Northern, Inc.
Consulting Engineers Environmental Scientists Geologists
Construction Materials Testing Geophysical Services

GEOLOGIC HAZARDS ASSESSMENT AND CRITICAL AREAS REPORT

PROPOSED 'SUNRISE RIDGE' RESIDENTIAL DEVELOPMENT
ASSESOR'S PARCEL NOS.: 124892000007000 & 124893012820003
S. OLYMPIA ST. & S. NEWPORT PL., KENNEWICK, WASHINGTON

GNN PROJECT NO. 216-672

FEBRUARY 2016

Prepared for

DJ SUNRISE DEVELOPMENT, LLC
5602 SOUTH NEWPORT PLACE
KENNEWICK, WASHINGTON 99337

Prepared by

GN NORTHERN, INC.
CONSULTING GEOTECHNICAL ENGINEERS
KENNEWICK, WASHINGTON
(509) 734-9320

GN Northern, Inc.

At GN Northern our mission is to serve our clients in the most efficient, cost effective way using the best resources and tools available while maintaining professionalism on every level. Our philosophy is to satisfy our clients through hard work, dedication and extraordinary efforts from all of our valued employees working as an extension of the design and construction team.

February 25, 2016 **GNN Project No. 216-672**

DJ Sunrise Development, LLC
5602 S. Newport Place
Kennewick, WA 99337
Attn: Mr. Jim Aust

CC: Mr. John Fetterolf, PE, JF Engineering, PLLC

Subject: **Geologic Hazards Assessment & Critical Areas Report**
Proposed 'Sunrise Ridge' Residential Development
Benton County APN # 124892000007000 and 124893012820003
S. Olympia Street & S. Newport Place, Kennewick, Washington

Dear Mr. Aust:

As requested, GN Northern, Inc. (GNN) has prepared this Geologic Hazards Assessment and Critical Areas Report to assess potential geologic hazards related to the proposed residential development property, currently identified as Benton County Assessor's Parcels 124892000007000 and 124893012820003, generally located east of Olympia Street and west of the KID Canal in the City of Kennewick, Benton County, Washington.

Based on the finding of our evaluation, we conclude that the existing geologic conditions at the site could pose potential hazards related to the proposed development if not properly mitigated. The identified geologic hazards, including erosion and slope stability, can be mitigated to acceptable levels of risk through appropriate engineering design and construction. The site is suitable for the proposed development provided the recommendations contained in this report and any subsequent site- and lot-specific design-level geotechnical engineering evaluations are followed both during the design and construction phases.

The report, which follows, describes in detail our evaluation, summarizes our findings, and presents our professional opinions and recommendations.

If you have any questions regarding this report, please contact us at 509-248-9798.

Respectfully submitted,

GN Northern, Inc.

Digitally signed by Karl A. Harmon
DN: cn=Karl A. Harmon, o=GN Northern, Inc., ou, email=kharmon@gnnorthern.com, c=US
Date: 2016.02.25 19:51:05 -08'00'

M. Yousuf Memon, EIT
Staff Engineer

Karl A. Harmon, LEG, PE
Senior Geologist/Engineer

KARL A. HARMON
STATE OF WASHINGTON
41534
REGISTERED
PROFESSIONAL ENGINEER
Expires 08/02/2017

State of Washington
Engineering Geologist
2535
Licensed Geologist
Karl A. Harmon

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EXECUTIVE SUMMARY

GN Northern, Inc. has prepared this executive summary solely to provide a general overview of the report. The report itself should be relied upon for information about the findings, conclusions, recommendations, and other concerns. The intent of this report is to assess various geologic hazards that may impact the proposed development and provide our recommendations for mitigation. Our site evaluation has been prepared in general accordance with the requirements of the City of Kennewick's Critical Areas Ordinance No. 5206, Chapters 18.58 and 18.62. This report does not constitute a geotechnical engineering report for development of the proposed residential subdivision at the project site.

We understand the client intends to develop the subject property with a proposed residential subdivision. Future improvements at the site will include construction of new roadways, subdivision infrastructure, and site grading to develop individual residential lots. The subject property currently consists of undeveloped hillside terrain with a moderate to dense growth of native grasses and brush. Portions of the project site are mapped within the City of Kennewick's Critical Areas for geologic hazards consisting of Steep Slopes (>15%) and Erosion Hazard due to potentially erodible soils.

Our site assessment was performed to identify common geologic conditions in the project region, including general and site-specific soil and bedrock conditions, groundwater, slopes, drainage, erosion, and geologic hazards. A review of selected information pertaining to the subject property and surrounding region was performed that included published technical literature, published geologic maps, available aerial photographs, and previous geotechnical/geologic studies prepared for this and other sites in the vicinity. Site-specific geologic and geotechnical data was obtained from our field exploration program consisting of nine (9) exploratory soil borings and fourteen (14) test-pits to observe the subsurface soil conditions and obtain samples for laboratory testing.

Based on our review and knowledge of the history of the site, and the findings of our subsurface exploration, it is clear that significant volumes of imported fill materials have been placed at the site. GN Northern prepared a Critical Areas Report along with a Grading Plan for placement of engineered fill over a portion of the project site relating to the adjacent Olympia Street improvements in 2014. Excess cut materials from the roadway widening project were transported

to the site and placed as controlled engineered fill under GNN's review. While the referenced fill placement from 2014 was tested and documented, some of the deeper fill materials encountered in our explorations included large volumes of miscellaneous trash and debris, and indications that the materials were not placed as competent engineered fill. Surface conditions and grades at the site have historically been notably altered from their native conditions, with indications of additional site grading activities after completion of the referenced placement of engineered fill in 2014.

Development on sloping ground poses an inherent risk related to global and local stability of site slopes. Our evaluation revealed that slope conditions at selected areas of the site do not meet typically recommended minimum factors of safety for stability. Additionally, selected areas with indications of ongoing surface erosion concerns were observed across the site, particularly in relation to the noted alterations of the native surface conditions. The proposed project development will require appropriate design and construction for both existing and proposed reconfigured slopes as well as drainage/erosion control measures to mitigate the observed geologic site constraints.

The subject property is situated in an area where sheet flow and erosion may occur and near-surface site soils are known to exhibit a moderate to severe risk for erosion. Erosion concerns will require mitigation with appropriate best management practices (BMPs), including proper drainage design as well as collection and disposal (conveyance) of water to approved points of discharge in a non-erosive manner.

In our professional opinion, the proposed project may be constructed as planned, provided that the recommendations in this report and any subsequent geotechnical engineering investigation(s)/evaluation(s) are incorporated in the final design and construction. Based on our site evaluation and analysis, the existing native slope conditions are relatively stable, however historically altered fill slopes and proposed cut and fill slopes for the planned development will require mitigation and remedial grading measures as recommended within this report to minimize the risk of slope instability and increase safety factors of the reconfigured slopes. Additionally, based on our evaluation, near surface site soils will not be subject to a significant threat of erosion, provided that the recommendations within this report and any subsequent geotechnical engineering report are incorporated during site grading operations along with appropriate project design, construction, and maintenance.

INTRODUCTION

Project Description

This Geologic Hazards Assessment and Critical Areas Report has been prepared for the site of the proposed Sunrise Ridge residential subdivision project to be developed west of the Kennewick Irrigation District - Division Four Canal (KID), and east of S. Olympia Street near the intersection with S. Newport Place, in the City of Kennewick, Benton County, Washington. Portions of the the subject property lie within the City of Kennewick – Critical Areas Map - Geologically Hazardous Areas Map, with selected areas mapped for steep slopes and erosion hazards. We understand that the proposed Sunrise Ridge residential development will include new roadways, subdivision utility & infrastructure improvements, and individual lots for future construction of single-family homes.

Proposed Site Grading & Development

Based on a review of the preliminary grading plans (Appendix X) prepared by JF Engineering, PLLC (dated February 18, 2016), we understand that a residential subdivision development is ultimately proposed at the project site. Proposed plans show 44 graded residential lots, along with associated roadways and infrastructure.

Site development will include clearing and grubbing of vegetation, as well as significant site grading including cuts and fills throughout the project site. Majority of the southern and west-central portions of the site will include cut grading, with fill grading in the south-central and eastern & northern portions of the site along the KID canal. Proposed grading for the residential lots ranges from cut/fill grading to create relatively level areas, to constructing 2H:1V cut and fill slopes as tall as 22 and 38 feet, respectively. As depicted on the current preliminary grading plans, individual residential lots and portions along the width of the proposed roadways will be constructed with partial cut and partial fill grading.

Purpose and Scope of Services

The purpose of our services was to evaluate the surface and subsurface soil and bedrock conditions and potential geologic hazards as they relate to the proposed development and provide professional opinions and recommendations for mitigations of any identified geologic hazards and constraints. The scope of work included the following:

- A detailed reconnaissance of the site;
- Subsurface exploration by excavating fourteen (14) exploratory test-pits and drilling nine (9) soil borings;
- Soil infiltration testing at five (5) locations;
- Laboratory testing of selected soil samples obtained from exploratory borings and test-pits;
- A review of selected published technical literature pertaining to the site and previous geotechnical/geologic reports prepared for similar projects in the vicinity;
- Review of selected available historic aerial photos and USGS topographic maps of the project site and vicinity;
- A geologic/engineering analysis and evaluation of the acquired data from the exploration and testing programs;
- Stability analyses of existing and proposed site slopes;
- A summary of our findings and recommendations in this written report.

This report contains the following:

- Discussions on subsurface soil, bedrock and groundwater conditions;
- Discussions on regional and local geologic conditions;
- Discussions on geologic and seismic hazards;
- Graphic and tabulated results of laboratory tests and field studies;
- Recommendations regarding site development and grading criteria including cut and fill slope construction.

Not Contained in This Report: Although available through GN Northern, the current scope of our services does not include:

- Site-specific geotechnical engineering evaluation or recommendations for future proposed residential structures or associated subdivision infrastructure improvements beyond the proposed initial mass grading and mitigation of geologic hazard at the site;
- An environmental assessment;
- An investigation for the presence or absence of wetlands, hazardous or toxic materials in the soil, surface water, groundwater, or air on, below, or adjacent to the subject property.

METHODS OF EXPLORATION AND TESTING

Technical Literature and Aerial Photo Review

A review of selected information pertaining to the site and surrounding area was performed that included published technical literature, published geologic maps, aerial photographs and previous geotechnical and geologic reports prepared for this and other sites in the vicinity. The review was performed to identify typical geotechnical and geologic constraints that may affect the proposed development, including soil and bedrock conditions, groundwater, slopes, drainage, erosion, and geologic hazards.

Field Reconnaissance

Field reconnaissance of the subject property was initially performed on January 29, 2016 and again in conjunction with our subsurface exploration on February 3 & 4, 2016 to observe the on-site surficial geologic and geotechnical conditions and to confirm the data obtained from our technical literature review.

Field Exploration

Field exploration was completed on February 3 & 4, 2016. A utility clearance was obtained prior to our field exploration. Nine (9) exploratory borings and five (5) infiltration test-hole were drilled; borings to depths of approximately 22.5 to 46.5 feet BGS, and infiltration test-holes to approximately 11.5 to 18.5 feet BGS. The exploratory borings were drilled using a BK 81 truck-mounted drill rig operated by Haz-Tech Drilling, Inc. Additionally, fourteen (14) exploratory test-pits, extending to depths of approximately 10 to 18 feet BGS, were excavated at the site. The exploratory test-pits were excavated with a John Deere 220C excavator operated by E-mac Corporation. The borings and test-pits were logged by a GNN field geologist/engineer. Upon completion, the borings were backfilled in general accordance with the Washington State guidelines and the test-pits were loosely backfilled with the excavated soils. Boring and test-pit locations are shown on *Site Exploration Plan* (Figure 7, Appendix I).

Samples were obtained from the test borings using a Standard Penetration (SPT) sampler. The SPT sampler has a 2-inch outside diameter and a 1.38-inch inside diameter. Samples were obtained by driving the sampler with a 140-pound automatic hammer, dropping 30 inches in general accordance with ASTM D1586. The number of blows required to advance the samplers through

each 6-inch increment is recorded in the field. The SPT resistance, or N-value, is defined as the number of blows required to drive the sampler from 6 inches to 18 inches below the auger tip, with the value reported as the number of blows per one foot of penetration. The SPT N-value, adjusted for hammer efficiency and sampler size, provides an indication of the relative density or consistency of the soil and is indicated on the boring logs. Recovered soil samples were sealed in containers and returned to our laboratory.

The soils observed during our field exploration were classified according to the Unified Soil Classification System (USCS), utilizing the field classification procedures as outlined in ASTM D2488. A copy of the USCS Classification Chart is included in Appendix II. Photographs of the site are presented in Appendix IV following this report. Depths referred to in this report are relative to the existing ground surface elevation at the time of our investigation. The surface and subsurface conditions described in this report are as observed at the time of our field investigation.

Laboratory Testing

Representative samples of the native soil obtained in the field during our subsurface exploration were selected for testing to determine the engineering and physical properties of the soils in general accordance with ASTM procedures. The following laboratory tests were performed:

Table 1: Laboratory Tests Performed

Test	To determine
Particle Size Distribution (ASTM D6913)	Soil classification based on proportion of sand, silt, and clay-sized particles
Natural Moisture Content (ASTM D2216)	Soil moisture content indicative of in-situ condition at the time samples were taken

Result of the laboratory tests are included on the boring and test-pit logs and also presented in graphic form in Appendix III attached to the end of the report.

SOIL INFILTRATION TESTING

Five (5) infiltration tests were conducted in general accordance with the EPA falling head method. The test was performed using a 3.5-inch diameter perforated HDPE pipe placed within the augered boreholes drilled to depths of approximately 11.5 to 18.5 feet BGS. Infiltration test locations are shown on *Site Exploration Plan* (Figure 7, Appendix I) Pea gravel was backfilled in the annulus of the test hole. The test holes were filled with water and allowed to presoak prior to the testing. Timed measurements of the drop in water level were taken within the test hole until a stabilized rate was established. The test results are indicative of the infiltration characteristic of the unique sub-soils encountered at the test depth interval. The following table presents the results of the infiltration test performed at the site:

Table 2: Infiltration Test Results

Test-Hole ID	Approx. GPS Coordinates	Test Depth (feet)	Field Soil Infiltration Rate (inch/hour)	Observed Soil Profile within Test-Hole
P-1	46° 9' 45.16" N 119° 8' 5.36" W	13.5	16	0' - 9.5' silt/fine-grained sand 9.5' - 11.5' silty/sandy gravel 11.5' - 13.5' very dense well-graded sand
P-2	46° 9' 41.23" N 119° 8' 0.78" W	11.5	32	0' - 11.5' medium-dense silt with sand
P-3	46° 9' 39.53" N 119° 8' 0.78" W	15	24	0' - 10' silt with sand 10' - 15' poorly graded sand/silty sand
P-4	46° 9' 35.62" N 119° 8' 5.43" W	18.5	44	0' - 3.5' apparent fill with organics 3.5' - 11' apparent trash/debris layer 11' - 18.5' loose fine silty sand
P5	46° 9' 31.79" N 119° 8' 6.03" W	15	12	0' - 2' apparent fill 2' - 13' silty gravel 13' - 15' silt with trace gravel

Due to the variability of the onsite materials including significant areas of existing fill, in our opinion the lowest infiltration rate (12 inches/hour), with an appropriate factor of safety, may be used for the native silty soils. For final design of the stormwater infiltration facilities, we recommend performing location- and depth-specific infiltration testing, following completion of site grading, to fully analyze the infiltration characteristics of the onsite material.

DISCUSSION

Site Conditions

The project site is located west of the KID Division Four Canal and east of S. Olympia Street near the intersection with S. Newport Place (S. Owens Road), in the City of Kennewick, Benton County, Washington. The undeveloped site is currently identified by the Benton County Assessor as parcel numbers: 124892000007000 and 124893012820003. The irregular-shaped site is generally bound by the KID canal to the northeast, undeveloped land to the east and south, and single family residences to the west and southeast. The site is located in the SW ¼ of the NW ¼, and the NW ¼ of the SW ¼, of Section 24, Township 8 North and Range 29 East of the Willamette Meridian, in Benton County, Washington. Site location is shown on *Site Vicinity Map* (Figure 1, Appendix I)

Based on site-specific topography, current site elevations within the project boundary range from approximately 845 in the southwestern portion near S. Olympia Street, to 670 feet in the northern portion near the KID canal. A local southwest-northeast trending valley (previously mapped by USGS with an intermittent stream) pre-exists at the site, extending from the southern end of the site to the eastern portion near the arched inflection of the KID canal. Native (un-altered) hillside slopes exist in the northern, western, southwestern, and southeastern portions of the project site. Surface conditions across the native hillside slopes include a moderate to dense growth of native grass and brush. Native slope gradients at the site generally range from approximately 10% to 33% in the northern and western portions, and approximately 10% to 29% across the southeastern and southwestern slopes (see Figure 3 in Appendix I for slope gradients).

Based on our review and knowledge of the history of the site, and the findings of our subsurface exploration, it is clear that significant volumes of imported fill materials have been placed at the site. Surface conditions and grades in the disturbed areas at the site have been notably altered from their native conditions. It appears that the majority of the central portion of this local valley has been infilled, as well as a strip along the existing access road extending northward and a section extending up the slope southward, with imported artificial (un-controlled) fill materials. The noted fills are estimated to be as great 40 feet in depth in the central portion of the site (see Figure 6 in Appendix I for the approximate aerial extent and depths of noted fills). A recent oblique aerial image captured from Google Earth below (image looking south) shows the current site conditions near central portion of the site:

Based on the findings of our subsurface exploration of the site, fill materials were observed to include miscellaneous trash and construction debris including concrete rubble, asphalt, wood, and metal. While the upper fill layer in the central portion of the site was properly placed in 2014 per GNN's Grading Plan (dated 10/30/2013) as engineered fill with associated testing and inspection, the underlying soils consisted of un-controlled and undocumented fill materials. Existing fill slopes at the site were noted to be as steep as 50% (2H:1V).

It is apparent that some additional fill placement and miscellaneous site grading has occurred at the site following the referenced engineered fill placement in 2014. A recently constructed access road was noted to have been graded/cut through the southeastern portion of the engineered fill area. It shall be noted that the site-specific topography provided by JF Engineering does not include this recent grading. It is presumed that cut soils from this relatively recent grading activity were transported and placed over the eastern-most fill slope along the project boundary.

Notable site features also included minor basins (low areas) with moist surface conditions, and areas of apparent soil erosion. Apparent rill and gully erosion, caused by the concentration of surface runoff, was noted along fill slopes in the eastern portion of the site and along the existing access road. Construction debris was noted in the northern portion of the site along the existing access road, including stockpiled soils, and metal, wood, and masonry building materials.

Photographs of the noted site features are included in Appendix IV, along with an *Existing Visible Features Plan* (Figure 5) included in Appendix I.

Site History

A review of selected available historic aerial photographs (Appendix VI) and USGS topographic maps indicate that the project site has been significantly altered form its native conditions. The 1952 photo shows the site and vicinity in its native condition before construction of the KID canal. The photo from 1988 shows the site vicinity developed with the canal and adjacent homes along Olympia Street, as well as preliminary pioneering of the northern access roadway to the site parallel to the canal. Published USGS maps of the site vicinity (Kennewick Quadrangle) depict an incised valley crossing the site from southwest to northwest with a blue-line intermittent stream terminating at the KID canal. Aerial photos from 1996 to current day show indication of ongoing filling and grading activities at the site that have resulted in significant infilling of the pre-existing natural drainage valley. Fill material appears to have been placed by dumping side-cast fill over the advancing slope face, as seen in an oblique aerial image captured from Bing Maps below:

Aside from the noted controlled fill placement in 2014, we are unaware of any documentation indicating that the fill materials were placed as engineered fill.

Soil Conditions

Based on our subsurface exploration and the results of laboratory testing, along with our previous knowledge regarding grading activities at the site, subsurface soils consist of areas of

undocumented fill, along with an area of recently placed engineered fill atop the undocumented fill material. Undocumented and uncontrolled fill materials were found to contain roots, organic matter, asphalt, concrete and brick debris, and miscellaneous trash. The uncontrolled fill materials were encountered to depths as great as approximately 37 feet BGS, and were found to range from 'very loose' to 'very dense'.

Native near-surface native soils across the site were primarily classified as Silt with Sand (ML) generally underlain by Silty Gravels (GM) and weathered bedrock at depth. The upper silty soils were noted to be 'loose' to 'medium dense', transitioning to 'dense' with the presence of ash and cementation at deeper elevations. Layers of Sandy Silt (ML) and some fine-grained Silty Sand (SM) were noted within the upper silty unit in the northern and western portions of the site. Deeper borings along the eastern and southeastern portions of the site encountered silty gravel soils underlying the silty material. Test-pits excavated within the native site slopes in the northern, southeastern and southwestern portions revealed gravelly soils at depths ranging from approximately 9 to 15 feet BGS. Highly weathered surface of the bedrock was encountered in boring B-7, drilled at the toe of the native hillside in the southwestern portion of the site, at approximately 17.5 feet BGS. Boring and test-pit logs provided in Appendix II include more detailed descriptions of the soils encountered. Fence diagrams created using the subsurface data are attached in Appendix I.

Although altered by previous grading activities and the placement of artificial fills, the soil survey map of the vicinity prepared by the Natural Resources Conservation Service (NRCS) indicates native soils in the vicinity of the project site are primarily mapped as Warden silt loam (WdAB & WdE3) situated on slopes ranging from 0 to 30%. The typical soil profile is described to consist of a relatively thin upper layer (less 12 inches) of silt loam over stratified very fine sandy loam to silt loam. The landform setting is identified as terraces and parent materials are described as loess over lacustrine deposits. Refer to the *NRCS Soil Survey Map* in Appendix VIII for more details.

Groundwater

Free groundwater was not encountered in any of our exploratory borings or test-pits within the maximum depths of exploration. To assist in our evaluation, we have reviewed the Washington State Department of Ecology (DOE) database of nearby well logs to estimated groundwater levels

in the vicinity. Based on our review of a single nearby well log, groundwater levels are anticipated to at depths greater than 100 feet BGS in the vicinity of the site; well log included in Appendix IX.

Geologic Setting

Regional Geology: The City of Kennewick lies on the Columbia Plateau, a broad plain situated between the Cascade Range to the west and the Rocky Mountains to the east. The Columbia Plateau was formed by a thick sequence of Miocene Age tholeiitic basalt flows, called the Columbia River Basalt Group (CRBG), which erupted from fissures in north central and northeastern Oregon, eastern Washington, and Western Idaho approximately 12 to 26 million years ago. The Columbia Plateau is often called the Columbia Basin because it forms a broad lowland surrounded by mountains. The CRBG is underlain by continental sedimentary rocks from early in the Tertiary Period. The Pliocene Age Ringold formation sediments overlie the Columbia basalts. The Ringold Formation sediments consist of a heterogeneous mix of variably cemented and compacted gravel, sand, silt, and clay deposited by the ancestral Columbia, Snake, and Yakima Rivers.

The project site is generally located near the base of the Horse Heaven Hills and in line with the Rattlesnake Hills (fault/fold structure) of the Yakima Fold Belt within the vast Columbia Basin physiographic province of southeastern Washington. The Rattlesnake and Horse Heaven Hills each consist of east-west trending anticline ridges of the Yakima Fold Belt formed by north–south compression in the regional lava flows.

Near the end of the Pleistocene, the Columbia Basin was subjected to a series of incredibly massive, high energy floods known as the Missoula Floods. During this time, a lobe of the Cordilleran ice sheet extended south into Idaho, damming up the Clark Fork River and creating Glacial Lake Missoula, impounding as much as 500 cubic miles of water. These ice dams periodically failed and then reformed numerous times during this period, draining the lake suddenly and unleashing a series of massive torrents of water that significantly scoured and altered landscapes in the Columbia Basin including significant erosion and deposition.

Local Geology: In the Tri-Cities area the uppermost layers of the CRBG are fractured bedrock of the Wanapum Basalt formation. Regionally, the top surface of the Wanapum Basalt is known to

slope to the northeast toward the Columbia River, although local variations exist in the area. The highly weathered upper surface of the local basalt bedrock was apparently encountered at an approximate depth of 17.5 feet BGS within boring B-7 drilled near the southwest, relatively elevated portion of the site. No indications of the buried bedrock surface were noted within any of the other points of exploration throughout the site to the maximum depths explored.

Overlying sediments in the project area consist of surficial deposits of Plio-Pleistocene loess, including silt and fine-grained sands, along with localized areas of Quaternary alluvium and a sequence of Pleistocene-age outburst flood deposits, commonly identified as the Missoula Flood Deposits. These deposits generally include boulder and cobble to granule-sized basaltic gravel, with lesser deposits of sand, silt, and non-basaltic gravel.

GEOLOGIC HAZARDS

Seismic Conditions:

The Tri-Cities area is generally not considered to be located within an area of high seismic activity. There are no confirmed major faults in the Tri-Cities region capable of producing strong earthquakes. Anticipated ground motions in the region due to seismic activity along faults in other parts of the Northwest are relatively low.

The seismic hazard in the project area and vicinity results from three seismic sources: interplate events, intraslab events, and crustal events (Geomatrix, 1995, 1996). Each of these events has different causes and therefore produces earthquakes with different characteristics (*i.e.,* peak ground accelerations, response spectra, and duration of strong shaking). Each is capable of generating a peak ground acceleration (pga) on rock larger than 0.05g.

Two of the potential seismic sources, interplate and intraslab events, are related to the subduction of the Juan De Fuca plate beneath the North American plate. Interplate events occur due to movement at the interface of these two tectonic plates. Intraslab events originate within the subducting tectonic plate, away from its edges, when built-up stresses within the subducting plate are released. These source mechanisms are referred to as the Cascadia Subduction Zone (CSZ) source mechanism. The CSZ originates off the coast of Oregon and Washington and subducts beneath both states.

Earthquakes caused by movements along crustal faults, generally in the upper 10 to 15 miles, result in the third source mechanism. These movements occur on the crust of the North America tectonic plate when built-up stresses near the surface are released. There are several crustal faults in the project site region, including the Rattlesnake-Wallula Trend, Columbia Hills Anticline, and Horse Heaven Hills NW Fault (Geomatrix 1995, 1996). These faults are generally considered to be inactive or have a low probability of activity.

The most notable earthquake event in the past century occurred on July 15, 1936 near Umapine, Oregon, approximately 35 miles to the east-southeast. The Umapine quake has been set at magnitude 5.7 or 6.4 on the Richter Scale by different resources, and was felt through large portions of Washington, Oregon, and Idaho, and caused ground cracking, small areas of soil liquefaction, structural damage, and isolated building collapses near Walla Walla, Washington and Milton-Freewater, Oregon. Damage was also reported in Waitsburg (approximately 50 east of the project site), and the quake was felt in Kennewick (estimated Modified Mercalli (MM) Intensity of III) but no damage was reported.

Within the past 10 years there have been a total of 28 earthquakes within a 100 kilometer radius from the site. The largest of these episodes had a magnitude of 3.7 and a hypocenter of 20 kilometers below the surface. It occurred in 2008 and the epicenter was 27 kilometers away from the site at a location of N 46.17 W -119.55. Of the 28 total earthquakes in the past 10 years, 21 had a focus of 10 kilometers or less, 6 were between 25 kilometers and 11 kilometers, and 1 was greater than 25 kilometers deep (a focus of 36 kilometers below the surface). All 28 events have an average magnitude of 2.9 on the Richter scale.

Regional Faulting:

There are three main fault structures in the project site region. These three consists of the Rattlesnake Hills fault/fold structure, the Horse Heaven Hills structure, and the Wallula Fault system. These three structures are included in many of the regional lineaments in the area including the Olympic Wallowa Lineament (OWL), the Cle Elum-Wallula deformed zone (CLEW), and the Rattlesnake-Wallula trend (RAW).

The Horse Heaven Hills structure is one of the longest fold and fault systems in south-central Washington, and is part of the Yakima Fold Belt. The structures are primarily north-verging anticlines possibly underlain by south-dipping thrust and reverse faults. Tightening or growth of other Yakima Fold Belt structures, and possibly the Horse Heaven Structures, has been hypothesized; however poor exposure of Quaternary deposits and lack of detailed mapping prevent determination of this. No definitive evidence has been documented to show Quaternary movement in the Horse Heaven Hills.

The Rattlesnake Hills fault/fold structures are also anticlinal segments cut and underlain by south- to southwest-dipping thrust or reverse faults in rocks of the Miocene CRBG. These anticlinal segments characterize the southeastern part of the Rattlesnake Hills uplift and are an echelon double-plunging anticline. The faults of the Rattlesnake Hills structures are covered by loess, landslide, and glacial outburst flood deposits of Quaternary age for much of their length. Based on published geologic maps, the concealed/buried alignment of the Rattlesnake Hills structure crosses beneath the south-central portion of the site. *Approximate Fault Alignment Map* (Figure 4, Appendix I) shows the approximate alignment of the buried/concealed fault zone, as mapped by Washington State Department of Resources – Washington Interactive Geologic Map. As with the Horse Heaven Structures, movement and tightening has been inferred, but no conclusive evidence has been presented to prove this, and no definitive evidence has been documented to show Quaternary displacement; the Rattlesnake Hills structure is therefore identified as a Class B fault.

The Wallula Fault System is a prominent northwest-striking fault zone that extends from near Milton-Freewater, OR to near Kennewick, WA. The northwest projection of the Wallula fault is generally mapped to line-up with the southeast projection of the Rattlesnake Hills fault. Unlike the two previously described structures, the Wallula Fault System is mostly mapped as linear, steeply dipping strike-slip, normal, or reverse faults in Quaternary surficial deposits and rocks of the Columbia River Basalt Group. The mapped fault pattern, and other evidence, supports a right-lateral strike-slip sense of movement on the Wallula Fault. Although poorly studied, some evidence suggests up to four surface-faulting events within the past 10,000 years along a portion of the Wallula Fault System in northeastern Oregon. Slip rate on all three faults is estimated to be less than 0.2 millimeters per year.

Secondary Seismic Hazards

Secondary seismic hazards related to ground shaking include soil liquefaction, ground subsidence, tsunamis, and seiches. The site is far inland, so the hazard from tsunamis is non-existent. The potential hazards from seiches generated in the adjacent KID Canal are also considered nil due to grade differential and the noted low magnitudes of potential seismic shaking.

Soil Liquefaction

Liquefaction is the loss of soil strength from sudden shock (usually earthquake shaking), causing the soil to become a fluid mass. In general, for the effects of liquefaction to be manifested at the surface, groundwater levels must be within 50 feet of the ground surface and the soils within the saturated zone must also be susceptible to liquefaction. A detailed liquefaction analysis was beyond the scope of this report. Based on the published Liquefaction Susceptibility Map of Benton County, Washington (dated September 2004) prepared by Washington State Department of Natural Resources, the site is primarily mapped in the upper portion as bedrock (non-liquefiable), with the lower portion mapped with a designation of 'Very Low'potential for liquefaction.

Slope Stability

Based on site-specific topography, current site elevations within the project boundary range from approximately 845 in the southwestern portion near S. Olympia Street, to 670 feet MSL in the northern portion near the KID canal. Native slope gradients at the site generally range from approximately 10% to 33% in the northern and western portions, and approximately 10% to 29% across the southeastern and southwestern slopes. Existing fill slopes at the site were noted to be as steep as 50% (2H:1V).

A field reconnaissance of the subject property was performed to observe site conditions and correlate the information gathered from our preliminary research. During our reconnaissance we looked for common geomorphic features of landslides as well as indications of possible signs demonstrating recent activity and instability of slide masses. No apparent indications of existing failure or significant slope instability were observed.

Flooding and Erosion

Based on a review of the published FEMA flood map (Community-Panel Number 530237 0617 B) for the site vicinity (Appendix VII), the subject property is not mapped within designated flood plains. The subject property is situated in an area where sheet flow and erosion may occur and the mapped pre-existing intermittent stream drainage crossing the site has been altered by historic site grading and filling. The near-surface site soils and surface conditions are known to exhibit a moderate to severe risk for erosion. Site observations revealed some areas of minor basins (low areas) with moist surface conditions, and apparent soil erosion. Apparent rill and gully erosion was noted along fill slopes in the eastern portion of the site and along the existing access road.

Erosion susceptibility from water is based on several factors, including the intensity of rainfall and runoff, soil erodibility, length and steepness of slopes, and surface condition. The erodibility factor of the soils is a measure of the soils resistance to erosion based on its physical characteristics. Typically very fine sand, silt and clay soils are generally susceptible to erosion. Based on site specific field exploration, observations, and laboratory testing, the surficial soil exposed at the project site consists primarily of silt with fine sand (sandy loam).

Soil erodibility is only one of several factors affecting the erosion susceptibility. Soil erosion by water also increases with the length and steepness of the site slopes due to the increased velocity of runoff and resulting greater degree of scour and sediment transport. Appropriate erosion and sediment control plan(s) and a drainage plan shall be prepared by the project civil engineer with the final construction drawings.

The need for and design of flood control devices and erosion protection measures is within the purview of the design Civil Engineer. In general, erosion should be mitigated with best management practices (BMPs) consisting of proper drainage design including collecting and disposal (conveyance) of water to approved points of discharge in a non-erosive manner. Appropriate project design, construction, and maintenance will be necessary to mitigate the site erosion hazards.

SLOPE STABILITY ANALYSIS

Slope stability analyses were conducted on selected existing slopes to evaluate their present state of stability, as well as proposed reconfigured slopes for the proposed project. The analyses were conducted using a generalized geologic cross section model developed from the existing and proposed site topography, and data obtained from our subsurface exploration. Slope stability of the existing site slopes was completed on five (5) slope section models as shown on Figures 8A and 8B (Appendix I), with associated section cut lines shown on *Site Exploration Plan* (Figure 7, Appendix I). Based on the preliminary grading plan, stability analysis for the proposed 2H:1V slope re-configurations was performed on the tallest cut slope, 22 feet tall cut slope in the southeastern portion of the site, and the tallest proposed fill slope, 38 feet tall in the northern portion of the site. Outputs of our slope stability analyses are attached in Appendix V.

The slope stability analyses were conducted by a two-dimensional limit equilibrium stability analysis of selected trial failure surfaces using the computer program *SLIDE*. Potential circular-arc failure surfaces were evaluated using the Spencer method. The computer program searched for critical potential failure surfaces with low computed factors of safety. The computed factor of safety (FS) against slope failure is simply the ratio of total resisting forces or moments (strength of the slope) to the total driving forces or moments for planar or circular failure surfaces respectively. A slope with a factor of safety of 1.0 is in equilibrium, indicating that the disturbing forces driving the slope down are equal to its strength to resist failure. Simply put slope-failure result when the strength of the slope is overcome by gravity.

Although earthquakes are generally not a significant concern in the Tri-Cities region, and anticipated seismic accelerations are expected to be relatively low, the stability of the slopes have been analyzed under both static and seismic conditions. Our analysis used the pseudostatic method which modifies the limit equilibrium method by incorporating a horizontal static seismic force to simulate the potential inertial forces generated from earthquake ground accelerations. For slope stability analyses under seismic loading, a pseudostatic seismic coefficient, kh (horizontal component), expressed in terms of acceleration (units of g), is typically estimated as a percentage of the horizontal peak ground acceleration (PGA). PGA for this site was calculated with a 950-year return interval (RI) using the USGS PSH Deaggregation tool for a 10% probability of exceedance

in 100 years. For our analyses, we have selected a value of kh = 0.06g, approximately half of the design PGA of 0.101g.

The selection of unit weight and shear strength parameters for the various earth materials were based on judgment and data obtained during our field investigation, laboratory testing, review of previous studies, research and previous experience with similar materials in similar geotechnical and geologic settings. Engineering and geologic judgment must be applied to the results of shear tests in order to consider lateral and vertical variations in the subsurface conditions, such as degree of cementation, fracturing, planes of weakness, and gradational characteristics. The following geotechnical strength parameters were used in our stability calculations:

Table 3: Estimated Strength Parameters

Material	Shear Strength Parameters		Unit Weight
	Friction Angle: ϕ	Cohesion: c (psf)	(pcf)
Native: Silt with Sand (low strength)	29	0	90
Native: Silt with Sand (relatively high strength)	34	0	110
Native: Silty Gravel	38	0	125
Fill: Loose (side-cast)	28	0	110
Fill: Undocumented (w/ trash/debris)	20	0	115
Engineered Fill (re-compacted onsite silt)	33	0	118
Engineered Fill (imported granular material)	35	0	120

Our slope stability analyses generally indicate two primary modes of failure: (1) deep-seeded global failure through the slope, and (2) shallow surficial failure through the near-surface (loose) soils. The factors of safety against slope failure, using the shear strength data as described above, were computed for existing and proposed slope configurations as summarized below:

Table 4: Calculated Factors of Safety

Slope Section	Slope Condition	Static Factor of Safety		Seismic Factor of Safety
		Local	Global	
A-A'	Existing	1.9	2.1	1.7
B-B'		1.3	2.4	1.9
C-C' Upper		1.5	1.4	1.6
C-C' Lower		1.0	1.3	
D-D'		3.3	3.5	2.5
E-E'		1.9	2.0	1.7
22' feet tall 2H:1V cut slope	Proposed	1.1	1.5	1.3
38' feet tall 2H:1V fill slope		1.3	1.4	1.2

GN Northern recommends that any reconfigured slopes should meet or be designed and constructed to meet a minimum factor of safety of 1.5 for the static condition and 1.1 under seismic loading. Our analysis indicates that existing native (undisturbed) site slopes, along with the existing engineered fill slope (shown in Section C-C'), meet or exceed these minimums. However, the existing fill slope present along the eastern-most boundary of the project site does not meet the minimum required safety factor. The noted shallow failures through the near-surface soils represent relatively insignificant displacement of the soft surficial veneer of residual soils that should be readily mitigated with appropriate erosion control measures (BMPs).

Our stability analyses of the proposed (re-graded) slopes indicates that 2H:1V cut slopes as tall as 22 feet in net height, into the native existing hillsides, will meet/exceed the required minimum safety factors. Our analysis indicates that the proposed 2H:1V, 38 feet tall fill slope constructed using the onsite native silty material placed as compacted engineered fill, does not meet the minimum required factors of safety.

Based on additional analysis, we recommend that fill slopes constructed with a 2H:1V slope gradient shall be limited to 15-feet in net (total) height. For fill slopes constructed at 2H:1V slope gradient, using imported granular material (as specified in the *Engineered Fill* section), we recommend a net slope height of no greater than 25-feet.

We recommend that all proposed cut and fill slopes at project site shall be constructed in accordance with the recommendations (*Graded Slope Construction* section) of this report. Optional steeper and/or taller slopes can be considered by the developer, however they will require an engineered reinforcement or reduced gradient, respectively, to increase safety factors and reduce the potential for slope failure (see *Optional Reinforced Engineered Slopes* section below).

FINDINGS AND CONCLUSIONS

The following is a summary of our findings, conclusions and professional opinions based on the data obtained from a review of selected technical literature and the site evaluation:

General:

- ***Based on our current understanding of the proposed development and subsurface conditions encountered, from a geologic perspective, it is our professional opinion that the site is suitable for the proposed development, provided the recommendations in this report and any subsequent site specific/design-level geotechnical evaluations are followed in the design and construction of this project.***

- This report does not constitute a geotechnical engineering report for development of the proposed residential subdivision at the project site. Additional lot- and structure-specific geotechnical evaluation(s) and recommendations will be required for the proposed residential subdivision infrastructure improvements and future residential structures.

- The recommendations in this report are indented to address any noted geologic hazards relative to development of the proposed subdivision infrastructure. Additional geotechnical investigations and recommendations will be necessary to address site constraints of future additional structures and improvements.

Geologic/Geotechnical Constraints and Mitigation:

- The primary geologic hazards and site constraints for the proposed project include surface erosion and the potential for slope failures. Engineered design and careful construction as recommended within this report can mitigate these geologic constraints and increase safety to allow development of potentially geologically hazardous areas.

- Although the alignment of the noted buried and concealed Rattlesnake Hills fault/fold structure crosses beneath the project site, it is not considered "active" with Holocene period displacement. We do not believe the Rattlesnake Hills structure represents or poses a significant geologic hazard risk to the proposed development of the site.

- Other common geologic hazards, including fault rupture, liquefaction, and seismic shaking are considered low or negligible on this site.

- Site soils are susceptible to wind and water erosion. Preventative measures to control runoff and reduce erosion should be incorporated into site grading plans.

- Large areas of the subject site have historically been subject to placement of significant volumes of imported fill materials. Based on the findings of our subsurface exploration of the site, some fill materials were observed to include miscellaneous trash and construction debris including concrete rubble, asphalt, wood, and metal. While the upper fill layer in the central portion of the site was properly placed in 2014 as engineered fill with associated testing and inspection, the deeper underlying fill materials consist of undocumented and uncontrolled fill.

- Development on sloping ground poses an inherent risk related to global and local stability of site slopes. The proposed project site development will require careful design and construction including slope stabilization and drainage/erosion control measures to mitigate the observed geotechnical and geologic site constraints.

- As depicted on the current preliminary grading plans, individual residential lots and portions along the width of the proposed roadways will be constructed with partial cut and partial fill grading.

- Site development may require the use of earth retaining structures as well as extensive grading to construct safe cut and fill slopes as proposed.

- Our analysis indicates that existing native (undisturbed) site slopes, along with the existing engineered fill slope (shown in Section C-C'), meet or exceed these minimums. However, the existing fill slope present along the eastern-most boundary of the project site <u>does not meet</u> the minimum required safety factor.

- Our stability analyses of the proposed (re-graded) slopes indicates that 2H:1V cut slopes as tall as 22 feet in net height, into the native existing hillsides, will meet/exceed the required minimum safety factors. Our analysis indicates that the proposed 2H:1V, 38 feet tall fill slope

constructed using the onsite native silty material placed as compacted engineered fill, does not meet the minimum required factors of safety.

- We recommend that fill slopes constructed with a 2H:1V slope gradient shall be limited to 15-feet in net (total) height. For fill slopes constructed at 2H:1V slope gradient, using imported granular material (as specified in the *Engineered Fill* section), we recommend a net slope height of greater than 25-feet.

- The noted shallow failures through the near-surface soils represent relatively insignificant displacement of the soft surficial veneer of residual soils that should be readily mitigated with appropriate erosion control measures (BMPs).

- We recommend that GNN be provided an opportunity to complete subsequent slope stability analyses on a structure- and lot-specific design basis.

- Remedial site grading will be necessary to appropriately mitigate the noted existing poor fill soil conditions and to develop appropriate cut/fill slopes and provide uniform competent support for future residential home-sites and subdivision infrastructure improvements.

- Adherence to the grading and structural recommendations in this report should reduce the potential hazard of slope failure, erosion and settlement problems.

- Optional steeper and/or taller slopes can be considered by the developer, however they will require an engineered reinforcement or reduced gradient, respectively, to increase safety factors and reduce the potential for slope failure.

- The upper soils were found to be relatively loose to medium dense and are unsuitable in their present condition to support structures, fill, and hardscape. The soils within the areas of proposed improvements will require moisture conditioning, over-excavation, and recompaction.

- Onsite soils can be readily cut by normal grading equipment.

- Due to the variability of the onsite materials including significant areas of existing fill, in our opinion the lowest infiltration rate (12 inches/hour), with an appropriate factor of safety, may be used for the native silty soils. For final design of the stormwater infiltration facilities, we recommend performing location- and depth-specific infiltration testing, following completion of site grading, to fully analyze the infiltration characteristics of the onsite material.

- We recommend that lot-specific geotechnical evaluation should establish appropriate slope set-backs for future structures and development.

- ***In our professional opinion, the proposed residential development at the site will not pose a threat to the health or safety of the citizens, or increase hazards to surrounding properties, provided the recommendations in this report and any subsequent site specific/design-level geotechnical evaluations are followed in the design and construction of this project.***

RECOMMENDATIONS

The recommendations in this report are indented to address any noted geologic hazards, including slope stability and erosion concerns relative to development of the proposed residential subdivision infrastructure. Additional geotechnical investigations and recommendations will be necessary to address site constraints of future additional structures and improvements. Furthermore, these recommendations are predicated upon appropriate monitoring and testing of the site grading activities by a representative of our Geotechnical-Engineer-of-Record (GER).

Site Development – Grading

Site grading shall incorporate the requirements of IBC 2012 Appendix J and/or City of Kennewick. The project GER or a representative of the GER should observe site clearing, grading, and the bottoms of excavations before placing fills. Local variations in soil conditions may warrant increasing the depth of over-excavation and recompaction. Seasonal weather conditions may adversely affect grading operations. To improve compaction efforts and prevent potential pumping and unstable ground conditions, we suggest performing site grading during dryer periods of the year.

Soil conditions shall be evaluated by in-place density testing, visual evaluation, probing, and proof-rolling of the imported fill and re-compacted on-site soil as it is prepared to check for compliance with recommendations of this report. A moisture-density curve shall be established in accordance with the ASTM D1557 method for all onsite soils and imported fill materials used as structural fill.

Clearing and Grubbing: At the start of site grading, areas of proposed improvements should be cleared of existing vegetation, large roots, non-engineered fill, construction debris, trash, and abandoned underground utilities. The surface should be stripped of organic growth and removed from the construction area. Areas disturbed during clearing should be properly backfilled and compacted as described below.

Removal of existing vegetation should be carefully controlled and limited to only those areas of proposed improvements and associated grading. Site vegetation and surface conditions should be maintained in their native condition to the greatest extent possible during construction. Areas

disturbed during grading and construction should employ appropriate BMPs and be immediately protected and/or re-vegetated to control runoff and erosion.

Engineered Fill: The native soil may be suitable for use as engineered fill and utility trench backfill, provided it is free of significant organic or deleterious matter. The native soil should be placed in maximum 8-inch lifts (loose) and compacted to at least 95% relative compaction (ASTM D1557) near its optimum moisture content. Compaction should be verified by testing. Rocks larger than 6 inches in greatest dimension should be removed from fill or backfill material.

Imported fill soils should be non-expansive, granular soils meeting the USCS classifications of SM, SP-SM, or SW-SM with a maximum rock size of 3 inches, minimum 80% passing the No. 4 sieve, and 5 to 35% passing the No. 200 sieve. The GER should evaluate the import fill soils before hauling to the site. However, because of the potential variations within the borrow source, import soil will not be prequalified by GNN. The imported fill should be placed in lifts no greater than 8 inches in loose thickness and compacted to at least 95% of the maximum dry density (ASTM D1557) near optimum moisture content.

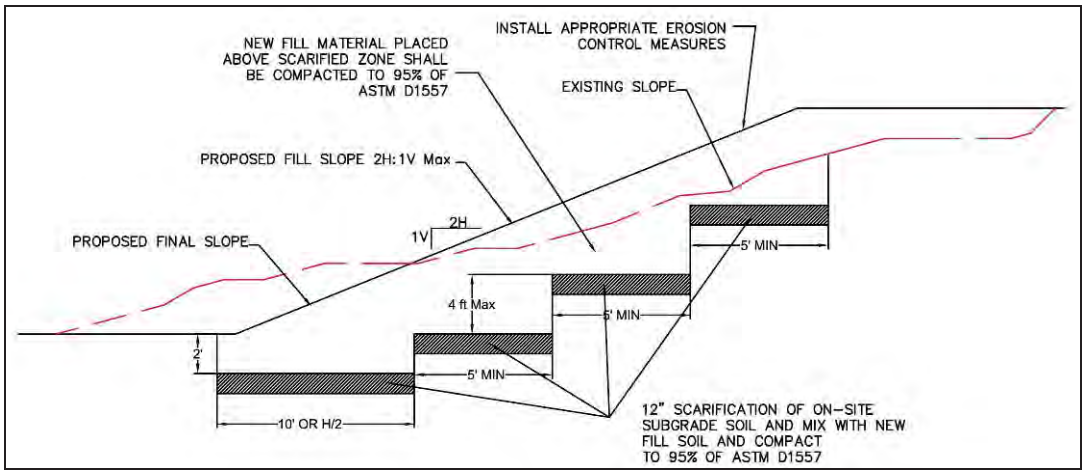
Graded Slope Construction

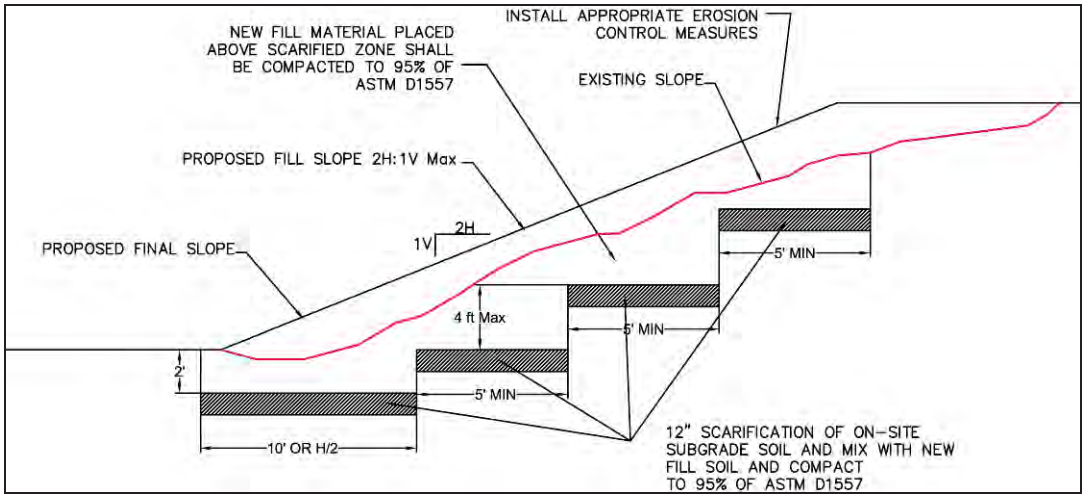
Development on sloping ground poses an inherent risk related to global and local stability of site slopes. In order to mitigate the potential hazards of erosion and slope instability, site development will require careful design and construction including slope stabilization and drainage/erosion control measures to mitigate the observed geotechnical and geologic site constraints.

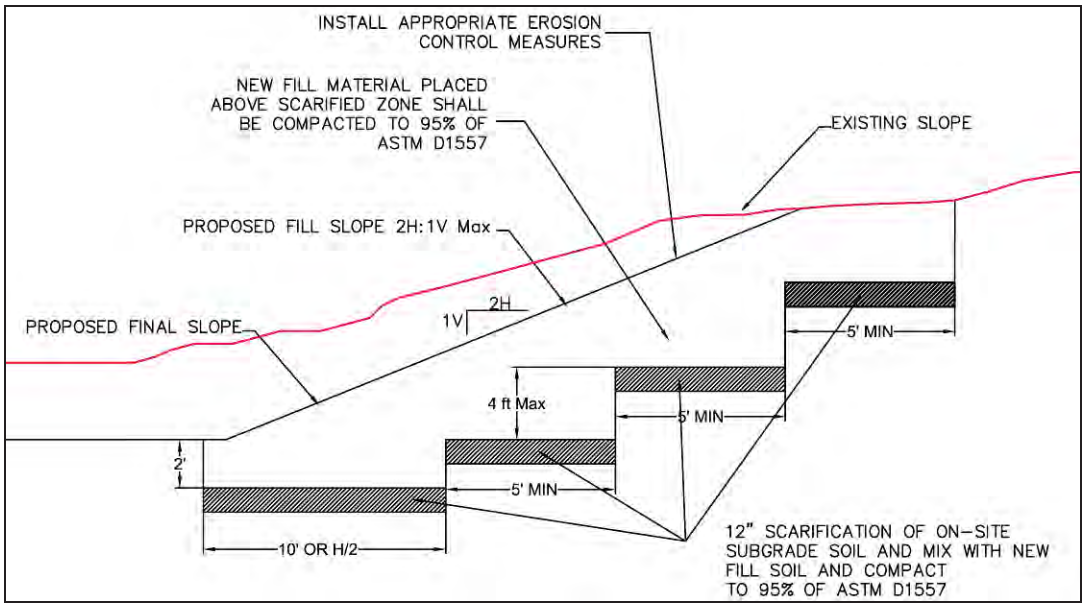
Proposed development of the site will require areas of significant slope grading in addition to the possible use of earth retaining structures. Our stability analyses of the proposed (re-graded) slopes indicates that 2H:1V cut slopes as tall as 22 feet in net height, into the native existing hillsides, will meet/exceed the required minimum safety factors. Our analysis indicates that the proposed 2H:1V, 38 feet tall fill slope constructed using the onsite native silty material placed as compacted engineered fill, does not meet the minimum required factors of safety.

All reconfigured slopes should be overfilled and trimmed back to competent material. A representative of the GER should observe all construction cuts to inspect for adverse geologic

conditions and make appropriate recommendations based on the exposed conditions. Grading details for proper slope construction are shown below:







BMPs to control erosion on all graded slopes will be required. Landscaping should take into consideration the engineering characteristics of the slopes, especially with regards to the surficial stability of the slopes.

Fill Slopes (2H:1V Maximum Gradient)

We recommend that fill slopes constructed with a 2H:1V (max.) slope gradient shall be limited to 15-feet in net (total) height. For fill slopes constructed at 2H:1V (max.) slope gradient, using imported granular material (as specified in the *Engineered Fill* section), we recommend a net slope height of greater than 25-feet. Fill slopes should be overfilled and trimmed back to uniformly compacted material. The final slope surface should be track-walked or grid rolled to improve the slope's resistance to erosion.

Where fill slopes or stabilization fill slopes are to be constructed on natural slopes steeper than 5V:1H, the fill should be keyed and benched into firm natural soil. Keyways for all slopes, greater than 5 feet in height, should be cut into firm natural soil. This helps ensure a good bond between the existing native soil and new fill, and to eliminate a plane of weakness at the interface. Benching dimensions into existing native slopes shall be a minimum 5 feet horizontal and maximum 4 feet vertical from the lowest adjacent soil grade. Before engineered fill is placed, the key should be observed by a representative of the GER, to observe compliance with the above recommendations. It is recommended that the GER, or their representatives, be present during the fill construction to observe compliance with the above recommendations.

Compacted fill slopes shall be overbuilt and cut back to grade, exposing the firm, compacted fill inner core. The actual amount of overbuilding should vary as field conditions dictate. The degree of overbuilding should be increased until the desired compacted slope surface condition is achieved. Care should be taken by the contractor to provide thorough mechanical compaction to the outer edge of the overbuilt slope surface. Fill placement should proceed in thin lifts (8-10 inch loose thickness, depending upon compaction equipment). Each lift should be moisture-conditioned and thoroughly compacted. The desired moisture condition should be maintained during the period between successive lifts, and each lift should be tested to ascertain that desired compaction is being achieved.

At intervals not exceeding 4 feet in vertical slope height or the capability of available equipment, whichever is less, fill slopes should be thoroughly back-rolled utilizing conventional equipment. Care should be taken to maintain the desired moisture conditions as needed prior to back-rolling. Upon achieving final grade, the slopes should again be moisture conditioned and thoroughly back-rolled. The use of a side boom roller may be necessary as well as vibratory methods. Without delay, the slopes should then be grid-rolled to achieve a relatively smooth surface and uniformly compact condition. Slope construction procedures shall be monitored, and moisture and density tests shall be taken at regular intervals.

Cut Slopes (2H:1H Maximum Gradient)

Based on our slope stability analysis of the proposed 22-foot high 2H:1V cut slope (max), remedial grading of the proposed slope face will be required. We recommend reconstruction of the slope face by keying and benching into native soils, along with replacement with engineered fill. A key shall be constructed at the toe of the proposed cut slope, 24-inches deep, with horizontal dimensions of 10 feet of H/2 (where H is the finished height of the slope). Benching dimensions into native cut slopes shall be a minimum 5 feet horizontal and maximum 4 feet vertical from the lowest adjacent soil grade. The exposed native surface of the overcut bench should be scarified, moisture conditioned, and recompacted to a dense and non-yielding surface prior to replacement with engineered fill. The reconstructed cut slope faces shall be overbuilt and cut back to grade, exposing the firm and compacted surface. The GER, or their representatives, should monitor cut slopes during construction, to check for adverse geologic features exposed within the cut face.

A representative of the GER, should monitor cut slopes during construction, to check for adverse geologic features exposed within the cut face. Although not anticipate, proposed slopes may require finished at a shallower gradient or reconstruction as buttressed slopes if adverse geologic conditions and/or unsuitable trash and debris are exposed during construction.

Optional Engineered Reinforced Slopes (Steeper Than 2H:1V)

If considered by the developer, slopes constructed at gradients steeper than 2H:1V will require an engineered reinforcement design to increase the factor of safety against slope failure to acceptable minimums. Several methods of engineered slope reinforcement are available. One of the more cost effective methods for slope reinforcement will consist of the inclusion of multiple layers of

reinforcements (geogrids) placed horizontally during grading operations to construct the proposed slopes. The commonly used term of *mechanically stabilized earth* (MSE) best describe this method of soil reinforcement, or *reinforced soils slopes* (RSS) for use in engineered strengthened slopes. Design requirements for MSE slope structures should be developed in accordance with the Federal Highway Administration's "Mechanically Stabilized Earth Walls and Reinforced Soil Slopes Design and Construction Guidelines" (FHWA NHI-00-043, 2001).

In addition to slope angle and soil strength parameters, the stability of the slopes is also controlled in part by the overall slope height and surcharge loads. Surface erosion control and internal drainage are also important integral parts of the final design and construction of the reinforced soils slopes. The engineered reinforcement should be designed to result in a stable slope with a minimum computed factor of safety of 1.5 for the static condition.

Because of the numerous variables controlling the effectiveness of the engineered reinforcement for optional steeper slopes, a specific reinforced slope design, including geogrids specification, spacing and embedment depths should be prepared for all proposed slopes with gradients steeper than 2H:1V. Careful site layout, planning and construction sequencing will be necessary to ensure that reinforced slopes are not weekend by subsequent construction of future improvements.

Slope Maintenance and Erosion Protection

Future proposed building sites will require appropriate setbacks from adjacent ascending or descending slopes in accordance with IBC Section 1808.7. Proper slope protection and maintenance will help minimize slope erosion and improve the stability of the project slopes. The project soils are prone to erosion and will require appropriate BMP protection and maintenance. Positive drainage should be provided at the tops of all slopes to divert runoff away from the face. Swales constructed in native soils should be lined with suitable no-erosive material. Erosion protection should be provided, especially where concentrated runoff is anticipated. A qualified Landscape Architect should provide recommendations for slope planting. As the exposed site soils are susceptible to erosion, it is required that erosion control measures, such as planting, erosion control blankets or fabrics, sprayed tackifiers, or some combination of these, be utilized on all slopes within the project. Landscaping should take into consideration the engineering characteristics of the slopes, especially with regards to the surficial stability.

The need for and design of flood control and erosion protection measures is within the purview of the design civil engineer. In general, erosion should be mitigated with best management practices (BMPs) consisting of proper drainage design including collecting and disposal (conveyance) of water to approved points of discharge in a non-erosive manner. Appropriate project design, construction, and maintenance will be necessary to mitigate the site erosion concerns.

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Washington State Department of Natural Resources (DNR), Washington Division of Geology and Earth Resources, on-line mapping tool, https://fortress.wa.gov/dnr/protectiongis/geology/

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ADITIONAL SERVICES

GNN recommends that the Client should maintain an adequate program of geotechnical consultation, construction monitoring, and soils testing during the final design and construction phases to monitor compliance with GNN's geotechnical recommendations. Maintaining GNN as the geotechnical consultant from beginning to end of the project will provide continuity of services. If GN Northern, Inc. is not retained by the owner/developer and/or the contractor to provide the recommended geotechnical inspections/observations and testing services, the geotechnical engineering firm or testing/inspection firm providing tests and observations shall assume the role and responsibilities of Geotechnical Engineer-of-Record.

GNN can provide construction monitoring and testing as additional services. The costs of these services are not included in our present fee arrangement, but can be obtained from our office. The recommended construction monitoring and testing includes, but is not necessarily limited to, the following:

- Consultation during the design stages of the project.
- Review of the grading and drainage plans to monitor compliance and proper implementation of the recommendations in GNN's Report.
- Observation and quality control testing during site preparation, grading, and placement of engineered fill as required by the local building ordinances.
- Geotechnical engineering consultation as needed during construction

LIMITATIONS OF THE GEOHAZARDS ASSESSMENT & CRITICAL AREAS REPORT

This GEOHAZARDS ASSESSMENT & CRITICAL AREAS REPORT ("Report") was prepared for the exclusive use of the Client. GN Northern, Inc.'s (GNN) findings, conclusions and recommendations in this Report are based on selected points of field exploration, laboratory testing, and GNN's understanding of the proposed project at the time the Report is prepared. Furthermore, GNN's findings and recommendations are based on the assumption that soil, rock and/or groundwater conditions do not vary significantly from those found at specific exploratory locations at the project site. Variations in soil, bedrock and/or groundwater conditions could exist between and beyond the exploration points. The nature and extent of these variations may not become evident until during or after construction. Variations in soil, bedrock and groundwater may require additional studies, consultation, and revisions to GNN's recommendations in the Report.

In many cases the scope of geotechnical exploration and the test locations are selected by others without consultation from the geotechnical engineer/consultant. GNN assumes no responsibility and, by preparing this Report, does not impliedly or expressly validate the scope of exploration and the test locations selected by others.

This Report's findings are valid as of the issued date of this Report. However, changes in conditions of the subject property or adjoining properties can occur due to passage of time, natural processes, or works of man. In addition, applicable building standards/codes may change over time. Accordingly, findings, conclusions, and recommendations of this Report may be invalidated, wholly or partially, by changes outside of GNN's control. Therefore, this Report is subject to review and shall not be relied upon after a period of one (1) year from the issued date of the Report.

In the event that any changes in the nature, design, or location of structures are planned, the findings, conclusions and recommendations contained in this Report shall not be considered valid unless the changes are reviewed by GNN and the findings, conclusions, and recommendations of this Report are modified or verified in writing.

This Report is issued with the understanding that the owner or the owner's representative has the responsibility to bring the findings, conclusions, and recommendations contained herein to the

attention of the architect and design professional(s) for the project so that they are incorporated into the plans and construction specifications, and any follow-up addendum for the project. The owner or the owner's representative also has the responsibility to verify that the general contractor and all subcontractors follow such recommendations during construction. It is further understood that the owner or the owner's representative is responsible for submittal of this Report to the appropriate governing agencies. The foregoing notwithstanding, no party other than the Client shall have any right to rely on this Report and GNN shall have no liability to any third party who claims injury due to reliance upon this Report, which is prepared exclusively for Client's use and reliance.

GNN has provided geotechnical services in accordance with generally accepted geotechnical engineering practices in this locality at this time. GNN expressly disclaims all warranties and guarantees, express or implied.

Client shall provide GNN an opportunity for to review the final design and specifications so that earthwork, drainage and foundation recommendations may be properly interpreted and implemented in the design and specifications. If GNN is not accorded the review opportunity, GNN shall have no responsibility for misinterpretation of GNN's recommendations.

Although GNN can provide environmental assessment and investigation services for an additional cost, the current scope of GNN's services does not include an environmental assessment or an investigation for the presence or absence of wetlands, hazardous or toxic materials in the soil, surface water, groundwater, or air on, below, or adjacent to the subject property.

APPENDICES

APPENDIX I

Figures, Maps, & Fence Diagrams

Northern, Inc.

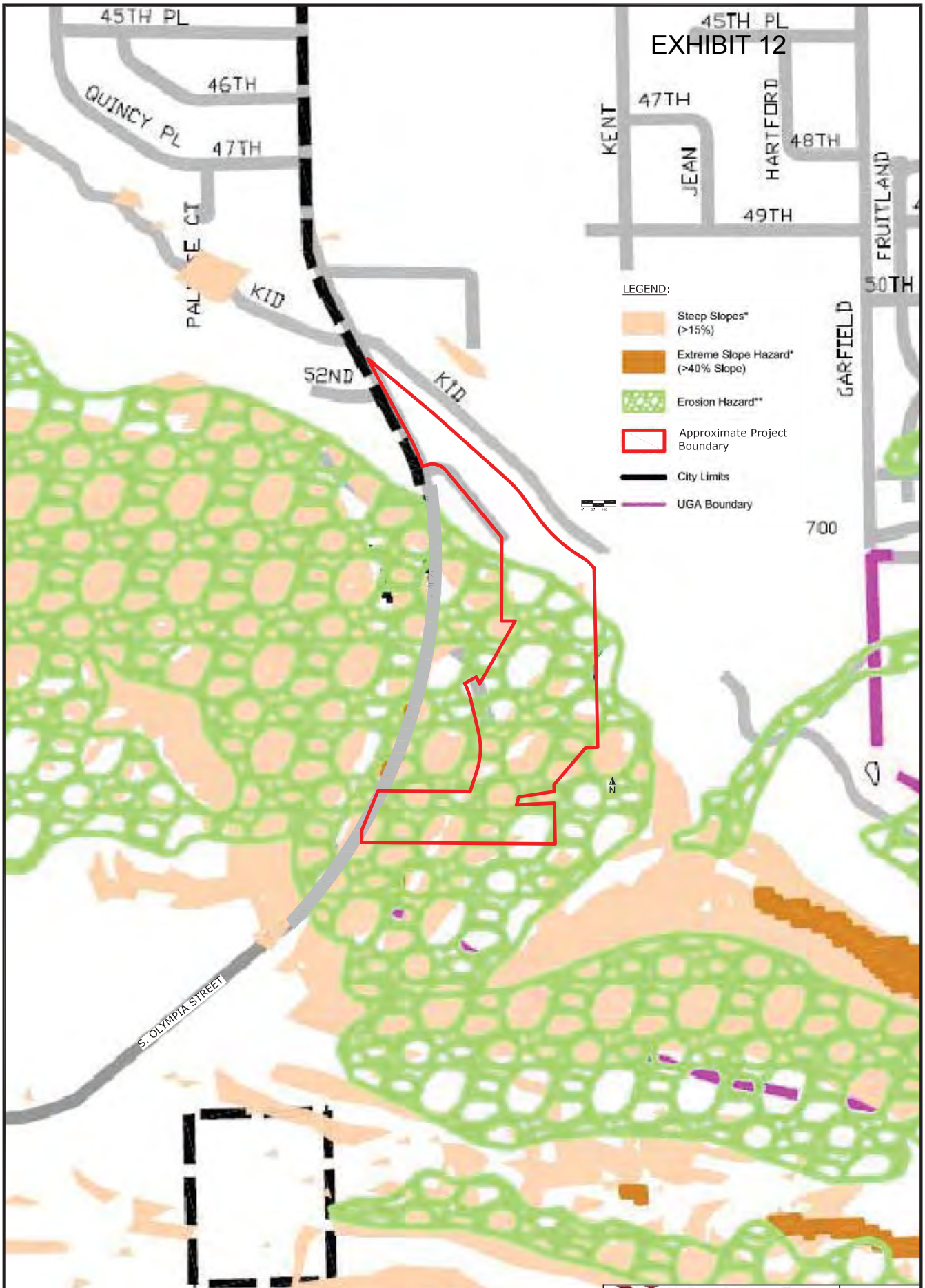
EXHIBIT 12

Consulting Engineers Environmental Scientists Construction Materials Testing

Notes:
1. Base maps from Bing Maps.
2. Image underlay from Google Earth.

GN Northern, Inc. Job Number: 216-672	Site Vicinity Map Proposed 'Sunrise Ridge' Residential Development S. Olympia Street Kennewick, Washington			
	Date 2/22/2016	Drawn By MYM	Reviewed By KAH	Figure 1

EXHIBIT 12



NOTES:

1. Base map excerpted from "Exhibit 4, City of Kennewick, Critical Areas Map, Geologically Hazardous Areas, 2007" prepared by HDR

Northern, Inc.

Project No. 216-672

Site Boundary Overlay on Critical Areas Map

Proposed 'Sunrise Ridge' Residential Development
S. Olympia Street, Kennewick, Washington

Date	Drawn by	Reviewed by	Figure
2/25/2016	MYM	KAH	2

EXHIBIT 12

NOTES:

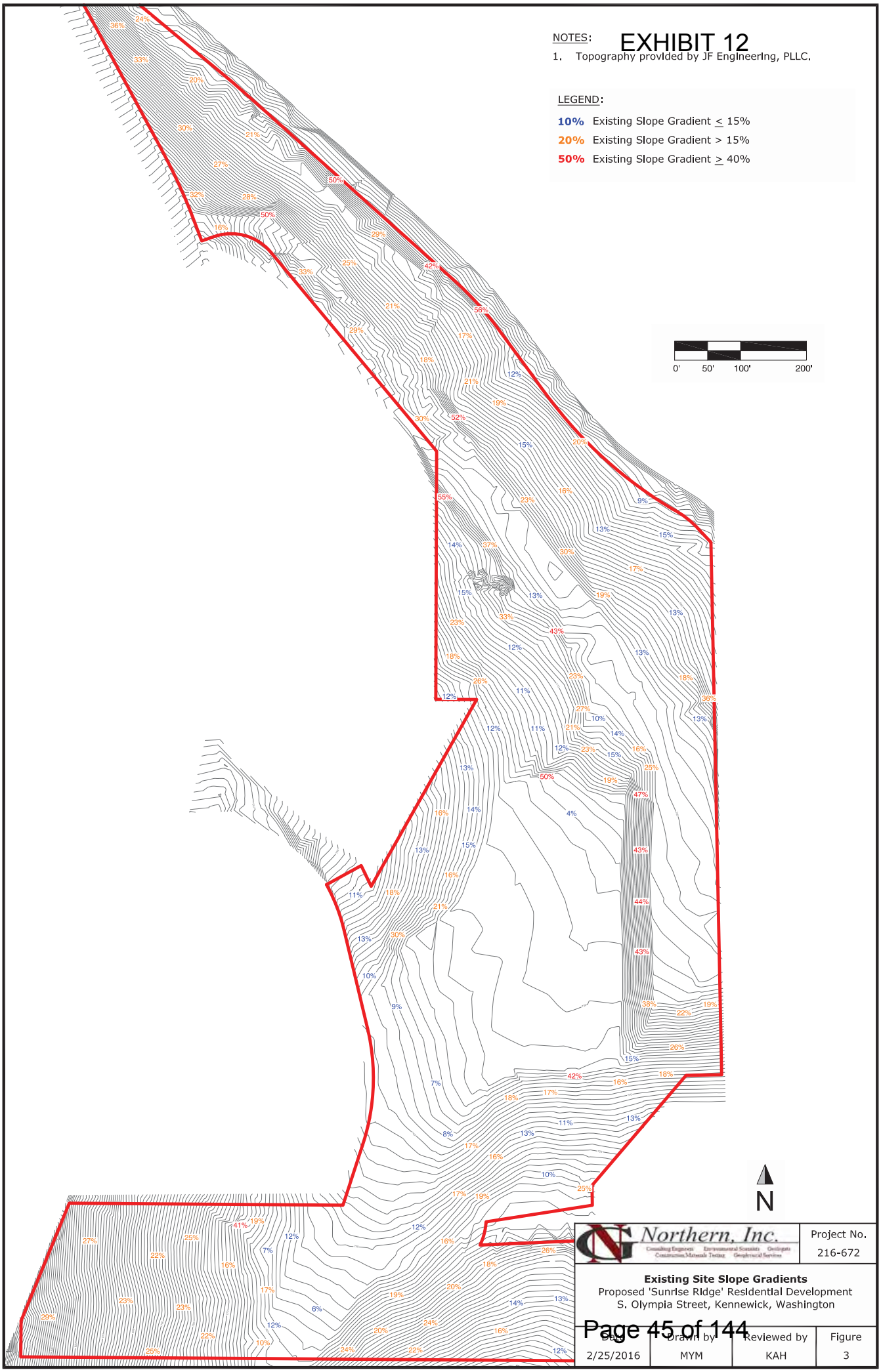
1. Topography provided by JF Engineering, PLLC.

LEGEND:

10% Existing Slope Gradient ≤ 15%

20% Existing Slope Gradient > 15%

50% Existing Slope Gradient ≥ 40%



Northern, Inc.

Consulting Engineers Environmental Scientists Geologists
Construction Materials Testing Geotechnical Services

Project No. 216-672

Existing Site Slope Gradients
Proposed 'Sunrise Ridge' Residential Development
S. Olympia Street, Kennewick, Washington

Date	Drawn by	Reviewed by	Figure
2/25/2016	MYM	KAH	3

EXHIBIT 12

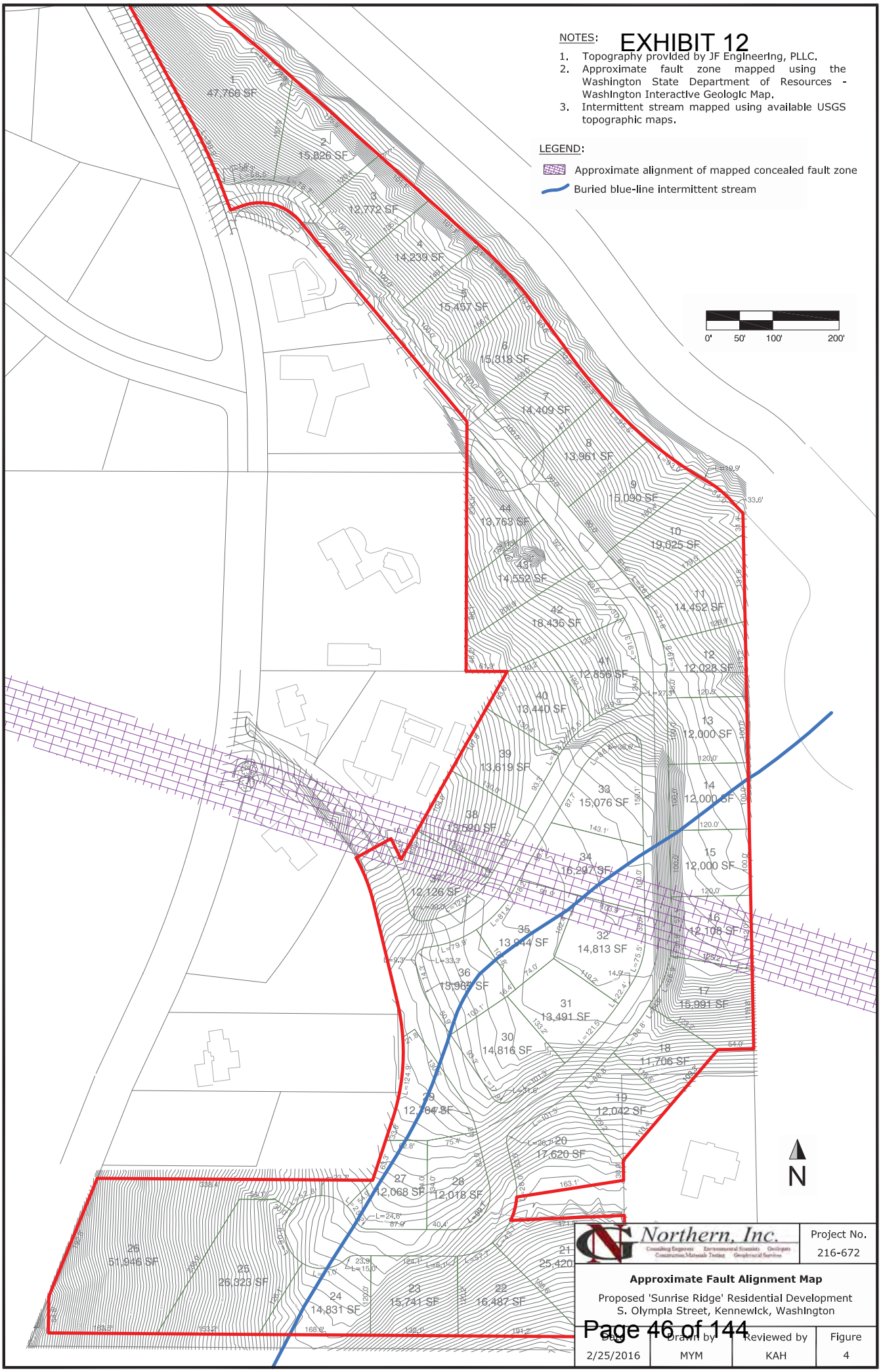
NOTES:

1. Topography provided by JF Engineering, PLLC.
2. Approximate fault zone mapped using the Washington State Department of Resources - Washington Interactive Geologic Map.
3. Intermittent stream mapped using available USGS topographic maps.

LEGEND:

Approximate alignment of mapped concealed fault zone

Buried blue-line intermittent stream



Northern, Inc.

Consulting Engineers Environmental Scientists Geologists Construction Materials Testing Geotechnical Services

Project No. 216-672

Approximate Fault Alignment Map

Proposed 'Sunrise Ridge' Residential Development
S. Olympia Street, Kennewick, Washington

Date	Drawn by	Reviewed by	Figure
2/25/2016	MYM	KAH	4

EXHIBIT 12

NOTES:
1. Topography provided by JF Engineering, PLLC
2. Aerial image underlay from Google Earth.

LEGEND:
- Areas of visible erosion
- Areas of noted trash and construction debris
- Apparent low areas (minor basins)
- Access road not shown on current existing topographic survey

0' 50' 100' 200'

Northern, Inc.
Consulting Engineers Environmental Scientists Geologists
Construction Materials Testing Geotechnical Services

Project No. 216-672

Existing Visible Site Features

Proposed 'Sunrise Ridge' Residential Development
S. Olympia Street, Kennewick, Washington

Date	Drawn by	Reviewed by	Figure
2/25/2016	MYM	KAH	5

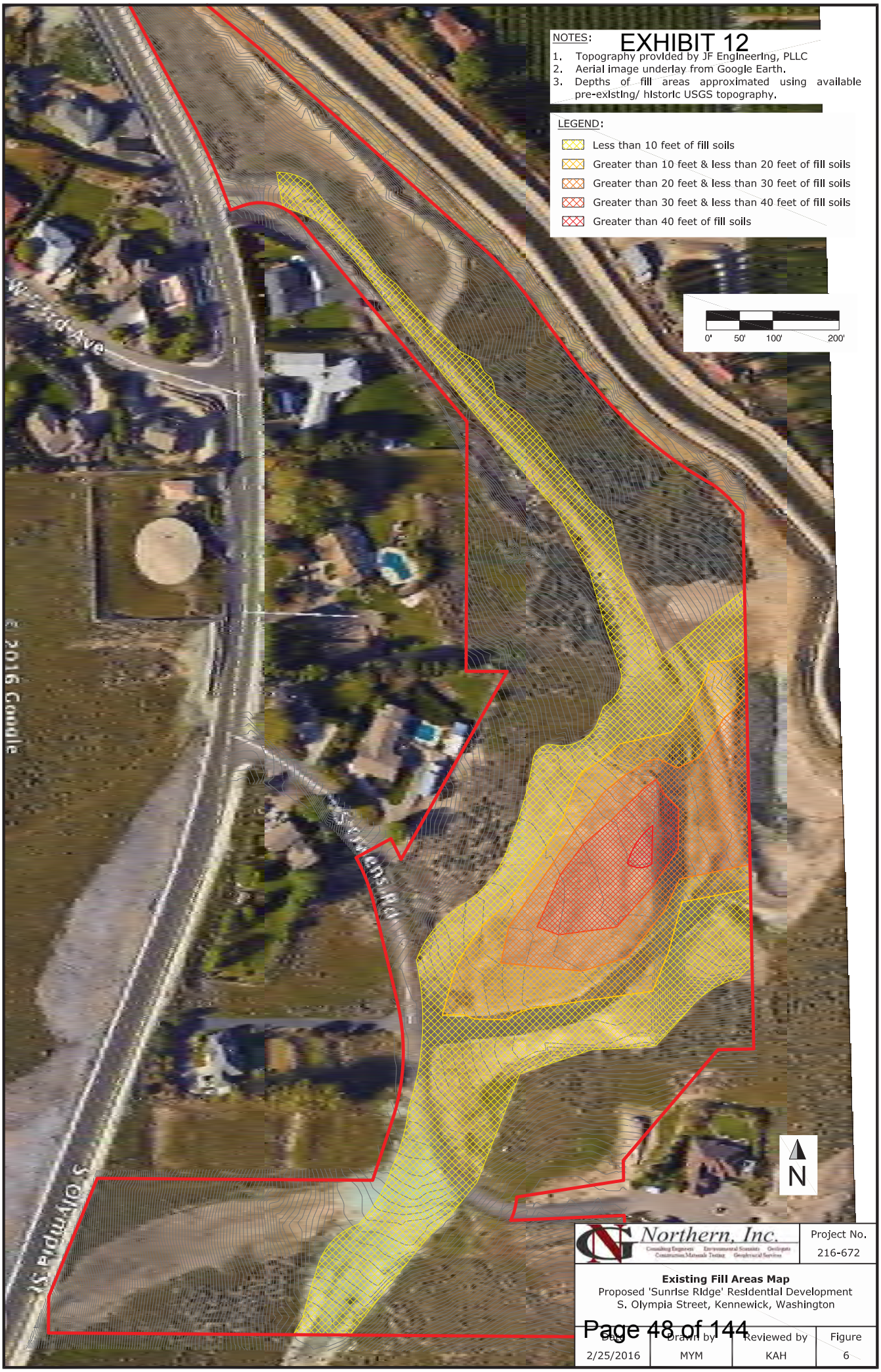


EXHIBIT 12
NOTES:
1. Topography provided by JF Engineering, PLLC
2. Aerial image underlay from Google Earth.
3. Depths of fill areas approximated using available pre-existing/ historic USGS topography.
LEGEND:
Less than 10 feet of fill soils
Greater than 10 feet & less than 20 feet of fill soils
Greater than 20 feet & less than 30 feet of fill soils
Greater than 30 feet & less than 40 feet of fill soils
Greater than 40 feet of fill soils
0' 50' 100' 200'
W 3rd Ave
© 2016 Google
S Olympia St
N
Northern, Inc.
Project No.
216-672
Existing Fill Areas Map
Proposed 'Sunrise Ridge' Residential Development
S. Olympia Street, Kennewick, Washington
Date
2/25/2016
Drawn by
MYM
Reviewed by
KAH
Figure
6

EXHIBIT 12

NOTES:
1. Topography provided by JF Engineering, PLLC
2. Aerial image underlay from Google Earth.
3. Boring, test-pit, and infiltration test locations are not surveyed and are approximate.
4. See Figures 8A & 8B for fence diagrams generated using the noted Section Cut Lines.

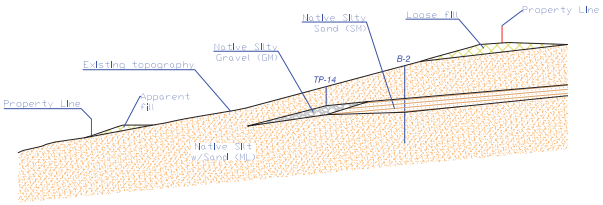
Northern, Inc.
Consulting Engineers Environmental Scientists Geologists
Construction Materials Testing Geotechnical Services

Project No. 216-672

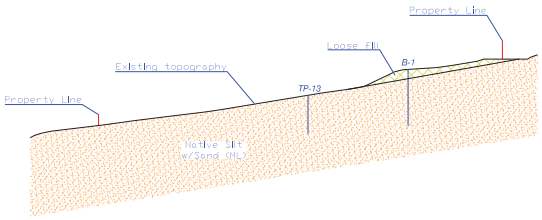
Site Exploration Plan

Proposed 'Sunrise Ridge' Residential Development
S. Olympia Street, Kennewick, Washington

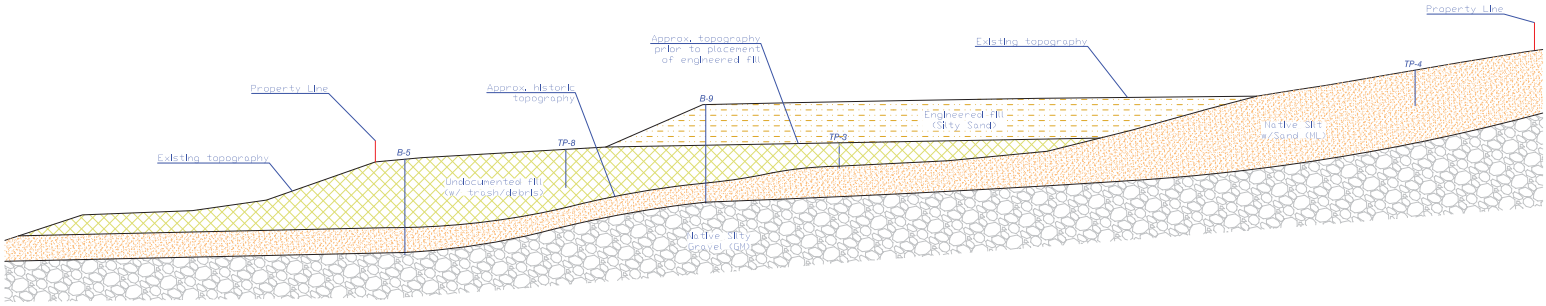
Date	Drawn by	Reviewed by	Figure
2/25/2016	MYM	KAH	7



SECTION A-A'



SECTION B-B'



SECTION C-C'

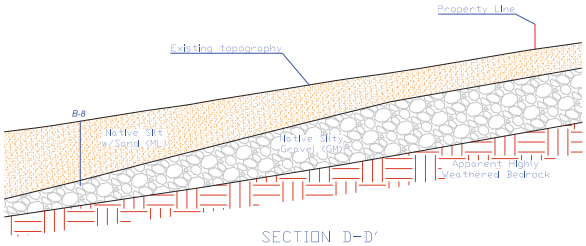
NOTES:

1. Section lines shown on Site Exploration Plan (Figure 2).
2. Existing topography provided by JF Engineering, PLLC.
3. Pre-existing grades, prior to placement of engineered fill in 2014, obtained from available pre-grading topography.
4. Native/historic grades approximated through available USGS topography and interpolation of site-specific exploration.
5. Boring and test-pit locations are not surveyed and are approximate.
6. No vertical exaggeration shown.

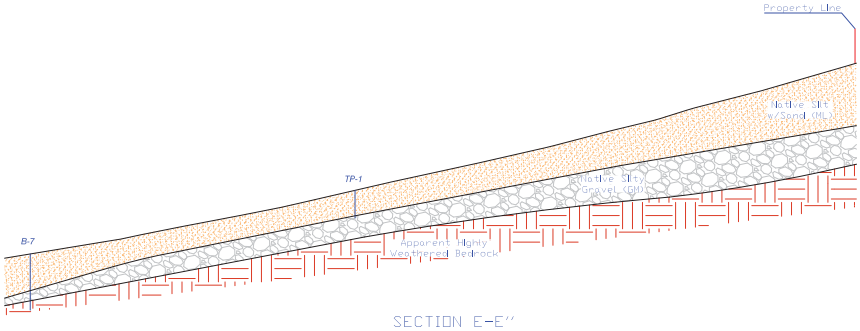
SCALE:

0' 25' 50' 100'

Northern, Inc.	Project No. 216-672		
Subsurface Fence Diagrams - Sections A-A', B-B' & C-C' Proposed 'Sunrise Ridge' Residential Development S. Olympia Street, Kennewick, Washington			
Date 2/22/2016	Drawn by MYM	Reviewed by KAH	Figure 8A



SECTION D-D'



SECTION E-E''

NOTES:

1. Section lines shown on Site Exploration Plan (Figure 2).
2. Existing topography provided by JF Engineering, PLLC.
3. Boring and test-pit locations are not surveyed and are approximate.
4. No vertical exaggeration shown.

SCALE:

0' 25' 50' 100'

Northern, Inc.			Project No. 216-672
Subsurface Fence Diagrams - Sections D-D' & E-E' Proposed 'Sunrise Ridge' Residential Development S. Olympia Street, Kennewick, Washington			
Date 2/22/2016	Drawn by MYM	Reviewed by KAH	Figure 8B

APPENDIX II

Exploratory Boring and Test-Pit Logs

BORING NUMBER B-1

GN Northern Inc.
11115 E. Montgomery, Suite C
Spokane Valley, WA, 99206
Telephone: (509) 248-9798
Fax: (509) 248-4220

CLIENT DJ Sunrise Development, LLC
PROJECT NAME Proposed 'Sunrise Ridge' Residential Development
PROJECT NUMBER 216-672
PROJECT LOCATION S. Olympia Street
DATE STARTED 2/3/16 **COMPLETED** 2/3/16
GROUND ELEVATION 701 ft **HOLE SIZE** 8 inches
DRILLING CONTRACTOR Haz-Tech Drilling, Inc.
GROUND WATER LEVELS:
DRILLING METHOD BK-81 Drill Rig w/ HSA & Autohammer
AT TIME OF DRILLING ---
LOGGED BY MYM **CHECKED BY** KAH
AT END OF DRILLING ---
NOTES Approx. GPS Coords.: 46°9'43.54"N, 119°8'3.24"W
AFTER DRILLING ---

DEPTH (ft)	SAMPLE TYPE NUMBER	BLOW COUNTS (N VALUE)	TESTS	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
0						SILT, (ML) tan brown, moist, loose, (POSSBILE FILL)
	SPT	2-3-5 (8)	MC = 2% Fines = 86%	ML		3.5 — 697.5
						SILT WITH SAND, (ML) tan brown, dry, loose, (APPARENT NATIVE)
	SPT	5-5-7 (12)				- soil becomes medium dense, trace rootlets, trace ash
	SPT	10-15-19 (34)				- soil becomes dense, with moderately cemented ash
10	SPT	11-13-15 (28)				- soil becomes medium dense, trace gravel
	SPT	12-30-39 (69)		ML		- soil becomes very dense
20	SPT	14-21-22 (43)				- soil becomes dense
	SPT	15-27-30 (57)				- soil becomes very dense, no ash
						26.5 — 674.5

- No groundwater was encountered at the time of drilling
- Referenced elevations are approximate and are based on topography provided by JF Engineering

Bottom of borehole at 26.5 feet.

GENERAL BH / TP / WELL - GINT STD US LAB.GDT - 2/24/16 10:15 - C:\USERS\GN NORTHERN\DROPBOX\5-ACTIVE PROJECTS\216-672 SUNRISE RIDGE\216-672 LOGS.GPJ

BORING NUMBER B-2

GN Northern Inc.
11115 E. Montgomery, Suite C
Spokane Valley, WA, 99206
Telephone: (509) 248-9798
Fax: (509) 248-4220

CLIENT DJ Sunrise Development, LLC
PROJECT NAME Proposed 'Sunrise Ridge' Residential Development
PROJECT NUMBER 216-672
PROJECT LOCATION S. Olympia Street
DATE STARTED 2/3/16 **COMPLETED** 2/3/16
GROUND ELEVATION 708 ft **HOLE SIZE** 8 inches
DRILLING CONTRACTOR Haz-Tech Drilling, Inc.
GROUND WATER LEVELS:
DRILLING METHOD BK-81 Drill Rig w/ HSA & Autohammer
AT TIME OF DRILLING ---
LOGGED BY MYM **CHECKED BY** KAH
AT END OF DRILLING ---
NOTES Approx. GPS Coords.: 46°9'47.21"N, 119°8'8.27"W
AFTER DRILLING ---

DEPTH (ft)	SAMPLE TYPE NUMBER	BLOW COUNTS (N VALUE)	TESTS	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION	
0	SPT	5-7-10 (17)	MC = 10% Fines = 36%			FILL: SILTY SAND WITH GRAVEL, gray brown, moist, medium dense, round gravel	
	SPT	24-17-10 (27)				- asphalt debris	
						4.0	704.0
	SPT	5-5-5 (10)	MC = 7%	ML		SILT WITH SAND, (ML) tan brown, dry to moist, loose to medium dense, (APPARENT NATIVE) - partial recovery in sampler	
	SPT	5-5-6 (11)					
10	SPT	4-5-2 (7)					
						15.5	692.5
	SPT	10-17-36 (53)		SM		SILTY SAND, (SM) tan light brown, dry, medium dense	
20	SPT	13-49-50/1"	MC = 4% Fines = 19%			- soil becomes very dense	
						22.0	686.0
	SPT	14-21-26 (47)		ML		SILT WITH SAND, (ML) tan brown, dry to moist, dense	
30	SPT	26-36-37 (73)				- soil becomes very dense, some ash cementation	
	SPT	13-33-43 (76)					
						36.5	671.5

- No groundwater was encountered at the time of drilling
- Referenced elevations are approximate and are based on topography provided by JF Engineering

Bottom of borehole at 36.5 feet.

GENERAL BH / TP / WELL - GINT STD US LAB.GDT - 2/24/16 10:15 - C:\USERS\GN NORTHERN\DROPBOX\5-ACTIVE PROJECTS\216-672 SUNRISE RIDGE\216-672 LOGS.GPJ

GN Northern Inc.
11115 E. Montgomery, Suite C
Spokane Valley, WA, 99206
Telephone: (509) 248-9798
Fax: (509) 248-4220

BORING NUMBER B-3

CLIENT DJ Sunrise Development, LLC
PROJECT NAME Proposed 'Sunrise Ridge' Residential Development
PROJECT NUMBER 216-672
PROJECT LOCATION S. Olympia Street
DATE STARTED 2/3/16 **COMPLETED** 2/3/16
GROUND ELEVATION 704 ft **HOLE SIZE** 8 inches
DRILLING CONTRACTOR Haz-Tech Drilling, Inc.
GROUND WATER LEVELS:
DRILLING METHOD BK-81 Drill Rig w/ HSA & Autohammer
AT TIME OF DRILLING ---
LOGGED BY MYM **CHECKED BY** KAH
AT END OF DRILLING ---
NOTES Approx. GPS Coords.: 46°9'45.90"N, 119°8'5.93"W
AFTER DRILLING ---

DEPTH (ft)	SAMPLE TYPE NUMBER	BLOW COUNTS (N VALUE)	TESTS	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION	
0						SANDY SILT, (ML) brown, dry to moist, loose, (POSSIBLE FILL)	
	SPT	4-3-3 (6)	MC = 6% Fines = 70%	ML			
4.5							699.5
	SPT	3-3-4 (7)	MC = 8% Fines = 88%			SILT, (ML) tan brown, dry to moist, loose, trace rootlets, trace ash (APPARENT NATIVE)	
	SPT	5-7-16 (23)				- soil becomes medium dense, trace gravel	
10	SPT	9-10-12 (22)		ML		- 12-inch lense of SILTY SAND(SM)	
16.0	SPT	10-34-35 (69)				- soil becomes very dense, with gravels	688.0
18.0				SM		SILTY SAND WITH GRAVEL, (SM) gray brown, fine to medium grained, dry, very dense	686.0
20						SILTY SAND, (SM) brown, dry, dense, trace gravel	
	SPT	11-15-17 (32)	MC = 4% Fines = 14%				
	SPT	11-21-23 (44)		SM		- fine to coarse sand	
30							
31.5	SPT	11-13-17 (30)				- soil becomes medium dense to dense	672.5

- No groundwater was encountered at the time of drilling
- Referenced elevations are approximate and are based on topography provided by JF Engineering

Bottom of borehole at 31.5 feet.

GENERAL BH / TP / WELL - GINT STD US LAB.GDT - 2/24/16 10:15 - C:\USERS\GN NORTHERN\DROPBOX\5-ACTIVE PROJECTS\216-672 SUNRISE RIDGE\216-672 LOGS.GPJ

GN Northern Inc.
11115 E. Montgomery, Suite C
Spokane Valley, WA, 99206
Telephone: (509) 248-9798
Fax: (509) 248-4220

BORING NUMBER B-4

CLIENT DJ Sunrise Development, LLC
PROJECT NAME Proposed 'Sunrise Ridge' Residential Development
PROJECT NUMBER 216-672
PROJECT LOCATION S. Olympia Street
DATE STARTED 2/3/16 **COMPLETED** 2/3/16
GROUND ELEVATION 702.5 ft **HOLE SIZE** 8 inches
DRILLING CONTRACTOR Haz-Tech Drilling, Inc.
GROUND WATER LEVELS:
DRILLING METHOD BK-81 Drill Rig w/ HSA & Autohammer
AT TIME OF DRILLING ---
LOGGED BY MYM **CHECKED BY** KAH
AT END OF DRILLING ---
NOTES Approx. GPS Coords.: 46°9'39.11"N, 119°7'58.85"W
AFTER DRILLING ---

DEPTH (ft)	SAMPLE TYPE NUMBER	BLOW COUNTS (N VALUE)	TESTS	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
0						FILL: SILTY SAND WITH GRAVEL, brown, dry to moist to moist, medium dense, with brick debris, roots, misc. trash (partial recovery in sampler)
	SPT	5-5-8 (13)				
	SPT	10-4-4 (8)				- soil becomes loose
	SPT	1-1-2 (3)				- soil becomes very loose
10	SPT	3-3-2 (5)	MC = 6% Fines = 80%			9.5 — 693.0 — SILT WITH SAND, (ML) tan brown, dry to moist, loose, (APPARENT NATIVE)
	SPT	6-7-8 (15)				- soil becomes medium dense
20	SPT	4-16-13 (29)		ML		- soil becomes medium dense to dense
	SPT	13-18-22 (40)				- soil becomes dense, with ash
30	SPT	7-14-17 (31)				
	SPT	21-50/3"		GM		33.5 — 669.0 — SILTY GRAVEL, (GM) gray brown, dry, very dense
	SPT	50/1"				37.5 — 665.0

- No groundwater was encountered at the time of drilling
- Referenced elevations are approximate and are based on topography provided by JF Engineering

Bottom of borehole at 37.5 feet.

GENERAL BH / TP / WELL - GINT STD US LAB.GDT - 2/24/16 10:15 - C:\USERS\GN NORTHERN\DROPBOX\5-ACTIVE PROJECTS\216-672 SUNRISE RIDGE\216-672 LOGS.GPJ

BORING NUMBER B-5

GN Northern Inc.
11115 E. Montgomery, Suite C
Spokane Valley, WA, 99206
Telephone: (509) 248-9798
Fax: (509) 248-4220

CLIENT DJ Sunrise Development, LLC
PROJECT NAME Proposed 'Sunrise Ridge' Residential Development
PROJECT NUMBER 216-672
PROJECT LOCATION S. Olympia Street
DATE STARTED 2/3/16 **COMPLETED** 2/3/16
GROUND ELEVATION 704 ft **HOLE SIZE** 88 inches
DRILLING CONTRACTOR Haz-Tech Drilling, Inc.
GROUND WATER LEVELS:
DRILLING METHOD BK-81 Drill Rig w/ HSA & Autohammer
AT TIME OF DRILLING ---
LOGGED BY MYM **CHECKED BY** KAH
AT END OF DRILLING ---
NOTES Approx. GPS Coords.: 46°9'37.18"N, 119°7'58.51"W
AFTER DRILLING ---

DEPTH (ft)	SAMPLE TYPE NUMBER	BLOW COUNTS (N VALUE)	TESTS	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION	
0						FILL: SILTY SAND WITH GRAVEL, brown, dry to moist to moist, medium dense, misc. trash	
	SPT	10-12-10 (22)					
	SPT	6-3-3 (6)				- soil becomes loose	
	SPT	1-0-1 (1)				- soil becomes very loose, no recovery in sampler	
10	SPT	3-1-4 (5)					
	SPT	2-9-10 (19)				- soil becomes medium dense	
20	SPT	3-4-22 (26)				- gravel at sampler tip	
						23.0	681.0
						SILT, (ML) tan brown, loose, (APPARENT FILL)	
	SPT	12-4-3 (7)		ML			
30	SPT	48-50/3"				- soil becomes very dense, no recovery in sampler	
						35.5	668.5
	SPT	21-13-6 (19)	MC = 9% Fines = 70%			SILT WITH SAND, (ML) tan brown, dry to moist, medium dense, some coarse sand, (APPARENT NATIVE)	
40	SPT	10-12-14 (26)		ML		- trace ash	
						44.0	660.0
				GM		45.0 SILTY GRAVEL, (GM) gray brown, dry, very dense	659.0
	SPT	50/2"					

- No groundwater was encountered at the time of drilling
- Referenced elevations are approximate and are based on topography provided by JF Engineering

Bottom of borehole at 45.0 feet.

GENERAL BH / TP / WELL - GINT STD US LAB.GDT - 2/24/16 10:15 - C:\USERS\GN NORTHERN\DROPBOX\5-ACTIVE PROJECTS\216-672 SUNRISE RIDGE\216-672 LOGS.GPJ

GN Northern Inc.
11115 E. Montgomery, Suite C
Spokane Valley, WA, 99206
Telephone: (509) 248-9798
Fax: (509) 248-4220

BORING NUMBER B-6

CLIENT DJ Sunrise Development, LLC
PROJECT NAME Proposed 'Sunrise Ridge' Residential Development
PROJECT NUMBER 216-672
PROJECT LOCATION S. Olympia Street
DATE STARTED 2/4/16 **COMPLETED** 2/4/16
GROUND ELEVATION 732 ft **HOLE SIZE** 8 inches
DRILLING CONTRACTOR Haz-Tech Drilling, Inc.
GROUND WATER LEVELS:
DRILLING METHOD BK-81 Drill Rig w/ HSA & Autohammer
AT TIME OF DRILLING ---
LOGGED BY MYM **CHECKED BY** KAH
AT END OF DRILLING ---
NOTES Approx. GPS Coords.: 46°9'34.55"N, 119°8'2.69"W
AFTER DRILLING ---

DEPTH (ft)	SAMPLE TYPE NUMBER	BLOW COUNTS (N VALUE)	TESTS	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION	
0						SILT WITH SAND, (ML) brown, dry, medium dense, (APPARENT FILL)	
	SPT	8-11-11 (22)	MC = 14% Fines = 85%	ML			
						4.5	727.5
	SPT	4-5-4 (9)				SILT WITH SAND, (ML) tan brown, dry, loose, (APPARENT NATIVE)	
	SPT	2-2-2 (4)	MC = 4% Fines = 87%			- soil becomes very loose to loose	
10	SPT	7-14-19 (33)		ML		- soil becomes dense, some ash	
	SPT	8-13-17 (30)				- soil becomes medium dense to dense	
						18.5	713.5
20				ML		GRAVELLY SILT, (ML) tan, subrounded, dry, very dense	
	SPT	19-32-50/5"				21.0	711.0
				GM		SILTY GRAVEL, (GM) very dense, no recovery in sampler	
						22.5	709.5
	SPT	50/2"					

- No groundwater was encountered at the time of drilling
- Referenced elevations are approximate and are based on topography provided by JF Engineering

Bottom of borehole at 22.5 feet.

GENERAL BH / TP / WELL - GINT STD US LAB.GDT - 2/24/16 10:15 - C:\USERS\GN NORTHERN\DROPBOX\5-ACTIVE PROJECTS\216-672 SUNRISE RIDGE\216-672 LOGS.GPJ

BORING NUMBER B-7

GN Northern Inc.
11115 E. Montgomery, Suite C
Spokane Valley, WA, 99206
Telephone: (509) 248-9798
Fax: (509) 248-4220

CLIENT DJ Sunrise Development, LLC
PROJECT NAME Proposed 'Sunrise Ridge' Residential Development
PROJECT NUMBER 216-672
PROJECT LOCATION S. Olympia Street
DATE STARTED 2/4/16 **COMPLETED** 2/4/16
GROUND ELEVATION 757 ft **HOLE SIZE** 8 inches
DRILLING CONTRACTOR Haz-Tech Drilling, Inc.
GROUND WATER LEVELS:
DRILLING METHOD BK-81 Drill Rig w/ HSA & Autohammer
AT TIME OF DRILLING ---
LOGGED BY MYM **CHECKED BY** KAH
AT END OF DRILLING ---
NOTES Approx. GPS Coords.: 46°9'30.95"N, 119°8'7.96"W
AFTER DRILLING ---

DEPTH (ft)	SAMPLE TYPE NUMBER	BLOW COUNTS (N VALUE)	TESTS	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
0						SILT WITH SAND, (ML) tan brown, dry, medium dense
	SPT	8-6-4 (10)	MC = 5% Fines = 78%			
	SPT	3-6-8 (14)	MC = 4% Fines = 84%			- soil becomes medium dense
	SPT	6-9-11 (20)		ML		- trace ash
10						
	SPT	9-17-20 (37)				- trace gravel - some cemented ash
						- some gravel from 15 to 16 feet BGS
						17.5 — 739.5
	SPT	19-50/6"				APPARENT HIGHLY WEATHERED BEDROCK, angular basatlic fragments, with fine to coarse-grained silty sand, reddish brown and yellow, dry to moist, very dense, some iron-oxide staining
20						
	SPT	19-21-24 (45)	MC = 20% Fines = 35%			
	SPT	39-26-50/6"				- soil becomes dry
						26.5 — 730.5

- No groundwater was encountered at the time of drilling
- Referenced elevations are approximate and are based on topography provided by JF Engineering

Bottom of borehole at 26.5 feet.

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BORING NUMBER B-8

GN Northern Inc.
11115 E. Montgomery, Suite C
Spokane Valley, WA, 99206
Telephone: (509) 248-9798
Fax: (509) 248-4220

CLIENT DJ Sunrise Development, LLC
PROJECT NAME Proposed 'Sunrise Ridge' Residential Development
PROJECT NUMBER 216-672
PROJECT LOCATION S. Olympia Street
DATE STARTED 2/4/16 **COMPLETED** 2/4/16
GROUND ELEVATION 755 ft **HOLE SIZE** 8 inches
DRILLING CONTRACTOR Haz-Tech Drilling, Inc.
GROUND WATER LEVELS:
DRILLING METHOD BK-81 Drill Rig w/ HSA & Autohammer
AT TIME OF DRILLING ---
LOGGED BY MYM **CHECKED BY** KAH
AT END OF DRILLING ---
NOTES Approx. GPS Coords.: 46°9'31.98"N, 119°8'4.19"W
AFTER DRILLING ---

DEPTH (ft)	SAMPLE TYPE NUMBER	BLOW COUNTS (N VALUE)	TESTS	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
0						0.5 Approx. 6-inches of organic topsoil — 754.5
				ML		SILT WITH SAND, (ML) tan brown, dry, medium dense
	SPT	8-8-7 (15)	MC = 6% Fines = 86%			
	SPT	3-3-3 (6)	MC = 5% Fines = 75%			- soil becomes loose, trace gravel
	SPT	3-5-10 (15)				- soil becomes medium dense
10	SPT	5-8-10 (18)				- lenses of cemented soil
	SPT	9-17-20 (37)				- soil becomes dense, some cemented ash
20	SPT	13-22-25 (47)				- some gravel
	SPT	12-22-26 (48)				- trace ash cementation, gravel
						28.0 — 727.0
				GM		SILTY GRAVEL WITH SAND, (GM) gray, dry, very dense, partial recovery in sampler
30	SPT	50/5"				30.5 — 724.5

- No groundwater was encountered at the time of drilling
- Referenced elevations are approximate and are based on topography provided by JF Engineering

Bottom of borehole at 30.5 feet.

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BORING NUMBER B-9

GN Northern Inc.
11115 E. Montgomery, Suite C
Spokane Valley, WA, 99206
Telephone: (509) 248-9798
Fax: (509) 248-4220

CLIENT DJ Sunrise Development, LLC
PROJECT NAME Proposed 'Sunrise Ridge' Residential Development
PROJECT NUMBER 216-672
PROJECT LOCATION S. Olympia Street
DATE STARTED 2/4/16 **COMPLETED** 2/4/16
GROUND ELEVATION 727 ft **HOLE SIZE** 8 inches
DRILLING CONTRACTOR Haz-Tech Drilling, Inc.
GROUND WATER LEVELS:
DRILLING METHOD BK-81 Drill Rig w/ HSA & Autohammer
AT TIME OF DRILLING ---
LOGGED BY MYM **CHECKED BY** KAH
AT END OF DRILLING ---
NOTES Approx. GPS Coords.: 46°9'37.37"N, 119°8'0.43"W
AFTER DRILLING ---

DEPTH (ft)	SAMPLE TYPE NUMBER	BLOW COUNTS (N VALUE)	TESTS	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION	
0	SPT	2-2-5 (7)		SM		FILL: SILTY SAND, (SM) brown, moist, loose, some angular gravel, rootlets (ENGINEERED FILL placed in 2014)	
	SPT	6-7-9 (16)				- soil becomes medium dense	
	SPT	9-15-25 (40)				- soil becomes dense	
	SPT	19-25-33 (58)				- soil becomes very dense	
10	SPT	11-18-25 (43)				- soil becomes dense	
	SPT	8-10-12 (22)				- soil becomes medium dense	
						18.0	709.0
20	SPT	10-16-15 (31)				HISTORIC UNDOCUMENTED FILL, silty sand with gravels, misc. trash/debris, dense	
	SPT	25-18-12 (30)				- concrete debris	
						28.0	699.0
30	SPT	7-13-9 (22)	MC = 9% Fines = 45%	ML		SANDY SILT WITH GRAVEL, (ML) tan brown, dry to moist, medium dense, (APPARENT FILL)	
	SPT	5-7-9 (16)					
						37.0	690.0
	SPT	7-11-19 (30)	MC = 8% Fines = 77%	ML		SILT WITH SAND, (ML) tan brown, dry, medium dense to dense, (APPARENT NATIVE)	
40	SPT	6-6-4 (10)					
	SPT	9-15-37 (52)				46.0	681.0
	SPT	50/1"		GM		46.5 SILTY GRAVEL, (GM) very dense, no recovery in sampler	680.5

- No groundwater was encountered at the time of drilling
- Referenced elevations are approximate and are based on topography provided by JF Engineering

Bottom of borehole at 46.5 feet.

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TEST PIT NUMBER TP-1

GN Northern Inc.
11115 E. Montgomery, Suite C
Spokane Valley, WA, 99206
Telephone: (509) 248-9798
Fax: (509) 248-4220

CLIENT DJ Sunrise Development, LLC
PROJECT NAME Proposed 'Sunrise Ridge' Residential Development
PROJECT NUMBER 216-672
PROJECT LOCATION S. Olympia Street
DATE STARTED 2/3/16 **COMPLETED** 2/3/16
GROUND ELEVATION 787 ft **TEST PIT SIZE** 24 x 96 inches
EXCAVATION CONTRACTOR E Mac Corporation
GROUND WATER LEVELS:
EXCAVATION METHOD John Deere 220C LC
AT TIME OF EXCAVATION ---
LOGGED BY MN **CHECKED BY** KAH
AT END OF EXCAVATION ---
NOTES Approx. GPS Coords.: 46°9'31.46"N, 119°8'10.17"W
AFTER EXCAVATION ---

DEPTH (ft)	SAMPLE TYPE NUMBER	TESTS	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
0					SILT WITH SAND, (ML) tan brown, dry to moist, loose to medium dense
5					
	GB	MC = 9% Fines = 72%	ML		- soil becomes dry
10					
12.0					775.0
			GM		SILTY GRAVEL, (GM) gray, dry, dense to very dense
13.0					774.0

- Test-pit terminated due to excavator refusal
- No groundwater was encountered at the time of excavation
- Referenced elevations are approximate and are based on topography provided by JF Engineering

Bottom of test pit at 13.0 feet.

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TEST PIT NUMBER TP-2

GN Northern Inc.
11115 E. Montgomery, Suite C
Spokane Valley, WA, 99206
Telephone: (509) 248-9798
Fax: (509) 248-4220

CLIENT DJ Sunrise Development, LLC
PROJECT NAME Proposed 'Sunrise Ridge' Residential Development
PROJECT NUMBER 216-672
PROJECT LOCATION S. Olympia Street
DATE STARTED 2/3/16 **COMPLETED** 2/3/16
GROUND ELEVATION 751 ft **TEST PIT SIZE** 24 x 96 inches
EXCAVATION CONTRACTOR E Mac Corporation
GROUND WATER LEVELS:
EXCAVATION METHOD John Deere 220C LC
AT TIME OF EXCAVATION ---
LOGGED BY MN **CHECKED BY** KAH
AT END OF EXCAVATION ---
NOTES Approx. GPS Coords.: 46°9'31.78"N, 119°8'5.58"W
AFTER EXCAVATION ---

DEPTH (ft)	SAMPLE TYPE NUMBER	TESTS	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
0					FILL: GRAVELLY SILT, gray brown, moist, loose
					- asphalt and concrete debris
2.5					748.5
					SILT WITH SAND, (ML) tan brown, dry to moist, loose to medium dense, (NATIVE)
	GB	MC = 4% Fines = 78%			
5					
10			ML		
15					
18.0					- trace gravel 733.0

- No groundwater was encountered at the time of excavation
- Referenced elevations are approximate and are based on topography provided by JF Engineering

Bottom of test pit at 18.0 feet.

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TEST PIT NUMBER TP-3

GN Northern Inc.
11115 E. Montgomery, Suite C
Spokane Valley, WA, 99206
Telephone: (509) 248-9798
Fax: (509) 248-4220

CLIENT DJ Sunrise Development, LLC
PROJECT NAME Proposed 'Sunrise Ridge' Residential Development
PROJECT NUMBER 216-672
PROJECT LOCATION S. Olympia Street
DATE STARTED 2/3/16 **COMPLETED** 2/3/16
GROUND ELEVATION 743 ft **TEST PIT SIZE** 24 x 96 inches
EXCAVATION CONTRACTOR E Mac Corporation
GROUND WATER LEVELS:
EXCAVATION METHOD John Deere 220C LC
AT TIME OF EXCAVATION ---
LOGGED BY MN **CHECKED BY** KAH
AT END OF EXCAVATION ---
NOTES Approx. GPS Coords.: 46°9'33.52"N, 119°8'3.28"W
AFTER EXCAVATION ---

DEPTH (ft)	SAMPLE TYPE NUMBER	TESTS	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION	
0					SILT WITH SAND, (ML) tan brown, dry to moist, loose to medium dense, some roots to 2.5 feet BGS	
5	GB	MC = 4% Fines = 72%	ML			
10					- soil beomes medium dense, trace gravel	
15					- soil becomes medium dense to dense	
18.0						725.0

- No groundwater was encountered at the time of excavation
- Referenced elevations are approximate and are based on topography provided by JF Engineering

Bottom of test pit at 18.0 feet.

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TEST PIT NUMBER TP-4

GN Northern Inc.
11115 E. Montgomery, Suite C
Spokane Valley, WA, 99206
Telephone: (509) 248-9798
Fax: (509) 248-4220

CLIENT DJ Sunrise Development, LLC
PROJECT NAME Proposed 'Sunrise Ridge' Residential Development
PROJECT NUMBER 216-672
PROJECT LOCATION S. Olympia Street
DATE STARTED 2/3/16 **COMPLETED** 2/3/16
GROUND ELEVATION 743 ft **TEST PIT SIZE** 24 x 96 inches
EXCAVATION CONTRACTOR E Mac Corporation
GROUND WATER LEVELS:
EXCAVATION METHOD John Deere 220C LC
AT TIME OF EXCAVATION ---
LOGGED BY MN **CHECKED BY** KAH
AT END OF EXCAVATION ---
NOTES Approx. GPS Coords.: 46°9'37.34"N, 119°8'4.72"W
AFTER EXCAVATION ---

DEPTH (ft)	SAMPLE TYPE NUMBER	TESTS	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
0					SANDY SILT, (ML) tan brown, dry to moist, loose to medium dense, some roots to 2.5 feet BGS
					- soil becomes dry
	GB	MC = 6% Fines = 66%			- some ash
5					- soil becomes medium dense, some ash cementation
					- soil becomes medium dense to dense, trace coarse sand
			ML		
10					
15					
				16.5	726.5

- No groundwater was encountered at the time of excavation
- Referenced elevations are approximate and are based on topography provided by JF Engineering

Bottom of test pit at 16.5 feet.

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GN Northern Inc.
11115 E. Montgomery, Suite C
Spokane Valley, WA, 99206
Telephone: (509) 248-9798
Fax: (509) 248-4220

TEST PIT NUMBER TP-5

CLIENT DJ Sunrise Development, LLC
PROJECT NAME Proposed 'Sunrise Ridge' Residential Development
PROJECT NUMBER 216-672
PROJECT LOCATION S. Olympia Street
DATE STARTED 2/3/16 **COMPLETED** 2/3/16
GROUND ELEVATION 729 ft **TEST PIT SIZE** 24 x 96 inches
EXCAVATION CONTRACTOR E Mac Corporation
GROUND WATER LEVELS:
EXCAVATION METHOD John Deere 220C LC
AT TIME OF EXCAVATION ---
LOGGED BY MN **CHECKED BY** KAH
AT END OF EXCAVATION ---
NOTES Approx. GPS Coords.: 46°9'38.62"N, 119°8'3.04"W
AFTER EXCAVATION ---

DEPTH (ft)	SAMPLE TYPE NUMBER	TESTS	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
0					SANDY SILT, (ML) tan brown, dry to moist, loose to medium dense, some roots to 2.5 feet BGS
	GB	MC = 13% Fines = 66%			- soil becomes dry
5					
			ML		- soil becomes medium dense to dense, trace coarse sand
10					
15	GB	MC = 13% Fines = 76%			- becomes SILT with SAND (ML)
				16.5	712.5

- No groundwater was encountered at the time of excavation
- Referenced elevations are approximate and are based on topography provided by JF Engineering

Bottom of test pit at 16.5 feet.

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GN Northern Inc.
11115 E. Montgomery, Suite C
Spokane Valley, WA, 99206
Telephone: (509) 248-9798
Fax: (509) 248-4220

TEST PIT NUMBER TP-6

CLIENT DJ Sunrise Development, LLC
PROJECT NAME Proposed 'Sunrise Ridge' Residential Development
PROJECT NUMBER 216-672
PROJECT LOCATION S. Olympia Street
DATE STARTED 2/3/16 **COMPLETED** 2/3/16
GROUND ELEVATION 736 ft **TEST PIT SIZE** 24 x 96 inches
EXCAVATION CONTRACTOR E Mac Corporation
GROUND WATER LEVELS:
EXCAVATION METHOD John Deere 220C LC
AT TIME OF EXCAVATION ---
LOGGED BY MN **CHECKED BY** KAH
AT END OF EXCAVATION ---
NOTES Approx. GPS Coords.: 46°9'34.30"N, 119°8'1.20"W
AFTER EXCAVATION ---

DEPTH (ft)	SAMPLE TYPE NUMBER	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION	
0				SILT WITH SAND, (ML) tan brown, dry to moist, loose	
				- soil becomes loose to medium dense, dry	
5					
		ML			
10					
				13.5	722.5
		GM		SILTY GRAVEL, (GM) gray, dry, dense to very dense	
				14.5	721.5

- Test-pit terminated due to excavator refusal
- No groundwater was encountered at the time of excavation
- Referenced elevations are approximate and are based on topography provided by JF Engineering

Bottom of test pit at 14.5 feet.

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TEST PIT NUMBER TP-7

GN Northern Inc.
11115 E. Montgomery, Suite C
Spokane Valley, WA, 99206
Telephone: (509) 248-9798
Fax: (509) 248-4220

CLIENT DJ Sunrise Development, LLC
PROJECT NAME Proposed 'Sunrise Ridge' Residential Development
PROJECT NUMBER 216-672
PROJECT LOCATION S. Olympia Street
DATE STARTED 2/3/16 **COMPLETED** 2/3/16
GROUND ELEVATION 730 ft **TEST PIT SIZE** 24 x 96 inches
EXCAVATION CONTRACTOR E Mac Corporation
GROUND WATER LEVELS:
EXCAVATION METHOD John Deere 220C LC
AT TIME OF EXCAVATION ---
LOGGED BY MN **CHECKED BY** KAH
AT END OF EXCAVATION ---
NOTES Approx. GPS Coords.: 46°9'34.69"N, 119°7'59.00"W
AFTER EXCAVATION ---

DEPTH (ft)	SAMPLE TYPE NUMBER	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION	
0				SILT WITH SAND, (ML) tan brown, dry to moist, loose, some roots to 3 feet BGS	
5				- soil becomes loose to medium dense, dry	
10		ML			
15			15.0		715.0
		GM		SILTY GRAVEL, (GM) gray, dry, dense to very dense	
			17.0		713.0

- Test-pit terminated due to excavator refusal
- No groundwater was encountered at the time of excavation
- Referenced elevations are approximate and are based on topography provided by JF Engineering

Bottom of test pit at 17.0 feet.

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TEST PIT NUMBER TP-8

GN Northern Inc.
11115 E. Montgomery, Suite C
Spokane Valley, WA, 99206
Telephone: (509) 248-9798
Fax: (509) 248-4220

CLIENT DJ Sunrise Development, LLC
PROJECT NAME Proposed 'Sunrise Ridge' Residential Development
PROJECT NUMBER 216-672
PROJECT LOCATION S. Olympia Street
DATE STARTED 2/3/16 **COMPLETED** 2/3/16
GROUND ELEVATION 706 ft **TEST PIT SIZE** 24 x 96 inches
EXCAVATION CONTRACTOR E Mac Corporation
GROUND WATER LEVELS:
EXCAVATION METHOD John Deere 220C LC
AT TIME OF EXCAVATION ---
LOGGED BY MN **CHECKED BY** KAH
AT END OF EXCAVATION ---
NOTES Approx. GPS Coords.: 46°9'37.60"N, 119°7'59.38"W
AFTER EXCAVATION ---

DEPTH (ft)	SAMPLE TYPE NUMBER	GRAPHIC LOG	MATERIAL DESCRIPTION	
0			FILL: GRAVELLY SILT, gray brown, moist, loose, wood debris, construction rubble, misc. trash	
5				
10				
15			- concrete debris	
			17.0	689.0

- No groundwater was encountered at the time of excavation
- Referenced elevations are approximate and are based on topography provided by JF Engineering

Bottom of test pit at 17.0 feet.

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TEST PIT NUMBER TP-9

GN Northern Inc.
11115 E. Montgomery, Suite C
Spokane Valley, WA, 99206
Telephone: (509) 248-9798
Fax: (509) 248-4220

CLIENT DJ Sunrise Development, LLC
PROJECT NAME Proposed 'Sunrise Ridge' Residential Development
PROJECT NUMBER 216-672
PROJECT LOCATION S. Olympia Street
DATE STARTED 2/3/16 **COMPLETED** 2/3/16
GROUND ELEVATION 699 ft **TEST PIT SIZE** 24 x 96 inches
EXCAVATION CONTRACTOR E Mac Corporation
GROUND WATER LEVELS:
EXCAVATION METHOD John Deere 220C LC
AT TIME OF EXCAVATION ---
LOGGED BY MN **CHECKED BY** KAH
AT END OF EXCAVATION ---
NOTES Approx. GPS Coords.: 46°9'40.57"N, 119°7'59.53"W
AFTER EXCAVATION ---

DEPTH (ft)	SAMPLE TYPE NUMBER	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION	
0				FILL: SANDY SILT, brown, moist, loose	
				1.0	698.0
		ML		SILT WITH SAND, (ML) tan brown, dry to moist, loose	
5				5.0	694.0
		ML		SANDY SILT, (ML) dry, medium dense	
10					
15					
				17.5	681.5

- No groundwater was encountered at the time of excavation
- Referenced elevations are approximate and are based on topography provided by JF Engineering

Bottom of test pit at 17.5 feet.

GENERAL BH / TP / WELL - GINT STD US LAB.GDT - 2/24/16 10:16 - C:\USERS\GN NORTHERN\DROPBOX\5-ACTIVE PROJECTS\216-672 SUNRISE RIDGE\216-672 LOGS.GPJ

TEST PIT NUMBER TP-10

GN Northern Inc.
11115 E. Montgomery, Suite C
Spokane Valley, WA, 99206
Telephone: (509) 248-9798
Fax: (509) 248-4220

CLIENT DJ Sunrise Development, LLC
PROJECT NAME Proposed 'Sunrise Ridge' Residential Development
PROJECT NUMBER 216-672
PROJECT LOCATION S. Olympia Street
DATE STARTED 2/3/16 **COMPLETED** 2/3/16
GROUND ELEVATION 715 ft **TEST PIT SIZE** 24 x 96 inches
EXCAVATION CONTRACTOR E Mac Corporation
GROUND WATER LEVELS:
EXCAVATION METHOD John Deere 220C LC
AT TIME OF EXCAVATION ---
LOGGED BY MN **CHECKED BY** KAH
AT END OF EXCAVATION ---
NOTES Approx. GPS Coords.: 46°9'40.60"N, 119°8'2.10"W
AFTER EXCAVATION ---

DEPTH (ft)	SAMPLE TYPE NUMBER	TESTS	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION	
0					SILT WITH SAND, (ML) tan brown, dry to moist, loose	
			ML		- soil becomes loose to medium dense	
5					5.0	710.0
					SANDY SILT, (ML) dry, medium dense, with laminated coarse sand	
			ML			
10					11.5	703.5
					SILT WITH SAND, (ML) tan brown, dry, medium dense to dense	
	GB	MC = 4% Fines = 77%				
			ML			
15					17.5	697.5

- No groundwater was encountered at the time of excavation
- Referenced elevations are approximate and are based on topography provided by JF Engineering

Bottom of test pit at 17.5 feet.

GENERAL BH / TP / WELL - GINT STD US LAB.GDT - 2/24/16 10:16 - C:\USERS\GN NORTHERN\DROPBOX\5-ACTIVE PROJECTS\216-672 SUNRISE RIDGE\216-672 LOGS.GPJ

TEST PIT NUMBER TP-11

GN Northern Inc.
11115 E. Montgomery, Suite C
Spokane Valley, WA, 99206
Telephone: (509) 248-9798
Fax: (509) 248-4220

CLIENT DJ Sunrise Development, LLC
PROJECT NAME Proposed 'Sunrise Ridge' Residential Development
PROJECT NUMBER 216-672
PROJECT LOCATION S. Olympia Street
DATE STARTED 2/3/16 **COMPLETED** 2/3/16
GROUND ELEVATION 691 ft **TEST PIT SIZE** 24 x 96 inches
EXCAVATION CONTRACTOR E Mac Corporation
GROUND WATER LEVELS:
EXCAVATION METHOD John Deere 220C LC
AT TIME OF EXCAVATION ---
LOGGED BY MN **CHECKED BY** KAH
AT END OF EXCAVATION ---
NOTES Approx. GPS Coords.: 46°9'42.65"N, 119°8'1.53"W
AFTER EXCAVATION ---

DEPTH (ft)	SAMPLE TYPE NUMBER	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION	
0				SILT WITH SAND, (ML) tan brown, dry to moist, loose, some roots to 1.5 feet BGS	
		ML		- trace ash	
5			5.0	- 6-inch lense of ash	686.0
				SANDY SILT, (ML) dry, medium dense	
10				- lenses of coarse sand	
		ML			
15			17.0		674.0

- No groundwater was encountered at the time of excavation
- Referenced elevations are approximate and are based on topography provided by JF Engineering

Bottom of test pit at 17.0 feet.

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TEST PIT NUMBER TP-12

GN Northern Inc.
11115 E. Montgomery, Suite C
Spokane Valley, WA, 99206
Telephone: (509) 248-9798
Fax: (509) 248-4220

CLIENT DJ Sunrise Development, LLC
PROJECT NAME Proposed 'Sunrise Ridge' Residential Development
PROJECT NUMBER 216-672
PROJECT LOCATION S. Olympia Street
DATE STARTED 2/3/16 **COMPLETED** 2/3/16
GROUND ELEVATION 717 ft **TEST PIT SIZE** 24 x 96 inches
EXCAVATION CONTRACTOR E Mac Corporation
GROUND WATER LEVELS:
EXCAVATION METHOD John Deere 220C LC
AT TIME OF EXCAVATION ---
LOGGED BY MN **CHECKED BY** KAH
AT END OF EXCAVATION ---
NOTES Approx. GPS Coords.: 46°9'41.81"N, 119°8'3.78"W
AFTER EXCAVATION ---

DEPTH (ft)	SAMPLE TYPE NUMBER	TESTS	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
0					SILT WITH SAND, (ML) tan brown, dry to moist, loose
			ML		- lenses of ash
5	GB	MC = 6% Fines = 71%			
6.0					711.0
					SANDY SILT, (ML) dry, medium dense, with laminated coarse sand
	GB	MC = 4% Fines = 69%			
10			ML		- soil becomes medium dense to dense
15					
17.0					700.0

- No groundwater was encountered at the time of excavation
- Referenced elevations are approximate and are based on topography provided by JF Engineering

Bottom of test pit at 17.0 feet.

GENERAL BH / TP / WELL - GINT STD US LAB.GDT - 2/24/16 10:16 - C:\USERS\GN NORTHERN\DROPBOX\5-ACTIVE PROJECTS\216-672 SUNRISE RIDGE\216-672 LOGS.GPJ

TEST PIT NUMBER TP-13

GN Northern Inc.
11115 E. Montgomery, Suite C
Spokane Valley, WA, 99206
Telephone: (509) 248-9798
Fax: (509) 248-4220

CLIENT DJ Sunrise Development, LLC
PROJECT NAME Proposed 'Sunrise Ridge' Residential Development
PROJECT NUMBER 216-672
PROJECT LOCATION S. Olympia Street
DATE STARTED 2/3/16 **COMPLETED** 2/3/16
GROUND ELEVATION 687 ft **TEST PIT SIZE** 24 x 96 inches
EXCAVATION CONTRACTOR E Mac Corporation
GROUND WATER LEVELS:
EXCAVATION METHOD John Deere 220C LC
AT TIME OF EXCAVATION ---
LOGGED BY MN **CHECKED BY** KAH
AT END OF EXCAVATION ---
NOTES Approx. GPS Coords.: 46°9'45.12"N, 119°8'3.51"W
AFTER EXCAVATION ---

DEPTH (ft)	SAMPLE TYPE NUMBER	TESTS	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION	
0					SILT WITH SAND, (ML) tan brown, dry to moist, loose	
	GB	MC = 12% Fines = 66%	ML			
					2.5	684.5
					SANDY SILT, (ML) tan brown, dry to moist, medium dense, with laminated coarse sand	
5						
					- 6-inch lense of gravels	
			ML			
10						
					14.0	673.0
			GM		SILTY GRAVEL, (GM) gray, dry, dense to very dense	
15					15.0	672.0

- Test-pit terminated due to excavator refusal
- No groundwater was encountered at the time of excavation
- Referenced elevations are approximate and are based on topography provided by JF Engineering

Bottom of test pit at 15.0 feet.

GENERAL BH / TP / WELL - GINT STD US LAB.GDT - 2/24/16 10:16 - C:\USERS\GN NORTHERN\DROPBOX\5-ACTIVE PROJECTS\216-672 SUNRISE RIDGE\216-672 LOGS.GPJ

TEST PIT NUMBER TP-14

GN Northern Inc.
11115 E. Montgomery, Suite C
Spokane Valley, WA, 99206
Telephone: (509) 248-9798
Fax: (509) 248-4220

CLIENT DJ Sunrise Development, LLC
PROJECT NAME Proposed 'Sunrise Ridge' Residential Development
PROJECT NUMBER 216-672
PROJECT LOCATION S. Olympia Street
DATE STARTED 2/3/16 **COMPLETED** 2/3/16
GROUND ELEVATION 698 ft **TEST PIT SIZE** 24 x 96 inches
EXCAVATION CONTRACTOR E Mac Corporation
GROUND WATER LEVELS:
EXCAVATION METHOD John Deere 220C LC
AT TIME OF EXCAVATION ---
LOGGED BY MN **CHECKED BY** KAH
AT END OF EXCAVATION ---
NOTES Approx. GPS Coords.: 46° 9'47.45"N, 119°8'7.54"W
AFTER EXCAVATION ---

DEPTH (ft)	SAMPLE TYPE NUMBER	TESTS	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION	
0					SILT WITH SAND, (ML) tan brown, dry to moist, loose	
	GB	MC = 5% Fines = 82%				
5			ML		- 6-inch lense of gravels - with laminated coarse sand	
	GB	MC = 14% Fines = 80%				
				9.5		688.5
10			GM	10.0	SILTY GRAVEL, (GM) gray, dry, dense to very dense	688.0

- Test-pit terminated due to excavator refusal
- No groundwater was encountered at the time of excavation
- Referenced elevations are approximate and are based on topography provided by JF Engineering

Bottom of test pit at 10.0 feet.

GENERAL BH / TP / WELL - GINT STD US LAB.GDT - 2/24/16 10:16 - C:\USERS\GN NORTHERN\DROPBOX\5-ACTIVE PROJECTS\216-672 SUNRISE RIDGE\216-672 LOGS.GPJ

Northern, Inc.
Kennewick, Yakima, Spokane, Hermiston (OR)

KEY CHART

RELATIVE DENSITY OR CONSISTENCY VERSUS SPT N-VALUE

COARSE-GRAINED SOILS			FINE-GRAINED SOILS		
DENSITY	N (BLOWS/FT)	FIELD TEST	CONSISTENCY	N (BLOWS/FT)	FIELD TEST
Very Loose	0 – 4	Easily penetrated with ½-inch reinforcing rod pushed by hand	Very Soft	0 – 2	Easily penetrated several inches by thumb
Loose	4 – 10	Difficult to penetrate with ½-inch reinforcing rod pushed by hand	Soft	2 – 4	Easily penetrated one inch by thumb
Medium -Dense	10 – 30	Easily penetrated with ½-inch rod driven with a 5-lb hammer	Medium-Stiff	4 – 8	Penetrated over ½-inch by thumb with moderate effort
Dense	30 – 50	Difficult to penetrate with ½-inch rod driven with a 5-lb hammer	Stiff	8 – 15	Indented about ½-inch by thumb but penetrated with great effort
Very Dense	> 50	penetrated only a few inches with ½-inch rod driven with a 5-lb hammer	Very Stiff	15 – 30	Readily indented by thumb
			Hard	> 30	Indented with difficulty by thumbnail

USCS SOIL CLASSIFICATION

MAJOR DIVISIONS			GROUP DESCRIPTION	
Coarse-Grained Soils <50% passes #200 sieve	**Gravel** and **Gravelly Soils** <50% coarse fraction passes #4 sieve	**Gravel** (with little or no fines)	GW	Well-graded **Gravel**
			GP	Poorly Graded **Gravel**
		Gravel (with >12% fines)	GM	Silty **Gravel**
			GC	Clayey **Gravel**
	Sand and **Sandy Soils** >50% coarse fraction passes #4 sieve	**Sand** (with little or no fines)	SW	Well-graded **Sand**
			SP	Poorly graded **Sand**
		Sand (with >12% fines)	SM	Silty **Sand**
			SC	Clayey **Sand**
Fine-Grained Soils >50% passes #200 sieve	**Silt** and **Clay** Liquid Limit < 50		ML	**Silt**
			CL	Lean **Clay**
			OL	Organic **Silt** and **Clay** (low plasticity)
	Silt and **Clay** Liquid Limit > 50		MH	Inorganic **Silt**
			CH	Inorganic **Clay**
			OH	Organic **Clay** and **Silt** (med. to high plasticity)
Highly Organic Soils			PT	**Peat**
				Top Soil

LOG SYMBOLS

	2S	2" OD Split Spoon (SPT)
	3S	3" OD Split Spoon
	NS	Non-Standard Split Spoon
	ST	Shelby Tube
	CR	Core Run
	BG	Bag Sample
	TV	Torvane Reading
	PP	Penetrometer Reading
	NR	No Recovery
	GW	Groundwater Table

MODIFIERS

DESCRIPTION	RANGE
Trace	<5%
Little	5% – 12%
Some	>12%

MOISTURE CONTENT

DESCRIPTION	FIELD OBSERVATION
Dry	Absence of moisture, dusty, dry to the touch
Moist	Damp but not visible water
Wet	Visible free water

SOIL CLASSIFICATION INCLUDES

1. Group Name
2. Group Symbol
3. Color
4. Moisture content
5. Density / consistency
6. Cementation
7. Particle size (if applicable)
8. Odor (if present)
9. Comments

MAJOR DIVISIONS WITH GRAIN SIZE

SIEVE SIZE						
12"	3"	3/4"	4	10	40	200
GRAIN SIZE (INCHES)						
12	3	0.75	0.19	0.079	0.0171	0.0029

Boulders	Cobbles	Gravel		Sand			Silt and Clay
		Coarse	Fine	Coarse	Medium	Fine	

Conditions shown on boring and testpit logs represent our observations at the time and location of the fieldwork, modifications based on lab test, analysis, and geological and engineering judgment. These conditions may not exist at other times and locations, even in close proximity thereof. This information was gathered as part of our investigation, and we are not responsible for any use or interpretation of the information by others.

APPENDIX III

Laboratory Testing Results

GRAIN SIZE DISTRIBUTION

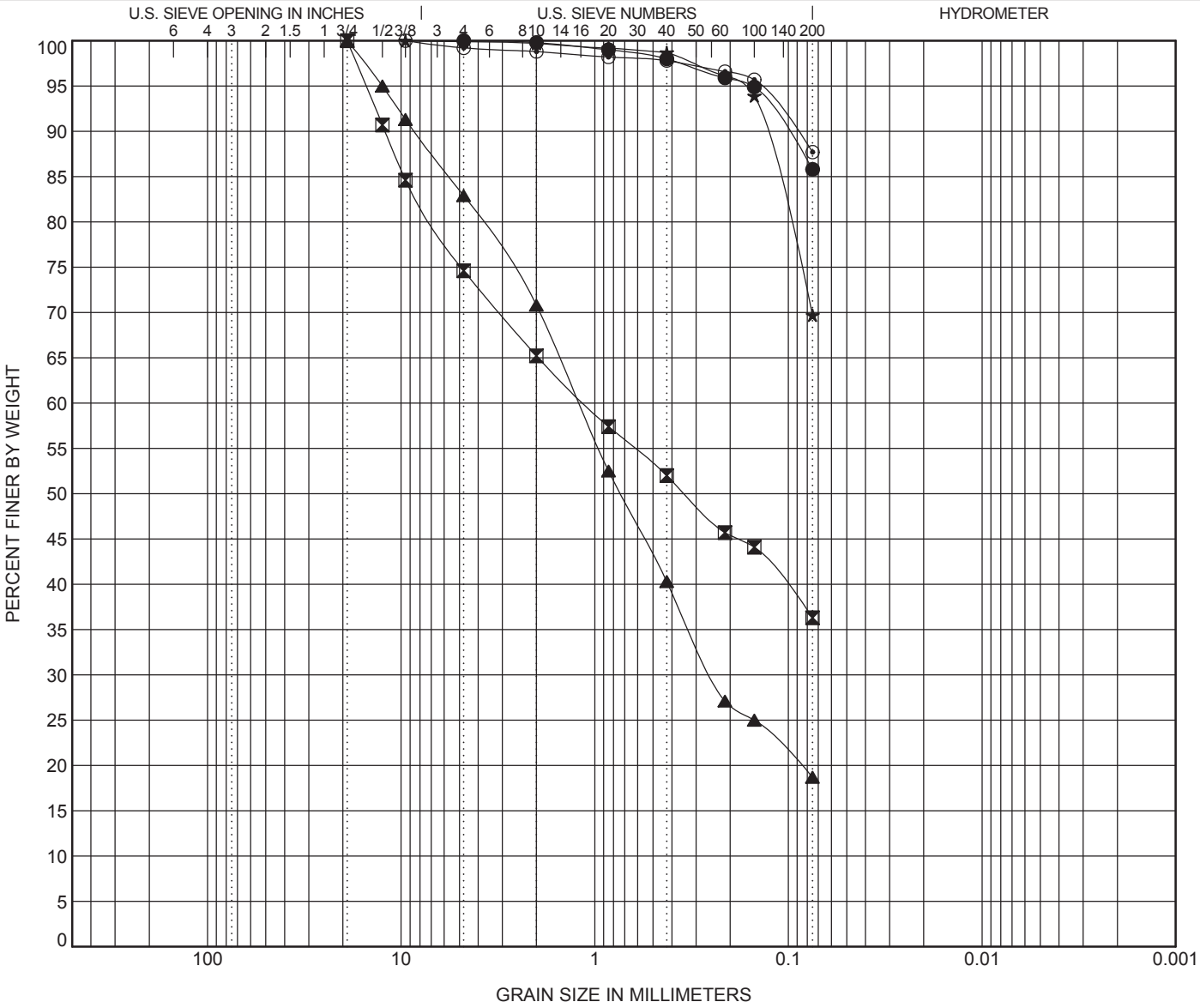
GN Northern Inc.
11115 E. Montgomery, Suite C
Spokane Valley, WA, 99206
Telephone: (509) 248-9798
Fax: (509) 248-4220

CLIENT DJ Sunrise Development, LLC

PROJECT NAME Proposed 'Sunrise Ridge' Residential Development

PROJECT NUMBER 216-672

PROJECT LOCATION S. Olympia Street



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	BOREHOLE	DEPTH	Classification	LL	PL	PI	Cc	Cu
●	B-1	2.5	SILT					
⊠	B-2	0.0	SILTY SAND with GRAVEL(SM)					
▲	B-2	20.0	SILTY SAND with GRAVEL(SM)					
★	B-3	2.5	SANDY SILT(ML)					
⊙	B-3	5.0	SILT(ML)					

	BOREHOLE	DEPTH	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	B-1	2.5	4.75				0.0	14.2	85.8	
⊠	B-2	0.0	19	1.131			25.4	38.3	36.3	
▲	B-2	20.0	19	1.207	0.247		17.1	64.2	18.7	
★	B-3	2.5	9.5				0.1	30.2	69.7	
⊙	B-3	5.0	9.5				0.8	11.5	87.7	

GRAIN SIZE - GINT STD US LAB.GDT - 2/17/16 18:11 - C:\USERS\GN NORTHERN\DROPBOX\5-ACTIVE PROJECTS\216-672 SUNRISE RIDGE\216-672 LOGS.GPJ

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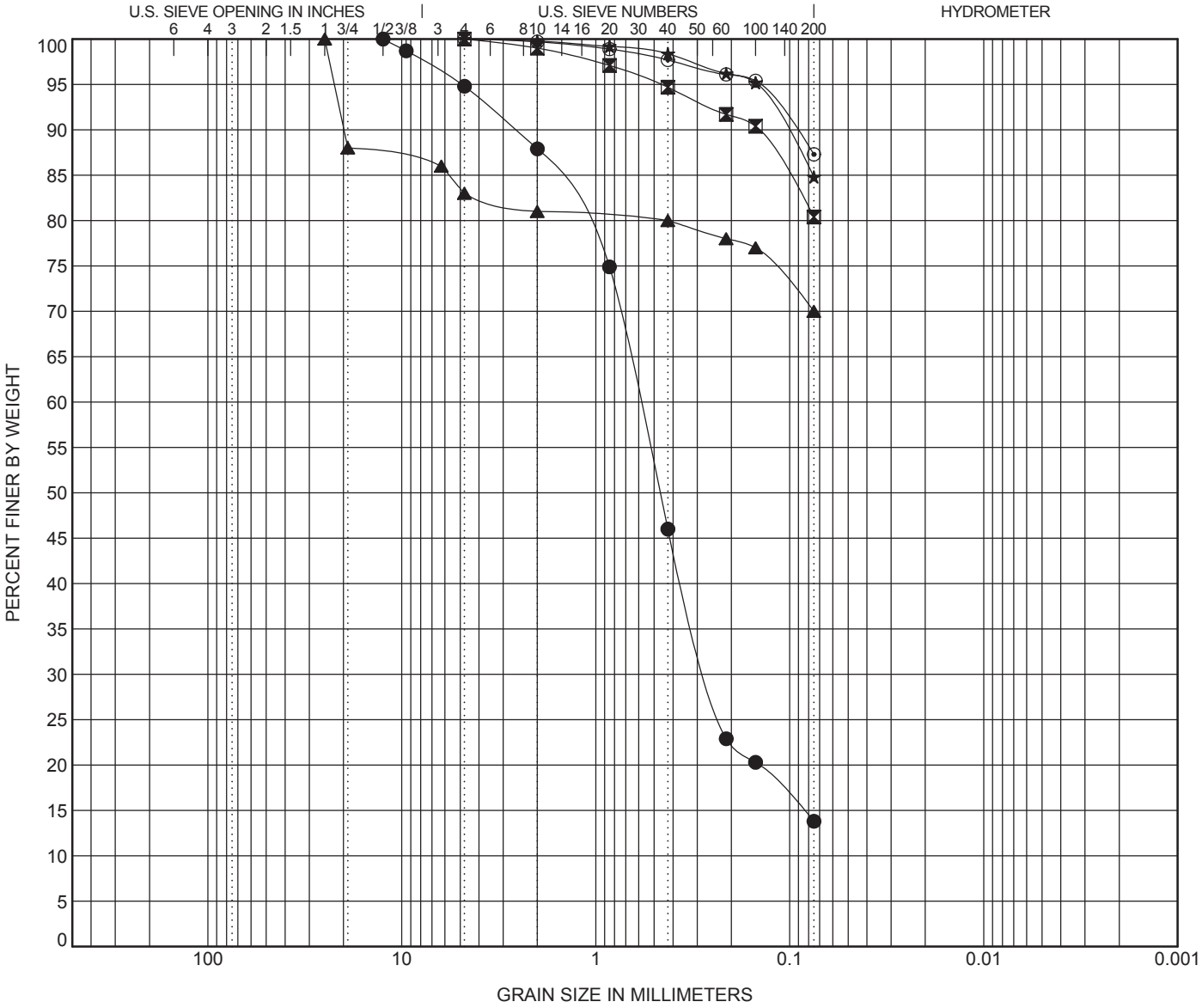

COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	BOREHOLE	DEPTH	Classification	LL	PL	PI	Cc	Cu
●	B-3	20.0	SILTY SAND(SM)					
⊠	B-4	10.0	SILT with SAND(ML)					
▲	B-5	35.0	GRAVELLY SILT(ML)					
★	B-6	2.5	SILT with SAND(ML)					
⊙	B-6	7.5	SILT(ML)					

	BOREHOLE	DEPTH	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	B-3	20.0	12.5	0.595	0.263		5.2	81.0	13.8	
⊠	B-4	10.0	4.75				0.0	19.6	80.4	
▲	B-5	35.0	25				17.0	13.0	70.0	
★	B-6	2.5	4.75				0.0	15.2	84.8	
⊙	B-6	7.5	4.75				0.0	12.7	87.3	

GRAIN SIZE - GINT STD US LAB.GDT - 2/17/16 18:11 - C:\USERS\GN NORTHERN\DROPBOX\5-ACTIVE PROJECTS\216-672 SUNRISE RIDGE\216-672 LOGS.GPJ

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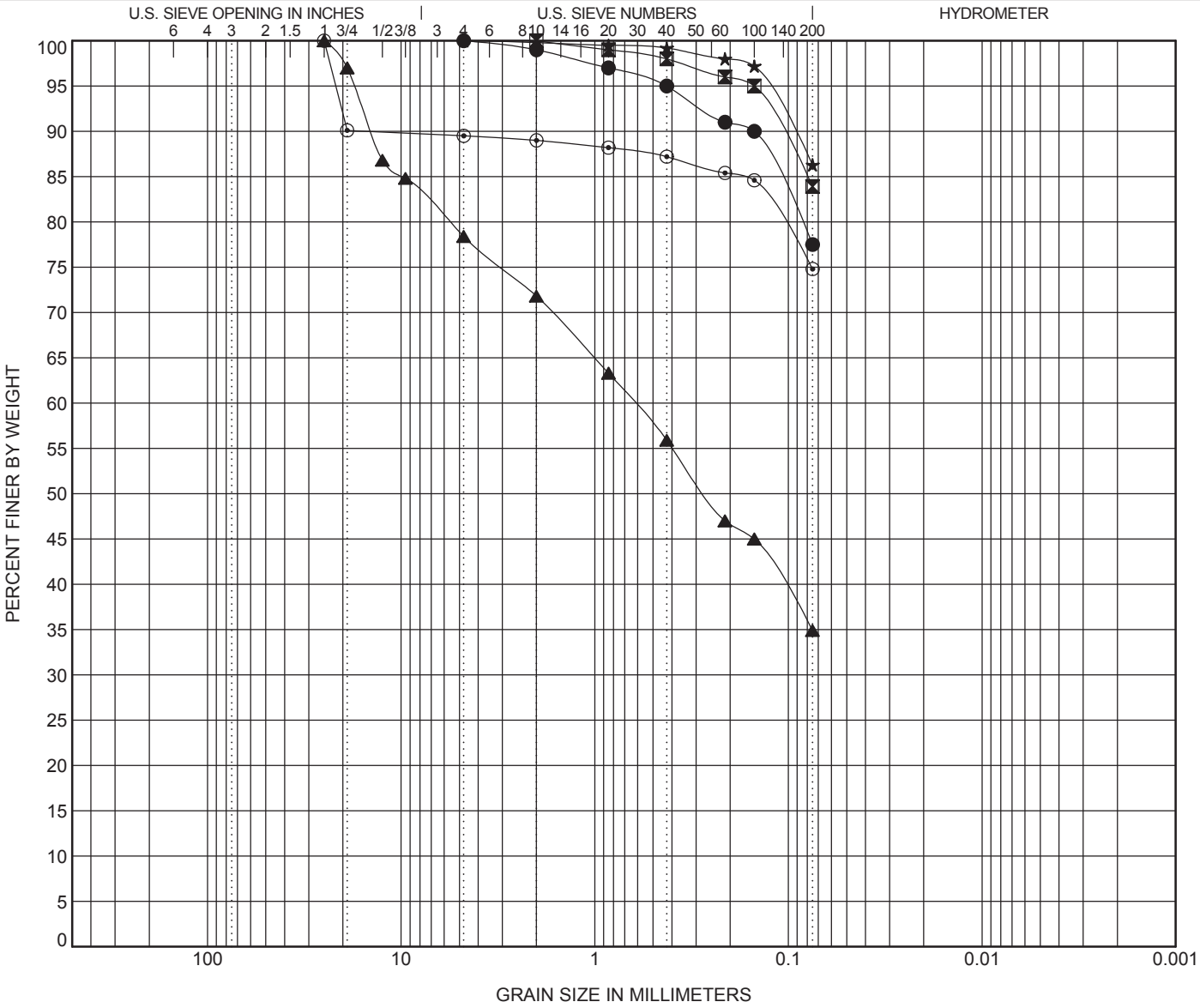


COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	BOREHOLE	DEPTH	Classification	LL	PL	PI	Cc	Cu
●	B-7	2.5	SILT with SAND(ML)					
⊠	B-7	5.0	SILT with SAND(ML)					
▲	B-7	20.0	SILTY SAND with GRAVEL(SM)					
★	B-8	2.5	SILT(ML)					
⊙	B-8	5.0	SILT with SAND(ML)					

	BOREHOLE	DEPTH	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	B-7	2.5	4.75				0.0	22.5	77.5	
⊠	B-7	5.0	2				0.0	16.1	83.9	
▲	B-7	20.0	25	0.624			21.6	43.5	34.9	
★	B-8	2.5	4.75				0.0	13.7	86.3	
⊙	B-8	5.0	25				10.5	14.7	74.8	

GRAIN SIZE - GINT STD US LAB.GDT - 2/17/16 18:11 - C:\USERS\GN NORTHERN\DROPBOX\5-ACTIVE PROJECTS\216-672 SUNRISE RIDGE\216-672 LOGS.GPJ

EXHIBIT 12

GRAIN SIZE DISTRIBUTION

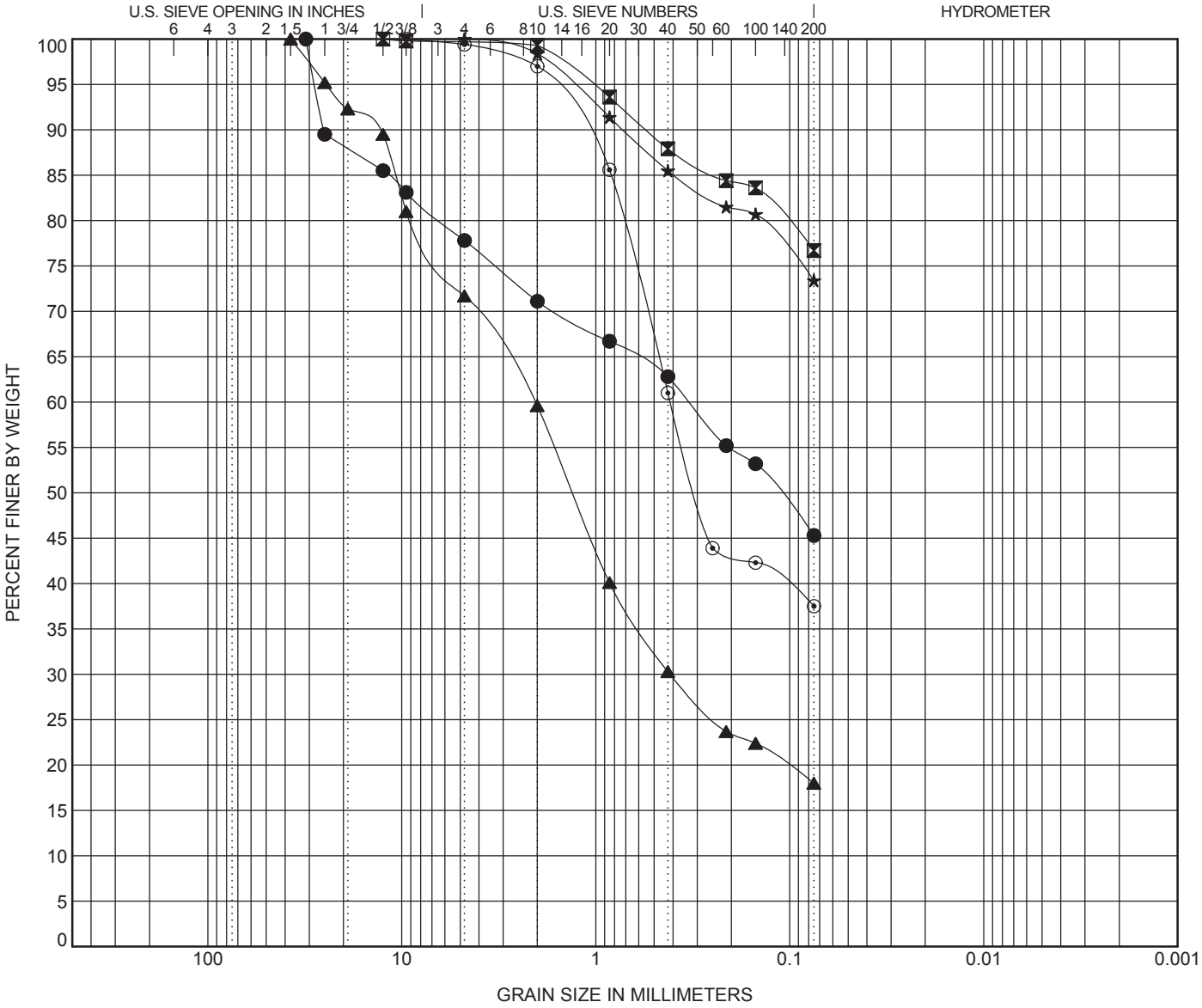
GN Northern Inc.
11115 E. Montgomery, Suite C
Spokane Valley, WA, 99206
Telephone: (509) 248-9798
Fax: (509) 248-4220

CLIENT DJ Sunrise Development, LLC

PROJECT NAME Proposed 'Sunrise Ridge' Residential Development

PROJECT NUMBER 216-672

PROJECT LOCATION S. Olympia Street



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	BOREHOLE	DEPTH	Classification	LL	PL	PI	Cc	Cu
●	B-9	30.0	SANDY SILT with GRAVEL(ML)					
⊠	B-9	37.5	SILT with SAND(ML)					
▲	P-1	12.0	SILTY SAND with GRAVEL(SM)					
★	P-2	10.0	SILT with SAND(ML)					
⊙	P-3	13.5	SILTY SAND(SM)					

	BOREHOLE	DEPTH	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	B-9	30.0	31.25	0.329			22.2	32.5	45.3	
⊠	B-9	37.5	12.5				0.4	22.9	76.7	
▲	P-1	12.0	37.5	2.058	0.412		28.3	53.7	18.0	
★	P-2	10.0	4.75				0.0	26.6	73.4	
⊙	P-3	13.5	9.5	0.412			0.6	61.9	37.5	

GRAIN SIZE - GINT STD US LAB.GDT - 2/17/16 18:11 - C:\USERS\GN NORTHERN\DROPBOX\5-ACTIVE PROJECTS\216-672 SUNRISE RIDGE\216-672 LOGS.GPJ

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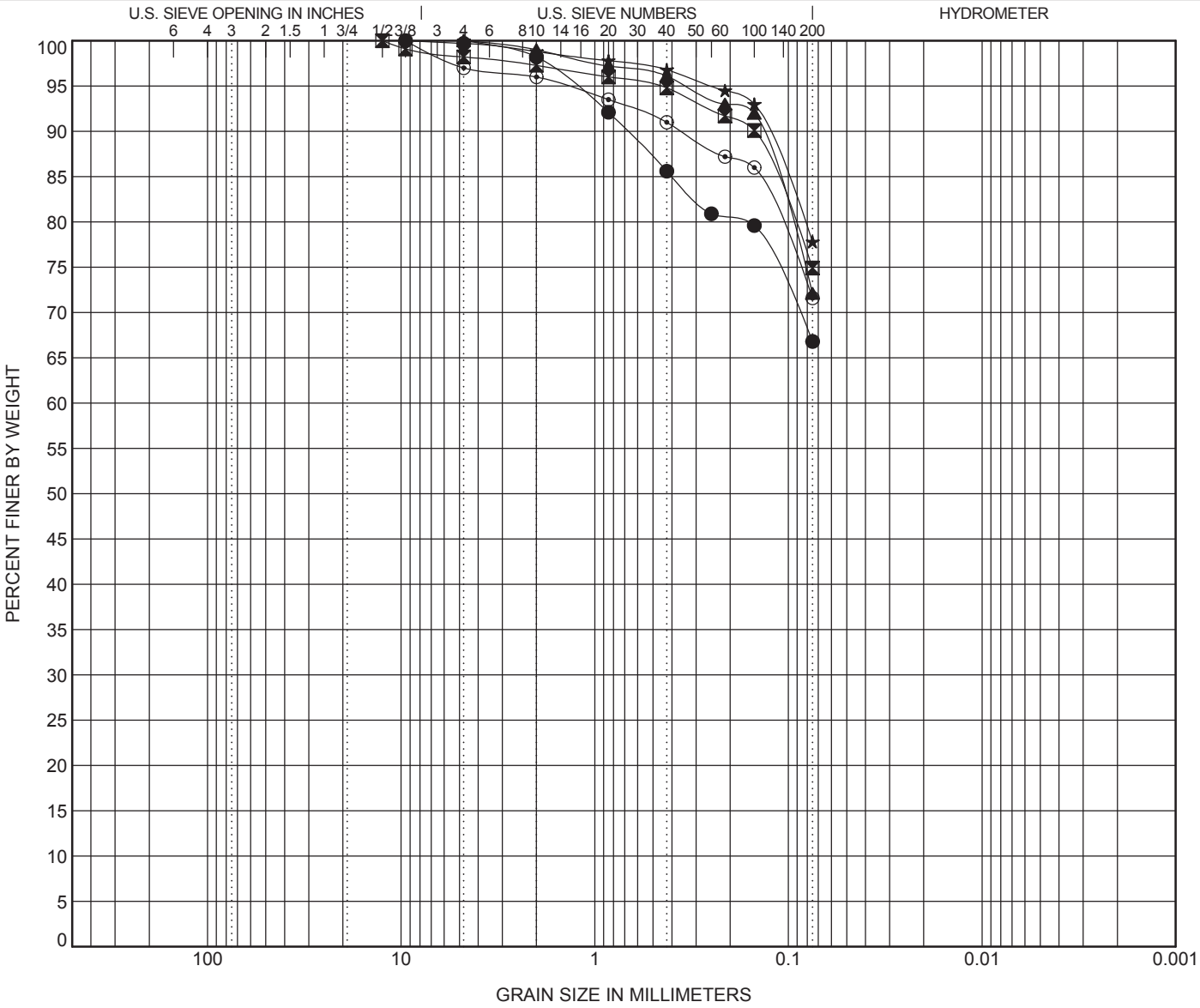

COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	BOREHOLE	DEPTH	Classification	LL	PL	PI	Cc	Cu
●	**P-4**	**17.0**	**SANDY SILT(ML)**					
⊠	**P-5**	**13.5**	**SILT with SAND(ML)**					
▲	**TP-1**	**6.0**	**SILT with SAND(ML)**					
★	**TP-2**	**4.0**	**SILT with SAND(ML)**					
⊙	**TP-3**	**5.0**	**SILT with SAND(ML)**					

	BOREHOLE	DEPTH	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	**P-4**	**17.0**	**9.5**				**0.3**	**32.9**	**66.8**	
⊠	**P-5**	**13.5**	**12.5**				**1.8**	**23.3**	**74.9**	
▲	**TP-1**	**6.0**	**4.75**				**0.0**	**27.9**	**72.1**	
★	**TP-2**	**4.0**	**4.75**				**0.0**	**22.2**	**77.8**	
⊙	**TP-3**	**5.0**	**9.5**				**3.0**	**25.4**	**71.6**	

GRAIN SIZE - GINT STD US LAB.GDT - 2/17/16 18:11 - C:\USERS\GN NORTHERN\DROPBOX\5-ACTIVE PROJECTS\216-672 SUNRISE RIDGE\216-672 LOGS.GPJ

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PROJECT NAME Proposed 'Sunrise Ridge' Residential Development

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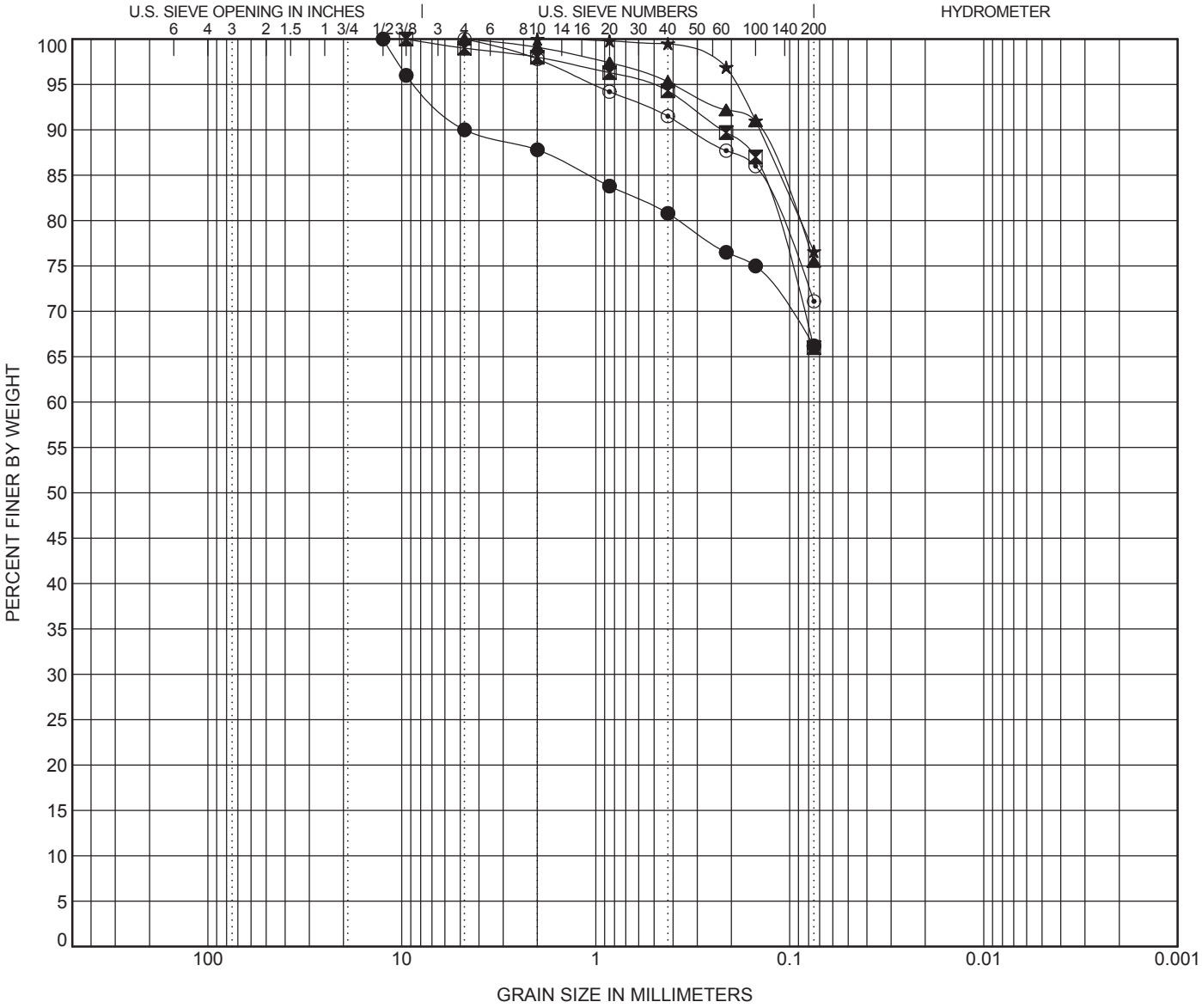
PROJECT LOCATION S. Olympia Street



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	BOREHOLE	DEPTH	Classification	LL	PL	PI	Cc	Cu
●	TP-4	4.0	SANDY SILT(ML)					
⊠	TP-5	2.0	SANDY SILT(ML)					
▲	TP-5	15.0	SILT with SAND(ML)					
★	TP-10	13.0	SILT with SAND(ML)					
⊙	TP-12	5.0	SILT with SAND(ML)					

	BOREHOLE	DEPTH	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	TP-4	4.0	12.5				10.0	23.8	66.2	
⊠	TP-5	2.0	9.5				1.0	33.0	66.0	
▲	TP-5	15.0	4.75				0.0	24.5	75.5	
★	TP-10	13.0	2				0.0	23.4	76.6	
⊙	TP-12	5.0	4.75				0.0	28.9	71.1	

GRAIN SIZE - GINT STD US LAB.GDT - 2/17/16 18:11 - C:\USERS\GN NORTHERN\DROPBOX\5-ACTIVE PROJECTS\216-672 SUNRISE RIDGE\216-672 LOGS.GPJ

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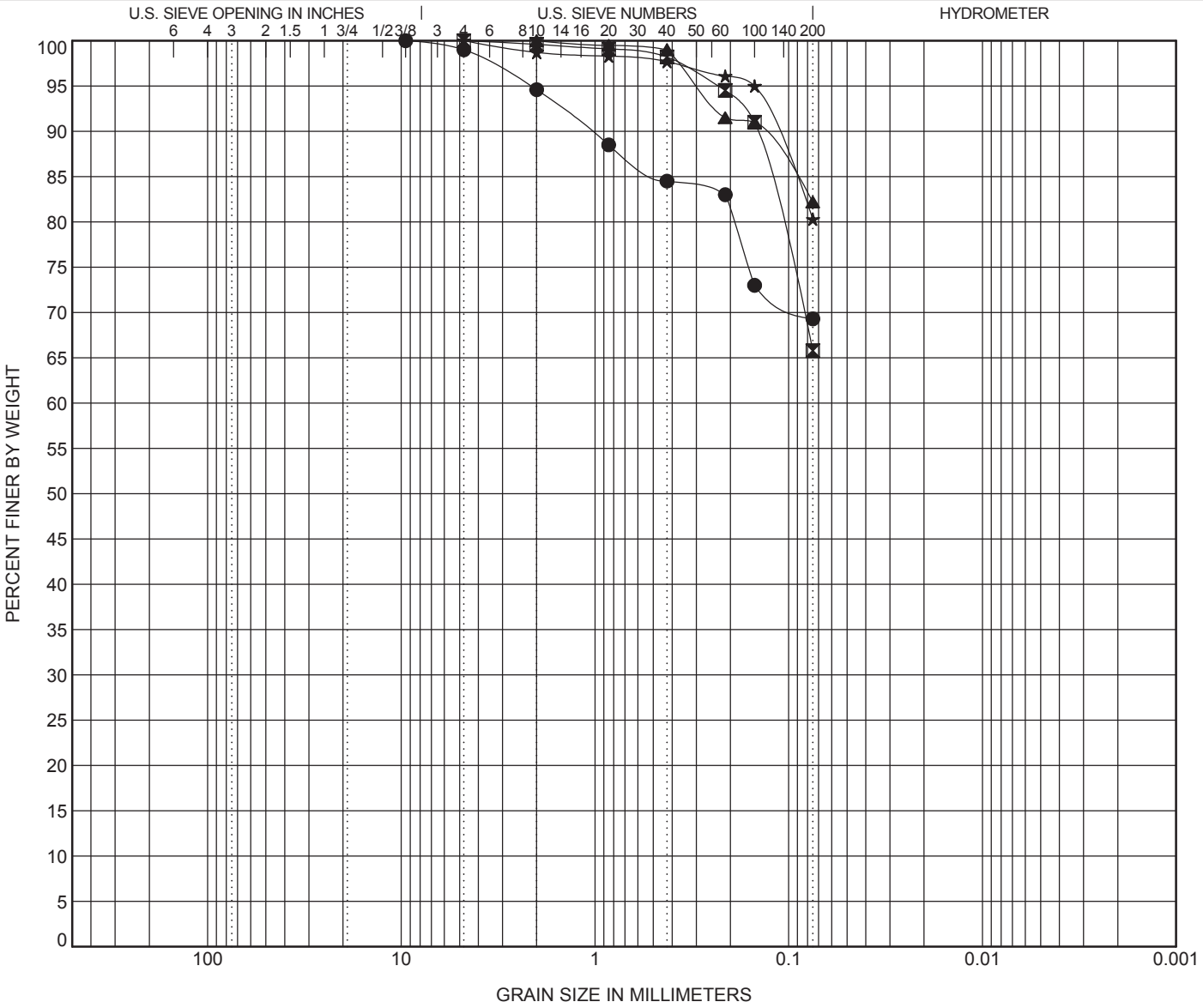
PROJECT NAME Proposed 'Sunrise Ridge' Residential Development

PROJECT NUMBER 216-672

PROJECT LOCATION S. Olympia Street



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

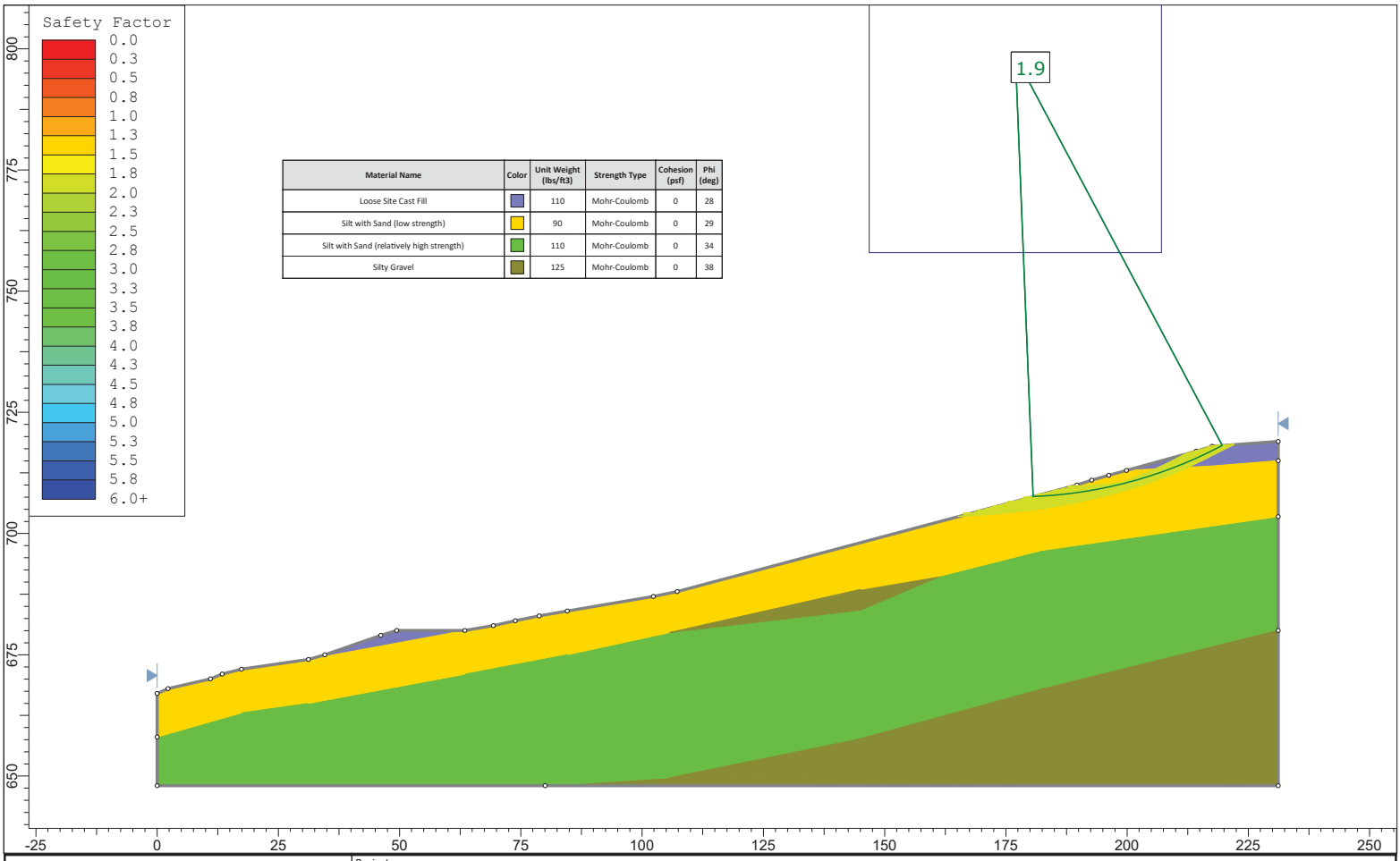
	BOREHOLE	DEPTH	Classification	LL	PL	PI	Cc	Cu
●	**TP-12**	**8.0**	**SANDY SILT(ML)**					
⊠	**TP-13**	**1.5**	**SANDY SILT(ML)**					
▲	**TP-14**	**3.0**	**SILT with SAND(ML)**					
★	**TP-14**	**8.0**	**SILT with SAND(ML)**					

	BOREHOLE	DEPTH	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	**TP-12**	**8.0**	**9.5**				**1.0**	**29.7**	**69.3**	
⊠	**TP-13**	**1.5**	**4.75**				**0.0**	**34.2**	**65.8**	
▲	**TP-14**	**3.0**	**2**				**0.0**	**17.8**	**82.2**	
★	**TP-14**	**8.0**	**4.75**				**0.0**	**19.7**	**80.3**	

GRAIN SIZE - GINT STD US LAB.GDT - 2/17/16 18:11 - C:\USERS\GN NORTHERN\DROPBOX\5-ACTIVE PROJECTS\216-672 SUNRISE RIDGE\216-672 LOGS.GPJ

APPENDIX IV

Slope Stability Analyses

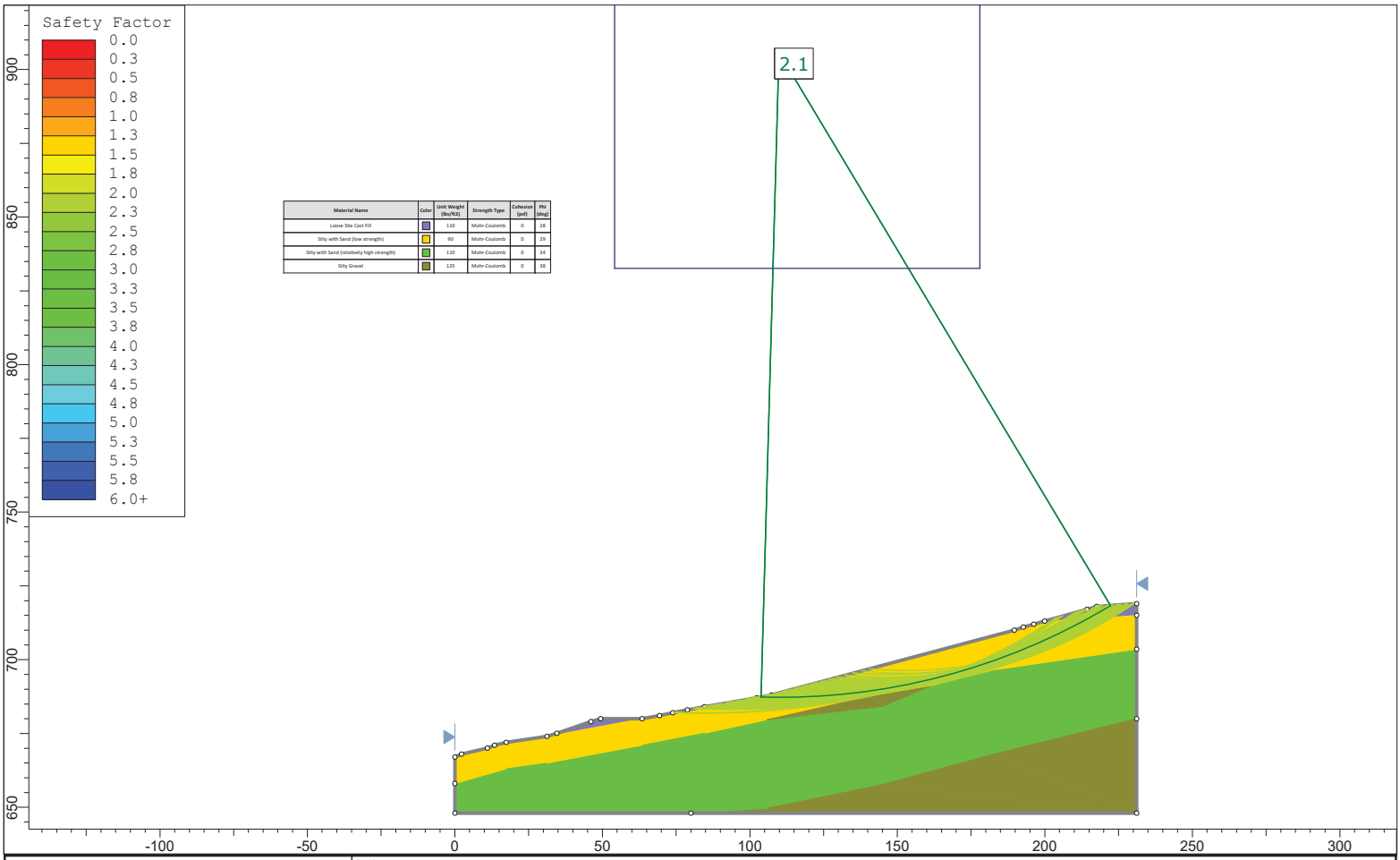


Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Loose Site Cast Fill		110	Mohr-Coulomb	0	28
Silt with Sand (low strength)		90	Mohr-Coulomb	0	29
Silt with Sand (relatively high strength)		110	Mohr-Coulomb	0	34
Silty Gravel		125	Mohr-Coulomb	0	38

Northern, Inc.
Consulting Engineers Environmental Scientists Geologists
Construction Materials Testing Geophysical Services

SLIDEINTERPRET 7.011

Project	Proposed 'Sunrise Ridge' Residential Development S. Olympia Street, Kennewick, Washington		
Analysis Description	Local Static Slope Stability - Section A-A'		
Drawn By Yong Lee	*Scale* 1:328	*Company* GN Northern, Inc.	
Date February 24, 2016		*File Name* SEC-AA' - Local.slim	

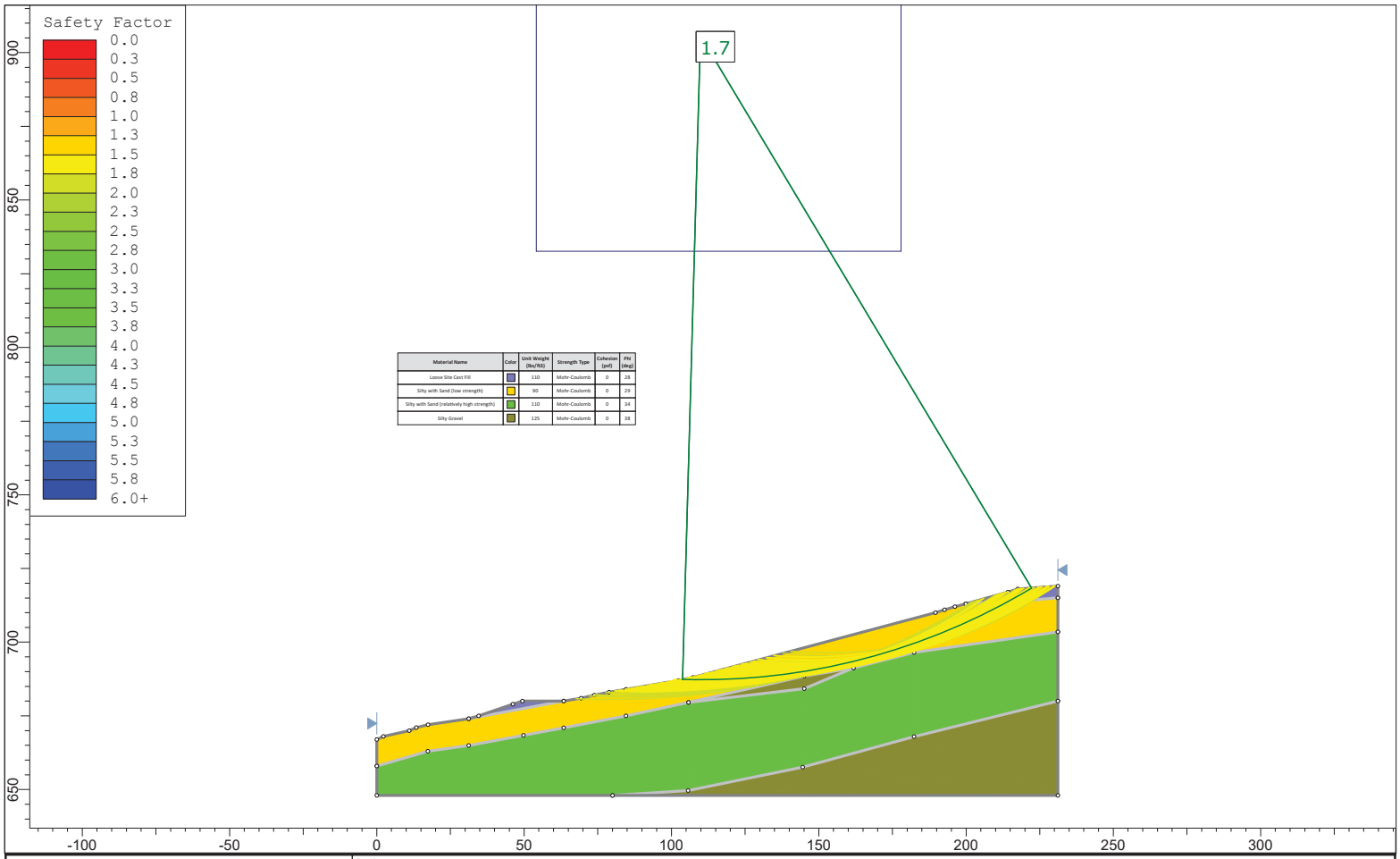


Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Loose Site Cast Fill		110	Mohr-Coulomb	0	28
Silty with Sand (low strength)		90	Mohr-Coulomb	0	29
Silty with Sand (relatively high strength)		110	Mohr-Coulomb	0	34
Silty Gravel		125	Mohr-Coulomb	0	38

Northern, Inc.
Consulting Engineers Environmental Scientists Geologists
Construction Materials Testing Geophysical Services

SLIDEINTERPRET 7.011

Project	Proposed 'Sunrise Ridge' Residential Development S. Olympia Street, Kennewick, Washington		
Analysis Description	Overall Static Slope Stability - Section A-A'		
Drawn By Yong Lee	*Scale* 1:540	*Company*	GN Northern, Inc.
Date February 24. 2016		*File Name*	SEC-AA' - Overall.slim



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Loose Site Cast Fill		110	Mohr-Coulomb	0	28
Silty with Sand (low strength)		90	Mohr-Coulomb	0	29
Silty with Sand (relatively high strength)		110	Mohr-Coulomb	0	34
Silty Gravel		125	Mohr-Coulomb	0	38

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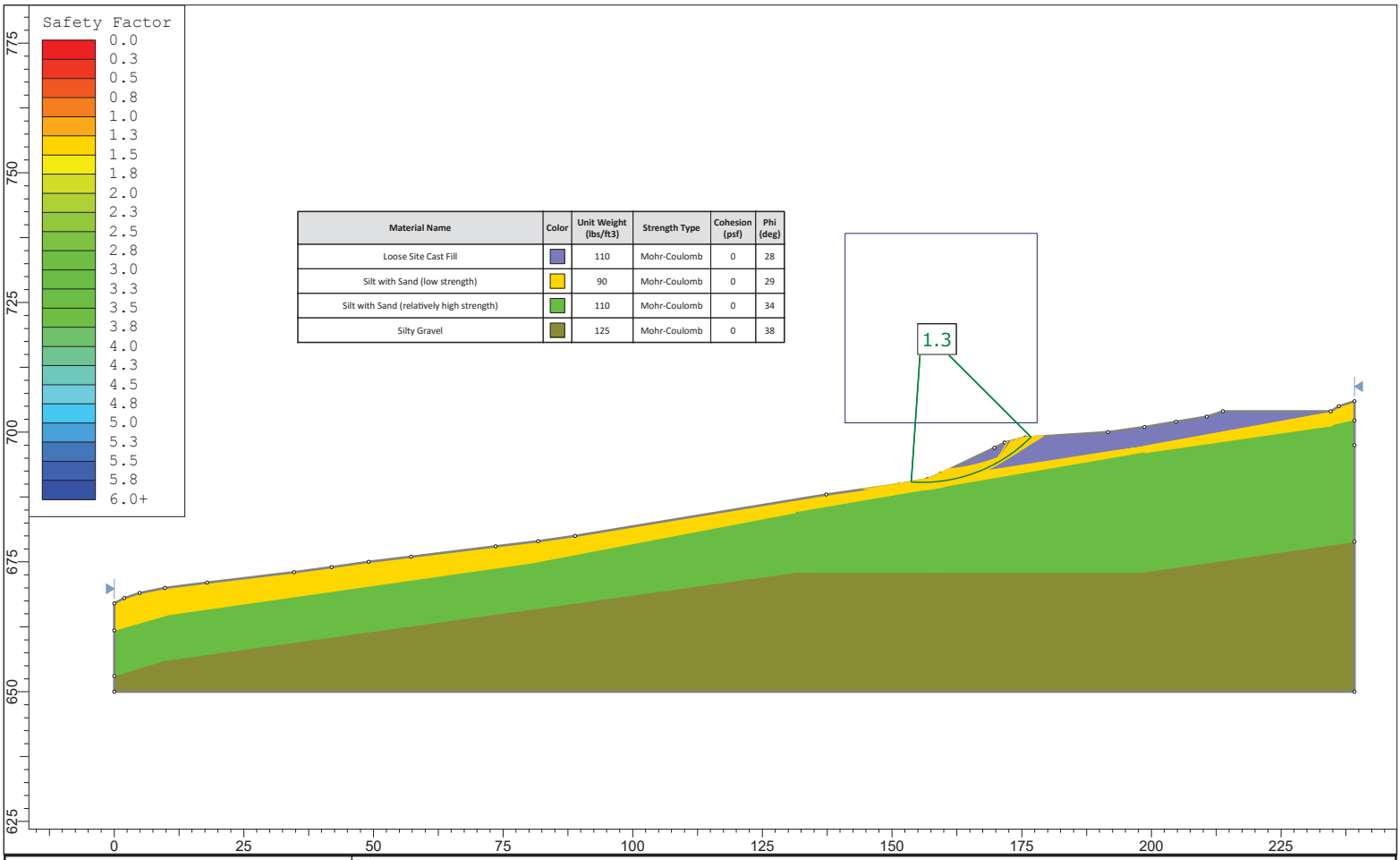
SLIDEINTERPRET 7.011

Project	Proposed 'Sunrise Ridge' Residential Development S. Olympia Street, Kennewick, Washington		
Analysis Description	Overall Pseudo-Static Slope Stability - Section A-A'		
Drawn By Yong Lee	*Scale* 1:540	*Company* GN Northern, Inc.	
Date February 24. 2016		*File Name* SEC-AA' - Overall_PS.slim	



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Loose Site Cast Fill		110	Mohr-Coulomb	0	28
Silt with Sand (low strength)		90	Mohr-Coulomb	0	29
Silt with Sand (relatively high strength)		110	Mohr-Coulomb	0	34
Silty Gravel		125	Mohr-Coulomb	0	38

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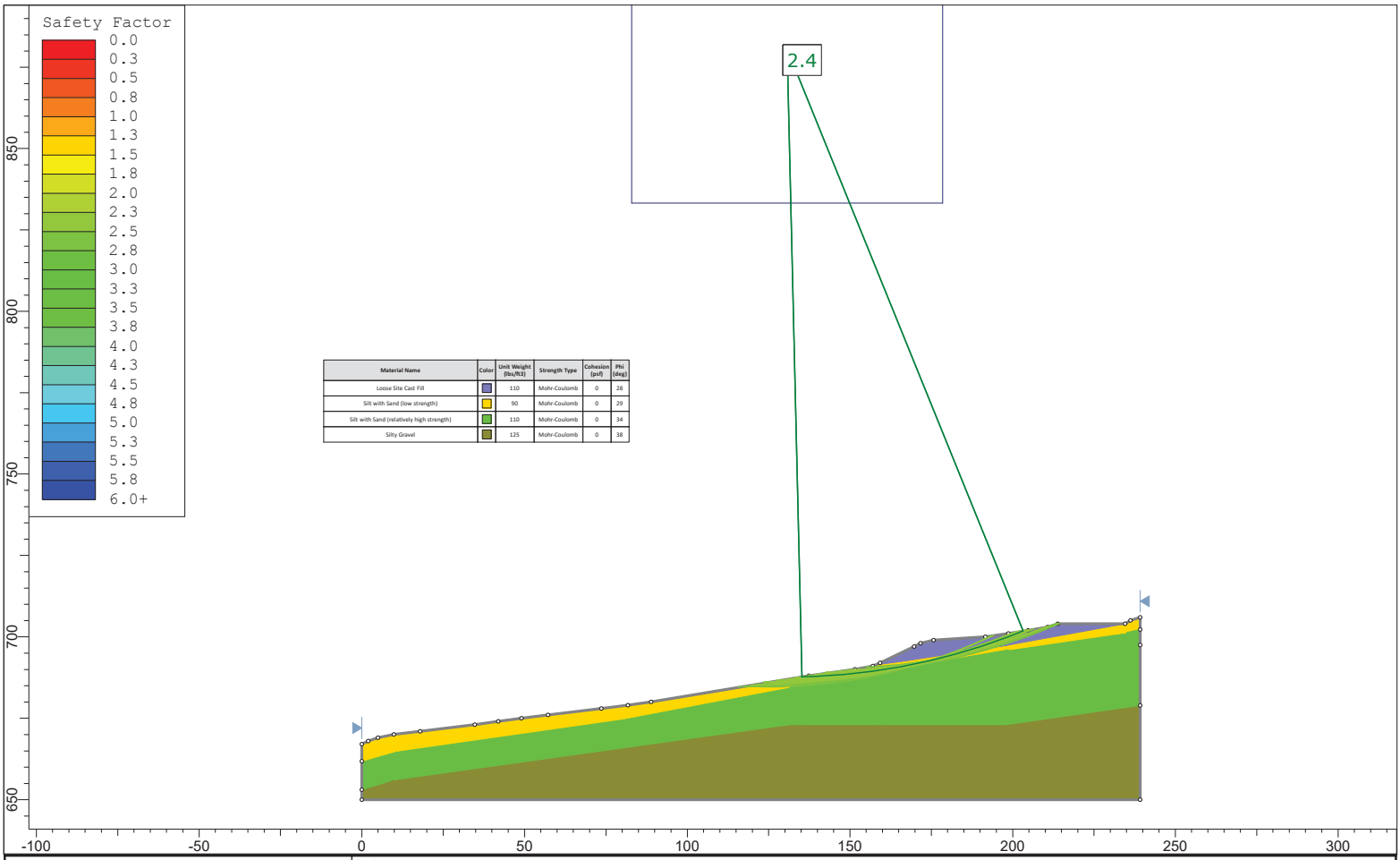
Project	Proposed 'Sunrise Ridge' Residential Development S. Olympia Street, Kennewick, Washington		
Analysis Description	Local Static Slope Stability - Section B-B'		
Drawn By Yong Lee	*Scale* 1:307	*Company*	GN Northern, Inc.
Date February 24. 2016		*File Name*	SEC-BB' - Local.slim



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Loose Site Cast Fill		110	Mohr-Coulomb	0	28
Silt with Sand (low strength)		90	Mohr-Coulomb	0	29
Silt with Sand (relatively high strength)		110	Mohr-Coulomb	0	34
Silty Gravel		125	Mohr-Coulomb	0	38

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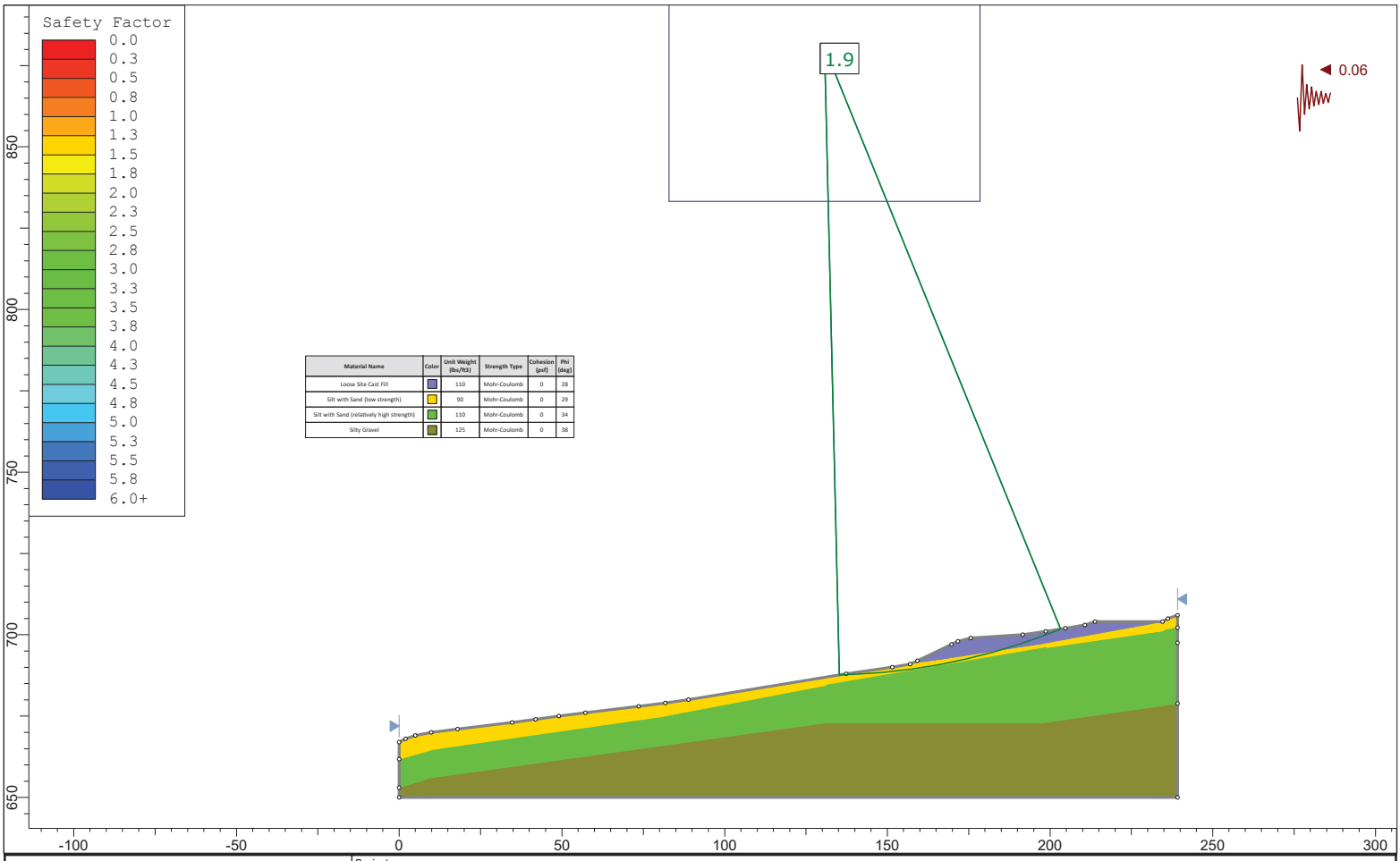
Project	Proposed 'Sunrise Ridge' Residential Development S. Olympia Street, Kennewick, Washington		
Analysis Description	Overall Static Slope Stability - Section B-B'		
Drawn By Yong Lee	*Scale* 1:489	*Company* GN Northern, Inc.	
Date February 24. 2016		*File Name* SEC-BB' - Overall.slim	



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Loose Site Cast Fill		110	Mohr-Coulomb	0	28
Silt with Sand (low strength)		90	Mohr-Coulomb	0	29
Silt with Sand (relatively high strength)		110	Mohr-Coulomb	0	34
Silty Gravel		125	Mohr-Coulomb	0	38

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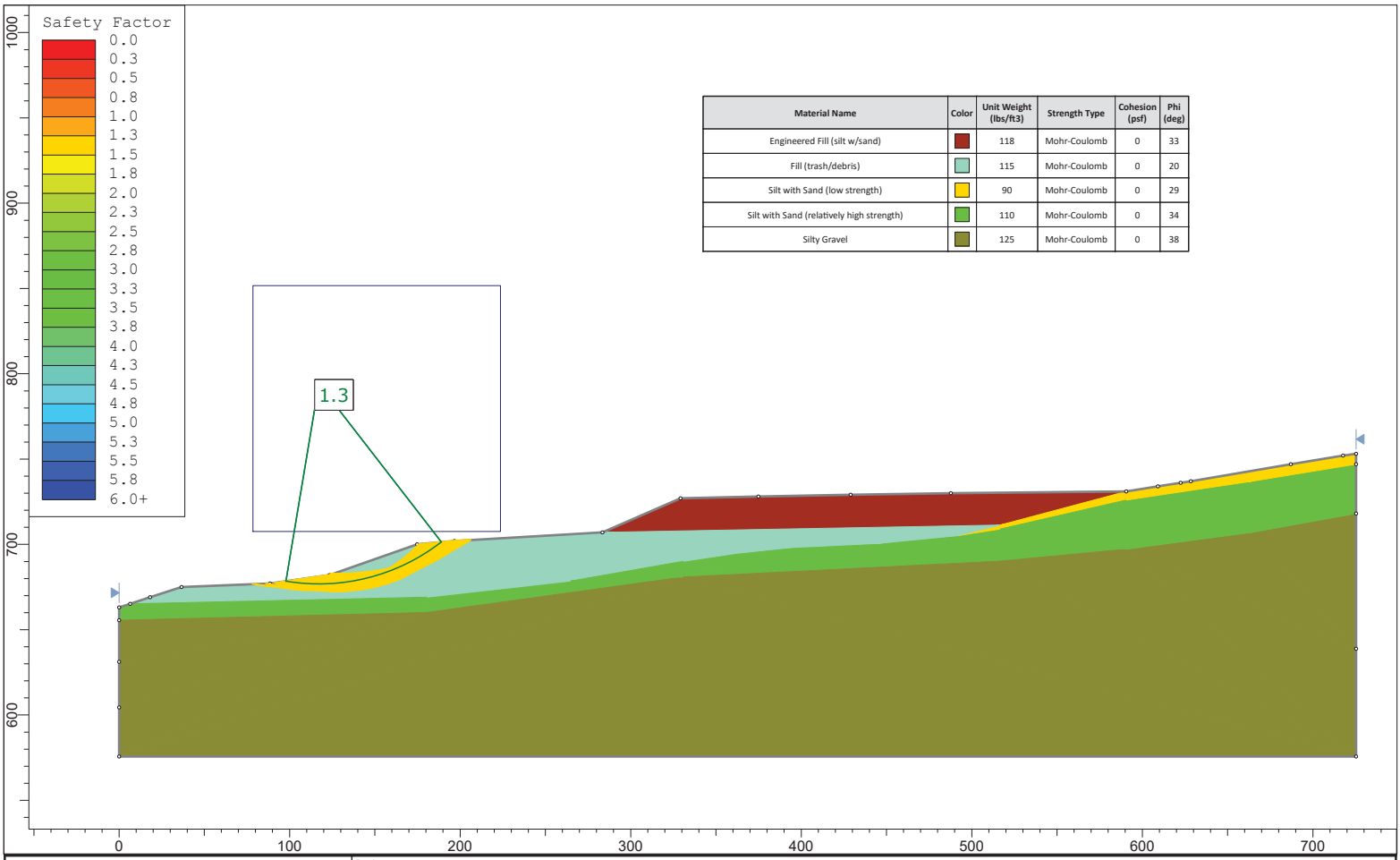
Project	Proposed 'Sunrise Ridge' Residential Development S. Olympia Street, Kennewick, Washington		
Analysis Description	Overall Pseudo-Static Slope Stability - Section B-B'		
Drawn By Yong Lee	*Scale* 1:489	*Company* GN Northern, Inc.	
Date February 24. 2016		*File Name* SEC-BB' - Overall_PS.slim	



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Engineered Fill (silt w/sand)		118	Mohr-Coulomb	0	33
Fill (trash/debris)		115	Mohr-Coulomb	0	20
Silt with Sand (low strength)		90	Mohr-Coulomb	0	29
Silt with Sand (relatively high strength)		110	Mohr-Coulomb	0	34
Silty Gravel		125	Mohr-Coulomb	0	38

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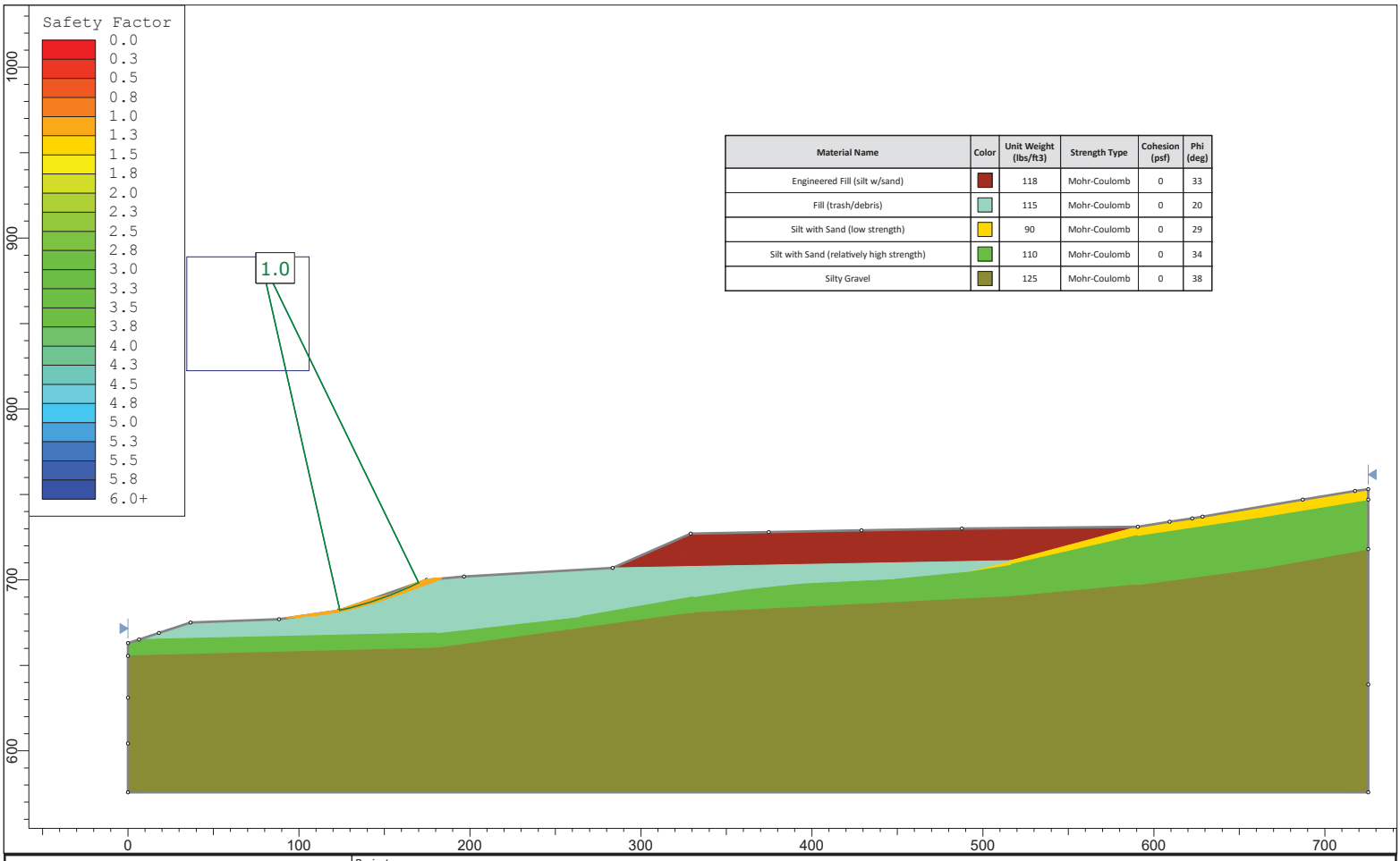
Project	Proposed 'Sunrise Ridge' Residential Development S. Olympia Street, Kennewick, Washington		
Analysis Description	Local Static Slope Stability - Section C-C'		
Drawn By	Yong Lee	Scale 1:934	Company GN Northern, Inc.
Date	February 24, 2016		File Name SEC-CC' - Local_1.slim



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Engineered Fill (silt w/sand)		118	Mohr-Coulomb	0	33
Fill (trash/debris)		115	Mohr-Coulomb	0	20
Silt with Sand (low strength)		90	Mohr-Coulomb	0	29
Silt with Sand (relatively high strength)		110	Mohr-Coulomb	0	34
Silty Gravel		125	Mohr-Coulomb	0	38

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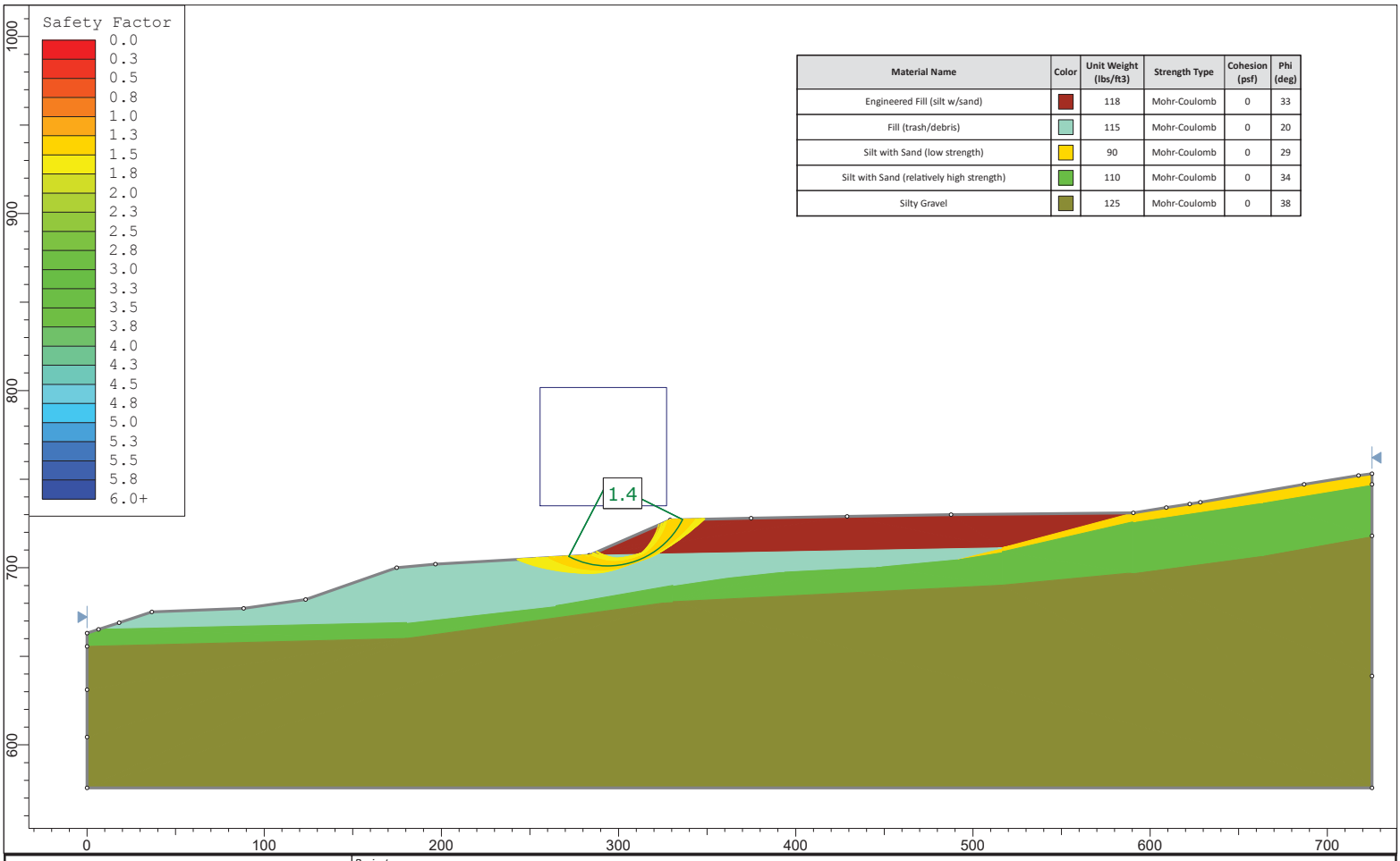
Project	Proposed 'Sunrise Ridge' Residential Development S. Olympia Street, Kennewick, Washington		
Analysis Description	Local Static Slope Stability - Section C-C'		
Drawn By	Yong Lee	*Scale* 1:931	*Company* GN Northern, Inc.
Date	February 24, 2016		*File Name* SEC-CC' - Local_2.slim



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Engineered Fill (silt w/sand)		118	Mohr-Coulomb	0	33
Fill (trash/debris)		115	Mohr-Coulomb	0	20
Silt with Sand (low strength)		90	Mohr-Coulomb	0	29
Silt with Sand (relatively high strength)		110	Mohr-Coulomb	0	34
Silty Gravel		125	Mohr-Coulomb	0	38

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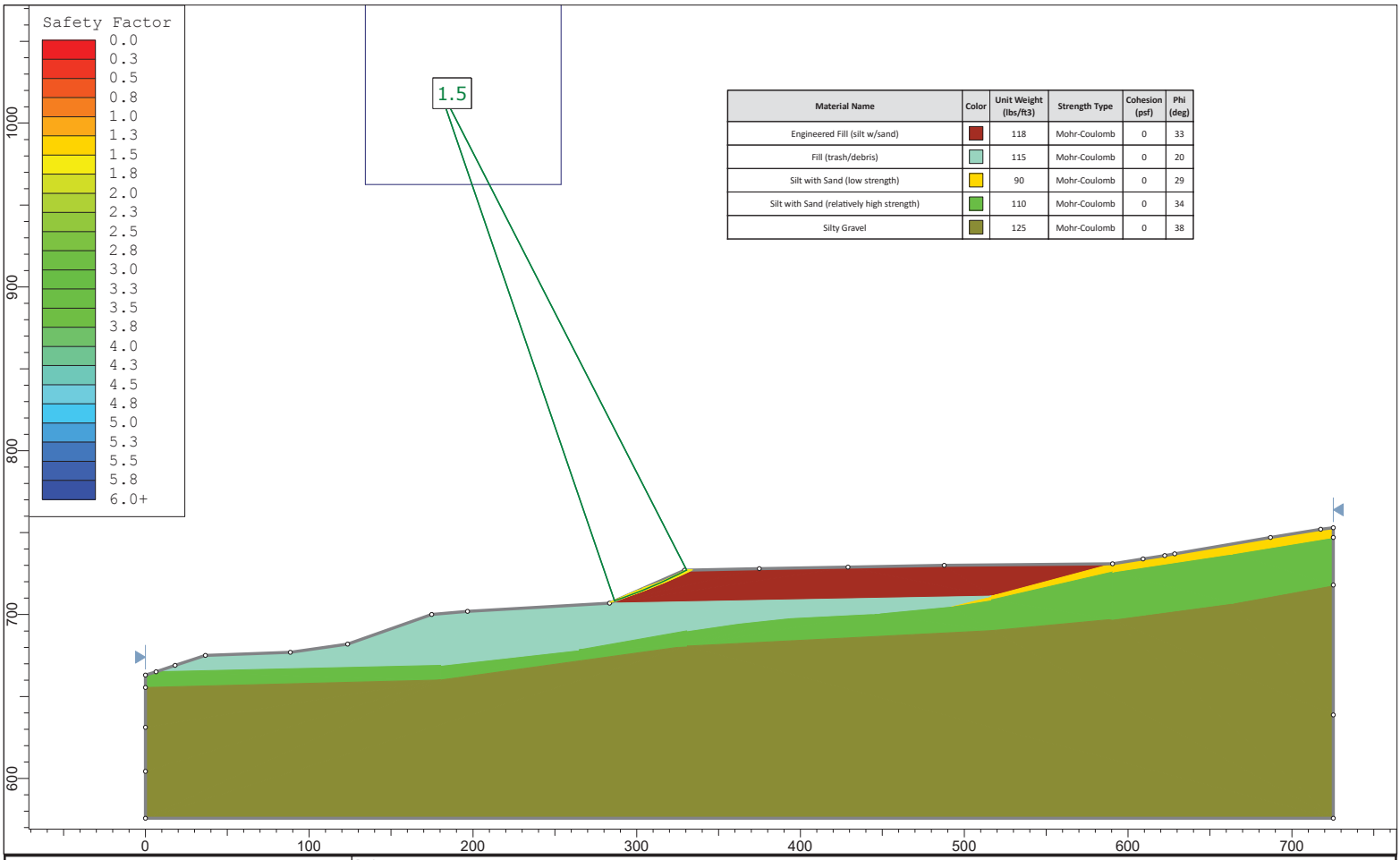
Project	Proposed 'Sunrise Ridge' Residential Development S. Olympia Street, Kennewick, Washington		
Analysis Description	Local Static Slope Stability - Section C-C'		
Drawn By	Yong Lee	Scale 1:899	Company GN Northern, Inc.
Date	February 24, 2016		File Name SEC-CC' - Local_3.slim



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Engineered Fill (silt w/sand)		118	Mohr-Coulomb	0	33
Fill (trash/debris)		115	Mohr-Coulomb	0	20
Silt with Sand (low strength)		90	Mohr-Coulomb	0	29
Silt with Sand (relatively high strength)		110	Mohr-Coulomb	0	34
Silty Gravel		125	Mohr-Coulomb	0	38

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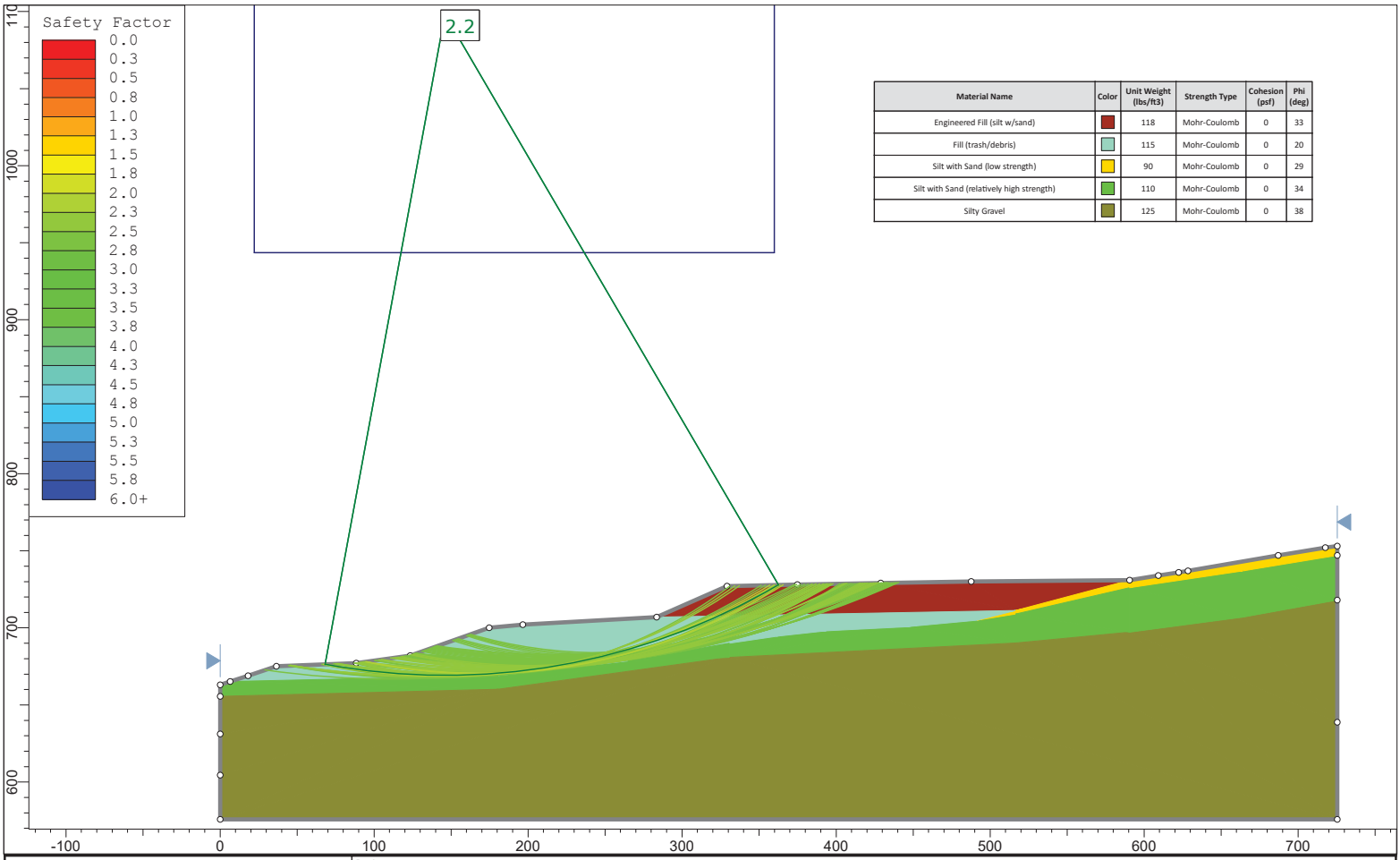
Project	Proposed 'Sunrise Ridge' Residential Development S. Olympia Street, Kennewick, Washington		
Analysis Description	Local Static Slope Stability - Section C-C'		
Drawn By Yong Lee	*Scale* 1:973	*Company*	GN Northern, Inc.
Date February 24, 2016		*File Name*	SEC-CC' - Local_4.slim



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Engineered Fill (silt w/sand)		118	Mohr-Coulomb	0	33
Fill (trash/debris)		115	Mohr-Coulomb	0	20
Silt with Sand (low strength)		90	Mohr-Coulomb	0	29
Silt with Sand (relatively high strength)		110	Mohr-Coulomb	0	34
Silty Gravel		125	Mohr-Coulomb	0	38

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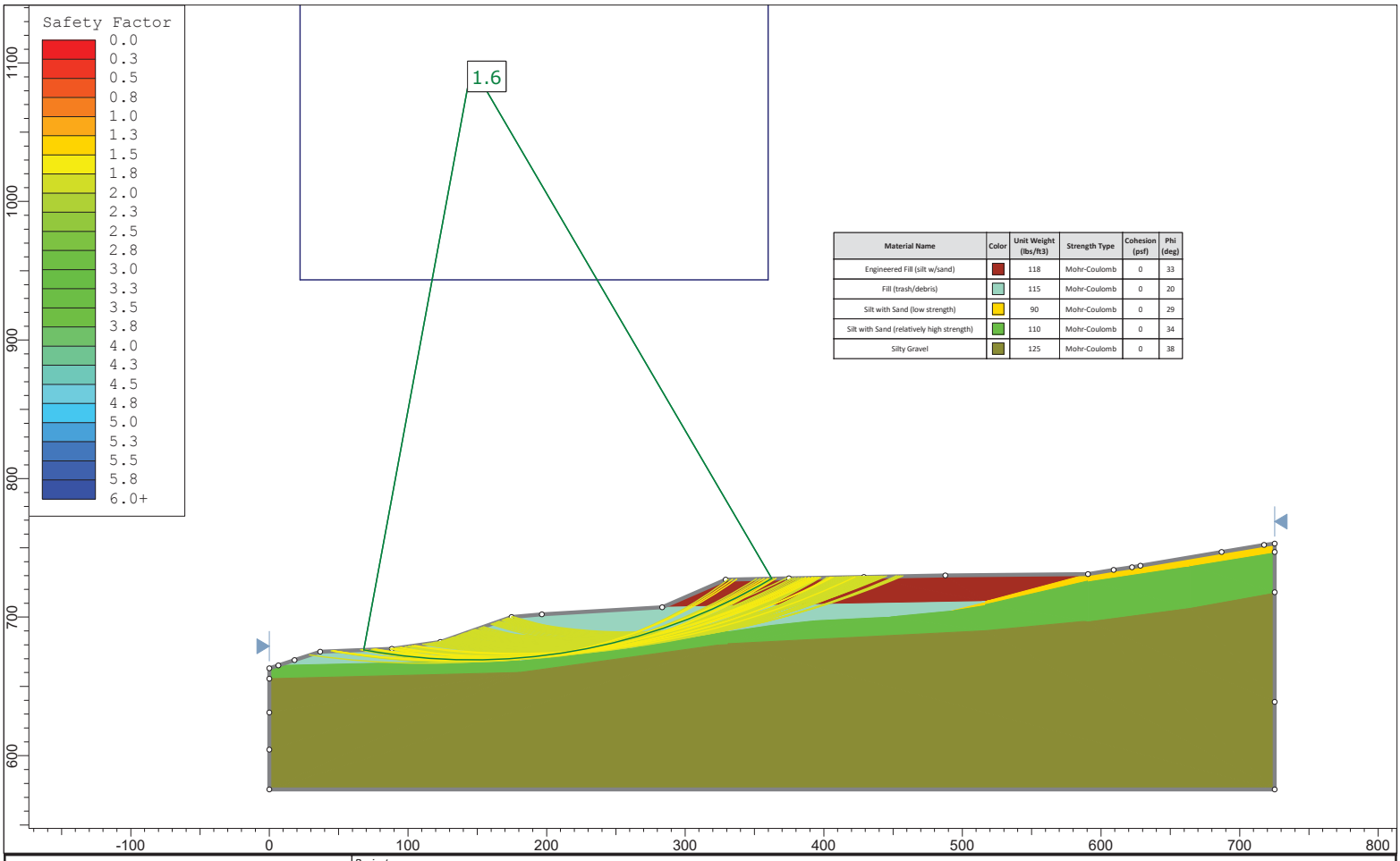
Project	Proposed 'Sunrise Ridge' Residential Development S. Olympia Street, Kennewick, Washington		
Analysis Description	Overall Static Slope Stability - Section C-C'		
Drawn By Yong Lee	*Scale* 1:1034	*Company* GN Northern, Inc.	
Date February 24, 2016		*File Name* SEC-CC' - Overall.slim	



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Engineered Fill (silt w/sand)		118	Mohr-Coulomb	0	33
Fill (trash/debris)		115	Mohr-Coulomb	0	20
Silt with Sand (low strength)		90	Mohr-Coulomb	0	29
Silt with Sand (relatively high strength)		110	Mohr-Coulomb	0	34
Silty Gravel		125	Mohr-Coulomb	0	38

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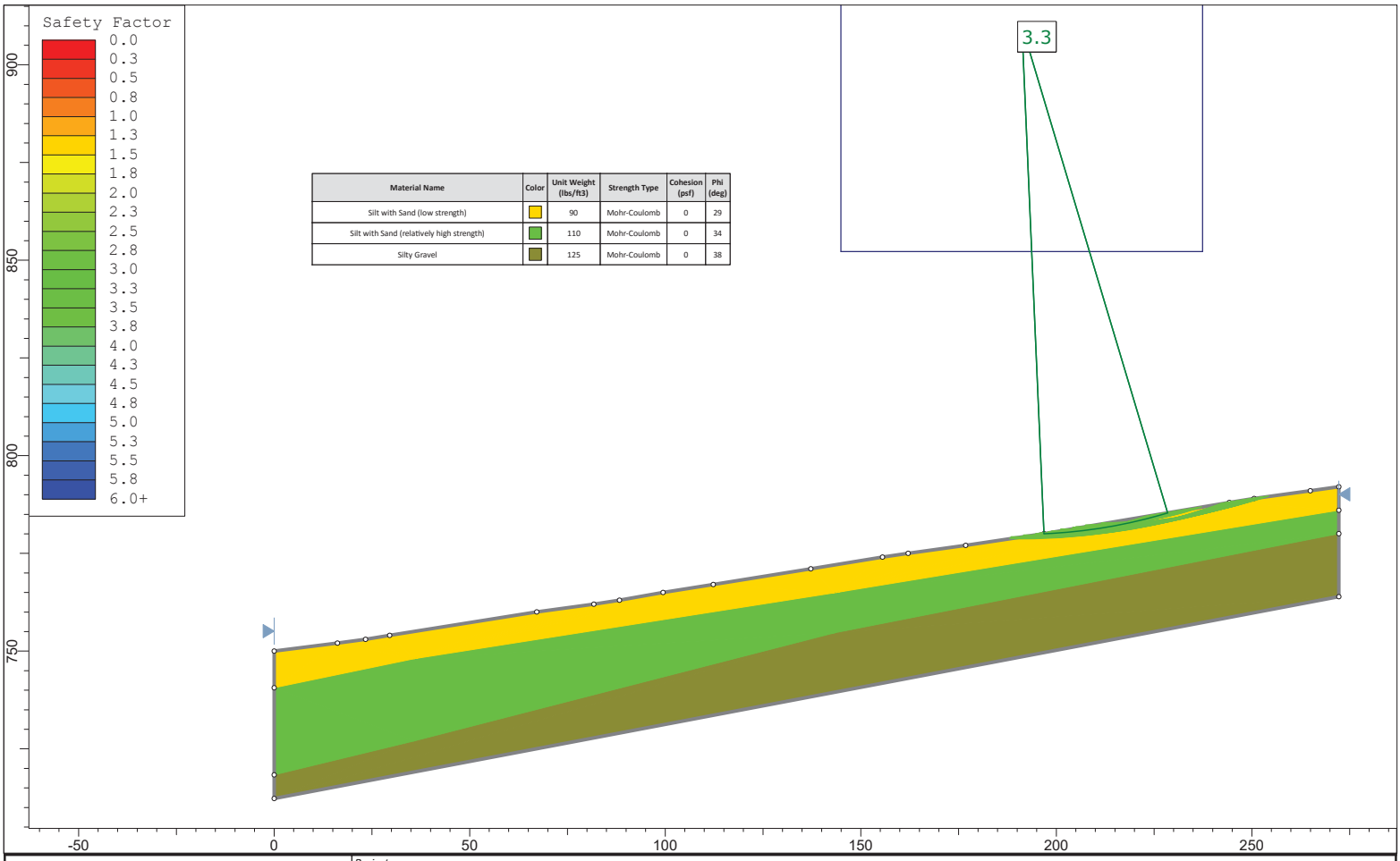
Project	Proposed 'Sunrise Ridge' Residential Development S. Olympia Street, Kennewick, Washington		
Analysis Description	Overall Pseudo-Static Slope Stability - Section C-C'		
Drawn By Yong Lee	*Scale* 1:1149	*Company*	GN Northern, Inc.
Date February 24, 2016		*File Name*	SEC-CC' - Overall_PS.slim



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Silt with Sand (low strength)		90	Mohr-Coulomb	0	29
Silt with Sand (relatively high strength)		110	Mohr-Coulomb	0	34
Silty Gravel		125	Mohr-Coulomb	0	38

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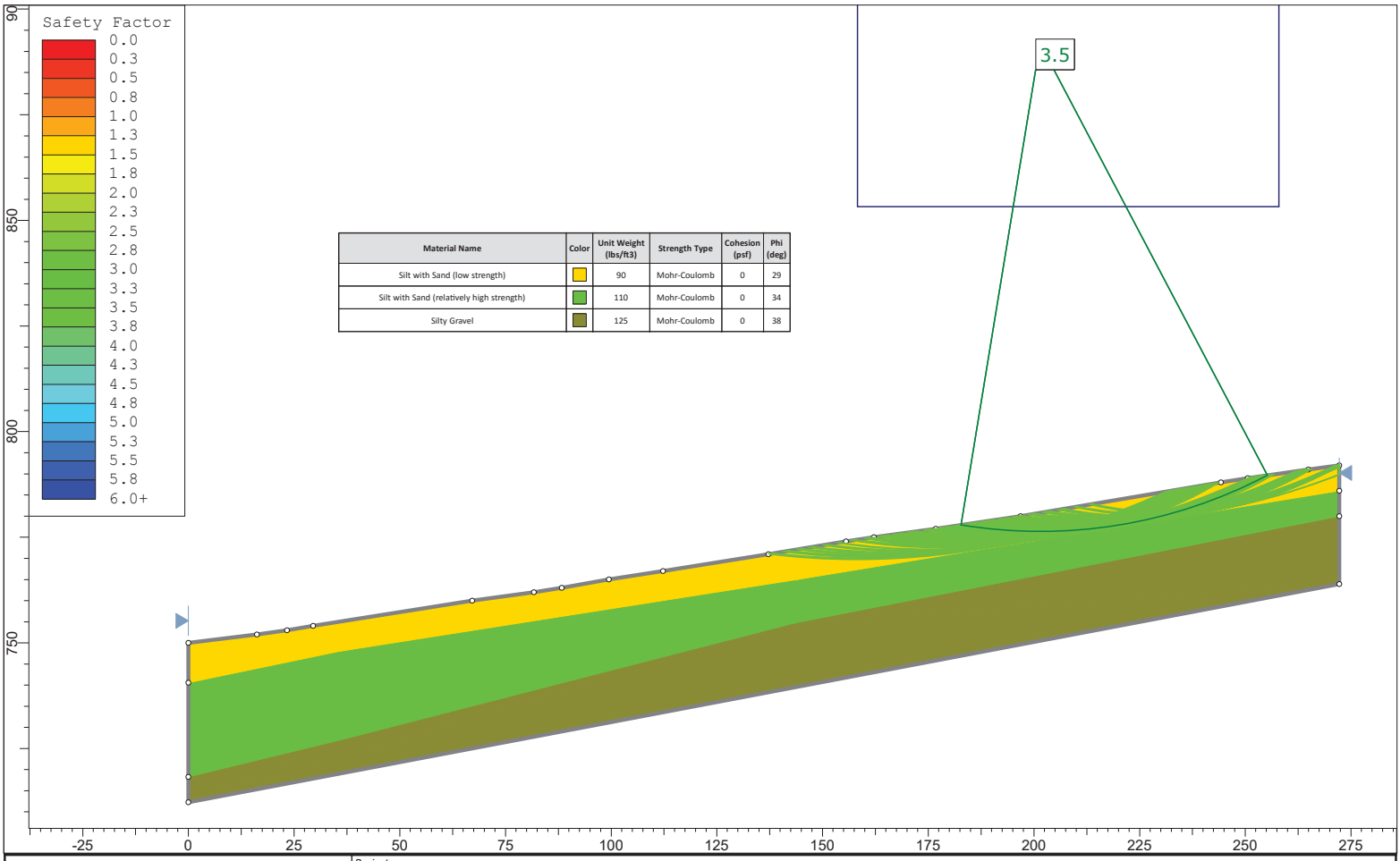
Project	Proposed 'Sunrise Ridge' Residential Development S. Olympia Street, Kennewick, Washington		
Analysis Description	Local Static Slope Stability - Section D-D'		
Drawn By Yong Lee	*Scale* 1:407	*Company* GN Northern, Inc.	
Date February, 24, 2016		*File Name* SEC-DD' - Local.slim	



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Silt with Sand (low strength)		90	Mohr-Coulomb	0	29
Silt with Sand (relatively high strength)		110	Mohr-Coulomb	0	34
Silty Gravel		125	Mohr-Coulomb	0	38

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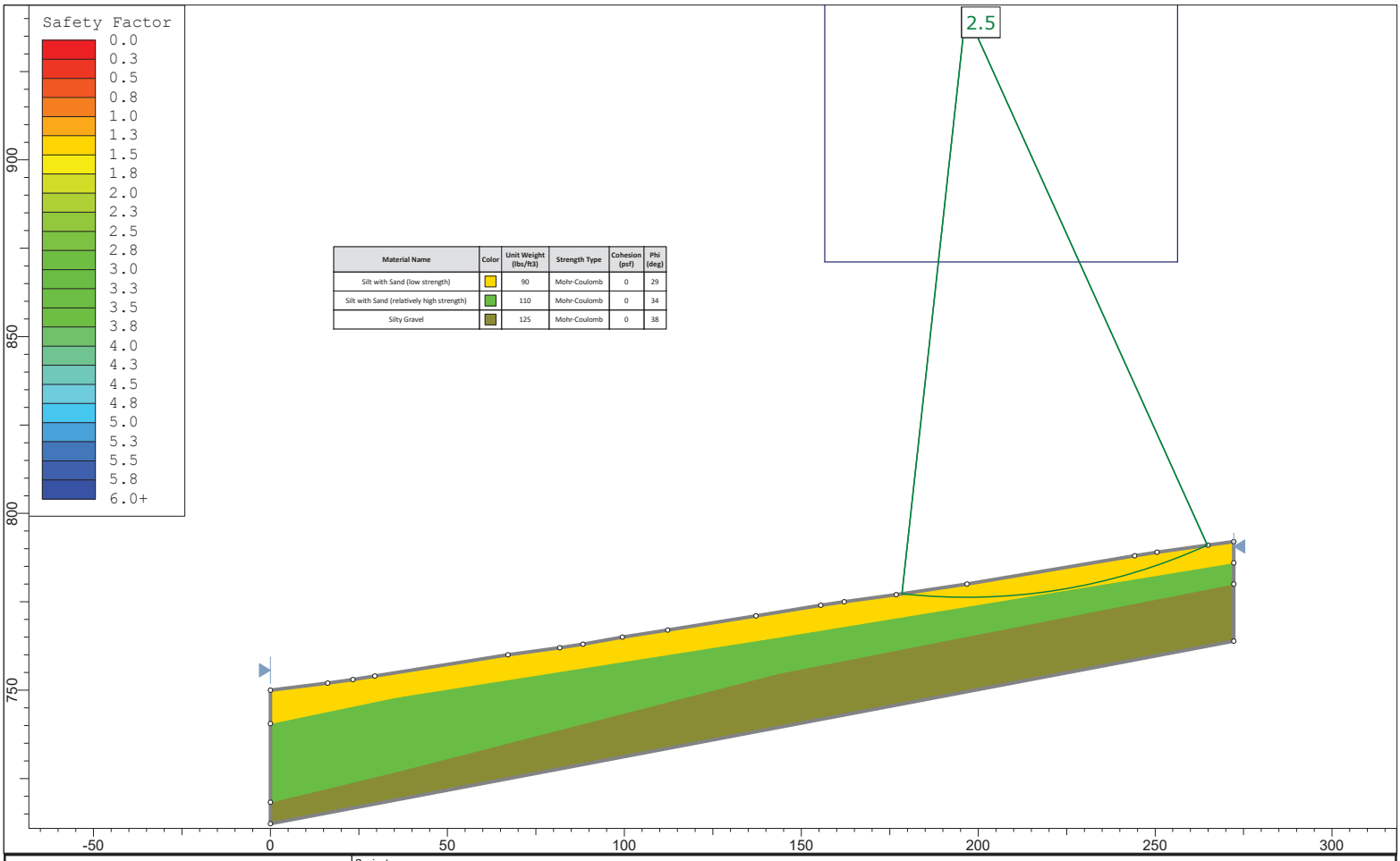
Project	Proposed 'Sunrise Ridge' Residential Development S. Olympia Street, Kennewick, Washington		
Analysis Description	Overall Static Slope Stability - Section D-D'		
Drawn By	Yong Lee	*Scale* 1:377	*Company* GN Northern, Inc.
Date	February, 24, 2016		*File Name* SEC-DD' - Overall.slim



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Silt with Sand (low strength)		90	Mohr-Coulomb	0	29
Silt with Sand (relatively high strength)		110	Mohr-Coulomb	0	34
Silty Gravel		125	Mohr-Coulomb	0	38

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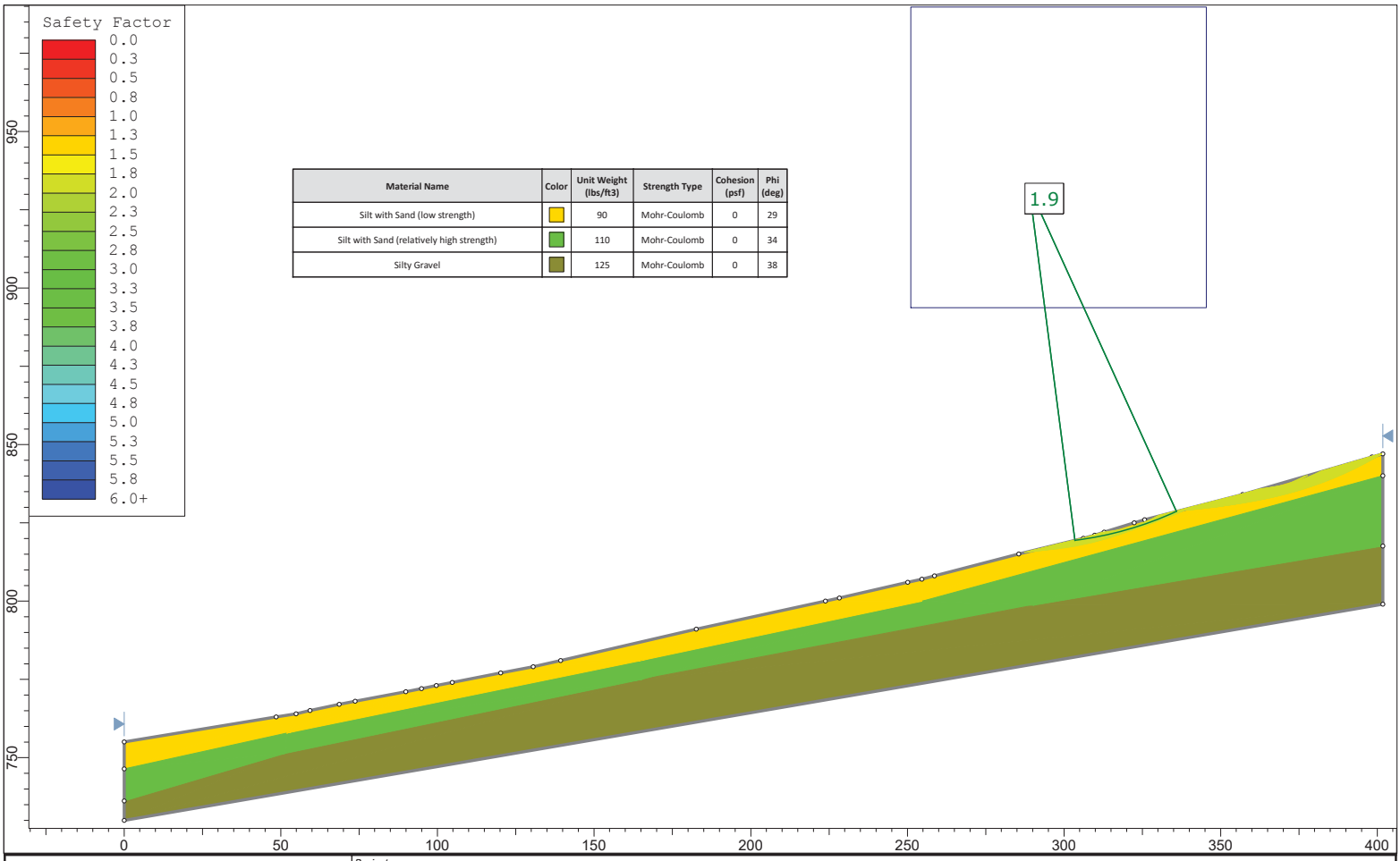
Project	Proposed 'Sunrise Ridge' Residential Development S. Olympia Street, Kennewick, Washington		
Analysis Description	Overall Pseudo-Static Slope Stability - Section D-D'		
Drawn By Yong Lee	*Scale* 1:450	*Company*	GN Northern, Inc.
Date February, 24, 2016		*File Name*	SEC-DD' - Overall_PS.slim



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Silt with Sand (low strength)		90	Mohr-Coulomb	0	29
Silt with Sand (relatively high strength)		110	Mohr-Coulomb	0	34
Silty Gravel		125	Mohr-Coulomb	0	38

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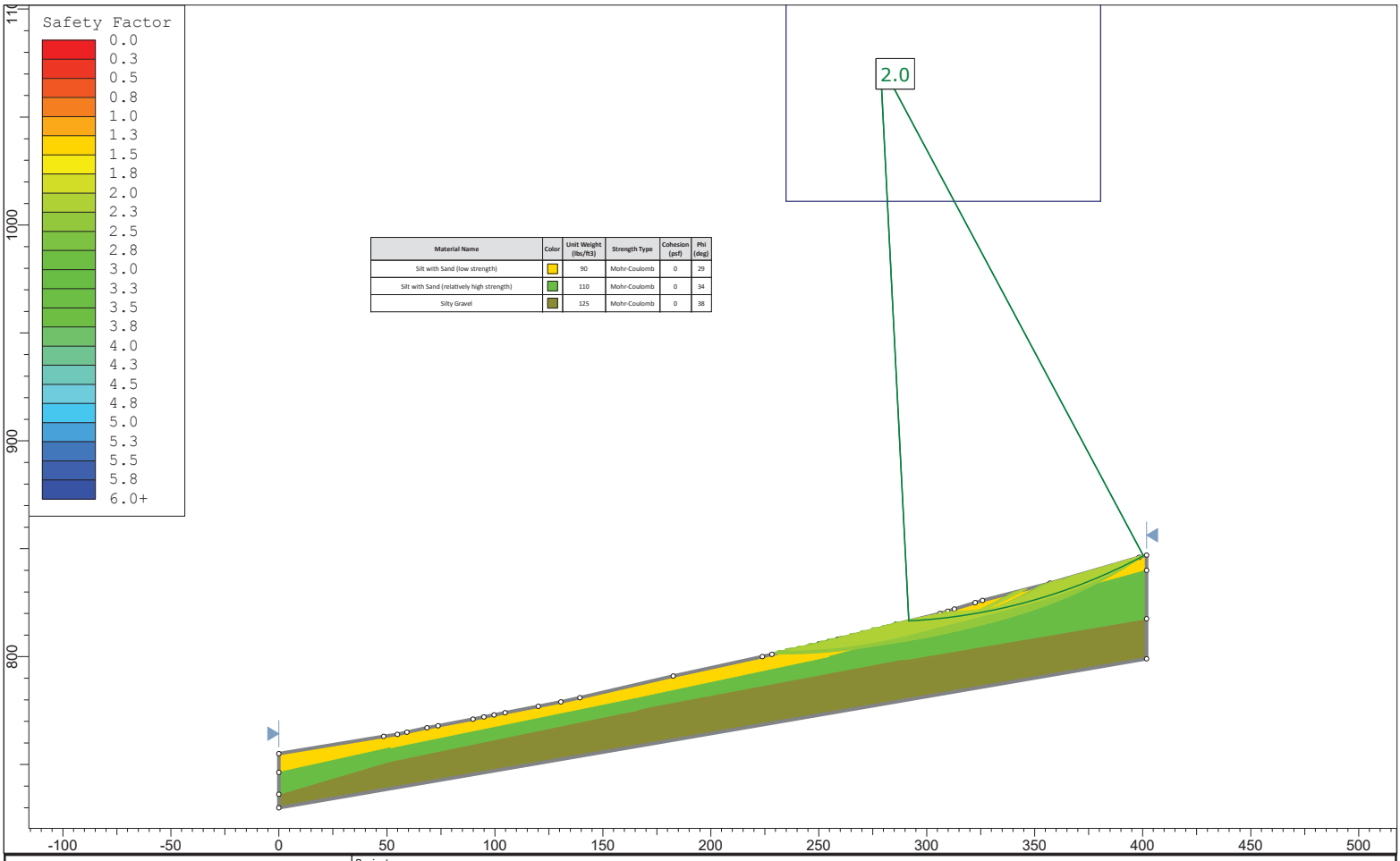
Project	Proposed 'Sunrise Ridge' Residential Development S. Olympia Street, Kennewick, Washington		
Analysis Description	Local Static Slope Stability - Section E-E'		
Drawn By Yong Lee	*Scale* 1:508	*Company*	GN Northern, Inc
Date February 24, 2016		*File Name*	SEC-EE' - Local.slim



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Silt with Sand (low strength)		90	Mohr-Coulomb	0	29
Silt with Sand (relatively high strength)		110	Mohr-Coulomb	0	34
Silty Gravel		125	Mohr-Coulomb	0	38

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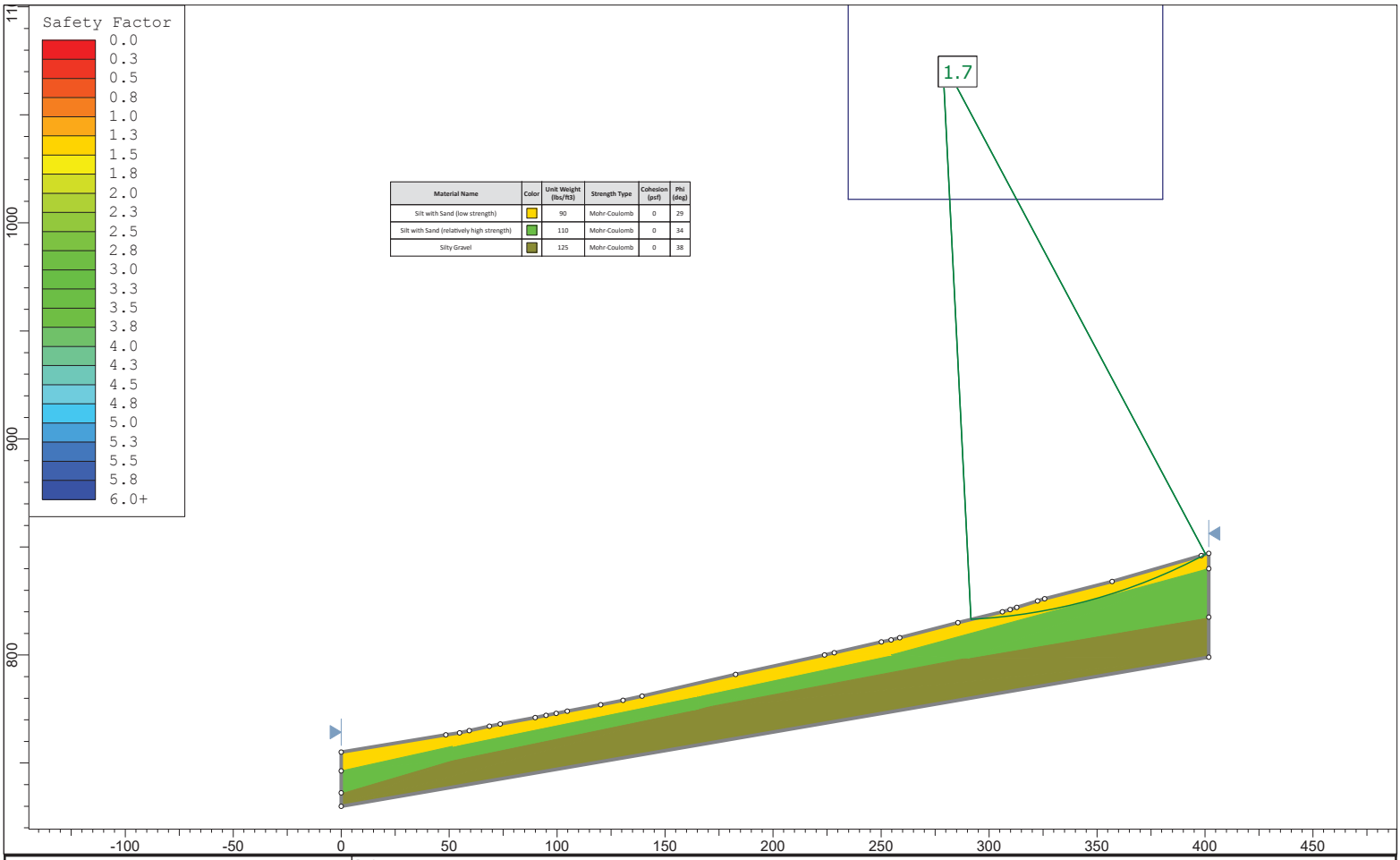
Project	Proposed 'Sunrise Ridge' Residential Development S. Olympia Street, Kennewick, Washington		
Analysis Description	Overall Static Slope Stability - Section E-E'		
Drawn By Yong Lee	*Scale* 1:737	*Company*	GN Northern, Inc
Date February 24, 2016		*File Name*	SEC-EE' -Overall.slim



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Silt with Sand (low strength)		90	Mohr-Coulomb	0	29
Silt with Sand (relatively high strength)		110	Mohr-Coulomb	0	34
Silty Gravel		125	Mohr-Coulomb	0	38

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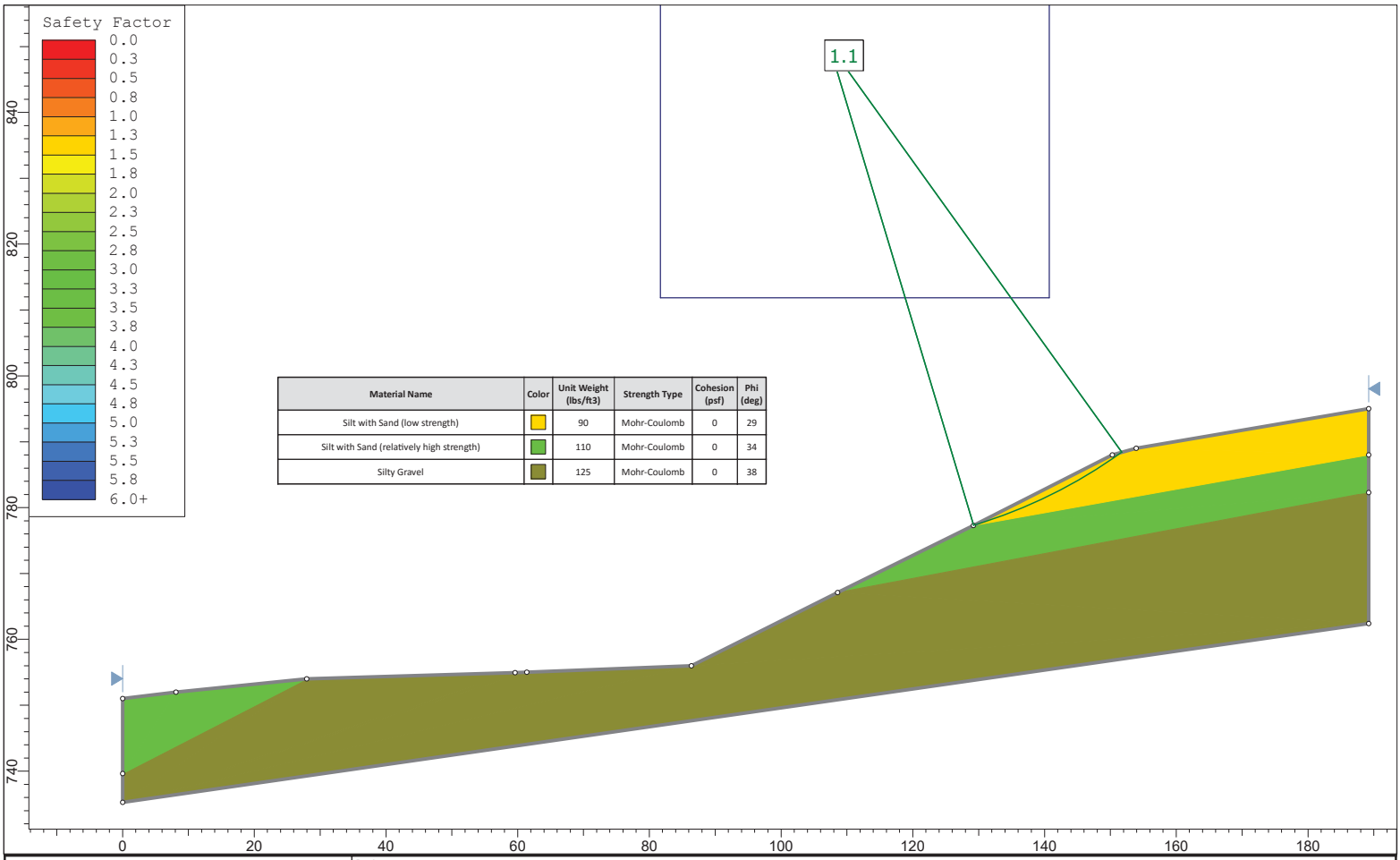
Project	Proposed 'Sunrise Ridge' Residential Development S. Olympia Street, Kennewick, Washington		
Analysis Description	Overall Pseudo-Static Slope Stability - Section E-E'		
Drawn By Yong Lee	*Scale* 1:737	*Company* GN Northern, Inc	
Date February 24, 2016		*File Name* SEC-EE' -Overall_PS.slim	



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Silt with Sand (low strength)		90	Mohr-Coulomb	0	29
Silt with Sand (relatively high strength)		110	Mohr-Coulomb	0	34
Silty Gravel		125	Mohr-Coulomb	0	38

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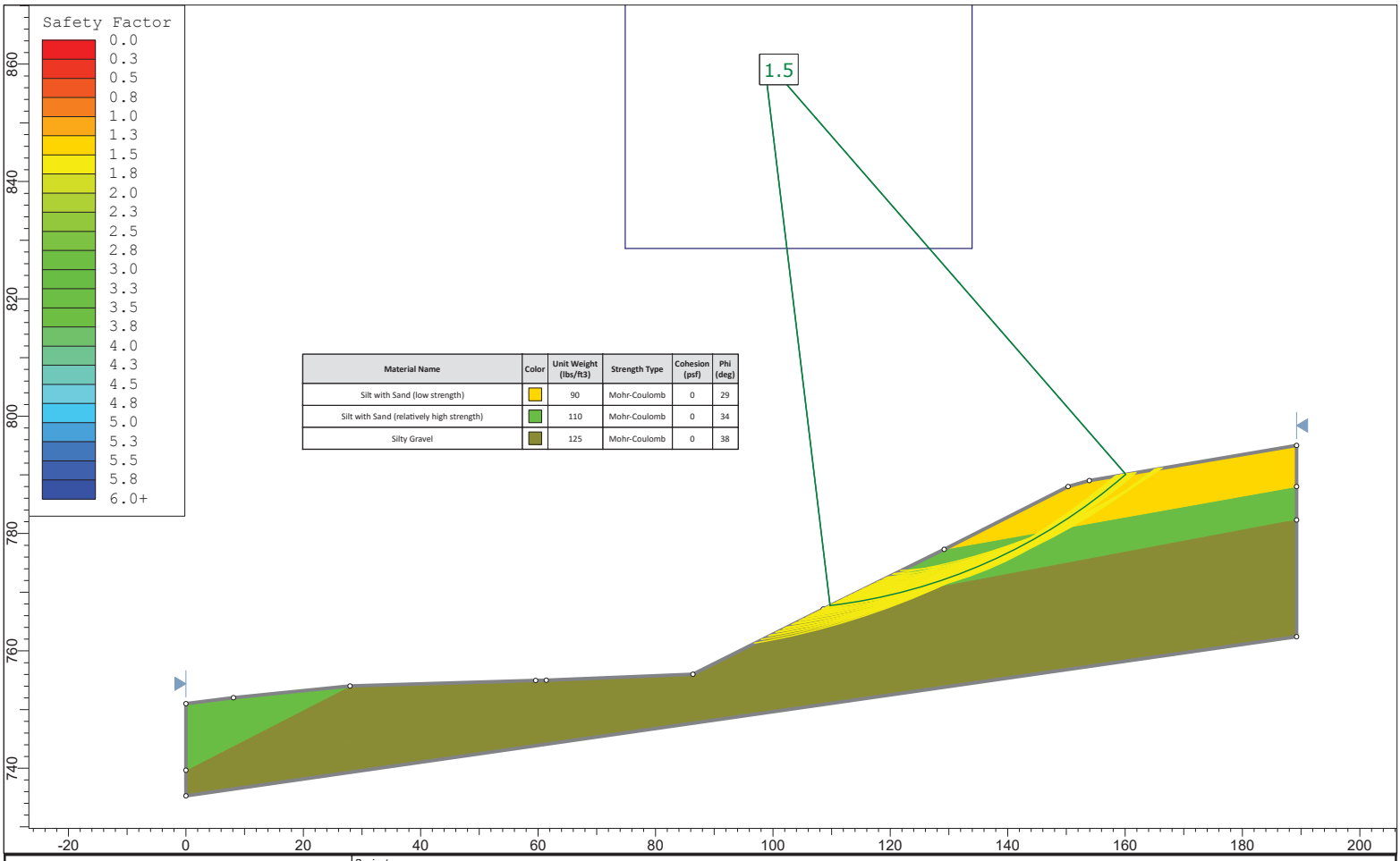
Project	Proposed 'Sunrise Ridge' Residential Development S. Olympia Street, Kennewick, Washington		
Analysis Description	Local Static Slope Stability - Proposed 22-foot Tall Cut Slope		
Drawn By Yong Lee	*Scale* 1:242	*Company*	GN Northern, Inc
Date February 24, 2016		*File Name*	22-foot_cut_slope - Local.slim



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Silt with Sand (low strength)		90	Mohr-Coulomb	0	29
Silt with Sand (relatively high strength)		110	Mohr-Coulomb	0	34
Silty Gravel		125	Mohr-Coulomb	0	38

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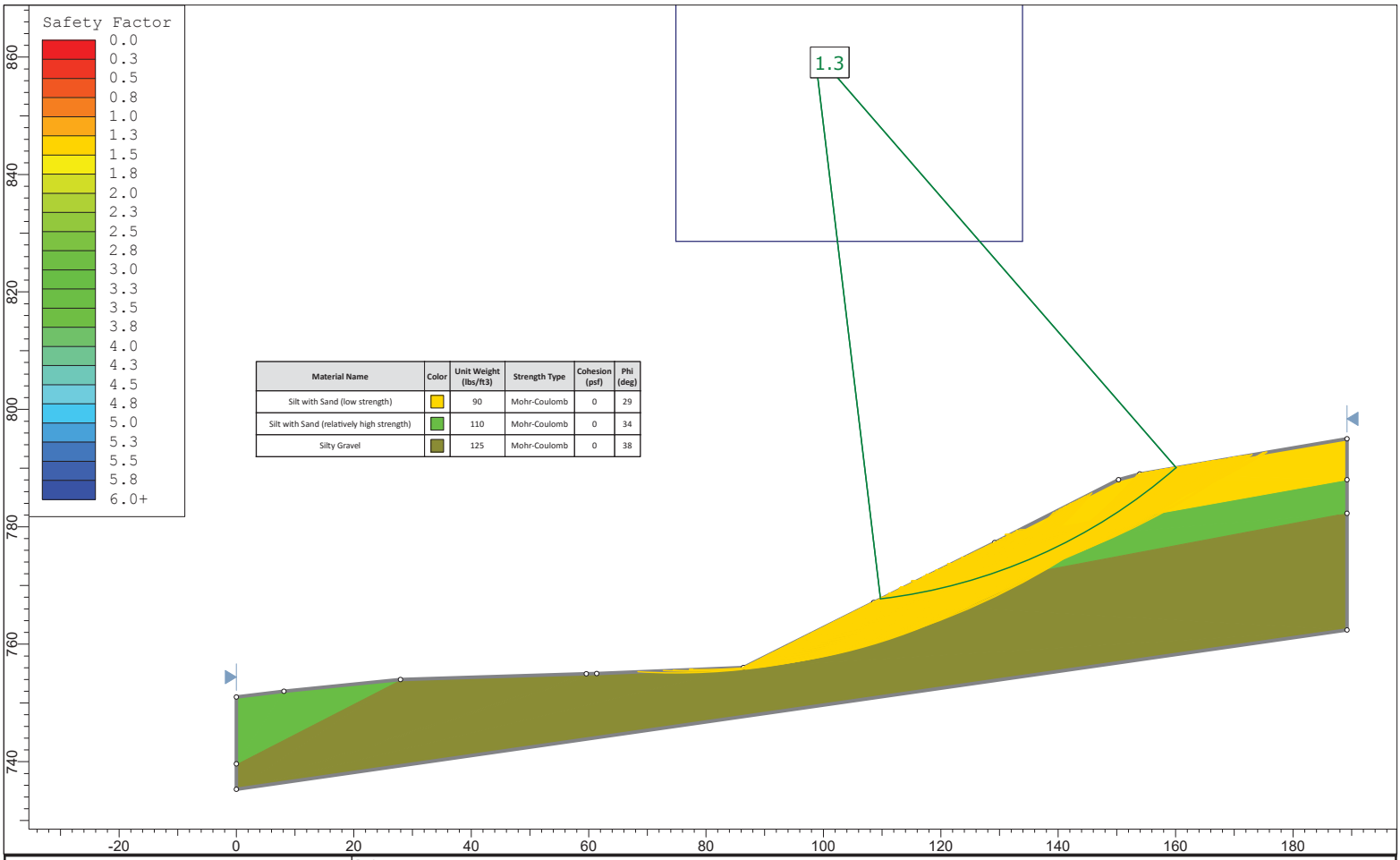
Project	Proposed 'Sunrise Ridge' Residential Development S. Olympia Street, Kennewick, Washington		
Analysis Description	Overall Static Slope Stability - Proposed 22-foot Tall Cut Slope		
Drawn By Yong Lee	*Scale* 1:271	*Company*	GN Northern, Inc
Date February 24, 2016		*File Name*	22-foot_cut_slope - Overall.slim



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Silt with Sand (low strength)		90	Mohr-Coulomb	0	29
Silt with Sand (relatively high strength)		110	Mohr-Coulomb	0	34
Silty Gravel		125	Mohr-Coulomb	0	38

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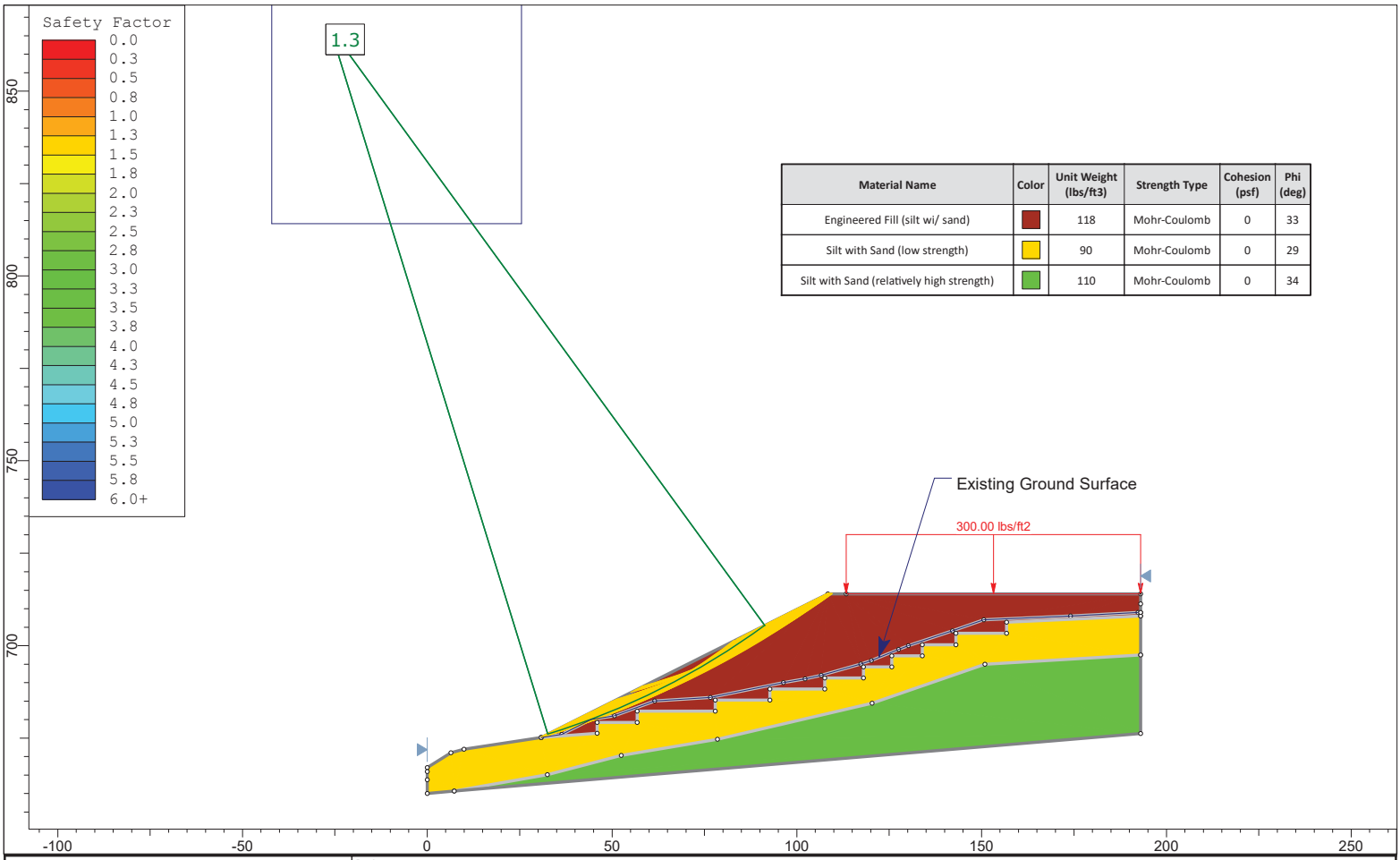
Project	Proposed 'Sunrise Ridge' Residential Development S. Olympia Street, Kennewick, Washington		
Analysis Description	Overall Pseudo-Static Slope Stability - Proposed 22-foot Tall Cut Slope		
Drawn By	Yong Lee	*Scale* 1:271	*Company* GN Northern, Inc
Date	February 24, 2016		*File Name* 22-foot_cut_slope - Overall_PS.slim



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Engineered Fill (silt wi/ sand)		118	Mohr-Coulomb	0	33
Silt with Sand (low strength)		90	Mohr-Coulomb	0	29
Silt with Sand (relatively high strength)		110	Mohr-Coulomb	0	34

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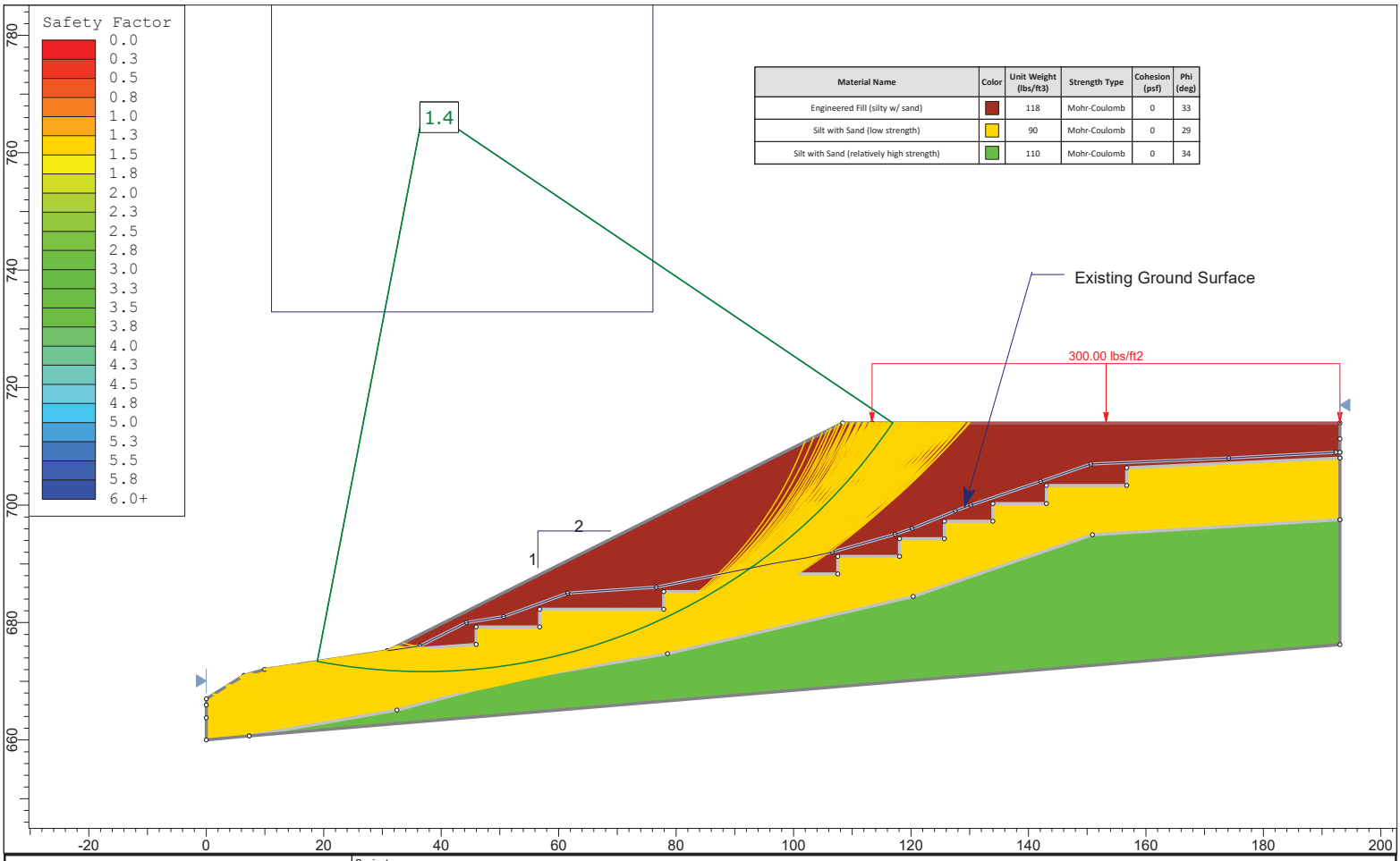
Project	Proposed 'Sunrise Ridge' Residential Development S. Olympia Street, Kennewick, Washington		
Analysis Description	Local Static Slope Stability - Proposed 38-foot Tall Fill Slope		
Drawn By	Yong Lee	Scale 1:431	Company GN Northern, Inc
Date	February 24, 2016		File Name 38-foot_fill_slope_33 - Local.slim



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Engineered Fill (silty w/ sand)		118	Mohr-Coulomb	0	33
Silt with Sand (low strength)		90	Mohr-Coulomb	0	29
Silt with Sand (relatively high strength)		110	Mohr-Coulomb	0	34

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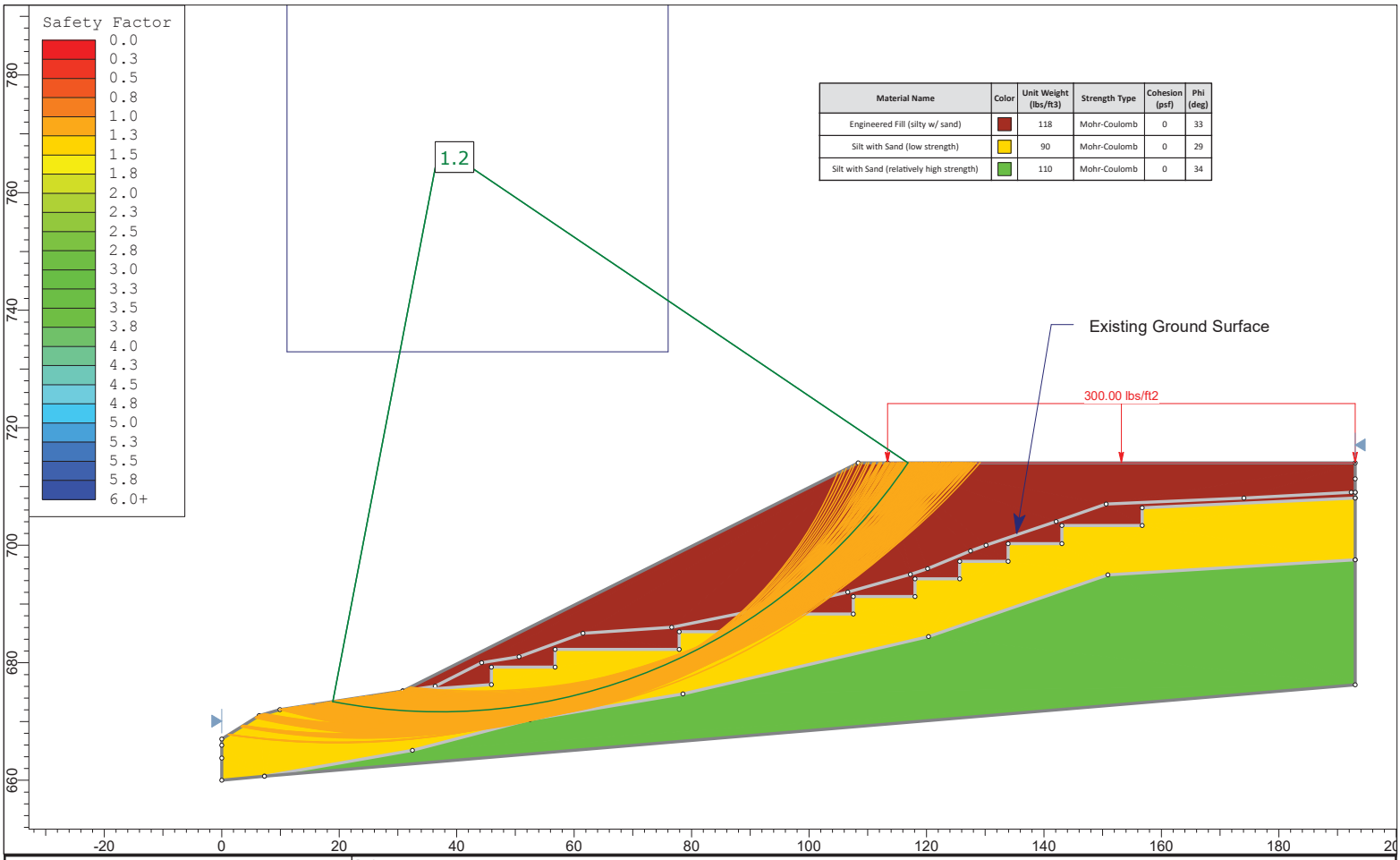
Project	Proposed 'Sunrise Ridge' Residential Development S. Olympia Street, Kennewick, Washington		
Analysis Description	Overall Static Slope Stability - Proposed 38-foot Tall Fill Slope		
Drawn By Yong Lee	*Scale* 1:271	*Company*	GN Northern, Inc
Date February 24, 2016		*File Name*	38-foot_fill_slope_33 - Overall.slim

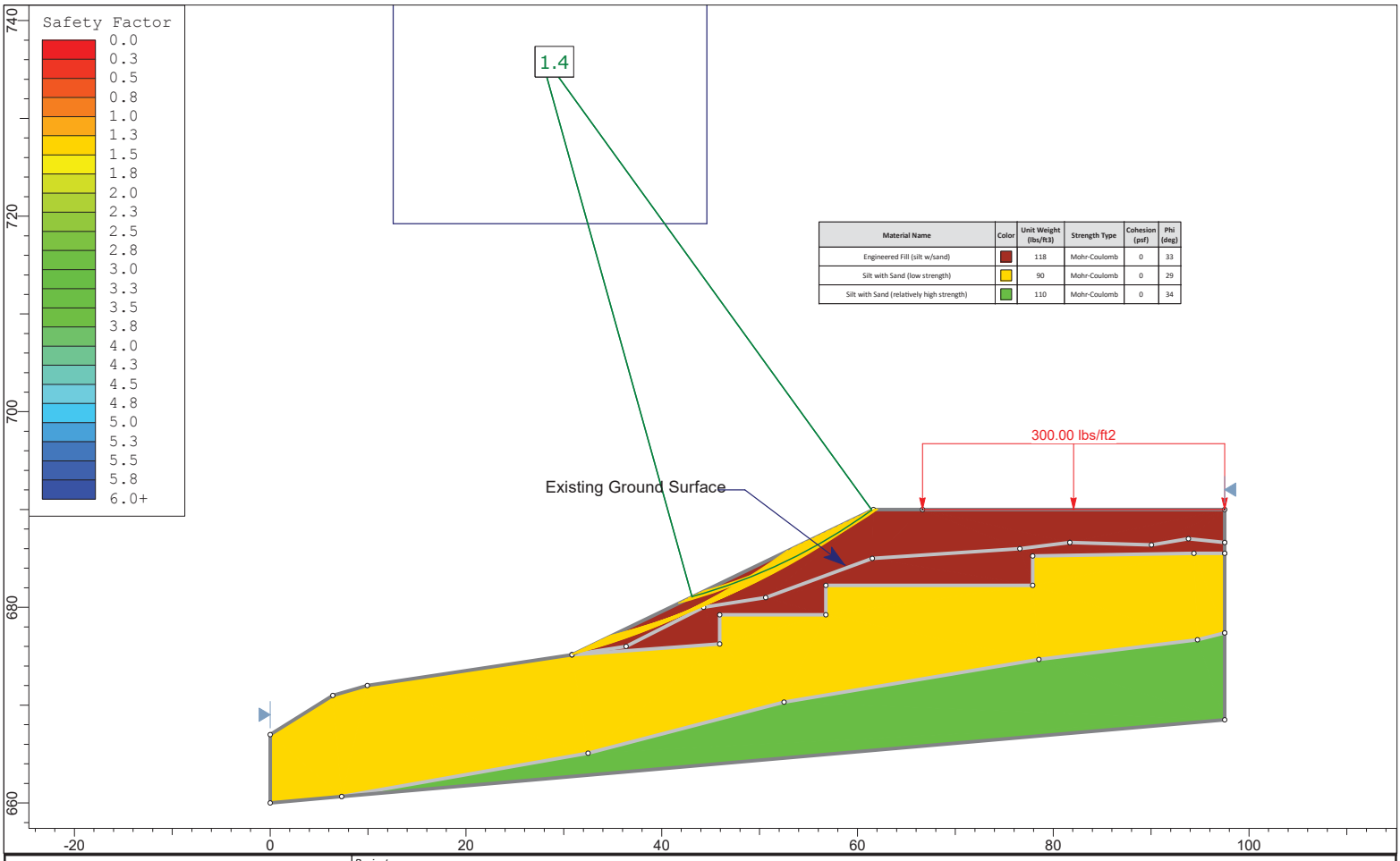


Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Engineered Fill (silty w/ sand)		118	Mohr-Coulomb	0	33
Silt with Sand (low strength)		90	Mohr-Coulomb	0	29
Silt with Sand (relatively high strength)		110	Mohr-Coulomb	0	34

Northern, Inc.
Consulting Engineers Environmental Scientists Geologists
Construction Materials Testing Geophysical Services

SLIDEINTERPRET 7.011

Project	Proposed 'Sunrise Ridge' Residential Development S. Olympia Street, Kennewick, Washington		
Analysis Description	Overall Pseudo-Static Slope Stability - Proposed 38-foot Tall Fill Slope		
Drawn By	Yong Lee	*Scale* 1:271	*Company* GN Northern, Inc
Date	February 24, 2016		*File Name* 38-foot_fill_slope_33 - Overall_PS.slim

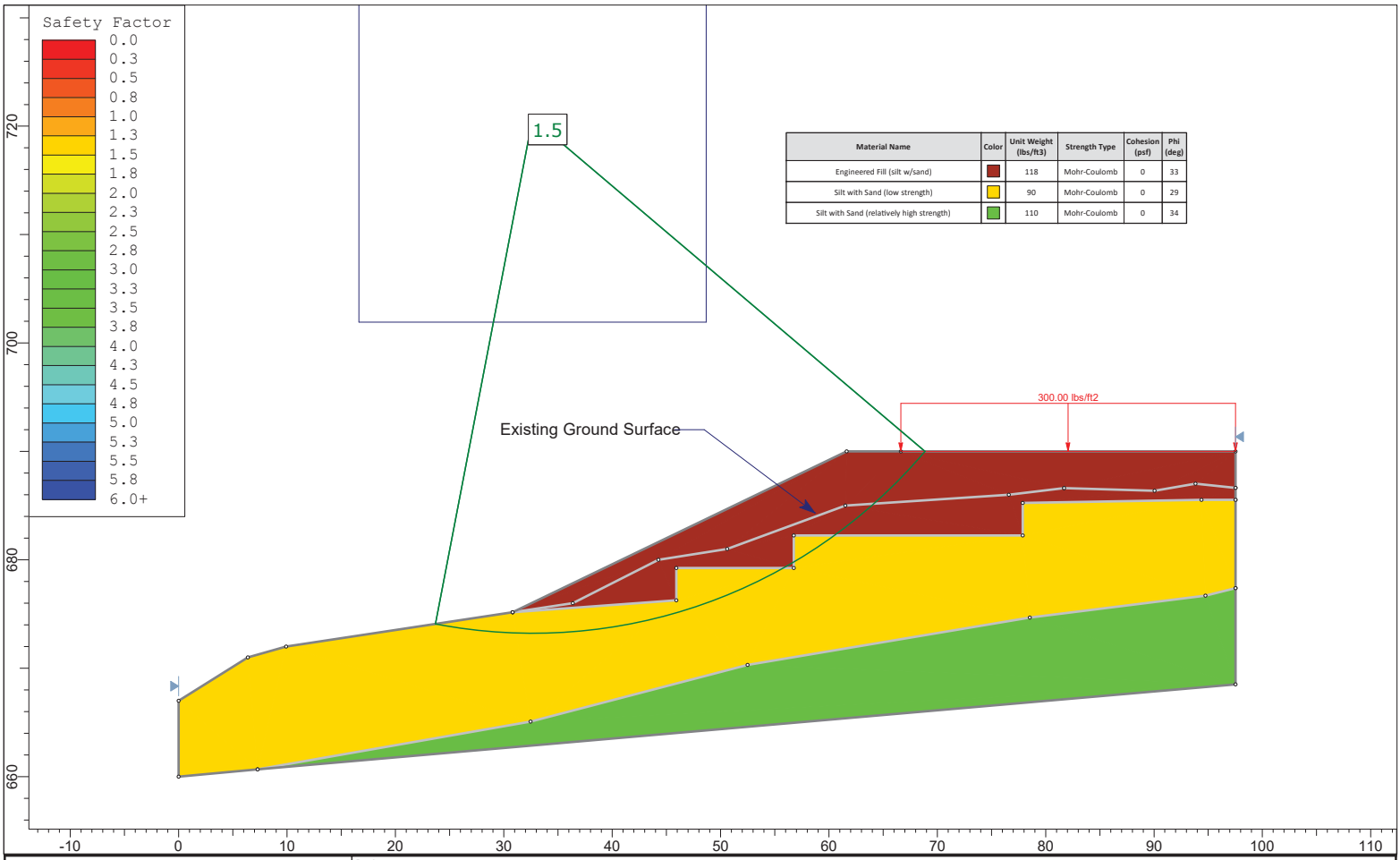


Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Engineered Fill (silt w/sand)		118	Mohr-Coulomb	0	33
Silt with Sand (low strength)		90	Mohr-Coulomb	0	29
Silt with Sand (relatively high strength)		110	Mohr-Coulomb	0	34

Northern, Inc.
Consulting Engineers Environmental Scientists Geologists
Construction Materials Testing Geophysical Services

SLIDEINTERPRET 7.011

Project	Proposed 'Sunrise Ridge' Residential Development S. Olympia Street, Kennewick, Washington		
Analysis Description	Local Static Slope Stability - Proposed 15-foot Tall Fill Slope		
Drawn By	Yong Lee	*Scale* 1:163	*Company* GN Northern, Inc
Date	February 24, 2016		*File Name* 15-foot_fill_slope - Overall.slim

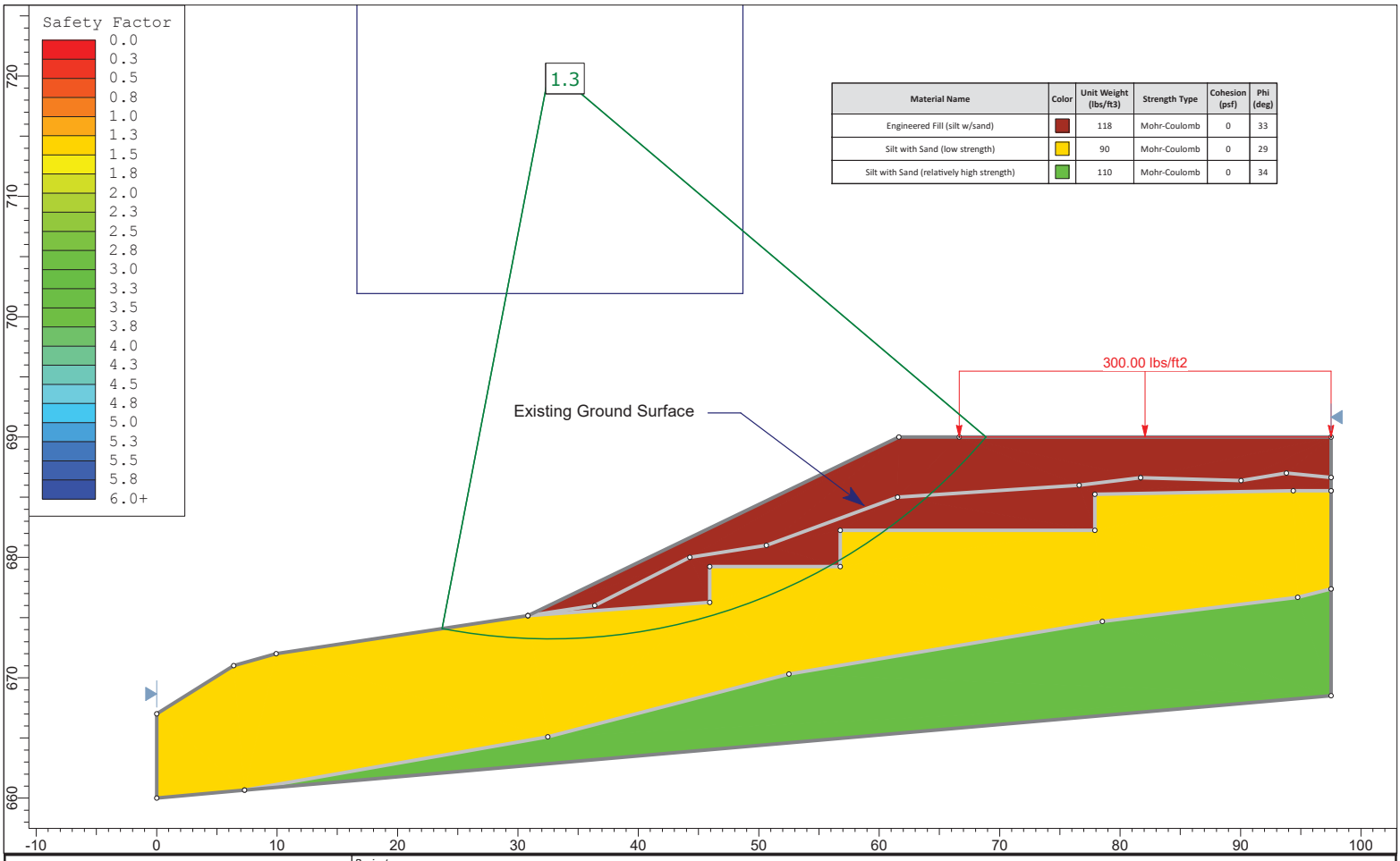


Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Engineered Fill (silt w/sand)		118	Mohr-Coulomb	0	33
Silt with Sand (low strength)		90	Mohr-Coulomb	0	29
Silt with Sand (relatively high strength)		110	Mohr-Coulomb	0	34

Northern, Inc.
Consulting Engineers Environmental Scientists Geologists
Construction Materials Testing Geophysical Services

SLIDEINTERPRET 7.011

Project	Proposed 'Sunrise Ridge' Residential Development S. Olympia Street, Kennewick, Washington		
Analysis Description	Overall Static Slope Stability - Proposed 15-foot Tall Fill Slope		
Drawn By	Yong Lee	*Scale* 1:147	*Company* GN Northern, Inc
Date	February 24, 2016		*File Name* 15-foot_fill_slope - Overall.slim

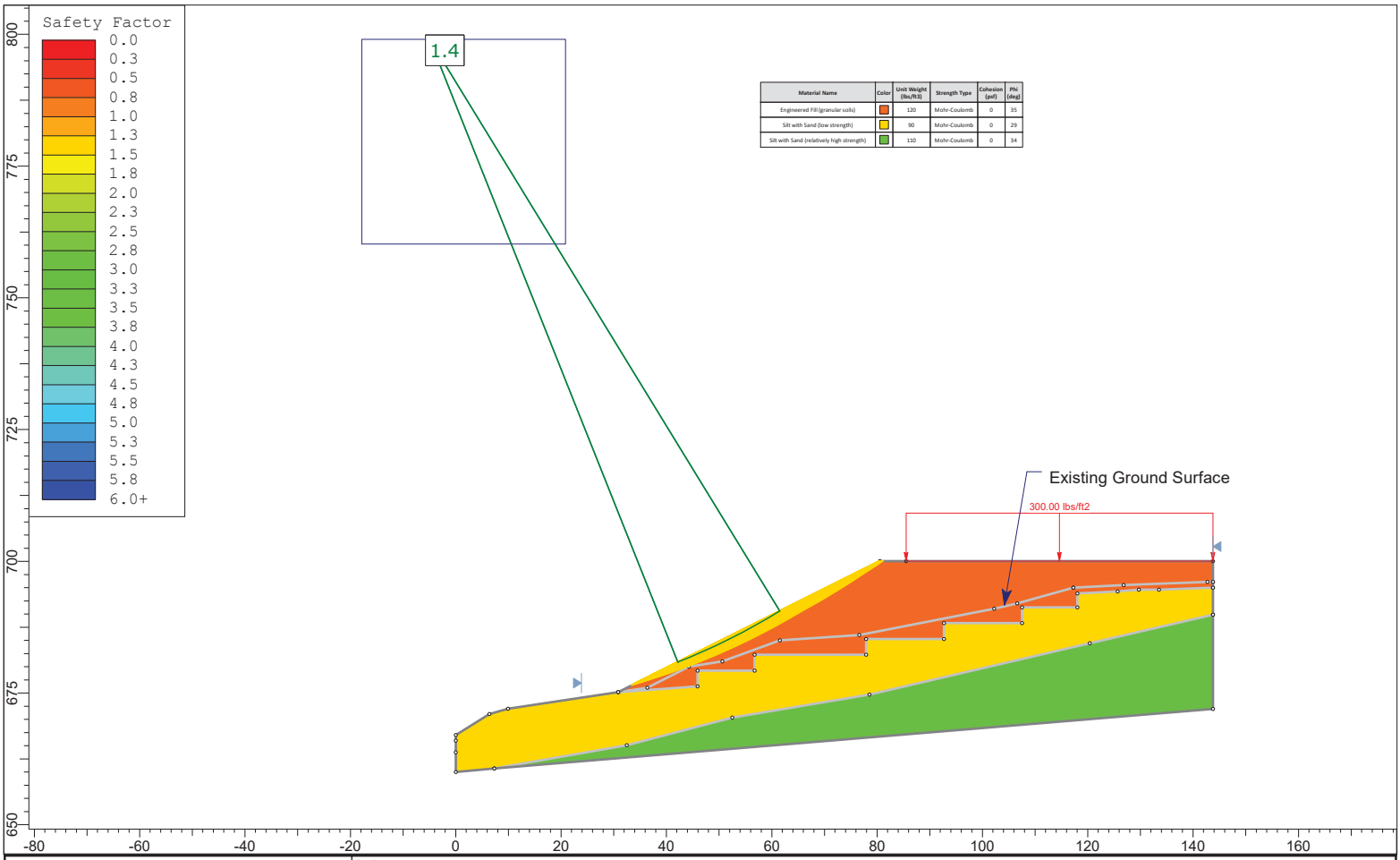


Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Engineered Fill (silt w/sand)		118	Mohr-Coulomb	0	33
Silt with Sand (low strength)		90	Mohr-Coulomb	0	29
Silt with Sand (relatively high strength)		110	Mohr-Coulomb	0	34

Northern, Inc.
Consulting Engineers Environmental Scientists Geologists
Construction Materials Testing Geophysical Services

SLIDEINTERPRET 7.011

Project	Proposed 'Sunrise Ridge' Residential Development S. Olympia Street, Kennewick, Washington		
Analysis Description	Overall Pseudo-Static Slope Stability - Proposed 15-foot Tall Fill Slope		
Drawn By	Yong Lee	*Scale* 1:132	*Company* GN Northern, Inc
Date	February 24, 2016		*File Name* 15-foot_fill_slope - Overall_PS.slim

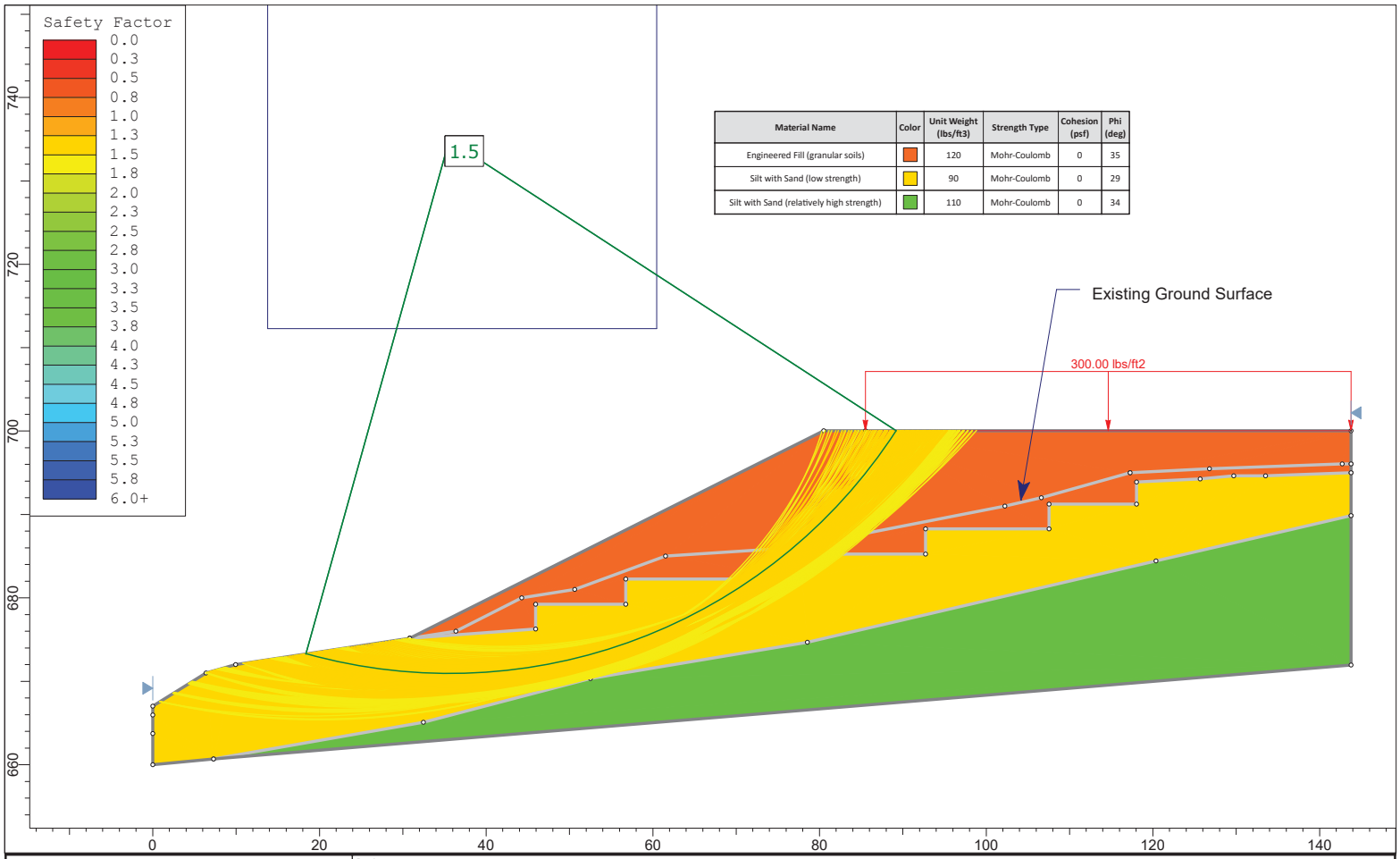


Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Engineered Fill (granular soils)		120	Mohr-Coulomb	0	35
Silt with Sand (low strength)		90	Mohr-Coulomb	0	29
Silt with Sand (relatively high strength)		110	Mohr-Coulomb	0	34

Northern, Inc.
Consulting Engineers Environmental Scientists Geologists
Construction Materials Testing Geophysical Services

SLIDEINTERPRET 7.011

Project	Proposed 'Sunrise Ridge' Residential Development S. Olympia Street, Kennewick, Washington		
Analysis Description	Local Static Slope Stability - Proposed 25-foot Tall Granular Fill Slope		
Drawn By	Yong Lee	*Scale* 1:302	*Company* GN Northern, Inc
Date	February 24, 2016		*File Name* 25-foot_fill_slope_35 - Local.slim

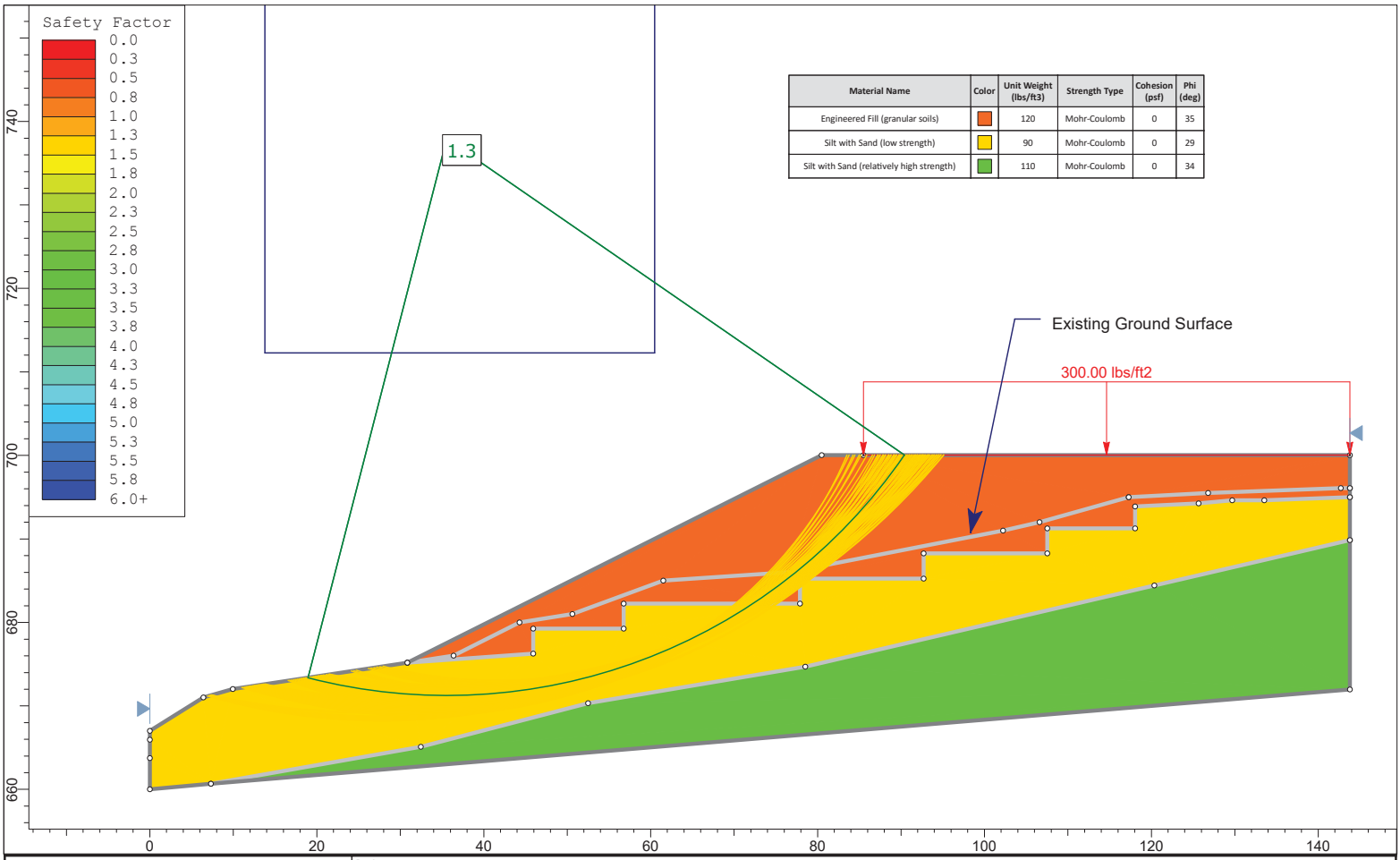


Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Engineered Fill (granular soils)		120	Mohr-Coulomb	0	35
Silt with Sand (low strength)		90	Mohr-Coulomb	0	29
Silt with Sand (relatively high strength)		110	Mohr-Coulomb	0	34

Northern, Inc.
Consulting Engineers Environmental Scientists Geologists
Construction Materials Testing Geophysical Services

SLIDEINTERPRET 7.011

Project	Proposed 'Sunrise Ridge' Residential Development S. Olympia Street, Kennewick, Washington		
Analysis Description	Overall Static Slope Stability - Proposed 25-foot Tall Granular Fill Slope		
Drawn By	Yong Lee	*Scale* 1:191	*Company* GN Northern, Inc
Date	February 24, 2016		*File Name* 25-foot_fill_slope_35 - Overall.slim



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Engineered Fill (granular soils)		120	Mohr-Coulomb	0	35
Silt with Sand (low strength)		90	Mohr-Coulomb	0	29
Silt with Sand (relatively high strength)		110	Mohr-Coulomb	0	34

Northern, Inc.
Consulting Engineers Environmental Scientists Geologists
Construction Materials Testing Geophysical Services

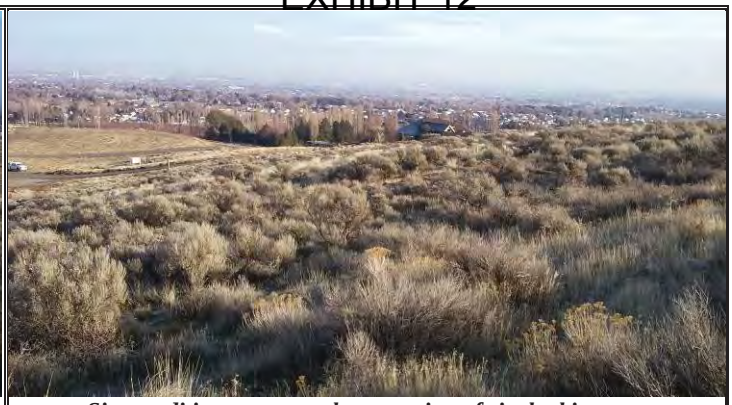
SLIDEINTERPRET 7.011

Project	Proposed 'Sunrise Ridge' Residential Development S. Olympia Street, Kennewick, Washington		
Analysis Description	Overall Pseudo-Static Slope Stability - Proposed 25-foot Tall Granular Fill Slope		
Drawn By Yong Lee	*Scale* 1:191	*Company*	GN Northern, Inc
Date February 24, 2016		*File Name*	25-foot_fill_slope_35 - Overall_PS.slim

APPENDIX V

Site & Exploration Photographs

Site conditions near southern portion of site looking north



Site conditions near southern portion of site looking east

Site conditions near southern portion of site looking west

Site conditions on western edge of site looking SW

Site conditions near southern portion of site looking NE

Site conditions near center of site looking NE

Site conditions near center of site looking SW

Site conditions near SE portion of site along access road

Northern, Inc.	**Site & Exploration Photographs** Proposed 'Sunrise Ridge' Residential Development S. Olympia Street Kennewick, Washington			
Job Number: 216-672	Date 2/22/2016	Mounted By: JS	Reviewed By: MYM	Plate 1

Site conditions near eastern portion of site looking SW

Slope conditions near eastern portion of site looking NE

Site/slope conditions near eastern portion of site looking NE

Site/slope conditions towards northern end of access road, looking SE

Slope conditions adjacent to KID Canal, east edge of site looking south

Site conditions parallel to KID Canal, NW edge of site looking SE

Site/slope conditions near northern portion of site looking NW

Site conditions along eastern property boundary looking north

Northern, Inc.	**Site & Exploration Photographs** Proposed 'Sunrise Ridge' Residential Development S. Olympia Street Kennewick, Washington			
Job Number: 216-672	Date 2/22/2016	Mounted By: JS	Reviewed By: MYM	Plate 2

Site conditions near northern portion of site looking NE

Site/slope conditions near northern portion of site along access road

Gully erosion noted in south-central portion of site along access road

Gully erosion noted in south-central portion of site along access road

Gully erosion noted in south-central portion of site along access road

Gully erosion noted along filled slope face in central portion of site

Gully erosion noted along filled slope face in central portion of site

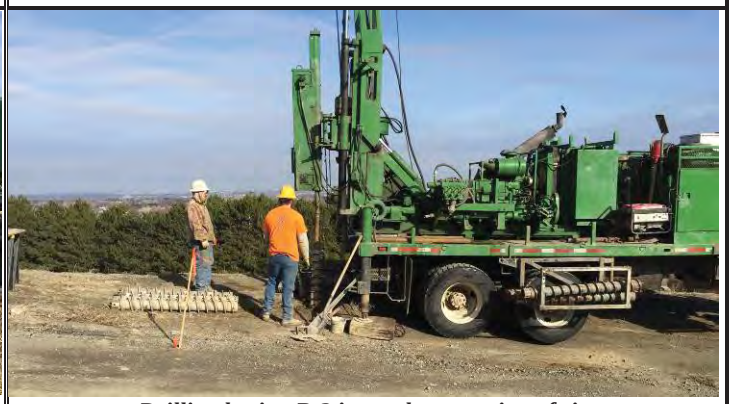
Stockpile soil/construction debris in north-central portion of site

Northern, Inc.	**Site & Exploration Photographs** Proposed 'Sunrise Ridge' Residential Development S. Olympia Street Kennewick, Washington			
Job Number: 216-672	Date 2/22/2016	Mounted By: JS	Reviewed By: MYM	Plate 3

Construction debris in north-central portion of site looking SW

Construction materials along access road, north-central portion of site

Drilling boring B-1 in northern portion of site



Drilling boring B-2 in northern portion of site

Drilling boring B-7 in southern portion of site

Drilling boring B-8 in southern portion of site

Split-spoon sample recovered from B-1 @ 15'

Split-spoon sample recovered from B-2 @ 7.5'

Northern, Inc.

Job Number: 216-672

Site & Exploration Photographs
Proposed 'Sunrise Ridge' Residential Development
S. Olympia Street
Kennewick, Washington

Date	Mounted By:	Reviewed By:	Plate
2/22/2016	JS	MYM	4

Split-spoon sample recovered from B-3 @ 2.5'

Split-spoon sample recovered from B-4 @ 25'

Split-spoon sample recovered from B-7 @ 17.5'

Split-spoon sample recovered from B-8 @ 25'

Split-spoon sample recovered from B-9 @ 40'

Excavating test-pit TP-2 in southern portion of site

Soil profile exposed in test-pit TP-2

Soil profile exposed in test-pit TP-3

Northern, Inc.	**Site & Exploration Photographs** Proposed 'Sunrise Ridge' Residential Development S. Olympia Street Kennewick, Washington			
Job Number: 216-672	Date 2/22/2016	Mounted By: JS	Reviewed By: MYM	Plate 5

Excavating test-pit TP-4 near central portion of site

Soil profile exposed in test-pit TP-4

Excavating test-pit TP-8 in eastern portion of site

Soil profile exposed in test-pit TP-8 (note trash/debris)

Uncontrolled fill with concrete debris from TP-8

Excavating test-pit TP-11 in NE portion of site

Very fine sand with lenses of coarse sand from TP-11

Excavating test-pit TP-13 in northern portion of site

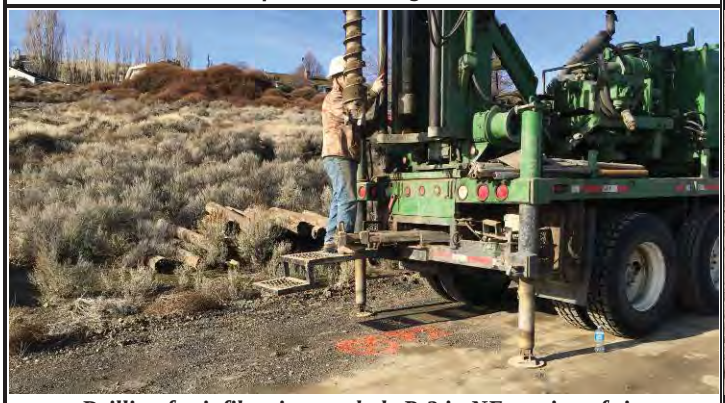
Northern, Inc.	**Site & Exploration Photographs** Proposed 'Sunrise Ridge' Residential Development S. Olympia Street Kennewick, Washington			
Job Number: 216-672	Date 2/22/2016	Mounted By: JS	Reviewed By: MYM	Plate 6

Soil profile exposed in test-pit TP-14

Drilling for infiltration test hole P-1 in northern portion of site

Infiltration testing at P-1

Pea gravel placed around test pipe in bottom of hole



Drilling for infiltration test hole P-2 in NE portion of site

Infiltration testing at P-3 near north-central portion of site

Drilling for infiltration test hole P-4 near western portion of site

Refilling P-4 from water tank

Northern, Inc.	**Site & Exploration Photographs** Proposed 'Sunrise Ridge' Residential Development S. Olympia Street Kennewick, Washington			
Job Number: 216-672	Date 2/22/2016	Mounted By: JS	Reviewed By: MYM	Plate 7

APPENDIX VI

Historic Aerial Photographs

HISTORIC plus Research Service

HistoricPlus.com
877-280-2239

Historic Plus Research Service Order ID:
H1979.1000

Completed: 10/28/2013

AERIAL PHOTO SEARCH

for the site:

OLYMPIA STREET PARCEL (213-422)
5353 S OLYMPIA ST
KENNEWICK, WA99337

46.160486 | -119.134236

Search Results Summary

Date	Source	Scale	Comment
2011	National Agriculture Information Program (NAIP)	700	
2005	National Agriculture Information Program (NAIP)	700	
1996	US Geological Survey (USGS)	700	
1988	US Geological Survey (USGS)	700	
1952	Army Mapping Service (AMS)	700	BEST COPY AVAILABLE

Date:	Scale:	Source:	JobID:	Project Number:
2011	1"=700'	NAIP	H1979.1000	213-422
Site Location:				Comment:
5353 S OLYMPIA ST KENNEWICK,WA				

HISTORIC plus Research Service

Date:	Scale:	Source:	JobID:	Project Number:
2005	1"=700'	NAIP	H1979.1000	213-422
Site Location:				Comment:
5353 S OLYMPIA ST KENNEWICK,WA				

HISTORIC plus Research Service

Date:	Scale:	Source:	JobID:	Project Number:
1996	1"=700'	USGS	H1979.1000	213-422
Site Location:				Comment:
5353 S OLYMPIA ST KENNEWICK,WA				

HISTORIC plus Research Service

Date:	Scale:	Source:	JobID:	Project Number:
1988	1"=700'	USGS	H1979.1000	213-422
Site Location:				Comment:
5353 S OLYMPIA ST KENNEWICK,WA				

HISTORIC plus Research Service

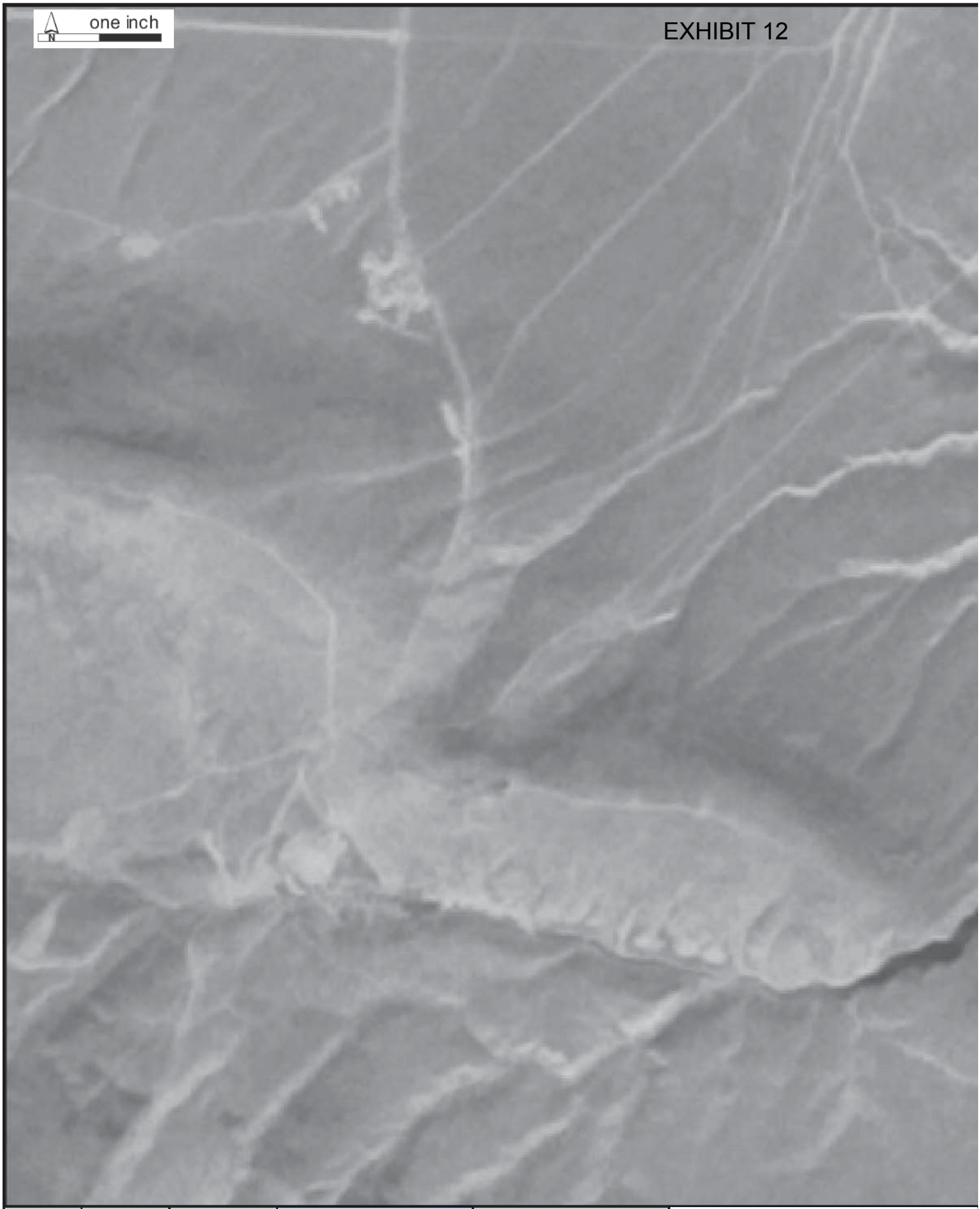


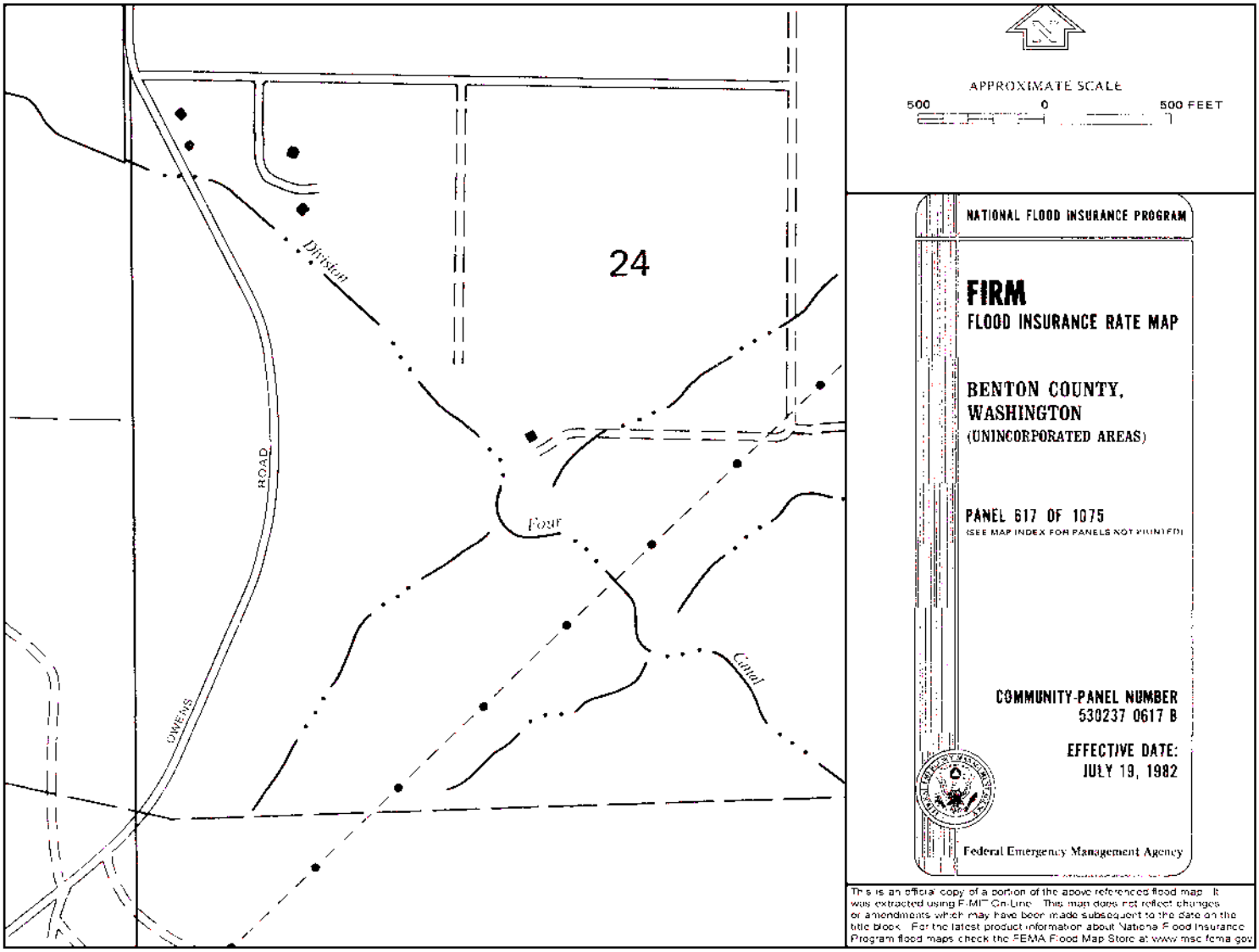
EXHIBIT 12

Date:	Scale:	Source:	JobID:	Project Number:
1952	1"=700'	AMS	H1979.1000	213-422
Site Location:				Comment:
5353 S OLYMPIA ST KENNEWICK,WA				BEST COPY AVAILABLE

HISTORIC plus Research Service

APPENDIX VII

FEMA Flood Map


24
Division
ROAD
OWENS
Four
Canal
APPROXIMATE SCALE
500
0
500 FEET
NATIONAL FLOOD INSURANCE PROGRAM
FIRM
FLOOD INSURANCE RATE MAP
BENTON COUNTY, WASHINGTON
(UNINCORPORATED AREAS)
PANEL 617 OF 1075
(SEE MAP INDEX FOR PANELS NOT PRINTED)
COMMUNITY-PANEL NUMBER
530237 0617 B
EFFECTIVE DATE:
JULY 19, 1982
Federal Emergency Management Agency
This is an official copy of a portion of the above referenced flood map. It was extracted using F-MIT On-Line. This map does not reflect changes or amendments which may have been made subsequent to the date on the title block. For the latest product information about National Flood Insurance Program flood maps check the FEMA Flood Map Store at www.msc.fema.gov

APPENDIX VIII
NRCS Soil Survey

EXHIBIT 12

United States Department of Agriculture

Natural Resources Conservation Service

A product of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local participants

Custom Soil Resource Report for

Benton County Area, Washington

Sunrise Ridge

EXHIBIT 12

Custom Soil Resource Report
Soil Map

Map Scale: 1:4,070 if printed on A portrait (8.5" x 11") sheet.

N

0 50 100 200 300 Meters

0 150 300 600 900 Feet

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 11N WGS84

Benton County Area, Washington

ShF—Shano silt loam, 30 to 65 percent slopes

Map Unit Setting

National map unit symbol: 2bdx
Elevation: 500 to 2,300 feet
Mean annual precipitation: 6 to 10 inches
Mean annual air temperature: 46 to 54 degrees F
Frost-free period: 125 to 200 days
Farmland classification: Not prime farmland

Map Unit Composition

Shano and similar soils: 100 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Shano

Setting

Landform: Hillslopes
Parent material: Loess

Typical profile

H1 - 0 to 8 inches: silt loam
H2 - 8 to 33 inches: silt loam
H3 - 33 to 60 inches: silt loam

Properties and qualities

Slope: 30 to 65 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.57 to 1.98 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum in profile: 15 percent
Salinity, maximum in profile: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water storage in profile: High (about 11.4 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7e
Hydrologic Soil Group: B
Ecological site: LOAMY 6-10 PZ (R007XY102WA)

WdAB—Warden silt loam, 0 to 5 percent slopes

Map Unit Setting

National map unit symbol: 2bfk
Elevation: 600 to 1,300 feet

Mean annual precipitation: 6 to 9 inches
Mean annual air temperature: 48 to 52 degrees F
Frost-free period: 135 to 200 days
Farmland classification: Prime farmland if irrigated

Map Unit Composition
Warden and similar soils: 100 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Warden

Setting
Landform: Terraces
Parent material: Loess over lacustrine deposits

Typical profile
H1 - 0 to 9 inches: silt loam
H2 - 9 to 19 inches: silt loam
H3 - 19 to 60 inches: stratified very fine sandy loam to silt loam

Properties and qualities
Slope: 0 to 5 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.57 to 1.98 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum in profile: 30 percent
Salinity, maximum in profile: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water storage in profile: High (about 11.8 inches)

Interpretive groups
Land capability classification (irrigated): 2e
Land capability classification (nonirrigated): 6e
Hydrologic Soil Group: B
Ecological site: LOAMY 6-10 PZ (R007XY102WA)

WdC—Warden silt loam, 5 to 8 percent slopes

Map Unit Setting
National map unit symbol: 2bfm
Elevation: 600 to 1,300 feet
Mean annual precipitation: 6 to 9 inches
Mean annual air temperature: 48 to 52 degrees F
Frost-free period: 135 to 200 days
Farmland classification: Farmland of statewide importance

Map Unit Composition
Warden and similar soils: 100 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Warden

Setting
Landform: Terraces
Parent material: Loess over lacustrine deposits

Typical profile
H1 - 0 to 9 inches: silt loam
H2 - 9 to 19 inches: silt loam
H3 - 19 to 60 inches: stratified very fine sandy loam to silt loam

Properties and qualities
Slope: 5 to 8 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.57 to 1.98 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum in profile: 30 percent
Salinity, maximum in profile: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water storage in profile: High (about 11.8 inches)

Interpretive groups
Land capability classification (irrigated): 3e
Land capability classification (nonirrigated): 6e
Hydrologic Soil Group: B

WdE3—Warden silt loam, 15 to 30 percent slopes, severely eroded

Map Unit Setting
National map unit symbol: 2bfp
Elevation: 600 to 1,300 feet
Mean annual precipitation: 6 to 9 inches
Mean annual air temperature: 48 to 52 degrees F
Frost-free period: 135 to 200 days
Farmland classification: Farmland of unique importance

Map Unit Composition
Warden and similar soils: 100 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Warden

Setting
Landform: Terraces
Parent material: Loess over lacustrine deposits

Typical profile
H1 - 0 to 2 inches: silt loam
H2 - 2 to 12 inches: silt loam

H3 - 12 to 60 inches: stratified very fine sandy loam to silt loam

Properties and qualities

Slope: 15 to 30 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.57 to 1.98 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum in profile: 30 percent
Salinity, maximum in profile: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water storage in profile: High (about 11.8 inches)

Interpretive groups

Land capability classification (irrigated): 6e
Land capability classification (nonirrigated): 6e
Hydrologic Soil Group: B
Ecological site: LOAMY 6-10 PZ (R007XY102WA)

APPENDIX IX

Washington Department of Ecology Well Log

EXHIBIT 12

File Original and First Copy with Department of Ecology
Second Copy — Owner's Copy
Third Copy — Driller's Copy

WATER WELL REPORT

STATE OF WASHINGTON

Application No. [redacted]
Permit No. [redacted]

(1) OWNER: Name Bill Burks Address 830 West "A" Pasco, Wa.

(2) LOCATION OF WELL: County Benton — ¼ ¼ Sec. 24 T. 8 N., R. 29 W.M.

Bearing and distance from section or subdivision corner 200 FT WASHINGTON ST + CAME FARM RD KENN.

(3) PROPOSED USE: Domestic ☒ Industrial ☐ Municipal ☐ Irrigation ☐ Test Well ☐ Other ☐

(4) TYPE OF WORK: Owner's number of well (if more than one)
New well ☒ Method: Dug ☐ Bored ☐
Deepened ☐ Cable ☐ Driven ☐
Reconditioned ☐ Rotary ☒ Jetted ☐

(5) DIMENSIONS: Diameter of well 6 inches.
Drilled 260 ft. Depth of completed well 260 ft.

(6) CONSTRUCTION DETAILS:

Casing installed: 6 " Diam. from 0 ft. to 136 ft.
Threaded ☐ " Diam. from ft. to ft.
Welded ☒ " Diam. from ft. to ft.

Perforations: Yes ☐ No ☐
Type of perforator used
SIZE of perforations in. by in.
perforations from ft. to ft.
perforations from ft. to ft.
perforations from ft. to ft.

Screens: Yes ☐ No ☐
Manufacturer's Name
Type Model No.
Diam. Slot size from ft. to ft.
Diam. Slot size from ft. to ft.

Gravel packed: Yes ☐ No ☐ Size of gravel:
Gravel placed from ft. to ft.

Surface seal: Yes ☒ No ☐ To what depth? 20 ft.
Material used in seal Bentonite
Did any strata contain unusable water? Yes ☐ No ☐
Type of water? Depth of strata
Method of sealing strata off

(7) PUMP: Manufacturer's Name JACUZZI
Type: SUBMERSIBLE H.P. 5

(8) WATER LEVELS: Land-surface elevation above mean sea level ft.
Static level 108 ft. below top of well Date
Artesian pressure lbs. per square inch Date
Artesian water is controlled by (Cap, valve, etc.)

(9) WELL TESTS: Drawdown is amount water level is lowered below static level
Was a pump test made? Yes ☐ No ☒ If yes, by whom?
Yield: gal./min. with ft. drawdown after hrs.
" " " "
" " " "

Recovery data (time taken as zero when pump turned off) (water level measured from well top to water level)

Time	Water Level	Time	Water Level	Time	Water Level

Date of test
Bailer test gal./min. with ft. drawdown after hrs.
Artesian flow g.p.m. Date
Temperature of water Was a chemical analysis made? Yes ☐ No ☒

(10) WELL LOG:

Formation: *Describe by color, character, size of material and structure, and show thickness of aquifers and the kind and nature of the material in each stratum penetrated, with at least one entry for each change of formation.*

MATERIAL	FROM	TO
Dirt sand & clay	0	131
Brown broken basalt	131	165
Black basalt	165	183
Black porous basalt with layer of clay	183	188
Black porous basalt 3 G.P.M.	188	193
Black fractured basalt	193	198
Brown decomposed basalt	198	203
Red decomposed basalt 4 G.P.M.	203	224
Black decomposed basalt	224	248
Black porous basalt 100 G.P.M.	248	260

RECEIVED
DEC 9 - 1977
DEPARTMENT OF ECOLOGY
CENTRAL REGIONAL OFFICE

Work started 10-21, 1977 Completed 10-25, 1977

WELL DRILLER'S STATEMENT:

This well was drilled under my jurisdiction and this report is true to the best of my knowledge and belief.

NAME H&H Drilling Inc. (Person, firm, or corporation) (Type or print)

Address Rt#2 Box 13-H Richland, Wa.

[Signed] James E. Haney (Well Driller)

License No. 0196 Date 10-26, 1977

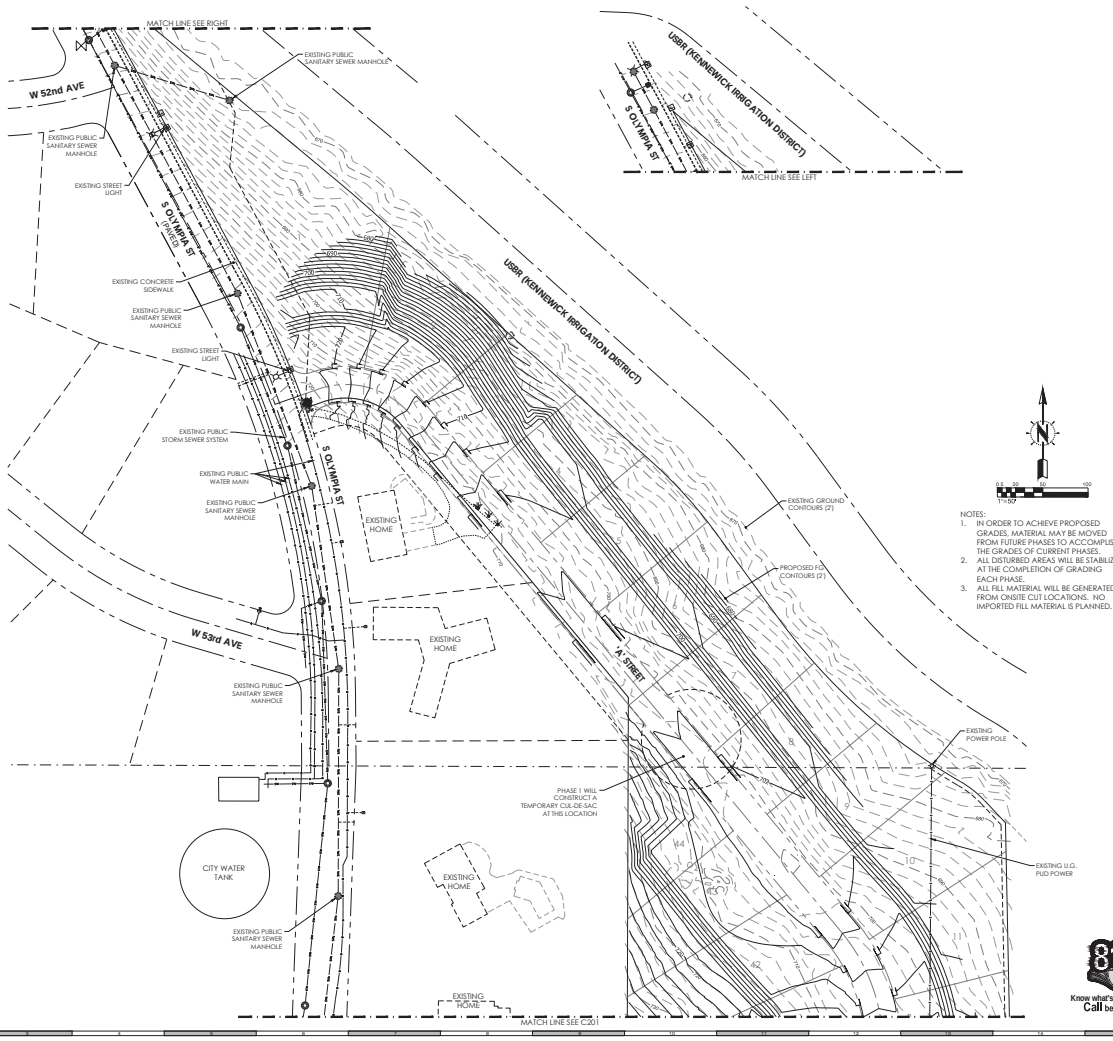
(USE ADDITIONAL SHEETS IF NECESSARY)

ECY 040-1-20

The Department of Ecology does NOT Warranty the Data and/or the Information on this Well Report.

APPENDIX X

Preliminary Site Grading Plan

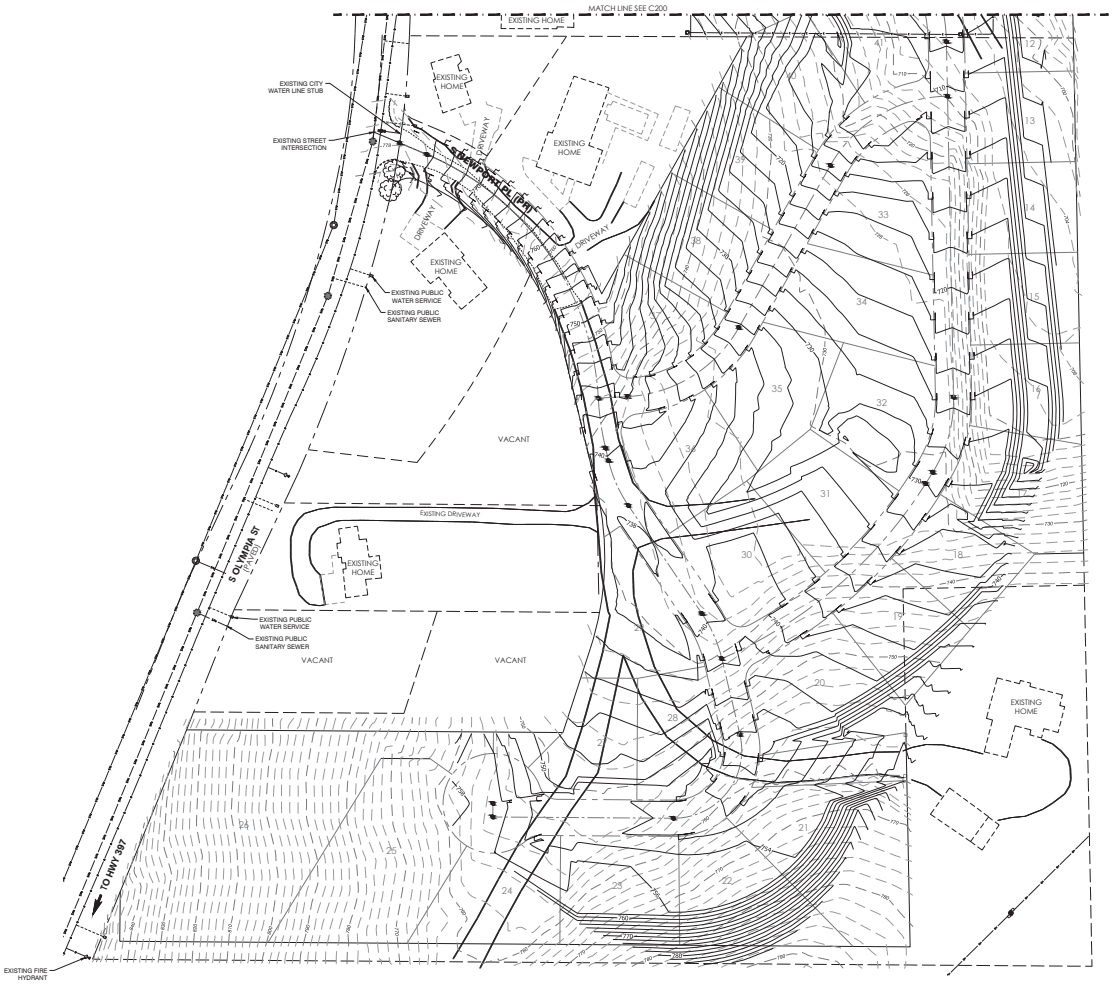


Existing conditions-north for
Sunrise Ridge Subdivision
A project in the City of, WA

S.J. Sunrise Development LLC
5623 S Newport Pl PR
Kennewick, WA 99336-4602

JF ENGINEERING, PLLC
CIVIL ENGINEERING
PLANNING
PROJECT MANAGEMENT
5220 S. Auburn Pl
(509) 30-8174 PRH
Kennewick, WA 99337
www.jfengineering.pro

Drawn by: JEF
Checked by: JEF
JF Eng. Job # 0032.00
Scale H: 1"=80'
Scale V: N/A
Date: FEB 18, 2016
C300



NOTES:
1. IN ORDER TO ACHIEVE PROPOSED GRADES, MATERIAL MAY BE MOVED FROM FUTURE PHASES TO ACCOMPLISH THE GRADES OF CURRENT PHASES.
2. ALL DISTURBED AREAS WILL BE STABILIZED AT THE COMPLETION OF GRADING EACH PHASE.
3. ALL FILL MATERIAL WILL BE GENERATED FROM ONSITE CUT LOCATIONS. NO IMPORTED FILL MATERIAL IS PLANNED.

Know what's below. Call before you dig.

Earling conditions-south for
Sunrise Ridge Subdivision
A project in the City of, WA

G.O. Sunrise Development LLC
5623 S Newport Pl PR
Kennewick, WA 99337-4402

JE ENGINEERING, PLLC
CIVIL ENGINEERING
PLANNING
PROJECT MANAGEMENT
Kennewick, WA 99337
www.jeengineering.pro
52203 - Auburn Pl
(509) 30-8174 PRH

Drawn by: JEF
Checked by: JEF
JF Eng. Job #
0052.00
Scale H: 1"=80'
Scale V: N/A
Date:
FEB 19, 2016
C301

J-U-B ENGINEERS, INC.

J-U-B COMPANIES THE LANGDON GROUP GATEWAY MAPPING INC.

February 25, 2016

John Deskins, PE, PTOE, Traffic Engineer
City of Kennewick
1010 E. Chemical Drive
Kennewick, WA 99308-0108

RE: SUNRISE RIDGE - TRIP GENERATION LETTER

Dear John:

J-U-B Engineers has prepared this Trip Generation Letter for the proposed Sunrise Ridge subdivision. It addresses all of appropriate items in the City of Kennewick Development Traffic Impact Criteria for a Level 2 development.

Site Information

Sunrise Ridge is a 44 unit single family residential subdivision situated east of Olympia Street south of the Kennewick Irrigation Canal and at the southern boundary of the City of Kennewick. It has two proposed accesses to Olympia Street that occur at existing driveway accesses, one approximately 300' north of 53rd Avenue and the other approximately 550' south of 53rd Avenue. Three local roadways provide the internal circulation for the development, with the two access roadways to Olympia Street being connected as well as one other connection between the two. A site plan and vicinity map are attached. Three phases are planned for the development, with the first beginning in 2016 and all phases anticipated to be completed within 5 years.

The proposed subdivision currently is comprised of two lots that total 22.89 acres that are Zoned Residential. The Comprehensive Plan designates these parcels as well as the surrounding land as Low-Density Residential. Olympia Street was recently widened from a two-lane county road to now include three lanes with a two-way left turn lane, shoulders and sidewalks. The speed limit is 35 MPH.

Trip Generation and Distribution

The Institute of Transportation Engineers (ITE) Trip Generation Manual (9th Edition) provides anticipated rates for residential developments (Land Use 210, Single Family Residential) as follows:

- Average Weekday Traffic – average rate of 9.57 trips per unit. With 44 residences this would result in 421 trips.
- AM Peak Hour of the adjacent roadway network – average rate of 0.75 trips per unit, resulting in 33 AM Peak Hour trips (8 inbound and 25 outbound).
- PM Peak Hour of the adjacent roadway network – average rate of 1.01 trips per unit, resulting in 44 PM Peak Hour trips (28 inbound 16 outbound).

For the purposes of this trip generation letter, no pass-by trips and no diverted trips are assumed, thus all of the trips are expected to be new trips to the roadway network.

a 2810 W. Clearwater Avenue, Suite 201, Kennewick, WA 99336 p 509 783 2144 f 509 736 0790 w www.jub.com

A preliminary trip distribution pattern is shown on the attached vicinity map. It is estimated that approximately 10% of inbound and outbound trips will be to/from the south on Olympia Street, 10% to/from the east on 45th Avenue, 20% to/from the west on 45th Avenue and 60% to/from the north on Olympia Street towards 27th Avenue.

Traffic Calming

Due to the inclusion of one segment of roadway ("A" Street) that is longer than 600 feet that has no curvature, and therefore the potential of higher operating speeds, a discussion of traffic calming was warranted. The straight segment is approximately 750 feet in length. To achieve the desired traffic calming effect to improve neighborhood livability, it is recommended that a single speed hump be installed on "A" Street . This speed hump should be installed consistent with the requirements identified in KAC 13.40, during Phase 2, likely on the southern lot line for Lot 7.

We hope that this letter adequately addresses all of the appropriate issues. If there are any questions, please contact us.

Sincerely,
J-U-B ENGINEERS, Inc.

Richard H. Door, P.E.

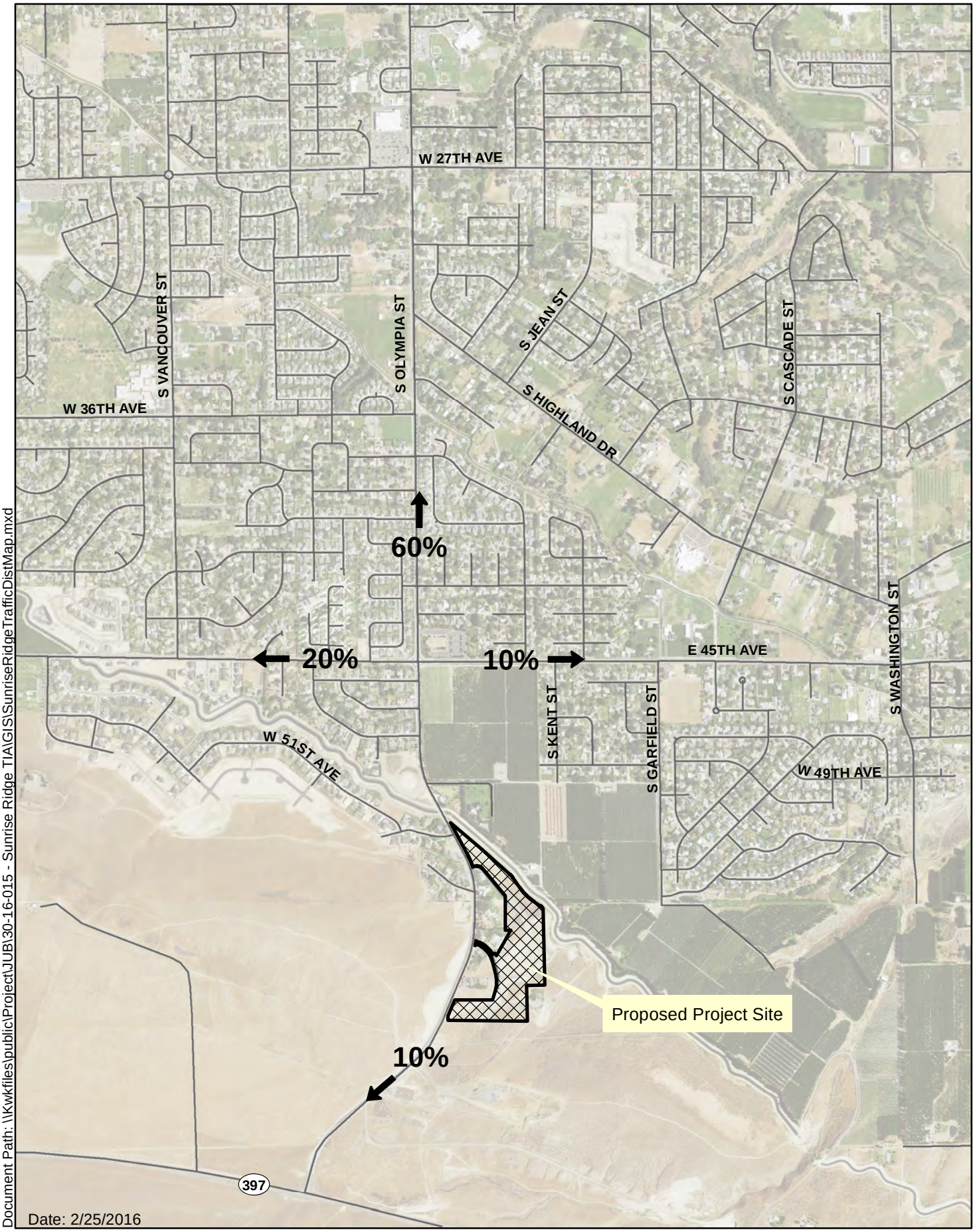
Spencer Montgomery
Transportation Planner

SDM:

Attachments: Trip Distribution, Preliminary Plat

c: Wes Romine
John Fetterolf
Jim Aust

EXHIBIT 13



Document Path: \\Kwkfiles\public\Project\JUB\30-16-015 - Sunrise Ridge TIA\GIS\SunriseRidgeTrafficDistMap.mxd

Date: 2/25/2016

J-U-B ENGINEERS, INC.

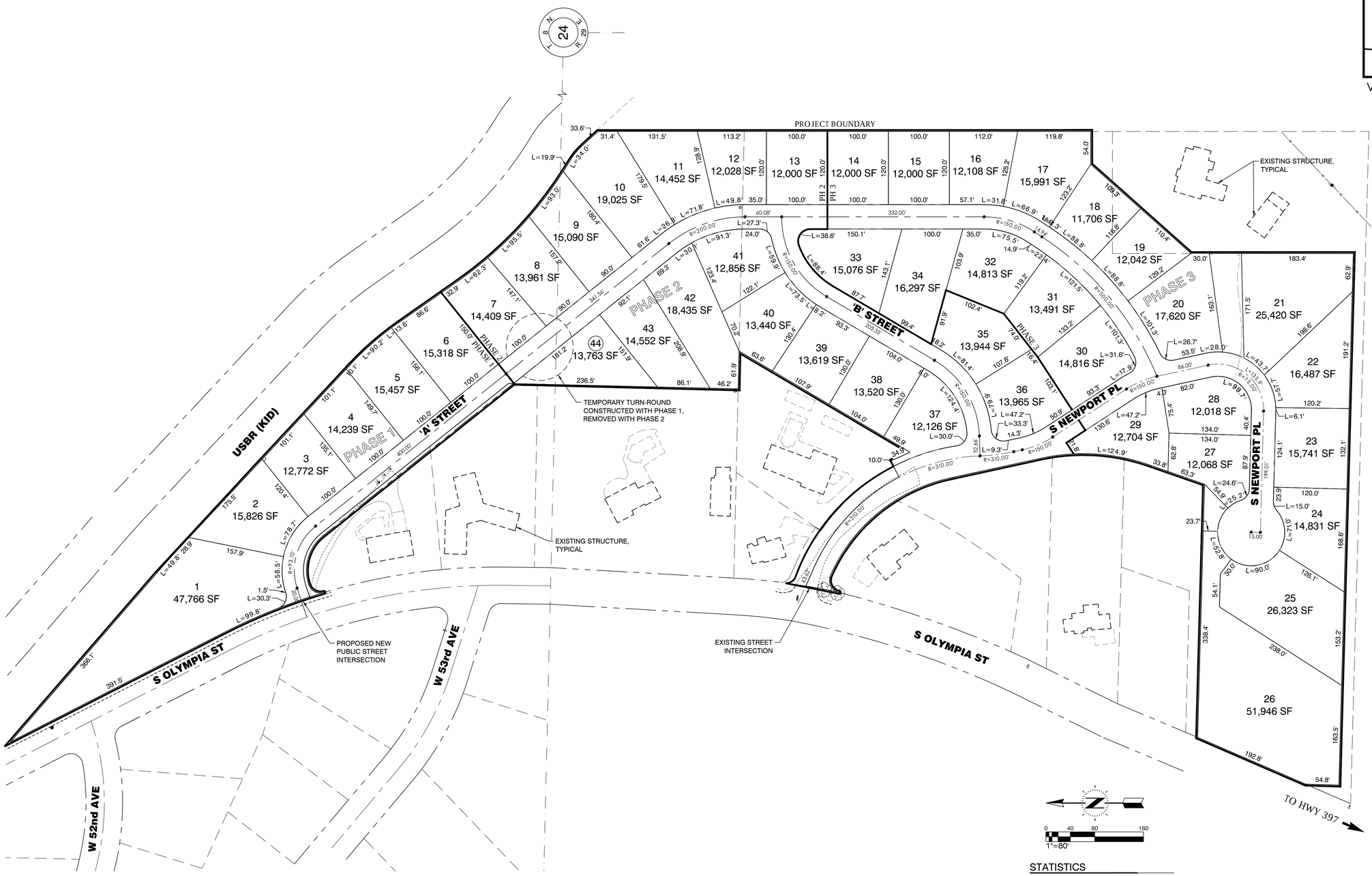
Sunrise Ridge Preliminary Plat

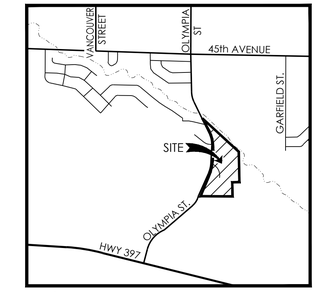
Trip Distribution

EXHIBIT 13

SUNRISE RIDGE

LOCATED IN THE W ½ OF SEC 24, T 8 N, R 29 E OF THE WILLAMETTE MERIDIAN





VICINITY MAP 1"=2,000'±

STATISTICS

COMPREHENSIVE PLAN DESIGNATION: LDR
LAND USE ZONING DESIGNATION: RS

TOTAL PROJECT AREA: nnAc
PROPOSED # LOTS: 44
AVERAGE LOT SIZE: nnn SF
MIN. LOT SIZE:

Know what's **below.** **Call** before you dig.

JOHN ERIC FELLEMAN STATE OF WASHINGTON 38322 REGISTERED PROFESSIONAL ENGINEER

PRELIMINARY

DJ Sunrise Development LLC
5207 S Shoport Place
Kennewick, WA 99337-4632

JF ENGINEERING, PLLC
CIVIL ENGINEERING
PLANNING
PROJECT MANAGEMENT
5220 S. Auburn Pl
(509) 531-8174 PHN
Kennewick, WA 99337
www.JFengineering.pro

Preliminary plat for:
Sunrise Ridge Subdivision
A project in the City of , WA

Drawn by: JEF
Checked by: JEF

JF Eng. Job # 0032.00

Scale H: 1"=80'
Scale V: N/A

Date: FEB 26, 2016

C101