LIU & ASSOCIATES, INC.

Geotechnical Engineering | Engineering Geology | Earth Science

October 11, 2017

Ms. Sunshine Kapus
Gamut 360 Holdings, LLC
3726 Broadway, Suite 301
Everett, WA 98201

Dear Ms. Kapus:

Subject: Geotechnical Investigation
Glein/Sears Properties
4028/4014 Sunnyside Boulevard
Marysville, Washington
L&A Job No. 17-017

INTRODUCTION

We understand the development of a residential plat project is proposed for the subject property located at the above addresses in Marysville, Washington. The project site will be platted into 44 single-family residence building lots with supporting infrastructure, and with a new residence will be constructed on each lot. We also understand that onsite stormwater disposal by infiltration is being considered for this development.

At your request, we have completed a geotechnical investigation for the subject project. The purpose of this investigation is to explore and characterize subsurface (soil and groundwater) conditions of the project site, evaluate feasibility of onsite stormwater disposal, and provide geotechnical recommendations on grading, slope stabilization, onsite stormwater disposal by infiltration (if feasible), erosion mitigation, surface and ground water drainage control, and foundation support to the new residences for the proposed development. Presented in this report are our findings and recommendations.

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PROJECT DESCRIPTION

The project includes the Glein property on its north side and two Sears parcels on its south side. The building lots on the Glein parcel will be accessed from Sunnyside Boulevard via a paved road traversing west down its middle, while the lots on the Sears parcels will be accessed via a paved road off the mid-point of the above road to go across the width of the Sears parcels and another road to T-off the mid-point of this road going to the west. Stormwater will be disposed onsite west of the building lots with a surface dispersion system. The project site generally slopes gently over about its east half and moderate to steep over about its west half. Grading of the site would require some cut and fill.

SCOPE OF SERVICES

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

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

2. Explore subsurface conditions of the to be developed area of the site with test pits excavated to a firm stable bearing soil stratum or to the maximum depth (about 10 feet) capable by the backhoe used in excavating the test pits, whichever occurs first.

3. Perform geotechnical analyses based on subsurface conditions encountered by the test pits and results of our geotechnical analyses.

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

SITE CONDITIONS

SURFACE CONDITION

The general location of the project site is shown on Plate 1 – Vicinity Map, attached hereto. The site is bounded by Sunnyside Boulevard to the east, adjoined by residential development to the north and south, and backed into a wetland to the west. The site is situated on a gentle to steep, westerly-declining slope. An existing house with detached barn and storage shed structures occupy the east end area of the Glein property on the north side of the project site while the Sears parcels on the south side is vacant and undeveloped. This east portion of the site slopes down gently westerly while the remaining area beyond descends moderately steeply to steeply westward towards the west boundary of the site. The open area of the project site is covered by over-grown lawn grass, with occasional isolate trees dotting the perimeter of the site.

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 Vashon Till (Q_{vt}) deposits.

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 Vashon till soil unit were plowed directly under glacial ice during the most recent glacial period as the glacier advanced over an eroded, irregular surface of older formations and sediments. This soil unit is composed of a mixture of unsorted clay, silt, sand, gravel, and scattered cobbles and boulders. The Vashon till soil over the top two to four feet is normally weathered to a medium-dense state, and is moderately permeable and compressible. The underlying fresh till soil, commonly referred to as "hard pan", is very-dense and weakly-cemented. The fresh till soil possesses a compressive strength comparable to that of low-grade concrete and can remain stable on steep natural slopes or man-make cuts for a long period. The fresh till deposits can provide excellent foundation support with little or no settlement, but are of extremely low permeability and would hardly allow stormwater to seep through.

SOIL CONDITION

Subsurface conditions of the project site were explored with seven backhoe test pits, with the first three excavated on September 20, 2016, and the last four excavated on October 10, 2017, when the Sears parcels were annexed to the project. The approximate locations of the test pits are shown on Plate 2 - Site and Exploration Location Plan. The test pits were located with either a tape measure or by visual reference to existing topographic features in the field and on the topographic survey map, and their locations should be considered as only accurate to the measuring method used.

A geotechnical engineer from our office was present during subsurface exploration, to monitor test pit excavation, examine soil and geologic conditions encountered, and complete logs of the test holes. 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 7.

The test pits, excavated to 7.0 to 8.0 feet deep, encountered a layer of topsoil, about 12 to 15 inches thick, mantling the site. The topsoil is underlain by a layer of weathered soil of light-brown to orange-brown, loose to medium-dense, silty fine sand with trace to some gravel and occasional cobble, about 1.8 to 3.5 feet thick. Underlying the weathered soil to the depths explored is a glacial till deposit of light-brown to light-gray, very-dense, cemented, gravelly, silty, fine sand, with occasional cobble.

GROUNDWATER CONDITION

Groundwater was not encountered by any of the three test pits excavated on the site. The very-dense, cemented, glacial till deposit underlying the site at shallow depth is of extremely low permeability and would hardly allow stormwater to seep through. This glacial till deposit has the potential to perch stormwater infiltrating into the more permeable surficial soils. The amount of and the depth to this near-surface perched groundwater would fluctuate seasonally, depending on precipitation, surface runoff, ground vegetation cover, site utilization, and other factors. The perched groundwater would accumulate and rise in the wet winter months and may dry up completely during the dryer summer months.

GEOLOGIC HAZARDS AND MITIGATION

Landslide Hazard

The project site is underlain at shallow depth by a very-dense cemented, glacial till deposit. The glacial till deposit is of very-high shear strength and has high resistance against slope failures. Therefore, the potential for deep-seated slides cutting into the high-strength glacial till deposit to occur on the site is minimal.

Erosion Hazard

The surficial topsoil and weathered soil are of low resistance against erosion, while the underlying very-dense cemented glacial till deposit is of high resistance against erosion. Therefore, erosion hazard in the weak surficial topsoil and weathered soil in the steeper portion of the site may exist if they are devoid of vegetation cover and saturated. Progressive erosion may result in shallow mud flow in surficial topsoil and weathered soil. To mitigate such hazard, vegetation cover outside of construction areas should be protected and maintained. Areas disturbed and devoid of vegetation by construction activities should be re-vegetated as soon as possible. Exposed ground during construction should be covered by plastic tarp for erosion protection. Concentrated stormwater should not be discharged uncontrolled onto the ground within the site. Stormwater over impervious surfaces, such as roofs and paved road and driveways, should be captured by underground drain line systems connected to roof downspouts and by catch basins installed in paved road and driveways. Water collected by these drain line systems should be tightlined to discharge into a storm sewer system or suitable stormwater disposal facilities.

Seismic Hazard

The Puget Sound region is in an active seismic zone. The site is underlain at shallow depth by very-dense, cemented, glacial till deposits of very-high shear strength. Therefore, the potential for seismic hazards, such as landslides, liquefaction, lateral soil spreading, to occur on the site should be minimal. The proposed residences, however, 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 C should be used in the seismic design of the proposed residences in accordance with the 2015 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 and following completion of construction. Conventional footing foundations constructed on or into the underlying very-dense cemented glacial till soil may be used to support the proposed residences. Unsuitable surficial topsoil and weathered soil should be stripped off within footprints of paved road and driveways and areas of structural fill.

The surficial topsoil and weathered soil contain a high percentage of fines and are moisture sensitive. They can be easily disturbed when saturated by construction traffic. Earthwork in wet winter season can cause significant complications for construction work. To minimize weather-related difficulties, 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 if construction is to be carried out beyond the above dryer period.

TEMPORARY DRAINAGE AND EROSION CONTROL

The onsite surficial weak soils are moisture sensitive and can be easily disturbed by construction traffic when saturated. A layer of clean, 2-to-4-inch quarry spalls should be placed over areas of frequent traffic, such as the entrance to and exit from the site, as required, 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 streets. The bottom of the filter cloth of the silt fence should be anchored in a trench filled with onsite soil.

Intercepting ditches or trench drains should be installed around 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 should be stored in temporary holding and settling pits onsite. Only clear and clean water may be discharged through perforated spreader pipes onto nearby well vegetated wetland buffer zone.

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 protection against erosion.

SITE PREPARATION AND GENERAL GRADING

Vegetation within construction limits should be cleared and grubbed. Existing structures to be demolished should also have their foundations removed. Loose topsoil and weak weathered soil should be completely stripped down to the very-dense glacial till soil within building pads of the residences; while topsoil and unsuitable soil in the root zone should be stripped down to the medium-dense to dense weathered soil and/or the underlying very-dense glacial till soil within footprints of paved road and driveways. The exposed soils 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 FOR GENERAL GRADING WORK

Under no circumstance should cut 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 cuts greater than 4 feet in height should be no steeper than 1H:1V in topsoil and weathered soils, and may be vertical in the underlying very-dense cemented glacial till soil if the overall depth of cut does not exceed 15 feet. Otherwise, cut in glacial till soil should be no steeper than 1/2H:1V. Permanent cut banks should be no steeper than 2H:1V in topsoil and weathered soils, and no steeper than 1-1/2H:1V in the underlying very-dense glacial till soil. 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 soils 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, excavation work should be immediately halted and slope stability re-evaluated. The slopes may have to be flattened and other measures taken 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 slope stability, and should be covered with clear plastic sheets, as required, to protect them from erosion until the vegetation is fully established.

STRUCTURAL FILL

Structural fill is the fill that supports structural or traffic load. Structural fill for grading work should consist of clean free-draining 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 enables 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 7.5 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 20% should be structurally supported. Ground steeper than 15% should be step-cut with vertical steps no more than 3 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 400 square feet per lift.

BUILDING FOUNDATIONS

Conventional footing foundations may be used to support the proposed residences. The footing foundations should be constructed on or into the underlying very-dense glacial till deposit or on compacted structural fill constructed over the glacial till basal soil. Water should not be allowed to accumulate in footing trenches. Disturbed soils in footing trenches should be completely removed down to native undisturbed till soil prior to pouring concrete for the footings.

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 3,000 psf. The footing bearing soil should be verified by a geotechnical engineer after the footing trenches are excavated and before the footings poured.

- 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 the 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 300 pcf (pounds per cubic foot) for the passive earth pressure be used for lateral resistance. The above passive pressure assumes that the backfill is level or inclines upward away from the foundations for a horizontal distance at least twice the depth of the foundations below the final grade. A coefficient of friction of 0.55 between the foundations and the subgrade soils 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 buildings.

SLAB-ON-GRADE FLOORS

Slab-on-grade floors, if used for proposed residences, should be placed on firm subgrade soil prepared as outlined in the SITE PREPARATION AND GENERAL EARTHWORK and the STRUCTURAL FILL sections of this report. Where moisture control is critical, the slab-on-grade floors should be placed on a capillary break which is in turn placed on the compacted subgrade. The capillary break should consist of a minimum four-inch-thick layer of clean, free-draining, 5/8-inch crushed rock, containing no more than 5 percent by weight passing the No. 4 sieve. A vapor barrier, such as a 6-mil plastic membrane, may be placed over the capillary break, as required, to keep moisture from migrating upwards.

CAST-IN-PLACE CONCRETE WALLS

Building foundation walls restrained at the top from lateral movement are considered unyielding and should be designed for a lateral soil pressure under the at-rest condition. Retaining walls unrestrained at the top from lateral movement may be designed for active soil pressure. For static loading condition, we recommend that an at-rest soil pressure of 50 pcf EFD (equivalent fluid density) and an active soil pressure of 35 pcf EFD be used for the design of building foundation walls and retaining walls, respectively, with a level or descending backslope. For walls with ascending backslope, an additional pressure of 0.75 pcf per degree of the backslope angle above the horizontal should be added to the above design pressures. To counter the above active or at-rest pressure, a passive lateral soil pressure of 300 pcf EFD may be used. This passive pressure value is applicable only to walls with a level or ascending backslope away from the walls for a horizontal distance at least 1.5 times the wall height. For seismic loading condition (100-year earthquakes), an additional uniform distribution pressure of 8H psf should be added to the above pressures for wall design. H is the overall height of walls from top of wall to bottom of footing in feet. To resist against sliding, the friction force between the footings and the subgrade soils may be calculated based on a coefficient of friction of 0.55. The above soil parameters are ultimate values based on a fully drained condition of the walls, and proper factors of safety should be applied in the design of the retaining and basement walls against sliding and overturning failures for static and seismic loadings.

The retaining walls may be supported on footing foundations. Preparation of footing bearing soil, allowable soil bearing pressure, drainage provision, and wall backfill should be in compliance with the recommendations for building foundations in this report.

PAVED ROAD AND DRIVEWAYS OF CONVENTIONAL PAVEMENT

Performance of road/driveway of conventional pavement is critically related to conditions of the underlying subgrade soils. We recommend that the subgrade soils under road/driveways be treated and prepared as described in the SITE PREPARATION AND GENERAL EARTHWORK section of this report. Prior to constructing pavement, 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 replaced with compacted structural fill 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 for public road and 4 inches thick for private driveways. The crushed rock base should be overlain 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 or joint-use driveways, and overlain by a 3-inch-thick Class B asphalt concrete (AC) surficial course for private driveways.

ONSITE STORMWATER DISPOSAL

Low Impact Development (LID) methods for onsite stormwater disposal, include infiltration trenches, storage and reuse, splash blocks, surface dispersion, rain gardens (bio-retention cells), porous pavement were considered and are discussed below.

Infiltration Trenches and Rain Gardens

The project site is underlain at shallow depth by a very-dense, cemented, glacial till deposit of extremely low permeability. Therefore, using infiltration trenches or rain gardens to dispose stormwater by infiltration would be inefficient and will not work well. Therefore, it is our opinion that infiltration trenches and rain gardens are not suitable for onsite stormwater disposal for the subject project.

Storage and Reuse

Roof runoff may be stored in cisterns or barrels during rainstorms. Stored water may be used later for watering plants and irrigating lawns.

Surface Dispersion

Runoff over roofs and paved driveways may be disposed onsite by surface dispersion. A surface dispersion system should consist of a distribution trench or elevated spreader pipe and a vegetated flowpath to be constructed. This method will work well if there is sufficient open space to install this surface dispersion system. The surface dispersion systems should be installed in areas no steeper than 25% grade.

The distribution trenches should be 10 feet long for each 750 s.f. of impervious surface to be served, up to 50 feet long for a total impervious surfaces of 5,000 s.f. for each residence. Alternatively, elevated spreader pipe distribution systems, consisting of 4-inch, perforated, PVC or aluminum pipes, based on 50 square feet of impervious area serve per foot of spreader pipe, may be used in lieu of distribution trenches. The flowpaths should each be at least 25 feet long in the direction perpendicular to the distribution trenches or spreader pipe systems. The surface dispersion systems should be located in the downhill areas of the areas of impervious surfaces they serve to spread stormwater in 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. 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.

Distribution trenches should be about 2 feet wide by 2.5 feet deep. The downstream rim of distribution trenches should be graded to 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 or crushed rock to within about 10 inches of the top of the trench. A 4-inch perforated PVC spreader pipe should be placed level in the distribution trench and embedded at about 16 to 18 inches below top of the trenches. The top of the gravel or crushed rock 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 trench should have sufficient grade to generate flow by gravity. A clay or lean concrete dam should be constructed in the tightline trenches to keep water from flowing backward to the residences.

Spreader pipe systems, if used in lieu of distribution trenches, should be set level at about 3 to 4 feet above ground surface. Spreader pipes may be loop around at 5 feet on centers. Spreader pipes should be supported on and anchored to 2-inch galvanized steel pipe piles spaced at no more than 10 feet on centers and driven at least 6 feet into the ground.

Porous Pavement

Porous pavement may be used for driveways of the proposed residences to allow runoff to infiltrate into the ground. A design infiltration rate of 0.2 iph (inch per hour) may be used for design of porous pavement. A 10-inch thick layer of railroad ballast rocks (3/4 to 2-1/2 inch crushed rock) is to be placed over prepared subgrade soils and compacted to a firm condition with a vibratory compactor. The railroad road ballast rocks should be covered with a layer of non-woven filter fabric (Mirafi 140NS) 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. The porous pavement with a minimum thickness of 4 inches should then be constructed over the crushed 5/8-inch crush rock base.

DRAINAGE CONTROL

Building Footprint Excavation

Footprint excavation for proposed residences, if encountering groundwater seepage, should have bottom of excavation sloped slightly and a trench excavated along the base of cut banks to intercept seeping groundwater. Water in the trenches should be directed 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 driveways of conventional pavement, should be collected by underground drain line systems connected to downspouts and by catch basins installed in paved driveway. Stormwater thus collected should be tightlined to discharge into a storm sewer or suitable stormwater disposal facility.

Building Footing Drains

A subdrain should be installed, around the perimeter footings of each residence. 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 should be backfilled with clean washed gravel to within 18 inches of finish grade, then topped 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 facility.

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 from the adjacent 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 adjacent 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.

LIMITATIONS

This report has been prepared for the specific application to this project for the exclusive use by Gamut 360 Holdings 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 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 subsurface conditions of the site. The scope of this investigation 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.

CLOSURE

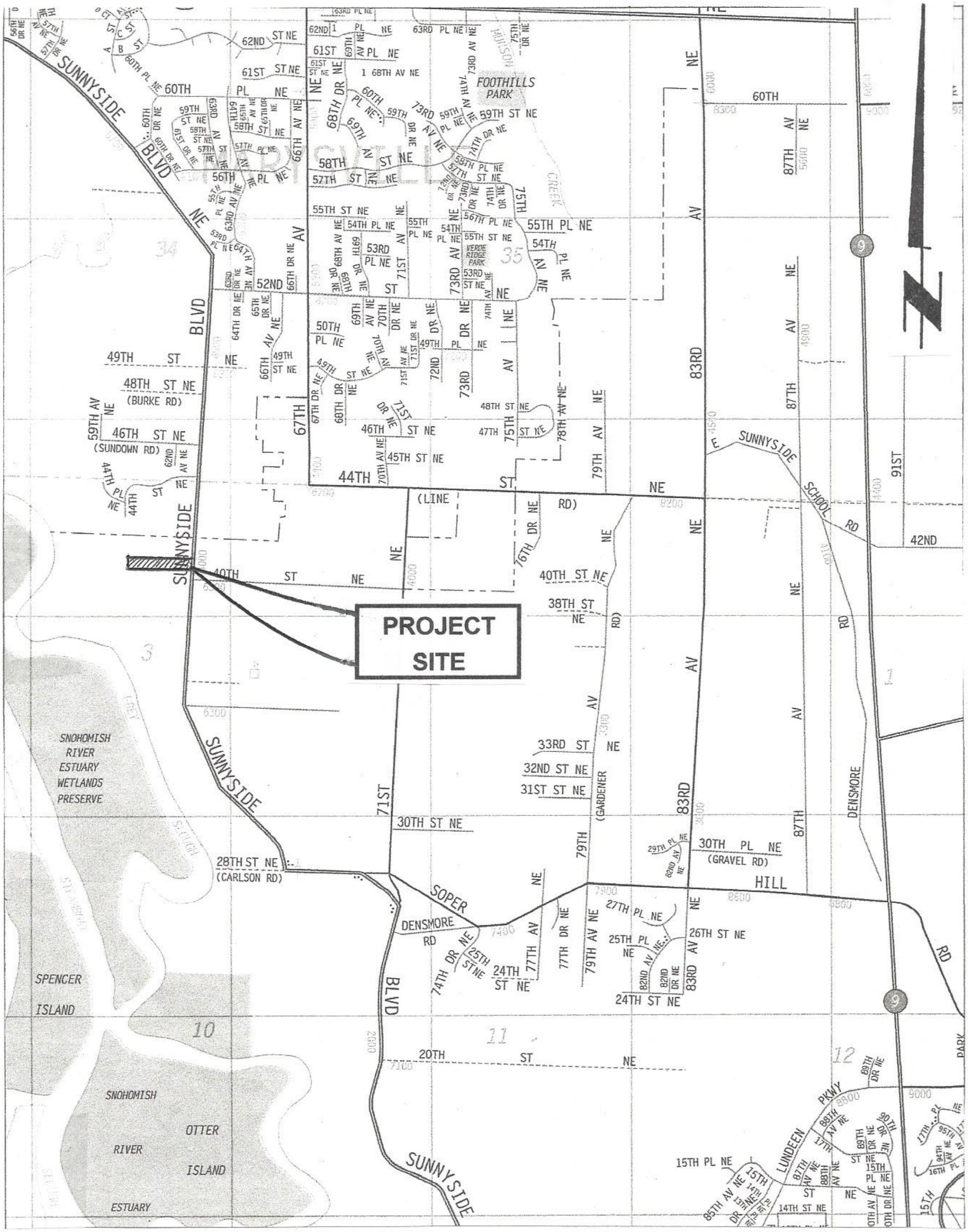
We are pleased to be of service to you on this project. Please feel free to contact us if you have any questions regarding this report or need further consultation.

JEONG S. LIU
STATE OF WASHINGTON
27589
REGISTERED
PROFESSIONAL ENGINEER

Yours very truly,
LIU & ASSOCIATES, INC.

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

Seven plates attached



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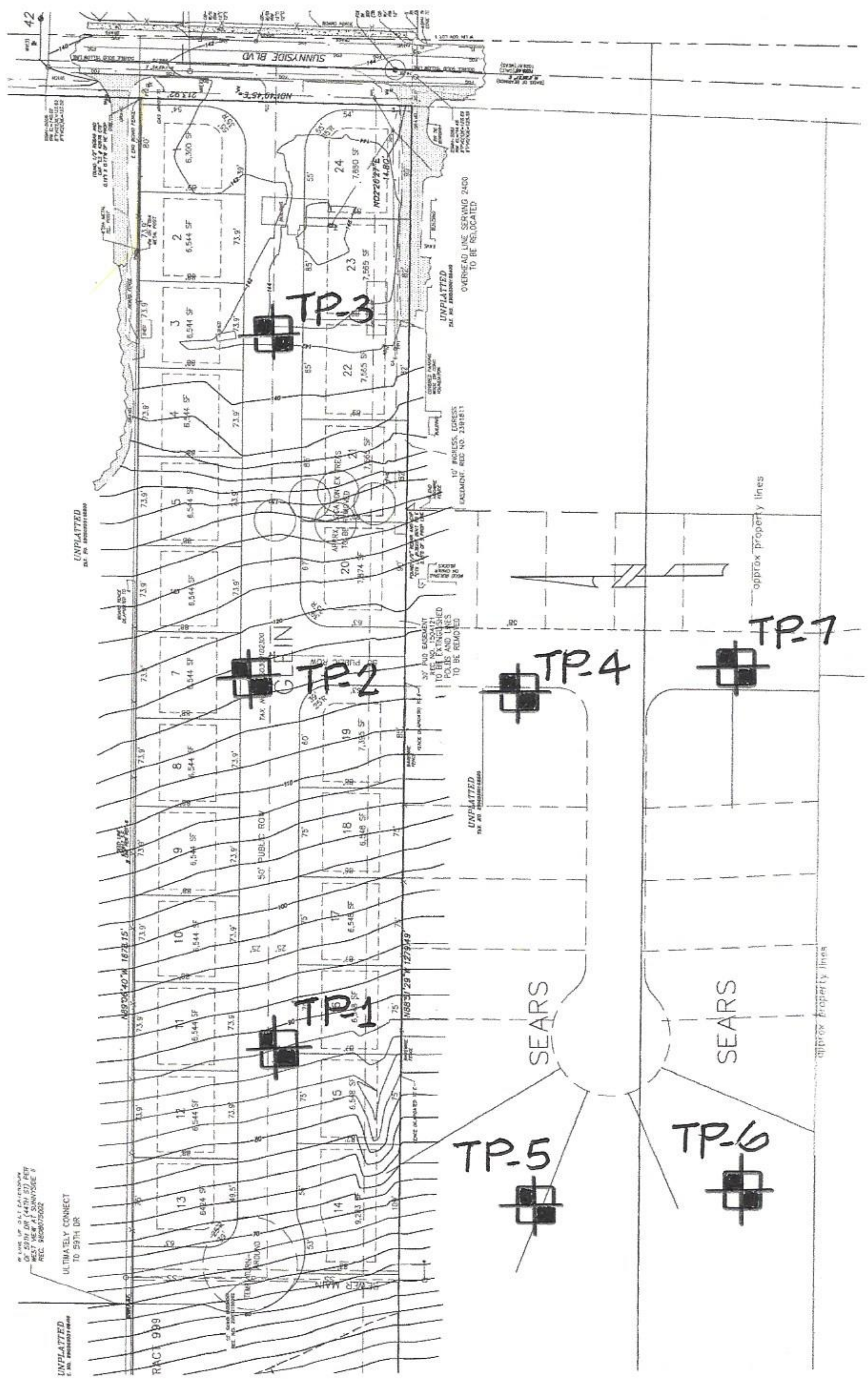
VICINITY MAP
GLEIN PROPERTY
4028 SUNNYSIDE BOULEVARD
MARYSVILLE, WASHINGTON

JOB NO. 17-017 | DATE 3/25/2017 | PLATE 1



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SITE AND EXPLORATION LOCATION PLAN
GLEIN/SEARS PROPERTIES
4028/4014 SUNNYSIDE BPOULEVARD
MARYSVILLE, WASHINGTON

JOB NO. 17-017	DATE 10/10/2017	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

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UNIFIED SOIL CLASSIFICATION SYSTEM

PLATE 3

TEST PIT NO. 1

Logged By: JSL Date: 9/20/2016 Ground El. ±

Depth ft.	USCS CLASS.	Soil Description	Sample No.	W %	Other Test
0–1	OL	Dark-brown, loose, organic, silty fine SAND, with buried boulder, dry (TOPSOIL)			
1.5–4	SM	Light-brown, medium-dense, silty fine SAND, trace to some gravel, dry			
4–7.5	SM	Light-gray, very-dense, gravelly, silty, fine SAND, occasional cobble, cemented, slightly-moist (VASHON TILL)			
		Test pit terminated at 7.5 ft; groundwater not encountered.			

TEST PIT NO. 2

Logged By: JSL Date: 9/20/2016 Ground El. ±

Depth ft.	USCS CLASS.	Soil Description	Sample No.	W %	Other Test
0–1	OL	Dark-brown, loose, organic, silty fine SAND, moist (TOPSOIL)			
1–4.5	SM	Light-brown, medium-dense, silty fine SAND, trace to some gravel, dry			
4.5–8	SM	Light-gray, very-dense, gravelly, silty, fine SAND, occasional cobble, cemented, slightly-moist (VASHON TILL)			
		Test pit terminated at 8.0 ft; groundwater not encountered.			

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TEST PIT LOGS
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JOB NO. 17-017 DATE 9/20/2016 PLATE 4

TEST PIT NO. 3

Logged By: JSL Date: 9/20/2016 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	Light-brown, medium-dense, silty fine SAND, trace to some gravel, dry			
4–7.5	SM	Light-gray, very-dense, gravelly, silty, fine SAND, occasional cobble, cemented, slightly-moist (VASHON TILL)			
		Test pit terminated at 7.5 ft; groundwater not encountered.			

TEST PIT NO. 4

Logged By: Date: 10/10/2017 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)			
1–3.5	SM	Brown, loose, silty fine SAND, some gravel and cobble, slightly-moist			
3.5–8	SM	Light-brown to light-gray, very-dense, gravelly, silty, fine SAND, occasional cobble, cemented, slightly-moist (VASHON TILL)			
		Test pit terminated at 8.0 ft; groundwater not encountered.			

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JOB NO. 17-017 DATE 10/10/2017 PLATE 5

TEST PIT NO. 5

Logged By: JSL   Date: 10/10/2017   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)			
1–3		SM	Light-brown, medium-dense, silty fine SAND, some gravel, slightly-moist			
3–7		SM	Light-gray, very-dense, gravelly, silty, fine SAND, occasional cobble, cemented, slightly-moist (VASHON TILL)			
7–10			Test pit terminated at 7.0 ft; groundwater not encountered.			

TEST PIT NO. 6

Logged By: ______   Date: 10/10/2017   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)			
1–3.5		SM	Light-brown, medium-dense, silty fine SAND, some gravel, slightly-moist			
3.5–7.5		SM	Light-brown to light-gray, very-dense, gravelly, silty, fine SAND, occasional cobble, cemented, slightly-moist (VASHON TILL)			
7.5–10			Test pit terminated at 7.5 ft; groundwater not encountered.			

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JOB NO. 17-017 | DATE 10/10/2017 | PLATE 6

TEST PIT NO. 7

Logged By: JSL Date: 10/10/2017 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)			
1–3		SM	Orange-brown, medium-dense, silty fine SAND, some gravel, slightly-moist			
3–7		SM	Light-gray, very-dense, gravelly, silty, fine SAND, occasional cobble, cemented, slightly-moist (VASHON TILL)			
7–10			Test pit terminated at 7.0 ft; groundwater not encountered.			

TEST PIT NO. ____

Logged By: ____ Date: ____ Ground El. ±

Depth ft.		USCS CLASS.	Soil Description	Sample No.	w %	Other Test
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						

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JOB NO. 17-017 DATE 10/10/2017 PLATE 7