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Redmond Geotechnical Services **25 August 2020**
P. O. Box 20547
Portland, Or 97294
Attention: Dan Redmond

Geological Assessment
Youth With A Mission Camp
7085 Battle Creek Rd SE
8S/3W-25B
Salem, Oregon

Dan:

The purpose of this letter is to present Northwest Geological Services, Inc. (NGS') Geological Assessment for the above referenced property. This study includes the engineering geology tasks required by Marion County to develop in areas that may have potential geologic hazards. We understand that our services are in support of your client's efforts to construct new dormitories, classrooms and other facilities for the existing camp. The work for this study was done in accordance with your 26 February 2020 email authorization.

1. SCOPE OF STUDY

The scope of our study was limited to the engineering geologic consultation necessary to assess potential slope hazards, as required by Marion County. Specifically, our work included:

- Obtain and review historic aerial photographs of the site;
- Obtain and review logs for wells near the site;
- Review available geologic investigations of the site and site area;
- Review and logs and samples of test pits for your geotechnical study of the site;
- Evaluate the potential landslide hazards using the information developed; and,
- Prepare this letter describing our work, findings and recommendations.

Our work did not include some items the County may request for Geological Assessments of slope hazard areas. Specifically, the excluded items are: site grading plans showing cuts and fills; and geologic cross sections showing subsurface conditions. First, we understand the grading plan will be developed as part of the plans for the building permit application for the site. In our opinion, the geology of the site is simple (Sections 3 and 4). Second, a cross section is not required to comprehend the subsurface conditions. Nor is a grading plan necessary to assess the stability of natural slopes underlain by thin residual soils and basalt bedrock.

2. SITE SETTING

The site is west of Battle Creek Rd SE and straddles Battle Creek and its flood plain (Site, Figures 1 and 2). It is in the NW corner of Section 25, T8S/R3W Willamette Meridian. Marion County Zoning shows the site is zoned IC (Industrial Commercial) and SA (Special Agricultural) and has Religious Organization status.

2.1 Location and Physiography

The property is located at the juncture of the Salem Hills, Waldo Hills and northern reach of the south Willamette Valley (locally, the Battle Creek floodplain portion). In the site area the elevations range from uplands of 500-700 ft elevation down to the Battle Creek floodplain (Figures 1 and 3). The flood plain slopes from 380-390 ft along the margins gently towards the creek that is incised a few feet into the floodplain (Figures 2 and 3). The LIDAR indicates the stream grade falls gently south across the site from 370 to 365 ft (Figure 3).

The east part of the site lies on the Battle Creek floodplain (Figures 2 and 3), The floodplain slopes gently east from Battle Creek Rd towards Battle Creek. West of Battle Creek the site rises to a terrace of old alluvium or Missoula Flood deposits (Figures 3 and 8). Above the floodplain and terrace the site rises towards the SW corner to about elevation 545 ft. The slope continues to rise west of the site to the uplands of 620 ft and higher

The east part of the site is currently covered by mixed grasses with local conifer and deciduous trees (Figure 2). Drainage is by sheet runoff and via small, shallow rills to Battle Creek. The bench and slope west of the creek are forested with mature conifers except in areas cleared for previous farming or the camp.

Historic maps and aerial photos indicate that the site was forest, farmland and orchard through the 1950s (Figure 4, left). County records show the original farm house and barns were built in 1940. However, the 1915 USGS Sidney quadrangle shows a structure at the NW part of the site. The 1967 aerial photo shows that the orchard was replaced by several structures and the stream terrace was widened (Figure 4, right and Figure 3, Man-made bench). Figure 5 shows the current configuration of the camp and the proposed additions and refurbishing. Figure 6 shows the east part of the site with the nearly-flat gentle slope towards Battle Creek.

2.2 Government Landslide Hazard Susceptibility Estimates

The State online hazard database, SLIDO, shows no historic or active landslides at the site. However, SLIDO shows a "mapped landslide" immediately south of the site.[1] SLIDO shows that area as "Very High" risk in the Landslide Susceptibility layer (Figure 7). Flat areas of the site (e.g., area shown on Figure 6) are shown as low or moderate risk. Gentle and moderate slopes (are interpreted by SLIDO to have "Moderate" to "High" risk of landsliding, respectively.[2]

2.3 Site Area Geology

The geology of the site area is well known. Mapping includes that by the State (Thayer, 1939) the US Geological Survey (Hampton, 1972; Walker & Duncan, 1989; Tolan and Beeson, 2000), for a Portland State MS thesis (Hoffman, 1981), and by us for Marion County (NGS, 1997. All studies found the site underlain by Miocene volcanic rocks of the Columbia River Basalt (CRB) and pre-basalt sedimentary strata at depth, with a veneer of alluvial and Missoula Flood deposits in lowlands. The terrain buried by the CRB was hilly with well-developed drainages. The oldest basalt flows filled the deepest drainages. Successive flows accumulated in low areas and eventually flooded broad areas. Consequently, the basalt thickness varies considerably from place to place, as does the type of rocks buried.

Our mapping (NGS, 1997) and review of nearby well logs indicate that the CRB is about 300 ft thick beneath the uplands west of the site (e.g., Mari 13140, Figure 8). The review also

[1] The SLIDO "mapped landslide" corresponds to the Qls (Holocene to Pleistocene) landslide mapped by Tolan and Beeson (2000) south of the site shown on Figure 8.

[2] Away from mapped landslides, SLIDO estimates landslide susceptibility mostly from slope angle determined from topographic maps, USGS Digital Elevation Models or LIDAR-determined slope angle (compare figure 3 and 7).

suggests the basalt is near horizontal or dips gently SSW. Tolan and Beeson (2000), mapped pre-basalt rocks along the east margin of the Battle Creek floodplain, just east of the site along Battle Creek Rd (Figure 8.) Tolan and Beeson (2000) interpreted a north-south fault along the west side of Battle Creek. They estimated fault offset as west-side-down and about 50+ feet. Based on water well logs, we inferred the fault extends up Battle Creek for at least 3 miles (NGS, 1997).

Available mapping indicates the Battle Creek floodplain is cut into the top of the Ortley basalt flows and mantled with alluvial and Missoula Flood deposits (Figure 8). The gently sloped hills east of the creek are underlain by marine sedimentary rocks and Sentinel Bluff basalt. The steeper slopes west of the creek are underlain by Winter Water, Sentinel Bluffs and Silver Falls basalt flows.

In much of the Salem Hills area the upper 50 – 75 feet of the basalt bedrock are weathered or decomposed to ferruginous bauxite (Corcoran and Libbey, 1956; Hoffman. 1981). However, the site is east of most of the bauxite and only the upper 10 – 20 feet of the basalt are weathered a hard, gritty, silty clay or clayey silt. The original volcanic texture of the basalt is preserved by the weathering. Thus, the basalt is generally recognizable, even when decomposed.[3] The weathered basalt is generally not involved in slope failures, except where its physical properties have been ignored during development.

The basalt flows are underlain by marine sedimentary rocks. They are exposed below soil and colluvium south and east of the site (Tms, Figure 8). A few nearby water wells have found tan to brown tuff, clay or siltstone below the basalt. The Tms is regionally extensive and is prone to slope failure in several areas.

3. SITE SPECIFIC STUDIES

3.1 Previous Site Use

We reviewed available historic topographic maps and aerial photographs[4] to assess previous use of the site that could affect slope stability. The aerial photographs were also reviewed for indications of slope failures at and near the site.

The maps and photos show that the site has a long history of rural agricultural use. The 1954 and 1967 aerial photos (e.g., Figure 4) show the site as pasture, orchard and woods. The 1967 photo shows the orchard replaced by structures. Later aerial photos and images show addition of the structures that make up the camp.

No signs of slope instability or failure were observed on the aerial photographs we examined. The resolution of the aerial photos is adequate to see vehicles on roads and relatively minor earthworks. Consequently, we believe that any significant slope failure should be identifiable on the photos we reviewed.

[3] However, the relict volcanic texture in soils derived from weathering of volcanic units can be hard to see on a cloudy or rainy day. Thus, some investigators have incorrectly mapped decomposed Columbia River Basalt as weathered tuffaceous sedimentary strata, Willamette Silt, or even landslide deposits.

[4] We reviewed aerial photos from 1955, 1967, 1971, 1985, 1994, 2000 and digital imagery from 2004 – 2018. Also reviewed USGS topographic maps from 1917, 1940, 1958, 1967 and 2011.

3.2 Surface and Subsurface Observations

We conducted a walking reconnaissance of the site, and observed road cuts and accessible excavations in the site neighborhood. As noted, we have previously mapped the site area and we reviewed our maps and notes from that work.

County and State hazards estimates (Section 2.2) rely very heavily on the steepness of surface slopes and generalized assumptions about soils. Consequently, we used the detailed topographic survey (Figure 3) along with our reconnaissance to evaluate slopes and observed eight test pits to assess site soils. The test pits were dug to practical refusal with a tracked excavator that could reach to 10+ ft depth. The test pits sampled each of the geologic settings at the site.[5]

WEATHERED BASALT: Test pit TH-1 sampled the weathered basalt beneath the slopes of the west part of the site, near the camp reservoir (Tgww, Figure 8). Below 1 ft of topsoil, it found red-brown, moist, sandy, clayey SILT that graded down from medium stiff to stiff. The SILT has the texture of severely weathered vesicular basalt with clay-filled relict vesicles and ghost crystal outlines.

OLDER ALLUVIUM: Test pit TH-2 sampled the old alluvial terrace deposit (Qoal) above the south bank of Battle Creek. It was dug as close as feasible to the part of the terrace mapped as landslide south of the site (Qls, Figure 8). The Below 1 ft of topsoil, the terrace was composed of 4 ft of red-brown, very moist, sandy, clayey SILT that graded downwards to medium stiff. Below that the Qoal was red brown and reddish tan gritty SILT to clayey silty SAND with abundant carbonized leaf and twig fragments. When dry the deposit is hard, but in-situ it was moist and medium stiff to medium dense. There was no evidence of shearing, breccia or landslide texture in TP-2.

Test pits TH-3, -5, -7 and -8 sampled the Qoal, (Figure 8) in the flat part of the site east of Battle Creek. The sediments in TH-3 were medium to stiff tan to brown sandy clayey SILT with thin local red-brown layers of silty CLAY. The SILT has relict texture of pebbly silty SAND. In TH-3 the Qoal was crudely bedded with the layers of brown SILT separate by thin bands of the reddish tan SILT. These are interpreted to be alluvial channel deposits separated by thin slack water silty clay.

In TH-5 the top of the Qoal consisted of 1.5 ft of grey to brown soft sandy, clayey SILT that was moist to very moist and slightly organic. Below that orange-brown, very moist, soft to medium stiff clayey, sandy SILT. Soils in TH-7 and TH-8 were similar to TH-3, except the weathered SANDSTONE was present below 4 ft in TH-7.

ALLUVIUM: Test pits TH-4 and -6 sampled the area along the east bank of Battle Creek mapped as alluvium (Qal, Figure 8). However, samples at 4 ft (TH-4) to 4.5 ft (TH-6) found medium dense to dense weathered grey to light brown gritty silty SANDSTONE.[6] The excavator reached practical refusal at 1.5 to 3 ft into the SANDSTONE.

[5] See the Redmond Geotechnical Services, LLC report for engineering descriptions and logs of the test pits.

[6] Individual grains are angular and varying lithologies. Grains range in size from very fine sand to 1 cm pebbles. The rock is best classified as a greywacke. The finest sand grains are weathered to silty clay but the matrix appears to be weakly silica or lime cemented.

We interpret the weathered rock in THs-4, -6 and -7 to be part of the pre-basalt marine sedimentary strata (Tms, Figure 8). The Tms were mapped as extending into the channel downstream of the site (Figure 8).

3.3 Ground Water Observations

No seeps or springs were observed at the site. No springs have been reported previously on immediately neighboring properties. Even so, we suspect that the relatively thin soils may saturate quickly during heavy precipitation because the weathered tops of the basalt and sandstone bedrock are shallow and relatively impervious compared to the overlying soils.

The ground water in Mari 18140 just SW of the site was at 156 ft depth (~elevation 470) in 1992 when the well was drilled. First water was at elevation ~450 ft so concealed seeps or small springs along the base of the west slope are possible. Additionally, we expect valley-bottom soils below the elevation of the stream are saturated during at least part of the year.

4. Interpretation of Site Conditions

The geologic mapping, area roadcuts and excavations, and historic aerial photographs, indicate that the site is underlain by bedrock consisting of Columbia River Basalt west of the Battle Creek fault and either basalt or pre-basalt sedimentary rock east of the fault (Figure 8). The top of the Basalt is decomposed to severely weathered, but it is still highly competent material. The bedrock on the slopes is typically covered by more than 6 ft of residual soils.

Based on past experience and pocket penetrometer measurements, the soils at shallow depths are medium stiff to hard and should be relatively competent. Compressive strengths as measured with a pocket penetrometer ranged from 2 to >4 tons/ft^2. None of the site soils show evidence of past or present slope failure

Typically, the soils derived from the basalt creep on moderate and steep slopes. However, curved, tilted or pistol-butted trees are absent at this site. Thus, soil creep must be slow.

The area south of the site mapped as Qls (old landslide) is geomorphically continuous with the old alluvium (Qoal) stream terrace. It is possible that the terrace south of the site is actually old landslide. However, our review of the LIDAR, aerial photos, and samples from the same geomorphic terrace show no indication of a slope failure. We also know that deposits similar to the high-water / flood silts from TH-2 have been misinterpreted as landslides because of the presence of wood and leaf fragments.

Available information indicates that the Basalt extends for some considerable depth below the site west of the fault. Site mapping indicates that the flows are horizontal or dip gently south to southwest beneath the site. Together with the competent nature of the site materials, it seems most unlikely to us that there is any significant risk of slope failure involving the bedrock. This interpretation is supported by a complete lack of evidence that the site has suffered from slope instability in the past.

5. Conclusions and Recommendations

We found no evidence that slopes at the site have ever failed, nor indication that they will fail under the expected range of future conditions. The site and neighbors have survived severe rainfall events in 1964, 1974, 1994, 1996, 2003 and 2006. Numerous slides occurred at other sites in the Salem region during these severe storms.

Even though the soils have not failed, they compress and spread under applied loads. Consequently, we recommend that foundations be placed on competent material. Foundations and retaining walls should be designed by a qualified professional to withstand forces from lateral loads from earthquakes.

On slopes cuts higher than 4 ft and steeper than 1V:2H, and fills more than 2 ft thick, should be designed by a qualified professional and the design reviewed by a geotechnical engineer. Walls, including retaining walls or foundation walls higher than 4 ft, should also be designed by a qualified professional and the design reviewed by a geotechnical engineer.

Additionally, we recommend against infiltration of large volumes of water into the small volumes of ground, particularly during intense rainfall events such as those noted above. Slope failures in the Salem Hills have been caused by injection of large volumes of storm water. Consequently, it is our opinion that surface runoff from roofs and pavements should be routed to the drainage or routed and dispersed over a broad area to simulate natural conditions. If it is found necessary to dispose of large amounts runoff to the soil, the location and method should be thoroughly evaluated by a qualified professional.

In our opinion, if you follow the above recommendations, development of site should not increase the potential for slope hazards on the site or adjacent properties.

6. LIMITATIONS AND LIABILITY

The area is changing through development, evolution of the terrain by weathering and erosion and by global warming. Such factors may change the balance between ground water, evapotranspiration, vegetation and soil and rock properties. Consequently, the interpretation and recommendations presented herein are limited to the near future and are limited to this specific project. For this report near future is defined as the next 5 years and this project as the improvements shown on Figure 5, herein.

We call your attention to the paragraphs on Warranty and Liability in the General Conditions (dated 1/2019) that you have approved previously. Interpretations and recommendations presented herein are based on limited data and observations. Actual subsurface conditions may vary from those inferred from the limited information available to us. If site excavations for development find conditions to differ significantly from those inferred herein, you should contact us and provide an opportunity for us to review our recommendations for the site.

We thank you for the opportunity to assist you with your project. Please contact me if you have questions about the report.

Yours very truly,
Northwest Geological Services, Inc.

CERTIFIED
OREGON
CLIVE F. KIENLE, JR.
E134
ENGINEERING GEOLOGIST

Expires 31 Oct 20

Clive F. (Rick) Kienle, Jr.
Vice President

NGS Reference 283.115-1

7. REFERENCES

Corcoran, R.E. and F.W. Libbey, 1956, Ferruginous Bauxite Deposits in the Salem Hills, Marion County, Oregon, DOGAMI Bulletin No, 46.

Hampton, E.R., 1972, Geology and ground Water of the Molalla-Salem Slope Area, Northern Willamette Valley, Oregon, US Geological Survey Water-Supply Paper 1997.

Hoffmann, C. W., 1981 A stratigraphic and geochemical investigation of ferruginous bauxite deposits in the Salem Hills, Marion County, Oregon, Portland State University MS Thesis, 130 p and map.

NGS, 1997, Geologic and Hydrogeologic Study of the Residential Acreage-Zoned Areas of Marion County Underlain by Columbia River Basalt and Older Rocks; Northwest Geological Services, Inc. Report dated May 1997 to Marion County.

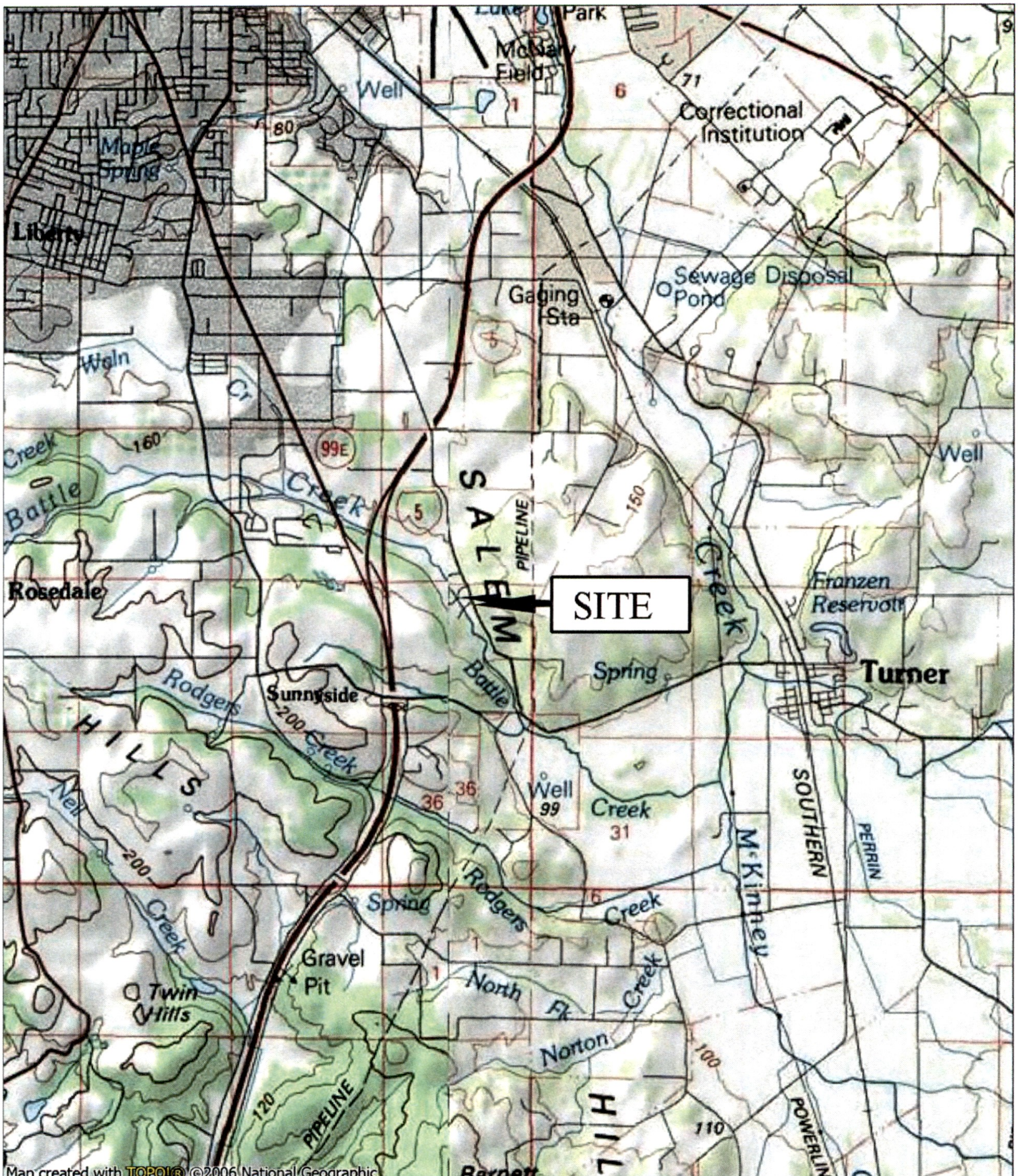
Salem, City of, undated, Slope Hazard Report Requirements.

Thayer, T.P., 1939, Geology of the Salem Hills and the North Santiam River Basin, Oregon, Oregon, DOGAMI Bulletin No, 16.

Tolan. T.L. and M.H. Beeson, 2000, Geologic Map of the Salem East and Turner, Oregon, 7½ Minute Quadrangles, U.S. Geological Survey Open-File Report 00-351.

Walker, G.W. and R.A. Duncan, 1989, Geologic map of the Salem 1 degree by 2-degree quadrangle, Western Oregon, U.S. Geological Survey Miscellaneous Investigations Map I-1893.

Wang, Y., and Leonard, W.J., 1996, Relative Earthquake Hazard Maps of the Salem East and Salem West Quadrangles, Marion and Polk Counties, Oregon, DOGAMI GMS-105.



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07/28/20

Youth With A Mission 7085 Battle Creek Rd SE, Salem, OR		
Geologic Assessment Site Location Map		
NGS, Inc.	August 2020	**Figure 1**

Image by Digital Globe

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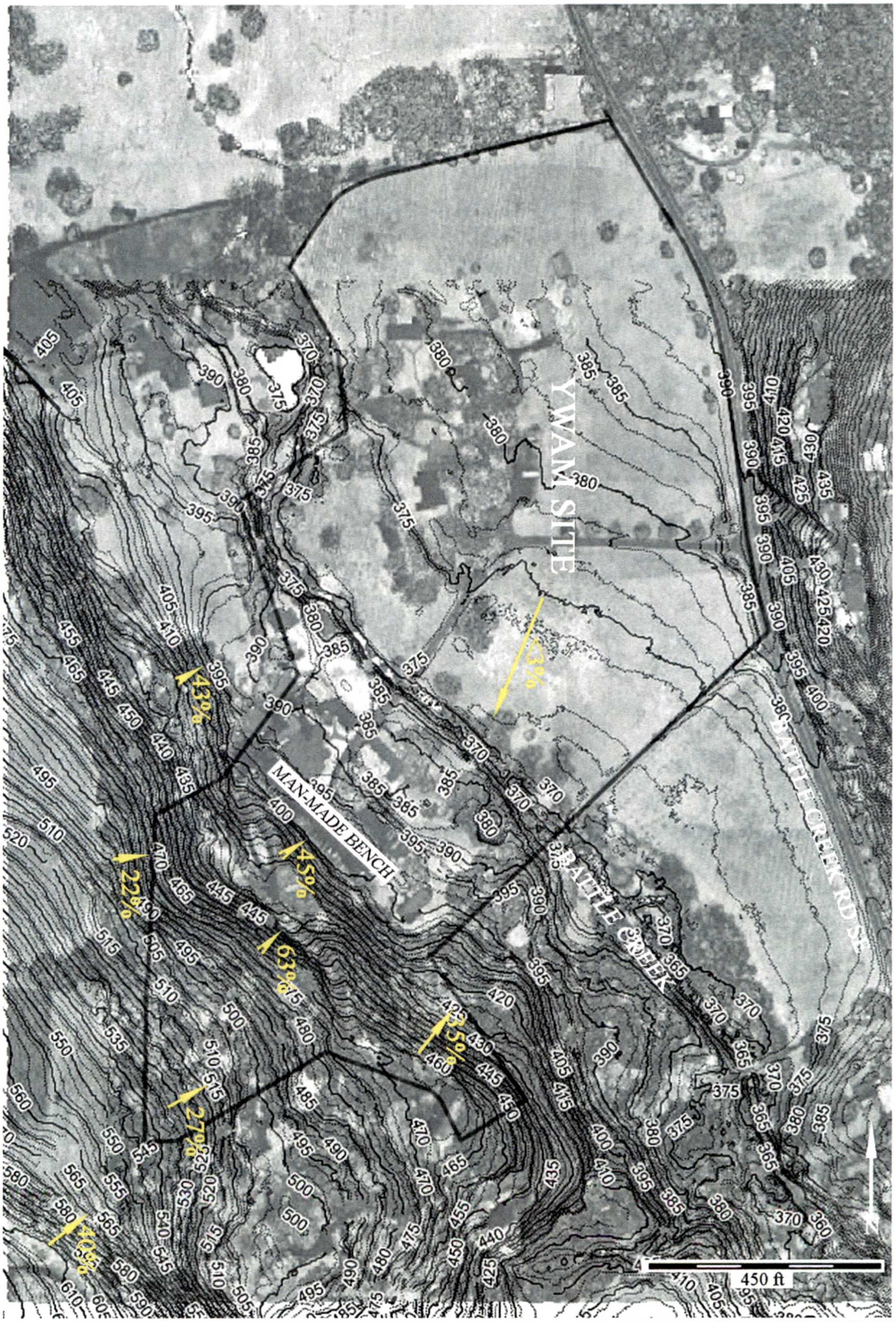
Youth With A Mission		
7085 Battle Creek Rd SE, Salem, OR		
Geologic Assessment		
2018 July 26 Aerial Image		
NGS, Inc.	August 2020	Figure 2



200 feet

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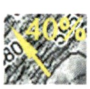
Youth With A Mission 7085 Battle Creek Rd SE, Salem, OR		
Geologic Assessment 2018 NOAA LIDAR ELEVATIONS		
NGS, Inc.	August 2020	**Figure 3**



Slope angle estimated by NGS, Inc from the NOAA contours

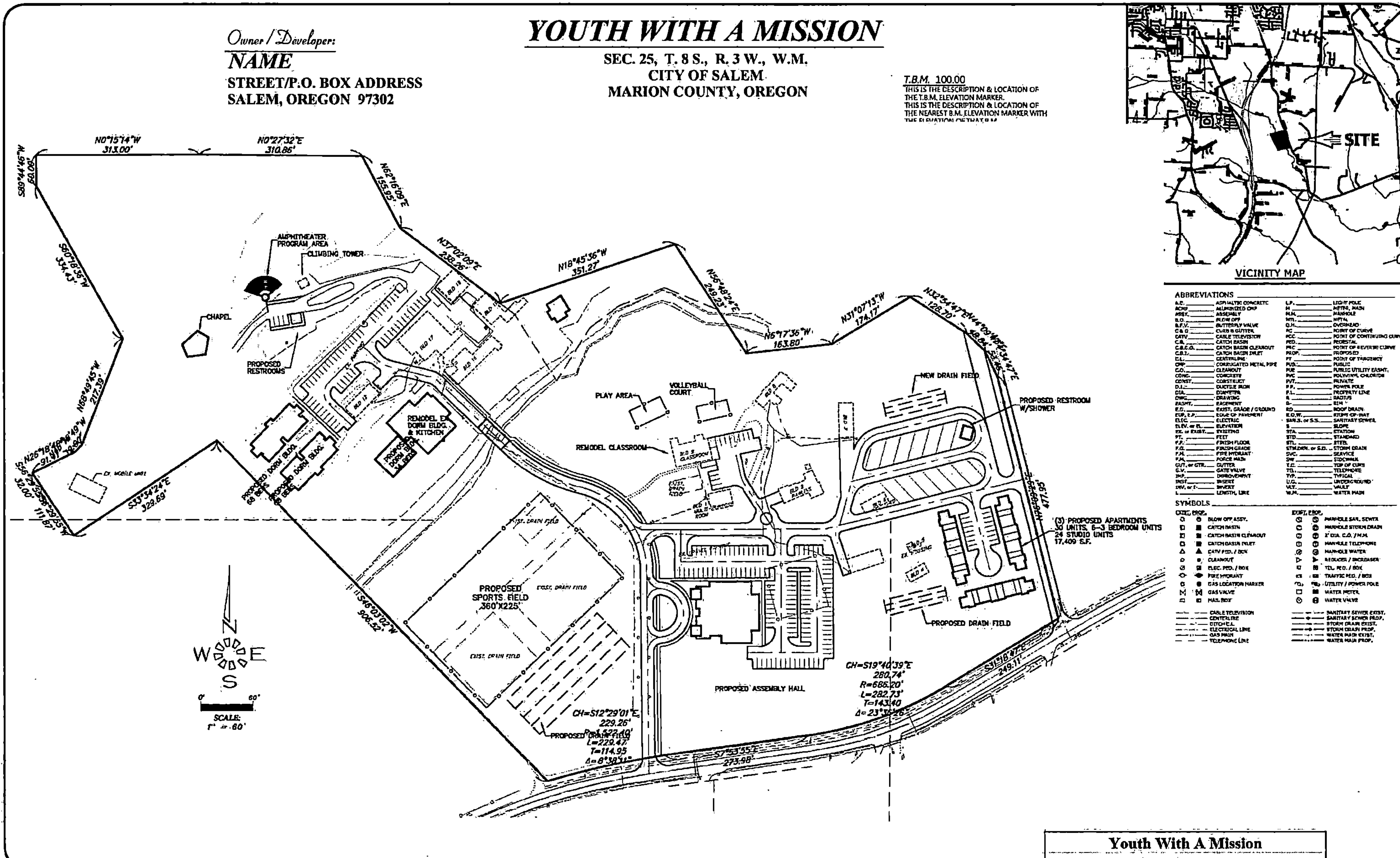
Intensity image, 2 ft and 5 ft contours from Noaa Data Aquisition Viewer

1954 Aug 10

1967 Nov 19

Aerial images downloaded from USGS https://earthexplorer.usgs.gov

Youth With A Mission		
7085 Battle Creek Rd SE, Salem, OR		
Geologic Assessment		
Historic Aerial Photos		
NGS, Inc.	August 2020	Figure 4



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YOUTH WITH A MISSION BATTLECREEK BASE

Youth With A Mission		
7085 Battle Creek Rd SE, Salem, OR		
Geologic Assessment		
Proposed Site Improvements		
NGS, Inc.	August 2020	Figure 5

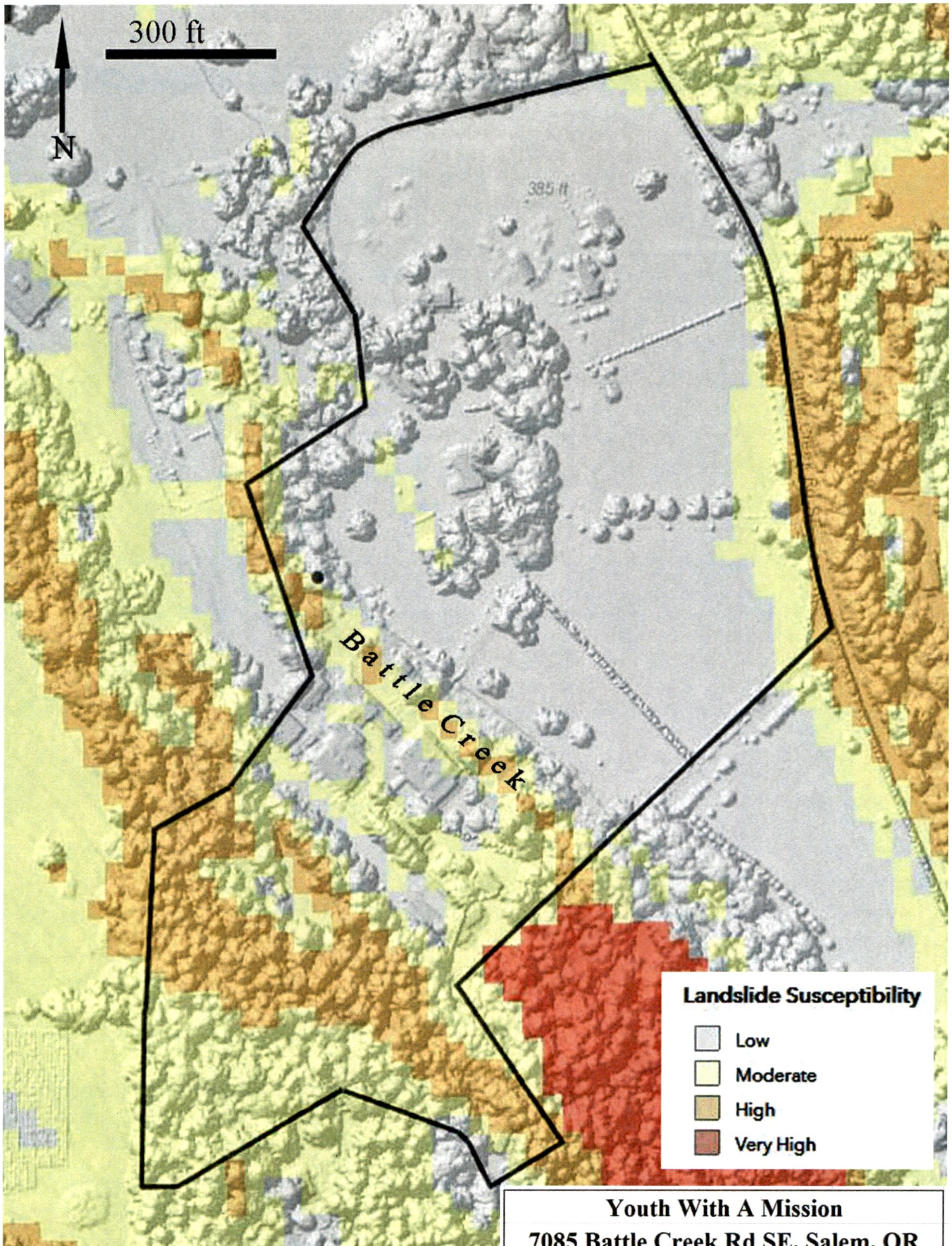
Project Number 6181
Sheet Number 101

ABOVE: View west from Battle Creek Rd SE across the NE part of site. Entrance road on left. Conifer grove at right center is location of original 1940s farm buildings.

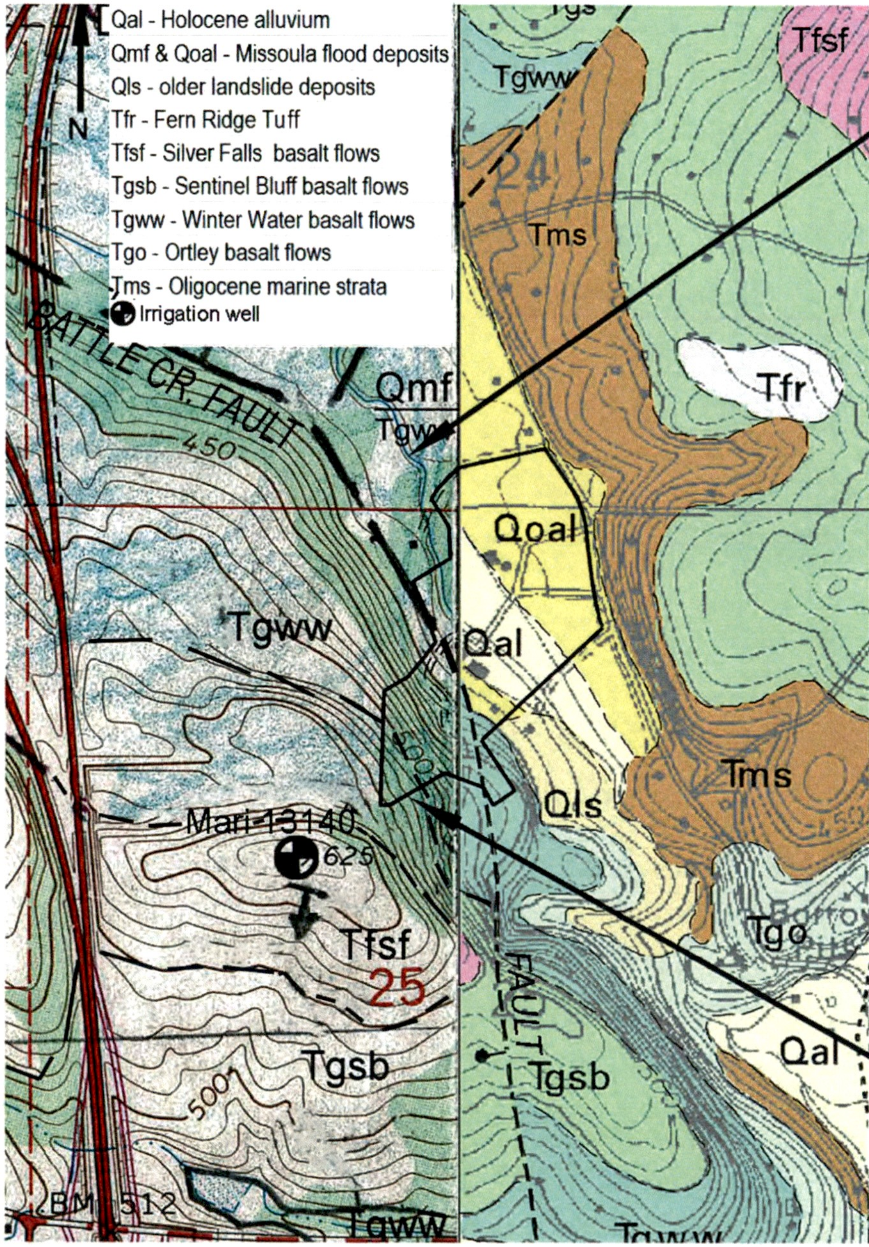
LEFT: View WSW from Battle Creek Rd SE across SE part of site. Diveway to proprty south of site at left. Existing dormatories at center and forested hillside in background.

Photos from GoogleMaps streetview

Youth With A Mission		
7085 Battle Creek Rd SE, Salem, OR		
Geologic Assessment		
SITE PHOTOS		
NGS, Inc.	August 2020	**Figure** 6

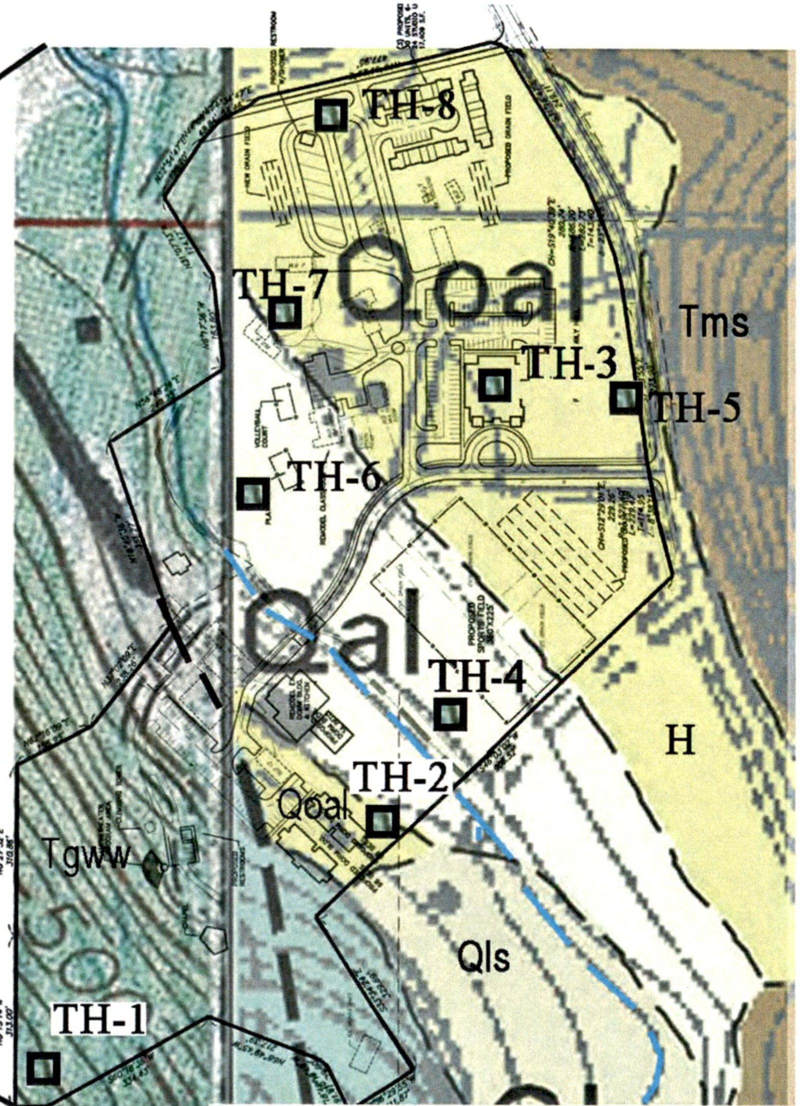


Youth With A Mission		
7085 Battle Creek Rd SE, Salem, OR		
Geologic Assessment		
SLIDO Landslide Susceptibility		
NGS, Inc.	August 2020	**Figure 7**



NGS (1997)

Tolan & Beeson (2000)



200 feet

Test pit for the Geotechnical Study

Youth With A Mission		
7085 Battle Creek Rd SE, Salem, OR		
Geologic Assessment		
NGS & USGS Geologic Maps		
NGS, Inc.	August 2020	Figure 8