Carlson Geotechnical

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Engineering Geologic Report
Miller Residence
East of 410 W E Avenue
La Center, Washington

CGT Project Number G2005397

Prepared for

Brandon Miller
2805 E 27th Street
Vancouver, Washington 98661

December 9, 2020

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Brandon Miller
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Vancouver, Washington 98661

Engineering Geologic Report
Miller Residence
East of 410 W E Avenue
La Center, Washington

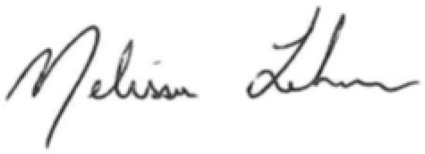
CGT Project Number G2005397

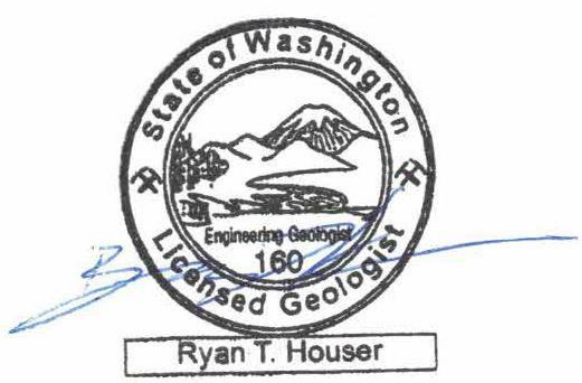
Dear Mr. Miller:

Carlson Geotechnical (CGT), a division of Carlson Testing, Inc. (CTI), is pleased to submit this Critical Areas Report (engineering geologic report) for the proposed Miller Residence project. The site is located on the lot east of 410 W E Avenue in La Center, Washington. We performed our work in general accordance with CGT Proposal GP9166, dated November 10, 2020. Written authorization for our services was received on November 18, 2020.

We appreciate the opportunity to work with you on this project. Please contact us at (503) 601-8250 if you have any questions regarding this report.

Respectfully Submitted,
CARLSON GEOTECHNICAL





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ATTACHMENTS

1.0 INTRODUCTION

Carlson Geotechnical (CGT), a division of Carlson Testing, Inc. (CTI), is pleased to submit this engineering geologic report for the proposed Miller Residence project. The site is located on the lot east of 410 W E Avenue (La Center Lots 3 and 4, Block 25) in La Center, Washington, as shown on the attached Site Location, Figure 1.

1.1 Project Information

CGT developed an understanding of the proposed project based on our correspondence with you and review of the Plot Plan, prepared by Adair Homes, Inc., dated January 30, 2020. Based on our review, we understand the project will include construction of a new, two-story, single-family residence. The new residence will be constructed at-grade with no subsurface (basement) levels.

We understand that a portion of the site contains slopes in excess of 20 percent, and that the City of La Center requires an engineering geologic report (critical areas report) be completed for the project prior to issuance of a building permit to ensure the proposed development will not negatively impact slope stability in the area.

1.2 Scope of Services

The purpose of our work will be to identify erosion and landslide hazards that may affect the property. Our specific scope of services will include the following:

- Review available literature for geologic hazards in the vicinity of the site. Specific hazards to be addressed by this study include:
  - Erosion potential
  - Landslide potential / Slope stability
- Review readily available historical aerial photographs of the site.
- Review available topographic, geologic, and geologic hazard maps for the area.
- Perform a surface reconnaissance of the site. The reconnaissance will include preparation of a cross-section of the site that includes pertinent slope features.
- Visit the site to mark (stake or paint) the locations of our proposed explorations for utility locating.
- Contact the Washington Utilities Notification Center to mark the locations of public utilities at the site within a 20-foot radius of our planned explorations.
- Explore shallow subsurface conditions at the site by advancing two, 3-inch-diameter, hand auger borings to depths of up to 5 feet below ground surface (bgs).
- Provide **qualitative** conclusions regarding the potential impacts of geologic hazards on the proposed development, and vice versa.
- Provide this written report summarizing the results of our study in general accordance with the La Center Municipal Code Division 4, Critical Lands, Chapter 18.300 specifically addressing slope stability and erosion on the subject property.

2.0 GEOLOGY

2.1 Regional Geology

The site is located on the eastern edge of the Portland Basin physiographic province in southwestern Washington (Moses, 2002[1]). The Portland Basin is included within the Willamette Valley physiographic province in Oregon. The Portland basin is a structural lowland situated between the Willapa Hills (coast range) to the west and Cascade Range to the east. The basin is surrounded and underlain by Miocene (16 to 13 million years ago) Columbia River Basalts. Pliocene (3 to 1.6 million years ago) infilling of the basin produced claystone, sandstone, and conglomerate of the Troutdale formation. Pleistocene catastrophic glacial flooding of the Missoula Floods (18,000 to 15,000 years ago[2]) carved the steep walls of the Columbia River Gorge, scoured channels within the basin and subsequently deposited unconsolidated silt, sands and gravels. Recent alluvium of the Columbia River included unconsolidated clay, silt, and sand flood deposits with sand, and gravel channel deposits (Schuster, 2002[3]). Modern development adjacent to the Columbia River included placement of dredge sand fill over recent alluvial deposits.

2.2 Site Geology

Based on available geologic mapping[4] of the area, the site is underlain by Pleistocene Catastrophic Flood Deposits (Figure 2). The flood deposits were produced by the periodic failure of glacial ice dams, which impounded Lake Missoula between 18,000 to 15,000 years ago[5]. Floodwaters raged through eastern Washington and through the Columbia River Gorge. Floodwaters in the Portland-Vancouver area were as much as 400 feet deep, leaving only the tops of the tallest hills dry. The flood deposits are typically split into two different facies in Clark County; the fine-grained facies and the coarse-grained (gravel) facies. The map indicates the site is located in the fine-grained facies, which consists primarily of silt and sand that extends to depths of up to about 70 feet bgs in the area of the site. Well logs indicate these soils are underlain at depth by Pleistocene conglomerate consisting of semi-consolidated pebble and cobbles. The conglomerate extends to about 100 feet bgs in the vicinity of the site.

3.0 LOCAL TOPOGRAPHY

Topography in the vicinity of the site is shown on the attached Figure 3. The site is situated on a gently undulating broad terrace approximately 1,000 feet north-northeast of the East Fork Lewis River at an elevation of 108 feet above mean sea level (MSL). The terrace trends to the southeast in the vicinity of the property. Above the site the slope ascends to the northwest at a gradient of 9 horizontal to 1 vertical (9H:1V). Below the site, slope gradients are generally flatter than 20H:1V. Site topography observed during our reconnaissance is discussed in detail in Section 5.1 below.

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1 Moses, Lynn, 2002. The Geology of Washington State: Washington State Department of Natural Resource.
2 Allen, John Eliot, Burns, Marjorie, and Burns, Scott, 2009. Cataclysms on the Columbia, The Great Missoula Floods, Revised Second Edition: Ooligan Press, Portland State University.
3 Schuster, J., Eric, 2002. Geologic Map of Washington: Washington State Department of Natural Resources.
4 Evarts, R.C., Dinterman, Philip, and Block, Jessica, 2004, Geologic map of the Ridgefield quadrangle, Clark and Cowlitz Counties, Washington: U.S. Geological Survey, Scientific Investigations Map SIM-2844, scale 1:24,000.
5 Allen, John Eliot, et al., 2009. Cataclysms on the Columbia, The Great Missoula Floods, Revised Second Edition: Ooligan Press, Portland State University.

4.0 HAZARDS

4.1 Landslides

Landsliding is a common hazard in the Pacific Northwest that can be initiated on marginally stable slopes by human disturbances such as grading and deforestation, and by natural processes including earthquake shaking, volcanism, heavy rainfalls, and rapid snow melt. Recent studies indicate that the most common causes for slope failures are intense rainfall and human alteration, including the placement of building loads on slopes, excavating or over-steepening slopes, and the infiltration or diversion of storm water runoff. For example, excavation into the base of marginally stable slopes may reduce forces resisting failure on those slopes, thus causing movement. Adding fill and/or a structure to the top or mid portion of a slope increases the driving forces on a slope and may contribute to failure. Redirecting water onto or into slopes may exploit existing planes of weakness within those slopes, causing failure.

The Clark County Property Information Center[6] shows a small portion of the southeast portion of the site within an Area of Potential Instability (landslide hazard area). The site and landslide hazard area are shown on the attached Figure 4. The landslide hazard zone was assigned based on topography (slope gradient). As shown on Figure 4, the area of proposed development is not located within this zone. In addition, as described in Section 5.1 below, the maximum gradient observed in the southeast portion of the site was about 5H:1V, and no signs of instability or past landsliding were noted.

Review of the Washington State Geologic Information Portal[7], indicates that no landslides are mapped on or in the immediate vicinity the site. Two small landslide masses are located about 1,000 feet to the west and southeast, respectively. These landslide masses are located on slopes adjacent to the East Fork Lewis River, and are likely the result of stream bank erosion. These slides are considered remote to the site and have no impact on stability at the site.

We also reviewed Light Detection and Ranging (lidar) data and imagery available from the Washington State Department of Natural Resources Division of Geology and Earth Resources on the Washington Lidar Portal (WLP). WLP provides contours and bare earth imagery, which has been filtered to remove foliage and buildings. The lidar data portray the topography at a much greater level of detail than traditional mapping methods, and can reveal features that are otherwise difficult to ascertain. In areas where human activity has modified the topography extensively, such as through road-building and general grading, the resulting "background noise" can mask features that might otherwise be apparent. The lidar data shows previous grading in the vicinity of the site consisted of minor cuts and fills, particularly in the commercial properties southeast of the site. Based on our review of the lidar data, we did not observe any obvious signs of previous landslides at or in the immediate vicinity of the site. A portion of the lidar map showing the area of the site is presented as Figure 3.

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[6] Clark County Information Center, 2020, Steep Slope and Landslide Hazards Map, Clark County, Washington, *accessed December 2020*, from Clark County website: https://gis.clark.wa.gov/mapsonline/.

[7] Washington State Department of Natural Resources, 2020. Washington State Geologic Information Portal, *accessed December 2020,* from Washington State DNR website: https://geologyportal-qa.dnr.wa.gov/.

4.2 Erosion

The Clark County Property Information Center[8] does not show that the site is within an area mapped as a severe erosion hazard. Erosion hazards are characterized as the breakdown, transport, and redistribution of sediment by forces of water, wind, and/or gravity. These areas are identified by the United States Department of Agriculture-Natural Resources Conservation Service (USDA-NRCS) as having moderate to very severe rill and inter-rill erosive hazards. Based on the overall moderate gradient and vegetation onsite, we conclude the erosion hazard is very low.

5.0 SITE RECONNAISSANCE

Melissa Lehman, GIT, under supervision of CGT Senior Engineering Geologist Ryan Houser, LG, LEG, performed a reconnaissance of the site on November 30, 2020.

5.1 Surface Conditions

5.1.1 On Site

The proposed site layout and conditions are shown on the attached Site Plan (Figure 5) and Site Photographs (Figure 6).

The approximate 0.23-acre site was bordered by West E Avenue to the west, developed residential properties to the north and south, and a vacant lot to the east. The site was vegetated with grasses and scattered trees. The site was not occupied by any structures or previous development at the time of our site visit.

The site descended to the southeast below West E Avenue at gradients ranging from about 8H:1V near the street to about 5H:1V near the southeast corner of the property. Topography of the site is shown on the Site Plan (Figure 5) and Site Topographic Profile (Figure 7).

No indicators of recent or ongoing slope instability were observed on the site during the reconnaissance.

5.1.2 Area Conditions

The site was observed from publically accessible areas from all cardinal directions of the site. The neighborhood where the site was located generally descended gradually to the southeast toward a commercial parking lot. No abrupt cuts were noted upslope or downslope of the site.

5.2 Site Subsurface Conditions

5.2.1 Subsurface Investigation

Our subsurface investigation consisted of two hand auger borings (HA-1 and HA-2) completed on November 30, 2020. The approximate exploration locations are shown on the Site Plan, attached as Figure 5. In summary, the borings were advanced to depths of 5 feet bgs. Details regarding the subsurface investigation, logs of the explorations are presented in Appendix A. Subsurface conditions encountered during our investigation are summarized below.

[8] Clark County Information Center, 2020, Environmental Hazards Map, Clark County, Washington, *accessed December 2020*, from Clark County website: https://gis.clark.wa.gov/mapsonline/.

5.2.2 Subsurface Materials

Logs of the explorations are presented in Appendix A. The following describes each of the subsurface materials encountered at the site.

Organic Soil (OL)
Organic soil was encountered at the surface of both borings and extended to approximately ½ foot bgs. The soil was generally dark brown, moist, exhibited low plasticity, and included abundant rootlets.

Lean Clay (CL)
Lean clay was encountered below the organic soil in both hand auger borings and extended to the full depths explored in both borings, approximately 5 feet bgs. The clay was generally medium stiff, brown, moist to wet, exhibited medium plasticity, and included some fine-grained sand.

The soils encountered during our subsurface investigation were consistent with the fine-grained Missoula Flood deposits described in Section 2.2.

5.2.3 Groundwater

Minor groundwater seepage was noted at 1 and 1½ feet bgs within the hand auger borings on November 30, 2020. We researched available well logs located within Section 3, Township 4 North, Range 1 East on the Washington Department of Ecology (WDE)[9] website. Our review indicated that groundwater levels in the area generally ranged from about 30 to 45 feet bgs. It should be noted that groundwater levels vary with local topography. In addition, the groundwater levels reported on the WDE logs often reflect the purpose of the well, so water well logs may only report deeper, confined groundwater, while geotechnical or environmental borings will often report any groundwater encountered, including shallow, unconfined groundwater. Therefore, the levels reported on the WDE well logs referenced above are considered generally indicative of local water levels and may not reflect actual groundwater levels at the project site.

It is our opinion that the groundwater seepage noted within the borings represents a “perched” groundwater condition, since the on-site, lean clay has a low transmissivity and is conducive to formation of perched groundwater.

6.0 FINDINGS & RECOMMENDATIONS

The Clark Regional Emergency Services Agency (CRESA)[10] shows a small portion of the southeast portion of the site within a potential landslide hazard area, where slopes exceed 15 percent. We did not observe signs of previous or ongoing instability during our reconnaissance of the site or surrounding areas. As described in Section 1.1, the proposed development will include construction of a new, two-story, single-family residence. The new residence will be constructed at-grade with no subsurface (basement) levels.

We anticipate that with proper construction control, the geology and topography of the site and the surrounding area will not adversely affect the proposed project, and the project will have no impact on the

[9] Washington State Department of Ecology, 2020. Well Log Records, *accessed November 2020*, from web site: https://fortress.wa.gov/ecy/waterresources/map/WCLSWebMap/textsearch.aspx

[10] Clark Regional Emergency Services Agency, 2020, Hazard Maps, Clark County, Washington, *accessed December 2020*, from CRESA website: https:// http://cresa911.org/emergency-management/mitigation/hazard-maps/

stability of adjacent properties. It is our opinion that, with the use of generally accepted construction techniques and by strictly following the recommendations contained in this report and in the building code, the site is geologically suitable for the proposed development.

Any construction within hillside areas inherently bears greater risk of slope instability. The on-site and off-site slopes may be susceptible to slope instability resulting from factors beyond the owner's control, such as off-site grading, erosion and other ground disturbance, a major earthquake, or heavy precipitation. The owners must recognize and accept the risk of potential slope instability from causes beyond their control or as yet unrecognized.

In no case should surface runoff or discharge from drains be directed onto the site slopes. The ground surface adjacent to the building should be sloped to drain away from the building and surface runoff should be collected and routed to a suitable discharge point. Surface water should not be directed into foundation drains. Surface and any subsurface drains should be connected to the nearest storm drain or other suitable discharge point.

7.0 LIMITATIONS

The scope of this assignment did not include services related to geotechnical engineering for the proposed development such as bearing capacity evaluation, settlement estimates, recommendations regarding stripping and filling, or the use of footing/floor slab drains, etc. Additionally, quantitative soil or rock slope stability analyses was not performed. Our recommendations are not intended to indicate that all geologic hazards can be mitigated by proper engineering. They are provided in order to assist the project engineer in evaluating site conditions based on geologic research and preliminary, site specific, surface and shallow subsurface exploration. If you would like CGT to provide geotechnical recommendations or geotechnical construction observations during site construction, we can prepare a geotechnical report for the site for an additional fee.

We have prepared this report for use by the owner/developer and other members of the design and construction team for the proposed development. The opinions and recommendations contained within this report are not intended to be, nor should they be construed as, a warranty of subsurface conditions, but are forwarded to assist in the planning and design process.

This site evaluation consisted of visual examinations of exposed soil conditions within shallow excavations and a review of readily available geologic resources judged pertinent to the evaluation. Accordingly, the limitations of the site evaluation must be recognized. An exploration of subsurface conditions at depth was not conducted for this evaluation. An investigation to explore subsurface conditions at depth using deeper soil borings or excavations could be conducted at additional cost to the owner to further define the risk of unforeseen, adverse geological issues on this site. However, based on our observations and the information available, the risk of unforeseen adverse geological issues on this site appear to be small and could, in our opinion, be assumed by the owner.

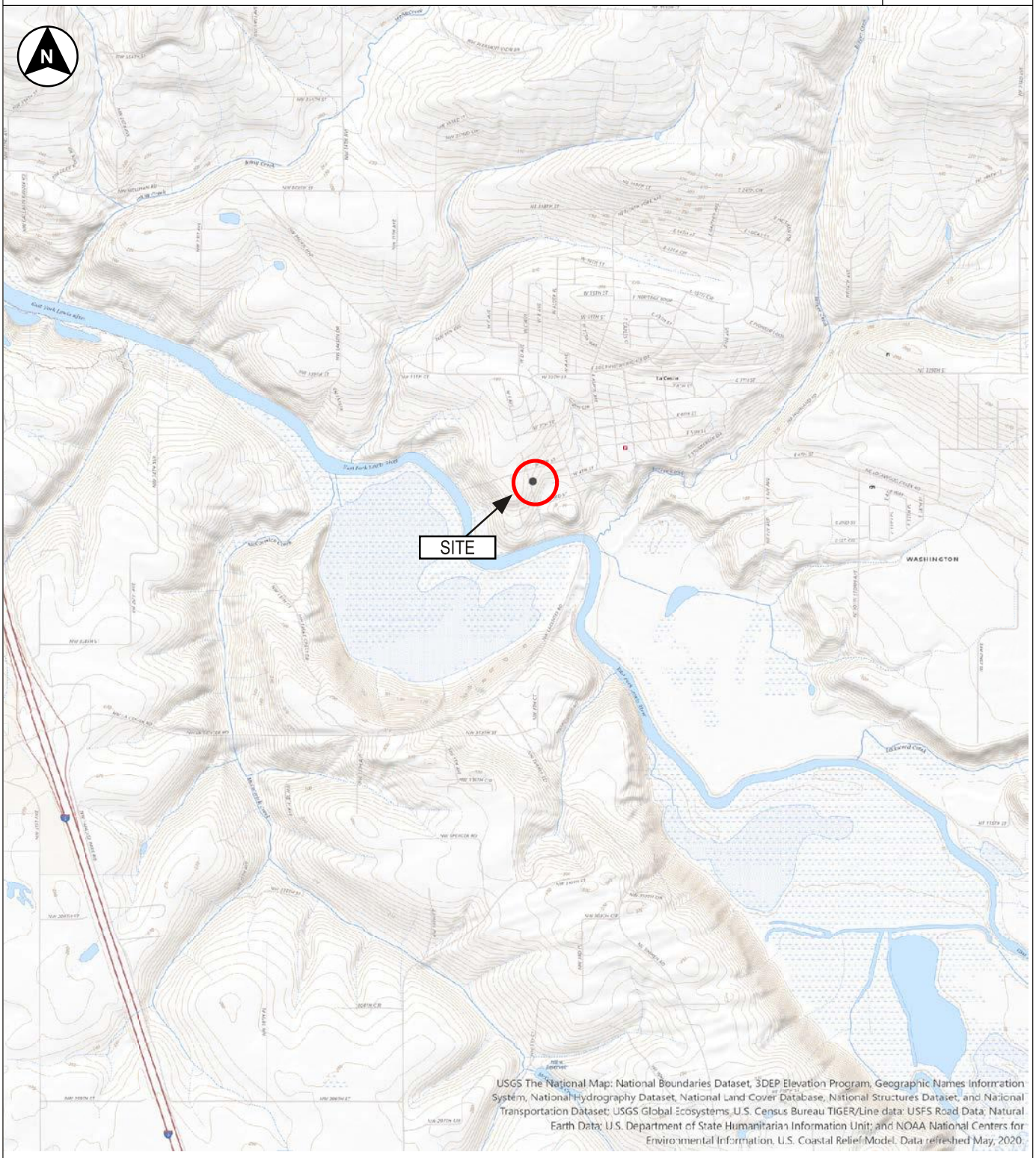
We have made observations based on our explorations that indicate the soil conditions at only those specific locations and only to the depths penetrated. These observations do not necessarily reflect soil types, strata thickness, or water level variations that may exist between or away from the explorations. If subsurface conditions vary from those encountered in our site exploration, CGT should be alerted to the change in

conditions so that we may provide additional recommendations, if necessary. Observation by experienced geotechnical personnel should be considered an integral part of the construction process. The owner/developer is responsible for insuring that the project designers and contractors implement our recommendations.

Within the limitations of scope, schedule, and budget, our services have been executed in accordance with the generally accepted practices in this area at the time this report was prepared. No warranty or other conditions, expressed or implied, should be understood. This report is subject to review and should not be relied upon after a period of three years.

MILLER RESIDENCE - LA CENTER, WASHINGTON
Project Number G2005397

FIGURE 1
Site Location



CARLSON CGT GEOTECHNICAL
503-601-8250
Drafted by: MLL

USGS Topographic base map created with The National Map, 2020, at https://viewer.nationalmap.gov/advanced-viewer/

Township 4 North, Range 1 East, Section 3, Willamette Meridian

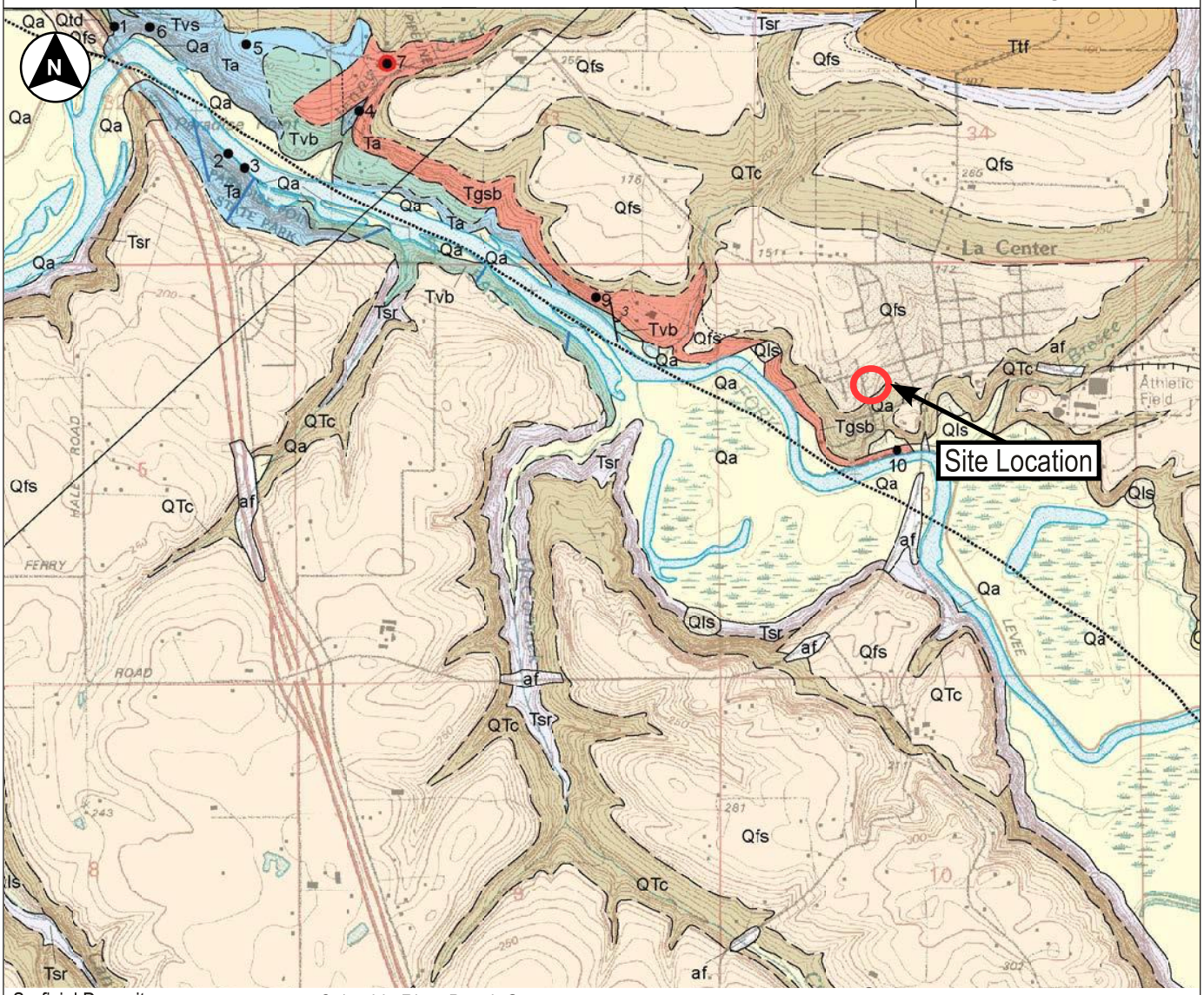
Latitude: 45.861879° North
Longitude: 122.674906° West

1 Inch = 2,000 feet

0 2000 4000

MILLER RESIDENCE - LA CENTER, WASHINGTON
Project Number G2005397

FIGURE 2
Geologic Map



Surficial Deposits

- af — Artificial fill
- Qa — Alluvium deposits
- Qoa — Older alluvium deposits
- Qls — Landslide deposits
- Ql — Lake deposits
- Qfs — Cataclysmic-flood deposits
- Qtd — Terrace deposits

Basin-Fill Deposits

- QTc — Conglomerate
- Ttf — Troutdale formation
- Tsr — Sandy River Mudstone

Columbia River Basalt Group

- Tgsb — Member of Sentinel Bluffs

Bedrock

- Ta — Andesite
- Tvb — Volcanic breccia

Contact—Dashed where approximately located; short-dashed where inferred; dotted where concealed

Fault—Dashed where inferred; dotted where concealed

Anticline—Dashed where inferred; dotted where concealed

Strike and dip of beds
Inclined
Horizontal

Terrace scarp

Sample locality for chemical analysis—See table 1

Glacial erratic

Oil well

Sample locality for paleomagnetic measurement

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Map adapted from Evarts, R.C., 2004, Geologic Map of the Ridgefield Quadrangle, Clark and Cowlitz Counties, Washington: U.S. Geological Survey, Scientific Investigation Map SIM-2844

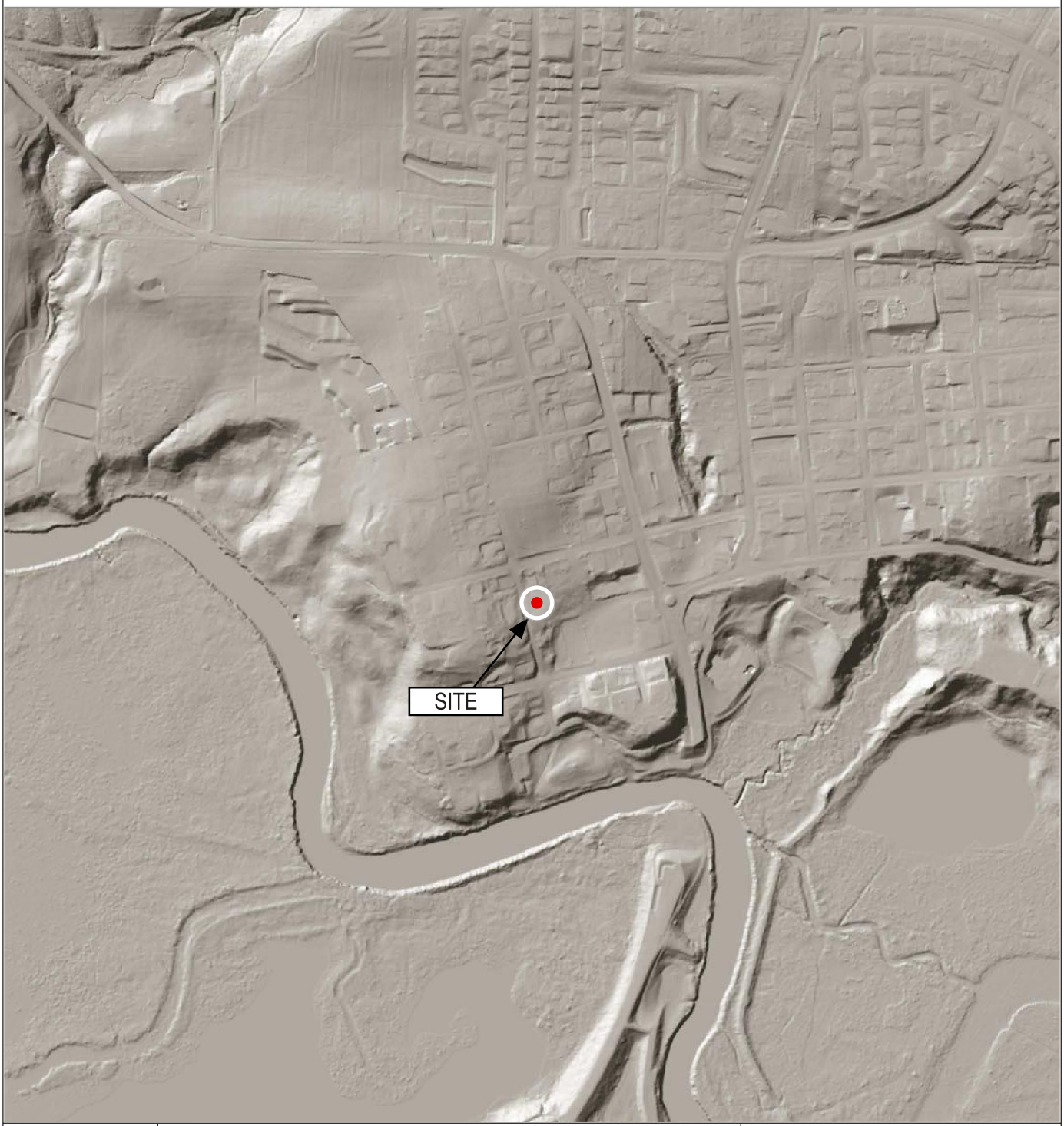
Township 4 North, Range 1 East, Section 3 Willamette Meridian

Latitude: 45.861879° North
Longitude: 122.674906° West

1 Inch = 2,000 feet

0 2000 4000

MILLER RESIDENCE - LA CENTER, WASHINGTON *Project Number G2005397*	**FIGURE 3** **Local Topography**



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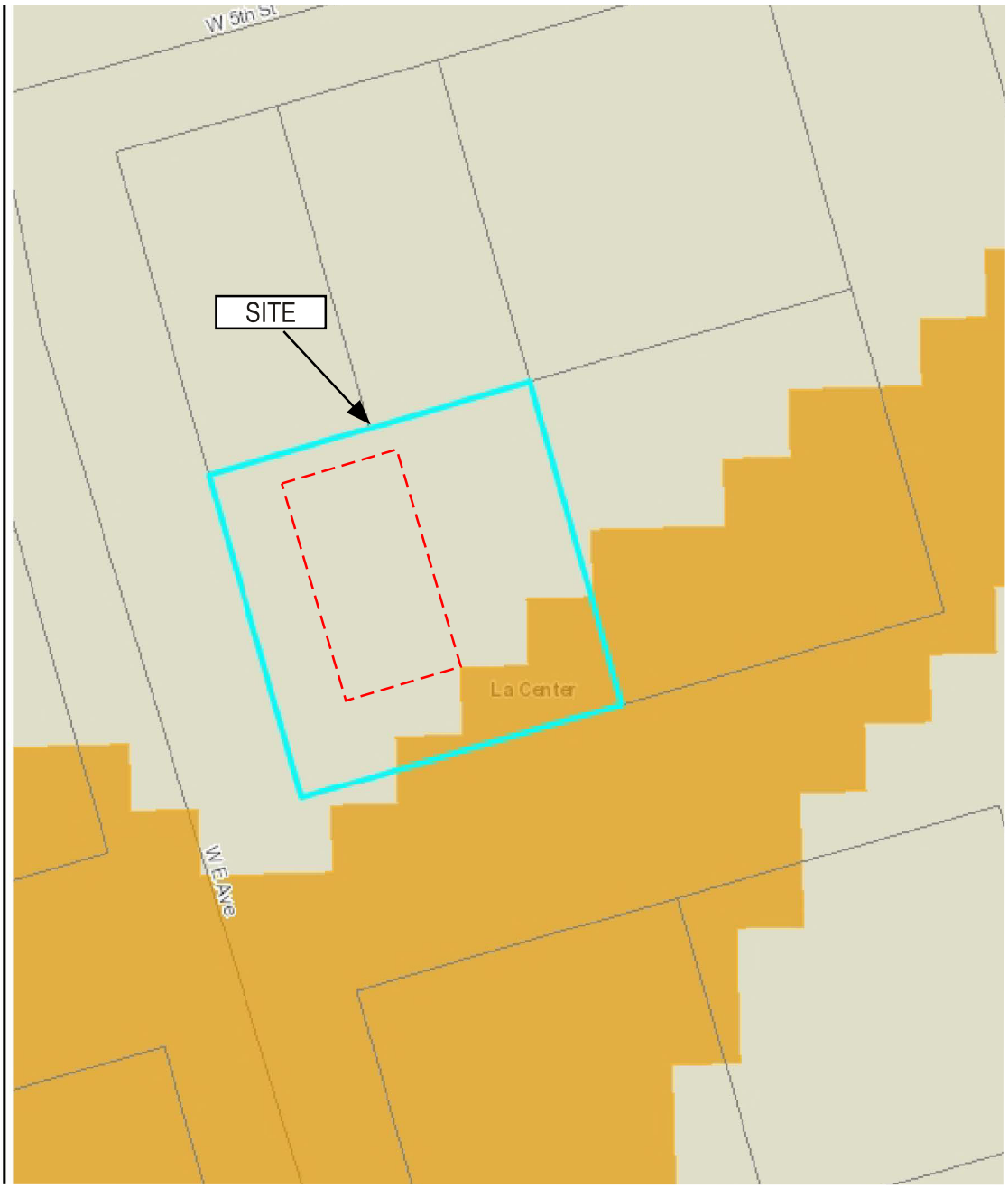
NOTES: Bare Earth Lidar Hillshade mapping obtained from Washington State Department of Natural Resources, 2020. Washington State Geologic Information Portal, accessed November 2020, from Washington State DNR website: https://geologyportal-qa.dnr.wa.gov/

Latitude: 45.861879° North
Longitude: 122.674906° West

1 Inch = 600 Feet

0 600 1,200

MILLER RESIDENCE - LA CENTER, WASHINGTON *Project Number G2005397*	**FIGURE 4** **Steep Slopes and Landslide Hazards Overlay**



LEGEND

Areas of Potential Instability

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Map adapted from Clark County Property Information Center, Environmental Hazards Map, accessed December 2020, https://gis.clark.wa.gov/mapsonline/

Latitude: 45.861879° North
Longitude: 122.674906° West

1 Inch = 50 feet

0 50 100

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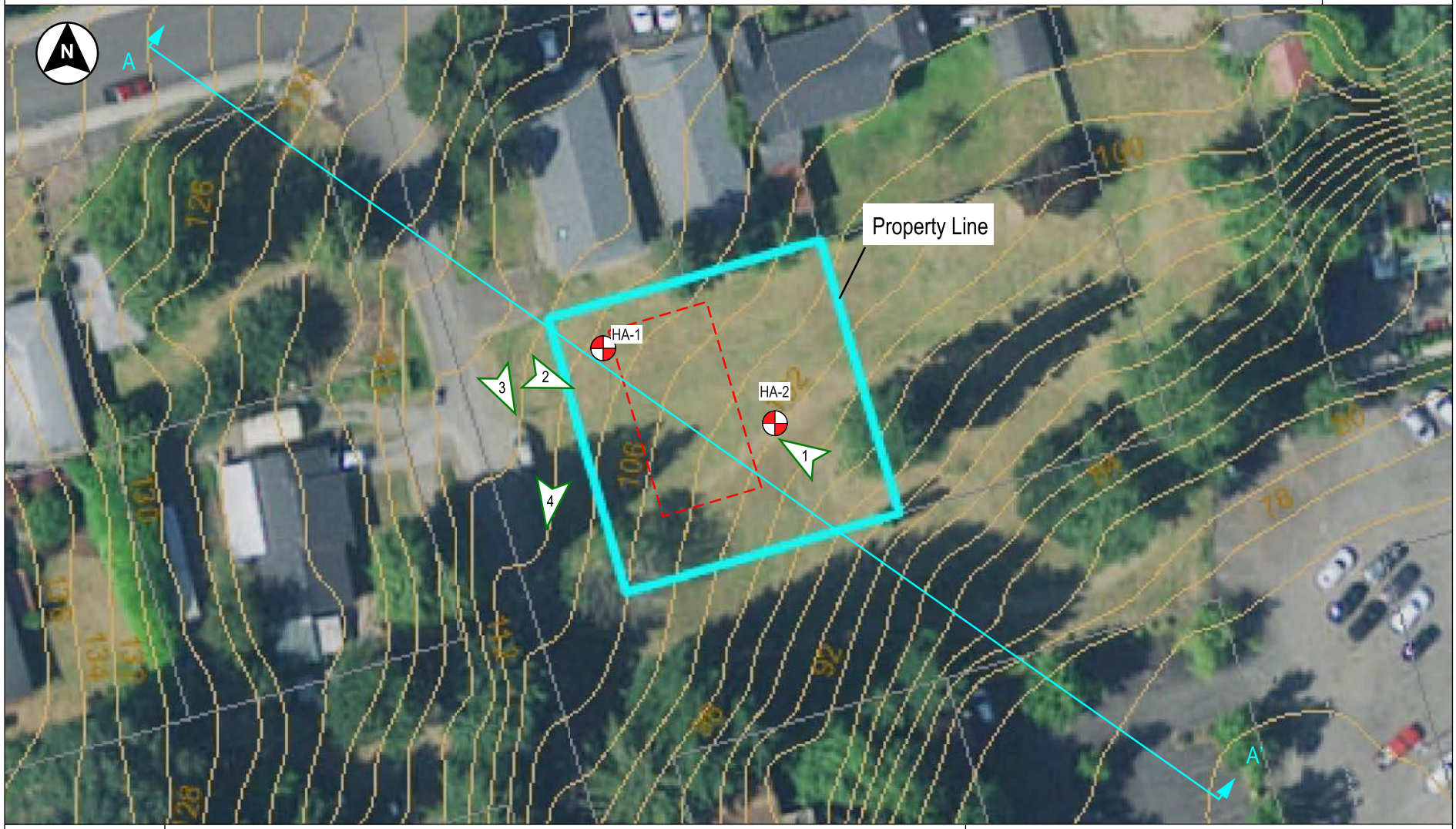
Project Number G2005397

FIGURE 5
Site Plan



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503-601-8250

Drafted by: MLL

LEGEND

HA-1 Hand auger boring

1 Orientation of site photographs shown on Figure 9

A A' Location of cross section shown on Figure 10

Proposed residence location

1 Inch = 50 Feet

0 50 100

NOTES: 2019 aerial photograph, contours and property lines from Clark County Washington Geographical Information Services data, accessed November 2020, from website: http://gis.clark.wa.gov. Exploration locations are approximate.

FIGURE 6
Site Photographs

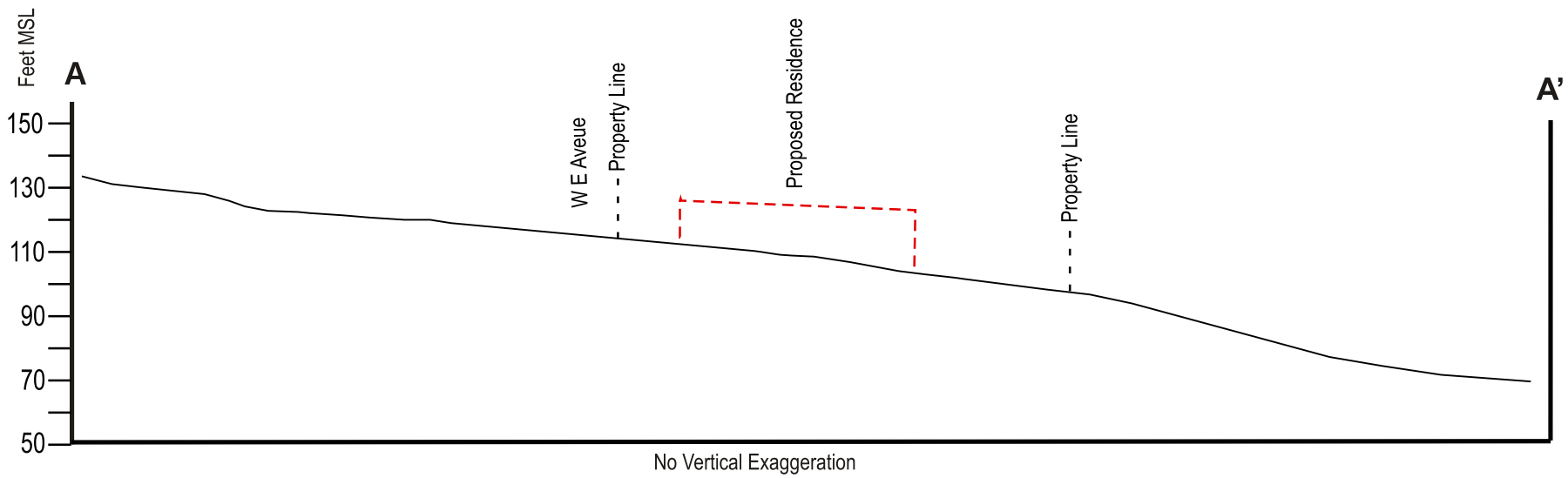
Photograph 1

Photograph 2

Photograph 3

Photograph 4

See Figure 8 for approximate photograph locations and directions. Photographs were taken at the time of our fieldwork.



1 Inch = 50 Feet

0 50 100

Note: Existing topography from Figure 5

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FIGURE 7

Topographic Profile

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Appendix A: Subsurface Investigation

Miller Residence
East of 410 W E Avenue
La Center, Washington

CGT Project Number G2005397

December 9, 2020

Prepared For:

Brandon Miller
2805 E 27th Street
Vancouver, Washington 98661

Prepared by
Carlson Geotechnical

A.1.0 SUBSURFACE INVESTIGATION

Our field investigation consisted of two hand auger borings completed in November 2020. The exploration locations are shown on the Site Plan, attached to the engineering geologic report as Figure 5. The exploration locations shown therein were determined based on measurements from existing site features (roadways, property boundaries, etc.) and are approximate. Surface elevations indicated on the logs were estimated based on the topographic contours shown on the referenced Site Plan and are approximate. The attached figures detail the exploration methods (Figure A1), soil classification criteria (Figure A2), and present detailed logs of the explorations (Figures A3 and A4), as discussed below.

A.1.1 Hand Auger Borings

CGT advanced two hand auger borings (HA-1 and HA-2) at the site on November 30, 2020, to depths of 5 feet bgs using equipment provided and operated by CGT. The hand auger borings were loosely backfilled with the excavated materials upon completion.

A.1.2 Material Classification & Sampling

Representative grab samples of the soils encountered were obtained at select intervals within the hand auger borings. A qualified member of CGT's geological staff collected the samples and logged the soils in general accordance with the Visual-Manual Procedure (ASTM D2488). An explanation of this classification system is attached as Figure A2. The grab samples were stored in sealable plastic bags and transported to our soils laboratory for further examination. Our geotechnical staff visually examined all samples in order to refine the initial field classifications.

A.1.3 Subsurface Conditions

Subsurface conditions are summarized in Section 5.2 of the engineering geologic report. Detailed logs of the explorations are presented on the attached exploration logs, Figures A3 and A4.

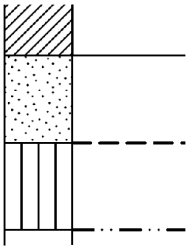
MILLER RESIDENCE - LA CENTER, WASHINGTON Project Number G2005397	FIGURE A1 Exploration Key

PL — LL MC	Atterberg limits (plasticity) test results (ASTM D4318): PL = Plastic Limit, LL = Liquid Limit, and MC= Moisture Content (ASTM D2216)
☐ FINES CONTENT (%)	Percentage passing the U.S. Standard No. 200 Sieve (ASTM D1140)

SAMPLING

GRAB	Grab sample
BULK	Bulk sample
SPT	**Standard Penetration Test** (SPT) consists of driving a 2-inch, outside-diameter, split-spoon sampler into the undisturbed formation with repeated blows of a 140-pound, hammer falling a vertical distance of 30 inches (ASTM D1586). The number of blows (N-value) required to drive the sampler the last 12 inches of an 18-inch sample interval is used to characterize the soil consistency or relative density. The drill rig was equipped with an cat-head or automatic hammer to conduct the SPTs. The observed N-values, hammer efficiency, and N_{60} are noted on the boring logs.
MC	**Modified California** sampling consists of 3-inch, outside-diameter, split-spoon sampler (ASTM G3550) driven similarly to the SPT sampling method described above. A sampler diameter correction factor of 0.44 is applied to calculate the equivalent SPT N_{60} value per Lacroix and Horn, 1973.
CORE	**Rock Coring** interval
SH	**Shelby Tube** is a 3-inch, inner-diameter, thin-walled, steel tube push sampler (ASTM D1587) used to collect relatively undisturbed samples of fine-grained soils.
WDCP	**Wildcat Dynamic Cone Penetrometer** (WDCP) test consists of driving 1.1-inch diameter, steel rods with a 1.4-inch diameter, cone tip into the ground using a 35-pound drop hammer with a 15-inch free-fall height. The number of blows required to drive the steel rods is recorded for each 10 centimeters (3.94 inches) of penetration. The blow count for each interval is then converted to the corresponding SPT N_{60} values.
DCP	**Dynamic Cone Penetrometer** (DCP) test consists of driving a 20-millimeter diameter, hardened steel cone on 16-millimeter diameter steel rods into the ground using a 10-kilogram drop hammer with a 460-millimeter free-fall height. The depth of penetration in millimeters is recorded for each drop of the hammer.
POCKET PEN. (tsf)	**Pocket Penetrometer** test is a hand-held instrument that provides an approximation of the unconfined compressive strength in tons per square foot (tsf) of cohesive, fine-grained soils.

CONTACTS



Observed (measured) contact between soil or rock units.

Inferred (approximate) contact between soil or rock units.

Transitional (gradational) contact between soil or rock units.

ADDITIONAL NOTATIONS

Italics	Notes drilling action or digging effort
{ Braces }	Interpretation of material origin/geologic formation (e.g. { Base Rock } or { Columbia River Basalt })

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All measurements are approximate.

MILLER RESIDENCE - LA CENTER, WASHINGTON
Project Number G2005397

FIGURE A2
Soil Classification

Classification of Terms and Content

NAME: Group Name and Symbol
Relative Density or Consistency
Color
Moisture Content
Plasticity
Other Constituents
Other: Grain Shape, Approximate Gradation
Organics, Cement, Structure, Odor, etc.
Geologic Name or Formation

Grain Size

		U.S. Standard Sieve
Fines		<#200 (0.075 mm)
Sand	Fine	#200 - #40 (0.425 mm)
	Medium	#40 - #10 (2 mm)
	Coarse	#10 - #4 (4.75 mm)
Gravel	Fine	#4 - 0.75 inch
	Coarse	0.75 inch - 3 inches
Cobbles		3 to 12 inches
Boulders		> 12 inches

Coarse-Grained (Granular) Soils

Relative Density

SPT N_{60}-Value	Density
0 - 4	Very Loose
4 - 10	Loose
10 - 30	Medium Dense
30 - 50	Dense
>50	Very Dense

Minor Constituents

Percent by Volume	Descriptor	Example
0 - 5%	"Trace" as part of soil description	"trace silt"
5 - 15%	"With" as part of group name	"**POORLY GRADED SAND WITH SILT**"
15 - 49%	Modifier to group name	"**SILTY SAND**"

Fine-Grained (Cohesive) Soils

SPT N_{60}-Value	Torvane tsf Shear Strength	Pocket Pen tsf Unconfined	Consistency	Manual Penetration Test
<2	<0.13	<0.25	Very Soft	Thumb penetrates more than 1 inch
2 - 4	0.13 - 0.25	0.25 - 0.50	Soft	Thumb penetrates about 1 inch
4 - 8	0.25 - 0.50	0.50 - 1.00	Medium Stiff	Thumb penetrates about ¼ inch
8 - 15	0.50 - 1.00	1.00 - 2.00	Stiff	Thumb penetrates less than ¼ inch
15 - 30	1.00 - 2.00	2.00 - 4.00	Very Stiff	Readily indented by thumbnail
>30	>2.00	>4.00	Hard	Difficult to indent by thumbnail

Minor Constituents

Percent by Volume	Descriptor	Example
0 - 5%	"Trace" as part of soil description	"trace fine-grained sand"
5 - 15%	"Some" as part of soil description	"some fine-grained sand"
15 - 30%	"With" as part of group name	"**SILT WITH SAND**"
30 - 49%	Modifier to group name	"**SANDY SILT**"

Moisture Content

Dry: Absence of moisture, dusty, dry to the touch
Moist: Leaves moisture on hand
Wet: Visible free water, likely from below water table

	Plasticity	Dry Strength	Dilatancy	Toughness
ML	Non to Low	Non to Low	Slow to Rapid	Low, can't roll
CL	Low to Medium	Medium to High	None to Slow	Medium
MH	Medium to High	Low to Medium	None to Slow	Low to Medium
CH	Medium to High	High to Very High	None	High

Structure

Stratified: Alternating layers of material or color >6 mm thick
Laminated: Alternating layers < 6 mm thick
Fissured: Breaks along definite fracture planes
Slickensided: Striated, polished, or glossy fracture planes
Blocky: Cohesive soil that can be broken down into small angular lumps which resist further breakdown
Lenses: Has small pockets of different soils, note thickness
Homogeneous: Same color and appearance throughout

Visual-Manual Classification

Major Divisions			Group Symbols	Typical Names
Coarse Grained Soils: More than 50% retained on No. 200 sieve	Gravels: 50% or more *retained* on the No. 4 sieve	Clean Gravels	GW	Well-graded gravels and gravel/sand mixtures, little or no fines
			GP	Poorly-graded gravels and gravel/sand mixtures, little or no fines
		Gravels with Fines	GM	Silty gravels, gravel/sand/silt mixtures
			GC	Clayey gravels, gravel/sand/clay mixtures
	Sands: More than 50% *passing* the No. 4 sieve	Clean Sands	SW	Well-graded sands and gravelly sands, little or no fines
			SP	Poorly-graded sands and gravelly sands, little or no fines
		Sands with Fines	SM	Silty sands, sand/silt mixtures
			SC	Clayey sands, sand/clay mixtures
Fine-Grained Soils: 50% or more Passes No. 200 Sieve	Silt and Clays Low Plasticity Fines		ML	Inorganic silts, rock flour, clayey silts
			CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, lean clays
			OL	Organic soil of low plasticity
	Silt and Clays High Plasticity Fines		MH	Inorganic silts, clayey silts
			CH	Inorganic clays of high plasticity, fat clays
			OH	Organic soil of medium to high plasticity
Highly Organic Soils			PT	Peat, muck, and other highly organic soils

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References:

ASTM D2487 Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System)
ASTM D2488 Standard Practice for Description and Identification of Soils (Visual-Manual Procedure)
Terzaghi, K., and Peck, R.B., 1948, Soil Mechanics in Engineering Practice, John Wiley & Sons.

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FIGURE A3
Boring HA-1

CLIENT Brandon Miller
PROJECT NAME Miller Residence
PROJECT NUMBER G2005397
PROJECT LOCATION East of 410 W E Avenue - La Center, Washington
DATE STARTED 11/30/20 **GROUND ELEVATION** 109 ft
ELEVATION DATUM See Figure 5
WEATHER ~45 degrees **SURFACE** grass
LOGGED BY MLL **REVIEWED BY** RTH
DRILLING CONTRACTOR CGT
SEEPAGE 1.0 ft / El. 108.0 ft
EQUIPMENT 3-inch diameter hand auger
GROUNDWATER DURING DRILLING ---
DRILLING METHOD Manual 3-inch diameter Hand Auger & WDCP
GROUNDWATER AFTER DRILLING ---

ELEVATION (ft)	GRAPHIC LOG	GROUP SYMBOL	MATERIAL DESCRIPTION	GROUNDWATER	DEPTH (ft)	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	WDCP N_{60} VALUE	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	▲ WDCP N_{60} VALUE ▲ PL LL MC ☐ FINES CONTENT (%) ☐ 0 20 40 60 80 100
		OL	**ORGANIC SOIL:** Dark brown, moist, low plasticity, abundant rootlets.		0						
108		CL	**LEAN CLAY:** *Medium stiff,* brown, moist to wet, medium plasticity. Brown with gray and orange mottling, some fine-grained sand below 1½ feet bgs.		2	GRAB 1	100				
106					4						
104											
102			• Boring terminated at 5 feet bgs. • Minor groundwater seepage noted at 1 foot bgs. • No caving encountered. • Loosely backfilled with excavated material upon completion.								
100											

CGT EXPLORATION WITH WDCP HAND AUGER LOGS.GPJ 12/9/20 DRAFTED BY: MLL

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FIGURE A4
Boring HA-2

CLIENT Brandon Miller
PROJECT NAME Miller Residence
PROJECT NUMBER G2005397
PROJECT LOCATION East of 410 W E Avenue - La Center, Washington
DATE STARTED 11/30/20 **GROUND ELEVATION** 102 ft
ELEVATION DATUM See Figure 5
WEATHER ~45 degrees **SURFACE** grass
LOGGED BY MLL **REVIEWED BY** RTH
DRILLING CONTRACTOR CGT
SEEPAGE 1.5 ft / El. 100.5 ft
EQUIPMENT 3-inch diameter hand auger
GROUNDWATER DURING DRILLING ---
DRILLING METHOD Manual 3-inch diameter Hand Auger & WDCP
GROUNDWATER AFTER DRILLING ---

ELEVATION (ft)	GRAPHIC LOG	GROUP SYMBOL	MATERIAL DESCRIPTION	GROUNDWATER	DEPTH (ft)	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	WDCP N_{60} VALUE	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	▲ WDCP N_{60} VALUE ▲ PL LL MC ☐ FINES CONTENT (%) ☐ 0 20 40 60 80 100
		OL	**ORGANIC SOIL:** Dark brown, moist, low plasticity, abundant rootlets.		0						
			LEAN CLAY: *Medium stiff,* brown, moist to wet, medium plasticity.	≈							
100			Brown with gray and orange mottling, some fine-grained sand below 1¾ feet bgs.		2						
		CL									
98					4						
96											
94											
92											

- Boring terminated at 5 feet bgs.
- Minor groundwater seepage noted at 1½ feet bgs.
- No caving encountered.
- Loosely backfilled with excavated material upon completion.

CGT EXPLORATION WITH WDCP HAND AUGER LOGS.GPJ 12/9/20 DRAFTED BY: MLL