8/4/2021

Alex Holtze
3425 Merrymen Place SE
Olympia, WA 98501

Subject: **Holtze Multi-family Consultation**
585 North 5th Avenue SW, Tumwater, WA
QG Project No.: QG21-088

Dear Mr. Holtze:

At your request, Quality Geo NW, PLLC (QG) has completed a follow-up critical slope review of the above referenced property's existing site conditions, including mapped slope analysis and review of existing geologic literature for the site. The project site consists of a vacant and partly forested property partly comprising a portion of a regional slope. It is our understanding that the client intends to construct new multi-family structures within an area designated by the permitting authority to be a potential critical slope and a potential landslide hazard area.

QG understands that the client is considering the purchase of the western adjacent lot in an effort to expand proposed structural and stormwater developments. The permitting authority requires a geotechnical consultation to confirm that current conditions are favorable, and to provide any additional and necessary recommendation regarding critical slope considerations including necessary setbacks if applicable. The following report provides additional geotechnical recommendations for planning and design intended to reduce the inherent risks associated with site development on or adjacent to slopes.

A site region and vicinity map are provided in Appendix A, and a site map is presented in Appendix B.

GEOTECHNICAL LITERATURE REVIEW

Previously in 2020, QG completed a geotechnical consultation and critical slope analysis (project # QG20-070) for Angel Larson, the owner of the eastern adjacent parcel (TPN 3323200002). Our report evaluated the slopes on site and offered construction recommendations for constructing a

house on (or adjacent to) the slopes. Of note, the highest concern for the site is the presence of a shallow seasonal perched water table, with seepage at the base of the slope. Any structural elements were specified to incorporate robust drainage controls to reduce the overall influx of stormwater into the soils of the slopes and prevent erosion from any possible discharge.

Additionally, QG was provided an existing geotechnical report (project #19S222) performed by Materials Testing & Consulting, Inc. in 2019 (herein referred to as "the MTC report"). The report included extensive subsurface soil explorations and slope characterization. Our review of the report concludes that the evaluation was completed adequately, and appears to be well prepared, addressing the same items required by the current critical area ordinance. The MTC report provides a slope crest setback as a conservative measure in support of previous construction proposals that did not anticipate possibly expanding towards other portions of the slope, or other adjacent parcels.

DISCUSSION & SLOPE RECOMMENDATIONS

The findings of QG's site reconnaissance at the subject site appear broadly consistent with available literature and do not indicate any excessively prohibitive conditions exist for the proposed development, assuming appropriate site management efforts are maintained.

Critical Area Ordinance Considerations

Failure mechanisms related to possible future deep-seated slides can be described as a series of complex interactions between groundwater and geologic contacts between sedimentary units, decreasing slope safety factors at depth across wide extents of the land, as a natural process of mass wasting in coastal sedimentary deposits. Failure mechanisms of these deep-seated landslide events are commonly at depths well beneath the depth and scope of most residential construction projects, which are generally of a weight and impact that is insignificant to global stability and safety factors.

Slopes on site are typically inclined at a 3H:1V or less, with few localized areas exceeding 40 percent. Those localized areas that may be oversteepened are typically less than 10 feet in vertical extent, tapering above and below. Shallow soils do not display any evidence of recent or historic slides. In consideration of the available information, and our direct observations, at this time **QG does not consider the site or subject slopes to be an active landslide hazard area.** From a geotechnical standpoint, no portions of the subject slopes are considered "unbuildable". Some areas may require greater effort and engineered solutions, such as deeper foundations, or retaining walls, with generally conventional construction techniques.

The entire site is sloped to some degree, and therefore QG does not impose any specific slope crest or toe setback. Setbacks instead should be considered more as embedment requirements to protect

foundations and preserve existing slope stability. These requirements are described in the following section.

At this point, QG does not recommend any further investigation be conducted. Based on the information herein, QG provides the following development- and site-specific recommendations that will minimize the inherent risks of developing in a sloped area.

Setback Recommendations:

Considering the inclination and conditions of the lower slope specific slope face setback requirements must be followed for successful construction at this location. The local critical area ordinance delineates minimum slope toe setbacks for slopes inclined greater than 40% (~22°), which may be further reduced upon review by a licensed geotechnical professional. QG's reviewed existing topographic data and general site observations made during our previous visit to infer general slope face setbacks based on height and inclination of the typical slopes present on the site in proximity to the proposed structure.

Horizontal foundation embedment/setbacks were determined based on two standard methods:

- First, standard International Building Code (IBC) requirements as accepted by the State of Washington. The IBC details required setback delineations for slopes with an overall inclination less than or equal to 45 degrees. Structures in the vicinity of slopes shall maintain a minimum horizontal slope face setback the lesser of H/3 or 40 feet. QG made limited inclination measurements in the field and reviewed existing topographic data, in comparison to our general site observations made during our visit, to evaluate the adjusted setback requirements. With the typical continuous slope height of up to 75 feet (H=75) the **minimum required horizontal embedment would equal 25 feet (H/3).**
- Second, QG considered a simplified slope stability evaluation based on methods described in Landslides: Investigation and Mitigation, Turner and Schuster, 1996.

  Factor of Safety (FS) = Tan (ϕ) / Tan (α)

  Where ϕ = Internal Angle of Friction

  α = Angle of Slope or Projection Plane

  An overly conservative ϕ = 27.5-degree friction angle was assigned to the overriding native soils for use in assessing slope factor of safety and determining a suitable building setback. Target factor of safety for residential structures is typically FS = 1.5 for static analysis. Factor of safety is an indication of stability; an FS = 1.0 or below corresponds to the point of failure. The setback projection angle for a suitable factor of safety is found by using:

Factor of Safety (FS) = Tan (ϕ) / Tan (α) = Tan (41) / Tan (α) = **1.5+**

ϕ = 27.5 degrees

α = 19 degrees

GQ's profile estimates were used to create a projection from the slope base for an α = 19-degree projection angle, as shown on Figure 2. This geometry meets typical factor of safety requirements for residential development. **To maintain embedment beneath this safety projection, a minimum vertical foundation embedment of 6 feet below adjacent grade shall be utilized.**

Results for both methods were found to closely correlate the expected slope inclinations with specified minimum embedments, suggesting their overall suitability for the proposed project. **So long as these recommendations are followed, existing slope safety factors will not be reduced.**

Foundation Design and Construction Recommendations:

For general foundation design considerations, QG recommends referring to guidelines and parameters of the International Building Code (IBC, 2015; or most recent edition at the time of construction). Footings should be placed to a minimum depth in accordance with the setback and factor of safety criteria above, as well as meeting minimum IBC (2015) requirements.

The proposed buildings may utilize either stepped or continuous footings with crawl space or slab-on-grade, depending on the chosen development style. Due to the reported presence of shallow bedrock and hardpan conditions in areas across the site, cuts deeper than 7 to 8 feet are expected to be difficult. For structures planned along the steeper slopes, stepped foundations with taller stem walls and crawl spaces may be more desirable than daylight basement foundations.

For foundation elements, upon reaching bearing strata, we recommend benching foundation lines flat, followed by moisture conditioning of the soil, and vibratory compaction to a firm and unyielding condition. Continuous perimeter and strip foundations may be stepped as needed to accommodate variations in final subgrade level. We recommend maximum vertical steps of 18 inches with horizontal spacing of at least 5 feet be constructed unless specified otherwise by the design engineer. Structural fill may then be placed as needed to reestablish final foundation grade. Any areas where footing subgrades are found to be directly over bedrock shall be separated from the bedrock by a minimum 6" lift of imported structural fill, compacted to a firm and unyielding condition.

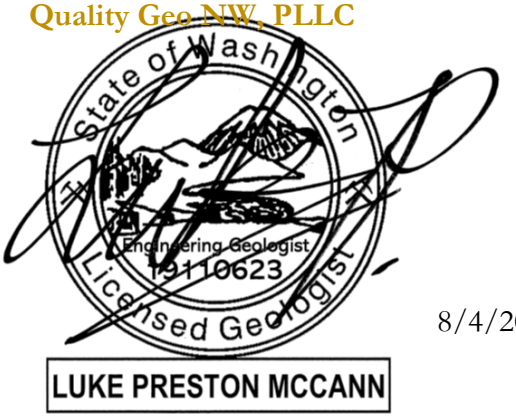
CLOSING:

The information included in this letter should be considered supplemental to the information contained in the original geotechnical reports. This letter should be used in conjunction with the above referenced documents. The design and conclusions presented in this letter are intended solely for the purposes of design and construction of multi-family residential structures as detailed to us by the client prior to the issuance of this letter. All other design, conclusions, and recommendations outlined in the previous reports remain unchanged. Furthermore, the sight design and civil engineering project plans and previous documents have not been inspected for accuracy beyond a cursory informational level. Any changes to the plans will need to be approved by the new project engineer of record. It shall also be noted that QG is not a licensed surveyor,

We trust this letter satisfies your project needs currently and thank you for the opportunity to be of service. QG wishes you the best while completing the project.

Respectfully Submitted,

Quality Geo NW, PLLC



8/4/2021

Luke Preston McCann, L.E.G.
Principal Licensed Engineering Geologist

Attachments: *Limitations*
Appendix A. Site Map
Appendix B. Slope Profile

LIMITATIONS

Upon acceptance and use of this report, and its interpretations and recommendations, the user shall agree to indemnify and hold harmless QG, including its owners, employees and subcontractors, from any adverse effects resulting from development and occupation of the subject site. Ultimately, it is the owner's choice to develop and live in such an area of possible geohazards (which exist in perpetuity across the earth in one form or another), and therefore the future consequences, both anticipated and unknown, are solely the responsibility of the owner. By using this report for development of the subject property, the owner must accept and understand that it is not possible to fully anticipate all inherent risks of development. The recommendations provided above are intended to reduce (but may not eliminate) such risks.

This report does not represent a construction specification or engineered plan and shall not be used or referenced as such. The information included in this report should be considered supplemental to the requirements contained in the project plans & specifications and should be read in conjunction with the above referenced information. The selected recommendations presented in this report are intended to inform only the specific corresponding subjects. All other requirements of the above-mentioned items remain valid, unless otherwise specified.

Recommendations contained in this report are based on our understanding of the proposed development and construction activities, field observations and explorations, and laboratory test results. It is possible that soil and groundwater conditions could vary and differ between or beyond the points explored. If soil or groundwater conditions are encountered during construction that differ from those described herein, or If the scope of the proposed construction changes from that described in this report, QG should be notified immediately in order to review and provide supplemental recommendations.

The findings of this study are limited by the level of scope applied. We have prepared this report in substantial accordance with the generally accepted geotechnical engineering practice as it exists in the subject region. No warranty, expressed or implied, is made. The recommendations provided in this report assume that an adequate program of tests and observations will be conducted by a WABO approved special inspection firm during the construction phase in order to evaluate compliance with our recommendations.

This report may be used only by the Client and their design consultants and only for the purposes stated within a reasonable time from its issuance, but in no event later than 18 months from the date of the report. It is the Client's responsibility to ensure that the Designer, Contractor, Subcontractors, etc. are made aware of this report in its entirety. Note that if another firm assumes Geotechnical Engineer of Record responsibilities they need to review this report and either concur with the findings, conclusions, and recommendations or provide alternate findings, conclusions and recommendation.

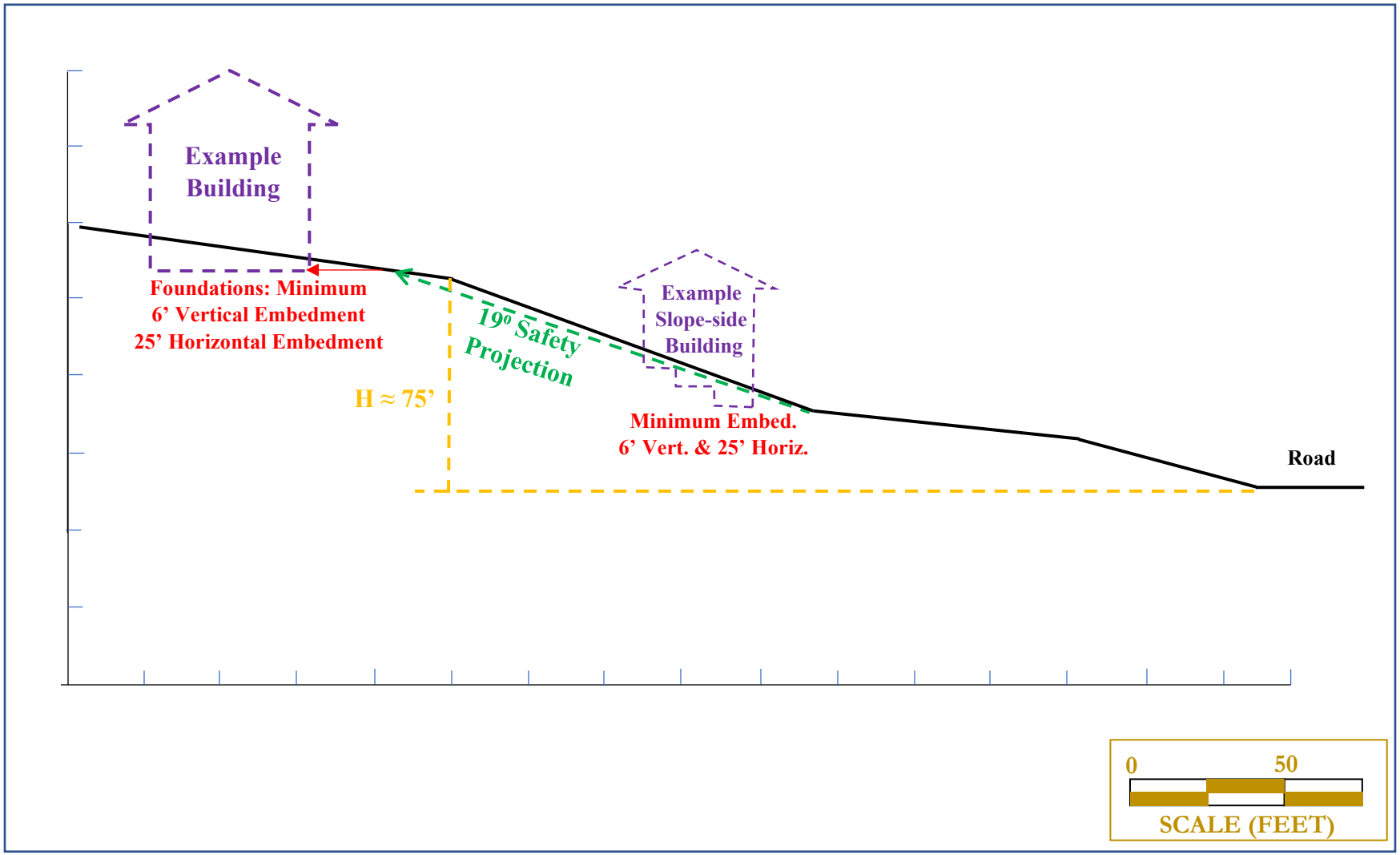
Land or facility use, on- and off-site conditions, regulations, or other factors may change over time, and additional work may be required. Based on the intended use of the report, QG may recommend that additional work be performed and that an updated report be issued. Non-compliance with any of these requirements by the Client or anyone else will release QG from any liability resulting from the use of this report. The Client, the design consultants, and any unauthorized party, agree to defend, indemnify, and hold harmless QG from any claim or liability associated with such unauthorized use or non-compliance. We recommend that QG be given the opportunity to review the final project plans and specifications to evaluate if our recommendations have been properly interpreted. We assume no responsibility for misinterpretation of our recommendations.

Appendix A. Site Map



Quality Geo NW, PLLC	**Site Map** Holtze Consultation	Source: Client provided site plan **Scale & Locations are approx.** **Not for Construction**	**Figure 1**

Appendix B. Slope Profile



Quality Geo NW, PLLC	**Site Map** Holtze Consultation	Source: MTC Report #19S222, 11/4/19 **Scale & Locations are approx.** **Not for Construction**	**Figure 2**