REDMOND GEOTECHNICAL SERVICES

October 24, 2016

Mr. Keith Whisenhunt
Project Delivery Group, LLC
3772 Portland Road NE
Salem, Oregon 97301

Dear Mr. Whisenhunt:

Re: Geotechnical Investigation and Geologic Hazard Assessment Services, Proposed Salem Heights Residential Subdivision Site, Tax Lot No's. 10400/10600/10601/10700 & 10800, 575 & 625 Salem Heights Avenue S, Salem (Marion County), Oregon

Submitted herewith is our report entitled "Geotechnical Investigation and Geologic Hazard Assessment Services, Proposed Salem Heights Residential Subdivision Site, Tax Lot No's. 10400/10600/10601/10700 & 10800, 575 & 625 Salem Heights Avenue S, Salem (Marion County), Oregon". The scope of our services was outlined in our formal proposal to Mr. Keith Whisenhunt of Project Delivery Group, LLC dated July 11, 2016. Written authorization of our services was provided by Mr. Keith Wisenhunt on July 21, 2016.

During the course of our investigation, we have kept you and/or others advised of our schedule and preliminary findings. We appreciate the opportunity to assist you with this phase of the project. Should you have any questions regarding this report, please do not hesitate to call.

Sincerely,

Daniel M. Redmond, P.E., G.E.
President/Principal Engineer

REGISTERED PROFESSIONAL ENGINEER
12,309
OREGON
July 15, 1983
DANIEL M. REDMOND
Exp. 12-31-16

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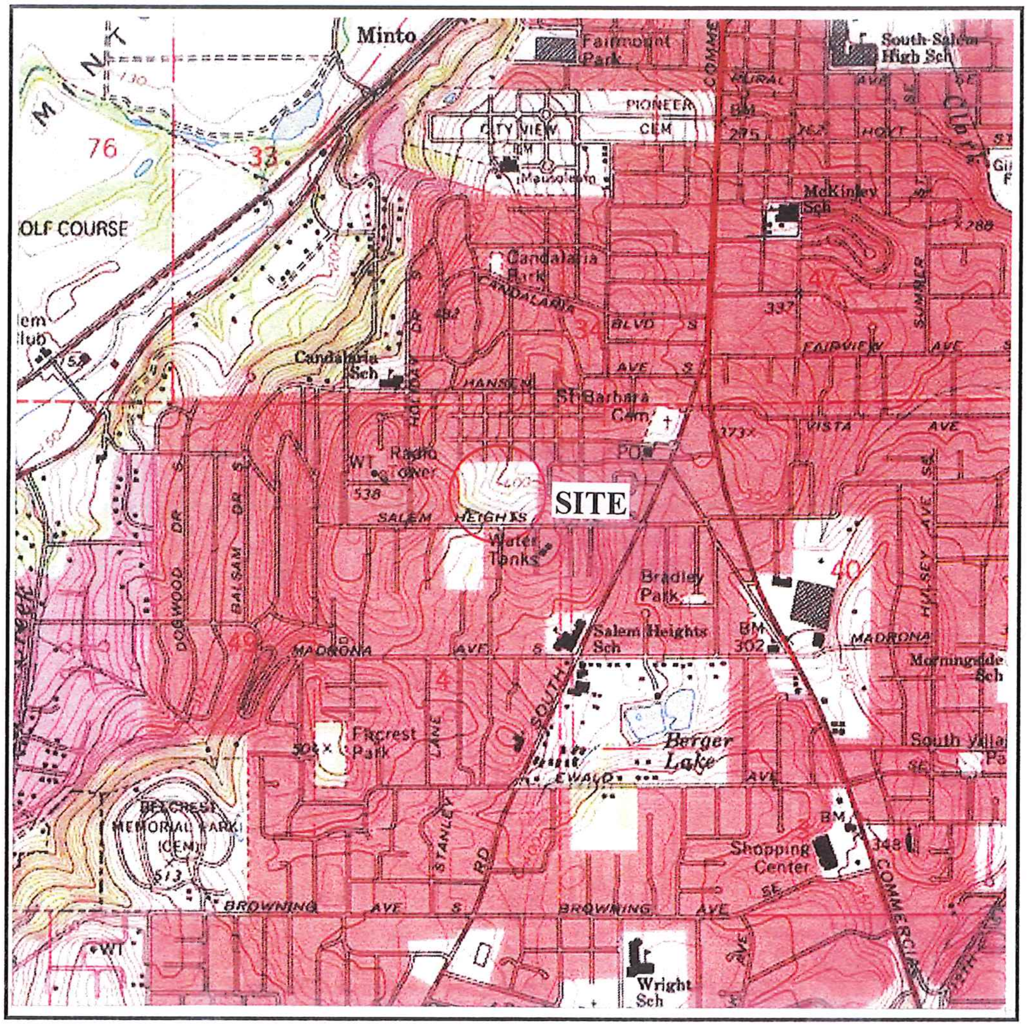
INTRODUCTION

Redmond Geotechnical Services, LLC is please to submit to you the results of our Geotechnical Investigation and Geologic Hazard Assessment at the site of the proposed new residential development located to the north of Salem Heights Avenue S and to the west of the intersection with Liberty Road S in Salem (Marion County), Oregon. The general location of the subject site is shown on the Site Vicinity Map, Figure No. 1. The purpose of our geotechnical investigation and geologic hazard study services at this time was to explore the existing subsurface soils and/or groundwater conditions across the subject site and to evaluate any potential concerns with regard to potential slope failure at the site as well as to develop and/or provide appropriate geotechnical design and construction recommendations for the proposed new residential development project.

PROJECT DESCRIPTION

We understand that present plans are to develop the subject property into new single-family residential lots. Based on a review of the proposed site development plan(s) prepared by Project Delivery Group, LLC, we understand that the proposed new residential development will consist of the construction of approximately thirty (30) new single-family residential lots ranging in size from about 6,200 to 11,800 square feet (see Site Exploration Plan, Figure No. 2). The new residential homes are anticipated to be of single- and/or two-story structures constructed with wood framing. Support of the new residential structures is anticipated to consist primarily of conventional shallow strip (continuous) footings although some individual (column) footings may also be required. Structural loading information, although unavailable at this time, is anticipated to be fairly typical and light for this type of wood-frame single-family residential structure and is expected to result in maximum dead plus live continuous (strip) and individual (column) footing loads on the order of about 1.5 to 2.5 kips per lineal foot (klf) and 10 to 20 kips, respectively.

Although a site grading plan is not available at this time, we understand that both cuts and fills are presently planned for the residential project. In general, relatively minor cuts and/or fills (i.e., 5 feet or less) will be required across the proposed residential lots and will generally be located along the lot perimeters and/or site boundaries. In this regard, due to the existing and/or finish grade sloping site conditions, some of the proposed new single-family residential structures and/or lots may also include the construction of a partial below grade floor(s) and/or retaining walls.



SALEM WEST QUADRANGLE
OREGON
7.5 MINUTE SERIES (TOPOGRAPHIC)

SCALE 1:24 000

1 ½ 0 1 MILE

1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

1 .5 0 1 KILOMETER

CONTOUR INTERVAL 10 FEET

DOTTED LINES CROSSING RIVER REPRESENT 5 FOOT CONTOURS
NATIONAL GEODETIC VERTICAL DATUM OF 1929

SITE VICINITY MAP		
Project No. 1338.011.G	SALEM HEIGHTS SUBDIVISION	Figure No. 1

Other associated site improvements for the project will include construction of new public street improvements along Salem Heights Avenue S as well as new local residential streets. Additionally, the project will include the construction of new underground utility services as well as new concrete curbs and sidewalks.

SCOPE OF WORK

The purpose of our geotechnical and/or geologic studies was to evaluate the overall subsurface soil and/or groundwater conditions underlying the subject site with regard to the proposed new residential development and construction at the site and any associated impacts or concerns with respect to potential slope failure at the site as well as provide appropriate geotechnical design and construction recommendations for the project. Additionally, due to the moderately steep sloping site gradients, a slope stability analysis was also performed.

Specifically, our geotechnical investigation and landslide hazard study performed as a collaboration with Northwest Geological Services, Inc. (NWGS, Inc.) included the following scope of work items:

1. Review of available and relevant geologic and/or geotechnical investigation reports for the subject site and/or area.

2. A detailed field reconnaissance and subsurface exploration program of the soil and ground water conditions underlying the site by means of eight (8) exploratory test pit excavations. The exploratory test pits were excavated to depths ranging from about five (5) to seven (7) feet beneath existing site grades at the approximate locations as shown on the Site Exploration Plan, Figure No. 2. Additionally, field infiltration testing was also performed within two (2) of the test pit excavations.

3. Laboratory testing to evaluate and identify pertinent physical and engineering properties of the subsurface soils encountered relative to the planned site development and construction at the site. The laboratory testing program included tests to help evaluate the natural (field) moisture content and dry density, maximum dry density and optimum moisture content, gradational characteristics, Atterberg Limits and (remolded) direct shear strength tests as well as "R"-value tests.

4. A literature review and engineering evaluation and assessment of the regional seismicity to evaluate the potential ground motion hazard(s) at the subject site. The evaluation and assessment included a review of the regional earthquake history and sources such as potential seismic sources, maximum credible earthquakes, and reoccurrence intervals as well as a discussion of the possible ground response to the selected design earthquake(s), fault rupture, landsliding, liquefaction, and tsunami and seiche flooding.

5. Engineering analyses utilizing the field and laboratory data as a basis for furnishing recommendations for foundation support of the proposed new residential structures. Recommendations include maximum design allowable contact bearing pressure(s), depth of footing embedment, estimates of foundation settlement, lateral soil resistance, and foundation subgrade preparation. Additionally, construction and/or permanent subsurface water drainage considerations have also been prepared. Further, our report includes recommendations regarding site preparation, placement and compaction of structural fill materials, suitability of the on-site soils for use as structural fill, criteria for import fill materials, and preparation of foundation, pavement and/or floor slab subgrades as well as the results of our slope stability analysis.

6. Flexible pavement design and construction recommendations for the proposed new public street improvements.

SITE CONDITIONS

Site Geology

The subject site and/or area is underlain by highly weathered Basalt bedrock deposits and/or residual soils of the Columbia River Basalt formation. A more detailed description of the site geology across and/or beneath the site is presented in the Geologic Hazard Study in Appendix B.

Surface Conditions

The subject proposed new residential development property consists of five (5) rectangular shaped tax lots (TL's 10400, 10600, 10601, 10700 and 10800) which encompass a total plan area of approximately 7.84 acres. The proposed residential development property is roughly located to the north of Salem Heights Avenue S and to the west of the intersection with Liberty Road S. The southerly and/or southwesterly portion(s) of the subject proposed residential development site (TL's 10400 and 10600) are presently improved and contain existing single-family residential homes while the remainder of the site (TL's 10601, 10700, and 10800) are unimproved and consist of existing open land. Surface vegetation across the site generally consists of a light to moderate growth of grass, weeds and brush as well as numerous small to large size trees. Additionally, an existing seasonal drainage basin is located along the northeasterly portion of the site.

Topographically, the site is characterized as gently to moderately sloping terrain (10 to 25 percent) descending downward towards the east/northeast with overall topographic relief estimated at about one hundred (100) feet and ranges from a low about Elevation 395 feet near the northeasterly corner of the subject site to a high of about Elevation 495 near the westerly portion of the site.

Subsurface Soil Conditions

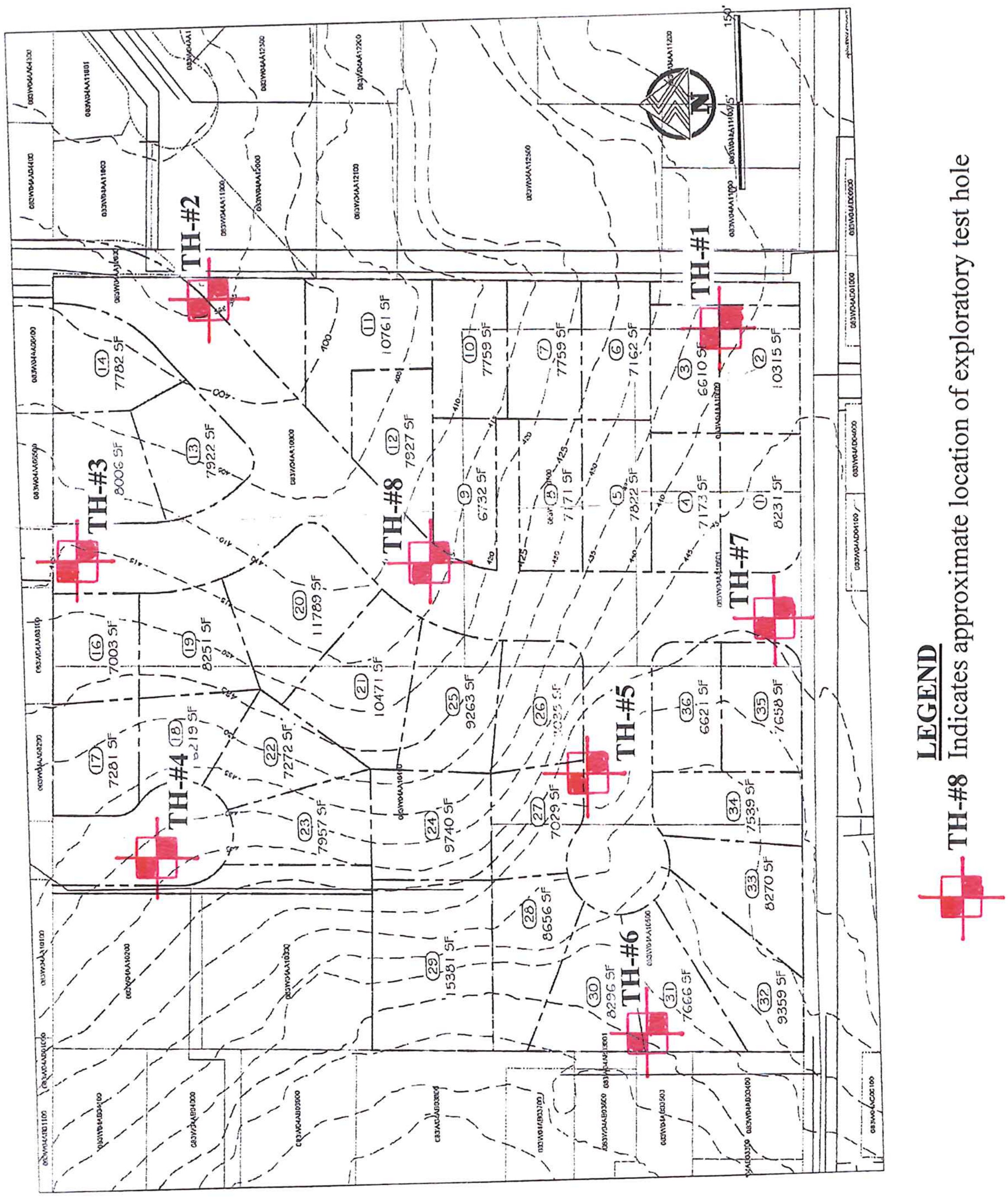
Our understanding of the subsurface soil conditions underlying the site was developed by means of eight (8) exploratory test pits excavated to depths ranging from about five (5) to seven (7) feet beneath existing site grades on August 9, 2016 with a John Deere 200C track-mounted excavator. The location of the exploratory test pits were located in the field by marking off distances from existing and/or known site features and are shown in relation to the proposed new residential structures and/or site improvements on the Site Exploration Plan, Figure No. 2. Detailed logs of the test pit explorations, presenting conditions encountered at each location explored, are presented in the Appendix, Figure No's. A-4 through A-7.

The exploratory test pit excavations were observed by staff from Redmond Geotechnical Services, LLC who logged each of the test pit explorations and obtained representative samples of the subsurface soils encountered across the site. Additionally, the elevation of the exploratory test pit excavations were referenced from the proposed Site Development Plan prepared by Project Delivery Group. and should be considered as approximate. All subsurface soils encountered at the site and/or within the exploratory test pit excavations were logged and classified in general conformance with the Unified Soil Classification System (USCS) which is outlined on Figure No. A-3.

The test pit explorations revealed that the subject site is underlain by native soil deposits comprised of highly weathered bedrock and/or residual soils composed of a surficial layer of dark brown, very moist, very soft, organic, sandy, clayey silt topsoil materials to depths of about 6 to 12 inches. These surficial topsoil materials were inturn underlain by medium to reddish--brown, moist to very moist, medium stiff, sandy, clayey silt to a depth of about two (2) to five (5) feet beneath the existing site and/or surface grades. These upper clayey silt subgrade soils are best characterized by relatively low to moderate strength and moderate compressibility. These upper clayey silt subgrade soils were inturn underlain by reddish- to orangish-brown, moist to very moist, medium dense becoming dense at depth, clayey, sandy silt to highly weathered bedrock deposits to the maximum depth explored of about seven (7) feet beneath the existing site and/or surface grades. These clayey, sandy silt subgrade soils and/or highly weathered bedrock deposits are best characterized by relatively moderate to high strength and low compressibility. In addition, localized fill soil materials are also present at and/or across the site in the area to the north of the existing residential homes (TL's 10400 and 10600) which consist of about six (6) feet or more of medium to reddish-brown, very moist to wet, moderately well compacted, sandy and clayey silt.

Groundwater

Groundwater was generally not encountered within any of the exploratory test pit explorations (TH-#1 through TH-#8) at the time of excavation to depths of at least seven (7) feet beneath existing surface grades. However, the northeasterly portion of the subject property contains an existing seasonal drainage basin and/or surface feature.



SITE EXPLORATION PLAN

Project No. 1338.011.G	SALEM HEIGHTS SUBDIVISION	Figure No. 2

In this regard, although groundwater elevations at the site may fluctuate seasonally in accordance with rainfall conditions and/or associated with runoff of the northeasterly drainage basins as well as changes in site utilization, we are generally of the opinion that the static water levels and/or surface water ponding not observed during our recent field exploration work generally reflect a high seasonal groundwater level(s) at and/or beneath the site.

INFILTRATION TESTING

We performed two (2) field infiltration tests at the site on August 9, 2016. The infiltration tests were performed in test holes TH-#2 and TH-#5 at depths of between two (2) to four (4) feet beneath the existing site and/or surface grades. The subgrade soils encountered in the infiltration test hole consisted of sandy, clayey silt. The infiltration testing was performed in general conformance with current EPA and/or the City of Salem Department of Public Works Administrative Rules Chapter 109 Division 004 Appendix C Encased Falling Head test method which consisted of advancing a 6-inch diameter PVC pipe approximately 6 inches into the exposed soil horizon at each test location. Using a steady water flow, water was discharged into the pipe and allowed to penetrate and saturate the subgrade soils. The water level was adjusted over a two (2) hour period and allowed to achieve a saturated subgrade soil condition consistent with the bottom elevation of the surrounding test pit excavation. Following the required saturating period, water was again added into the PVC pipe and the time and/or rate at which the water level dropped was monitored and recorded. Each measurable drop in the water level was recorded until a consistent infiltration rate was observed and/or repeated.

Based on the results of the field infiltration testing at the site, we have found that the native sandy, clayey silt subgrade soil deposits posses an ultimate infiltration rate on the order of about 0.4 to 0.6 inches per hour (in/hr).

LABORATORY TESTING

Representative samples of the on-site subsurface soils were collected at selected depths and intervals from various test pit excavations and returned to our laboratory for further examination and testing and/or to aid in the classification of the subsurface soils as well as to help evaluate and identify their engineering strength and compressibility characteristics. The laboratory testing consisted of visual and textural sample inspection, moisture content and dry density determinations, maximum dry density and optimum moisture content, gradation analyses and Atterberg Limits as well as (remolded) direct shear strength and "R"-value tests. Results of the various laboratory tests are presented in the Appendix, Figure No's. A-8 through A-13.

SEISMICITY AND EARTHQUAKE SOURCES

The seismicity of the southwest Washington and northwest Oregon area, and hence the potential for ground shaking, is controlled by three separate fault mechanisms. These include the Cascadia Subduction Zone (CSZ), the mid-depth intraplate zone, and the relatively shallow crustal zone. Descriptions of these potential earthquake sources are presented below.

The CSZ is located offshore and extends from northern California to British Columbia. Within this zone, the oceanic Juan de Fuca Plate is being subducted beneath the continental North American Plate to the east. The interface between these two plates is located at a depth of approximately 15 to 20 kilometers (km). The seismicity of the CSZ is subject to several uncertainties, including the maximum earthquake magnitude and the recurrence intervals associated with various magnitude earthquakes. Anecdotal evidence of previous CSZ earthquakes has been observed within coastal marshes along the Washington and Oregon coastlines. Sequences of interlayered peat and sands have been interpreted to be the result of large Subduction zone earthquakes occurring at intervals on the order of 300 to 500 years, with the most recent event taking place approximately 300 years ago. A study by Geomatrix (1995) and/or USGS (2008) suggests that the maximum earthquake associated with the CSZ is moment magnitude (Mw) 8 to 9. This is based on an empirical expression relating moment magnitude to the area of fault rupture derived from earthquakes that have occurred within Subduction zones in other parts of the world. An Mw 9 earthquake would involve a rupture of the entire CSZ. As discussed by Geomatrix (1995) this has not occurred in other subduction zones that have exhibited much higher levels of historical seismicity than the CSZ. However, the 2008 USGS report has assigned a probability of 0.67 for a Mw 9 earthquake and a probability of 0.33 for a Mw 8.3 earthquake. For the purpose of this study an earthquake of Mw 9.0 was assumed to occur within the CSZ.

The intraplate zone encompasses the portion of the subducting Juan de Fuca Plate located at a depth of approximately 30 to 50 km below western Washington and western Oregon. Very low levels of seismicity have been observed within the intraplate zone in western Oregon and western Washington. However, much higher levels of seismicity within this zone have been recorded in Washington and California. Several reasons for this seismic quiescence were suggested in the Geomatrix (1995) study and include changes in the direction of Subduction between Oregon, Washington, and British Columbia as well as the effects of volcanic activity along the Cascade Range. Historical activity associated with the intraplate zone includes the 1949 Olympia magnitude 7.1 and the 1965 Puget Sound magnitude 6.5 earthquakes. Based on the data presented within the Geomatrix (1995) report, an earthquake of magnitude 7.25 has been chosen to represent the seismic potential of the intraplate zone.

The third source of seismicity that can result in ground shaking within the Vancouver and southwest Washington area is near-surface crustal earthquakes occurring within the North American Plate. The historical seismicity of crustal earthquakes in this area is higher than the seismicity associated with the CSZ and the intraplate zone. The 1993 Scotts Mills (magnitude 5.6) and Klamath Falls (magnitude 6.0), Oregon earthquakes were crustal earthquakes.

Liquefaction

Seismic induced soil liquefaction is a phenomenon in which lose, granular soils and some silty soils, located below the water table, develop high pore water pressures and lose strength due to ground vibrations induced by earthquakes. Soil liquefaction can result in lateral flow of material into river channels, ground settlements and increased lateral and uplift pressures on underground structures.

Buildings supported on soils that have liquefied often settle and tilt and may displace laterally. Soils located above the ground water table cannot liquefy, but granular soils located above the water table may settle during the earthquake shaking.

Our review of the subsurface soil test pit logs from our exploratory field explorations (TH-#1 through TH-#8) and laboratory test results indicate that the site is generally underlain by medium stiff, sandy, clayey silt soils and/or medium dense to dense highly weathered bedrock deposits to depths of at least 7.0 feet beneath existing site grades. Additionally, groundwater was generally not encountered within any of the exploratory test pit excavations (TH-#1 through TH-#8) at the site during our field exploration work to depths of at least 7.0 feet.

As such, due to the medium stiff and/or cohesive nature of the sandy, clayey silt subgrade soils and/or medium dense to dense highly weathered bedrock deposits beneath the site, it is our opinion that the native sandy, clayey silt subgrade soil and/or highly weathered bedrock deposits located beneath the subject site have a very low potential for liquefaction during the design earthquake motions previously described.

Landslides

No ancient and/or active landslides were observed or are known to be present on the subject site. Additionally, development of the subject site into the planned residential homes sites does not appear to present a potential geologic and/or landslide hazard provided that the site grading and development activities conform with the recommendations presented within this report. A more detailed assessment of the potential landslide hazard of the subject site is presented in the Geologic Hazard Study in Appendix B.

Surface Rupture

Although the site is generally located within a region of the country known for seismic activity, no known faults exist on and/or immediately adjacent to the subject site. As such, the risk of surface rupture due to faulting is considered negligible.

Tsunami and Seiche

A tsunami, or seismic sea wave, is produced when a major fault under the ocean floor moves vertically and shifts the water column above it. A seiche is a periodic oscillation of a body of water resulting in changing water levels, sometimes caused by an earthquake. Tsunami and seiche are not considered a potential hazard at this site because the site is not near to the coast and/or there are no adjacent significant bodies of water.

Flooding and Erosion

Stream flooding is a potential hazard that should be considered in lowland areas of Marion County and Salem. The FEMA (Federal Emergency Management Agency) flood maps should be reviewed as part of the design for the proposed new residential structures and site improvements. Elevations of structures on the site should be designed based upon consultants reports, FEMA (Federal Emergency Management Agency), and Marion County requirements for the 100-year flood levels of any nearby creeks, streams and/or drainage basins.

SLOPE STABILITY ANALYSIS

For the purpose of evaluating slope stability at the subject site, we performed quantitative slope stability modeling and analyses based upon the existing site conditions and/or the proposed site development plan.

Quantitative slope stability modeling and analyses were performed to evaluate slope stability on the site under the existing and/or post construction in-situ conditions using Slide 7.0 computer program developed by Rocscience, Inc. of Toronto, Ontario, Canada. This numerical analysis program utilizes a two-dimensional limiting equilibrium method to calculate the factor of safety of a potential slip surface, and incorporates search routines to identify the most critical potential failure surfaces for the case(s) analyzed. Factors of safety were calculated under static conditions using Bishop and Janbu method of slices and using the Spencer method under seismic loading conditions.

Proposed residential development at the subject site is generally anticipated to be constructed above the existing in-situ soil conditions of the existing gently to moderately steep descending slope and were modeled as a single (1) layer system with the soil layer as the existing medium stiff, sandy, clayey silt representative of the subsurface conditions encountered in test holes TH-#1 through TH-# 8 below the existing surficial topsoil materials. Site and slope topography, subsurface geometry, and other site conditions modeled in the analyses are based on topographic mapping and/or our field measurements. In our analysis, we considered potential groundwater levels to be located greater than 20 feet beneath the site based on the results of our test hole explorations and available geologic maps.

For stability calculations, the potential failure model was considered primarily as circular sliding along a basal shear surface. Shear strength parameters used in the model were selected based on soil conditions encountered in the test holes, SPT N-value correlations, and/or our local experience with similar soil types and geologic conditions. The results of our slope stability analyses for the proposed single-family residential structures constructed above the in-situ subgrade soil conditions is summarized in Table 2. The slope stability analyses cross-section is presented as an attachment to this report in Appendix B. The location of the cross-section used is indicated on the Site Exploration Plan, Figure No. 2.

Table 1 - Summary of Estimated In-Situ Soil Strength Parameters

Geologic Unit	Wet Unit Weight (pcf)	Friction Angle	Cohesion (psf)
Medium stiff, sandy, clayey SILT (ML)	110	24	250

Table 2 - Summary of Slope Stability Analyses for In-Situ Soil Conditions with Proposed Development

Condition Analyzed	Factor of Safety
Section A-A' Subject site, pre-residential construction on in-situ soil conditions	2.387

The results of the quantitative slope stability modeling and analysis performed using Slide 7.0 computer program indicated an existing in-situ and/or post construction "static" slope stability factor of safety (FS) greater than 1.5 and a "seismic" slope stability factor of safety (FS) of approximately 1.490 which is greater than 1.1 (see Slope Stability Results in Appendix B). In our opinion, the calculated factor(s) of safety are adequate for the proposed residential construction and development of the subject site as we understand it.

CONCLUSIONS AND RECOMMENDATIONS

General

Based on the results of our field explorations, laboratory testing, and engineering analyses, it is our opinion that the site is presently stable and suitable for the proposed new single-family residential development and its associated site improvements provided that the recommendations contained within this report are properly incorporated into the design and construction of the project.

The primary features of concern at the site are 1) the presence of highly moisture sensitive clayey and silty subgrade soils across the site, 2) the presence of gently to moderately sloping site conditions across the proposed new residential lots and/or home sites, and 3) the relatively low infiltration rates anticipated within the near surface clayey and silty subgrade soils.

With regard to the moisture sensitive clayey and silty subgrade soils, we are generally of the opinion that all site grading and earthwork activities be scheduled for the drier summer months which is typically June through September.

In regards to the gently to moderately sloping site conditions across the proposed new residential home sites and/or lots, we are of the opinion that site grading and/or structural fill placement should be minimized where possible and should generally limit cuts and/or fills to about five (5) feet. Additionally, where existing site slopes and/or surface grades exceed about 20 percent (1V:5H) and in order to construct the proposed improvements to Salem Heights Avenue S and/or new local residential streets, benching and keying of all fills into the natural site slopes may be required. With regard to the relatively low infiltration rates anticipated within the clayey and silty subgrade soils beneath the site, we generally do not recommend any storm water infiltration within structural and/or embankment fills. However, some limited storm water infiltration may be feasible within the residential lots and/or areas of the site where the existing and/or finish slope gradients are no steeper than about 20 percent (1V:5H). In this regard, we recommend that all proposed storm water detention and/or infiltration systems for the project be reviewed and approved by Redmond Geotechnical Services, LLC.

The following sections of this report provide specific recommendations regarding subgrade preparation and grading as well as foundation and floor slab design and construction for the new residential development project.

Site Preparation

As an initial step in site preparation, we recommend that the proposed new residential building sites and/or lots as well as their associated structural and/or site improvement area(s) be stripped and cleared of all existing improvements, any existing unsuitable fill materials, surface debris, existing vegetation, topsoil materials, and/or any other deleterious materials present at the time of construction. In general, we envision that the site stripping to remove existing vegetation and topsoil materials will generally be about 6 to 12 inches. However, localized areas requiring deeper removals, such as existing undocumented and/or unsuitable fill materials as well as old foundation remnants, will likely be encountered and should be evaluated at the time of construction by the Geotechnical Engineer. The stripped and cleared materials should be properly disposed of as they are generally considered unsuitable for use/reuse as fill materials.

Following the completion of the site stripping and clearing work and prior to the placement of any required structural fill materials and/or structural improvements, the exposed subgrade soils within the planned structural improvement area(s) should be inspected and approved by the Geotechnical Engineer and possibly proof-rolled with a half and/or fully loaded dump truck. Areas found to be soft or otherwise unsuitable should be over-excavated and removed or scarified and recompacted as structural fill. During wet and/or inclement weather conditions, proof rolling and/or scarification and recompaction as noted above may not be appropriate.

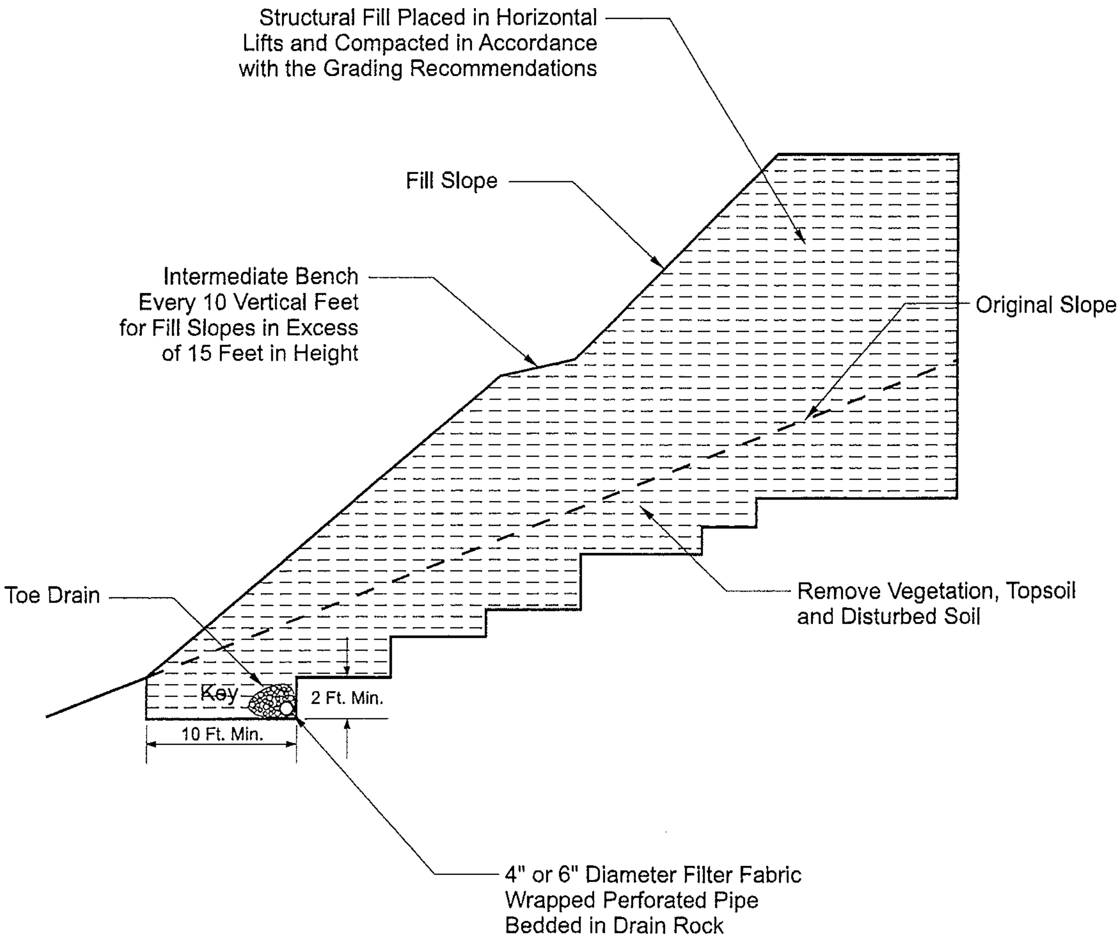
The on-site native sandy, clayey silt subgrade soil materials are generally considered suitable for use/reuse as structural fill materials provided that they are free of organic materials, debris, and rock fragments in excess of about 6 inches in dimension. However, if site grading is performed during wet or inclement weather conditions, the use of some of the on-site native soil materials which contain significant silt and clay sized particles will be difficult at best.

In this regard, during wet or inclement weather conditions, we recommend that an import structural fill material be utilized which should consist of a free-draining (clean) granular fill (sand & gravel) containing no more than about 5 percent fines. Representative samples of the materials which are to be used as structural fill materials should be submitted to the Geotechnical Engineer and/or laboratory for approval and determination of the maximum dry density and optimum moisture content for compaction.

In general, all site earthwork and grading activities should be scheduled for the drier summer months (late June through September) if possible. However, if wet weather site preparation and grading is required, it is generally recommended that the stripping of topsoil materials be accomplished with a tracked excavator utilizing a large smooth-toothed bucket working from areas yet to be excavated. Additionally, the loading of strippings into trucks and/or protection of moisture sensitive subgrade soils will also be required during wet weather grading and construction. In this regard, we recommend that areas in which construction equipment will be traveling be protected by covering the exposed subgrade soils with a geotextile fabric such as Mirafi 140N followed by at least 12 inches or more of crushed aggregate base rock. Further, the geotextile fabric should have a minimum Mullen burst strength of at least 250 pounds per square inch for puncture resistance and an apparent opening size (AOS) between the U.S. Standard No. 70 and No. 100 sieves.

All structural fill materials placed within the new building and/or pavement areas should be moistened or dried as necessary to near (within 3 percent) optimum moisture conditions and compacted by mechanical means to a minimum of 92 percent of the maximum dry density as determined by the ASTM D-1557 (AASHTO T-180) test procedures. Structural fill materials should be placed in lifts (layers) such that when compacted do not exceed about 8 inches. Additionally, all fill materials placed within five (5) lineal feet of the perimeter (limits) of the proposed residential structures and/or pavements should be considered structural fill. Additionally, due to the sloping site conditions, we recommend that all structural fill materials planned in areas where existing surface and/or slope gradients exceed about 20 percent (1V:5H) be properly benched and/or keyed into the native (natural) slope subgrade soils. In general, a bench width of at least eight (8) feet and a keyway depth of at least one (1) foot is recommended. However, the actual bench width and keyway depth should be determined at the time of construction by the Geotechnical Engineer. Further, all fill slopes should be constructed with a finish slope surface gradient no steeper than about 2H:1V.

As such, settlement sensitive site and/or surface improvements (i.e., concrete curbs and sidewalks) should not be constructed until after primary consolidation and/or settlement has been completed. All aspects of the site grading, including a review of the proposed site grading plan(s), should be approved and/or monitored by a representative of Redmond Geotechnical Services, LLC.



TYPICAL FILL SLOPE DETAIL		
Project No. 1338.011.G	SALEM HEIGHTS SUBDIVISION	Figure No. 3

Foundation Support

Based on the results of our investigation, it is our opinion that the site of the proposed new residential development is suitable for support of the one- and/or two-story wood-frame structures provided that the following foundation design recommendations are followed. The following sections of this report present specific foundation design and construction recommendations for the planned new residential structures.

Shallow Foundations

In general, conventional shallow continuous (strip) footings and individual (spread) column footings may be supported by approved native (untreated) subgrade soil materials and/or silty sand structural fill soils based on an allowable contact bearing pressure of about 2,000 pounds per square foot (psf). This recommended allowable contact bearing pressure is intended for dead loads and sustained live loads and may be increased by one-third for the total of all loads including short-term wind or seismic loads. In general, continuous strip footings should have a minimum width of at least 16 inches and be embedded at least 18 inches below the lowest adjacent finish grade (includes frost protection). Individual column footings (where required) should be embedded at least 18 inches below grade and have a minimum width of at least 24 inches. Additionally, if foundation excavation and construction work is planned to be performed during wet and/or inclement weather conditions, we recommend that a 3 to 4 inch layer of compacted crushed rock be used to help protect the exposed foundation bearing surfaces until the placement of concrete.

Total and differential settlements of foundations constructed as recommended above and supported by approved native subgrade soils or by properly compacted structural fill materials are expected to be well within the tolerable limits for this type of lightly loaded wood-frame structure and should generally be less than about 1-inch and 1/2-inch, respectively.

Allowable lateral frictional resistance between the base of the footing element and the supporting subgrade bearing soil can be expressed as the applied vertical load multiplied by a coefficient of friction of 0.30 and 0.45 for native silty subgrade soils and/or import gravel fill materials, respectively. In addition, lateral loads may be resisted by passive earth pressures on footings poured "neat" against in-situ (native) subgrade soils or properly backfilled with structural fill materials based on an equivalent fluid density of 300 pounds per cubic foot (pcf). This recommended value includes a factor of safety of approximately 1.5 which is appropriate due to the amount of movement required to develop full passive resistance.

Floor Slab Support

In order to provide uniform subgrade reaction beneath concrete slab-on-grade floors, we recommend that the floor slab area be underlain by a minimum of 6 inches of free-draining (less than 5 percent passing the No. 200 sieve), well-graded, crushed rock. The crushed rock should help provide a capillary break to prevent migration of moisture through the slab. However, additional moisture protection can be provided by using a 10-mil polyolefin geo-membrane sheet such as StegoWrap.

The base course materials should be compacted to at least 95 percent of the maximum dry density as determined by the ASTM D-1557 (AASHTO T-180) test procedures. Where floor slab subgrade materials are undisturbed, firm and stable and where the underslab aggregate base rock section has been prepared and compacted as recommended above, we recommend that a modulus of subgrade reaction of 150 pci be used for design.

Retaining/Below Grade Walls

Retaining and/or below grade walls should be designed to resist lateral earth pressures imposed by native soils or granular backfill materials as well as any adjacent surcharge loads. For walls which are unrestrained at the top and free to rotate about their base, we recommend that active earth pressures be computed on the basis of the following equivalent fluid densities:

Non-Restrained Retaining Wall Pressure Design Recommendations

Slope Backfill (Horizontal/Vertical)	Equivalent Fluid Density/Sand (pcf)	Equivalent Fluid Density/Gravel (pcf)
Level	35	30
3H:1V	60	50
2H:1V	90	80

For walls which are fully restrained at the top and prevented from rotation about their base, we recommend that at-rest earth pressures be computed on the basis of the following equivalent fluid densities:

Restrained Retaining Wall Pressure Design Recommendations

Slope Backfill (Horizontal/Vertical)	Equivalent Fluid Density/Sand (pcf)	Equivalent Fluid Density/Gravel (pcf)
Level	45	35
3H:1V	65	60
2H:1V	95	90

The above recommended values assume that the walls will be adequately drained to prevent the buildup of hydrostatic pressures. Where wall drainage will not be present and/or if adjacent surcharge loading is present, the above recommended values will be significantly higher.

Backfill materials behind walls should be compacted to 90 percent of the maximum dry density as determined by the ASTM D-1557 (AASHTO T-180) test procedures. Special care should be taken to avoid over-compaction near the walls which could result in higher lateral earth pressures than those indicated herein. In areas within three (3) to five (5) feet behind walls, we recommend the use of hand-operated compaction equipment.

Pavements

Flexible pavement design for the proposed street improvements along the south side of Salem Heights Avenue S as well as the proposed new street improvements for the residential development project was determined in accordance with the City of Salem Department of Public Works Administrative Rules Chapter 109-006 (Street Design Standards) Section 6 dated January 1, 2014.

Specifically, on August 9, 2016, samples of the subgrade soils from the existing and/or proposed public streets were collected by means of various test hole excavations. The subgrade soils encountered in the test holes located across the proposed residential subdivision site as well as along the existing pavement grade of Salem Heights Avenue S generally consisted of native and/or residual soils comprised of medium to reddish-brown, medium stiff to stiff, sandy, clayey SILT (ML).

The subgrade soil samples collected at the site were tested in the laboratory in accordance with the ASTM Vol. 4.08 Part D-2844-69 (AASHTO T-190-93) test method for the determination of the subgrade soil "R"-value and expansion pressure. The results of the "R"-value testing was then converted to an equivalent Resilient Modulus (MRSG) in accordance with current AASHTO methodology. The results of the laboratory "R"-value tests revealed that the subgrade soils have an apparent "R"-value of between 24 and 28 with an average "R"-value of 26 (see Figure No. A-12). Using the current AASHTO methodology for converting "R"-value to Resilient Modulus (MRSG), the subgrade soils have a Resilient Modulus (MRSG) of about 5,291 psi which is classified a "Fair" (MRSG = 5,000 psi to 10,000 psi).

In addition to the above, Dynamic Cone Penetration (DCP) tests were performed along the proposed new interior public street alignment at approximate 100-feet intervals. The results of the DCP tests found that the underlying native sandy, clayey silt subgrade soils have a DCP value of between 2 to 3 blows per 2-inches which correlates to a California Bearing Ratio (CBR) of between 5 and 12. Using current AASHTO methodology for converting CBR to Resilient Modulus (MRSG), the subgrade soils have a Resilient Modulus (MRSG) of between 5,842 and 10,637 psi with an average MRSG of 7,150 psi which is classified as "Fair" (MRSG = 5,000 psi to 10,000 psi).

Salem Heights Avenue S

The following documents and/or design input parameters were used to help determine the flexible pavement section design for improvements to Salem Heights Avenue S:

- **Street Classification:** Collector Street
- **Design Life:** 20 years
- **Serviceability:** 4.2 initial, 2.5 terminal
- **Traffic Loading Data:** 1,000,000 18-kip EAL's
- **Reliability Level:** 90%
- **Drainage Coefficient:** 1.0 (asphalt), 0.8 (aggregate)
- **Asphalt Structural Coefficient:** 0.41
- **Aggregate Structural Coefficient:** 0.10

Based on the above design input parameters and using the design procedures contained within the AASHTO 1993 Design of Pavement Structures Manual, a Structural Number (SN) of 4.1 was determined.

In this regard, we recommend the following flexible pavement section for the new improvements to Salem Heights Avenue S:

Material Type	Pavement Section (inches)
Asphaltic Concrete	5.0
Aggregate Base Rock	14.0

Local Residential Streets

The following documents and/or design input parameters were used to help determine the flexible pavement section design for new local residential streets:

- **Street Classification:** Local Residential Street
- **Design Life:** 25 years
- **Serviceability:** 4.2 initial, 2.5 terminal
- **Traffic Loading Data:** 100,000 18-kip EAL's
- **Reliability Level:** 90%
- **Drainage Coefficient:** 1.0 (asphalt), 0.8 (aggregate)
- **Asphalt Structural Coefficient:** 0.41
- **Aggregate Structural Coefficient:** 0.10

Based on the above design input parameters and using the design procedures contained within the AASHTO 1993 Design of Pavement Structures Manual, a Structural Number (SN) of 2.6 was determined.

In this regard, we recommend the following flexible pavement section for the construction of new Local Residential Streets:

Material Type	Pavement Section (inches)
Asphaltic Concrete	4.0
Aggregate Base Rock	10.0

Wet Weather Grading and Soft Spot Mitigation

Construction of the proposed new public street improvements is generally recommended during dry weather. However, during wet weather grading and construction, excavation to subgrade can proceed during periods of light to moderate rainfall provided that the subgrade remains covered with aggregate. A total aggregate thickness of 8-inches may be necessary to protect the subgrade soils from heavy construction traffic. Construction traffic should not be allowed directly on the exposed subgrade but only atop a sufficient compacted base rock thickness to help mitigate subgrade pumping. If the subgrade becomes wet and pumps, no construction traffic shall be allowed on the road alignment. Positive site drainage away from the street shall be maintained if site paving will not occur before the on-set of the wet season.

Depending on the timing for the project, any soft subgrade found during proof-rolling or by visual observations can either be removed and replaced with properly dried and compacted fill soils or removed and replaced with compacted crushed aggregate. However, and where approved by the Geotechnical Engineer, the soft area may be covered with a bi-axial geogrid and covered with compacted crushed aggregate.

Soil Shrink-Swell and Frost Heave

The results of the laboratory "R"-value tests indicate that the native subgrade soils possess a low to moderate expansion potential. As such, the exposed subgrade soils should not be allowed to completely dry and should be moistened to near optimum moisture content (plus or minus 3 percent) at the time of the placement of the crushed aggregate base rock materials. Additionally, exposure of the subgrade soils to freezing weather may result in frost heave and softening of the subgrade. As such, all subgrade soils exposed to freezing weather should be evaluated and approved by the Geotechnical Engineer prior to the placement of the crushed aggregate base rock materials.

Excavation/Slopes

Temporary excavations of up to about four (4) feet in depth may be constructed with near vertical inclinations. Temporary excavations greater than about four (4) feet but less than eight (8) feet should be excavated with inclinations of at least 1 to 1 (horizontal to vertical) or properly braced/shored. Where excavations are planned to exceed about eight (8) feet, this office should be consulted. All shoring systems and/or temporary excavation bracing for the project should be the responsibility of the excavation contractor. Permanent slopes should be constructed no steeper than about 2H to 1V unless approved by the Geotechnical Engineer.

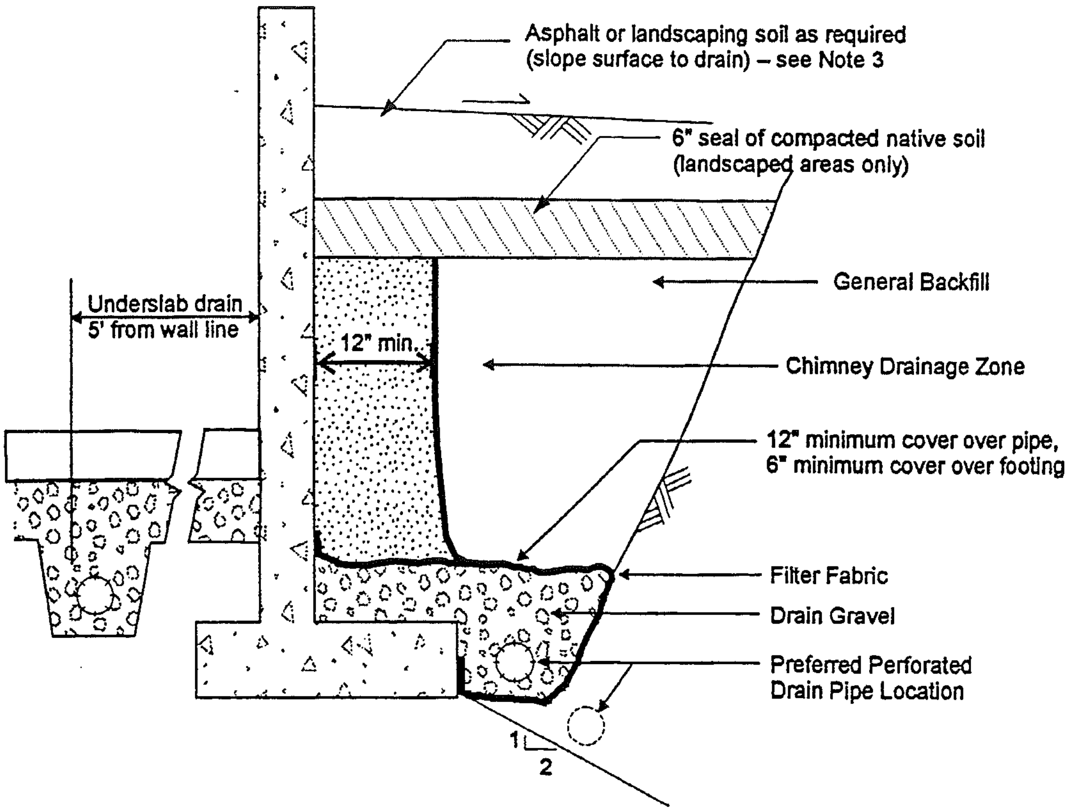
Depending on the time of year in which trench excavations occur, trench dewatering may be required in order to maintain dry working conditions if the invert elevations of the proposed utilities are located at and/or below the groundwater level. If groundwater is encountered during utility excavation work, we recommend placing trench stabilization materials along the base of the excavation. Trench stabilization materials should consist of 1-foot of well-graded gravel, crushed gravel, or crushed rock with a maximum particle size of 4 inches and less than 5 percent fines passing the No. 200 sieve. The material should be free of organic matter and other deleterious material and placed in a single lift and compacted until well keyed.

Surface Drainage/Groundwater

We recommend that positive measures be taken to properly finish grade the site so that drainage waters from the residential structures and landscaping areas as well as adjacent properties or buildings are directed away from the new residential structures foundations and/or floor slabs. All roof drainage should be directed into conduits that carry runoff water away from the residential structures to a suitable outfall. Roof downspouts should not be connected to foundation drains. A minimum ground slope of about 2 percent is generally recommended in unpaved areas around the proposed new residential structures.

Groundwater was not encountered at the site in any of the exploratory test pits (TH-#1 through TH-#8) at the time of excavation to depths of at least 7 feet beneath existing site grades. Additionally, surface water ponding was not observed at the site during our field exploration work. However, the northeasterly portion of the site contains an existing seasonal drainage basin feature. Further, groundwater elevations in the area and/or across the subject property may fluctuate seasonally and may temporarily pond/perch near the ground surface during periods of prolonged rainfall.

As such, based on our current understand of the possible site grading required to bring the subject site and/or residential lots to finish design grade(s), we are of the opinion that an underslab drainage system is not required for the proposed single-family residential structures. However, a perimeter foundation drain is recommended for any perimeter footings and/or below grade retaining walls. A typical recommended perimeter footing/retaining wall drain detail is shown on Figure No. 4.



SCHEMATIC - NOT TO SCALE

NOTES:

1. Filter Fabric to be non-woven geotextile (Amoco 4545, Mirafi 140N, or equivalent)
2. Lay perforated drain pipe on minimum 0.5% gradient, widening excavation as required. Maintain pipe above 2:1 slope, as shown.
3. All-granular backfill is recommended for support of slabs, pavements, etc. (see text for structural fill).
4. Drain gravel to be clean, washed ¾" to 1½" gravel.
5. General backfill to be on-site gravels, or ¾""-0 or 1½"-0 crushed rock compacted to 92% Modified Proctor (AASHTO T-180).
6. Chimney drainage zone to be 12" wide (minimum) zone of clean washed, medium to coarse sand or drain gravel if protected with filter fabric. Alternatively, prefabricated drainage structures (Miradrain 6000 or similar) may be used.

PERIMETER FOOTING/RETAINING WALL DRAIN DETAIL		
Project No. 1338.011.G	SALEM HEIGHTS SUBDIVISION	Figure No. 4

Further, due to our understanding that various surface infiltration ditches and/or swales may be utilized for the project as well as the relatively low infiltration rates of the near surface sandy, clayey silt subgrade soils anticipated within and/or near to the foundation bearing level of the proposed residential structures, we are generally of the opinion that storm water detention and/or disposal systems should not be utilized within the residential lots and/or around the proposed residential structures unless approved by the Geotechnical Engineer.

Design Infiltration Rates

Based on the results of our field infiltration testing, we recommend using the following infiltration rate to design any on-site near surface storm water infiltration and/or disposal systems for the project:

Subgrade Soil Type	Recommended Infiltration Rate
sandy, clayey SILT (ML)	0.2 to 0.3 inches per hour (in/hr)

Note: A safety factor of two (2) was used to calculate the above recommended design infiltration rate. Additionally, given the gradational variability of the on-site sandy, clayey sit subgrade soils beneath the site as well as the anticipation of some site grading for the project, it is generally recommended that field testing be performed during and/or following construction of any on-site storm water infiltration system(s) in order to confirm that the above recommended design infiltration rates are appropriate.

Seismic Design Considerations

Structures at the site should be designed to resist earthquake loading in accordance with the methodology described in the latest edition (2014) of the State of Oregon Structural Specialty Code and/or Amendments to the 2015 International Building Code (IBC). The maximum considered earthquake ground motion for short period and 1.0 period spectral response may be determined from the Oregon Structural Specialty Code and/or from the National Earthquake Hazard Reduction Program (NEHRP) "Recommended Provisions for Seismic Regulations for New Buildings and Other Structures" published by the Building Seismic Safety Council.

We recommend Site Class "C" be used for design. Using this information, the structural engineer can select the appropriate site coefficient values (F_a and F_v) from the 2012 IBC to determine the maximum considered earthquake spectral response acceleration for the project. However, we have assumed the following response spectrum for the project:

Table 1. Recommended Seismic Design Parameters

Site Class	S_S	S_1	F_a	F_v	S_{MS}	S_{M1}	S_{DS}	S_{D1}
C	0.929	0.439	1.028	1.361	0.955	0.598	0.637	0.398

Notes: 1. S_S and S_1 were established based on the USGS 2012 mapped maximum considered earthquake spectral acceleration maps for 2% probability of exceedence in 50 years.

2. F_a and F_v were established based on IBC 2015 tables using the selected S_S and S_1 values.

CONSTRUCTION MONITORING AND TESTING

We recommend that **Redmond Geotechnical Services, LLC** be retained to provide construction monitoring and testing services during all earthwork operations for the proposed new residential development. The purpose of our monitoring services would be to confirm that the site conditions reported herein are as anticipated, provide field recommendations as required based on the actual conditions encountered, document the activities of the grading contractor and assess his/her compliance with the project specifications and recommendations. It is important that our representative meet with the contractor prior to any site grading to help establish a plan that will minimize costly over-excavation and site preparation work. Of primary importance will be observations made during site preparation and stripping, structural fill placement, footing excavations and construction as well as retaining wall backfill.

CLOSURE AND LIMITATIONS

This report is intended for the exclusive use of the addressee and/or their representative(s) to use to design and construct the proposed new single-family residential structures and their associated site improvements described herein as well as to prepare any related construction documents. The conclusions and recommendations contained in this report are based on site conditions as they presently exist and assume that the explorations are representative of the subsurface conditions between the explorations and/or at other locations across the study area. The data, analyses, and recommendations herein may not be appropriate for other structures and/or purposes. We recommend that parties contemplating other structures and/or purposes contact our office. In the absence of our written approval, we make no representation and assume no responsibility to other parties regarding this report. Additionally, the above recommendations are contingent on Redmond Geotechnical Services, LLC being retained to provide all site inspections and constriction monitoring services for this project. Redmond Geotechnical Services, LLC will not assume any responsibility and/or liability for any engineering judgment, inspection and/or testing services performed by others.

It is the owners/developers responsibility for insuring that the project designers and/or contractors involved with this project implement our recommendations into the final design plans, specifications and/or construction activities for the project. Further, in order to avoid delays during construction, we recommend that the final design plans and specifications for the project be reviewed by our office to evaluate as to whether our recommendations have been properly interpreted and incorporated into the project.

If during any future site grading and construction, subsurface conditions different from those encountered in the explorations are observed or appear to be present beneath excavations, we should be advised immediately so that we may review these conditions and evaluate whether modifications of the design criteria are required. We also should be advised if significant modifications of the proposed site development are anticipated so that we may review our conclusions and recommendations.

LEVEL OF CARE

The services performed by the Geotechnical Engineer for this project have been conducted with that level of care and skill ordinarily exercised by members of the profession currently practicing in the area under similar budget and time restraints. No warranty or other conditions, either expressed or implied, is made.

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Appendix "A"

Test Pit Logs and Laboratory Test Data

APPENDIX

FIELD EXPLORATIONS AND LABORATORY TESTING

FIELD EXPLORATION

Subsurface conditions at the site were explored by excavating eight (8) exploratory test pits (TH-#1 through TH-#8) on August 9, 2016. The approximate location of the test pit explorations are shown in relation to the proposed new residential lots and the associated site improvements on the Site Exploration Plan, Figure No. 2.

The test pits were excavated using track-mounted excavating equipment in general conformance with ASTM Methods in Vol. 4.08, D-1586-94 and D-1587-83. The test pits were excavated to depths ranging from about 5.0 to 7.0 feet beneath existing site grades. Detailed logs of the test pits are presented on the Log of Test Pits, Figure No's. A-4 through A-7. The soils were classified in accordance with the Unified Soil Classification System (USCS), which is outlined on Figure No. A-3.

The exploration program was coordinated by a field engineer who monitored the excavating and exploration activity, obtained representative samples of the subsurface soils encountered, classified the soils by visual and textural examination, and maintained continuous logs of the subsurface conditions. Disturbed and/or undisturbed samples of the subsurface soils were obtained at appropriate depths and/or intervals and placed in plastic bags and/or with a thin walled ring sample.

Groundwater was not encountered in any of the exploratory test pits (TH-#1 through TH-#8) at the time of excavating to depths of at least 7.0 feet beneath existing surface grades.

LABORATORY TESTING

Pertinent physical and engineering characteristics of the soils encountered during our subsurface investigation were evaluated by a laboratory testing program to be used as a basis for selection of soil design parameters and for correlation purposes. Selected tests were conducted on representative soil samples. The program consisted of tests to evaluate the existing (in-situ) moisture-density, maximum dry density and optimum moisture content, gradational characteristics, and Atterberg Limits as well as direct shear strength and "R"-value tests.

Dry Density and Moisture Content Determinations

Density and moisture content determinations were performed on both disturbed and relatively undisturbed samples from the test pit explorations in general conformance with ASTM Vol. 4.08 Part D-216. The results of these tests were used to calculate existing overburden pressures and to correlate strength and compressibility characteristics of the soils. Test results are shown on the test pit logs at the appropriate sample depths.

Maximum Dry Density

Two (2) Maximum Dry Density and Optimum Moisture Content tests were performed on representative samples of the on-site sandy, clayey silt subgrade soils in accordance with ASTM Vol. 4.08 Part D-1557. This tests were conducted to help establish various engineering properties for use as structural fill. The test results are presented on Figure No. A-8.

Atterberg Limits

Two (2) Liquid Limit (LL) and Plastic Limit (PL) tests were performed on representative samples of the sandy, clayey silt subgrade soils in accordance with ASTM Vol. 4.08 Part D-4318-85. These tests were conducted to facilitate classification of the soils and for correlation purposes. The test results appear on Figure No. A-9.

Gradation Analysis

Two (2) Gradation analyses were performed on representative samples of the subsurface soils in accordance with ASTM Vol. 4.08 Part D-422. The test results were used to classify the soil in accordance with the Unified Soil Classification System (USCS). The test results are shown graphically on Figure No. A-10.

Direct Shear Strength Test

Two (2) Direct Shear Strength tests were performed on undisturbed and/or remolded samples at a continuous rate of shearing deflection (0.02 inches per minute) in accordance with ASTM Vol. 4.08 Part D-3080-79. The test results were used to determine engineering strength properties and are shown graphically on Figure No's. A-11 and A-12.

"R"-Value Tests

Two (2) "R"-value tests were performed on remolded subgrade soil samples in accordance with ASTM Vol. 4.08 Part D-2844. The test results were used to help evaluate the subgrade soils supporting and performance capabilities when subjected to traffic loading. The test results are shown on Figure No. A-13.

The following figures are attached and complete the Appendix:

Figure No. A-3	Key To Exploratory Test Pit Logs
Figure No's. A-4 through A-7	Log of Test Pits/Dynamic Cone
Figure No. A-8	Maximum Dry Density
Figure No. A-9	Atterberg Limits Test Results
Figure No. A-10	Gradation Test Results
Figure No's. A-11 and A-12	Direct Shear Strength Test Results
Figure No. A-13	Results of "R"-Value Tests
Figure No's. A-14 and A-15	Field Infiltration Test Results

PRIMARY DIVISIONS			GROUP SYMBOL	SECONDARY DIVISIONS
COARSE GRAINED SOILS — MORE THAN HALF OF MATERIAL IS LARGER THAN NO. 200 SIEVE SIZE	GRAVELS — MORE THAN HALF OF COARSE FRACTION IS LARGER THAN NO. 4 SIEVE	CLEAN GRAVELS (LESS THAN 5% FINES)	GW	Well graded gravels, gravel-sand mixtures, little or no fines.
			GP	Poorly graded gravels or gravel-sand mixtures, little or no fines.
		GRAVEL WITH FINES	GM	Silty gravels, gravel-sand-silt mixtures, non-plastic fines.
			GC	Clayey gravels, gravel-sand-clay mixtures, plastic fines.
	SANDS — MORE THAN HALF OF COARSE FRACTION IS SMALLER THAN NO. 4 SIEVE	CLEAN SANDS (LESS THAN 5% FINES)	SW	Well graded sands, gravelly sands, little or no fines.
			SP	Poorly graded sands or gravelly sands, little or no fines.
		SANDS WITH FINES	SM	Silty sands, sand-silt mixtures, non-plastic fines.
			SC	Clayey sands, sand-clay mixtures, plastic fines.
FINE GRAINED SOILS — MORE THAN HALF OF MATERIAL IS SMALLER THAN NO. 200 SIEVE SIZE	SILTS AND CLAYS — LIQUID LIMIT IS LESS THAN 50%		ML	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands or clayey silts with slight plasticity.
			CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays.
			OL	Organic silts and organic silty clays of low plasticity.
	SILTS AND CLAYS — LIQUID LIMIT IS GREATER THAN 50%		MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts.
			CH	Inorganic clays of high plasticity, fat clays.
			OH	Organic clays of medium to high plasticity, organic silts.
HIGHLY ORGANIC SOILS			Pt	Peat and other highly organic soils.

DEFINITION OF TERMS

U.S. STANDARD SERIES SIEVE: 200 | 40 | 10 | 4 — CLEAR SQUARE SIEVE OPENINGS: 3/4" | 3" | 12"

SILTS AND CLAYS	SAND			GRAVEL		COBBLES	BOULDERS
	FINE	MEDIUM	COARSE	FINE	COARSE		

GRAIN SIZES

SANDS, GRAVELS AND NON-PLASTIC SILTS	BLOWS/FOOT†
VERY LOOSE	0 - 4
LOOSE	4 - 10
MEDIUM DENSE	10 - 30
DENSE	30 - 50
VERY DENSE	OVER 50

RELATIVE DENSITY

CLAYS AND PLASTIC SILTS	STRENGTH‡	BLOWS/FOOT†
VERY SOFT	0 - 1/4	0 - 2
SOFT	1/4 - 1/2	2 - 4
FIRM	1/2 - 1	4 - 8
STIFF	1 - 2	8 - 16
VERY STIFF	2 - 4	16 - 32
HARD	OVER 4	OVER 32

CONSISTENCY

†Number of blows of 140 pound hammer falling 30 inches to drive a 2 inch O.D. (1-3/8 inch I.D.) split spoon (ASTM D-1586).
‡Unconfined compressive strength in tons/sq. ft. as determined by laboratory testing or approximated by the standard penetration test (ASTM D-1586), pocket penetrometer, torvane, or visual observation.

REDMOND GEOTECHNICAL SERVICES
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KEY TO EXPLORATORY TEST PIT LOGS
Unified Soil Classification System (ASTM D-2487)

SALEM HEIGHTS SUBDIVISION
Salem, Oregon

PROJECT NO.	DATE	
1338.011.G	10/28/16	Figure A-3

BACKHOE COMPANY: Gene S. McMurrin BUCKET SIZE: 24 inches DATE: 8/09/16

SOIL DESCRIPTION

TEST PIT NO. TH-#1 ELEVATION 437'±

DEPTH (FEET)	BAG SAMPLE	DENSITY TEST	DRY DENSITY (pcf)	MOISTURE CONTENT (%)	SOIL CLASS. (U.S.C.S.)	SOIL DESCRIPTION
0					ML	Dark brown, very moist, very soft, organic, sandy, clayey SILT (Topsoil)
					ML	Medium to reddish-brown, moist to very moist, medium stiff, sandy, clayey SILT
5					ML/RK	Orangish-brown, moist to very moist, medium dense, clayey, sandy SILT to highly weathered bedrock
						Total Depth = 5.0 feet No groundwater enciuntered at time of exploration
10						
15						

TEST PIT NO. TH-#2 ELEVATION 395'±

DEPTH (FEET)	BAG SAMPLE	DENSITY TEST	DRY DENSITY (pcf)	MOISTURE CONTENT (%)	SOIL CLASS. (U.S.C.S.)	SOIL DESCRIPTION
0					ML	Dark brown, very moist to wet, very soft, organic, sandy, clayey SILT (Topsoil)
	X			22.7		
					ML	Medium to reddish-brown, very moist, medium stiff, sandy, clayey SILT
	X			26.6		
5					ML/RK	Orangish-brown, moist to very moist, medium dense, clayey, sandy SILT to highly weathered bedrock
						Total Depth = 6.0 feet No groundwater encountered at time of exploration
10						
15						

LOG OF TEST PITS

PROJECT NO. 1338.011.G SALEM HEIGHTS SUBDIVISION FIGURE NO. A-4

BACKHOE COMPANY: Gene S. McMurrin BUCKET SIZE: 24 inches DATE: 8/09/16

TEST PIT NO. TH-#3 ELEVATION 416'±

DEPTH (FEET)	BAG SAMPLE	DENSITY TEST	DRY DENSITY (pcf)	MOISTURE CONTENT (%)	SOIL CLASS. (U.S.C.S.)	SOIL DESCRIPTION
0					ML	Dark brown, very moist, very soft, organic, sandy, clayey SILT (Topsoil)
					ML	Medium to reddish-brown, moist to very moist, medium stiff, sandy, clayey SILT
5					ML/RK	Orangish-brown, moist to very moist, medium dense, clayey, sandy SILT to highly weathered bedrock
						Total Depth = 6.0 feet No groundwater encountered at time of exploration
10						
15						

TEST PIT NO. TH-#4 ELEVATION 443'±

DEPTH (FEET)	BAG SAMPLE	DENSITY TEST	DRY DENSITY (pcf)	MOISTURE CONTENT (%)	SOIL CLASS. (U.S.C.S.)	SOIL DESCRIPTION
0	X			23.4	ML	Dark brown, very moist, very soft, organic, sandy, clayey SILT (Topsoil)
	X			25.9	ML	Medium to reddish-brown, moist to very moist, medium stiff, sandy, clayey SILT
5					ML/RK	Orangish-brown, moist to very moist, medium dense, clayey, sandy SILT to highly weathered bedrock
						Total Depth = 5.0 feet No groundwater encountered at time of exploration
10						
15						

LOG OF TEST PITS

PROJECT NO. 1338.011.G | SALEM HEIGHTS SUBDIVISION | FIGURE NO. A-5

BACKHOE COMPANY: Gene S. McMurrin BUCKET SIZE: 24 inches DATE: 8/09/16

TEST PIT NO. TH-#5 ELEVATION 452'±

DEPTH (FEET)	BAG SAMPLE	DENSITY TEST	DRY DENSITY (pcf)	MOISTURE CONTENT (%)	SOIL CLASS. (U.S.C.S.)	SOIL DESCRIPTION
0					ML	Dark brown, very moist, very soft, organic, sandy, clayey SILT (Topsoil/Fill)
					ML	Medium to reddish-brown, moist to very moist, medium stiff, sandy, clayey SILT
5					ML/RK	Reddish- to orangish-brown, very moist, medium dense, clayey, sandy SILT to highly weathered bedrock
						Total Depth = 7.0 feet No groundwater encountered at time of exploration
10						
15						

TEST PIT NO. TH-#6 ELEVATION 475'±

DEPTH (FEET)	BAG SAMPLE	DENSITY TEST	DRY DENSITY (pcf)	MOISTURE CONTENT (%)	SOIL CLASS. (U.S.C.S.)	SOIL DESCRIPTION
0					ML	Dark brown, very moist, very soft, organic, sandy, clayey SILT (Topsoil)
					ML	Medium to reddish-brown, very moist, medium stiff, sandy, clayey SILT
5					ML/RK	Reddish- to orangish-brown, moist to very moist, medium dense, clayey, sandy SILT to highly weathered bedrock
						Total Depth = 6.0 feet No groundwater encountered at time of exploration
10						
15						

LOG OF TEST PITS

PROJECT NO. 1338.011.G | SALEM HEIGHTS SUBDIVISION | FIGURE NO. A-6

BACKHOE COMPANY: Gene S. McMurrin BUCKET SIZE: 24 inches DATE: 8/09/16

SOIL DESCRIPTION

TEST PIT NO. TH-#7 ELEVATION 449'±

DEPTH (FEET)	BAG SAMPLE	DENSITY TEST	DRY DENSITY (pcf)	MOISTURE CONTENT (%)	SOIL CLASS. (U.S.C.S.)	SOIL DESCRIPTION
0					ML	Dark brown, very moist, very soft, organic, sandy, clayey SILT (Topsoil)
	X			23.8	ML	Medium to reddish-brown, very moist, medium stiff, sandy, clayey SILT
5	X			24.8	ML/RK	Reddish- to orangish-brown, moist to very moist, medium dense, clayey, sandy SILT to highly weathered bedrock
						Total Depth = 6.0 feet No groundwater encountered at time of exploration
10						
15						

TEST PIT NO. TH-#8 ELEVATION 413'±

DEPTH (FEET)	BAG SAMPLE	DENSITY TEST	DRY DENSITY (pcf)	MOISTURE CONTENT (%)	SOIL CLASS. (U.S.C.S.)	SOIL DESCRIPTION
0					ML	Dark brown, very moist, very soft, organic, sandy, clayey SILT (Topsoil)
					ML	Medium to reddish-brown, very moist, medium stiff, sandy, clayey SILT
5					ML/RK	Reddish- to orangish-brown, very moist, medium dense, clayey, sandy SILT to highly weathered bedrock
						Total Depth = 6.0 feet No groundwater encountered at time of exploration
10						
15						

LOG OF TEST PITS

PROJECT NO. 1338.011.G SALEM HEIGHTS SUBDIVISION FIGURE NO. A-7

MAXIMUM DENSITY TEST RESULTS

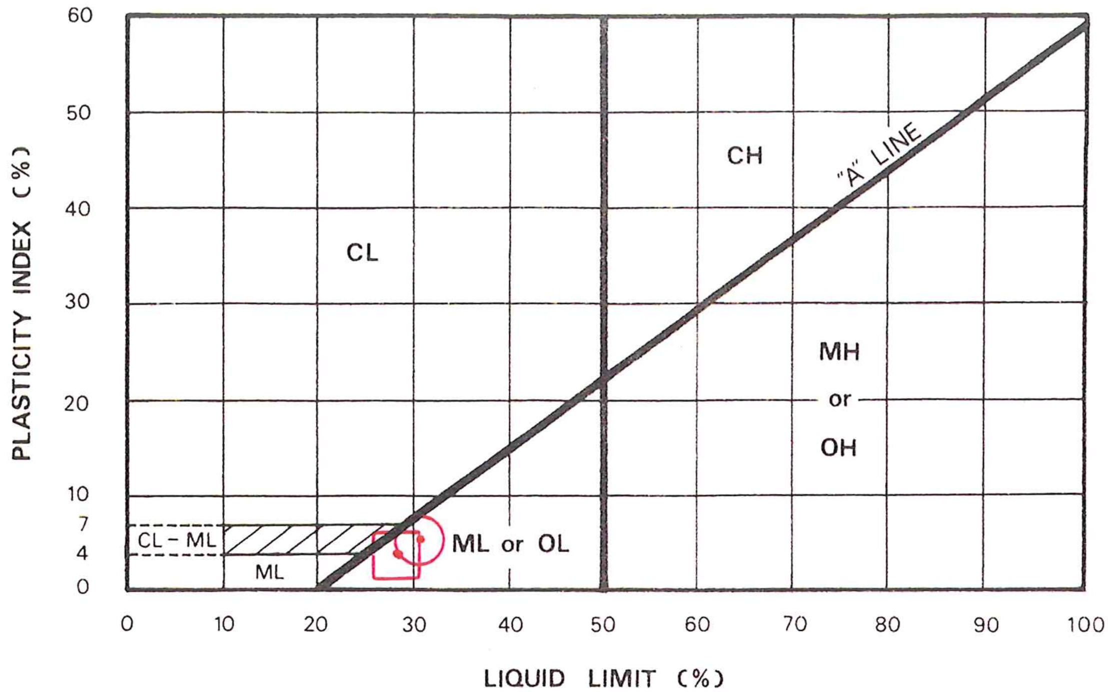
SAMPLE LOCATION	SOIL DESCRIPTION	MAXIMUM DRY DENSITY (pcf)	OPTIMUM MOISTURE CONTENT (%)
TH-#2 @ 1.5'	Medium to reddish-brown, sandy, clayey SILT (ML)	103.0	19.0
TH-#7 @ 2.0'	Medium to reddish-brown, sandy, clayey SILT (ML)	104.0	18.0

EXPANSION INDEX TEST RESULTS

SAMPLE LOCATION	INITIAL MOISTURE (%)	COMPACTED DRY DENSITY (pcf)	FINAL MOISTURE (%)	VOLUMETRIC SWELL (%)	EXPANSION INDEX	EXPANSIVE CLASS.

MAXIMUM DENSITY & EXPANSION INDEX TEST RESULTS

PROJECT NO.: 1338.011.G | SALEM HEIGHTS SUBDIVISION | FIGURE NO.: A-8



KEY SYMBOL	BORING NO.	SAMPLE DEPTH (feet)	NATURAL WATER CONTENT %	LIQUID LIMIT %	PLASTICITY INDEX %	PASSING NO. 200 SIEVE %	LIQUIDITY INDEX	UNIFIED SOIL CLASSIFICATION SYMBOL
	TH-#2	1.5	22.7	27.9	4.3	86.2		ML
	TH-#7	2.0	23.8	30.2	6.3	92.0		ML

REDMOND GEOTECHNICAL SERVICES

PO Box 20547 • Portland, Oregon 97294

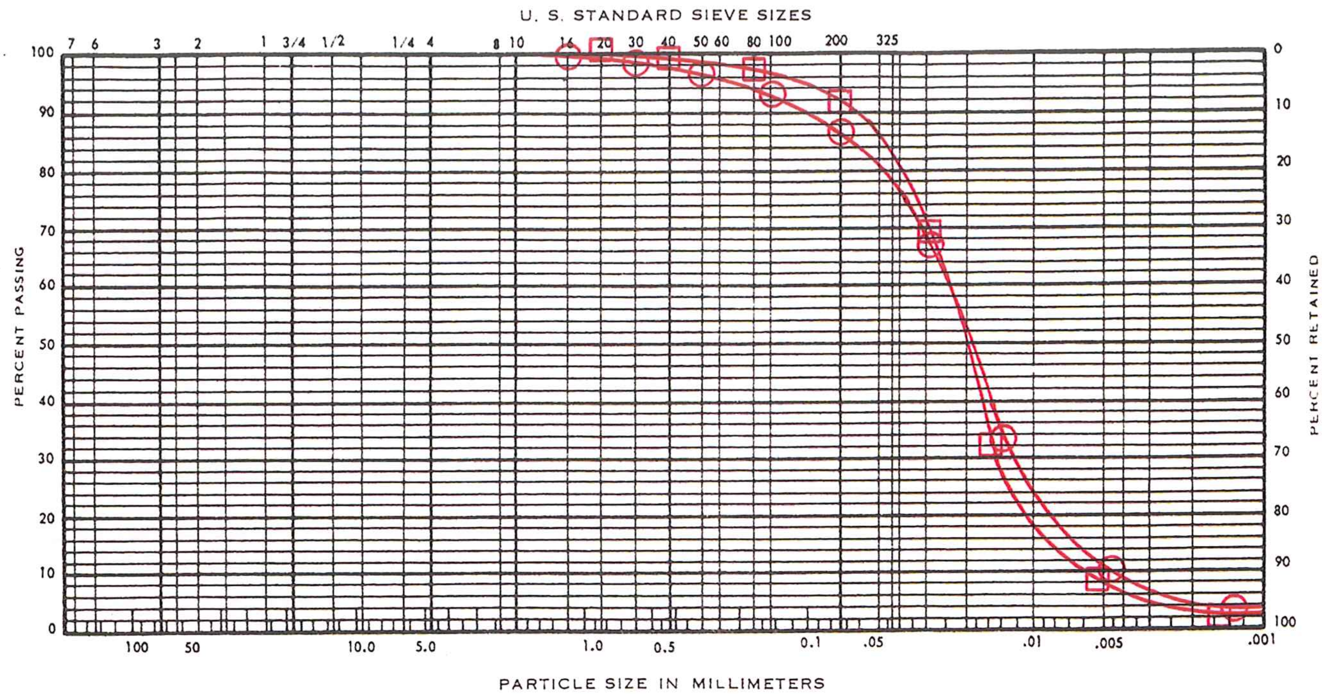
PLASTICITY CHART AND DATA

SALEM HEIGHTS SUBDIVISION
Salem, Oregon

PROJECT NO.	DATE	
1338.011.G	10/24/16	Figure A-9

UNIFIED SOIL CLASSIFICATION SYSTEM

(ASTM D 422-72)



COBBLES	GRAVEL		SAND			SILT AND CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	

KEY SYMBOL	BORING NO.	SAMPLE DEPTH (feet)	ELEV. (feet)	UNIFIED SOIL CLASSIFICATION SYMBOL	SAMPLE DESCRIPTION
	TH-#2	1.5		ML	Medium to reddish-brown, sandy, clayey SILT
	TH-#7	2.0		ML	Medium to reddish-brown, sandy, clayey SILT

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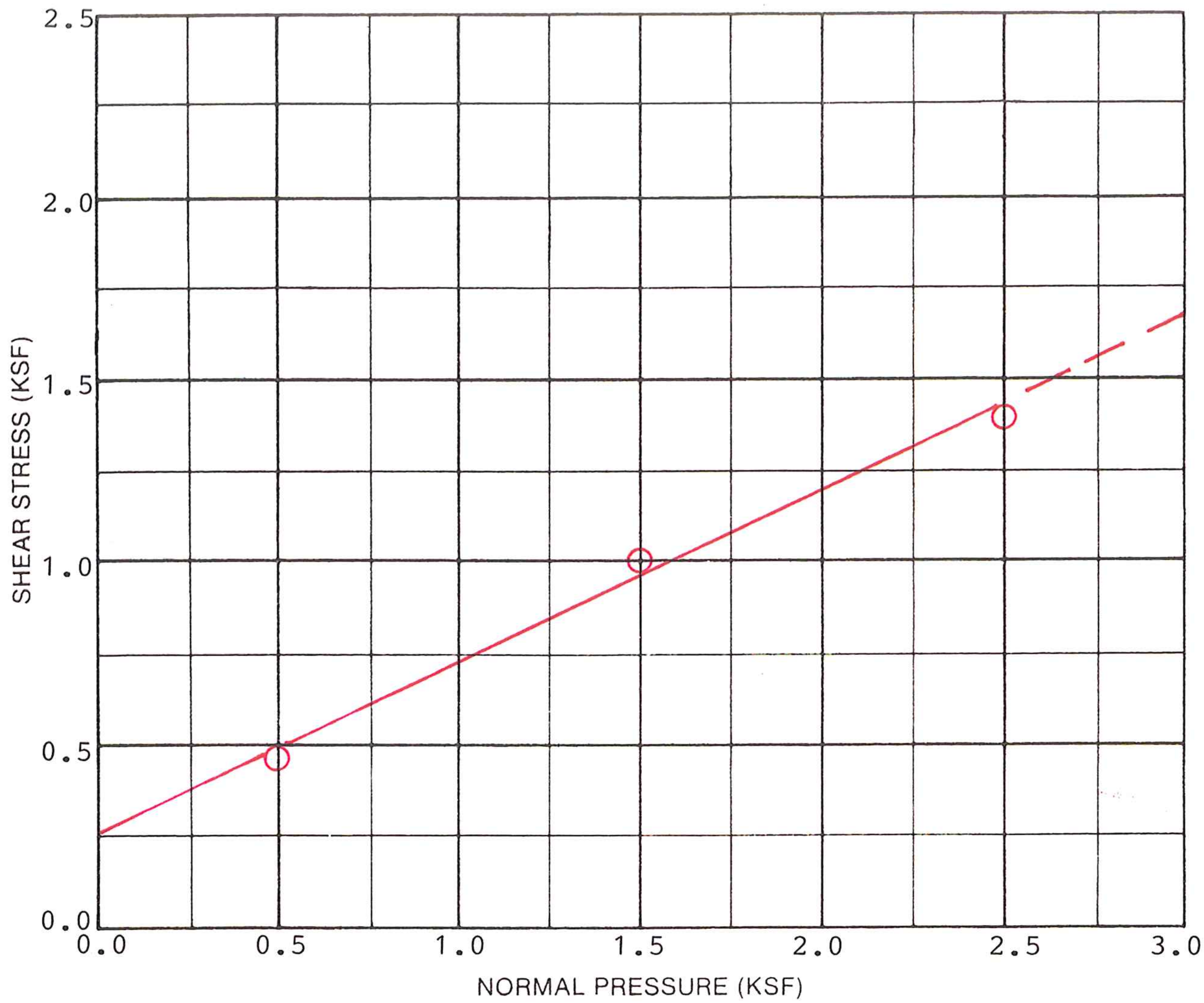
PO Box 20547 • Portland, Oregon 97294

GRADATION TEST DATA

SALEM HEIGHTS SUBDIVISION
Salem, Oregon

PROJECT NO.	DATE	FIGURE
1338.011.G	10/24/16	A-10



SAMPLE DATA	
DESCRIPTION:	Medium to reddish-brown sandy, clayey SILT (ML)
BORING NO.:	TH-#2
DEPTH (ft.): [illegible]	ELEVATION (ft):

TEST RESULTS	
APPARENT COHESION (C):	250 psf
APPARENT ANGLE OF INTERNAL FRICTION (ϕ):	24°

TEST DATA				
TEST NUMBER	1	2	3	4
NORMAL PRESSURE (KSF)	0.5	1.5	2.5	
SHEAR STRENGTH (KSF)	0.5	1.0	1.4	
INITIAL H_2O CONTENT (%)	22.5	22.5	22.5	
FINAL H_2O CONTENT (%)	22.3	19.8	16.2	
INITIAL DRY DENSITY (PCF)	90.0	90.0	90.0	
FINAL DRY DENSITY (PCF)	90.4	95.5	99.8	
STRAIN RATE: 0.02 inches per minute				

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DIRECT SHEAR TEST DATA		
SALEM HEIGHTS SUBDIVISION Salem, Oregon		
PROJECT NO.	DATE	Figure A-11
1338.011.G	10/24/16	

RESULTS OF R (RESISTANCE) VALUE TESTS

SAMPLE LOCATION: TH-#2

SAMPLE DEPTH: 1.5 feet bgs

Specimen	A	B	C
Exudation Pressure (psi)	212	320	428
Expansion Dial (o.ooo1”)	0	2	5
Expansion Pressure (psf)	0	7	18
Moisture Content (%)	22.6	18.9	14.2
Dry Density (pcf)	89.1	93.7	97.6
Resistance Value, “R”	14	25	34
“R”-Value at 300 psi Exudation Pressure = 24			

SAMPLE LOCATION: TH-#7

SAMPLE DEPTH: 2.0 feet bgs

Specimen	A	B	C
Exudation Pressure (psi)	202	322	434
Expansion Dial (0.0001”)	0	2	4
Expansion Pressure (psf)	0	7	14
Moisture Content (%)	22.3	18.5	14.0
Dry Density (pcf)	90.2	94.1	98.4
Resistance Value “R”	17	29	38
“R”-Value at 300 psi Exudation Pressure = 28			

Division 004 Appendix C - Infiltration Testing

Location: Salem Heights Subdivision	**Date:** August 9, 2016	**Test Hole:** TH-#2
Depth to Bottom of Hole: 2.0 feet	**Hole Diameter:** 6 inches	**Test Method:** Encased Falling Head
Tester's Name: Daniel M. Redmond, P.E., G.E. **Tester's Company:** Redmond Geotechnical Services, LLC		**Tester's Contact Number:** 503-285-0598

Depth (feet)	Soil Characteristics
0-0.5	Dark brown Topsoil
0.5-2.0	Medium to reddish-brown, sandy, clayey SILT (ML)

Time	Time Interval (Minutes)	Measurement (inches)	Drop in Water (inches)	Infiltration Rate (inches/hour)	Remarks
10:00	0	12.00	----		Filled w/12" water
10:20	20	12.30	0.30	0.90	
10:40	20	12.55	0.25	0.75	
11:00	20	12.75	0.20	0.60	
11:20	20	12.92	0.17	0.50	
11:40	20	13.07	0.15	0.45	
12:00	20	13.21	0.14	0.42	
12:20	20	13.34	0.13	0.40	
12:40	20	13.47	0.13	0.40	

Infiltration Test Data Table

Figure No. 14

Division 004 Appendix C - Infiltration Testing

Location: Salem Heights Subdivision	**Date:** August 9, 2016	**Test Hole:** TH-#5
Depth to Bottom of Hole: 4.0 feet	**Hole Diameter:** 6 inches	**Test Method:** Encased Falling Head
Tester's Name: Daniel M. Redmond, P.E., G.E. **Tester's Company:** Redmond Geotechnical Services, LLC		**Tester's Contact Number:** 503-285-0598

Depth (feet)	Soil Characteristics
0-1.0	Dark brown Topsoil/Fill
1.0-4.0	Medium to reddish-brown, sandy, clayey SILT (ML)

Time	Time Interval (Minutes)	Measurement (inches)	Drop in Water (inches)	Infiltration Rate (inches/hour)	Remarks
10:10	0	36.00	----		Filled w/12" water
10:30	20	36.37	0.37	1.10	
10:50	20	36.69	0.32	0.95	
11:10	20	36.96	0.27	0.80	
11:30	20	37.19	0.23	0.70	
11:50	20	37.41	0.22	0.65	
12:10	20	37.62	0.21	0.62	
12:30	20	37.82	0.20	0.60	
12:50	20	38.02	0.20	0.60	

Infiltration Test Data Table

Figure No. 15

Appendix "B"

Geologic Hazard Assessment

NORTHWEST GEOLOGICAL SERVICES, INC.
Consulting Geologists and Hydrogeologists
2505 N.E. 42nd Avenue, Portland, Oregon 97213-1201
503-249-1093 ngs@spiritone.com

Redmond Geotechnical Services LLC
P.O. Box 20547
Portland, OR 97294

16 August 2016

Attention: Dan Redmond

Geologic Assessment
Ewald Fruit Farms Tract
Salem Heights Ave. S
8S/3W-4AA Ewald Fruit Farm Tract
TLs 10400, 10500, 10600, 10601, 10700 & 10800
Salem, Oregon 97302

Dan:

The purpose of this letter is to present Northwest Geological Services, Inc. (NGS') Geological Assessment for the above referenced property. We understand that our services are in support of your client's intention to repartition and subdivide the property for future residential development on the new parcels. The work for this study was done in accordance with your authorization of 1 August 2016.

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 the City of Salem. Specifically, our work included:

- Obtain and review historic maps, aerial photographs, LIDAR and digital images of the site;
- Review published and selected unpublished geologic investigations of the site and site area;
- Conduct a geologic reconnaissance of the site and adjacent area on 9 August 2016;
- Observe & log six test pits at the site;
- Evaluate the potential landslide hazards using the information developed; and,
- Prepare this letter-report describing our work, findings and recommendations.

Our work did not include review of a site grading plan showing proposed cuts and fills. In our opinion, the client's proposed location and general layout for the parcels and infrastructure appear feasible. However, we anticipate that the detailed plans will be in accordance with the recommendations provided herein, and by your engineering and design professionals.

2. SITE SETTING

The subject property consists of approximately 9.06 acres located in Salem, Marion County, Oregon. The site is located on the north side of Salem Heights Ave. S (Site, Figures 1 and 2). It is in the NE ¼ of the NE ¼ Section 4, T8S, R3W. It is presently zoned single family residential. Two residences, both built before 1954, are located in the SW part of the site at 525 and 625 Salem Heights Ave S (Figure 3).

2.1 Location and Physiography

The property is located near the top of Salem Heights (Figure 1). The site is accessed from the south via Salem Heights Ave S, or from the north via, Felton St S, Earhart St S or Doughton St S (Figure 2). It is surrounded by built-up residential subdivisions. The site was an orchard (Ewald Fruit Farms) through the 1950s. TLs 10400 and 10500 have unoccupied residences and landscaping. The remainder was intermittently maintained as orchard but is now overgrown and largely unmaintained (Figure 3).

Elevations in the site area range from about 465 at the west edge of the site, down to about 395 ft near the NE corner. Site slopes are generally moderate (<20%) to the east and northeast, with a NNW-SSE band of steeper (20% - 30%) through the west central part of the site (Figure 4). The southwest corner has only a slight slope to the ESE. Short (<10 ft) steeper man-made slopes are present below a landscaped terrace downhill of the two existing residences.

2.2 Proposed Site Development

The proposed site layout is shown on Figure 4. It includes 36 residential lots arranged along new streets and cul-de-sacs. Lots range from 6219 to 15381 ft^2. The existing residences will be demolished.

2.3 Government Slope Hazard Estimates

Several years ago DOGAMI estimated a "low to intermediate" relative earthquake risk for the site area (Wang & Leonard, 1996). Additionally DOGAMI recently added potential landslide susceptibility ranking to its SLIDO web site. That ranking shows the site with a moderate to high susceptibility to landslides. Finally, the City of Salem shows some slopes steep enough to present a level 2 to 3 risk (on a scale of 0 to 6).

2.3.1 DOGAMI Earthquake-Induced Slope Hazard Estimates

GMS-105 (Wang & Leonard, 1996) estimated the site had the following <u>relative</u> earthquake hazard risks:

- Liquefaction susceptibility: 0 on a scale of 0 (none) to 5 (high) based on an estimated lack of potentially liquefiable soil in the subsurface.
- Amplification susceptibility: 2 on scale of 0 to 5. This ranking is based on an assumed presence of several feet of unconsolidated or soft soils in the subsurface.
- Landslide susceptibility: 1 to 2 on scale of 0 (low) to 5 (high) based on slopes of less than 6% to more than 15%.
- Overall Relative Earthquake Hazard: Zone C (low to intermediate) on scale of D (low) to A (highest) based on combination of the above hazards.

A subsequent (and more realistic) hazard model in IMS-17 (Hofmeister and others, 2001) found low to no hazard from earthquake-induced slope failures at the site.

2.3.2 DOGAMI Landslide Susceptibility

The SLIDO landslide susceptibility map estimates the site has an intermediate landslide risk (on scale of low-intermediate-high). These maps are derived from generalized digital geologic maps, evaluation of LIDAR imagery and comparison with information for existing nearby landslides and or estimated hazards. For this area the susceptibility is based on GMS-105, discussed above, and topography. The susceptibility maps are not maps of landslides. Rather, they denote areas that should be evaluated by a qualified professional Engineering Geologist. They are similar to the City of Salem risk maps that are also based mainly on slope and the presence of nearby landslides and/or estimated risks.

2.4 Site Area Geology

The site area is underlain by lava flows of the Columbia River Basalt (Figures 5 and 6). Areas west of the site and below elevations of about 250 ft are underlain by marine sedimentary strata comprised mostly of siltstone and silty sandstone (Figure 5). Logs of nearby water wells indicate that these sedimentary strata occur beneath a thickness of 200 – 300 ft or more of the basalt at the site (Foxworthy, 1970).

The geology of the area around the site was mapped by the State and US Geological Survey (Bela, 1981; Foxworthy, 1970) as underlain by Miocene volcanic rocks of the Columbia River Basalt (Tcr on Figure 5). Both Foxworthy and Bella interpreted the slopes west of Salem Heights as landslide topography developed on extensive ancient landslides. Mapping by NGS (1997) and Beeson & Tolan (2001) mapped the individual flows within the Basalt (Tgsb, Tgww and Tgo on Figure 6) and pre-basalt sedimentary strata (Tms on Figure 6). This more recent mapping shows that the steep slope west of Salem Heights is not a landslide scarp as interpreted by Bella (Figure 5). Instead, the steep slope area is underlain by basalt bedrock. Missoula Flood deposits and local surficial slides mantle the bedrock, as demonstrated by numerous outcrops and road cuts.

The topography of gentle knolls and swales produced by the Missoula floods has been mistakenly identified as "landslide topography" by Bela and other geologists.[1] However, extensive work by the US Geological Survey and Oregon Department of Water Resources clearly agrees with the Missoula flood origin of the Willamette Silt, scarp-like slopes, and anomalous topography around the lower elevations of the Salem Hills (e.g., Waitt, 1985, NGS, 1997; O'Connor and others, 2001).

3. SITE SPECIFIC STUDIES

3.1 Previous Site Development

We reviewed available historic topographic maps and aerial photographs[2] to assess previous use of the site. The aerial photographs were also reviewed for indications of slope failures at and near the site. The resolution of the aerial photos is adequate to see vehicles on roads and relatively modest earthworks. The photos do show that the site has a long history of use as an orchard through the 1950s. The 1936 photos show the flat, SW corner of the site was forested. The sloped remainder was planted in orchard. The 1954 air photos show the site residences were built and the surrounding area landscaped. They also show the terrace behind the houses had been cut and landscaped. Maps and photos through the late 1990s show the site in its present layout with the houses, but with the orchards only intermittently maintained. Since the 1990s the orchards have been overgrown by brush and seedling trees.

[1] Note, however, that numerous actual landslides did occur during the floods. These usually are easily identified.

[2] Photos from 1936, 1954, 1971, 1985, 1990 and 2000 were reviewed. We also checked Google Earth imagery (dated 1990-2014) online.

In summary, the photos show no obvious use of the site except as residential and orchard. No signs of slope instability or failure were observed on the aerial photographs we examined.

3.2 Site Reconnaissance

We conducted a walking reconnaissance of the site and surrounding area and a drive-through of the neighborhood on 9 August 2016. We observed cut slopes and excavation spoils at the site to confirm the thickness and nature of the soils and weathered rock overlying the bed-rock. Our reconnaissance observations were consistent with the previous geologic mapping (Figures 5 and 6).

3.3 Site Explorations

Test pits at the site (locations on Figure 4) indicate that only a several inches to a few feet of soil overlay the bedrock. The top several feet of the basalt are usually weathered to a hard to very hard clayey silt. Along ridge tops the basalt has decomposed to a bleached grey laterite. Locally, patches of weathered to fresh basalt bedrock occur at the ground surface.

The test pits (Table 1) confirm that the soils are thin, cobbly to bouldery, sandy SILT and have reasonable strength characteristics, in agreement with our findings just to the northwest (NGS, 2014). Our experience is that the weathered basalt is very competent with compressive strength in excess of 5 tsf.

Geologic Unit	TP-1	TP-2	TP-3	TP-4	TP-5	TP-6
Fill (SILT)	0 - 1				0 - 1 ft	
Brown sandy SILT				0 - 3.5 ft		
Red brown sandy SILT (residual)	1 - 3 ft	0 - 1 ft	0 - 1.5 ft		1 - 3 ft	1 - 2.7 ft
Decomposed Basalt (bleached)	3 - 4.5 ft	1 - 2.7 ft	0.5 - 3.5 ft		3 - 4.5 ft	2.7 - 3.5
Weathered Basalt	4.5 ft	2.7 - 3 ft	3.5 -4 ft	3.5 - 4.5 ft		3.5 - 4.5 ft
Total Depth	4.5	3	4 ft	4.5 ft	4.5 ft	4.5 ft

TABLE 1 - Test Pit Summary

Fill covers the terraced area north and east of the residences. The fill appears be spoils of colluvial soil derived from preparing the house sites. The fill is thin, probably ranging from less than 2 - 2½ ft up to 5 or 6 ft. Other patches of fill are likely present along buried water lines for the orchard and from local gardening and/or landscaping.

Colluvium mantles the site bedrock in the northwest part of the site. It consists of a mix of residual soil and fragments of moderately to severely weathered CRB. In TP-4 the colluvium was 3.5 ft thick. The colluvium is brown sandy SILT with a trace of, clay, pebbles and cobbles and rare boulders of basalt. The top 0.2 to 0.5 ft of the silt is poorly-developed organic topsoil. The colluvium grades downward into decomposed basalt.

Decomposed Basalt – Residual soil consisting of decomposed basalt mantles the weathered basalt bedrock. It was present in all test pits except TP-5. It consists of medium to hard, red to red brown sandy SILT with a trace of clay and some to abundant cobble and boulder sized fragments of severely weathered basalt. The severely weathered basalt fragments are hard, are but beached to a light grey mix of sand-sized secondary minerals. Cobbles are bleached throughout, but boulders have cores of dark grey weathered basalt beneath 1 – 3 inch rinds of bleach basalt.

The Columbia River Basalt bedrock is visible in nearby road cuts and was found in the test pits. Additionally, the severely weathered top of the basalt is visible in several other cuts within a few blocks of the site. In these locations the Basalt ranged from dark red brown and decomposed at the top to severely weathered, and then to orange-brown and moderately weathered at depth. Even the most decomposed Basalt was highly competent. Note that residual boulders of basalt are present beneath the colluvium at the site. Thus, excavations at the site that extend into the basalt will encounter basalt boulders.

Unconfined compressive strength of the soils was not evaluated at this site. However, at three nearby sites and in nearby roadcuts, compressive strength of the decomposed basalt ranged from a low of 2 to >4.5 tsf. However, we expect the clayey decomposed basalt to be near the low end of this range when wet. Severely weathered basalt ranged from 4 to >5 tsf in nearby cuts. Moderately weathered and fresh basalt in the area were both >>5 tsf.

3.4 Ground Water Observations

No seeps or springs were observed at or near the site. We expect regional groundwater to be fairly deep below this Salem Heights site. We expect that small seeps develop in the thin colluvial site soils during heavy or prolonged precipitation. Some of these will be perched at the top of the decomposed basalt, which is essentially impermeable.

4. Interpretation of Site Conditions

The reconnaissance, cut slopes, test pits, and historic aerial photographs, indicate that the site is underlain at shallow depth by bedrock consisting of basalt, as mapped previously (Foxworthy, 1970; Beeson and Tolan, 2001). Available information indicates that the basalt reaches a thickness of at least 200 ft beneath the site. The site is not part of a landslide.

The sloping surface of the Basalt bedrock was cut by the Willamette River over a period of millions of years. The top of the Basalt was decomposed to severely weathered during that vast time, but it is still highly competent material. The bedrock is overlain by a thin (1 to <5 ft) layer of brown to red-brown residual and/or colluvial soil. Thin fill for a terraced area covers a portion of the upper, SW part of the site.

5. Geologic Hazards

Review of published and online sources and maps from the City GIS show no known historic or recent slope failures at or near the site. The site and surrounding area were estimated by the State to have an intermediate susceptibility landslide hazard (SLIDO, Section 2.3.2). Additionally, GMS-105 (Wang & Leonard, 1996), estimated low to intermediate hazard for earthquake-induced slope failure.

Our reconnaissance and test pits at the site indicate that areas shown "moderate" or "high" hazard by GMS-105 are, in fact, areas of thin, competent soils, except for the terraced area. The man made slopes in the terraced area are only a few feet in amplitude.

The test pits and nearby cut slopes demonstrate a lack of soil or rock susceptible to slope failure on slopes as low as those at the site. Thus on-the-ground geologic information indicates that there are no geologic or topographic features that create seismic induced slope failure risk beyond that of adjacent areas shown as "no risk" areas by GMS-105. Finally, a more recent State study shows the site as having low to no risk of earthquake induced slope failure (Hofmeister and others, 2001).

In summary, the site and surrounding area are underlain by basalt bedrock. Soil cover is generally thin, so the risk is much less than indicated by older state studies or SLIDO. However, nearby areas with a significant thickness of soil over the bedrock may have a high susceptibility to landslides.

6. Conclusions and Recommendations

We found no evidence that slopes at the site have failed. It seems unlikely to us that there is any significant risk of slope failure at the site in its present condition. This interpretation is supported by a complete lack of evidence that predevelopment slopes were unstable in this area. This interpretation is also supported by the observable lack of problems at the adjacent properties. They were all built on cut and fill into/onto the native slopes, and have survived through severe storms and moderate earthquakes without damage.

The site and neighbors have survived severe rainfall events in 1964, 1974, 1996, and most recently 2003. Numerous slides occurred at other sites in the Salem region during the severe storms of February and November 1996. In the Willamette Valley the February 1996 storm was the most severe rainfall event of the 20th century.

In our opinion, the site can be developed by using the precautions one normally takes for slope areas underlain by colluvial soil and decomposed basalt. Cuts, fills and pavements should be designed by a qualified professional and reviewed by a geotechnical engineer. Foundations and retaining walls should also be designed by a qualified engineer to withstand forces from soil creep and lateral loads from earthquakes. Given the thin soils and shallow depth to weathered bedrock, this requirement should not be onerous.

In our opinion, footing drains for new structures could be routed to the storm sewer, to infiltration trenches or to diffusers above the sidewalk. Neither option should have a measurable impact on the ground water or drainage ways at the site because the volume of water will be small. However, we recommend against infiltration of large volumes of storm water into small volumes of the ground (i.e., disposal to drywells), particularly during intense rainfall events such as those noted above. The soils do not have the capacity to take large volumes of storm water. Infiltration trenches that diffuse the water and storm water retention facilities have both been successfully employed in the colluvial soils underlain by the basalt. Both take space and we recommend configuring the project to allow for an appropriate storm water disposal/retention system. We recommend you consult a qualified professional to help you choose and design an appropriate storm water disposal system.

In our opinion, development of the new parcels as proposed should not increase the potential for slope hazards on the site or adjacent properties, given the above caveats. We repeat that it would be prudent to conduct geotechnical investigations of any infrastructure or structures that require deep fills or high cuts.

7. LIMITATIONS AND LIABILITY

We call your attention to the paragraphs on Warranty and Liability in the General Conditions (dated 1/2013) that you approved. 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 October 2016
Clive F. (Rick) Kienle, Jr.
Vice President

NGS Reference 235.85-1

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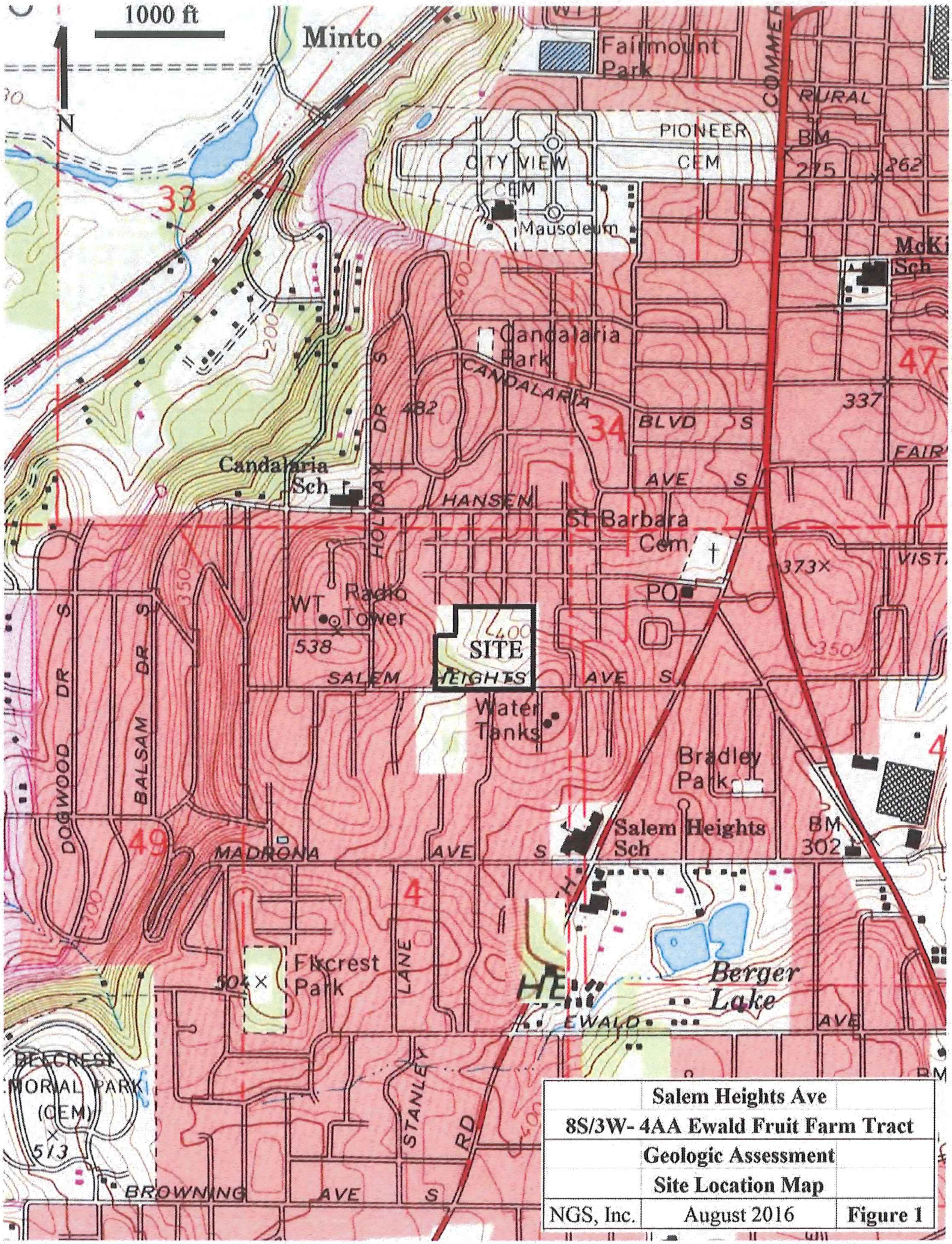
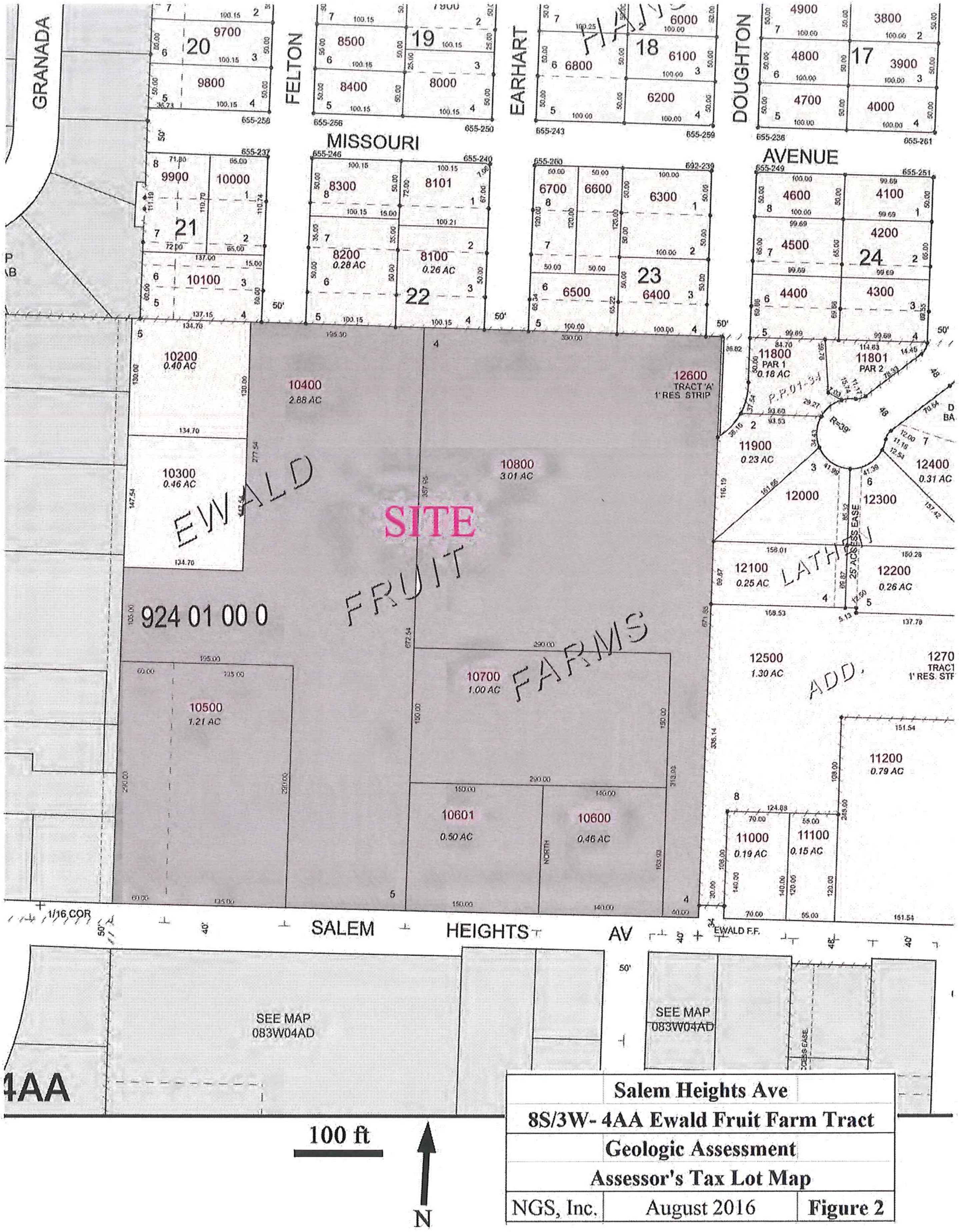


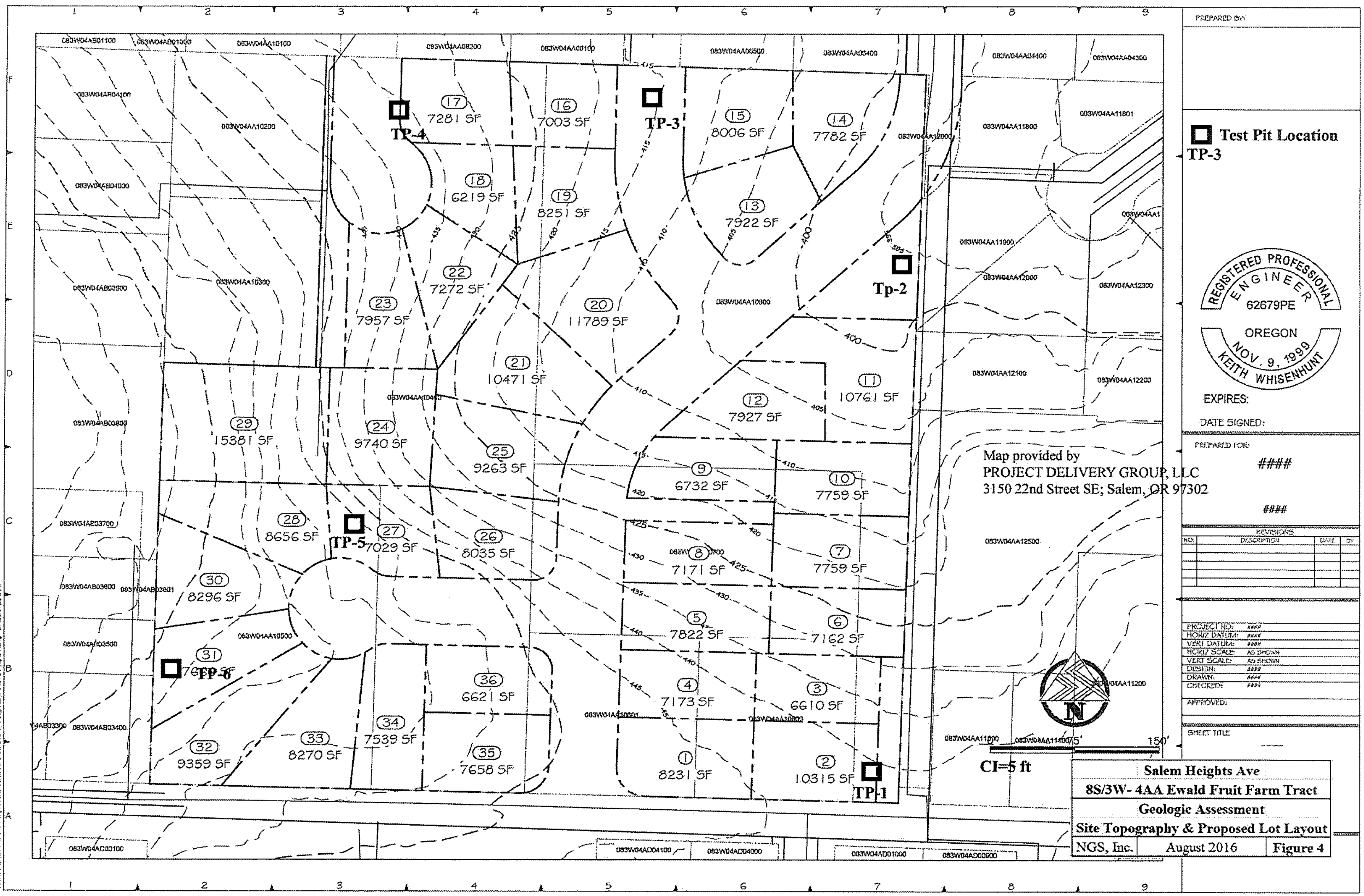
Salem Heights Ave		
8S/3W- 4AA Ewald Fruit Farm Tract		
Geologic Assessment		
Site Location Map		
NGS, Inc.	August 2016	Figure 1



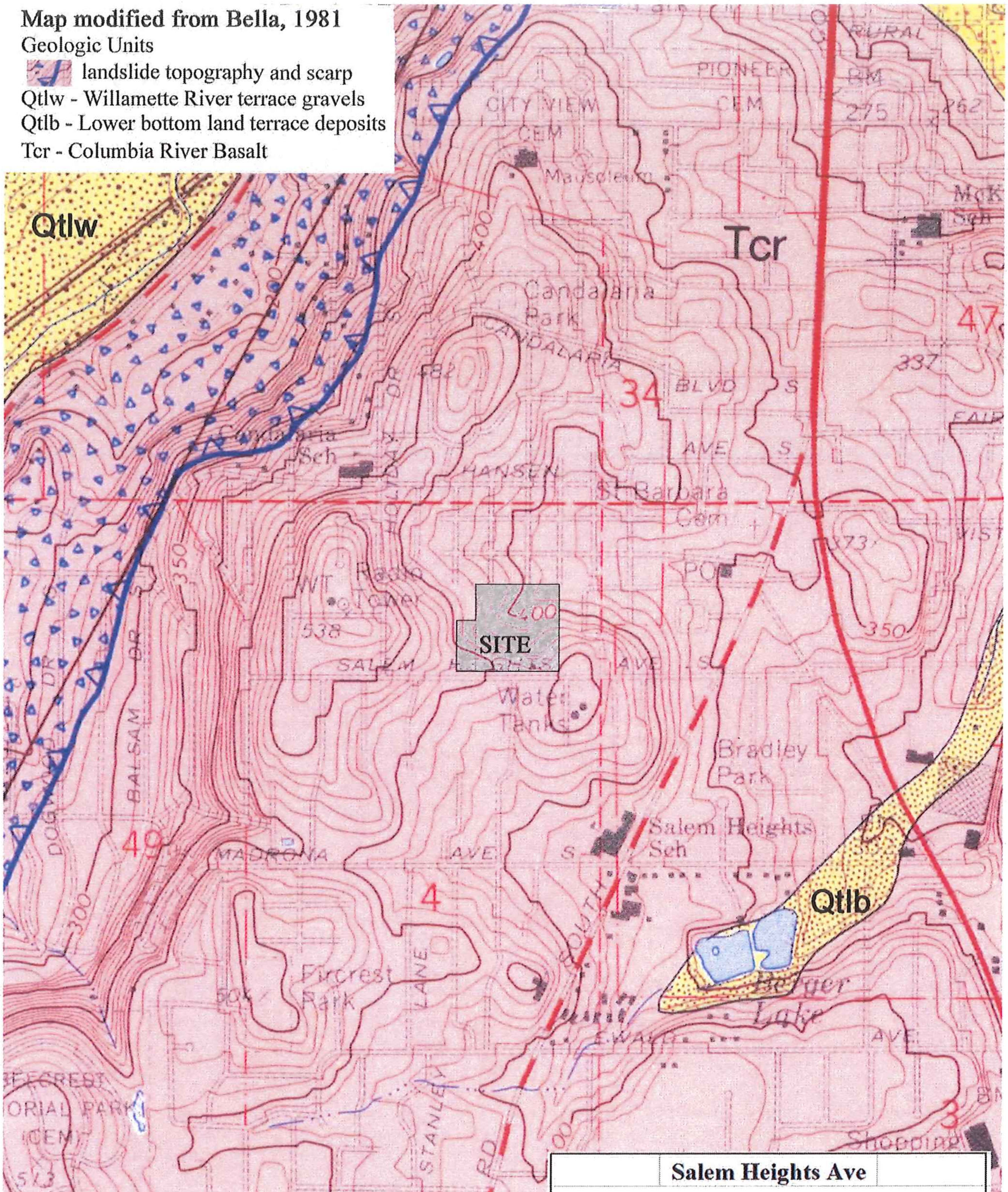
Salem Heights Ave		
8S/3W- 4AA Ewald Fruit Farm Tract		
Geologic Assessment		
Assessor's Tax Lot Map		
NGS, Inc.	August 2016	Figure 2

Salem Heights Ave		
8S/3W- 4AA Ewald Fruit Farm Tract		
Geologic Assessment		
24 July 2014 Digital Earth Image		
NGS, Inc.	August 2016	**Figure 3**

Property boundary approximate



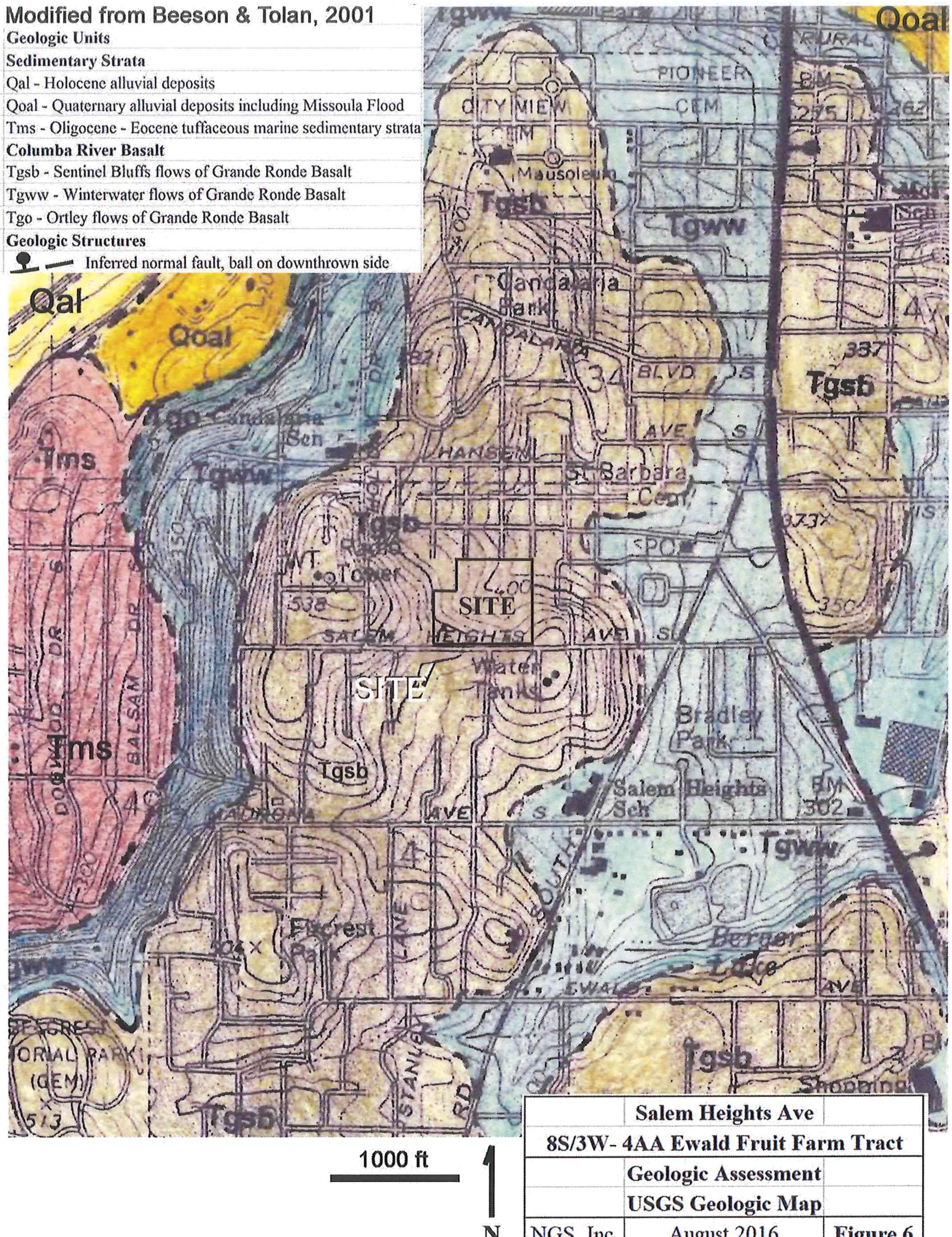
Test Pit Location
TP-3
TP-1
Tp-2
TP-3
TP-4
TP-5
TP-6
Map provided by
PROJECT DELIVERY GROUP, LLC
3150 22nd Street SE; Salem, OR 97302
CI=5 ft
150'
1 7281 SF
16 7003 SF
15 8006 SF
14 7782 SF
18 6219 SF
19 8251 SF
13 7922 SF
22 7272 SF
23 7957 SF
20 11789 SF
21 10471 SF
11 10761 SF
12 7927 SF
29 15381 SF
24 9740 SF
25 9263 SF
9 6732 SF
10 7759 SF
28 8656 SF
27 7029 SF
26 8035 SF
8 7171 SF
7 7759 SF
30 8296 SF
5 7822 SF
6 7162 SF
36 6621 SF
4 7173 SF
3 6610 SF
34 7539 SF
32 9359 SF
33 8270 SF
35 7658 SF
1 8231 SF
2 10315 SF
REGISTERED PROFESSIONAL ENGINEER
62679PE
OREGON
NOV. 9, 1999
KEITH WHISENHUNT
EXPIRES:
DATE SIGNED:
PREPARED BY:
PREPARED FOR:
####
####
REVISIONS
NO. DESCRIPTION DATE BY
PROJECT NO.:
HORIZ DATUM:
VERT DATUM:
HORIZ SCALE: AS SHOWN
VERT SCALE: AS SHOWN
DESIGN:
DRAWN:
CHECKED:
APPROVED:
SHEET TITLE
Salem Heights Ave
8S/3W- 4AA Ewald Fruit Farm Tract
Geologic Assessment
Site Topography & Proposed Lot Layout
NGS, Inc.
August 2016
Figure 4



1000 ft

N

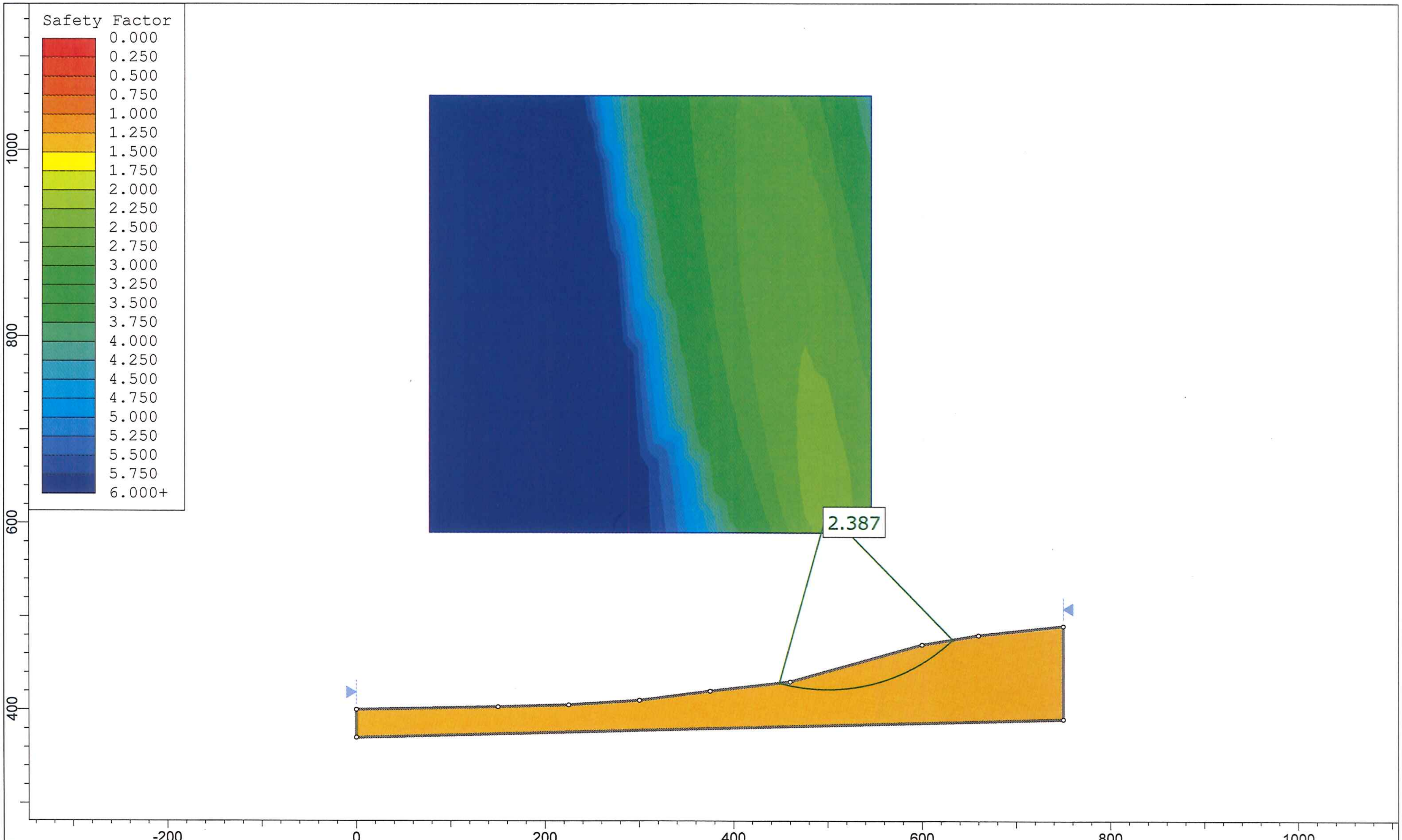
Salem Heights Ave		
8S/3W- 4AA Ewald Fruit Farm Tract		
Geologic Assessment		
DOGAMI Geologic Map		
NGS, Inc.	August 2016	**Figure 5**



	Salem Heights Ave	
8S/3W- 4AA Ewald Fruit Farm Tract		
	Geologic Assessment	
	USGS Geologic Map	
NGS, Inc.	August 2016	Figure 6

Appendix "C"

Slope Stability Analysis



Project	SLIDE - An Interactive Slope Stability Program		
Analysis Description			
Drawn By		Scale 1:1692	Company
Date	10/30/2016, 5:00:41 PM	File Name	Salem Hts Static.slim

SLIDEINTERPRET 7.017

Slide Analysis Information

SLIDE - An Interactive Slope Stability Program

Project Summary

File Name:	Salem Hts Static
Slide Modeler Version:	7.017
Project Title:	SLIDE - An Interactive Slope Stability Program
Date Created:	10/30/2016, 5:00:41 PM

General Settings

Units of Measurement:	Imperial Units
Time Units:	days
Permeability Units:	feet/second
Failure Direction:	Right to Left
Data Output:	Standard
Maximum Material Properties:	20
Maximum Support Properties:	20

Analysis Options

Slices Type:	Vertical

Analysis Methods Used	
	Bishop simplified
	Janbu simplified

Number of slices:	50
Tolerance:	0.005
Maximum number of iterations:	75
Check malpha < 0.2:	Yes
Create Interslice boundaries at intersections with water tables and piezos:	Yes
Initial trial value of FS:	1
Steffensen Iteration:	Yes

Groundwater Analysis

Groundwater Method:	Water Surfaces
Pore Fluid Unit Weight [lbs/ft3]:	62.4
Use negative pore pressure cutoff:	Yes
Maximum negative pore pressure [psf]:	0
Advanced Groundwater Method:	None

Random Numbers

Pseudo-random Seed:	10116
Random Number Generation Method:	Park and Miller v.3

Surface Options

Surface Type:	Circular
Search Method:	Grid Search
Radius Increment:	10
Composite Surfaces:	Disabled
Reverse Curvature:	Invalid Surfaces
Minimum Elevation:	Not Defined
Minimum Depth:	Not Defined
Minimum Area:	Not Defined
Minimum Weight:	Not Defined

Seismic

Advanced seismic analysis:	No
Staged pseudostatic analysis:	No

Material Properties

Property	Material 1
Color	
Strength Type	Mohr-Coulomb
Unit Weight [lbs/ft3]	110
Cohesion [psf]	250
Friction Angle [deg]	24
Water Surface	None
Ru Value	0

Global Minimums

Method: bishop simplified

FS	2.386700
Center:	499.577, 613.217
Radius:	191.469
Left Slip Surface Endpoint:	448.601, 428.659
Right Slip Surface Endpoint:	632.513, 475.419
Resisting Moment:	4.08831e+007 lb-ft
Driving Moment:	1.71295e+007 lb-ft
Total Slice Area:	3354.01 ft2
Surface Horizontal Width:	183.913 ft
Surface Average Height:	18.237 ft

Method: janbu simplified

FS	2.249100
Center:	499.577, 589.781
Radius:	171.926
Left Slip Surface Endpoint:	441.788, 427.857
Right Slip Surface Endpoint:	627.150, 474.525
Resisting Horizontal Force:	219677 lb
Driving Horizontal Force:	97673 lb
Total Slice Area:	3762.5 ft2
Surface Horizontal Width:	185.362 ft
Surface Average Height:	20.2981 ft

Valid / Invalid Surfaces

Method: bishop simplified

Number of Valid Surfaces:	3303
Number of Invalid Surfaces:	1548

Error Codes:

Error Code -103 reported for 1548 surfaces

Method: janbu simplified

Number of Valid Surfaces:	3296
Number of Invalid Surfaces:	1555

Error Codes:

Error Code -103 reported for 1548 surfaces
Error Code -108 reported for 7 surfaces

Error Codes

The following errors were encountered during the computation:

-103 = Two surface / slope intersections, but one or more surface / nonslope external polygon intersections lie between them. This usually occurs when the slip surface extends past the bottom of the soil region, but may also occur on a benched slope model with two sets of Slope Limits.
-108 = Total driving moment or total driving force < 0.1. This is to limit the calculation of extremely high safety factors if the

driving force is very small (0.1 is an arbitrary number).

Slice Data

Global Minimum Query (bishop simplified) - Safety Factor: 2.3867

Slice Number	Width [ft]	Weight [lbs]	Angle of Slice Base [degrees]	Base Material	Base Cohesion [psf]	Base Friction Angle [degrees]	Shear Stress [psf]	Shear Strength [psf]	Base Normal Stress [psf]	Pore Pressure [psf]	Effective Normal Stress [psf]
1	3.67826	285.141	-14.8712	Material 1	250	24	125.42	299.34	110.82	0	110.82
2	3.67826	839.709	-13.7352	Material 1	250	24	154.371	368.438	266.016	0	266.016
3	3.67826	1363.08	-12.6047	Material 1	250	24	181.444	433.053	411.144	0	411.144
4	3.67826	1957.17	-11.4792	Material 1	250	24	212.038	506.071	575.145	0	575.145
5	3.67826	2668.28	-10.3581	Material 1	250	24	248.544	593.201	770.843	0	770.843
6	3.67826	3350.57	-9.24108	Material 1	250	24	283.271	676.082	956.996	0	956.996
7	3.67826	4003.13	-8.12754	Material 1	250	24	316.191	754.654	1133.47	0	1133.47
8	3.67826	4626.21	-7.0171	Material 1	250	24	347.343	829.004	1300.46	0	1300.46
9	3.67826	5220.03	-5.90929	Material 1	250	24	376.759	899.21	1458.15	0	1458.15
10	3.67826	5784.8	-4.8037	Material 1	250	24	404.468	965.344	1606.69	0	1606.69
11	3.67826	6320.67	-3.6999	Material 1	250	24	430.497	1027.47	1746.22	0	1746.22
12	3.67826	6827.76	-2.59747	Material 1	250	24	454.872	1085.64	1876.88	0	1876.88
13	3.67826	7306.17	-1.49601	Material 1	250	24	477.612	1139.92	1998.79	0	1998.79
14	3.67826	7755.95	-0.395098	Material 1	250	24	498.738	1190.34	2112.03	0	2112.03
15	3.67826	8177.13	0.705667	Material 1	250	24	518.266	1236.95	2216.72	0	2216.72
16	3.67826	8569.71	1.80669	Material 1	250	24	536.213	1279.78	2312.92	0	2312.92
17	3.67826	8933.64	2.90839	Material 1	250	24	552.587	1318.86	2400.7	0	2400.7
18	3.67826	9268.87	4.01116	Material 1	250	24	567.403	1354.22	2480.13	0	2480.13
19	3.67826	9575.3	5.11542	Material 1	250	24	580.672	1385.89	2551.24	0	2551.24
20	3.67826	9852.77	6.22159	Material 1	250	24	592.395	1413.87	2614.09	0	2614.09
21	3.67826	10101.1	7.3301	Material 1	250	24	602.577	1438.17	2668.68	0	2668.68
22	3.67826	10320.2	8.44137	Material 1	250	24	611.225	1458.81	2715.04	0	2715.04
23	3.67826	10509.7	9.55586	Material 1	250	24	618.339	1475.79	2753.18	0	2753.18

24	3.67826	10669.4	10.674	Material 1	250	24	623.92	1489.11	2783.1	0	2783.1
25	3.67826	10799	11.7963	Material 1	250	24	627.963	1498.76	2804.76	0	2804.76
26	3.67826	10898	12.9232	Material 1	250	24	630.469	1504.74	2818.19	0	2818.19
27	3.67826	10966.2	14.0552	Material 1	250	24	631.424	1507.02	2823.3	0	2823.3
28	3.67826	11003.1	15.1928	Material 1	250	24	630.825	1505.59	2820.09	0	2820.09
29	3.67826	11008.1	16.3366	Material 1	250	24	628.663	1500.43	2808.5	0	2808.5
30	3.67826	10980.7	17.4871	Material 1	250	24	624.921	1491.5	2788.47	0	2788.47
31	3.67826	10920.4	18.645	Material 1	250	24	619.592	1478.78	2759.9	0	2759.9
32	3.67826	10826.5	19.8108	Material 1	250	24	612.658	1462.23	2722.71	0	2722.71
33	3.67826	10698.3	20.9852	Material 1	250	24	604.098	1441.8	2676.83	0	2676.83
34	3.67826	10534.8	22.169	Material 1	250	24	593.895	1417.45	2622.14	0	2622.14
35	3.67826	10335.4	23.3628	Material 1	250	24	582.021	1389.11	2558.5	0	2558.5
36	3.67826	10099	24.5674	Material 1	250	24	568.459	1356.74	2485.77	0	2485.77
37	3.67826	9824.59	25.7838	Material 1	250	24	553.17	1320.25	2403.82	0	2403.82
38	3.67826	9510.98	27.0127	Material 1	250	24	536.125	1279.57	2312.45	0	2312.45
39	3.67826	9156.92	28.2553	Material 1	250	24	517.293	1234.62	2211.5	0	2211.5
40	3.67826	8760.99	29.5125	Material 1	250	24	496.633	1185.32	2100.75	0	2100.75
41	3.67826	8321.65	30.7856	Material 1	250	24	474.103	1131.54	1979.97	0	1979.97
42	3.67826	7774.77	32.0757	Material 1	250	24	446.822	1066.43	1833.73	0	1833.73
43	3.67826	7068.39	33.3843	Material 1	250	24	412.522	984.566	1649.86	0	1649.86
44	3.67826	6310.55	34.7129	Material 1	250	24	376.184	897.839	1455.07	0	1455.07
45	3.67826	5501.19	36.0633	Material 1	250	24	337.855	806.358	1249.6	0	1249.6
46	3.67826	4637.64	37.4373	Material 1	250	24	297.471	709.975	1033.12	0	1033.12
47	3.67826	3716.91	38.837	Material 1	250	24	254.967	608.529	805.27	0	805.27
48	3.67826	2735.59	40.2648	Material 1	250	24	210.266	501.843	565.65	0	565.65
49	3.67826	1689.82	41.7234	Material 1	250	24	163.289	389.723	313.824	0	313.824
50	3.67826	575.15	43.216	Material 1	250	24	113.947	271.958	49.3179	0	49.3179

Global Minimum Query (janbu simplified) - Safety Factor: 2.2491

			Angle		Base	Base	Shear	Shear	Base	Pore	Effective

Number	[ft]	[lbs]	of Slice Base [degrees]	Material	Cohesion [psf]	Friction Angle [degrees]	Stress [psf]	Strength [psf]	Normal Stress [psf]	Pressure [psf]	Normal Stress [psf]
1	3.70723	349.023	-18.9877	Material 1	250	24	139.293	313.284	142.139	0	142.139
2	3.70723	1028.01	-17.686	Material 1	250	24	177.253	398.659	333.894	0	333.894
3	3.70723	1669.28	-16.3937	Material 1	250	24	212.695	478.373	512.934	0	512.934
4	3.70723	2273.62	-15.1099	Material 1	250	24	245.713	552.633	679.723	0	679.723
5	3.70723	2842.69	-13.8338	Material 1	250	24	276.443	621.748	834.958	0	834.958
6	3.70723	3523.47	-12.5647	Material 1	250	24	313.136	704.274	1020.32	0	1020.32
7	3.70723	4274.96	-11.3019	Material 1	250	24	353.431	794.901	1223.87	0	1223.87
8	3.70723	4991.86	-10.0446	Material 1	250	24	391.455	880.421	1415.95	0	1415.95
9	3.70723	5674.6	-8.7921	Material 1	250	24	427.267	960.966	1596.85	0	1596.85
10	3.70723	6323.56	-7.54388	Material 1	250	24	460.92	1036.66	1766.86	0	1766.86
11	3.70723	6939.05	-6.29924	Material 1	250	24	492.462	1107.6	1926.19	0	1926.19
12	3.70723	7521.33	-5.05759	Material 1	250	24	521.935	1173.89	2075.08	0	2075.08
13	3.70723	8070.61	-3.81832	Material 1	250	24	549.378	1235.61	2213.71	0	2213.71
14	3.70723	8587.08	-2.58083	Material 1	250	24	574.825	1292.84	2342.25	0	2342.25
15	3.70723	9070.83	-1.34454	Material 1	250	24	598.302	1345.64	2460.85	0	2460.85
16	3.70723	9521.95	-0.108886	Material 1	250	24	619.843	1394.09	2569.66	0	2569.66
17	3.70723	9940.46	1.12672	Material 1	250	24	639.465	1438.22	2668.78	0	2668.78
18	3.70723	10326.3	2.36285	Material 1	250	24	657.187	1478.08	2758.31	0	2758.31
19	3.70723	10679.5	3.60009	Material 1	250	24	673.029	1513.71	2838.34	0	2838.34
20	3.70723	10999.9	4.839	Material 1	250	24	686.999	1545.13	2908.92	0	2908.92
21	3.70723	11287.4	6.0802	Material 1	250	24	699.115	1572.38	2970.12	0	2970.12
22	3.70723	11541.6	7.32426	Material 1	250	24	709.382	1595.47	3021.97	0	3021.97
23	3.70723	11762.5	8.57181	Material 1	250	24	717.803	1614.41	3064.51	0	3064.51
24	3.70723	11949.6	9.82346	Material 1	250	24	724.379	1629.2	3097.73	0	3097.73
25	3.70723	12102.6	11.0799	Material 1	250	24	729.109	1639.84	3121.63	0	3121.63
26	3.70723	12221.1	12.3417	Material 1	250	24	731.995	1646.33	3136.21	0	3136.21
27	3.70723	12304.7	13.6097	Material 1	250	24	733.022	1648.64	3141.41	0	3141.41

28	3.70723	12352.7	14.8844	Material 1	250	24	732.191	1646.77	3137.19	0	3137.19
29	3.70723	12364.6	16.1668	Material 1	250	24	729.483	1640.68	3123.53	0	3123.53
30	3.70723	12339.7	17.4576	Material 1	250	24	724.886	1630.34	3100.28	0	3100.28
31	3.70723	12277.2	18.7575	Material 1	250	24	718.376	1615.7	3067.42	0	3067.42
32	3.70723	12176.3	20.0676	Material 1	250	24	709.937	1596.72	3024.79	0	3024.79
33	3.70723	12036.1	21.3887	Material 1	250	24	699.546	1573.35	2972.29	0	2972.29
34	3.70723	11855.4	22.7219	Material 1	250	24	687.173	1545.52	2909.77	0	2909.77
35	3.70723	11633.2	24.0682	Material 1	250	24	672.78	1513.15	2837.09	0	2837.09
36	3.70723	11368.1	25.4287	Material 1	250	24	656.334	1476.16	2754.02	0	2754.02
37	3.70723	11058.8	26.8049	Material 1	250	24	637.797	1434.47	2660.36	0	2660.36
38	3.70723	10703.5	28.1979	Material 1	250	24	617.118	1387.96	2555.88	0	2555.88
39	3.70723	10300.6	29.6094	Material 1	250	24	594.247	1336.52	2440.38	0	2440.38
40	3.70723	9848.05	31.0409	Material 1	250	24	569.125	1280.02	2313.47	0	2313.47
41	3.70723	9343.62	32.4943	Material 1	250	24	541.695	1218.33	2174.9	0	2174.9
42	3.70723	8784.79	33.9716	Material 1	250	24	511.88	1151.27	2024.28	0	2024.28
43	3.70723	8159.32	35.4751	Material 1	250	24	479.161	1077.68	1859	0	1859
44	3.70723	7344.03	37.0072	Material 1	250	24	437.888	984.853	1650.51	0	1650.51
45	3.70723	6423.44	38.5709	Material 1	250	24	392.164	882.016	1419.53	0	1419.53
46	3.70723	5434.52	40.1695	Material 1	250	24	343.818	773.28	1175.31	0	1175.31
47	3.70723	4372.38	41.8067	Material 1	250	24	292.738	658.397	917.276	0	917.276
48	3.70723	3231.35	43.4869	Material 1	250	24	238.804	537.094	644.824	0	644.824
49	3.70723	2004.73	45.2152	Material 1	250	24	181.88	409.066	357.268	0	357.268
50	3.70723	684.559	46.998	Material 1	250	24	121.817	273.98	53.8587	0	53.8587

Interslice Data

Global Minimum Query (bishop simplified) - Safety Factor: 2.3867

Slice Number	X coordinate [ft]	Y coordinate - Bottom [ft]	Interslice Normal Force [lbs]	Interslice Shear Force [lbs]	Interslice Force Angle [degrees]
1	448.601	428.659	0	0	0
2	452.279	427.682	569.499	0	0
3	455.957	426.783	1376.39	0	0
4	459.635	425.961	2381.86	0	0
5	463.314	425.214	3591.28	0	0
6	466.992	424.541	5023.6	0	0
7	470.67	423.943	6638.1	0	0
8	474.348	423.418	8396.37	0	0
9	478.027	422.965	10262.6	0	0
10	481.705	422.584	12203.3	0	0
11	485.383	422.275	14187.5	0	0
12	489.061	422.037	16186.1	0	0
13	492.74	421.87	18172.1	0	0
14	496.418	421.774	20120.6	0	0
15	500.096	421.749	22008.4	0	0
16	503.774	421.794	23814	0	0
17	507.453	421.91	25517.7	0	0
18	511.131	422.097	27101.3	0	0
19	514.809	422.355	28548.4	0	0
20	518.487	422.684	29843.8	0	0
21	522.166	423.085	30974.3	0	0
22	525.844	423.558	31927.7	0	0
23	529.522	424.104	32693.5	0	0
24	533.2	424.723	33262.8	0	0
25	536.879	425.417	33627.9	0	0
26	540.557	426.185	33782.8	0	0
27	544.235	427.029	33722.9	0	0
28	547.913	427.95	33445.2	0	0
29	551.592	428.949	32948.3	0	0
30	555.27	430.027	32232.4	0	0
31	558.948	431.186	31299.3	0	0
32	562.626	432.427	30152.7	0	0
33	566.305	433.752	28798.1	0	0
34	569.983	435.163	27243.2	0	0
35	573.661	436.661	25497.4	0	0
36	577.34	438.25	23572.8	0	0
37	581.018	439.932	21483.6	0	0
38	584.696	441.709	19246.7	0	0
39	588.374	443.584	16882.1	0	0
40	592.053	445.561	14412.8	0	0
41	595.731	447.643	11865.3	0	0
42	599.409	449.834	9269.91	0	0
43	603.087	452.139	6686.09	0	0
44	606.766	454.563	4204.09	0	0
45	610.444	457.111	1879.81	0	0
46	614.122	459.79	-224.865	0	0
47	617.8	462.606	-2040.16	0	0
48	621.479	465.567	-3487.11	0	0
49	625.157	468.683	-4476.1	0	0
50	628.835	471.963	-4904.88	0	0
51	632.513	475.419	0	0	0

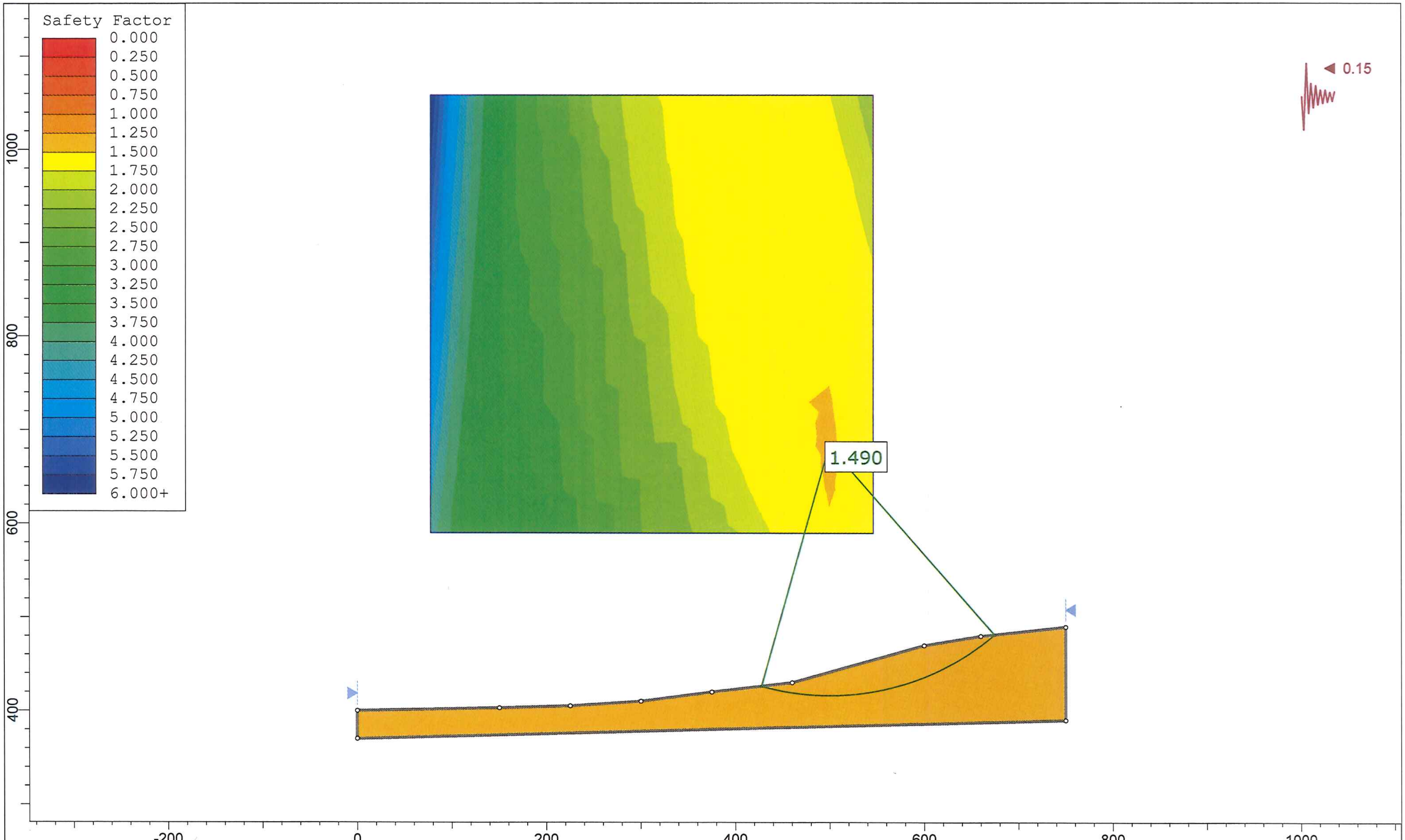
Global Minimum Query (janbu simplified) - Safety Factor: 2.2491

Slice Number	X coordinate [ft]	Y coordinate - Bottom [ft]	Interslice Normal Force [lbs]	Interslice Shear Force [lbs]	Interslice Force Angle [degrees]
1	441.788	427.857	0	0	0
2	445.496	426.582	698.387	0	0
3	449.203	425.4	1751.08	0	0
4	452.91	424.309	3100.06	0	0
5	456.617	423.308	4692.56	0	0
6	460.325	422.395	6480.99	0	0
7	464.032	421.569	8486.45	0	0
8	467.739	420.828	10705.2	0	0
9	471.446	420.171	13088.1	0	0
10	475.154	419.598	15589.8	0	0
11	478.861	419.107	18168.2	0	0
12	482.568	418.698	20784.6	0	0
13	486.275	418.37	23402.9	0	0
14	489.982	418.122	25990	0	0
15	493.69	417.955	28515.2	0	0
16	497.397	417.868	30950.3	0	0
17	501.104	417.861	33269.3	0	0
18	504.811	417.934	35448.5	0	0
19	508.519	418.087	37466.1	0	0
20	512.226	418.32	39302.5	0	0
21	515.933	418.634	40939.7	0	0
22	519.64	419.029	42362.1	0	0
23	523.348	419.505	43555.4	0	0
24	527.055	420.064	44507.5	0	0
25	530.762	420.706	45208	0	0
26	534.469	421.432	45648.3	0	0
27	538.176	422.243	45821.7	0	0
28	541.884	423.141	45723.2	0	0
29	545.591	424.126	45350	0	0
30	549.298	425.201	44701	0	0
31	553.005	426.367	43777.4	0	0
32	556.713	427.626	42582.3	0	0
33	560.42	428.98	41121.2	0	0
34	564.127	430.432	39402.3	0	0
35	567.834	431.984	37435.9	0	0
36	571.542	433.64	35235.6	0	0
37	575.249	435.403	32817.7	0	0
38	578.956	437.276	30202.3	0	0
39	582.663	439.264	27413	0	0
40	586.371	441.37	24477.5	0	0
41	590.078	443.602	21428.5	0	0
42	593.785	445.963	18303.9	0	0
43	597.492	448.461	15147.6	0	0
44	601.199	451.103	12015	0	0
45	604.907	453.897	9028.45	0	0
46	608.614	456.853	6287.56	0	0
47	612.321	459.983	3885.77	0	0
48	616.028	463.298	1931.3	0	0
49	619.736	466.815	550.301	0	0
50	623.443	470.55	-109.005	0	0
51	627.15	474.525	0	0	0

List Of Coordinates

External Boundary

X	Y
750	390
750	490
660	480
600	470
460	430
375	420
300	410
225	405
150	403
0	400
0	370



Project	SLIDE - An Interactive Slope Stability Program		
Analysis Description			
Drawn By		Scale 1:1692	Company
Date 10/30/2016, 5:00:41 PM		File Name	Salem Hts Seismic.slim

SLIDEINTERPRET 7.017

Slide Analysis Information

SLIDE - An Interactive Slope Stability Program

Project Summary

File Name:	Salem Hts Seismic
Slide Modeler Version:	7.017
Project Title:	SLIDE - An Interactive Slope Stability Program
Date Created:	10/30/2016, 5:00:41 PM

General Settings

Units of Measurement:	Imperial Units
Time Units:	days
Permeability Units:	feet/second
Failure Direction:	Right to Left
Data Output:	Standard
Maximum Material Properties:	20
Maximum Support Properties:	20

Analysis Options

Slices Type:	Vertical

Analysis Methods Used	
	Bishop simplified
	Janbu simplified

Number of slices:	50
Tolerance:	0.005
Maximum number of iterations:	75
Check malpha < 0.2:	Yes
Create Interslice boundaries at intersections with water tables and piezos:	Yes
Initial trial value of FS:	1
Steffensen Iteration:	Yes

Groundwater Analysis

Groundwater Method:	Water Surfaces
Pore Fluid Unit Weight [lbs/ft3]:	62.4
Use negative pore pressure cutoff:	Yes
Maximum negative pore pressure [psf]:	0
Advanced Groundwater Method:	None

Random Numbers

Pseudo-random Seed: 10116
Random Number Generation Method: Park and Miller v.3

Surface Options

Surface Type: Circular
Search Method: Grid Search
Radius Increment: 10
Composite Surfaces: Disabled
Reverse Curvature: Invalid Surfaces
Minimum Elevation: Not Defined
Minimum Depth: Not Defined
Minimum Area: Not Defined
Minimum Weight: Not Defined

Seismic

Advanced seismic analysis: No
Staged pseudostatic analysis: No

Loading

Seismic Load Coefficient (Horizontal): 0.15

Material Properties

Property	Material 1
Color	
Strength Type	Mohr-Coulomb
Unit Weight [lbs/ft3]	110
Cohesion [psf]	250
Friction Angle [deg]	24
Water Surface	None
Ru Value	0

Global Minimums

Method: bishop simplified

FS	1.490070
Center:	499.577, 683.525
Radius:	267.169
Left Slip Surface Endpoint:	427.716, 426.202
Right Slip Surface Endpoint:	674.540, 481.616
Resisting Moment:	8.9939e+007 lb-ft
Driving Moment:	6.0359e+007 lb-ft
Total Slice Area:	5710.43 ft2
Surface Horizontal Width:	246.823 ft
Surface Average Height:	23.1357 ft

Method: janbu simplified

FS	1.404090
Center:	499.577, 613.217
Radius:	201.711
Left Slip Surface Endpoint:	424.839, 425.863
Right Slip Surface Endpoint:	649.478, 478.246
Resisting Horizontal Force:	309840 lb
Driving Horizontal Force:	220670 lb
Total Slice Area:	5632.47 ft2
Surface Horizontal Width:	224.639 ft
Surface Average Height:	25.0734 ft

Valid / Invalid Surfaces

Method: bishop simplified

Number of Valid Surfaces:	3303
Number of Invalid Surfaces:	1548

Error Codes:

Error Code -103 reported for 1548 surfaces

Method: janbu simplified

Number of Valid Surfaces:	3303
Number of Invalid Surfaces:	1548

Error Codes:

Error Code -103 reported for 1548 surfaces

Error Codes

The following errors were encountered during the computation:

-103 = Two surface / slope intersections, but one or more surface / nonslope external polygon intersections lie between them. This usually occurs when the slip surface extends past the bottom of the soil region, but may also occur on a benched slope model with two sets of Slope Limits.

Slice Data

Global Minimum Query (bishop simplified) - Safety Factor: 1.49007

Slice Number	Width [ft]	Weight [lbs]	Angle of Slice Base [degrees]	Base Material	Base Cohesion [psf]	Base Friction Angle [degrees]	Shear Stress [psf]	Shear Strength [psf]	Base Normal Stress [psf]	Pore Pressure [psf]	Effective Normal Stress [psf]
1	4.93647	518.185	-15.055	Material 1	250	24	216.532	322.648	163.169	0	163.169
2	4.93647	1527.26	-13.9614	Material 1	250	24	281.085	418.836	379.212	0	379.212
3	4.93647	2482.13	-12.873	Material 1	250	24	341.305	508.569	580.757	0	580.757
4	4.93647	3383.52	-11.7892	Material 1	250	24	397.338	592.061	768.283	0	768.283
5	4.93647	4232.11	-10.7098	Material 1	250	24	449.312	669.507	942.229	0	942.229
6	4.93647	5028.46	-9.63415	Material 1	250	24	497.35	741.086	1103	0	1103
7	4.93647	5820.82	-8.56195	Material 1	250	24	544.583	811.467	1261.08	0	1261.08
8	4.93647	6899.11	-7.49276	Material 1	250	24	609.297	907.895	1477.66	0	1477.66
9	4.93647	7992.22	-6.42619	Material 1	250	24	674.207	1004.62	1694.89	0	1694.89
10	4.93647	9034.84	-5.36185	Material 1	250	24	735.247	1095.57	1899.18	0	1899.18
11	4.93647	10027.3	-4.29937	Material 1	250	24	792.502	1180.88	2090.8	0	2090.8
12	4.93647	10969.7	-3.23836	Material 1	250	24	846.054	1260.68	2270.02	0	2270.02
13	4.93647	11862.4	-2.17847	Material 1	250	24	895.971	1335.06	2437.07	0	2437.07
14	4.93647	12705.5	-1.11932	Material 1	250	24	942.318	1404.12	2592.19	0	2592.19
15	4.93647	13499	-0.0605503	Material 1	250	24	985.162	1467.96	2735.58	0	2735.58
16	4.93647	14242.9	0.998196	Material 1	250	24	1024.55	1526.65	2867.4	0	2867.4
17	4.93647	14937.3	2.05728	Material 1	250	24	1060.53	1580.27	2987.84	0	2987.84
18	4.93647	15582	3.11707	Material 1	250	24	1093.16	1628.88	3097.02	0	3097.02
19	4.93647	16177	4.17793	Material 1	250	24	1122.46	1672.55	3195.11	0	3195.11
20	4.93647	16722	5.24023	Material 1	250	24	1148.49	1711.33	3282.18	0	3282.18
21	4.93647	17216.9	6.30434	Material 1	250	24	1171.25	1745.25	3358.4	0	3358.4
22	4.93647	17661.3	7.37063	Material 1	250	24	1190.8	1774.38	3423.8	0	3423.8
23	4.93647	18055	8.43951	Material 1	250	24	1207.14	1798.73	3478.5	0	3478.5
24	4.93647	18397.4	9.51134	Material 1	250	24	1220.31	1818.34	3522.54	0	3522.54
25	4.93647	18688.3	10.5866	Material	250	24	1230.3	1833.23	3555.99	0	3555.99

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26	4.93647	18926.9	11.6655	Material 1	250	24	1237.13	1843.41	3578.87	0	3578.87
27	4.93647	19112.8	12.7488	Material 1	250	24	1240.83	1848.92	3591.23	0	3591.23
28	4.93647	19245.3	13.8366	Material 1	250	24	1241.38	1849.74	3593.08	0	3593.08
29	4.93647	19323.7	14.9296	Material 1	250	24	1238.79	1845.89	3584.43	0	3584.43
30	4.93647	19347.2	16.0282	Material 1	250	24	1233.07	1837.36	3565.27	0	3565.27
31	4.93647	19314.9	17.1328	Material 1	250	24	1224.2	1824.15	3535.59	0	3535.59
32	4.93647	19225.8	18.2441	Material 1	250	24	1212.18	1806.24	3495.36	0	3495.36
33	4.93647	19078.9	19.3625	Material 1	250	24	1197	1783.61	3444.55	0	3444.55
34	4.93647	18872.9	20.4887	Material 1	250	24	1178.64	1756.25	3383.09	0	3383.09
35	4.93647	18605.1	21.6231	Material 1	250	24	1156.99	1723.99	3310.64	0	3310.64
36	4.93647	18087.4	22.7666	Material 1	250	24	1121.99	1671.85	3193.53	0	3193.53
37	4.93647	17377.2	23.9197	Material 1	250	24	1076.97	1604.76	3042.85	0	3042.85
38	4.93647	16602.1	25.0833	Material 1	250	24	1028.89	1533.12	2881.92	0	2881.92
39	4.93647	15760.4	26.2579	Material 1	250	24	977.719	1456.87	2710.67	0	2710.67
40	4.93647	14849.9	27.4446	Material 1	250	24	923.433	1375.98	2528.99	0	2528.99
41	4.93647	13868.5	28.6443	Material 1	250	24	865.986	1290.38	2336.72	0	2336.72
42	4.93647	12813.8	29.8578	Material 1	250	24	805.345	1200.02	2133.78	0	2133.78
43	4.93647	11683.1	31.0862	Material 1	250	24	741.465	1104.84	1919.98	0	1919.98
44	4.93647	10473.5	32.3308	Material 1	250	24	674.297	1004.75	1695.2	0	1695.2
45	4.93647	9181.72	33.5927	Material 1	250	24	603.792	899.692	1459.23	0	1459.23
46	4.93647	7804.18	34.8734	Material 1	250	24	529.893	789.577	1211.91	0	1211.91
47	4.93647	6336.86	36.1743	Material 1	250	24	452.541	674.318	953.034	0	953.034
48	4.93647	4708.73	37.4972	Material 1	250	24	368.397	548.938	671.426	0	671.426
49	4.93647	2899.16	38.8441	Material 1	250	24	276.724	412.338	364.619	0	364.619
50	4.93647	984.382	40.2169	Material 1	250	24	181.531	270.493	46.0285	0	46.0285

Global Minimum Query (janbu simplified) - Safety Factor: 1.40409

Slice Number	Width [ft]	Weight [lbs]	Angle of Slice Base [degrees]	Base Material	Base Cohesion [psf]	Base Friction Angle [degrees]	Shear Stress [psf]	Shear Strength [psf]	Base Normal Stress [psf]	Pore Pressure [psf]	Effective Normal Stress [psf]

1	4.49279	558.196	-21.0642	Material 1	250	24	247.675	347.757	219.566	0	219.566
2	4.49279	1644.56	-19.7026	Material 1	250	24	331.768	465.832	484.767	0	484.767
3	4.49279	2671.63	-18.3525	Material 1	250	24	409.674	575.219	730.454	0	730.454
4	4.49279	3640.82	-17.0129	Material 1	250	24	481.72	676.378	957.661	0	957.661
5	4.49279	4553.43	-15.6828	Material 1	250	24	548.196	769.717	1167.3	0	1167.3
6	4.49279	5410.6	-14.3614	Material 1	250	24	609.361	855.598	1360.19	0	1360.19
7	4.49279	6213.34	-13.0477	Material 1	250	24	665.445	934.345	1537.06	0	1537.06
8	4.49279	6968.21	-11.7409	Material 1	250	24	717.082	1006.85	1699.91	0	1699.91
9	4.49279	7910.54	-10.4404	Material 1	250	24	782.025	1098.03	1904.72	0	1904.72
10	4.49279	8928.21	-9.1452	Material 1	250	24	851.633	1195.77	2124.24	0	2124.24
11	4.49279	9894.48	-7.85475	Material 1	250	24	916.451	1286.78	2328.65	0	2328.65
12	4.49279	10809.9	-6.56829	Material 1	250	24	976.625	1371.27	2518.42	0	2518.42
13	4.49279	11674.8	-5.28515	Material 1	250	24	1032.3	1449.44	2693.99	0	2693.99
14	4.49279	12489.6	-4.00466	Material 1	250	24	1083.58	1521.45	2855.73	0	2855.73
15	4.49279	13254.6	-2.72618	Material 1	250	24	1130.6	1587.46	3004	0	3004
16	4.49279	13969.9	-1.44906	Material 1	250	24	1173.43	1647.6	3139.07	0	3139.07
17	4.49279	14635.7	-0.172651	Material 1	250	24	1212.17	1702	3261.26	0	3261.26
18	4.49279	15252.1	1.10367	Material 1	250	24	1246.91	1750.77	3370.78	0	3370.78
19	4.49279	15818.9	2.38054	Material 1	250	24	1277.7	1794	3467.88	0	3467.88
20	4.49279	16336.2	3.65859	Material 1	250	24	1304.6	1831.78	3552.72	0	3552.72
21	4.49279	16803.6	4.93847	Material 1	250	24	1327.68	1864.18	3625.5	0	3625.5
22	4.49279	17221.1	6.22082	Material 1	250	24	1346.96	1891.26	3686.33	0	3686.33
23	4.49279	17588.2	7.50632	Material 1	250	24	1362.51	1913.09	3735.35	0	3735.35
24	4.49279	17904.5	8.79563	Material 1	250	24	1374.34	1929.7	3772.67	0	3772.67
25	4.49279	18169.6	10.0894	Material 1	250	24	1382.48	1941.13	3798.34	0	3798.34
26	4.49279	18382.8	11.3885	Material 1	250	24	1386.96	1947.41	3812.46	0	3812.46
27	4.49279	18543.5	12.6935	Material 1	250	24	1387.77	1948.56	3815.05	0	3815.05
28	4.49279	18650.9	14.0052	Material 1	250	24	1384.95	1944.59	3806.12	0	3806.12
29	4.49279	18704.2	15.3245	Material	250	24	1378.47	1935.5	3785.68	0	3785.68

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30	4.49279	18702.3	16.6521	Material 1	250	24	1368.35	1921.28	3753.77	0	3753.77
31	4.49279	18644.2	17.9891	Material 1	250	24	1354.56	1901.92	3710.27	0	3710.27
32	4.49279	18528.5	19.3362	Material 1	250	24	1337.09	1877.4	3655.19	0	3655.19
33	4.49279	18353.9	20.6946	Material 1	250	24	1315.93	1847.68	3588.44	0	3588.44
34	4.49279	18118.9	22.0652	Material 1	250	24	1291.04	1812.73	3509.94	0	3509.94
35	4.49279	17821.7	23.4493	Material 1	250	24	1262.38	1772.49	3419.56	0	3419.56
36	4.49279	17460.5	24.848	Material 1	250	24	1229.91	1726.91	3317.2	0	3317.2
37	4.49279	17033	26.2628	Material 1	250	24	1193.59	1675.91	3202.65	0	3202.65
38	4.49279	16536.8	27.695	Material 1	250	24	1153.37	1619.43	3075.77	0	3075.77
39	4.49279	15969.4	29.1463	Material 1	250	24	1109.15	1557.35	2936.37	0	2936.37
40	4.49279	15192.1	30.6184	Material 1	250	24	1052.85	1478.29	2758.79	0	2758.79
41	4.49279	14208.4	32.1133	Material 1	250	24	984.972	1382.99	2544.74	0	2544.74
42	4.49279	13143.1	33.633	Material 1	250	24	913.182	1282.19	2318.33	0	2318.33
43	4.49279	11992.1	35.1801	Material 1	250	24	837.394	1175.78	2079.33	0	2079.33
44	4.49279	10750.4	36.7573	Material 1	250	24	757.508	1063.61	1827.39	0	1827.39
45	4.49279	9412.28	38.3676	Material 1	250	24	673.423	945.547	1562.22	0	1562.22
46	4.49279	7971.41	40.0147	Material 1	250	24	585.029	821.434	1283.46	0	1283.46
47	4.49279	6420.21	41.7025	Material 1	250	24	492.208	691.104	990.734	0	990.734
48	4.49279	4749.88	43.4359	Material 1	250	24	394.832	554.379	683.645	0	683.645
49	4.49279	2950.01	45.2206	Material 1	250	24	292.771	411.077	361.784	0	361.784
50	4.49279	1008.14	47.0633	Material 1	250	24	185.896	261.015	24.7401	0	24.7401

Interslice Data

Global Minimum Query (bishop simplified) - Safety Factor: 1.49007

Slice Number	X coordinate [ft]	Y coordinate - Bottom [ft]	Interslice Normal Force [lbs]	Interslice Shear Force [lbs]	Interslice Force Angle [degrees]
1	427.716	426.202	0	0	0
2	432.653	424.874	1207.03	0	0
3	437.589	423.647	2829.86	0	0
4	442.526	422.519	4796.3	0	0
5	447.462	421.488	7040.31	0	0
6	452.398	420.555	9501.54	0	0
7	457.335	419.717	12124.9	0	0
8	462.271	418.974	14875.3	0	0
9	467.208	418.324	17805.3	0	0
10	472.144	417.768	20874.5	0	0
11	477.081	417.305	24026	0	0
12	482.017	416.934	27207.1	0	0
13	486.954	416.655	30369	0	0
14	491.89	416.467	33466.9	0	0
15	496.827	416.37	36459.3	0	0
16	501.763	416.365	39308.3	0	0
17	506.7	416.451	41979.1	0	0
18	511.636	416.628	44440.1	0	0
19	516.573	416.897	46662.5	0	0
20	521.509	417.258	48620.6	0	0
21	526.446	417.711	50291.5	0	0
22	531.382	418.256	51655	0	0
23	536.318	418.895	52693.4	0	0
24	541.255	419.627	53391.9	0	0
25	546.191	420.454	53738.3	0	0
26	551.128	421.377	53722.9	0	0
27	556.064	422.396	53338.8	0	0
28	561.001	423.513	52581.6	0	0
29	565.937	424.729	51449.5	0	0
30	570.874	426.045	49943.7	0	0
31	575.81	427.463	48068	0	0
32	580.747	428.985	45829.2	0	0
33	585.683	430.612	43236.9	0	0
34	590.62	432.347	40304.1	0	0
35	595.556	434.191	37046.8	0	0
36	600.493	436.148	33484.9	0	0
37	605.429	438.22	29690.2	0	0
38	610.365	440.409	25733.6	0	0
39	615.302	442.72	21659.4	0	0
40	620.238	445.155	17517	0	0
41	625.175	447.719	13361	0	0
42	630.111	450.415	9251.68	0	0
43	635.048	453.249	5255.57	0	0
44	639.984	456.225	1446.2	0	0
45	644.921	459.35	-2095.18	0	0
46	649.857	462.629	-5278.71	0	0
47	654.794	466.069	-8004.86	0	0
48	659.73	469.679	-10163.1	0	0
49	664.667	473.466	-11595.3	0	0
50	669.603	477.441	-12114.6	0	0
51	674.54	481.616	0	0	0

Global Minimum Query (janbu simplified) - Safety Factor: 1.40409

Slice Number	X coordinate [ft]	Y coordinate - Bottom [ft]	Interslice Normal Force [lbs]	Interslice Shear Force [lbs]	Interslice Force Angle [degrees]
1	424.839	425.863	0	0	0
2	429.331	424.133	1408.17	0	0
3	433.824	422.524	3430.92	0	0
4	438.317	421.034	5958.13	0	0
5	442.81	419.659	8891.23	0	0
6	447.302	418.398	12141.8	0	0
7	451.795	417.247	15630.7	0	0
8	456.288	416.206	19286.6	0	0
9	460.781	415.272	23048.1	0	0
10	465.274	414.444	26949.4	0	0
11	469.766	413.721	30970	0	0
12	474.259	413.101	35043.6	0	0
13	478.752	412.584	39109.6	0	0
14	483.245	412.168	43112.7	0	0
15	487.738	411.854	47002.3	0	0
16	492.23	411.64	50732.7	0	0
17	496.723	411.526	54262.2	0	0
18	501.216	411.513	57553.2	0	0
19	505.709	411.599	60571.7	0	0
20	510.201	411.786	63287.5	0	0
21	514.694	412.073	65673.6	0	0
22	519.187	412.462	67706.4	0	0
23	523.68	412.951	69365.3	0	0
24	528.173	413.543	70632.9	0	0
25	532.665	414.238	71494.8	0	0
26	537.158	415.038	71939.6	0	0
27	541.651	415.943	71959	0	0
28	546.144	416.955	71547.4	0	0
29	550.637	418.075	70702.4	0	0
30	555.129	419.307	69424.8	0	0
31	559.622	420.65	67718.4	0	0
32	564.115	422.109	65590.5	0	0
33	568.608	423.686	63051.7	0	0
34	573.1	425.383	60116.3	0	0
35	577.593	427.204	56802.5	0	0
36	582.086	429.153	53132.8	0	0
37	586.579	431.233	49134	0	0
38	591.072	433.45	44838	0	0
39	595.564	435.809	40282.1	0	0
40	600.057	438.314	35509.6	0	0
41	604.55	440.973	30622.1	0	0
42	609.043	443.793	25737.4	0	0
43	613.536	446.781	20936.8	0	0
44	618.028	449.948	16312.4	0	0
45	622.521	453.304	11968.4	0	0
46	627.014	456.861	8023.4	0	0
47	631.507	460.633	4613.2	0	0
48	635.999	464.636	1893.8	0	0
49	640.492	468.89	45.7504	0	0
50	644.985	473.418	-720.312	0	0
51	649.478	478.246	0	0	0

List Of Coordinates

External Boundary

X	Y
750	390
750	490
660	480
600	470
460	430
375	420
300	410
225	405
150	403
0	400
0	370