1/6/2022

Love Legacy Land Team
Attn: John Love
15215 SE 272nd St
Suite 202, Kent, WA

Subject: **Walker Lake Residential Slope Consult – Critical Area Ordinance (CAO)**
TPN #3421079044, E Lake Walker Drive SE, Enumclaw, WA
QG Project No.: QG21-178

Dear Client:

At your request, Quality Geo NW, PLLC (QG) has completed a preliminary critical area review of the above referenced property's existing site conditions, including site visual reconnaissance, subsurface evaluation, slope analysis, and review of existing geologic literature for the site. The project site consists of a partly developed residential property adjacent to a portion of a regional coastal bluff slope. It is our understanding that the client intends to make improvements and additions within an area designated by the permitting authority to be a potential critical slope.

QG understands that the permitting authority requires a geotechnical consultation to confirm that currently proposed project is feasible, and to provide any additional and necessary recommendation regarding critical slope considerations including necessary setbacks. The following report presents the findings and conclusions of our review, addresses feasibility of proposed site development, and provides additional geotechnical recommendations for planning and design intended to reduce the inherent risks associated with site development within a potentially geologically hazardous area.

A site region and vicinity map are provided in Appendix A, and a site map is presented in Appendix B. Typical slope conditions are shown schematically on the attached site slope profile in Appendix C.

GEOLOGIC LITERATURE REVIEW

QG reviewed available map publications to assess known geologic conditions and hazards present at the site location. The Washington Geologic Information Portal (WGIP), maintained by the

Department of Natural Resources Division of Geology and Earth Resources, provides 1:24,000-scale geologic mapping of the region. Geology of the site location and vicinity consists of glacial drift deposits (Qg) mantling volcanic bedrock deposits. The Qg on site is described as "chiefly till composed of gray silty clay mixed with boulders and sand in the uplands, stratified outwash gravel adjacent to uplands, and ground moraine, chiefly till, in the lowlands. Pattern indicates drumlinized ground moraine, chiefly till. Deposited in the lowlands."

According to the regional-scale interactive map, prehistoric deep seated landslide deposits are mapped to exist along the eastern portions of the parcel, along the same slope. The mapped boundaries do extend within the property. Available LiDAR imagery of the site did not reveal obvious or prominent landslide features within the site or immediate vicinity. The prehistoric features appear to be dormant and have been weathered/worn over for some time with no indications of reactivation. The activation point appears to be several hundred feet off site to the west. Overall, map resources suggest a very low potential for the presence of active deep-seated landslide features on site.

The original geotechnical report for the neighborhood development was made available to QG by the client. This was prepared by Icicle Creek Engineers, Inc. in 2005, and appears to focus on the known slope hazards at the time. All available resources within the document indicate that slope hazards exist to the east, but are off site and do not appear to encroach within the subject parcel boundaries.

SITE INVESTIGATION METHODOLOGY

On 12/9/2021, a QG Staff Geologist visited the site to perform visual reconnaissance of the surface and topographic features of the subject property and its proximal slope. While on site, we conducted site surface explorations for a geologic hazard assessment and site feasibility characterization. Approximate relevant property dimensions and slope topography were documented and mapped at representative intervals as access allowed. Soil conditions were evaluated through local exposures along the slope face. Salient slope features and existing vegetation were documented to assess general site stability as well as observe for signs of local instability of an erosional or subsurface nature currently or in the past.

SURFACE OBSERVATION

The project site is irregular in shape with a gentle upland in the south, dropping off towards the north end of the parcel. The site is accessed by a gravel driveway off of East Lake Walker Dr SE. Lake Walker Drive itself (along the northern parcel boundary) was noted to be in poor condition, with clear indications of recent settlement, and significant erosion, including tension cracks,

ponding water, and scouring. While this is technically off site, it was one of the most concerning features regarding its poor condition and signs of movement. The site itself within the parcel boundaries did not display any of the same signs of movement.

A stormwater channel is present near the center of the northern parcel extent, and was noted to be slowing during out visit. This appears to be a result of stormwater percolating through the overriding glacial drift soils, and perching on the underlying bedrock. The small ravine near the north end of the site allows for this transient stormwater to daylight in the form of a small channel.

The upland site is relatively gentle in topography, with several possible locations for new construction. The steeper northern slopes on site appear to mostly be a result of the roadcut for Lake Walker Drive. Site slopes are moderately vegetated with grasses and small shrubs. Mature trees in the upland area as well as the lower bench were relatively straight.

QG performed reconnaissance within the site to observe for and document indications of surface degradation or large-scale slope instability. Within the anticipated upland building areas, no obvious features were observed that would indicate an active or prior deep-seated slope failure within the proposed home area, such as headscarps or significant downslope accumulations. No obvious evidence of rotational or translational failures or major toppling hazards was observed on the slope in the proximity of the potential building footprint. No obvious failure features were observed on adjacent slope areas visible from the subject property during our site visit.

SUBSURFACE CONDITIONS:

Soil exposures along the upper site slope face and within exposed surface soils appear generally consistent throughout, comprising a weathered cover soil over a denser brown sandy gravel unit that dominates the soil column below. There were no signs of seepage or daylighting stormwater along the flatter upland areas.

DISCUSSION & CRITICAL SLOPE RECOMMENDATIONS

In consideration of the available information, while the site itself does not display features of being a potential landslide or erosional hazard, the adjacent Lake Walker Drive does and will likely continue to experience small erosional and slump events slowly over time, which may compound into a larger issue for the vicinity. This would likely take a substantial effort on the part of the local homeowners association to fully mitigate. In the meantime, certain steps can be taken to increase the longevity of the road and adjacent property. Based on the information herein, we provide the following development- and site-specific recommendations that will minimize the inherent risks of developing in a sloped area.

The findings of QG's site reconnaissance at the subject site appear broadly consistent with available geologic literature and do not indicate any excessively prohibitive conditions exist for the site, assuming appropriate site management efforts are maintained. It appears that the designation as a landslide hazard area is based on mapped topography and mapped nearby landslide deposits, rather than a known active deep-seated hazard on the subject parcel.

In consideration of the available information, and our direct observations, at this time **QG does not consider the building site to be within an active landslide hazard area.** Based on the information herein, we provide the following development- and site-specific recommendations that will minimize the inherent risks of developing in a sloped area.

Due to the anticipated construction of a building pad and home, specific foundation setbacks must be maintained to protect the slopes and structures. Additionally, we recommend final design and construction practices limit additional surface excavation to the smallest extent possible. Large excavations are generally discouraged.

Foundation 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 of 18 inches for freeze-thaw protection, but not less that required by the setback and factor of safety criteria below.

The proposed buildings may utilize either stepped or continuous footings with slab-on-grade. For these elements, upon reaching bearing strata (approximately 2 feet below present grade), 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.

Existing site soils may be considered for reuse as structural fill on a case-by-case basis, if supported by laboratory gradation testing. Imported material may be used as structural fill. Imported structural fill material should conform to the *WSDOT Standard Specifications, Section 9-03.14(1) Gravel Borrow*, or an approved alternative. For lateral and bearing support, structural fill placement below footings shall extend at minimum a distance past each edge of the base of the footing equal to the depth of structural fill placed below the footing [e.g., for a 2.0-foot wide footing, fills placed to approximately 1.5 feet below footing grade will require a minimum backfill

width of 5.0 feet (1.5 feet each side plus 2.0-foot width of footing)] Fill shall be placed in maximum 12" thick, horizontal lifts, compacted to a firm and unyielding condition.

Newly Graded Permanent Slopes & Fill Embankments:

QG recommends that new areas of permanently graded slopes in native soil be inclined no greater than 3H:1V, catching natural topography at the top and toe. We recommend that areas expected to receive imported fill be benched, placed, and compacted in accordance with WSDOT Standard Specifications: *Embankment Construction & Hillside Terraces*, sections 2-03.3(14) through 2-03.3(14)D. Fill slopes may be inclined no greater than 2H:1V. All site slopes should be permanently stabilized from erosion.

Setback Recommendations:

Considering the inclination and conditions of the lower slope specific 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 visit to infer general slope face and slope toe setbacks based on height and inclination of the typical slopes present on the site in proximity to the proposed structure.

Horizontal setbacks were determined based on the following standard methods: QG reviewed the 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.

QG recommends that any new building foundations be embedded to maintain a minimum horizontal slope setback of 50 feet (See Appendix C) from the northern slopes that exceed 3H:1V inclination. The gentle portions of the upland appear suitable. We recommend the area within 20 feet of the crest be maintained as a vegetated buffer, with increased plantings of deep rooting shrubs. The setback does not prohibit lightweight surface improvements such as septic, uncovered decks, patios, walkways, landscaping, pathways, etc (if approved by the project engineer). QG does not recommend reducing the setback unless further site-specific foundation design efforts are undertaken to ensure building and slope stability is maintained.

Hill Side Drives

If upland flat area is used as building site, then it is our understanding that a new hillside drive will be required to service the new home. As such, QG does not anticipate high or regular traffic loads or frequent heavy loads on the proposed road. Furthermore, we assume that the road improvements will be constructed as narrowly as feasible and allowed by local jurisdiction. With the only feasible easement to the site existing at its base, total avoidance of the slope is generally infeasible for the project. The installation of a retaining wall to support upland slopes and cut face exposures is generally anticipated to improve the overall stabilization of the roadway and slopes. The separation of structural roadway sections from native soils by a geo-grid material may provide additional stability and increase resistance to future shallow soil creep near the slope crest.

Where proximity to the slope cannot be avoided, QG recommends that the roadways be regraded in a manner to maintain a suitable buffer between the road and the adjacent descending crests. Regrading through cut and fill of the existing road grade by a reasonable extent can be used to create a wider road pad, providing extra protection between the road structural section and drive lane versus the slope crest. Preliminarily, QG recommends a *minimum 5-foot horizontal buffer* be maintained between the outer edge of the new road area permitting vehicle access (edge of pavement or shoulder as applicable) and the newly graded adjacent slope crest.

Where grading is required, the entirety of the new roadways should be constructed using a cut scenario. Minimal fills should be placed in order to level the road, aside from the structural section as recommended by the design engineer and confirmed by final design. QG recommends removing topsoil deposits and any organic or unsuitably loose or soft subgrade soils from beneath pavement areas. Exposed subgrade should be in a firm and unyielding condition prior to commencing further road preparations. Locally loose conditions may be recompacted in place as possible and evaluated for suitability. After excavation to subgrade level, but before placing the pavement section, soils should be evaluated for suitability. Where possible, the subgrade should be proof-rolled with a minimum of two passes with a fully loaded dump truck, water truck or loader. In circumstances where this seems unfeasible, alternative methods can be used for subgrade evaluation. If unsuitably organic or loose conditions persist, we recommend over-excavating to suitably dense soils and replacing to proposed subgrade level with structural fill. The separation of structural roadway and aggregate sections from native soils by a geo-grid material will provide additional stability and increase resistance to future shallow soil creep near the slope crest.

The roadway shall be inclined a minimum of 2% back towards a constructed curb/gutter on the uphill side of the cut to prevent stormwater from sheeting over the descending slope. Curb/gutter water shall

be directed to an appropriately sized catchment system, and either redirected to an approved stormwater outfall location with appropriate energy reducing features, or to an approved dispersion site.

Additionally, QG recommends the use of a small physical barrier to limit loading due to vehicle traffic near the crest edge of the road cut outside of the traffic area. A flat, unobstructed roadside should be avoided to prevent intentional or accidental loading of the slope crest and as a safety measure. Examples of potentially suitable physical barriers are concrete curb lines, small rock features, fences, or thick brush. If possible, the roadbed should reside at a lower elevation than the adjacent crest area as an additional natural barrier. Additional localized walls along downslope edges may be considered, if determined necessary by the design engineer, where near crest construction is required.

One of the important considerations in designing a high-quality and durable pavement is providing adequate drainage. It is important that bird baths (leeching basins) and surface waves are not created during construction of the HMA layer. A proper slope should be allowed, and drainage shall be provided along the edges of pavements and around catch basins to prevent the accumulation of free water within the base course, which otherwise may result in subgrade softening and pavement deterioration under exposure and repeated traffic conditions.

All pavements require regular maintenance and repair in order to maintain the serviceability of the pavement. These repairs and maintenance are due to normal wear and tear of the pavement surface and are required in order to extend the serviceability life of the pavement. However, after 10 years of service, a normal pavement structure is likely to deteriorate to a point where pavement rehabilitation may be required to maintain the serviceability. The deterioration is more likely if the pavement is constructed over poor subgrade soils or in area of higher traffic volumes.

Drainage Controls:

QG recommends proper drainage controls for stormwater runoff during and after site development to protect the site. The ground surface adjacent to structures should be sloped to drain away at a 5% minimum to prevent ponding of water adjacent to them.

Due to the potential shallow groundwater conditions and the known seasonal water fluctuations, footing drains should be incorporated to maintain dry foundation conditions. QG recommends footing drains employ 4-inch minimum perforated pipe. Footing drains shall be backfilled with free-draining material wrapped in filter fabric.

During prolonged wet weather events, surface conditions may become saturated and daylighting stormwater may occur. For localized shallow stormwater control over restrictive conditions, a series of linear interceptor or curtain drain system may be helpful in reducing or eliminating shallow transient

water inundation. Curtain drains can be particularly effective in low gradient directional upland environments where permeable soils overlie relatively impermeable conditions and groundwater is traveling from an upgradient source. Typical curtain drain construction consists of excavating a trench through permeable soils into silt and clay deposits or restrictive glacial tills if present. Actual embedment should be adjusted for conditions encountered to limit the potential for piping (subterranean erosion). A sturdy impermeable barrier (such as 10-mil PVC sheeting) is recommended along the downslope wall of the drain trench, tucked along the trench base and backfilled over with a lift of compacted native fine-grained soils to match existing conditions. QG recommends a perforated or slotted rigid PVC pipe of 4-inch minimum diameter wrapped in filter fabric or a filter sock be placed near the base of the trench. A greater diameter pipe will be advantageous for higher flows. Finally, backfill with gravel drain rock meeting WSDOT Standard Specification 9-03-12(4) gravel Backfill for Drains or equivalent. Top dressing with grass lawn or driveway fill is permitted. QG generally recommends filter fabric placed over the drain rock prior to capping with a non-free-draining material to avoid clogging over time. Final stormwater design shall be the responsibility of the retained design engineer, who shall make any adjustments necessary.

QG recommends all stormwater catchments (new or existing) be tightlined (piped) away from the upland site to an existing catch basin, stormwater system, established channel, or down the slope to be released beyond the base using appropriate energy-dissipating features at the outfall to minimize point erosion. Roof and footing drains should be tightlined separately or should be gathered in an appropriately sized catch basin structure and redistributed collectively. If storm drains are incorporated for impervious flatworks (driveways, patios, etc.), collected waters should also be discharged according to the above recommendations. All drainage tightlines should be composed of appropriately sturdy material (such as rigid PVC), sized adequately according to anticipated flow, and anchored sufficiently. QG recommends slope tightlines be inspected by the owner periodically to look for signs of damage or displacement requiring repair.

QG does not recommend dispersion or infiltration of collected stormwater on site, as increased runoff or localized stormwater inundation can negatively impact long-term erosional and global slope stability. With county/city approval, an outfall at the existing stormwater drainage ditch may be considered for reasonable quantities of stormwater, so long as appropriate energy reducing features are established at the outfall, such as fabric and quarry spalls, or other approved methods, to prevent erosion.

Erosion Controls:

Erosion is one of the most common driving forces leading to slope instability. In addition to the above commentary, the following general recommendations should be implemented in general to reduce long-term erosion potential of the slope below the project site and maintain slope stability:

- Minimize the volume and velocity of water that travels toward and down the slope face (via proper choice of site development features including stormwater controls discussed above).
- Avoid accelerating slope erosion and mass wasting due to human activity such as:
  - ✓ Adding side-cast such as dumping landscape debris or fallen trees on or above the slopes.
  - ✓ Using heavy construction equipment on or near steep slopes.
  - ✓ Excavating near adjacent steep slopes toe or on slope face.
  - ✓ Placing excavated soil near the steep slope crest.
- Prior to construction, a silt fence and/or a continuous line of straw bales should be placed on the slopeward edge of the construction area. Heavy construction equipment, construction materials, or native and imported soils should not be placed behind the erosion control devices. Suitable temporary erosion and sediment control measures should be implemented at the construction site during and immediately after ground disturbance occurs. Temporary areas bare of vegetation should be protected from erosion via a blanket of straw or rolled erosion control product (RECP) during prolonged breaks in site work and prior to reseeding or revegetation.
- At the end of the project, all bare surfaces and areas of disturbed vegetation should be replanted and maintained until fully reestablished. Concentrated surface water should not be allowed to traverse the slope during or after the construction phase of the project. Roof downspouts and footing drains should be routed into closed separate pipes which outfall into appropriate drainages. Outlets for these pipes should be protected from erosion through the use of rip-rap (quarry spalls) or some other energy dissipating device. Similarly, concentrated drainages should be captured in closed pipe systems and routed down slope to appropriate outfalls.
- Clearing of existing vegetation outside the proposed building area on and adjacent to the existing slopes should be avoided except as approved by a qualified professional. This provides additional stability to the loose topsoil and minimizes the effects of down-slope water movement. This is excepting removal of problem, dead, or dying, trees if posing a direct hazard to site installations or adjacent roadways.
- Grading or excavation of soils during construction should be accompanied by grass reseeding and re-vegetation as the project is completed. Areas of existing moderate vegetation can also benefit from additional deep rooting plants. According to “Vegetation Management: A Guide

for Puget Sound Bluff Property Owners" (Manashe, 1993) the following types of vegetation provide good to excellent erosion control:

Common Name	*Botanical Name*	*Deciduous/Evergreen*	*Mature Height (ft)*
Bigleaf Maple	Acer macrophyllum	Deciduous	60
Douglas Fir	Pseudotsuga menziesii	Evergreen	200+
Evergreen	Vaccinium ovatum	Evergreen	To 8
Oceanspray	Holodiscus discolor	Deciduous	10+
Oregon Grape	Mahonia spp.	Evergreen	To 6
Pacific Madrone	Arbutus menziesii	Evergreen	70
Red huckleberry	Vaccinium parvifolium	Deciduous	To 12
Rose	Rose spp.	Deciduous	2-10
Salal	Gaultheria shallon	Evergreen	To 4
Salmonberry	Rubus spectabilis	Deciduous	To 12
Serviceberry	Amelanchier alnifolia	Deciduous	12+
Snowberry	Symphoricarpos albus	Deciduous	3+
Vine Maple	Acer cricinatum	Deciduous	10+
Willow	Salix spp.	Deciduous	10+

CLOSING:

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

1/6/2022

LUKE PRESTON MCCANN

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

Attachments: *Limitations*
Appendix A. Site Region and Vicinity Maps
Appendix B. Aerial Site Map
Appendix C. Site 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.

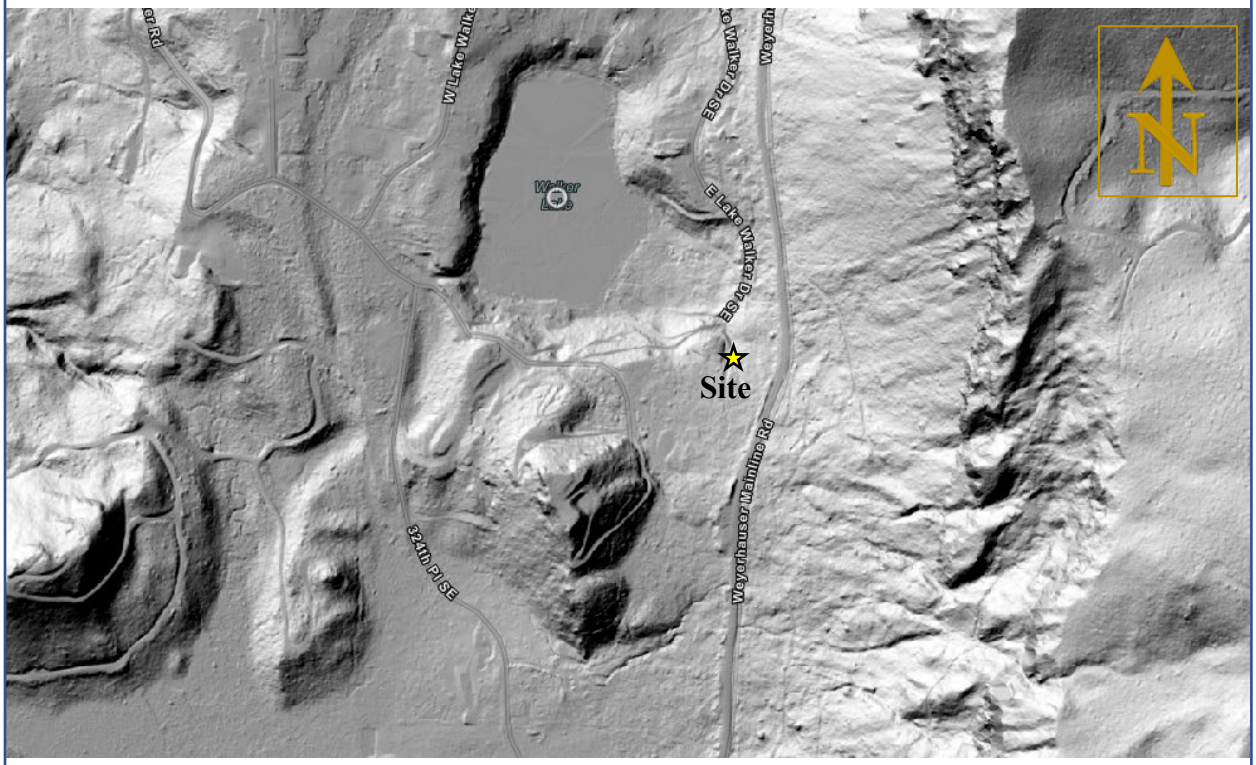
The findings of this study are limited by the level of scope applied. We have prepared this report in substantial accordance with the generally accepted geotechnical engineering practice as it exists in the subject region. No warranty, expressed or implied, is made. The recommendations provided in this 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.

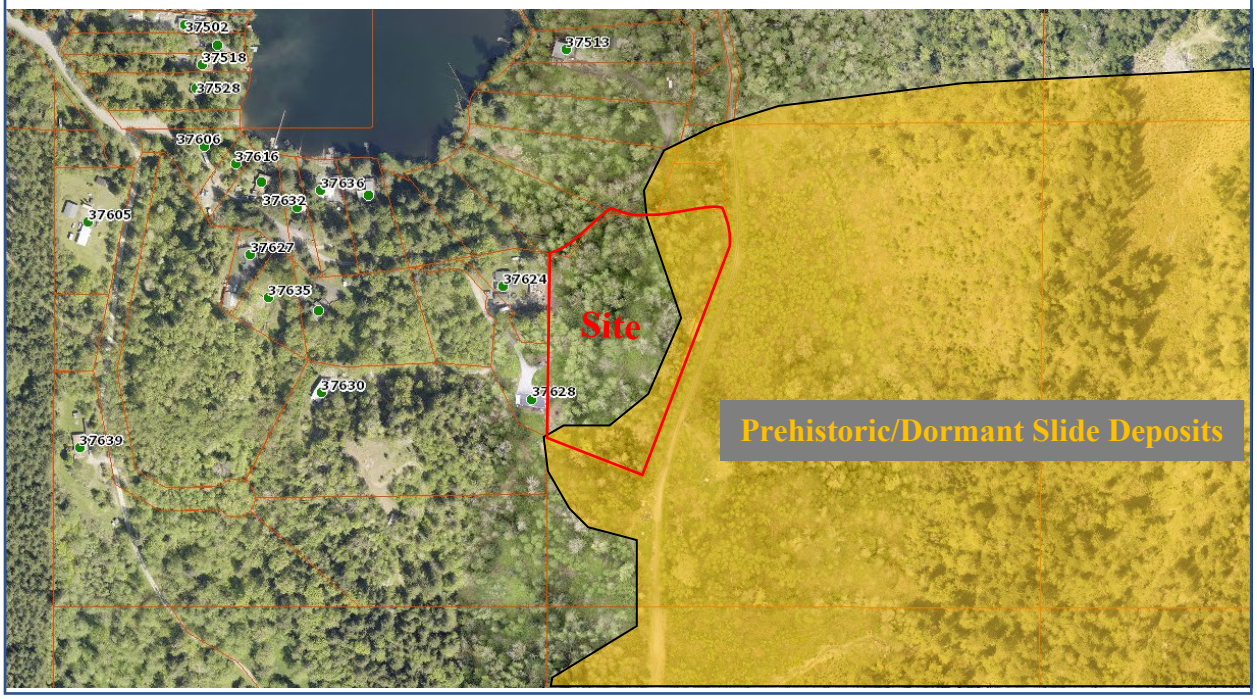
Land or facility use, on- and off-site conditions, regulations, or other factors may change over time, and additional work may be required. Based on the intended use of the report, QG may recommend that additional work be performed and that an updated report be issued. Non-compliance with any of these 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 Region & Vicinity

REGION

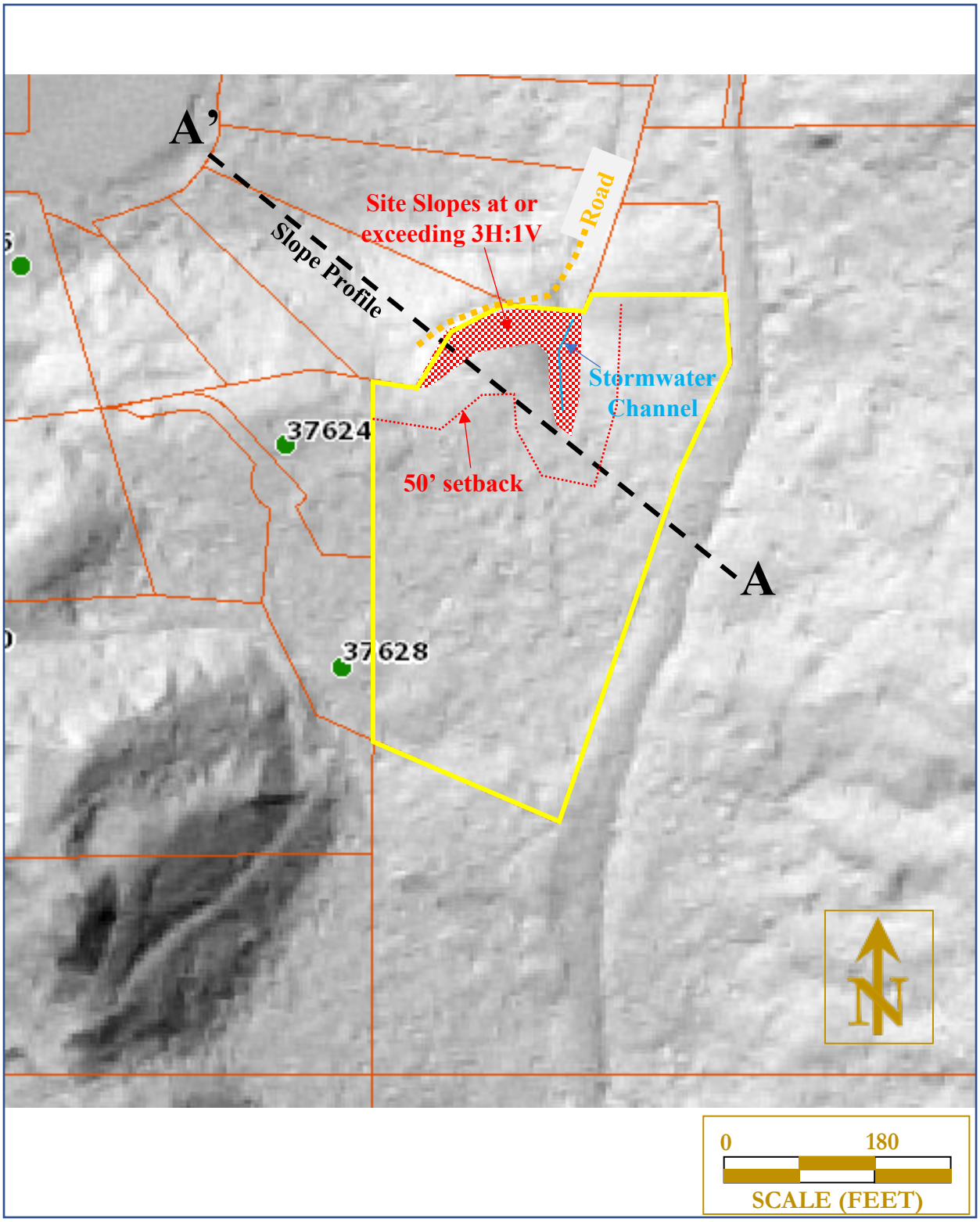


VICINITY



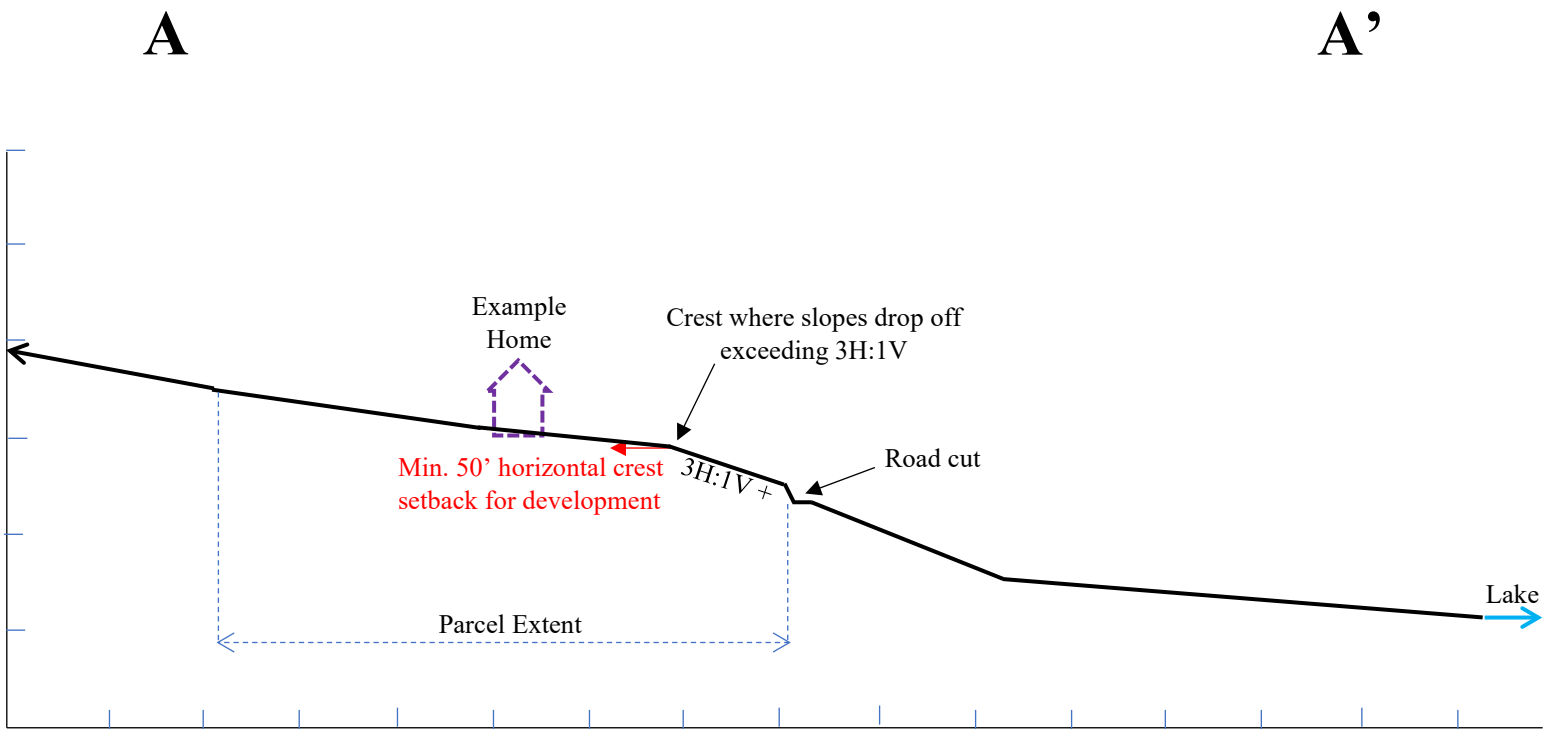
Quality Geo NW, PLLC	**Site Region** Walker Lake CAO	Source: WA DNR & King Co. **Scale & Locations are approx.** **Not for Construction**	**Figure 1**

Appendix B. Aerial Site Map



Quality Geo NW, PLLC	**Site Map** Walker Lake CAO	Source: Lewis County GIS **Scale & Locations are approx. Not for Construction**	Figure 2

Appendix C. Slope Profile



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SCALE (FEET)

Quality Geo NW, PLLC	**Slope Profile A – A'** Walker Lake CAO	Source: Mapped Topo & Hand Measurements **Scale & Locations are approx.** **Not for Construction**	**Figure 3**