

07/26/2022

**Small Site Drainage Report
Gagandeep SFR**

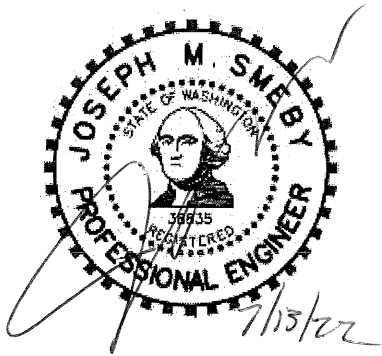
for

Owner:

Gagandeep Oberoi

SITE LOCATION:

9XX Webster St
Mukilteo, WA 98275
Tax ID: 00527504701200



Prepared by:
Joseph M. Smeby, P.E.

Job No: 21-0701
July 2022

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1. PROJECT OVERVIEW

This document is intended to provide the engineering information necessary to support the building permit application for a new single-family residence (SFR) in the City of Mukilteo. The site covers 0.44 acres and is currently undeveloped. The parcel is surrounded by developed parcels. The slope of the site is steep and averages approximately 30 percent down to the northwest. This development proposes to construct a new SFR and driveway. The proposed disturbance area is the entirety of the parcel outside the critical area buffers for a total on-site area of disturbance of 5,348 sf with an additional 760 sf of disturbance within the City R/W for the driveway construction. The proposed SFR will be set approximately 22 feet from the western property line and 10 feet from the southern property line. Access to the new SFR will be taken from the proposed driveway which will take access from the existing roadway to the west (Webster St).

This project proposes to construct approximately 3,532 sf of new impervious surfaces including roof and driveway surfaces on-site with an additional 378 sf of driveway off-site, therefore minimum requirements 1-5 apply to all of the new impervious surfaces for this project along with all the disturbed pervious surfaces. This proposal does not meet any of the land-use criteria that require specific source control for the final use and a SWPPP has been prepared to address the runoff from the site during construction. Refer to Sections 4 and 5 for a detailed discussion.

Figures 2 & 3 are provided to show the existing and developed basins and runoff conditions for this site. The runoff in the existing condition spreads over the pervious surfaces to the northwest and across the western property line or collects in the existing on-site wetland/stream and leaves the site near the northwest corner. In the developed conditions all of the runoff from the new roof will be dispersed via splash blocks. Some of the westerly downspouts will not be located to provide the minimum 50' vegetated flow path but have been laid out to maximize the flow path. Driveway surfaces will be dispersed on-site via sheet flow dispersion where possible and eventually directed to the existing drainage ditch in Webster St. See Section 7 for a detailed discussion.

Due to the size of this project only Minimum requirements 1-5 apply to the proposed drainage design as noted above. All on-site drainage improvements have been designed to meet or exceed the 2019 DOE Stormwater Management Manual.

The project location is 9XX Webster St in the City of Mukilteo, and in Section 04, Township 28N, Range 4E, Willamette Meridian. See Figure 1 - Vicinity Map.

2. EXISTING SITE CONDITIONS

The project location is 9XX Webster St, in the City of Mukilteo, and in Section 04, Township 28N, Range 4E, Willamette Meridian. See Figure 1 - Vicinity Map. The site covers approximately 0.44 acres. As previously mentioned, the site is undeveloped. A category IV wetland and Type 4(L) stream exist on site that will be retained per the biologist mitigation plan. The vegetation found on the existing site consists primarily of brush and trees.

Land use around the site is primarily single-family homes. Access to the site will be from Webster St to the west. Approximately 3,910 sf (0.09 acres) of the site and adjacent R/W will be impacted by new impervious surfaces with approximately 6,108 sf (0.14 acres) being disturbed as needed for the clearing/grubbing and restoration of the existing site and adjacent R/W.

The proposed area of disturbance drains to the northwest and eventually into the roadside ditch or on-site wetland/stream system that drains to the roadside ditch in Webster St. This project will not affect any off-site flows from passing through/around the site. Runoff from the proposed impervious surfaces will be dispersed to the maximum extent feasible.

The USDA Web-Soil Survey was used to determine the existing soil conditions for the parcel. Refer to Appendix A. The soils are mapped as Alderwood gravelly sandy loam and Everett very gravelly sandy loam. The general site slopes, in the area of disturbance, are steep and average approximately 30 percent down to the northwest. Based on the existing soil information and site slopes and retained vegetation, there is moderate potential for erosion or sedimentation during construction. However, with the proper BMPs included in the SWPPP installed and maintained properly this project can minimize the risk. Refer to Figure 2 for an existing basin map.

3. OFF-SITE UPSTREAM/DOWNSTREAM ANALYSIS

Upstream Analysis: Runoff from the property to the south currently drains onto this property along with the stream system from the east. To protect future structures on this site, the ground around the new SFR should be graded to direct upstream runoff around the structure or an upsized foundation drain should be installed to handle the flows collected along the foundation wall. All foundation drain runoff should be directed to the existing ditch in Webster St.

Downstream Analysis: Runoff from the proposed area of disturbance of the existing site sheet flows over pervious surfaces in a generally northwestern direction toward the on-site wetland/stream system or the western property line. Runoff leaves the parcel over the western property line as sheet flow or within the existing stream and is immediately collected by the existing roadside ditch within Webster St. Runoff flows north within the existing ditch and is collected at the southeast corner of the intersection of Webster St and 9th St. The piped conveyance system continues north along the east side of the R/W within Webster St to the point where it turns east and becomes 5th St.

At this point the pipe system could no longer be found/followed in the field. However, the Mukilteo GIS Stormwater Network Viewer shows that the flows at this location are directed to the west and discharge at the edge of Puget Sound along the west side of the railroad embankment.

In the developed condition, the new surfaces will allow the site runoff to continue to flow in the same direction as noted above. The roof and driveway runoff will be dispersed on-site to the maximum extent feasible and continue to flow in the same direction as noted above.

4. SWPPP NARRATIVE

The intent of this section is to provide the information necessary to support the engineering plans in order to implement a design that will; reduce, eliminate or prevent the discharge of stormwater pollutants, meet or exceed the water quality and sediment management standards for the City and State, and prevent adverse impacts to the receiving waters for this project. Note: this narrative is intended to support the SWPPP that is included with the Drainage Plans also a part of this submittal package to the City.

A. SITE GRADING/EROSION CONTROL RISK ASSESSMENT

Area proposed to be cleared/worked:	0.14 acres
Average slope for the site:	30% (Area of Disturbance Only)
Erosion Hazard of Soil	Moderate
Critical Areas downslope	Yes
Site is upstream of an ESA Stream	No

Based on the above information and the fact that the area of the site to be disturbed is moderate to steep and construction site runoff will pass through silt fencing or other perimeter filtration features prior to leaving the site, and that if site conditions warrant, additional BMP's can be implemented as corrective measures the Risk Category for this site is **Moderate Risk**.

B. SWPPP MINIMUM ELEMENTS

1: Preserve Vegetation and Mark Clearing Limits

The first step in the construction process is for the contractor to flag or fence the limits of clearing/disturbance prior to any other construction activity. The engineering plans locate and provide the square footages for the areas of grading, clearing, impervious surfaces and un-disturbed areas on the proposed site.

2: Establish Construction Access

The SWPPP calls for the proposed construction entrance to be installed as the second step after the staking of clearing limits. At this time winter work is expected during the wet season.

3: Control Flow Rates

This project is below the thresholds requiring flow control for the project. However, dispersion of the construction site runoff will aid in protecting the downstream critical areas and conveyance systems.

4: Install Sediment Controls

This site SWPPP proposes to construct/maintain a gravel entrance, vegetative buffer, silt fencing if necessary and retention of the existing vegetation that will provide a vegetated strip between the cleared areas and any property line. The construction of these features should be completed before the clearing and grading of the site. Mulch will also be used on the exposed soil as necessary to limit erosion.

5: Stabilize Soils

The "Construction Sequence" calls for the stabilization of soils that remain unworked for certain lengths of time based on the time of year. Stabilization techniques may include but not limited to mulching, plastic sheeting or hydroseeding, notes have been added to the plan regarding protection for the stockpile area if necessary. A stockpile area has been identified on the SWPPP and is setback a minimum of 10-feet from any down slope property line.

6: Protect Slopes

All disturbed slopes on site during construction are required to be protected with mulch or other means as specified in the construction sequence. No concentrated runoff or significant amounts of sheet flow will be directed to new cut or fill slopes during construction.

7: Protect Drain Inlets

No existing or proposed inlets are on or near this project.

8: Stabilize Channels and Outlets

The existing roadside ditch will be protected with strawbale check dams during construction.

9: Control Pollutants

No outside chemicals are expected to be necessary for the construction of this project. Concrete truck chutes, pumps, internals and hand tools shall be washed out only into formed areas awaiting installation of concrete or asphalt. Unused concrete remaining in the truck and pump shall be returned to the originating batch plant for recycling. When no formed areas are available, washwater and leftover product shall be contained in a lined container and disposed of in a manner that does not violate water quality standards. All vehicles working on and around the site would need to meet the State requirements for emissions. A drip pan or other appropriate temporary containment device shall be placed at locations where leaks or spills may occur during the fueling or maintenance of machinery.

10: Control DeWatering

DeWatering runoff shall be discharged in the northwestern portion of the property. The contractor is to monitor the outfall for excessive sedimentation and erosion.

11: Maintain BMPs

The construction supervisor will be responsible for maintaining all BMPs during construction and working with the City of Mukilteo to relocate or add BMPs as necessary as site conditions change.

12: Manage the Project

It will be the responsibility of the Contractor and Developer to manage this project and coordinate with the City Inspector and Engineer.

Inspection and Monitoring:

Site inspections shall be done by a person who is knowledgeable in the principles and practices of erosion and sediment control. The person must have skills to first assess the site conditions and construction activities that could impact the quality of stormwater, and second assess the effectiveness of erosion and sediment control measures used to control the quality of stormwater discharges. Whenever inspection and/or monitoring reveals that the BMPs identified in the Construction SWPPP are inadequate, due to the actual discharge of or potential to discharge a significant amount of any pollutant, appropriate BMPs or design changes shall be implemented as soon as possible.

Maintaining an Updated Construction SWPPP:

The construction SWPPP shall be retained on-site or within reasonable access to the site. The SWPPP shall be modified whenever there is a change in the design, construction, operation, or maintenance at the construction site that has, or could have, a significant effect on the discharge of pollutants to waters of the state. The SWPPP shall be modified if, during inspections or investigations conducted by the owner/operator, or the applicable local or state regulatory authority, it is determined that the SWPPP is ineffective in eliminating or significantly minimizing pollutants in stormwater discharges from the site. The SWPPP shall be modified as necessary to include additional or modified BMPs designed to correct problems identified. Revisions to the SWPPP shall be completed within seven days following inspection.

13: Protect On-Site Stormwater Management BMPs for Runoff from Hard Surfaces

The use of on-site management BMPs for this project will allow for the installation of the splash blocks at the end of the project during final stabilization. This will protect those areas from disturbance or compaction. In addition, the organic content of the amended soils will be tested and verified prior to final project acceptance.

5. SOURCE CONTROL

This project proposes to construct a new SFR and driveway. Chapter 2 of Volume IV of the 2019 DOE Stormwater Management Manual were reviewed for specific BMPs required for this type of land-use. None of the activities or land uses contained in any of the chapters in Volume IV applies to this project. Therefore, no site/development specific source control BMPs are required for this project.

6. PRESERVATION OF NATURAL DRAINAGE SYSTEM

The runoff from the new hard surfaces will be dispersed to the maximum extent feasible on-site. By not grading or compacting the majority of the pervious surfaces to remain after construction in the area of disturbance a maximum amount of site runoff from the developed project will be absorbed and infiltrated into the existing on-site soils. This will mimic the existing conditions by maintaining the existing direction and condition of flow from this site.

7. ON-SITE STORMWATER MANAGEMENT

This project is required to assess the feasibility of the on-site BMP options per List #2 of the DOE manual. List #2 is as follows:

Lawn and Landscaped Areas:

1. Post-Construction Soil Quality and Depth: Required. Any area of the site not proposed to be covered with impervious surfaces but graded or compacted will be treated to meet the criteria for DOE BMP T5.13. Soil management will be incorporated on the existing disturbed soils on the site and will be treated to meet the DOE requirements for amended soils.

Roofs:

- 1a. Full Dispersion: Not selected due to the 65:35 requirement.
- 1b. Downspout Infiltration Systems: The site slopes are too steep so stormwater infiltration is infeasible.
2. Bioretention: Not feasible, see 1b.
3. Downspout Dispersion: Minimum vegetated on-site flow paths can be achieved for most of the downspouts. Since infiltration is not recommended on this parcel all downspouts will be directed to splash blocks so a perforated stubout is not used. This will result in a few of the splash blocks not having the 50-foot vegetated flow path intended for this BMP.
4. Perforated stub-out connection: Not feasible due to slopes and excessive grading needed for this project.

Other Hard Surfaces:

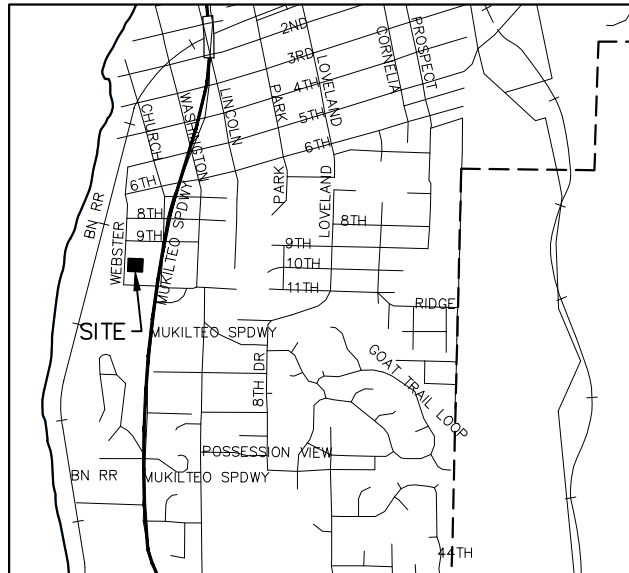
1. Full Dispersion: Not selected due to the 65:35 requirement.
2. Permeable Pavement: Infeasible based on slopes and grading.
3. Bioretention: Not feasible (see 'Roofs').
- 4a. Sheet Flow Dispersion: Feasible and selected.

Runoff from the proposed driveway will sheet flow to the northwest, but due to the on-site grades only a small portion for the edge of the driveway can disperse flows partially on-site. Most of the driveway flows will be directed to the City R/W

- 4b. Concentrated Flow Dispersion: Higher priority BMP selected.

8. SUMMARY

This project proposes to construct less than 5,000 sf of new impervious surfaces including driveway and roof areas. As a result, the use and land cover for less than 5,000 sf of the site will be converted from pervious lawn to impervious surfaces. On-site stormwater management techniques have been incorporated into the design to mitigate for this land conversion. In addition, based on the proposed improvements for the site drainage design the post developed runoff from the site is expected to be slightly more than the runoff from the existing system. Therefore, the stormwater design for this project has meet or exceeded all of the applicable Minimum Requirements 1-5.



VICINITY MAP
SCALE 1" = 2000'



FIG. 1



**OMEGA
ENGINEERING, INC.**

**2707 WETMORE AVE.
Everett, WA 98201
(o)425.387.3820 (f) 425.259.1958**

VICINITY MAP
GAGANDEEP SFR

DATE	JOB NO.	SCALE	SHEET
7/5/22	21-0701	1" = 2000'	1 OF 1

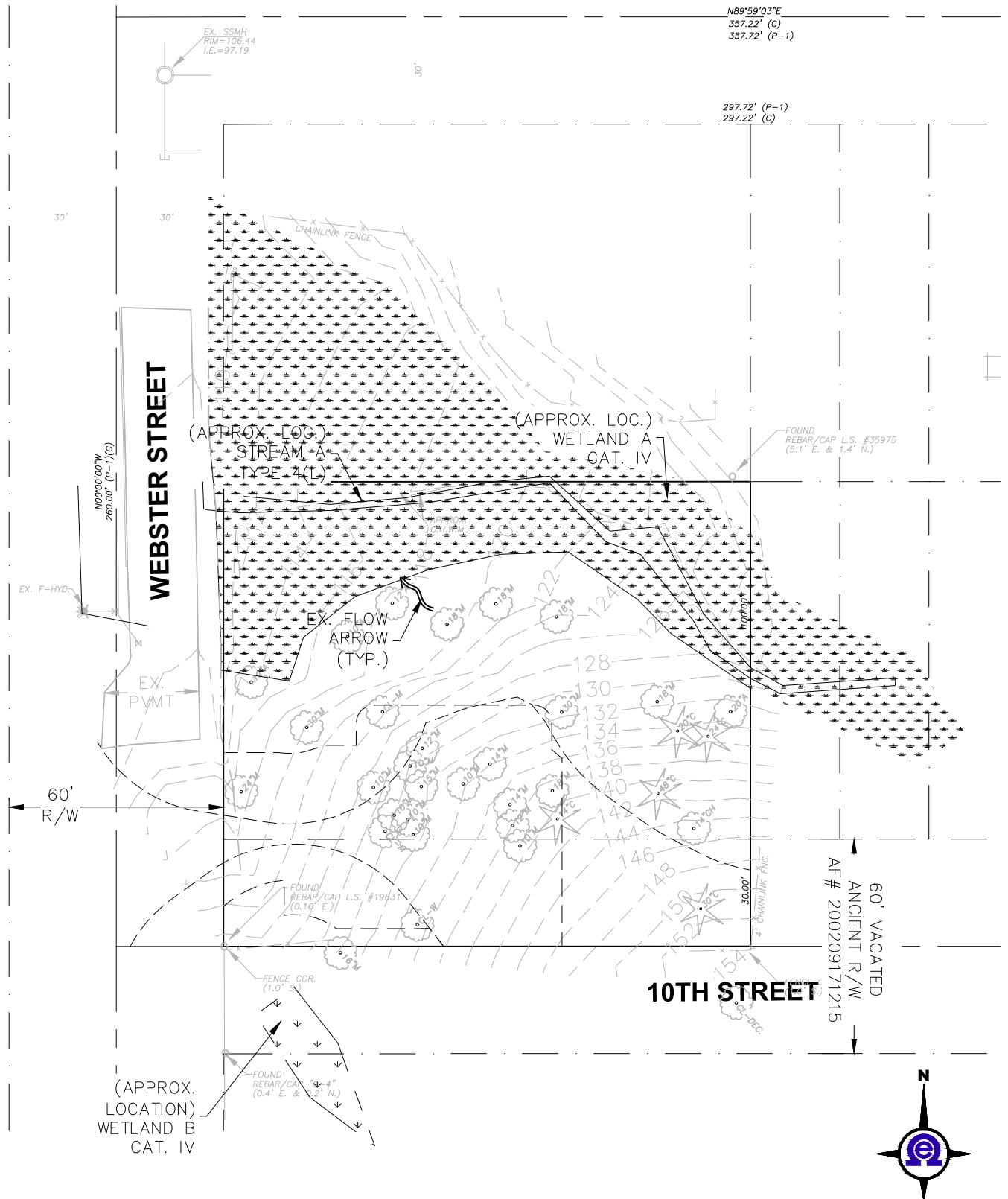


FIG. 2



**OMEGA
ENGINEERING, INC.**

**2707 WETMORE AVE.
Everett, WA 98201
(o)425.387.3820 (f) 425.259.1958**

EXISTING BASIN MAP GAGANDEEP SFR

DATE	JOB NO.	SCALE	SHEET
7/5/22	21-0701	1" = 40'	1 OF 1

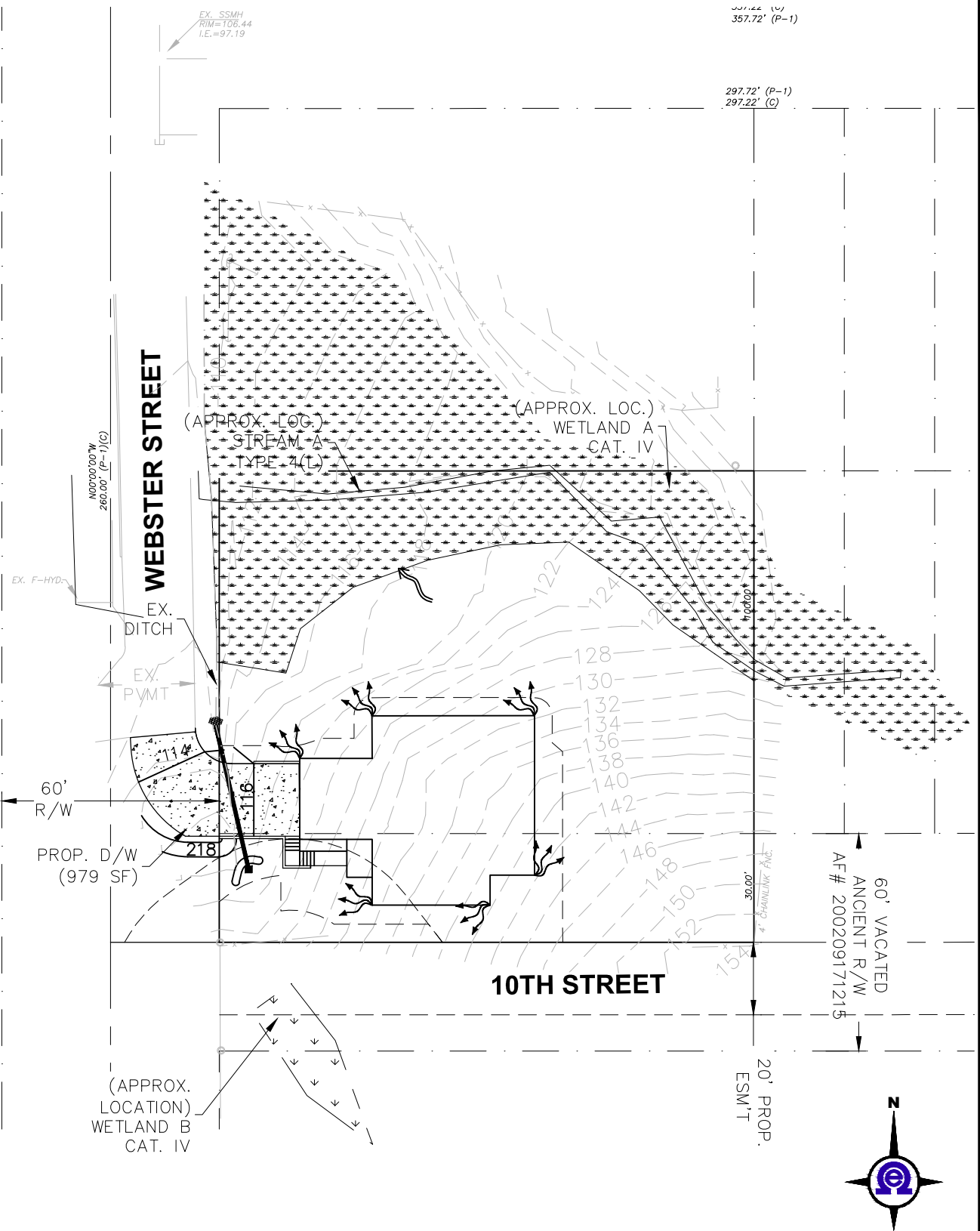


FIG. 3



**OMEGA
ENGINEERING, INC.**

**2707 WETMORE AVE.
Everett, WA 98201
(o)425.387.3820 (f) 425.259.1958**

DEVELOPED BASIN MAP GAGANDEEP SFR

DATE	JOB NO.	SCALE	SHEET
7/5/22	21-0701	1" = 40'	1 OF 1

APPENDIX A



Cobalt Geosciences, LLC
P.O. Box 82243
Kenmore, Washington 98028

June 22, 2021

Gagandeep Oberoi
Magnificentnw@gmail.com

RE: Geotechnical Evaluation
Proposed Residential Development
Parcel No. 00527504701200
Mukilteo, 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, concrete walls, stormwater management, and earthwork.

Site Description

The site is located at 9xx Webster Street in Mukilteo, Washington. The site consists of one rectangular shaped parcel (No. 0052704701200) with a total area of 0.44 acres.

The property is undeveloped and heavily vegetated with blackberry vines, ivy, ferns, grasses, and variable diameter evergreen and deciduous trees.

The site slopes downward from southeast to northwest and west at magnitudes of 15 to 40 percent and total relief of about 40 feet. There is standing water in the northern portion of the ditch along the west property line.

The site is bordered to the north, east, and south by residential properties (locally developed), and to the west by Webster Street and right-of-way.

The proposed development includes a new residence with a daylight basement level. The residence will likely be situated in the western half of the property with a short driveway. We anticipate that foundation loads will be light to moderate and grading may include cuts of 12 feet or less. Stormwater will be infiltrated if determined to be feasible. We should be provided with the final plans verify that our recommendations are valid and do not require updating.

Area Geology

The Geologic Map of the Mukilteo Quadrangle indicates that the site is underlain by Transitional Beds.

Transitional Beds include silt and clay deposited in non-glacial and glacial environments just prior to Vashon-era deposits. These materials are typically medium dense to very dense/hard below a weathered zone.

Soil & Groundwater Conditions

As part of our evaluation, we excavated two test pits and one hand boring within the property, where accessible.

The explorations encountered approximately 12 inches of vegetation and topsoil underlain by about 1.5 to 2.5 feet of loose to medium dense, silty-fine to medium grained sand with gravel (Weathered Transitional Beds). These materials were underlain by dense to very dense, silty-fine to medium grained sand trace gravel (Transitional Beds), which continued to the termination depths of the explorations.

Groundwater was not encountered during our exploration work. Based on our observations, shallow perched groundwater likely develops on the denser soils. The depth to groundwater will likely be 2 to 5 feet during the wet season. There is standing water in the ditch along the west property line.

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.

Landslide/Steep Slope Hazard

Most critical area ordinances designate slopes with magnitudes greater than about 40 percent and vertical relief of at least 10 feet as potentially geologically hazardous (steep slope/landslide hazards).

The site slopes downward from southeast to northwest and west at magnitudes of 15 to 40 percent and total relief of about 40 feet.

It is our opinion that the slope system within and near the property is stable at this time. We did not observe evidence of erosion, landslide activity or soil creep.

Provided all stormwater is fully managed and directed away from slope systems, the proposed development should not increase the risk of soil movements on the subject property and adjacent areas.

Any new foundation systems should be embedded an adequate depth in order to create a minimum 7 foot effective setback from adjacent slope systems (downslope areas) where slope magnitudes are 30 percent or more. This is the horizontal distance from the lower outside face of the footing to the face of the adjacent slope.

Buildings should be setback at least 10 feet from the toe of any slopes with magnitudes of 40 percent or more and relief of at least 20 feet. It should be noted that steep slopes can be effectively modified to create yard areas and setbacks. Local retaining walls may be required.

Erosion Hazard

The Natural Resources Conservation Services (NRCS) maps for Snohomish County indicate that the site is underlain by Alderwood-Everett gravelly sandy loam (25 to 70 percent slopes) and Everett very gravelly sandy loam (0 to 8 percent slopes). These soils would have a slight to severe 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 31st to April 1st. 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_l , 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_a	F_v	S_{DS}	S_{D1}	
D	1.466	0.569	1.0	1.5	0.977	0.569	0.626

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_a	F_v	S_{DS}	S_{D1}	
D	1.405	0.501	1.0	Null	0.937	Null	0.607

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, relatively dense silty-sands and sandy silts, likely associated with Transitional Beds. The proposed building may be supported on a shallow foundation system bearing on medium dense or firmer native soils or on structural fill placed on the native soils. Local overexcavation or re-compaction of loose weathered native soils may be necessary depending on the proposed elevations and locations of the new footings. We should be provided with the final plans to verify suitability.

Any new foundation systems should be embedded an adequate depth in order to create a minimum 7 foot effective setback from adjacent slope systems where slope magnitudes are 30 percent or greater. This is the horizontal distance from the lower outside face of the footing to the face of the adjacent slope. Buildings should be setback at least 10 feet from the toe of any slopes with magnitudes of 40 percent or more. It should be noted that steep slopes can be effectively modified to create yard areas and setbacks. Local retaining walls may be required.

Infiltration of stormwater runoff is not feasible due to the soil and groundwater conditions along with slope magnitudes. We recommend direct connection of all runoff collection devices into City infrastructure.

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 12 to 24 inches.

The native soils consist of silty-sand with gravel and sandy silt with gravel. Unless work takes place during July through September, the native soils will not likely be suitable for use as structural fill. If they are used as structural fill, they must be able to achieve compaction requirements and be within 3 percent of the optimum moisture. These soils are highly moisture sensitive.

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 12 feet or less for foundation and utility placement. 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 hard 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 residence may be supported on a shallow spread footing foundation system bearing on undisturbed medium 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 3,000 pounds per square foot (psf) may be used for design.

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, if proposed.

Wall Design Criteria	
"At-rest" Conditions (Lateral Earth Pressure – EFD ⁺)	55 pcf (Equivalent Fluid Density)
"Active" Conditions (Lateral Earth Pressure – EFD ⁺)	35 pcf (Equivalent Fluid Density)
Seismic Increase for "At-rest" Conditions (Lateral Earth Pressure)	21H* (Uniform Distribution) 1 in 2,500 year event
Seismic Increase for "At-rest" Conditions (Lateral Earth Pressure)	14H* (Uniform Distribution) 1 in 500 year event
Seismic Increase for "Active" Conditions (Lateral Earth Pressure)	7H* (Uniform Distribution)
Passive Earth Pressure on Low Side of Wall (Allowable, includes F.S. = 1.5)	Neglect upper 2 feet, then 250 pcf EFD ⁺
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),

*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. If groundwater is present or cannot be drained, we recommend using lateral earth pressures of 80 and 110 pcf (active and at-rest, respectively).

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.

Slab-on-Grade

We recommend that the near surface soils be compacted to a firm and unyielding condition as part of subgrade preparation.

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.

Stormwater Management Feasibility

The site is underlain by a thin layer of weathered silty-sands and at depth by dense to hard silty-sand to sandy silt. These soils were generally cemented and mottled at shallow depths. Due to the likely presence of very shallow groundwater during the wet season, infiltration is not feasible. Due to the presence of relatively steep slopes, we recommend utilizing direct connection of runoff collection devices to City infrastructure.

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.

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 subgrade preparation of roadways
- 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 Gagandeep Oberoi and his 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 Gagandeep Oberoi 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



6/22/2021
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.

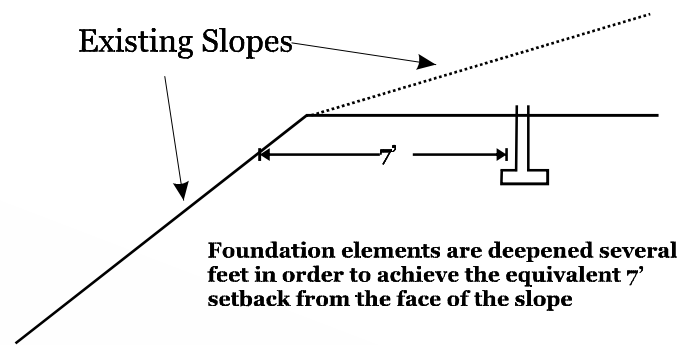
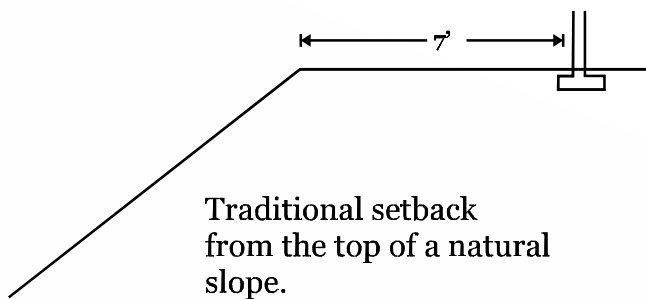
VARYING OR UNEXPECTED CONDITIONS: Should any site or subsurface conditions be encountered that are different from those described in this report or encountered at the test locations, Cobalt Geosciences must be notified immediately to assess if the varying or unexpected conditions are substantial and 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.



Illustration of Effective Setback and Traditional Setbacks from Slopes

**TP-1
HB-1**  **Approximate
Test Pit & Hand
Boring Location**



Proposed Residence
9xx Webster Street
Mukilteo, Washington

**SITE
PLAN
FIGURE 1**

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Unified Soil Classification System (USCS)

MAJOR DIVISIONS			SYMBOL	TYPICAL DESCRIPTION
COARSE GRAINED SOILS (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
			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
			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
			SP	Poorly graded sand, gravelly sands, little or no fines
		Sands with Fines (more than 12% fines)	SM	Silty sands, sand-silt mixtures
			SC	Clayey sands, sand-clay mixtures
FINE GRAINED SOILS (50% or more passes the No. 200 sieve)	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
			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
			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	Peat, humus, swamp soils with high organic content (ASTM D4427)

Classification of Soil Constituents

MAJOR constituents compose more than 50 percent, by weight, of the soil. Major constituents are capitalized (i.e., SAND).

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).

Trace constituents compose 0 to 5 percent of the soil (i.e., slightly silty SAND, trace gravel).

Relative Density (Coarse Grained Soils)

N, SPT, Blows/FT	Relative Density
0 - 4	Very loose
4 - 10	Loose
10 - 30	Medium dense
30 - 50	Dense
Over 50	Very dense

Consistency (Fine Grained Soils)

N, SPT, Blows/FT	Relative Consistency
Under 2	Very soft
2 - 4	Soft
4 - 8	Medium stiff
8 - 15	Stiff
15 - 30	Very stiff
Over 30	Hard

Grain Size Definitions

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

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

Soil Classification Chart

Figure C1



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Test Pit TP-1

Date: June 2021		Depth: 8'		Groundwater: None	
Contractor: Jim		Elevation:		Logged By: PH	Checked By: SC
Depth (Feet)	Interval	Graphic Log	USCS Symbol	Material Description	Groundwater
					<div> Moisture Content (%) </div> <div> Plastic Limit ———— Liquid Limit </div> <div> DCP Equivalent N-Value </div>
1				Topsoil/Vegetation	
2			SM/ML	Loose to medium dense, silty-fine to fine grained sand with gravel, mottled yellowish brown to grayish brown, moist. (Weathered Transitional Beds)	
3			SM/ML	Dense, silty-fine to fine grained sand with gravel trace cobbles, mottled yellowish brown to grayish brown, moist. (Transitional Beds)	
4					
5					
6					
7					
8				End of Test Pit 8'	
9					
10					

Test Pit TP-2

Date: June 2021		Depth: 6'		Groundwater: None	
Contractor: Jim		Elevation:		Logged By: PH	Checked By: SC
Depth (Feet)	Interval	Graphic Log	USCS Symbol	Material Description	Groundwater
					<div> Moisture Content (%) </div> <div> Plastic Limit ———— Liquid Limit </div> <div> DCP Equivalent N-Value </div>
1				Topsoil/Grass	
2			SM/ML	Loose to medium dense, silty-fine to fine grained sand with gravel, mottled yellowish brown to grayish brown, moist. (Weathered Transitional Beds)	
3			SM/ML	Dense, silty-fine to fine grained sand with gravel trace cobbles, mottled yellowish brown to grayish brown, moist. (Transitional Beds)	
4					
5					
6				End of Test Pit 6'	
7					
8					
9					
10					



Proposed Residence
9xx Webster Street
Mukilteo, Washington

**Test Pit
Logs**

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Hand Boring HB-1

Date: June 2021	Depth: 6'	Groundwater: None
Contractor: Cobalt	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
				Topsoil/Grass							
1			SM/ML	Loose to medium dense, silty-fine to fine grained sand with gravel, mottled yellowish brown to grayish brown, dry to moist.							
2											
3											
4			SM/ML	Dense, silty-fine to fine grained sand with gravel trace cobbles, yellowish brown to grayish brown, moist.							
5											
6				End of Hand Boring 6'							
7											
8											
9											
10											



Proposed Residence
9xx Webster Street
Mukilteo, Washington

**Hand
Boring
Logs**

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