted]

Subject: **Transmittal Letter – Geotechnical Engineering Study**
Proposed Single-Family Residence
13XX – 35th Avenue South
Seattle, Washington

[redacted]

We are pleased to present this geotechnical engineering report for the proposed residence to be constructed in Seattle, 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 criteria for foundations, retaining walls, and temporary excavations. This work was authorized by your acceptance of our proposal dated April 20, 2010.

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

cc: **David Neiman Architects**
via email david@neimanarchitects.com

DRW: jyb

GEOTECHNICAL ENGINEERING STUDY
Proposed Single-Family Residence
13XX – 35th Avenue South
Seattle, Washington

This report presents the findings and recommendations of our geotechnical engineering study for the site of the proposed residence to be located in Seattle.

We first point out that this project has already been granted a development exemption with regards to the Steep Slope Hazard Areas portion of Seattle Code. We prepared a letter dated April 14, 2010 in support of the exemption.

We were recently provided with project architectural plans that also included a topographic map. David Neiman Architects developed these plans. Based on these plans, we understand that the residence will be located on the western portion of the property. The residence will have a main/garage level that is near the grade of the adjacent street. The garage will be located 4 feet from the western property line. Two basement levels will be situated below the main/garage level, with the westernmost wall of the first basement located about 16 feet from the western property line. The lowest, second basement will only be located below the eastern side of the residence. Small decks will extend off the eastern side of the main floor and first basement. Most of the residence floors and the garage slab will be above the existing site grades. Only some relatively small excavations will be needed at the western side of the site in order to construct 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 near the Mount Baker Tunnel of Interstate 90 in Seattle. The property is bordered on its upper, western side by 35th Avenue South and on its lower, eastern side by the right-of-way of Lakeside Avenue South. Overall, the lot slopes downward to the east. The western end of the site, which is where the proposed residence will be located, has a very steep slope with a height of approximately 14 to 26 feet; the top of the slope is at the grade of 35th Avenue South. As noted in the documents for the development exemption, major filling was done to construct 35th Avenue that created all or most of this steep western slope. In general, a moderate slope is located below this very steep portion. The site is mostly very densely vegetated, having some large scattered evergreen trees, but mostly brushy growth. The right-of-way for Lakeside Avenue, which is quite large as the actual street is located on its eastern edge, contains similar vegetation.

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 May 5, 2008 using a portable, hollow-stem auger drill. Samples were taken at 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 soils revealed in all of the test borings consisted of loose, unengineered fill. The depths ranged from about 3 feet in the easternmost, lower test boring to 13 feet in the uppermost, westernmost test boring. The fill was found to be underlain by approximately 5 to 20 feet of loose, silty sand colluvium (old landslide soil). At depths ranging from approximately 10 feet in the easternmost test boring and approximately 35 feet in the westernmost test boring, competent native soils consisting of dense to mostly very dense, slightly silty to silty sand was revealed.

Groundwater Conditions

Groundwater seepage was observed at a depth of 27.5 feet in the upper test boring. The test boring was 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. It is possible that more groundwater seepage could be found at the site than was revealed in the test borings during the normally wet winter and spring months.

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 approximately 10 to 35 feet of loose fill and colluvial soils overlying very competent native soil. Piles that are embedded into the competent soil are needed to support the new residence. In addition, as discussed below, a "complete stabilization wall" is needed on the eastern, downslope side of the residence based on geotechnical considerations and Seattle Code for Steep Slope Hazard Areas; the piles used for this wall will need to be concrete. Driven piles that are mostly supporting vertical loads can be used to support the remainder of the residence.

Due to the steep nature of the site and the loose condition of the upper site of soils, lateral stability of the project is a significant geotechnical engineering consideration for the project. Lateral stability is needed because there is some potential for relatively deep-seated movement or landsliding of the upper loose soils during periods of extreme precipitation or large seismic event; this is possible even though no surficial landslides were observed on the site. Therefore, closely-spaced piles should be installed at the eastern side of the residence to deter a deep-seated landslide from occurring below and upslope of the residence, and to provide "complete stabilization. A small deck is proposed to extend well above but east of this wall. We believe that this deck will remain stable also if two things are done: first, if the deck is structurally supported by the piles foundation and no deck foundations extend down to the ground, and secondly, the deck should be impermeable so that water from it can be collected and discharged into the residence's stormwater system.

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. 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.

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 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 Table 1613.5.2 of the 2009 Seattle Building Code (SBC), the site soil profile within 100 feet of the ground surface is best represented by Site Class Type D (Stiff Site 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 1.45g and 0.49g, respectively.

The (Seattle) International Building Code (SBC) (IBC) states that a site-specific seismic study need not be performed provided that the peak ground acceleration be equal to $S_{DS}/2.5$, where S_{DS} is determined in Section 21.2.1 of ASCE 7. Section 21.2.1 indicates that Section 11.4.7 of ASCE 7 should be used. In Equation 11.4-3 it is noted that S_{DS} is equal to $2/3S_{MS}$. Based on Equation 11.4-1, S_{MS} equals F_a times S_S, where F_a is determined in Table 11.4-1. For our site, F_a = 1.0. Thus, the peak ground acceleration = 0.39g.

This statement regarding liquefaction includes the knowledge of the determined peak ground acceleration noted above.

DRILLED CONCRETE PILES

As noted earlier, drilled, closely-spaced, concrete-filled piles are recommended on the downslope side of the residence as a "complete stabilization" wall to deter deep-seated soil movement or landslides beneath and upslope of the residence. Based on our explorations, it appears that the piles may be constructed by open-hole methods (use of Lo-drill or similar equipment). However, some caving may occur. These piles could be drilled with conventional auger drills, but the drilling contractor should have casing available on-site in case sloughing occurs in the near-surface soils. The piles could also be installed using augercast equipment, as access to Lo-drill equipment could be very difficult. An experienced concrete pile contractor should be used to install the piles.

The piles at these sides should be spaced no more than 3 feet edge-to-edge. Based on our test borings, it appears that approximately 15 feet of incompetent soil exists in the downslope side of the residence. Thus, the upper 15 feet of these piles should be designed as a continuous retaining wall with an active soil pressure equal to that pressure exerted by an equivalent fluid with a unit weight of 55 pcf. An ultimate passive soil pressure equal to that pressure exerted by a fluid with a density of 525 pcf will resist the lateral movement of the piles below the 15-foot depth. For long term conditions, a safety factor or 1.5 should be applied to the design of this wall. This passive soil pressure acts on two times the concrete pile diameter. See the section below regarding vertical capacity. The length of the pile will be determined based on the structural design using the above noted parameters. In addition to the active pressures noted above, the following section of the report should be reviewed for the seismic design on the closely-spaced pile walls on the eastern and southern sides of the residence.

For a minimum embedment of 10 feet into the competent, native soils and a pile diameter of 24 inches, we recommend assuming an allowable compressive capacity of 50 tons per pier. The length of the pile will be determined based on the structural design using the above noted parameters. However, based on the test boring, it appears that the minimum length of the piles should be at least 30 feet.

We estimate that the total settlement of single piles installed as described above will be on the order of one-half inch. Most of this settlement should occur during the construction phase as the dead loads are applied. The remaining post-construction settlement would be realized as the live-loads are applied. We estimate that differential settlements over any portion of the structures should be less than about one-quarter inch.

PIPE PILES

Driven piles can be used for the residence foundation with the exception of the easternmost foundation. Three- or 4-inch-diameter pipe piles (possibly 6-inch-diameter piles if lateral loading is needed, as discussed below) driven with a 650- or 800- or 1,100-pound hydraulic jackhammer to the following final penetration rates may be assigned the following compressive capacities.

INSIDE PILE DIAMETER	FINAL DRIVING RATE (650-pound hammer)	FINAL DRIVING RATE (800-pound hammer)	FINAL DRIVING RATE (1,100-pound hammer)	ALLOWABLE COMPRESSIVE CAPACITY
3 inches	12 sec/inch	10 sec/inch	6 sec/inch	6 tons
4 inches	20 sec/inch	15 sec/inch	10 sec/inch	10 tons

Note: The refusal criteria indicated in the above table are valid only for pipe piles that are installed using a hydraulic impact hammer carried on leads that allow the hammer to sit on the top of the pile during driving. If the piles are installed by alternative methods, such as a vibratory hammer or a hammer that is hard-mounted to the installation machine, numerous load tests to 200 percent of the design capacity would be necessary to substantiate the allowable pile load. The appropriate number of load tests would need to be determined at the time the contractor and installation method are chosen. As a minimum, load tests on 20 percent of the piles is typical where alternative pile installation methods are used.

As a minimum, Schedule 40 pipe should be used. The site soils should not be highly corrosive. Considering this, it is our opinion that standard “black” pipe can be used, and corrosion protection, such as galvanizing, is not necessary for the pipe piles.

Seattle Director’s Rule 10-2009 contains several prescriptive requirements related to the use of pipe piles having a diameter of less than 10 inches. Under Director’s Rule 10-2009, load tests are required on 3 percent of the installed piles up to a maximum of 5 piles, with a minimum of one pile load test on each project. Additionally, full-time observation of the pile installation by the geotechnical engineer-of-record is required by Director’s Rule 10-2009.

Based on test borings, we recommend that the piles achieve at least 5 feet of embedment into the competent, native soils. Pile caps and grade beams should be used to transmit loads to the piles. Isolated pile caps should include a minimum of two piles to reduce the potential for eccentric loads being applied to the piles. Subsequent sections of pipe can be connected with slip or threaded couplers, or they can be welded together. If slip couplers are used, they should fit snugly into the pipe sections. This may require that shims be used or that beads of welding flux be applied to the outside of the coupler. We recommend that the project structural engineer review the design of the couplers.

Lateral loads due to wind or seismic forces 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 250 pounds per cubic foot (pcf) for this resistance. If the ground in front of a foundation is loose or sloping, 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. Due to their small diameter, the lateral capacity of vertical pipe piles is relatively small. However, if lateral resistance in addition to passive soil resistance is required, we recommend driving battered piles in the same direction as the applied lateral load. For this project, because of the large depth to competent soil, 6-inch-diameter piles, designed to the same capacity as 4-inch-diameter piles, should be used if lateral capacity of the piles is needed. The allowable vertical capacity of battered piles does not need to be reduced if the piles are battered steeper than 1:5 Horizontal:Vertical (H:V).

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 backfill:

PARAMETER	VALUE
Active Earth Pressure * - level backslope	40 pcf
Active Earth Pressure * - inclined backslope	55 pcf
Passive Earth Pressure	250 pcf
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. We can assist with design of these types of walls, if desired. 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 10**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. 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.

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 build up 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 a specialty 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.

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.

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 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.

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. Topsoil is often placed on regraded slopes to promote growth of vegetation. Proper preparation of the regraded surface, and use of appropriate topsoil is necessary to prevent the topsoil from sliding off the slope. This is most likely to occur following extended wet weather if a silty topsoil is used. On steeper slopes, it may be necessary to "track walk" the slope or cut small grooves across the slope prior to placing the topsoil.

Any disturbance to the existing slope outside of the building limits may reduce the stability of the slope. Damage to the existing vegetation and ground should be minimized, and any disturbed areas should be revegetated as soon as possible. Soil from the excavation should not be placed on the slope, and this may require the off-site disposal of any surplus soil.

DRAINAGE CONSIDERATIONS

Foundation drains should be used 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 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. A typical drain detail is attached to this report as Plate 6. 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.

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. Also, an outlet drain is recommended for all crawl spaces to prevent a build up of any water that may bypass the footing drains.

Some 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. Final site grading in areas adjacent to the building 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. Water from roof, storm water, and foundation drains should not be discharged onto slopes; it should be tightlined to a suitable outfall located away from any slopes.

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, 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%
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).

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 soil conditions are commonly encountered on construction sites and cannot be fully anticipated by merely taking soil samples in test pits. 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 structure 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. At additional cost, we can provide recommendations for reducing the risk of future movement on the steep slopes, which could involve regrading the slopes or installing subsurface drains or costly retaining structures. However, the owner must ultimately accept the possibility that some slope movement could occur, resulting in possible loss of ground or damage to the facilities around the proposed residence.

This report has been prepared for the exclusive use of Brook Stuart and her representatives, for specific application to this project and site. Our recommendations and conclusions are based on observed site materials and engineering analyses. Our conclusions and recommendations are professional opinions derived in accordance with current standards of practice within the scope of our services and within budget and time constraints. 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
Plate 6	Typical Footing Drain Detail

We appreciate the opportunity to be of service on this project. If you have any questions, or if we may be of further service, please do not hesitate to contact us.

Respectfully submitted,

GEOTECH CONSULTANTS, INC.

D. ROBERT WARD
STATE OF WASHINGTON
REGISTERED
PROFESSIONAL ENGINEER

1/31/11

D. Robert Ward, P.E.
Principal

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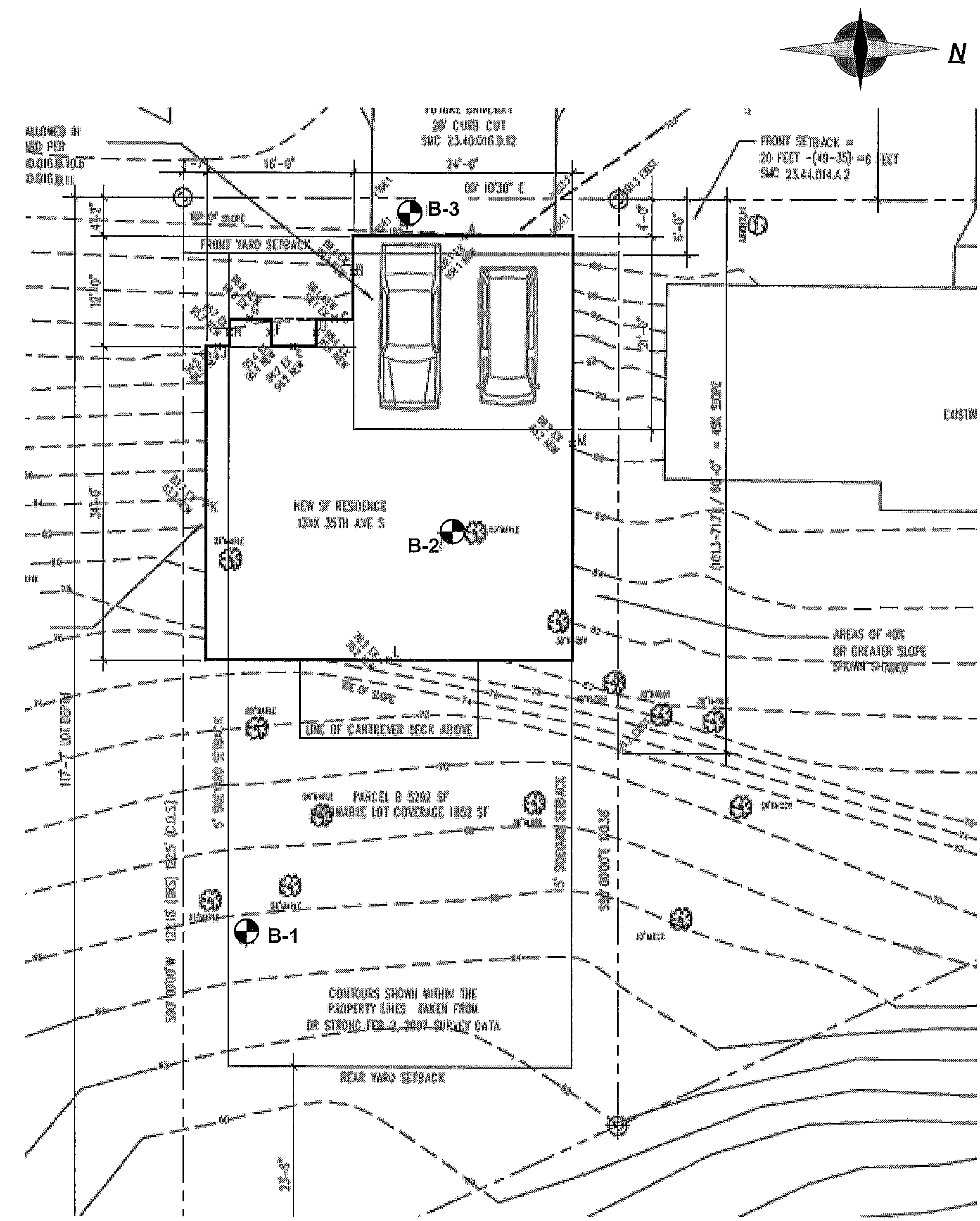
GEOTECH
CONSULTANTS, INC.

VICINITY MAP

13XX - 35th Avenue South
Seattle, Washington

Job No:	Date:		Plate:
08125	Jan. 2011		1



GEOTECH
CONSULTANTS, INC.

SITE EXPLORATION PLAN

13XX - 35th Avenue South
Seattle, Washington

Job No:	Date:		Plate:
08125	Jan. 2011		2

BORING 1

Depth (ft)	Moisture	Water Table	Blows per Foot	Sample	USCS	Description
0–4			4	1	FILL	Brown, silty SAND with gravel and organics, medium- to fine-grained, moist, loose (***FILL***)
4–11			14	2	ML	Brown, iron staining, sandy SILT with gravel, jumbled, medium plasticity, very moist, medium stiff (***Colluvium***)
			17	3		
11–18			40	4	SW	Brown, slightly silty SAND with gravels, coarse- to fine-grained, very moist, dense
						- large gravels
			50/5"	5		- becomes very dense
			50/6"	6		

Depth scale: 5, 10, 15, 20, 25, 30, 35, 40

*** Test boring was terminated at 18 feet during drilling on May 5, 2008.**
*** No groundwater seepage was encountered during drilling.**

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BORING LOG

13XX - 35th Avenue South
Seattle, Washington

Job	*Date:*	*Logged by:*	*Plate:*
08125	Jan. 2011	ZJM	3

BORING 2

Moisture	Water Table	Blows per Foot	Sample	USCS	Description
		6	1	FILL	Brown, silty SAND with gravel and organics, medium- to fine-grained, moist, loose (***FILL***)
		8	2		
		15	3	ML	Brown, sandy SILT with occasional gravel, jumbled, highly plastic, very moist, medium-stiff (***Colluvium***)
		48	4		
		21	5		
		46	6	SM	Brown, silty SAND with gravel, medium- to fine-grained, very moist, dense - becomes coarse- to fine-grained, very dense
		64	7		

Depth scale: 5, 10, 15, 20, 25, 30

* **Test boring was terminated at 26.5 feet due to auger refusal during drilling on May 5, 2008.**

* **No groundwater seepage was encountered during drilling.**

* **Blows overstated, driving on a rock.**

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BORING LOG

13XX - 35th Avenue South
Seattle, Washington

Job	Date:	Logged by:	Plate:
08125	Jan. 2011	ZJM	4

BORING 3

Depth (ft)	Moisture	Water Table	Blows per Foot	Sample	USCS	Description
0						Topsoil
						- pieces of concrete
						Brown, silty SAND with gravel, medium- to fine-grained, very moist, loose (***FILL***)
5			3	1	FILL	
10			5	2		
13					ML	Brown, slightly sandy SILT, jumbled, slightly plastic, very moist, \ medium-stiff (***Colluvium***)
15			13	3		
20			7	4		- gravels
25			9	5		
27.5		▼				
30			19	6		
33					SW	Brown, slightly silty SAND with gravels, coarse- to fine-grained, wet, loose
35			5	7		- large gravels
40			49	8		

* **Test boring was terminated at 42 feet due to auger refusal during drilling on May 5, 2008.**

* **Groundwater seepage was encountered at 27.5 feet during drilling.**

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BORING LOG

13XX - 35th Avenue South
Seattle, Washington

Job	Date:	Logged by:	Plate:
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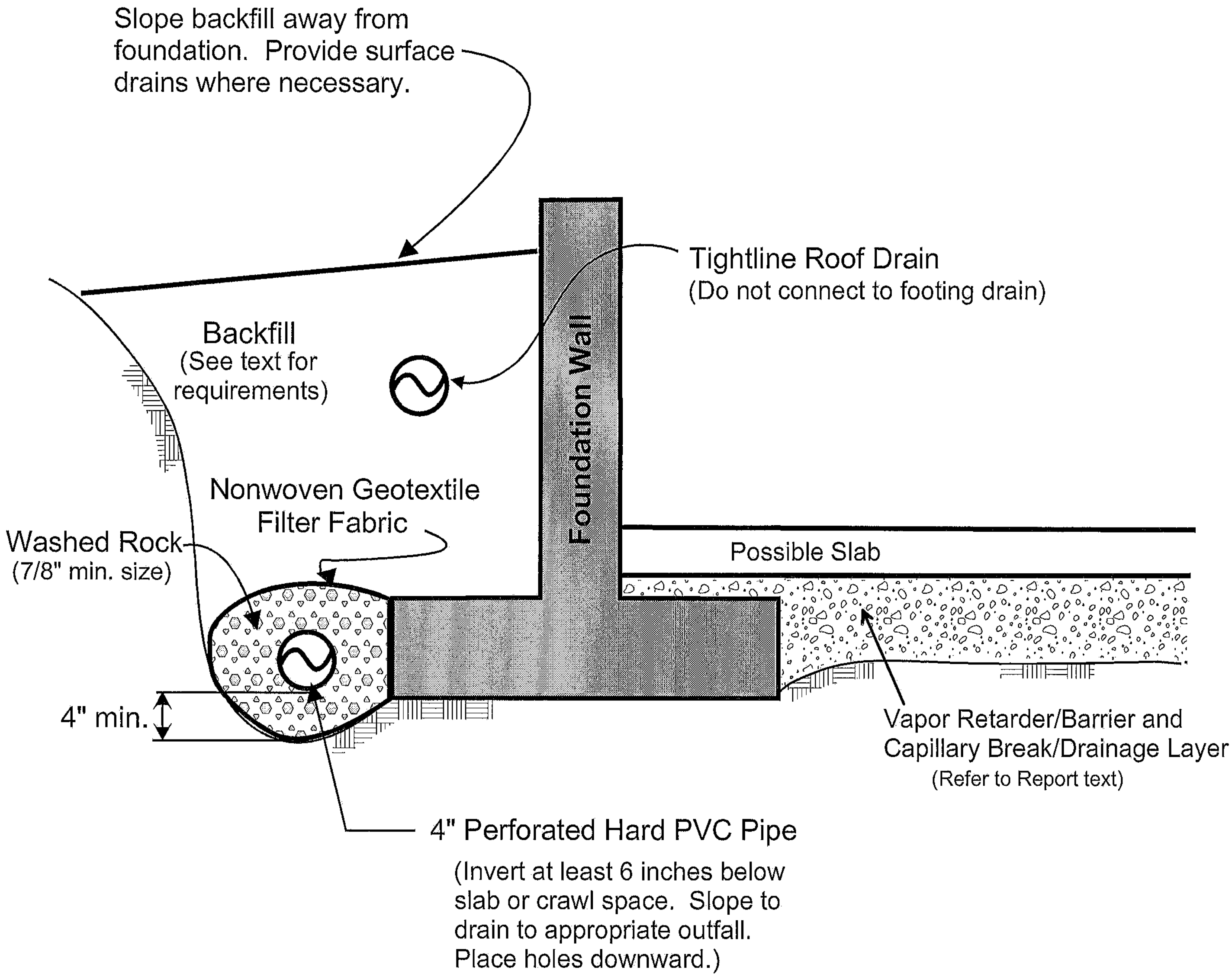

NOTES:

(1) In crawl spaces, provide an outlet drain to prevent buildup of water that bypasses the perimeter footing drains.

(2) Refer to report text for additional drainage, waterproofing, and slab considerations.

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FOOTING DRAIN DETAIL

13XX - 35th Avenue South
Seattle, Washington

Job No:	Date:		Plate:
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