



December

JM1 Holdings, LLC  
C/O Land Pro Group  
10515 20<sup>th</sup> Street SE, Suite 202  
Lake Stevens, Washington

**RE: Geotechnical Investigation**  
Proposed 27 Lot Subdivision  
4614 87<sup>th</sup> Avenue NE and 8507 E. Sunnyside School Road  
Marysville, Washington

In accordance with your authorization, Cobalt Geosciences, LLC has prepared this letter to discuss the results of our geotechnical evaluation at the referenced site.

The purpose of our evaluation was to provide recommendations for foundation design, grading, and earthwork.

### **Site Description**

The site is located at 4614 87<sup>th</sup> Avenue NE in Marysville, Washington. The site consists of two irregularly shaped parcels (No.'s 00590700016201 & 00590700016202) with a total area of 4.23 acres.

The eastern portion of the site is developed with a residence, driveway, and several outbuildings. There is a barn in the northwest corner of the site. The remainder of the site is vegetated with grasses, bushes, ferns, ivy, blackberry vines, and variable diameter trees. Most of the site is a grass field.

The site slopes gently downward from north to south and southwest at magnitudes of 5 to 15 percent and total relief of about 32 feet.

The site is bordered to the east by 87<sup>th</sup> Avenue NE, to the south by a residence and East Sunnyside School Road, and to the north and west by residential properties.

The proposed development includes up to 27 residential lots, access roadways, detention systems, and utilities. Stormwater will include infiltration or other systems depending on feasibility. Site grading may include cuts and fills of 8 feet or less and foundation loads are expected to be light. We should be provided with the final plans to verify that our recommendations remain valid and do not require updating.

### **Area Geology**

The Geologic Map of the Lake Stevens Quadrangle, indicates that the site is underlain by Vashon Glacial Till.

Vashon Glacial Till includes mixtures of silt, sand, clay, and gravel. These materials are usually impermeable and are typically dense to very dense below a weathered zone. Vashon Recessional Outwash includes normally consolidated sand and gravels. The advance outwash includes dense fine to medium grained sands

## Soil & Groundwater Conditions

As part of our evaluation, we excavated four test pits and four hand borings within the property, where accessible.

The explorations encountered approximately 6 to 12 inches of grass and topsoil underlain by approximately 3 to 4.5 feet of loose to medium dense, silty-fine to medium grained sand trace to with gravel (Weathered Glacial Till). These materials were underlain by dense to very dense, silty-fine to fine grained sand trace gravel (Vashon Glacial Till), which continued to the termination depths of the explorations. The till was partially to well cemented.

Groundwater was encountered in all of the explorations at 2 to 5 feet below grade during our excavation work. Groundwater was generally perched on the dense till or within the weathered till as interflow. This groundwater will likely not be present during a typical dry season.

Water table elevations often fluctuate over time. The groundwater level will depend on a variety of factors that may include seasonal precipitation, irrigation, land use, climatic conditions and soil permeability. Water levels at the time of the field investigation may be different from those encountered during the construction phase of the project.

## Erosion Hazard

The Natural Resources Conservation Services (NRCS) maps for Snohomish County indicate that the site is underlain by Tokul gravelly medial loam (0 to 8 percent slopes). These soils would have a slight to moderate erosion potential in a disturbed state depending on the slope magnitude.

It is our opinion that soil erosion potential at this project site can be reduced through landscaping and surface water runoff control. Typically, erosion of exposed soils will be most noticeable during periods of rainfall and may be controlled by the use of normal temporary erosion control measures, such as silt fences, hay bales, mulching, control ditches and diversion trenches. The typical wet weather season, with regard to site grading, is from October 31<sup>st</sup> to April 1<sup>st</sup>. Erosion control measures should be in place before the onset of wet weather.

## Seismic Hazard

The overall subsurface profile corresponds to a Site Class *D* as defined by Table 1613.5.2 of the International Building Code (IBC). A Site Class *D* applies to an overall profile consisting of stiff/medium dense soils within the upper 100 feet.

We referenced the U.S. Geological Survey (USGS) Earthquake Hazards Program Website to obtain values for  $S_s$ ,  $S_i$ ,  $F_a$ , and  $F_v$ . The USGS website includes the most updated published data on seismic conditions. The following tables provide seismic parameters from the USGS web site with referenced parameters from ASCE 7-10 and 7-16.

Seismic Design Parameters (ASCE 7-10)

Site Class	Spectral Acceleration at 0.2 sec. (g)	Spectral Acceleration at 1.0 sec. (g)	Site Coefficients		Design Spectral Response Parameters		Design PGA
			F <sub>a</sub>	F <sub>v</sub>	S <sub>DS</sub>	S <sub>D1</sub>	
D	1.127	0.435	1.049	1.565	0.788	0.454	0.455

Seismic Design Parameters (ASCE 7-16)

Site Class	Spectral Acceleration at 0.2 sec. (g)	Spectral Acceleration at 1.0 sec. (g)	Site Coefficients		Design Spectral Response Parameters		Design PGA
			F <sub>a</sub>	F <sub>v</sub>	S <sub>DS</sub>	S <sub>D1</sub>	
D	1.096	0.389	1.062	Null	0.775	Null	0.466

Additional seismic considerations include liquefaction potential and amplification of ground motions by soft/loose soil deposits. The liquefaction potential is highest for loose sand with a high groundwater table. The site has a low likelihood of liquefaction. For items listed as “Null” see Section 11.4.8 of the ASCE.

## Conclusions and Recommendations

### General

The site is underlain by weathered and unweathered glacial till which becomes denser with depth. There may be areas of fill above the till in yard areas around the residence.

The proposed residential structures may be supported on shallow foundation systems bearing on medium dense or firmer native soils or on structural fill placed on the native soils. Local overexcavation or recompaction of loose weathered native soils may be necessary depending on the proposed elevations and locations of the new footings.

Widespread infiltration of runoff is not feasible based on the dense soil conditions at shallow depths and groundwater conditions during the winter months. Local permeable pavements and dispersion systems may be feasible depending on their location and elevation. We recommend utilizing detention systems with overflow to City or County infrastructure. We can provide additional recommendations once a civil plan has been prepared.

## Site Preparation

Trees, shrubs and other vegetation should be removed prior to stripping of surficial organic-rich soil and fill. Based on observations from the site investigation program, it is anticipated that the stripping depth will be 6 to 18 inches. Deeper excavations will be necessary in areas of existing foundation systems (where present) and in any areas underlain by undocumented fill.

The native soils consist of silty-sand with gravel grading to sandy silt with gravel. Most of the native soils may be used as structural fill provided they achieve compaction requirements and are within 3 percent of the optimum moisture. Some of these soils may only be suitable for use as fill during the summer months, as they will be above the optimum moisture levels in their current state. These soils are variably moisture sensitive and may degrade during periods of wet weather and under equipment traffic. If work occurs outside of the summer months, we do not anticipate that native soils will be suitable for use as fill in most areas.

Imported structural fill should consist of a sand and gravel mixture with a maximum grain size of 3 inches and less than 5 percent fines (material passing the U.S. Standard No. 200 Sieve). Structural fill should be placed in maximum lift thicknesses of 12 inches and should be compacted to a minimum of 95 percent of the modified proctor maximum dry density, as determined by the ASTM D 1557 test method.

## Temporary Excavations

Based on our understanding of the project, we anticipate that the grading could include local cuts on the order of approximately 4 feet or less for foundation and most of the utility placement. Any deeper temporary excavations should be sloped no steeper than 1.5H:1V (Horizontal:Vertical) in loose native soils and fill, 1H:1V in medium dense native soils and 3/4H:1V in dense to very dense native soils. If an excavation is subject to heavy vibration or surcharge loads, we recommend that the excavations be sloped no steeper than 2H:1V, where room permits.

Temporary cuts should be in accordance with the Washington Administrative Code (WAC) Part N, Excavation, Trenching, and Shoring. Temporary slopes should be visually inspected daily by a qualified person during construction activities and the inspections should be documented in daily reports. The contractor is responsible for maintaining the stability of the temporary cut slopes and reducing slope erosion during construction.

Temporary cut slopes should be covered with visqueen to help reduce erosion during wet weather, and the slopes should be closely monitored until the permanent retaining systems or slope configurations are complete. Materials should not be stored or equipment operated within 10 feet of the top of any temporary cut slope.

Soil conditions may not be completely known from the geotechnical investigation. In the case of temporary cuts, the existing soil conditions may not be completely revealed until the excavation work exposes the soil. Typically, as excavation work progresses the maximum inclination of temporary slopes will need to be re-evaluated by the geotechnical engineer so that supplemental recommendations can be made. Soil and groundwater conditions can be highly variable. Scheduling for soil work will need to be adjustable, to deal with unanticipated conditions, so that the project can proceed and required deadlines can be met.

If any variations or undesirable conditions are encountered during construction, we should be notified so that supplemental recommendations can be made. If room constraints or groundwater conditions do not permit temporary slopes to be cut to the maximum angles allowed

by the WAC, temporary shoring systems may be required. The contractor should be responsible for developing temporary shoring systems, if needed. We recommend that Cobalt Geosciences and the project structural engineer review temporary shoring designs prior to installation, to verify the suitability of the proposed systems.

## Foundation Design

The proposed structures may be supported on shallow spread footing foundation systems bearing on undisturbed dense or firmer native soils or on properly compacted structural fill placed on the suitable native soils. Any undocumented fill and/or loose native soils should be removed and replaced with structural fill below foundation elements. Structural fill below footings should consist of clean angular rock 5/8 to 4 inches in size. We should verify soil conditions during foundation excavation work.

For shallow foundation support, we recommend widths of at least 16 and 24 inches, respectively, for continuous wall and isolated column footings supporting the proposed structure. Provided that the footings are supported as recommended above, a net allowable bearing pressure of 2,500 pounds per square foot (psf) may be used for design. Detention vaults set at least 5 feet below grade may be designed with a bearing pressure of 5,000 psf.

A 1/3 increase in the above value may be used for short duration loads, such as those imposed by wind and seismic events. Structural fill placed on bearing, native subgrade should be compacted to at least 95 percent of the maximum dry density based on ASTM Test Method D1557. Footing excavations should be inspected to verify that the foundations will bear on suitable material.

Exterior footings should have a minimum depth of 18 inches below pad subgrade (soil grade) or adjacent exterior grade, whichever is lower. Interior footings should have a minimum depth of 12 inches below pad subgrade (soil grade) or adjacent exterior grade, whichever is lower.

If constructed as recommended, the total foundation settlement is not expected to exceed 1 inch. Differential settlement, along a 25-foot exterior wall footing, or between adjoining column footings, should be less than 1/2 inch. This translates to an angular distortion of 0.002. Most settlement is expected to occur during construction, as the loads are applied. However, additional post-construction settlement may occur if the foundation soils are flooded or saturated. All footing excavations should be observed by a qualified geotechnical consultant.

Resistance to lateral footing displacement can be determined using an allowable friction factor of 0.40 acting between the base of foundations and the supporting subgrades. Lateral resistance for footings can also be developed using an allowable equivalent fluid passive pressure of 225 pounds per cubic foot (pcf) acting against the appropriate vertical footing faces (neglect the upper 12 inches below grade in exterior areas). The frictional and passive resistance of the soil may be combined without reduction in determining the total lateral resistance.

Care should be taken to prevent wetting or drying of the bearing materials during construction. Any extremely wet or dry materials, or any loose or disturbed materials at the bottom of the footing excavations, should be removed prior to placing concrete. The potential for wetting or drying of the bearing materials can be reduced by pouring concrete as soon as possible after completing the footing excavation and evaluating the bearing surface by the geotechnical engineer or his representative.

## Concrete Retaining Walls

The following table, titled **Wall Design Criteria**, presents the recommended soil related design parameters for retaining walls with a level backslope. Contact Cobalt if an alternate retaining wall system is used. This has been included for new cast in place walls.

<b>Wall Design Criteria</b>	
“At-rest” Conditions (Lateral Earth Pressure – EFD <sup>+</sup> )	55 pcf (Equivalent Fluid Density)
“Active” Conditions (Lateral Earth Pressure – EFD <sup>+</sup> )	35 pcf (Equivalent Fluid Density)
Seismic Increase for “At-rest” Conditions (Lateral Earth Pressure)	18H* (Uniform Distribution) 1 in 2,500 year event
Seismic Increase for “At-rest” Conditions (Lateral Earth Pressure)	12H* (Uniform Distribution) 1 in 500 year event
Seismic Increase for “Active” Conditions (Lateral Earth Pressure)	6H* (Uniform Distribution)
Passive Earth Pressure on Low Side of Wall (Allowable, includes F.S. = 1.5)	Neglect upper 2 feet, then 275 pcf EFD <sup>+</sup>
Soil-Footing Coefficient of Sliding Friction (Allowable; includes F.S. = 1.5)	0.40

\*H is the height of the wall; Increase based on one in 500 year seismic event (10 percent probability of being exceeded in 50 years),

<sup>+</sup>EFD – Equivalent Fluid Density

The stated lateral earth pressures do not include the effects of hydrostatic pressure generated by water accumulation behind the retaining walls. Uniform horizontal lateral active and at-rest pressures on the retaining walls from vertical surcharges behind the wall may be calculated using active and at-rest lateral earth pressure coefficients of 0.3 and 0.5, respectively. A soil unit weight of 125 pcf may be used to calculate vertical earth surcharges.

To reduce the potential for the buildup of water pressure against the walls, continuous footing drains (with cleanouts) should be provided at the bases of the walls. The footing drains should consist of a minimum 4-inch diameter perforated pipe, sloped to drain, with perforations placed down and enveloped by a minimum 6 inches of pea gravel in all directions.

The backfill adjacent to and extending a lateral distance behind the walls at least 2 feet should consist of free-draining granular material. All free draining backfill should contain less than 3 percent fines (passing the U.S. Standard No. 200 Sieve) based upon the fraction passing the U.S. Standard No. 4 Sieve with at least 30 percent of the material being retained on the U.S. Standard No. 4 Sieve. The primary purpose of the free-draining material is the reduction of hydrostatic pressure. Some potential for the moisture to contact the back face of the wall may exist, even with treatment, which may require that more extensive waterproofing be specified for walls, which require interior moisture sensitive finishes.

We recommend that the backfill be compacted to at least 90 percent of the maximum dry density based on ASTM Test Method D1557. In place density tests should be performed to verify adequate compaction. Soil compactors place transient surcharges on the backfill. Consequently, only light hand operated equipment is recommended within 3 feet of walls so that excessive stress is not imposed on the walls.

### Stormwater Management Feasibility

The site is underlain by relatively dense glacial till. The unweathered till was cemented and acts as a restrictive layer. We performed a small scale pilot infiltration test (PIT) in TP-1. The test was performed in general accordance with the Washington State Department of Ecology stormwater manual.

The area was excavated to a testing depth of approximately 3 feet below the ground surface. Note that groundwater was present in this exploration at 5 feet below grade (initial excavation 10 feet from testing location).

During testing, we reduced the flow rate into the hole to the minimum available with the equipment and water source being used and continued to observe a rising water level. Since a steady state rate was not achieved, we performed a falling head test until the testing water was fully infiltrated.

The design infiltration rate was determined by applying correction factors to the measured infiltration rate as prescribed in Volume III, Section 3.3.6 of the DOE. The measured rate must be reduced through appropriate correction factors for site variability ( $CF_V$ ), uncertainty of test method ( $CF_T$ ), and degree of influent control ( $CF_M$ ) to prevent siltation and bio-buildup.

It should be noted that construction traffic or other disturbance to the target infiltration area could compact the soil, which may decrease the effective infiltration rates. The correction factors and resulting design infiltration rate are also shown in the table below.

Test Number	Test Depth (ft)	Measured Infiltration Rate (in/hr)	Correction Factors			Design Infiltration Rate (in/hr)
			$CF_V$	$CF_T$	$CF_M$	
TP-1	4.0	0.34	0.9	0.5	0.9	0.14

Widespread infiltration is not feasible due to the dense soil conditions at depth. Additionally, groundwater was present in the test pits at relatively shallow depths. There is inadequate clearance above groundwater for most typical infiltration devices.

We recommend collection of runoff from new impervious surfaces with connection to detention systems and overflow to City infrastructure. Local permeable pavements and dispersion systems could be feasible depending on their location and elevation. We can provide additional recommendations upon request and once civil plans have been prepared.

We should be provided with final plans for review to determine if the intent of our recommendations has been incorporated or if additional modifications are needed.



## Slab-on-Grade

We recommend that the upper 18 inches of the native soils within slab areas be re-compacted to at least 95 percent of the modified proctor (ASTM D1557 Test Method).

Often, a vapor barrier is considered below concrete slab areas. However, the usage of a vapor barrier could result in curling of the concrete slab at joints. Floor covers sensitive to moisture typically requires the usage of a vapor barrier. A materials or structural engineer should be consulted regarding the detailing of the vapor barrier below concrete slabs. Exterior slabs typically do not utilize vapor barriers.

The American Concrete Institutes ACI 360R-06 Design of Slabs on Grade and ACI 302.1R-04 Guide for Concrete Floor and Slab Construction are recommended references for vapor barrier selection and floor slab detailing.

Slabs on grade may be designed using a coefficient of subgrade reaction of 210 pounds per cubic inch (pci) assuming the slab-on-grade base course is underlain by structural fill placed and compacted as outlined in Section 8.1. A 4- to 6-inch-thick capillary break layer should be placed over the prepared subgrade. This material should consist of pea gravel or 5/8 inch clean angular rock.

A perimeter drainage system is recommended unless interior slab areas are elevated a minimum of 12 inches above adjacent exterior grades. If installed, a perimeter drainage system should consist of a 4-inch diameter perforated drain pipe surrounded by a minimum 6 inches of drain rock wrapped in a non-woven geosynthetic filter fabric to reduce migration of soil particles into the drainage system. The perimeter drainage system should discharge by gravity flow to a suitable stormwater system.

Exterior grades surrounding buildings should be sloped at a minimum of one percent to facilitate surface water flow away from the building and preferably with a relatively impermeable surface cover immediately adjacent to the building.

## Erosion and Sediment Control

Erosion and sediment control (ESC) is used to reduce the transportation of eroded sediment to wetlands, streams, lakes, drainage systems, and adjacent properties. Erosion and sediment control measures should be implemented, and these measures should be in general accordance with local regulations. At a minimum, the following basic recommendations should be incorporated into the design of the erosion and sediment control features for the site:

- Schedule the soil, foundation, utility, and other work requiring excavation or the disturbance of the site soils, to take place during the dry season (generally May through September). However, provided precautions are taken using Best Management Practices (BMP's), grading activities can be completed during the wet season (generally October through April).
- All site work should be completed and stabilized as quickly as possible.
- Additional perimeter erosion and sediment control features may be required to reduce the possibility of sediment entering the surface water. This may include additional silt fences, silt fences with a higher Apparent Opening Size (AOS), construction of a berm, or other filtration systems.



- Any runoff generated by dewatering discharge should be treated through construction of a sediment trap if there is sufficient space. If space is limited other filtration methods will need to be incorporated.

### **Utilities**

Utility trenches should be excavated according to accepted engineering practices following OSHA (Occupational Safety and Health Administration) standards, by a contractor experienced in such work. The contractor is responsible for the safety of open trenches. Traffic and vibration adjacent to trench walls should be reduced; cyclic wetting and drying of excavation side slopes should be avoided. Depending upon the location and depth of some utility trenches, groundwater flow into open excavations could be experienced, especially during or shortly following periods of precipitation.

In general, silty soils were encountered at shallow depths in the explorations at this site. These soils have low cohesion and density and will have a tendency to cave or slough in excavations. Shoring or sloping back trench sidewalls is required within these soils in excavations greater than 4 feet deep.

All utility trench backfill should consist of imported structural fill or suitable on site soils. Utility trench backfill placed in or adjacent to buildings and exterior slabs should be compacted to at least 95 percent of the maximum dry density based on ASTM Test Method D1557. The upper 5 feet of utility trench backfill placed in pavement areas should be compacted to at least 95 percent of the maximum dry density based on ASTM Test Method D1557. Below 5 feet, utility trench backfill in pavement areas should be compacted to at least 90 percent of the maximum dry density based on ASTM Test Method D1557. Pipe bedding should be in accordance with the pipe manufacturer's recommendations.

The contractor is responsible for removing all water-sensitive soils from the trenches regardless of the backfill location and compaction requirements. Depending on the depth and location of the proposed utilities, we anticipate the need to re-compact existing fill soils below the utility structures and pipes. The contractor should use appropriate equipment and methods to avoid damage to the utilities and/or structures during fill placement and compaction procedures.

### **Pavements**

The near surface subgrade soils generally consist of silty sand with gravel to sandy silt with gravel. These soils are rated as good for pavement subgrade material (depending on silt content and moisture conditions). We estimate that the subgrade will have a California Bearing Ratio (CBR) value of 10 and a modulus of subgrade reaction value of  $k = 200$  pci, provided the subgrade is prepared in general accordance with our recommendations.

We recommend that at a minimum, 18 inches of the existing subgrade material be moisture conditioned (as necessary) and re-compacted to prepare for the construction of pavement sections. Deeper levels of recompaction or overexcavation and replacement may be necessary in areas where fill and/or very poor (soft/loose) soils are present.

The subgrade should be compacted to at least 95 percent of the maximum dry density as determined by ASTM Test Method D1557. In place density tests should be performed to verify proper moisture content and adequate compaction.

The recommended flexible and rigid pavement sections are based on design CBR and modulus of subgrade reaction (k) values that are achieved, only following proper subgrade preparation. It should be noted that subgrade soils that have relatively high silt contents will likely be highly sensitive to moisture conditions. The subgrade strength and performance characteristics of a silty subgrade material may be dramatically reduced if this material becomes wet.

Based on our knowledge of the proposed project, we expect the traffic to range from light duty (passenger automobiles) to heavy duty (delivery trucks). The following tables show the recommended pavement sections for light duty and heavy duty use.

**ASPHALTIC CONCRETE (FLEXIBLE) PAVEMENT**

**LIGHT DUTY**

<b>Asphaltic Concrete</b>	<b>Aggregate Base*</b>	<b>Compacted Subgrade* **</b>
2.5 in.	6.0 in.	18.0 in.

**HEAVY DUTY**

<b>Asphaltic Concrete</b>	<b>Aggregate Base*</b>	<b>Compacted Subgrade* **</b>
3.5 in.	6.0 in.	18.0 in.

**PORTLAND CEMENT CONCRETE (RIGID) PAVEMENT**

<b>Min. PCC Depth</b>	<b>Aggregate Base*</b>	<b>Compacted Subgrade* **</b>
6.0 in.	6.0 in.	18.0 in.

\* 95% compaction based on ASTM Test Method D1557

\*\* A proof roll may be performed in lieu of in place density tests

The asphaltic concrete depth in the flexible pavement tables should be a surface course type asphalt, such as Washington Department of Transportation (WSDOT) 1/2 inch HMA. The rigid pavement design is based on a Portland Cement Concrete (PCC) mix that has a 28 day compressive strength of 4,000 pounds per square inch (psi). The design is also based on a concrete flexural strength or modulus of rupture of 550 psi.

**CONSTRUCTION FIELD REVIEWS**

Cobalt Geosciences should be retained to provide part time field review during construction in order to verify that the soil conditions encountered are consistent with our design assumptions and that the intent of our recommendations is being met. This will require field and engineering review to:

- Monitor and test structural fill placement and soil compaction
- Observe bearing capacity at foundation locations
- Observe slab-on-grade preparation

- Monitor foundation drainage placement
- Observe excavation stability

Geotechnical design services should also be anticipated during the subsequent final design phase to support the structural design and address specific issues arising during this phase. Field and engineering review services will also be required during the construction phase in order to provide a Final Letter for the project.

## CLOSURE

This report was prepared for the exclusive use of JM1 Holdings, LLC and their appointed consultants. Any use of this report or the material contained herein by third parties, or for other than the intended purpose, should first be approved in writing by Cobalt Geosciences, LLC.

The recommendations contained in this report are based on assumed continuity of soils with those of our test holes and assumed structural loads. Cobalt Geosciences should be provided with final architectural and civil drawings when they become available in order that we may review our design recommendations and advise of any revisions, if necessary.

Use of this report is subject to the Statement of General Conditions provided in Appendix A. It is the responsibility of JM1 Holdings, LLC who is identified as “the Client” within the Statement of General Conditions, and its agents to review the conditions and to notify Cobalt Geosciences should any of these not be satisfied.

Sincerely,

**Cobalt Geosciences, LLC**



12/20/2021  
Phil Haberman, PE, LG, LEG  
Principal

### **Statement of General Conditions**

**USE OF THIS REPORT:** This report has been prepared for the sole benefit of the Client or its agent and may not be used by any third party without the express written consent of Cobalt Geosciences and the Client. Any use which a third party makes of this report is the responsibility of such third party.

**BASIS OF THE REPORT:** The information, opinions, and/or recommendations made in this report are in accordance with Cobalt Geosciences present understanding of the site specific project as described by the Client. The applicability of these is restricted to the site conditions encountered at the time of the investigation or study. If the proposed site specific project differs or is modified from what is described in this report or if the site conditions are altered, this report is no longer valid unless Cobalt Geosciences is requested by the Client to review and revise the report to reflect the differing or modified project specifics and/or the altered site conditions.

**STANDARD OF CARE:** Preparation of this report, and all associated work, was carried out in accordance with the normally accepted standard of care in the state of execution for the specific professional service provided to the Client. No other warranty is made.

**INTERPRETATION OF SITE CONDITIONS:** Soil, rock, or other material descriptions, and statements regarding their condition, made in this report are based on site conditions encountered by Cobalt Geosciences at the time of the work and at the specific testing and/or sampling locations. Classifications and statements of condition have been made in accordance with normally accepted practices which are judgmental in nature; no specific description should be considered exact, but rather reflective of the anticipated material behavior. Extrapolation of in situ conditions can only be made to some limited extent beyond the sampling or test points. The extent depends on variability of the soil, rock and groundwater conditions as influenced by geological processes, construction activity, and site use.

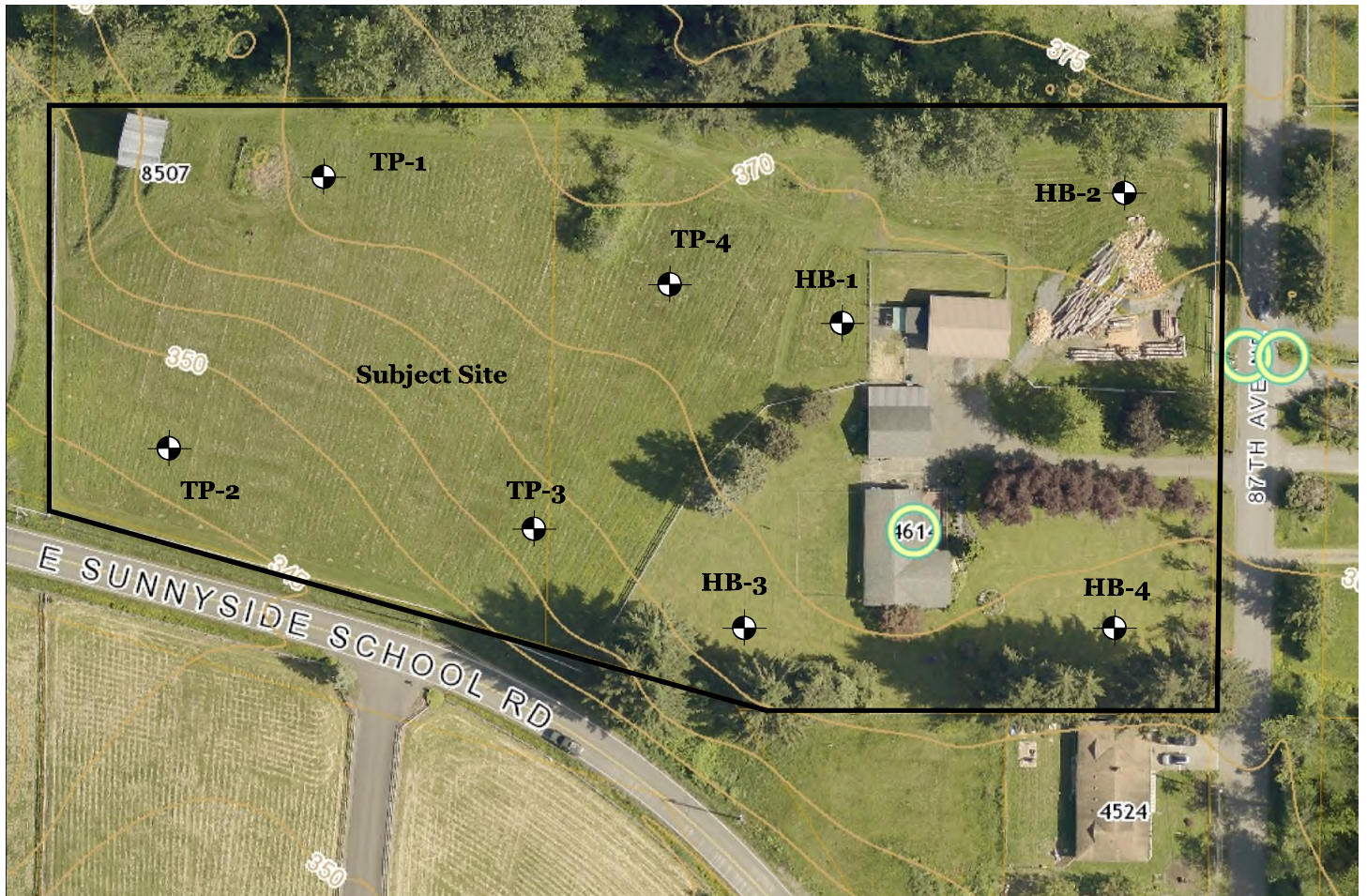
**VARYING OR UNEXPECTED CONDITIONS:** Should any site or subsurface conditions be encountered that are different from those described in this report or encountered at the test locations, Cobalt Geosciences must be notified immediately to assess if the varying or unexpected conditions are substantial and if reassessments of the report conclusions or recommendations are required. Cobalt Geosciences will not be responsible to any party for damages incurred as a result of failing to notify Cobalt Geosciences that differing site or sub-surface conditions are present upon becoming aware of such conditions.

**PLANNING, DESIGN, OR CONSTRUCTION:** Development or design plans and specifications should be reviewed by Cobalt Geosciences, sufficiently ahead of initiating the next project stage (property acquisition, tender, construction, etc), to confirm that this report completely addresses the elaborated project specifics and that the contents of this report have been properly interpreted. Specialty quality assurance services (field observations and testing) during construction are a necessary part of the evaluation of sub-subsurface conditions and site preparation works. Site work relating to the recommendations included in this report should only be carried out in the presence of a qualified geotechnical engineer; Cobalt Geosciences cannot be responsible for site work carried out without being present.





Provided Site layout



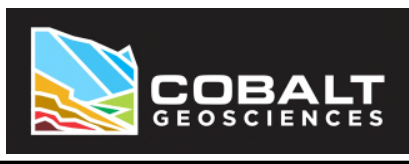
TP-1  
HB-1  

**Approximate Test Pit & Hand Boring Location**

Sno. County Aerial Image



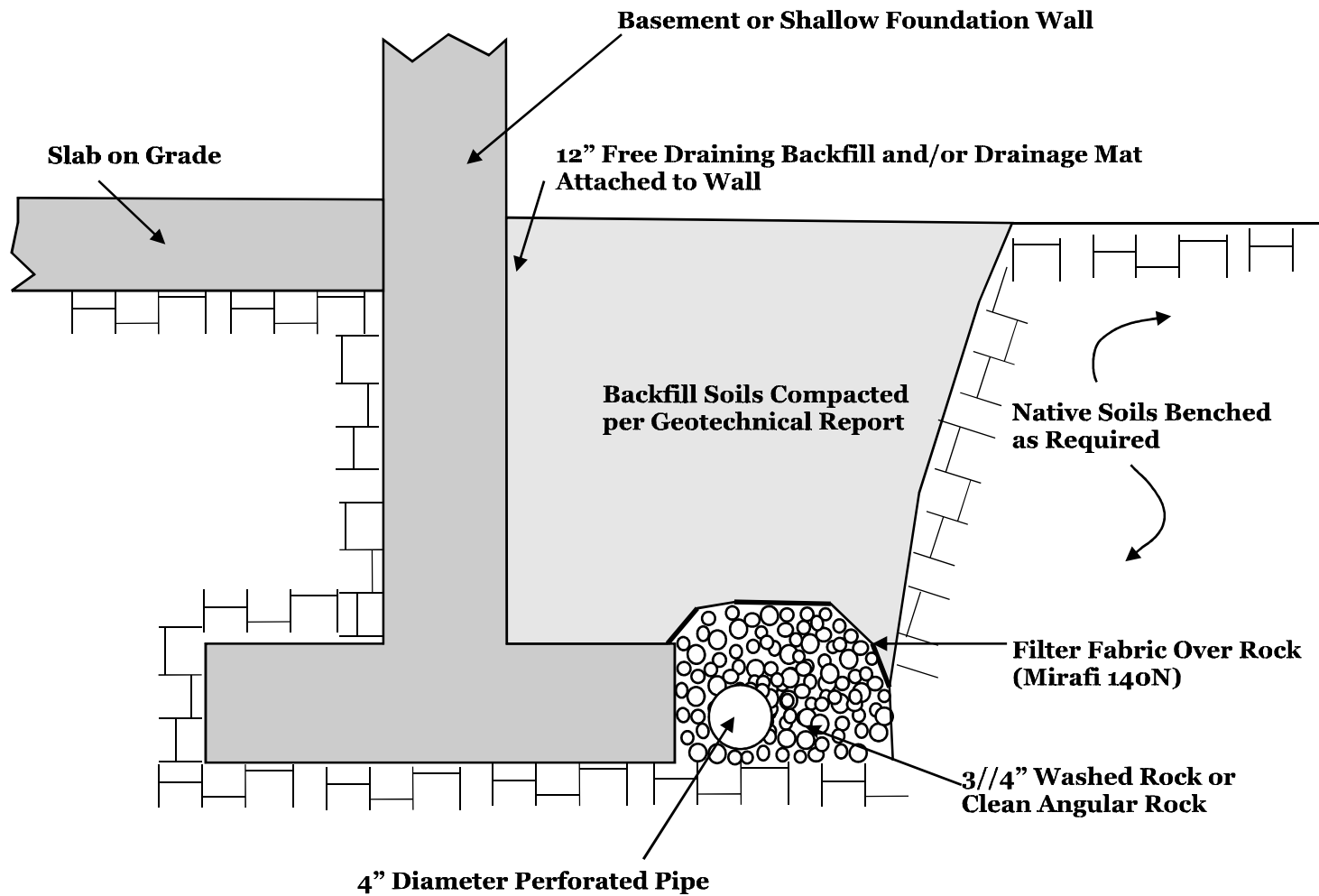
Not to Scale



Proposed Development  
4614 87th Avenue NE  
Marysville, Washington

**SITE PLAN**  
**FIGURE 1**

Cobalt Geosciences, LLC  
P.O. Box 82243  
Kenmore, WA 98028  
(206) 331-1097  
[www.cobaltgeo.com](http://www.cobaltgeo.com)  
[cobaltgeo@gmail.com](mailto:cobaltgeo@gmail.com)



Not to Scale



Typical Foundation Drain Detail

Attachment

Cobalt Geosciences, LLC  
 PO Box 1792  
 North Bend, WA 98045  
 (206) 331-1097  
[www.cobaltgeo.com](http://www.cobaltgeo.com)  
[phil@cobaltgeo.com](mailto:phil@cobaltgeo.com)



## Unified Soil Classification System (USCS)

MAJOR DIVISIONS			SYMBOL	TYPICAL DESCRIPTION	
<b>COARSE GRAINED SOILS</b> (more than 50% retained on No. 200 sieve)	Gravels (more than 50% of coarse fraction retained on No. 4 sieve)	Clean Gravels (less than 5% fines)	GW	Well-graded gravels, gravels, gravel-sand mixtures, little or no fines	
		Gravels with Fines (more than 12% fines)	GP	Poorly graded gravels, gravel-sand mixtures, little or no fines	
		Gravels with Fines (more than 12% fines)	GM	Silty gravels, gravel-sand-silt mixtures	
		Gravels with Fines (more than 12% fines)	GC	Clayey gravels, gravel-sand-clay mixtures	
	Sands (50% or more of coarse fraction passes the No. 4 sieve)	Clean Sands (less than 5% fines)	SW	Well-graded sands, gravelly sands, little or no fines	
		Sands with Fines (more than 12% fines)	SP	Poorly graded sand, gravelly sands, little or no fines	
		Sands with Fines (more than 12% fines)	SM	Silty sands, sand-silt mixtures	
		Sands with Fines (more than 12% fines)	SC	Clayey sands, sand-clay mixtures	
		Silts and Clays (liquid limit less than 50)	Inorganic	ML	Inorganic silts of low to medium plasticity, sandy silts, gravelly silts, or clayey silts with slight plasticity
			Inorganic	CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays
Organic	OL		Organic silts and organic silty clays of low plasticity		
Silts and Clays (liquid limit 50 or more)	Inorganic		MH	Inorganic silts, micaceous or diatomaceous fine sands or silty soils, elastic silt	
	Inorganic	CH	Inorganic clays of medium to high plasticity, sandy fat clay, or gravelly fat clay		
	Organic	OH	Organic clays of medium to high plasticity, organic silts		
HIGHLY ORGANIC SOILS	Primarily organic matter, dark in color, and organic odor	PT	PT	Peat, humus, swamp soils with high organic content (ASTM D4427)	

Classification of Soil Constituents
<p>MAJOR constituents compose more than 50 percent, by weight, of the soil. Major constituents are capitalized (i.e., SAND).</p> <p>Minor constituents compose 12 to 50 percent of the soil and precede the major constituents (i.e., silty SAND). Minor constituents preceded by "slightly" compose 5 to 12 percent of the soil (i.e., slightly silty SAND).</p> <p>Trace constituents compose 0 to 5 percent of the soil (i.e., slightly silty SAND, trace gravel).</p>

Grain Size Definitions	
Description	Sieve Number and/or Size
Fines	< #200 (0.08 mm)
Sand	#200 to #40 (0.08 to 0.4 mm)
-Fine	#40 to #10 (0.4 to 2 mm)
-Medium	#10 to #4 (2 to 5 mm)
-Coarse	
Gravel	#4 to 3/4 inch (5 to 19 mm)
-Fine	3/4 to 3 inches (19 to 76 mm)
-Coarse	
Cobbles	3 to 12 inches (75 to 305 mm)
Boulders	>12 inches (305 mm)

Relative Density (Coarse Grained Soils)		Consistency (Fine Grained Soils)	
N, SPT, Blows/FT	Relative Density	N, SPT, Blows/FT	Relative Consistency
0 - 4	Very loose	Under 2	Very soft
4 - 10	Loose	2 - 4	Soft
10 - 30	Medium dense	4 - 8	Medium stiff
30 - 50	Dense	8 - 15	Stiff
Over 50	Very dense	15 - 30	Very stiff
		Over 30	Hard

Moisture Content Definitions	
Dry	Absence of moisture, dusty, dry to the touch
Moist	Damp but no visible water
Wet	Visible free water, from below water table



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Soil Classification Chart

Figure C1



## Test Pit TP-1

Date: December, 2021	Depth: 9'	Groundwater: 5'
Contractor: Jim	Elevation: N/A	Logged By: PH      Checked By: SC

Depth (Feet)	Interval	Graphic Log	USCS Symbol	Material Description	Groundwater	Moisture Content (%)					
						Plastic Limit	Liquid Limit				
						DCP Equivalent N-Value					
						0	10	20	30	40	50
				Grass and Topsoil							
1			SM	Loose to medium dense, silty-fine to fine grained sand with gravel, mottled yellowish brown to grayish brown, moist to wet. (Weathered Glacial Till)							
2	■										
3											
4											
5			SM	Dense to very dense, silty-fine to medium grained sand with gravel, grayish brown to olive gray, moist. (Glacial Till)  Locally gradational with sandy silt with gravel (ML)		▽					
6	■										
7											
8											
9				End of Test Pit 9'							
10											

## Test Pit TP-2

Date: December , 2021	Depth: 8'	Groundwater: 2.5'
Contractor: Jim	Elevation: N/A	Logged By: PH      Checked By: SC

Depth (Feet)	Interval	Graphic Log	USCS Symbol	Material Description	Groundwater	Moisture Content (%)					
						Plastic Limit	Liquid Limit				
						DCP Equivalent N-Value					
						0	10	20	30	40	50
				Grass and Topsoil							
1			SM	Loose to medium dense, silty-fine to medium grained sand with gravel, mottled reddish brown to yellowish brown, moist to wet. (Weathered Glacial Till)		▽					
2	■										
3											
4											
5			SM	Dense to very dense, silty-fine to medium grained sand with gravel, grayish brown, moist. (Glacial Till)  Locally gradational with sandy silt with gravel (ML)							
6	■										
7											
8											
9				End of Test Pit 8'							
10											



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### Test Pit Logs

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## Test Pit TP-3

Date: December, 2021		Depth: 9'		Groundwater: 3.5'			
Contractor: Jim		Elevation: N/A		Logged By: PH      Checked By: SC			
Depth (Feet)	Interval	Graphic Log	USCS Symbol	Material Description	Groundwater	Moisture Content (%)	
						<div style="text-align: center;">                     Plastic Limit  -----●-----  Liquid Limit                 </div>	
						DCP Equivalent N-Value	
						0    10    20    30    40    50	
1		Grass and Topsoil		Grass and Topsoil			
2			SM	Loose to medium dense, silty-fine to fine grained sand with gravel, mottled yellowish brown to grayish brown, moist to wet. (Weathered Glacial Till)	▽		
3							
4							
5			SM	Dense to very dense, silty-fine to medium grained sand with gravel, grayish brown to olive gray, moist. (Glacial Till)			
6				Locally gradational with sandy silt with gravel (ML)			
7							
8							
9							
10				End of Test Pit 9'			

## Test Pit TP-4

Date: December, 2021		Depth: 8'		Groundwater: 3'			
Contractor: Jim		Elevation: N/A		Logged By: PH      Checked By: SC			
Depth (Feet)	Interval	Graphic Log	USCS Symbol	Material Description	Groundwater	Moisture Content (%)	
						<div style="text-align: center;">                     Plastic Limit  -----●-----  Liquid Limit                 </div>	
						DCP Equivalent N-Value	
						0    10    20    30    40    50	
1		Grass and Topsoil		Grass and Topsoil			
2			SM	Loose to medium dense, silty-fine to medium grained sand with gravel, mottled reddish brown to yellowish brown, moist to wet. (Weathered Glacial Till)	▽		
3							
4							
5			SM	Dense to very dense, silty-fine to medium grained sand with gravel, grayish brown, moist. (Glacial Till)			
6				Locally gradational with sandy silt with gravel (ML)			
7							
8							
9							
10				End of Test Pit 8'			

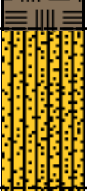

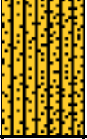



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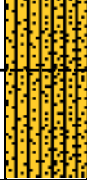

**Test Pit  
Logs**

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# Hand Boring HB-1

Date: December 2021		Depth: 6'		Groundwater: 2'		
Contractor:		Elevation:		Logged By: PH      Checked By: SC		
Depth (Feet)	Interval	Graphic Log	USCS Symbol	Material Description	Groundwater	Moisture Content (%)
						Plastic Limit  -----●-----  Liquid Limit
						DCP Equivalent N-Value
						0    10    20    30    40    50
1			SM	Topsail/Grass Loose to medium dense, silty-fine to medium grained sand with gravel, dark yellowish brown, moist. (Weathered Glacial Till)	▽	
2						
3						
4			SM	Dense to very dense, silty-fine to medium grained sand with gravel, mottled yellowish brown to grayish brown, moist. (Glacial Till)		
5						
6						
7				End of Hand Boring 6'		
8						
9						
10						

# Hand Boring HB-2

Date: December 2021		Depth: 6'		Groundwater: 3'		
Contractor:		Elevation:		Logged By: PH      Checked By: SC		
Depth (Feet)	Interval	Graphic Log	USCS Symbol	Material Description	Groundwater	Moisture Content (%)
						Plastic Limit  -----●-----  Liquid Limit
						DCP Equivalent N-Value
						0    10    20    30    40    50
1			SM	Topsail/Grass Loose to medium dense, silty-fine to medium grained sand with gravel, dark yellowish brown, moist. (Weathered Glacial Till)	▽	
2						
3						
4			SM	Dense to very dense, silty-fine to medium grained sand with gravel, mottled yellowish brown to grayish brown, moist. (Glacial Till)		
5						
6						
7				End of Hand Boring 6'		
8						
9						
10						



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**Test Pit &  
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# Hand Boring HB-3

Date: December 2021	Depth: 6'	Groundwater: 3.5'
Contractor:	Elevation:	Logged By: PH      Checked By: SC

Depth (Feet)	Interval	Graphic Log	USCS Symbol	Material Description	Groundwater	Moisture Content (%)					
						Plastic Limit	Liquid Limit				
						DCP Equivalent N-Value					
						0	10	20	30	40	50
		[Graphic Log: Horizontal lines]		Topsoil/Grass							
1		[Graphic Log: Yellow dots]	SM	Loose to medium dense, silty-fine to medium grained sand with gravel, dark yellowish brown, moist. (Weathered Glacial Till)	▽						
2		[Graphic Log: Yellow dots]									
3	■	[Graphic Log: Yellow dots]									
4		[Graphic Log: Yellow dots]									
5		[Graphic Log: Yellow dots]	SM	Dense to very dense, silty-fine to medium grained sand with gravel, mottled yellowish brown to grayish brown, moist. (Glacial Till)							
6	■	[Graphic Log: Yellow dots]									
7				End of Hand Boring 6'							
8											
9											
10											

# Hand Boring HB-4

Date: December 2021	Depth: 6'	Groundwater: 4'
Contractor:	Elevation:	Logged By: PH      Checked By: SC

Depth (Feet)	Interval	Graphic Log	USCS Symbol	Material Description	Groundwater	Moisture Content (%)					
						Plastic Limit	Liquid Limit				
						DCP Equivalent N-Value					
						0	10	20	30	40	50
		[Graphic Log: Horizontal lines]		Topsoil/Grass							
1		[Graphic Log: Yellow dots]	SM	Loose to medium dense, silty-fine to medium grained sand with gravel, dark yellowish brown, moist. (Weathered Glacial Till)	▽						
2	■	[Graphic Log: Yellow dots]									
3		[Graphic Log: Yellow dots]									
4		[Graphic Log: Yellow dots]									
5		[Graphic Log: Yellow dots]	SM	Dense to very dense, silty-fine to medium grained sand with gravel, mottled yellowish brown to grayish brown, moist. (Glacial Till)							
6	■	[Graphic Log: Yellow dots]									
7				End of Hand Boring 6'							
8											
9											
10											



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