LIU & ASSOCIATES, INC.
Geotechnical Engineering · Engineering Geology · Earth Science

December 26, 2016

Mr. Kurt Campbell
CamNel Properties, LLC
24329 Highway 99
Edmonds, WA 98026

Dear Mr. Campbell:

Subject: Geotechnical Investigation
CamNel Properties
16xxx Smokey Point Boulevard
Marysville, Washington
L&A Job No. 16-122

INTRODUCTION

We understand that the development of a couple of car dealerships and two light industry complexes is proposed for the subject properties located at the above address in Marysville, Washington. The project site is consisted of four parcels of land. We understand the proposed plan for the project site is to develop it in four phases: a car dealership with a 30,000 s.f. (square feet) showroom/repair shop building surrounded by a parking lot with 181 parking stalls for each of Phases 1 and 2 located in the west portion of the site; a 90,000 s.f. light industrial building for Phase 3 located in the northeast portion of the site; and four light industrial buildings (two at 6,500 s.f. and two at 10,000 s.f.) with two parking lots in between the buildings. We understand the showroom/repair shop buildings are to be two-story structures with a smaller second story, and the industrial buildings to be single-story structures.

19213 Kenlake Place NE · Kenmore, Washington 98028
Phone (425) 483-9134 · Fax (425) 486-2746

At your request, we have completed a geotechnical investigation for the proposed development of the project site. The purpose of this investigation is to explore and characterize subsurface conditions of the site and provide geotechnical recommendations on site stabilization, grading, erosion mitigation, surface and groundwater drainage control, onsite stormwater disposal, and foundation support to the proposed buildings.

SCOPE OF SERVICES

Our scope of services for this investigation comprises specifically the following:

1 Review the geologic and soil conditions at the project site based on a published geologic map.

2. Explore subsurface (soil and groundwater) conditions of the site with backhoe test pits to a soil stratum capable of provide adequate foundation support to buildings or to the maximum depth (about 8 feet) capable by the backhoe used in excavating the test pits, whichever occurs first.

3. Perform geotechnical analysis based on subsurface data obtained from test pits and provide geotechnical recommendations.

4. Prepare a written report to present our findings, conclusions, and recommendations.

SITE CONDITIONS

SURFACE CONDITION

The general location of the project site is shown on Plate 1 – Vicinity Map. For our use in this investigation, you provided us with a site and layout plan of the proposed development project. The project site is bounded by Smokey Boulevard to the west, adjoined by an industrial development over the west portion of its north boundary, and border by undeveloped land on the rest of the north side and its south and east sides. The project site is situated on a nearly flat flood plain of the nearby Quilceda Creek and its tributary streams. The project site is currently vacant and undeveloped. The south parcel of the site are cleared and graded, while the northeast and northwest parcels are wooded.

GEOLOGIC SETTING

The Geologic Map of the Marysville Quadrangle, Snohomish County, Washington, by James P. Minard, published by U. S. Geological Survey in 1985, was referenced for the geologic and soil conditions at the project site. According to this publication, the surficial soil unit at and in the vicinity of the project site is mapped as Marysville Sand member (Q_{vrm}).

The geology of the Puget Sound Lowland has been modified by the advance and retreat of several glaciers in the past one million years or so and the subsequent deposits and erosions. The latest glacier advanced to the Puget Sound Lowland is referred to as the Vashon Stade of the Fraser Glaciation which had occurred during the later stages of the Pleistocene Epoch, and retreated from the region some 12,500 years ago.

The deposits of the Marysville sand member are recessional outwash composed of fine to coarse sand with trace to some gravel laid down by melt water along the front of glaciers during the Fraser glaciation. The Marysville sand member deposits had not been over-ridden by glacier as the glacier started to retreat after they were deposited. Therefore, the Maryville sand member deposits are generally loose to medium-dense in their undisturbed native state, and are of moderately high permeability.

SOIL CONDITION

Subsurface conditions of the project site were explored with six test pits. The test pits were excavated on August 25, 2016, with a rubber-track backhoe to depths from 6.5 to 8.5 feet. The approximate locations of the test pits are shown on Plate 2 - Site and Exploration Location Plan. These test pits were located with either a tape measure or by visual reference to existing topographic features in the field and on the survey plan, and their locations should be considered only as accurate to the measuring method used.

A geotechnical engineer from our office was present during subsurface exploration, examined the soil and geologic conditions encountered, and completed logs of test pits. Soil samples obtained from each soil layer in the test pits were visually classified in general accordance with United Soil Classification System, a copy of which is presented on Plate 3. Detailed descriptions of soils encountered during site exploration are presented in test pit logs on Plates 4 through 6.

Test Pits TP-1 encountered a layer of dark-brown to black, medium-dense, organic, silty fine sand, about 6 inches thick, while Test Pit TP-2 encountered a layer of crushed rock about 8 inches thick. These are fill placed on the surface of the southwest portion of the project site where it has been cleared and graded. Underlying the surficial fill layer and on the surface of the rest of the test pits is a layer of loose organic topsoil, about 12 inches thick. The topsoil is underlain by a layer of weathered soil of brown to light-brown, loose, slightly-silty, fine sand, about 1.4 to 3.0 feet thick. This layer of weathered soil is underlain to the depths explored by a loose, fine to medium sand with trace gravel, which appears to be of Marysville sand member.

GROUNDWATER CONDITION

Groundwater table was encountered by all six test pits at 6.0 to 7.5 feet deep. The test pits were excavated in summer when the groundwater table is normally at its lowest. According to our experience in the neighborhood of the project site, the winter groundwater table may rise up to within 2 to 3 feet of the ground surface.

GEOLOGIC HAZARDS AND MITIGATION

Landslide Hazard

The project site is almost flat. Therefore, the landslide hazard for the site should be nil.

Erosion Hazard

The topsoil, weathered soil, and Marysville sand member soil are all of low resistance against erosion. However, the project site is almost flat and the erosion hazard of the site should be nil.

Seismic Hazard

The Puget Sound region is in an active seismic zone. The site is nearly flat. Therefore, seismic hazards, such as landslides and lateral soil spreading, should be minimal.

The site is underlain at shallow depth by Marysville sand member soil of loose fine sand. Liquefaction is another form of seismic hazard. The type of soil most susceptible to liquefaction during a strong earthquake is saturated, loose, fine sand to silty fine sand deposits. Such a loose sand deposit, when subjected to strong ground shaking, can be densified and decrease in volume. If water in the deposit is unable to drain quickly, pore water pressure in the deposit would increase. When the pore water pressure continues to build up by prolonged ground shaking, a "quick" condition will be reached when the pore water pressure equals the effective overburden soil pressure at some depths. Under this condition, the sand deposit will turn into a liquid state and lose its load bearing capacity. The Marysville sand member deposits underlying the site coupled with high groundwater table are prone to liquefaction during strong earthquakes. To mitigate liquefaction hazard and minimize damages to the proposed residential buildings, the subgrade soil supporting footing foundations should be prepared in accordance with the recommendations under BUILDING FOUNDATIONS of this report to mitigate liquefaction potential.

The proposed residential buildings should be designed for seismic forces induced by strong earthquakes. Based on the soil conditions encountered by the test pits, it is our opinion that Seismic Use Group I and Site Class E should be used in the seismic design of the proposed residence in accordance with the 2012 International Building Code (IBC).

DISCUSSION AND RECOMMENDATIONS

GENERAL

Based on the subsurface conditions encountered by the test pits excavated on the project site, it is our opinion that the site is suitable for the proposed development from the geotechnical engineering viewpoint, provided that the recommendations in this report are fully implemented and observed during construction. Conventional footing foundations constructed on or into the underlying Marysville sand member of light-gray, loose, fine sand deposit, prepared in accordance with the recommendations under the BUILDING FOUNDATIONS section of this report, may be used to support the proposed showroom/repair shop and light industrial buildings. Unsuitable surficial topsoil should be stripped down to the underlying loose to medium-dense weathered soil within footprint of the driveway and areas of structural fill, if any.

The surficial topsoil and weathered soil contain a high percentage of fines and can be easily disturbed when saturated. Earthwork in the wet winter season can cause significant complications for construction work. To minimize weather-related complications, grading and foundation construction work should proceed and be completed during the dryer period from April 1st to October 31st, if possible. Erosion protection and drainage control measures recommended in this report should be implemented for site stabilization beyond the above dryer period.

TEMPORARY DRAINAGE AND EROSION CONTROL

The onsite surficial weak soils are sensitive to moisture and can be easily disturbed by construction traffic. A layer of clean, 2-to-4-inch quarry spalls should be placed over areas of frequent construction traffic, such as entrance to and exit out of the project site, to protect subgrade soils from disturbance by construction traffic.

A silt fence should be installed along the downhill sides of construction areas to minimize transport of sediment by storm runoff onto neighboring properties or the street. The bottom of the filter cloth of the silt fences should be anchored in a trench filled with onsite soil.

Intercepting ditches or trench drains should be installed around the construction areas, as required, to intercept and drain away storm runoff and near-surface groundwater seepage.

Water captured by such ditches or interceptor trench drains may be dispersed into the ground through excavated pits within the site.

Spoil soils should be hauled off of the site as soon as possible. Spoil soils and imported structural fill material to be stored onsite should be securely covered with plastic tarps, as required, for erosion protection.

SITE PREPARATION AND GENERAL GRADING

Vegetation within construction limits should be cleared and grubbed. Loose topsoil and weak weathered soil should be completely stripped down to the loose to medium-dense Marysville sand member soil within building pads of proposed showroom/repair shop and industrial buildings; while topsoil and unsuitable soil in the root zone should be stripped down to medium-dense weathered soil within paved roads and driveways. Exposed soils after stripping should be compacted to a non-yielding state with a mechanical compactor and proof-rolled with a piece of heavy earthwork equipment.

EXCAVATION AND FILL SLOPES

Under no circumstance should excavation slopes be steeper than the limits specified by local, state and federal safety regulations if workers have to perform construction work in excavated areas. Unsupported temporary vertical cuts should be no higher than 4 feet. Temporary cuts higher than 4 feet should be no steeper than 1-1/4H:1V in fill, topsoil, weathered soil, or the Marysville sand member soil. Permanent cut banks should be no steeper than 2-1/2H:1V in fill, topsoil, weathered soil or Marysville sand member soil. Dewatering will be required if excavation is to proceed below groundwater table. The soil units and stability of cut slopes should be observed and verified by a geotechnical engineer during excavation.

Permanent fill embankments required to support structural or traffic load should be constructed with compacted structural fill placed over undisturbed, proof-rolled, firm, native soil after the surficial unsuitable soils are completely stripped. The slope of permanent fill embankments should be no steeper than 2-1/4H:1V. Upon completion, the sloping face of permanent fill embankments should be thoroughly compacted to a non-yielding state with a hoe-pack.

The above recommended cut and fill slopes are under the assumption that groundwater seepage would not be encountered during construction. If groundwater is encountered, grading work should be immediately halted and slope stability re-evaluated. The slopes may have to be flattened and other measures, such as dewatering wells may be required to stabilize the slopes. Stormwater should not be allowed to flow uncontrolled over cut and fill slopes. Permanent cut slopes or fill embankments should be seeded and vegetated as soon as possible for erosion protection and long-term stability, and should be covered with clear plastic sheets, as required, to protect them from erosion until the vegetation is fully established.

ONSITE STORMWATER DISPOSAL

General

The site is underlain at shallow depth by Marysville sand member soil of moderately-high permeability with a normal infiltrate rate of around 20 iph. However, winter high ground table may rise up to within 2 to 3 feet of the existing ground surface and impede flow of water. Therefore, onsite disposal of stormwater by infiltration into the Marysville sand member deposit along would not work well. Other LID (low impact development) methods may be considered for onsite stormwater disposal include: surface dispersion, rain garden, and porous pavement. These methods are discussed below:

LID Methods

Infiltration Trenches/galleries

Due to potential winter high groundwater table under the site, onsite stormwater disposal by infiltration into the Marysville sand member deposit would decrease than its normal rate. If infiltration trenches or galleries are used, a design infiltration rate of 0.15 iph (inches per hour) should be used for sizing such facilities.

Surface Dispersion

Runoff over roofs and areas of conventional pavement may be disposed onsite by surface dispersion. A surface dispersion system should consist of a distribution trench and a vegetated flowpath on the downhill side of the proposed residences. The distribution trenches should be 50 to 100 feet long each, while the flowpath should be at least 25 feet long in the direction perpendicular to the distribution trenches.

The distribution trenches should be at least 2 feet wide by 2.5 feet deep. The downstream rim of a distribution trench should be a few inches lower than the upstream rim, and should be level to spread overflowing water into uniform sheet flow onto the vegetated flowpaths. The side walls and bottom of the distribution trenches should be lined with a layer of non-woven filter fabric. The trenches should then be filled with clean 3/4 to 1-1/2 inch washed gravel to within about 10 inches of the top of the trench. A 4-inch perforated PVC spreader pipe should be placed level in the gravel-filled distribution trenches and embedded at about 16 to 18 inches below top of the trenches. The top of the gravel fill should also be covered with a filter fabric liner. The remaining trenches should then be filled with additional gravel or crushed rock to the surface. The tightlines conveying stormwater into the distribution trenches should have sufficient grade to generate flow by gravity. A clay or lean concrete dam should be constructed in uphill end of the tightline trenches to keep water from flowing backward to the residences.

The flowpath areas should be graded to a very gentle slope, as required, to spread stormwater into a uniform sheet flow. Water flowing over flowpaths would mostly be evaporating into the air and absorbed by the root system of vegetation in the flowpath, with only a small fraction infiltrating into the ground. Flowpaths should be covered by well-established native plants. Vegetation cover within flowpaths should be dense enough to help disperse water without causing erosion. Vegetation in flowpaths should be fully established and firmly rooted down before the systems may be used for stormwater disposal.

Rain Gardens

Rain gardens with its bottom cut into the underlying fine sand of the Marysville sand member may be used to dispose stormwater collected over impervious surfaces. Water stored in rain gardens would mostly be evaporating into the air and absorbed by vegetation root systems, with only a small fraction infiltrating into the ground. We recommend a design infiltration rate of 0.75 iph (inch per hour) be used for sizing rain gardens.

Rain gardens should be no more than 5 feet deep. The bank slopes of rain gardens should be no steeper than 2.5H:1V for cut banks and no steeper than 3H:1V for fill embankments. Footprints of fill embankments should be cleared and thoroughly grubbed and surficial topsoil and weathered soils should be completely stripped down to weathered soil. Fill embankments should be constructed of clean, fine-grained, fine-sandy to clayey silt or clay soil, free of organics and other deleterious substances, with the following gradation requirements:

% Passing	U.S. Standard Sieve No.
100	10
65 - 90	20
50 - 75	40
40 - 70	60
35 - 60	100
30 - 50	200

Fill embankments should be placed in lifts no more than 8-inch thick in loose state and compacted to at least 95% of the maximum dry density determined by ASTM D1557 (Modified Proctor method). After completion, the sloping face of cut banks and fill embankments should be compacted to a non-yielding state with a hoe-pack.

For water quality purpose, rain gardens should be lined with a layer of amended soil at least 18 inches thick. The amended soil should have 40 percent of compost tilled into the rain garden native soil to achieve an organic content of 10% by dry weight.

Rain gardens should be vegetated for erosion control and the vegetation should be fully established before they can be put in use. Planted vegetation should be tolerant of ponding water and saturated soil conditions in the winter months and drought in the summer months. In general, the predominant plants should be of facultative species adapted to stresses associated with wet and dry conditions. Typically, the plants may comprise of red twig dogwood, rushes, sedges, salmonberry and twinberry and ornamentals such as royal ferns, big-leaved ligularias or various primroses.

Porous Pavement

Porous pavement may be used for paved areas to allow runoff over the pavement to infiltrate into the ground. A design infiltration rate of 0.2 iph (inch per hour) may be used for design of porous pavement. Fill and topsoil should be stripped down to the loose weathered soil beneath the topsoil. A 10-inch thick layer of railroad ballast rocks (3/4 to 2-1/2 inch crushed rock) is then placed over the prepared subgrade soil and compacted to a non-yielding state with a vibratory mechanical compactor. The railroad road ballast rocks should be covered with a layer of non-woven filter fabric, such as Mirafi 140NS or equal and topped with a 4-inch layer of 5/8-inch crushed rock. This crushed rock base should also be compacted to a non-yielding state with a vibratory compactor. The porous pavement with a minimum thickness of 4 inches should then be constructed over the crushed 5/8-inch crush rock base.

STRUCTURAL FILL

Structural fill is the fill that supports structural or traffic load. Structural fill for grading work should consist of clean granular soils free of organic, debris and other deleterious substances and with particles not larger than three inches. Structural fill should have a moisture content within one percent of its optimum moisture content at the time of placement. The optimum moisture content is the water content in the soils that enable the soils to be compacted to the highest dry density for a given compaction effort. Onsite clean soils meeting the above requirements may be used as structural fill. Imported material to be used as structural fill should be clean, free-draining, granular soils containing no more than 5 percent by weight finer than the No. 200 sieve based on the fraction of the material passing No. 4 sieve, and should have individual particles not larger than three inches.

The ground over which structural fill is to be placed should be prepared in accordance with recommendations in the SITE PREPARATION AND GENERAL GRADING and EXCAVATION AND FILL SLOPES sections of this report. Structural fill placed on ground steeper than 15% should be structurally supported. Ground steeper than 20% should be stepped with vertical step no more than 4 feet before placing structural fill. Structural fill should be placed in lifts no more than 10 inches thick in its loose state, with each lift compacted to a minimum percentage of the maximum dry density determined by ASTM D1557 (Modified Proctor Method) as follows:

Application	% of Maximum Dry Density
Within building pads and under foundations	95%
Roadway/driveway subgrade	95% for top 3 feet and 90% below
Retaining/foundation wall backfill	92%
Utility trench backfill	95% for top 4 feet and 90% below

In-situ density of structural fill should be tested with a nuclear densometer by a testing agency specialized in fill placement and construction work. Testing frequency should be one test per every 250 square feet per lift.

BUILDING FOUNDATIONS

Conventional footing foundations may be used to support proposed buildings in accordance with the following recommendations. Loose to medium-dense Marysville sand member coupled with high groundwater table may result in liquefaction during strong earthquakes. To mitigate such liquefaction hazard, we recommend building footprint excavation be over-excavated to at least 4.0 feet deep with its bottom cut at least 12 inches into the underlying Marysville sand member deposit, and at least 5.0 feet laterally beyond the building limits. The exposed soil at bottom of excavation should be compacted to a non-yielding state with a vibratory mechanical compactor. The bottom and side walls of the excavated foundation pits should be lined with a layer of non-woven filter fabric (Mirafi 140NS or equal). The excavation is then backfilled with 2-to-4-inch rock spalls at least 2.0 feet thick, topped with a 6-inch layer of 2-inch crushed rock. The rock spall fill and the crushed rock base course should be placed in lifts no more than 10 inch thick, with each lift compacted to a non-yielding state with a vibratory mechanical compactor. Footing foundations may then be poured on the crushed rock base. The purpose of the non-woven filter fabric liner is to allow potential upwelling groundwater during strong earthquakes to flow into the voids in the rock spall fill and crushed rock base while keep the soil underneath in place, and thus providing effective and economical mitigation to liquefaction hazard.

If the above recommendations are followed, our recommended design criteria for footing foundations are as follows:

- The allowable soil bearing pressure for design of footing foundations, including dead and live loads, should be no greater than 2,000 psf.
- The minimum depth to bottom of perimeter footings below adjacent final exterior grade should be no less than 18 inches. The minimum depth to bottom of the interior footings below top of floor slab should be no less than 12 inches.
- The minimum width should be no less than 18 inches for continuous footings, and no less than 24 inches for individual footings, except those footings supporting light-weight decks or porches.

A one-third increase in the above recommended allowable soil bearing pressure may be used when considering short-term, transitory, wind or seismic loads. For footing foundations designed and constructed per recommendations above, we estimate that the maximum total post-construction settlement of the buildings should be 3/4 inch or less and the differential settlement across building width should be 1/2 inch or less.

Lateral loads on proposed buildings may be resisted by the friction force between the foundations and the subgrade soils or the passive earth pressure acting on the below-grade portion of the foundations. For the latter, the foundations must be poured "neat" against undisturbed soils or backfilled with a clean, free-draining, compacted structural fill. We recommend that an equivalent fluid density (EFD) of 270 pcf (pounds per cubic foot) for the passive earth pressure be used for lateral resistance. A coefficient of friction of 0.55 between the foundations and the crushed rock base may be used. The above soil parameters are unfactored values, and a proper factor of safety should be used in calculating the resisting forces against lateral loads on the residence.

CONVENTIONAL PAVED ROADS AND DRIVEWAYS

Performance of road/driveway pavement is critically related to the conditions of the underlying subgrade soils. We recommend that the subgrade soils under the driveways be treated and prepared as described in the SITE PREPARATION AND GENERAL EARTHWORK section of this report. Prior to placing base material, the subgrade soils should be compacted to a non-yielding state with a vibratory roller compactor and proof-rolled with a piece of heavy construction equipment, such as a fully-loaded dump truck. Any areas with excessive flexing or pumping should be over-excavated and re-compacted or replaced with a structural fill or crushed rock placed and compacted in accordance with the recommendations provided in the STRUCTURAL FILL section of this report.

We recommend that a layer of compacted, 7/8-inch crushed rock base (CRB), be placed for the driveways. This crushed rock base should be at least 6 inches thick for public roads and 4 inches thick for the private driveways. This crushed rock base should be overlain with a 3-inch asphalt treated base (ATB) topped by a 2-inch-thick Class B asphalt concrete (AC) surficial course for the public roads, and overlain by a 3.5-inch-thick Class B asphalt concrete (AC) surficial course for the private driveways.

DRAINAGE CONTROL

Building Footprint Excavation

Footprint excavation for proposed buildings, if encountering groundwater seepage, should have bottom of excavation sloped slightly and ditches excavated along bases of the cut banks to direct collected groundwater into sump pits from which water can be pumped out. A layer of 2-inch crushed rock should be placed over footing bearing subgrade soils, as required, to protect the soils from disturbance by construction traffic. This crushed rock base should be built to a few inches above groundwater level, but not less than 6 inches thick. The crush rock base should be compacted in 12-inch lifts to a non-yielding state with a vibratory mechanical compactor.

Runoff over Impervious Surfaces

Storm runoff over impervious surfaces, such as roofs and conventional paved roads/driveways, should be collected by underground drain line systems connected to downspouts and by catch basins installed in paved driveways. Stormwater thus collected should be tightlined to discharge into a storm sewer or suitable stormwater disposal facilities such as infiltration trenches.

Building Footing Drains

A subdrain should be installed, around the perimeter footings of each proposed building. The subdrains should consist of a 4-inch-minimum-diameter, perforated, rigid, drain pipe, laid a few inches below bottom of the perimeter footings of the buildings. The trenches and the drain lines should have a sufficient gradient (0.5% minimum) to generate flow by gravity. The drain lines should be wrapped in a non-woven filter fabric sock and completely enclosed in clean washed gravel. The remaining trenches may be backfilled with clean onsite soils. Water collected by the perimeter footing subdrain systems should be tightlined, separately from the roof and surface stormwater drain lines, to discharge into a storm sewer or suitable stormwater disposal facilities.

Surface Drainage

Water should not be allowed to stand in any areas where footings, on-grade slabs, or pavement is to be constructed. Finish ground surface should be graded to direct surface runoff away proposed buildings. We recommend the finish ground be sloped at a gradient of 3 percent minimum for a distance of at least 10 feet away from the buildings, except in the areas to be paved.

Cleanouts

Sufficient number of cleanouts at strategic locations should be provided for underground drain lines. The underground drain lines should be cleaned and maintained periodically to prevent clogging.

RISK EVALUATION STATEMENT

The subject site is nearly level and is underlain at shallow depth by loose to medium-dense Marysville sand member deposit. Therefore, the project site should be quite stable, and if the recommendations in this report are fully implemented and complied with, the liquefaction potential for the proposed buildings should also be significantly mitigated. It is our opinion that if the recommendations in this report are fully implemented and observed during and following completion of construction, the areas disturbed by construction will be stabilized and will remain stable, and will not increase the potential for soil movement. In our opinion, the risk for damages to the proposed development and from the development to adjacent properties from soil instability should be minimal.

LIMITATIONS

This report has been prepared for the specific application to this project for the exclusive use by CamNel Properties, LLC, and its associates, representatives, consultants and contractors. We recommend that this report, in its entirety, be included in the project contract documents for the information of the prospective contractors for their estimating and bidding purposes and for compliance with the recommendations in this report during construction. The conclusions and interpretations in this report, however, should not be construed as a warranty of the subsurface conditions. The scope of this study 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 this report for design considerations. All geotechnical construction work should be monitored by a geotechnical engineer during construction.

Our recommendations and conclusions are based on the geologic and soil conditions encountered in the test pits, and our experience and engineering judgment. The conclusions and recommendations are professional opinions derived in a manner consistent with the level of care and skill ordinarily exercised by other members of the profession currently practicing under similar conditions in this area. No warranty, expressed or implied, is made.

The actual subsurface conditions of the site may vary from those encountered by the test pits excavated on the site. The nature and extent of such variations may not become evident until construction starts. If variations appear then, we should be retained to re-evaluate the recommendations of this report, and to verify or modify them in writing prior to proceeding further with the construction of the proposed development of the site.

LIU & ASSOCIATES, INC.

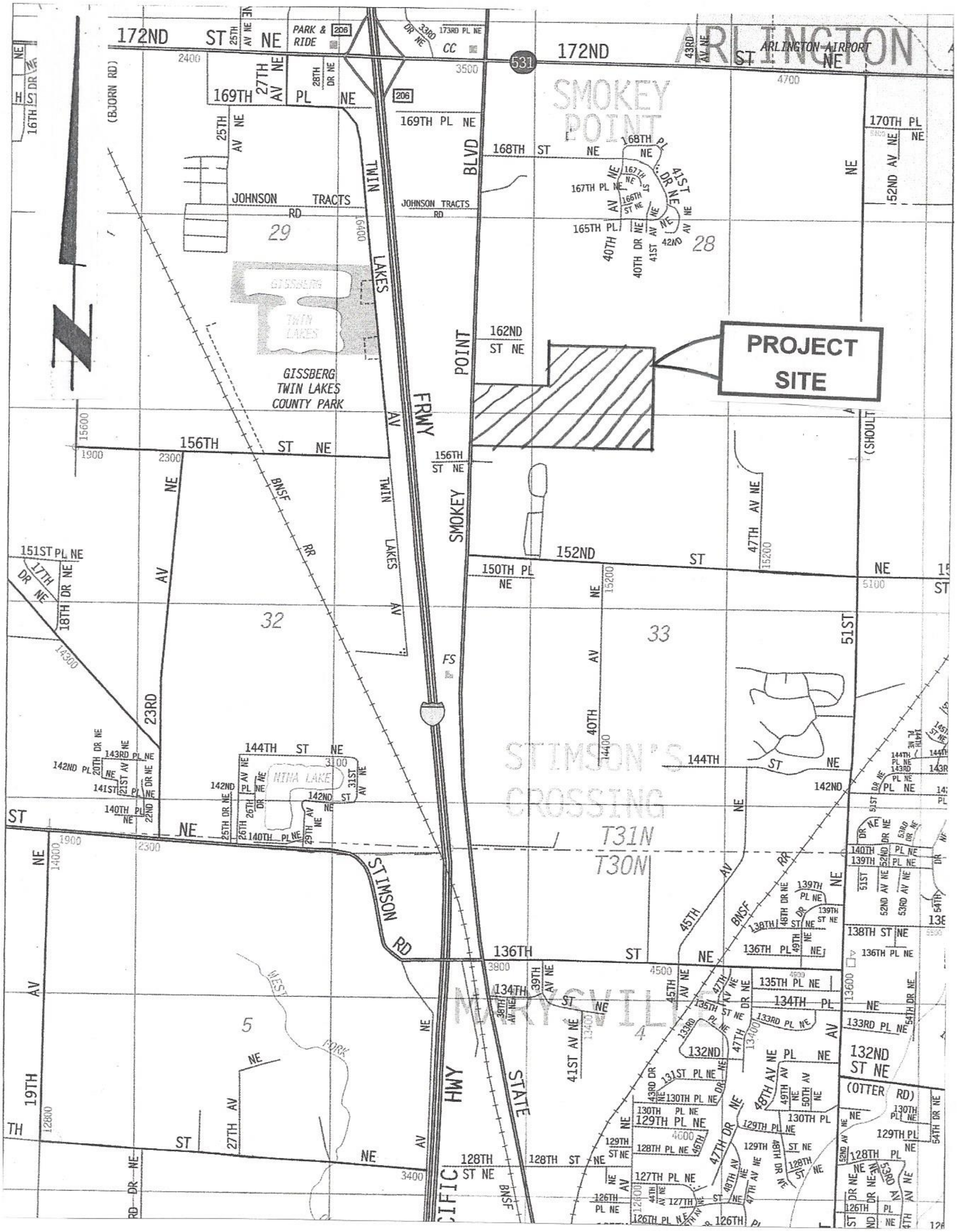
CLOSURE

We are pleased to be of service to you on this project. Please feel free to contact us if you have questions regarding this report or need further consultation.

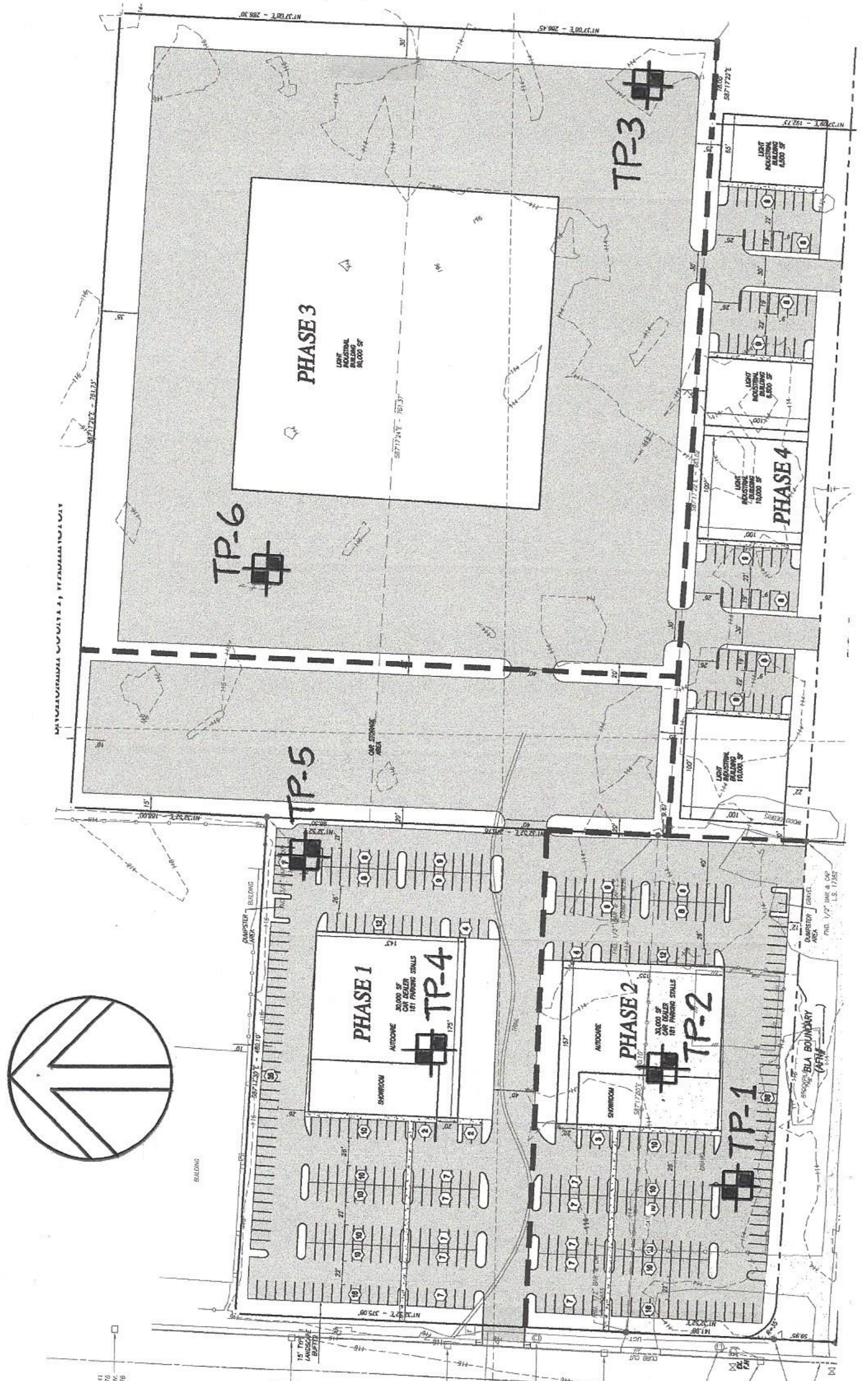
Yours very truly,
LIU & ASSOCIATES, INC.

J. S. (Julian) Liu, Ph.D., P.E.
Principal

Six plates attached



LIU & ASSOCIATES, INC. Geotechnical Engineering · Engineering Geology · Earth Science	VICINITY MAP CAMPBELL NELSON PROPERTIES 16xxx SMOKEY POINT BOULEVARD MARYSVILLE, WASHINGTON
	JOB NO. 16-122 | DATE 11/1/2016 | PLATE 1



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SITE AND EXPLORATION LOCATION PLAN
CAMPBELL NELSON PROPERTIES
16xxx SMOKEY POINT BOULEVARD
MARYSVILLE, WASHINGTON

JOB NO. 16-122	DATE 11/1/2016	PLATE 2

UNIFIED SOIL CLASSIFICATION SYSTEM

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

NOTES:

1. FIELD CLASSIFICATION IS BASED ON VISUAL EXAMINATION OF SOIL IN GENERAL ACCORDANCE WITH ASTM D2488-83.
2. SOIL CLASSIFICATION USING LABORATORY TESTS IS BASED ON ASTM D2487-83.
3. DESCRIPTIONS OF SOIL DENSITY OR CONSISTENCY ARE BASED ON INTERPRETATION OF BLOW-COUNT DATA, VISUAL APPEARANCE OF SOILS, AND/OR TEST DATA.

SOIL MOISTURE MODIFIERS:

DRY - ABSENCE OF MOISTURE, DUSTY, DRY TO THE TOUCH

SLIGHTLY MOIST - TRACE MOISTURE, NOT DUSTY

MOIST - DAMP, BUT NO VISIBLE WATER

VERY MOIST - VERY DAMP, MOISTURE FELT TO THE TOUCH

WET - VISIBLE FREE WATER OR SATURATED, USUALLY SOIL IS OBTAINED FROM BELOW WATER TABLE

TEST PIT NO. 1

Logged By: JSL Date: 8/25/2016 Ground El. ±

Depth ft.	USCS CLASS.	Soil Description	Sample No.	W %	Other Test
0–1	OL	Dark-brown to black, medium-dense, organic, silty fine SAND mixed with crushed rock, slightly-moist (FILL)			
1–1.5	OL	Dark-brown, loose, organic, silty fine SAND, moist (relic TOPSOIL)			
1.5–4.5	SM/SP	Brown, loose, slightly-silty, fine SAND, slightly moist			
4.5–7.5	SP	Gray, loose, fine to coarse SAND, trace gravel, moist to wet (fresh MARYSVILLE SAND member)			
		Test pit terminated at 7.5 ft; caved in gray sand; groundwater table @ 6.0 ft.			

TEST PIT NO. 2

Logged By: JSL Date: 8/25/2016 Ground El. ±

Depth ft.	USCS CLASS.	Soil Description	Sample No.	W %	Other Test
0–1	GP	Crushed Rock			
1–2	SP	Dark-brown, loose, organic, silty fine SAND, slightly-moist			
2–3	SM/SP	Brown, loose, slightly-silty, fine SAND, slightly-moist			
3–7.5	SP	Gray, medium-dense, fine to coarse SAND, trace gravel, moist to wet (fresh MARYSVILLE SAND member)			
		Test pit terminated at 7.5 ft; caved in gray sand; groundwater table @ 6.3 ft.			

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TEST PIT LOGS
CAMPBELL NELSON PROPERTIES
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MARYSVILLE, WASHINGTON

JOB NO. 16-122 DATE 8/26/2016 PLATE 4

TEST PIT NO. 3

Logged By: JSL   Date: 8/25/2016   Ground El. ±

Depth ft.		USCS CLASS.	Soil Description	Sample No.	W %	Other Test
0–1		OL	Dark-brown, loose, organic, silty fine SAND, slightly-moist (TOPSOIL)			
1–4		SM/SP	Brown, loose, slightly-silty, fine SAND, slightly moist			
4–8		SP	Gray, loose, fine to medium SAND, trace gravel, moist to wet (fresh MARYSVILLE SAND)			
8–10			Test pit terminated at 6.5 ft; caved in gray sand; groundwater table @ 6.5 ft.			

TEST PIT NO. 4

Logged By: JSL   Date: 8/25/2016   Ground El. ±

Depth ft.		USCS CLASS.	Soil Description	Sample No.	W %	Other Test
0–1		OL	Dark-brown, loose, organic, silty fine SAND, dry (TOPSOIL)			
1–3		SM/SP	Light-brown, loose, slightly-silty, fine SAND, dry			
3–8		SP	Gray, loose, fine to coarse SAND, trace gravel, moist to wet (fresh MARYSVILLE SAND)			
8–10			Test pit terminated at 8.0 ft; caved in gray sand; groundwater table @ 7.0 ft.			

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TEST PIT LOGS
CAMPBELL NELSON PROPERTIES
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MARYSVILLE, WASHINGTON

JOB NO. 16-122 | DATE 8/26/2016 | PLATE 5

TEST PIT NO. 5

Logged By: JSL Date: 8/25/2016 Ground El. ±

Depth ft.		USCS CLASS.	Soil Description	Sample No.	W %	Other Test
1		OL	Dark-brown, loose, organic, silty fine SAND, dry (TOPSOIL)			
2		SM/SP	Brown, loose, slightly-silty, fine SAND, dry			
3						
4						
5		SP	Gray, loose, fine to medium SAND, trace gravel, moist to wet (fresh MARYSVILLE SAND)			
6						
7						
8						
9						
10			Test pit terminated at 7.0 ft; caved in gray sand; groundwater table @7.0 ft.			

TEST PIT NO. 6

Logged By: JSL Date: 8/25/2016 Ground El. ±

Depth ft.		USCS CLASS.	Soil Description	Sample No.	W %	Other Test
1		OL	Dark-brown, loose, organic, silty fine SAND, dry (TOPSOIL)			
2		SM/SP	Light-brown, loose, slightly-silty, fine SAND, dry			
3						
4		SP	Gray, loose, fine to medium SAND, trace gravel, moist to wet (fresh MARYSVILLE SAND)			
5						
6						
7						
8						
9						
10			Test pit terminated at 8.5 ft; caved in gray sand; groundwater table @ 7.5 ft.			