EXHIBIT I

REDMOND GEOTECHNICAL SERVICES

# Geotechnical Investigation and Consultation Services

# Proposed Vista Loop Apartments Site

# Tax Lot No's. 900 and 1000

# 40808 and 41010 Highway 26

# Sandy (Clackamas County), Oregon

for

**Roll Tide Property Corporation**

Project No. 1861.001.G
November 23, 2020

**REDMOND GEOTECHNICAL SERVICES**

November 23, 2020

Mr. Dave Vandehey
Roll Tide Property Corporation
P.O. Box 703
Cornelius, Oregon 97113

Dear Mr. Vandehey:

**Re: Geotechnical Investigation and Consultation Services,**
**Proposed Vista Loop Apartments Development Site, Tax Lot No's. 900 and 1000,**
**40808 and 41010 Highway 26, Sandy (Clackamas County), Oregon**

Submitted herewith is our report entitled "Geotechnical Investigation and Consultation Services, Proposed Vista Loop Apartments Development Site, Tax Lot No's. 900 and 1000, 40808 and 41010 Highway 26, Sandy (Clackamas County), Oregon". The scope of our services was outlined in our formal discussions with Mr. Carey Sheldon of Sheldon Development, Inc. October 12, 2020. Authorization of our services was provided by Mr. Dave Vandehey of Roll Tide Property Corporation on October 20, 2020.

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
12309
OREGON
July 15, 1983
DANIEL M. REDMOND
Exp. 12-31-20

Cc: Mr. Ray Moore
All County Surveyors & Planners, Inc.

PO Box 20547 • Portland, Oregon 97294 • Fax 503/286-7176 • Phone 503/285-0598

# TABLE OF CONTENTS

**Table of Contents** (continued)

**Table of Contents** (continued)

# GEOTECHNICAL INVESTIGATION AND CONSULTATION SERVICES
# PROPOSED VISTA LOOP APARTMENTS DEVELOPMENT SITE
# TAX LOT NO'S. 900 AND 1000
# 40808 AND 41010 HIGHWAY 26
# SANDY (CLACKAMAS COUNTY) OREGON

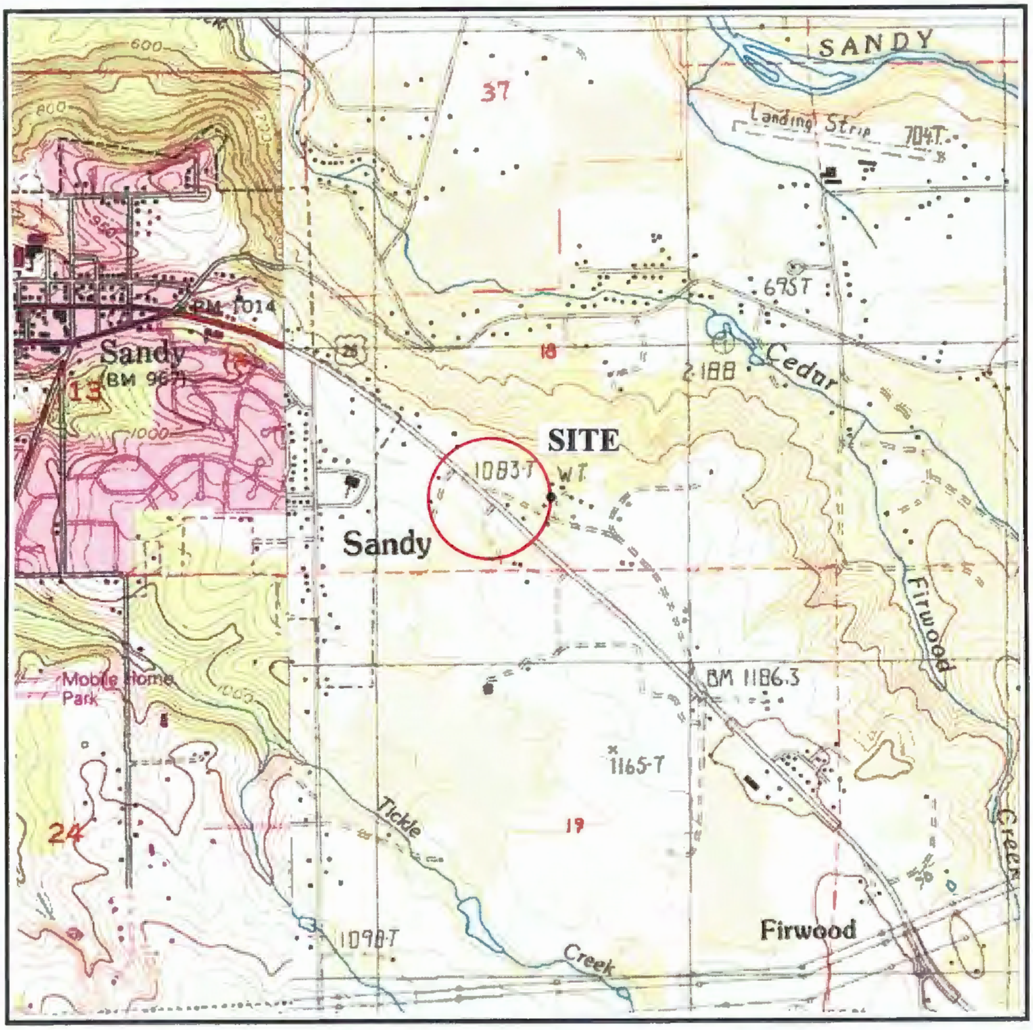
## INTRODUCTION

Redmond Geotechnical Services, LLC is please to submit to you the results of our Geotechnical Investigation and Consultation Services at the site of the proposed new Vista Loop Apartments development project located to the southwest of Highway 26 and the intersection of SE Vista Loop Drive in Sandy (Clackamas 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 consultation 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 development at the site as well as to develop and/or provide appropriate geotechnical design and construction recommendations for the proposed new Vista Loop Apartments development project.

## PROJECT DESCRIPTION

Based on a review of the proposed site development plan(s), we understand that present plans for the project will consist primarily of the construction of new multi-family apartments. However, due to the current site zoning, the site development may also include the construction of new single-family residential homes as well as some mixed use and/or commercial structures. We understand that the multi-family apartments will likely be two- and/or three-story wood-frame structures with a concrete slab-on-grade floor system. However, the single-family lots will likely be developed with new single- and/or two-story wood-frame residential structures with raised wooden post and beam floors. Construction and/or development within the mixed use and/or commercial zoned portion of the property is unknown at this time but is anticipated to result in single- and/or two-story wood-frame structures with concrete slab-on-grade floors.

Support of the proposed new multi-family residential structures is anticipated to consist primarily of conventional shallow continuous (strip) footings although some individual (spread) column-type footings may also be required. Additionally, due to the existing sloping site grades and/or the finish slope grades following the site grading activities for the project, we anticipate that some of the proposed new residential homes and/or multi-family structures may be constructed with partial and/or below levels. As such, construction of some below grade retaining walls is also anticipated for the project.




## BULL RUN QUADRANGLE
### OREGON
### 7.5-MINUTE SERIES

SCALE 1:24 000

1 0.5 0 KILOMETERS 1 2

1000 500 0 METERS 1000 2000

1 0.5 0 MILES 1

1000 0 1000 2000 3000 4000 5000 6000 7000 8000 9000 10000 FEET

CONTOUR INTERVAL 10 FEET
NORTH AMERICAN VERTICAL DATUM OF 1988

# SITE VICINITY MAP

| Project No. 1861.001.G | **VISTA LOOP APARTMENTS**<br>**Tax Lots 600, 700, 900 and 1000** | Figure No. 1 |
|---|---|---|

Structural loading information, although unavailable at this time, is anticipated to be fairly typical for this type of single- and/or three-story wood-frame 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 4.0 kips per lineal foot (klf) and 10 to 50 kips, respectively.

Other associated site improvements for the project will include construction of new paved public streets and/or private access drives and parking areas. Additionally, the project will include the construction of new underground utility services as well as new concrete curbs and sidewalks. Further, we understand that development of the site will also include the collection of storm water from hard and/or impervious surfaces (i.e., roofs and pavements) for on-site treatment and disposal within various storm water detention facilities designed by the Civil Engineer.

Earthwork and grading operations for the project to bring the subject property to finish design grades and/or elevations are unknown at this time. However, based on our past experience with similar types of projects, we envision that the site grading and earthwork for the project will include cuts and/or fills of between five (5) and ten (10) feet.

## SCOPE OF WORK

The purpose of our geotechnical 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 development at the site as well as provide appropriate geotechnical design and construction recommendations for the project. Specifically, our geotechnical investigation 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 including a Geotechnical and Slope Stability Investigation for the proposed Vista Loop North and Vista Loop South Subdivisions prepared by GeoPacific Engineering, Inc. dated August 16, 2005.

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 six (6) 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 various test pits excavated across the subject site.

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, Atterberg Limits and gradational characteristics, as well as (remolded) direct shear strength and "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.

6. Flexible pavement design and construction recommendations for the proposed new public streets and private access drives and parking area improvements.

7. A quantitative limit equilibrium slope stability analysis.

## SITE CONDITIONS

### Regional and Site Geology

The subject site and/or area is located on the eastern margin of the Portland Basin near where the basin meets the western edge of the Cascade Mountains physiographic province (Orr and Orr, 1999). Bedrock in this region consists of volcanic rocks emplaced tens of millions of years ago, associated with the Columbia River Basalt Group and with volcanics from the Western Cascades province (Gannet and Caldwell, 1998).

The volcanic basement is overlain by silts, sands and gravels of Miocene to Pleistocene age which form the majority of the basin fill in the area. The basin fill sediments generally are mapped as Sandy River Mudstone towards the lower portion of the assemblage inturn overlain by the Troutdale Formation, a series of gravels, sands and silts deposited by the ancestral Columbia River and smaller rivers flowing from the Cascade Mountains (Schlicker and Finlayson, 1979). In the vicinity of Sandy, the Troutdale Formation is overlain by the Springwater Formation, a conglomerate with some volcaniclastic sands, silts, and debris flows derived from the Cascade Range. The conglomerate consists of gravels, cobbles, and boulders of volcanic composition that are strongly and deeply weathered to completely decomposed residual soils often producing a red, fine-grained soil up to 75 feet deep.

## Surface Conditions

The proposed new Vista Loop Apartments development property consists of two (2) generally irregular shaped tax lots (TL's 900 and 1000) which encompass a total plan area of approximately 15.04 acres. The proposed Vista Loop Apartments development property is roughly located to the southwest of Highway 26 and to the southwest of the intersection with SE Vista Loop Drive. The subject property is presently unimproved. However, we understand that the subject property was previously improved and contained two (2) single-family residential homes the northwesterly and southeasterly portions of the subject site. 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 sized trees. Additionally, the northeasterly portion of the subject property contains an existing seasonal drainage basin.

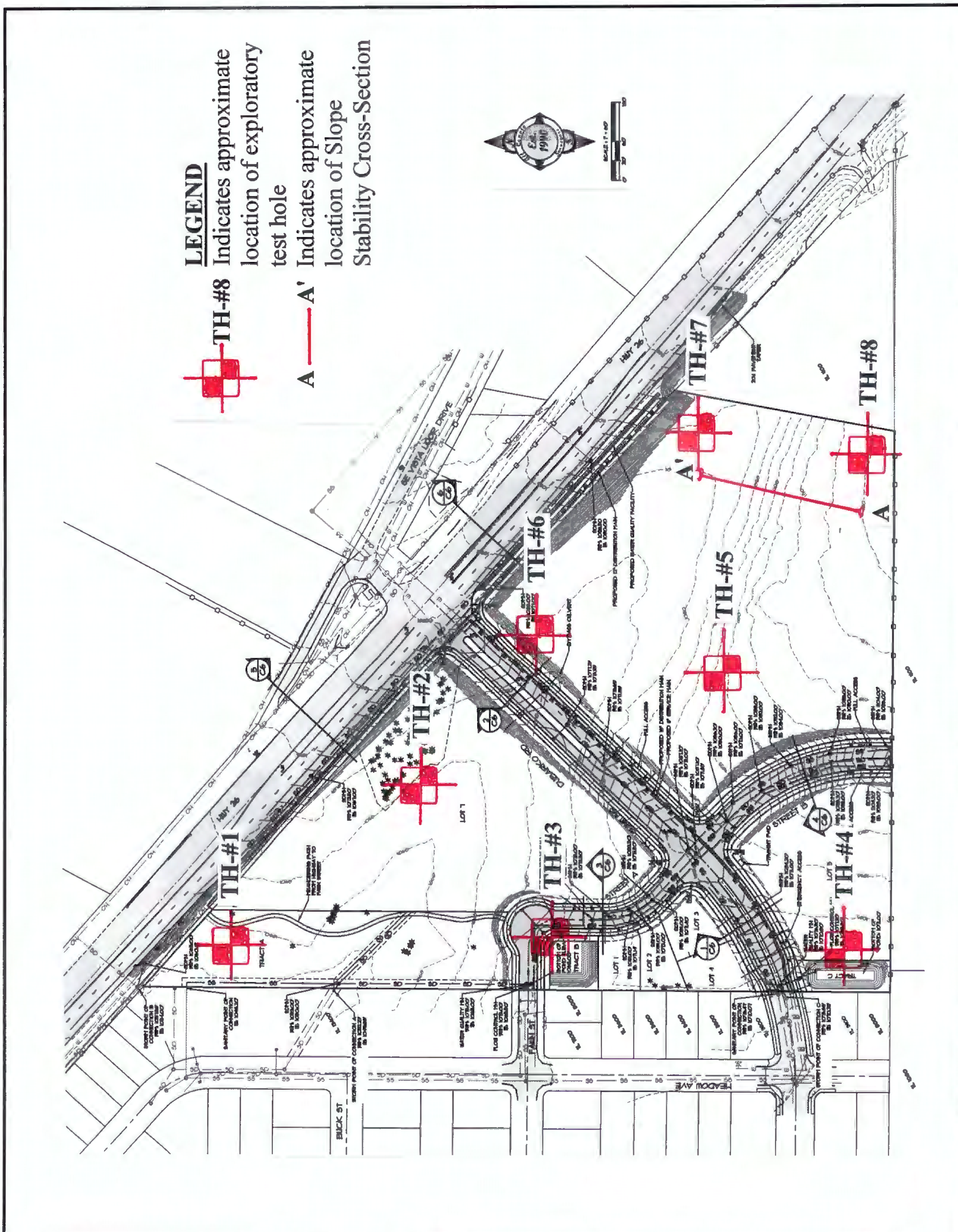
Topographically, the subject site is characterized as gently sloping terrain (i.e., 5 to 30 percent) descending downward towards the north and/or northwest with overall topographic relief estimated at about seventy (70) feet and ranges from a low about Elevation 1052 feet near the northwesterly corner of the subject site to a high of about Elevation 1123 near the southeasterly corner 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 six (6) to seven (7) feet beneath existing site grades on October 20, 2020 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 existing site features 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 a site topographic survey 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 residual soils and/or highly weathered bedrock deposits composed of a surficial layer of dark brown, wet, soft , organic, sandy, clayey silt topsoil materials to depths of about 10 to 16 inches. These surficial topsoil materials were inturn underlain by medium to reddish-brown, very moist, medium stiff to stiff, sandy, clayey silt to the maximum depth explored of about seven (7) feet beneath the existing site and/or surface grades.




# SITE EXPLORATION PLAN

| Project No. 1861.001.G | VISTA LOOP APARTMENTS<br>Tax Lot's 600, 700, 900 and 1000 | Figure No. 2 |
|---|---|---|

These sandy, clayey silt subgrade soils and/or residual soils (highly weathered bedrock deposits) are best characterized by relatively moderate strength and low to moderate compressibility.

### Groundwater

Groundwater was 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 7.0 feet beneath existing surface grades except. However, the northerly portion of the subject property contain existing seasonal drainage basin. In this regard, groundwater elevations at the site may fluctuate seasonally in accordance with rainfall conditions and/or associated with runoff across the site as well as changes in site utilization. As such, we are generally of the opinion that the static water levels and/or surface water ponding observed and/or not observed during our recent field exploration work generally reflect the seasonal groundwater level(s) at and/or beneath the site.

## INFILTRATION TESTING

We performed two (2) field infiltration tests at the site on October 20, 2020. The infiltration tests were performed in test holes TH-#3 and TH-#4 at depths of between four (4) and five (5) 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 Sandy/Clackamas County 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 0.1 to 0.2 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 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-12.

## 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 to stiff, sandy, clayey silt residual soils and/or 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.

As such, due to the medium stiff to stiff and/or cohesive nature of the sandy, clayey silt subgrade soils and/or highly weathered bedrock deposits beneath the site, it is our opinion that the native clayey, sandy 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, the subject property does not contain any steep slopes (i.e., greater than 40 percent). As such, development of the subject site into the planned residential development 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.

## 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 Clackamas County and Sandy. 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 Clackamas 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 using Bishop and Janbu method of slices.

Proposed residential development at the subject site is anticipated to be constructed at and/or above the existing in-situ soil conditions of the existing gently descending slope(s) at the site and were modeled as a two (2) layer system with the upper layer as native, stiff, sandy, clayey silt soil and the lower layer as the existing (native) very moist, very stiff, sandy, clayey silt and/or residual soils encountered in test holes TH-#1 through TH-#8. Site and slope topography, subsurface geometry, and other site conditions modeled in the analyses are based on a topographic map provided by the client and/or our field measurements. In our analysis, we considered potential groundwater levels to be located greater than 30 feet beneath the site.

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 pits, SPT N-value correlations, and 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 on structural fill soils are 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/Fill Soil Strength Parameters**

| Geologic Unit | Wet Unit Weight (pcf) | Friction Angle | Cohesion (psf) |
|---|---|---|---|
| Stiff, andy, clayey SILT (ML) | 110 | 24 | 450 |
| Very stiff, sandy, clayey SILT (ML) | 110 | 26 | 350 |

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

| Pre-Construction | Factor of Safety (Static) | Factor of Safety (Seismic) |
|---|---|---|
| Cross-Section A-A' | 4.626 | 1.857 |

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 slope stability factor of safety (FS) under static and seismic loading greater than 1.5 and 1.2 (see Slope Stability Results in Appendix B). In our opinion, the calculated factor of safety is 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 Vista Loop Apartments development and its associated site improvements provided that the recommendations contained within this report are properly incorporated into the design and construction of the Vista Loop Apartments development 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 steep sloping site conditions across the site 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 sloping site conditions across the site, 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 ten (10) feet unless approved by the Geotechnical Engineer. Additionally, where existing site slopes and/or surface grades exceed about 20 percent (1V:5H) and in order to construct the proposed new site improvements, benching and keying of all fills into the natural site slopes will be required. Further, due to the presence of the existing seasonal drainage basin across the northerly portion of the site, the use of subdrains may be required beneath all structural fills and/or within all fill slopes

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 detention and/or infiltration within structural and/or embankment fills. However, storm water detention and some infiltration may be feasible within storm water detention basins excavated into the existing medium stiff to stiff, sandy, clayey silt residual soils across the lower westerly portion of the site. 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 Vista Loop Apartments development project.

## Site Preparation

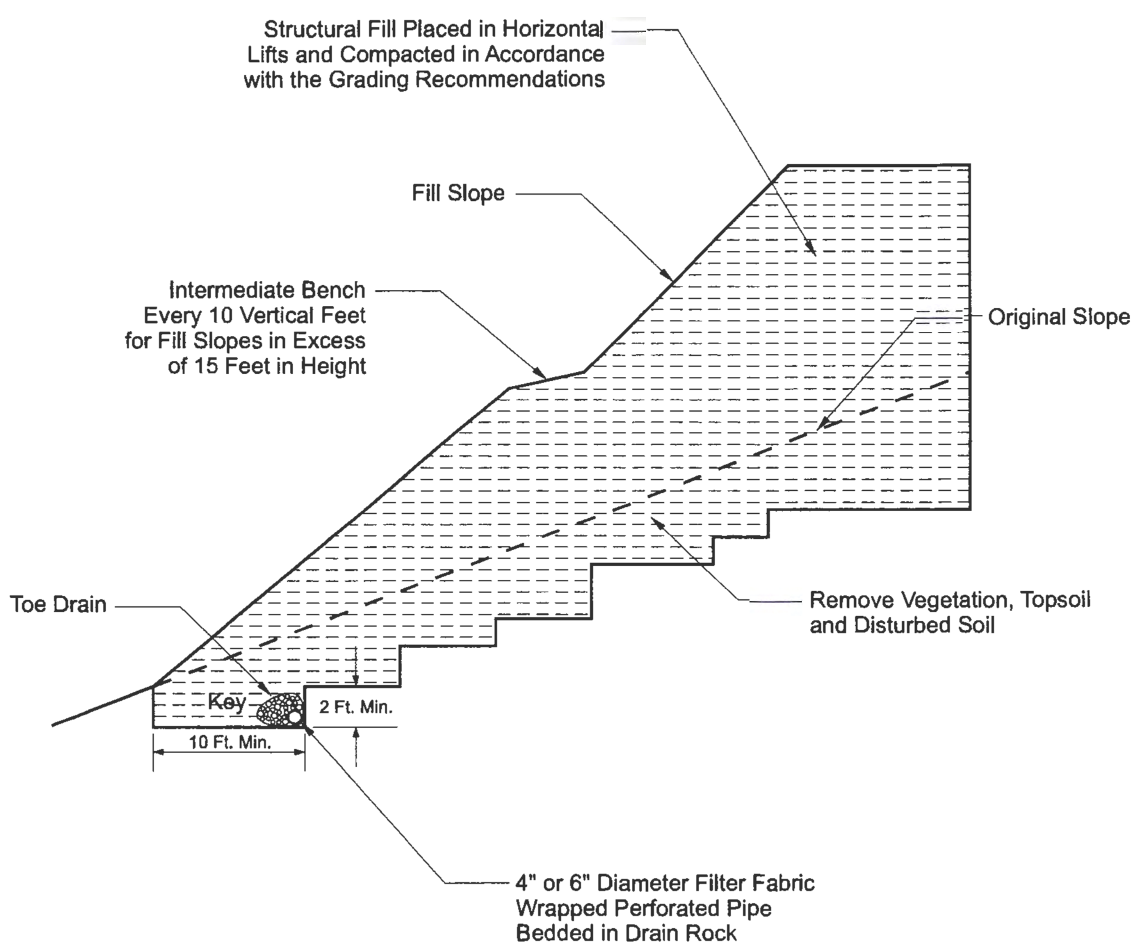
As an initial step in site preparation, we recommend that the proposed new Vista Loop Apartments development site as well as any associated structural and/or site improvement area(s) be stripped and cleared of all existing improvements, any existing unsuitable fill materials, surface debris, existing 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 10 to 14 inches. However, localized areas requiring deeper removals, such as any 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 (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 FW404 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 single-family and/or multi-family 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 about eight (8) to ten (10) feet and a keyway depth of about one (1) to one and one-half (1.5) feet is recommended (see Typical Key and Bench Fill Slope Detail, Figure No. 3). 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. 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 KEY AND BENCH FILL SLOPE DETAIL | | |
|---|---|---|
| Project No. 1861.001.G | VISTA LOOP APARTMENTS<br>Tax Lot's 600, 700, 900 and 1000 | Figure No. 3 |

## Foundation Support

Based on the results of our investigation, it is our opinion that the site of the proposed new Vista Loop Apartments development is suitable for support of the planned single- and/or three-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 single-family and/or multi-family 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 clayey silt 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 2- 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 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/Silt (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/Silt (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. For seismic loading, we recommend an additional uniform earth pressure of 8H where H is the height of the wall in feet.

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 new public street improvements as well as the proposed new private drives and parking area improvements for the Vista Loop Apartments development was determined in accordance with the City of Sandy and/or Clackamas County Department of Public Works standards.

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 ($M_{RSG}$) 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 29 and 31 with an average "R"-value of 30 (see Figure No. A-12). Using the current AASHTO methodology for converting "R"-value to Resilient Modulus ($M_{RSG}$), the subgrade soils have a Resilient Modulus ($M_{RSG}$) of about 6,070 psi which is classified a "Fair" ($M_{RSG}$ = 5,000 psi to 10,000 psi). Based on the above, we recommend that the asphaltic concrete pavement section(s) for the new The Views planned development areas at the site consist of the following:

### Collector Streets

The following documents and/or design input parameters were used to help determine the flexible pavement section design for improvements to new and/or existing Collector Streets:

- **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 new and/or existing Collector Streets:

| 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 |

**Private Access Drives and Parking Areas**

We recommend that the asphaltic concrete pavement section(s) for any private access drives and parking areas associated with The Views planned development areas consist of the following:

| | Asphaltic Concrete Thickness (inches) | Crushed Base Rock Thickness (inches) |
|---|---|---|
| Automobile Parking Areas | 3.0 | 8.0 |
| Automobile Drive Areas | 3.5 | 10.0 |

Note: Where heavy vehicle traffic is anticipated such as those required for fire and/or garbage trucks, we recommend that the automobile drive area pavement section be increased by adding 0.5 inches of asphaltic concrete and 2.0 inches of aggregate base rock. Additionally, the above recommended flexible pavement section(s) assumes a design life of 20 years.

**Pavement Subgrade, Base Course & Asphalt Materials**

The above recommended pavement section(s) were based on the design assumptions listed herein and on the assumption that construction of the pavement section(s) will be completed during an extended period of reasonably dry weather. All thicknesses given are intended to be the minimum acceptable. Increased base rock sections and the use of a woven geotextile fabric may be required during wet and/or inclement weather conditions and/or in order to adequately support construction traffic and protect the subgrade during construction. Additionally, the above recommended pavement section(s) assume that the subgrade will be prepared as recommended herein, that the exposed subgrade soils will be properly protected from rain and construction traffic, and that the subgrade is firm and unyielding at the time of paving. Further, it assumes that the subgrade is graded to prevent any ponding of water which may tend to accumulate in the base course.

Pavement base course materials should consist of well-graded 1-1/2 inch and/or 3/4-inch minus crushed base rock having less than 5 percent fine materials passing the No. 200 sieve. The base course and asphaltic concrete materials should conform to the requirements set forth in the latest edition of the Oregon Department of Transportation, Standard Specifications for Highway Construction. 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. The asphaltic concrete paving materials should be compacted to at least 92 percent of the theoretical maximum density as determined by the ASTM D-2041 (Rice Gravity) test method.

**Wet Weather Grading and Soft Spot Mitigation**

Construction of the proposed new paved site 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- to 12-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 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 single- and/or multi-family 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 within any of the exploratory test pits excavated at the site at the time of excavation to depths of up to 8.0 feet beneath existing site grades. However, the northerly, easterly and southerly portion(s) of the site contain existing seasonal drainage basins. 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 to finish design grade(s), we are of the opinion that an underslab drainage system is generally not required for the proposed multi-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. Additionally, a subdrain is recommended beneath and/or within all structural fills which are constructed within and/or above the existing seasonal drainage basins. Further, due to our understanding that various storm water detention and/or infiltration basins will be utilized for the project as well as the relatively low infiltration rates of the near surface sandy, clayey silt subgrade soils and/or highly weathered bedrock deposits 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 basins and/or infiltration systems should not be utilized around and/or up-gradient of the proposed residential structures unless approved by the Geotechnical Engineer.

## Design Infiltration Rates

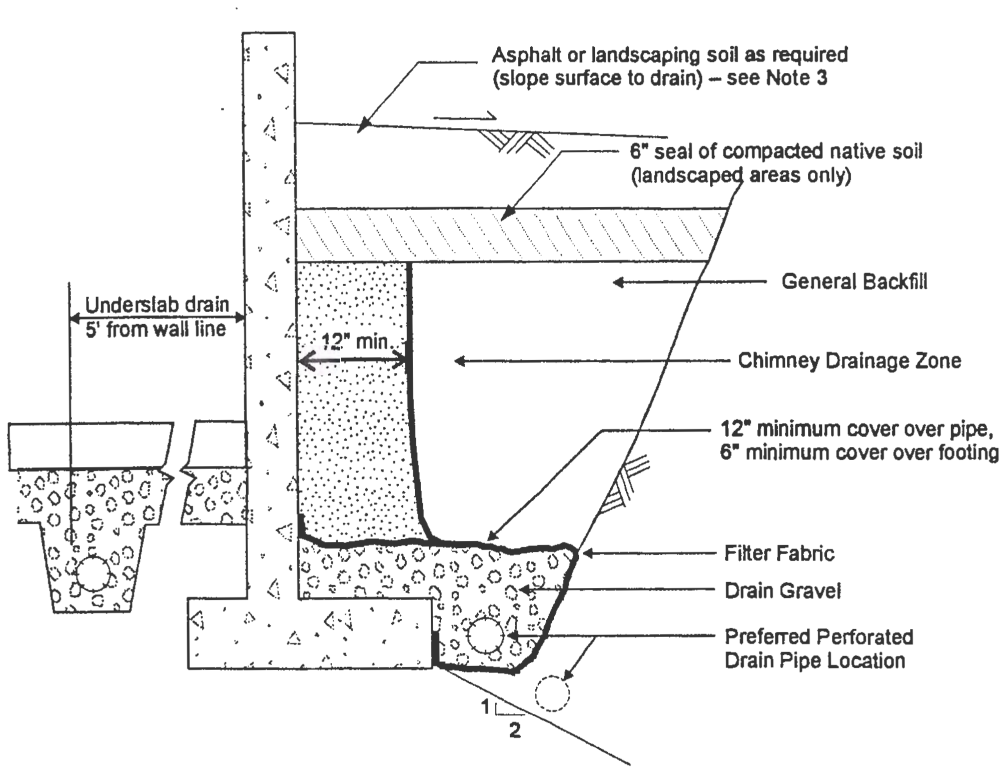
Based on the results of our field infiltration testing, we recommend using the following infiltration rate to design any on-site near surface storm water infiltration and/or disposal systems for the project:

| **Subgrade Soil Type** | **Recommended Infiltration Rate** |
|---|---|
| sandy, clayey SILT (ML) | less than 0.1 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 2019 and/or latest edition of the State of Oregon Structural Specialty Code (OSSC), ASCE 7-16 and/or Amendments to the 2018 International Building Code (IBC).




**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. 1861.001.G | VISTA LOOP APARTMENTS<br>Tax Lot's 600, 700, 900 and 1000 | Figure No. 4 |

The maximum considered earthquake ground motion for short period and 1.0 period spectral response may be determined from the Oregon Structural Specialty Code, ASCE 7-16 and/or from the 2015 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 "D" be used for design. Using this information, the structural engineer can select the appropriate site coefficient values ($F_a$ and $F_v$) from the 2018 IBC and/or ASCE 7-16 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. ASCE 7-16 Seismic Design Parameters**

| Site Class | $S_S$ | $S_1$ | Fa | Fv | $S_{MS}$ | $S_{M1}$ | $S_{DS}$ | $S_{D1}$ |
|---|---|---|---|---|---|---|---|---|
| D | 0.705 | 0.314 | 1.236 | 1.986 | 0.871 | 0.623 | 0.581 | 0.416 |

Notes: 1. $S_s$ and $S_1$ were established based on the ASCE 7-16 mapped maximum considered earthquake spectral acceleration maps for 2% probability of exceedence in 50 years.

2. Fa and Fv were established based on the ASCE 7-16 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 Vista Loop Apartments 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- and/or multi-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.

# REFERENCES

Adams, John, 1984, Active Deformation of the Pacific Northwest Continental Margin: Tectonics, v.3, no. 4, p. 449-472.

Applied Technology Council, ATC-13, 1985, Earthquake Damage Evaluation Data for California.

Atwater, B.F., 1992, Geologic evidence for earthquakes during the past 2000 years along the Copalis River, southern coastal Washington: Journal of Geophysical Research, v. 97, p. 1901-1919.

Atwater, B.F., 1987a, A periodic Holocene recurrence of widespread, probably coseismic Subsidence in southwestern Washington: EOS, v. 68, no. 44.

Atwater, B.F., 1987b, Evidence for great Holocene earthquakes along the outer coast of Washington State: Science, v. 236, no. 4804, pp. 942-944.

Campbell, K.W., 1990, Empirical prediction of near-surface soil and soft-rock ground motion for the Diablo Canyon Power Plant site, San Luis Obispo County, California: Dames & Moore report to Lawrence Livermore National Laboratory.

Carver, G.A., and Burke, R.M., 1987, Late Holocene paleoseismicity of the southern end of the Cascadia Subduction zone [abs.]: EOS, v. 68, no. 44, p. 1240.

Chase, R.L., Tiffin, D.L., Murray, J.W., 1975, The western Canadian continental margin: In Yorath, C.J., Parker, E.R., Glass, D.J., editors, Canada's continental margins and offshore petroleum exploration: Canadian Society of Petroleum Geologists Memoir 4, p. 701-721.

Crouse, C.B., 1991a, Ground motion attenuation equations for earthquakes on the Cascadia Subduction Zone: Earthquake Spectra, v. 7, no. 2, pp. 201-236.

Crouse, C.B., 1991b, Errata to Crouse (1991a), Earthquake Spectra, v. 7, no. 3, p. 506.

Darienzo, M.E., and Peterson, C.D., 1987, Episodic tectonic subsidence recorded in late Holocene salt marshes, northern Oregon central Cascadia margin: Tectonics, v. 9, p. 1-22.

Darienzo, M.E., and Peterson, C.D., 1987, Episodic tectonic subsidence recorded in late Holocene salt marshes northwest Oregon [abs]: EOS, v. 68, no. 44, p. 1469.

EERI (Earthquake Engineering Research Institute), 1993, The March 25, 1993, Scotts Mill Earthquake, Western Oregon's Wake-Up Call: EERI Newsletter, Vol. 27, No. 5, May.

Geomatrix, 1995 Seismic Design Mapping, State of Oregon: Final Report to Oregon Department of Transportation, January.

Geologic Map Series (GMS-49), Map of Oregon Seismicity, 1841-1986 dated 1986.

Geologic Map Series (GMS-97), Geologic Map of the Damascus Quadrangle, Clackamas County, Oregon dated 1995.

Grant, W.C., and McLaren, D.D., 1987, Evidence for Holocene Subduction earthquakes along the northern Oregon coast [abs]: EOS v. 68, no. 44, p. 1239.

Grant, W.C., Atwater, B.F., Carver, G.A., Darienzo, M.E., Nelson, A.R., Peterson, C.D., and Vick, G.S., 1989, Radiocarbon dating of late Holocene coastal subsidence above the Cascadia Subduction zone-compilation for Washington, Oregon, and northern California, [abs]: EOS Transactions of the American Geophysical Union, v. 70, p. 1331.

International Conference of Building Officials (ICBO), 1994, Uniform Building Code: 1994 Edition, Whittier, CA. 1994.

Joyner, W.B., and Boore, D.M., 1998, Measurement, characterization and prediction of strong ground motion: Earthquake Engineering and Soil Dynamics II – Recent Advances in Ground Motion Evaluation, ASCE Geotech. Special Publ. No. 20, p. 43-102.

Riddihough, R.P., 1984, Recent movements of the Juan de Fuca plate system: Journal of Geophysical Research, v. 89, no. B8, p. 6980-6994.

Youngs, R.R., Day, S.M., and Stevens, J.L., 1998, Near field ground motions on rock for large Subduction earthquakes: Earthquake Engineering and Soil Dynamics II – Recent Advances in Ground Motion Evaluation, ASCE Geotech. Special Publ. No. 20, p. 445-462.

# 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 October 20, 2020. The approximate location of the test pit explorations are shown in relation to the existing site features and/or 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 6.0 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 within any of the exploratory test pits (TH-#1 through TH-#8) at the time of excavating to depths of up to 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, Atterberg Limits and gradational characteristics 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 test was 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 sandy, clayey silt 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**

One (1) Direct Shear Strength test was performed on an undisturbed and/or remolded sample of the sandy, clayey silt subgrade soils 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. A-11.

**"R"-Value Tests**

Two (2) "R"-value tests were performed on remolded samples of the sandy, clayey silt subgrade soils 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-12.

The following figures are attached and complete the Appendix:

| 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
PO Box 20547 • Portland, Oregon 97294

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

VISTA LOOP APARTMENTS
40808 and 41010 Highway 26

| PROJECT NO. | DATE | Figure |
|---|---|---|
| 1861.001.G | 11/23/20 | A-3 |

BACKHOE COMPANY: Inland Company | BUCKET SIZE: 24 inches | DATE: 10/20/20

## SOIL DESCRIPTION

TEST PIT NO. TH-#1 | ELEVATION 1058'±

| DEPTH (FEET) | BAG SAMPLE | DENSITY TEST | DRY DENSITY (pcf) | MOISTURE CONTENT (%) | SOIL CLASS. (U.S.C.S.) | SOIL DESCRIPTION |
|---|---|---|---|---|---|---|
| 0 | | | | | ML | Dark brown, wet, soft, organic, sandy, clayey SILT (Topsoil) |
| | X | | | 35.5 | ML | Medium to reddish-brown, very moist, stiff, sandy, clayey SILT |
| 5 | X | | | 40.3 | | Becomes very stiff |
| | | | | | | Total Depth = 7.0 feet<br>No groundwater encountered at time of exploration |
| 10 | | | | | | |
| 15 | | | | | | |

TEST PIT NO. TH-#2 | ELEVATION 1067'±

| DEPTH (FEET) | BAG SAMPLE | DENSITY TEST | DRY DENSITY (pcf) | MOISTURE CONTENT (%) | SOIL CLASS. (U.S.C.S.) | SOIL DESCRIPTION |
|---|---|---|---|---|---|---|
| 0 | | | | | ML | Dark brown, wet, soft, organic, sandy, clayey SILT (Topsoil) |
| | | | | | ML | Medium to reddish-brown, very moist, stiff, sandy, clayey SILT |
| 5 | | | | | | Becomes very stiff |
| | | | | | | Total Depth = 6.0 feet<br>No groundwater encountered at time of exploration |
| 10 | | | | | | |
| 15 | | | | | | |

# LOG OF TEST PITS

PROJECT NO. 1861.001.G | VISTA LOOP APARTMENTS | FIGURE NO. A-4

REDMOND GEOTECHNICAL SERVICES

BACKHOE COMPANY: Inland Company | BUCKET SIZE: 24 inches | DATE: 10/20/20

SOIL DESCRIPTION

TEST PIT NO. TH-#3 | ELEVATION 1075'±

| DEPTH (FEET) | BAG SAMPLE | DENSITY TEST | DRY DENSITY (pcf) | MOISTURE CONTENT (%) | SOIL CLASS. (U.S.C.S.) | SOIL DESCRIPTION |
|---|---|---|---|---|---|---|
| 0 | | | | | ML | Dark brown, wet, soft, organic, sandy, clayey SILT (Topsoil) |
| | X | | | 36.1 | ML | Medium to reddish-brown, very moist, stiff, sandy, clayey SILT |
| 5 | | | | | | Becomes very stiff |
| | X | | | 41.7 | | |
| | | | | | | Total Depth = 7.0 feet<br>No groundwater encountered at time of exploration |
| 10 | | | | | | |
| 15 | | | | | | |

TEST PIT NO. TH-#4 | ELEVATION 1082'±

| DEPTH (FEET) | BAG SAMPLE | DENSITY TEST | DRY DENSITY (pcf) | MOISTURE CONTENT (%) | SOIL CLASS. (U.S.C.S.) | SOIL DESCRIPTION |
|---|---|---|---|---|---|---|
| 0 | | | | | ML | Dark brown, wet, very soft, highly organic, sandy, clayey SILT (Topsoil) |
| | X | | | 35.5 | ML | Medium to reddish-brown, very moist, stiff, sandy, clayey SILT |
| 5 | | | | | | Becomes very stiff |
| | | | | | | Total Depth = 7.0 feet<br>No groundwater encountered at time of exploration |
| 10 | | | | | | |
| 15 | | | | | | |

# LOG OF TEST PITS

PROJECT NO. 1861.001.G | VISTA LOOP APARTMENTS | FIGURE NO. A-5

BACKHOE COMPANY: Inland Company BUCKET SIZE: 24 inches DATE: 10/20/20

**SOIL DESCRIPTION**

TEST PIT NO. TH-#5 ELEVATION 1095'±

| DEPTH (FEET) | BAG SAMPLE | DENSITY TEST | DRY DENSITY (pcf) | MOISTURE CONTENT (%) | SOIL CLASS. (U.S.C.S.) | SOIL DESCRIPTION |
|---|---|---|---|---|---|---|
| 0 | | | | | ML | Dark brown, wet, soft, organic, sandy, clayey SILT (Topsoil) |
| | | | | | ML | Medium to reddish-brown, very moist, stiff, sandy, clayey SILT |
| 5 | | | | | | Becomes very stiff |
| | | | | | | Total Depth = 6.0 feet<br>No groundwater encountered at time of exploration |
| 10 | | | | | | |
| 15 | | | | | | |

TEST PIT NO. TH-#6 ELEVATION 1075'±

| DEPTH (FEET) | BAG SAMPLE | DENSITY TEST | DRY DENSITY (pcf) | MOISTURE CONTENT (%) | SOIL CLASS. (U.S.C.S.) | SOIL DESCRIPTION |
|---|---|---|---|---|---|---|
| 0 | | | | | ML | Dark brown, wet, soft, organic, sandy, clayey SILT (Topsoil) |
| | X | | | 34.9 | ML | Medium to reddish-brown, very moist, stiff, sandy, clayey SILT |
| 5 | X | | | 41.4 | | Becomes very stiff |
| | | | | | | Total Depth = 7.0 feet<br>No groundwater encountered at time of exploration |
| 10 | | | | | | |
| 15 | | | | | | |

# LOG OF TEST PITS

PROJECT NO. 1861.001.G | VISTA LOOP APARTMENTS | FIGURE NO. A-6

REDMOND GEOTECHNICAL SERVICES

BACKHOE COMPANY: Inland Company BUCKET SIZE: 24 inches DATE: 10/20/20

SOIL DESCRIPTION

TEST PIT NO. TH-#7 ELEVATION 1085'±

| DEPTH (FEET) | BAG SAMPLE | DENSITY TEST | DRY DENSITY (pcf) | MOISTURE CONTENT (%) | SOIL CLASS. (U.S.C.S.) | SOIL DESCRIPTION |
|---|---|---|---|---|---|---|
| 0 | | | | | ML | Dark brown, wet, soft, organic, sandy, clayey SILT (Topsoil) |
| | X | | | 35.7 | ML | Medium to reddish-brown, very moist, stiff, sandy, clayey SILT |
| 5 | | | | | | Becomes very stiff |
| | | | | | | Total Depth = 6.0 feet<br>No groundwater encountered at time of exploration |
| 10 | | | | | | |
| 15 | | | | | | |

TEST PIT NO. TH-#8 ELEVATION 1120'±

| DEPTH (FEET) | BAG SAMPLE | DENSITY TEST | DRY DENSITY (pcf) | MOISTURE CONTENT (%) | SOIL CLASS. (U.S.C.S.) | SOIL DESCRIPTION |
|---|---|---|---|---|---|---|
| 0 | | | | | ML | Dark brown, wet, soft, organic, sandy, clayey SILT (Topsoil) |
| | X | | | 36.7 | ML | Medium to reddish-brown, very moist, stiff, sandy, clayey SILT |
| 5 | | | | | | Becomes very stiff |
| | | | | | | Total Depth = 7.0 feet<br>No groundwater encountered at time of exploration |
| 10 | | | | | | |
| 15 | | | | | | |

# LOG OF TEST PITS

PROJECT NO. 1861.001.G | VISTA LOOP APARTMENTS | FIGURE NO. A-7

REDMOND GEOTECHNICAL SERVICES

MAXIMUM DENSITY TEST RESULTS

| SAMPLE LOCATION | SOIL DESCRIPTION | MAXIMUM DRY DENSITY (pcf) | OPTIMUM MOISTURE CONTENT (%) |
|---|---|---|---|
| TH-#3 @ 2.5' | Medium to reddish-brown, sandy, clayey, SILT (ML) | 104.0 | 28.0 |

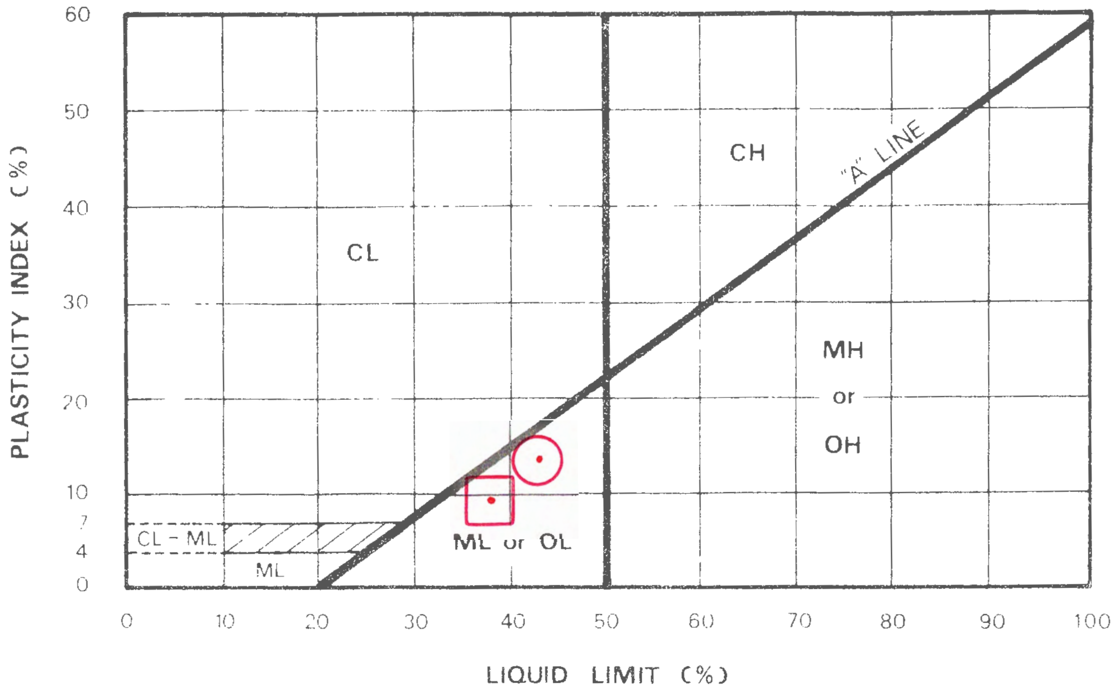
EXPANSION INDEX TEST RESULTS

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

**MAXIMUM DENSITY & EXPANSION INDEX TEST RESULTS**

| PROJECT NO.: 1861.001.G | VISTA LOOP APARTMENTS | FIGURE NO.: A-8 |
|---|---|---|

REDMOND GEOTECHNICAL SERVICES




| 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-#1 | 2.0 | 35.5 | 38.2 | 9.9 | 77.3 | | ML |
| ⊙ | TH-#1 | 5.0 | 40.3 | 42.6 | 12.7 | 85.5 | | ML |

REDMOND GEOTECHNICAL SERVICES
PO Box 20547 • Portland, Oregon 97294

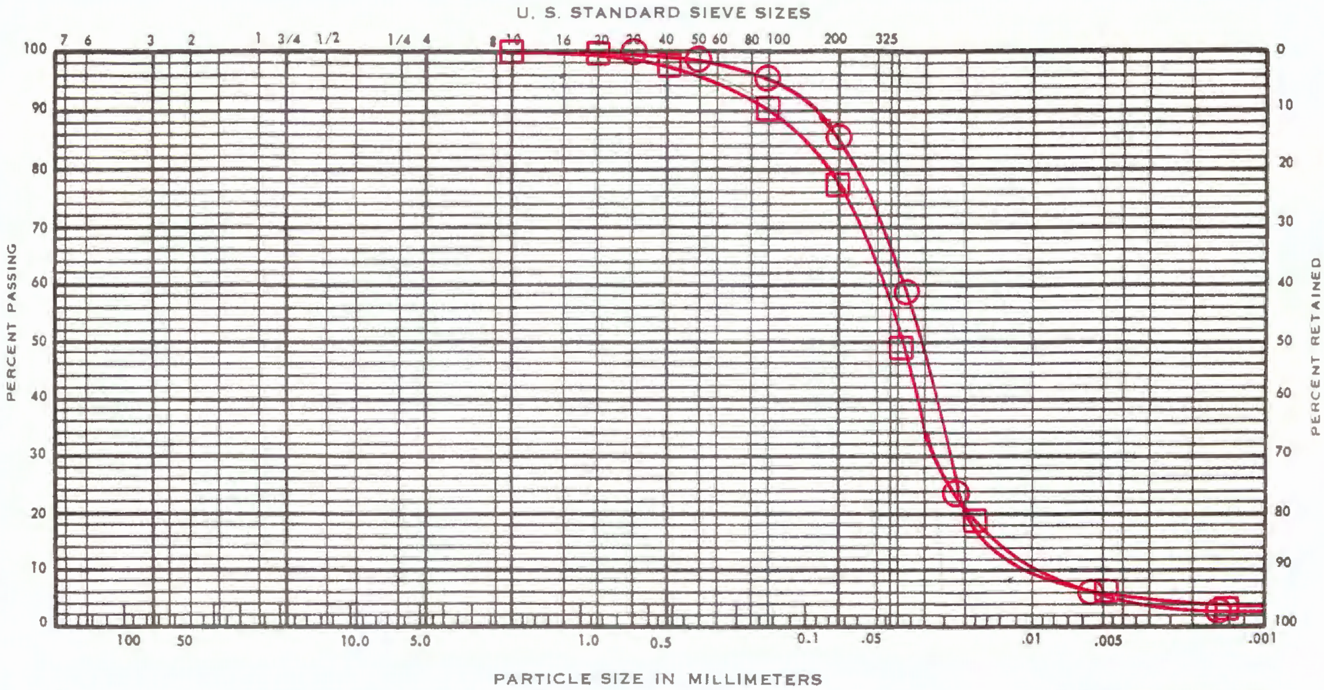
## PLASTICITY CHART AND DATA

VISTA LOOP APARTMENTS
40808 and 41010 Highway 26

| PROJECT NO | DATE | |
|---|---|---|
| 1861.001.G | 11/23/20 | Figure A-9 |

# UNIFIED SOIL CLASSIFICATION SYSTEM

(ASTM D 422-72)

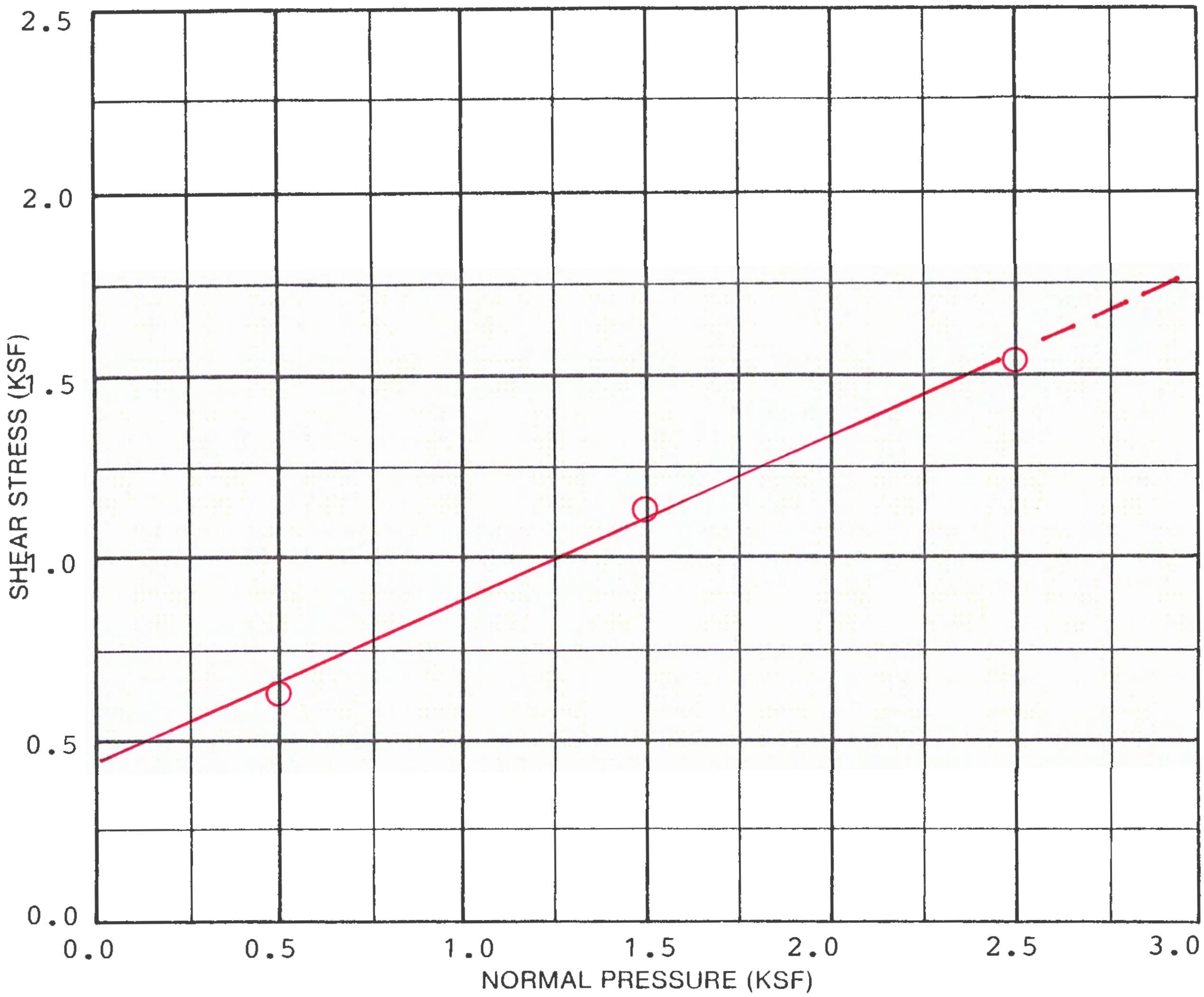



| COBBLES | GRAVEL | | SAND | | | SILT AND CLAY |
|---|---|---|---|---|---|---|
| | COARSE | FINE | COARSE | MEDIUM | FINE | |

| KEY SYMBOL | BORING NO. | SAMPLE DEPTH (feet) | ELEV. (feet) | UNIFIED SOIL CLASSIFICATION SYMBOL | SAMPLE DESCRIPTION |
|---|---|---|---|---|---|
| -□- | TH-#1 | 2.0 | | ML | Medium to reddish-brown, sandy, clayey SILT |
| -○- | TH-#1 | 5.0 | | ML | Medium to reddish-brown, sandy, clayey SILT |

REDMOND GEOTECHNICAL SERVICES
PO Box 20547 • Portland, Oregon 97294

| GRADATION TEST DATA | | |
|---|---|---|
| VISTA LOOP APARTMENTS<br>40808 and 41010 Highway 26 | | |
| PROJECT NO. | DATE | FIGURE A-10 |
| 1861.001.G | 11/23/20 | |




| SAMPLE DATA | |
|---|---|
| DESCRIPTION: Medium to reddish-brown sandy, clayey SILT (ML) (Remolded) | |
| BORING NO.: TH-#3 | |
| DEPTH (ft.): 2.5 | ELEVATION (ft): |
| **TEST RESULTS** | |
| APPARENT COHESION (C): 450 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) | 0.6 | 1.1 | 1.5 | |
| INITIAL $H_2O$ CONTENT (%) | 28.0 | 28.0 | 28.0 | |
| FINAL $H_2O$ CONTENT (%) | 28.9 | 23.2 | 16.6 | |
| INITIAL DRY DENSITY (PCF) | 95.0 | 95.0 | 95.0 | |
| FINAL DRY DENSITY (PCF) | 95.7 | 98.9 | 103.3 | |
| STRAIN RATE: 0.02 inches per minute | | | | |


REDMOND GEOTECHNICAL SERVICES
PO Box 20547 • Portland, Oregon 97294


**DIRECT SHEAR TEST DATA**

VISTA LOOP APARTMENTS
40808 and 41010 Highway 26

| PROJECT NO. | DATE | Figure A-11 |
|---|---|---|
| 1861.001.G | 11/23/20 | |

# RESULTS OF R (RESISTANCE) VALUE TESTS

**SAMPLE LOCATION: TH-#3**

**SAMPLE DEPTH: 2.5 feet bgs**

| Specimen | A | B | C |
|---|---|---|---|
| Exudation Pressure (psi) | 219 | 329 | 431 |
| Expansion Dial (o.ooo1") | 0 | 1 | 2 |
| Expansion Pressure (psf) | 0 | 3 | 8 |
| Moisture Content (%) | 17.6 | 14.4 | 11.1 |
| Dry Density (pcf) | 93.4 | 98.2 | 102.6 |
| Resistance Value, "R" | 17 | 30 | 41 |
| "R"-Value at 300 psi Exudation Pressure = 29 | | | |

**SAMPLE LOCATION: TH-#6**

**SAMPLE DEPTH: 2.0 feet bgs**

| Specimen | A | B | C |
|---|---|---|---|
| Exudation Pressure (psi) | 208 | 326 | 439 |
| Expansion Dial (0.0001") | 0 | 1 | 2 |
| Expansion Pressure (psf) | 0 | 3 | 8 |
| Moisture Content (%) | 17.3 | 14.1 | 10.7 |
| Dry Density (pcf) | 94.9 | 99.1 | 103.7 |
| Resistance Value "R" | 19 | 32 | 43 |
| "R"-Value at 300 psi Exudation Pressure = 31 | | | |

# Division 004 Appendix C - Infiltration Testing

| | | |
|---|---|---|
| **Location:** Vista Loop Apartments | **Date:** October 20, 2020 | **Test Hole:** TH-#3 |
| **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.<br>**Tester's Company:** Redmond Geotechnical Services, LLC | **Tester's Contact Number:** 503-285-0598 | |

| Depth (feet) | Soil Characteristics |
|---|---|
| 0-1.0 | Dark brown Topsoil |
| 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 |
|---|---|---|---|---|---|
| 11:00 | 0 | 48.00 | ---- | | Filled w/12" water |
| 11:20 | 20 | 48.20 | 0.20 | 0.60 | |
| 11:40 | 20 | 48.34 | 0.14 | 0.42 | |
| 12:00 | 20 | 48.45 | 0.11 | 0.33 | |
| 12:20 | 20 | 48.54 | 0.09 | 0.27 | |
| 12:40 | 20 | 48.62 | 0.08 | 0.24 | |
| 1:00 | 20 | 48.69 | 0.07 | 0.21 | |
| 1:20 | 20 | 48.76 | 0.07 | 0.21 | |
| 1:40 | 20 | 48.83 | 0.07 | 0.21 | |
| | | | | | |

Infiltration Test Data Table

# Division 004 Appendix C - Infiltration Testing

| | | |
|---|---|---|
| **Location:** Vista Loop Apartments | **Date:** October 20, 2020 | **Test Hole:** TH-#4 |
| **Depth to Bottom of Hole:** 5.0 feet | **Hole Diameter:** 6 inches | **Test Method:** Encased Falling Head |
| **Tester's Name:** Daniel M. Redmond, P.E., G.E.<br>**Tester's Company:** Redmond Geotechnical Services, LLC **Tester's Contact Number:** 503-285-0598 | | |

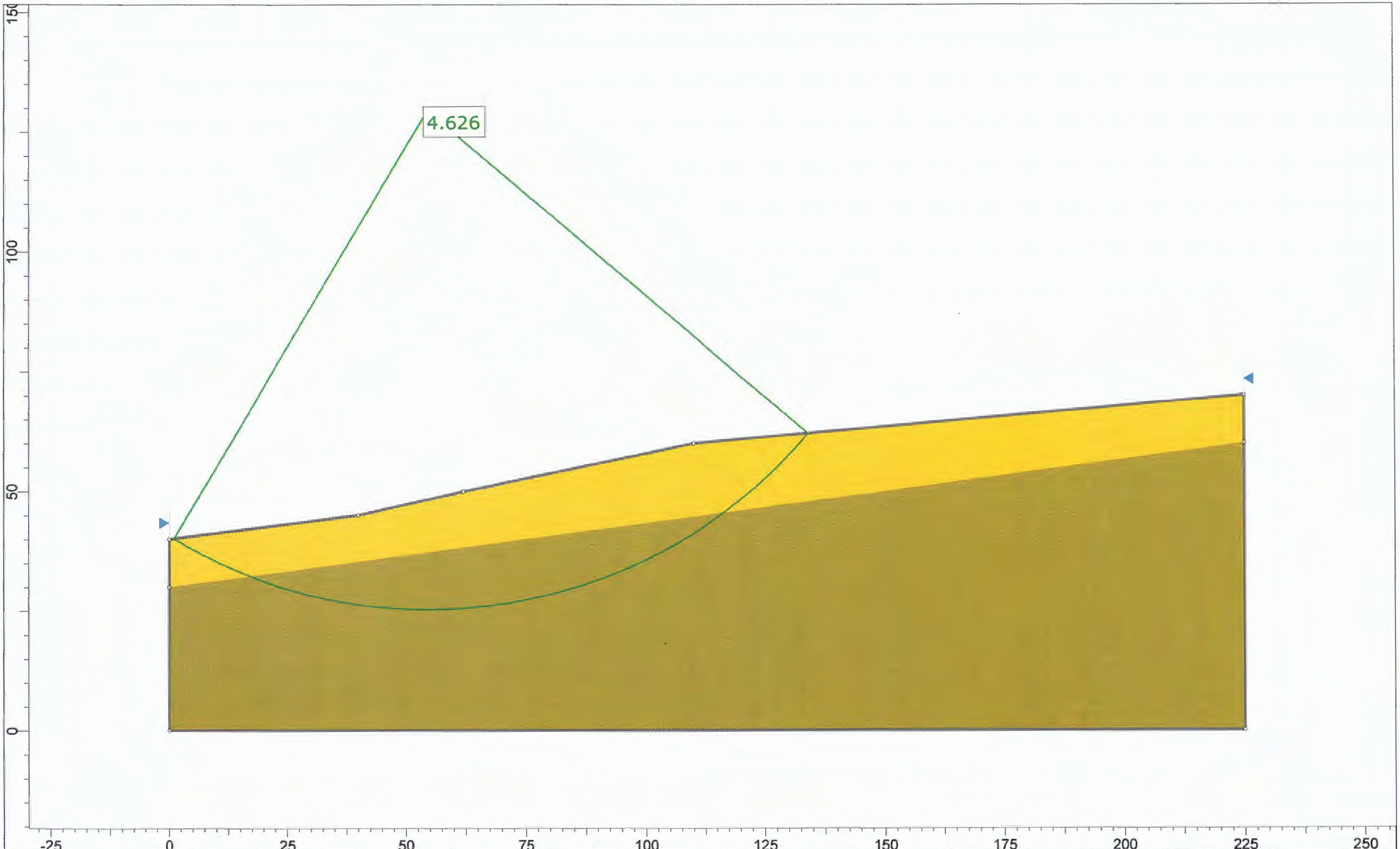
| Depth (feet) | Soil Characteristics |
|---|---|
| 0-1.0 | Dark brown Topsoil |
| 1.0-5.0 | Medium to reddish-brown, sandy, clayey SILT (ML) |
| | |
| | |

| Time | Time Interval (Minutes) | Measurement (inches) | Drop in Water (inches) | Infiltration Rate (inches/hour) | Remarks |
|---|---|---|---|---|---|
| 11:30 | 0 | 60.00 | ---- | | Filled w/12" water |
| 11:50 | 20 | 60.15 | 0.15 | 0.45 | |
| 12:10 | 20 | 60.25 | 0.10 | 0.30 | |
| 12:30 | 20 | 60.32 | 0.07 | 0.21 | |
| 12:50 | 20 | 60.37 | 0.05 | 0.15 | |
| 1:10 | 20 | 60.41 | 0.04 | 0.12 | |
| 1:30 | 20 | 60.44 | 0.03 | 0.09 | |
| 1:50 | 20 | 60.47 | 0.03 | 0.09 | |
| 2:10 | 20 | 60.50 | 0.03 | 0.09 | |
| | | | | | |

Infiltration Test Data Table

# Appendix "B"

**Slope Stability Analysis**




rocscience

SLIDEINTERPRET 8.020

| | | | |
|---|---|---|---|
| *Project* | Vista Loop Apartments | | |
| *Analysis Description* | | | |
| *Drawn By* | Daniel M. Redmond, P.E., G.E. | *Scale* | 1:333 |
| *Company* | Redmond Geotechnical Services, LLC | | |
| *Date* | November 21, 2020 | *File Name* | Vista Loop Apartments Static.slmd |

# Slide Analysis Information

# Vista Loop Apartments Static

## Project Summary

| | |
|---|---|
| File Name: | Vista Loop Apartments Static.slmd |
| Slide Modeler Version: | 8.02 |
| Compute Time: | 00h:00m:01.150s |
| Project Title: | Vista Loop Apartments |
| Author: | Daniel M. Redmond, P.E., G.E. |
| Company: | Redmond Geotechnical Services, LLC |
| Date Created: | November 21, 2020 |

## General Settings

| | |
|---|---|
| Units of Measurement: | Imperial Units |
| Time Units: | days |
| Permeability Units: | feet/second |
| Data Output: | Standard |
| Failure Direction: | Right to Left |

## 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: | Auto Refine Search |
| Divisions along slope: | 20 |
| Circles per division: | 10 |
| Number of iterations: | 10 |
| Divisions to use in next iteration: | 50% |
| Composite Surfaces: | Disabled |
| Minimum Elevation: | Not Defined |
| Minimum Depth: | Not Defined |
| Minimum Area: | Not Defined |
| Minimum Weight: | Not Defined |

## Seismic Loading

| | |
|---|---|
| Advanced seismic analysis: | No |
| Staged pseudostatic analysis: | No |

## Materials

| Property | Material 1 | Material 5 |
|---|---|---|
| Color | | |
| Strength Type | Mohr-Coulomb | Mohr-Coulomb |
| Unit Weight [lbs/ft3] | 110 | 110 |
| Cohesion [psf] | 450 | 350 |
| Friction Angle [°] | 24 | 26 |
| Water Surface | None | None |
| Ru Value | 0 | 0 |

# *Global Minimums*

## Method: bishop simplified

| FS | 4.626110 |
|---|---|
| Center: | 54.656, 129.596 |
| Radius: | 104.317 |
| Left Slip Surface Endpoint: | 1.015, 40.127 |
| Right Slip Surface Endpoint: | 134.197, 62.104 |
| Resisting Moment: | 1.90519e+07 lb-ft |
| Driving Moment: | 4.11834e+06 lb-ft |
| Total Slice Area: | 2301.38 ft2 |
| Surface Horizontal Width: | 133.182 ft |
| Surface Average Height: | 17.28 ft |

## Method: janbu simplified

| FS | 4.243600 |
|---|---|
| Center: | 58.497, 104.803 |
| Radius: | 81.443 |
| Left Slip Surface Endpoint: | 7.895, 40.987 |
| Right Slip Surface Endpoint: | 127.487, 61.521 |
| Resisting Horizontal Force: | 162738 lb |
| Driving Horizontal Force: | 38349 lb |
| Total Slice Area: | 2275.47 ft2 |
| Surface Horizontal Width: | 119.591 ft |
| Surface Average Height: | 19.027 ft |

# *Valid/Invalid Surfaces*

## Method: bishop simplified

| | |
|---|---|
| Number of Valid Surfaces: | 12126 |
| Number of Invalid Surfaces: | 44 |

### Error Codes:

Error Code -112 reported for 44 surfaces

## Method: janbu simplified

| | |
|---|---|
| Number of Valid Surfaces: | 11229 |
| Number of Invalid Surfaces: | 941 |

### Error Codes:

Error Code -108 reported for 342 surfaces
Error Code -111 reported for 599 surfaces

### Error Codes

*The following errors were encountered during the computation:*

-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).
-111 = safety factor equation did not converge
-112 = The coefficient M-Alpha = cos(alpha)(1+tan(alpha)tan(phi)/F) < 0.2 for the final iteration of the safety factor calculation. This screens out some slip surfaces which may not be valid in the context of the analysis, in particular, deep seated slip surfaces with many high negative base angle slices in the passive zone.

## Slice Data

- **Global Minimum Query (bishop simplified) - Safety Factor: 4.62611**

| 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 | 2.67883 | 278.075 | -30.0942 | Material 1 | 450 | 24 | 113.6 | 525.528 | 169.639 | 0 | 169.639 |
| 2 | 2.67883 | 818.959 | -28.4075 | Material 1 | 450 | 24 | 133.654 | 618.297 | 378.003 | 0 | 378.003 |
| 3 | 2.67883 | 1330.02 | -26.7473 | Material 1 | 450 | 24 | 152.452 | 705.26 | 573.323 | 0 | 573.323 |
| 4 | 2.67883 | 1812.58 | -25.1109 | Material 1 | 450 | 24 | 170.066 | 786.742 | 756.335 | 0 | 756.335 |
| 5 | 2.67883 | 2267.82 | -23.4962 | Material 1 | 450 | 24 | 186.555 | 863.025 | 927.668 | 0 | 927.668 |
| 6 | 2.67883 | 2696.74 | -21.9011 | Material 1 | 450 | 24 | 201.974 | 934.356 | 1087.88 | 0 | 1087.88 |
| 7 | 2.68435 | 3107.05 | -20.322 | Material 5 | 350 | 26 | 205.722 | 951.694 | 1233.66 | 0 | 1233.66 |
| 8 | 2.68435 | 3487.49 | -18.7573 | Material 5 | 350 | 26 | 220.528 | 1020.18 | 1374.08 | 0 | 1374.08 |
| 9 | 2.68435 | 3843.89 | -17.207 | Material 5 | 350 | 26 | 234.279 | 1083.8 | 1504.51 | 0 | 1504.51 |
| 10 | 2.68435 | 4176.87 | -15.6696 | Material 5 | 350 | 26 | 247.013 | 1142.71 | 1625.3 | 0 | 1625.3 |
| 11 | 2.68435 | 4486.99 | -14.1437 | Material 5 | 350 | 26 | 258.763 | 1197.07 | 1736.74 | 0 | 1736.74 |
| 12 | 2.68435 | 4774.73 | -12.628 | Material 5 | 350 | 26 | 269.557 | 1247 | 1839.12 | 0 | 1839.12 |
| 13 | 2.68435 | 5040.51 | -11.1212 | Material 5 | 350 | 26 | 279.419 | 1292.62 | 1932.66 | 0 | 1932.66 |
| 14 | 2.68435 | 5284.68 | -9.62213 | Material 5 | 350 | 26 | 288.373 | 1334.04 | 2017.59 | 0 | 2017.59 |
| 15 | 2.68435 | 5516.31 | -8.12971 | Material 5 | 350 | 26 | 296.785 | 1372.96 | 2097.39 | 0 | 2097.39 |
| 16 | 2.68435 | 5787.61 | -6.64283 | Material 5 | 350 | 26 | 306.737 | 1419 | 2191.78 | 0 | 2191.78 |
| 17 | 2.68435 | 6049.7 | -5.16044 | Material 5 | 350 | 26 | 316.277 | 1463.13 | 2282.25 | 0 | 2282.25 |
| 18 | 2.68435 | 6291.13 | -3.6815 | Material 5 | 350 | 26 | 324.951 | 1503.26 | 2364.54 | 0 | 2364.54 |
| 19 | 2.68435 | 6512.03 | -2.20502 | Material 5 | 350 | 26 | 332.774 | 1539.45 | 2438.74 | 0 | 2438.74 |
| 20 | 2.68435 | 6712.49 | -0.729997 | Material 5 | 350 | 26 | 339.754 | 1571.74 | 2504.93 | 0 | 2504.93 |
| 21 | 2.68435 | 6892.53 | 0.744538 | Material 5 | 350 | 26 | 345.895 | 1600.15 | 2563.18 | 0 | 2563.18 |
| 22 | 2.68435 | 7052.16 | 2.21957 | Material 5 | 350 | 26 | 351.202 | 1624.7 | 2613.53 | 0 | 2613.53 |
| 23 | 2.68435 | 7190.8 | 3.69607 | Material 5 | 350 | 26 | 355.662 | 1645.33 | 2655.81 | 0 | 2655.81 |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 24 | 2.68435 | 7298.45 | 5.17504 | Material 5 | 350 | 26 | 358.885 | 1660.24 | 2686.39 | 0 | 2686.39 |
| 25 | 2.68435 | 7381.43 | 6.65747 | Material 5 | 350 | 26 | 361.126 | 1670.61 | 2707.65 | 0 | 2707.65 |
| 26 | 2.68435 | 7443.58 | 8.1444 | Material 5 | 350 | 26 | 362.542 | 1677.16 | 2721.07 | 0 | 2721.07 |
| 27 | 2.68435 | 7484.7 | 9.63688 | Material 5 | 350 | 26 | 363.126 | 1679.86 | 2726.62 | 0 | 2726.62 |
| 28 | 2.68435 | 7504.53 | 11.136 | Material 5 | 350 | 26 | 362.875 | 1678.7 | 2724.23 | 0 | 2724.23 |
| 29 | 2.68435 | 7502.75 | 12.6429 | Material 5 | 350 | 26 | 361.779 | 1673.63 | 2713.85 | 0 | 2713.85 |
| 30 | 2.68435 | 7479 | 14.1587 | Material 5 | 350 | 26 | 359.831 | 1664.62 | 2695.38 | 0 | 2695.38 |
| 31 | 2.68435 | 7432.87 | 15.6847 | Material 5 | 350 | 26 | 357.021 | 1651.62 | 2668.72 | 0 | 2668.72 |
| 32 | 2.68435 | 7363.87 | 17.2223 | Material 5 | 350 | 26 | 353.334 | 1634.56 | 2633.74 | 0 | 2633.74 |
| 33 | 2.68435 | 7271.44 | 18.7727 | Material 5 | 350 | 26 | 348.753 | 1613.37 | 2590.29 | 0 | 2590.29 |
| 34 | 2.68435 | 7154.97 | 20.3376 | Material 5 | 350 | 26 | 343.262 | 1587.97 | 2538.21 | 0 | 2538.21 |
| 35 | 2.68435 | 7013.74 | 21.9184 | Material 5 | 350 | 26 | 336.84 | 1558.26 | 2477.3 | 0 | 2477.3 |
| 36 | 2.68435 | 6846.94 | 23.5171 | Material 5 | 350 | 26 | 329.463 | 1524.13 | 2407.32 | 0 | 2407.32 |
| 37 | 2.68435 | 6653.67 | 25.1354 | Material 5 | 350 | 26 | 321.103 | 1485.46 | 2328.04 | 0 | 2328.04 |
| 38 | 2.68435 | 6432.87 | 26.7754 | Material 5 | 350 | 26 | 311.731 | 1442.1 | 2239.14 | 0 | 2239.14 |
| 39 | 2.68435 | 6183.38 | 28.4396 | Material 5 | 350 | 26 | 301.311 | 1393.9 | 2140.31 | 0 | 2140.31 |
| 40 | 2.68435 | 5903.86 | 30.1304 | Material 5 | 350 | 26 | 289.805 | 1340.67 | 2031.17 | 0 | 2031.17 |
| 41 | 2.68435 | 5585.54 | 31.8506 | Material 5 | 350 | 26 | 276.899 | 1280.97 | 1908.76 | 0 | 1908.76 |
| 42 | 2.68435 | 5162.95 | 33.6037 | Material 5 | 350 | 26 | 260.208 | 1203.75 | 1750.45 | 0 | 1750.45 |
| 43 | 2.68435 | 4686.95 | 35.3931 | Material 5 | 350 | 26 | 241.642 | 1117.86 | 1574.35 | 0 | 1574.35 |
| 44 | 2.5412 | 3964.63 | 37.1733 | Material 1 | 450 | 24 | 230.597 | 1066.77 | 1385.28 | 0 | 1385.28 |
| 45 | 2.5412 | 3470 | 38.9466 | Material 1 | 450 | 24 | 212.188 | 981.604 | 1194 | 0 | 1194 |
| 46 | 2.5412 | 2938.5 | 40.7654 | Material 1 | 450 | 24 | 192.584 | 890.917 | 990.316 | 0 | 990.316 |
| 47 | 2.5412 | 2367.06 | 42.6355 | Material 1 | 450 | 24 | 171.707 | 794.335 | 773.39 | 0 | 773.39 |
| 48 | 2.5412 | 1752.02 | 44.5637 | Material 1 | 450 | 24 | 149.461 | 691.424 | 542.247 | 0 | 542.247 |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 49 | 2.5412 | 1088.94 | 46.5583 | Material 1 | 450 | 24 | 125.738 | 581.676 | 295.749 | 0 | 295.749 |
| 50 | 2.5412 | 372.395 | 48.6292 | Material 1 | 450 | 24 | 100.406 | 464.488 | 32.5414 | 0 | 32.5414 |

- **Global Minimum Query (janbu simplified) - Safety Factor: 4.2436**

| 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 | 2.53101 | 312.373 | -37.2927 | Material 1 | 450 | 24 | 129.324 | 548.801 | 221.911 | 0 | 221.911 |
| 2 | 2.53101 | 916.276 | -35.0855 | Material 1 | 450 | 24 | 155.483 | 659.808 | 471.238 | 0 | 471.238 |
| 3 | 2.53101 | 1480.1 | -32.9366 | Material 1 | 450 | 24 | 179.604 | 762.168 | 701.141 | 0 | 701.141 |
| 4 | 2.53101 | 2006.79 | -30.8388 | Material 1 | 450 | 24 | 201.875 | 856.675 | 913.408 | 0 | 913.408 |
| 5 | 2.53101 | 2498.8 | -28.786 | Material 1 | 450 | 24 | 222.448 | 943.98 | 1109.5 | 0 | 1109.5 |
| 6 | 2.39611 | 2789.74 | -26.8256 | Material 5 | 350 | 26 | 229.639 | 974.496 | 1280.41 | 0 | 1280.41 |
| 7 | 2.39611 | 3175.29 | -24.9514 | Material 5 | 350 | 26 | 248.05 | 1052.63 | 1440.6 | 0 | 1440.6 |
| 8 | 2.39611 | 3535.88 | -23.1054 | Material 5 | 350 | 26 | 265.08 | 1124.89 | 1588.77 | 0 | 1588.77 |
| 9 | 2.39611 | 3872.56 | -21.2844 | Material 5 | 350 | 26 | 280.805 | 1191.62 | 1725.58 | 0 | 1725.58 |
| 10 | 2.39611 | 4186.26 | -19.4858 | Material 5 | 350 | 26 | 295.287 | 1253.08 | 1851.59 | 0 | 1851.59 |
| 11 | 2.39611 | 4477.75 | -17.7069 | Material 5 | 350 | 26 | 308.584 | 1309.51 | 1967.28 | 0 | 1967.28 |
| 12 | 2.39611 | 4747.73 | -15.9455 | Material 5 | 350 | 26 | 320.744 | 1361.11 | 2073.08 | 0 | 2073.08 |
| 13 | 2.39611 | 4996.8 | -14.1995 | Material 5 | 350 | 26 | 331.808 | 1408.06 | 2169.34 | 0 | 2169.34 |
| 14 | 2.39611 | 5250.62 | -12.4668 | Material 5 | 350 | 26 | 343.051 | 1455.77 | 2267.16 | 0 | 2267.16 |
| 15 | 2.39611 | 5523.46 | -10.7457 | Material 5 | 350 | 26 | 355.165 | 1507.18 | 2372.58 | 0 | 2372.58 |
| 16 | 2.39611 | 5777.12 | -9.0343 | Material 5 | 350 | 26 | 366.281 | 1554.35 | 2469.28 | 0 | 2469.28 |
| 17 | 2.39611 | 6011.49 | -7.33102 | Material 5 | 350 | 26 | 376.395 | 1597.27 | 2557.28 | 0 | 2557.28 |
| 18 | 2.39611 | 6226.8 | -5.63424 | Material 5 | 350 | 26 | 385.529 | 1636.03 | 2636.75 | 0 | 2636.75 |
| 19 | 2.39611 | 6423.25 | -3.94241 | Material 5 | 350 | 26 | 393.699 | 1670.7 | 2707.83 | 0 | 2707.83 |
| 20 | 2.39611 | 6600.97 | -2.25402 | Material 5 | 350 | 26 | 400.919 | 1701.34 | 2770.65 | 0 | 2770.65 |
| 21 | 2.39611 | 6760.06 | -0.567591 | Material 5 | 350 | 26 | 407.199 | 1727.99 | 2825.3 | 0 | 2825.3 |
| 22 | 2.39611 | 6900.56 | 1.11835 | Material 5 | 350 | 26 | 412.548 | 1750.69 | 2871.85 | 0 | 2871.85 |
| 23 | 2.39611 | 7019.52 | 2.80526 | Material 5 | 350 | 26 | 416.832 | 1768.87 | 2909.12 | 0 | 2909.12 |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 24 | 2.39611 | 7111.33 | 4.49461 | Material 5 | 350 | 26 | 419.792 | 1781.43 | 2934.87 | 0 | 2934.87 |
| 25 | 2.39611 | 7183.84 | 6.18789 | Material 5 | 350 | 26 | 421.807 | 1789.98 | 2952.4 | 0 | 2952.4 |
| 26 | 2.39611 | 7237.43 | 7.88662 | Material 5 | 350 | 26 | 422.9 | 1794.62 | 2961.92 | 0 | 2961.92 |
| 27 | 2.39611 | 7271.9 | 9.59236 | Material 5 | 350 | 26 | 423.07 | 1795.34 | 2963.38 | 0 | 2963.38 |
| 28 | 2.39611 | 7286.97 | 11.3067 | Material 5 | 350 | 26 | 422.304 | 1792.09 | 2956.73 | 0 | 2956.73 |
| 29 | 2.39611 | 7282.32 | 13.0314 | Material 5 | 350 | 26 | 420.598 | 1784.85 | 2941.88 | 0 | 2941.88 |
| 30 | 2.39611 | 7257.56 | 14.7683 | Material 5 | 350 | 26 | 417.938 | 1773.56 | 2918.72 | 0 | 2918.72 |
| 31 | 2.39611 | 7212.24 | 16.5191 | Material 5 | 350 | 26 | 414.304 | 1758.14 | 2887.11 | 0 | 2887.11 |
| 32 | 2.39611 | 7145.82 | 18.2859 | Material 5 | 350 | 26 | 409.68 | 1738.52 | 2846.88 | 0 | 2846.88 |
| 33 | 2.39611 | 7057.67 | 20.071 | Material 5 | 350 | 26 | 404.044 | 1714.6 | 2797.84 | 0 | 2797.84 |
| 34 | 2.39611 | 6947.07 | 21.8767 | Material 5 | 350 | 26 | 397.368 | 1686.27 | 2739.76 | 0 | 2739.76 |
| 35 | 2.39611 | 6813.2 | 23.7055 | Material 5 | 350 | 26 | 389.622 | 1653.4 | 2672.37 | 0 | 2672.37 |
| 36 | 2.39611 | 6655.1 | 25.5604 | Material 5 | 350 | 26 | 380.771 | 1615.84 | 2595.35 | 0 | 2595.35 |
| 37 | 2.39611 | 6471.66 | 27.4444 | Material 5 | 350 | 26 | 370.77 | 1573.4 | 2508.35 | 0 | 2508.35 |
| 38 | 2.39611 | 6261.59 | 29.3613 | Material 5 | 350 | 26 | 359.574 | 1525.89 | 2410.94 | 0 | 2410.94 |
| 39 | 2.39611 | 6023.4 | 31.315 | Material 5 | 350 | 26 | 347.13 | 1473.08 | 2302.65 | 0 | 2302.65 |
| 40 | 2.39611 | 5755.36 | 33.3102 | Material 5 | 350 | 26 | 333.366 | 1414.67 | 2182.9 | 0 | 2182.9 |
| 41 | 2.39611 | 5455.42 | 35.3522 | Material 5 | 350 | 26 | 318.211 | 1350.36 | 2051.04 | 0 | 2051.04 |
| 42 | 2.39611 | 5121.14 | 37.4474 | Material 5 | 350 | 26 | 301.576 | 1279.77 | 1906.31 | 0 | 1906.31 |
| 43 | 2.39611 | 4732.47 | 39.603 | Material 5 | 350 | 26 | 282.605 | 1199.26 | 1741.25 | 0 | 1741.25 |
| 44 | 2.39611 | 4247.71 | 41.8282 | Material 5 | 350 | 26 | 259.53 | 1101.34 | 1540.48 | 0 | 1540.48 |
| 45 | 2.24803 | 3501.02 | 44.0598 | Material 1 | 450 | 24 | 244.603 | 1038 | 1320.66 | 0 | 1320.66 |
| 46 | 2.24803 | 2989.47 | 46.305 | Material 1 | 450 | 24 | 221.266 | 938.966 | 1098.24 | 0 | 1098.24 |
| 47 | 2.24803 | 2431.11 | 48.6467 | Material 1 | 450 | 24 | 196.126 | 832.279 | 858.613 | 0 | 858.613 |
| 48 | 2.24803 | 1819.15 | 51.103 | Material 1 | 450 | 24 | 168.971 | 717.044 | 599.791 | 0 | 599.791 |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 49 | 2.24803 | 1144.63 | 53.6982 | Material 1 | 450 | 24 | 139.535 | 592.13 | 319.227 | 0 | 319.227 |
| 50 | 2.24803 | 395.219 | 56.4655 | Material 1 | 450 | 24 | 107.474 | 456.075 | 13.6445 | 0 | 13.6445 |

## *Interslice Data*

- **Global Minimum Query (bishop simplified) - Safety Factor: 4.62611**

| Slice Number | X coordinate [ft] | Y coordinate - Bottom [ft] | Interslice Normal Force [lbs] | Interslice Shear Force [lbs] | Interslice Force Angle [degrees] |
|---|---|---|---|---|---|
| 1 | 1.01512 | 40.1269 | 0 | 0 | 0 |
| 2 | 3.69395 | 38.5744 | 567.672 | 0 | 0 |
| 3 | 6.37278 | 37.1255 | 1473.38 | 0 | 0 |
| 4 | 9.0516 | 35.7754 | 2655.79 | 0 | 0 |
| 5 | 11.7304 | 34.5199 | 4060.92 | 0 | 0 |
| 6 | 14.4093 | 33.3554 | 5640.99 | 0 | 0 |
| 7 | 17.0881 | 32.2784 | 7353.62 | 0 | 0 |
| 8 | 19.7724 | 31.2843 | 9132.26 | 0 | 0 |
| 9 | 22.4568 | 30.3727 | 10976.8 | 0 | 0 |
| 10 | 25.1411 | 29.5414 | 12856.4 | 0 | 0 |
| 11 | 27.8255 | 28.7884 | 14743.3 | 0 | 0 |
| 12 | 30.5098 | 28.1119 | 16612.7 | 0 | 0 |
| 13 | 33.1942 | 27.5105 | 18442.3 | 0 | 0 |
| 14 | 35.8785 | 26.9828 | 20212.2 | 0 | 0 |
| 15 | 38.5629 | 26.5278 | 21904.4 | 0 | 0 |
| 16 | 41.2472 | 26.1443 | 23505.3 | 0 | 0 |
| 17 | 43.9316 | 25.8317 | 25013.9 | 0 | 0 |
| 18 | 46.6159 | 25.5892 | 26416.1 | 0 | 0 |
| 19 | 49.3003 | 25.4165 | 27696.8 | 0 | 0 |
| 20 | 51.9846 | 25.3132 | 28842.1 | 0 | 0 |
| 21 | 54.669 | 25.279 | 29839.8 | 0 | 0 |
| 22 | 57.3533 | 25.3139 | 30678.8 | 0 | 0 |
| 23 | 60.0377 | 25.4179 | 31349.6 | 0 | 0 |
| 24 | 62.722 | 25.5913 | 31843.8 | 0 | 0 |
| 25 | 65.4064 | 25.8344 | 32154 | 0 | 0 |
| 26 | 68.0907 | 26.1477 | 32275 | 0 | 0 |
| 27 | 70.7751 | 26.5319 | 32202.9 | 0 | 0 |
| 28 | 73.4594 | 26.9877 | 31934.8 | 0 | 0 |
| 29 | 76.1438 | 27.5161 | 31469.4 | 0 | 0 |
| 30 | 78.8281 | 28.1182 | 30806.4 | 0 | 0 |
| 31 | 81.5125 | 28.7954 | 29947 | 0 | 0 |
| 32 | 84.1968 | 29.5492 | 28893.7 | 0 | 0 |
| 33 | 86.8812 | 30.3813 | 27650.7 | 0 | 0 |
| 34 | 89.5655 | 31.2937 | 26223.5 | 0 | 0 |
| 35 | 92.2498 | 32.2886 | 24619.4 | 0 | 0 |
| 36 | 94.9342 | 33.3687 | 22847.8 | 0 | 0 |
| 37 | 97.6185 | 34.5369 | 20920.1 | 0 | 0 |
| 38 | 100.303 | 35.7963 | 18850 | 0 | 0 |
| 39 | 102.987 | 37.1509 | 16653.8 | 0 | 0 |
| 40 | 105.672 | 38.6047 | 14350.9 | 0 | 0 |
| 41 | 108.356 | 40.1626 | 11964.4 | 0 | 0 |
| 42 | 111.04 | 41.8303 | 9524.49 | 0 | 0 |
| 43 | 113.725 | 43.614 | 7100.64 | 0 | 0 |

| | | | | | |
|---|---|---|---|---|---|
| 44 | 116.409 | 45.5212 | 4746.69 | 0 | 0 |
| 45 | 118.95 | 47.4482 | 2663.21 | 0 | 0 |
| 46 | 121.491 | 49.5021 | 750.037 | 0 | 0 |
| 47 | 124.033 | 51.6929 | -930.196 | 0 | 0 |
| 48 | 126.574 | 54.0326 | -2303.34 | 0 | 0 |
| 49 | 129.115 | 56.5354 | -3280.67 | 0 | 0 |
| 50 | 131.656 | 59.2187 | -3754.75 | 0 | 0 |
| 51 | 134.197 | 62.1041 | 0 | 0 | 0 |

- **Global Minimum Query (janbu simplified) - Safety Factor: 4.2436**

| Slice Number | X coordinate [ft] | Y coordinate - Bottom [ft] | Interslice Normal Force [lbs] | Interslice Shear Force [lbs] | Interslice Force Angle [degrees] |
|---|---|---|---|---|---|
| 1 | 7.89535 | 40.9869 | 0 | 0 | 0 |
| 2 | 10.4264 | 39.0593 | 755.076 | 0 | 0 |
| 3 | 12.9574 | 37.2815 | 1986.4 | 0 | 0 |
| 4 | 15.4884 | 35.6418 | 3590.62 | 0 | 0 |
| 5 | 18.0194 | 34.1307 | 5481.81 | 0 | 0 |
| 6 | 20.5504 | 32.7401 | 7587.73 | 0 | 0 |
| 7 | 22.9465 | 31.5283 | 9689.44 | 0 | 0 |
| 8 | 25.3426 | 30.4135 | 11889.8 | 0 | 0 |
| 9 | 27.7387 | 29.3912 | 14149.2 | 0 | 0 |
| 10 | 30.1348 | 28.4577 | 16432.8 | 0 | 0 |
| 11 | 32.5309 | 27.6099 | 18710.2 | 0 | 0 |
| 12 | 34.927 | 26.8449 | 20954.6 | 0 | 0 |
| 13 | 37.3231 | 26.1603 | 23142.3 | 0 | 0 |
| 14 | 39.7193 | 25.554 | 25252.6 | 0 | 0 |
| 15 | 42.1154 | 25.0243 | 27275.6 | 0 | 0 |
| 16 | 44.5115 | 24.5695 | 29205.5 | 0 | 0 |
| 17 | 46.9076 | 24.1886 | 31023.9 | 0 | 0 |
| 18 | 49.3037 | 23.8803 | 32714.1 | 0 | 0 |
| 19 | 51.6998 | 23.6439 | 34261.2 | 0 | 0 |
| 20 | 54.0959 | 23.4788 | 35651.7 | 0 | 0 |
| 21 | 56.492 | 23.3845 | 36873.6 | 0 | 0 |
| 22 | 58.8881 | 23.3607 | 37916.4 | 0 | 0 |
| 23 | 61.2842 | 23.4075 | 38770.5 | 0 | 0 |
| 24 | 63.6803 | 23.5249 | 39427.7 | 0 | 0 |
| 25 | 66.0764 | 23.7133 | 39880.8 | 0 | 0 |
| 26 | 68.4726 | 23.973 | 40124.5 | 0 | 0 |
| 27 | 70.8687 | 24.305 | 40154.7 | 0 | 0 |
| 28 | 73.2648 | 24.7099 | 39968.4 | 0 | 0 |
| 29 | 75.6609 | 25.189 | 39563.8 | 0 | 0 |
| 30 | 78.057 | 25.7436 | 38940.1 | 0 | 0 |
| 31 | 80.4531 | 26.3752 | 38097.9 | 0 | 0 |
| 32 | 82.8492 | 27.0858 | 37039 | 0 | 0 |
| 33 | 85.2453 | 27.8776 | 35766.5 | 0 | 0 |
| 34 | 87.6414 | 28.7531 | 34285.2 | 0 | 0 |
| 35 | 90.0375 | 29.7152 | 32601.4 | 0 | 0 |
| 36 | 92.4336 | 30.7673 | 30723.4 | 0 | 0 |
| 37 | 94.8298 | 31.9133 | 28661.5 | 0 | 0 |
| 38 | 97.2259 | 33.1577 | 26428.6 | 0 | 0 |
| 39 | 99.622 | 34.5057 | 24040.2 | 0 | 0 |
| 40 | 102.018 | 35.9634 | 21515.3 | 0 | 0 |
| 41 | 104.414 | 37.5379 | 18877 | 0 | 0 |
| 42 | 106.81 | 39.2378 | 16153.1 | 0 | 0 |
| 43 | 109.206 | 41.0729 | 13377.4 | 0 | 0 |

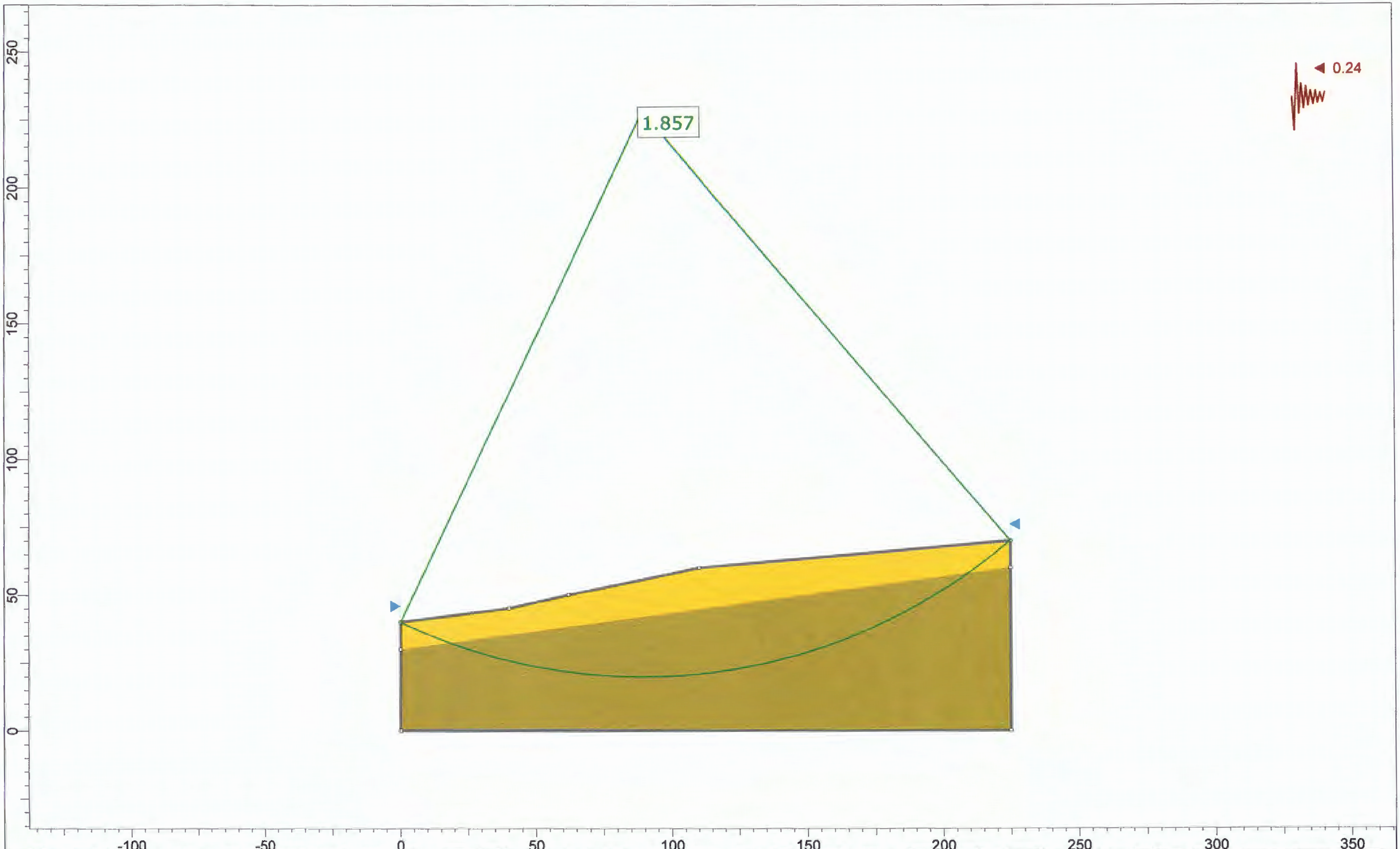
| | | | | | |
|---|---|---|---|---|---|
| 44 | 111.603 | 43.0553 | 10602.6 | 0 | 0 |
| 45 | 113.999 | 45.1998 | 7920.92 | 0 | 0 |
| 46 | 116.247 | 47.3753 | 5597.76 | 0 | 0 |
| 47 | 118.495 | 49.7281 | 3511.2 | 0 | 0 |
| 48 | 120.743 | 52.2822 | 1759.13 | 0 | 0 |
| 49 | 122.991 | 55.0685 | 467.77 | 0 | 0 |
| 50 | 125.239 | 58.1286 | -195.43 | 0 | 0 |
| 51 | 127.487 | 61.5206 | 0 | 0 | 0 |

## *Entity Information*

### Group: Group 1

#### Shared Entities

| Type | Coordinates (X, Y) |
|---|---|
| External Boundary | 225, 0; 225, 60; 225, 70; 110, 60; 62, 50; 40, 45; 0, 40; 0, 30; 0, 0 |
| Material Boundary | 0, 30; 225, 60 |




| | | | |
|---|---|---|---|
| rocscience | Project: Vista Loop Apartments | | |
| | Analysis Description | | |
| | Drawn By: Daniel M. Redmond, P.E., G.E. | Scale: 1:587 | Company: Redmond Geotechnical Services, LLC |
| SLIDEINTERPRET 8.020 | Date: November 21, 2020 | | File Name: Vista Loop Apartments Seismic.slmd |

# Slide Analysis Information

# Vista Loop Apartments Seismic

## Project Summary

| | |
|---|---|
| File Name: | Vista Loop Apartments Seismic.slmd |
| Slide Modeler Version: | 8.02 |
| Compute Time: | 00h:00m:00.963s |
| Project Title: | Vista Loop Apartments |
| Author: | Daniel M. Redmond, P.E., G.E. |
| Company: | Redmond Geotechnical Services, LLC |
| Date Created: | November 21, 2020 |

## General Settings

| | |
|---|---|
| Units of Measurement: | Imperial Units |
| Time Units: | days |
| Permeability Units: | feet/second |
| Data Output: | Standard |
| Failure Direction: | Right to Left |

## 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: | Auto Refine Search |
| Divisions along slope: | 20 |
| Circles per division: | 10 |
| Number of iterations: | 10 |
| Divisions to use in next iteration: | 50% |
| Composite Surfaces: | Disabled |
| Minimum Elevation: | Not Defined |
| Minimum Depth: | Not Defined |
| Minimum Area: | Not Defined |
| Minimum Weight: | Not Defined |

## Seismic Loading

| | |
|---|---|
| Advanced seismic analysis: | No |
| Staged pseudostatic analysis: | No |

Seismic Load Coefficient (Horizontal): 0.24

## Materials

| Property | Material 1 | Material 5 |
|---|---|---|
| Color | | |
| Strength Type | Mohr-Coulomb | Mohr-Coulomb |
| Unit Weight [lbs/ft3] | 110 | 110 |
| Cohesion [psf] | 450 | 350 |
| Friction Angle [°] | 24 | 26 |
| Water Surface | None | None |
| Ru Value | 0 | 0 |

## *Global Minimums*

### Method: bishop simplified

| **FS** | **1.856590** |
|---|---|
| Center: | 89.369, 228.460 |
| Radius: | 208.568 |
| Left Slip Surface Endpoint: | 0.015, 40.002 |
| Right Slip Surface Endpoint: | 224.980, 69.998 |
| Resisting Moment: | 8.13211e+07 lb-ft |
| Driving Moment: | 4.38013e+07 lb-ft |
| Total Slice Area: | 5650.2 ft2 |
| Surface Horizontal Width: | 224.966 ft |
| Surface Average Height: | 25.1158 ft |

### Method: janbu simplified

| **FS** | **1.731380** |
|---|---|
| Center: | 95.068, 183.089 |
| Radius: | 171.782 |
| Left Slip Surface Endpoint: | 0.015, 40.002 |
| Right Slip Surface Endpoint: | 224.322, 69.941 |
| Resisting Horizontal Force: | 446877 lb |
| Driving Horizontal Force: | 258104 lb |
| Total Slice Area: | 7072.08 ft2 |
| Surface Horizontal Width: | 224.307 ft |
| Surface Average Height: | 31.5286 ft |

## *Valid/Invalid Surfaces*

### Method: bishop simplified

| | |
|---|---|
| Number of Valid Surfaces: | 11493 |
| Number of Invalid Surfaces: | 0 |

## Method: janbu simplified

Number of Valid Surfaces: 11438
Number of Invalid Surfaces: 55

### Error Codes:

Error Code -108 reported for 41 surfaces
Error Code -111 reported for 4 surfaces
Error Code -112 reported for 10 surfaces

### Error Codes

*The following errors were encountered during the computation:*

-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).
-111 = safety factor equation did not converge
-112 = The coefficient M-Alpha = cos(alpha)(1+tan(alpha)tan(phi)/F) < 0.2 for the final iteration of the safety factor calculation. This screens out some slip surfaces which may not be valid in the context of the analysis, in particular, deep seated slip surfaces with many high negative base angle slices in the passive zone.

## *Slice Data*

---

- **Global Minimum Query (bishop simplified) - Safety Factor: 1.85659**

| 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 | 4.53789 | 662.052 | -24.6812 | Material 1 | 450 | 24 | 311.709 | 578.715 | 289.1 | 0 | 289.1 |
| 2 | 4.53789 | 1953.83 | -23.3164 | Material 1 | 450 | 24 | 385.462 | 715.645 | 596.65 | 0 | 596.65 |
| 3 | 4.53789 | 3181.93 | -21.9656 | Material 1 | 450 | 24 | 454.478 | 843.78 | 884.444 | 0 | 884.444 |
| 4 | 4.53789 | 4348.21 | -20.6274 | Material 1 | 450 | 24 | 519.003 | 963.575 | 1153.51 | 0 | 1153.51 |
| 5 | 4.4484 | 5336.64 | -19.314 | Material 5 | 350 | 26 | 554.736 | 1029.92 | 1394.04 | 0 | 1394.04 |
| 6 | 4.4484 | 6344.29 | -18.0239 | Material 5 | 350 | 26 | 615.808 | 1143.3 | 1626.51 | 0 | 1626.51 |
| 7 | 4.4484 | 7297.93 | -16.7433 | Material 5 | 350 | 26 | 672.648 | 1248.83 | 1842.88 | 0 | 1842.88 |
| 8 | 4.4484 | 8198.68 | -15.4712 | Material 5 | 350 | 26 | 725.429 | 1346.83 | 2043.79 | 0 | 2043.79 |
| 9 | 4.4484 | 9048.48 | -14.207 | Material 5 | 350 | 26 | 774.371 | 1437.69 | 2230.09 | 0 | 2230.09 |
| 10 | 4.4484 | 9977.17 | -12.9497 | Material 5 | 350 | 26 | 827.711 | 1536.72 | 2433.13 | 0 | 2433.13 |
| 11 | 4.4484 | 10947.5 | -11.6987 | Material 5 | 350 | 26 | 883.054 | 1639.47 | 2643.79 | 0 | 2643.79 |
| 12 | 4.4484 | 11868.4 | -10.4534 | Material 5 | 350 | 26 | 934.703 | 1735.36 | 2840.4 | 0 | 2840.4 |
| 13 | 4.4484 | 12740.4 | -9.21307 | Material 5 | 350 | 26 | 982.775 | 1824.61 | 3023.41 | 0 | 3023.41 |
| 14 | 4.4484 | 13563.7 | -7.97707 | Material 5 | 350 | 26 | 1027.34 | 1907.35 | 3193.04 | 0 | 3193.04 |
| 15 | 4.4484 | 14313.4 | -6.74479 | Material 5 | 350 | 26 | 1066.95 | 1980.88 | 3343.82 | 0 | 3343.82 |
| 16 | 4.4484 | 15000.7 | -5.51565 | Material 5 | 350 | 26 | 1102.35 | 2046.62 | 3478.58 | 0 | 3478.58 |
| 17 | 4.4484 | 15640.9 | -4.28904 | Material 5 | 350 | 26 | 1134.55 | 2106.4 | 3601.14 | 0 | 3601.14 |
| 18 | 4.4484 | 16234.3 | -3.06441 | Material 5 | 350 | 26 | 1163.61 | 2160.34 | 3711.75 | 0 | 3711.75 |
| 19 | 4.4484 | 16781 | -1.84117 | Material 5 | 350 | 26 | 1189.58 | 2208.56 | 3810.62 | 0 | 3810.62 |
| 20 | 4.4484 | 17281.3 | -0.618778 | Material 5 | 350 | 26 | 1212.51 | 2251.14 | 3897.92 | 0 | 3897.92 |
| 21 | 4.4484 | 17735 | 0.603335 | Material 5 | 350 | 26 | 1232.46 | 2288.18 | 3973.86 | 0 | 3973.86 |
| 22 | 4.4484 | 18142.4 | 1.82572 | Material 5 | 350 | 26 | 1249.47 | 2319.75 | 4038.59 | 0 | 4038.59 |
| 23 | 4.4484 | 18503.2 | 3.04895 | Material 5 | 350 | 26 | 1263.56 | 2345.91 | 4092.24 | 0 | 4092.24 |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 24 | 4.4484 | 18817.4 | 4.27356 | Material 5 | 350 | 26 | 1274.77 | 2366.73 | 4134.91 | 0 | 4134.91 |
| 25 | 4.4484 | 19068 | 5.50013 | Material 5 | 350 | 26 | 1282.17 | 2380.46 | 4163.06 | 0 | 4163.06 |
| 26 | 4.4484 | 19078.9 | 6.72924 | Material 5 | 350 | 26 | 1275.7 | 2368.46 | 4138.45 | 0 | 4138.45 |
| 27 | 4.4484 | 18987.5 | 7.96147 | Material 5 | 350 | 26 | 1263.43 | 2345.68 | 4091.75 | 0 | 4091.75 |
| 28 | 4.4484 | 18848.4 | 9.19742 | Material 5 | 350 | 26 | 1248.53 | 2318.01 | 4035.01 | 0 | 4035.01 |
| 29 | 4.4484 | 18660.9 | 10.4377 | Material 5 | 350 | 26 | 1231 | 2285.46 | 3968.28 | 0 | 3968.28 |
| 30 | 4.4484 | 18424.7 | 11.683 | Material 5 | 350 | 26 | 1210.84 | 2248.04 | 3891.55 | 0 | 3891.55 |
| 31 | 4.4484 | 18139 | 12.9338 | Material 5 | 350 | 26 | 1188.07 | 2205.76 | 3804.88 | 0 | 3804.88 |
| 32 | 4.4484 | 17803.1 | 14.191 | Material 5 | 350 | 26 | 1162.67 | 2158.61 | 3708.2 | 0 | 3708.2 |
| 33 | 4.4484 | 17416.2 | 15.4552 | Material 5 | 350 | 26 | 1134.66 | 2106.59 | 3601.55 | 0 | 3601.55 |
| 34 | 4.4484 | 16977.5 | 16.7272 | Material 5 | 350 | 26 | 1104 | 2049.68 | 3484.86 | 0 | 3484.86 |
| 35 | 4.4484 | 16485.9 | 18.0077 | Material 5 | 350 | 26 | 1070.7 | 1987.85 | 3358.08 | 0 | 3358.08 |
| 36 | 4.4484 | 15940.3 | 19.2976 | Material 5 | 350 | 26 | 1034.73 | 1921.07 | 3221.18 | 0 | 3221.18 |
| 37 | 4.4484 | 15339.5 | 20.5978 | Material 5 | 350 | 26 | 996.084 | 1849.32 | 3074.06 | 0 | 3074.06 |
| 38 | 4.4484 | 14682 | 21.9091 | Material 5 | 350 | 26 | 954.734 | 1772.55 | 2916.65 | 0 | 2916.65 |
| 39 | 4.4484 | 13966.4 | 23.2326 | Material 5 | 350 | 26 | 910.648 | 1690.7 | 2748.84 | 0 | 2748.84 |
| 40 | 4.4484 | 13190.9 | 24.5694 | Material 5 | 350 | 26 | 863.799 | 1603.72 | 2570.5 | 0 | 2570.5 |
| 41 | 4.4484 | 12353.6 | 25.9207 | Material 5 | 350 | 26 | 814.149 | 1511.54 | 2381.52 | 0 | 2381.52 |
| 42 | 4.4484 | 11452.5 | 27.2876 | Material 5 | 350 | 26 | 761.66 | 1414.09 | 2181.72 | 0 | 2181.72 |
| 43 | 4.4484 | 10485.2 | 28.6715 | Material 5 | 350 | 26 | 706.292 | 1311.3 | 1970.95 | 0 | 1970.95 |
| 44 | 4.4484 | 9449.05 | 30.074 | Material 5 | 350 | 26 | 647.991 | 1203.05 | 1749.02 | 0 | 1749.02 |
| 45 | 4.4484 | 8341.23 | 31.4967 | Material 5 | 350 | 26 | 586.704 | 1089.27 | 1515.73 | 0 | 1515.73 |
| 46 | 4.4484 | 7158.45 | 32.9414 | Material 5 | 350 | 26 | 522.372 | 969.831 | 1270.84 | 0 | 1270.84 |
| 47 | 4.4484 | 5897.03 | 34.4101 | Material 5 | 350 | 26 | 454.932 | 844.622 | 1014.13 | 0 | 1014.13 |
| 48 | 5.17765 | 5161.99 | 36.0301 | Material 1 | 450 | 24 | 409.975 | 761.156 | 698.868 | 0 | 698.868 |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 49 | 5.17765 | 3201.89 | 37.8098 | Material 1 | 450 | 24 | 329.402 | 611.564 | 362.879 | 0 | 362.879 |
| 50 | 5.17765 | 1093 | 39.6335 | Material 1 | 450 | 24 | 244.462 | 453.865 | 8.68085 | 0 | 8.68085 |

- **Global Minimum Query (janbu simplified) - Safety Factor: 1.73138**

| 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 | 4.54862 | 872.643 | -32.6947 | Material 1 | 450 | 24 | 370.438 | 641.369 | 429.822 | 0 | 429.822 |
| 2 | 4.54862 | 2568.82 | -30.9091 | Material 1 | 450 | 24 | 478.934 | 829.217 | 851.736 | 0 | 851.736 |
| 3 | 4.54862 | 4169.44 | -29.1563 | Material 1 | 450 | 24 | 578.719 | 1001.98 | 1239.77 | 0 | 1239.77 |
| 4 | 4.43565 | 5521.15 | -27.454 | Material 5 | 350 | 26 | 647.664 | 1121.35 | 1581.5 | 0 | 1581.5 |
| 5 | 4.43565 | 6876.98 | -25.7987 | Material 5 | 350 | 26 | 739.714 | 1280.73 | 1908.27 | 0 | 1908.27 |
| 6 | 4.43565 | 8156.16 | -24.1663 | Material 5 | 350 | 26 | 824.441 | 1427.42 | 2209.03 | 0 | 2209.03 |
| 7 | 4.43565 | 9361.69 | -22.5545 | Material 5 | 350 | 26 | 902.367 | 1562.34 | 2485.65 | 0 | 2485.65 |
| 8 | 4.43565 | 10496.2 | -20.9613 | Material 5 | 350 | 26 | 973.946 | 1686.27 | 2739.75 | 0 | 2739.75 |
| 9 | 4.43565 | 11562.5 | -19.3849 | Material 5 | 350 | 26 | 1039.6 | 1799.94 | 2972.81 | 0 | 2972.81 |
| 10 | 4.43565 | 12685.6 | -17.8236 | Material 5 | 350 | 26 | 1108.26 | 1918.82 | 3216.55 | 0 | 3216.55 |
| 11 | 4.43565 | 13841.4 | -16.2759 | Material 5 | 350 | 26 | 1178.18 | 2039.88 | 3464.76 | 0 | 3464.76 |
| 12 | 4.43565 | 14933.9 | -14.7404 | Material 5 | 350 | 26 | 1242.77 | 2151.7 | 3694.05 | 0 | 3694.05 |
| 13 | 4.43565 | 15964.6 | -13.2156 | Material 5 | 350 | 26 | 1302.26 | 2254.71 | 3905.24 | 0 | 3905.24 |
| 14 | 4.43565 | 16934.5 | -11.7003 | Material 5 | 350 | 26 | 1356.86 | 2349.24 | 4099.04 | 0 | 4099.04 |
| 15 | 4.43565 | 17820.5 | -10.1932 | Material 5 | 350 | 26 | 1405.15 | 2432.84 | 4270.46 | 0 | 4270.46 |
| 16 | 4.43565 | 18631.5 | -8.69326 | Material 5 | 350 | 26 | 1447.82 | 2506.73 | 4421.96 | 0 | 4421.96 |
| 17 | 4.43565 | 19384.5 | -7.19928 | Material 5 | 350 | 26 | 1486.16 | 2573.11 | 4558.06 | 0 | 4558.06 |
| 18 | 4.43565 | 20080.3 | -5.71022 | Material 5 | 350 | 26 | 1520.28 | 2632.18 | 4679.18 | 0 | 4679.18 |
| 19 | 4.43565 | 20719.3 | -4.22502 | Material 5 | 350 | 26 | 1550.3 | 2684.15 | 4785.72 | 0 | 4785.72 |
| 20 | 4.43565 | 21302 | -2.74266 | Material 5 | 350 | 26 | 1576.3 | 2729.17 | 4878.02 | 0 | 4878.02 |
| 21 | 4.43565 | 21828.5 | -1.26213 | Material 5 | 350 | 26 | 1598.38 | 2767.4 | 4956.41 | 0 | 4956.41 |
| 22 | 4.43565 | 22299.1 | 0.217548 | Material 5 | 350 | 26 | 1616.61 | 2798.96 | 5021.13 | 0 | 5021.13 |
| 23 | 4.43565 | 22713.9 | 1.69737 | Material 5 | 350 | 26 | 1631.05 | 2823.96 | 5072.39 | 0 | 5072.39 |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 24 | 4.43565 | 23072.6 | 3.17833 | Material 5 | 350 | 26 | 1641.75 | 2842.5 | 5110.39 | 0 | 5110.39 |
| 25 | 4.43565 | 23364.8 | 4.66143 | Material 5 | 350 | 26 | 1648.12 | 2853.53 | 5133.01 | 0 | 5133.01 |
| 26 | 4.43565 | 23416.2 | 6.14766 | Material 5 | 350 | 26 | 1639.49 | 2838.58 | 5102.34 | 0 | 5102.34 |
| 27 | 4.43565 | 23342.7 | 7.63805 | Material 5 | 350 | 26 | 1623.24 | 2810.44 | 5044.65 | 0 | 5044.65 |
| 28 | 4.43565 | 23211.8 | 9.13367 | Material 5 | 350 | 26 | 1603.61 | 2776.45 | 4974.97 | 0 | 4974.97 |
| 29 | 4.43565 | 23022.8 | 10.6356 | Material 5 | 350 | 26 | 1580.61 | 2736.64 | 4893.34 | 0 | 4893.34 |
| 30 | 4.43565 | 22774.9 | 12.145 | Material 5 | 350 | 26 | 1554.25 | 2690.99 | 4799.75 | 0 | 4799.75 |
| 31 | 4.43565 | 22467.2 | 13.6629 | Material 5 | 350 | 26 | 1524.52 | 2639.53 | 4694.23 | 0 | 4694.23 |
| 32 | 4.43565 | 22098.5 | 15.1908 | Material 5 | 350 | 26 | 1491.42 | 2582.22 | 4576.71 | 0 | 4576.71 |
| 33 | 4.43565 | 21667.6 | 16.7297 | Material 5 | 350 | 26 | 1454.93 | 2519.04 | 4447.19 | 0 | 4447.19 |
| 34 | 4.43565 | 21173.1 | 18.2813 | Material 5 | 350 | 26 | 1415.02 | 2449.94 | 4305.52 | 0 | 4305.52 |
| 35 | 4.43565 | 20613.2 | 19.8468 | Material 5 | 350 | 26 | 1371.67 | 2374.89 | 4151.65 | 0 | 4151.65 |
| 36 | 4.43565 | 19986.1 | 21.4279 | Material 5 | 350 | 26 | 1324.84 | 2293.81 | 3985.4 | 0 | 3985.4 |
| 37 | 4.43565 | 19289.7 | 23.0264 | Material 5 | 350 | 26 | 1274.49 | 2206.62 | 3806.64 | 0 | 3806.64 |
| 38 | 4.43565 | 18521.5 | 24.6441 | Material 5 | 350 | 26 | 1220.55 | 2113.24 | 3615.17 | 0 | 3615.17 |
| 39 | 4.43565 | 17678.8 | 26.283 | Material 5 | 350 | 26 | 1162.97 | 2013.55 | 3410.79 | 0 | 3410.79 |
| 40 | 4.43565 | 16758.6 | 27.9455 | Material 5 | 350 | 26 | 1101.69 | 1907.44 | 3193.22 | 0 | 3193.22 |
| 41 | 4.43565 | 15757.1 | 29.634 | Material 5 | 350 | 26 | 1036.61 | 1794.76 | 2962.19 | 0 | 2962.19 |
| 42 | 4.43565 | 14670.5 | 31.3513 | Material 5 | 350 | 26 | 967.639 | 1675.35 | 2717.38 | 0 | 2717.38 |
| 43 | 4.43565 | 13494 | 33.1006 | Material 5 | 350 | 26 | 894.691 | 1549.05 | 2458.4 | 0 | 2458.4 |
| 44 | 4.43565 | 12222.2 | 34.8854 | Material 5 | 350 | 26 | 817.637 | 1415.64 | 2184.87 | 0 | 2184.87 |
| 45 | 4.43565 | 10849 | 36.71 | Material 5 | 350 | 26 | 736.353 | 1274.91 | 1896.35 | 0 | 1896.35 |
| 46 | 4.43565 | 9367.16 | 38.5791 | Material 5 | 350 | 26 | 650.7 | 1126.61 | 1592.28 | 0 | 1592.28 |
| 47 | 4.43565 | 7767.99 | 40.4982 | Material 5 | 350 | 26 | 560.518 | 970.47 | 1272.15 | 0 | 1272.15 |
| 48 | 4.43565 | 6041.34 | 42.474 | Material 5 | 350 | 26 | 465.638 | 806.196 | 935.34 | 0 | 935.34 |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 49 | 5.52855 | 4890.6 | 44.7759 | Material 1 | 450 | 24 | 388.242 | 672.195 | 499.057 | 0 | 499.057 |
| 50 | 5.52855 | 1684.4 | 47.438 | Material 1 | 450 | 24 | 264.207 | 457.444 | 16.7184 | 0 | 16.7184 |

## *Interslice Data*

- **Global Minimum Query (bishop simplified) - Safety Factor: 1.85659**

| Slice Number | X coordinate [ft] | Y coordinate - Bottom [ft] | Interslice Normal Force [lbs] | Interslice Shear Force [lbs] | Interslice Force Angle [degrees] |
|---|---|---|---|---|---|
| 1 | 0.0146863 | 40.0018 | 0 | 0 | 0 |
| 2 | 4.55258 | 37.9164 | 1858.09 | 0 | 0 |
| 3 | 9.09047 | 35.9606 | 4304.83 | 0 | 0 |
| 4 | 13.6284 | 34.1303 | 7221.71 | 0 | 0 |
| 5 | 18.1662 | 32.4222 | 10503 | 0 | 0 |
| 6 | 22.6146 | 30.8631 | 13862.6 | 0 | 0 |
| 7 | 27.063 | 29.4157 | 17432.8 | 0 | 0 |
| 8 | 31.5114 | 28.0775 | 21138.9 | 0 | 0 |
| 9 | 35.9598 | 26.8462 | 24913.7 | 0 | 0 |
| 10 | 40.4082 | 25.72 | 28697.3 | 0 | 0 |
| 11 | 44.8566 | 24.6971 | 32472.5 | 0 | 0 |
| 12 | 49.305 | 23.776 | 36207.4 | 0 | 0 |
| 13 | 53.7534 | 22.9553 | 39846.9 | 0 | 0 |
| 14 | 58.2018 | 22.2338 | 43341.2 | 0 | 0 |
| 15 | 62.6502 | 21.6104 | 46645.1 | 0 | 0 |
| 16 | 67.0986 | 21.0843 | 49713.9 | 0 | 0 |
| 17 | 71.547 | 20.6548 | 52510.3 | 0 | 0 |
| 18 | 75.9954 | 20.3211 | 55003.4 | 0 | 0 |
| 19 | 80.4438 | 20.083 | 57165.8 | 0 | 0 |
| 20 | 84.8922 | 19.94 | 58973.5 | 0 | 0 |
| 21 | 89.3406 | 19.892 | 60405.5 | 0 | 0 |
| 22 | 93.789 | 19.9388 | 61443.9 | 0 | 0 |
| 23 | 98.2374 | 20.0806 | 62073.6 | 0 | 0 |
| 24 | 102.686 | 20.3175 | 62282.4 | 0 | 0 |
| 25 | 107.134 | 20.65 | 62060.9 | 0 | 0 |
| 26 | 111.583 | 21.0783 | 61403.3 | 0 | 0 |
| 27 | 116.031 | 21.6032 | 60325.5 | 0 | 0 |
| 28 | 120.479 | 22.2253 | 58841.5 | 0 | 0 |
| 29 | 124.928 | 22.9456 | 56963.9 | 0 | 0 |
| 30 | 129.376 | 23.765 | 54707.9 | 0 | 0 |
| 31 | 133.825 | 24.6849 | 52091.1 | 0 | 0 |
| 32 | 138.273 | 25.7065 | 49134.3 | 0 | 0 |
| 33 | 142.721 | 26.8313 | 45860.9 | 0 | 0 |
| 34 | 147.17 | 28.0612 | 42297.4 | 0 | 0 |
| 35 | 151.618 | 29.3981 | 38473.6 | 0 | 0 |
| 36 | 156.067 | 30.8442 | 34422.6 | 0 | 0 |
| 37 | 160.515 | 32.4018 | 30181.2 | 0 | 0 |
| 38 | 164.963 | 34.0736 | 25790.1 | 0 | 0 |
| 39 | 169.412 | 35.8627 | 21294.1 | 0 | 0 |
| 40 | 173.86 | 37.7723 | 16742.8 | 0 | 0 |
| 41 | 178.309 | 39.806 | 12190.7 | 0 | 0 |
| 42 | 182.757 | 41.968 | 7697.59 | 0 | 0 |
| 43 | 187.205 | 44.2628 | 3329.68 | 0 | 0 |

| | | | | | |
|---|---|---|---|---|---|
| 44 | 191.654 | 46.6953 | -840.208 | 0 | 0 |
| 45 | 196.102 | 49.2713 | -4731.66 | 0 | 0 |
| 46 | 200.551 | 51.9969 | -8255.71 | 0 | 0 |
| 47 | 204.999 | 54.8793 | -11313.7 | 0 | 0 |
| 48 | 209.447 | 57.9263 | -13795.9 | 0 | 0 |
| 49 | 214.625 | 61.6923 | -15544.6 | 0 | 0 |
| 50 | 219.803 | 65.7099 | -16065.9 | 0 | 0 |
| 51 | 224.98 | 69.9983 | 0 | 0 | 0 |

- **Global Minimum Query (janbu simplified) - Safety Factor: 1.73138**

| Slice Number | X coordinate [ft] | Y coordinate - Bottom [ft] | Interslice Normal Force [lbs] | Interslice Shear Force [lbs] | Interslice Force Angle [degrees] |
|---|---|---|---|---|---|
| 1 | 0.0146863 | 40.0018 | 0 | 0 | 0 |
| 2 | 4.5633 | 37.0823 | 2731.9 | 0 | 0 |
| 3 | 9.11192 | 34.359 | 6615.27 | 0 | 0 |
| 4 | 13.6605 | 31.8214 | 11395.3 | 0 | 0 |
| 5 | 18.0962 | 29.5169 | 16590.1 | 0 | 0 |
| 6 | 22.5318 | 27.3727 | 22315.2 | 0 | 0 |
| 7 | 26.9675 | 25.3824 | 28414.5 | 0 | 0 |
| 8 | 31.4031 | 23.5402 | 34752.9 | 0 | 0 |
| 9 | 35.8388 | 21.8409 | 41213.2 | 0 | 0 |
| 10 | 40.2744 | 20.2802 | 47693.2 | 0 | 0 |
| 11 | 44.7101 | 18.854 | 54156.1 | 0 | 0 |
| 12 | 49.1457 | 17.559 | 60551.7 | 0 | 0 |
| 13 | 53.5814 | 16.392 | 66795.8 | 0 | 0 |
| 14 | 58.017 | 15.3503 | 72813.6 | 0 | 0 |
| 15 | 62.4526 | 14.4317 | 78538.5 | 0 | 0 |
| 16 | 66.8883 | 13.6342 | 83905.6 | 0 | 0 |
| 17 | 71.3239 | 12.956 | 88860.6 | 0 | 0 |
| 18 | 75.7596 | 12.3957 | 93360 | 0 | 0 |
| 19 | 80.1952 | 11.9521 | 97365.4 | 0 | 0 |
| 20 | 84.6309 | 11.6244 | 100843 | 0 | 0 |
| 21 | 89.0665 | 11.412 | 103765 | 0 | 0 |
| 22 | 93.5022 | 11.3142 | 106107 | 0 | 0 |
| 23 | 97.9378 | 11.3311 | 107847 | 0 | 0 |
| 24 | 102.373 | 11.4625 | 108970 | 0 | 0 |
| 25 | 106.809 | 11.7088 | 109463 | 0 | 0 |
| 26 | 111.245 | 12.0705 | 109316 | 0 | 0 |
| 27 | 115.68 | 12.5483 | 108537 | 0 | 0 |
| 28 | 120.116 | 13.1431 | 107140 | 0 | 0 |
| 29 | 124.552 | 13.8562 | 105140 | 0 | 0 |
| 30 | 128.987 | 14.6892 | 102556 | 0 | 0 |
| 31 | 133.423 | 15.6438 | 99408.4 | 0 | 0 |
| 32 | 137.859 | 16.722 | 95722.8 | 0 | 0 |
| 33 | 142.294 | 17.9264 | 91528.3 | 0 | 0 |
| 34 | 146.73 | 19.2597 | 86857.9 | 0 | 0 |
| 35 | 151.166 | 20.725 | 81749.3 | 0 | 0 |
| 36 | 155.601 | 22.326 | 76244.7 | 0 | 0 |
| 37 | 160.037 | 24.0668 | 70391.9 | 0 | 0 |
| 38 | 164.473 | 25.9521 | 64244 | 0 | 0 |
| 39 | 168.908 | 27.987 | 57860.9 | 0 | 0 |
| 40 | 173.344 | 30.1776 | 51309.3 | 0 | 0 |
| 41 | 177.779 | 32.5307 | 44664.3 | 0 | 0 |
| 42 | 182.215 | 35.0539 | 38010.2 | 0 | 0 |
| 43 | 186.651 | 37.7563 | 31441.8 | 0 | 0 |

| | | | | | |
|---|---|---|---|---|---|
| 44 | 191.086 | 40.6479 | 25066.4 | 0 | 0 |
| 45 | 195.522 | 43.7406 | 19005.8 | 0 | 0 |
| 46 | 199.958 | 47.048 | 13399 | 0 | 0 |
| 47 | 204.393 | 50.5863 | 8405.74 | 0 | 0 |
| 48 | 208.829 | 54.3745 | 4210.72 | 0 | 0 |
| 49 | 213.265 | 58.4353 | 1029.74 | 0 | 0 |
| 50 | 218.793 | 63.9208 | -733.296 | 0 | 0 |
| 51 | 224.322 | 69.941 | 0 | 0 | 0 |

## *Entity Information*

### Group: Group 1

#### Shared Entities

| Type | Coordinates X | Coordinates Y |
|---|---|---|
| External Boundary | 225 | 0 |
| | 225 | 60 |
| | 225 | 70 |
| | 110 | 60 |
| | 62 | 50 |
| | 40 | 45 |
| | 0 | 40 |
| | 0 | 30 |
| | 0 | 0 |
| Material Boundary | 0 | 30 |
| | 225 | 60 |