ecology and environment, inc.
Global Environmental Specialists
720 Third Avenue, Suite 1700
Seattle, Washington 98104
Tel: (206) 624-9537, Fax: (206) 621-9832

July 5, 2016

Mr. Dan Heister
On-Scene Coordinator
United States Environmental Protection Agency – Region 10
805 SW Broadway Avenue, Suite 500
Portland, Oregon 97205

RE: Contract No. EP-S7-13-07; Technical Direction Document No. 14-06-0006
Bonanza Mine Site – DRAFT After Action Report and Alternatives Analysis

Dear Mr. Heister:

Enclosed please find the DRAFT After Action Report and Alternatives Analysis for the Bonanza Mine Site. If you have any questions about this report, please call Jim Petersen at 907-257-5000 or me at 206-624-9537.

Sincerely,

ECOLOGY AND ENVIRONMENT, INC.

Steven G. Hall
START-IV Removal Team Leader

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DRAFT AFTER ACTION REPORT AND ALTERNATIVES ANALYSIS

Bonanza Mine Site
Nonpareil, Oregon
TDD: 14-06-0006

July 2016

Prepared for:

U.S. Environmental Protection Agency, Region 10
1200 Sixth Avenue, Suite 900
Seattle, Washington 98101

Prepared by:

ECOLOGY AND ENVIRONMENT, INC.
720 Third Avenue, Suite 1700
Seattle, Washington 98104

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List of Abbreviations and Acronyms

Centerline	Centerline Concepts Land Surveying, Inc.
cm/s	centimeters per second
cfs	cubic feet per second
DOGAMI	Oregon Department of Geology and Mineral Industries
E & E	Ecology and Environment, Inc.
EPA	U.S. Environmental Protection Agency
ERRS	Emergency and Rapid Response Services
FOS	factors of safety
ft/s	feet per second
ft^2	square foot
GDC	geosynthetic drainage layer
GPS	global positioning system
HDPE	high-density polyethylene
LLDPE	low-linear density polyethylene
m^2/s	meters squared per second
MVA	mercury vapor analyzer
ODEQ	Oregon Department of Environmental Quality
ODOT	Oregon Department of Transportation
pcf	pounds per cubic foot
Site	Bonanza Mine Site
START	Superfund Technical Assessment and Response Team
TDD	Technical Direction Document
yd^3	cubic yards

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1 Introduction

Ecology and Environment, Inc. (E & E) has been tasked by the U.S. Environmental Protection Agency (EPA) under Superfund Technical Assessment and Response Team (START)-IV contract number EP-S7-13-07, Technical Direction Document (TDD) 14-06-0006, to provide support for an After Action Report and Alternatives Analysis at the Bonanza Mine Site (Site).

In 2014, EPA performed a time-critical removal action at the Site that entailed placing the majority of waste materials into an on-site repository under a protective cover consisting of an impermeable membrane with a vegetated soil cover. The Site consisted of a former mercury mine and mill that operated from the mid-1860s to the 1960s and produced more than 3,000,000 pounds of mercury. EPA performed the removal action to mitigate the potential human health and ecological threats posed by exposure to mercury and arsenic, including direct contact, ingestion, and inhalation pathways. The removal action was initiated on August 4, 2014 and all personnel were demobilized from the Site by December 6, 2014. At that time, EPA turned over the responsibility of maintaining, monitoring, and repairing of Site features to the property owner under Oregon Department of Environmental Quality (ODEQ) oversight.

On Wednesday, January 13, 2016 Bryn Thoms, ODEQ project manager for the Site, received a call from Don Smith, property owner of the Site, who indicated that a slide of the repository cover material had occurred within the last two days, likely during the heavy rains earlier that week (on or about Jan 12, 2016).

On Friday January 15, 2016, Mr. Thoms made a site visit to preliminarily assess and document the slide. Upon observing the slide, he estimated that approximately two-thirds of the repository cover material showed evidence of movement. Dan Heister, EPA On-Scene Coordinator; Jake Moersen and Tom Campbell, START members; and Mark Conway with the Emergency and Rapid Response Services (ERRS) contractor performed a site visit on February 24 and 25, 2016 to inspect the slide, document on-site conditions, and assess repair alternatives. During the Site visit, the face of the repository was visually inspected and samples of cover material were collected for geotechnical and agronomic testing. The conditions of the cover were photo-documented and the area of the slide was mapped using a hand-held global positioning system (GPS) device.

EPA tasked START to complete this After Action Report and Alternatives Analysis following the Site visit. This report is composed of four sections. Section 1 presents the introduction, states the purpose for developing the report, and summarizes background information about the Site. Section 2 presents an overview of the existing Site conditions, preliminary surveys, and investigations to assist in determining factors that led to the slide, and Section 3 presents repair alternatives and describes additional considerations for planning of a removal action aimed at cap repair. Section 4 is a list of the references used in this report.

1.1 Site Description and Background

The Bonanza Mine Site is an abandoned historical mercury mine and mill located near the small community of Nonpareil 6 miles east of Sutherlin, Douglas County, Oregon (Figures 1-1 and 1-2). The Site is located within the southwest quarter of Section 16, Township 25 South, Range 4 West, Willamette Meridian (E & E 1999).

Discovery of the Bonanza Mine occurred between 1865 and 1870. In May 1939, the main ore body was discovered and by the end of 1944, the mine had become Oregon's largest all-time producer of quicksilver. Other than some short closures from 1949 to 1951 and in 1954, the mine operated continuously until October 1960 when minable reserves were exhausted and the mine closed.

Records of the property are incomplete from 1960 until 2000, at which time EPA performed a site investigation at the property. For the next 15 years, EPA and the ODEQ performed a variety of field events and surveys at the property. In February 2014, ODEQ initiated a time-critical removal action to achieve prompt human health risk reduction by removing and capping soil in certain inhabited areas of the Site that were impacted by elevated concentrations of mercury and arsenic. The removal action left large swaths of contamination in place because of the complexity of Site conditions, including the Site's location on steep forested terrain and limited availability of funds and other resources.

By 1951, the mine had 12 adits and more than three miles of subterranean tunnels and shafts (USGS 1951). Except for one former building used as a residence, mine and mill buildings were no longer present at the beginning of the 2014 removal action, leaving only the mill concrete foundations, waste rock pile, and calcine (retorted ore and associated tailings) pile. Prior to the EPA removal action, ruderal habitat on the Site included actively logged hillsides, waste rock piles, calcine piles, logging roads and valley floor, and rural residential land uses.

In April 2014, EPA performed a pre-removal survey/sampling event at the Site along with ODEQ, a START engineer, and an ERRS response manager. EPA mobilized to the Site in August 2014 to perform a time-critical removal action at the Site, including the former mill site and associated areas downgradient of the mine waste and calcine piles. EPA identified two additional locations associated with recently inhabited manufactured homes for removal activities.

In total, EPA removed 38,500 cubic yards (yd^3) of mine-waste contaminated material during the removal action. The excavated material was placed with approximately 130,000 yd^3 of preexisting calcine and waste rock in a designed repository constructed on Site. The total face of the repository was 196,000 square feet (ft^2), or nearly five acres in size. The repository was covered with a cap that consisted of an impermeable liner composed of low-linear density polyethylene (LLDPE); a geosynthetic drainage composite (GDC) liner on top of the LLDPE liner to allow for infiltrated water drainage; and then approximately 24 inches of vegetated soil. During the removal action, the quantity of waste materials encountered were greater than estimated during the pre-removal design phase, and several design changes were implemented to increase the size of the repository and to accommodate the additional quantity of waste material. The drainage systems were expanded to accommodate increased volumes of surface water runoff from the repository face.

The excavated areas were backfilled and graded with 44,500 yd^3 of clean backfill obtained from off-Site quarries and on-Site source locations. Pre-existing grades were restored and disturbed areas were stabilized by placing slash material for erosion control and seeding.

During the removal action, EPA also removed two manufactured homes that were contaminated with elevated concentrations of mercury and other contaminants. The homes were transported for off-site disposal and replaced with similar manufactured homes for site residents.

Figure 1-3 shows the site layout upon completion of removal activities.

The Removal Action Report for the Bonanza Mine 2014 Removal Action (E & E 2015) contains additional information concerning previous site investigations and ensuing cleanup actions.

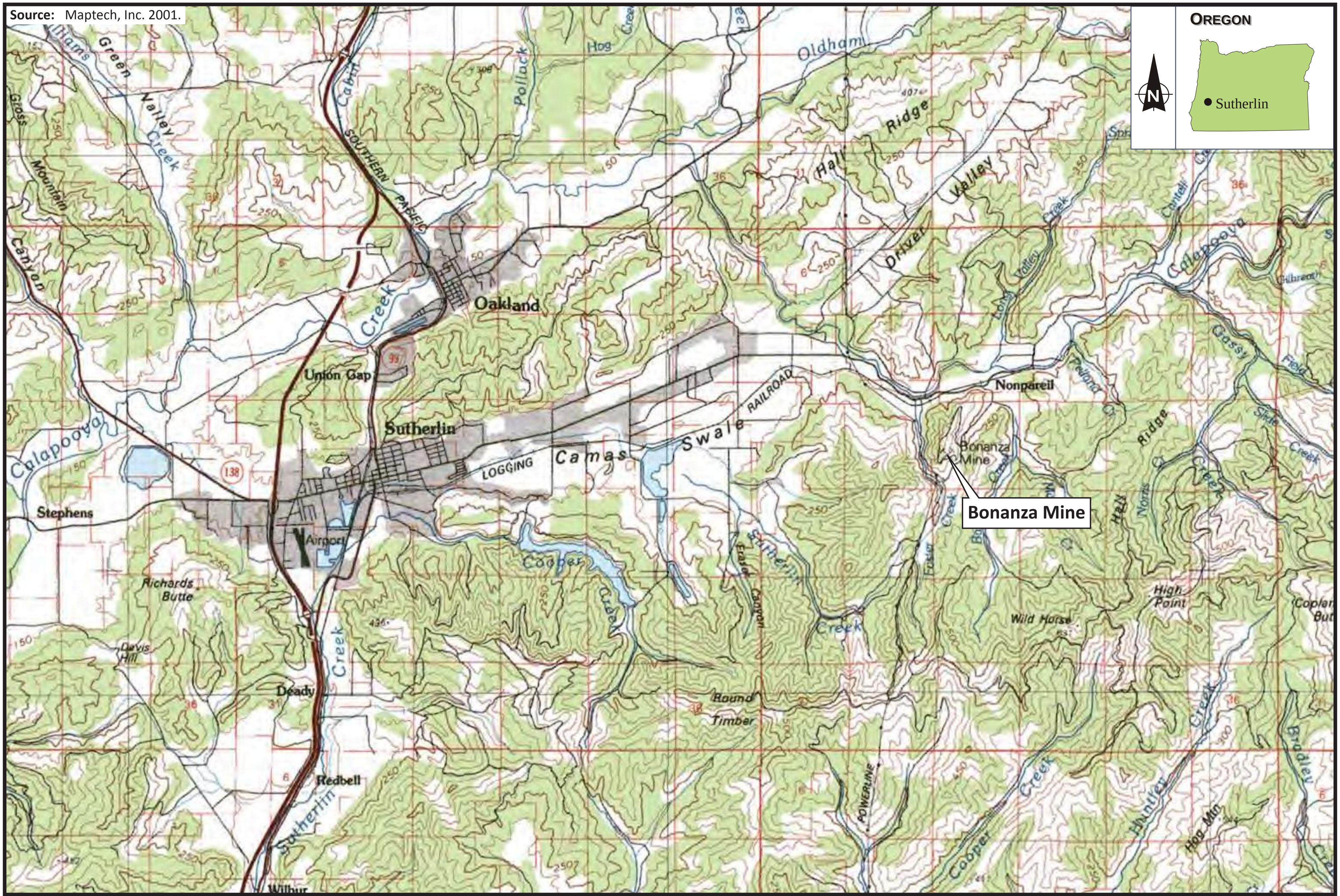
1.2 Purpose of the Report

The purpose of this After Action Report and Alternatives Analysis is to compile, for EPA Region 10 and stakeholder review, the functional and technical requirements and provisions applicable to understanding the mechanisms leading to the 2016 repository cap slide, which include the following:

- Work plan assumptions and parameters, including technical and functional restrictions based on results of previous investigations;
- Channel design calculations, including determination of hydrologic, hydraulic, and slope stability characteristics;
- Interpretation of recent survey, geotechnical and agronomic data with comparisons to work plan assumptions and parameters;
- Underground workings investigation and analysis with limitations found in that mapping; and

- Recommendations for repair.

Following submittal of this After Action Report and Alternatives Analysis the scope and direction of the project will be discussed and agreed upon between EPA Region 10, ERRS, and START so that Work Plan and Conceptual Design Report documents may be prepared. The Work Plan and Conceptual Design Report will be a comprehensive set of documents designed to meet the objectives established for repairs at the Site.



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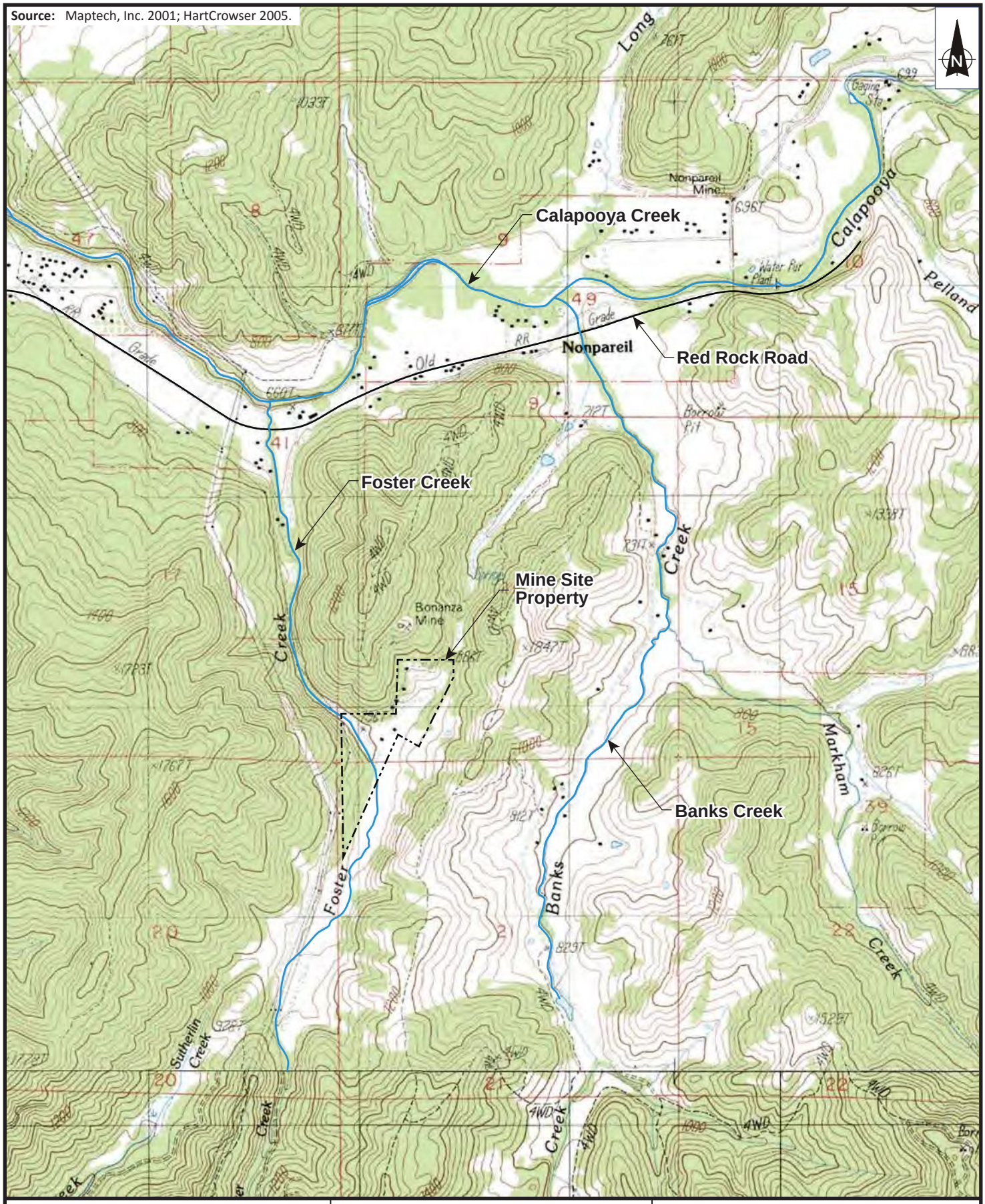
BONANZA MINE SITE Sutherlin, Oregon	Figure 1-1 SITE LOCATION MAP		
0 .75 1.5 Approximate Scale in Miles	Date: 6/27/16	Drawn by: AES	10:START-IV\14060006\fig 1-1



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BONANZA MINE SITE
Sutherlin, Oregon

Figure 1-2
SITE VICINITY MAP

0 1000 2000
Approximate Scale in Feet

Date:	Drawn by:	
6/27/16	AES	10:START-IV\14060006\fig 1-2

Source: © 2014 Microsoft Corporation (Bing); HartCrowser 2005; Apex Companies LLC 2014.

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RESIDENCE 1

BLM Road 25-4-9.0

REPOSITORY

Service Pole and Meter

Gravel Backfill

MILL SITE

Vegetation

Rocked Drainage Swale

RESIDENCE 2

Service Pole and Meter

RESIDENCE 6

Bonanza Mine Road

Vegetation

AREA 1

Shallow Pond

BLM Road 25-4-9.0

Rocked Drainage Swale

AREA 2

Residence 3

Gravel Backfill

Vegetation

Residence 4

PUMP HOUSEPUMP HOUSE

AREA 4

Drain Field

Residence 5

Property Boundary

Vegetation

Gravel Backfill

EPA COMMAND POST & BORROW SOURCEEPA COMMAND POST& BORROW SOURCE

Foster Creek

Bonanza Mine Road

Key:

- Creek
- Removal Action Areas
- Repository
- Project Boundary
- Drain Field
- Rocked Drainage Swale
- Current Home Location
- Gravel Backfill
- Vegetation
- Culvert

Note: Contamination may be present in all other areas not included in the removal action.

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BONANZA MINE SITE
Sutherlin, Oregon

Figure 1-3
POST-REMOVAL SITE FEATURES

Not to Scale

Date: 7/1/16

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2 Existing Site Conditions, Surveys, Data Collection and Interpretation

This section details the existing site conditions at the time of the February 2016 Site inspection. Additional site surveys and investigations performed to determine site conditions following the slide are also presented.

2.1 Existing Cover Conditions

During the February 24 and 25, 2016 Site inspection, visual observation revealed that a cover material slide had occurred on the repository cover that exposed the underlying LLDPE liner. A portion of the slide was oriented toward the south as it was located on the southern facing slope of the repository (the south face). Another portion of the slide was located on the northern end of the repository that is facing toward the east (the northeast face). The east-facing portion of the repository toward the southern end (the southeast face) did not have apparent slide activity (Photo 2-1).

Photo 2-1: Slide areas.

The south face had less area of vertically exposed liner and the slide had occurred in the southern direction along the orientation of the underlying drainage layer seams. Starting from the upper location of the south face slide, the northeast face had slid to the east along the orientation of the underlying drainage layer. The northeast face had more exposed liner since it had slid a greater distance toward the repository toe. Upon both slide faces, the zone of depletion (the area where cover material slid leaving it lower than the original ground surface) removed both the cover soil and the GDC drainage material down to the LLDPE liner. A zone of accumulation (the area at the bottom of the slide where cover material accumulated above the original ground surface) was observed below each of the slide areas as mounding of soil deposited in a

hummocky formation. The LLDPE liner appeared visually intact. START screened the slide area with a Lumex Mercury Vapor Analyzer (MVA); no elevated readings were detected with the Lumex MVA. Additional photographs of the Site including the slide area are located in Appendix A.

The GDC was observed along the edge of many areas of the slide just above the LLDPE liner. The GDC is composed of a polyethylene Geonet and nonwoven, polypropylene, needle-punched geotextile joined by heat lamination. During construction, the liner installation subcontractor attached the GDC panels in place with zip ties and then heat fused overlapping geotextile fabric together. Upon visual inspection, the GDC had separated at seams in some areas while in others it had sheared. In the sheared areas, the shears left long strands of plastic from the Geonet mesh and ripped through the geotextile fabric. START observed the GDC folded over onto itself in several areas along the edges of the slide.

2.2 Existing Drainage Conditions

Precipitation falling upon the face of the repository runs along the sloped ground surface directly toward one of the Site drainage channels or percolates into the cover soil. Water infiltrating the cover soil enters the GDC and is transported to a toe drain. The toe drains are located within the Site drainage channels. The drainage channels transport water through Area 1 before continuing through Areas 2 and 4, eventually crossing Bonanza Mine Road to Foster Creek (see Figure 1-3).

The main drainage channel for the northeast face of the repository is a rocked drainage swale from the hydrologic reentrant point north of the Site running parallel to the toe of the northeast face. The drainage channel for the south and southeast faces of the repository consists of a rocked drainage swale located at the toe of the repository corresponding to those areas. The drainage channel at the toe of the south and southeast faces contains a 6-inch diameter perforated pipe.

Located at the top of the repository is a rocked drainage swale running parallel to the BLM Road and discharging through a rock-lined down chute at the southern edge of the repository. The section of the BLM Road at the repository top is sloped to drain away from this channel toward the former Mill Site. The repository was constructed so that it does not receive any runoff from the above hillside. The rocked drainage channel at the repository top would only receive stormwater runoff in extreme precipitation events that result in runoff flowing across the BLM Road. Modeling for this precipitation event has not been completed so it is not known if recent precipitation events have caused water to flow across the BLM Road. There was no evidence of water flow across the road at the time of the Site inspection. Therefore, the only known drainage transported within the repository's drainage layer comes from precipitation that falls directly onto the repository face.

The down chute receives additional drainage from the hillside northwest of the BLM Road including the former Mill Site. A high-density polyethylene (HDPE)

drainage pipe beneath the BLM Road west of the Mill Site drains to the down chute. The down chute is joined by the rock lined drainage swale at the toe of the southeast face of the repository. This drainage channel only drains the south and southeast faces of the repository.

During the February Site inspection, the drainage channels at the toe of the repository had water present. Along the main drainage channel several seeps were identified which originated from the adjacent hillside. The hydrologic reentrant point north of the Site did not appear to have running water present; however, the culvert pipe running beneath the driveway to Residence 3 had flowing water. The flowrate, while not measured in the field, was approximated at 60 gallons per minute using the assumed pipe slope and video showing the depth of water in the pipe. Flow through this pipe was coming from seeps and the repository's northeast face drainage layer.

Photo 2-2: Toe drain seep below the southeast face of the repository

START also identified one seep within the toe drain of the southeast face of the repository (Photo 2-2). The seep had eroded a hole within the rock channel and appeared to have been flowing for a long period based on the amount and size of vegetation clusters downgradient. Flow from the seep was draining through a second culvert pipe that passes beneath the driveway to Residence 3. START measured the flow coming from this pipe using a 5-gallon bucket and determined it to be approximately 17.5 gallons per minute. This flow represents drainage from the south and southeast faces of the repository and the identified seep. There was no water flowing from the culvert that drains the Mill Area during the Site inspection. By January 25, surrounding weather stations had measurable precipitation for 22 of the 25 days in January. Selected rainfall and temperature data for weather stations near the Site are included in Appendix B and discussed in the next section.

The ultimate discharge location from the on-Site drainages is to Foster Creek. Foster Creek passes through a small pond located on the property before running the length of Bonanza Mine Road. During the Site inspection, it was noted that the recent rainstorms had breached the pond's dam and the pond was now empty. Tall grass along the edges of the pond and remaining sections of the dam were laid flat within the direction of flow. Foster Creek's channel along the length of Bonanza Mine Road was severely eroded and the water was carrying a large sediment load. The rock-lined drainage channels that were constructed on Site during the removal had clear running water with no sediment. Most of the length

of the rock-lined swales located at the toe of the repository had essentially folded over on themselves at the time of the inspection. The channels were essentially operating as French drains in this manner. Immediately below these areas, the channels did not show recent sediment accumulation. This included the seep from the toe of the southeast face, which was running clear with no calcined, red-colored material noticeable around the seep.

It was noted during the inspection that cover soils near the top of the repository were fairly well drained and exhibited from no to only a few inches of wet soil above the liner system. The soils at the toe of the repository were completely saturated throughout most of the soil column.

2.3 Surveys and Data Collection

2.3.1 Weather Patterns Surrounding the Slide

An Associated Press article from Eugene, Oregon, on March 28, 2016, titled *Landslides plaguing Oregon after unusually soggy winter* discussed the number of landslides that Oregon was experiencing at the end of the 2015-2016 winter season. The article has been included in Appendix B. The quarry operators at Umpqua Sand and Gravel Concrete Service Company also mentioned the unusually wet winter and showed START areas of the quarry where groundwater was above the ground surface. The operators indicated having never seen groundwater that high and that it was affecting quarry operation. This correlated with current conditions on Site; in particular, seeps that had not been encountered during the removal action.

START accessed recorded weather data from several weather stations near the Site. Selected rainfall and temperature data for weather stations near the Site are included in Appendix B. An extremely wet December was apparently followed by a dry period early in January turning to heavy rainfall at the end of January. Most of the heaviest January rainfalls occurred after the slide was reported. January saw increasing temperatures and for approximately a week before the slide, the low temperatures were maintained above freezing. The Site owner indicated to ODEQ that a hard freeze and sudden thaw had occurred just prior to the slide.

2.3.2 Geotechnical Sampling

The soil observed along the edges of the slide consisted of an earth-rock mixture (a mixture of cohesionless and cohesive soils, gravels, and cobbles) (Photo 2-3). This cover soil had been sourced from an on-Site location near the EPA Command Post.

Photo 2-3: Repository cover soil consisting of an earth-rock mixture

Following the slide, START collected soil samples with oversized material removed for geotechnical analysis. Two samples collected from the Site consisted of soil from the south face of the repository above the slide and soil from the south face below the slide near the bottom of the repository. START also collected unscreened topsoil, washed sand, and 3-inch minus gravel from Umpqua Sand and Gravel Concrete Service Company, Roseburg, Oregon, which ERRS identified as a potential source for repair materials. The five samples were analyzed by GeoTesting Express, Inc., Acton, Massachusetts, for Grain Size Sieve Analysis, ASTM Methods D-421/-422; Compaction, ASTM D-698; Atterberg Limits, ASTM D4318; Direct Shear, ASTM D-3080; Hydraulic Conductivity, ASTM D-5084; Visual Classification, ASTM D-2487; and Interface Shear Strength against the LLDPE liner and the GDC, ASTM D-5321. The results of the geotechnical analysis are in Appendix C.

2.3.3 Agronomic Sampling

During the February Site inspection, it was noted that vegetation was sparse across much of the repository cover. A large percentage of the vegetation appeared to have died off over the winter. Small patches of perennial vegetation were present but were not at a density that was providing full coverage (Photo 2-4). During the removal action, as a result of project schedule, budget constraints, and limited availability of suitable import top soil, the planned 6-inch top soil cover was eliminated and replaced by additional on-Site borrow soil material to serve as the final surface cover. A 16:16:1 fertilizer pellet blend was applied to the soil surface, and a turf grass seed mix was broadcast over the repository. The slash that was preserved and

Photo 2-4: Vegetation density on the repository cover

stockpiled from the initial clearing of the repository area was distributed over the repository surface using a mini-excavator. The excavator placed logs perpendicular to the slope and dispersed stumps, light slash, and brushweed in between the logs.

During the site visit in February, existing cover soils were collected from the Site's repository cover and unscreened topsoil was collected from Umpqua Sand and Gravel Concrete Service Company and tested for agronomic properties. The samples were analyzed by A & L Western Agricultural Laboratories, Portland, Oregon, for analysis of Organic Matter, Estimated Nitrogen Release, Phosphorus (Weak Bray and Sodium Bicarbonate-P), Extractable Cations (Potassium, Magnesium, Calcium, and Sodium), Hydrogen, Sulfate-S, pH, Cation Exchange Capacity, and computed Percent Cation Saturation. The results of the agronomic analysis are in Appendix C.

2.3.4 Topographic Survey

A topographic survey of the repository surface was conducted on March 21, 2016 by Centerline Concepts Land Surveying, Inc. (Centerline), Oregon City, Oregon. The survey was performed in order to provide additional information on the repository surface following the slide. Centerline tied the survey into previous surveys that they had performed at the Site. Throughout 2014, Centerline performed six separate surveys to support the removal action. The initial survey was performed in June 2014 to prepare an existing conditions map of the waste rock and calcine piles. START used this information to design the on-Site repository. During construction of the repository, Centerline performed three additional surveys to assess its size and scope. Specifically, the increased area of the repository required a concomitant increase in repository liner material. A boundary survey was prepared in mid-October during the search for potential on-Site borrow source material and to assess potential locations for the replacement of manufactured homes. Centerline performed a record (as-built) survey upon conclusion of the 2014 removal action to document Site conditions, drainage features, and utilities. Topographic surveys from June 2014 (initial conditions survey), November 2014 (record survey), and March 2016 (post-slide survey) are presented in Appendix D.

2.4 Data Interpretation

2.4.1 Cover Assumptions and As-Built Field Conditions

The Action Memo (Liverman 2014) for the 2014 removal action presented waste rock and/or calcine removal volumes from estimates created by ERRS. Areas to be excavated in 2014 included:

- Area 2 with an estimated 2,400 yd^3 of mine-waste contaminated material, including the roadway and sediment from the intermittent unnamed tributary;
- Area 4 with an estimated 3,200 yd^3 of mine-waste contaminated material, including the road way and driveways; and

- The Mill Site with an estimated 2,000 yd^3 of mine-waste contaminated material, including the mill concrete foundations.

START used the above volumes for the conceptual repository design volume. The repository was designed with a 60,000 yd^3 capacity, over a repository face (or front) of 85,000 square foot (ft^2), an approximate 2-acre footprint, with a final height of approximately 60 feet against the bluff. The amount of calcine and waste rock already present in the footprint of the repository was originally estimated at 46,500 yd^3. This estimate included 44,400 yd^3 of waste rock (also estimated) from the waste rock pile that was to be pulled back from the top of the bluff and spread and compacted within the repository footprint.

The repository cover was designed to consist of a textured 40-mil LLDPE liner, overlain by a geocomposite drainage layer, overlain by an 18-inch minimum layer of random fill and 6-inch minimum layer of topsoil. The cover was designed at a 3:1 slope ratio (18.4 degrees) and record surveys show that this requirement was met. Tables 2-1 through 2-3 show the factors of safety (FOS) calculated when conducting the veneer cover analysis for soil in unsaturated conditions, soil with parallel to slope seepage (fully saturated conditions), and for the geomembrane interface (geotextile to geocomposite).

The veneer cover calculations for parallel to slope seepage assume a clogged drainage layer with saturated soils and represents situations where the cover is not free draining. The geomembrane interface veneer cover calculations assume free-draining conditions. Pore pressure within the cover is not represented within the veneer cover calculation results for a geomembrane interface; however, the geomembrane interface results are still valid as long as the saturated soils calculations remain above a FOS of 1.0. Failure results when the FOS is reduced to less than 1.0. Calculations were performed using both the design values and the sample analysis values from the soils collected near the top and bottom of the repository. Appendix E contains the veneer cover calculations for the Site.

2.4.2 Hydrology Assumptions and As-Built Field Conditions

The 2014 removal hydraulic design peak discharge rate calculations used two hydrologic methods as recommended by the Oregon Department of Transportation (ODOT) Hydraulic Manual. The peak discharges were used to size Site culverts at access road crossings and redesign the intermittent tributary that flows through the Site. The analysis estimated the rate of flow and volume of water that the culverts and drainage tributaries within the Site would need to convey. The peak discharge rates were used in selecting adequate size, material type, and orientation of culverts and drainage channels. The hydrologic analysis for the Bonanza Mine drainage area identified the peak discharge rate estimates that are anticipated to flow through the site including the 2-year, 10-year, 25-year, 50-year, and 100-year storm events.

The ODOT Hydraulic Manual recommends using a minimum of two hydrologic methods to predict peak flows in order to provide a sensitivity and reasonableness check. Due to the size of the delineated watershed and lack of existing hydrologic data (i.e., established Flood Insurance Studies or stream gages), the primary method for analysis selected was the Rational Method. USGS regression equations for the Rural Unregulated Streams in Western Oregon (USGS 2005) were used as a sensitivity and verification check using the USGS StreamSTATs software application.

The following assumptions were made for the 2014 removal action based on engineering judgment:

- The primary watershed ($A_{primary}$) is comprised of an average slope of 20% based on USGS map calculations.
- A secondary subbasin ($A_{secondary}$) is comprised of an average slope of 11% based on USGS map calculations.
- The majority of $A_{primary}$ is undeveloped, forested area (some areas clear cut) with prominent soil type consisting of hydrologic soil group C. Composite $C_{primary}$ value is estimated as 0.21.
- The majority of $A_{secondary}$ consists mostly of gravel access roads with prominent soil type consisting of hydrologic soil group C. $C_{secondary}$ value is estimated as 0.85.

Table 2-4 and Table 2-5 provide summaries of the resulting peak flows calculated from the Rational Method for each subbasin. Table 2-4 also includes a comparison with the USGS StreamStat's Regression Equation analysis results. Based on removal activities performed at the site in 2014, the table assumptions and resulting calculations used to develop the Rational Method have been determined not to vary from the design and are therefore deemed reasonable. The 25-year flow from the hydrologic analysis was used as the basis for culvert and channel design per the requirements of the ODOT Hydraulic Manual as described in the next section of this report (Channel Assumptions and As-Built Field Conditions).

2.4.3 Channel Assumptions and As-Built Field Conditions

The hydraulic design methodology used to design the channel geometry, alignment, and bank protection of the re-aligned channel that discharges from the Bonanza Mine Site was performed for the 2014 removal action to mitigate the potential for overflow of the channel banks during large storm events. The main objective was to convey existing site drainage to Foster Creek while protecting the toe of the proposed waste-rock tailings repository from erosion or undercutting from stream flows during large precipitation events.

The ODOT Hydraulic Manual allows the design of small channels (<50 cubic feet per second [cfs]) using the Single-Section method (slope-area method) as long as the waterbody contains a relatively uniform cross-section, roughness, and slope. The Single-Section method utilizes Manning's Equation and simplifies the design

process so that detailed hydraulic modeling is not necessary. This method assumes normal depth where the channel is under steady, uniform flow. The ODOT Hydraulics Manual also requires that the 25-year peak storm event be used in design of channel modifications. The 25-year peak storm flowrate (22.6 cfs) was estimated in the peak discharge rate calculations.

The following assumptions were made for the 2014 removal action based on engineering judgment and project considerations:

- Cross sections, slopes, and roughness along the re-engineered channel will be uniform throughout;
- The slope profile for the stream will match the existing slope (0.033 ft/ft);
- A manning's coefficient of 0.030 for the channel was assumed to represent rip rap lining that was selected in order to provide bed stability and stream bank protection;
- The channel will consist of the channel bed and side slope banks covered in rip rap for stability and erosion control; and
- The channel will include 1 foot of freeboard.

Calculations performed in 2014 showed the design flow (25-year flood) contained within the channel with more than1 foot of additional freeboard. The calculated depth of flow during the 25-year storm was 0.85 foot. The proposed channel design was a 2-foot deep trapezoidal channel, with 3:1 side slopes (horizontal: vertical), and a 2-foot bottom width. The total width of the stream was designed to be 14 feet, which was similar to the existing extent of the stream banks as indicated from survey data collected at the site in July 2014. The design included ODOT Class 50 riprap installation along the entire length and height of the streambed and banks to provide protection against erosion. Additionally, calculations indicated that the 100-year storm would be contained within the channel with approximately 1 foot of freeboard.

In 2014, it was assumed that the proposed channel would be installed with the same profile slope as the existing drainage path; this value was measured from survey data collected and calculated to be approximately 0.033 ft/ft. The velocity of flow under normal depth conditions for the 25-year flood event was calculated as 5.85 feet/second (ft/s). Rip Rap lining or other stabilization measures were required along the stream bed due to the permissible velocity identified for non-vegetated channel beds consisting of silty loam (permissible velocity ranges from 1.75 and 2.25 ft/s) (USACE 2001).

Using the channel design geometry and hydraulic design results identified it was found that Class 50 riprap was sufficient for the streambank lining for erosion protection up to the 25-year design flow. Based on the 2016 observations of the channels in Area 2 and 4 and the clarity of the water in the channels, the design appears satisfactory. However, channels within Area 1 at the toe of the repository have been affected by the slide and will require repairs.

2.4.4 Drainage Layer Assumptions and As-Built Field Conditions

The following assumptions were made during the 2014 removal action design:

- A repository runoff area of 1.59 acres based on initial volume estimates;
- Watershed hydrologic characteristics were modeled to represent an impermeable soil to provide a conservative estimate of runoff from the repository cover;
- Peak drainage contributing to the toe drain would be from repository runoff;
- The drain discharged under gravity flow;
- The repository would be sloped at 3:1 (horizontal: vertical). The bench that extends approximately 40-80 feet from the road to the repository will be sloped at 10:1 (horizontal: vertical);
- The toe drain will be installed at a 2% slope running parallel with the toe of the repository to match the proposed grade.

The results of the hydraulic analysis performed for the 2014 removal action indicated that a drainpipe of 8-inch perforated HDPE would be required. The French drain was designed so that it also had the capacity to transmit surface water runoff from the repository slope. It was assumed that the peak runoff rate would exceed the flow from the Geonet and would drive the design. This was done in order to be conservative in selecting the pipe size. The French drain was designed so that it included a minimum 18-inch wide, 2-foot deep trench filled with coarse, graded gravel, which surrounded the pipe to allow infiltration of runoff from the repository to be captured by the pipe. Analysis indicated that an 8-inch pipe installed at a 2% slope would transmit the 25-year storm peak runoff at approximately the 75% capacity. The drainage channel was also designed to transmit surface water flow from the repository cover through the channel to the Unnamed Tributary to Foster Creek.

Construction of the repository consisted of several cover layers selected to reduce the precipitation infiltration into the contaminated waste rock. The repository cap design included a Geonet drain fabric on top of LLDPE geomembrane liner. The Geonet drain fabric was designed to capture water that infiltrated the cover soil and transfer it to a toe drain. The constructed toe drainage system utilizes a French drain. The French drain beneath the south and southeast faces is constructed with 6-inch diameter perforated pipe wrapped with filter sock and surrounded by gravel that is burrito-wrapped with a nonwoven geotextile fabric. Water from the Geonet and drainage channel enters the gravel bed and flows into the drainpipe before discharging to the site's intermittent tributary using gravity flow. The toe drainage system at the base of the northeast face was constructed without a perforated pipe due to timing issues and budget constraints.

Geocomposite drainage calculations were performed using the 2016 geotechnical data to determine whether the drainage layer would remain free draining. A free-draining drainage layer prevents the buildup of pore pressures within the cover. The veneer cover calculations for saturated soils assume a clogged drainage layer and represents situations where the cover is not free draining. The geomembrane interface veneer cover calculations assume free-draining conditions. Pore pressure within the cover is not represented within the veneer cover calculation results for a geomembrane interface.

In order to ensure free-draining conditions the transmissivity of the geocomposite was calculated. The design for the 2014 removal action assumed cover soil with properties of $1x10^{-5}$ centimeters per second (cm/s) resulting in a required minimum transmissivity that was well below the transmissivity of the geocomposite, which is $1.4x10^{-4}$ meters squared per second (m^2/s). The 2016 geotechnical analysis included permeability testing on the repository soils at 90% compaction. Based on calculations performed in 2016, the bottom repository soils met the required minimum transmissivity for the geocomposite, while the top repository soils did not. This means that the bottom soils drained slow enough to keep the drainage layer in a free-draining state thus preventing pore pressure buildup. The top repository soils drain too quickly and thus lead to conditions in which pore pressure buildup occurs. Table 2-6 provides a summary of the results from geocomposite drainage layer calculations. Appendix F contains the drainage layer calculations.

2.5 Topographic Survey Review

Upon review of the March 2016 survey, it was apparent that predicted conditions following the slide were not being seen in the actual survey results. Both the south and northeast slide zones of depletion can be seen in the survey but a zone of accumulation is not readily apparent on the south face. The south face of the repository is as much as 3 feet lower than when it was surveyed in December 2014. In some areas it appears that the surface elevation of the repository in March 2016 was beneath the December 2014 LLDPE liner elevation. This would mean that the entire south face has settled. The opposite is true for the northeast and southeast faces of the repository. Both of these faces have risen by up to 3 feet in areas that do not appear to be impacted by the slide. The northeast face differs from the south face in that a definite zone of accumulation can be observed. The zone of accumulation rises up to 4.5 feet above the December 2014 elevation of the repository surface. The causes of the rise and fall of certain sections beneath the repository's LLDPE liner are not known. Appendix G contains figures with comparisons between the March 2016 and December 2014 survey surfaces.

2.6 Additional Mine Site Background Review

The Oregon Department of Geology and Mineral Industries (Oregon DOGAMI) online library was searched for additional documentation on underground workings at the Bonanza Mine. The underground workings map was last updated in July 1956. One additional map, Plate BAK0255, was found which showed new

workings from a later unknown date. The Bonanza Mine was worked until 1960, so several years of underground mapping is not available. The underground workings map was aligned with the Site surveys based on suspected locations of No. 10 Adit and No. 11 Adit near Residence 1 (see drawing in Appendix H). Neither adit was identified during the removal action and subsequently were not surveyed so a definite location could not be targeted for alignment. Once aligned on the drawing, it was apparent that there were several features uncovered during the removal action that do appear on the underground workings map. This includes the adits that were found when excavating mercury-contaminated soil in the Mill Site. One of the adits found is assumed to have had significant workings based on the small gauge rail lines that were found exiting it.

What can be determined from the available maps is that the workings were shallow as they followed the slope of the hillside and were in weak rock. Several locations within the mine are marked as caved on the map. Drifts were used by the mining company to bypass caved sections. Appendix H contains selected maps of the underground workings through 1956.

2.7 Site Status – June 2016

OSC Heister visited the site for a second time on June 24, 2016, and documented Site conditions. Photographs taken during this visit were compared to February 24, 2016 photographs. The photographs show that the size and location of the slide has not changed. This indicates that the repository cover has remained stable since the slide in January. Photographs taken during this visit are included in Appendix A.

Table 2-1: Veneer Cover Analysis – Soil in Unsaturated Conditions

Parameters	Design Values	Sample Values	
		Repos. Top	Repos. Bottom
Unit Weight of Cover Soil	112.7 pounds per cubic foot (pcf)	111.9 pcf	106.8 pcf
Thickness of Cover Soil	1 ft	0.25 ft	2 ft
Length of slope	250 ft	245 ft	245 ft
Soil slope angle	18.4 degrees	18.4 degrees	18.4 degrees
Friction angle of cover soil	30 degrees	41.2	38.1
Adhesion (soil-geomembrane)	0 psf	9	Not Tested
Interface friction angle	41.5 degrees	42.7	Not Tested
Cohesion of cover soil	0 psf	0.2	19.9
Calculated Factor of Safety	2.66	3.88	2.97[a]

[a] Calculated Factor of Safety utilizes adhesion and interface friction angle values of the repository top sample

Table 2-2: Veneer Cover Soil Analysis – Parallel to Slope Seepage

Parameters	Design Values	Sample Values	
		Repos. Top	Repos. Bottom
Saturated Unit Weight of Cover Soil	125.8 pcf	123.3 pcf	123.3 pcf
Unit Weight of Cover Soil	112.7 pcf	111.9 pcf	106.8 pcf
Thickness of Cover Soil	1 ft	0.25 ft	2 ft
Length of slope	250 ft	245 ft	245 ft
Soil slope angle	18.4 degrees	18.4 degrees	18.4 degrees
Friction angle of cover soil	30 degrees	41.2	38.1
Interface friction angle	41.5 degrees	42.7	Not Tested
Calculated Factor of Safety	1.35	1.37	1.39[b]

[b] Calculated Factor of Safety utilizes interface friction angle value of the repository top sample

Table 2-3: Veneer Cover Analysis – Geomembrane Interface

Parameters	Design Values	Sample Values	
		Repos. Top	Repos. Bottom
Saturated Unit Weight of Cover Soil	125.8 pcf	123.3 pcf	123.3 pcf
Unit Weight of Cover Soil	112.7 pcf	111.9 pcf	106.8 pcf
Thickness of Cover Soil	1 ft	0.25 ft	2 ft
Length of slope	250 ft	245 ft	245 ft
Soil slope angle	18.4 degrees	18.4 degrees	18.4 degrees
Friction angle of cover soil	30 degrees	41.2 degrees	38.1 degrees
Interface friction angle	41.5 degrees	42.7 degrees	Not Tested
Calculated Factor of Safety – Moist (in-place) Unit Weight	1.34	2.66	1.20
Calculated Factor of Safety – Saturated Unit Weight	1.30	2.50	1.15

Table 2-4: Peak Flow Comparison Summary Table Primary Culvert		
Storm Interval (years)	**Peak Qs- Rational Method**	**Peak Qs from Stream-Stats using Regression Equations**
2	11.2 cfs	10 cfs
10	14.5 cfs	17.8 cfs
25	22.6 cfs	21.7 cfs
50	28.0 cfs	24.5 cfs
100	32.6 cfs	27.3 cfs

Table 2-5: Peak Flow Summary Table Secondary Culvert	
Storm Interval (years)	**Peak Qs- Rational Method**
2	2.5 cfs
10	3.6 cfs
25	4.6 cfs
50	5.7 cfs
100	6.8 cfs

Table 2-6: Geocomposite Drainage Layer Calculations				
Parameters	**Design Values**	**Sample Values**		
		Borrow Source[a]	**Repos. Top**	**Repos. Bottom**
Cover Soil Permeability (cm/s)	$1x10^{-5}$	$1.6x10^{-4}$	$1.8x10^{-5}$	$1.2x10^{-5}$
Interface friction angle (degrees)	16.2	16.2	16.2	16.2
Total Serviceability Factor	3.06	3.06	3.06	3.06
Slope length (feet)	250	245	245	245
Soil slope angle (degrees)	18.4	18.4	18.4	18.4
Required Minimum Transmissivity (m^2/s)[b]	$7.39x10^{-5}$	$1.16x10^{-3}$	$1.30x10^{-3}$	$8.75x10^{-5}$

[a] Borrow Source is the topsoil sample collected from Umpqua Sand and Gravel Concrete Service Company.
[b] The Geocomposite has a transmissivity of 1x10-4 m^2/s.

3 Repair Alternatives

The following subsections describe the preliminary approach for the proposed repair alternatives. The options presented herein are based on the understanding of site conditions at the time of this writing, visual observations from the February Site inspection, and limited testing of cover materials obtained following the slide. Additional factors have been identified that could have resulted in sliding of the cover material. Section 3.4 addresses these potential mitigating factors. It cannot be verified with any degree of certainty that the same mitigating factors will not be present following repairs. The details presented below and in the accompanying appendices can be used as a basis for conducting the removal action.

3.1 Option 1 - Remove and Replace Soil Cover and Drainage System

This option for stabilizing the repository cover system includes removing and replacing all components of the cover system above the LLDPE liner. The ERRS contractor would remove and stockpile the slash currently on the repository surface. Cover soil and Geonet drainage layer material above the LLDPE liner would be excavated while taking care to avoid damage to the LLDPE liner. Any punctures and abrasions in the LLDPE would need to be identified and repaired. A new drainage layer consisting of porous sand would be installed over the LLDPE. The drainage system would also include lateral drains, consisting of horizontal drain pipes installed approximately one-third and two-thirds down slope from the top of the repository. A slope drain installed from the top of the repository to the toe drain would collect water from the run-on control ditch at the top of the slope, as well as from the two horizontal drains, and discharge at the toe drain. The drainpipe system will help alleviate excessive pore pressure at the LLDPE interface, stabilizing the repository cover during heavy precipitation events.

To further stabilize the lower portion of the slope against additional movement and maintain positive drainage along the toe of the repository, an approximately 400-foot section of rock-filled gabion baskets (gabions) would be installed along the repository toe. The repository slope behind the gabions would be filled with soil with adequate drainage capacity and graded to the repository slope to maintain a positive drainage profile.

A non-woven geotextile filter fabric would be placed on the drainage layer followed by a two-foot cover soil layer. Finally, the soil cover would be seeded and temporarily stabilized using a combination of mulch and slash.

Although this option would improve the overall stability of the cover system from the current configuration with improved drainage and slope toe support, it is not our recommended alternative. We expect that even with careful excavation, numerous liner punctures and abrasions would likely result and require extensive repair. Moreover, large areas of the current cover that are stable, or that could be stabilized with improved slope drainage, would be unnecessarily replaced at a high cost.

3.2 Option 2 – Replace Cover at Exposed Areas of Liner, Improve Drainage, Install Rock Gabions

This stabilization option includes repairing the areas of exposed LLDPE liner. An area approximately 350 feet by 150 feet in the upper portion of the repository where the liner has been exposed would be cleared down to the LLDPE liner. A porous sand drain layer would be placed on the exposed liner.

A slope drain system would be added to improve drainage by installing two lateral pipe drains, approximately one-third and two-thirds down slope from the top of the repository, connected to a slope drain installed from the top of the repository to the toe drain. The drainage system would collect water from the run-on control ditch at the top of the slope, as well as from the two horizontal drains, and discharge to the toe drain. The drainpipe system will help alleviate excessive pore pressure at the LLDPE interface and help to stabilize the repository cover during heavy precipitation events. A non-woven geotextile filter fabric and two feet of soil cover will placed over the repair area.

Option 2 also includes an approximately 400-foot section of rock-filled gabion baskets installed along the repository toe. The gabions will help stabilize the lower portion of the slope against additional movement and maintain positive drainage along the toe of the repository. The repository slope behind the gabions would be filled with soil with adequate drainage capacity, and then graded up to the adjacent repository slope to maintain a positive drainage profile. Areas of exposed cover soil will be seeded and temporarily stabilized using a combination of mulch and slash.

This alternative carries moderate cost while addressing the issues of overall slope drainage capacity, toe stability, and repair of the displaced repository cover. This is our recommended alternative.

3.3 Option 3 – Replace Exposed Areas of Liner

This limited repair option is the least extensive of the options presented, and includes only drainage layer and soil cover replacement at the exposed areas of the LLDPE. The exposed LLDPE and immediate surrounding area in the upper portion of the repository, approximately 350 feet by 150 feet, would be cleared

down to the LLDPE liner. A porous sand drain layer would be place on the exposed liner followed by a non-woven geotextile filter fabric and two feet of cover soil. Bare soil would be stabilized by seeding, and placing mulch and slash.

While this option has the lowest cost of those presented and will provide at least temporary protection of the exposed LLDPE liner, it does not address existing cover soil drainage conditions, nor does it improve the stability of the slope toe. We, therefore, do not recommend this alternative without additional measures to address factors affecting slope stability.

3.4 Next Steps

The discrepancies between the December 2014 and June 2016 topographic surveys are not addressed in the options presented above. If the south face has settled by several feet and the northeast and southeast faces of the repository have risen by up to 3 feet then a cause should be identified.

Determining the locations of No. 10 Adit and No. 11 Adit will help to determine how the underground workings and fault lines lay beneath the Site. This may also help in determining potential areas of subsidence and the origin of seeps that are seen near the toe of the repository.

The apparent elevation rise of material beneath the liner could be due to groundwater-induced pore pressures beneath the liner. It could also be a result of saturation of the calcined waste and waste rock. Determining the response of calcine and waste rock to moisture changes may help to answer this question.

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4 References

Associated Press. March 28, 2016. *Landslides plaguing Oregon after unusually soggy winter.*

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A Photograph Log

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325.jpg Date: 2/25/16 Time: 08:07 Direction: Southwest

Western, upslope area of repository where cover soil and drainage layer has slid, exposing linear low-density polyethylene (LLDPE) liner. (E&E photograph.)

326.jpg Date: 2/25/16 Time: 08:07 Direction: Southeast

Exposed LLDPE liner. (E&E photograph.)

334.jpg Date: 2/25/16 Time: 08:09 Direction: Northeast

Exposed LLDPE liner in upper slope of northwestern side of repository. (E&E photograph.)

IMG9216.jpg Date: 3/1/16 Time: 10:54 Direction: Northwest

Eastern side of repository, with areas of exposed LLDPE liner on upper slope. (E&E photograph.)

IMG_0245.jpg Date: 3/1/16 Time: 10:08 Direction: West

Toe drain ditch at bottom of repository, western side. Note the side of the rock-lined ditch nearest the repository has steepened due to slope movement. (E&E photograph.)

IMG_0254.jpg Date: 3/1/16 Time: 10:12 Direction: Northwest

Alternate view of toe drain ditch at bottom of slope, western side of repository. (E&E photograph.)

360.jpg Date: 2/25/16 Time: 09:18 Direction: East

Exposed LLDPE liner and drainage layer after slope displacement. Note that filter fabric component of drainage layer is not present at this location. (E&E photograph.)

IMG_0247.jpg Date: 2/25/16 Time: 10:09 Direction: West

Water seeping from subsurface in western portion of the toe drain ditch. (E&E photograph.)

IMG_0456.jpg Date: 6/24/16 Time: 11:09 Direction: Northeast

Exposed LLDPE liner observed in June 2016. There appears to be little or no change in the area of exposed liner from conditions seen February 2016. (EPA photograph.)

IMG_0473.jpg Date: 6/24/16 Time: 11:29 Direction: North

Repository with exposed LLDPE liner observed in June 2016. There is little or no apparent change from conditions observed in February 2016. (EPA photograph.)

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B Weather Data

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k source of tainted water at UW Tacoma

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doesn't affect the drinking supply and poses little risks to human health.

But it's important to determine the extent of the contamination and how to clean it up, said UWT spokesman Michael Wark.

"We want to do this for the environment, and we want to do it to ensure health and safety," he said.

Ecology department officials say a long history of industrial use left several plumes of groundwater contamination under what is now the campus in south downtown Tacoma. The area was once home to commercial and industrial uses such as dry cleaning, auto-repair operations and various manufacturing.

Contamination was found as the campus was built and as it expanded. Studies found groundwater polluted with contaminants including petroleum hydrocarbons and other chemicals, which at high enough levels could harm people and the environment.

The university is legally required to clean up groundwater on its site. If the investigation identifies contaminated areas beyond the campus, other property owners may be required to help clean up.

The source of the contamination appears to be somewhere higher on the hillside, according to previous studies by the UWT.

Ecology officials are primarily worried about the chemicals reaching the Foss Waterway and whether they are rising up through the soil as vapors that could be harmful for people to inhale, said Marv Coleman, Ecology's site manager for the project.

So far, testing hasn't found any problems with vapor intrusions on campus, he said. University officials say their testing indicates the groundwater contamination hasn't reached the Foss Waterway yet.

JOHN ULMAN

eorge Bernard
: Shakespeare

THEATER REVIEW

'Mrs. Warren's Profession'

by George Bernard Shaw. Through April 10, a Seattle Shakespeare Company production, Center House Theatre, lower level, Seattle Center; $31-$45 (206-733-8222 or *seattleshakespeare.org*).

's Profession' er to provoke

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outlines her
ima: work
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tory drudge
r sisters) or
ve sex trade
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or herself, her
l Vivie.
e to moraliz-
w framed
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t/economic
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thete, architect Praed (excellent Robert Champaign), pitted against Sir George's hard-nosed business mentality and the hypocritical religiosity of the Rev. Gardner, father of the candidly self-serving Frank.

The actors deliver Shaw's elegantly wry witticisms with style. And under the assured command of Pappas, the wrenching emotional changes Chisholm's fully limned Vivie undergoes pierce through the stiff-necked British propriety. Kotula, usually cast in

Landslides plaguing Oregon after unusually soggy winter

The Associated Press

EUGENE, Ore. — A wet winter in Oregon has led to numerous landslides, and officials warn of continuing dangers even as the weather shifts in coming months. Oregon is in the midst of a "pretty active landslide season" after a relatively dry winter last year, said Ali Ryan Hansen, a spokeswoman for the state Department of Geology and Mineral Industries.

Repeat storms have destabilized many hillsides and former landslide sites, she added.

A woman was killed in December when a slide hit her home north of Florence. The same storm led to another landslide near Newport that damaged four homes and a sinkhole that swallowed a car, The Register-Guard reported (http://goo.gl/WMOt19).

Slides have closed state highways on the Oregon coast and in the Coast Range.

A slide closed Highway 36 west of Triangle Lake for eight days earlier this month and another slide shut down Highway 42 in rural southwest Oregon for 10 days in December.

Smaller landslides closed Highway 101 south of Heceta Head on the Oregon coast for a day in late February.

State officials warn motorists and others to be cautious of slides in coming months.

"With the wet and wild weather, we've had a lot of slides, big and small," said Angela Beers Seydel, a spokeswoman with the state Department of Transportation.

"People need to be aware of their surroundings and know that when you're driving around corners, there's always the possibility that something may have come down off of that hill. Be aware, be cautious and be ready," Seydel added.

A recent state study found as much as a third of Oregon's land mass is deemed high risk for landslides, including swaths of land in the Coast and Cascade mountain ranges and in southwest Oregon.

Besides heavy rainfall, landslides can be caused by rapid thawing of frost or snowmelt. That means there will be a greater risk at higher elevations in the near future even if rains let up.

RANT & RAVE

RAVE To the anonymous good Samaritans who left a cord. Thanks!

RANT To people who stand throughout entire concerts. Of course invariably I'm seated behind tall, big guys. It's not as if they dance to the music; they're simply standing with their arms crossed. and have nothing to see but your backsides? Have you considered that perhaps they aren't 20-somethings who have no trouble standing for a few hours? Sit down!

The Seattle Times publishes reader rants and raves on a space-available basis. We reserve the

THE WEATHER COLLECTOR

The **EASY** Way to Get Local Rain and Snow Totals!

Daily Details

Station ID: USC00359461
Station Name: WINCHESTER
State: OR
Elevation: 460
From: 1-1-2016 **To** 1-31-2016
Min Low Temp (Farenheit): 20
You may have to scroll down to see all the data.
2016-01-01: 20
2016-01-02: 23
2016-01-03: 20
2016-01-04: 30
2016-01-05: 34
2016-01-06: 35
2016-01-07: 35
2016-01-08: 35
2016-01-09: 36
2016-01-10: 39
2016-01-11: 38
2016-01-12: 37
2016-01-13: 42
2016-01-14: 31
2016-01-15: 32
2016-01-16: 32
2016-01-17: 37
2016-01-18: 33
2016-01-19: 32
2016-01-20: 33
2016-01-21: 34
2016-01-22: 43
2016-01-23: 42
2016-01-24: 41
2016-01-25: 37
2016-01-26: 37
2016-01-27: 42
2016-01-28: 45
2016-01-29: 47
2016-01-30: 36
2016-01-31: 34

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Daily Details

Station ID: USC00359461
Station Name: WINCHESTER
State: OR
Elevation: 460
From: 1-1-2016 **To** 1-31-2016
Max High Temp(Farenheit): 65
You may have to scroll down to see all the data.
2016-01-01: 42
2016-01-02: 40
2016-01-03: 41
2016-01-04: 38
2016-01-05: 38
2016-01-06: 50
2016-01-07: 45
2016-01-08: 45
2016-01-09: 43
2016-01-10: 52
2016-01-11: 47
2016-01-12: 49
2016-01-13: 58
2016-01-14: 58
2016-01-15: 45
2016-01-16: 48
2016-01-17: 55
2016-01-18: 52
2016-01-19: 56
2016-01-20: 51
2016-01-21: 48
2016-01-22: 52
2016-01-23: 56
2016-01-24: 51
2016-01-25: 47
2016-01-26: 51
2016-01-27: 55
2016-01-28: 65
2016-01-29: 57
2016-01-30: 51
2016-01-31: 46

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Daily Details

Station ID: US1ORDG0026
Station Name: GLIDE 2.9 SSW
State: OR
Elevation: 857
From: 12-1-2015 **To** 12-31-2015
Amount of Rain In Inches: 16.93
You may have to scroll down to see all the data.
2015-12-01: 0.00
2015-12-02: 0.37
2015-12-03: 0.12
2015-12-04: 1.02
2015-12-05: 0.10
2015-12-06: 0.55
2015-12-07: 0.39
2015-12-08: 0.33
2015-12-09: 1.08
2015-12-10: 1.20
2015-12-11: 0.69
2015-12-12: 0.87
2015-12-13: 3.27
2015-12-14: 0.65
2015-12-15: 0.32
2015-12-16: 0.02
2015-12-17: 0.82
2015-12-18: 0.91
2015-12-19: 0.24
2015-12-20: 0.10
2015-12-21: 0.75
2015-12-22: 0.62
2015-12-23: 0.54
2015-12-24: 0.66
2015-12-25: 0.34
2015-12-26: 0.07
2015-12-27: 0.00
2015-12-28: 0.44
2015-12-29: 0.13
2015-12-30: 0.34
2015-12-31: 0.00

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Daily Details

Station ID: US1ORDG0026
Station Name: GLIDE 2.9 SSW
State: OR
Elevation: 857
From: 1-1-2016 **To** 1-31-2016
Amount of Rain In Inches: ?
You may have to scroll down to see all the data.
2016-01-01: Missing
2016-01-02: Missing
2016-01-03: 0.05
2016-01-04: 0.17
2016-01-05: 0.10
2016-01-06: Missing
2016-01-07: Missing
2016-01-08: Missing
2016-01-09: 0.13
2016-01-10: Missing
2016-01-11: 0.03
2016-01-12: 0.10
2016-01-13: 0.20
2016-01-14: 0.52
2016-01-15: 0.46
2016-01-16: 0.25
2016-01-17: 0.65
2016-01-18: 1.40
2016-01-19: 0.16
2016-01-20: 0.95
2016-01-21: 0.03
2016-01-22: 0.33
2016-01-23: 0.40
2016-01-24: 0.15
2016-01-25: 0.26
2016-01-26: Missing
2016-01-27: Missing
2016-01-28: Missing
2016-01-29: Missing
2016-01-30: Missing
2016-01-31: Missing

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Daily Details

Station ID: US1ORDG0010
Station Name: GLIDE 1.1 SE
State: OR
Elevation: 930
From: 1-1-2016 **To** 1-31-2016
Amount of Rain In Inches: ?
You may have to scroll down to see all the data.
2016-01-01: 0.00
2016-01-02: 0.00
2016-01-03: 0.05
2016-01-04: 0.12
2016-01-05: 0.10
2016-01-06: 0.03
2016-01-07: 0.02
2016-01-08: 0.00
2016-01-09: 0.11
2016-01-10: 0.02
2016-01-11: 0.02
2016-01-12: 0.11
2016-01-13: 0.19
2016-01-14: 0.37
2016-01-15: 0.51
2016-01-16: 0.25
2016-01-17: 0.49
2016-01-18: 1.46
2016-01-19: 0.17
2016-01-20: 0.81
2016-01-21: 0.02
2016-01-22: 0.30
2016-01-23: 0.40
2016-01-24: 0.29
2016-01-25: 0.30
2016-01-26: Missing
2016-01-27: Missing
2016-01-28: Missing
2016-01-29: Missing
2016-01-30: Missing
2016-01-31: Missing

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Daily Details

Station ID: USC00353320
Station Name: GLIDE 2NW
State: OR
Elevation: 742
From: 1-1-2016 **To** 1-31-2016
Amount of Rain In Inches: ?
You may have to scroll down to see all the data.
2016-01-01: 0.00
2016-01-02: 0.00
2016-01-03: 0.05
2016-01-04: 0.14
2016-01-05: Missing
2016-01-06: 0.02
2016-01-07: Missing
2016-01-08: Missing
2016-01-09: Missing
2016-01-10: Missing
2016-01-11: 0.00
2016-01-12: 0.19
2016-01-13: 0.22
2016-01-14: Missing
2016-01-15: 0.43
2016-01-16: 0.38
2016-01-17: 0.63
2016-01-18: 1.17
2016-01-19: 0.23
2016-01-20: 0.82
2016-01-21: Missing
2016-01-22: Missing
2016-01-23: Missing
2016-01-24: Missing
2016-01-25: 0.00
2016-01-26: Missing
2016-01-27: Missing
2016-01-28: Missing
2016-01-29: Missing
2016-01-30: Missing
2016-01-31: Missing

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Daily Details

Station ID: US1ORDG0012
Station Name: IDLEYLD PARK 4 ESE
State: OR
Elevation: 1628
From: 1-1-2016 **To** 1-31-2016
Amount of Rain In Inches: ?
You may have to scroll down to see all the data.
2016-01-01: 0.00
2016-01-02: 0.00
2016-01-03: 0.09
2016-01-04: 0.24
2016-01-05: 0.19
2016-01-06: 0.03
2016-01-07: 0.02
2016-01-08: 0.00
2016-01-09: 0.23
2016-01-10: 0.03
2016-01-11: 0.03
2016-01-12: 0.17
2016-01-13: 0.36
2016-01-14: 0.51
2016-01-15: 0.46
2016-01-16: 0.62
2016-01-17: Missing
2016-01-18: Missing
2016-01-19: 0.21
2016-01-20: 1.20
2016-01-21: 0.02
2016-01-22: 0.33
2016-01-23: 0.47
2016-01-24: 0.44
2016-01-25: 0.34
2016-01-26: Missing
2016-01-27: Missing
2016-01-28: Missing
2016-01-29: Missing
2016-01-30: Missing
2016-01-31: Missing

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Daily Details

Station ID: US1ORDG0048
Station Name: ROSEBURG 9.9 NE
State: OR
Elevation: 677
From: 1-1-2016 **To** 1-31-2016
Amount of Rain In Inches: ?
You may have to scroll down to see all the data.
2016-01-01: 0.00
2016-01-02: 0.00
2016-01-03: 0.05
2016-01-04: 0.12
2016-01-05: 0.20
2016-01-06: 0.02
2016-01-07: 0.02
2016-01-08: 0.02
2016-01-09: 0.13
2016-01-10: 0.02
2016-01-11: 0.00
2016-01-12: 0.16
2016-01-13: 0.32
2016-01-14: 0.38
2016-01-15: 0.55
2016-01-16: 0.35
2016-01-17: 0.51
2016-01-18: 1.18
2016-01-19: 0.28
2016-01-20: 1.01
2016-01-21: 0.02
2016-01-22: 0.34
2016-01-23: 0.43
2016-01-24: 0.13
2016-01-25: 0.26
2016-01-26: Missing
2016-01-27: Missing
2016-01-28: Missing
2016-01-29: Missing
2016-01-30: Missing
2016-01-31: Missing

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Daily Details

Station ID: USC00358536
Station Name: TOKETEE FALLS
State: OR
Elevation: 2060
From: 1-1-2016 **To** 1-31-2016
Amount of Rain In Inches: ?
You may have to scroll down to see all the data.
2016-01-01: 0.00
2016-01-02: 0.00
2016-01-03: 0.13
2016-01-04: 0.13
2016-01-05: 0.01
2016-01-06: Missing
2016-01-07: 0.00
2016-01-08: 0.00
2016-01-09: 0.00
2016-01-10: 0.00
2016-01-11: 0.02
2016-01-12: 0.13
2016-01-13: 0.51
2016-01-14: 0.51
2016-01-15: 0.11
2016-01-16: 0.14
2016-01-17: 1.15
2016-01-18: 0.33
2016-01-19: 0.57
2016-01-20: 0.05
2016-01-21: 0.00
2016-01-22: 0.60
2016-01-23: 0.76
2016-01-24: 0.25
2016-01-25: Missing
2016-01-26: Missing
2016-01-27: Missing
2016-01-28: Missing
2016-01-29: Missing
2016-01-30: Missing
2016-01-31: Missing

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Daily Details

Station ID: USS0022F45S
Station Name: Toketee Airstrip
State: OR
Elevation: 3240
From: 1-1-2016 **To** 1-31-2016
Amount of Rain In Inches: ?
You may have to scroll down to see all the data.
2016-01-01: 0.00
2016-01-02: 0.00
2016-01-03: 0.10
2016-01-04: 0.00
2016-01-05: 0.10
2016-01-06: 0.00
2016-01-07: 0.00
2016-01-08: 0.00
2016-01-09: 0.20
2016-01-10: 0.00
2016-01-11: 0.10
2016-01-12: 0.20
2016-01-13: 0.50
2016-01-14: 0.20
2016-01-15: 0.20
2016-01-16: 0.60
2016-01-17: 1.70
2016-01-18: 0.10
2016-01-19: 0.90
2016-01-20: 0.00
2016-01-21: 0.00
2016-01-22: 0.60
2016-01-23: 0.80
2016-01-24: 0.10
2016-01-25: Missing
2016-01-26: Missing
2016-01-27: Missing
2016-01-28: Missing
2016-01-29: Missing
2016-01-30: Missing
2016-01-31: Missing

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Daily Details

Station ID: USW00024231
Station Name: ROSEBURG RGNL AP
State: OR
Elevation: 525
From: 1-1-2016 **To** 1-31-2016
Amount of Rain In Inches: ?
You may have to scroll down to see all the data.
2016-01-01: 0.00
2016-01-02: 0.00
2016-01-03: 0.09
2016-01-04: 0.07
2016-01-05: 0.11
2016-01-06: 0.05
2016-01-07: 0.00
2016-01-08: 0.08
2016-01-09: 0.14
2016-01-10: 0.00
2016-01-11: 0.05
2016-01-12: 0.16
2016-01-13: 0.63
2016-01-14: 0.41
2016-01-15: 0.14
2016-01-16: 0.26
2016-01-17: 1.41
2016-01-18: 0.23
2016-01-19: 0.89
2016-01-20: 0.00
2016-01-21: 0.18
2016-01-22: 0.44
2016-01-23: 0.20
2016-01-24: Missing
2016-01-25: Missing
2016-01-26: Missing
2016-01-27: Missing
2016-01-28: Missing
2016-01-29: Missing
2016-01-30: Missing
2016-01-31: Missing

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Daily Details

Station ID: US1ORDG0033
Station Name: ROSEBURG 1.2 WNW
State: OR
Elevation: 422
From: 1-1-2016 **To** 1-31-2016
Amount of Rain In Inches: ?
You may have to scroll down to see all the data.
2016-01-01: 0.00
2016-01-02: 0.00
2016-01-03: 0.00
2016-01-04: 0.13
2016-01-05: 0.14
2016-01-06: 0.06
2016-01-07: 0.06
2016-01-08: 0.00
2016-01-09: 0.25
2016-01-10: 0.00
2016-01-11: 0.00
2016-01-12: 0.07
2016-01-13: 0.44
2016-01-14: 0.34
2016-01-15: 0.51
2016-01-16: 0.24
2016-01-17: 0.69
2016-01-18: 1.10
2016-01-19: 0.35
2016-01-20: 0.91
2016-01-21: 0.00
2016-01-22: 0.51
2016-01-23: 0.33
2016-01-24: 0.03
2016-01-25: 0.21
2016-01-26: Missing
2016-01-27: Missing
2016-01-28: Missing
2016-01-29: Missing
2016-01-30: Missing
2016-01-31: Missing

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Daily Details

Station ID: USC00357169
Station Name: RIDDLE
State: OR
Elevation: 680
From: 1-1-2016 **To** 1-31-2016
Amount of Rain In Inches: ?
You may have to scroll down to see all the data.
2016-01-01: 0.00
2016-01-02: 0.00
2016-01-03: 0.11
2016-01-04: 0.01
2016-01-05: 0.06
2016-01-06: 0.01
2016-01-07: 0.02
2016-01-08: 0.01
2016-01-09: 0.10
2016-01-10: 0.01
2016-01-11: 0.02
2016-01-12: 0.18
2016-01-13: 0.88
2016-01-14: 0.08
2016-01-15: 0.44
2016-01-16: 0.68
2016-01-17: 1.49
2016-01-18: 0.21
2016-01-19: 0.73
2016-01-20: 0.13
2016-01-21: 0.01
2016-01-22: 0.68
2016-01-23: 0.50
2016-01-24: 0.22
2016-01-25: Missing
2016-01-26: Missing
2016-01-27: Missing
2016-01-28: Missing
2016-01-29: Missing
2016-01-30: Missing
2016-01-31: Missing

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Daily Details

Station ID: US1ORDG0026
Station Name: GLIDE 2.9 SSW
State: OR
Elevation: 857
From: 12-1-2015 **To** 12-31-2015
Amount of Rain In Inches: 16.93
You may have to scroll down to see all the data.
2015-12-01: 0.00
2015-12-02: 0.37
2015-12-03: 0.12
2015-12-04: 1.02
2015-12-05: 0.10
2015-12-06: 0.55
2015-12-07: 0.39
2015-12-08: 0.33
2015-12-09: 1.08
2015-12-10: 1.20
2015-12-11: 0.69
2015-12-12: 0.87
2015-12-13: 3.27
2015-12-14: 0.65
2015-12-15: 0.32
2015-12-16: 0.02
2015-12-17: 0.82
2015-12-18: 0.91
2015-12-19: 0.24
2015-12-20: 0.10
2015-12-21: 0.75
2015-12-22: 0.62
2015-12-23: 0.54
2015-12-24: 0.66
2015-12-25: 0.34
2015-12-26: 0.07
2015-12-27: 0.00
2015-12-28: 0.44
2015-12-29: 0.13
2015-12-30: 0.34
2015-12-31: 0.00

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Daily Details

Station ID: US1ORDG0026
Station Name: GLIDE 2.9 SSW
State: OR
Elevation: 857
From: 1-1-2016 **To** 1-31-2016
Amount of Rain In Inches: ?
You may have to scroll down to see all the data.
2016-01-01: Missing
2016-01-02: Missing
2016-01-03: 0.05
2016-01-04: 0.17
2016-01-05: 0.10
2016-01-06: Missing
2016-01-07: Missing
2016-01-08: Missing
2016-01-09: 0.13
2016-01-10: Missing
2016-01-11: 0.03
2016-01-12: 0.10
2016-01-13: 0.20
2016-01-14: 0.52
2016-01-15: 0.46
2016-01-16: 0.25
2016-01-17: 0.65
2016-01-18: 1.40
2016-01-19: 0.16
2016-01-20: 0.95
2016-01-21: 0.03
2016-01-22: 0.33
2016-01-23: 0.40
2016-01-24: 0.15
2016-01-25: 0.26
2016-01-26: Missing
2016-01-27: Missing
2016-01-28: Missing
2016-01-29: Missing
2016-01-30: Missing
2016-01-31: Missing

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Daily Details

Station ID: US1ORDG0010
Station Name: GLIDE 1.1 SE
State: OR
Elevation: 930
From: 1-1-2016 **To** 1-31-2016
Amount of Rain In Inches: ?
You may have to scroll down to see all the data.
2016-01-01: 0.00
2016-01-02: 0.00
2016-01-03: 0.05
2016-01-04: 0.12
2016-01-05: 0.10
2016-01-06: 0.03
2016-01-07: 0.02
2016-01-08: 0.00
2016-01-09: 0.11
2016-01-10: 0.02
2016-01-11: 0.02
2016-01-12: 0.11
2016-01-13: 0.19
2016-01-14: 0.37
2016-01-15: 0.51
2016-01-16: 0.25
2016-01-17: 0.49
2016-01-18: 1.46
2016-01-19: 0.17
2016-01-20: 0.81
2016-01-21: 0.02
2016-01-22: 0.30
2016-01-23: 0.40
2016-01-24: 0.29
2016-01-25: 0.30
2016-01-26: Missing
2016-01-27: Missing
2016-01-28: Missing
2016-01-29: Missing
2016-01-30: Missing
2016-01-31: Missing

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Daily Details

Station ID: USC00353320
Station Name: GLIDE 2NW
State: OR
Elevation: 742
From: 1-1-2016 **To** 1-31-2016
Amount of Rain In Inches: ?
You may have to scroll down to see all the data.
2016-01-01: 0.00
2016-01-02: 0.00
2016-01-03: 0.05
2016-01-04: 0.14
2016-01-05: Missing
2016-01-06: 0.02
2016-01-07: Missing
2016-01-08: Missing
2016-01-09: Missing
2016-01-10: Missing
2016-01-11: 0.00
2016-01-12: 0.19
2016-01-13: 0.22
2016-01-14: Missing
2016-01-15: 0.43
2016-01-16: 0.38
2016-01-17: 0.63
2016-01-18: 1.17
2016-01-19: 0.23
2016-01-20: 0.82
2016-01-21: Missing
2016-01-22: Missing
2016-01-23: Missing
2016-01-24: Missing
2016-01-25: 0.00
2016-01-26: Missing
2016-01-27: Missing
2016-01-28: Missing
2016-01-29: Missing
2016-01-30: Missing
2016-01-31: Missing

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Daily Details

Station ID: US1ORDG0012
Station Name: IDLEYLD PARK 4 ESE
State: OR
Elevation: 1628
From: 1-1-2016 **To** 1-31-2016
Amount of Rain In Inches: ?
You may have to scroll down to see all the data.
2016-01-01: 0.00
2016-01-02: 0.00
2016-01-03: 0.09
2016-01-04: 0.24
2016-01-05: 0.19
2016-01-06: 0.03
2016-01-07: 0.02
2016-01-08: 0.00
2016-01-09: 0.23
2016-01-10: 0.03
2016-01-11: 0.03
2016-01-12: 0.17
2016-01-13: 0.36
2016-01-14: 0.51
2016-01-15: 0.46
2016-01-16: 0.62
2016-01-17: Missing
2016-01-18: Missing
2016-01-19: 0.21
2016-01-20: 1.20
2016-01-21: 0.02
2016-01-22: 0.33
2016-01-23: 0.47
2016-01-24: 0.44
2016-01-25: 0.34
2016-01-26: Missing
2016-01-27: Missing
2016-01-28: Missing
2016-01-29: Missing
2016-01-30: Missing
2016-01-31: Missing

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Daily Details

Station ID: US1ORDG0048
Station Name: ROSEBURG 9.9 NE
State: OR
Elevation: 677
From: 1-1-2016 **To** 1-31-2016
Amount of Rain In Inches: ?
You may have to scroll down to see all the data.
2016-01-01: 0.00
2016-01-02: 0.00
2016-01-03: 0.05
2016-01-04: 0.12
2016-01-05: 0.20
2016-01-06: 0.02
2016-01-07: 0.02
2016-01-08: 0.02
2016-01-09: 0.13
2016-01-10: 0.02
2016-01-11: 0.00
2016-01-12: 0.16
2016-01-13: 0.32
2016-01-14: 0.38
2016-01-15: 0.55
2016-01-16: 0.35
2016-01-17: 0.51
2016-01-18: 1.18
2016-01-19: 0.28
2016-01-20: 1.01
2016-01-21: 0.02
2016-01-22: 0.34
2016-01-23: 0.43
2016-01-24: 0.13
2016-01-25: 0.26
2016-01-26: Missing
2016-01-27: Missing
2016-01-28: Missing
2016-01-29: Missing
2016-01-30: Missing
2016-01-31: Missing

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Daily Details

Station ID: USC00358536
Station Name: TOKETEE FALLS
State: OR
Elevation: 2060
From: 1-1-2016 **To** 1-31-2016
Amount of Rain In Inches: ?
You may have to scroll down to see all the data.
2016-01-01: 0.00
2016-01-02: 0.00
2016-01-03: 0.13
2016-01-04: 0.13
2016-01-05: 0.01
2016-01-06: Missing
2016-01-07: 0.00
2016-01-08: 0.00
2016-01-09: 0.00
2016-01-10: 0.00
2016-01-11: 0.02
2016-01-12: 0.13
2016-01-13: 0.51
2016-01-14: 0.51
2016-01-15: 0.11
2016-01-16: 0.14
2016-01-17: 1.15
2016-01-18: 0.33
2016-01-19: 0.57
2016-01-20: 0.05
2016-01-21: 0.00
2016-01-22: 0.60
2016-01-23: 0.76
2016-01-24: 0.25
2016-01-25: Missing
2016-01-26: Missing
2016-01-27: Missing
2016-01-28: Missing
2016-01-29: Missing
2016-01-30: Missing
2016-01-31: Missing

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Daily Details

Station ID: USS0022F45S
Station Name: Toketee Airstrip
State: OR
Elevation: 3240
From: 1-1-2016 **To** 1-31-2016
Amount of Rain In Inches: ?
You may have to scroll down to see all the data.
2016-01-01: 0.00
2016-01-02: 0.00
2016-01-03: 0.10
2016-01-04: 0.00
2016-01-05: 0.10
2016-01-06: 0.00
2016-01-07: 0.00
2016-01-08: 0.00
2016-01-09: 0.20
2016-01-10: 0.00
2016-01-11: 0.10
2016-01-12: 0.20
2016-01-13: 0.50
2016-01-14: 0.20
2016-01-15: 0.20
2016-01-16: 0.60
2016-01-17: 1.70
2016-01-18: 0.10
2016-01-19: 0.90
2016-01-20: 0.00
2016-01-21: 0.00
2016-01-22: 0.60
2016-01-23: 0.80
2016-01-24: 0.10
2016-01-25: Missing
2016-01-26: Missing
2016-01-27: Missing
2016-01-28: Missing
2016-01-29: Missing
2016-01-30: Missing
2016-01-31: Missing

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Daily Details

Station ID: USW00024231
Station Name: ROSEBURG RGNL AP
State: OR
Elevation: 525
From: 1-1-2016 **To** 1-31-2016
Amount of Rain In Inches: ?
You may have to scroll down to see all the data.
2016-01-01: 0.00
2016-01-02: 0.00
2016-01-03: 0.09
2016-01-04: 0.07
2016-01-05: 0.11
2016-01-06: 0.05
2016-01-07: 0.00
2016-01-08: 0.08
2016-01-09: 0.14
2016-01-10: 0.00
2016-01-11: 0.05
2016-01-12: 0.16
2016-01-13: 0.63
2016-01-14: 0.41
2016-01-15: 0.14
2016-01-16: 0.26
2016-01-17: 1.41
2016-01-18: 0.23
2016-01-19: 0.89
2016-01-20: 0.00
2016-01-21: 0.18
2016-01-22: 0.44
2016-01-23: 0.20
2016-01-24: Missing
2016-01-25: Missing
2016-01-26: Missing
2016-01-27: Missing
2016-01-28: Missing
2016-01-29: Missing
2016-01-30: Missing
2016-01-31: Missing

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Daily Details

Station ID: US1ORDG0033
Station Name: ROSEBURG 1.2 WNW
State: OR
Elevation: 422
From: 1-1-2016 **To** 1-31-2016
Amount of Rain In Inches: ?
You may have to scroll down to see all the data.
2016-01-01: 0.00
2016-01-02: 0.00
2016-01-03: 0.00
2016-01-04: 0.13
2016-01-05: 0.14
2016-01-06: 0.06
2016-01-07: 0.06
2016-01-08: 0.00
2016-01-09: 0.25
2016-01-10: 0.00
2016-01-11: 0.00
2016-01-12: 0.07
2016-01-13: 0.44
2016-01-14: 0.34
2016-01-15: 0.51
2016-01-16: 0.24
2016-01-17: 0.69
2016-01-18: 1.10
2016-01-19: 0.35
2016-01-20: 0.91
2016-01-21: 0.00
2016-01-22: 0.51
2016-01-23: 0.33
2016-01-24: 0.03
2016-01-25: 0.21
2016-01-26: Missing
2016-01-27: Missing
2016-01-28: Missing
2016-01-29: Missing
2016-01-30: Missing
2016-01-31: Missing

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THE WEATHER COLLECTOR

The **EASY** Way to Get Local Rain and Snow Totals!

Daily Details

Station ID: USC00357169
Station Name: RIDDLE
State: OR
Elevation: 680
From: 1-1-2016 **To** 1-31-2016
Amount of Rain In Inches: ?
You may have to scroll down to see all the data.
2016-01-01: 0.00
2016-01-02: 0.00
2016-01-03: 0.11
2016-01-04: 0.01
2016-01-05: 0.06
2016-01-06: 0.01
2016-01-07: 0.02
2016-01-08: 0.01
2016-01-09: 0.10
2016-01-10: 0.01
2016-01-11: 0.02
2016-01-12: 0.18
2016-01-13: 0.88
2016-01-14: 0.08
2016-01-15: 0.44
2016-01-16: 0.68
2016-01-17: 1.49
2016-01-18: 0.21
2016-01-19: 0.73
2016-01-20: 0.13
2016-01-21: 0.01
2016-01-22: 0.68
2016-01-23: 0.50
2016-01-24: 0.22
2016-01-25: Missing
2016-01-26: Missing
2016-01-27: Missing
2016-01-28: Missing
2016-01-29: Missing
2016-01-30: Missing
2016-01-31: Missing

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THE WEATHER COLLECTOR

The **EASY** Way to Get Local Rain and Snow Totals!

Daily Details

Station ID: USC00359461
Station Name: WINCHESTER
State: OR
Elevation: 460
From: 1-1-2016 **To** 1-31-2016
Min Low Temp (Farenheit): 20
You may have to scroll down to see all the data.
2016-01-01: 20
2016-01-02: 23
2016-01-03: 20
2016-01-04: 30
2016-01-05: 34
2016-01-06: 35
2016-01-07: 35
2016-01-08: 35
2016-01-09: 36
2016-01-10: 39
2016-01-11: 38
2016-01-12: 37
2016-01-13: 42
2016-01-14: 31
2016-01-15: 32
2016-01-16: 32
2016-01-17: 37
2016-01-18: 33
2016-01-19: 32
2016-01-20: 33
2016-01-21: 34
2016-01-22: 43
2016-01-23: 42
2016-01-24: 41
2016-01-25: 37
2016-01-26: 37
2016-01-27: 42
2016-01-28: 45
2016-01-29: 47
2016-01-30: 36
2016-01-31: 34

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THE WEATHER COLLECTOR

The **EASY** Way to Get Local Rain and Snow Totals!

Daily Details

Station ID: USC00359461
Station Name: WINCHESTER
State: OR
Elevation: 460
From: 1-1-2016 **To** 1-31-2016
Max High Temp(Farenheit): 65
You may have to scroll down to see all the data.
2016-01-01: 42
2016-01-02: 40
2016-01-03: 41
2016-01-04: 38
2016-01-05: 38
2016-01-06: 50
2016-01-07: 45
2016-01-08: 45
2016-01-09: 43
2016-01-10: 52
2016-01-11: 47
2016-01-12: 49
2016-01-13: 58
2016-01-14: 58
2016-01-15: 45
2016-01-16: 48
2016-01-17: 55
2016-01-18: 52
2016-01-19: 56
2016-01-20: 51
2016-01-21: 48
2016-01-22: 52
2016-01-23: 56
2016-01-24: 51
2016-01-25: 47
2016-01-26: 51
2016-01-27: 55
2016-01-28: 65
2016-01-29: 57
2016-01-30: 51
2016-01-31: 46

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C Geotechnical and Agronomic Data

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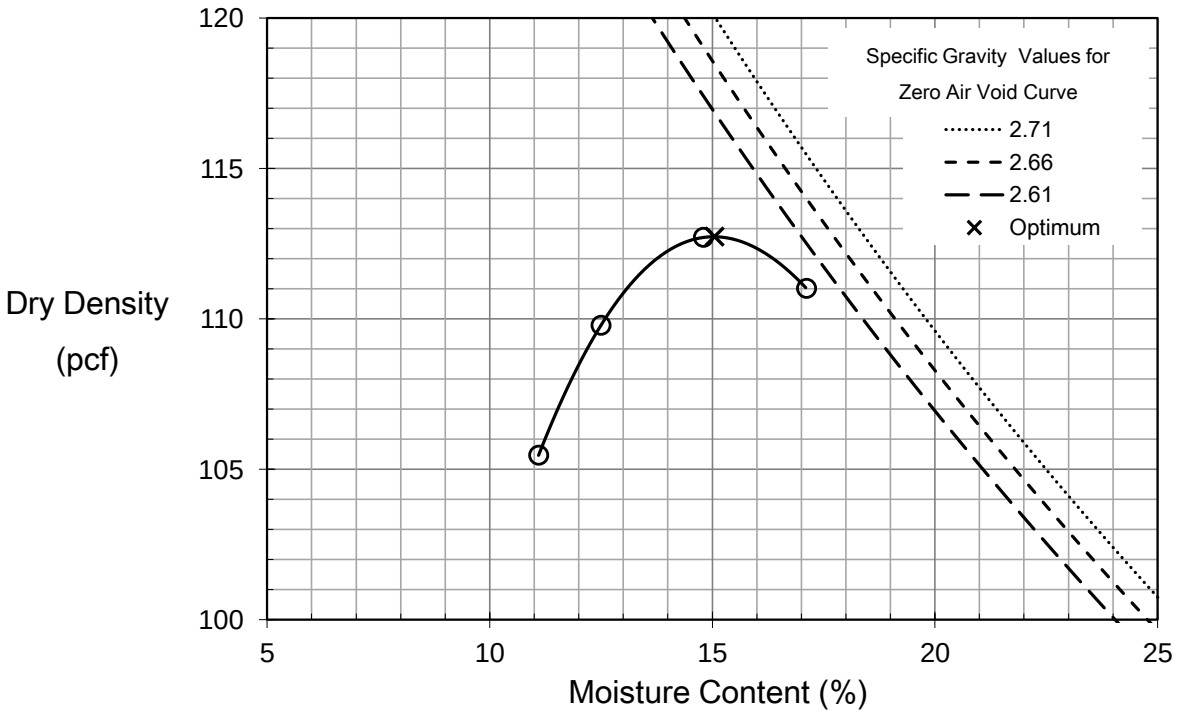
Laboratory Compaction Characteristics of Soil Using Standard Effort (ASTM D698)

Client:	Northwest Linings	TRI Log #:	E2391-14-07
Project:	Bonanza Mine	Test Date:	10/7/2014
Sample ID:	Soil		

Compaction Effort	-	Standard
Method	-	A
Rammer Type	-	Automatic
Maximum Dry Density	pcf	112.7
Optimum Water Content	%	15.0

Oversize Particle / "Rock" Correction (ASTM D4718)		
Oversized Particles	%	- -
Maximum Dry Density	pcf	- -
Optimum Water Content	%	- -



Jeffrey A. Kuhn, Ph.D, P.E., 10/9/2014
Quality Review / Date
Tested by: IB

TRI ENVIRONMENTAL, INC.
9063 BEE CAVES RD. – AUSTIN, TX 78733 – USA | PH: 800.880.TEST OR 512.263.2101

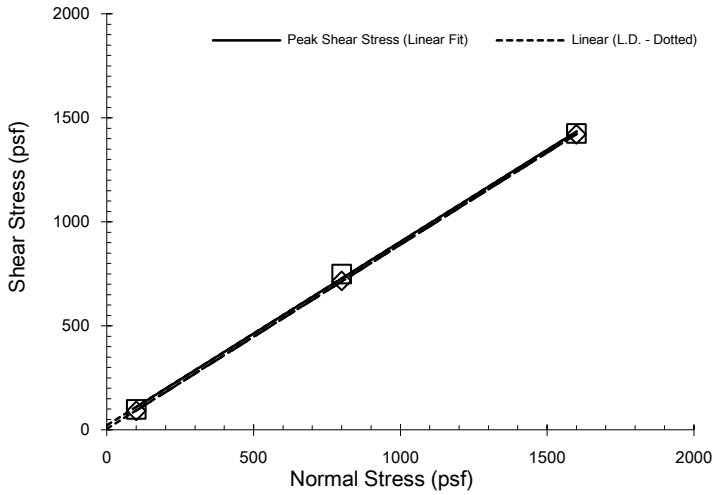
Interface Friction Test Report

Client: **Northwest Liners**
Project: **Bonanza Mine**
Date: 10-15-2014 to 10-15-2014

TRI Log#: E2388-46-05
Test Method: ASTM D5321

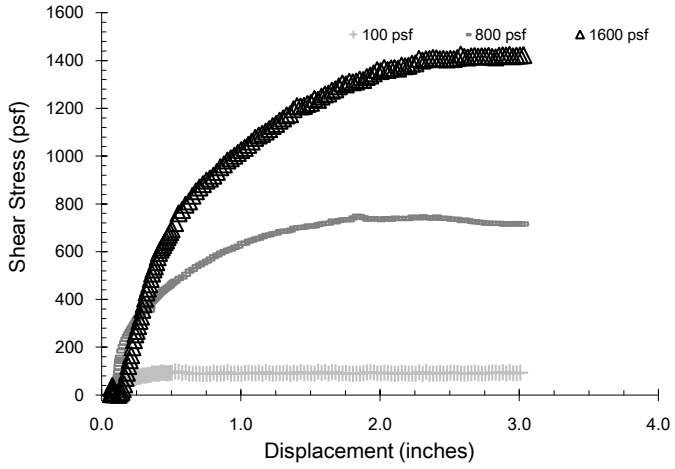
John M. Allen, P.E., 10/15/2014
Quality Review/Date

Tested Interface: Soil vs. Agru 200-1-6 Single-sided Geocomposite (529216-11)



Test Results		
	Peak	Large Displacement (@ 3.0 in.)
Friction Angle (degrees):	41.5	41.6
Y-intercept or Adhesion (psf):	21	4

Shearing occurred at the interface.



Test Conditions	
Upper Box & Lower Box	Soil remolded to 95% of the maximum dry density at the optimum moisture content or 107.1 pcf at 15.0% Agru 200-1-6 single-sided geocomposite (net side down)
Box Dimensions: 12"x12"x4"	
Interface Conditioning:	Interface soaked and loading applied for a minimum of 1 hour prior to shear.
Test Condition: Wet	
Shearing Rate: 0.04 inches/minute	

Test Data			
Specimen No.	1	2	3
Bearing Slide Resistance (lbs)	9	16	23
Normal Stress (psf)	100	800	1600
Corrected Peak Shear Stress (psf)	98	749	1425
Corrected Large Displacement Shear Stress (psf)	91	716	1421
Peak Secant Angle (degrees)	44.5	43.1	41.7
Large Displacement Secant Angle (degrees)	42.3	41.8	41.6
Asperity (mils)	--	--	--

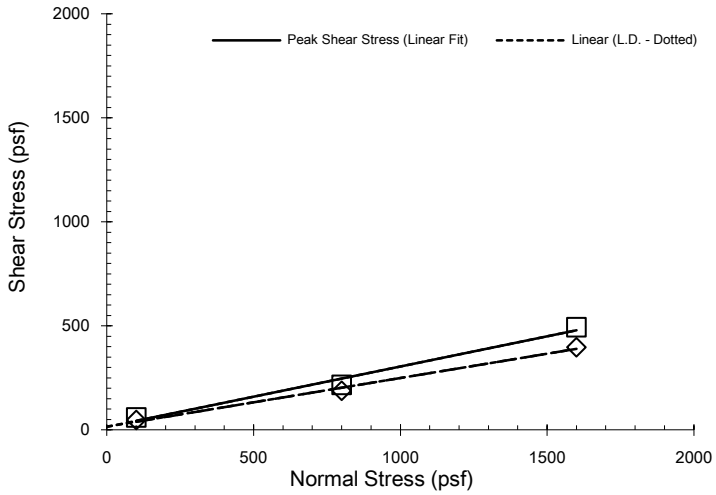
Interface Friction Test Report

Client: **Northwest Liners**
Project: **Bonanza Mine**
Date: 10-08-2014 to 10-08-2014

TRI Log#: E2388-46-05
Test Method: ASTM D5321

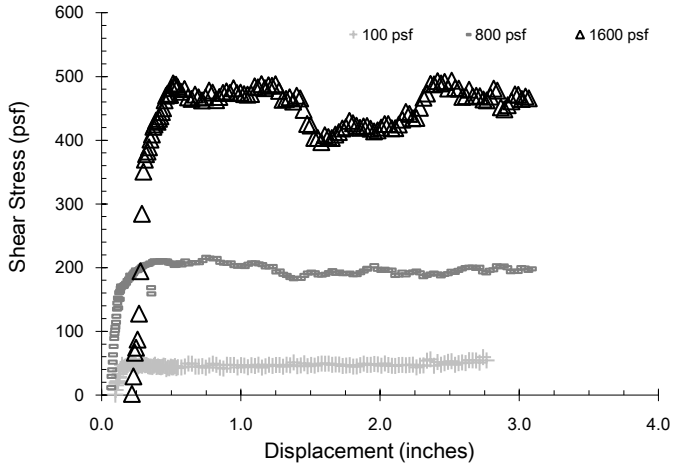
John M. Allen, P.E., 10/08/2014
Quality Review/Date

Tested Interface: Agru 200-1-6 Single-sided Geocomposite (529216-11) vs. Agru 40 mil LLDPE Microspike Geomembrane (F14A391005)



Test Results		
	Peak	Large Displacement (@ 3.0 in.)
Friction Angle (degrees):	16.2	13.2
Y-intercept or Adhesion (psf):	14	16

Shearing occurred at the interface.



Test Conditions	
Upper Box &	Agru 200-1-6 single-sided geocomposite (net side down)
Lower Box	Agru 40 mil LLDPE Microspike geomembrane (dull side up)
Box Dimensions: 12"x12"x4"	
Interface Conditioning:	Interface loading applied for a minimum of 15 hours prior to shear.
Test Condition: Dry	
Shearing Rate: 0.2 inches/minute	

Test Data

Specimen No.	1	2	3
Bearing Slide Resistance (lbs)	9	16	23
Normal Stress (psf)	100	800	1600
Corrected Peak Shear Stress (psf)	59	216	493
Corrected Large Displacement Shear Stress (psf)	47	188	397
Peak Secant Angle (degrees)	30.7	15.1	17.1
Large Displacement Secant Angle (degrees)	25.4	13.2	13.9
Asperity (mils)	26.6	26.6	26.8

ecology and environment, inc.
Global Environmental Specialists

720 Third Avenue, Suite 1700
Seattle, Washington 98104
Tel: (206) 624-9537, Fax: (206) 621-9832

MEMORANDUM

DATE: April 4, 2016

TO: Jake Moersen, START-4 Project Manager, E & E, Seattle, WA

FROM: Mark Woodke, START-4 Chemist, E & E, Seattle, Washington MW

SUBJ: **Agronomics Data Validation Memo, Bonanza Mine 2014 Removal Action Site, Sutherlin, Oregon**

REF: TDD: 14-06-0006 PAN: 1004530.0004.064.02

The data validation of 3 soil samples collected from the Bonanza Mine 2014 Removal Action site located in Sutherlin, Oregon has been completed. Analyses for organic matter, phosphorus, potassium, magnesium, calcium, sodium, pH, hydrogen, cation exchange capacity, and computed cation saturation were performed at A & L Western Agricultural Laboratories, Inc. Portland, Oregon. All sample analyses were evaluated following EPA's Stage 2 Data Validation Manual Process (S2VM).

The samples were numbered: 31001 31004 31005

The samples were collected on March 22, 2016, and were analyzed by March 28, 2016.

The following qualifiers were applied based on laboratory-provided information: The Olsen Method Phosphorus results for samples 31004 and 31005 were qualified as estimated quantities with an unknown bias (JK) because the result is unreliable at this pH.

A & L WESTERN AGRICULTURAL LABORATORIES

10220 SW NIMBUS AVE Bldg K-9 I PORTLAND OREGON 97223 I (503) 968-9225 I FAX (503) 598-7702

REPORT NUMBER: 16-078-097

CLIENT NO: 4290

SEND TO: TESTAMERICA ANALYTICAL TESTING CORP
5755 8TH STREET EAST
TACOMA, WA 98424-

SUBMITTED BY: KRIS ALLEN

GROWER: PROJ #:10045300004.064.02

DATE OF REPORT: 03/28/16

SOIL ANALYSIS REPORT

SAMPLE ID	LAB NUMBER	Organic Matter		Phosphorus		Potassium	Magnesium	Calcium	Sodium	pH		Hydrogen	Cation Exchange Capacity	PERCENT CATION SATURATION (COMPUTED)				
		* % Rating	** ENR lbs/A	P1 (Weak Bray) **** * ppm	$NaHCO_3$-P (Olsen Method) **** * ppm	K ***** * ppm	Mg *** * ppm	Ca *** * ppm	Na *** * ppm	Soil pH	Buffer Index	H meq/100g	C.E.C. meq/100g	K %	Mg %	Ca %	H %	Na %
31001	59778	1.7L	65	14L	11L	62L	537VH	1339L	39L	6.2	6.9	1.6	13.0	1.2	34.0	51.5	12.0	1.3
31004	59779	2.1L	71	3VL	6**JK	66L	620VH	1013L	37L	5.7	6.4	2.8	13.3	1.3	38.4	38.1	21.0	1.2
31005	59780	1.5L	60	1VL	39**JK	64L	622VH	971L	46L	5.6	6.6	3.2	13.5	1.2	37.9	35.9	23.5	1.5

** NaHCO3-P unreliable at this soil pH

SAMPLE NUMBER	Nitrogen NO_3-N ppm	Sulfur SO_4-S ppm	Zinc Zn ppm	Manganese Mn ppm	Iron Fe ppm	Copper Cu ppm	Boron B ppm	Excess Lime Rating	Soluble Salts mmhos/cm	Chloride Cl ppm		PARTICLE SIZE ANALYSIS SAND %	SILT %	CLAY %	SOIL TEXTURE
31001		2VL													
31004		7L													
31005		6L													

4-4-16

* CODE TO RATING: VERY LOW (VL), LOW (L), MEDIUM (M), HIGH (H), AND VERY HIGH (VH).
** ENR - ESTIMATED NITROGEN RELEASE
*** MULTIPLY THE RESULTS IN ppm BY 2 TO CONVERT TO LBS. PER ACRE OF THE ELEMENTAL FORM
**** MULTIPLY THE RESULTS IN ppm BY 4.6 TO CONVERT TO LBS. PER ACRE P_2O_5
***** MULTIPLY THE RESULTS IN ppm BY 2.4 TO CONVERT TO LBS. PER ACRE K_2O
MOST SOILS WEIGH TWO (2) MILLION POUNDS (DRY WEIGHT) FOR AN ACRE OF SOIL 6-2/3 INCHES DEEP

This report applies only to the sample(s) tested. Samples are retained a maximum of thirty days after testing.

Darcy L. Peebles

Darcy L. Peebles, CCA
A & L WESTERN LABORATORIES, INC.

ecology and environment, inc.
Global Environmental Specialists

720 Third Avenue, Suite 1700
Seattle, Washington 98104
Tel: (206) 624-9537, Fax: (206) 621-9832

MEMORANDUM

DATE: April 28, 2016

TO: Jake Moersen, START-4 Project Manager, E & E, Seattle, WA

FROM: Mark Woodke, START-4 Chemist, E & E, Seattle, Washington MW

SUBJ: **Geotechnical Data Validation Memo, Bonanza Mine 2014 Removal Action Site, Sutherlin, Oregon**

REF: TDD: 14-06-0006 PAN: 1004530.0004.064.02

The data validation of 5 solid (gravel, sand, and soil) samples collected from the Bonanza Mine 2014 Removal Action site located in Sutherlin, Oregon has been completed. Interface shear strength (ASTM D-5321), Direct Shear (ASTM D-3080), USCS Visual Classification (ASTM Method D2487), particle size analysis (ASTM Methods D421/D422), Atterberg limits (ASTM Method D4318), compaction (ASTM Method D698), hydraulic conductivity (ASTM Method D5084), and permeability of granular soils (ASTM Method D2434) were performed by GeoTesting Express, Inc., Acton, Massachusetts. All sample analyses were evaluated following EPA's Stage 2B Data Validation Manual Process (S2BVM).

The samples were numbered:

16031001	16031002	16031003	16031004	16031005

Data Qualifications:

The samples were collected on March 11, 2016, and were analyzed by April 21, 2016. No anomalies were noted in the case narrative.

The overall usefulness of the data is based on the criteria outlined in the Site-Specific Sampling Plan and the geotechnical methods. Based upon the information provided, the data are acceptable for use with the above stated data qualifications.

Data Qualifiers and Definitions

U - The analyte was analyzed for, but was not detected above the level of the reported sample quantitation limit.

J - The result is an estimated quantity. The associated numerical value is the approximate concentration of the analyte in the sample.

Client:	Test America				
Project:	Bonanza Mine				
Location:	---			Project No:	GTX-304536
Boring ID:	---	Sample Type:	---	Tested By:	cam
Sample ID:	---	Test Date:	04/15/16	Checked By:	emm
Depth :	---	Test Id:	370696		

USCS Classification - ASTM D2487

Boring ID	Sample ID	Depth	Group Name	Group Symbol	Gravel, %	Sand, %	Fines, %
Umpqua	16031001	Unscreened Topsoil	Clayey sand	SC	4.2	55.1	40.7
Umpqua	16031002	Washed Sand	Poorly graded sand	SP	1.5	95.1	3.4
Umpqua	16031003	3 Inch Minus	Well-graded gravel with sand	GW	75.2	21.3	3.5
Bonanza	16031004	Top Repos	Sandy Lean clay with gravel	CL	16.2	33.0	50.8
Bonanza	16031005	Bottom Repos	Sandy Lean clay	CL	8.2	38.9	52.9

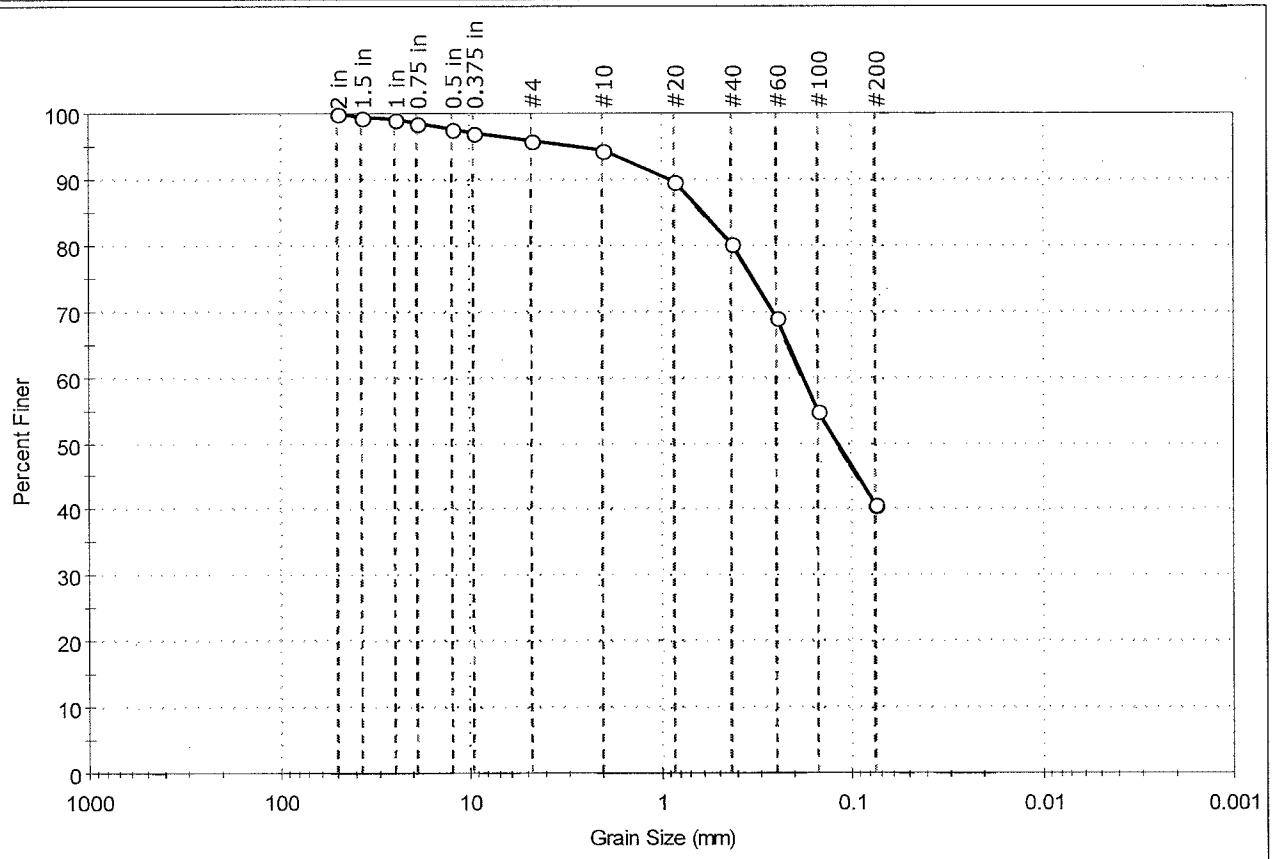
Remarks: Grain Size analysis performed by ASTM D422 results enclosed
Atterberg Limits performed by ASTM D4318, results enclosed

MW 4-28-16

EXPRESS

Client:	Test America				
Project:	Bonanza Mine				
Location:	---			Project No:	GTX-304536
Boring ID:	Umpqua	Sample Type:	bucket	Tested By:	jbr
Sample ID:	16031001	Test Date:	04/04/16	Checked By:	emm
Depth :	Unscreened Topsoil	Test Id:	370682		
Test Comment:	---				
Visual Description:	Moist, dark brown clayey sand				
Sample Comment:	---				

Particle Size Analysis - ASTM D422



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	4.2	55.1	40.7

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
2 in	50.00	100		
1.5 in	37.50	99		
1 in	25.00	99		
0.75 in	19.00	98		
0.5 in	12.50	98		
0.375 in	9.50	97		
#4	4.75	96		
#10	2.00	94		
#20	0.85	90		
#40	0.42	80		
#60	0.25	69		
#100	0.15	55		
#200	0.075	41		

Coefficients

D_{85} =0.6040 mm	D_{30} =N/A
D_{60} =0.1813 mm	D_{15} =N/A
D_{50} =0.1187 mm	D_{10} =N/A
C_u =N/A	C_c =N/A

Classification

ASTM Clayey sand (SC)

AASHTO Clayey Soils (A-6 (1))

Sample/Test Description

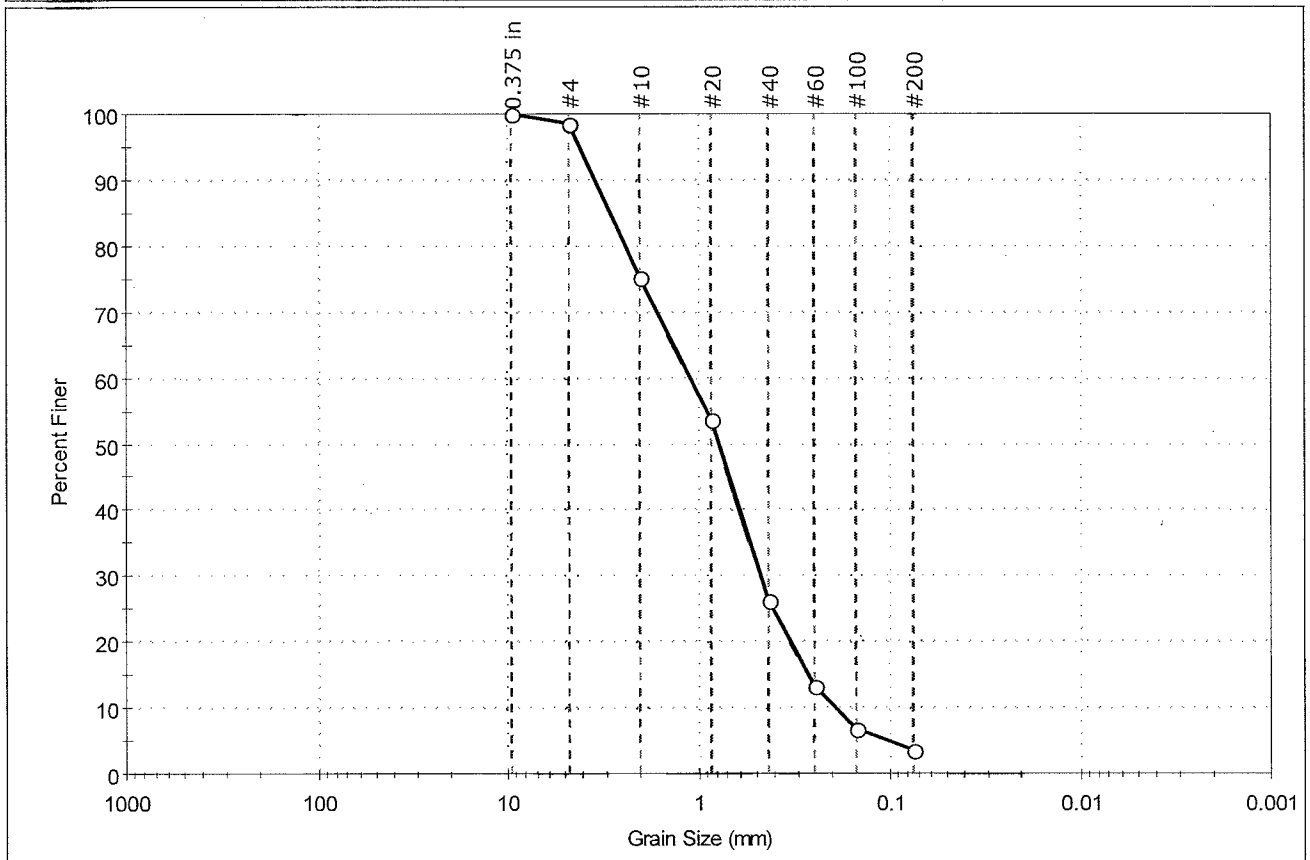
Sand/Gravel Particle Shape : ANGULAR

Sand/Gravel Hardness : HARD

EXPRESS

Client:	Test America				
Project:	Bonanza Mine				
Location:	---			Project No:	GTX-304536
Boring ID:	Umpqua	Sample Type:	bucket	Tested By:	jbr
Sample ID:	16031002	Test Date:	04/01/16	Checked By:	emm
Depth :	Washed Sand	Test Id:	370683		
Test Comment:	---				
Visual Description:	Moist, dark olive brown sand				
Sample Comment:	---				

Particle Size Analysis - ASTM D422



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	1.5	95.1	3.4

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
0.375 in	9.50	100		
#4	4.75	98		
#10	2.00	75		
#20	0.85	54		
#40	0.42	26		
#60	0.25	13		
#100	0.15	7		
#200	0.075	3.4		

Coefficients

D_{85} =2.8783 mm	D_{30} =0.4673 mm
D_{60} =1.0965 mm	D_{15} =0.2695 mm
D_{50} =0.7765 mm	D_{10} =0.1934 mm
C_u =5.670	C_c =1.030

Classification

ASTM Poorly graded sand (SP)

AASHTO Stone Fragments, Gravel and Sand (A-1-b (1))

Sample/Test Description

Sand/Gravel Particle Shape : ANGULAR

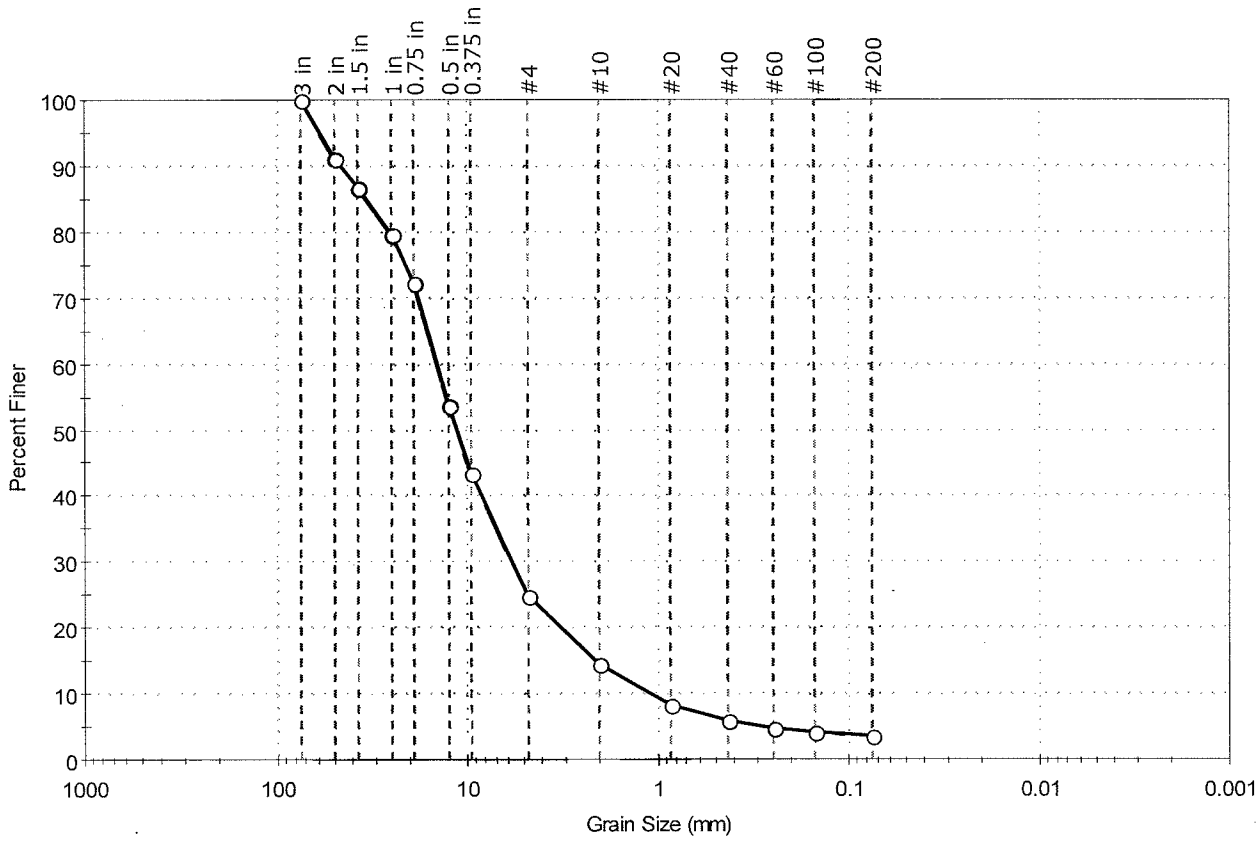
Sand/Gravel Hardness : HARD

MW 472816

04/27/2016

Client:	Test America				
Project:	Bonanza Mine				
Location:	---			Project No:	GTX-304536
Boring ID:	Umpqua	Sample Type:	bucket	Tested By:	jbr
Sample ID:	16031003	Test Date:	04/01/16	Checked By:	emm
Depth :	3 Inch Minus	Test Id:	370684		
Test Comment:	---				
Visual Description:	Moist, dark olive gray gravel with sand				
Sample Comment:	---				

Particle Size Analysis - ASTM D422



% Cobble	% Gravel	% Sand	% Silt & Clay Size
–	75.2	21.3	3.5

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
3 in	75.00	100		
2 in	50.00	91		
1.5 in	37.50	87		
1 in	25.00	80		
0.75 in	19.00	72		
0.5 in	12.50	54		
0.375 in	9.50	43		
#4	4.75	25		
#10	2.00	14		
#20	0.85	8		
#40	0.42	6		
#60	0.25	5		
#100	0.15	4		
#200	0.075	3.5		

Coefficients

D_{85} =33.9764 mm D_{30} =5.7633 mm
D_{60} =14.3957 mm D_{15} =2.1146 mm
D_{50} =11.3291 mm D_{10} =1.1009 mm
C_u =13.076 C_c =2.096

Classification

ASTM Well-graded gravel with sand (GW)

AASHTO Clayey Gravel and Sand (A-2-6 (0))

Sample/Test Description

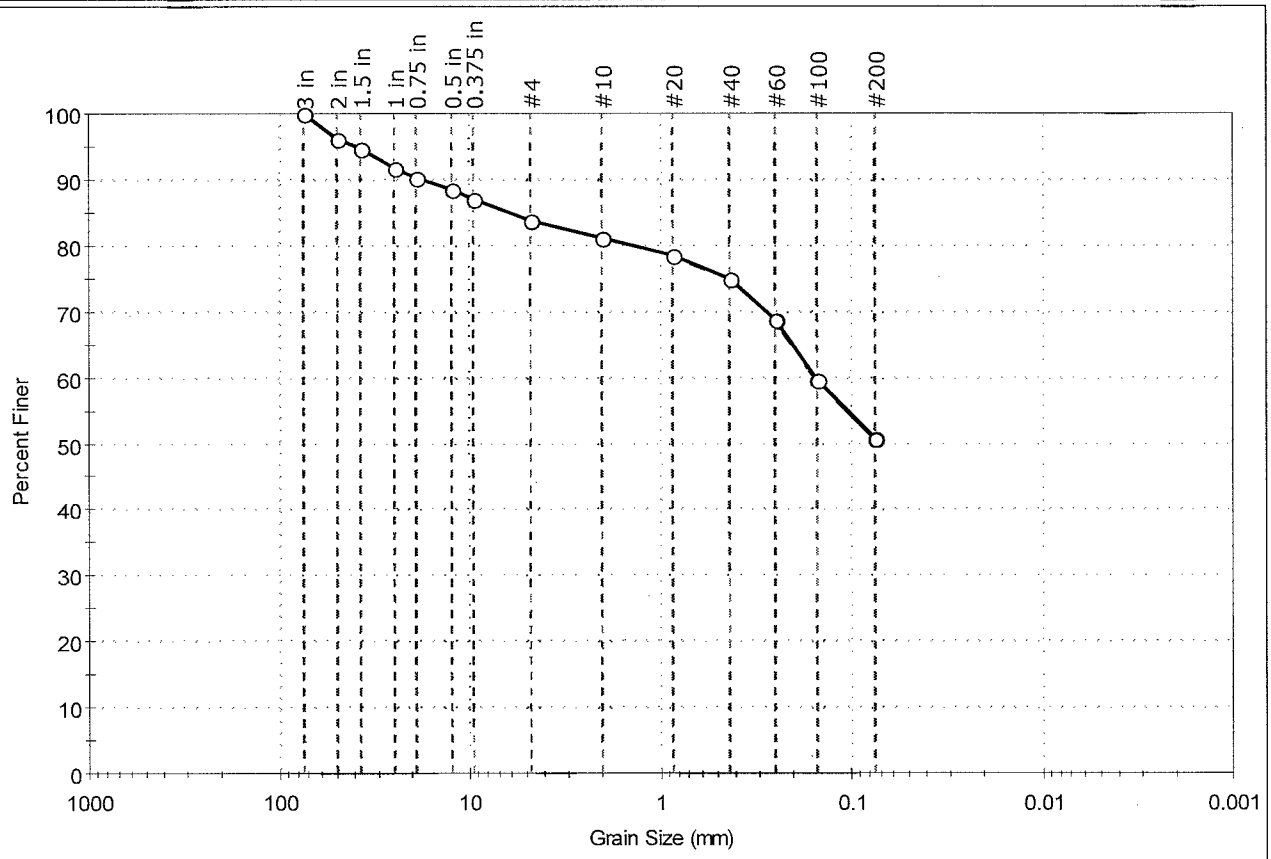
Sand/Gravel Particle Shape : ANGULAR

Sand/Gravel Hardness : HARD

EXPRESS

Client:	Test America				
Project:	Bonanza Mine				
Location:	---			Project No:	GTX-304536
Boring ID:	Bonanza	Sample Type:	bucket	Tested By:	jbr
Sample ID:	16031004	Test Date:	04/04/16	Checked By:	emm
Depth :	Top Repos	Test Id:	370685		
Test Comment:	---				
Visual Description:	Moist, light olive brown sandy clay with gravel				
Sample Comment:	---				

Particle Size Analysis - ASTM D422



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	16.2	33.0	50.8

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
3 in	75.00	100		
2 in	50.00	96		
1.5 in	37.50	95		
1 in	25.00	92		
0.75 in	19.00	90		
0.5 in	12.50	88		
0.375 in	9.50	87		
#4	4.75	84		
#10	2.00	81		
#20	0.85	79		
#40	0.42	75		
#60	0.25	69		
#100	0.15	60		
#200	0.075	51		

Coefficients

D_{85} =6.1631 mm	D_{30} =N/A
D_{60} =0.1532 mm	D_{15} =N/A
D_{50} =N/A	D_{10} =N/A
C_u =N/A	C_c =N/A

Classification

ASTM Sandy Lean clay with gravel (CL)

AASHTO Clayey Soils (A-7-6 (8))

Sample/Test Description

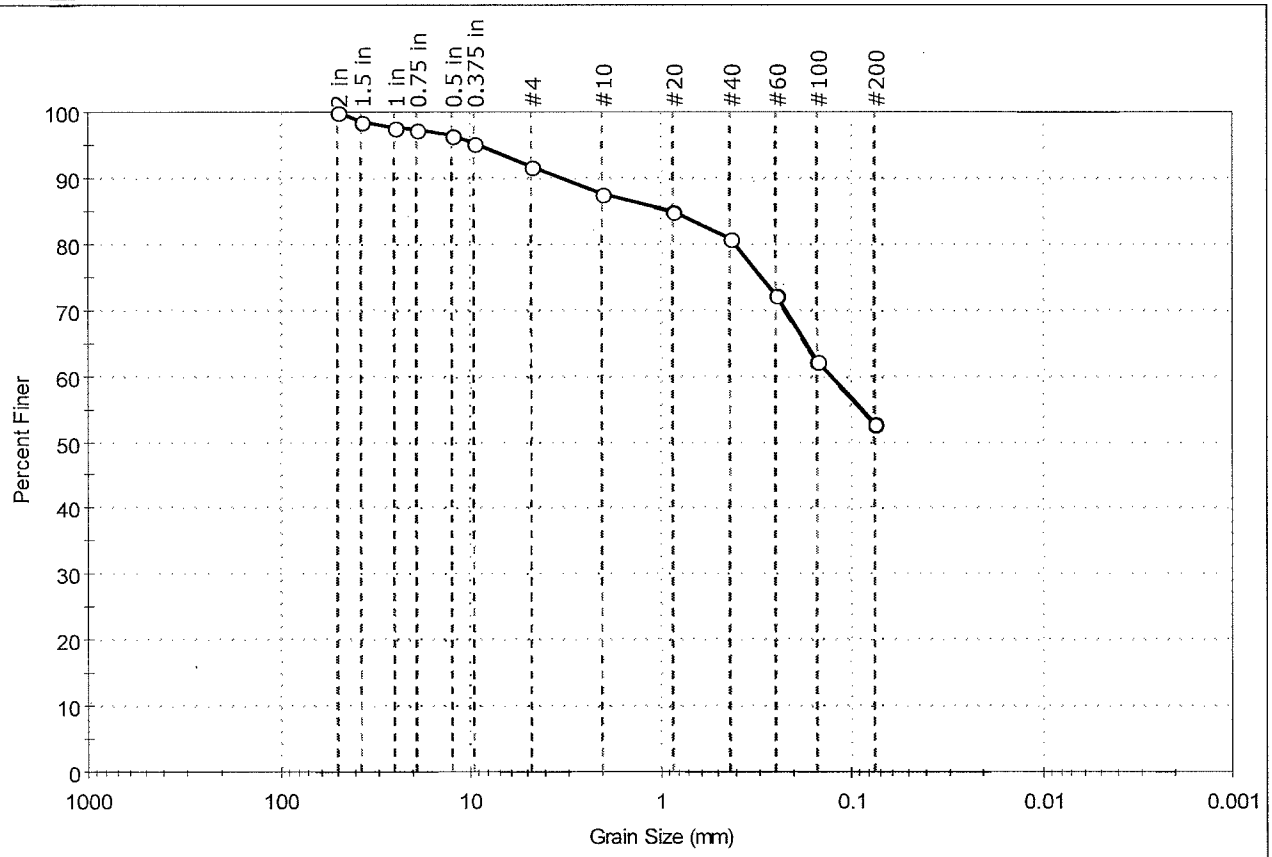
Sand/Gravel Particle Shape : ANGULAR

Sand/Gravel Hardness : HARD

EXPRESS

Client:	Test America				
Project:	Bonanza Mine				
Location:	---			Project No:	GTX-304536
Boring ID:	Bonanza	Sample Type:	bucket	Tested By:	jbr
Sample ID:	16031005	Test Date:	04/04/16	Checked By:	emm
Depth :	Bottom Repos	Test Id:	370686		
Test Comment:	---				
Visual Description:	Moist, light olive brown sandy clay				
Sample Comment:	---				

Particle Size Analysis - ASTM D422



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	8.2	38.9	52.9

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
2 in	50.00	100		
1.5 in	37.50	98		
1 in	25.00	98		
0.75 in	19.00	97		
0.5 in	12.50	97		
0.375 in	9.50	95		
#4	4.75	92		
#10	2.00	88		
#20	0.85	85		
#40	0.42	81		
#60	0.25	72		
#100	0.15	62		
#200	0.075	53		

Coefficients

D_{85} = 0.8573 mm D_{30} = N/A
D_{60} = 0.1268 mm D_{15} = N/A
D_{50} = N/A D_{10} = N/A
C_u = N/A C_c = N/A

Classification

ASTM Sandy Lean clay (CL)

AASHTO Clayey Soils (A-6 (6))

Sample/Test Description

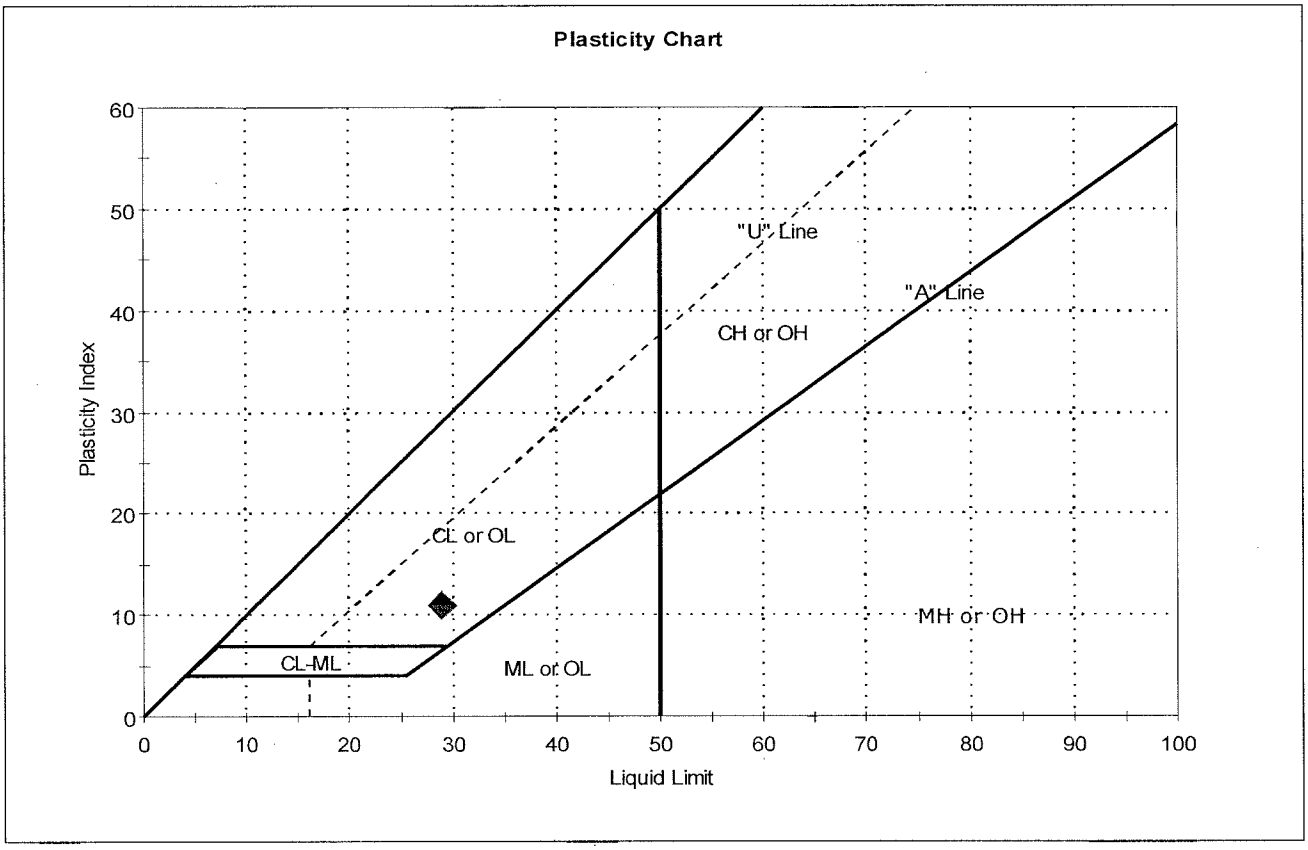
Sand/Gravel Particle Shape : ANGULAR

Sand/Gravel Hardness : HARD

EXPRESS

Client:	Test America				
Project:	Bonanza Mine				
Location:	---			Project No:	GTX-304536
Boring ID:	Umpqua	Sample Type:	bucket	Tested By:	cam
Sample ID:	16031001	Test Date:	04/01/16	Checked By:	emm
Depth :	Unscreened Topsoil	Test Id:	370687		
Test Comment:	---				
Visual Description:	Moist, dark brown clayey sand				
Sample Comment:	---				

Atterberg Limits - ASTM D4318

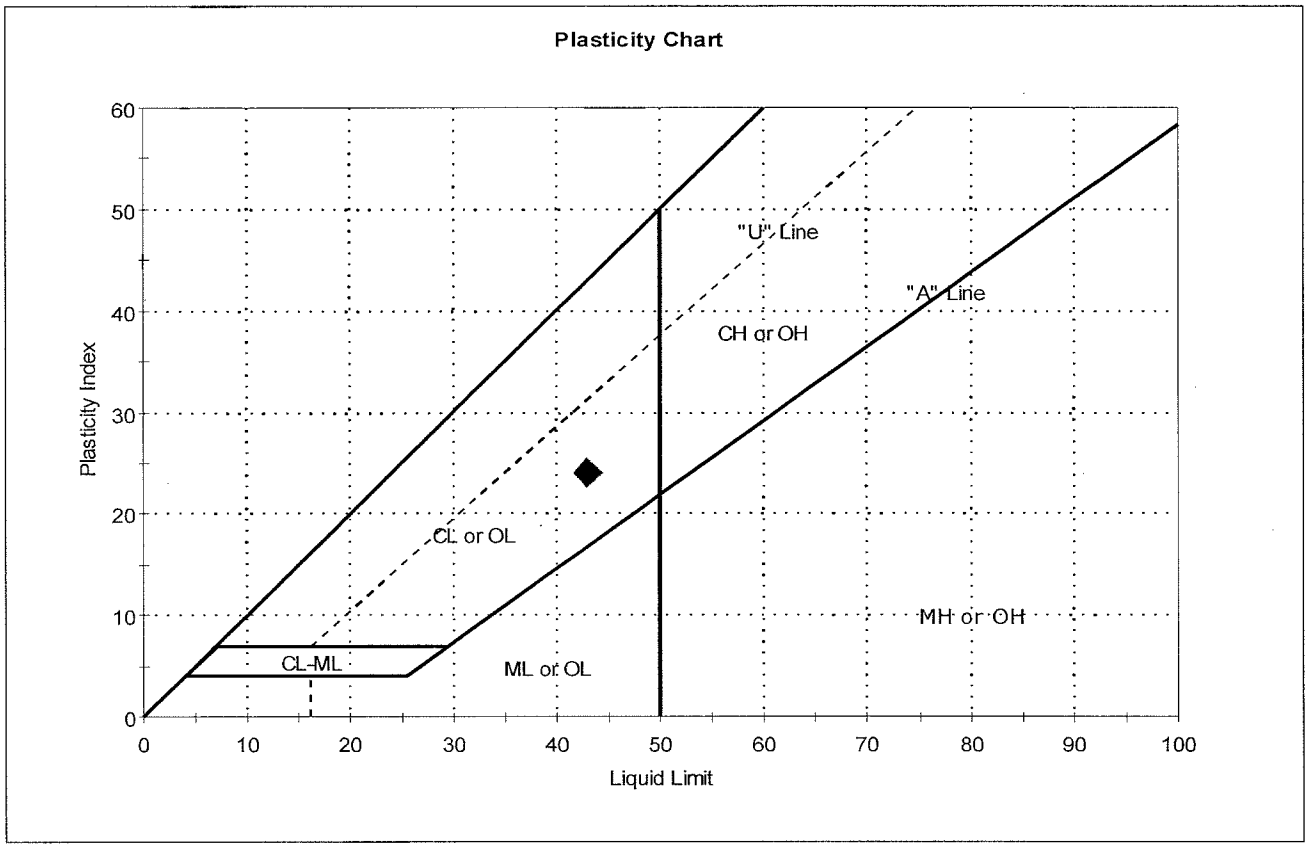


Symbol	Sample ID	Boring	Depth	Natural Moisture Content,%	Liquid Limit	Plastic Limit	Plasticity Index	Liquidity Index	Soil Classification
◆	16031001	Umpqua	Inscreene Topsoil	15	29	18	11	-0.2	Clayey sand (SC)

Sample Prepared using the WET method
20% Retained on #40 Sieve
Dry Strength: VERY HIGH
Dilatancy: SLOW
Toughness: LOW

Client:	Test America				
Project:	Bonanza Mine				
Location:	---			Project No:	GTX-304536
Boring ID:	Bonanza	Sample Type:	bucket	Tested By:	cam
Sample ID:	16031004	Test Date:	04/04/16	Checked By:	emm
Depth :	Top Repos	Test Id:	370690		
Test Comment:	---				
Visual Description:	Moist, light olive brown sandy clay with gravel				
Sample Comment:	---				

Atterberg Limits - ASTM D4318

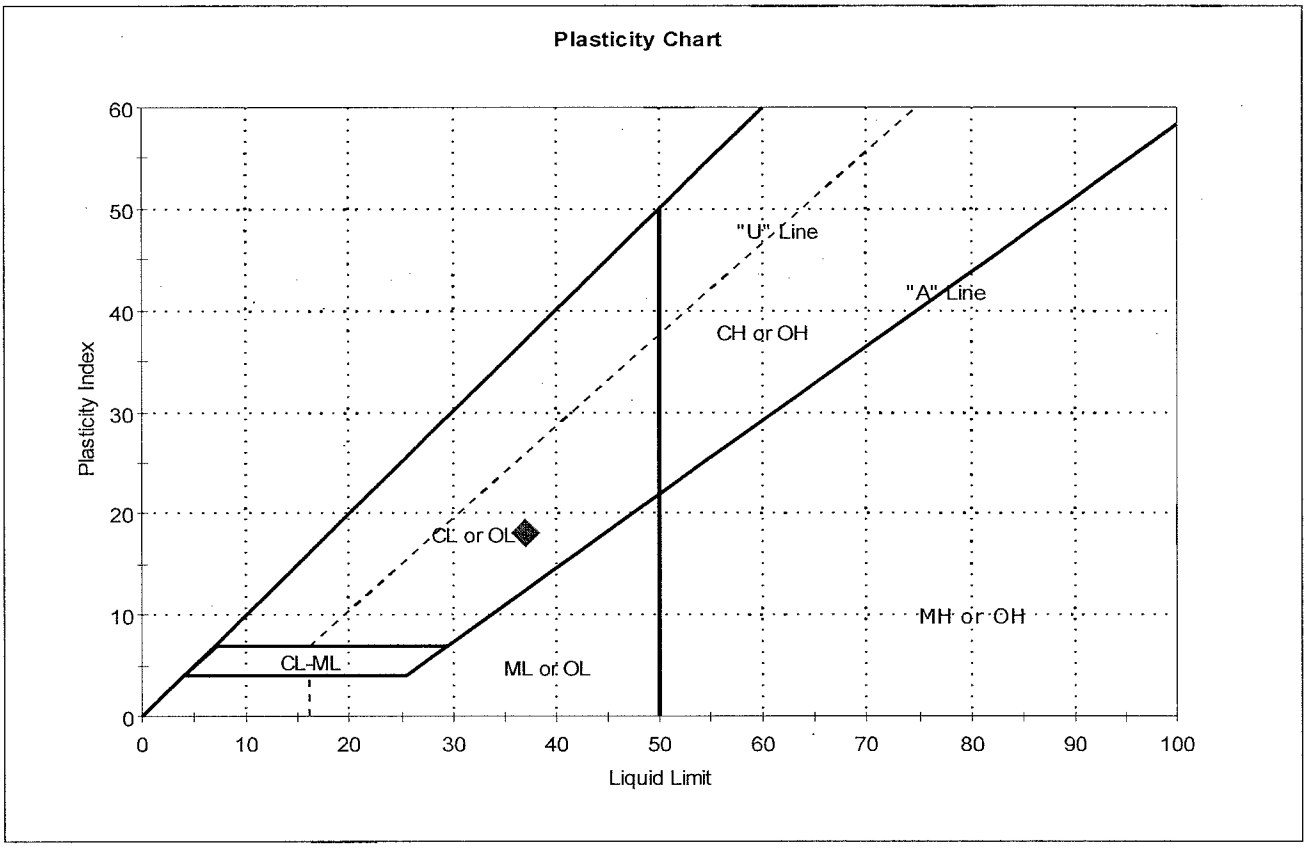


Symbol	Sample ID	Boring	Depth	Natural Moisture Content,%	Liquid Limit	Plastic Limit	Plasticity Index	Liquidity Index	Soil Classification
◆	16031004	Bonanza	Top Repos	22	43	19	24	0.1	Sandy Lean clay with gravel (CL)

Sample Prepared using the WET method
25% Retained on #40 Sieve
Dry Strength: VERY HIGH
Dilatancy: SLOW
Toughness: LOW

Client:	Test America				
Project:	Bonanza Mine				
Location:	---			Project No:	GTX-304536
Boring ID:	Bonanza	Sample Type:	bucket	Tested By:	cam
Sample ID:	16031005	Test Date:	04/05/16	Checked By:	emm
Depth :	Bottom Repos	Test Id:	370691		
Test Comment:	---				
Visual Description:	Moist, light olive brown sandy clay				
Sample Comment:	---				

Atterberg Limits - ASTM D4318



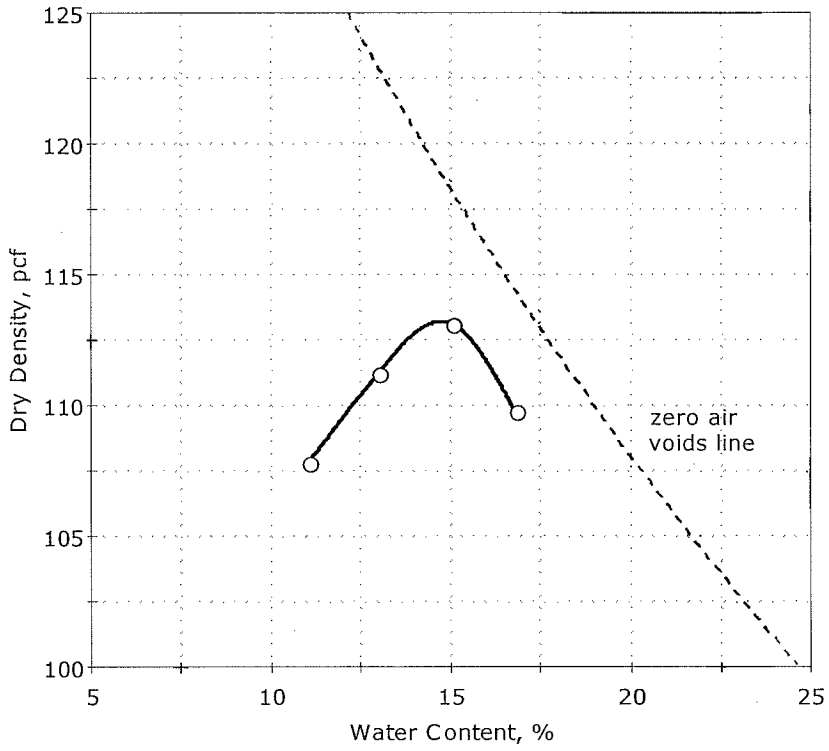
Symbol	Sample ID	Boring	Depth	Natural Moisture Content,%	Liquid Limit	Plastic Limit	Plasticity Index	Liquidity Index	Soil Classification
◆	16031005	Bonanza	Bottom Repos	24	37	19	18	0.3	Sandy Lean clay (CL)

Sample Prepared using the WET method
19% Retained on #40 Sieve
Dry Strength: VERY HIGH
Dilatancy: SLOW
Toughness: LOW

EXPRESS

Client:	Test America				
Project:	Bonanza Mine				
Location:	---			Project No:	GTX-304536
Boring ID:	Umpqua	Sample Type:	bucket	Tested By:	pmh
Sample ID:	16031002	Test Date:	03/31/16	Checked By:	emm
Depth :	Washed Sand	Test Id:	370698		
Test Comment:	---				
Visual Description:	Moist, dark olive brown sand				
Sample Comment:	---				

Compaction Report - ASTM D698



Data Points	Point 1	Point 2	Point 3	Point 4
Dry density, pcf	107.8	111.2	113.1	109.7
Moisture Content, %	11.1	13.0	15.0	16.8

Method : A

Preparation : DRY

As received Moisture :8 %

Rammer : Manual

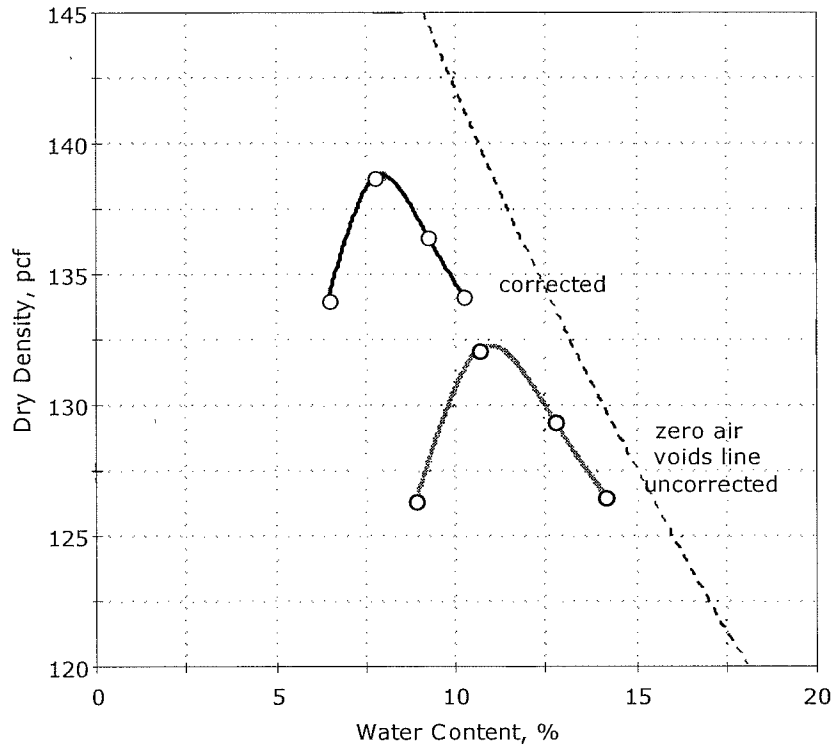
Zero voids line based on assumed specific gravity of 2.65

Maximum Dry Density= 113.2 pcf

Optimum Moisture= 14.7 %

Client:	Test America				
Project:	Bonanza Mine				
Location:	---			Project No:	GTX-304536
Boring ID:	Umpqua	Sample Type:	bucket	Tested By:	pmh
Sample ID:	16031003	Test Date:	04/04/16	Checked By:	emm
Depth :	3 Inch Minus	Test Id:	370699		
Test Comment:	---				
Visual Description:	Moist, dark olive gray gravel with sand				
Sample Comment:	---				

Compaction Report - ASTM D698



Data Points	Point 1	Point 2	Point 3	Point 4
Dry density, pcf	126.4	132.1	129.4	126.5
Moisture Content, %	8.9	10.7	12.8	14.2

Method : C

Preparation : DRY

As received Moisture :6 %

Rammer : Manual

Zero voids line based on assumed specific gravity of 2.95

Maximum Dry Density= 132.3 pcf

Optimum Moisture= 11.0 %

Oversize Correction (27.7% > 3/4 inch Sieve)

Corrected Maximum Dry Density= 138.8 pcf

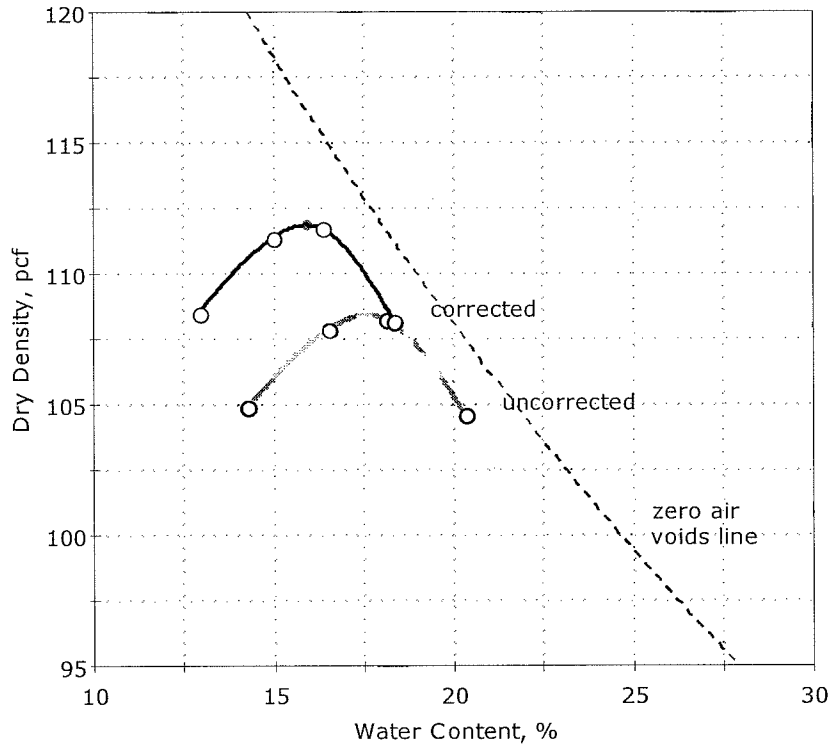
Corrected Optimum Moisture= 8.0 %

Assumed Average Bulk Specific Gravity = 2.55

EXPRESS

Client:	Test America				
Project:	Bonanza Mine				
Location:	---			Project No:	GTX-304536
Boring ID:	Bonanza	Sample Type:	bucket	Tested By:	pmh
Sample ID:	16031004	Test Date:	04/04/16	Checked By:	emm
Depth :	Top Repos	Test Id:	370700		
Test Comment:	---				
Visual Description:	Moist, light olive brown sandy clay with gravel				
Sample Comment:	---				

Compaction Report - ASTM D698



Data Points	Point 1	Point 2	Point 3	Point 4
Dry density, pcf	104.9	107.9	108.3	104.6
Moisture Content, %	14.3	16.5	18.1	20.3

Method : C

Preparation : DRY

As received Moisture :22 %

Rammer : Manual

Zero voids line based on assumed specific gravity of 2.65

Maximum Dry Density= 108.4 pcf

Optimum Moisture= 17.6 %

Oversize Correction (9.6% > 3/4 inch Sieve)

Corrected Maximum Dry Density= 111.9 pcf

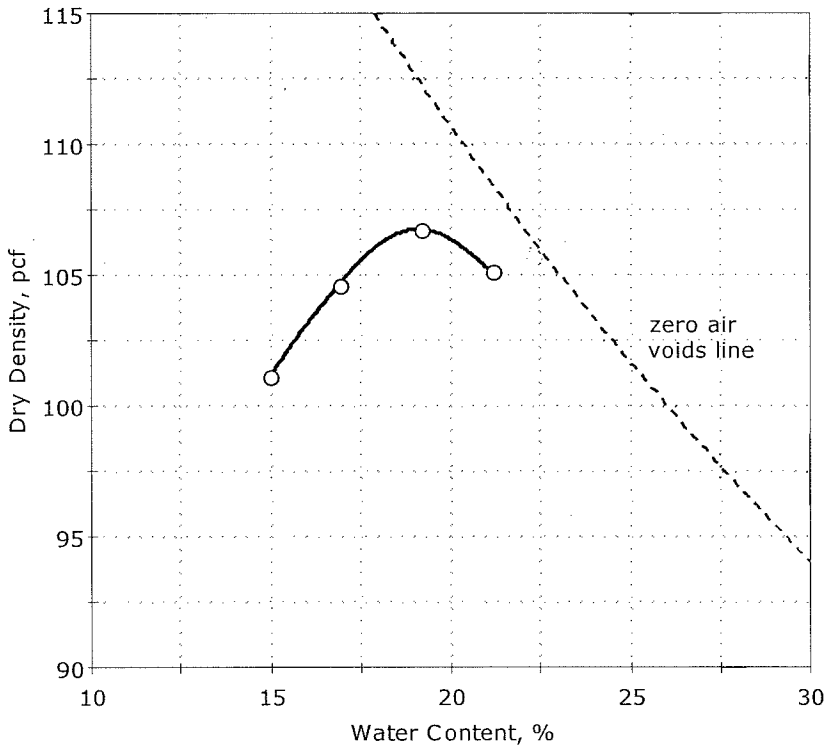
Corrected Optimum Moisture= 15.9 %

Assumed Average Bulk Specific Gravity = 2.55

EXPRESS

Client:	Test America				
Project:	Bonanza Mine				
Location:	---			Project No:	GTX-304536
Boring ID:	Bonanza	Sample Type:	bucket	Tested By:	pmh
Sample ID:	16031005	Test Date:	04/04/16	Checked By:	emm
Depth :	Bottom Repos	Test Id:	370701		
Test Comment:	---				
Visual Description:	Moist, light olive brown sandy clay				
Sample Comment:	---				

Compaction Report - ASTM D698



Data Points	Point 1	Point 2	Point 3	Point 4
Dry density, pcf	101.1	104.6	106.8	105.1
Moisture Content, %	15.0	16.9	19.2	21.1

Method : B

Preparation : DRY

As received Moisture :24 %

Rammer : Manual

Zero voids line based on assumed specific gravity of 2.75

Maximum Dry Density= 106.8 pcf

Optimum Moisture= 19.1 %

Client:	Test America		
Project Name:	Bonanza Mine		
Project Location:	---		
GTX #:	304536		
Start Date:	4/5/2016	Tested By:	jcw
End Date:	4/7/2016	Checked By:	emm
Boring #:	Umpqua		
Sample #:	16031001		
Depth:	Unscreened Topsoil		
Visual Description:	Moist, dark brown clayey sand		

Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Permeameter by ASTM D5084

Constant Gradient

Sample Type:	Remolded	Permeant Fluid:	De-aired Distilled water
Orientation:	Vertical	Cell #:	9/15

Sample Preparation: Test specimen compacted with moderate effort at the as-recieved moisture content. Values specified by client. Material >3/8-inch removed from sample prior to testing (3% of sample). Trimmings moisture content = 15.4%

Assumed Specific Gravity: 2.65

Parameter	Initial	Final
Height, in	2.98	2.98
Diameter, in	2.86	2.86
Area, in^2	6.42	6.42
Volume, in^3	19.1	19.1
Mass, g	599	632
Bulk Density, pcf	119.0	125.5
Moisture Content, %	15.1	21.4
Dry Density, pcf	103.3	103.3
Degree of Saturation, %	67	95

B COEFFICIENT DETERMINATION

Cell Pressure, psi:	92.03	Increased Cell Pressure, psi:	96.96	Cell Pressure Increment, ps	4.93
Sample Pressure, psi:	87.03	Corresponding Sample Pressure, psi:	91.49	Sample Pressure Increment	4.46
				B Coefficient:	0.90

*B value did not increase with increase in pressure. Final degree of saturation >95%.

FLOW DATA

Date	Time, sec	Pressure, psi Cell	Inlet	Outlet	Gradient	Flow Volume, cc In	Out	Δ In	Δ Out	Temp, °C	R_t	Permeability K @ 20 °C, cm/sec
4/6	---	92.0	87.1	86.9	1.9	12.30	13.50	---	---	---	---	---
4/6	73	92.0	87.1	86.9	1.9	13.30	12.50	1.00	1.00	20.4	0.991	1.8E-04
4/6	----	92.0	87.1	86.9	1.9	12.50	13.60	---	---	---	---	---
4/6	49	92.0	87.1	86.9	1.9	13.10	13.00	0.60	0.60	20.4	0.991	1.6E-04
4/6	----	92.0	87.1	86.9	1.9	12.50	13.20	---	---	---	---	---
4/6	58	92.0	87.1	86.9	1.9	13.20	12.50	0.70	0.70	20.4	0.991	1.6E-04
4/6	----	92.0	87.1	86.9	1.9	12.60	13.50	---	---	---	---	---
4/6	40	92.0	87.1	86.9	1.9	13.10	13.00	0.50	0.50	20.4	0.991	1.6E-04

PERMEABILITY AT 20° C: 1.6 x 10^{-4} cm/sec (@ 5 psi effective stress)

04/27/2016

Client:	Test America		
Project Name:	Bonanza Mine		
Project Location:	---		
GTX #:	304536		
Start Date:	04/07/16	Tested By:	jcw
End Date:	04/07/16	Checked By:	emm
Boring #:	Umpqua		
Sample #:	16031002		
Depth:	Washed Sand		
Visual Description:	Moist, dark olive brown sand		

Permeability of Granular Soils (Constant Head) by ASTM D2434

Sample Type: Remolded

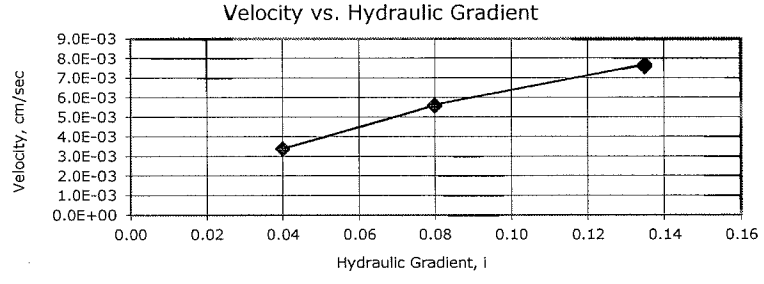
Sample Information:

Maximum Dry Density:	113.2 pcf
Optimum Moisture Content:	14.7 %
Compaction Test Method:	D698
Classification (ASTM D2487):	SP
Assumed Specific Gravity:	2.65

Sample Preparation / Test Setup: Target Compaction: 90% of maximum dry density (113.2 pcf) at air-dried moisture content. Values specified by client. Material >3/8-inch removed from sample prior to testing (0% of sample).

Parameter	Initial	Final
Height, in	4.03	4.03
Diameter, in	3.98	3.98
Area, in^2	12.4	12.4
Volume, in^3	50.1	50.1
Mass, g	1344	1637
Bulk Density, pcf	102.1	124.4
Moisture Content, %	0.8	22.8
Dry Density, pcf	101.3	101.3
Degree of Saturation, %	---	95.3
Void Ratio, e	---	0.63

Date	Reading #	Volume of Flow, cc	Time of Flow, sec	Flow Rate, cc/sec	Gradient	Permeability, cm/sec	Temp., °C	Correction Factor	Permeability @ 20 °C, cm/sec
4/7	1	2.7	10	0.27	0.04	8.5E-02	19.1	1.023	8.7E-02
4/7	2	2.7	10	0.27	0.04	8.4E-02	19.1	1.023	8.6E-02
4/7	3	2.7	10	0.27	0.04	8.5E-02	19.1	1.023	8.6E-02
4/7	4	4.5	10	0.45	0.08	7.0E-02	19.1	1.023	7.1E-02
4/7	5	4.4	10	0.44	0.08	6.9E-02	19.1	1.023	7.1E-02
4/7	6	4.5	10	0.45	0.08	7.0E-02	19.1	1.023	7.2E-02
4/7	7	6.2	10	0.62	0.14	5.7E-02	19.1	1.023	5.8E-02
4/7	8	6.1	10	0.61	0.14	5.6E-02	19.1	1.023	5.7E-02
4/7	9	6.1	10	0.61	0.14	5.6E-02	19.1	1.023	5.7E-02



PERMEABILITY @ 20 °C = 7.2 x 10^{-2} cm/sec

Note: This standard has been withdrawn by ASTM with no replacement.

MW 4-28-16 04/27/2016

Geo Testing EXPRESS

Client:	Test America		
Project Name:	Bonanza Mine		
Project Location:	---		
GTX #:	304536		
Start Date:	4/6/2016	Tested By:	jcw
End Date:	4/8/2016	Checked By:	emm
Boring #:	Bonanza		
Sample #:	16031004		
Depth:	Top Repos		
Visual Description:	Moist, light olive brown sandy clay with gravel		

Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Permeameter by ASTM D5084

Constant Gradient

Sample Type:	Remolded	Permeant Fluid:	De-aired Distilled water
Orientation:	Vertical	Cell #:	6/7

Sample Preparation: Target Compaction: 90% of maximum dry density (108.5 pcf) at the optimum moisture content (17.6%). Values specified by client. Material >3/8-inch removed from sample prior to testing (13% of sample). Trimmings moisture content = 17.5%

Assumed Specific Gravity: 2.65

Parameter	Initial	Final
Height, in	3.00	2.99
Diameter, in	2.86	2.86
Area, in^2	6.42	6.42
Volume, in^3	19.3	19.2
Mass, g	581	616
Bulk Density, pcf	114.6	121.9
Moisture Content, %	17.9	24.9
Dry Density, pcf	97.2	97.6
Degree of Saturation, %	68	95

B COEFFICIENT DETERMINATION

Cell Pressure, psi:	90.03	Increased Cell Pressure, psi:	95.00	Cell Pressure Increment, ps	4.97
Sample Pressure, psi:	85.00	Corresponding Sample Pressure, psi:	89.70	Sample Pressure Increment	4.70
				B Coefficient:	0.95

FLOW DATA

Date	Time, sec	Pressure, psi Cell	Inlet	Outlet	Gradient	Flow Volume, cc In	Out	Δ In	Δ Out	Temp, °C	R_t	Permeability K @ 20 °C, cm/sec
4/7	---	90.0	85.1	84.9	1.9	12.50	13.40	---	---	---	---	---
4/7	31	90.0	85.1	84.9	1.9	12.90	13.00	0.40	0.40	20.5	0.988	1.7E-04
4/7	----	90.0	85.1	84.9	1.9	12.80	13.50	---	---	---	---	---
4/7	49	90.0	85.1	84.9	1.9	13.50	12.80	0.70	0.70	20.5	0.988	1.8E-04
4/7	----	90.0	85.1	84.9	1.9	12.20	13.20	---	---	---	---	---
4/7	50	90.0	85.1	84.9	1.9	12.90	12.50	0.70	0.70	20.5	0.988	1.8E-04
4/7	----	90.0	85.1	84.9	1.9	12.50	13.30	---	---	---	---	---
4/7	55	90.0	85.1	84.9	1.9	13.30	12.50	0.80	0.80	20.5	0.988	1.9E-04

PERMEABILITY AT 20° C: 1.8 x 10^{-4} cm/sec (@ 5 psi effective stress)

MW 4/28/16

Client:	Test America		
Project Name:	Bonanza Mine		
Project Location:	---		
GTX #:	304536		
Start Date:	4/6/2016	Tested By:	jcw
End Date:	4/8/2016	Checked By:	emm
Boring #:	Bonanza		
Sample #:	16031005		
Depth:	Bottom Repo		
Visual Description:	Moist, light olive brown sandy clay		

Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Permeameter by ASTM D5084

Constant Gradient

Sample Type:	Remolded	Permeant Fluid:	De-aired Distilled water
Orientation:	Vertical	Cell #:	2/5

Sample Preparation: Target Compaction: 90% of maximum dry density (106.8 pcf) at the optimum moisture content (19.1%). Values specified by client. Material >3/8-inch removed from sample prior to testing (5% of sample). Trimmings moisture content = 19.3%

Assumed Specific Gravity: 2.65

Parameter	Initial	Final
Height, in	3.00	2.98
Diameter, in	2.86	2.86
Area, in^2	6.42	6.42
Volume, in^3	19.3	19.1
Mass, g	579	610
Bulk Density, pcf	114.2	121.1
Moisture Content, %	19.3	25.6
Dry Density, pcf	95.8	96.4
Degree of Saturation, %	70	95

B COEFFICIENT DETERMINATION

Cell Pressure, psi:	90.00	Increased Cell Pressure, psi:	94.97	Cell Pressure Increment, ps	4.97
Sample Pressure, psi:	84.99	Corresponding Sample Pressure, psi:	89.70	Sample Pressure Increment	4.71
				B Coefficient:	0.95

FLOW DATA

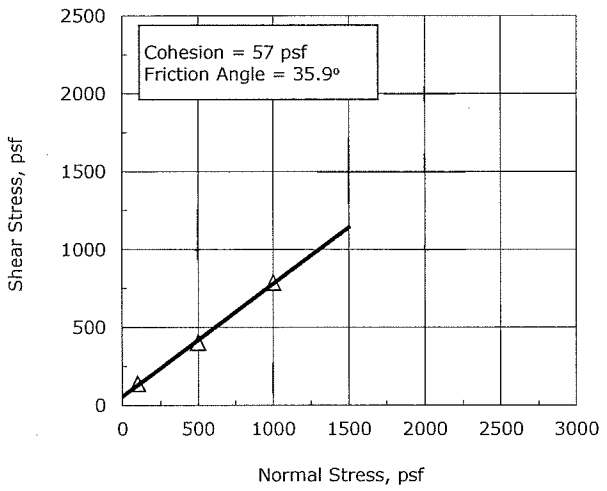
Date	Time, sec	Pressure, psi Cell	Inlet	Outlet	Gradient	Flow Volume, cc In	Out	Δ In	Δ Out	Temp, °C	R_t	Permeability K @ 20 °C, cm/sec
4/7	---	90.0	85.3	84.8	4.6	12.50	13.00	---	---	---	---	---
4/7	136	90.0	85.3	84.8	4.6	12.80	12.70	0.30	0.30	20.5	0.988	1.1E-05
4/7	----	90.0	85.3	84.8	4.6	12.40	13.10	---	---	---	---	---
4/7	122	90.0	85.3	84.8	4.6	12.70	12.80	0.30	0.30	20.5	0.988	1.3E-05
4/7	----	90.0	85.3	84.8	4.6	13.00	13.30	---	---	---	---	---
4/7	152	90.0	85.3	84.8	4.6	13.30	13.00	0.30	0.30	20.5	0.988	1.0E-05
4/7	----	90.0	85.3	84.8	4.6	12.90	12.90	---	---	---	---	---
4/7	120	90.0	85.3	84.8	4.6	13.20	12.60	0.30	0.30	20.5	0.988	1.3E-05

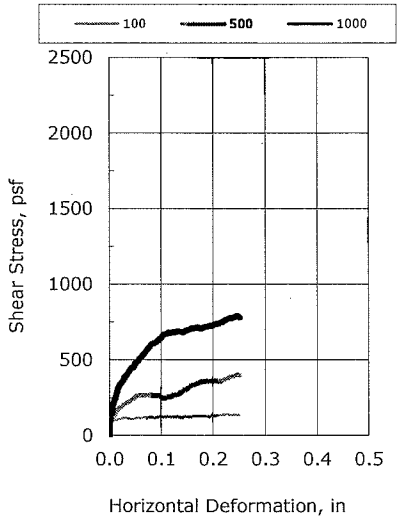
PERMEABILITY AT 20° C: 1.2 x 10^{-5} cm/sec (@ 5 psi effective stress)

04/27/2016

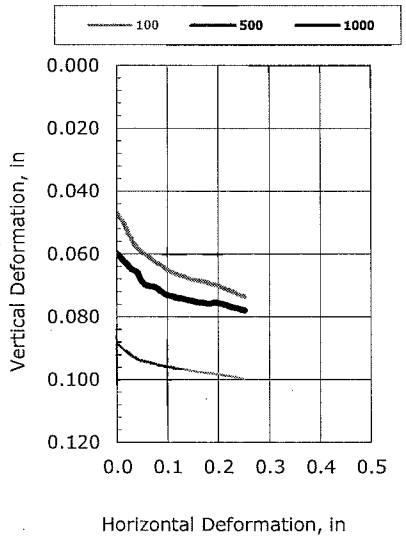
Client:	Test America
Project Name:	Bonanza Mine
Project Location:	---
GTX #:	304536
Test Date:	04/12/16
Tested By:	md
Checked By:	njh
Boring ID:	Umpqua
Sample ID:	16031002
Depth, ft:	Washed Sand
Visual Description:	Moist, dark olive brown sand

Direct Shear Test of Soils Under Consolidated Drained Conditions by ASTM D3080





Test No.:	DS-1	DS-2	DS-3
Initial Diameter, in:	2.5	2.5	2.5
Initial Height, in:	1.0	1.0	1.0
Initial Mass, grams:	151	151	151
Initial Dry Density, pcf:	102.9	102.9	102.9
Initial Moisture Content, %:	13.6	13.6	13.6
Initial Bulk Density, pcf:	116.9	116.9	116.9
Initial Degree of Saturation:	59.2	59.2	59.2
Initial Void Ratio:	0.61	0.61	0.61
Final Dry Density, pcf:	114.3	111.1	111.6
Final Moisture Content, %:	20.2	19.8	19.1
Final Bulk Density, pcf:	137.3	133.0	132.9
Normal Stress, psf:	100	500	1000
Maximum Shear Stress, psf:	138	403	788.0
Shear Rate, in/min:	0.001	0.001	0.001



Sample Type:	reconstituted
Estimated Specific Gravity:	2.65
Liquid Limit:	Non-Plastic
Plastic Limit:	Non-Plastic
Plasticity Index:	Non-Plastic
% Passing #200 sieve:	3.4
Soil Classification:	Poorly Graded Sand
Group Symbol:	SP

Notes:

Material greater than #5 sieve screened out of sample prior to testing

Moisture content obtained before shear from sample trimmings

Moisture Content determined by ASTM D2216

Percent passing #200 sieve determined by ASTM D422

Target Compaction: 90% of the maximum dry density (113.2 pcf) at the optimum moisture content (14.7%). Values specified by client.

Values for cohesion and friction angle determined from best-fit straight line to the data for the specific test conditions. Actual strength parameters may vary and should be determined by an engineer for site-specific conditions.

"---" indicates testing required to determine these values was not requested.

04/27/2016

GeoTesting Express

Client:	Test America		
Project Name:	Bonanza Mine		
Project Location:	---		
GTX #:	304536		
Start Date:	04/16/16	Tested By:	dln
End Date:	04/19/16	Checked By:	jdt
Boring ID:	Umpqua		
Sample ID:	16031003		
Depth, ft:	3 inch minus		
Soil Description:	Moist, dark olive gray gravel with sand		

Direct Shear Test Series by ASTM D3080

Soil Preparation:	Target Compaction: 90% of Maximum Dry Density at Optimum Moisture Content		
Compaction Characteristics:	Corrected Maximum Dry Density	138.8 pcf	
	Corrected Optimum Moisture Content	8.0 %	
	Compaction Test Method	ASTM D698	
Test Equipment:	Top box = 12 in x 12 in; Bottom box = 12 in x 12 in; Load cells and LVDTs connected to data acquisition system for shear force, normal load and horizontal displacement readings; surface area = 144 in^2		
Maximum Particle Size Used, in:	0.5	Horizontal Displacement, in/min:	0.02
Soil Height, in:	3	Test Condition:	inundated
Gap Between Boxes, in:	0.25		

Parameter	Point 1	Point 2	Point 3	Point 4	Point 5	Point 6
Initial Moisture Content, %	8.3	8.3	8.6	---	---	---
Initial Dry Density, pcf	124.3	124.4	124.0	---	---	---
Percent Compaction, %	89.6	89.6	89.3	---	---	---
Normal Compressive Stress, psf	100	500	1000	---	---	---
Peak Shear Stress, psf	141	485	1049	---	---	---
Final Moisture Content, %	14.6	12.9	14.3	---	---	---

Notes:

Peak Friction Angle:	**45.4**	**degrees**
Peak Cohesion:	**17.8**	**psf**

Figure a. Shear Force vs. Horizontal Displacement

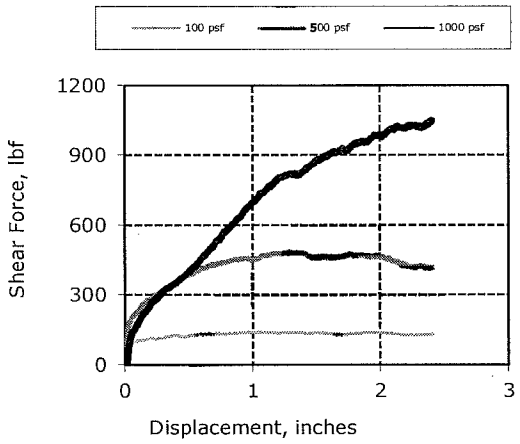
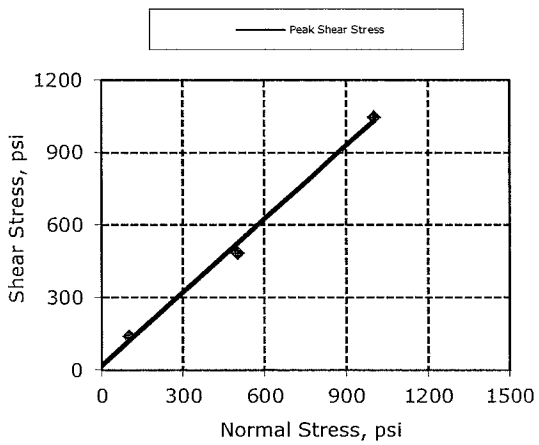


Figure b. Shear Stress vs. Normal Stress



Notes: These results apply only to the sample tested for the specific test conditions. The test procedures employed follow accepted industry practice and the indicated test method. GeoTesting Express has no specific knowledge as to conditioning, origin, sampling procedure or intended use of the material. Values for cohesion and friction angle determined from best-fit straight line to the data for the specific test conditions. Actual strength parameters may vary and should be determined by an engineer for site-specific conditions.

MW 4-28-16

04/27/2016

Client:	Test America		
Project Name:	Bonanza Mine		
Project Location:	---		
GTX #:	304536		
Start Date:	04/15/16	Tested By:	dln
End Date:	04/18/16	Checked By:	jdt
Boring ID:	Bonanza		
Sample ID:	16031005		
Depth, ft:	Bottom Repos		
Soil Description:	Moist, light olive brown sandy clay		

Direct Shear Test Series by ASTM D3080

Soil Preparation:	Target Compaction: 90% of Maximum Dry Density at Optimum Moisture Content		
Compaction Characteristics:	Maximum Dry Density	106.8 pcf	
	Optimum Moisture Content	19.1 %	
	Compaction Test Method	ASTM D698	
Test Equipment:	Top box = 12 in x 12 in; Bottom box = 12 in x 12 in; Load cells and LVDTs connected to data acquisition system for shear force, normal load and horizontal displacement readings; surface area = 144 in^2		
Maximum Particle Size Used, in:	0.5	Horizontal Displacement, in/min:	0.02
Soil Height, in:	3	Test Condition:	inundated
Gap Between Boxes, in:	0.25		

Parameter	Point 1	Point 2	Point 3	Point 4	Point 5	Point 6
Initial Moisture Content, %	18.7	18.4	18.8	---	---	---
Initial Dry Density, pcf	96.2	96.5	96.2	---	---	---
Percent Compaction, %	90.1	90.4	90.0	---	---	---
Normal Compressive Stress, psf	100	500	1000	---	---	---
Peak Shear Stress, psf	113	386	817	---	---	---
Final Moisture Content, %	29.6	25.4	23.8	---	---	---

Notes:

Peak Friction Angle:	**38.1**	**degrees**
Peak Cohesion:	**19.9**	**psf**

Figure a. Shear Force vs. Horizontal Displacement

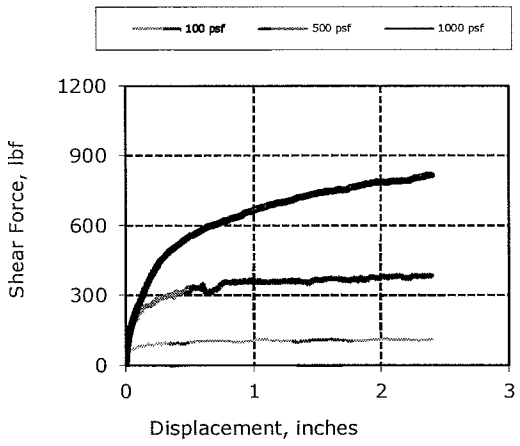
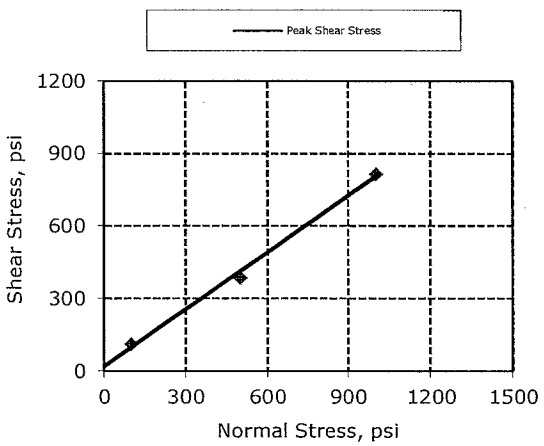


Figure b. Shear Stress vs. Normal Stress



Notes: These results apply only to the sample tested for the specific test conditions. The test procedures employed follow accepted industry practice and the indicated test method. GeoTesting Express has no specific knowledge as to conditioning, origin, sampling procedure or intended use of the material. Values for cohesion and friction angle determined from best-fit straight line to the data for the specific test conditions. Actual strength parameters may vary and should be determined by an engineer for site-specific conditions.

MW 4-28-16

Client:	Test America		
Project Name:	Bonanza Mine		
Project Location:	---		
GTX #:	304536		
Start Date:	04/15/16	Tested By:	dln
End Date:	04/21/16	Checked By:	jdt
Boring ID:	Bonanza		
Sample ID:	16031004		
Depth, ft:	Top Repos		
Soil Description:	Moist, light olive brown sandy clay with gravel		

Direct Shear Test Series by ASTM D3080

Soil Preparation:	Target Compaction: 90% of Maximum Dry Density at Optimum Moisture Content		
Compaction Characteristics:	Corrected Maximum Dry Density	111.9 pcf	
	Corrected Optimum Moisture Content	15.9 %	
	Compaction Test Method	ASTM D698	
Test Equipment:	Top box = 12 in x 12 in; Bottom box = 12 in x 12 in; Load cells and LVDTs connected to data acquisition system for shear force, normal load and horizontal displacement readings; surface area = 144 in^2		
Maximum Particle Size Used, in:	0.5	Horizontal Displacement, in/min:	0.02
Soil Height, in:	3	Test Condition:	inundated
Gap Between Boxes, in:	0.25		

Parameter	Point 1	Point 2	Point 3	Point 4	Point 5	Point 6
Initial Moisture Content, %	16.1	14.1	14.3	---	---	---
Initial Dry Density, pcf	100.3	102.1	101.9	---	---	---
Percent Compaction, %	89.6	91.2	91.1	---	---	---
Normal Compressive Stress, psf	100	500	1000	---	---	---
Peak Shear Stress, psf	121	378	902	---	---	---
Final Moisture Content, %	28.5	28.6	27.7	---	---	---

Notes:

Peak Friction Angle:	**41.2**	**degrees**
Peak Cohesion:	**0.2**	**psf**

Figure a. Shear Force vs. Horizontal Displacement

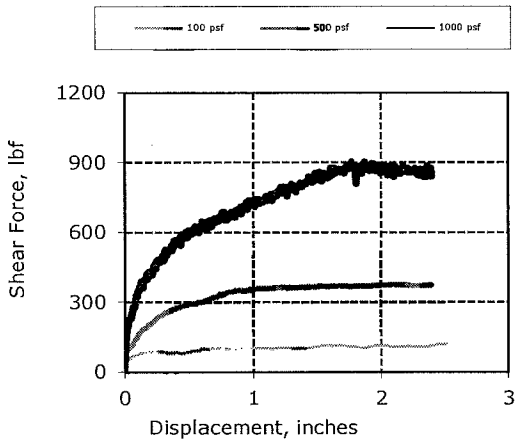
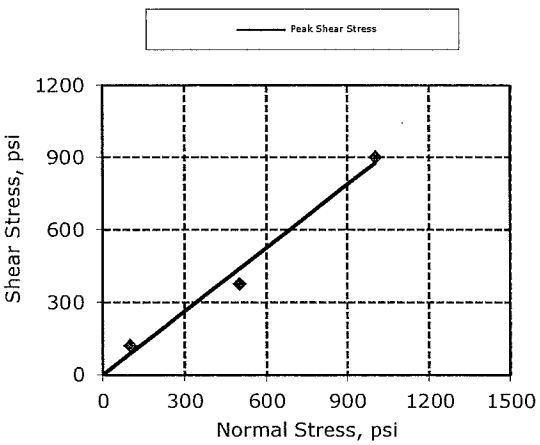


Figure b. Shear Stress vs. Normal Stress



Notes: These results apply only to the sample tested for the specific test conditions. The test procedures employed follow accepted industry practice and the indicated test method. GeoTesting Express has no specific knowledge as to conditioning, origin, sampling procedure or intended use of the material. Values for cohesion and friction angle determined from best-fit straight line to the data for the specific test conditions. Actual strength parameters may vary and should be determined by an engineer for site-specific conditions.

MW 4/28/16

Client:	Test America		
Project Name:	Bonanza Landfill		
Project Location:	---		
GTX #:	304536		
Start Date:	04/12/16	Tested By:	dln
End Date:	04/15/16	Checked By:	emm
Soil ID:	Umpqua, 16031003, 3 inch minus		
Soil Description:	Moist, dark olive gray clayey gravel with sand		
Geosynthetic ID:	Geocomposite: Roll #G14E407251		
Geosynthetic Description:	Black, single sided nonwoven biplanar geocomposite		

Interface Shear Test Series by ASTM D5321

Test Series #:	4
Test Profile - Top to Bottom:	steel plate / SOIL/ GEOCOMPOSITE / textured gripping surface
Soil Preparation:	Soil compacted to 90% of Maximum Dry Density at Optimum Moisture Content
Compaction Characteristics:	Corrected Maximum Dry Density 138.8 pcf Corrected Optimum Moisture Content 8.0 % Compaction Test Method ASTM D698
Geosynthetic Preparation:	Test set-up saturated at normal load for 1 hour prior to shear
Test Equipment:	Top box = 12 in x 12 in; Bottom box = 12 in x 12 in; Load cells and LVDTs connected to data acquisition system for shear force, normal load and horizontal displacement readings; Flat plate clamping device; surface area = 144 in^2
Horizontal Displacement, in/min:	0.04 Test Condition: inundated

Parameter	Point 1	Point 2	Point 3	Point 4	Point 5	Point 6
Initial Moisture Content, %	8.7	8.6	8.8	---	---	---
Initial Dry Density, pcf	123.8	124.0	123.7	---	---	---
Percent Compaction, %	89.2	89.3	89.1	---	---	---
Final Moisture Content, %	17.0	14.6	14.9	---	---	---
Normal Compressive Stress, psf	100	500	1000	---	---	---
Peak Shear Stress, psf	121	435	935	---	---	---
Post Peak Shear Stress, psf	115	392	753	---	---	---
Peak Secant Friction Angle, °	50.5	41.0	43.1	---	---	---
Post-Peak Secant Friction Angle, °	49.0	38.1	37.0	---	---	---

NOTES:

Peak Friction Angle:	**42.3**	**degrees**
Peak Adhesion:	**13**	**psf**
Post Peak Friction Angle:	**35.3**	**degrees**
Post Peak Adhesion:	**42**	**psf**

Figure a. Shear Force vs. Horizontal Displacement

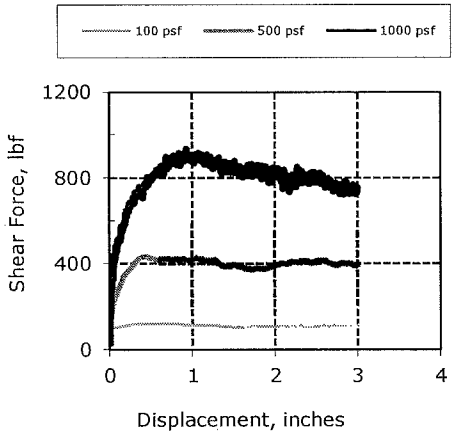
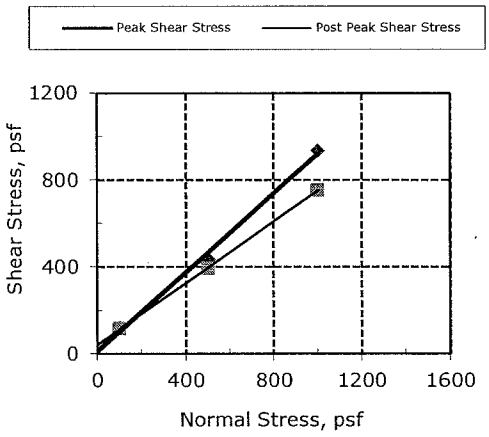


Figure b. Shear Stress vs. Normal Stress



Notes: These results apply only to the sample tested for the specific test conditions. The test procedures employed follow accepted industry practice and the indicated test method. GeoTesting Express has no specific knowledge as to conditioning, origin, sampling procedure or intended use of the material. Values for cohesion and friction angle determined from best-fit straight line to the data for the specific test conditions. Actual strength parameters may vary and should be determined by an engineer for site-specific conditions.

GeoTesting EXPRESS

Client:	Test America		
Project Name:	Bonanza Landfill		
Project Location:	---		
GTX #:	304536		
Start Date:	04/12/16	Tested By:	dln
End Date:	04/15/16	Checked By:	emm
Soil ID:	Bonanza, 16031005, Bottom Repos		
Soil Description:	Moist, light olive brown sandy clay		
Geomembrane ID:	Roll 3/24/16 (Roll # not provided)		
Geomembrane Description:	Black, 40 mil Agru textured LLDPE geomembrane		

Interface Shear Test Series by ASTM D5321

Test Series #:	1
Test Profile - Top to Bottom:	steel plate / SOIL / GEOMEMBRANE / textured gripping surface
Soil Preparation:	Soil compacted to 90% of Maximum Dry Density at Optimum Moisture Content.
Compaction Characteristics:	Maximum Dry Density 106.8 pcf Optimum Moisture Content 19.1 % Compaction Test Method ASTM D698
Geosynthetic Preparation:	Test set-up saturated at normal load for 1 hour prior to shear
Test Equipment:	Top box = 12 in x 12 in; Bottom box = 12 in x 12 in; Load cells and LVDTs connected to data acquisition system for shear force, normal load and horizontal displacement readings; Flat plate clamping device; surface area = 144 in^2
Horizontal Displacement, in/min:	0.04 Test Condition: inundated

Parameter	Point 1	Point 2	Point 3	Point 4	Point 5	Point 6
Initial Moisture Content, %	20.0	19.9	20.0	---	---	---
Initial Dry Density, pcf	97.2	97.3	97.2	---	---	---
Percent Compaction, %	91.0	91.1	91.0	---	---	---
Final Moisture Content, %	30.0	26.1	25.4	---	---	---
Normal Compressive Stress, psf	100	500	1000	---	---	---
Peak Shear Stress, psf	125	364	732	---	---	---
Post Peak Shear Stress, psf	125	325	722	---	---	---
Peak Secant Friction Angle, °	51.3	36.1	36.2	---	---	---
Post-Peak Secant Friction Angle, °	51.3	33.0	35.8	---	---	---
Pre-Test: Average Asperity, mils	37.0	38.1	41.1	---	---	---
Post-Test: Average Asperity, mils	36.3	37.8	39.1	---	---	---

NOTES: Asperity measurements taken on side of membrane involved in shear plane in general accordance with ASTM D7466. Six measurements taken at the same locations before and after test.

Peak Friction Angle:	**34.1**	**degrees**
Peak Adhesion:	**46**	**psf**
Post Peak Friction Angle:	**33.8**	**degrees**
Post Peak Adhesion:	**34**	**psf**

Figure a. Shear Force vs. Horizontal Displacement

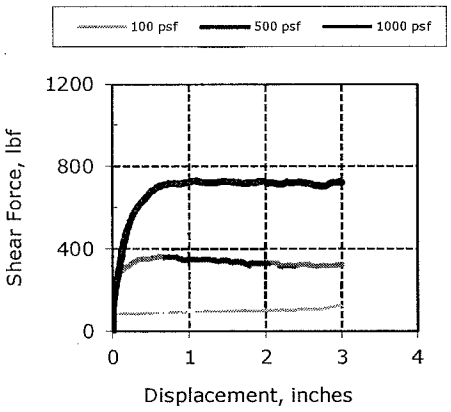
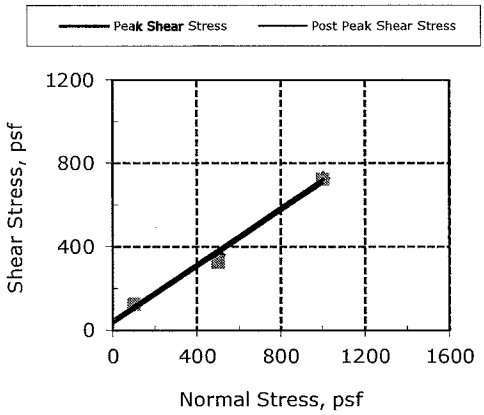


Figure b. Shear Stress vs. Normal Stress



Notes: These results apply only to the sample tested for the specific test conditions. The test procedures employed follow accepted industry practice and the indicated test method. GeoTesting Express has no specific knowledge as to conditioning, origin, sampling procedure or intended use of the material. Values for cohesion and friction angle determined from best-fit straight line to the data for the specific test conditions. Actual strength parameters may vary and should be determined by an engineer for site-specific conditions.

Form D5321, version 2

4/28/16

Client:	Test America		
Project Name:	Bonanza Landfill		
Project Location:	---		
GTX #:	304536		
Start Date:	04/12/16	Tested By:	dln
End Date:	04/15/16	Checked By:	jdt
Soil ID:	Bonanza, 16031004, Top Repos		
Soil Description:	Moist, light olive brown sandy clay wih gravel		
Geosynthetic ID:	Geocomposite: Roll #G14E407251		
Geosynthetic Description:	Black, single sided nonwoven biplanar geocomposite		

Interface Shear Test Series by ASTM D5321

Test Series #:	2
Test Profile - Top to Bottom:	steel plate / SOIL / GEOCOMPOSITE / textured gripping surface
Soil Preparation:	Soil compacted to 90% of Maximum Dry Density at Optimum Moisture Content.
Compaction Characteristics:	Corrected Maximum Dry Density 111.9 pcf Corrected Optimum Moisture Content 15.9 % Compaction Test Method ASTM D698
Geosynthetic Preparation:	Test set-up saturated at normal load for 1 hour prior to shear
Test Equipment:	Top box = 12 in x 12 in; Bottom box = 12 in x 12 in; Load cells and LVDTs connected to data acquisition system for shear force, normal load and horizontal displacement readings; Flat plate clamping device; surface area = 144 in^2
Horizontal Displacement, in/min:	0.04 Test Condition: inundated

Parameter	Point 1	Point 2	Point 3	Point 4	Point 5	Point 6
Initial Moisture Content, %	15.8	17.2	16.7	---	---	---
Initial Dry Density, pcf	101	99	100	---	---	---
Percent Compaction, %	89.9	88.8	89.2	---	---	---
Final Moisture Content, %	27.7	24.0	22.8	---	---	---
Normal Compressive Stress, psf	100	500	1000	---	---	---
Peak Shear Stress, psf	127	423	953	---	---	---
Post Peak Shear Stress, psf	127	402	904	---	---	---
Peak Secant Friction Angle, °	51.8	40.2	43.6	---	---	---
Post-Peak Secant Friction Angle, °	51.8	38.8	42.1	---	---	---

NOTES:

Peak Friction Angle:	**42.7**	**degrees**
Peak Adhesion:	**9**	**psf**
Post Peak Friction Angle:	**41.0**	**degrees**
Post Peak Adhesion:	**14**	**psf**

Figure a. Shear Force vs. Horizontal Displacement

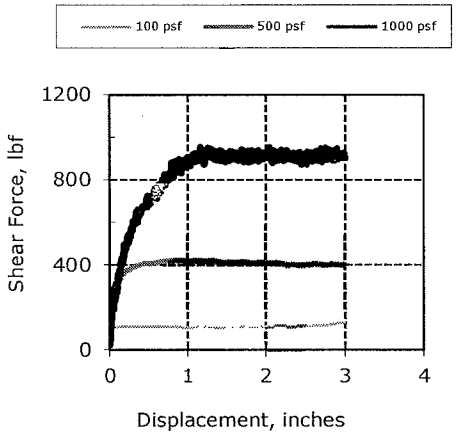
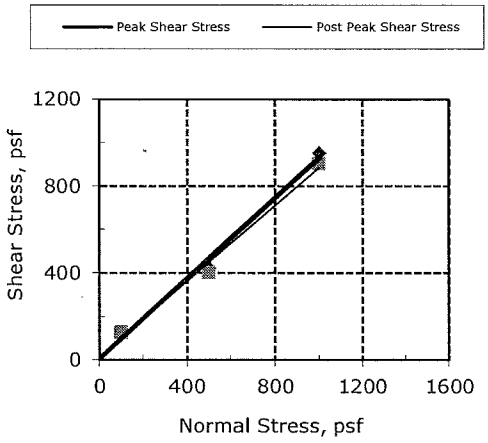


Figure b. Shear Stress vs. Normal Stress



Notes: These results apply only to the sample tested for the specific test conditions. The test procedures employed follow accepted industry practice and the indicated test method. GeoTesting Express has no specific knowledge as to conditioning, origin, sampling procedure or intended use of the material. Values for cohesion and friction angle determined from best-fit straight line to the data for the specific test conditions. Actual strength parameters may vary and should be determined by an engineer for site-specific conditions.

Form D5321, version 2

4/28/16

Client:	Test America		
Project Name:	Bonanza Landfill		
Project Location:	---		
GTX #:	304536		
Start Date:	04/12/16	Tested By:	dln
End Date:	04/15/16	Checked By:	jdt
Soil ID:	Umpqua, 16031002, Washed Sand		
Soil Description:	Moist, dark olive brown sand		
Geomembrane ID:	Roll 3/24/16 (Roll # not provided)		
Geomembrane Description:	Black, 40 mil Agru textured LLDPE geomembrane		

Interface Shear Test Series by ASTM D5321

Test Series #:	3
Test Profile - Top to Bottom:	steel plate / SOIL / GEOMEMBRANE / textured gripping surface
Soil Preparation:	Soil compacted to 90% of Maximum Dry Density at Optimum Moisture Content.
Compaction Characteristics:	Maximum Dry Density 113.2 pcf Optimum Moisture Content 14.7 % Compaction Test Method ASTM D698
Geosynthetic Preparation:	Test set-up saturated at normal load for 1 hour prior to shear
Test Equipment:	Top box = 12 in x 12 in; Bottom box = 12 in x 12 in; Load cells and LVDTs connected to data acquisition system for shear force, normal load and horizontal displacement readings; Flat plate clamping device; surface area = 144 in^2
Horizontal Displacement, in/min:	0.04 Test Condition: inundated

Parameter	Point 1	Point 2	Point 3	Point 4	Point 5	Point 6
Initial Moisture Content, %	13.5	13.8	13.6	---	---	---
Initial Dry Density, pcf	102.8	102.5	102.6	---	---	---
Percent Compaction, %	90.8	90.6	90.7	---	---	---
Final Moisture Content, %	20.7	19.7	19.6	---	---	---
Normal Compressive Stress, psf	100	500	1000	---	---	---
Peak Shear Stress, psf	106	364	811	---	---	---
Post Peak Shear Stress, psf	95.8	326	762	---	---	---
Peak Secant Friction Angle, °	46.6	36.1	39.0	---	---	---
Post-Peak Secant Friction Angle, °	43.8	33.1	37.3	---	---	---
Pre-Test: Average Asperity, mils	40.1	41.7	40.3	---	---	---
Post-Test: Average Asperity, mils	39.6	41.3	39.7	---	---	---

NOTES: Asperity measurements taken on side of membrane involved in shear plane in general accordance with ASTM D7466. Six measurements taken at the same locations before and after test.

Peak Friction Angle:	**38.2**	**degrees**
Peak Adhesion:	**7**	**psf**
Post Peak Friction Angle:	**36.7**	**degrees**
Post Peak Adhesion:	**0**	**psf**

Figure a. Shear Force vs. Horizontal Displacement

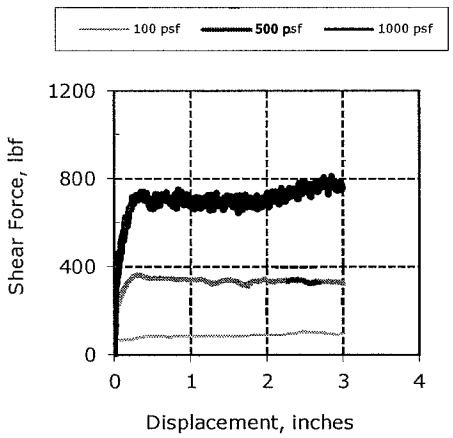
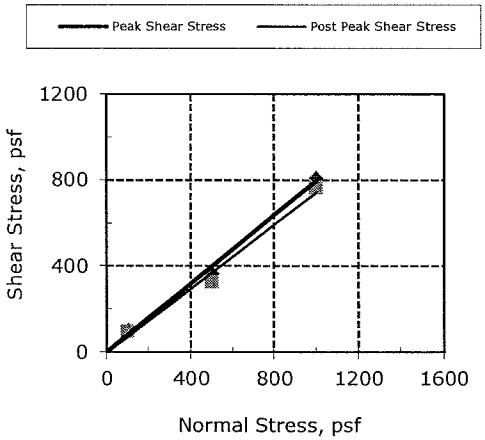


Figure b. Shear Stress vs. Normal Stress



Notes: These results apply only to the sample tested for the specific test conditions. The test procedures employed follow accepted industry practice and the indicated test method. GeoTesting Express has no specific knowledge as to conditioning, origin, sampling procedure or intended use of the material. Values for cohesion and friction angle determined from best-fit straight line to the data for the specific test conditions. Actual strength parameters may vary and should be determined by an engineer for site-specific conditions.

Form D5321, version 2

04/27/2016

TestAmerica
THE LEADER IN ENVIRONMENTAL TESTING

ANALYTICAL REPORT

Job Number: 580-58100-1

Job Description: EE-004439-Laboratory BOA 14-06-0006

For:
Ecology and Environment, Inc.
Pacific Building
720 Third Avenue
Suite 1700
Seattle, WA 98104

Attention: Mr. Mark Woodke

Approved for release.
Kristine D Allen
Manager of Project Management
3/28/2016 5:37 PM

Kristine D Allen, Manager of Project Management
5755 8th Street East, Tacoma, WA, 98424
(253)248-4970
kristine.allen@testamericainc.com
03/28/2016

TestAmerica Seattle is a part of TestAmerica Laboratories, Inc.

The results included in this report have been reviewed for compliance with the laboratory QA/QC plan and meet all requirements of NELAC. All data have been found to be compliant with laboratory protocol, with the exception of any items noted in the case narrative.

Table of Contents

Job Narrative
580-58100-1

Comments
No additional comments.

Receipt
The samples were received on 3/17/2016 2:30 PM; the samples arrived in good condition, properly preserved and, where required, on ice.

Receipt Exceptions

The Field Sampler was not listed on the Chain of Custody.

Subcontract Work
Method Agronomic Analyses - Package S1B: This method was subcontracted to A & L Western Agricultural Laboratories. The subcontract laboratory certification is different from that of the facility issuing the final report.

SAMPLE SUMMARY

Client: Ecology and Environment, Inc. Job Number: 580-58100-1

Lab Sample ID	Client Sample ID	Client Matrix	Date/Time Sampled	Date/Time Received
580-58100-1	16031001	Solid	03/11/2016 0000	03/17/2016 1430
580-58100-2	16031004	Solid	03/11/2016 0000	03/17/2016 1430
580-58100-3	16031005	Solid	03/11/2016 0000	03/17/2016 1430

METHOD SUMMARY

Client: Ecology and Environment, Inc. Job Number: 580-58100-1

Description	Lab Location	Method	Preparation Method
Matrix: Solid			
General Sub Contract Method	TAL SEA	Subcontract	

Lab References:

TAL SEA = TestAmerica Seattle

Method References:

DATA REPORTING QUALIFIERS

Lab Section	Qualifier	Description

Certification Summary

Client: Ecology and Environment, Inc. TestAmerica Job ID: 580-58100-1
Project/Site: EE-004439-Laboratory BOA 14-06-0006

Laboratory	Authority	Program	EPA Region	Certification ID
TestAmerica Seattle	Alaska (UST)	State Program	10	UST-022
TestAmerica Seattle	California	State Program	9	2901
TestAmerica Seattle	L-A-B	DoD ELAP		L2236
TestAmerica Seattle	L-A-B	ISO/IEC 17025		L2236
TestAmerica Seattle	Montana (UST)	State Program	8	N/A
TestAmerica Seattle	Oregon	NELAP	10	WA100007
TestAmerica Seattle	US Fish & Wildlife	Federal		LE058448-0
TestAmerica Seattle	USDA	Federal		P330-14-00126
TestAmerica Seattle	Washington	State Program	10	C553

Accreditation may not be offered or required for all methods and analytes reported in this package. Please contact your project manager for the laboratory's current list of certified methods and analytes.

A & L WESTERN AGRICULTURAL LABORATORIES

10220 SW NIMBUS AVE Bldg K-9 I PORTLAND OREGON 97223 I (503) 968-9225 I FAX (503) 598-7702

REPORT NUMBER: 16-078-097

CLIENT NO: 4290

SEND TO: TESTAMERICA ANALYTICAL TESTING CORP
5755 8TH STREET EAST
TACOMA, WA 98424-

SUBMITTED BY: KRIS ALLEN

GROWER: PROJ #:10045300004.064.02

DATE OF REPORT: 03/28/16

SOIL ANALYSIS REPORT

SAMPLE ID	LAB NUMBER	Organic Matter		Phosphorus		Potassium	Magnesium	Calcium	Sodium	pH		Hydrogen	Cation Exchange Capacity	PERCENT CATION SATURATION (COMPUTED)				
		* % Rating	** ENR lbs/A	P1 (Weak Bray) **** * ppm	$NaHCO_3$-P (OlsenMethod) **** * ppm	K ***** * ppm	Mg *** * ppm	Ca *** * ppm	Na *** * ppm	Soil pH	Buffer Index	H meq/100g	C.E.C. meq/100g	K %	Mg %	Ca %	H %	Na %
31001	59778	1.7L	65	14L	11L	62L	537VH	1339L	39L	6.2	6.9	1.6	13.0	1.2	34.0	51.5	12.0	1.3
31004	59779	2.1L	71	3VL	6**	66L	620VH	1013L	37L	5.7	6.4	2.8	13.3	1.3	38.4	38.1	21.0	1.2
31005	59780	1.5L	60	1VL	39**	64L	622VH	971L	46L	5.6	6.6	3.2	13.5	1.2	37.9	35.9	23.5	1.5

** NaHCO3-P unreliable at this soil pH

SAMPLE NUMBER	Nitrogen NO_3-N ppm	Sulfur SO_4-S ppm	Zinc Zn ppm	Manganese Mn ppm	Iron Fe ppm	Copper Cu ppm	Boron B ppm	Excess Lime Rating	Soluble Salts mmhos/cm	Chloride Cl ppm		PARTICLE SIZE ANALYSIS			
												SAND %	SILT %	CLAY %	SOIL TEXTURE
31001		2VL													
31004		7L													
31005		6L													

* CODE TO RATING: VERY LOW (VL), LOW (L), MEDIUM (M), HIGH (H), AND VERY HIGH (VH).
** ENR - ESTIMATED NITROGEN RELEASE
*** MULTIPLY THE RESULTS IN ppm BY 2 TO CONVERT TO LBS. PER ACRE OF THE ELEMENTAL FORM
**** MULTIPLY THE RESULTS IN ppm BY 4.6 TO CONVERT TO LBS. PER ACRE P_2O_5
***** MULTIPLY THE RESULTS IN ppm BY 2.4 TO CONVERT TO LBS. PER ACRE K_2O
MOST SOILS WEIGH TWO (2) MILLION POUNDS (DRY WEIGHT) FOR AN ACRE OF SOIL 6-2/3 INCHES DEEP.

This report applies only to the sample(s) tested. Samples are retained a maximum of thirty days after testing.

Darcy L. Peebles, CCA
A & L WESTERN LABORATORIES, INC.

03/28/2016

Shipping and Receiving Documents

Test America
4290 ~~Bothell~~ Tacoma

CHAIN OF CUSTODY RECORD

No: 2016-F

Lab: A&L Western Laboratories
Lab Phone: 503-968-9225
AirbillNo: 8047-8801-9838

Site #: 10NE
Project Code:
Cooler #:

FedEx Account 2006-6560-0
Contact Name: Jacob Moersen
Contact Phone: 206-920-9566

	Lab #	Sample #	Location	Analyses	Matrix	Collected	Numb Cont	Container	Preservative	Lab QC
12		16031001	Umpqua - Unscreened Topsoil	Agronomics Package S1B (TAT 1 Weeks)	Topsoil	3/11/2016	2	8 oz glass jar	None	N
13		16031004	Bonanza - Top Repos	Agronomics Package S1B (TAT 1 Weeks)	Soil	3/11/2016	2	8 oz glass jar	None	N
14		16031005 *	Bonanza - Bottom Repos	Agronomics Package S1B (TAT 1 Weeks)	Soil	3/11/2016	2	8 oz glass jar	None	N

Special Instructions: All three samples requested 1 week TAT for agronomic screening package S1B (organic matter, estimated nitrogen release, phosphorous, extractable cations, hydrogen, sulfate-s, pH, cation exchange capacity, and percent cation saturated).

SAMPLES TRANSFERRED FROM
CHAIN OF CUSTODY #

Items/Reason	Relinquished by (Signature and Organization)	Date/Time	Received by (Signature and Organization)	Date/Time	Sample Condition Upon Receipt
Shipping	E&E START	1600 3/16/16	Angelika Murphy A&L	3/17/16 0830	Good

* Will drop 160 on sample # to fit A&L 5 digit sample ID. Am

Login Sample Receipt Checklist

Client: Ecology and Environment, Inc.

Job Number: 580-58100-1

Login Number: 58100
List Number: 1
Creator: Presley, Kim A

List Source: TestAmerica Seattle

Question	Answer	Comment
Radioactivity wasn't checked or is </= background as measured by a survey meter.	N/A	
The cooler's custody seal, if present, is intact.	N/A	
Sample custody seals, if present, are intact.	N/A	
The cooler or samples do not appear to have been compromised or tampered with.	True	
Samples were received on ice.	True	
Cooler Temperature is acceptable.	True	
Cooler Temperature is recorded.	True	
COC is present.	True	
COC is filled out in ink and legible.	True	
COC is filled out with all pertinent information.	True	
Is the Field Sampler's name present on COC?	False	Not requested on COC.
There are no discrepancies between the containers received and the COC.	True	
Samples are received within Holding Time (excluding tests with immediate HTs)	True	
Sample containers have legible labels.	True	
Containers are not broken or leaking.	True	
Sample collection date/times are provided.	True	
Appropriate sample containers are used.	True	
Sample bottles are completely filled.	True	
Sample Preservation Verified.	True	
There is sufficient vol. for all requested analyses, incl. any requested MS/MSDs	True	
Containers requiring zero headspace have no headspace or bubble is <6mm (1/4").	True	
Multiphasic samples are not present.	True	
Samples do not require splitting or compositing.	True	
Residual Chlorine Checked.	N/A	

TestAmerica
THE LEADER IN ENVIRONMENTAL TESTING

ANALYTICAL REPORT

Job Number: 580-58737-1

Job Description: EE-004439-Laboratory BOA 14-06-0006

For:
Ecology and Environment, Inc.
Pacific Building
720 Third Avenue
Suite 1700
Seattle, WA 98104

Attention: Mr. Mark Woodke

Approved for release.
Kristine D Allen
Manager of Project Management
4/27/2016 12:50 PM

Kristine D Allen, Manager of Project Management
5755 8th Street East, Tacoma, WA, 98424
(253)248-4970
kristine.allen@testamericainc.com
04/27/2016

TestAmerica Seattle is a part of TestAmerica Laboratories, Inc.

The results included in this report have been reviewed for compliance with the laboratory QA/QC plan and meet all requirements of NELAC. All data have been found to be compliant with laboratory protocol, with the exception of any items noted in the case narrative.

Table of Contents

Job Narrative
580-58737-1

Comments
No additional comments.

Receipt
The samples were received on 3/24/2016 8:57 AM; the samples arrived in good condition, properly preserved and, where required, on ice.

Subcontract Work
Methods ASTM D-2487 Visual Classification, ASTM D-3080 Direct Shear, ASTM D4318 Atterberg Limits, ASTM D-5084 Hydraulic Conductivity, ASTM D-5321 Interface Shear Strength, ASTM D-698 Compaction, ASTM Methods D-421/422 Grain Size Sieve: These methods were subcontracted to GeoTesting - Boxboro. The subcontract laboratory certifications are different from that of the facility issuing the final report.

SAMPLE SUMMARY

Client: Ecology and Environment, Inc. Job Number: 580-58737-1

Lab Sample ID	Client Sample ID	Client Matrix	Date/Time Sampled	Date/Time Received
580-58737-1	16031001	Solid	03/11/2016 0001	03/24/2016 0857
580-58737-2	16031002	Solid	03/11/2016 0001	03/24/2016 0857
580-58737-3	16031003	Solid	03/11/2016 0001	03/24/2016 0857
580-58737-4	16031004	Solid	03/11/2016 0001	03/24/2016 0857
580-58737-5	16031005	Solid	03/11/2016 0001	03/24/2016 0857

METHOD SUMMARY

Client: Ecology and Environment, Inc. Job Number: 580-58737-1

Description	Lab Location	Method	Preparation Method
Matrix: Solid			
General Sub Contract Method	GeoTesting	Subcontract	

Lab References:

GeoTesting = GeoTesting - Boxboro

Method References:

DATA REPORTING QUALIFIERS

Lab Section	Qualifier	Description

Client:	Test America				
Project:	Bonanza Mine				
Location:	---			Project No:	GTX-304536
Boring ID:	---	Sample Type:	---	Tested By:	cam
Sample ID:	---	Test Date:	04/15/16	Checked By:	emm
Depth :	---	Test Id:	370696		

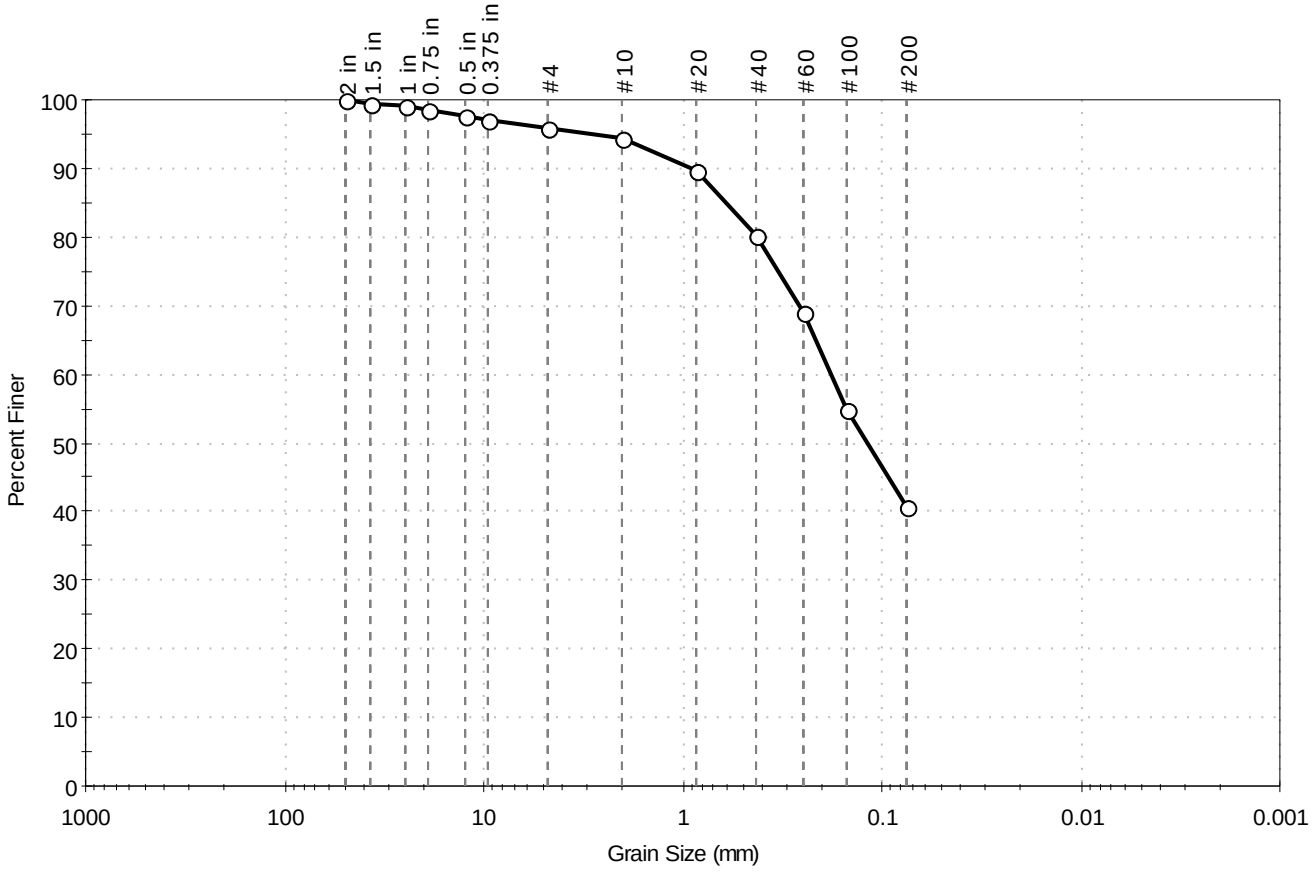
USCS Classification - ASTM D2487

Boring ID	Sample ID	Depth	Group Name	Group Symbol	Gravel, %	Sand, %	Fines, %
Umpqua	16031001	Unscreened Topsoil	Clayey sand	SC	4.2	55.1	40.7
Umpqua	16031002	Washed Sand	Poorly graded sand	SP	1.5	95.1	3.4
Umpqua	16031003	3 Inch Minus	Well-graded gravel with sand	GW	75.2	21.3	3.5
Bonanza	16031004	Top Repos	Sandy Lean clay with gravel	CL	16.2	33.0	50.8
Bonanza	16031005	Bottom Repos	Sandy Lean clay	CL	8.2	38.9	52.9

Remarks: Grain Size analysis performed by ASTM D422 results enclosed
Atterberg Limits performed by ASTM D4318, results enclosed

Client:	Test America				
Project:	Bonanza Mine				
Location:	---			Project No:	GTX-304536
Boring ID:	Umpqua	Sample Type:	bucket	Tested By:	jbr
Sample ID:	16031001	Test Date:	04/04/16	Checked By:	emm
Depth :	Unscreened Topsoil	Test Id:	370682		
Test Comment:	---				
Visual Description:	Moist, dark brown clayey sand				
Sample Comment:	---				

Particle Size Analysis - ASTM D422



% Cobble	% Gravel	% Sand	% Silt & Clay Size
---	4.2	55.1	40.7

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
2 in	50.00	100		
1.5 in	37.50	99		
1 in	25.00	99		
0.75 in	19.00	98		
0.5 in	12.50	98		
0.375 in	9.50	97		
#4	4.75	96		
#10	2.00	94		
#20	0.85	90		
#40	0.42	80		
#60	0.25	69		
#100	0.15	55		
#200	0.075	41		

Coefficients

D_{85} = 0.6040 mm	D_{30} = N/A
D_{60} = 0.1813 mm	D_{15} = N/A
D_{50} = 0.1187 mm	D_{10} = N/A
C_u = N/A	C_c = N/A

Classification

ASTM Clayey sand (SC)

AASHTO Clayey Soils (A-6 (1))

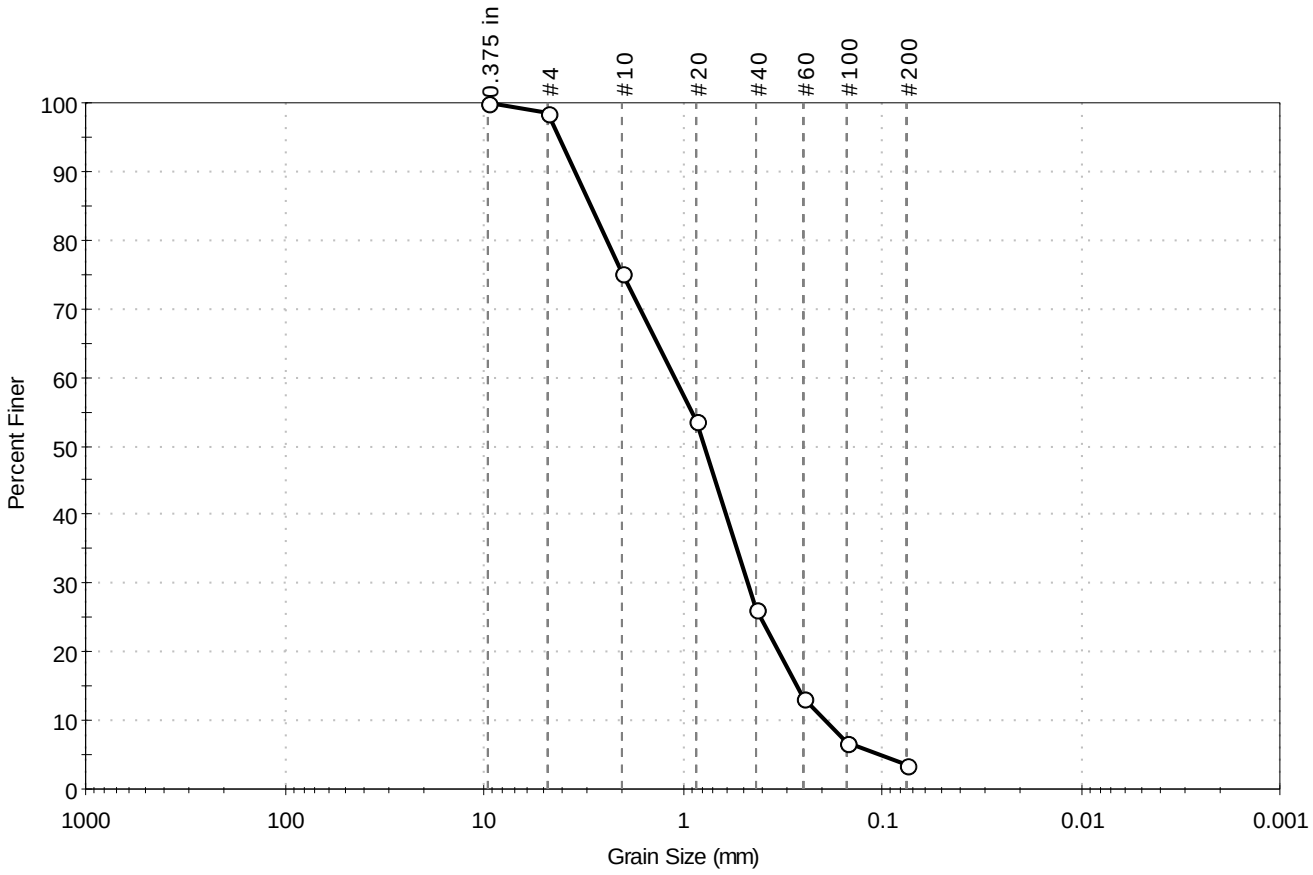
Sample / Test Description

Sand/Gravel Particle Shape : ANGULAR

Sand/Gravel Hardness : HARD

Client:	Test America				
Project:	Bonanza Mine				
Location:	---			Project No:	GTX-304536
Boring ID:	Umpqua	Sample Type:	bucket	Tested By:	jbr
Sample ID:	16031002	Test Date:	04/01/16	Checked By:	emm
Depth :	Washed Sand	Test Id:	370683		
Test Comment:	---				
Visual Description:	Moist, dark olive brown sand				
Sample Comment:	---				

Particle Size Analysis - ASTM D422



% Cobble	% Gravel	% Sand	% Silt & Clay Size
---	1.5	95.1	3.4

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
0.375 in	9.50	100		
#4	4.75	98		
#10	2.00	75		
#20	0.85	54		
#40	0.42	26		
#60	0.25	13		
#100	0.15	7		
#200	0.075	3.4		

Coefficients

D_{85} = 2.8783 mm	D_{30} = 0.4673 mm
D_{60} = 1.0965 mm	D_{15} = 0.2695 mm
D_{50} = 0.7765 mm	D_{10} = 0.1934 mm
C_u = 5.670	C_c = 1.030

Classification

ASTM — Poorly graded sand (SP)

AASHTO — Stone Fragments, Gravel and Sand (A-1-b (1))

Sample / Test Description

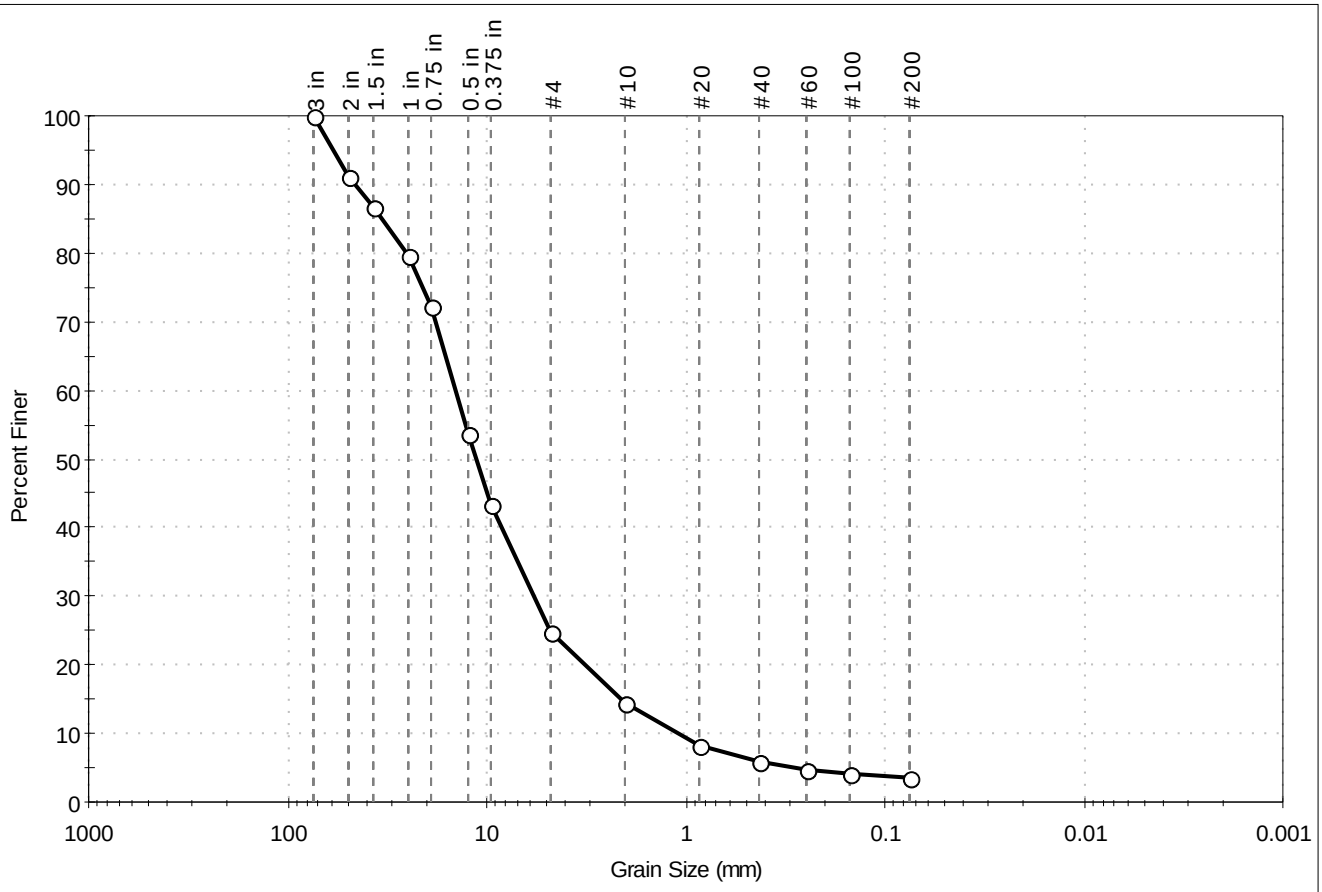
Sand/Gravel Particle Shape : ANGULAR

Sand/Gravel Hardness : HARD

Client:	Test America				
Project:	Bonanza Mine				
Location:	---			Project No:	GTX-304536
Boring ID:	Umpqua	Sample Type:	bucket	Tested By:	jbr
Sample ID:	16031003	Test Date:	04/01/16	Checked By:	emm
Depth :	3 Inch Minus	Test Id:	370684		

Test Comment: ---
Visual Description: Moist, dark olive gray gravel with sand
Sample Comment: ---

Particle Size Analysis - ASTM D422



% Cobble	% Gravel	% Sand	% Silt & Clay Size
---	75.2	21.3	3.5

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
3 in	75.00	100		
2 in	50.00	91		
1.5 in	37.50	87		
1 in	25.00	80		
0.75 in	19.00	72		
0.5 in	12.50	54		
0.375 in	9.50	43		
#4	4.75	25		
#10	2.00	14		
#20	0.85	8		
#40	0.42	6		
#60	0.25	5		
#100	0.15	4		
#200	0.075	3.5		

Coefficients

D_{85} = 33.9764 mm D_{30} = 5.7633 mm
D_{60} = 14.3957 mm D_{15} = 2.1146 mm
D_{50} = 11.3291 mm D_{10} = 1.1009 mm
C_u = 13.076 C_c = 2.096

Classification

ASTM Well-graded gravel with sand (GW)

AASHTO Clayey Gravel and Sand (A-2-6 (0))

Sample / Test Description

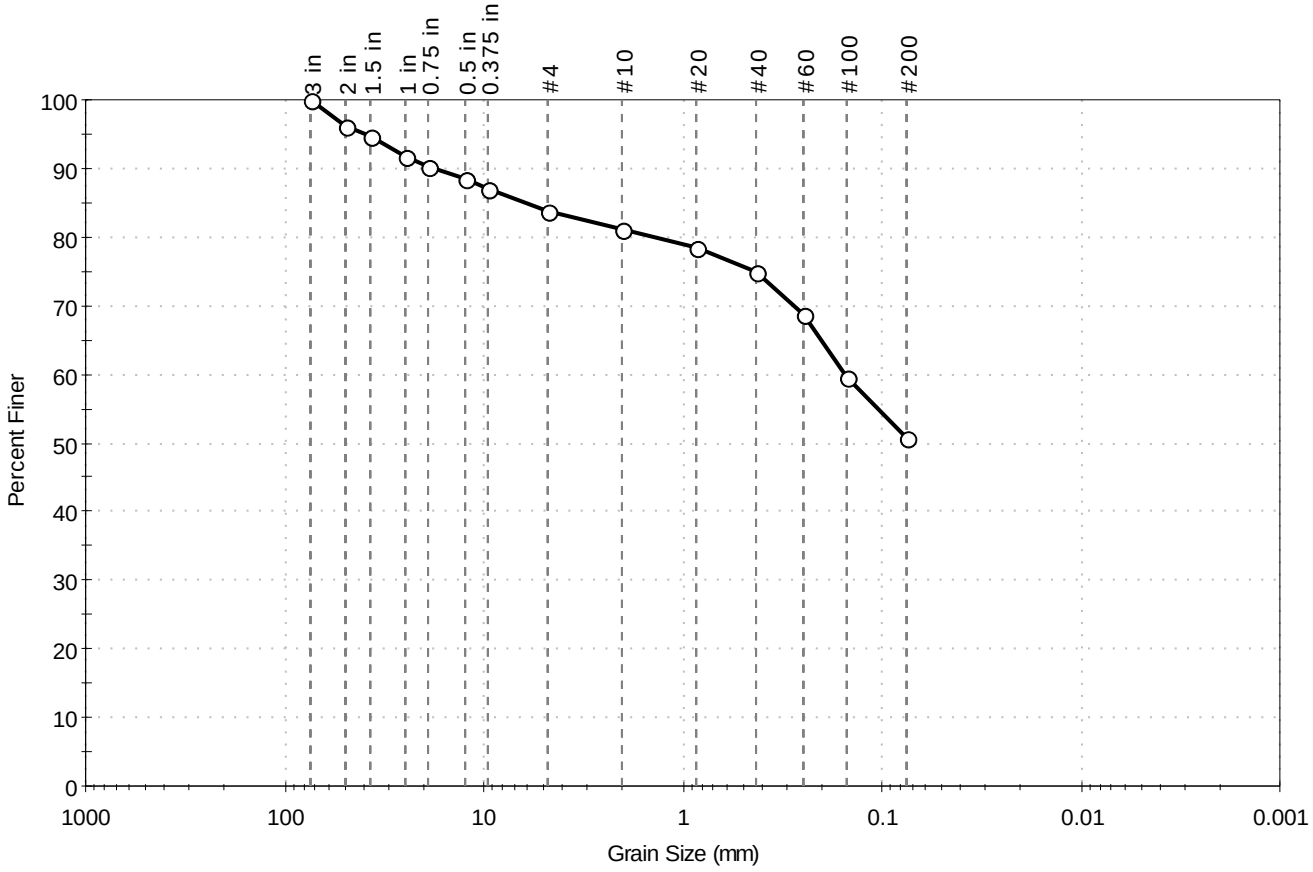
Sand/Gravel Particle Shape : ANGULAR

Sand/Gravel Hardness : HARD

Client:	Test America				
Project:	Bonanza Mine				
Location:	---			Project No:	GTX-304536
Boring ID:	Bonanza	Sample Type:	bucket	Tested By:	jbr
Sample ID:	16031004	Test Date:	04/04/16	Checked By:	emm
Depth :	Top Repos	Test Id:	370685		

Test Comment: ---
Visual Description: Moist, light olive brown sandy clay with gravel
Sample Comment: ---

Particle Size Analysis - ASTM D422



% Cobble	% Gravel	% Sand	% Silt & Clay Size
---	16.2	33.0	50.8

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
3 in	75.00	100		
2 in	50.00	96		
1.5 in	37.50	95		
1 in	25.00	92		
0.75 in	19.00	90		
0.5 in	12.50	88		
0.375 in	9.50	87		
#4	4.75	84		
#10	2.00	81		
#20	0.85	79		
#40	0.42	75		
#60	0.25	69		
#100	0.15	60		
#200	0.075	51		

Coefficients

D_{85} = 6.1631 mm D_{30} = N/A
D_{60} = 0.1532 mm D_{15} = N/A
D_{50} = N/A D_{10} = N/A
C_u = N/A C_c = N/A

Classification

ASTM Sandy Lean clay with gravel (CL)

AASHTO Clayey Soils (A-7-6 (8))

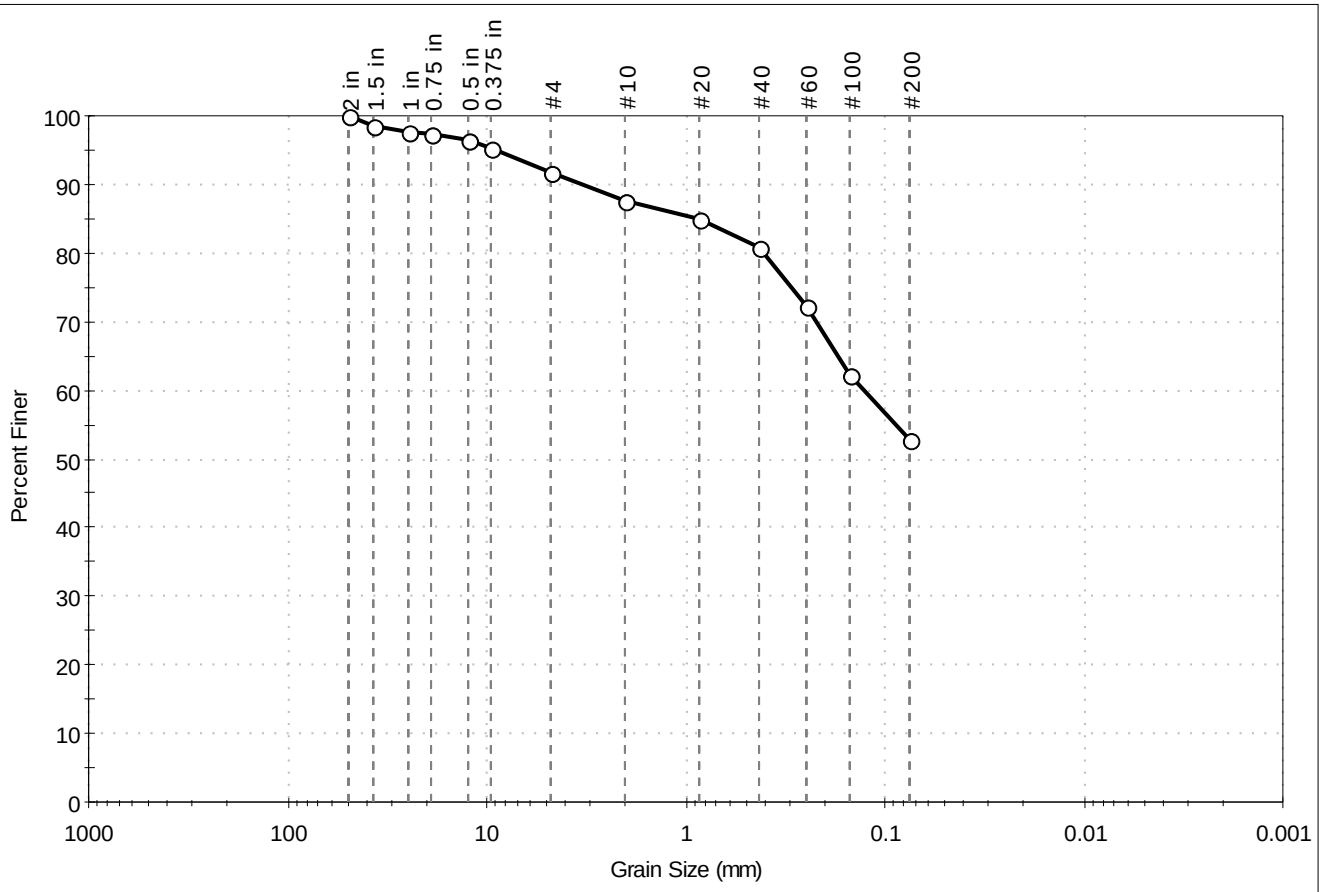
Sample / Test Description

Sand/Gravel Particle Shape : ANGULAR
Sand/Gravel Hardness : HARD

Client:	Test America				
Project:	Bonanza Mine				
Location:	---			Project No:	GTX-304536
Boring ID:	Bonanza	Sample Type:	bucket	Tested By:	jbr
Sample ID:	16031005	Test Date:	04/04/16	Checked By:	emm
Depth :	Bottom Repos	Test Id:	370686		

Test Comment: ---
Visual Description: Moist, light olive brown sandy clay
Sample Comment: ---

Particle Size Analysis - ASTM D422



% Cobble	% Gravel	% Sand	% Silt & Clay Size
---	8.2	38.9	52.9

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
2 in	50.00	100		
1.5 in	37.50	98		
1 in	25.00	98		
0.75 in	19.00	97		
0.5 in	12.50	97		
0.375 in	9.50	95		
#4	4.75	92		
#10	2.00	88		
#20	0.85	85		
#40	0.42	81		
#60	0.25	72		
#100	0.15	62		
#200	0.075	53		

Coefficients

D_{85} = 0.8573 mm	D_{30} = N/A
D_{60} = 0.1268 mm	D_{15} = N/A
D_{50} = N/A	D_{10} = N/A
C_u = N/A	C_c = N/A

Classification

ASTM Sandy Lean clay (CL)

AASHTO Clayey Soils (A-6 (6))

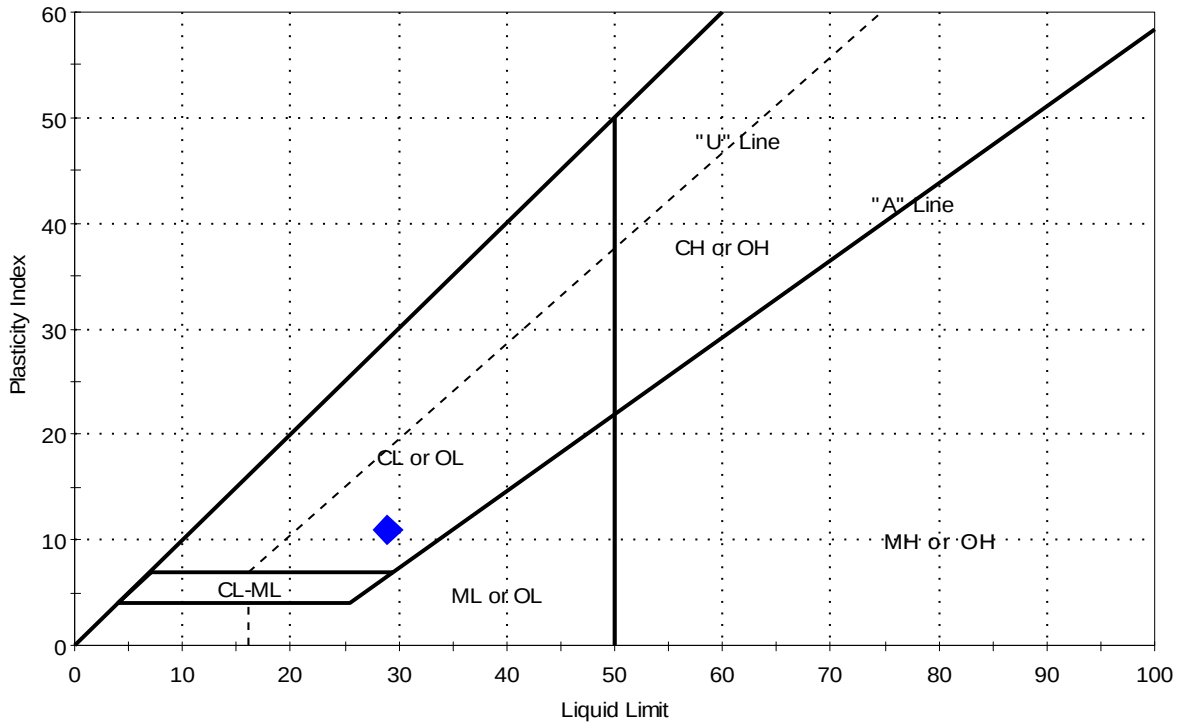
Sample / Test Description

Sand/Gravel Particle Shape : ANGULAR

Sand/Gravel Hardness : HARD

Client:	Test America				
Project:	Bonanza Mine				
Location:	---			Project No:	GTX-304536
Boring ID:	Umpqua	Sample Type:	bucket	Tested By:	cam
Sample ID:	16031001	Test Date:	04/01/16	Checked By:	emm
Depth :	Unscreened Topsoil	Test Id:	370687		
Test Comment:	---				
Visual Description:	Moist, dark brown clayey sand				
Sample Comment:	---				

Atterberg Limits - ASTM D4318

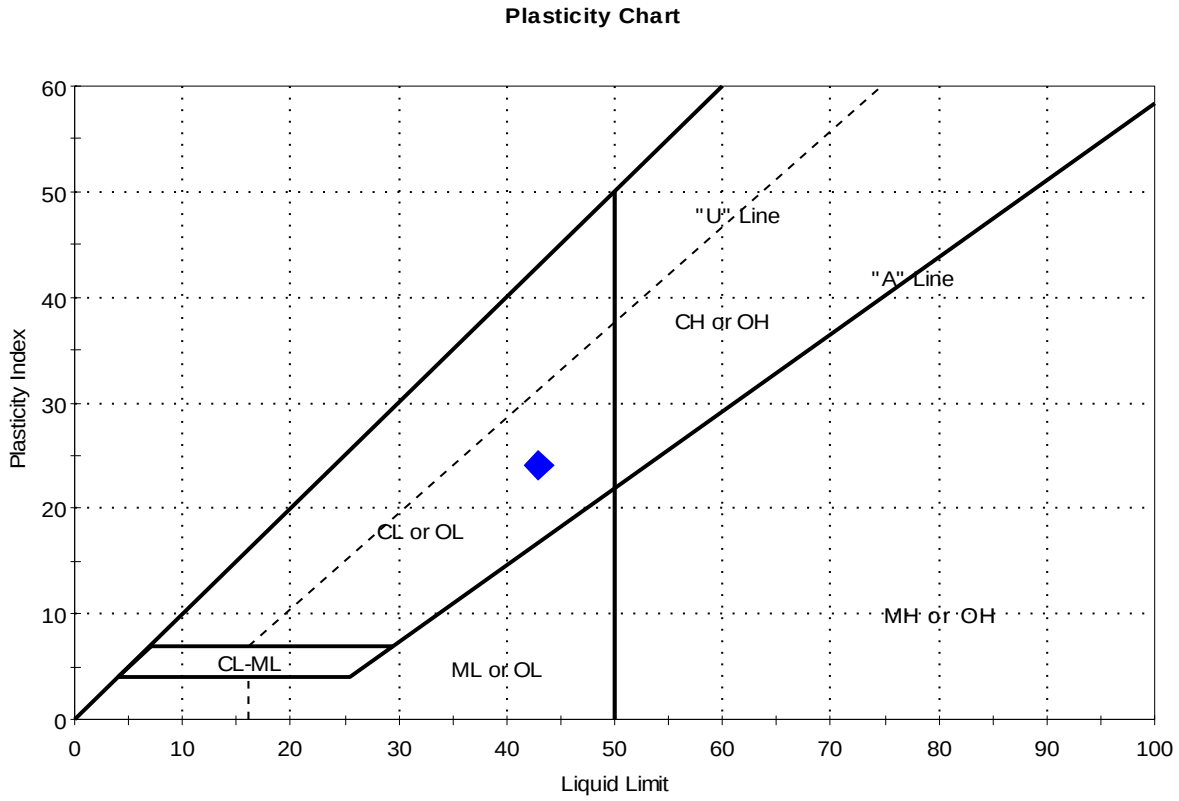


Symbol	Sample ID	Boring	Depth	Natural Moisture Content, %	Liquid Limit	Plastic Limit	Plasticity Index	Liquidity Index	Soil Classification
◆	16031001	Umpqua	Inscreene Topsoil	15	29	18	11	-0.2	Clayey sand (SC)

Sample Prepared using the WET method
20% Retained on #40 Sieve
Dry Strength: VERY HIGH
Dilatancy: SLOW
Toughness: LOW

Client:	Test America				
Project:	Bonanza Mine				
Location:	---			Project No:	GTX-304536
Boring ID:	Bonanza	Sample Type:	bucket	Tested By:	cam
Sample ID:	16031004	Test Date:	04/04/16	Checked By:	emm
Depth :	Top Repos	Test Id:	370690		
Test Comment:	---				
Visual Description:	Moist, light olive brown sandy clay with gravel				
Sample Comment:	---				

Atterberg Limits - ASTM D4318

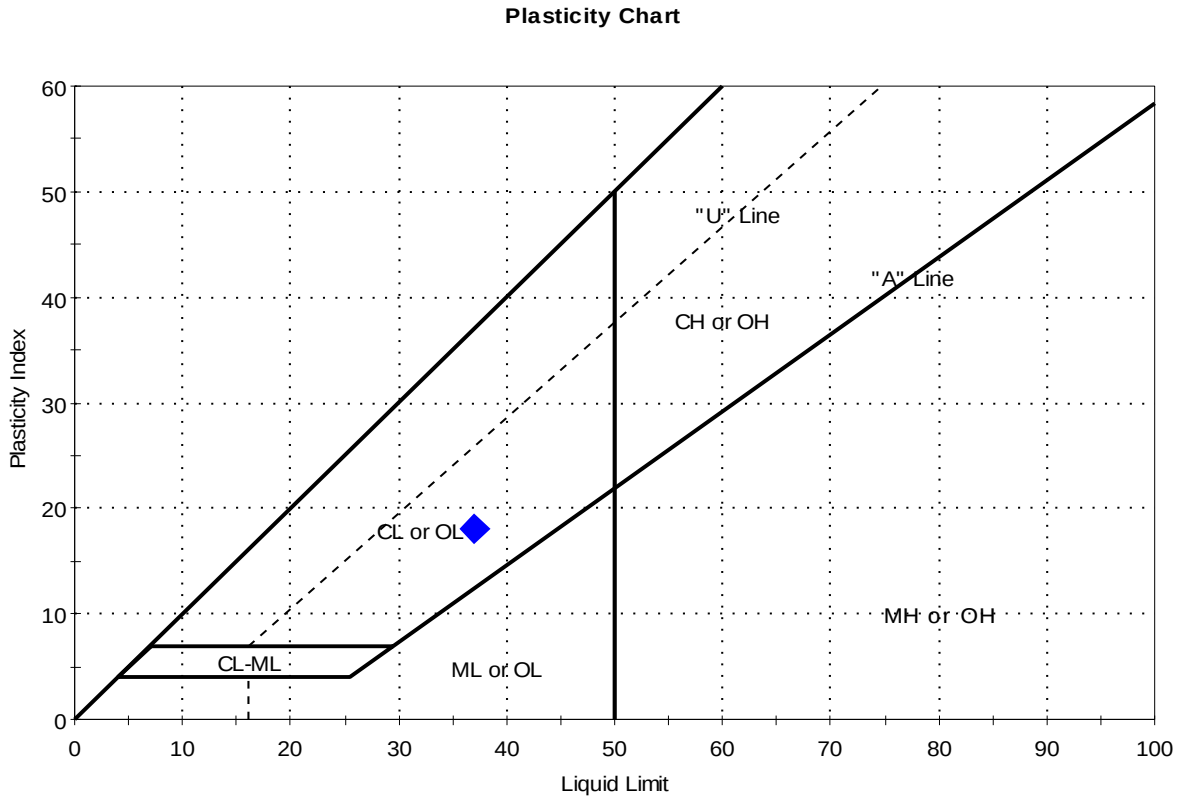


Symbol	Sample ID	Boring	Depth	Natural Moisture Content, %	Liquid Limit	Plastic Limit	Plasticity Index	Liquidity Index	Soil Classification
◆	16031004	Bonanza	Top Repos	22	43	19	24	0.1	Sandy Lean clay with gravel (CL)

Sample Prepared using the WET method
25% Retained on #40 Sieve
Dry Strength: VERY HIGH
Dilatancy: SLOW
Toughness: LOW

Client:	Test America				
Project:	Bonanza Mine				
Location:	---			Project No:	GTX-304536
Boring ID:	Bonanza	Sample Type:	bucket	Tested By:	cam
Sample ID:	16031005	Test Date:	04/05/16	Checked By:	emm
Depth :	Bottom Repos	Test Id:	370691		
Test Comment:	---				
Visual Description:	Moist, light olive brown sandy clay				
Sample Comment:	---				

Atterberg Limits - ASTM D4318

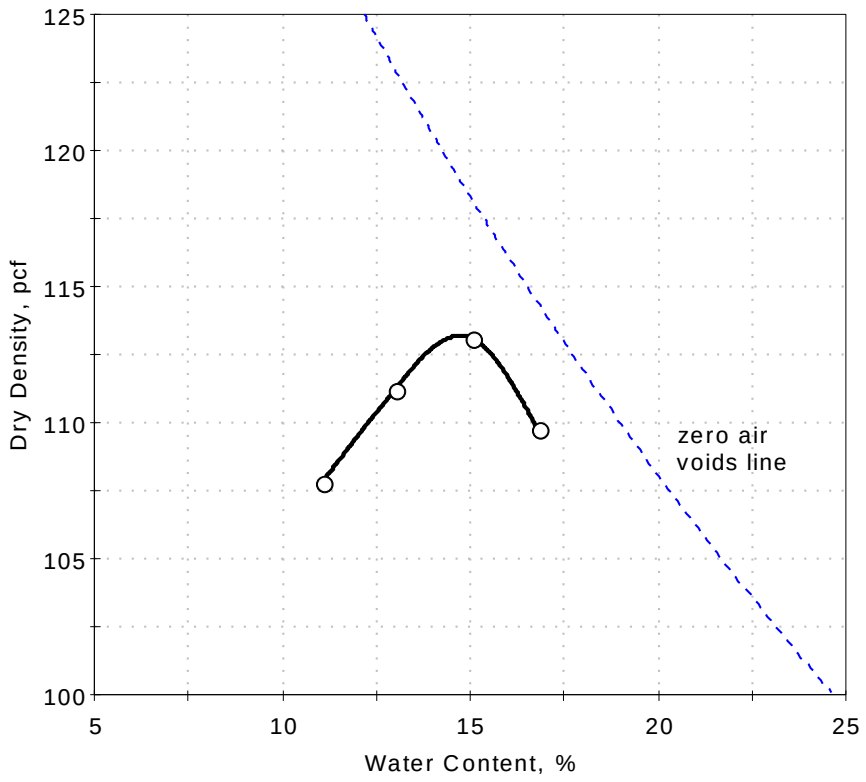


Symbol	Sample ID	Boring	Depth	Natural Moisture Content, %	Liquid Limit	Plastic Limit	Plasticity Index	Liquidity Index	Soil Classification
◆	16031005	Bonanza	Bottom Repos	24	37	19	18	0.3	Sandy Lean clay (CL)

Sample Prepared using the WET method
19% Retained on #40 Sieve
Dry Strength: VERY HIGH
Dilatancy: SLOW
Toughness: LOW

Client:	Test America				
Project:	Bonanza Mine				
Location:	---			Project No:	GTX-304536
Boring ID:	Umpqua	Sample Type:	bucket	Tested By:	pmh
Sample ID:	16031002	Test Date:	03/31/16	Checked By:	emm
Depth :	Washed Sand	Test Id:	370698		
Test Comment:	---				
Visual Description:	Moist, dark olive brown sand				
Sample Comment:	---				

Compaction Report - ASTM D698



Data Points	Point 1	Point 2	Point 3	Point 4
Dry density, pcf	107.8	111.2	113.1	109.7
Moisture Content, %	11.1	13.0	15.0	16.8

Method : A

Preparation : DRY

As received Moisture :8 %

Rammer : Manual

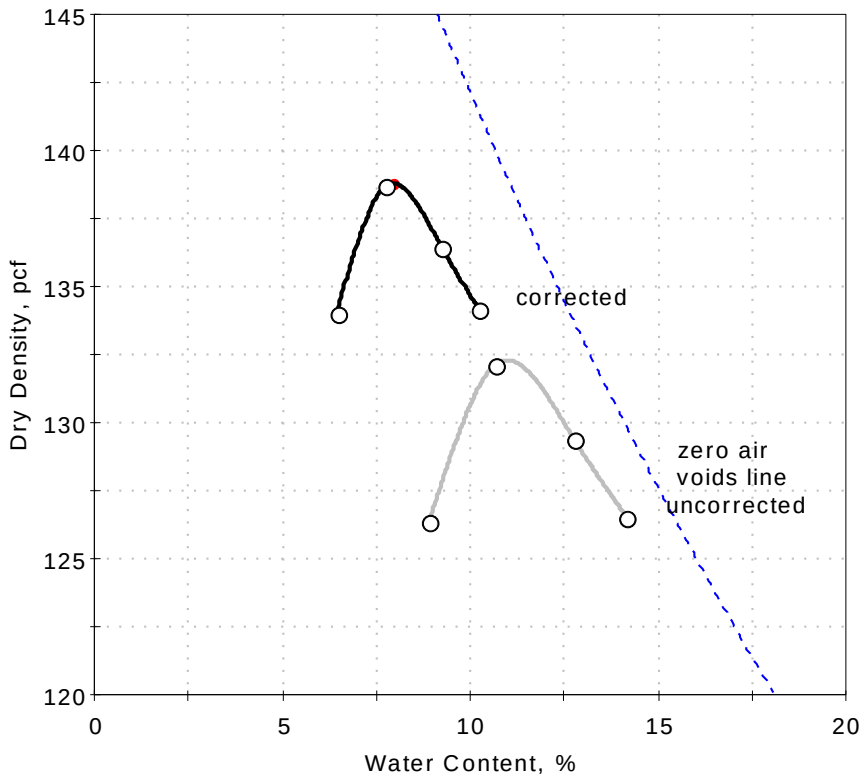
Zero voids line based on assumed specific gravity of 2.65

Maximum Dry Density= 113.2 pcf

Optimum Moisture= 14.7 %

Client:	Test America				
Project:	Bonanza Mine				
Location:	---			Project No:	GTX-304536
Boring ID:	Umpqua	Sample Type:	bucket	Tested By:	pmh
Sample ID:	16031003	Test Date:	04/04/16	Checked By:	emm
Depth :	3 Inch Minus	Test Id:	370699		
Test Comment:	---				
Visual Description:	Moist, dark olive gray gravel with sand				
Sample Comment:	---				

Compaction Report - ASTM D698



Data Points	Point 1	Point 2	Point 3	Point 4
Dry density, pcf	126.4	132.1	129.4	126.5
Moisture Content, %	8.9	10.7	12.8	14.2

Method : C

Preparation : DRY

As received Moisture :6 %

Rammer : Manual

Zero voids line based on assumed specific gravity of 2.95

Maximum Dry Density= 132.3 pcf

Optimum Moisture= 11.0 %

Oversize Correction (27.7% > 3/4 inch Sieve)

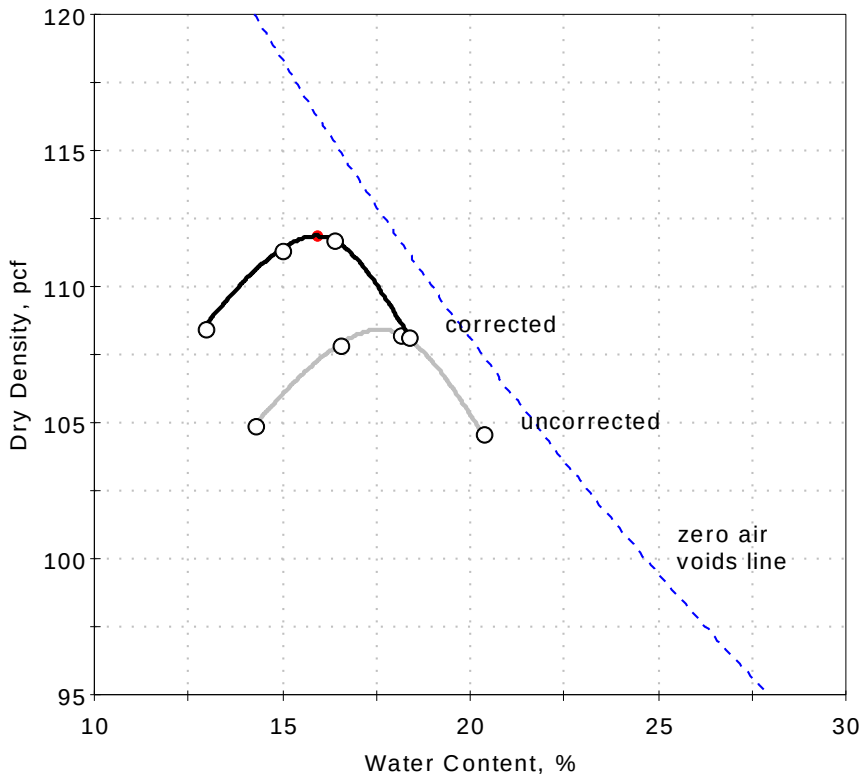
Corrected Maximum Dry Density= 138.8 pcf

Corrected Optimum Moisture= 8.0 %

Assumed Average Bulk Specific Gravity = 2.55

Client:	Test America				
Project:	Bonanza Mine				
Location:	---			Project No:	GTX-304536
Boring ID:	Bonanza	Sample Type:	bucket	Tested By:	pmh
Sample ID:	16031004	Test Date:	04/04/16	Checked By:	emm
Depth :	Top Repos	Test Id:	370700		
Test Comment:	---				
Visual Description:	Moist, light olive brown sandy clay with gravel				
Sample Comment:	---				

Compaction Report - ASTM D698



Data Points	Point 1	Point 2	Point 3	Point 4
Dry density, pcf	104.9	107.9	108.3	104.6
Moisture Content, %	14.3	16.5	18.1	20.3

Method : C

Preparation : DRY

As received Moisture :22 %

Rammer : Manual

Zero voids line based on assumed specific gravity of 2.65

Maximum Dry Density= 108.4 pcf

Optimum Moisture= 17.6 %

Oversize Correction (9.6% > 3/4 inch Sieve)

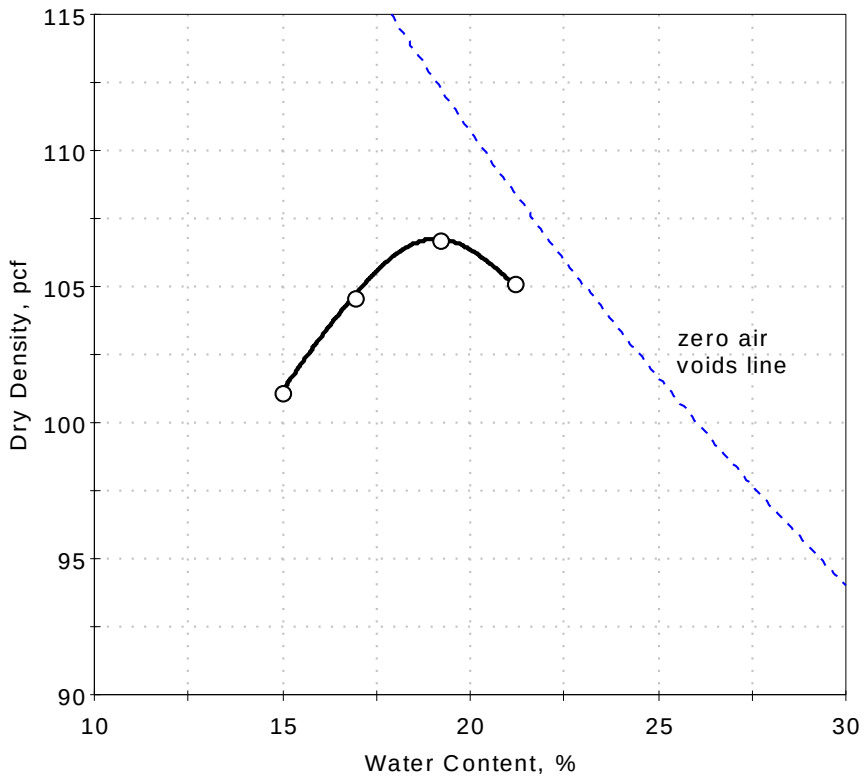
Corrected Maximum Dry Density= 111.9 pcf

Corrected Optimum Moisture= 15.9 %

Assumed Average Bulk Specific Gravity = 2.55

Client:	Test America				
Project:	Bonanza Mine				
Location:	---			Project No:	GTX-304536
Boring ID:	Bonanza	Sample Type:	bucket	Tested By:	pmh
Sample ID:	16031005	Test Date:	04/04/16	Checked By:	emm
Depth :	Bottom Repos	Test Id:	370701		
Test Comment:	---				
Visual Description:	Moist, light olive brown sandy clay				
Sample Comment:	---				

Compaction Report - ASTM D698



Data Points	Point 1	Point 2	Point 3	Point 4
Dry density, pcf	101.1	104.6	106.8	105.1
Moisture Content, %	15.0	16.9	19.2	21.1

Method : B

Preparation : DRY

As received Moisture :24 %

Rammer : Manual

Zero voids line based on assumed specific gravity of 2.75

Maximum Dry Density= 106.8 pcf

Optimum Moisture= 19.1 %

Client:	Test America		
Project Name:	Bonanza Mine		
Project Location:	---		
GTX #:	304536		
Start Date:	4/5/2016	Tested By:	jcw
End Date:	4/7/2016	Checked By:	emm
Boring #:	Umpqua		
Sample #:	16031001		
Depth:	Unscreened Topsoil		
Visual Description:	Moist, dark brown clayey sand		

Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Permeameter by ASTM D5084

Constant Gradient

Sample Type:	Remolded	Permeant Fluid:	De-aired Distilled water
Orientation:	Vertical	Cell #:	9/15

Sample Preparation: Test specimen compacted with moderate effort at the as-recieved moisture content. Values specified by client. Material >3/8-inch removed from sample prior to testing (3% of sample). Trimmings moisture content = 15.4%

Assumed Specific Gravity: 2.65

Parameter	Initial	Final
Height, in	2.98	2.98
Diameter, in	2.86	2.86
Area, in^2	6.42	6.42
Volume, in^3	19.1	19.1
Mass, g	599	632
Bulk Density, pcf	119.0	125.5
Moisture Content, %	15.1	21.4
Dry Density, pcf	103.3	103.3
Degree of Saturation, %	67	95

B COEFFICIENT DETERMINATION

Cell Pressure, psi:	92.03	Increased Cell Pressure, psi:	96.96	Cell Pressure Increment, ps	4.93
Sample Pressure, psi:	87.03	Corresponding Sample Pressure, psi:	91.49	Sample Pressure Increment	4.46
				B Coefficient:	0.90

*B value did not increase with increase in pressure. Final degree of saturation >95%.

FLOW DATA

Date	Time, sec	Pressure, psi Cell	Inlet	Outlet	Gradient	Flow Volume, cc In	Out	Δ In	Δ Out	Temp, °C	R_t	Permeability K @ 20 °C, cm/sec
4/6	---	92.0	87.1	86.9	1.9	12.30	13.50	---	---	---	---	---
4/6	73	92.0	87.1	86.9	1.9	13.30	12.50	1.00	1.00	20.4	0.991	1.8E-04
4/6	----	92.0	87.1	86.9	1.9	12.50	13.60	---	---	---	---	---
4/6	49	92.0	87.1	86.9	1.9	13.10	13.00	0.60	0.60	20.4	0.991	1.6E-04
4/6	----	92.0	87.1	86.9	1.9	12.50	13.20	---	---	---	---	---
4/6	58	92.0	87.1	86.9	1.9	13.20	12.50	0.70	0.70	20.4	0.991	1.6E-04
4/6	----	92.0	87.1	86.9	1.9	12.60	13.50	---	---	---	---	---
4/6	40	92.0	87.1	86.9	1.9	13.10	13.00	0.50	0.50	20.4	0.991	1.6E-04

PERMEABILITY AT 20° C: 1.6 x 10^{-4} cm/sec (@ 5 psi effective stress)

Client:	Test America		
Project Name:	Bonanza Mine		
Project Location:	---		
GTX #:	304536		
Start Date:	04/07/16	Tested By:	jcw
End Date:	04/07/16	Checked By:	emm
Boring #:	Umpqua		
Sample #:	16031002		
Depth:	Washed Sand		
Visual Description:	Moist, dark olive brown sand		

Permeability of Granular Soils (Constant Head) by ASTM D2434

Sample Type: Remolded

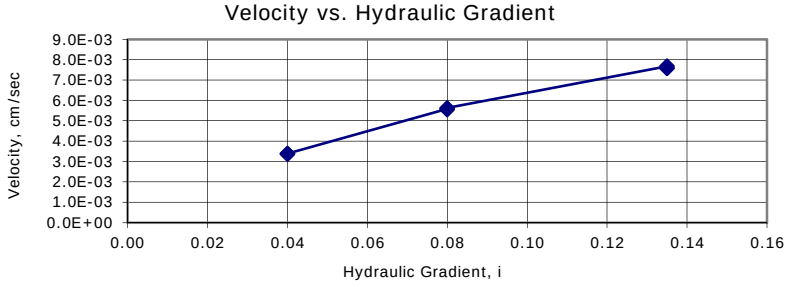
Sample Information:

Maximum Dry Density:	113.2 pcf
Optimum Moisture Content:	14.7 %
Compaction Test Method:	D698
Classification (ASTM D2487):	SP
Assumed Specific Gravity:	2.65

Sample Preparation / Test Setup: Target Compaction: 90% of maximum dry density (113.2 pcf) at air-dried moisture content. Values specified by client. Material >3/8-inch removed from sample prior to testing (0% of sample).

Parameter	Initial	Final
Height, in	4.03	4.03
Diameter, in	3.98	3.98
Area, in^2	12.4	12.4
Volume, in^3	50.1	50.1
Mass, g	1344	1637
Bulk Density, pcf	102.1	124.4
Moisture Content, %	0.8	22.8
Dry Density, pcf	101.3	101.3
Degree of Saturation, %	---	95.3
Void Ratio, e	---	0.63

Date	Reading #	Volume of Flow, cc	Time of Flow, sec	Flow Rate, cc/sec	Gradient	Permeability, cm/sec	Temp., °C	Correction Factor	Permeability @ 20 °C, cm/sec
4/7	1	2.7	10	0.27	0.04	8.5E-02	19.1	1.023	8.7E-02
4/7	2	2.7	10	0.27	0.04	8.4E-02	19.1	1.023	8.6E-02
4/7	3	2.7	10	0.27	0.04	8.5E-02	19.1	1.023	8.6E-02
4/7	4	4.5	10	0.45	0.08	7.0E-02	19.1	1.023	7.1E-02
4/7	5	4.4	10	0.44	0.08	6.9E-02	19.1	1.023	7.1E-02
4/7	6	4.5	10	0.45	0.08	7.0E-02	19.1	1.023	7.2E-02
4/7	7	6.2	10	0.62	0.14	5.7E-02	19.1	1.023	5.8E-02
4/7	8	6.1	10	0.61	0.14	5.6E-02	19.1	1.023	5.7E-02
4/7	9	6.1	10	0.61	0.14	5.6E-02	19.1	1.023	5.7E-02



PERMEABILITY @ 20 °C = 7.2×10^{-2} cm/sec

Note: This standard has been withdrawn by ASTM with no replacement.

Client:	Test America		
Project Name:	Bonanza Mine		
Project Location:	---		
GTX #:	304536		
Start Date:	4/6/2016	Tested By:	jcw
End Date:	4/8/2016	Checked By:	emm
Boring #:	Bonanza		
Sample #:	16031004		
Depth:	Top Repos		
Visual Description:	Moist, light olive brown sandy clay with gravel		

Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Permeameter by ASTM D5084
Constant Gradient

Sample Type:	Remolded	Permeant Fluid:	De-aired Distilled water
Orientation:	Vertical	Cell #:	6/7

Sample Preparation: Target Compaction: 90% of maximum dry density (108.5 pcf) at the optimum moisture content (17.6%). Values specified by client. Material >3/8-inch removed from sample prior to testing (13% of sample). Trimmings moisture content = 17.5%

Assumed Specific Gravity: 2.65

Parameter	Initial	Final
Height, in	3.00	2.99
Diameter, in	2.86	2.86
Area, in^2	6.42	6.42
Volume, in^3	19.3	19.2
Mass, g	581	616
Bulk Density, pcf	114.6	121.9
Moisture Content, %	17.9	24.9
Dry Density, pcf	97.2	97.6
Degree of Saturation, %	68	95

B COEFFICIENT DETERMINATION

Cell Pressure, psi:	90.03	Increased Cell Pressure, psi:	95.00	Cell Pressure Increment, ps	4.97
Sample Pressure, psi:	85.00	Corresponding Sample Pressure, psi:	89.70	Sample Pressure Increment	4.70
				B Coefficient:	0.95

FLOW DATA

Date	Time, sec	Pressure, psi			Gradient	Flow Volume, cc				Temp, °C	R_t	Permeability K @ 20 °C, cm/sec
		Cell	Inlet	Outlet		In	Out	Δ In	Δ Out			
4/7	---	90.0	85.1	84.9	1.9	12.50	13.40	---	---	---	---	---
4/7	31	90.0	85.1	84.9	1.9	12.90	13.00	0.40	0.40	20.5	0.988	1.7E-04
4/7	----	90.0	85.1	84.9	1.9	12.80	13.50	---	---	---	---	---
4/7	49	90.0	85.1	84.9	1.9	13.50	12.80	0.70	0.70	20.5	0.988	1.8E-04
4/7	----	90.0	85.1	84.9	1.9	12.20	13.20	---	---	---	---	---
4/7	50	90.0	85.1	84.9	1.9	12.90	12.50	0.70	0.70	20.5	0.988	1.8E-04
4/7	----	90.0	85.1	84.9	1.9	12.50	13.30	---	---	---	---	---
4/7	55	90.0	85.1	84.9	1.9	13.30	12.50	0.80	0.80	20.5	0.988	1.9E-04

PERMEABILITY AT 20° C: 1.8 x 10^{-4} cm/sec (@ 5 psi effective stress)

Client:	Test America		
Project Name:	Bonanza Mine		
Project Location:	---		
GTX #:	304536		
Start Date:	4/6/2016	Tested By:	jcw
End Date:	4/8/2016	Checked By:	emm
Boring #:	Bonanza		
Sample #:	16031005		
Depth:	Bottom Repo		
Visual Description:	Moist, light olive brown sandy clay		

Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Permeameter by ASTM D5084
Constant Gradient

Sample Type:	Remolded	Permeant Fluid:	De-aired Distilled water
Orientation:	Vertical	Cell #:	2/5

Sample Preparation: Target Compaction: 90% of maximum dry density (106.8 pcf) at the optimum moisture content (19.1%). Values specified by client. Material >3/8-inch removed from sample prior to testing (5% of sample). Trimmings moisture content = 19.3%

Assumed Specific Gravity: 2.65

Parameter	Initial	Final
Height, in	3.00	2.98
Diameter, in	2.86	2.86
Area, in^2	6.42	6.42
Volume, in^3	19.3	19.1
Mass, g	579	610
Bulk Density, pcf	114.2	121.1
Moisture Content, %	19.3	25.6
Dry Density, pcf	95.8	96.4
Degree of Saturation, %	70	95

B COEFFICIENT DETERMINATION

Cell Pressure, psi:	90.00	Increased Cell Pressure, psi:	94.97	Cell Pressure Increment, ps	4.97
Sample Pressure, psi:	84.99	Corresponding Sample Pressure, psi:	89.70	Sample Pressure Increment	4.71
				B Coefficient:	0.95

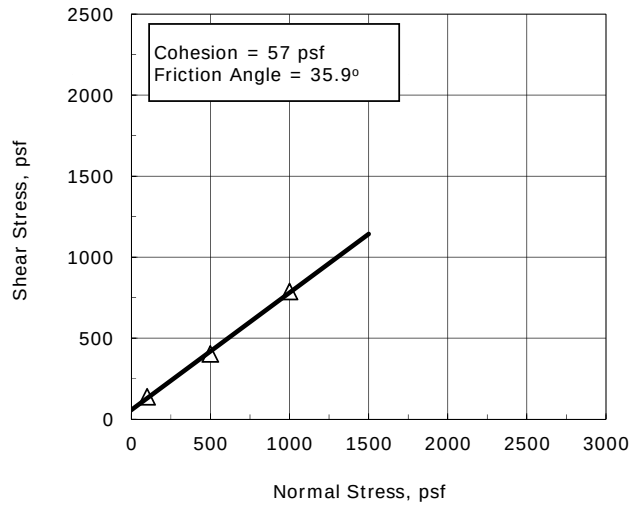
FLOW DATA

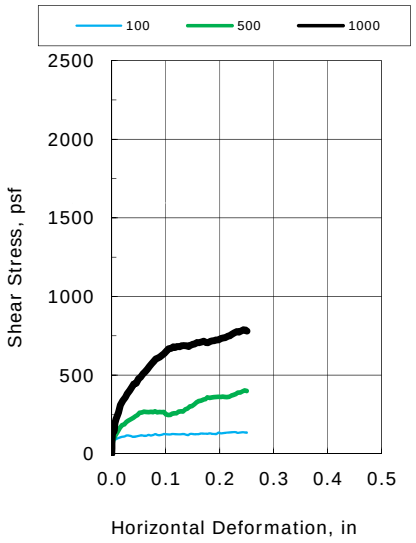
Date	Time, sec	Pressure, psi Cell	Inlet	Outlet	Gradient	Flow Volume, cc In	Out	Δ In	Δ Out	Temp, °C	R_t	Permeability K @ 20 °C, cm/sec
4/7	---	90.0	85.3	84.8	4.6	12.50	13.00	---	---	---	---	---
4/7	136	90.0	85.3	84.8	4.6	12.80	12.70	0.30	0.30	20.5	0.988	1.1E-05
4/7	----	90.0	85.3	84.8	4.6	12.40	13.10	---	---	---	---	---
4/7	122	90.0	85.3	84.8	4.6	12.70	12.80	0.30	0.30	20.5	0.988	1.3E-05
4/7	----	90.0	85.3	84.8	4.6	13.00	13.30	---	---	---	---	---
4/7	152	90.0	85.3	84.8	4.6	13.30	13.00	0.30	0.30	20.5	0.988	1.0E-05
4/7	----	90.0	85.3	84.8	4.6	12.90	12.90	---	---	---	---	---
4/7	120	90.0	85.3	84.8	4.6	13.20	12.60	0.30	0.30	20.5	0.988	1.3E-05

PERMEABILITY AT 20° C: 1.2 x 10^{-5} cm/sec (@ 5 psi effective stress)

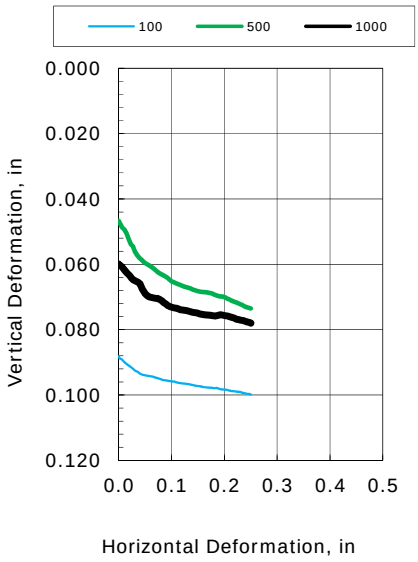
Client:	Test America
Project Name:	Bonanza Mine
Project Location:	---
GTX #:	304536
Test Date:	04/12/16
Tested By:	md
Checked By:	njh
Boring ID:	Umpqua
Sample ID:	16031002
Depth, ft:	Washed Sand
Visual Description:	Moist, dark olive brown sand

Direct Shear Test of Soils Under Consolidated Drained Conditions by ASTM D3080





Test No.:	DS-1	DS-2	DS-3
Initial Diameter, in:	2.5	2.5	2.5
Initial Height, in:	1.0	1.0	1.0
Initial Mass, grams:	151	151	151
Initial Dry Density, pcf:	102.9	102.9	102.9
Initial Moisture Content, %:	13.6	13.6	13.6
Initial Bulk Density, pcf:	116.9	116.9	116.9
Initial Degree of Saturation:	59.2	59.2	59.2
Initial Void Ratio:	0.61	0.61	0.61
Final Dry Density, pcf:	114.3	111.1	111.6
Final Moisture Content, %:	20.2	19.8	19.1
Final Bulk Density, pcf:	137.3	133.0	132.9
Normal Stress, psf:	100	500	1000
Maximum Shear Stress, psf:	138	403	788.0
Shear Rate, in/min:	0.001	0.001	0.001



Sample Type:	reconstituted
Estimated Specific Gravity:	2.65
Liquid Limit:	Non-Plastic
Plastic Limit:	Non-Plastic
Plasticity Index:	Non-Plastic
% Passing #200 sieve:	3.4
Soil Classification:	Poorly Graded Sand
Group Symbol:	SP

Notes:

Material greater than #5 sieve screened out of sample prior to testing

Moisture content obtained before shear from sample trimmings

Moisture Content determined by ASTM D2216

Percent passing #200 sieve determined by ASTM D422

Target Compaction: 90% of the maximum dry density (113.2 pcf) at the optimum moisture content (14.7%). Values specified by client.

Values for cohesion and friction angle determined from best-fit straight line to the data for the specific test conditions. Actual strength parameters may vary and should be determined by an engineer for site-specific conditions.

"---" indicates testing required to determine these values was not requested.

Client:	Test America		
Project Name:	Bonanza Mine		
Project Location:	---		
GTX #:	304536		
Start Date:	04/16/16	Tested By:	dln
End Date:	04/19/16	Checked By:	jdt
Boring ID:	Umpqua		
Sample ID:	16031003		
Depth, ft:	3 inch minus		
Soil Description:	Moist, dark olive gray gravel with sand		

Direct Shear Test Series by ASTM D3080

Soil Preparation:	Target Compaction: 90% of Maximum Dry Density at Optimum Moisture Content		
Compaction Characteristics:	Corrected Maximum Dry Density	138.8 pcf	
	Corrected Optimum Moisture Content	8.0 %	
	Compaction Test Method	ASTM D698	
Test Equipment:	Top box = 12 in x 12 in; Bottom box = 12 in x 12 in; Load cells and LVDTs connected to data acquisition system for shear force, normal load and horizontal displacement readings; surface area = 144 in^2		
Maximum Particle Size Used, in:	0.5	Horizontal Displacement, in/min:	0.02
Soil Height, in:	3	Test Condition:	inundated
Gap Between Boxes, in:	0.25		

Parameter	Point 1	Point 2	Point 3	Point 4	Point 5	Point 6
Initial Moisture Content, %	8.3	8.3	8.6	---	---	---
Initial Dry Density, pcf	124.3	124.4	124.0	---	---	---
Percent Compaction, %	89.6	89.6	89.3	---	---	---
Normal Compressive Stress, psf	100	500	1000	---	---	---
Peak Shear Stress, psf	141	485	1049	---	---	---
Final Moisture Content, %	14.6	12.9	14.3	---	---	---

Notes:

Peak Friction Angle:	**45.4**	**degrees**
Peak Cohesion:	**17.8**	**psf**

Figure a. Shear Force vs. Horizontal Displacement

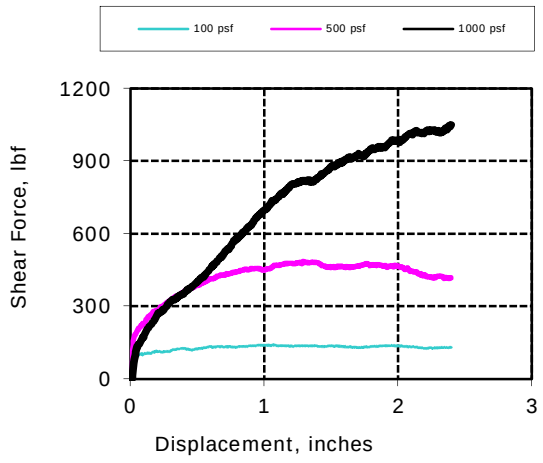
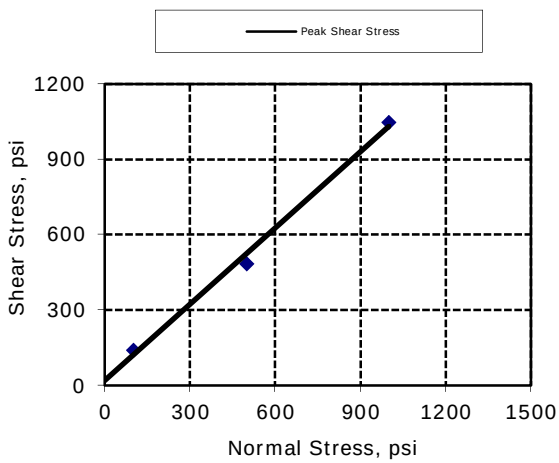


Figure b. Shear Stress vs. Normal Stress



Notes: These results apply only to the sample tested for the specific test conditions. The test procedures employed follow accepted industry practice and the indicated test method. GeoTesting Express has no specific knowledge as to conditioning, origin, sampling procedure or intended use of the material. Values for cohesion and friction angle determined from best-fit straight line to the data for the specific test conditions. Actual strength parameters may vary and should be determined by an engineer for site-specific conditions.

Client:	Test America		
Project Name:	Bonanza Mine		
Project Location:	---		
GTX #:	304536		
Start Date:	04/15/16	Tested By:	dln
End Date:	04/18/16	Checked By:	jdt
Boring ID:	Bonanza		
Sample ID:	16031005		
Depth, ft:	Bottom Repos		
Soil Description:	Moist, light olive brown sandy clay		

Direct Shear Test Series by ASTM D3080

Soil Preparation:	Target Compaction: 90% of Maximum Dry Density at Optimum Moisture Content		
Compaction Characteristics:	Maximum Dry Density	106.8 pcf	
	Optimum Moisture Content	19.1 %	
	Compaction Test Method	ASTM D698	
Test Equipment:	Top box = 12 in x 12 in; Bottom box = 12 in x 12 in; Load cells and LVDTs connected to data acquisition system for shear force, normal load and horizontal displacement readings; surface area = 144 in^2		
Maximum Particle Size Used, in:	0.5	Horizontal Displacement, in/min:	0.02
Soil Height, in:	3	Test Condition:	inundated
Gap Between Boxes, in:	0.25		

Parameter	Point 1	Point 2	Point 3	Point 4	Point 5	Point 6
Initial Moisture Content, %	18.7	18.4	18.8	---	---	---
Initial Dry Density, pcf	96.2	96.5	96.2	---	---	---
Percent Compaction, %	90.1	90.4	90.0	---	---	---
Normal Compressive Stress, psf	100	500	1000	---	---	---
Peak Shear Stress, psf	113	386	817	---	---	---
Final Moisture Content, %	29.6	25.4	23.8	---	---	---

Notes:

Peak Friction Angle:	**38.1**	**degrees**
Peak Cohesion:	**19.9**	**psf**

Figure a. Shear Force vs. Horizontal Displacement

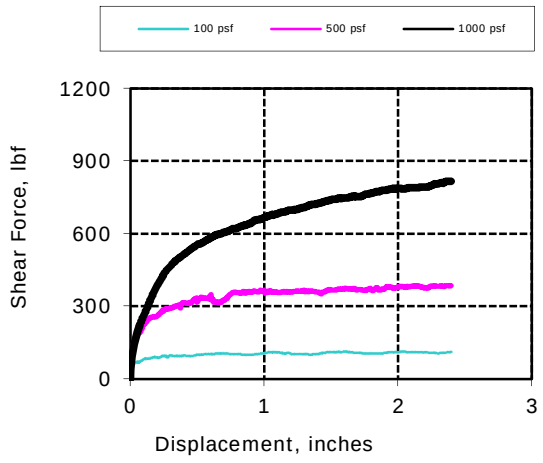
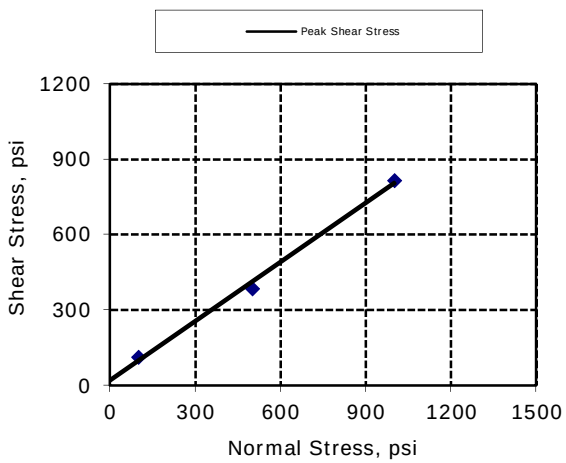


Figure b. Shear Stress vs. Normal Stress



Notes: These results apply only to the sample tested for the specific test conditions. The test procedures employed follow accepted industry practice and the indicated test method. GeoTesting Express has no specific knowledge as to conditioning, origin, sampling procedure or intended use of the material. Values for cohesion and friction angle determined from best-fit straight line to the data for the specific test conditions. Actual strength parameters may vary and should be determined by an engineer for site-specific conditions.

Client:	Test America		
Project Name:	Bonanza Mine		
Project Location:	---		
GTX #:	304536		
Start Date:	04/15/16	Tested By:	dln
End Date:	04/21/16	Checked By:	jdt
Boring ID:	Bonanza		
Sample ID:	16031004		
Depth, ft:	Top Repos		
Soil Description:	Moist, light olive brown sandy clay with gravel		

Direct Shear Test Series by ASTM D3080

Soil Preparation:	Target Compaction: 90% of Maximum Dry Density at Optimum Moisture Content		
Compaction Characteristics:	Corrected Maximum Dry Density	111.9 pcf	
	Corrected Optimum Moisture Content	15.9 %	
	Compaction Test Method	ASTM D698	
Test Equipment:	Top box = 12 in x 12 in; Bottom box = 12 in x 12 in; Load cells and LVDTs connected to data acquisition system for shear force, normal load and horizontal displacement readings; surface area = 144 in^2		
Maximum Particle Size Used, in:	0.5	Horizontal Displacement, in/min:	0.02
Soil Height, in:	3	Test Condition:	inundated
Gap Between Boxes, in:	0.25		

Parameter	Point 1	Point 2	Point 3	Point 4	Point 5	Point 6
Initial Moisture Content, %	16.1	14.1	14.3	---	---	---
Initial Dry Density, pcf	100.3	102.1	101.9	---	---	---
Percent Compaction, %	89.6	91.2	91.1	---	---	---
Normal Compressive Stress, psf	100	500	1000	---	---	---
Peak Shear Stress, psf	121	378	902	---	---	---
Final Moisture Content, %	28.5	28.6	27.7	---	---	---

Notes:

Peak Friction Angle:	**41.2**	**degrees**
Peak Cohesion:	**0.2**	**psf**

Figure a. Shear Force vs. Horizontal Displacement

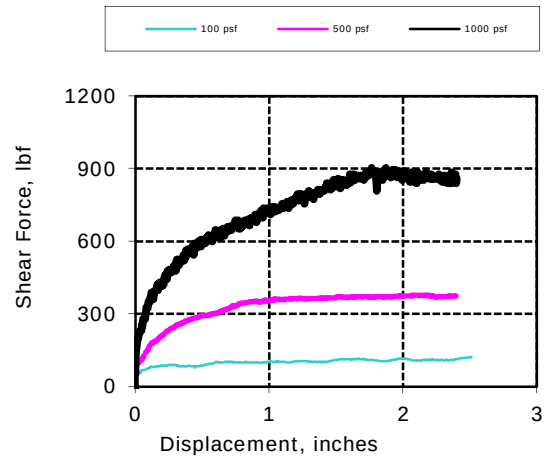
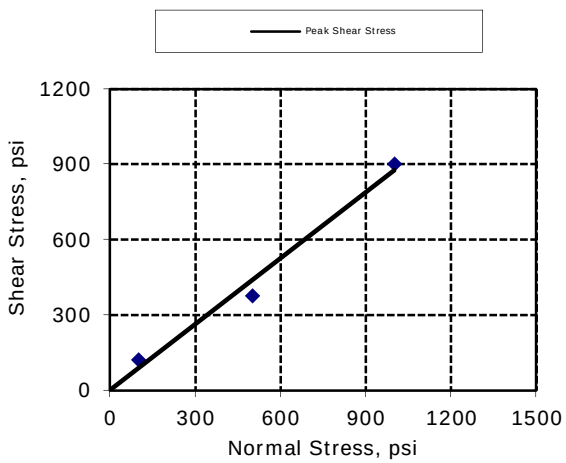


Figure b. Shear Stress vs. Normal Stress



Notes: These results apply only to the sample tested for the specific test conditions. The test procedures employed follow accepted industry practice and the indicated test method. GeoTesting Express has no specific knowledge as to conditioning, origin, sampling procedure or intended use of the material. Values for cohesion and friction angle determined from best-fit straight line to the data for the specific test conditions. Actual strength parameters may vary and should be determined by an engineer for site-specific conditions.

Client:	Test America		
Project Name:	Bonanza Landfill		
Project Location:	---		
GTX #:	304536		
Start Date:	04/12/16	Tested By:	dln
End Date:	04/15/16	Checked By:	emm
Soil ID:	Umpqua, 16031003, 3 inch minus		
Soil Description:	Moist, dark olive gray clayey gravel with sand		
Geosynthetic ID:	Geocomposite: Roll #G14E407251		
Geosynthetic Description:	Black, single sided nonwoven biplanar geocomposite		

Interface Shear Test Series by ASTM D5321

Test Series #:	4
Test Profile - Top to Bottom:	steel plate / SOIL/ GEOCOMPOSITE / textured gripping surface
Soil Preparation:	Soil compacted to 90% of Maximum Dry Density at Optimum Moisture Content
Compaction Characteristics:	Corrected Maximum Dry Density 138.8 pcf Corrected Optimum Moisture Content 8.0 % Compaction Test Method ASTM D698
Geosynthetic Preparation:	Test set-up saturated at normal load for 1 hour prior to shear
Test Equipment:	Top box = 12 in x 12 in; Bottom box = 12 in x 12 in; Load cells and LVDTs connected to data acquisition system for shear force, normal load and horizontal displacement readings; Flat plate clamping device; surface area = 144 in^2
Horizontal Displacement, in/min:	0.04 Test Condition: inundated

Parameter	Point 1	Point 2	Point 3	Point 4	Point 5	Point 6
Initial Moisture Content, %	8.7	8.6	8.8	---	---	---
Initial Dry Density, pcf	123.8	124.0	123.7	---	---	---
Percent Compaction, %	89.2	89.3	89.1	---	---	---
Final Moisture Content, %	17.0	14.6	14.9	---	---	---
Normal Compressive Stress, psf	100	500	1000	---	---	---
Peak Shear Stress, psf	121	435	935	---	---	---
Post Peak Shear Stress, psf	115	392	753	---	---	---
Peak Secant Friction Angle, °	50.5	41.0	43.1	---	---	---
Post-Peak Secant Friction Angle, °	49.0	38.1	37.0	---	---	---

NOTES:

Peak Friction Angle:	**42.3**	**degrees**
Peak Adhesion:	**13**	**psf**
Post Peak Friction Angle:	**35.3**	**degrees**
Post Peak Adhesion:	**42**	**psf**

Figure a. Shear Force vs. Horizontal Displacement

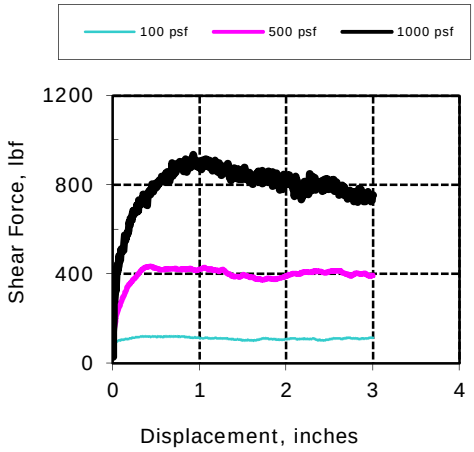
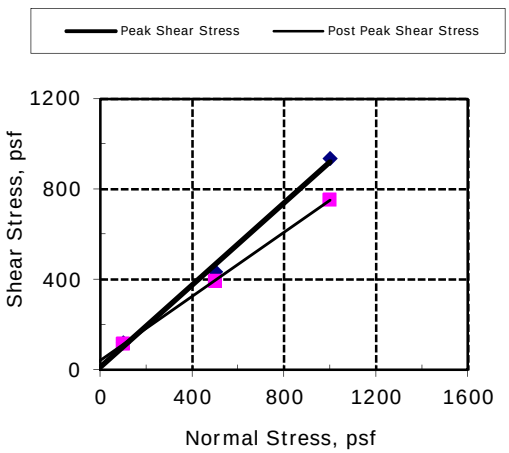


Figure b. Shear Stress vs. Normal Stress



Notes: These results apply only to the sample tested for the specific test conditions. The test procedures employed follow accepted industry practice and the indicated test method. GeoTesting Express has no specific knowledge as to conditioning, origin, sampling procedure or intended use of the material. Values for cohesion and friction angle determined from best-fit straight line to the data for the specific test conditions. Actual strength parameters may vary and should be determined by an engineer for site-specific conditions.

Form D5321, version 2

Client:	Test America		
Project Name:	Bonanza Landfill		
Project Location:	---		
GTX #:	304536		
Start Date:	04/12/16	Tested By:	dln
End Date:	04/15/16	Checked By:	emm
Soil ID:	Bonanza, 16031005, Bottom Repos		
Soil Description:	Moist, light olive brown sandy clay		
Geomembrane ID:	Roll 3/24/16 (Roll # not provided)		
Geomembrane Description:	Black, 40 mil Agru textured LLDPE geomembrane		

Interface Shear Test Series by ASTM D5321

Test Series #:	1	
Test Profile - Top to Bottom:	steel plate / SOIL / GEOMEMBRANE / textured gripping surface	
Soil Preparation:	Soil compacted to 90% of Maximum Dry Density at Optimum Moisture Content.	
Compaction Characteristics:	Maximum Dry Density	106.8 pcf
	Optimum Moisture Content	19.1 %
	Compaction Test Method	ASTM D698
Geosynthetic Preparation:	Test set-up saturated at normal load for 1 hour prior to shear	
Test Equipment:	Top box = 12 in x 12 in; Bottom box = 12 in x 12 in; Load cells and LVDTs connected to data acquisition system for shear force, normal load and horizontal displacement readings; Flat plate clamping device; surface area = 144 in^2	
Horizontal Displacement, in/min:	0.04	Test Condition: inundated

Parameter	Point 1	Point 2	Point 3	Point 4	Point 5	Point 6
Initial Moisture Content, %	20.0	19.9	20.0	---	---	---
Initial Dry Density, pcf	97.2	97.3	97.2	---	---	---
Percent Compaction, %	91.0	91.1	91.0	---	---	---
Final Moisture Content, %	30.0	26.1	25.4	---	---	---
Normal Compressive Stress, psf	100	500	1000	---	---	---
Peak Shear Stress, psf	125	364	732	---	---	---
Post Peak Shear Stress, psf	125	325	722	---	---	---
Peak Secant Friction Angle, °	51.3	36.1	36.2	---	---	---
Post-Peak Secant Friction Angle, °	51.3	33.0	35.8	---	---	---
Pre-Test: Average Asperity, mils	37.0	38.1	41.1	---	---	---
Post-Test: Average Asperity, mils	36.3	37.8	39.1	---	---	---

NOTES: Asperity measurements taken on side of membrane involved in shear plane in general accordance with ASTM D7466. Six measurements taken at the same locations before and after test.

Peak Friction Angle:	**34.1**	**degrees**
Peak Adhesion:	**46**	**psf**
Post Peak Friction Angle:	**33.8**	**degrees**
Post Peak Adhesion:	**34**	**psf**

Figure a. Shear Force vs. Horizontal Displacement

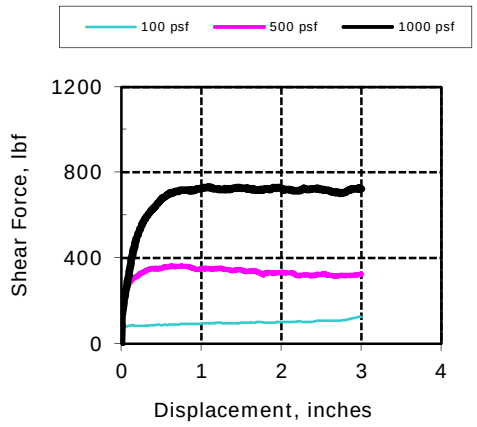
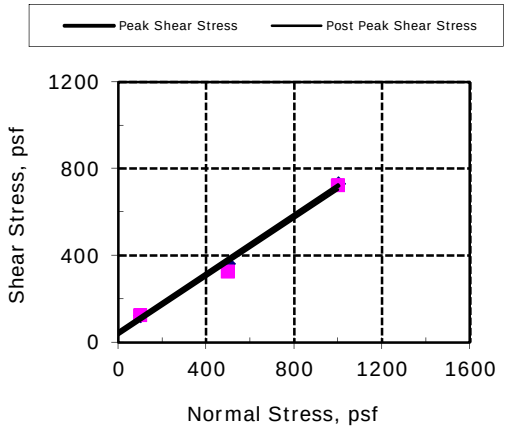


Figure b. Shear Stress vs. Normal Stress



Notes: These results apply only to the sample tested for the specific test conditions. The test procedures employed follow accepted industry practice and the indicated test method. GeoTesting Express has no specific knowledge as to conditioning, origin, sampling procedure or intended use of the material. Values for cohesion and friction angle determined from best-fit straight line to the data for the specific test conditions. Actual strength parameters may vary and should be determined by an engineer for site-specific conditions.

Form D5321, version 2

Client:	Test America		
Project Name:	Bonanza Landfill		
Project Location:	---		
GTX #:	304536		
Start Date:	04/12/16	Tested By:	dln
End Date:	04/15/16	Checked By:	jdt
Soil ID:	Bonanza, 16031004, Top Repos		
Soil Description:	Moist, light olive brown sandy clay wih gravel		
Geosynthetic ID:	Geocomposite: Roll #G14E407251		
Geosynthetic Description:	Black, single sided nonwoven biplanar geocomposite		

Interface Shear Test Series by ASTM D5321

Test Series #:	2
Test Profile - Top to Bottom:	steel plate / SOIL / GEOCOMPOSITE / textured gripping surface
Soil Preparation:	Soil compacted to 90% of Maximum Dry Density at Optimum Moisture Content.
Compaction Characteristics:	Corrected Maximum Dry Density 111.9 pcf Corrected Optimum Moisture Content 15.9 % Compaction Test Method ASTM D698
Geosynthetic Preparation:	Test set-up saturated at normal load for 1 hour prior to shear
Test Equipment:	Top box = 12 in x 12 in; Bottom box = 12 in x 12 in; Load cells and LVDTs connected to data acquisition system for shear force, normal load and horizontal displacement readings; Flat plate clamping device; surface area = 144 in^2
Horizontal Displacement, in/min:	0.04 Test Condition: inundated

Parameter	Point 1	Point 2	Point 3	Point 4	Point 5	Point 6
Initial Moisture Content, %	15.8	17.2	16.7	---	---	---
Initial Dry Density, pcf	101	99	100	---	---	---
Percent Compaction, %	89.9	88.8	89.2	---	---	---
Final Moisture Content, %	27.7	24.0	22.8	---	---	---
Normal Compressive Stress, psf	100	500	1000	---	---	---
Peak Shear Stress, psf	127	423	953	---	---	---
Post Peak Shear Stress, psf	127	402	904	---	---	---
Peak Secant Friction Angle, °	51.8	40.2	43.6	---	---	---
Post-Peak Secant Friction Angle, °	51.8	38.8	42.1	---	---	---

NOTES:

Peak Friction Angle:	**42.7**	**degrees**
Peak Adhesion:	**9**	**psf**
Post Peak Friction Angle:	**41.0**	**degrees**
Post Peak Adhesion:	**14**	**psf**

Figure a. Shear Force vs. Horizontal Displacement

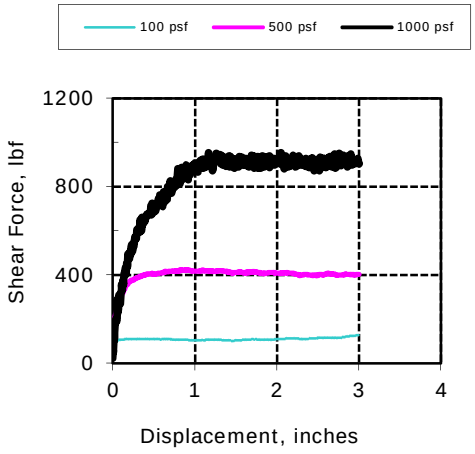
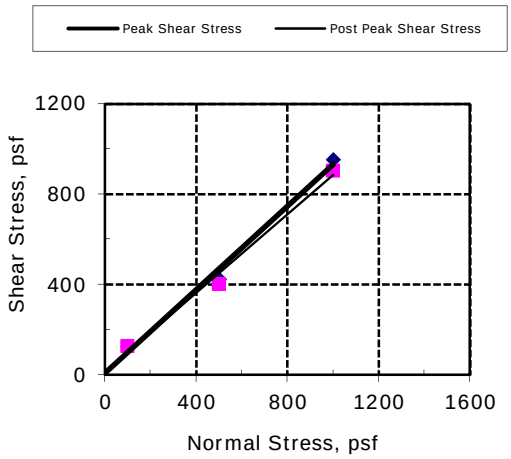


Figure b. Shear Stress vs. Normal Stress



Notes: These results apply only to the sample tested for the specific test conditions. The test procedures employed follow accepted industry practice and the indicated test method. GeoTesting Express has no specific knowledge as to conditioning, origin, sampling procedure or intended use of the material. Values for cohesion and friction angle determined from best-fit straight line to the data for the specific test conditions. Actual strength parameters may vary and should be determined by an engineer for site-specific conditions.

Form D5321, version 2

Client:	Test America		
Project Name:	Bonanza Landfill		
Project Location:	---		
GTX #:	304536		
Start Date:	04/12/16	Tested By:	dln
End Date:	04/15/16	Checked By:	jdt
Soil ID:	Umpqua, 16031002, Washed Sand		
Soil Description:	Moist, dark olive brown sand		
Geomembrane ID:	Roll 3/24/16 (Roll # not provided)		
Geomembrane Description:	Black, 40 mil Agru textured LLDPE geomembrane		

Interface Shear Test Series by ASTM D5321

Test Series #:	3
Test Profile - Top to Bottom:	steel plate / SOIL / GEOMEMBRANE / textured gripping surface
Soil Preparation:	Soil compacted to 90% of Maximum Dry Density at Optimum Moisture Content.
Compaction Characteristics:	Maximum Dry Density 113.2 pcf
	Optimum Moisture Content 14.7 %
	Compaction Test Method ASTM D698
Geosynthetic Preparation:	Test set-up saturated at normal load for 1 hour prior to shear
Test Equipment:	Top box = 12 in x 12 in; Bottom box = 12 in x 12 in; Load cells and LVDTs connected to data acquisition system for shear force, normal load and horizontal displacement readings; Flat plate clamping device; surface area = 144 in^2
Horizontal Displacement, in/min:	0.04 Test Condition: inundated

Parameter	Point 1	Point 2	Point 3	Point 4	Point 5	Point 6
Initial Moisture Content, %	13.5	13.8	13.6	---	---	---
Initial Dry Density, pcf	102.8	102.5	102.6	---	---	---
Percent Compaction, %	90.8	90.6	90.7	---	---	---
Final Moisture Content, %	20.7	19.7	19.6	---	---	---
Normal Compressive Stress, psf	100	500	1000	---	---	---
Peak Shear Stress, psf	106	364	811	---	---	---
Post Peak Shear Stress, psf	95.8	326	762	---	---	---
Peak Secant Friction Angle, °	46.6	36.1	39.0	---	---	---
Post-Peak Secant Friction Angle, °	43.8	33.1	37.3	---	---	---
Pre-Test: Average Asperity, mils	40.1	41.7	40.3	---	---	---
Post-Test: Average Asperity, mils	39.6	41.3	39.7	---	---	---

NOTES: Asperity measurements taken on side of membrane involved in shear plane in general accordance with ASTM D7466. Six measurements taken at the same locations before and after test.

Peak Friction Angle:	**38.2**	**degrees**
Peak Adhesion:	**7**	**psf**
Post Peak Friction Angle:	**36.7**	**degrees**
Post Peak Adhesion:	**0**	**psf**

Figure a. Shear Force vs. Horizontal Displacement

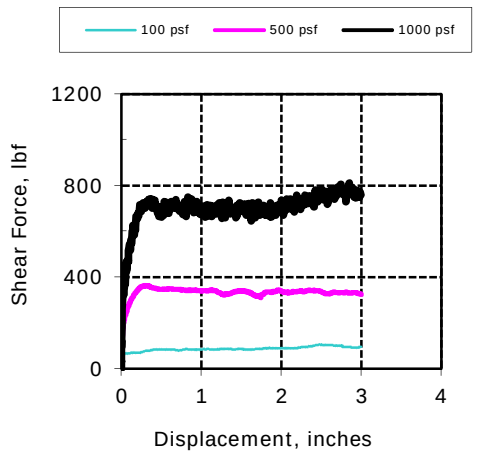
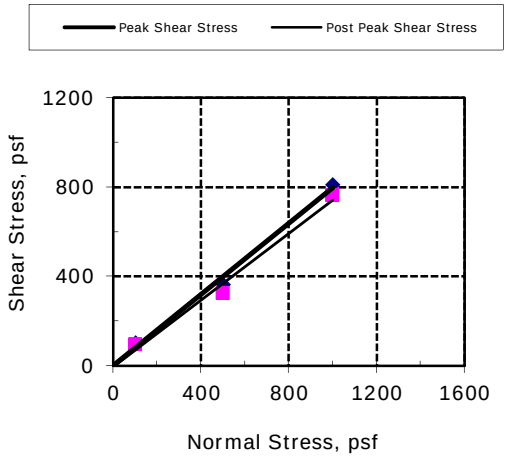


Figure b. Shear Stress vs. Normal Stress



Notes: These results apply only to the sample tested for the specific test conditions. The test procedures employed follow accepted industry practice and the indicated test method. GeoTesting Express has no specific knowledge as to conditioning, origin, sampling procedure or intended use of the material. Values for cohesion and friction angle determined from best-fit straight line to the data for the specific test conditions. Actual strength parameters may vary and should be determined by an engineer for site-specific conditions.

Form D5321, version 2

Subcontract Data

Shipping and Receiving Documents

CHAIN OF CUSTODY RECORD

No: 2016-A

Lab: GeoTesting Express
Lab Phone: 978-635-0424
AirbillNo: 3168125

Site #: 10NE
Project Code:
Cooler #:

FedEx Account 2006-6560-0
Contact Name: Jacob Moersen
Contact Phone: 206-920-9566

Lab #	Sample #	Location	Analyses	Matrix	Collected	Numb Cont	Container	Preservative	Lab QC
	16031001	Umpqua - Unscreened Topsoil	ASTM D 421/422 (TAT 2 Weeks)	Topsoil	3/11/2016	3	5 gal bucket	None	N
	16031001	Umpqua - Unscreened Topsoil	ATSM D 5084	Topsoil	3/11/2016	3	5 gal bucket	None	N
	16031001	Umpqua - Unscreened Topsoil	ATSM D 2487	Topsoil	3/11/2016	3	5 gal bucket	None	N
	16031001	Umpqua - Unscreened Topsoil	ASTM D 4318	Topsoil	3/11/2016	3	5 gal bucket	None	N

580-58737 Chain of Custody

Special Instructions: Request 2 week TAT for ASTM D421/422, D4318, D5084, and D2487.

SAMPLES TRANSFERRED FROM
CHAIN OF CUSTODY #

Items/Reason	Relinquished by (Signature and Organization)	Date/Time	Received by (Signature and Organization)	Date/Time	Sample Condition Upon Receipt
shipping	E & E	3/17/16			

CHAIN OF CUSTODY RECORD

No: 2016-B

Lab: GeoTesting Express
Lab Phone: 978-635-0424
AirbillNo: 316127

Site #: 10NE
Project Code:
Cooler #:

FedEx Account 2006-6560-0
Contact Name: Jacob Moersen
Contact Phone: 206-920-9566

Lab #	Sample #	Location	Analyses	Matrix	Collected	Numb Cont	Container	Preservative	Lab QC
	16031002	Umpqua - Washed Sand	ASTM D 421/422 (TAT 2 Weeks)	Sand	3/11/2016	3	5 gal bucket	None	N
	16031002	Umpqua - Washed Sand	ASTM D 698	Sand	3/11/2016	3	5 gal bucket	None	N
	16031002	Umpqua - Washed Sand	ATSM D 2487	Sand	3/11/2016	3	5 gal bucket	None	N
	16031002	Umpqua - Washed Sand	ATSM D 3080	Sand	3/11/2016	3	5 gal bucket	None	N
	16031002	Umpqua - Washed Sand	ATSM D 5084	Sand	3/11/2016	3	5 gal bucket	None	N
	16031002	Umpqua - Washed Sand	ATSM D 5321	Sand	3/11/2016	3	5 gal bucket	None	N

Special Instructions: Request 2 week TAT for ASTM D421/422, D698, D3080, D5084, D2487, and D5321.

SAMPLES TRANSFERRED FROM
CHAIN OF CUSTODY #

Items/Reason	Relinquished by (Signature and Organization)	Date/Time	Received by (Signature and Organization)	Date/Time	Sample Condition Upon Receipt
Shipping	E i E	3/17/16			

CHAIN OF CUSTODY RECORD

No: 2016-C

Lab: GeoTesting Express
Lab Phone: 978-635-0424
AirbillNo: 9976850

Site #: 10NE
Project Code:
Cooler #:

FedEx Account 2006-6560-0
Contact Name: Jacob Moersen
Contact Phone: 206-920-9566

Lab #	Sample #	Location	Analyses	Matrix	Collected	Numb Cont	Container	Preservative	Lab QC
	16031003	Umpqua - 3 Inch Minus	ASTM D 421/422 (TAT 2 Weeks)	Gravel	3/11/2016	3	5 gal bucket	None	N
	16031003	Umpqua - 3 Inch Minus	ASTM D 698	Gravel	3/11/2016	3	5 gal bucket	None	N
	16031003	Umpqua - 3 Inch Minus	ATSM D 2487	Gravel	3/11/2016	3	5 gal bucket	None	N
	16031003	Umpqua - 3 Inch Minus	ATSM D 3080	Gravel	3/11/2016	3	5 gal bucket	None	N
	16031003	Umpqua - 3 Inch Minus	ATSM D 5084	Gravel	3/11/2016	3	5 gal bucket	None	N
	16031003	Umpqua - 3 Inch Minus	ATSM D 5321	Gravel	3/11/2016	3	5 gal bucket	None	N

Special Instructions: Request 2 week TAT for ASTM D421/422, D698, D3080, D5084, D2487, and D5321.

SAMPLES TRANSFERRED FROM
CHAIN OF CUSTODY #

Items/Reason	Relinquished by (Signature and Organization)	Date/Time	Received by (Signature and Organization)	Date/Time	Sample Condition Upon Receipt
shipping	E i E	3/17/16			

CHAIN OF CUSTODY RECORD

No: 2016-D

Lab: GeoTesting Express
Lab Phone: 978-635-0424
AirbillNo: 9976997

Site #: 10NE
Project Code:
Cooler #:

FedEx Account 2006-6560-0
Contact Name: Jacob Moersen
Contact Phone: 206-920-9566

Lab #	Sample #	Location	Analyses	Matrix	Collected	Numb Cont	Container	Preservative	Lab QC
	16031004	Bonanza - Top Repos	ASTM D 421/422 (TAT 2 Weeks)	Soil	3/11/2016	3	5 gal bucket	None	N
	16031004	Bonanza - Top Repos	ASTM D 4318	Soil	3/11/2016	3	5 gal bucket	None	N
	16031004	Bonanza - Top Repos	ASTM D 698	Soil	3/11/2016	3	5 gal bucket	None	N
	16031004	Bonanza - Top Repos	ATSM D 2487	Soil	3/11/2016	3	5 gal bucket	None	N
	16031004	Bonanza - Top Repos	ATSM D 3080	Soil	3/11/2016	3	5 gal bucket	None	N
	16031004	Bonanza - Top Repos	ATSM D 5084	Soil	3/11/2016	3	5 gal bucket	None	N
	16031004	Bonanza - Top Repos	ATSM D 5321	Soil	3/11/2016	3	5 gal bucket	None	N

Special Instructions: Request 2 week TAT for ASTM D421/422, D698, D4318, D3080, D5084, D2487, and D5321.

SAMPLES TRANSFERRED FROM CHAIN OF CUSTODY #

Items/Reason	Relinquished by (Signature and Organization)	Date/Time	Received by (Signature and Organization)	Date/Time	Sample Condition Upon Receipt
shipping	E & E	3/17/16			

CHAIN OF CUSTODY RECORD

No: 2016-E

Lab: GeoTesting Express
Lab Phone: 978-635-0424
AirbillNo: 9976999

Site #: 10NE
Project Code:
Cooler #:

FedEx Account 2006-6560-0
Contact Name: Jacob Moersen
Contact Phone: 206-920-9566

Lab #	Sample #	Location	Analyses	Matrix	Collected	Numb Cont	Container	Preservative	Lab QC
	16031005	Bonanza - Bottom Repos	ASTM D 421/422 (TAT 2 Weeks)	Soil	3/11/2016	3	5 gal bucket	None	N
	16031005	Bonanza - Bottom Repos	ASTM D 4318	Soil	3/11/2016	3	5 gal bucket	None	N
	16031005	Bonanza - Bottom Repos	ASTM D 698	Soil	3/11/2016	3	5 gal bucket	None	N
	16031005	Bonanza - Bottom Repos	ATSM D 2487	Soil	3/11/2016	3	5 gal bucket	None	N
	16031005	Bonanza - Bottom Repos	ATSM D 3080	Soil	3/11/2016	3	5 gal bucket	None	N
	16031005	Bonanza - Bottom Repos	ATSM D 5084	Soil	3/11/2016	3	5 gal bucket	None	N
	16031005	Bonanza - Bottom Repos	ATSM D 5321	Soil	3/11/2016	3	5 gal bucket	None	N

Special Instructions: Request 2 week TAT for ASTM D421/422, D698, D4318, D3080, D5084, D2487, and D5321.

SAMPLES TRANSFERRED FROM CHAIN OF CUSTODY #

Items/Reason	Relinquished by (Signature and Organization)	Date/Time	Received by (Signature and Organization)	Date/Time	Sample Condition Upon Receipt
shipping	E&E	3/17/16			

Login Sample Receipt Checklist

Client: Ecology and Environment, Inc.

Job Number: 580-58737-1

Login Number: 58737
List Number: 1
Creator: Gamble, Cathy L

List Source: TestAmerica Seattle

Question	Answer	Comment
Radioactivity wasn't checked or is </= background as measured by a survey meter.	True	
The cooler's custody seal, if present, is intact.	True	
Sample custody seals, if present, are intact.	True	
The cooler or samples do not appear to have been compromised or tampered with.	True	
Samples were received on ice.	True	
Cooler Temperature is acceptable.	True	
Cooler Temperature is recorded.	True	
COC is present.	True	
COC is filled out in ink and legible.	True	
COC is filled out with all pertinent information.	True	
Is the Field Sampler's name present on COC?	True	
There are no discrepancies between the containers received and the COC.	True	
Samples are received within Holding Time (excluding tests with immediate HTs)	True	
Sample containers have legible labels.	True	
Containers are not broken or leaking.	True	
Sample collection date/times are provided.	True	
Appropriate sample containers are used.	True	
Sample bottles are completely filled.	True	
Sample Preservation Verified.	True	
There is sufficient vol. for all requested analyses, incl. any requested MS/MSDs	True	
Containers requiring zero headspace have no headspace or bubble is <6mm (1/4").	True	
Multiphasic samples are not present.	True	
Samples do not require splitting or compositing.	True	
Residual Chlorine Checked.	N/A	

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D Survey Information

Appendix D-1	Initial Conditions Survey
Appendix D-2	Record (As-Built) Survey
Appendix D-3	Slide Survey

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EXISTING CONDITIONS MAP

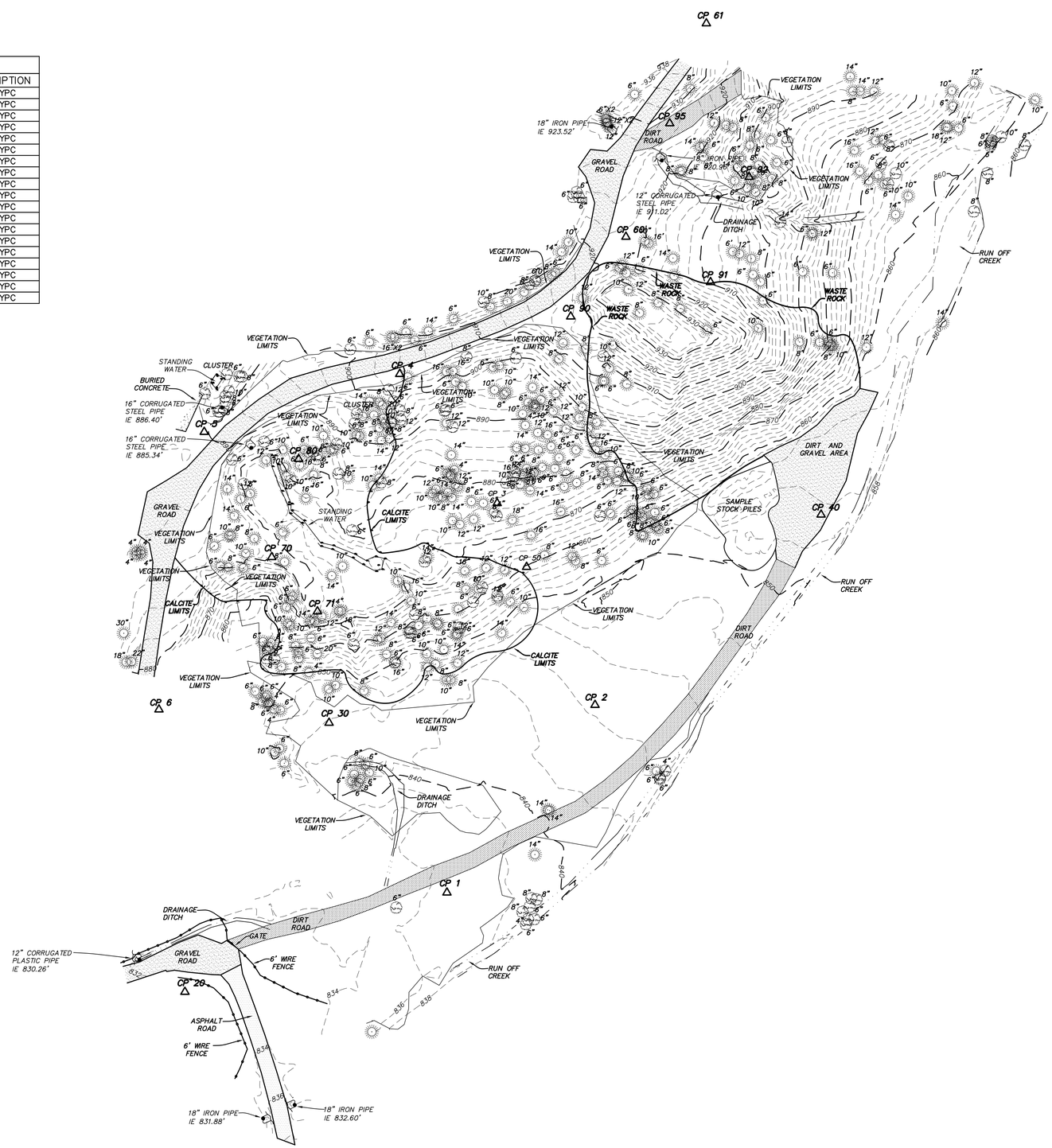
LOCATED IN THE
S.W. 1/4 SECTION 16, T.25S., R.4W., W.M.,
DOUGLAS COUNTY, OREGON
JULY 1, 2014 SCALE 1"=40'

CONTROL POINT TABLE				
CONTROL POINT	NORTHING	EASTING	ELEVATION	DESCRIPTION
1	639806.5239	4208396.1322	837.1500	CP-YPC
2	639938.3988	4208500.1499	844.5314	CP-YPC
3	640080.1950	4208431.3993	877.3261	CP-YPC
4	640170.9468	4208362.9666	903.7346	CP-YPC
5	640130.2458	4208225.6246	889.7945	CP-YPC
6	639935.2004	4208193.8442	876.9675	CP-YPC
20	639736.7305	4208212.0834	832.3762	CP-YPC
30	639925.8267	4208313.3298	843.8468	CP-YPC
40	640072.1059	4208658.9380	853.7070	CP-YPC
50	640035.3454	4208452.0967	859.7818	CP-YPC
60	640267.3933	4208521.8529	921.7987	CP-YPC
61	640417.3851	4208578.3462	939.9411	CP-YPC
70	640042.2389	4208273.0758	883.1091	CP-YPC
71	640004.0820	4208305.1486	878.3804	CP-YPC
80	640111.2323	4208291.9723	884.3486	CP-YPC
90	640211.3449	4208483.0712	917.7464	CP-YPC
91	640235.5251	4208581.2895	909.1940	CP-YPC
92	640309.4545	4208608.3964	907.3665	CP-YPC
95	640347.1022	4208552.6251	927.0864	CP-YPC

GEODETIC CONTROL POINTS

POINT NUMBER-20000
DESIGNATION-C 749
NORTHING-671618.6390
EASTING-4172350.3230
ELEVATION-482.61'

POINT NUMBER-20001
DESIGNATION-LESLEE
NORTHING-652140.948
EASTING-417233.476
ELEVATION-489.00'



SURVEY NOTES:

THE HORIZONTAL DATUM AND BASIS OF BEARINGS ARE BASED UPON THE NORTH AMERICAN DATUM OF 1983 (NAD83), OREGON STATE PLANE COORDINATE SYSTEM (SPCS), SOUTH ZONE, U.S. FEET. TRAVERSE WAS COMPLETED TO FGCS THIRD ORDER CLASS I STANDARDS.

THE VERTICAL DATUM FOR THIS SURVEY IS BASED UPON GEODETIC CONTROL C 749 WITH AN ADJUSTED ELEVATION 482.61, NAVD 88 DATUM, UNITS IN U.S. FEET AND IN ACCORDANCE WITH FGCS THIRD ORDER CLASS II REQUIREMENTS.

A TRIMBLE S6-SERIES ROBOTIC INSTRUMENT WAS USED TO COMPLETE A CLOSED LOOP FIELD TRAVERSE.

FIELD WORK WAS PERFORMED ON JUNE 20-22 AND JUNE 26-29, 2014.

LEGEND:

Some Symbols shown may not be used on map

- DECIDUOUS TREE
- EVERGREEN TREE
- CONTROL MARKER
- FENCELINE
- STORM PIPE

GRAPHIC SCALE

40 0 20 40 80

(IN FEET)
1 inch = 40 ft.

SIGNED ON: 7-9-2014

REGISTERED
PROFESSIONAL
LAND SURVEYOR

OREGON
NOVEMBER 30, 2007
JAMES BURTON BROWN
60379

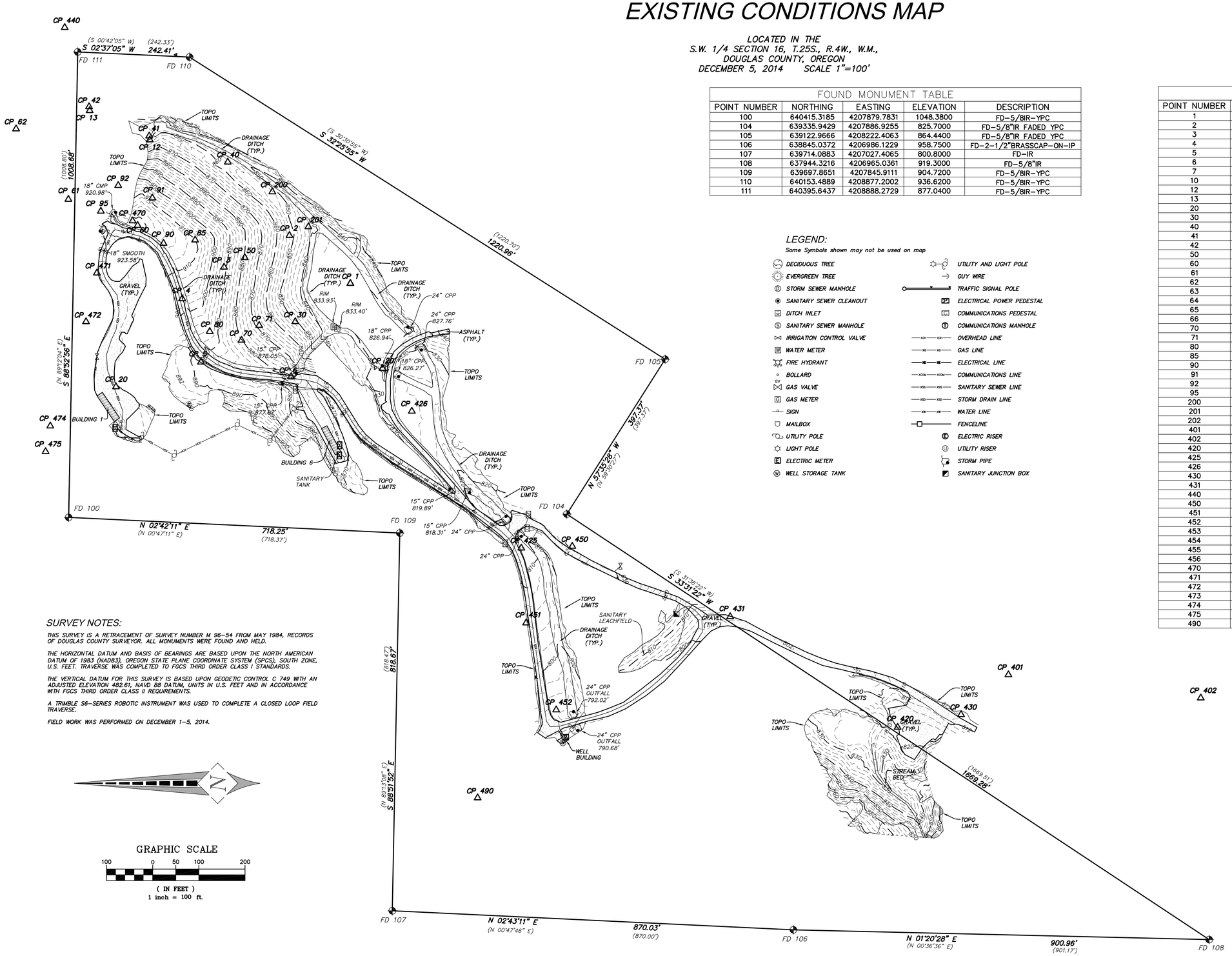
VALID THROUGH DECEMBER 31, 2015

CENTERLINE CONCEPTS
LAND SURVEYING, INC.
729 MOLALLA AVE., SUITE 1 & 2
OREGON CITY, OREGON 97045
PHONE 503.650.0188 FAX 503.650.0189

Plotted: M:\PROJECTS\E & E INC-BONANZA MINE\dwg\ECM.dwg

EXISTING CONDITIONS MAP

LOCATED IN THE
S.W. 1/4 SECTION 16, T.25S., R.4W., W.M.,
DOUGLAS COUNTY, OREGON
DECEMBER 5, 2014 SCALE 1"=100'



FOUND MONUMENT TABLE

POINT NUMBER	NORTHING	EASTING	ELEVATION	DESCRIPTION
100	640415.3185	4207879.7831	1048.3800	FD-5/8IR-YPC
104	639335.9429	4207886.9255	825.7000	FD-5/8"IR FADED YPC
105	639122.9666	4208222.4063	864.4400	FD-5/8"IR FADED YPC
106	638845.0372	4206986.1229	958.7500	FD-2-1/2"BRASSCAP-ON-IP
107	639714.0883	4207027.4065	800.8000	FD-IR
108	637944.3216	4206965.0361	919.3000	FD-5/8"IR
109	639697.8651	4207845.9111	904.7200	FD-5/8IR-YPC
110	640153.4889	4208877.2002	936.6200	FD-5/8IR-YPC
111	640395.6437	4208888.2729	877.0400	FD-5/8IR-YPC

LEGEND:

Some Symbols shown may not be used on map

- DECIDUOUS TREE
- EVERGREEN TREE
- STORM SEWER MANHOLE
- SANITARY SEWER CLEANOUT
- DITCH INLET
- SANITARY SEWER MANHOLE
- IRRIGATION CONTROL VALVE
- WATER METER
- FIRE HYDRANT
- BOLLARD
- GAS VALVE
- GAS METER
- SIGN
- MAILBOX
- UTILITY POLE
- LIGHT POLE
- ELECTRIC METER
- WELL STORAGE TANK
- UTILITY AND LIGHT POLE
- GUY WIRE
- TRAFFIC SIGNAL POLE
- ELECTRICAL POWER PEDESTAL
- COMMUNICATIONS PEDESTAL
- COMMUNICATIONS MANHOLE
- OVERHEAD LINE
- GAS LINE
- ELECTRICAL LINE
- COMMUNICATIONS LINE
- SANITARY SEWER LINE
- STORM DRAIN LINE
- WATER LINE
- FENCELINE
- ELECTRIC RISER
- UTILITY RISER
- STORM PIPE
- SANITARY JUNCTION BOX

CONTROL POINT TABLE

POINT NUMBER	NORTHING	EASTING	ELEVATION	DESCRIPTION
1	639805.1809	4208387.7852	837.1500	CP-YPC
2	639937.0558	4208491.8029	844.5314	CP-YPC
3	640078.8520	4208423.0523	877.3261	CP-YPC
4	640169.6038	4208354.6196	903.7346	CP-YPC
5	640128.9028	4208217.2776	889.7945	CP-YPC
6	639933.8574	4208185.4972	876.9675	CP-YPC
7	639805.1809	4208387.7852	837.1500	CP-YPC
10	639933.8774	4208185.4829	876.9725	CP-YPC
12	640239.6960	4208698.8600	859.0980	CP-YPC
13	640369.9650	4208762.3220	865.3280	CP-YPC
20	639735.3875	4208203.7364	832.3762	CP-YPC
30	639924.4837	4208304.9828	843.8468	CP-YPC
40	640070.7629	4208650.5910	853.7070	CP-YPC
41	640240.9762	4208707.2779	859.0970	CP-YPC
42	640371.2462	4208770.7398	865.3310	CP-YPC
50	640034.0024	4208443.7497	859.7818	CP-YPC
60	640266.0503	4208513.5059	921.7987	CP-YPC
61	640416.0421	4208569.9992	939.9411	CP-YPC
62	640529.4259	4208722.6104	940.0909	CP-YPC
63	640694.1780	4208798.8988	940.6696	CP-YPC
64	641254.6098	4208863.5978	943.1985	CP-YPC
65	642297.4640	4208719.5560	1049.1415	CP-YPC
66	642516.5733	4208841.4804	1060.0067	CP-YPC
70	640040.8959	4208264.7288	883.1091	CP-YPC
71	640002.7390	4208296.8016	878.3804	CP-YPC
80	640109.8893	4208283.6253	884.3486	CP-YPC
85	640141.4900	4208481.8960	907.9390	CP-SPIKE
90	640210.0019	4208474.7242	917.7464	CP-YPC
91	640234.1821	4208572.9425	909.1940	CP-YPC
92	640308.1115	4208600.0494	907.3665	CP-YPC
95	640345.7592	4208544.2781	927.0864	CP-YPC
200	639974.2140	4208586.1940	848.0130	CP-SPIKE
201	639896.0540	4208510.5520	843.6950	CP-SPIKE
202	639896.0540	4208510.5560	843.7150	CP-SPIKE
401	638379.4620	4207539.8387	807.3000	CP-SPIKE
402	637962.7089	4207489.5776	816.6100	CP-SPIKE
420	638619.4200	4207426.1323	818.1300	CP-SPIKE
425	639434.7166	4207814.4224	812.3700	CP-SPIKE
426	639671.9487	4208110.9037	825.9900	CP-SPIKE
430	638481.9920	4207453.5028	811.9800	CP-MN
431	638982.2887	4207665.7618	802.1600	CP-SPIKE
440	640423.9933	4208942.3097	901.4900	CP-SPIKE
450	639324.4077	4207818.2317	822.5600	CP-SPIKE
451	639424.2199	4207652.1928	806.6000	CP-SPIKE
452	639359.2524	4207463.8045	794.8800	CP-SPIKE
453	639301.4555	4206685.9277	1098.7700	CP-SPIKE
454	639032.4491	4206815.7553	1055.9400	CP-SPIKE
455	638282.4915	4206595.9378	1039.6300	CP-SPIKE
456	638023.8794	4206866.8487	955.1900	CP-SPIKE
470	640277.0035	4208523.3429	921.6800	CP-SPIKE
471	640354.3513	4208410.2799	937.3500	CP-SPIKE
472	640377.8611	4208304.8985	949.7800	CP-SPIKE
473	640312.9904	4208163.8071	937.3700	CP-SPIKE
474	640455.3095	4208078.9433	978.9300	CP-SPIKE
475	640465.4967	4208023.4439	983.3400	CP-SPIKE
490	639529.4019	4207273.1961	789.5600	CP-SPIKE

SURVEY NOTES:

THIS SURVEY IS A RETRACEMENT OF SURVEY NUMBER M 96-54 FROM MAY 1984, RECORDS OF DOUGLAS COUNTY SURVEYOR. ALL MONUMENTS WERE FOUND AND HELD.

THE HORIZONTAL DATUM AND BASIS OF BEARINGS ARE BASED UPON THE NORTH AMERICAN DATUM OF 1983 (NAD83), OREGON STATE PLANE COORDINATE SYSTEM (SPCS), SOUTH ZONE, U.S. FEET. TRAVERSE WAS COMPLETED TO FGCS THIRD ORDER CLASS I STANDARDS.

THE VERTICAL DATUM FOR THIS SURVEY IS BASED UPON GEODETIC CONTROL C 749 WITH AN ADJUSTED ELEVATION 482.61, NAVD 88 DATUM, UNITS IN U.S. FEET AND IN ACCORDANCE WITH FGCS THIRD ORDER CLASS II REQUIREMENTS.

A TRIMBLE S6-SERIES ROBOTIC INSTRUMENT WAS USED TO COMPLETE A CLOSED LOOP FIELD TRAVERSE.

FIELD WORK WAS PERFORMED ON DECEMBER 1-5, 2014.

GRAPHIC SCALE

100 0 50 100 200

(IN FEET)

1 inch = 100 ft.

SIGNED ON: _____

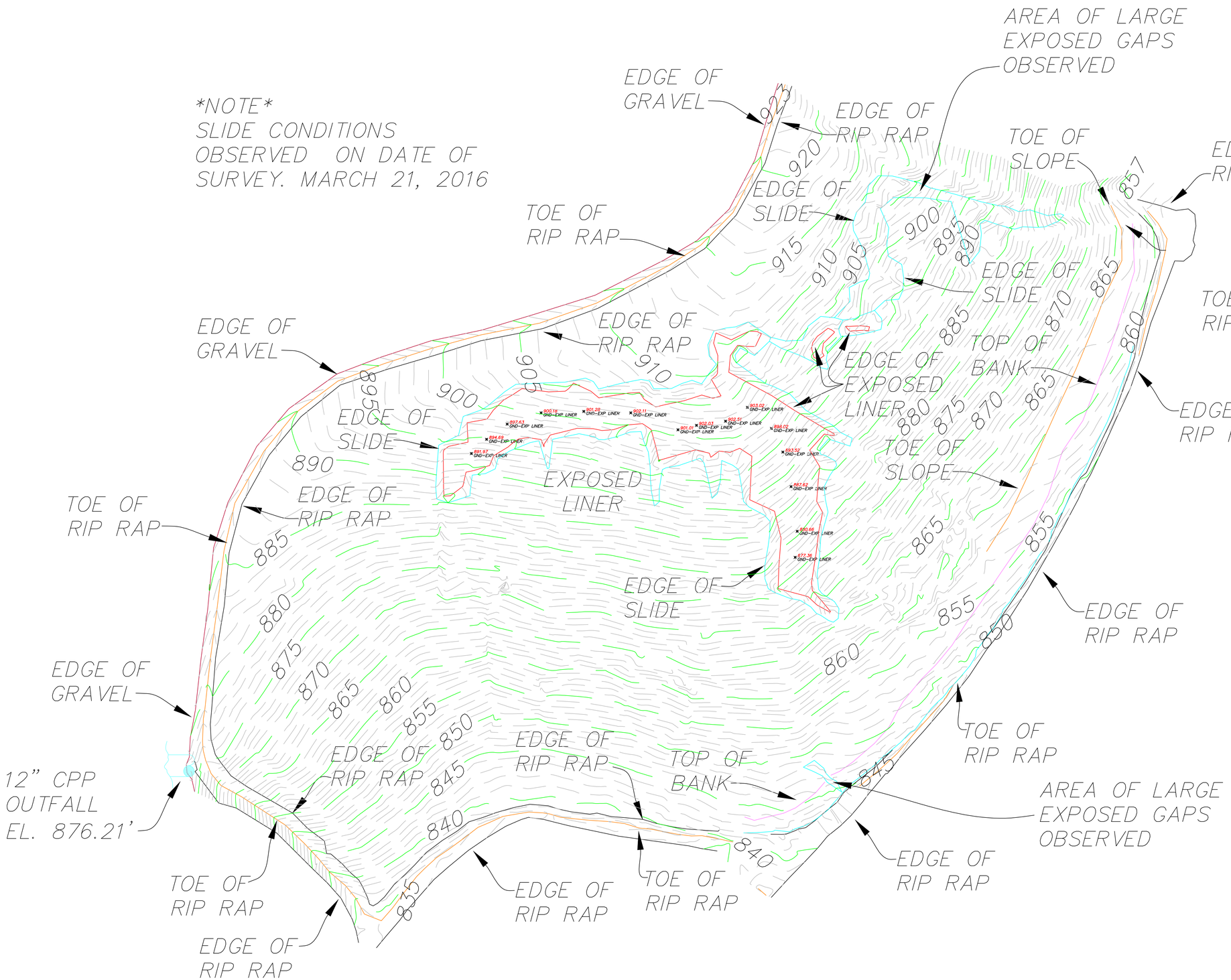
REGISTERED PROFESSIONAL LAND SURVEYOR

OREGON
NOVEMBER 20, 2007
JAMES BURTON BROWN
60379

VALID THROUGH DECEMBER 31, 2015

CENTERLINE CONCEPTS
LAND SURVEYING, INC.
729 MOLALLA AVE., SUITE 1 & 2
OREGON CITY, OREGON 97045
PHONE 503.650.0188 FAX 503.650.0189

Plotted:M: \PROJECTS\E & E INC-BONANZA MINE\dwg\12-5-2014 ASBUILT.dwg


NOTE
SLIDE CONDITIONS OBSERVED ON DATE OF SURVEY. MARCH 21, 2016
EDGE OF GRAVEL
EDGE OF RIP RAP
AREA OF LARGE EXPOSED GAPS OBSERVED
TOE OF SLOPE
EDGE OF RIP RAP
TOE OF RIP RAP
EDGE OF SLIDE
EDGE OF SLIDE
TOE OF RIP RAP
EDGE OF GRAVEL
EDGE OF RIP RAP
EDGE OF EXPOSED LINER
TOP OF BANK
EDGE OF RIP RAP
EDGE OF SLIDE
EXPOSED LINER
TOE OF SLOPE
TOE OF RIP RAP
EDGE OF RIP RAP
EDGE OF SLIDE
EDGE OF RIP RAP
EDGE OF GRAVEL
12" CPP OUTFALL EL. 876.21'
EDGE OF RIP RAP
EDGE OF RIP RAP
TOP OF BANK
TOE OF RIP RAP
AREA OF LARGE EXPOSED GAPS OBSERVED
TOE OF RIP RAP
EDGE OF RIP RAP
TOE OF RIP RAP
EDGE OF RIP RAP

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E Veneer Stability Calculations

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Limit Equilibrium Forces involved in a Finite Length Slope Analysis for a Uniformly Thick Cover Soil

Bonanza Mine Site
2014 Design Parameters

Slope Inputs

γ =	17.70	kN/m3	Unit weight of the cover soil
h =	0.31	m	Thickness of the cover soil
L =	76	m	Length of slope measured along the geomembrane
B =	18.4	degrees	Soil slope angle beneath the geomembrane
Φ =	30	degrees	Friction angle of the cover soil
c_a =	0	kN/m2	Adhesion between the cover soil and the geomembrane
δ =	41.5	degrees	Interface friction angle between cover soil and geomembrane
c =	0	kN/m2	cohesion of the cover soil

Total weight of the active wedge

$W_A = \gamma * h^2 * (L/h - 1/\sin\mathrm{B} - \tan(\mathrm{B}/2))$ = 413

Effective force normal to the failure plane of the active wedge

$N_A = W_A * \cos\mathrm{B}$ = 391

Adhesive force between the cover soil of the active wedge and the geomembrane

$C_A = c_a * (L - h/\sin\mathrm{B})$ = 0

Total weight of the passive wedge

$W_P = \gamma * h^2 / \sin(2*\mathrm{B})$ = 2.8

Cohesive force along the failure plane and the passive wedge

$C_P = c * h / \sin\mathrm{B}$ = 0

Quadratic Equation to solve for FS

$a_q(FS)^2 + b_q(FS) + c_q = 0$

$a_q = (W_A - N_A*\cos\mathrm{B}) * \cos\mathrm{B}$ = 39

$b_q = -[(W_A - N_A*\cos B)*\sin\mathrm{B}*\tan\Phi + (N_A*\tan\delta + C_A*\sin\mathrm{B}*\cos\mathrm{B} + \sin\mathrm{B}*(C_P + W_P*\tan\Phi)]$

= -112

$c_q = (N_A * \tan\delta + C_A) * \sin^2\mathrm{B}*\tan\Phi$ = 20

Factor of safety against cover soil sliding on the geomembrane

$FS = (-b_q + \mathrm{sqrt}(b_q\text{^}2 - 4 * a_q * c_q)) / 2 * a_q$ = **2.67**

Limit Equilibrium Forces involved in a Finite Length Slope Analysis for a Uniformly Thick Cover Soil

Bonanza Mine Site
2016 Sample Parameters for Repository Top

Slope Inputs

γ =	17.58	kN/m3	Unit weight of the cover soil
h =	0.08	m	Thickness of the cover soil
L =	75	m	Length of slope measured along the geomembrane
B =	18.4	degrees	Soil slope angle beneath the geomembrane
Φ =	41.2	degrees	Friction angle of the cover soil
c_a =	0.430922	kN/m2	Adhesion between the cover soil and the geomembrane
δ =	42.7	degrees	Interface friction angle between cover soil and geomembrane
c =	0.009576	kN/m2	cohesion of the cover soil

Total weight of the active wedge

$W_A = \gamma * h^2 * (L/h - 1/\sin\mathrm{B} - \tan(\mathrm{B}/2))$ = 100

Effective force normal to the failure plane of the active wedge

$N_A = W_A * \cos\mathrm{B}$ = 95

Adhesive force between the cover soil of the active wedge and the geomembrane

$C_A = c_a * (L - h/\sin\mathrm{B})$ = 32.075528

Total weight of the passive wedge

$W_P = \gamma * h^2 / \sin(2*\mathrm{B})$ = 0.2

Cohesive force along the failure plane and the passive wedge

$C_P = c * h / \sin\mathrm{B}$ = 0.0023117

Quadratic Equation to solve for FS

$a_q(FS)^2 + b_q(FS) + c_q = 0$

$a_q = (W_A - N_A*\cos\mathrm{B}) * \cos\mathrm{B}$ = 9

$b_q = -[(W_A - N_A*\cos B)*\sin\mathrm{B}*\tan\Phi + (N_A*\tan\delta + C_A*\sin\mathrm{B}*\cos\mathrm{B} + \sin\mathrm{B}*(C_P + W_P*\tan\Phi)]$

= -39

$c_q = (N_A * \tan\delta + C_A) * \sin^2\mathrm{B}*\tan\Phi$ = 8

Factor of safety against cover soil sliding on the geomembrane

$FS = (-b_q + \mathrm{sqrt}(b_q\text{^}2 - 4 * a_q * c_q)) / 2 * a_q$ = **3.88**

Limit Equilibrium Forces involved in a Finite Length Slope Analysis for a Uniformly Thick Cover Soil

Bonanza Mine Site
2016 Sample Parameters for Repository Bottom

Slope Inputs

γ =	16.78	kN/m3	Unit weight of the cover soil
h =	0.61	m	Thickness of the cover soil
L =	75	m	Length of slope measured along the geomembrane
B =	18.4	degrees	Soil slope angle beneath the geomembrane
Φ =	38.1	degrees	Friction angle of the cover soil
c_a =	0.430922	kN/m2	Adhesion between the cover soil and the geomembrane
δ =	42.7	degrees	Interface friction angle between cover soil and geomembrane
c =	0.952817	kN/m2	cohesion of the cover soil

Total weight of the active wedge

$W_A = \gamma * h^2 * (L/h - 1/\sin\mathrm{B} - \tan(\mathrm{B}/2))$ = 743

Effective force normal to the failure plane of the active wedge

$N_A = W_A * \cos\mathrm{B}$ = 705

Adhesive force between the cover soil of the active wedge and the geomembrane

$C_A = c_a * (L - h/\sin\mathrm{B})$ = 31.347333

Total weight of the passive wedge

$W_P = \gamma * h^2 / \sin(2*\mathrm{B})$ = 10.4

Cohesive force along the failure plane and the passive wedge

$C_P = c * h / \sin\mathrm{B}$ = 1.8401366

Quadratic Equation to solve for FS

$a_q(FS)^2 + b_q(FS) + c_q = 0$

$a_q = (W_A - N_A*\cos\mathrm{B}) * \cos\mathrm{B}$ = 70

$b_q = -[(W_A - N_A*\cos B)*\sin\mathrm{B}*\tan\Phi + (N_A*\tan\delta + C_A*\sin\mathrm{B}*\cos\mathrm{B} + \sin\mathrm{B}*(C_P + W_P*\tan\Phi)]$

= -226

$c_q = (N_A * \tan\delta + C_A) * \sin^2\mathrm{B}*\tan\Phi$ = 51

Factor of safety against cover soil sliding on the geomembrane

$FS = (-b_q + \mathrm{sqrt}(b_q\text{^}2 - 4 * a_q * c_q)) / 2 * a_q$ = **2.97**

Limit Equilibrium Forces involved in a Finite Length Slope Analysis
for a Uniformly Thick Cover Soil with Parallel to Slope Seepage Buildup

Bonanza Mine Site
2014 Design Parameters

Slope Inputs

γ_{sat} =	19.76	kN/m3	Saturated unit weight of the cover soil
γ =	17.70	kN/m3	Unit weight of the cover soil (engineered condition)
γ_w =	9.80	kN/m3	Unit weight of water
h =	0.30	m	Thickness of the cover soil
L =	76	m	Length of slope measured along the geomembrane
β =	18.4	degrees	Soil slope angle beneath the geomembrane
ϕ =	30	degrees	Friction angle of the cover soil
δ =	41.5	degrees	Interface friction angle between cover soil and geomembrane

Vertical height of the slope measured from the toe

$H = L * \sin\beta$ = 24 m

Vertical height of the free water surface measured in the direction perpendicular to the slope

h_w = Set equal to h for worst case scenario = 0.3 m

Total weight of the active wedge

$W_A = \gamma*(h - h_w)*(2*H*\cos\beta - (h + h_w))/\sin(2*\beta) + \gamma_{sat}*h_w*(2*H*\cos\beta - h_w)/\sin(2*\beta)$

= 456 kN/m

Resultant of the pore pressures acting perpendicular to the slope

$U_n = (\gamma w * h_w * \cos\beta * (2 * H * \cos\beta - h_w))/\sin(2 * \beta)$

= 215 kN/m

Resultant of the pore pressures acting on the interwedge surfaces

$U_h = \gamma w * h_w^2 / 2$ = 0.5 kN/m

Effective force normal to the failure plane of the active wedge

$N_A = W_A * \cos\beta + U_h * \sin\beta - U_n$ = 218 kN/m

Total weight of the passive wedge

$W_P = (\gamma * (h^2 - h_w^2) + \gamma_{sat} * h_w^2)/ \sin(2*\beta)$ = 3.1 kN/m

Resultant of the vertical pore pressures acting on the passive wedge

$U_v = U_h * \cot\beta$ = 1.4 kN/m

Quadratic Equation to solve for FS

$a_q(FS)^2 + b_q(FS) + c_q = 0$

$a_q = W_A * \sin\beta * \cos\beta - U_h * \cos^2\beta + U_h$ = 137 kN/m

$b_q = -W_A * \sin^2\beta * \tan\phi + U_h * \sin\beta * \cos\beta * \tan\phi - N_A * \cos\beta * \tan\delta - (W_P - U_V) * \tan\phi$

= -210 kN/m

$c_q = N_A * \sin B * \tan\delta * \tan\phi$ = 35 kN/m

Factor of safety against cover soil sliding on the geomembrane

$FS = (-b_q + \sqrt{b_q^2 - 4 * a_q * c_q}) / 2 * a_q$ = **1.35**

Limit Equilibrium Forces involved in a Finite Length Slope Analysis
for a Uniformly Thick Cover Soil with Parallel to Slope Seepage Buildup

Bonanza Mine Site
2016 Sample Parameters for Repository Top

Slope Inputs

γ_{sat} =	19.37	kN/m3	Saturated unit weight of the cover soil
γ =	17.58	kN/m3	Unit weight of the cover soil (engineered condition)
γ_w =	9.80	kN/m3	Unit weight of water
h =	0.08	m	Thickness of the cover soil
L =	75	m	Length of slope measured along the geomembrane
β =	18.4	degrees	Soil slope angle beneath the geomembrane
Φ =	41.2	degrees	Friction angle of the cover soil
δ =	42.7	degrees	Interface friction angle between cover soil and geomembrane

Vertical height of the slope measured from the toe

$H = L * \sin\beta$ = 24 m

Vertical height of the free water surface measured in the direction perpendicular to the slope

h_w = Set equal to h for worst case scenario = 0.1 m

Total weight of the active wedge

$W_A = \gamma*(h - h_w)*(2*H*\cos\beta - (h + h_w))/\sin(2*\beta) + \gamma_{sat}*h_w*(2*H*\cos\beta - h_w)/\sin(2*\beta)$

= 110 kN/m

Resultant of the pore pressures acting perpendicular to the slope

$U_n = (\gamma w * h_w * \cos\beta * (2 * H * \cos\beta - h_w))/\sin(2 * \beta)$

= 53 kN/m

Resultant of the pore pressures acting on the interwedge surfaces

$U_h = \gamma w * h_w^2 / 2$ = 0.0 kN/m

Effective force normal to the failure plane of the active wedge

$N_A = W_A * \cos\beta + U_h * \sin\beta - U_n$ = 52 kN/m

Total weight of the passive wedge

$W_P = (\gamma * (h^2 - h_w^2) + \gamma_{sat} * h_w^2)/ \sin(2*\beta)$ = 0.2 kN/m

Resultant of the vertical pore pressures acting on the passive wedge

$U_v = U_h * \cot\beta$ = 0.1 kN/m

Quadratic Equation to solve for FS

$a_q(FS)^2 + b_q(FS) + c_q = 0$

$a_q = W_A * \sin\beta * \cos\beta - U_h * \cos^2\beta + U_h$ = 33 kN/m

$b_q = -W_A * \sin^2\beta * \tan\Phi + U_h * \sin\beta * \cos\beta * \tan\Phi - N_A * \cos\beta * \tan\delta - (W_P - U_V) * \tan\Phi$

= -55 kN/m

$c_q = N_A * \sin B * \tan\delta * \tan\Phi$ = 13 kN/m

Factor of safety against cover soil sliding on the geomembrane

$FS = (-b_q + \sqrt{b_q^2 - 4 * a_q * c_q}) / 2 * a_q$ = **1.37**

Limit Equilibrium Forces involved in a Finite Length Slope Analysis
for a Uniformly Thick Cover Soil with Parallel to Slope Seepage Buildup

Bonanza Mine Site
2016 Sample Parameters for Repository Bottom

Slope Inputs

γ_{sat} =	19.37	kN/m3	Saturated unit weight of the cover soil
γ =	16.78	kN/m3	Unit weight of the cover soil (engineered condition)
γ_w =	9.80	kN/m3	Unit weight of water
h =	0.61	m	Thickness of the cover soil
L =	75	m	Length of slope measured along the geomembrane
β =	18.4	degrees	Soil slope angle beneath the geomembrane
ϕ =	38.1	degrees	Friction angle of the cover soil
δ =	42.7	degrees	Interface friction angle between cover soil and geomembrane

Vertical height of the slope measured from the toe

$H = L * \sin\beta$ = 24 m

Vertical height of the free water surface measured in the direction perpendicular to the slope

h_w = Set equal to h for worst case scenario = 0.6 m

Total weight of the active wedge

$W_A = \gamma*(h - h_w)*(2*H*\cos\beta - (h + h_w))/\sin(2*\beta) + \gamma_{sat}*h_w*(2*H*\cos\beta - h_w)/\sin(2*\beta)$

= 870 kN/m

Resultant of the pore pressures acting perpendicular to the slope

$U_n = (\gamma w * h_w * \cos\beta * (2 * H * \cos\beta - h_w))/\sin(2 * \beta)$

= 418 kN/m

Resultant of the pore pressures acting on the interwedge surfaces

$U_h = \gamma w * h_w^2 / 2$ = 1.8 kN/m

Effective force normal to the failure plane of the active wedge

$N_A = W_A * \cos\beta + U_h * \sin\beta - U_n$ = 408 kN/m

Total weight of the passive wedge

$W_P = (\gamma * (h^2 - h_w^2) + \gamma_{sat} * h_w^2)/ \sin(2*\beta)$ = 12.0 kN/m

Resultant of the vertical pore pressures acting on the passive wedge

$U_v = U_h * \cot\beta$ = 5.5 kN/m

Quadratic Equation to solve for FS

$a_q(FS)^2 + b_q(FS) + c_q = 0$

$a_q = W_A * \sin\beta * \cos\beta - U_h * \cos^2\beta + U_h$ = 261 kN/m

$b_q = -W_A * \sin^2\beta * \tan\phi + U_h * \sin\beta * \cos\beta * \tan\phi - N_A * \cos\beta * \tan\delta - (W_P - U_V) * \tan\phi$

= -430 kN/m

$c_q = N_A * \sin B * \tan\delta * \tan\phi$ = 93 kN/m

Factor of safety against cover soil sliding on the geomembrane

$FS = (-b_q + \sqrt{b_q^2 - 4 * a_q * c_q}) / 2 * a_q$ = **1.39**

Limit Equilibrium Forces involved in a Finite Length Slope Analysis
for Geomembrane Interface beneath a Uniformly Thick Cover Soil

Bonanza Mine Site
2014 Design Parameters

Slope Inputs

γ =	17.70	kN/m3	112.7	pcf	Unit weight of the cover soil
h =	0.31	m	1	ft	Thickness of the cover soil
L =	76	m	250	ft	Length of slope measured along the geomembrane
β =	18.4	degrees	18.4		Soil slope angle beneath the geomembrane
ϕ =	30	degrees	30		Friction angle of the cover soil
c_a =	0.67	kN/m2	14	psf	Adhesion between geomembranes
δ =	16.2	degrees	16.2		Interface friction angle between geomembranes
c =	0	kN/m2	0	psf	cohesion of the cover soil

Total weight of the active wedge

$W_A = \gamma * h^2 * (L/h - 1/\sin\beta - \tan(\beta/2))$ = 413

Effective force normal to the failure plane of the active wedge

$N_A = W_A * \cos\beta$ = 391

Adhesive force between the cover soil of the active wedge and the geomembrane

$C_A = c_a * (L - h/\sin\beta)$ = 50.420333

Total weight of the passive wedge

$W_P = \gamma * h^2 / \sin(2*\beta)$ = 2.8

Cohesive force along the failure plane and the passive wedge

$C_P = c * h / \sin\beta$ = 0

Quadratic Equation to solve for FS

$$a_q(FS)^2 + b_q(FS) + c_q = 0$$

$a_q = (W_A - N_A*\cos\beta) * \cos\beta$ = 39

$b_q = -[(W_A - N_A*\cos\beta)*\sin\beta*\tan\phi + (N_A*\tan\delta + C_A*\sin\beta*\cos\beta + \sin\beta*(C_P + W_P*\tan\phi)]$

= -57

$c_q = (N_A * \tan\delta + C_A) * \sin^2\beta*\tan\phi$ = 7

Factor of safety against cover soil sliding on the geomembrane

$FS = (-b_q + \text{sqrt}(b_q\text{^}2 - 4 * a_q * c_q)) / 2 * a_q$ = **1.34**

Limit Equilibrium Forces involved in a Finite Length Slope Analysis
for Geomembrane Interface beneath a Uniformly Thick Cover Soil

Bonanza Mine Site
2016 Sample Parameters for Repository Top

Slope Inputs

γ =	17.58	kN/m3	111.9	pcf	Unit weight of the cover soil
h =	0.08	m	0.25	ft	Thickness of the cover soil
L =	75	m	245	ft	Length of slope measured along the geomembrane
B =	18.4	degrees	18.4		Soil slope angle beneath the geomembrane
Φ =	41.2	degrees	41.2		Friction angle of the cover soil
c_a =	0.67	kN/m2	14	psf	Adhesion between geomembranes
δ =	16.2	degrees	16.2		Interface friction angle between geomembranes
c =	0.01	kN/m2	0.2	psf	cohesion of the cover soil

Total weight of the active wedge

$W_A = \gamma * h^2 * (L/h - 1/\sin\mathrm{B} - \tan(\mathrm{B}/2))$ = 100

Effective force normal to the failure plane of the active wedge

$N_A = W_A * \cos\mathrm{B}$ = 95

Adhesive force between the cover soil of the active wedge and the geomembrane

$C_A = c_a * (L - h/\sin\mathrm{B})$ = 49.895266

Total weight of the passive wedge

$W_P = \gamma * h^2 / \sin(2*\mathrm{B})$ = 0.2

Cohesive force along the failure plane and the passive wedge

$C_P = c * h / \sin\mathrm{B}$ = 0.0023117

Quadratic Equation to solve for FS

$$a_q(FS)^2 + b_q(FS) + c_q = 0$$

$a_q = (W_A - N_A*\cos\mathrm{B}) * \cos\mathrm{B}$ = 9

$b_q = -[(W_A - N_A*\cos B)*\sin\mathrm{B}*\tan\Phi + (N_A*\tan\delta + C_A*\sin\mathrm{B}*\cos\mathrm{B} + \sin\mathrm{B}*(C_P + W_P*\tan\Phi)]$

= -26

$c_q = (N_A * \tan\delta + C_A) * \sin^2\mathrm{B}*\tan\Phi$ = 2

Factor of safety against cover soil sliding on the geomembrane

$FS = (-b_q + \mathrm{sqrt}(b_q\text{^}2 - 4 * a_q * c_q)) / 2 * a_q$ = **2.66**

Limit Equilibrium Forces involved in a Finite Length Slope Analysis
for Geomembrane Interface beneath a Uniformly Thick Cover Soil

Bonanza Mine Site
2016 Sample Parameters for Repository Bottom

Slope Inputs

γ =	16.78	kN/m3	106.8	pcf	Unit weight of the cover soil
h =	0.61	m	2	ft	Thickness of the cover soil
L =	75	m	245	ft	Length of slope measured along the geomembrane
β =	18.4	degrees	18.4		Soil slope angle beneath the geomembrane
ϕ =	38.1	degrees	38.1		Friction angle of the cover soil
c_a =	0.67	kN/m2	14	psf	Adhesion between geomembranes
δ =	16.2	degrees	16.2		Interface friction angle between geomembranes
c =	0.9528	kN/m2	19.9	psf	cohesion of the cover soil

Total weight of the active wedge

$W_A = \gamma * h^2 * (L/h - 1/\sin\beta - \tan(\beta/2)) = 743$

Effective force normal to the failure plane of the active wedge

$N_A = W_A * \cos\beta = 705$

Adhesive force between the cover soil of the active wedge and the geomembrane

$C_A = c_a * (L - h/\sin\beta) = 48.762518$

Total weight of the passive wedge

$W_P = \gamma * h^2 / \sin(2*\beta) = 10.4$

Cohesive force along the failure plane and the passive wedge

$C_P = c * h / \sin\beta = 1.8401366$

Quadratic Equation to solve for FS

$a_q(FS)^2 + b_q(FS) + c_q = 0$

$a_q = (W_A - N_A*\cos\beta) * \cos\beta = 70$

$b_q = -[(W_A - N_A*\cos\beta)*\sin\beta*\tan\phi + (N_A*\tan\delta + C_A*\sin\beta*\cos\beta + \sin\beta*(C_P + W_P*\tan\phi)] = -97$

$c_q = (N_A * \tan\delta + C_A) * \sin^2\beta*\tan\phi = 16$

Factor of safety against cover soil sliding on the geomembrane

$FS = (-b_q + \text{sqrt}(b_q\text{^}2 - 4 * a_q * c_q)) / 2 * a_q = 1.20$

Limit Equilibrium Forces involved in a Finite Length Slope Analysis
for Geomembrane Interface beneath a Uniformly Thick Saturated Cover Soil

Bonanza Mine Site
2014 Design Parameters

Slope Inputs

γ =	19.76	kN/m3	125.8	pcf	Unit weight of the cover soil
h =	0.31	m	1	ft	Thickness of the cover soil
L =	76	m	250	ft	Length of slope measured along the geomembrane
β =	18.4	degrees	18.4	degrees	Soil slope angle beneath the geomembrane
ϕ =	30	degrees	30	degrees	Friction angle of the cover soil
c_a =	0.67	kN/m2	14	psf	Adhesion between geomembranes
δ =	16.2	degrees	16.2	degrees	Interface friction angle between geomembranes
c =	0	kN/m2	0	psf	cohesion of the cover soil

Total weight of the active wedge

$W_A = \gamma * h^2 * (L/h - 1/\sin\beta - \tan(\beta/2))$ = 460

Effective force normal to the failure plane of the active wedge

$N_A = W_A * \cos\beta$ = 437

Adhesive force between the cover soil of the active wedge and the geomembrane

$C_A = c_a * (L - h/\sin\beta)$ = 50.420333

Total weight of the passive wedge

$W_P = \gamma * h^2 / \sin(2*\beta)$ = 3.2

Cohesive force along the failure plane and the passive wedge

$C_P = c * h / \sin\beta$ = 0

Quadratic Equation to solve for FS

$$a_q(FS)^2 + b_q(FS) + c_q = 0$$

$a_q = (W_A - N_A*\cos\beta) * \cos\beta$ = 44

$b_q = -[(W_A - N_A*\cos\beta)*\sin\beta*\tan\phi + (N_A*\tan\delta + C_A*\sin\beta*\cos\beta + \sin\beta*(C_P + W_P*\tan\phi)]$

= -62

$c_q = (N_A * \tan\delta + C_A) * \sin^2\beta*\tan\phi$ = 7

Factor of safety against cover soil sliding on the geomembrane

FS = $(-b_q + \text{sqrt}(b_q\text{^}2 - 4 * a_q * c_q)) / 2 * a_q$ = **1.30**

Limit Equilibrium Forces involved in a Finite Length Slope Analysis
for Geomembrane Interface beneath a Uniformly Thick Saturated Cover Soil

Bonanza Mine Site
2016 Sample Parameters for Repository Top

Slope Inputs

γ =	19.37	kN/m3	123.3	pcf	Unit weight of the cover soil
h =	0.08	m	0.25	ft	Thickness of the cover soil
L =	75	m	245	ft	Length of slope measured along the geomembrane
β =	18.4	degrees	18.4		Soil slope angle beneath the geomembrane
ϕ =	41.2	degrees	41.2		Friction angle of the cover soil
c_a =	0.67	kN/m2	14	psf	Adhesion between geomembranes
δ =	16.2	degrees	16.2		Interface friction angle between geomembranes
c =	0	kN/m2	0	psf	cohesion of the cover soil

Total weight of the active wedge

$W_A = \gamma * h^2 * (L/h - 1/\sin\beta - \tan(\beta/2))$ = 110

Effective force normal to the failure plane of the active wedge

$N_A = W_A * \cos\beta$ = 104

Adhesive force between the cover soil of the active wedge and the geomembrane

$C_A = c_a * (L - h/\sin\beta)$ = 49.895266

Total weight of the passive wedge

$W_P = \gamma * h^2 / \sin(2*\beta)$ = 0.2

Cohesive force along the failure plane and the passive wedge

$C_P = c * h / \sin\beta$ = 0

Quadratic Equation to solve for FS

$$a_q(FS)^2 + b_q(FS) + c_q = 0$$

$a_q = (W_A - N_A*\cos\beta) * \cos\beta$ = 10

$b_q = -[(W_A - N_A*\cos\beta)*\sin\beta*\tan\phi + (N_A*\tan\delta + C_A*\sin\beta*\cos\beta + \sin\beta*(C_P + W_P*\tan\phi)]$

= -27

$c_q = (N_A * \tan\delta + C_A) * \sin^2\beta*\tan\phi$ = 3

Factor of safety against cover soil sliding on the geomembrane

$FS = (-b_q + \text{sqrt}(b_q\text{^}2 - 4 * a_q * c_q)) / 2 * a_q$ = **2.50**

Limit Equilibrium Forces involved in a Finite Length Slope Analysis
for Geomembrane Interface beneath a Uniformly Thick Saturated Cover Soil

Bonanza Mine Site
2016 Sample Parameters for Repository Bottom

Slope Inputs

γ =	19.37	kN/m3	123.3	pcf	Unit weight of the cover soil
h =	0.61	m	2	ft	Thickness of the cover soil
L =	75	m	245	ft	Length of slope measured along the geomembrane
B =	18.4	degrees	18.4	degrees	Soil slope angle beneath the geomembrane
Φ =	38.1	degrees	38.1	degrees	Friction angle of the cover soil
c_a =	0.67	kN/m2	14	psf	Adhesion between geomembranes
δ =	16.2	degrees	16.2	degrees	Interface friction angle between geomembranes
c =	0	kN/m2	0	psf	cohesion of the cover soil

Total weight of the active wedge

$W_A = \gamma * h^2 * (L/h - 1/\sin\mathrm{B} - \tan(\mathrm{B}/2))$ = 858

Effective force normal to the failure plane of the active wedge

$N_A = W_A * \cos\mathrm{B}$ = 814

Adhesive force between the cover soil of the active wedge and the geomembrane

$C_A = c_a * (L - h/\sin\mathrm{B})$ = 48.762518

Total weight of the passive wedge

$W_P = \gamma * h^2 / \sin(2*\mathrm{B})$ = 12.0

Cohesive force along the failure plane and the passive wedge

$C_P = c * h / \sin\mathrm{B}$ = 0

Quadratic Equation to solve for FS

$a_q(FS)^2 + b_q(FS) + c_q = 0$

$a_q = (W_A - N_A*\cos\mathrm{B}) * \cos\mathrm{B}$ = 81

$b_q = -[(W_A - N_A*\cos B)*\sin\mathrm{B}*\tan\Phi + (N_A*\tan\delta + C_A*\sin\mathrm{B}*\cos\mathrm{B} + \sin\mathrm{B}*(C_P + W_P*\tan\Phi)]$

= -110

$c_q = (N_A * \tan\delta + C_A) * \sin^2\mathrm{B}*\tan\Phi$ = 19

Factor of safety against cover soil sliding on the geomembrane

$FS = (-b_q + \mathrm{sqrt}(b_q\text{^}2 - 4 * a_q * c_q)) / 2 * a_q$ = **1.15**

F

Drainage Layer Calculations

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Design Assumption Cover Soils Compacted silty or clayey fine sands at 1E-5 cm/s permeability

Maximum Critical Slope Angle

The slope angle at which the cover system will remain stable against a veneer sliding failure even under non-freely-draining subsurface conditions (i.e., without the buildup of seepage forces). Additional subsurface drainage is not required for veneer stability of slopes less than the critical slope angle.

$FS_{CS} = 0.5 * (\tan \delta / \tan \beta)$

FS_{CS} =	1.5		factor of safety for critical slope angle
δ =	16.2	degrees	interface friction angle
β =	**5.5**	**degrees**	critical slope angle

To avoid pore pressure buildup between the geosynthetics a free-draining layer must be installed on any slope steeper than 5.5 degrees (1:18).

Total Serviceability Factor

The long-term capacity of the geocomposite drainage layer is likely less than the capacity of the laboratory test results. This reduction is expressed through the Total Serviceability Factor.

$TSF = RF_{IN} * RF_{CR} * RF_{CC} * RF_{BC} * FS$, where

RFIN =	1.1	geotextile intrusion reduction factor
RFCR =	1.25	creep reduction in geonet core thickness reduction factor
RFCC =	1.1	chemical clogging reduction factor
RFBC =	1.35	biological clogging reduction factor
FS =	1.5	factor of safety
TSF =	**3.06**	Total Serviceability Factor

Minimum Required Transmissivity

The minimum required transmissivity is based on the longest and flattest slope with a gradient steeper than 5.5 degrees.

The longest and flattest slope is 250 feet long at 30 degrees.

$t_{down\ max} = TSF * q_h * L / k_{down} * \sin(\beta_{down})$ and $\theta = t_{down\ max} * k_{down}$

$t_{downmax}$ =	Unknown	m	thickness of geonet core in geocomposite
k_{down} =	Unknown	m/s	hydraulic conductivity of drainage layer

Since $t_{down\ max}$ and k_{down} are both unknowns, combine the two equations to form the one equation

$\theta = TSF * q_h * L / \sin(\beta_{down})$, where

TSF =	3.06		Total Serviceability Factor		
q_h =	1E-07	m/s	impingement rate, permeability of soil	0.00001	cm/s
L =	76	m	length of drainage layer	250	feet
β =	18.4	degrees	slope angle of drainage layer		
θ =	**7.39E-05**	**m^2/s**	minimum required transmissivity of drainage layer		

Borrow Source Cover Soils Non-compacted clayey sand at 1.6E-4 cm/s permeability

Maximum Critical Slope Angle

The slope angle at which the cover system will remain stable against a veneer sliding failure even under non-freely-draining subsurface conditions (i.e., without the buildup of seepage forces). Additional subsurface drainage is not required for veneer stability of slopes less than the critical slope angle.

$FS_{CS} = 0.5 * (\tan \delta / \tan \beta)$

FS_{CS} =	1.5		factor of safety for critical slope angle
δ =	16.2	degrees	interface friction angle
β =	**5.5**	**degrees**	critical slope angle

To avoid pore pressure buildup between the geosynthetics a free-draining layer must be installed on any slope steeper than 5.5 degrees (1:18).

Total Serviceability Factor

The long-term capacity of the geocomposite drainage layer is likely less than the capacity of the laboratory test results. This reduction is expressed through the Total Serviceability Factor.

$TSF = RF_{IN} * RF_{CR} * RF_{CC} * RF_{BC} * FS$, where

RFIN =	1.1	geotextile intrusion reduction factor
RFCR =	1.25	creep reduction in geonet core thickness reduction factor
RFCC =	1.1	chemical clogging reduction factor
RFBC =	1.35	biological clogging reduction factor
FS =	1.5	factor of safety
TSF =	**3.06**	Total Serviceability Factor

Minimum Required Transmissivity

The minimum required transmissivity is based on the longest and flattest slope with a gradient steeper than 5.5 degrees.

The longest and flattest slope is 245 feet long at 30 degrees.

$t_{down\ max} = TSF * q_h * L / k_{down} * \sin(\beta_{down})$ and $\theta = t_{down\ max} * k_{down}$

$t_{downmax}$ =	Unknown	m	thickness of geonet core in geocomposite
k_{down} =	Unknown	m/s	hydraulic conductivity of drainage layer

Since $t_{down\ max}$ and k_{down} are both unknowns, combine the two equations to form the one equation

$\theta = TSF * q_h * L / \sin(\beta_{down})$, where

TSF =	3.06		Total Serviceability Factor		
q_h =	1.6E-06	m/s	impingement rate, permeability of soil	0.00016	cm/s
L =	75	m	length of drainage layer	245	feet
β =	18.4	degrees	slope angle of drainage layer		
θ =	**0.001159**	**m^2/s**	minimum required transmissivity of drainage layer		

Repository Top Cover Soils Compacted sandy clay at 1.8E-4 cm/s permeability

Maximum Critical Slope Angle

The slope angle at which the cover system will remain stable against a veneer sliding failure even under non-freely-draining subsurface conditions (i.e., without the buildup of seepage forces). Additional subsurface drainage is not required for veneer stability of slopes less than the critical slope angle.

$FS_{CS} = 0.5 * (\tan \delta / \tan \beta)$

FS_{CS} =	1.5		factor of safety for critical slope angle
δ =	16.2	degrees	interface friction angle
β =	**5.5**	**degrees**	critical slope angle

To avoid pore pressure buildup between the geosynthetics a free-draining layer must be installed on any slope steeper than 5.5 degrees (1:18).

Total Serviceability Factor Compacted sandy clay at 1.8E-4 cm/s permeability

The long-term capacity of the geocomposite drainage layer is likely less than the capacity of the laboratory test results. This reduction is expressed through the Total Serviceability Factor.

$TSF = RF_{IN} * RF_{CR} * RF_{CC} * RF_{BC} * FS$, where

RFIN =	1.1	geotextile intrusion reduction factor
RFCR =	1.25	creep reduction in geonet core thickness reduction factor
RFCC =	1.1	chemical clogging reduction factor
RFBC =	1.35	biological clogging reduction factor
FS =	1.5	factor of safety
TSF =	**3.06**	Total Serviceability Factor

Minimum Required Transmissivity

The minimum required transmissivity is based on the longest and flattest slope with a gradient steeper than 5.5 degrees.

The longest and flattest slope is 245 feet long at 30 degrees.

$t_{down\ max} = TSF * q_h * L / k_{down} * \sin(\beta_{down})$ and $T = t_{down\ max} * k_{down}$

$t_{downmax}$ =	Unknown	m	thickness of geonet core in geocomposite
k_{down} =	Unknown	m/s	hydraulic conductivity of drainage layer

Since $t_{down\ max}$ and k_{down} are both unknowns, combine the two equations to form the one equation

$T = TSF * q_h * L / \sin(\beta_{down})$, where

TSF =	3.06		Total Serviceability Factor		
q_h =	1.8E-06	m/s	impingement rate, permeability of soil	0.00018	cm/s
L =	75	m	length of drainage layer	245	feet
β =	18.4	degrees	slope angle of drainage layer		
T =	**0.001304**	**m^2/s**	minimum required transmissivity of drainage layer		

Repository Bottom Cover Soils Compacted sandy clay at 1.2E-5 cm/s permeability

Maximum Critical Slope Angle

The slope angle at which the cover system will remain stable against a veneer sliding failure even under non-freely-draining subsurface conditions (i.e., without the buildup of seepage forces). Additional subsurface drainage is not required for veneer stability of slopes less than the critical slope angle.

$FS_{CS} = 0.5 * (\tan \delta / \tan \beta)$

FS_{CS} =	1.5		factor of safety for critical slope angle
δ =	16.2	degrees	interface friction angle
β =	**5.5**	**degrees**	critical slope angle

To avoid pore pressure buildup between the geosynthetics a free-draining layer must be installed on any slope steeper than 5.5 degrees (1:18).

Total Serviceability Factor

The long-term capacity of the geocomposite drainage layer is likely less than the capacity of the laboratory test results. This reduction is expressed through the Total Serviceability Factor.

$TSF = RF_{IN} * RF_{CR} * RF_{CC} * RF_{BC} * FS$, where

RFIN =	1.1	geotextile intrusion reduction factor
RFCR =	1.25	creep reduction in geonet core thickness reduction factor
RFCC =	1.1	chemical clogging reduction factor
RFBC =	1.35	biological clogging reduction factor
FS =	1.5	factor of safety
TSF =	**3.06**	Total Serviceability Factor

Minimum Required Transmissivity

The minimum required transmissivity is based on the longest and flattest slope with a gradient steeper than 5.5 degrees.

The longest and flattest slope is 245 feet long at 30 degrees.

$t_{down\ max} = TSF * q_h * L / k_{down} * \sin(\beta_{down})$ and $T = t_{down\ max} * k_{down}$

$t_{downmax}$ =	Unknown	m	thickness of geonet core in geocomposite
k_{down} =	Unknown	m/s	hydraulic conductivity of drainage layer

Since $t_{down\ max}$ and k_{down} are both unknowns, combine the two equations to form the one equation

$T = TSF * q_h * L / \sin(\beta_{down})$, where

TSF =	3.06		Total Serviceability Factor		
q_h =	1.2E-07	m/s	impingement rate, permeability of soil	0.000012	cm/s
L =	75	m	length of drainage layer	245	feet
β =	18.4	degrees	slope angle of drainage layer		
T =	**8.7E-05**	**m^2/s**	minimum required transmissivity of drainage layer		

G Topographic Mapping Comparisons

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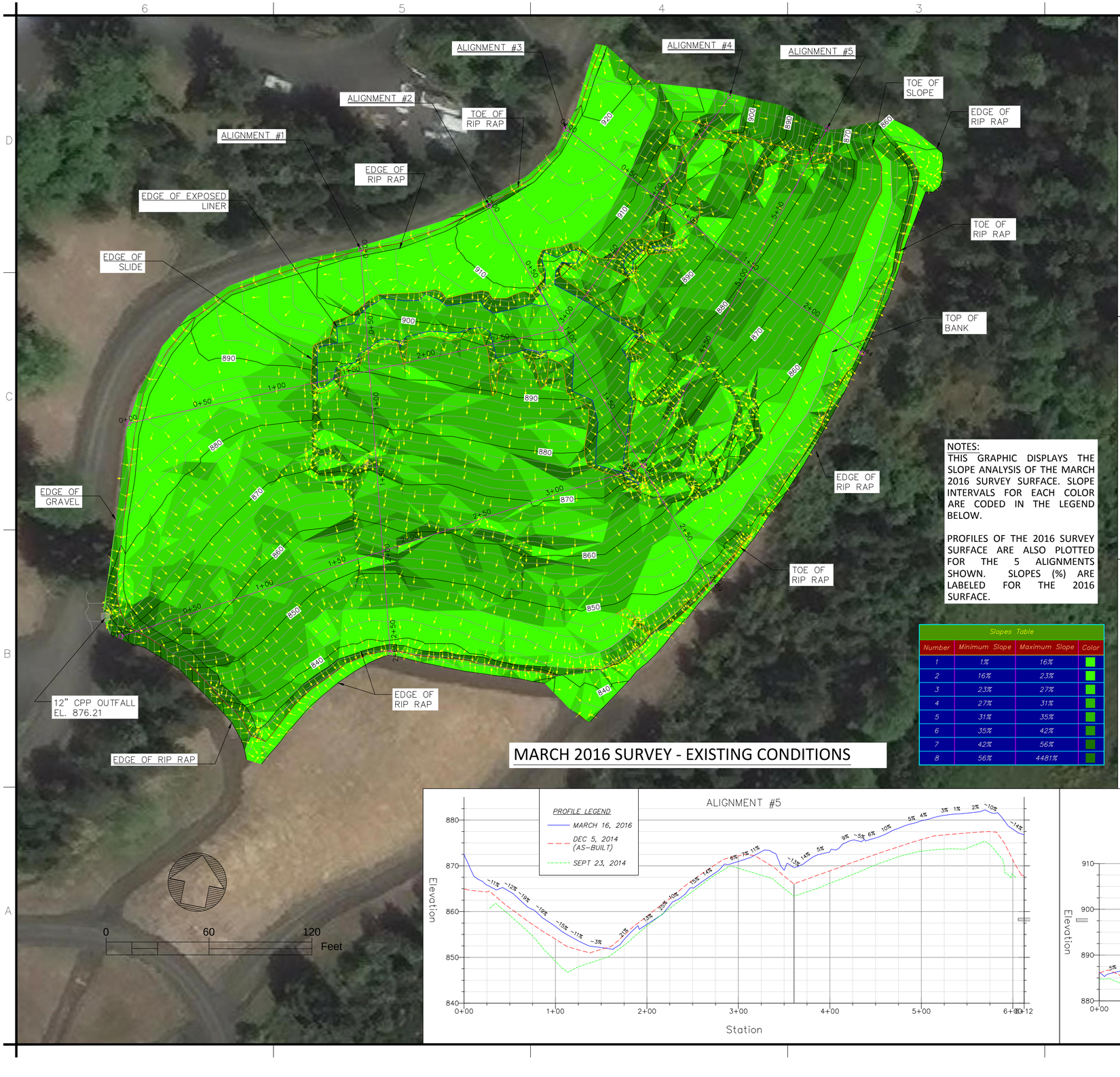
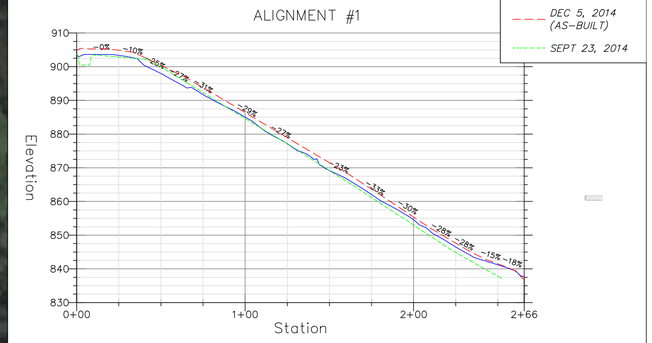


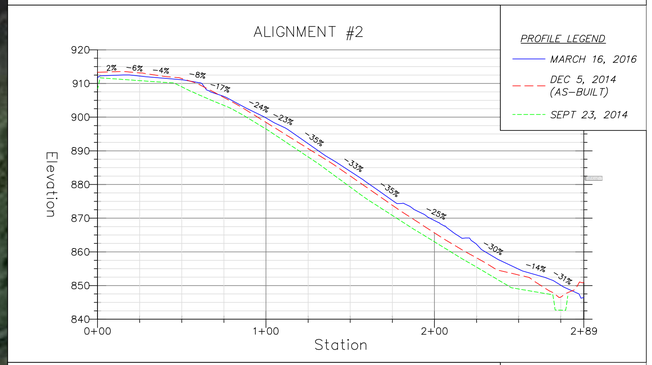
MARCH 2016 SURVEY - EXISTING CONDITIONS

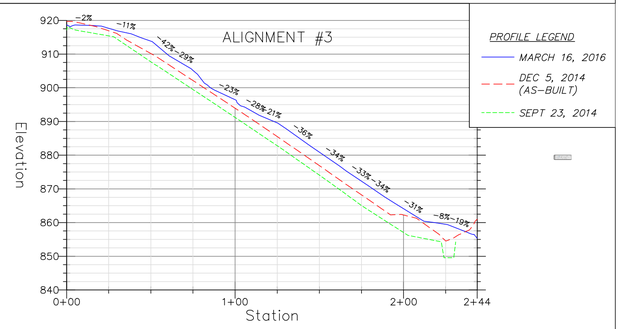
NOTES:
THIS GRAPHIC DISPLAYS THE SLOPE ANALYSIS OF THE MARCH 2016 SURVEY SURFACE. SLOPE INTERVALS FOR EACH COLOR ARE CODED IN THE LEGEND BELOW.

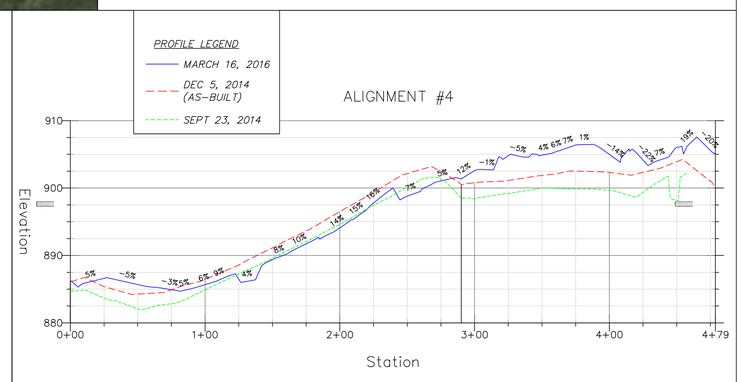
PROFILES OF THE 2016 SURVEY SURFACE ARE ALSO PLOTTED FOR THE 5 ALIGNMENTS SHOWN. SLOPES (%) ARE LABELED FOR THE 2016 SURFACE.

Slopes Table			
Number	Minimum Slope	Maximum Slope	Color
1	1%	16%	
2	16%	23%	
3	23%	27%	
4	27%	31%	
5	31%	35%	
6	35%	42%	
7	42%	56%	
8	56%	4481%	









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Drawn by: TJC
Reviewed by: T. CAMPBELL, P.E.
Approved by: T. CAMPBELL, P.E., Watershed Ecologist/Section Manager
Date: 6/23/2016
Spec No: TDD No. 14-06-0006
PAN No. 100453.0004.0644.02
File name:
Plot date:
Dwg scale: AS SHOWN

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Global Environmental Specialists
720 Third Avenue, Suite 1700
Seattle, Washington 98104
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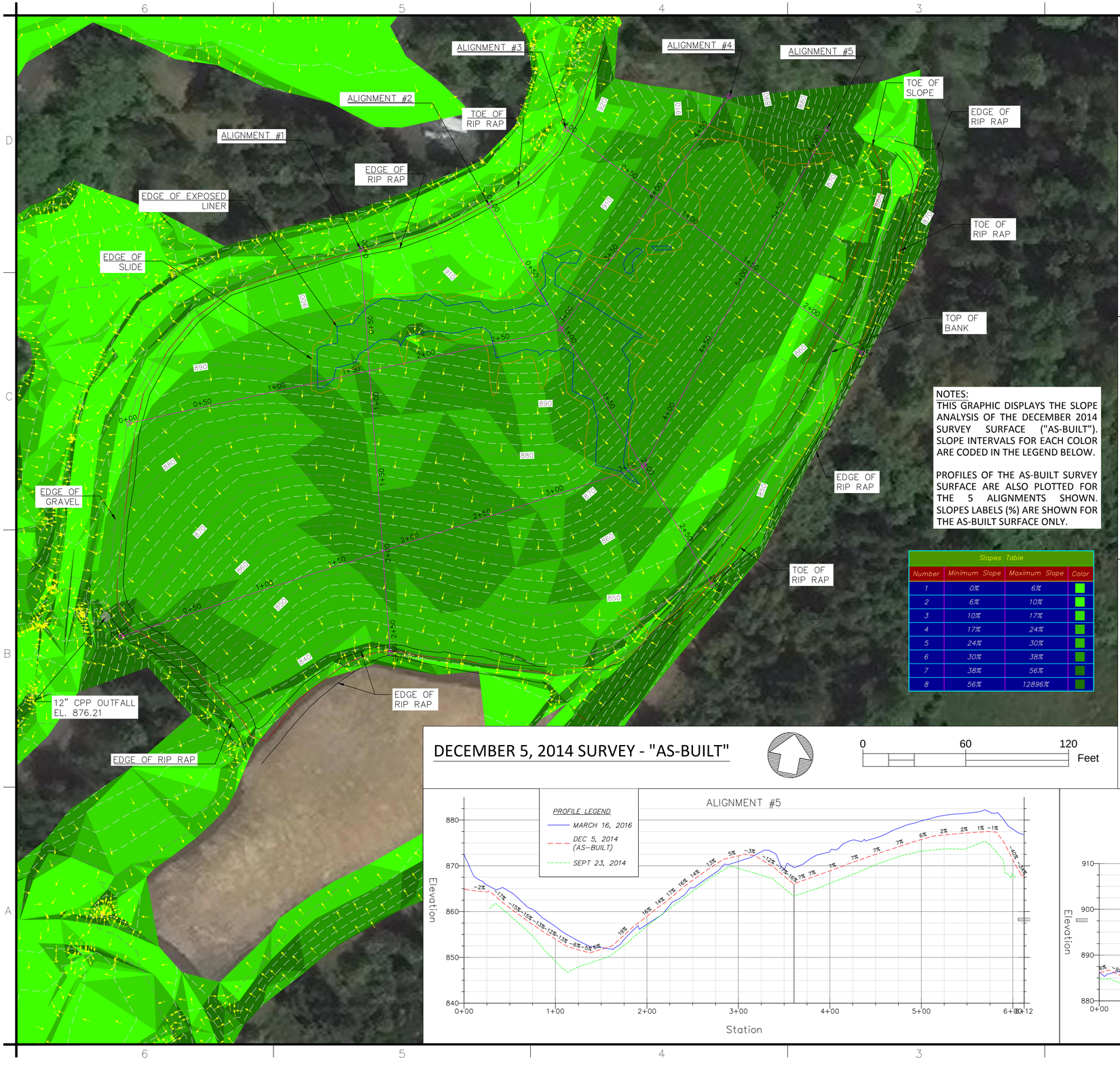
DOUGLAS COUNTY OREGON
BONANZA MINE SITE
NONPAREIL, OREGON

REPOSITORY COVER EVALUATION
MARCH 2016 SLOPE ANALYSIS

Sheet reference number:
C-3
SHEET 3 OF 4



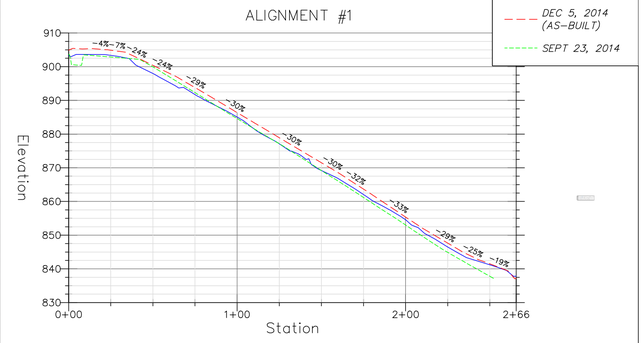
NOTES:
THIS GRAPHIC DISPLAYS THE SLOPE ANALYSIS OF THE DECEMBER 2014 SURVEY SURFACE ("AS-BUILT"). SLOPE INTERVALS FOR EACH COLOR ARE CODED IN THE LEGEND BELOW.

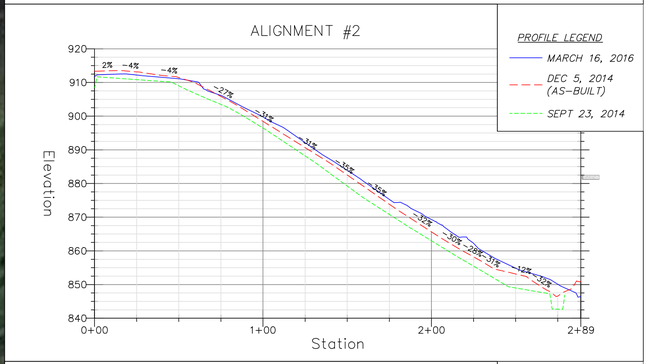
PROFILES OF THE AS-BUILT SURVEY SURFACE ARE ALSO PLOTTED FOR THE 5 ALIGNMENTS SHOWN. SLOPES LABELS (%) ARE SHOWN FOR THE AS-BUILT SURFACE ONLY.

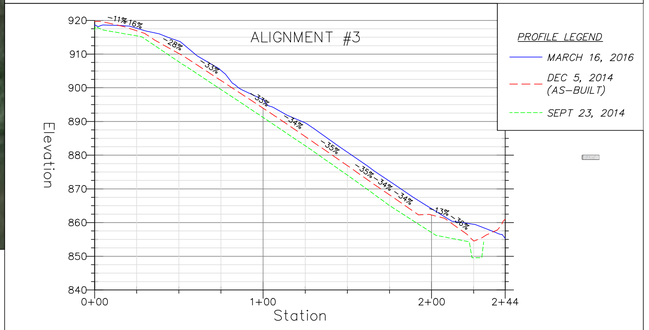
Slopes Table			
Number	Minimum Slope	Maximum Slope	Color
1	0%	6%	
2	6%	10%	
3	10%	17%	
4	17%	24%	
5	24%	30%	
6	30%	38%	
7	38%	56%	
8	56%	12896%	

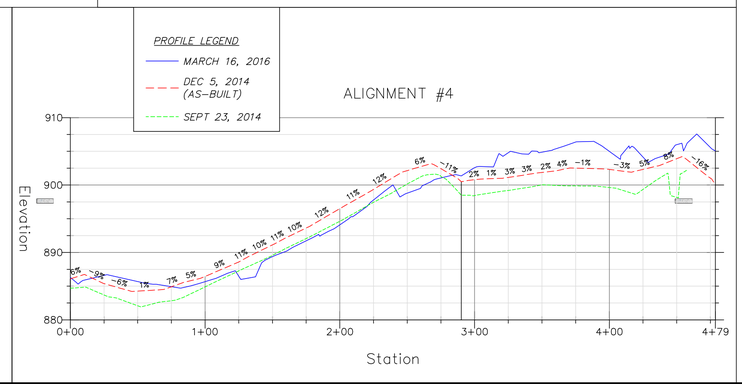
DECEMBER 5, 2014 SURVEY - "AS-BUILT"

0 60 120 Feet









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Approved by: T. CAMPBELL, P.E. Authorized for Publication
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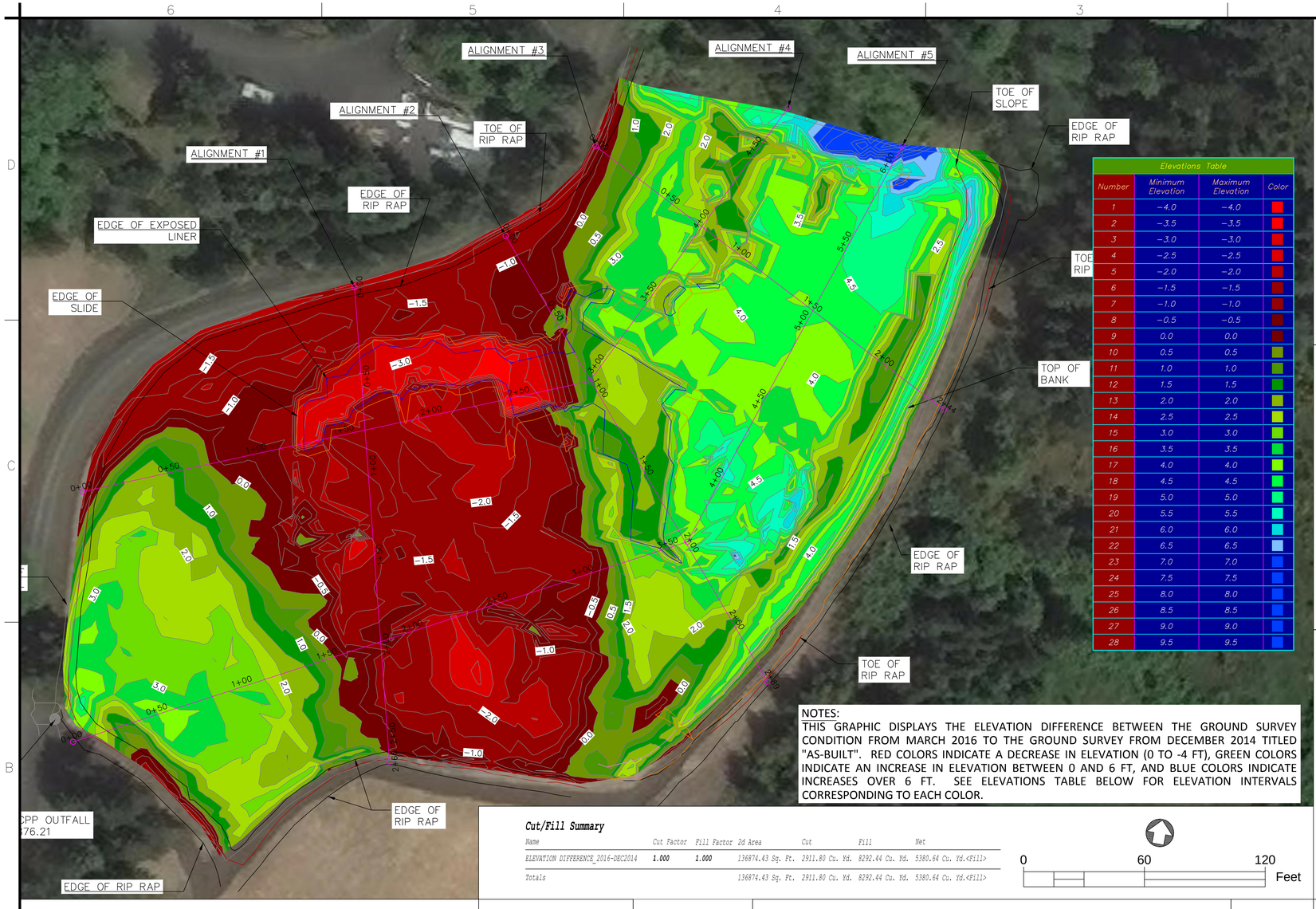
DOUGLAS COUNTY OREGON
BONANZA MINE SITE
NONPAREIL, OREGON

REPOSITORY COVER EVALUATION
DEC 2014 SLOPES ANALYSIS

Sheet reference number:
C-4
SHEET 4 OF 4



Elevations Table			
Number	Minimum Elevation	Maximum Elevation	Color
1	−4.0	−4.0	
2	−3.5	−3.5	
3	−3.0	−3.0	
4	−2.5	−2.5	
5	−2.0	−2.0	
6	−1.5	−1.5	
7	−1.0	−1.0	
8	−0.5	−0.5	
9	0.0	0.0	
10	0.5	0.5	
11	1.0	1.0	
12	1.5	1.5	
13	2.0	2.0	
14	2.5	2.5	
15	3.0	3.0	
16	3.5	3.5	
17	4.0	4.0	
18	4.5	4.5	
19	5.0	5.0	
20	5.5	5.5	
21	6.0	6.0	
22	6.5	6.5	
23	7.0	7.0	
24	7.5	7.5	
25	8.0	8.0	
26	8.5	8.5	
27	9.0	9.0	
28	9.5	9.5	

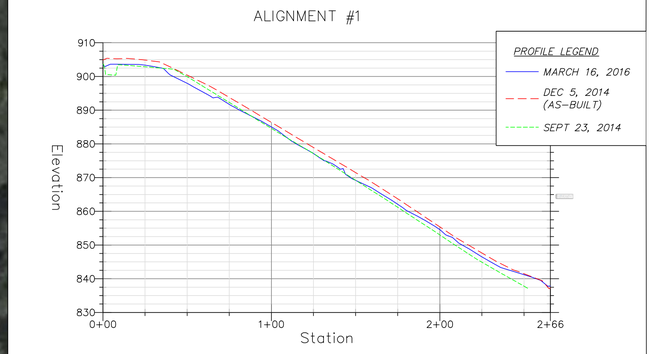
NOTES:
THIS GRAPHIC DISPLAYS THE ELEVATION DIFFERENCE BETWEEN THE GROUND SURVEY CONDITION FROM MARCH 2016 TO THE GROUND SURVEY FROM DECEMBER 2014 TITLED "AS-BUILT". RED COLORS INDICATE A DECREASE IN ELEVATION (0 TO -4 FT), GREEN COLORS INDICATE AN INCREASE IN ELEVATION BETWEEN 0 AND 6 FT, AND BLUE COLORS INDICATE INCREASES OVER 6 FT. SEE ELEVATIONS TABLE BELOW FOR ELEVATION INTERVALS CORRESPONDING TO EACH COLOR.

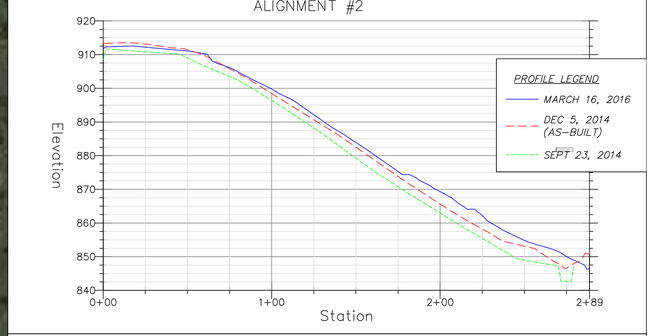
Cut/Fill Summary

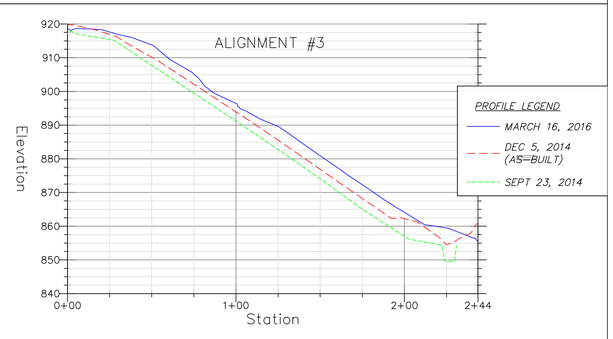
Name	Cut Factor	Fill Factor	2d Area	Cut	Fill	Net
ELEVATION DIFFERENCE_2016-DEC2014	1.000	1.000	136874.43 Sq. Ft.	2911.80 Cu. Yd.	8292.44 Cu. Yd.	5380.64 Cu. Yd.<Fill>
Totals			136874.43 Sq. Ft.	2911.80 Cu. Yd.	8292.44 Cu. Yd.	5380.64 Cu. Yd.<Fill>

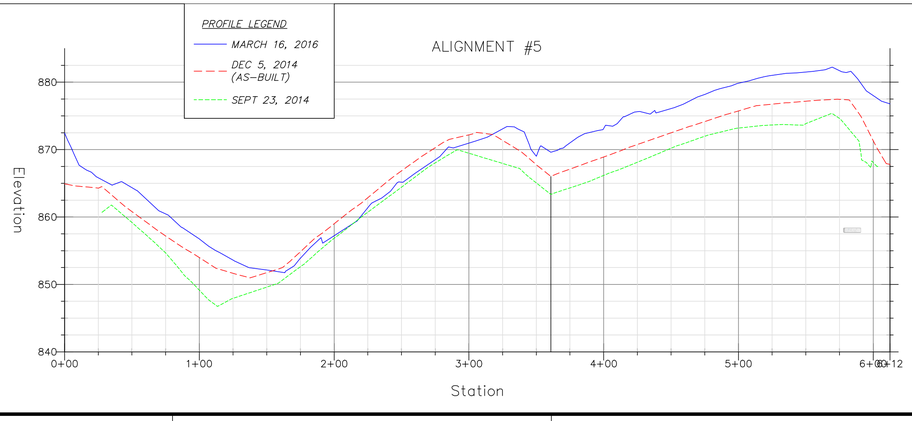
0 60 120 Feet

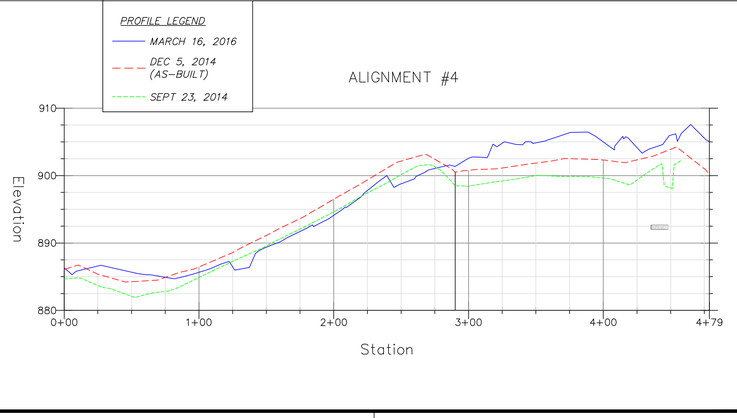
PHOTOGRAPH OF REPOSITORY COVER NEAR COMPLETION, NOVEMBER 5, 2014.











UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

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Approved by: CAMPBELL, P.E.
Date: 4/18/2016
Spec No:
TDD No. 19-05-0008
PAN No. 1004530.0004.0642.02
File name:
Plot date:
Dwg scale: AS SHOWN
Revisions or addendum no.

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DOUGLAS COUNTY OREGON
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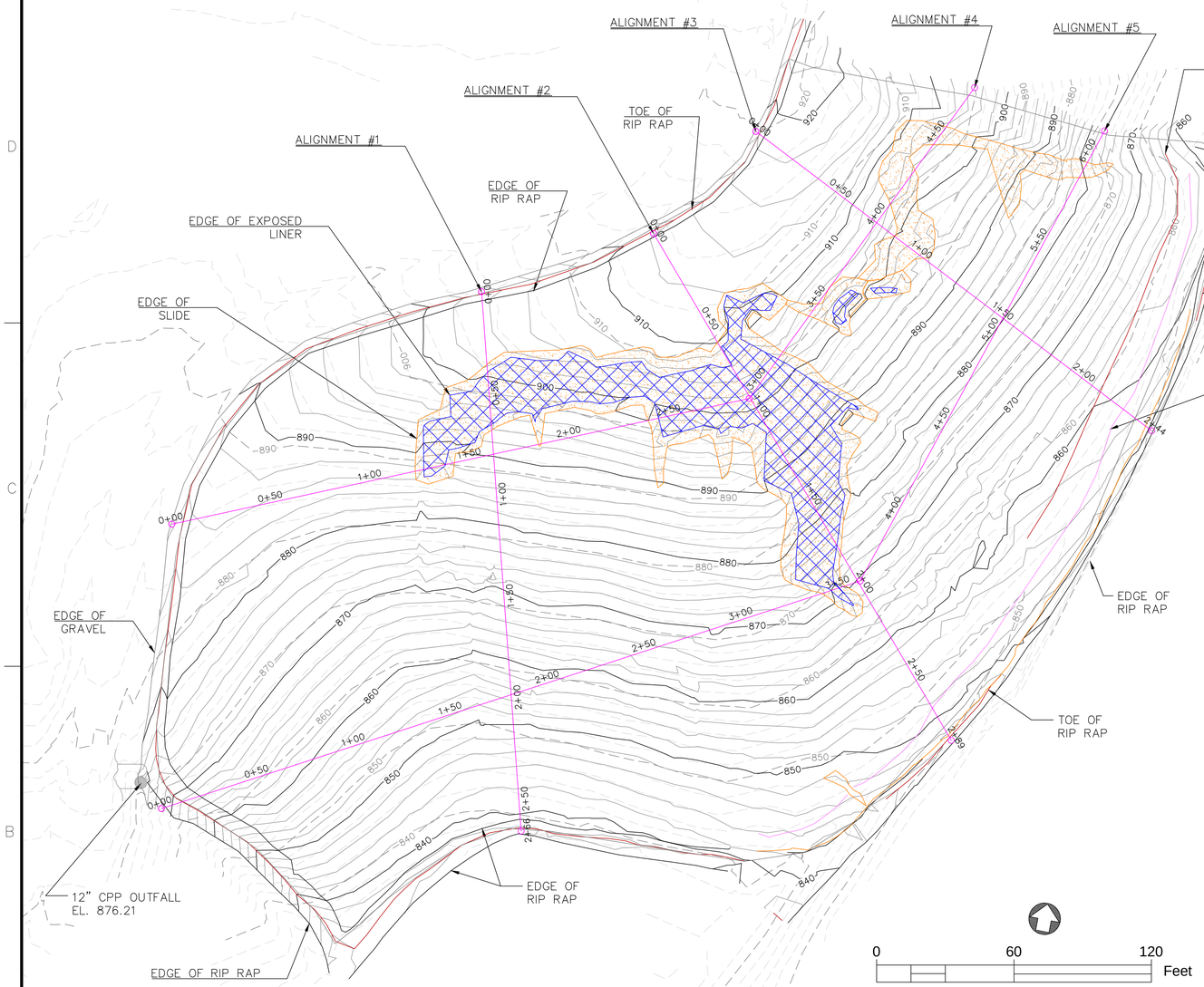
REPOSITORY COVER EVALUATION CHANGE IN ELEVATION

Sheet reference number:
C-2
SHEET 2 OF 4

File: R:\ACTIVE\4 Short #\Bonanza 2016\CAD\SURFACE_COMPARISONS_D.dwg ID: CampbellTC Date: 30-Jun-16 6:46:23pm

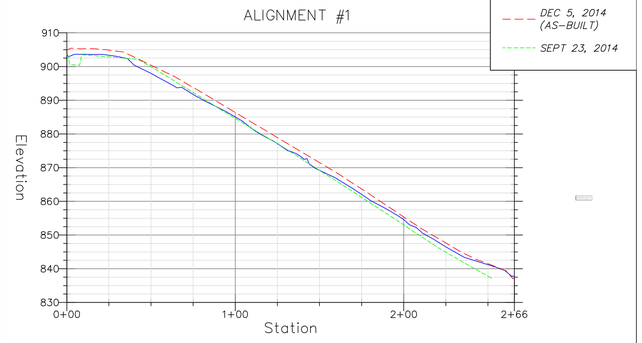


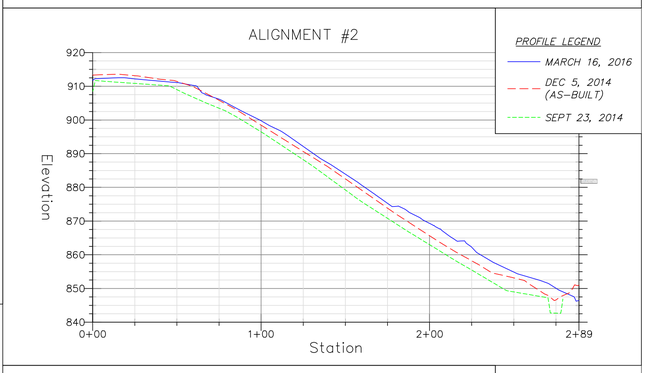
NOTES:

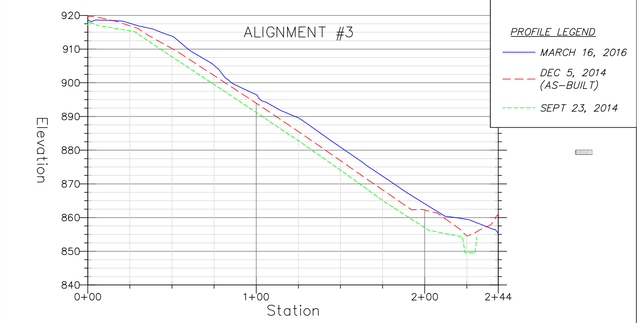
THIS GRAPHIC DISPLAYS THE MARCH 2016 SURVEY SURFACE OVERLAYING THE "AS-BUILT" SURVEY SURFACE FROM DECEMBER 2014. PROFILES ARE PLOTTED FOR THE 5 ALIGNMENTS SHOWN, ALONG WITH SURFACES FROM SURVEY DATA COLLECTED IN SEPTEMBER AND NOVEMBER 2014 DURING REPOSITORY CONSTRUCTION.

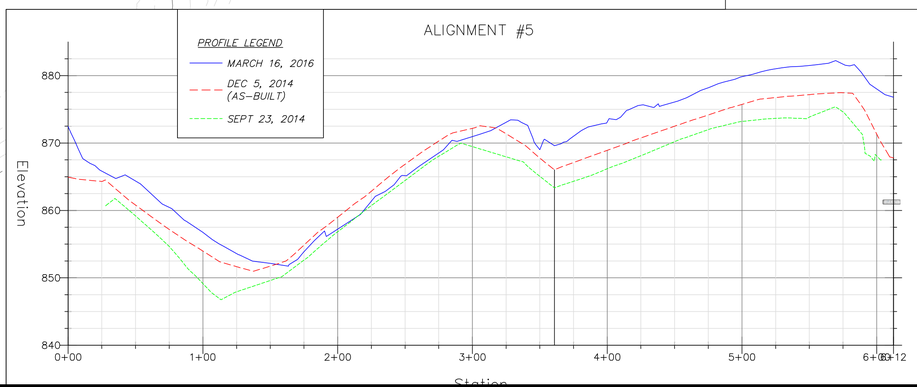
TOPOGRAPHIC LEGEND

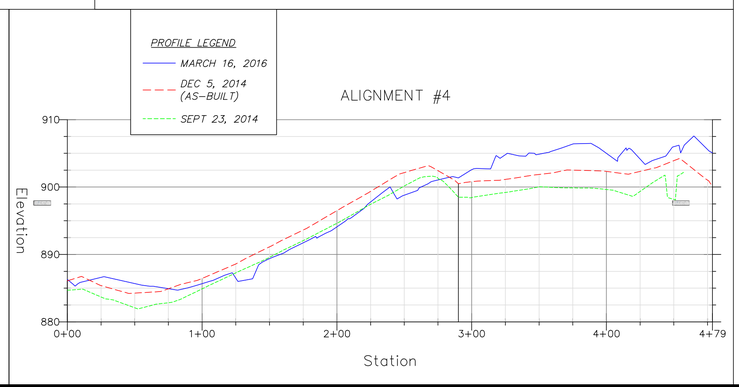
- 870 — *EXISTING MAJOR CONTOUR MARCH 2016*
- *EXISTING MINOR CONTOUR MARCH 2016*
- 870 - *MAJOR CONTOUR DEC 2014*
- *MINOR CONTOUR DEC 2014*
- *EXPOSED LINER MARCH 2016*
- *SLIDE AREA MARCH 2016*











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Symbol	Description	Date	Approved

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Approved by: T. CAMPBELL, P.E.
Date: 6/23/2016
Spec No: TDD No. 14-06-0006
PAN No. 1004530.0004.0642.02
File name: Plot date: Day screen: AS SHOWN
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OREGON
DOUGLAS COUNTY
BONANZA MINE SITE
NONPAREIL, OREGON

REPOSITORY COVER EVALUATION TOPOGRAPHIC COMPARISON

Sheet reference number:
C-1
SHEET 1 OF 4

File: K:\ACTIVE\4 Start 4\Bonanza 2016\CAD\SURFACE_COMPARISONS_D.dwg ID: CampbellTC Date: 30-Jun-16 6:52:15pm

H

Underground Workings Information

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CP 42
CP 13
CP 62
CP 41
CP 12
CP 40
CP 92
CP 61
CP 91
CP 95
CP 470
CP 60
CP 90
CP 85
CP 200
CP 201
CP 2
CP 50
CP 3
CP 471
CP 4
CP 472
CP 80
CP 70
CP 30
CP 1
CP 20
CP 474
CP 475
CP 426
CP 5
CP 6

TOPO LIMITS
DRAINAGE DITCH (TYP.)
18" CMP 920.98'
18" SMOOTH 923.58'
GRAVEL (TYP.)
CAVED
UNMAPPED
BUILDING 7
BUILDING 6
SANITARY
RIM 833.93'
RIM 833.40'
18" CPP 826.94'
24" CPP 827.[illegible]
15" CPP
16" CPP 826.27'
ASPHALT (TYP.)
XCOM
HDX
NEW WORKING IDENTIFIED IN BAK0255

(1008.80') 1008.68'
(S 30°30'55" W)
S 32°25'55" W
(1220.[illegible]
1220.[illegible]

GRAPHIC SCALE
40 0 20 40 80
(IN FEET)
1 inch = 40 ft.

630 LEVEL (ELEV 676')
700 LEVEL (ELEV 724')
500 LEVEL (ELEV
(ELEV 900')

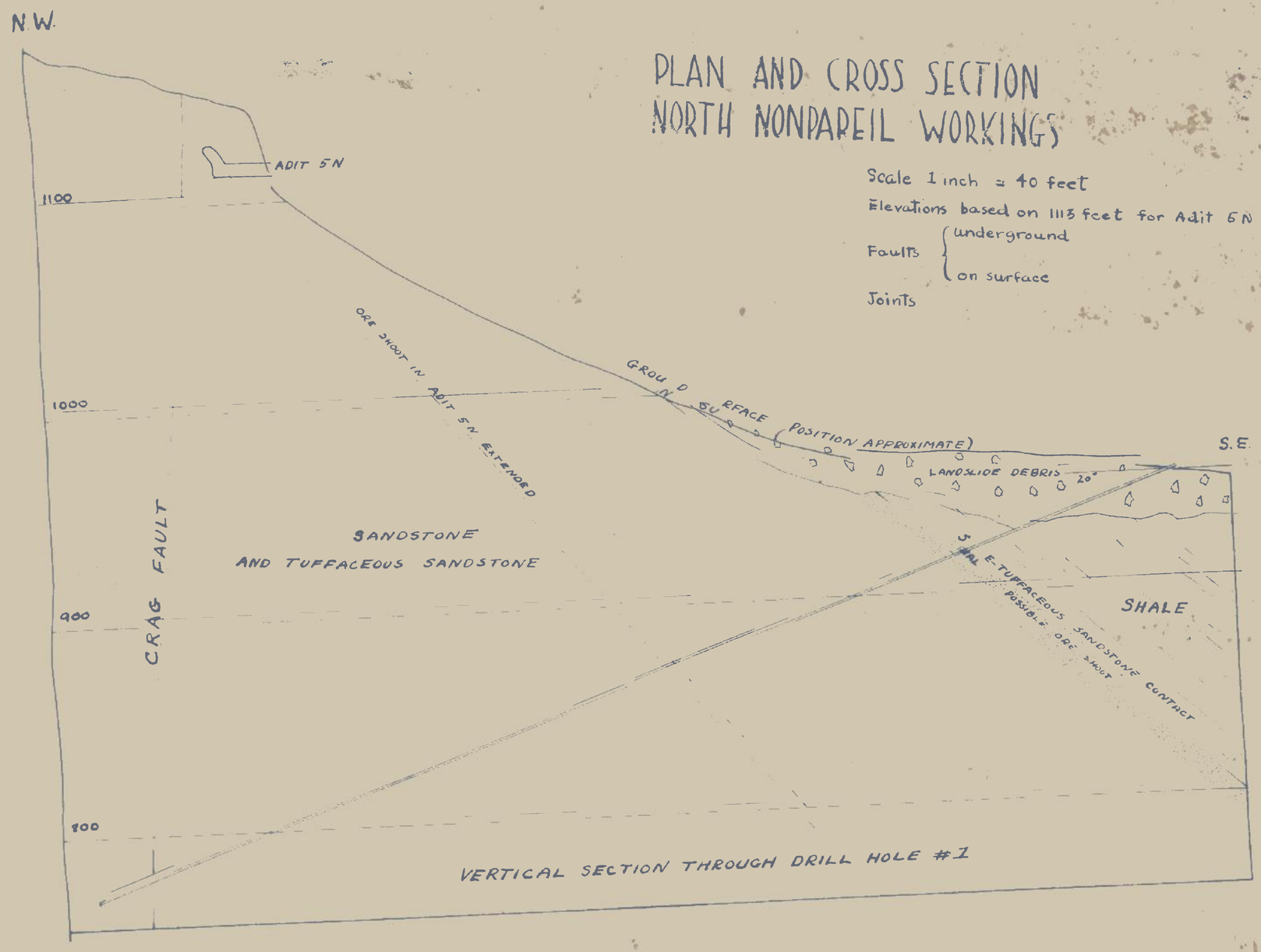
PLAN AND CROSS SECTION
NORTH NONPAREIL WORKINGS

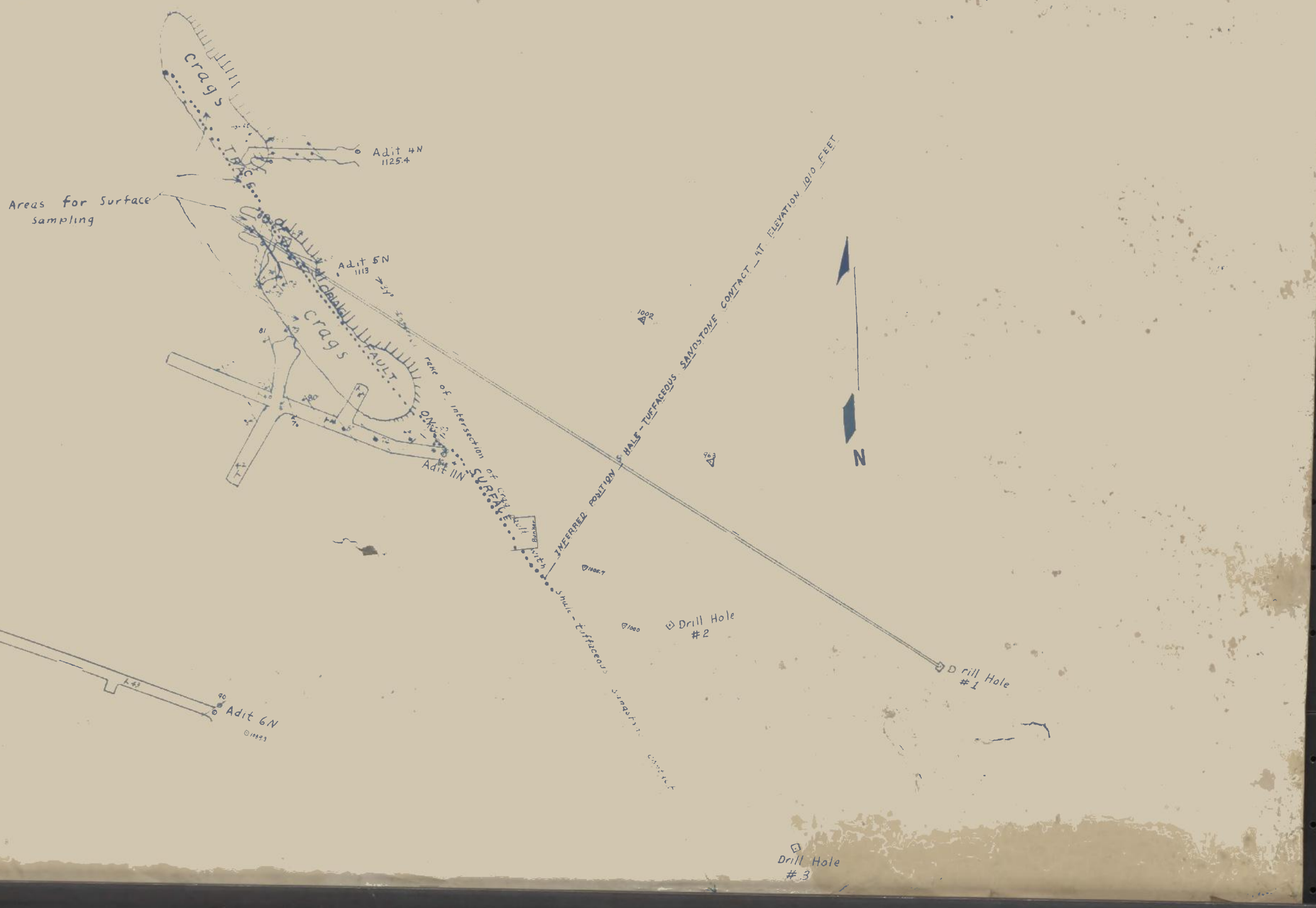
Scale 1 inch = 40 feet

Elevations based on 1113 feet for Adit 5N

Faults { underground / on surface

Joints





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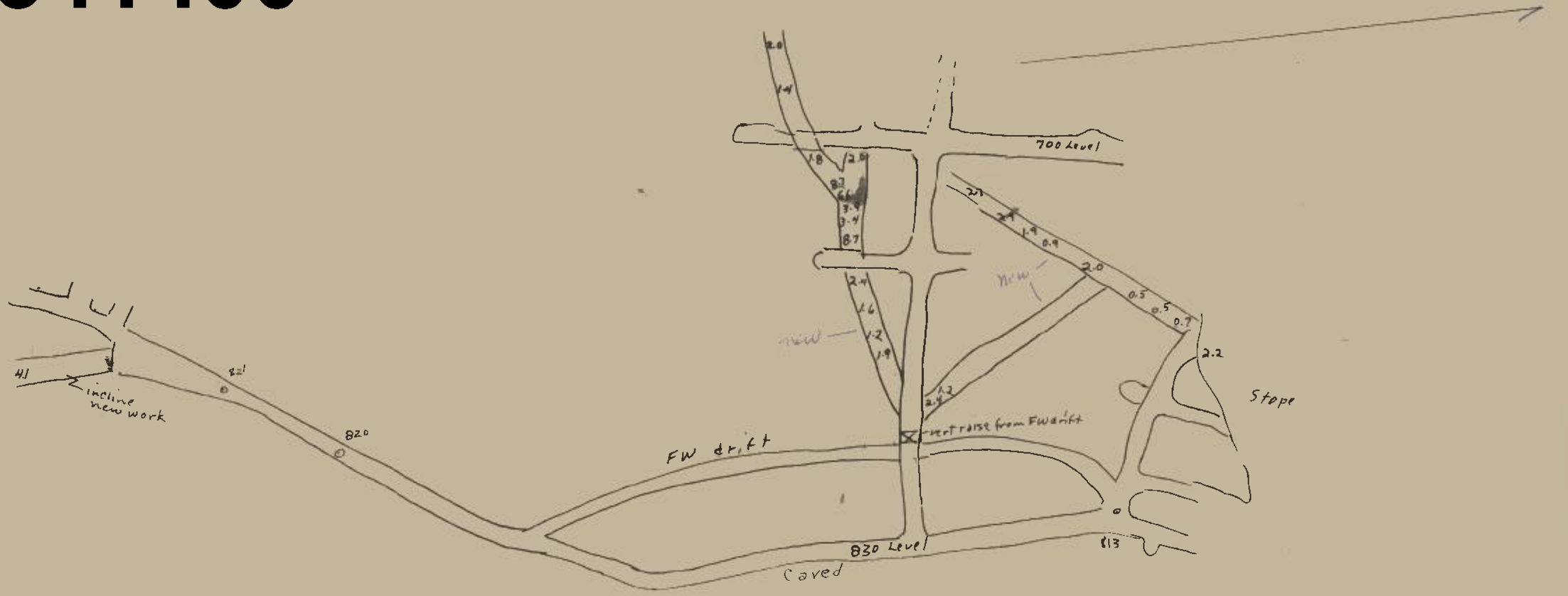
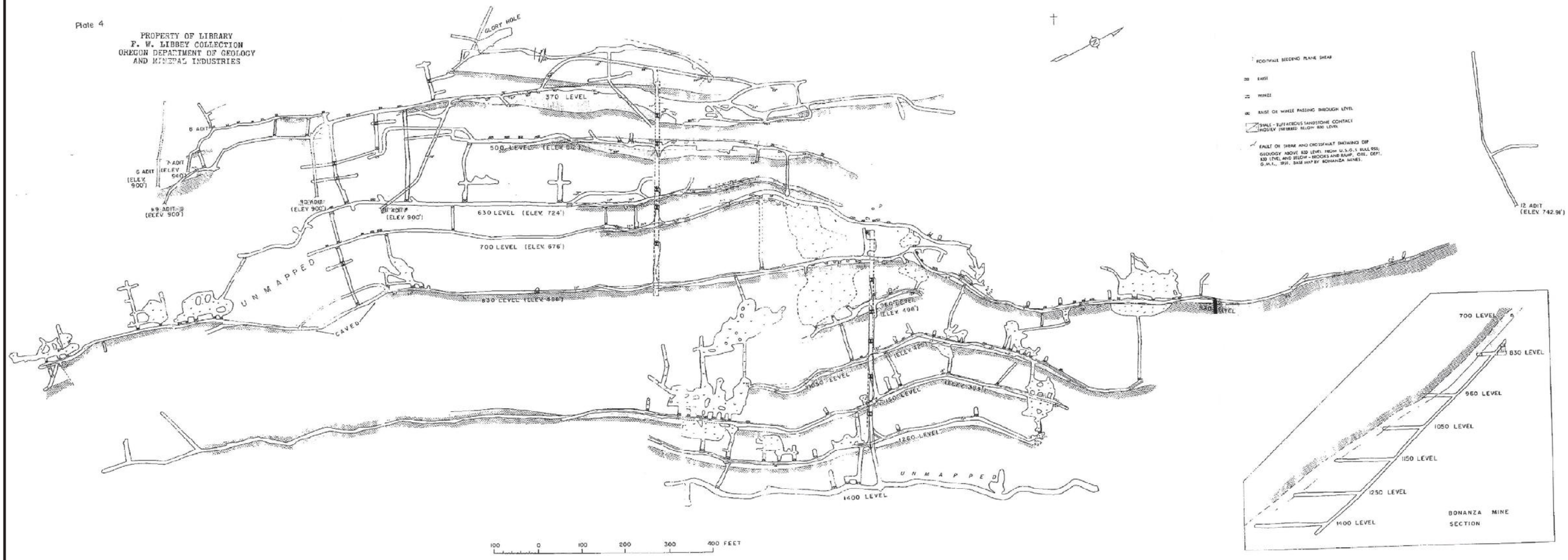


BAK0255

Source: Hart Crowser 2005.

Plate 4



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BONANZA MINE SITE
Sutherlin, Oregon

Figure 2-6
GEOLOGIC MAP OF BONANZA MINE

Date:	Drawn by:	
7/8/15	AES	10:START-IV\\14030011\fig 2-6