HARDMAN GEOTECHNICAL SERVICES INC.
Practical, Cost-Effective Geotechnical Solutions

March 30, 2016
Project No. 16-1957

Victor Remmers / Bruce Howard
Everett Custom Homes
735 SW 158th Avenue
Beaverton, Oregon 97006

Copy: Keith Buisman / Mike Peebles, Otak

Subject: **Landslide Hazard Study**
5920 SW 48th Avenue Subdivision
Portland, Oregon

References:
1. *Geotechnical Engineering Report, 5920 SW 48th Avenue, Portland, Oregon*; Hardman Geotechnical Services Inc., report dated March 2, 2016.
2. *Landslide Hazard Assessment – Residential Development, 5920 SW 48th Avenue Subdivision, Portland, Oregon*; report by John E. Jenkins GeoConsulting PC, dated March 28, 2016 [Copy Attached].

As requested, Hardman Geotechnical Services Inc. (HGSI) performed a landslide hazard study for the property at 5920 SW 48th Avenue in Portland, Oregon (Figure 1). The purpose of this study is to evaluate the potential for landslides or other slope stability hazards to impact the site, in accordance with City of Portland requirements for a Landslide Hazard Study. The requirement for this study is a result of the site being within a mapped Potential Landslide Hazard Zone, as defined by City of Portland.

Results of the landslide hazard study are summarized below. This study was conducted in conjunction with John E. Jenkins GeoConsulting PC (JEJG). Mr. Jenkins is a Certified Engineering Geologist, and the JEJG report (Reference 2; attached) has his CEG stamp affixed as required by City of Portland.

HGSI previously conducted a geotechnical engineering study for the site (Reference 1).

SITE AND PROJECT DESCRIPTION

The site is approximately 2.31 acres in size, rectangular in shape, and is currently occupied by a residential home that is planned to be removed (Figure 2). The site slopes moderately to the south west with a heavily sloped area on the southeast edge of the property. Vegetation around the site consists of many trees and bushes.

The proposed development includes subdividing the property to create 11 lots for single family home construction. The southwest portion of the site will be undeveloped to preserve a sensitive area. A new 300-foot long extension of SW Pendleton Street will provide access to Lots 4-11; the other lots will be accessed

off of the existing SW Pendleton Street. Underground utilities are also planned. We anticipate site development will consist of single family residential structures up to three stories in height.

FIELD EXPLORATION

On January 26, 2016, HGSI excavated six backhoe test pits, designated TP-1 through TP-6, and performed falling head infiltration tests. The tests were conducted using the open-hole method. Infiltration testing was performed at depths of 4, 7 and 9 feet below ground surface (bgs) in test pits TP-3, TP-4 and TP-5 respectively. Measured infiltration rates were 0.1 inch/hour at the test depths in TP-3 and TP-4. In TP-5 at 9 feet bgs an infiltration rate of 2.0 inches/hour resulted.

The test pits were excavated using a small excavator, at the approximate locations shown on the attached site plan (Figure 2). It should be noted that exploration locations were determined in the field by pacing or taping distances from apparent property corners and other site features shown on the plans provided and should therefore be considered approximate. During the exploration, HGSI observed and recorded pertinent soil information such as color, stratigraphy, strength, and soil moisture. Soils were classified in general accordance with the Unified Soil Classification System (USCS). At the completion of the test pit and infiltration testing, the excavation was backfilled using the excavated soils tamped into place.

SOIL CONDITIONS

Results of the exploration program indicate that the site is underlain by silt belonging to the Willamette Formation. The observed conditions and soil properties are summarized below.

Topsoil: In all test pits the ground surface was directly underlain by topsoil consisting of dark brown, moderately organic silt with fine roots throughout. Topsoil thickness in test pits was about 1 to 2 feet.

Silt: Beneath the topsoil in all test pits we encountered very stiff, brown mottled with orange and gray, slightly moist, Silt. These soils are interpreted as belonging to the Willamette Formation and extended to the termination of test pits TP-3 through TP-6

Clay: Below the silt unit in test pits TP-1 and TP-2 we encountered light brown, moist, clay; also interpreted as Willamette Formation materials. These soils extended to the termination of each test pit where encountered.

GROUNDWATER

At the time of our explorations, groundwater was not encountered beneath the site. Based on experience and interpolation of a nearby depth to ground water map (Snyder, 2008) we anticipate ground water to be present at a depth of about 40 feet below the existing ground surface at the site. In our experience, it is not uncommon to encounter thin perched groundwater zones within the Willamette Formation in this area, particularly during the wet season.

The groundwater conditions reported above are for the specific date and locations indicated, and therefore may not necessarily be indicative of other times and/or locations. Furthermore, it is anticipated that groundwater conditions will vary depending on the season, local subsurface conditions, changes in land use and other factors.

CONCLUSIONS AND RECOMMENDATIONS

For the purpose of evaluating slope stability, we reviewed published geologic and hazard mapping, reviewed regional site topography and LIDAR images, performed a field reconnaissance, and evaluated subsurface soil conditions in exploratory soil borings. Results of the geologic site reconnaissance and review of geologic maps and LIDAR data are presented in the attached JEJG report.

Reconnaissance observations indicate that slope geomorphology at the site is generally smooth and uniform, consistent with stable slope conditions. No geomorphic evidence of prior slope instability (such as hummocky topography, benches or old scarps) was observed. No seeps or springs were observed on site.

The planned development will involve cut and fill earthwork with anticipated cuts and fills up to about 5 feet deep/high maximum. Earthwork performed in accordance with the recommendations of the geotechnical report (Reference 1) is not anticipated to present a slope stability hazard. Final slope grades will be no steeper than 2H:1V (Horizontal:Vertical). Fill slopes will be keyed and benched into sloping ground per the geotechnical recommendations. With these provisions, and assuming adequate observation and testing are performed by HGSI during construction, it is our opinion that no special design or construction provisions are needed to address slope issues on the site. The project will be designed and constructed per current building codes, City of Portland requirements, and the current standard-of-practice in geotechnical engineering. As such, it is our opinion that adequate slope stability factors of safety will be maintained for both temporary construction, and long-term conditions.

We understand that the proposed storm water management plan may include a system of StormTech stormwater chambers, flow-through planters, pervious pavement and/or West Side Soakage Trenches. The planned storm water facilities are not anticipated to impact slope stability on site, or to create any unstable conditions on the site or adjacent properties.

UNCERTAINTIES AND LIMITATIONS

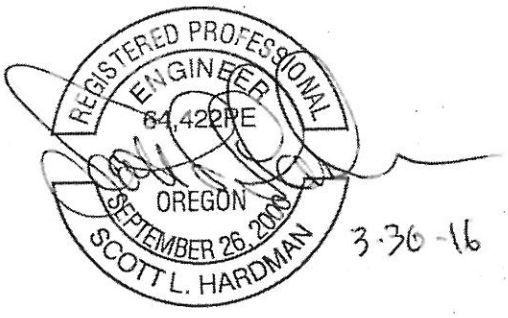
We have prepared this report for the owner and his/her consultants for use in design of this project only. The conclusions and interpretations presented in this report should not be construed as a warranty of the subsurface conditions. Experience has shown that soil and groundwater conditions can vary significantly over small distances. Inconsistent conditions can occur between explorations that may not be detected by a geotechnical study. If, during future site operations, subsurface conditions are encountered which vary appreciably from those described herein, HGSI should be notified for review of the recommendations of this report, and revision of such if necessary.

Within the limitations of scope, schedule and budget, HGSI executed these services in accordance with generally accepted professional principles and practices in the field of geotechnical engineering at the time the report was prepared. No warranty, expressed or implied, is made. The scope of our work did not include environmental assessments or evaluations regarding the presence or absence of wetlands or hazardous or toxic substances in the soil, surface water, or groundwater at this site.

We appreciate this opportunity to be of service.

Sincerely,

HARDMAN GEOTECHNICAL SERVICES INC.



3-30-16

EXPIRES: 06-30-20 17

Scott L. Hardman, P.E., G.E.
Principal Geotechnical Engineer

Attachments: Figure 2 – Site and Exploration Plan
Report by John E. Jenkins GeoConsulting PC, dated March 6, 2016

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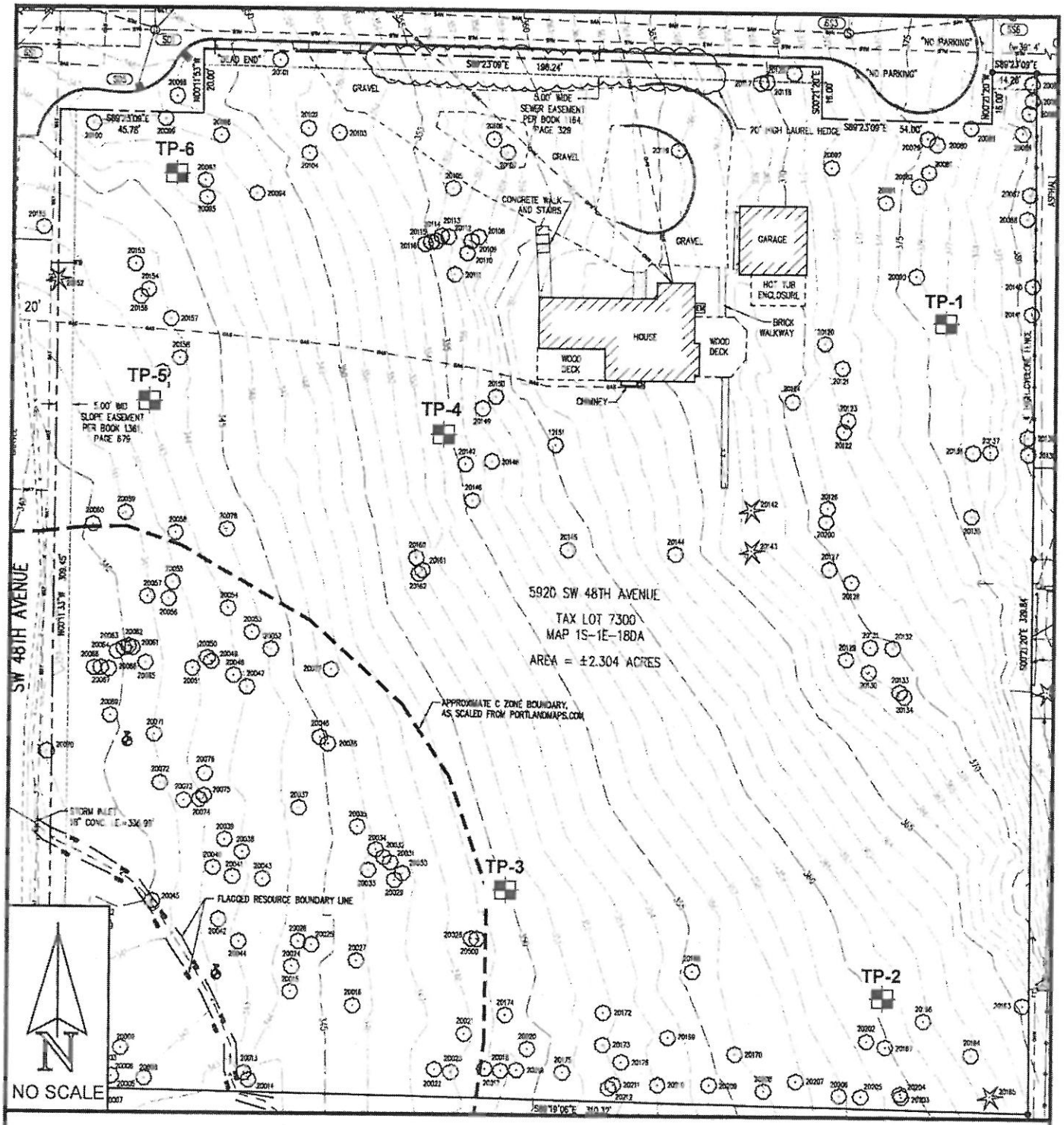
SITE AND EXPLORATION PLAN



Legend

TP-6 Test Pit Designation and Approximate Location

Base map provided by: Northwest Surveying Inc.

Project: 5920 SW 48th Ave Portland, Oregon	Project No. 16-1957	FIGURE 2

John E. Jenkins GeoConsulting
9260 SE Bachelor Dr. • Portland, OR 97086
Phone: 971-227-2542 • E-mail: Jenkins-John@comcast.net

March 28, 2016

Scott Hardman Geotechnical Services Inc.
10110 SW Nimbus Ave. Ste. B5
Portland, OR 97223

RE: Landslide Hazard Assessment – Residential Development, 5920 SW 48th Avenue Subdivision, Portland, OR

Dear Mr. Hardman,

As requested, John E. Jenkins GeoConsulting completed this landslide hazard assessment for the subject Site a planned subdivision on 2.31 acres at 5920 SW 48th Avenue, Portland, Oregon (see Figure 1 – Site Vicinity Map and Figure 2 – Lidar Hillshade Map). This assessment is required by the City of Portland as part of the permit process for development of the project Site.

Hardman Geotechnical Services Inc. (HGSI) performed a geotechnical study that included subsurface explorations and infiltration testing to evaluate storm water disposal (HGSI, 2016[1]). The location of the test pits by HGSI are indicated on a Site and Exploration Plan that shows topography, lot lines, trees, and other information (Attached – Figure 2 from HGSI, 2016).

PROJECT DESCRIPTION

The project Site is approximately 2.31 acres in area and rectangular. A home and a detached garage are present in the northeast part of the lot that will be removed for development. The Site slopes moderately to the southwest and is partly wooded.

The proposed development is to subdivide the property into 11 lots for construction of single family residential homes. As indicated on HGSI Figure 2 (attached) the southwest portion of the site will be undeveloped to preserve a sensitive area. The lots will be accessed from the existing SW Pendleton Street and an extension of that street. Underground utilities are also planned.

SITE GEOLOGY AND LANDSLIDE HAZARD MAPPING

The project Site is in the Tualatin Hills that are situated between the Portland Basin to the east and Tualatin River basin to the west. Based on regional geologic mapping Beeson, et. al., 1989[2] the area is underlain by sediments associated with volcanic bedrock units (Undifferentiated Sediments, Map unit Qts). As the local elevation is over 350 feet these sediments are correlated to the Portland Hills Silt a loess (wind deposited) type of deposit comprised of silt, clay and fine sand of Pliocene to Pleistocene age. The soil observed in the Site borings is correlated to the Portland Hills Silt unit.

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[1] Hardman Geotechnical Services Inc., March 2, 2016, Geotechnical Engineering Report, 5920 SW 48th Avenue Subdivision, Portland, OR; Letter report to Everett Custom Homes, Beaverton, OR; HGSI Project No. 16-1957.

[2] Beeson, M.H., Tolan, T.L. and Madin, I.P., 1989, Geologic map of the Lake Oswego quadrangle, Multnomah, Clackamas and Washington counties, Oregon and Clark County, Washington, Oregon Department of Geology and Mineral Industries, Geological Map Series 59, Scale 1:24,000

Volcanic bedrock in the region include the Boring Lava and Columbia River Basalt Group. The Boring Lava unit is a series of basaltic lava flows of Pliocene to Pleistocene age. These erupted from vents around Portland at locations within the Tualatin Hills and the Portland Basin to the east. Portland Hills Silt layers may be interbedded with Boring Lava flows. Older basalt flows of the Columbia River Basalt Group (Miocene-age) erupted from vents near the Oregon-Idaho-Washington border.

A northwest-southeast trending normal fault is mapped about one-half mile to the northeast of the Site. These and other nearby faults occur in the bedrock and are not considered seismogenic. Typically three major fault zones capable of generating damaging earthquakes are known to exist in the region. These include the Portland Hills Fault Zone, Gales Creek-Newberg-Mt. Angel Structural Zone, and the Cascadia Subduction Zone.

The Oregon Department of Geology and Mineral Industries (DOGAMI) maintain a data base of landslides in an online web service: Statewide Landslide Information Database for Oregon (SLIDO). The latest version of SLIDO (release 3.2) was viewed[3]. Mapped landslides are not shown on the Site or immediate site vicinity. The closest mapped landslide is approximately 2,400 feet to the northwest and located along the side slope of a northwest flowing creek, a tributary to Fanno Creek. That slide is characterized as a shallow complex earth slide and earth flow. Two other similar landslides are located approximately 2,600 and 3,300 feet from the Site to the northeast and southwest, respectively.

Subsurface Explorations

Subsurface soil conditions were investigated via six test pits by HGSI on January 26, 2015 at the locations shown on the attached Site and Exploration Plan Map (Figure 2 by HGSI, 2016). Test pit depths were between 4 and 9 feet below ground surface (bgs).

Logs of the test pits indicate a one to two foot thick surface topsoil layer consisting of very soft to medium stiff, dark brown, very moist, moderately organic Silt with fine roots was encountered in each location. This was underlain by stiff to very stiff or hard, slightly moist or moist, brown mottled orange and gray, Silt. The Silt unit was underlain by light brown, moist Clay below a depth of 8 feet to the depth explored of 9 feet in TP-1 and TP-2.

Groundwater and Infiltration Testing

Slight to moderate water seepage was observed from the topsoil zone at the time of exploration in test pits TP-2, TP-3, and TP-5. Heavier seepage was observed in TP-4. The underlying Silt and Clay soils were not wet or saturated and the seepage from the topsoil was believed to be due a heavy rain storm just prior to explorations (Ian Moore, HGSI; personal communication).

Perched groundwater conditions are often found in the Portland Hills Silt (PHS) where it overlies basaltic bedrock. A regional study by the U.S. Geological Survey (Snyder, 2008[4]) indicates the depth to groundwater beneath the site vicinity is approximately 40 feet. The ground slope and groundwater depths found indicate a probable westerly direction.

HGSI completed falling head infiltration tests using the stand pipe method in test pits TP-3, TP-4, and TP-5 at test depths of 4.0, 7.0, and 9.0 feet bgs, respectively. Prior to testing the soils were pre-saturated for several hours. The reported infiltration rates were 0.1 inches/hour for TP-3 and TP-4 and 2.0 inches/hour for TP-5.

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[3] Oregon Department of Geology and Mineral Industries. SLIDO viewed 03/25/2016: http://www.oregongeology.org/slido/

[4] Snyder, D.T., 2008, Estimated Depth to Ground Water and Configuration of the Water Table in the Portland, Oregon Area. U.S. Geological Survey Scientific Investigations Report 2008-5059, 41 p., 3 plates.

SITE RECONNASAINCE

Site reconnaissance was completed by the undersigned Oregon Certified Engineering Geologist on March 27, 2016. The ground slopes west to southwesterly at the Site at approximately 15 percent. Slopes in the southwestern conservation area are lower at approximately 7 percent. Slopes up to approximately 22 percent are present in the eastern portion of the site. The existing home and garage is in the northeastern part of the Site project where a lawn is present along with other landscaped vegetation. Probable fill slopes are apparent on the western side of the home and portions of the east side where existing residential development is present on the east.

As indicated on HGSI Figure 2 (Attached) a ditch crosses the southwestern conservation area. Some standing water was observed in low areas. Tree locations are indicated on HGSI Figure 2. Much of the property is open without trees where vegetation includes shrubs and a ground cover of blackberries or English ivy. Where the ground was disturbed from the test pit excavations bare soil is present that was wet from incident rainfall.

Evidence of distress associated with slope movements (such as ground or structure cracks, scarps, irregular or hummocky ground) was not observed at the Site or the immediate vicinity. Evidence of uncontrolled surface water and erosion was also not present. The slopes on the Site and vicinity are moderate to gentle; where observed the slopes do not show geomorphic indicators of recent or past slope failures and are consistent with stable slope conditions.

LANDSLIDE HAZARD ASSESSMENT

A low landslide hazard is recognized at the Site and immediate vicinity as the Site is on moderate to gently sloped ground, evidence of earth movements or landslides was not observed, and the Site is not bordered by steeper, potentially unstable slopes.

Subsurface explorations by HGSI indicate some seepage from the soft, more permeable organic topsoil zone in response to a large storm just prior to explorations and underlying stiff to hard Silt and Clay soils were not wet or saturated. Very low or low infiltration rates (0.5 inches per hour and 2.0 inches per hour) were measured within Silt soil that is correlated to the Portland Hills Silt geologic unit. I understand that a storm water disposal system will be designed by others; HGSI indicates the system must be designed with factors of safety and include options for potential overflows and that roof drains and foundation drain flows should be kept separated.

The referenced HGSI geotechnical report provides recommendations for spread footings including foundation drainage systems. Recommendations for embankment fills and below grade retaining walls are provided. Seismic design parameters are provided for final foundation design.

Based on the results of this investigation it is my opinion that the landslide hazard is low and the planned residential development can be safely constructed and not increase the hazard to neighboring properties. This opinion assumes that all geotechnical, storm water design and construction recommendations are implemented including critical site inspections by the qualified professionals during construction.

STATEMENT OF QUALIFICATIONS

This Landslide Hazard Assessment was prepared by John E. Jenkins. He is an Oregon Certified Engineering Geologist with over 30 years' experience working as a geotechnical, water resources, and geologic hazards consultant primarily in Washington, Oregon, and California.

John E. Jenkins GeoConsulting
9260 SE Bachelor Dr. • Portland, OR 97086
Phone: 971-227-2542 • E-mail: Jenkins-John@comcast.net

STATEMENT OF ACCURACY

The accuracy of this Landslide Hazard Assessment is high. Information relied upon is presented in this report and included the results from field reconnaissance, site measurements, review of a soil infiltration report prepared by others, literature review and professional experience working in similar geologic and geotechnical conditions.

LIMITATIONS

This letter report has been prepared for the exclusive use of the addressee and his consultants for aiding in the design and construction of the proposed development. It is the addresses' responsibility to provide this report to the appropriate design professionals, building officials, and contractors. The opinions, comments and conclusions presented in this letter were based upon information derived from site reconnaissance, documents provided by the addressee, and literature review. No formal subsurface exploration was authorized or completed as part of our work.

This work has been conducted in general conformance with the standard of care in the field of engineering geology currently in practice in the Pacific Northwest for projects of this nature and magnitude. No warrant, expressed or implied, exists on the information presented in this report. By utilizing the conclusions within this report, the addressee and owner acknowledges and accepts the risks and limitation of development at the Site, as outlined within this letter.

CLOSING

I appreciate the opportunity to assist you with this project. Please call me if you have any questions regarding this letter report.

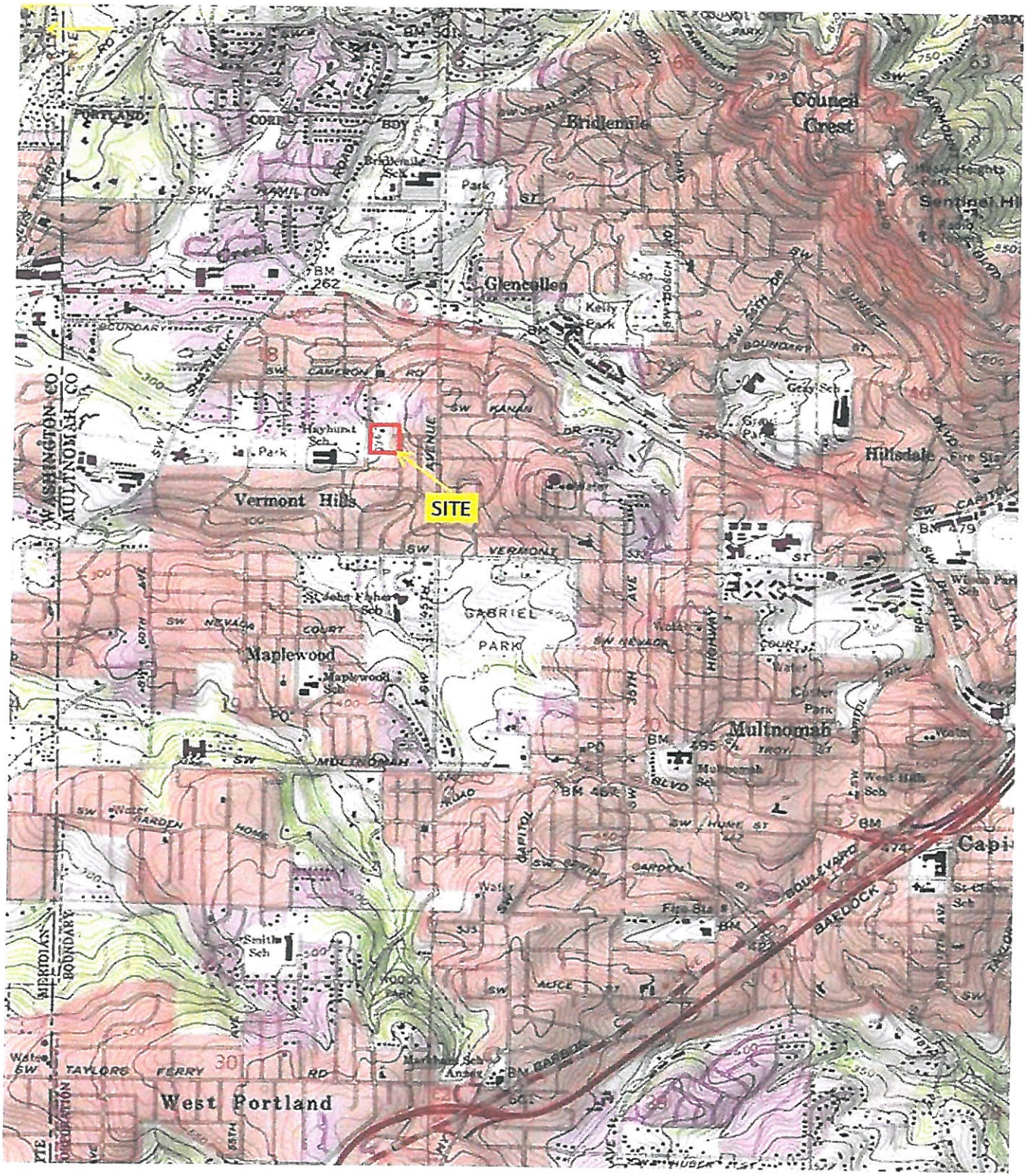
Sincerely,
John E. Jenkins GeoConsulting

John E. Jenkins, C.E.G.
Certified Engineering Geologist

Attachments:

Figure 1 – Site Vicinity Map
Figure 2 – Lidar Hillshade Map

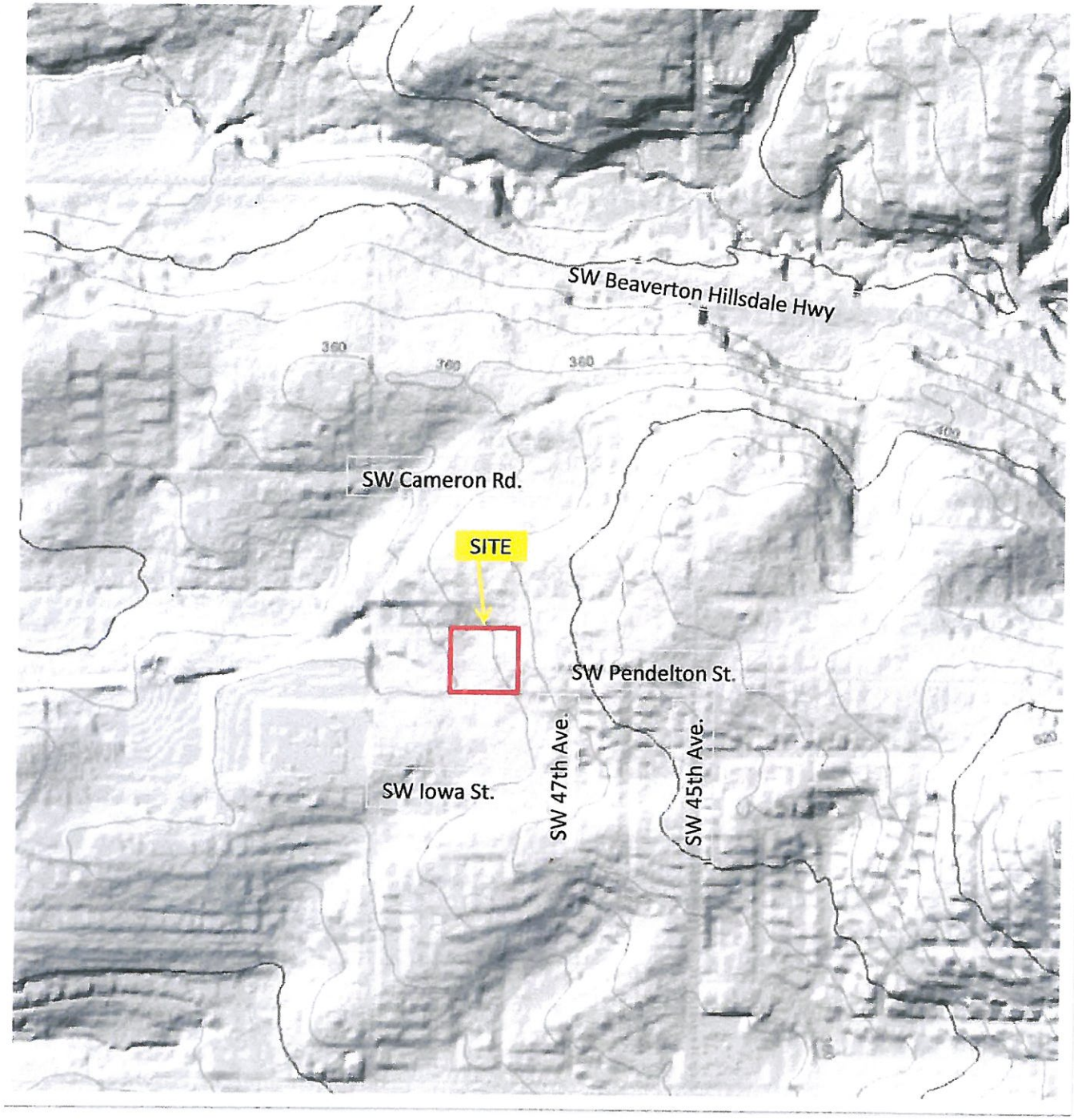
Site and Exploration Plan, Figure 2 (from: HGSI, 2016)



North

Site Location Approximate

Figure 1: Site Vicinity Map 5920 SW 48th Ave. Subdivision, Portland, Oregon	John E. Jenkins GeoConsulting Project: Hardman-28-16 Source: USGS Topographic Map - Lake Oswego quadrangle, 1961, photorevised 1984



North

Site Location Approximate

Figure 2: Lidar Hillshade Map 5920 SW 48th Ave. Subdivision, Portland, Oregon	John E. Jenkins GeoConsulting Project: Hardman-28-16 Source: DOGAMI Lidar Data Viewer